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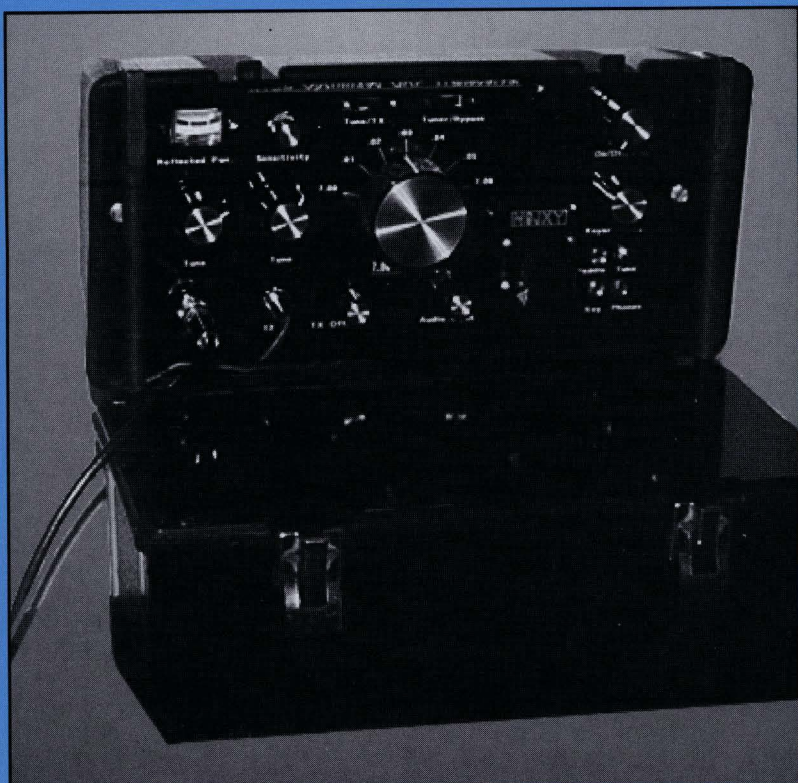
QRP Quarterly

Journal of the QRP Amateur Radio Club, International

April 1998 Volume XXXVI Number 2

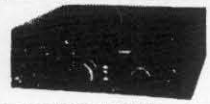


The cover photo contest winner this issue is Denny Payton, N9JXY. The lunch box rig is completely self contained and doesn't have any screws showing on the outside! But inside there is Roy Lewallen's Optimized Transceiver with added audio amplification, antenna tuner, SWR bridge, iambic keyer, homebrew paddle assembly and a battery. There is also storage between the battery and the rig for log books and other small items.

You too can win a one year membership or renewal to the QRP ARCI. Just send your entry photo for the cover picture contest to the editor at the address on the back cover.

The QRP ARCI is a non-profit organization dedicated to increasing world-wide enjoyment of QRP operation and experimentation, and to the formation and promotion of local and regional QRP Clubs throughout the world.

YAESU HF



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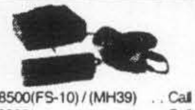

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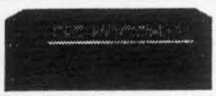

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.875"	.058"	.759"	$.90/ft.
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1.125"	.058"	1.009"	$1.15/ft.
1.250"	.058"	1.134"	$1.30/ft.
1.375"	.058"	1.259"	$1.45/ft.
1.500"	.058"	1.384"	$1.70/ft.
1.625"	.058"	1.509"	$1.95/ft.
1.750"	.058"	1.634"	$2.10/ft.
1.875"	.058"	1.759"	$2.25/ft.
2.000"	.058"	1.884"	$2.45/ft.
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2.000"	.120"	1.760"	$3.20/ft.
2.000"	.250	1.500"	$5.50/ft.
2.500"	.120"	2.260"	$3.75/ft.
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Table of contents

IN THIS EDITION OF THE IDEA EXCHANGE:

NOTICE

Please take the time to fill out the Reader's Survey on page 58 and let us know what you think. Thanks, Ron, KU7Y

NOTES FROM THE PRESIDENT

Mike Czuhajewski, WA8MCQ

DAYTON COMING SOON

It's almost that time again! For years, the Dayton Hamvention has been the de facto annual gathering of QRPers from across the country. (Judging from the reports from Pacificon in 1997, QRP Dayton may be getting a little West Coast competition in the future, though! The NorCal folks put on quite a QRP show there in 1997.) Dayton is a huge hamfest with lots of vendors and tailgating, and many folks enjoy that part of it but it's also a great way to meet QRPers from around the world, and share in the QRP camaraderie. Wander the grounds of the Hara Arena during the day, with occasional stops by the booths of the various QRP clubs and QRP vendors, and then on to the "QRP Hotel" for the night's events. And this year, like the last two, there will be an all day QRP seminar at the QRP Hotel with a variety of speakers, on the day before the Hamvention opens.

We have a number of volunteers handling various aspects of Dayton. Scott Rosenfeld, NF3I, is running the QRP banquet this year, giving Pete Meier a well deserved rest. Hank Kohl, K8DD, has taken over the rooms reservations at the QRP Hotel from Myron Koyle, N8DHT, who did it for what seems like forever. Myrons handling of the rooms for so many years has been a significant contribution to the success of "QRP Dayton" for quite some time. Signup for the QRP seminar is being done by Cam Bailey, KT3A. Jim Stafford, W4QU, is acting as Dayton Czar, overseeing the arrangements for everything (with the assistance and kibitzing from a couple of dozen people in the Inner Circle of the club!).

ROOMS: This one is always a problem; getting a room anywhere in or near Dayton during the Hamvention period is always difficult if you wait too long. Historically, the QRPers have always had a block of about 70 rooms reserved at the QRP Hotel (this year we have 80 and may be able to get more next year). For years we stayed at an 11 story hotel in downtown Dayton, and we always had some really great antennas strung from the hospitality suite near the top floor! Sadly, that shut down a while back and we've been at the Days Inn South for several years, near the Dayton Mall. It's only two stories, but that doesn't stop an antenna farm from being erected!

Reservations should always be made early, and the block of QRP rooms has all been spoken for, but don't panic just yet. As this is written in February, there has already been a waiting list for a while, but don't lose heart; people often turn their reservations back in, allowing someone else to get them, and there are often people willing to let someone else share their rooms. (We've been asked why we handle the list ourselves instead of having everyone deal directly with the hotel using their toll free number. One reason is that the hotel does NOT maintain waiting lists. If they have a cancellation, the next caller asking for a QRP room would get one, and we don't think that's fair to those who have been on the waiting list for weeks.)

Some of the Maryland Milliwatts have been staying across I-75 at the Motel 6 for a couple of years, in rooms reserved by Scott, NF3I. He does it right--as soon as he arrives in Dayton, he immediately reserves his usual 4 rooms for the next year! And at the QRP Hotel there is usually a signup sheet for those wanting to book a room for the following year. That is never filled up on the spot, but they do go quickly over the months. This year we're taking advantage of e-mail and the Internet. If you'd like to get on the waiting list for a room, you can send e-mail (or drop a letter) to Hank, K8DD, whose addresses appear on the rear page. You can also check the QRP ARCI web page to see what the list looks like at the moment. If you don't already have a reservation, the situation is far from hopeless and there's a good chance you can be accommodated somehow.

If you're planning on going to Dayton, please contact the appropriate people well ahead of time to get signed up and pay for each item; don't wait until the last minute! Expecting to get "tickets at the door" is risky at best, going by past experience, and it's always best to sign up early. Contact K8DD for a room at the QRP Hotel, KT3A for the QRP symposium the day before Dayton officially starts, W4DU for general questions, and NF3I for the QRP banquet. All of their street and e-mail addresses can be found on the rear page, except for NF3I:

Scott Rosenfeld, NF3I
QRP ARCI Banquet Tickets
4015 Sparrow House Lane
Burtonsville, MD 20866-1333

NEW QRP ARCI AWARDS PROGRAM COMING

For quite some time we've realized the need for some sort of program to recognize people who do good things for QRP. The QRP Hall of Fame was a start, but we also need something along the lines of an annual awards program. We're finally getting it off the ground, and it's being handled by Steve Pituch, W2MY (formerly N2MNN). Look for details elsewhere in this issue.

COMMONALITY BETWEEN QRP ARCI, NORCAL, QRP-L

One thing I've long wondered about is how many people belong to more than one of the three major QRP entities in the US. (I didn't say "club" since the Internet QRP forum, QRP-L, doesn't exactly fit the traditional definition of the term.) One concern I've had for some time is the fact that my Idea Exchange column, as well as the rest of the QRP Quarterly, runs things from QRP-L as well as NorCal's QRPp, and QRPp uses a lot from QRP-L. This gives readers of the two journals a great deal of good information, but some will be seeing a portion of it for the second or even third time; the question is, how many? (This is also a problem with reprints from the GQRP Club's SPRAT.) Chuck Adams, K5FO, matched up the various subscriber lists on his computer and came up with these numbers, in December 1997:

Members of QRP ARCI also in NorCal: 687
Members of QRP ARCI also on QRP-L: 440
Members of NorCal also on QRP-L: 623

The bottom line is that while several hundred folks will be seeing some reprinted material for the second time, lots more will be seeing it for the first time. To those who will see it twice, I apologize, but good QRP info is always worth spreading around, and don't forget, not everyone subscribes to multiple QRP journals.

NEW SPECTRAL PURITY REQUIREMENTS COMING

There's little detail yet, but expect more to be heard on this topic. The February 1998 QST contained a report on the 1997 World Radiocommunications Conference (WRC-97) and near the end of page 33 is a section titled "Unwanted Emissions". The bottom line is that hams will have some new spectral purity requirements being imposed eventually. The current requirements for HF are that all spurious emissions (including harmonics) must be at least 40 dB below the carrier when running above 5 watts, or at least 30 dB if under 5 watts. They give the formula for the new spec as 43 + 10 log (PEP) or 50 dB, whichever is less stringent, at HF. (The VHF spec has an upper limit of 70 dB.) This represents a substantial increase.

Running a few QRP power levels through the formula, we find that 5 watts requires the full 50 dB; 4 watts is 49 dB, 2 watts is 46, and even one watt requires 43 dB, all of which are significantly tighter specs than the 30 dB limit we currently have.

These limits can be achieved without unreasonable measures being taken, and things could have been much worse. The QST report mentioned that we could have been given even tougher specs. They said that an ITU task group had been working on this for several years, and both the ARRL and the Japan Amateur Radio League (JARL) were involved in the process. They say that "had we not been involved in these studies, we could have had to comply with unnecessarily stringent limits."

Here's some additional insight on the issue, from the AMATEUR RADIO NEWSLINE online text archives on their webpage on the Internet. (The ARN is a regular audio broadcast on topics relating to ham radio, heard regularly on the ham bands around the country.) This was part of Newsline report number 1067, for release on January 23, 1998.

ITU Almost Outlaws Home Brewing

"An amazing revelation. Ham radio came close to losing the right to put home brew equipment on the air. This, as a result of technocrats at last November's World Radiocommunications Conference in Geneva, Switzerland.

"Delegates in Geneva were asked to consider type approval for all equipment used in the Amateur Radio Service according to a story in Fred Maia's W5YI Report.

"But the quietly made pitch to working groups at the International Telecommunications Union meeting in Geneva was countered by the International Amateur Radio Union, since type acceptance would have made it illegal for hams to design and build their own transmitters -- something we've done throughout the history of the hobby.

"Other working groups meantime wanted to implement a uniform set of spurious emissions standards for all transmitters. That too, could have made it tough for hams, if they had to demonstrate homebrew compliance before regulatory bodies. Moreover, all current homebrew and store bought transmitters in ham radio would have been incompatible with the proposed worldwide emissions standards.

"None of the proposals ever made [it] out of working groups, avoiding a major fight on the assembly floor in Geneva. Protecting the rights of hams to repair and modify contemporary gear, and to build and restore vintage radios such as Classic AM rigs now popular on the short-wave ham bands.

"It cost the IARU delegation a lot of time and money to keep these measures from being brought before the conference in their original form which might have seen their approval by consensus."

(Via W5YI Report, Newsline)

http://www.arnewsline.org/newsline_archives/cbbs1067.txt

Expect to see coverage on this topic in QST and other ham magazines in the future.

QRP ARCI ON THE WORLDWIDE WEB

We've been on the web for a while, with Dave Johnson, WA4NID as the webmeister. Recently, due to a lot of hard work by Vice President Jim Stafford, W4QO, we now have our own, easy to remember URL: www.qrparci.org. It's linked back to the original page at rtpnet.org for now. Be sure to take a look at it every now and then. (And don't forget, you can hop to the list of Dayton room reservations from there.)

DON'T FORGET TO RENEW ON TIME

Be sure to check your address label for the expiration date, and be sure to renew EARLY if you want to continue receiving regular copies of the QRP Quarterly without missing one. (Yes, we know the information was not on the labels for the January issue. That's the first time we sent the information to the printer electronically and due to a misunderstanding the renewal info was not placed on the labels. It will appear there in the future.) The Membership Chairman has a well publicized cutoff date for renewals; please observe it, and get your renewals to him before that. Late renewals cause lots of extra work and may well result in you having to buy the copy you missed (including postage), if any extra copies are even available. And if anyone feels that they are being singled out since they didn't renew on time, that's not the case. This has been a chronic problem ever since I became active in the club again, 12 years ago! --qrp--

NOTES FROM THE VEEP

Jim Stafford, W4QO

As your VP, I seem to have a bunch of odd things in my bag of responsibilities. Thought I would mention a few of them to let you know that I am not sleeping all the time!

First, I had been working for some time to get the club their own domain name. After several false starts related to sites wanting more monthly revenue to host our domain than I was willing to pay, our Membership dude, WA4NID, came across Bob Applegate, K2UT, who runs Water Wheel Systems and was willing to host us at a very attractive rate! So we now have our own web domain name;

www.qrparci.org

We hope this is easier to remember than our previous home page address. We plan to move more of our pages to Water Wheel soon and spiff them up some in the process. WA4NID is still the webmaster but I will be assisting in the process.

Second, I spent quite a lot of time working on trying to iron out challenges associated with Dayton and QRP ARCI activities planned for this year. Hopefully the "full posting" of room reservations by Hank, K8DD, will be most helpful to all those seeking rooms. You should see the room list on our web site, and as the date gets closer, this should change frequently so keep an eye on the list if you are seeking a room. Just go to the web site and look for a button that says "Dayton Rooms".

Third, Mike wanted someone to be the clearinghouse for Dayton info and when no one else seemed to want to be that person, he appointed me the Dayton Intergroup Coordinator. This doesn't mean that I have all the answers but hopefully I know who does. If your group is planning some QRP activity for Dayton, please let me know so I can make sure we don't trample on each other and actually get the most fun out of this fantastic weekend.

Fourth, I am the vendor coordinator for the hospality suite at the Days Inn South. If you are a vendor and would like a table for the "Vendor Night" which is officially Friday night after the banquet, please let me know. Their is no charge to get a table for your use, but we would like to know who wants to be part of this ever popular event.

Just email me at w4qo@amsat.org or call me and leave a message at 1-800-484-6866 x3888.

See you at Dayton. Jim Stafford, W4QO

FROM THE EDITOR

Monte "Ron" Stark, KU7Y

Here we are, time for another issue of the Quarterly. Things have been almost calm here for a change. Nothing has broken or bent. All rigs and antennas are working just fine. I have seen winds up to almost 70 mph blowing on the antenna and it just sits there waiting for my command!

The other day I did try to move it in a high wind and even with this bigger rotor, there wasn't enough power at times! That must be what the vertical is for!

Conditions on the bands has been improving almost daily. From all the e-mail I have seen on QRP-L, there has been a LOT of good DX put into the deserving QRPers log books. Jim, KL7FS and I had a nice chat at 50 mW back in January. Had a 2xQRP contact with E21AOY. That was another fun one!

With 5 watts I managed to get into the following logs; P4, ZS6, 9V1, DS1, VP8, YS1, BV4, A35, RZ0, KH2, HR6, T88, 3W6, HC5, 9M0C, ZL7, EW35, ZK1, EM1, YS9 and etc. While those are fun, and remembering the bigger the pile up the more fun it is, I have been doing more and more with less than one watt. If you have any doubts of what Milliwatts will do, read on. 950 mW got me into the logs of; HL1CG, FO0/OK5DX, NH1 and HL0C. 200 mW got LU/UX1KA, in the Antartic. 100 mW got ZL1DK and a nice twenty minute chat was had with KH6AFS, Sam, with both of us running 50 mW.

But why will the ARRL not believe me when I say I was running QRP when I earned my DXCC?

And why would the anyone, let alone the ARRL, allow contacts made from the welfare office of ham radio (DX Nets) to even count for such a prestigious award?

One big help you can get is the DX news bulletins. I use the one called The Daily DX. It is done by Bernie, W3UR and more information can be found on his home page;

http://www.wdn.com/thedailydx

You can also contact him for more information via e-mail: bernie.mcclenny@mail.wdn.com

So no mater what you have for an antenna and no matter how much power you can get out of your rig, just get on the air. You might just be surprised at who you talk to!

The CW Sprint came and went. For those of us who tried it with QRP, most said "Wow"! This has got to be one of the most fun contests of all. Only 4 hours so it's not one of those things that just keeps on going and going and going. There is about 5 months left before the next one in September. Get your stations ready and join us in the fun. We managed to get two teams made up this time. Next time we hope to have at least one more. Rules are on the NCJ home page,

http://www.waterw.com/~ncj/

To sign or not to sign /QRP has been the topic of some lively discussion on the contest mailing list. Almost all contesters DO NOT want you to sign /QRP. Or /M or / anything unless it's needed to make the call legal or as a contest requirement. (Some contests require you to sign with the call area you are operating from. If you live in California and have a W4 call, you would need to send your call as W4xxx/6). And I agree with them. Sending /QRP just slows them down and gives them a greater chance for error in copying your call.

The discussion also included what to do when working DX stations. Here there was not a united mind set on the subject. Some feel that during busy times it's best not to do it. But that it's OK when the pile ups get thinner. And I can go along with that. We want to work the stations with QRP or QRPp. We are not trying to make things harder for them!

Then the discussion started heating up when it came to having the DX or contest station include the /QRP on the QSL card. Some say to just go ahead and put the other persons call on the card however they want it. Others seem to feel that somehow they are certifying that what you say is true! I don't feel that way and can't for the life of me understand why they do. I had been under the impression that the /QRP was needed by the ARRL for the WAS award. But it turns out that that isn't true. You just sign a statement saying you were QRP and that's all that is needed. So the issue of having a /QRP after your call on the QSL card is really a non issue for the ARRL. Same for the ARCI. And that just stands to reason. After all, we have NO control over what the other station wants to do!

Now for the one that kills me. And Doug Hendricks and just about every other QRPer that I know. The ARRL will believe me when I tell them that I was running QRP for my WAS award. They will also believe me when I tell them I was running QRP for my WAC award. They will also believe me when I tell them that I wasn't running more than the legal amount of power when I earned my DXCC. They will believe me when I say that I didn't violate any sub band rules.

But why will the ARRL not believe me when I say I was running QRP when I earned my DXCC?

If you should send them a letter or e-mail, (and I'd love it if you did!) keep in mind that for this super duper high class award, it's just fine to not have an Extra class license and still work the SSB DX nets that are in the extra class sub bands. That has been going on for years. And why would the anyone, let alone the ARRL, allow contacts made from the welfare office of ham radio (DX Nets) to even count for such a prestigious award?

There is a new foot of snow on the ground outside and the ARRL SSB DX test is in full bloom. George, K5TR (of TR Log fame) asked me to be sure and find my mic and work them at 6D2X. I also got a request from the NCJ editor and neighbor, Dennis, K7BV to listen for him at KP3P. After thinking about it long and hard, I finally thought what the heck, I'll do it! I found the mic, unpacked it and plugged it into the radio. Within ten minutes I heard George on 40m signing 6D2X. They were way over S9! So I worked him. Then in a few more minutes I found and worked Dennis! Man, this SSB stuff is easy, right? A few minutes later I found the other station of 6D2X on 75m and worked them.

So, before it ended, I had worked George and co. on 4 bands. I heard them on 160 just above the noise but they couldn't hear me. And I never did hear them on 10m. Worked a few other stations. Dan, KL7Y up in AK. I always work him in any contest I can! Couple of EU stations and ZD8Z. The last one was running 20 over S9 on 10m! So you heard it here first. I have finally made a SSB QSO with the new radio!

How about Doug Hendricks and NorCal breathing new life into the Tuna Tin II ? What a great way to remember Doug DeMaw!

Get your soldering irons ready. There is some great building in this issue. Don't miss out on the fun. de Ron, KU7Y

Incoming Mail

Compiled by Monte "Ron" Stark, KU7Y

Ron and the QRP ARCI Quarterly "staff":

Great quarterly. My only complaint is that it happened to have been rained on the day it came -- wrinkled but readable. (It was to my advantage that you went to the new (?) slick cover -- less damage overall.) Pass on the thanks to all on the staff.

What's missing? I haven't decided yet. I'll let you know if I think of something. One idea that just popped into my head -- for the "winner of the month" photos, a paragraph that describes more what or how they did what ever they did to create their rig/paddle/keyer/tuner/ etc. that you are featuring, especially if it is homebrew or involved significant changes to the kit. Another opportunity for me to learn.

Cheers/73 Kevin Anderson, KB9IUA

Hi Kevin, That sounds like a good idea. ed

Ron,

You and the QQ staff are to be commended on the production of a very professional journal. I recently re-subscribed after letting my subscription lapse for many years. If I'd known what I've been missing, I would have re-subscribed sooner!

During my engineering career, I met a lot of fine professional people, and your authors are among the best!

Thanks, 72/73, Bill wb0cld

Hi Bill, I agree that our authors are super. And don't forget that they do this for no pay! What a nice group of people! ed

Ron,

The QRP Quarterly arrived here in San Francisco Bay Area this weekend and even though it's been said before: WOW, am I impressed. You hereby have my permission to increase my membership fees to keep this quality!! What an incredible amount of work went into this issue. I'm still a novice and learning, but maybe someday I'll be able to be a contributor rather than being in the learning mode. I thank all of the contributors -- you sure are helping this guy!!! P.S. Paul Harden deserves a RAISE! I love articles like that!

Bob Bayha, K6RKB

Hi Bob, Thank you for your support and I know I can say 'Thank You' for each of the contributors. ed

Hi Ron

Great job with the QUARTERLY. I liked the blue cover. This is a far cry from the "old" days when the QUARTERLY was just 2 to 4 pages on a mimeograph machine!

Noted the reloading table in the Radio room - reminds me of my days in Colorado, only I had the reloading table in a radio club room. 73, Red, K5VOL

Hi Red, They used to call me Red years ago! There just seems to be something about QRP and Reloading that just go together!! ed

What To Do With My Beloved Junk

The Problem: I am AE9G, Hans, 68 years old and healthy. I like to tinker and homebrew and have over the years bought and accumulated more nice "junk" than I am ever likely to use, such as component parts, rummage sale gear, home-built stuff, and of course the equipment that goes with a QRP station, etc. The XYL has been leaning on me to get rid of some of my "junk", and, although I hate to admit it, she has a point. But any good "junk-collector" / homebrewer will know that it is terribly difficult to throw things away while having the nagging feeling that someone out there surely would love to have it. What is even worse is to imagine what would happen after my (inevitable) end. (Did you realize how dangerous QRP operation is? The death rate among QRP operators is 100%. Sorry about this morbid note). Anyway, I can imagine the executors looking at my "beloved junk" and saying "What are we going to do with all that garbage? Let's get a (small) dumpster!" --- Makes one cry, doesn't it?

The Solution: Establish "diplomatic relations" with one or several hams who know what I am talking about, and who would like some of my junk. I remember my teenage years when I was first bit by the "radio"-bug, and parts were substantially unavailable (WW II, in Germany), and how happy I was then to latch on to a plug-in coil form, a transformer, a tube, a tube socket, even wire (fabric- insulated then). If I could provide similar joy and perhaps also a learning experience to someone, that would be particularly nice. But I wouldn't want to be choosy about the recipient of my beloved junk. What I am envisioning is a gradual process with appropriate correspondence, and then, when I get sent to the ultimate DX country, that I will know where the remainder of my equipment should be shipped. --- If you know what my feelings are, if you are also a junk-lover ("junquophile"?), let's communicate. My E-mail address is schroede@msoe.edu, and my mailing address is Hans Schroeder, P.O. Box 92163, Milwaukee, WI 53202-0163.

Hi Hans, I know how you feel! ed

Unless specifically requested that it not be published, any letter, note, etc. received via any means, by the editors and or staff of the QRP Quarterly, that is of general interest to our readers will be published when space is available. We reserve the right to edit all published correspondence as we find necessary. Opinions expressed are those of the authors' and do not necessarily reflect those of The Quarterly editors or the ARCI Board of Directors.

Hi All, Got something you would like to say? Something you would like us to do? Articles you want to see? Remember, this is your magazine. Let me know what you want. E-Mail to; ku7y@sage.dri.edu And thanks for all your support. ed.

Still QRP Really!

QRP WISDOM FROM UNCLE BRUCE

Bruce Muscolino, W6TOY
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Wow, it's been a busy several months here at W6TOY/3; lots of water, and debris, under the bridge! No, I'm not talking about El Ninja, the big guy that's ravishing the western world with rain and such. I'm talking about life, both in and out of ham radio.

By day I'm a mild mannered logistics engineer and MS Access programmer. My background in Logistics underlies most of what I do at work and my interest in MS Access has led to some interesting assignments where I work. Last October, about the time I wrote my last epistle, my boss assigned me to write two small databases for use by our customer (the US Navy). These had to be a cut above my usual in-house product; they had to be full featured, bullet proof, and useable by folks who had little or no interest in the mechanics of databases! I finished the first one last week (second week of February); the second one promises to stretch on to the end of this month. As a consequence time for ham radio has been a bit scarce, but I did manage to find some time...

The 1997 Pennsylvania QSO Party

I'm going to get to the good stuff right away! Two contests I've really begun to enjoy are the ARRL Sweepstakes and the Pennsylvania QSO Party. The Pennsylvania QSO Party is held in the second weekend in October every year. My first visit to this contest was in 1995 when I was still living in a condo with my mother, and using my infamous "stealth" antenna. As it turned out I also used a "Stealth" radio that year.

Back then I was also the "Contest Manager" for "Hambrew" magazine. I had scheduled our first contest for the second weekend in October! Seriously, I'd researched contest dates for the previous five years using CQ and QST magazines; that weekend looked clear; and I guess it was west of the Mississippi! But east? Bedlam.

Since the event I was going to enter was a "Hambrew" contest, I settled on using one of Dave Benson's NE4040s that I had built a year or so before on a visit with my best friend on the planet, Bruce Williams, WA6IVC. When I first hooked it to an antenna the radio had seemed a bit down on sensitivity (stone deaf, really) but in the spirit of "Hambrewing" I hooked it up and sallied forth. I never heard another QRP station that weekend, but the band was full of guys calling CQ PA. I made 50 contacts in about 4 hours Saturday afternoon. I was happy enough with the result to make a firm promise to do it again the next year.

Oh yeah, the radio. It WAS stone deaf. A few months later I enlisted the help of our esteemed President, WA8MCQ, in doing a little troubleshooting on the little devil. Seems Dave used a small RF choke in series with the crystal filter input to match impedances. The choke was OPEN; yep, bad to the bone from the start! Replacing that choke made that little radio into a really nice performer!

Anyhow, where I was going with this is that last Thursday afternoon the mailman dropped off a large envelope from the Nittany Amateur Radio Club. Great, I said, the Pennsylvania QSO Party contest results. Right, and WRONG! Inside the envelope was a very nice certificate made out to W6TOY as the highest scoring out of state QRPer in the 3rd call district. What a rush, as they say. Actually my score wasn't all that great, 103 QSOs and 47 counties, but I've got the paper! By the way, I was number 20 in the Top 20 QRPers!

I guess I should say my goal in this year's Pennsylvania QSO Party was the coffee mug they sold to anyone who made more than 100 QSOs. Notice the similarity between that number and the number of QSOs I made?

Sweepstakes '97

And then, along came Sweepstakes! My first Sweepstakes entry was just last year! For the longest time I was put off by the long and complex exchange used in the Sweepstakes, but last year, at the urging of Bob White, WO3B, I gave it a shot, and I got hooked, big time! Heck, it's pretty easy to see why -- there I was, working California on 80 meters, running 5 watts into a 60 foot piece of wire, Oh, they offer a participation pin for over 100 QSOs.

I was really looking forward to this year's edition, but over the summer I fell into a bad health patch. Those of you who know me personally know that I ain't scrawny. Well, after a lifetime of abuse my body's joints finally paid me back with some nasty arthritis related (so they say) aches and pains. While I've sort of got it under control now through medication, exercise, and weight loss, last November I wasn't exactly what you'd call comfortable sitting at a radio for long periods. But, like the old hunting dog, the smell of fall was in the air and I ran around barking, looking for the game.

I had planned to make my 1997 operation different -- I'd replaced the 60 foot long wire with a 200 foot long wire. And, I reasoned that if I concentrated on both QSOs and sections, how could I go wrong? And it worked, sort of; while the pain in my hips reduced my enthusiasm for long periods at the key (yes, Virginia, I use a STRAIGHT KEY) the strategy was otherwise sound. I was only on about 60% of the time I'd been on in 1996, but I worked as many sections and had nearly the same score. I worked 47 of the 48 contiguous states and Alaska. Tongue in cheek, it's said there are no hams in Nebraska -- I think it's true! Oh yes, did I mention the participation pin? I now have two, one for 1996 and one for 1997 -- this could be the start of a collection!

Trials and Tribulations

My usual rig is a Kenwood TS130V, and I've been using the 200 foot longwire since Christmas day 1996. I found the combination, fed through an elderly Johnson 275 Watt Matchbox worked equally well. Sadly the 200 foot wire finally got tired of rubbing against the fork in one of the support trees and broke in two, a week to the day after it went up. This morning I convinced my Whammo slingshot to put a line through that same fork. Tomorrow, NEW WIRE!!

A second problem I was really not ready for was the hard disk crash a week ago. Not a fatal crash, but an extremely annoying one. My home computer is a three, going on four year old Gateway Pentium P60. When I bought it its 540 Mb hard drive seemed to offer all the space I could ever need, even with the full Microsoft Office Professional installed. But, left to their own devices, hard drives fill up! After a year of moving applications to a Zip Drive I bought to put off buying a larger hard drive, I bit the bullet and bought a brand spanking new 4 Gig Western Digital drive. Last Saturday was to be phase one of the installation.

I started backing up all my "important" software to Zip Disks (there's that Zip Drive again, handy little tool!). Then I attempted to upgrade the BIOS. The upgrade was supposed to be a simple procedure; just running a patch from DOS. Half way through the patch I got a beep and an error message. "Your FLASH memory cannot be upgraded" it said! Oh darn. I ran the patch a second time and got the same results!

Well, said I, I'll just go into Windows and worry about it later. That's when I got the second error message saying "You may need to run Windows setup"! Hmmm, seems the hard disk's head did what we pilots call a "touch and go" somewhere on the platter. Wiped out about 10 Mb of space. Not a great loss, but a crucial 10 Mb; the 10 Mb where Windows wrote all its .INI files. To make a miserable story shorter, I spent the last 6 days (part time) getting the system back to life. I ended up having to reformat the hard drive and reload everything. Who says Windows isn't important software!

The "Great Back to the Future Project"

Oh boyohboyohboyoh! If you haven;t heard about this one, listen up! After Doug DeMaw passed away many people began to look for a "fitting" QRP memorial for him. The "Great Back to the Future Project" is that memorial. I think Doug would have liked the idea, because it encompasses his greatest joys, building and using simple radios, and is also one of the best examples of inter-club cooperation I've ever had the pleasure to be associated with.

Not too long ago Doug Hendricks published an article about the Tuna Tin 2 transmitter in QRPp, the Northern California QRP Club's magazine. The article raised a lot of interest in the design, but since one of the key pieces, an RF choke sold by Radio Shack, was not longer available, interest in the project cooled. Then Doug DeMaw passed away, and the "Great Back to the Future Project" was born

With Doug Hendricks enthusiasm and drive pushing us along a small design team was formed to revive the pieces that grew out of the Tuna Tin 2. All of them used discrete components and were packaged in readily available containers from the supermarket. The group includes:

The "Tuna Tin 2", a 250 to 400 mW transmitter,
The Herring Aid 5, a Direct Conversion receiver.
and the CB Slider, a VFO for the transmitter.

There has also been talk of reviving the "linear" designed for this set, called, I think, the "Sardine Sender".

Because of the Radio Shack RF Choke problem a certain amount of circuit redesign and re-layout has been done. Doug Hendricks took on the Tuna Tin 2, Glen Torr, VK1FB, took on the Herring Aid 5, and yours truly took on the :Chopped Beef Slider. Interesting project -- one I also just finished this past week.

These rigs all use parts you probably have in your junk box, or that you can easily buy from Mouser or Digi-Key. Schematics and board layouts will be published both in QRP Quarterly and QRPp, and will be on several Internet Web Sites. Boards will be available through Fred Reimers of FAR Circuits. Get on the bandwagon -- build one of these "supermarket" stations. Show your appreciation for the work Doug DeMaw and friends did back then, and the work Doug Hendricks is doing for us today!

The "Infamous 2N2222 Design Contest"

What? There's more? You betcha. This project is the brainchild of Wayne Burdick, Mr. Norcal40, Mr. SST, Mr. Sierra, and soon to be Mr. NEW RADIO! The idea was to see just what could be done using ONLY 2N2222 transistors in a transceiver design. That's right, just the 2N2222, -- no PNPs, and NO Integrated Circuits, and there's a limit to the total number of 2N2222s you can use in your design!

Watching the QRP List on the Internet it's clear that Wayne struck a nerve here. There has been a tremendous amount of interest in this project. Even your faithful scribe has a rig in design and if his employer lets up a bit he'll get it finished. The contest is sponsored by NorCal and the judging will be at Dayton this year.

Dayton

Once again Dayton is on the horizon. This year the QRP ARCI has taken on the challenge of making Dayton the biggest and most memorable QRP experience of 1998. They're calling it FDIM, or Four Days In May (hmmm, sound familiar?). It should, the name's been in use since Bob Gobrick (Russian Bob, to his friends) and I started using it to describe our fledgling QRP Technical Conference back in 1996.

This year there's a new slant on things. The QRP ARCI is doing it all. The technical conference is now a QRP ARCI operation. None of the original crew are involved with it except as advisors. The banquet, a not to be missed affair, with Ade Weiss as the keynote speaker has a new chairman, Scott Rosenfeld, NF3I. We've essentially taken the Days Inn - Dayton South hostage for four days, starting on Thursday with the technical conference and ending on Sunday when we take down the antennas. If your schedule and your finances permit, DON'T MISS IT! If you've never been to Dayton, how you gonna get into ham heaven? Seriously, it's not to be believed! There's something there for everyone, QRPer and QROer alike.

The end

That's it from W6TOY this time. Until next time, keep the QRP faith, baby, and GET ON THE AIR. Get in a contest and work some DX. Join a QRP club. Go to Dayton. Do something, don't just stand there! **73**

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ByteMark Corporation is announcing the availability of a new DDS product, the PC-VFOjr. The PC-VFOjr is a DDS signal generator with 7dBm output from 50 KHz to 54 MHz. It is an ISA PC plug-in card, compatible with 8088 and forward architecture. The PC-VFOjr has an MSRP of $139 US Dollars, and will begin shipping the same week as the Dayton Hamfest. Prepaid orders are being accepted, and will be shipped postpaid when the units come off the production line. This prepaid offer is available only through ByteMark. Watch the publications for PC-VFOjr availability soon at a dealer near you.

QRP CLUBHOUSE

Bob Gobrick, N0EB, (VO1DRB & UN7N0EB)

Welcome to the QRP Clubhouse - What's the secret password - Why "QRP" of course. This issue will be devoted to some up and coming activities of one particular club - and that club is the **QRP Amateur Radio Club International**. QRP ARCI is well known for it's service to the QRP ham radio community, as well as this wonderful publication "QRP Quarterly" that you are now reading. In May of this year, the QRP ARCI will be embarking on what the Club hopes to become an annual event for QRPers and that is the **"Four Days in May" QRP Conference,** to be held concurrently with the 1998 Dayton Hamvention. You'll find the announcement for FDIM elsewhere in the QRP Quarterly as well as on many of the regional QRP Club and the Dayton Hamvention homepage.

During this four day extravaganza there will be a number of events related to Regional QRP Clubs and the "elmering" aspect that comes from Club activities. Here are just a few of the scheduled activities that will be of interest to the QRP Clubs:

FDIM QRP Club Social

Saturday evening, May 16 will be the gathering place for two great events at the QRP ARCI Days Inn Dayton South Hospitality Suite. **NorCal QRP** will be hosting the annual QRP Building Contest with a host of prizes to be awarded this year for best entries. Building categories this year include rigs solely based on the venerable 2N2222 transistor (a contest inspired by **Wayne Burdick N6KR** in honor of the anniversary of the Bell Labs invention of the transistor), the "customized" **Wayne Smith K8FF** NorCal iambic paddle kit, and a contest for the best "new" designs of the past year (always a popular event for clubs to second-guess what **Doug Hendricks KI6DS** will pluck out for the next NorCal kit).

Saturday evening, in the Hospitality Room will also be the setting for the first annual QRP Club Social. All QRP Clubs are invited to bring a banner, newsletters, club kits for sale as well as membership application forms. QRP ARCI would like to assist advertising QRP Clubs as well as being able to promote QRP Club Kits. I'm sure we will see some nice kits for sale from the **NorCal QRP, New Jersey QRP, Columbus (OH) QRP, Knightlite's QRP Club** and others. Maybe with enough encouragement we'll see some kits from the **ScQRPions, St. Louis QRP, QRP Society of Central Pennsylvania, Minnesota QRP Clubs** to name a few. This is also an opportunity for a number of the newer clubs to pick up some ideas on Club kit projects for their members. So come one, come all. Registration is not mandatory but please contact **Jim Stafford W4QO**, the QRP ARCI FDIM coordinator, for further details (w4qo@amsat.org).

QRP Elmering

There has been quite a bit of activity recently by QRP Clubs to officially set up "Elmering" programs with the goal of assisting new and old-time hams with the hobby. There are so many topics that folks seek help on - antennas, learning cw, building and troubleshooting kits, keeping abreast of new technology. In the January 1998 issue of the **Colorado QRP Club** "The Low Down", **Dennis Edinger W0GD** and **Rich High W0HEP** had a wonderful 1997 Year in Review of the CQC "Elmer" Program. Dennis points out that a lot of the original Elmers for the program came from the active officers and as time went on those officers identified further Elmers at the monthly meetings and contributors to the newsletter. The CQC also helped identify Elmers to their members from the QRP-L internet email list (it helps that two of "The Low Down" featured writers are **Paul Harden NA5N** and **L.B. Cebik W4RNL,** both famous Elmers on the QRP-L). One interesting outshoot of the CQC Elmer Program was the establishment of a "Skyhook" team that assists QRP club members with designing and installing antennas.

QRP-L Elmer Projects

"Back to the Future Project" - Two recent happenings on the QRP-L internet email list fit very well into the category of Elmer projects that QRP Clubs may want to make available to their members. The "Back to the Future Project" inspired by **Doug Hendricks KI6DS** of the **NorCal QRP Club** rejuvenates the great classic QRP designs of the late **Doug DeMaw W1FB**. With the help of QRP designers from around the world NorCal will be publishing up-to-date designs for the Tuna Tin 2 transmitter, Herring Aid 5 receiver, Chopped Beef Slider vfo and Codzilla amplifier. This is a wonderful update of some classic DeMaw designs using readily available parts - ideal for a club elmer project. For more information contact Doug Hendricks KI6DS at ki6ds@dpol.k12.ca.us

QRP-L Elmer Project - A more recent posting on the QRP-L was an Elmer Project inspired by **Chuck Adams K5FO,** who made the case for picking a simple low cost QRP transceiver design as the basis for a learn-as-you-build Elmer series for new and old timer QRPers alike. The design that Chuck suggested was one of the great classics from the **New England QRP Club** called the NE-4040. This **Dave Benson NN1G** design is still available in the ARRL Handbook and a number of mods have been introduced over the years making it a super little QRP transceiver. Furthermore, since the design has been well documented, it serves as a great little rig to analysis and use as a basis for understanding modern QRP transceiver designs.

Within a matter of days, **Dave Benson NN1G** (Bensondj@aol.com) stepped forward and said that he would offer a special to the QRP-L Elmer Project by updating his Small Wonder Lab version of that kit and offering a SW-40+ and SW-30+ to the QRP-L list. **Mike Maiorana KF4TRD** volunteered to keep a sign up list for the kit and manage the "course" registration. The initial run will be for 164 first time course participants with the tutorial to begin late March 1998. This Elmer Project may be a wonderful basis for a QRP Club group project. So if you would like additional information you can contact Mike KF4TRD at mikemo@ibm.net

QRP Elmer Event of the Year - "Four Days in May" QRP Symposium

The lead off event of the QRP ARCI FDIM QRP Conference is the Thursday May 14, 1998 FDIM QRP Symposium. The QRP Symposium was started in 1996 by the team of **Bruce Muscolino W6TOY, Paulette Quick WB9VHF, Preston Douglas WJ2V, Bob Follett AB7ST** and **Bob Gobrick N0EB**. In order to keep the spirit of the QRP Symposium alive, the previous years team made a generous financial donation of past proceeds to facilitate QRP ARCI incorporating the QRP Symposium into the full four days of high end QRP activities. The 1998 FDIM QRP Symposium will be ably handled **by Ken Evans W4DU, Cam Bailey KT3A, George Heron N2APB and Bob Gobrick N0EB** with coordination assistance from **Jim Stafford W4QO**.

Of note this year, will be the availability of the **QRP Symposium Proceedings** at a low cost to the QRP ARCI membership so that all members can partake in the Symposium whether they are able to attend Dayton of not. Availability of the Proceedings will be posted in the next issue of the QRP Quarterly.

So why will everyone want to get a copy of the Proceedings? Well for one good reason - the 1998 FDIM QRP Symposium will have the best collection of talks from some of the greatest QRP Elmers. The following is a preliminary list of the speakers and their talks. You be the judge - is this not a great line up of some of the best QRP Elmers in the world?

A Dozen Ways to See and Love Your Feedlines by L. B. Cebik, W4RNL

By organizing the ways in which we look at transmission lines, we can better understand them. Therefore, we shall look at them 1. with a tape measure, 2. with a protractor, 3. with a lost-power meter, 4. with an X-ray machine, 5. with a ruler and LCR meter, 6. with a thermometer, 7. with a field detector, 8. with an SWR meter, 9. without a Smith Chart, 10. with a calculator and a graph, 11. with pruning shears, and 12. with a trigonometer. In the end, we shall learn to love our feedlines.

L. B. Cebik, W4RNL, studies, designs, and builds antennas. He also studies and test antenna modeling software. He serves as Technical and Educational Advisor to ARRL, and as internet coordinator for 10-10 International. He writes for Low Down, QQ, Communications Quarterly, and other publications. A ham since 1954, he is also professor of philosophy at the University of Tennessee, Knoxville.

"The Rainbow Analyzer -- A Low-Cost, Automated and Graphical Way to Determine Antenna Performance" by George Heron, N2APB and Joe Everhart, N2CX

An exciting new project has been designed especially for the QRP community to construct an inexpensive microcontroller-based antenna analyzer. A PIC-controlled VFO is coupled with the popular Rainbow Tuner/Bridge (1997 NorCal Design Contest winner) to automatically sweep a micropower signal through the ham bands while collecting SWR readings of the connected antenna. The frequencies of lowest SWR are colorfully displayed on the handheld unit's LEDs, and graphically on a PC through an optional serial connection. There are many configurable aspects to the Analyzer -- one of particular interest to many is a fully documented and available source code for the software of both the microcontroller and the PC data collection/display program. The FDIM presentation will feature discussion of the design (rf, PIC, software) as well as live demonstration of the unit.

George Heron, N2APB is a Software developer/manager for over 20 years in the northeast, working at Kodak Research Labs, Edsun Labs and currently with Dialogic Corporation working on "computer telephony" products. A consummate homebrewer -- rf, digital, microcontrollers, and totally enthralled with QRP. Built many kits, repaired a long-dormant HW-8, got an HW-100 working QRP, and design interest is now on Coherent CW and DSP applications to ham radio. Webmaster for the NJ-QRP Club (http://www.njqrp.org). Currently live in Sparta, New Jersey with wife and five year old daughter, who constantly helps rearrange the radio shack! E-mail:g.heron@dialogic.com.

Joe Everhart, N2CX is a Senior engineer for several companies in the commercial and military/aerospace communications field. Licensed as a ham back so far it's painful to think about. (Hint - built my first beer can vertical in 1962.) Professional experience includes digital and analog transmitters, receivers, modems, antennas, etc. from 150 Khz to 15 Ghz. These days involved in systems engineering for L-3 Communications. Ham-wise I love homebrewing, antennas and QRP and love writing about it all. Have designed a number of projects including the Rainbow Bridge and Tuner and a bunch of Joe's Quickies. Published lots of articles in 73 Magazine and in many of the current QRP newsletters. Neither my wife nor my two sons will have anything to do with ham radio, though my dogs tolerate it well. Will design for fun! Available on-line at n2cx@voicenet.com.

"Alternatives to the Printed Circuit Board" by Dick Pascoe G0BPS.

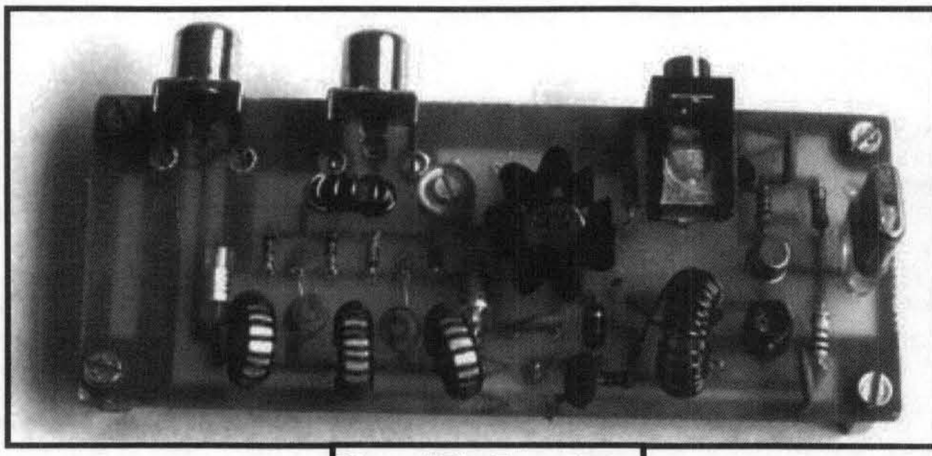
With this paper I intend to show prospective builders that a PCB is not a re-requisit of a finished product. There are many ways to build circuits and I intend to show a few of these. From the simple Dead Bug style to the W1FB favourite, the 'Blob Board' all will be explored. We will look at the above, but also Bread Boards, Tag boards, Pad boards, Hammer and nail boards and many others.

Dick Pascoe G0BPS is actively involved in QRP in the UK, both through the G-QRP journal SPRAT as their SSB columnist but also, since 1990 as a monthly QRP Columnist in the British Journal 'Ham Radio Today'. His book 'Introducing QRP' has been acclaimed by Rob Mannion G3XFD (the editor of the UK's 'Practical Wireless Magazine') as "This book will become a QRP classic". Dick is also the sole member of the UK's Kanga Products, QRP kit company. Dick promotes the G-QRP club at various events throughout Europe especially at the Freiderichshafen hamfest amongst the various British ones he attends. He is the QRP ARCI DX membership contact, and has been so since 1990. Dick was inducted into the QRP ARCI Hall of Fame in 1997.

"Modern Components for Homebrew Design and Construction" or "Oh, no! Not another NE602/LM386 project!" by Gary Breed, K9AY

This talk will present some alternatives to the 'old standby' components typically used in QRP projects. Some of these parts offer improved performance, some have unique functions, while others just add variety! Components have been selected from the worlds of digital, cellular, consumer and power electronics. If you're ready to explore new ways to build your next gadget, you'll find something here!

Gary Breed, K9AY has published receiver, transceiver and antenna articles in QST and the ARRL Antenna Compendium. His amateur radio hobby includes three main activities: equipment design and construction (QRP to QRO), antenna development, and some fairly serious contesting (also QRP to QRO). Gary is President of Noble Publishing, publishers of technical books and Applied Microwave & Wireless magazine. QTH- Grayson, Georgia



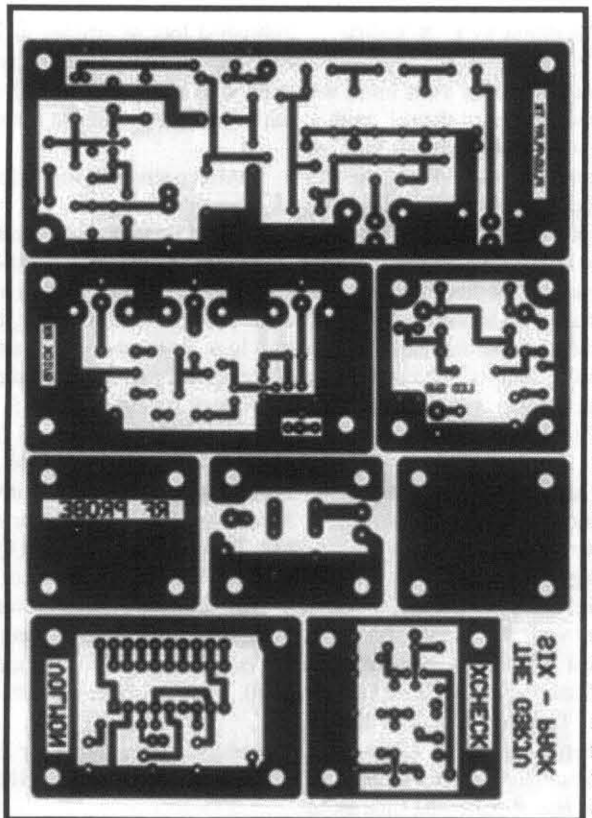
Plug and Play Transmitter

THE G3RJV SIX-PACK by George Dobbs G3RJV

This presentation will educate everyone on six circuits and send every attendee away with something to build. The basic material is a printed circuit board, which each attendee will receive. The board contains 6 projects and is grooved so each circuit will snap off. Each project is a "one nighter" which can be built by anyone who has a soldering iron and each is useful in its own right. The projects are a follows (see photos)

1. A Plug and Play Transmitter

2. The Quick Receiver
3. An Instant SWR Meter
4. A Diode Probe
5. An LED Voltage Monitor
6. A Crystal Checker


G3RJV Six-Pack Board

George Dobbs G3RJV is a world renowned QRPer and a member of the QRP Hall of Fame. He is an avid builder and author. Founder of the G-QRP Club, he also serves as editor of their excellent magazine, SPRAT. He is a regular contributor to Radcom and Practical Wireless.

COHERENT CW -- "The More You Know About a Signal, the Easier it is to Copy"
by Peter Eaton WB9FLW and George Heron N2APB

Coherent CW is a communications mode relying on precise code timing and frequency stability to provide more than 20db improvement in signal reception ... the ultimate QRPp operation! Invented by Ray Petit W7GHM, CCW has been around for more than 25 years and has been promoted since then by such notables as Woody Woodson W6NEY, Ade Weiss W0RSP, Peter Lamb W3IRM and Bill De Carle VE3IQ. Our presentation will focus on the lighter side of how this technology evolved over the years, borrowing on anecdotal recountings, recordings of on-the-air signal reception, and from audio tapes of some of these famous pioneers. The current state-of-the-art will be overviewed (use of PC and DSP technology), and a live demonstration will be given showing CCW in action. A "CCW Compendium" will be provided to augment the talk with much of the technical background and theory of operation. This is guaranteed to be a treasure-trove of a talk!

Peter Eaton WB9FLW is a member of the St. Louis QRP Club and one of the founding members of the Tucson Amateur Packet Radio Association (TAPR) and head cheerleader for the TAPR TNC-1 and TNC-2 terminal node controllers kits. (bio by N0EB - sorry for any misinterpretation since Pete's bio was not received by press time - hi)

Additional Papers to be Announced prior to the FDIM QRP Conference.

The QRP ARCI FDIM 1998 QRP Symposium will be the QRP Event of the Year - Don't miss it or the Proceedings.

ANNOUNCEMENT regarding the "MFJ 90's NEWSLETTER"

[QRP Clubs should be aware of a great newsletter that just got better - the MFJ 90's Newsletter. I am posting this from the QRP-L and I believe that **Paul Harden NA5N** will make this one, first class, reference to all MFJ 90's owners. As many of you know, I am a big fan of the **Rick Littlefield K1BQT** designed rig. This design was the grand-daddy of many of the NE-602 designs we see today and the basis for Emtech's NW series of nice kits. If you own an MFJ QRP rig (I have three) then you can not be without this newsletter. (ed. note by N0EB)]

If you have any of the MFJ 9000 QRP rigs (9040, 9020, etc.), read on ...

The ***MFJ 90's NEWSLETTER*** has been published for many years as a service to owners of the MFJ 9000 series of QRP rigs. It has waned over the past year due to changing personal and job commitments by the current editor, **Dave Luscombe, W5RIF**. Recognizing that he does not have the time to devote to the newsletter, Dave has asked me if I would take it over. I have finally agreed. Therefore, effective immediately, the new editor of the MFJ 90's NEWSLETTER is **Paul Harden, NA5N**, PO Box 757, Socorro, New Mexico 87801

I am planning on getting the next issue out in about a month (mid March) with some content and format changes as follows: 1. It will go to an 11x17 format, printed offset. 2. It will be folded to 8.5x3.5 as a self-mailer, which will unfold into a 4-page 8.5x11 "booklet," already punched to store in a 3-ring binder. 3. Due to a lack of some technical information for some time, this next issue will concentrate on aligning the MFJ 9000's back into peak performance, and some circuit theory/analysis. 4. Future issues will contain various modifications to the MFJ's for better AGC, selectivity, relay replacement, adding an S- or power meter, etc. (Many of which I have added to my own MFJ's). 5. Construction articles on making your own CW filter, adding a TiCK keyer, etc. 6. Mods, alignment and other technical information to the power supply and antenna tuner for those who have the complete integrated station. 7. Other items of interest to MFJ owners, such as upcoming contests, news from MFJ, photos and operting reports from MFJ 9000 users, etc., as the newsletter is also an open forum to share info between users. 8. And, basically whatever anyone wants to send me MFJ 90's related :-)

PURPOSE - The purpose of the newsletter is to share operating and technical information to those with MFJ 90's rigs. Furthermore, to elevate the reputation of these rigs out of the gutter and get them back into some respectable light. Us MFJ's owners shouldn't have to be embarrassed to admit we have one or two! Not everyone has the will or means to build QRP kits, and the MFJ rigs are the best bang-for-the-buck, already built and ready to go monobanders you can buy. They're built like a tank and have fairly good performance. Sometimes they need a little attention, some alignment, some repair ... for which the newsletter is primarily intended. TLC for these overlooked rigs.

I have enough irons in the fire as it is, but I do believe it important to see the MFJ 90 Newsletter continue. I look forward to starting on it and doing the best job I can ... and I thank those of you who emailed me to encourage me to take it over. It made me realize how many MFJ owners there are out there, and how important the newsletter has been. I hope to do it justice. For more information on subscribing to the new MFJ 90s Newsletter please contact Paul NA5N at pharden@aoc.nrao.edu

Well that's it for this issue of the QRP Clubhouse. Next issue I'll have additional posting on your QRP Club activities. Please mail your club news and photos (jpeg would be great) to **Bob Gobrick N0EB**, PO Box 249, Lake Elmo, MN 55042 or email me at rgobrick@worldnet.att.net. Also drop the QRP Clubhouse a note if your QRP Club would like to exchange newsletters with the QRP ARCI. Cheers 73/72 Bob N0EB, QRP CLUBHOUSE.

What's the secret password? - "QRP"

Link-Coupled Antenna Tuners
Part 1: Inductive Coupling

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Link-coupled--or inductively-coupled--antenna tuners virtually disappeared from the amateur market almost a quarter century ago. In their place came network tuners, most notably the C-L-C Tee network and its variants: the Universal Transmatch of Lew McCoy, and the SPC brought to our attention by Doug DeMaw. Although these networks perform admirably with unbalanced (coaxial) cables, they require special accommodations for balanced (parallel) transmission lines. As a result, there is a growing new interest in link-coupled tuners, along with a continuing interest on the part of many wire antenna users.

Just as interest grows, the number of available link-coupled tuners continues to dwindle. Moreover, parts for such tuners grow scarcer. Along with the depletion in tuners and parts, there is also a scarcity in available information on the operating and construction principles underlying the link-coupled tuner. This series of articles is designed at least to correct the information part of the problem. Restoration of the parts supply and the inventory of complete units is another problem entirely.

The Need

Although numerous hams have found ways of adapting single ended antenna tuners to service with balanced lines, perfectionists see many remaining problems. Some tuners use baluns at their outputs, and these units may be (depending upon design) subject to losses when faced with highly reactive loads. Many of these baluns use a 4:1 ratio, which can give the tuner added problems when it is presented with very low load impedances. A few operators have gone so far as to carefully measure their parallel transmission lines so as to present a 200-ohm load with a mild capacitive reactance that is tuned out with an external capacitor across the line.

Some hams have attempted to avoid balun losses by placing a 1:1 balun at the source side of the tuner and floating the unit to provide a nearly balanced output to the load. Common-mode currents continue to be a problem in many installations.

Rarely have hams attempted to build balanced networks for their tuners. Balanced Ls, Tees, and PIs are certainly feasible, but at a cost. In some schemes, component values double; in others, mechanical linkages present construction complexities. Such units remain rare.

For many hams, the tuner of choice for parallel transmission line systems is the inductively-coupled tuner. It yieldss efficient power transfer to a naturally balanced output. Moreover, it provides a degree of isolation from the line due to the inductive or magnetic coupling. This latter feature often suffices to attenuate out-of-band RF from strong local sources.

However, not just any old tank and link will make a satisfactory tuner. We have largely forgotten the fundamental principles behind good tuners of this type. Perhaps the high point of available information was in the 1960s. In my own collection of old ARRL *Antenna Books*, the 9th Edition of 1960 contains an account that is both mathematically and practically superior to the account of my next older edition, the 7th of 1955. By the 13th edition of 1974, much of the material had been digested to make room for the single ended network and baluns and has remained essentially unchanged since that time. The link coupled transmatch still in the 18th edition of the *ARRL Antenna Book* of 1997 is the same as that in my 1982 *ARRL Handbook* (although few have noticed that the front panel photo has changed appearance over the years, while the top view shows the original unit).

These notes on the evolutionary ups and downs in available link tuner information are not at all a criticism of ARRL publications. Quite to the contrary, other handbooks in English present considerably less information on these tuners and their principles. Yet the information is available from a combination of sources. The 1960 *ARRL Antenna Book* account is, of course, crucial. One source especially useful on inductive coupling is George Grammer's *A Course in Radio Fundamentals* which ARRL published as a full text in 1972. The source behind this treatment--as it is for so many other matters relating to radio fundamentals--is Terman's *Radio Engineers' Handbook*. They all make good reading for those interested in going beyond the treatment presented here.

So perhaps it is time to go back to the beginning and reintroduce the link coupler from the ground up. Nothing in these notes will be new, but only a restatement of principles and practices gleaned from the sources. At most, I shall be adding some tables and examples to the account in order to give the applicable equations some real meaning. The tables may also allow those who do their math intuitively a chance to see the trends of values to permit more accurate ballpark extrapolations. Moreover, I shall not try to give a fully integrated mathematical account, but simply present certain of the most useful equations that either explain tuner operation or permit calculations useful to constructing such tuners. Since most will be practical simplifications, there will be gaps in mathematical progressions of derivation. But then, our aim is to provide--so far as possible--a practical grounding in inductive tuner principles.

What's in a Name

We call the line-to-transmitter matching device a link-coupled tuner, which it is and isn't. The name arose in the days before PI network outputs. As shown in Figure 1A, older transmitters used a parallel-tuned output circuit, with energy coupled to a low-impedance secondary. Often, the secondary coil was connected to another such coil, which in turn was coupled to a high-impedance parallel-tuned circuit used to match the high impedance of the antenna. The link, as such low-impedance-to-low-impedance coils were called, might be something as simple as a twisted line. Such circuits were equivalent (assuming zero losses in the link) to a direct coupling between the two tank coils, as shown in Figure 1B, with theoretically calculable adjustments of values. Few hams made the calculations because it was simply easier to adjust the number of turns in the link coils to achieve maximum power transfer.

In isolation, the antenna tuning unit (ATU) shown in Figure 2, is an inductively coupled impedance matching network. Even though networks dominate the output circuits of modern transmitters, the concept of coefficient of coupling may still be applied to the inductively coupled circuit, and to that degree it is still correct to call these ATUs link-coupled tuners.

However, the old name often carries with it an attitude: the small coil is merely the link and as such is not of great importance. Calling the unit an inductively coupled impedance matching network gives equal importance to both the primary and secondary inductors. That is crucial for understanding this class of ATUs.

We shall keep the old name, since that is only a war of words, but we shall lose the old attitude. That way, the link coupler and the inductively coupled impedance matching network will become one and the same. Now if we only knew what is going on with inductive coupling, we would be in good shape to understand the link coupler.

Inductive Coupling: Back to Basics

When any two coils are positioned such that the magnetic lines of force of the one which is connected to a source of RF energy cut across the turns of the other coil (assumed to be connected to a load), energy is coupled to the second coil. The expanding and collapsing field of the first coil provides the changing magnetic field necessary to induce a voltage across the second coil, with a consequential current flow through the load.

Two key concepts arise in this connection. The first is mutual inductance (M), that is, the voltage induced in the second coil by the rate of current change in the first. M is measured in Henrys, just as is the inductance of the coils. Often neglected is the fact that mutual inductance can be measured. First measure the inductance of the two coils individually and well apart from each other. Second, fix the positions of the coils with respect to each other, connect the coils in series, and measure the total inductance. Finally, reverse the series connections and remeasure the inductance. Note that inductance-measuring devices ordinarily use an internal alternating current signal source to make their measurements.

If the two coils as positioned have any mutual inductance, as illustrated in Figure 3, then the two readings will differ, one being larger than the sum of the inductances of the coils as measured independently, the second smaller than that sum. The larger reading (L_{TA}) records the coils connected so that the fields are said to aid each other; the smaller (L_{TO}) records the connections that oppose each other. In fact, the readings express some precise relationships:

1 $$L_{TA} = L_1 + L_2 + 2M$$

and

2 $$L_{TO} = L_1 + L_2 - 2M$$

where all values are in Henrys or in fractions thereof. By some easy combination of the equations, we get

3 $$M = \frac{L_{TA} - L_{TO}}{4}$$

again, in Henrys.

The importance of reviewing this very basic idea is to establish the significance of mutual inductance in the coupling of energy in a magnetic circuit. Because M is a real inductance, it also has a reactance (X_M) associated with it for any given frequency, which we calculate in the ordinary way:

4 $$X_M = 2\pi f M$$

where X_M is in ohms, M in Henrys, and f is the frequency in Hertz.

Mutual coupling increases as the coils are brought closer together or positioned so that more lines of force from the source or primary coil cut across the turns of the load or secondary coil. If we use magnetic materials, such as iron cores as power line frequencies, the value of M can reach close to the square root of the product of the two individual inductors. In fact, the square root of the product of the inductances of the two coils defines the highest possible value for M. Under these ideal conditions, the coupling is as high as it can possible go and is said to be 1. All other situations will have a coefficient of coupling (k) of less than 1.

5 $$k = \frac{M}{\sqrt{L_1 L_2}}$$

Air wound coils, no matter how closely coupled, will have a coefficient of coupling well below 1. For most cases, values of k from 0.3 to 0.6 are common with air wound coils. Table 1 provides a sampling of some variations in k and M with different values for L_1 and L_2.

One misconception is that a lower coefficient of coupling implies that less than full power is being coupled from the primary to the secondary circuit. This is incorrect. The value of k is simply a very convenient way of helping to calculate various factors involved in the transfer of energy or in impedance matching. What is correct is this: the rules we learn to use with power and other transformers with high coefficients of coupling do not apply to air wound coil pairs with lower coefficients of coupling. Hence, the technique of using the turns ratio to calculate voltage, current, and impedance ratios must be set aside for inductive coupling with air wound coils.

Transformers with strong magnetic core materials not only achieve high coefficients of coupling, but tend also to be frequency insensitive within the working range of the core material. Thus, we can build wide-band transformers for radio work by employing either ferrite or powdered iron materials in a toroidal core. Like the laminated iron cores of power transformers, these cores concentrate the magnetic lines of force within a very tight area surrounding all the turns of the primary and secondary coils. Air-wound coils have more widely spread magnetic fields. They tend to retain their energy transfer characteristics over a much narrower frequency range in ways related to the reactance of the coils.

Simple (Untuned) Inductive Circuits

Figure 4A shows the simplest inductively coupled circuit, with a resistive source and a resistive load. The inductors are designated L_P and L_S, as primary and secondary coils for the circuit. Because the circuits are coupled, the coupled impedance from the secondary appears in the primary in the form of series components. The values for the series resistance (R_A) and reactance (X_A) can be approximated from the following equations:

6 $$R_A = \frac{X_M^2}{R_S^2 + X_S^2} R_S$$

and

7 $$X_A = -j\frac{X_M^2}{R_S^2 + X_S^2} X_S$$

where X_M is the reactance of the mutual inductance, R_S is the secondary circuit resistance, and X_S is the secondary circuit reactance. Figure 4B shows the coupled impedance factors in place.

For example, suppose we use an inductor pair (taken from a table of recommended values) where L_P is 1.2 μH and L_S is 12 μH. X_S will be 528 Ω at 7 MHz. Add a load resistance of 1500 Ω. We shall assume a coefficient of coupling (k) of 0.6. From equation (5) transformed, M = 2.3 μH, and the value of X_M is 100 Ω. Under these conditions, using the equations above, the coupled values in the primary will be R_A = 5.9 Ω and X_A = 2.1 Ω.

Note that the reactance of the secondary which is coupled back to the primary is numerically equal to the transformed secondary reactance, but of the opposite sign or type. Hence, the reactances cancel in part. Ideally, selection of the right values for the two inductors and the right coefficient of coupling would provide a resistive load for the source.

In order to effect a match between the load and the source, both the mutual inductance and the reactance of one of the inductors must be varied, a highly impractical situation. I have passed along these equations only to demonstrate the reversal of reactance sign in the mutually coupled reactance, a factor that will be of importance in practical link-coupled circuits of only slightly more complex design.

Coupling With a Tuned Secondary

Figure 5A shows the more commonly used inductively coupled circuit: an untuned primary circuit with a resonated secondary circuit. For resonate circuits, the Q is determined almost wholly by the load resistance relative to the reactance of either the coil or the capacitor (which are equal) at resonance. The resistive impedance of a resonant parallel tuned circuit is very high, and the lower load resistance in parallel with the tuned circuit largely determines the coupled resistance into the primary.

The loaded Q (Q_L) of the secondary of Figure 5A is given by

$$Q_L = \frac{R_L}{X} \quad (8)$$

where X is the reactance of either the coil or the capacitor at resonance. For example, if the resistive load is 2500 ohms and the reactance of the coil and capacitor are each 250 ohms at resonance (a common value), the loaded Q is 10.

For loaded Qs of 10 and better, simplified equations are possible with little error. With lower values of Q_L, some error will results, but not outside the range of the variable components. One way to show the resistance coupled back to the primary (R_A)--shown as a series resistance in Figure 5B--is with this expression:

$$R_A = \frac{X_M^2 R_L}{X_L^2} \quad (9)$$

where X_M is the reactance of the mutual inductance, R_L is the resistive load on the secondary, and X_L is the reactance of the coil at resonance.

If we use the same coil values as earlier, 1.2 µH and 12 µH, for the primary and secondary coils, along with the presumed coefficient of coupling, 0.6, we may obtain values of 100 Ω for X_M and 528 Ω for X_L at 7 MHz. The requisite capacitor to resonate the circuit at this frequency is 43 pF. With a load resistance of R_L = 1500 Ω, Q_L = 2.8. Since the loaded Q of the circuit is well under 10, the calculations from this point onward will provide ballpark guidance, not accuracy, since the equations employed are intended for use with circuits with loaded Qs of 10 or more. However, employing equation (9), we derive a value for R_A of about 54 Ω.

Notice that in figure 5B we have a primary impedance consisting of a resistance (desired) and a reactance (not desired in matching circuits). The reactance of the primary inductance remains uncompensated because the tuned secondary is wholly resistive. To make the primary impedance wholly resistive, we must alter the component values of the tuned circuit to permit it to show a small inductive reactance. From equation 7, we know that the transformed and coupled value of this inductive reactance will be capacitive, thus cancelling the inductive reactance. What is left will be a pure resistance.

The procedure employed is normally derived empirically rather than calculated. We tune the secondary circuit to a higher frequency than the operating frequency, normally by reducing the value of capacitance and thereby increasing the value of capacitive reactance to the increased value of the fixed inductor at this higher frequency. The parallel resonant secondary circuit at the original (slightly lower) frequency will show inductive reactance, just what we need to couple back to the primary, where it appears as a capacitive reactance in series with the reactance of the primary inductor. With the correct selection of secondary values, the primary reactances will cancel, leaving a purely resistive impedance for the primary circuit. In the process, the value of the resistance coupled back to the primary will not change by very much at all.

Because we are now using ballpark equations at low operating or loaded Qs, any calculation of this phenomenon will not be precise. However, if we walk through the process a couple of times, we can get a view of the trends and understand how things work. The standard equation for determining the reactance of a parallel combination of L and C, when transformed into reactances X_L and X_C for the frequency in question, is

$$X_P = -j\frac{X_L X_C}{X_L - X_C} \quad (10)$$

where X_P is the resultant reactance that is in parallel with the load resistance, R_L.

Using the same example we have been tracking, we can plug simplified series transforms of these parallel values into equations (6) and (7) and obtain something like the values in Table 2. Although these values are not precise by any means, they do show that as we increase the resonant frequency of the parallel resonant secondary circuit, the capacitive reactance coupled back to the primary increases steadily, while the resistance decreases very slowly. The right combination of values will eventually yield a purely resistive input impedance, although the coefficient of coupling might have to be altered to keep the value of R_A close to 50 Ω. Remember that in equations (6) and (7), the numerator is X_M^2, and raising its value will raise the values of both the R_A and X_A. However, the example employs a value of k of 0.6, already close to the limit of what is feasible with air-wound inductors.

The purpose of this exercise in equation-mongering is to provide you with an understanding of some of the basic principles of link-coupled tuners. More exacting forms of the equations applicable to the low values of loaded Q often encountered in ATUs are available. We have restricted ourselves to these convenient approximations because the evolution of practical coupler circuits has largely proceeded by workbench experience. If this brief account simply makes you a little more comfortable dealing with inductively coupled circuits and convinces you that they operate in accord with principles that do allow us to calculate necessary values, it will have served its purpose.

The next step is to begin wending our way through typical inductively coupled circuits in order to see how some of the enhancements work. Unlike many other accounts of tuners, we shall start where the transmitted signal starts: on the input side of the tuner.

L.B.

Sample Values of M and k With Sundry Values of L1 and L2

L1	L2	LTA	LTB	M	k
Values yielding k = 1					
5	5	20	0	5	1.0
8	4	23.32	0.68	5.66	1.0
10	1	17.32	4.68	3.16	1.0
Values yielding M = 2.5					
5	5	15	5	2.5	0.5
8	4	17	7	2.5	0.44
10	1	16	6	2.5	0.79
Values yielding M = 1.0					
5	5	12	8	1.0	0.2
8	4	14	10	1.0	0.18
10	1	13	9	1.0	0.32

Note: Values of L1, L2, and M are inductances and may be read as Henrys, milli-Henrys, or micro-Henrys, so long as the unit of measure is the same for L1, L2, and M.

Table 1. Sample values of M and k with sundry values of L1 and L2.

Sample Values of R_A and X_A as the Secondary is Resonated at Higher Frequencies

Resonant Frequency F_{MHz}	Parallel Resistance R_L (Ω)	Parallel Reactance X_P (Ω)	Series Resistance R_S (Ω)	Series Reactance X_S (Ω)	Coupled Resistance R_A (Ω)	Coupled Reactance X_A (Ω)
7.0	1500	--	186	--	54	--
7.3	1500	6590	186	42	51	-12
7.5	1500	4090	186	68	47	-18

Note 1. Resonant Frequency refers to the resonant frequency of the parallel tuned secondary circuit and is altered by reductions in the capacitance, while maintaining a fixed value for the inductor.

Note 2. Because simplified calculations have been used, the table is useful only for noting the trends in values. Actual values will vary considerably due both to the the low loaded Q of the circuit and the variables of actual coupler construction.

Table 2. Sample values of R_A and X_A as the secondary is resonated at higher frequencies.

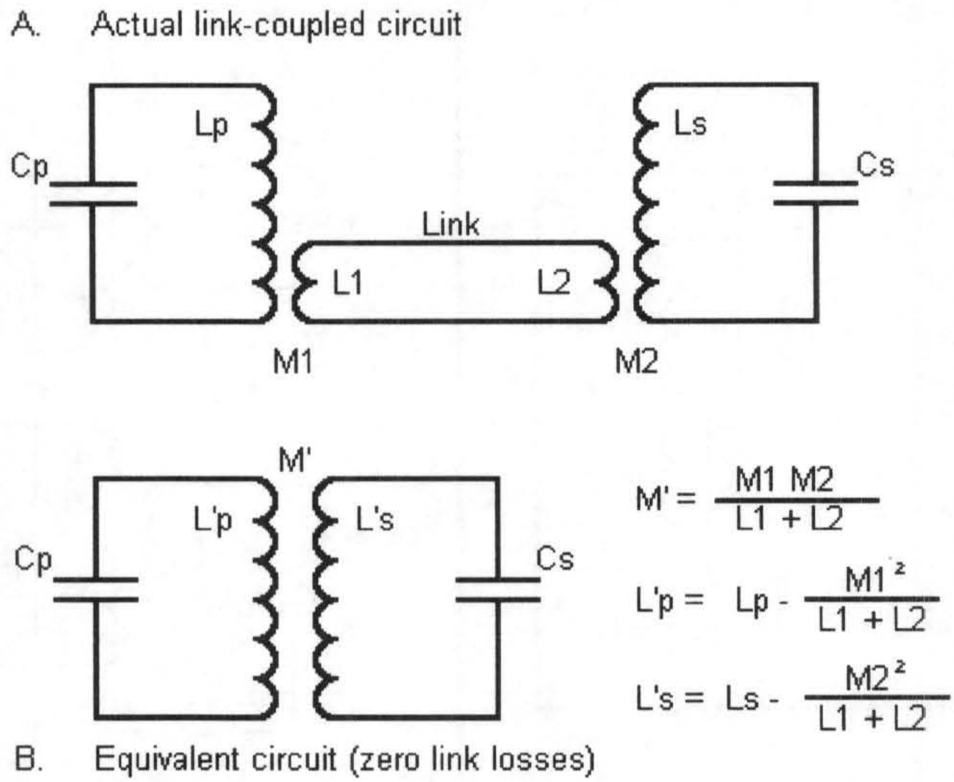


Fig. 1 The "true" link-coupled circuit.

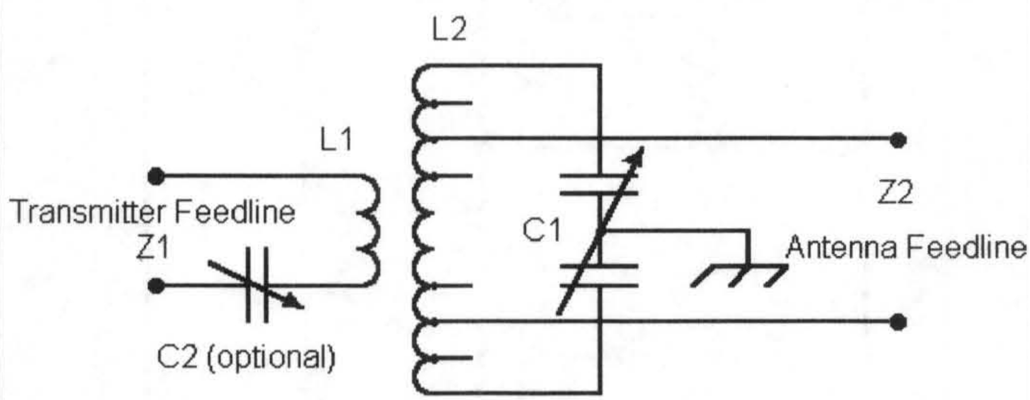


Fig. 2 A typical basic inductively coupled antenna tuning unit.

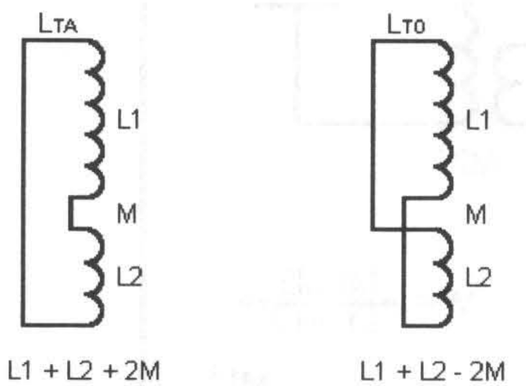


Fig. 3 Inductors with aiding and with opposing fields.

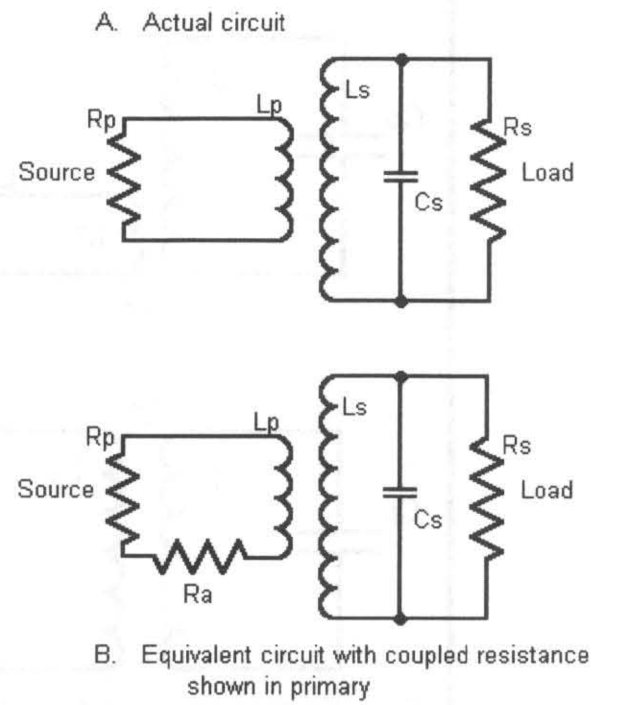


Fig. 5 The tuned-secondary inductively coupled circuit.

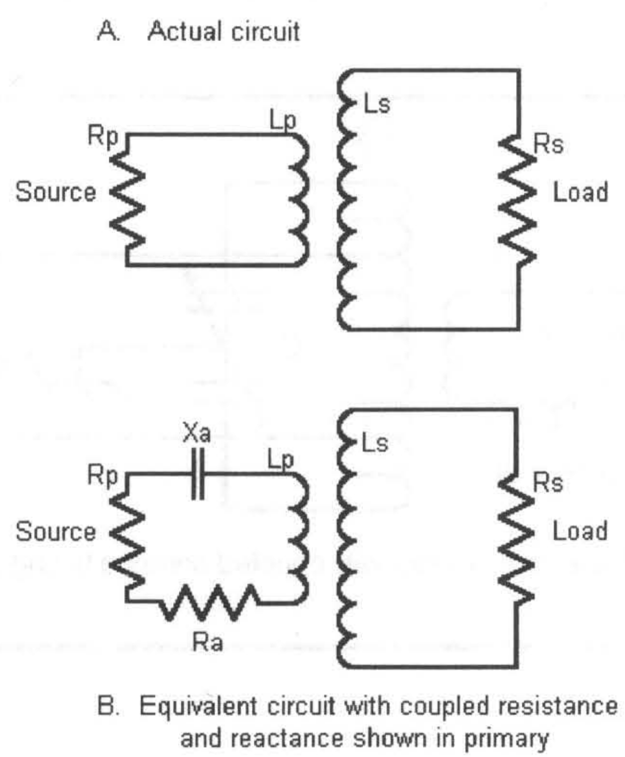


Fig. 4 The untuned inductively coupled circuit.

Members' News

Richard Fisher, nu6SN
1940 Wetherly Way
Riverside, CA 92506
(e-mail: nu6SN@aol.com)

One QRPer's story: nu6SN

Please allow me to devote a few paragraphs in this quarter's MN to explain the new callsign you see at the head of this column.

Indeed, in the genre of contemporary call letters it looks a bit odd, doesn't it — lowercase "nu," and all? For radio amateurs in general, and QRPers in particular, though, it's nothing new. Quite the contrary: Lowercase prefixes were around *before* the "W," "K" and "N" we're so accustomed to today.

nu6SN
Richard Fisher

A callsign scholar I am not. But this revelation just kind of tumbled out — along with a bunch of other fascinating stuff — as I was reading "The History of QRP in the U.S., 1924-1960" a fabulous book by Adrian Weiss, W0RSP. A copy should be in every QRPer's library.

Published in 1987, this wonderful chronicle of the U.S. QRP movement tells the story of such low power pioneers as Robert S. Kruse, 1XAQ; L.W. Hatry, 1OX; F.H. Schnell, W9UZ; F.E. Handy, W1BDI; E.L. Battey, W1UE; and many, many others.

It was QRPers' stories from a 20-month period in the mid-1920s, though, that really piqued my interest in obtaining a new callsign.

During that time, low power operators — along with the whole amateur community — had been making transcontinental contacts with relative ease. Soon the number-and-letters scheme of station identification was causing massive headaches and confusion. Was the station signing 6SN, for example, from the United States, Japan or Great Britain? There was no easy way to tell.

In January 1927, the executive committee of the International Amateur Radio Union made a bold pronouncement in QST magazine. It had set up a system of two-letter "intermediates," special prefixes to identify the location of a calling station by continent and country. For U.S. operators, the IARU designated "n" for North America and "u" for United States. So the western U.S. amateur signing 6SN became nu6SN; 6SN from Japan became aj6SN (Asia/Japan); from England it was eg6SN (Europe/Great Britain), and so on. Problem solved.

In literature of the period, the "intermediate" prefixes appeared in lowercase letters.

One of the real QRP heroes in Weiss' "History" is Col. Clair Foster, nu6HM — whose achievements inspired me to apply for nu6SN.

On October 1, 1928, U.S. amateurs were directed by the IARU to use "W" and "K" prefixes, and the "intermediate" program faded into the band noise. The stories from the mid-'20s, though, made an indelible mark on me.

Since receiving this new callsign, I've had many, many queries about its meaning. Even though it's impossible to tell "n" from "N" in Morse code, for some reason operators are curious about the derivation of "nu" in my call. I'm more than happy to tell them, and it's also a great entre to tell the story of some titans of QRP who were making their mark in the 1920s.

"The History of QRP in the U.S., 1924-1960" is available for $15 shipped first class in the U.S.; $10 for seniors; $19 DX. To order, write: Adrian Weiss, W0RSP, 526 N. Dakota St., Vermillion, SD 57069.

It's great reading, and certainly adds perspective to the U.S. radio amateurs' contribution to the QRP community we have grown to become today.

— R. E. F.

Passion renewed: Bring on the QRP

Michael Sealfon, WA2OCG, writes from Kent, WA, that "after being licensed since 1960, 1997 was my most exciting and challenging year to date for amateur radio.

"With the recent award of the coveted DXCC-CW certificate, working 'new ones' to increase my country total was not sustaining my radio interest.

"Enter my 'Elmer,' **John Shuster, K7MP,** of Port Orchard, WA, who graciously gave me a new MFJ-9020 (QRP transceiver). All it took was one weekend on a camping trip and the QRP-bug took hold.

"Soon he 'donated' an OHR-400, LDG Tuner, and a NorCal-40 and I was really in business. I quickly assembled a travel box which included the OHR-400 LDG Tuner, an MFJ electronic keyer, earphones, a 4 ampere power supply, and a lifetime supply of power cords.

"The antenna farm included three flavors of Hamstiks for 20-40 meters and a 20 meter dipole. The box has been well traveled during the last nine months — including trips to Alaska, Oregon and Arizona.

"Mobile operation from numerous Washington campsites was accomplished from the tailgate of a Jeep Cherokee Sport. This set-up was used for QRP to the Field in Spring 1997 and proved to be very successful.

"Field Day '97 operation was from our stepson's dining room table in Tuscon using the NorCal-40, MFJ 4111 battery pack, and a 40-meter Hamstik and put a decent signal into the Los Angeles area.

"The highlights of the year included a very successful November CW Sweepstakes QRP score of 10,800 points; portable operation from an Anchorage hotel room with the NorCal-40 and a 40-meter Hamstik located *inside* the room. Working into 6-land with this set-up was a rush!

"Now I need only Mississippi for QRP Worked All States.

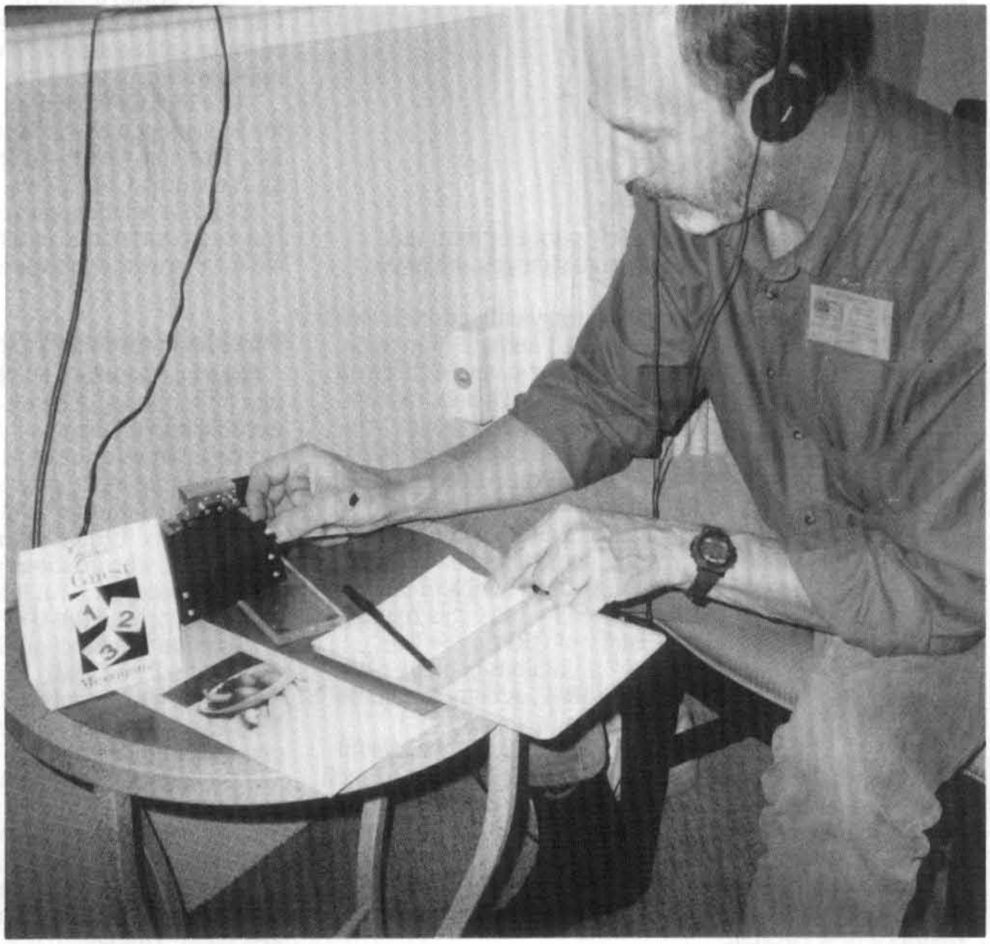
"I'm looking forward to (this year) and QRP to the Field, FYBO Winter QRP Field Day and so much more.

"QRP operation has really brought a new dimension to this special hobby, such that each business trip becomes a 'mini-DXpedition.' Just bring on more sunspots!"

Field operations in QRP Afield

Eric McFadden, WD8RIF, sends e-mail that "two members of the SE Ohio Radio Adventure Team participated in the NE QRP Afield contest from Highland Park in Athens, OH using the callsign **WD8RIF.** I was to arrive first, to be met by **Mike Hansgen, AA8EB,** later.

"I arrived on site about 1900Z to find the park overrun with young children attending a birthday party which occupied the shelter house.



QRP ARCI Contest Manager Cam Hartford, N6GA, listens intently as he operates during the club's Fall QSO Party in October 1997 from a hotel room in Concord, CA. Hartford was among hundreds of other QRPers attending the West Coast QRP Symposium, sponsored by the NorCal QRP Club and held in conjunction with Pacificon.

"Undaunted — well, not very daunted — I threw a line over a tree far from the shelter house, hoisted up the 20 meter dipole, and set up the QRP+ in a lawn chair I had brought. Sitting in another lawn chair, holding the paddle and log in my lap, I started making QSOs about 2005Z and had a good run for about an hour.

"During this good run, the weather became more and more threatening, and it got colder and windier. By 2108Z I had worked about all the 20 meter stations I could hear and my CQs were going unanswered, so I decided to switch to 40 meters. I dropped the 20 meter dipole intending to pull the 40 meter dipole up on the same tree, and suddenly realized that the birthday party was over and I was alone at the park — the shelter was available.

"While I attempted to throw a line over a tree near the shelter, the wind really picked up and the clouds got scary, so I packed everything up, just in case the skies opened, and waited for Mike to arrive or to call on the repeater.

"Mike arrived about 2200Z, and while we discussed whether to brave the elements, the sky cleared, the sun came out, and the wind died. We quickly erected the 40 meter dipole, and set up the QRP+ in the shelter house. We worked 40 meter CW until 2346Z, at which time we were almost literally chased away from the key by the mosquitoes.

"In all, we made 39 QSOs: 13 on 20 meters and 26 on 40 meters. I made all the QSOs but one. Stations were worked in FL, TX (8!), NM, OK, CO, NY, AL, MN, NJ, MO, AR, MI, GA, IA, NC, and MA.

"This was a very fun event, and I look forward to next year!"

SCORE:

Number of QSOs: 39
Points/QSO: 4 (field location using high power QRP)
Multiplier: 18 (States/Provinces/Countries)
Total: 2,808 points

STATION:

Index Labs QRP+ at 5 watt
10Ah gel cell
Idiom Press Super CMOS II keyer
Whiterook paddle
20 meter dipole
40 meter dipole

The QRP Iceland-man cometh

Joel Malman, WA1QVM, writes from Concord, MA, that he "had a pretty good time with the 1997 CQ WW contest. Naturally, when you try to work QRP on a band (15 meters) filled with QRO — you are not going to be able to run stations and a lot of times there will be 10 minutes between QSOs.

"Most memorable contact: Came across **TF3IRA** (Iceland, Zone 40). He was packing quite a pile-up.

"My guess was that Zone 40 (Greenland, Iceland, and all the icebergs to the north) were needed by just about everybody.

"Even though there was a pile-up, he was running stations pretty good, everyone in the queue was pretty nice, you put in a call and you got the Q.

"So I put in my call. Nothing. Call again. Nothing. Called about 10 times. Still nothing. Geee, I'm not really that far from Iceland, I should be able to work him.

"Hummmm, started to think about Fox hunting. Decided to QSY (up) about 300 Hz. Tail ended a G3 and bingo: an Iceland pelt on the first call at the new frequency.

"Sure is nice when 4 watts and the hidden dipole breaks into the pile up!

"Credit for this one goes to the foxes for making us *hunters better!*"

QRP key (paddle) to success

"Well gang," writes **Preston Douglas, WJ2V,** from Lawrence, NY, "(my NorCal Paddles) won't win the big beauty contest when held up against the ones the fellers are doing with graduated rouges, but they are certainly handsome enough next to my Benchers, my borrowed square-based Vibroplex, my old beat-up Hamkey, and my shiny-but-chintzy MFJ imitation bencher paddles.

"And the NorCals feel as good as any of them. Matter of fact, I got lucky because the magnet press-fit in place by firm hand pressure — that's accuracy in machining!

"And the bearing clearance on the dit paddle was perfect. That made it easy to see the amount of clearance I could shave down to on the dash paddle.

"I did three passes with the fine triangular file on the bearing; tried it; it was better, but not quite . . . So, off it came again, for three more strokes with the fine file, resulting in removing, in all, barely enough to see new metal, and it was perfect when I put it back.

"I could see wobble along the length of the arm when I tried to "send" (mostly rocking in the vertical plane) when the bearing was a mite long. This wobble will disappear when you have it right, but geeze, you have to be careful not to go too far.

"When you have it right though, and the contacts are set, and the magnet distance is adjusted, those little paddles are really excellent. No toy this one. They almost don't move between open and closed on each side.

"Thanks to both **Dougs (Hendricks, KI6DS and Hauff, KE6IRE)** for brilliant and tireless work, and **Wayne Smith's (K8FF)** design, and **Paul Harden, NA5N,** (who illustrated the NorCal Paddle kit's manual) and **Jim Cates, WA6GER.** I figure (these) guys can do almost anything.

"I think (they) ought to do a NorCal kit for a faster-than-light ship, or a time machine or something useful like that. I figure (they) can get the kit prototyped by the spring, and sell it for less than a hundred without the case. I'd buy one. I'll just make my check payable to Jim Cates."

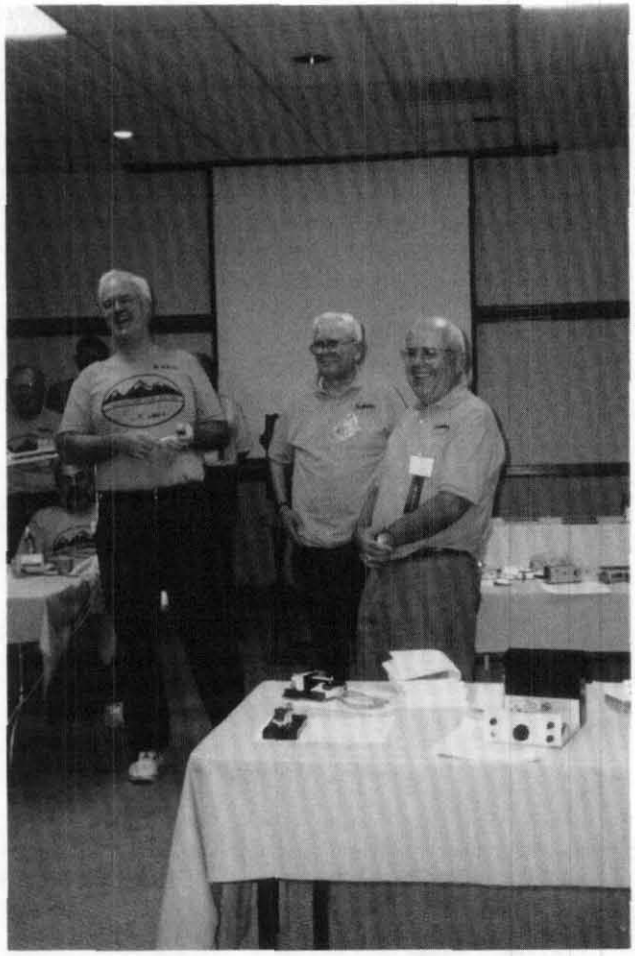
QRP miles and persistence

John Pendrey, KL0DB, writes from Kodiak, AK that "this has to be the most challenging and personally *rewarding hobby a person could stumble into. In the past* two days, I have been busy on the SSB side of 20 meters, (my CW module for my MFJ 9420 is still broken).

"I talked with **JA1WXP, JA7QVK,** and **JA1CG** yesterday and was feeling quite good about my efforts with 5 watts. I was never told about the sounds of disbelief from the QRO operators at the other end.

"This morning, as I was watching the sun rising on the snow covered mountain outside my shack window, (inspiring), I was startled to hear **Bruce, VK4AMV** calling for the Majestic net. He was not getting any response, so I decided to attempt it. He answered back after my first call. He was 5X5 and gave me a 2X4. I'll take it. He is in Brisbane, Australia — 6662 miles for 1,332+ miles per watt! So why didn't I do this 20 years ago when I first started reading? Sure makes these snow and ice covered mornings go by faster."

John's station includes an MFJ 9040 at 4 watts and an MFJ 9420 at 5 watts SSB.



Veteran QRPer and QRP-L administrator Chuck Adams, K5FO, left, laughs as he announces to fellow low power enthusiasts, the selection of Jim Cates, WA6GER, center, and Doug Hendricks, KI6DS, right, as joint recipients of California Ham of the Year at the West Coast QRP Symposium during Pacificon.

QRP 'hunting' skills pay off

Joe Gervais, AB7TT, of Goodyear, AZ, writes that "sometimes a hacking cough that keeps you up all night is a good thing.

"Around 2 a.m. (0900Z) my rig was calling to me, so figured what the heck — let's see what 40 meters is up to.

"Found a small pileup on another **P4 (Aruba)** and worked him (2 P4s in a week) then stumbled around and heard a very faint call. About as faint as (the Fox) **K8CV** several hours earlier.

"*Hmmmm.* Conditions were slowly picking up. Hang in there. He/she's calling CQ. No takers. Almost got it . . . **SM4BNZ** in Sweden!

"*Hmmmm.* Now all I had to do was work 'em. My first Swede if I can pull it off. Fire off my call. Nope. Still CQing.

"Another shot. Nope. Signals slowly building. Third try — *BLAMMO!*

"Well, almost — I get a 'QRZ?' but at least I winged the critter. Send my call a few more times and . . . YES! We have a nice chat for 10 minutes. He's running 100 watts to my 5 watts.

"Man, this op has good ears! The weather there is cold and overcast. Kind of figured. His QTH is Hammar, which doesn't show up in my *very* complete atlas, but I'm sure I copied it right.

"Conditions are tough so we sign off, and immediately half a dozen U.S. hams are calling the Swede. I smile to myself.

"Then it hits me. *This* was Fox hunting! All the little tricks and skills I'd picked up during the countless foggy nights of chasing Elusive Furry Ones (during the QRP-L-sponsored Foxhunts), I'd just used 'em all.

"The pileup techniques let me beat a small pack of QRO ops to work Aruba on my first call. The sharpened listening skills let me find and work a DX station before anyone else knew there was an SM4 on the air!

"So you see, even if you aren't carting around piles o' Fox Pelts, you can win (and win *big*) by joining the Pack in the Fox Hunt!"

C6A: Where on QRP man is an island

Hank Kohl, K8DD, writes from Port Huron, MI that he's "finally back home after a week in the Bahamas — wife included! — and then 2½ weeks in Springfield and Chicago, IL for work.

Here is the list of /QRP stations that I worked (as **K8DD/C6A QRP**) outside of the CQ WW CW contest. These are all 2-way CW, 2-way QRP contacts on 40 meters. I hope I got everyone in the log with a /QRP who I recognized or who signed with the /QRP.

AA2U, AB5UA, K3MHS, K5OI, K5TF, K5ZTY, K8CV, KA3WTF, KU7Y, N2VPK, N3AT, N3AZH, N4OFA, N4ROA, N4SO, N9DD, NF0R, NQ7X, NU4N, VE3ELA, W0CH, W2UX, W3MWY, W4GNK, W8TYX, W9NIP, WA1QVM, WB8E and WS8D.

The rig was my TS-50S at just under 5 watts and a Cushcraft 2 element yagi at 50 feet. Excellent signals. My totals outside of the contest were:
CW: 498; SSB: 88. About 100 were CW QRP.

In the CQ WW CW contest K8DD/C6A was Multi-Single with **AC8W, N8KR** and me operating. We made 4,066 QSO's after dupes, 113 Zones and 345 Countries.

The QRP stations in the log are: **AA1ME, AA1MI, AA2U, AA3GM, EA7AAW, NZ5A, W0HEP, W6JRL, W8SFF, W9IZZ and W9NIP.**

The radios used were IC-751As and a Hy-Gain 5 element tribander, the 2 element yagi, 80 meter and 160 meter dipoles and an R7000 vertical.

Thanks a lot to all the QRP stations that worked us in the contest and worked me outside of the contest. It was great to hear calls from the (QRP-L) list.

The Bahamas is a 250 watt output limit country, which to some is QRP!

It sure is great to be on the "other side of the pile-up" and hear a QRP station break the pile!

Keeping in QRP contact

Part of the fun and fascination of QRP comes in hearing of the experiences, challenges and success of others. And telling your story is part of that natural process.

Why not drop a card, letter, photograph or e-mail to Members' News? Sending off a few lines takes only a few minutes. Putting it in the mail or on the wire is painless, and the camaraderie it invokes in the QRP community is a substantial payback.

Here are the only mailing addresses you need:

Richard Fisher, nu6SN
Quarterly Members' News
1940 Wetherly Way
Riverside, CA 92506

(e-mail: nu6SN@aol.com)

High-flying QRP beacon

Paul Stroud, AA4XX, writes from North Carolina that **"Don Shipman, W3RDF,** will be flying several kite-supported — attended — HF beacons (in April) from the North Carolina Outer Banks in conjunction with the Knightlite's Second Annual QRPedition to the Outer Banks.

"Our destination is a sliver of sand known as Core Banks, located midway between Cape Hatteras and Cape Lookout, about four miles off the mainland of North Carolina. At this time, Don is dreaming up some QRP fun for all the QRPers out there (such as announcing that there will be a beacons on 15, 20 and 30 meters during such-and-such times. You'll have to scan the CW portion of the bands to find the beacons! Certificates may be awarded.

"This weekend was intentionally selected to coincide with the QRP ARCI Spring QSO Party. Please be listening for **WQ4RP/NA67.** While some of the operators will be working the contest, others will be engaging in ragchewing and chasing DX — and hopefully being chased by some DX.

"Further information about this QRPedition, including pictures of Don's beacons and one of his kites, may be found at the Core Banks Website:

http://www.ipass.net/ aa4xx/core.htm

A QRP DXer's dream

Jim Lageson, N0UR, writes from Minneapolis that he's "been doing this QRP thing awhile now but never had a morning like (Dec. 27, 1997). Here is a list of the stations I logged on 14.060 CW from 1400-1700Z. It was like being a fox. I had a pileup on me. I think someone must have put me on a packet cluster in Europe. I held a frequency for three hours.

"The toughest part was trying to cut the QSOs short. These guys wanted to ragchew and I wanted to get to the next guy calling me. It all started with me calling **LZ1SM/**

QRP. He was running 500 mw to a dipole and had a nice 559 signal.

"While working him other European stations started calling me: **G4JZO/QRP, GM4XQJ/QRP, HB9ATG/QRP, HB9DCL/QRP, DL2HRP/QRP, SM3CCT/QRP, G8PG/QRP, G3NIJ/QRP, OM2ZZ/QRP, G4VNL/QRP, S53BH/QRP, GM4VYE/QRP, ON5UP/QRP, DJ0GD/QRP, G4IBH/QRP, G3KKQ/QRP, DL1AUM/QRP, DL2UR/QRP, GM3OXX/QRP** (1 watt), **G3FNM/QRP, GM4AJV/QRP.**

"Then throw in a handful of EU QRO stations. But the highlight was having 7X4AN/QRP (Algeria) call me. He was running 5 watts to a dipole, I told him to take the frequency and let other QRPers take a shot at him. I was running 5 watts to my new (old) 3 element yagi up about 40 feet.

"I know I'm tooting my own little QRP horn, but I just had to share this. I can't remember ever having this much fun."

Europe's 'Dayton' beckons U.S. QRPers

The Rev. George Dobbs, G3RJV, writes from Great Britain that while "completing the form to acquire a booth for the G QRP Club, I was reminded that not all U.S. (QRPers) may know about the Annual Amateur Radio Exhibition in Friedrichshafen.

"This is probably Europe's biggest Ham Radio event and takes place this year June 25-27 in Friedrichshafen in southern Germany. Three hundred companies from 40 countries and 21,000 visitors last year. This year the event is being divided into Ham Radio and Computing sections.

"Friedrichshafen is situated on Lake Constance at the point where the German, Austrian and Swiss borders meet. A beautiful place — which makes it ideal to enjoy a radio event and also take the family for vacation. A one hour drive from the site brings you straight into the Austrian Alps. The food is excellent and the wine is outstanding! There is a local airport, although it is probably easier to fly into Munich or Stuttgart and take a (rental) car.

"Being in central Europe, people attend from all over Europe — from Turkey to Scandanavia, including many hams from eastern Europe. We usually have G QRP Club visitors from about a dozen countries on the booth through the 3 days.

"The fleamarket is a famous feature of the event and usually manages to produce a whole variety of interesting material from behind the old iron curtain.

"The G QRP Club has run a booth at this event for the last 5 years and have been joined by **W7EL** and **K5HBG,** both of whom took their wives and enjoyed the experience. **Dick Pascoe, G0BPS,** myself and **Sheldon Hands** from Hands Electronics form the basic booth staff.

"If you want further information — you can contact me (*g3rjv@gqrp.demon.co.uk*), or write direct to:

Karin Rausch — Ham Radio
Messe Friedrichshafen
Meisterhofener Str. 25
D - 88045 Friedrichshafen
Germany

Making QRP waves (digitally)

Bill Jones, KD7S, sends e-mail from Sanger, CA that "the annual ARRL RTTY Roundup contest was held (in January) and I had a wonderful time showing off with QRP.

"My equipment consisted of an Icom IC-728 transceiver (set to 4.5 watts output), a roof-mounted Butternut HF6V-X vertical, Hamcomm 3.1 (shareware — $30 dollar registration) and a homebrew PC to Transceiver interface (cost under $25).

"During 4½ hours of casual operation I made just under a hundred contacts.

"I logged 38 states (including Alaska and Hawaii), several Canadian provinces and a bonus contact with **FK8VHN** in New Caledonia. The only other (known) QRPer I encountered was **Al, K0FRP,** who was knocking the sox off the bands from Colorado.

"My contest exchange read, *"(callsign) UR 599 CA 599 CA DE KD7S/QRP 5 WATTS K"*

"I had numerous contesters stop to ask, "Are you *really* running QRP . . . 5 watts . . . *really?*" Several wanted to know what rig and antenna I was running.

"I suspect that between K0FRP and myself several members of the RTTY clubhouse have gained a renewed respect for QRP. Maybe it will be enough to include a QRP power category in next year's RTTY Roundup."

Fun by the 'Fireside'

Russ Carpenter, AA7QU, of McKenzie River, OR, was pleasantly surprised by the SSB activity in the January QRP ARCI Winter Fireside SSB Sprint.

"Gosh," he writes, "I had no idea there are so many sideband operators concealed in QRP-Land. Thanks to **Cam Hartford's (N6GA)** creative thinking, the Fireside event was a big success, with swarms of talented SSB operators coming to light.

"This person managed to contact 35 of them on 20 meters, in 20 states, and I'm pretty rusty. Let's do this again!"

Goodie Giveaway

As anyone who visits ham radio swap meets, conventions or pizza parties knows, it's always nice to wear the colors of the amateur radio organizations you belong to and support. Letting your fellow radio amateurs know you're a member of QRP ARCI is a good way to pump up the club.

Dick Swanson, N5JWL, of San Antonio, TX, has kindly donated a batch of oval pins displaying the QRP ARCI logo — perfect for affixing to a hat, shirt or necktie. A half dozen of these pins are this quarter's prize in the Members' News Goodie Giveaway.

And the winners are: **Michael Sealfon, WA2OCG,** of Kent, WA; **Joel Malman, WA1QVM,** Concord, MA; **John Pendrey, KL0DB,** Kodiak, AK; **Larry Boellhoff, W3MGL,** Toano, VA; **Russ Carpenter, AA7QU,** McKenzie River, OR; and **Jim Lageson, N0UR,** Minneapolis.

As always, each MN contributors' name and callsign are thrown into a hat for a random drawing. There's a new prize each quarter.

The hat, of course, is being emptied for next quarter's giveaway, and here's hoping you share your stories and photos with Quarterly readers — and get into the drawing at the same time. The addresses at the head of this column are all you need.

Items for the Members' News column should be sent to Richard Fisher, nu6SN, 1940 Wetherly Way, Riverside, CA 92506.

SOLAR PHENOMENON OF THE ACTIVE SUN

Part 2

by Paul Harden, NA5N

Correction to Part I: *Two figures were inadvertently labeled "FIG. 4." The first, on page 21, refers to the discussion on page 21 on "Evolution of a Solar Storm." The second Fig. 4 appears on page 22, and is that Fig. 4 referred to on page 22 under "The Physics of a Solar Storm" and the discussion on plasma frequencies. I apologize for any confusion this might have caused.. -- NA5N*

SUMMARY of Part I: A solar disturbance is a complicated sequence of events occuring at or near the sun's surface. It is a powerful "explosion" that causes powerful releases of energy and electrons. **Fig. 1** summarizes the major sources of radio emissions due to a solar disturbance. First -- the energetic electrons released by the disturbance -- which travel outward from the sun at the speed of light, arriving on earth about 8 minutes later (not illustrated). Some of these energetic electrons get trapped and spiral along the sun's open field lines, arriving on Earth from 10-60 minutes later. Radio emissions are also caused by the expanding gas cloud. This shock wave of mass, electrons and protons, originating at the disturbance (solar prominence), travel outward from the sun at super-sonic velocity, or about 1/10th the speed of light. As these electrons travel through the sun's magnetic field lines, they produce radio emissions. Thus, the shock wave rises above the sun relatively slowly, while the radio emissions produced do propagate at the speed of light. This is shown in the central portion of Fig. 1. This shock wave fails to produce radio emissions once it has traveled several solar radii (<10), but continues traveling outward from the sun for tens of days across our solar system, relatively benign ... until it collides with another magnetic field, such as the earth's. It is this shock wave of particles that will eventually cause geomagnetic storming on the earth several days later, and for which the remainder of this article focuses.

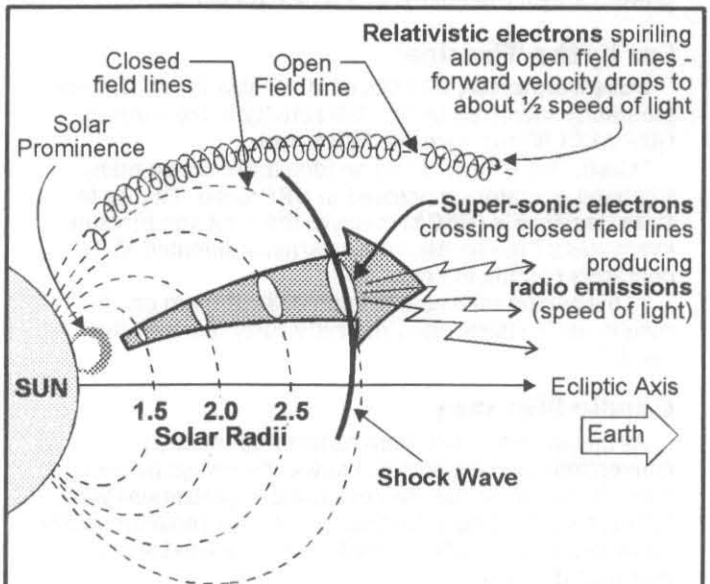


FIG. 1 - Radio emissions due to sprialing electrons and the expanding gas cloud

PARTICLE RADIATION: THE SOLAR WIND

It is common belief that the 93 million mile gap between the sun and earth is a void of total vacuum. Instead, we now know this "void" is bridged with **coronal streamers**, particle radiation forming the **solar wind**, which presses against the earth's magnetic field producing eddy currents (as it does with our other planets). This solar wind flows outward from the sun constantly ... during a quiet sun, the active sun, or following a disturbance, filling interplanetary space to beyond our solar system, to the edge of the heliosphere (the edge of our sun's magnetic influence). Particles are very small pieces of matter ... they have shape and weight ... but individually, have little energy. They, in themselves, radiate very little radio energy. Comparing a solar disturbance to a bomb blast, the radio energy released by the sun would be like the momentary flash of light, while the particle radiation would be the dust and debris blown outward by the shock wave. The light (or radio energy) has very little mass, but plenty of energy to travel at relativistic speeds and ionize gases it may encounter. On the other hand, the dust blowing along with the shock wave (particle radiation) has little energy, but plenty of mass. It is this shock wave and the associated wave front of particles that causes the significant damage due to its mass. And so with a solar storm ... **the first attack** of energetic electrons produce radio storming *immediately* following a solar disturbance, but is of short duration and does its damage from its energy, mostly by ionizing gases in our atmosphere. **The second attack** of a solar storm is the particle radiation ... the shock wave of particles striking the earth several days later.

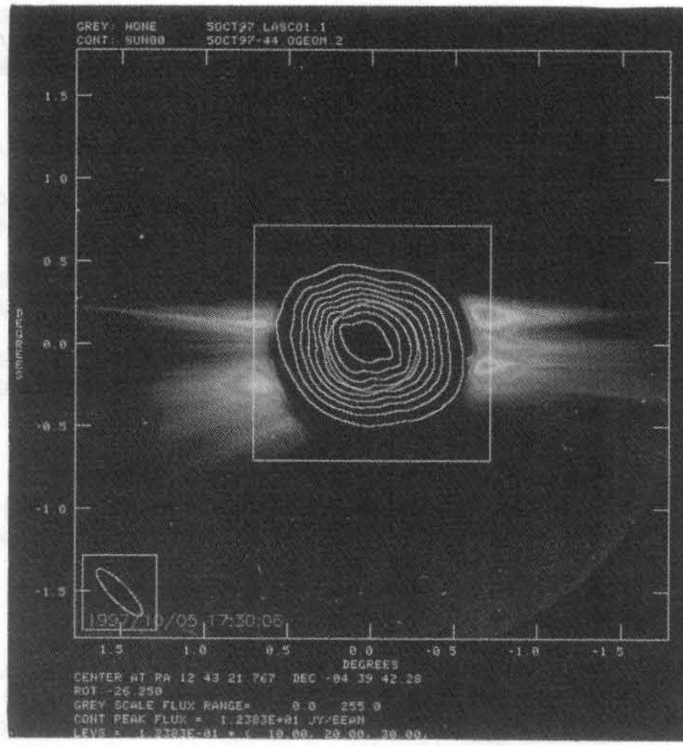


Fig. 2 - Coronal streamers giving birth to our solar wind. The constant contours of the low-resolution VLA radio map indicate a very quiet sun, inspite of the dramatic escape of particles on the underlying SOHO satellite photo.

The concept of the solar wind is fairly new. It was first proposed by Sidney Chapman in 1931. Surprisingly, it was not actually measured until 1960, when the Soviet spaceprobe *Lunik 2* traveled to the moon and made some tentative detections. Finally, in 1962, dedicated instrumentation onboard the *Mariner 2* spacecraft measured the solar wind at about 400 km/sec. (250 mi./sec. or 900,000 miles per hour), providing the first proof of its existence.

What produces the solar wind? How can tiny solar particles escape the huge magnetic and gravitational fields of the sun? During the 1960's, dozens of models were proposed. One such model was from

Swiss astronomer Max Waldmeir, who noticed dark regions on the sun he called **coronal holes**, to distinguish them from the more common sun spots. Max theorized that local field lines around these holes must punch holes through the sun's magnetic field, allowing the particles to tunnel themselves into space. However, the overwhelming brightness of the sun makes this sort of model difficult to observe. His theory was finally proven during the solar eclipse in 1970 when during totality, jets of coronal mass were seen streaming away from the sun contrary to the normal field patterns due to a sizeable coronal hole on the sun at the time. Coronal holes, spewing out plumes of particle emissions, are now an accepted characteristic of our sun, and the source of the solar wind. (See **Fig. 2**). The classic model of how the solar wind propagates across our galactic plane is illustrated in **Fig. 3**.

An understanding of solar wind is important to the QRPer because nearly all significant disturbances to HF communications is the result of pressure exerted on the earth's magnetic field by the solar wind ... whether the day-to-day variations in velocity, or the sudden surges due to a solar disturbance.

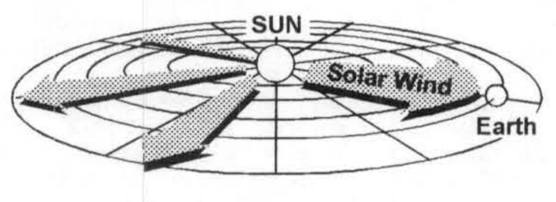


Fig. 3 - Classical model of the solar wind flowing along the plane of our solar system

THE EARTH

We have all seen photographs of the earth from space ... a brilliant, blue orb against the blackness of space. How beautiful the earth must be if we could see the elaborate systems of radiation belts, magnetic fields, plasma tail and our own shock wave as it plows through the sun's electromagnetic field and interstellar space. While invisable, they all play a part in HF communications.

Fig. 4 is a schematic represention of some of these systems. The earth revolves around the sun on the ecliptic axis (the imaginary line that intersects the sun to the planets), with our magnetic poles slightly inclined. We are 93 million miles from the sun, or about 8 light minutes.

The magnetic field around the earth is called the **magnetosphere** and consists of two major elements. First, the **magnetopause**, is the intense toroidal pattern of our dipolar field (meaning, it has a north and south pole), with maximum intensity roughly aligned with our equator, and minimum intensity at our poles, called the cusps. The magnetopause can be considered to be the **closed field lines** of our magnetic field, leaving the earth at one pole and reentering at the other. Surrounding the toroidal field like a cocoon is a less intense field called the **magnetosheath**, and considered to be the earth's **open field lines**.

If the earth were sitting in space with no external forces, our magnetic field would be a symetrical toroid, with the magnetosheath a uniform sphere fading in intensity into interplantary space with no distinct boundries. But it doesn't -- *because the pressure of the solar wind compresses the fields towards the earth on the sun-facing side*, forming its shape. Due to the influence of the solar wind, our magnetic field has a tear-shaped, or "torpedo" shaped pattern. On the sun facing side, the magnetosphere is squashed, extending outward about 20 earth radii, while on the trailing side, it outstretches hundreds of earth radii, or well past our moon (Fig. 4 is not drawn to scale). As the earth revolves around the sun, it tunnels through the solar wind. Where the pressure of the solar wind compresses the magnetosheath, the earth's **bow shock** is formed, just as a bow shock forms in front of a speeding boat upon a calm lake.

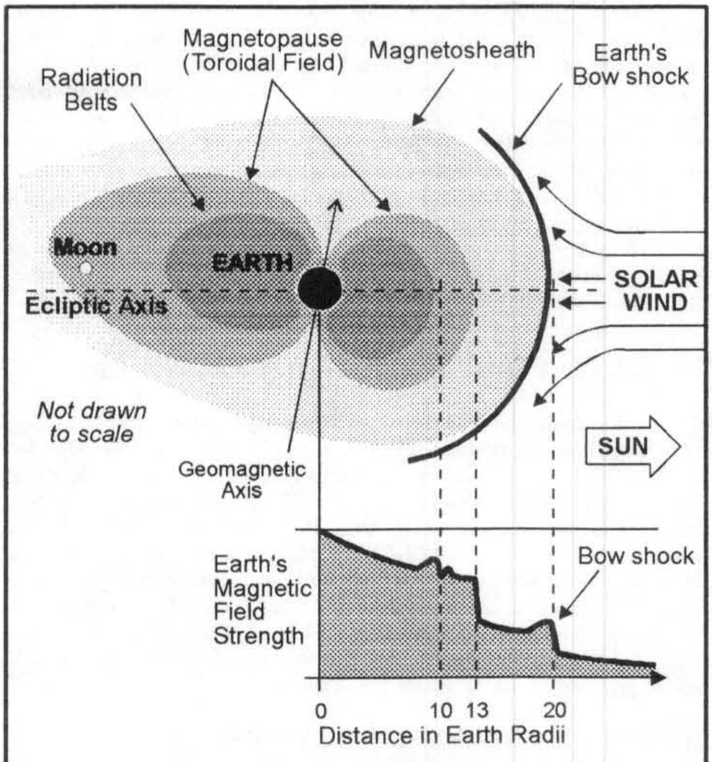


Fig. 4 - Illustration of Earth's Magnetosphere, major features, and Magnetic Field Strength

Such an intense magnetic field would seem to be firm and rigid. In actuality, it is very fragile. As the solar wind collides with our magnetic field, it wiggles and quivers as if the earth were encased in a bubble of jello. And as this magnetic field shivers, electric currents are generated by the dynamo process -- just as electricity is generated by any moving magnetic field -- except in this case, on a *very* grand scale.

SOLAR WIND AND THE BACKGROUND NOISE

The "normal" solar wind from the undisturbed sun passes around (and through) the bow shock to flow along the open field lines of the magnetosheath. It does not have enough energy to penetrate the boundry of the toroidal fields (at about 13 earth radii as shown in Fig. 4) and thus flows along the "outer skin" of the closed field lines of the magnetopause, generating electric currents as they skim along the magnetic field. This electric field produces the background noise we hear on the HF spectrum. However, with a constant solar wind velocity, the electric currents generated would be constant and the resulting noise would be a very constant "white noise." As any ham knows, the background noise on HF is far from constant, but varies with swings in intensity, minor crashes, popping sounds and other irritating phenomenon. What causes the noise levels to vary so, even during a very quiet sun?

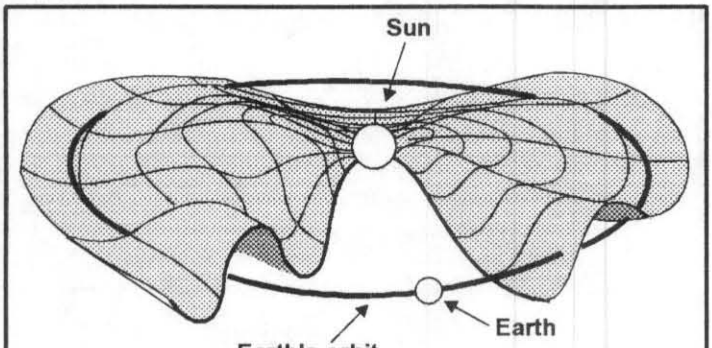


Fig. 5 - "Balerina Skirt" model of the sun's electric field and the distorted current flows around the sun

Refering again to Fig. 3, the "text book" model has the constant solar wind flowing along the flat surface of the galactic plane. **Fig. 5** depicts the electric field of the galactic plane in the real world (or should we say, the real *solar system*?). As the solar wind flows along this warped current sheet, its velocity and direction changes as it flows up and down the ridges. By the time the solar wind reaches the earth, it is swirling about in whimsical fashion, generating an electric current with great variation, which in turn produces erratic noise levels. Furthermore, the earth is passing into and out of the contours of the current sheet causing a variable compression to our magnetic field, which further modulates our electric field. Suddenly, this "steady state" universe we live in doesn't seem so steady, does it?

RADIO PROPAGATION: OUR IONOSPHERE

Under normal conditions, radio waves transmitted from the surface of the earth travel upward into our ionosphere, to be attenuated (or absorbed) by the D-layer, and reflected back to earth by the E and F layers. Long range communications on HF depends on our ionopshere being reflective. At any given time, below a certain frequency *(the lowest usable frequency, or LUF)*, signals can be fully absorbed by the D-layer, and above a certain frequency *(the maximum usable frequency, or MUF)*, the signal passes on to space. For the QRPer, the objective is to operate on a ham band that happens to lie in the window between the LUF and MUF to achieve the benefits of this "skip" propagation, and on frequencies affording the least absorption.

IONIZATION & IONOSPHERIC LAYERING

Our ionosphere is a bag of gasses and free electrons surrounding the earth. During the day, energetic x-ray and ultraviolet radiation from the sun **ionizes** the thin gasses in the upper portions of our atmosphere. That is, molecules are stipped of their electrons. The deeper the solar radiation penetrates, the higher the rate of ionization, simply because our atmosphere gets more dense. The increased density also begins to absorb this solar energy. As the nitrogen, oxygen and ozone molecules are ionized, the free electrons tend to stratisfy at different levels where their density is the same as the density of the atomosphere, forming distinct layers of ionized gases.

THE RADIO WAVE CONNECTION

If a layer is substantially dense, it will be very difficult for a radio wave to penetrate; longer wavelengths would bounce back or be absorbed due to the billions of collisions it encounters. **During the day**, with highly ionoized layers, the radio frequency would have to be fairly high to pass through the layers. **At night**, ionization stops and the recombination of the free electrons back into molecules makes the layer less dense, but heavier. This will allow lower frequencies to pass through, and the heavier layers begins to sink lower into the atmosphere. **Fig. 6** shows the heights of the dominant layers: the D, E, F1 and F2 during the day, and the D, E and F (F1 and F2 combines) at night. This changing electron density of these layers is exactly what dictates the MUF, and the height of the layer establishes the skip distance. Fig. 6 is observatory data, derived from bouncing frequency swept signals off the ionosphere to determine the heights of the layers (by measuring the time delay of the returned signal) and the critical or plasma frequency -- that frequency and above where the signal passes through the layer to space. Of course for communications, we're interested in using frequencies that are *below* the critical frequency (or MUF) as our hobby seldom involves *intentionally* sending signals out into space! This explains why during the day, we can often utilize the higher frequencies for communications, but at night, the higher frequencies afford no useful propagation.

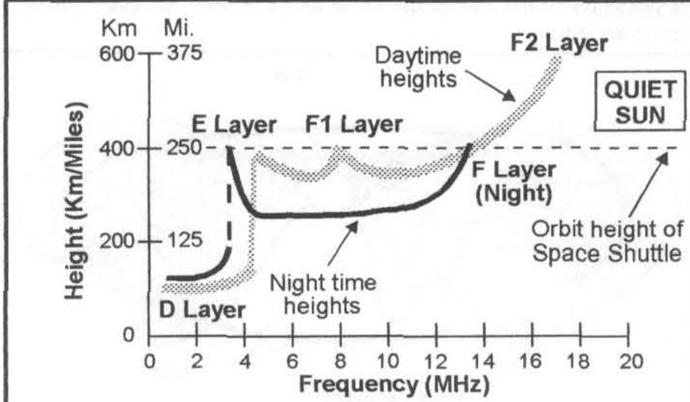


Fig. 6 - HF Reflection Heights vs. Frequency (Based on Ionosonde sounding measurements)

Incidentally, these layers were named in 1927 by co-discoverer Edward Appleton, an engineer at the U.S. Naval Research Laboratory. He named the first layer discovered the "D-layer" to leave room to name the layers below (A,B and C) and above (E, F, G) they felt surely existed. Turns out, the first layer discovered was the lowest one, which is why the layers start with the "D" layer.

THE SOLAR FLUX CONNECTION

Just as solar radiation during the day ionizes the layers to reflect signals at higher frequencies, so does the increased solar radiation from an active sun. The solar radiation is measured at 2880 MHz and is called the **solar flux**. During the quiet sun, the solar flux averages well below 100; while during an active sun, it is in the 100-200 range. The heights and critical frequencies shown in Fig. 6 were measured during the quiet sun. Note that during the day, the critical frequency is about 18MHz, for which signals above that frequency will easily pass to space where the layer seems to disappear. At night time, the MUF drops to below the 20M band. During an active sun, the layer heights remain about the same, but the daytime MUF extends towards 30MHz.

THE SOLAR STORM CONNECTION (The First Attack)

When a solar disturbance occurs that triggers a solar storm, the first wave of attack is the electro-magnetic radiation released by the sun. This is the radio bursting that arrives from 8 minutes to perhaps an hour following the disturbance. These are energetic electrons traveling at relativistic speeds, and when they smack into our ionosphere, they heavily ionize the D, E and F layers. Now on the one hand, this is good, since it raises the MUF and the average solar flux for a day or two. But on the otherhand, the extent of this "first attack" solar radiation allows it to penetrate deep into our atmosphere, often reaching the D-layer (the ozone layer). During a fairly strong solar storm, the last of the solar radiation ionizes the D-layer, making it very dense with the electrons stripped from the ozone molecules (O_3), which have an additional electron to "rob." This can make the D-layer totally absorptive to radio waves even at high frequencies, effectively raising the LUF. Refering to Fig. 6, this would be moving the D-to-E layer transition line from 4 MHz to say 10-20 MHz (day or night!). When this happens, it is called an **HF blackout** as only short distance ground wave propagation remains. The onset of a black out can be very sudden, and last from hours to days, depending upon the quantity of ionizing radiation produced by the solar disturbance.

To grasp the severity of such an onslaught, let's do some quick physics. Under normal daytime conditions in a moderately active sun, the MUF is usually around 18MHz, dictated by the F1/F2 layers some 300+ miles above the earth. The electron density (Ne) is:

$$Ne = \left(\frac{fp}{9}\right)^2$$

where, Ne = electron density per cubic meter
fp = plasma frequency = maximum usable frequency (MUF)

For an MUF of 18 MHz:

$$Ne = \left(\frac{18MHz}{9}\right)^2 \approx 4 \times 10^{12}$$

and if the MUF goes to 100MHz:

$$Ne = \left(\frac{100MHz}{9}\right)^2 \approx 1.2 \times 10^{14}$$

. The above needs little explanation upon noting that the electron density increased by nearly two orders of magnitude.

QRP Operating Tips during a SOLAR STORM

The sudden onset of a healthy solar storm is characterized by about an hour of bursting static that may be difficult to QSO through, but is of short duration. Thereafter, the step increase in solar flux can raise the MUF to 100 MHz or more. Many seasoned hams have learned to recognize the arrival of such an event by the sudden fluttering of FM signals or the appearance of distant TV stations, even on the UHF channels. (With so many people now on cable TV, this fingerprint may be missed). The D-layer will cause heavy (if not total) absorption into the higher frequencies, say to 20MHz. But still, this creates a unique DX window on the 10-15M bands, and above. 6M and 2M enthusiasts live for these occurances! And note how this could exist at night, since the heavy ionization can take many hours after sundown to boil off. So learn to recognize the fluttering of signals or sudden appearance of distant stations on the commercial FM band or above as a trigger to a possible solar storm. Many DXers around the world, also recognizing these signs, will immediately go to 10M to see if it's open, affording the QRPer a unique opportunity to work some rare DX. Call CQ and see what happens. Favorable conditions following the solar storm can exist for a day or two until the resulting *Geomagnetic Storm* occurs. Such solar storms will often trigger enhanced *auroral activity*, which may drift into the middle latitudes ... so keep your eyes on the northern sky as well!

THE GEOMAGNETIC STORM
(The Second Attack)

A **Geomagnetic Storm** is a disturbance to earth's magnetic field. But since the magnetic, electric and plasma fields surrounding our planet are so closely linked, a disturbance to one will trigger a disturbance in the other. Most disturbances to our magnetic field are directly linked to disturbances, or enhanced activity, from our sun. The elements of a solar induced geomagnetic storm have already been discussed.

Following a solar flare or a **coronal mass ejection (CME)**, a shock wave from the disturbance carries a thick wall of dense particles through the sun's magnetic field and propels them outward into our solar system (See Fig. 1). They do not leave the sun in an omni--directional pattern, but are more of a stream of particles that fan out as they travel away from the sun. Sometimes the trajectory of this blob of particles will intersect the earth, other times not. For example, a solar disturbance well above the sun's equator may belch out particles far away from the galactic plane, to merely travel endlessly into intersteller space. A disturbance near the sun's equator will be confined to travel along the galactic plane, but may safely pass by earth causing no effect. And other times, even a small flare will serendipitously aim for a head-on collision with earth ... possibly triggering a major geomagnetic storm from a relatively minor solar event. Furthermore, the velocity of these speeding particles is highly variable, such that the time of contact with the earth and their impact velocity is often little more than conjecture. For these reasons, predicting the effects of a geomagnetic storm following a solar event is very difficult and far from a well-groomed science. New instruments, both ground- and space-based, are allowing scientists to improve the accuracy of their predictions, but there are still many unknowns.

For the QRPer, the likelihood of a geomagnetic storm 2-3 days following a solar disturbance *should be anticipated.* If it doesn't come to pass -- we're lucky. Otherwise, when the wavefront of particles strikes the earth, it will jiggle our magnetic field into generating huge electric currents ... all the while, breeding copious amounts of noise on the HF bands. One such event, during the last active sun, was observed to generate a 100,000 volt difference between our poles and the current flow measured at 10^{13} amps! (Let's see, $P=IE=10^{18}$ watts of noise power!). While most of these particles flow around the earth along the open field lines, generating these currents, some do penetrate the magnetic field to accumulate at the poles, get sucked into the Van Allen radiation belts, etc. These particles, in turn, cause high polar absorption, which can "spread" into the D-layer for enhanced radio absorption to global proportions. And if that's not enough, These particles, for a time, also tend to absorb the ionizing radiation from the sun, causing depleted ionization of the upper F2 layer, lowering the MUF. And particles trapped near the polar regions, combined with the boost in the electric field, can trigger auroral activity.

So in case you've lost count, the effects of a geomagnetic storm include:

1. Strong, bursty noise levels that can last hours to days, rendering communications on HF frequencies poor to useless. (Global)
2. Depleted F2 layer ionization can lower the MUF to 10MHz or less (i.e., loss of "skip" propagation).
3. Total absorption at the polar regions.
4. Enhanced D-layer absorption of radio signals, for a blackout condition on HF (mid-latitudes to global)
5. Auroral activity creating even more electrical noise (providing at least *some* entertainment!).

Other than that ... have a nice day :-)

QRP Operating Tips during a GEOMAGNETIC STORM

Unfortunately, the extent and severity of a geomagnetic storm is difficult to predict. When a solar storm occurs, the QRPer should be prepared to "ride out" the resulting geomagnetic storm. However, some storms may only last a few hours, while others will yield very poor conditions for several days. The best advise following the start of a geomagnetic storm is to periodically check the bands for conditions. With S-9 noise, a low MUF and high absorption, it is virtually worthless to attempt HF communications. But by monitoring for signals from some of the HF beacons, WWV, etc., this can provide a good indication when the effects of the storm begins to lift.

The best time to operate is often *just following* a geomagnetic storm for four reasons:

1) Atmospheric noise levels often tends to be *very* quiet for a day or two following a geomagnetic storm, being particularly favorable for QRP weak-signal work.
2) The solar flux tends to still be elevated from the solar disturbance, and thus, a high MUF, good E-F layer reflection, and good "skip".
3) The recovering D-layer can also foster low absorption for a time, making weaking signal work on 40M and 80M quite favorable.
4) A long geomagnetic storm means a bunch of other hams anxious to get back on the air, thus plenty of QSO's and DX likely.

Every solar/geomagnetic storm sequence will have its own unique characteristics -- no two are alike. **Fig. 7** attempts to depict a "typical" sequence of events, and the related strengths and intensities. The timing and duration, however, is always the largest variable.

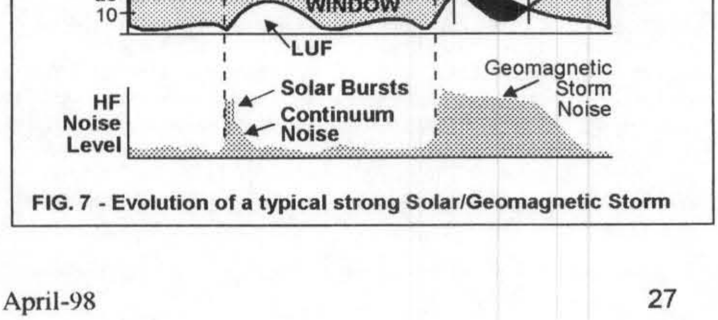


FIG. 7 - Evolution of a typical strong Solar/Geomagnetic Storm

There are two other types of geomagnetic effects on the earth that will occur: a **Polar Cap Absorption (PCA)** event and a **Sudden Ionospheric Disturbance (SID)**. Both of these events can be associated with a major solar disturbance, or can occur independently for reasons that are not well understood.

POLAR CAP ABSORPTION EVENT (PCA)

Some solar flares can emit high energy protons sufficient to penetrate deep into the ionosphere over the earth's poles, where the magnetic field is the weakest, ionizing the D-layer for heightened absorption. Since these events are localized to the polar regions, they are referred to as *Polar Cap Absorption Events.* A PCA is a scientific curiosity, as there is not yet a sufficiently accepted model to explain how such energetic protons are produced in the solar corona. Solar astronomers are looking forward to this active sun cycle as much as hams are, in the hopes that new instruments available might answer some of these lingering questions about our nearest star.

Some success has been made in predicting PCA's, however, and they appear on most solar/geophysical forecasts. PCA's are rated by a color code:

PCA Green: No PCA event in progress or imminent.
PCA Yellow: Warning. A PCA event is likely.
PCA Red: A PCA event is currently in progress.

SUDDEN IONOSPHERIC DISTURBANCES (SID's)

The typical response from a solar flare is the near immediate arrival of bursting static (Type II and III bursts), then continuum noise (Type IV storm), and on stronger flares, the radio sweeps. While a flare in the C-5 category or larger will cause these short duration static bursts, it takes a much larger flare to cause disruption due to ionization (most HF disruptions are due to the *particle radiation).* However, there has been a long noted effect from some flares, even relatively small ones, that seem to cause immediate ionization down to the D-layer. These events are known as **Sudden Ionospheric Disturbances (SID's).** They are marked by a very sudden onset of HF fadeouts *or even blackouts* of an hour or two duration. It has since been learned that SID's are associated with flares, that for reasons not yet well understood, generate intense x-ray emissions. X-ray emissions are associated with very high energies, such as the solar oven deep in the sun's interior, and there is no concise explanation how x-rays are generated on the sun's surface amidst moderate flares. None-the-less, it happens! And when a flare occurs with intense x-rays, this radiation speeds towards the earth at light speed, entering our ionosphere, and ionizing the gases down to the D-layer. Remember, the D-layer is the "absorption layer" that determines the lowest usable frequency (LUF). Ionizing this layer can raise the LUF very high, causing heavy fadeouts due to the extra absorption, or total blackouts, as illustrated in **Fig. 8**. Fortunately, they are relatively short in duration, but their effects are complete failure of HF communications. Since they are triggered by relatively small flares, that for some reason flourish with x-rays, a SID can not be predicted. Thus, most SID's are total surprises. So if you're working that good DX on 15M and all of a sudden, the band seems to go dead, it may be a SID event. This can be confirmed by noting that the lower ham bands are suffering from heavy absorption of signals as well. And another sign .. unlike a solar storm, SID's seldom start out with bursty static ... just a very quiet shut-down of the HF spectrum for an hour or two.

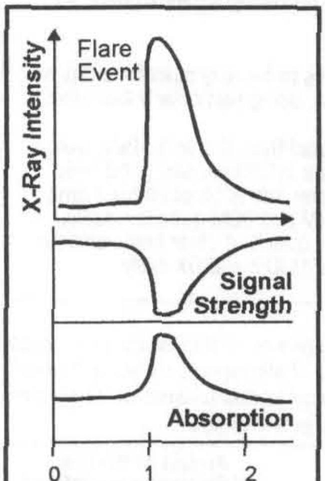


Fig. 8 - Illustration of a SID Event

CLASSIFICATION OF FLARES

Solar flares are "ranked" by solar observatories shortly after their occurance based on their physical size, optical brightness, and a couple of other factors. The flares of concern are ranked C, M and X flares with each letter ranking further divided into a scale of 1 to 9. For example, a C5 flare, or an M2. Each ranking of flare is an order of magnitude stronger, much like the Richter Scale of ranking earthquakes.

C-Class Flares are moderate flares (or **C**ommon flares). Generally, C flares will cause some bursting noise, with C5 flares or higher causing a moderate solar storm and some related geomagnetic storming.

M-Class Flares are the **M**ajor flare group, that almost assuredly will cause significant solar storming and active geomagnetic storming, possible HF blackouts and auroral activity.

X-Class Flares are the **eX**tra large ones causing the most severe solar and geomagnetic storming. They are rare with only one or two per solar cycle. The photos you may have seen of a flare (or CME) whipping out solar material for great distances are in this ranking. In short, it is the X-class flares that makes the evening news - providing the TV satellites are still in service! Total HF blackouts will occur and the effect will be felt on earth for many days ... including fabulous aurora's, which have been seen as far south as the Gulf of Mexico.

Hopefully you have enjoyed learning about the solar phenomenon and gained an appreciation for the complexities involved and the labor of the scientists who have contributed to our current level of understanding. I have attempted to present this information in an understandable fashion from current research, not interpret it (that's what astronomer do). But for the following, I will offer my meager attempt at playing an amateur solar astronomer, based on my intense interest in this subject.

THE BIG ONE!

The last really big X-class "grand daddy" flare was in 1960. The last two solar cycles have had few major flares. So one can't help but wonder if we "are due" for **"the Big One"** during this solar cycle. I don't know. But should one occur, I propose the following effects:

First, and foremost, would be some very serious effects to the network of satellites orbitting our planet. Remember, the last "big one" was only three years following *Sputnik*. The satellites now in orbit have never experienced a major solar eruption! The very high energetic x-rays, protons and electrons from an X-class flare could likely fry the electronics in many of these satellites, rendering them useless or badly crippled. Then a couple of days later, an immense solar wind and wavefront of solar particles will smack the earth. This shockwave, if sufficient in size (and density), would be like a huge blast of wind blowing these satellites towards the earth. Those in low-earth orbit could very well be propelled into our atmosphere for assured destruction. This would be millions of dollars of damage as a minimum, and likely, you could kiss goodbye many of the services we've learned to enjoy, such as DDS and satellite TV, a good chunk of the long-distance telephone links, and GPS (although GPS satellites are x-ray hardened). Let's hope the *Space Shuttle* is docked!

Secondly, strong electric fields on earth will induce currents into telephone and electrical lines causing failures in these systems. Therefore, disconnect antennas as damage to FET or sensitive "front end" electronics would be high. And who knows, with this precaution, QRP may be the only rigs left on the air! Damage to other electronics with IC's is not out of the question. But for those with an interest, it will be an unforgettable event, akin to seeing the *Hale-Bopp* comet.

Inspite of our sun entering its active phase, it has thus far been rather quiet from flare activity. Upon the occurance of a strong flare event, I will gather as much information I can with VLA, optical and satellite images and submit a "photo gallery" page or two for the QQ to galvanize the concepts presented in this series.

-- 72, Paul NA5N

IDEA EXCHANGE

Technical tidbits for the QRPer

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IN THIS EDITION OF THE IDEA EXCHANGE:

THE CPR/MON RECEIVER

From one of the technical guiding lights of the New Jersey QRP Club, ***Joe Everhart, N2CX*** *of Brooklawn, NJ, (n2cx@voicenet.com) presents Joe's Quickie #25—*

The recent 2N2222 Building Competition has inspired many of us to dig back onto our dog-eared piles of... err... our archives, yeah, that's the ticket, our archives - to resurrect some oldie but goodie circuits. I'm hardly immune so the next several Quickies will be in that spirit. Alas I got started too late to design a whole rig and enter it for judging, but I DO have a few ideas to share.

Ten years or so ago, the RCA Camden Amateur Radio Club was very active in drawing new blood to our hobby. We ran a number of license and code classes to help recruits and a number of us became VE's. One fairly common lament was heard - "I want to listen to code on the air, but I don't want to buy an expensive receiver in case I don't like those beeps and boops." So, in the time-honored tradition of would-be elmers, we sponsored a club project - a simple inexpensive code practice receiver. Thus the title of this piece. However recent discussions in the New Jersey QRP Club (NJQRP) have been in favor of setting up a club net and perhaps monitoring the net frequency whenever we are in our shacks. Thus the code practice receiver can also serve as a monitor - hence the CPR/MON.

What will be described here is an 80 meter receiver. 80 is most practical in the Northeastern and mid-Atlantic states for monitoring W1AW code practice sessions. It is also the band we have chosen for the NJQRP net. The same receiver is potentially usable on 40 or even 30 meters though the front end robustness and selectivity may prove marginal up there!

The receiver circuit was adapted from an article in the much lamented Ham Radio magazine by Ed Gellender, WB2EAV. It used a single integrated circuit to serve as both local oscillator and mixer in a direct conversion receiver. These days that function is often performed by the popular NE602 chip by Signetics. The original receiver used a CA3028 to serve this purpose, but the 3028 can be simulated with three discrete NPN's in the form of 2N2222's. While the 602 is a double-balanced mixer, the 3028 and its 2222 incarnation serve as a single balanced mixer. Thus they are somewhat more subject to AM breakthrough than DBMs. Performance will still be superior to currently popular simple receivers like the Pixie since the CPR/MON uses a true product detector.

Circuit Description

In the original article, a CA3028 differential amplifier IC was used as a single balanced mixer. In the club project we used an integrated circuit transistor array for the same purpose since we could get them free. However three 2N2222 transistors can be used instead as shown in Figure 1. The differential pair Q1/Q2 serves as the mixer, while the current source Q3 acts as a local oscillator. The action is rather unique, combining multiple functions rather simply. RF input to the mixer is via tuned circuit L1/L2/C1/C2. C1 and C2 form a high impedance parallel tuned circuit with L2. L1 is a low impedance link that feeds the low impedance input signals from the antenna, transforming that low impedance to a much higher one by transformer

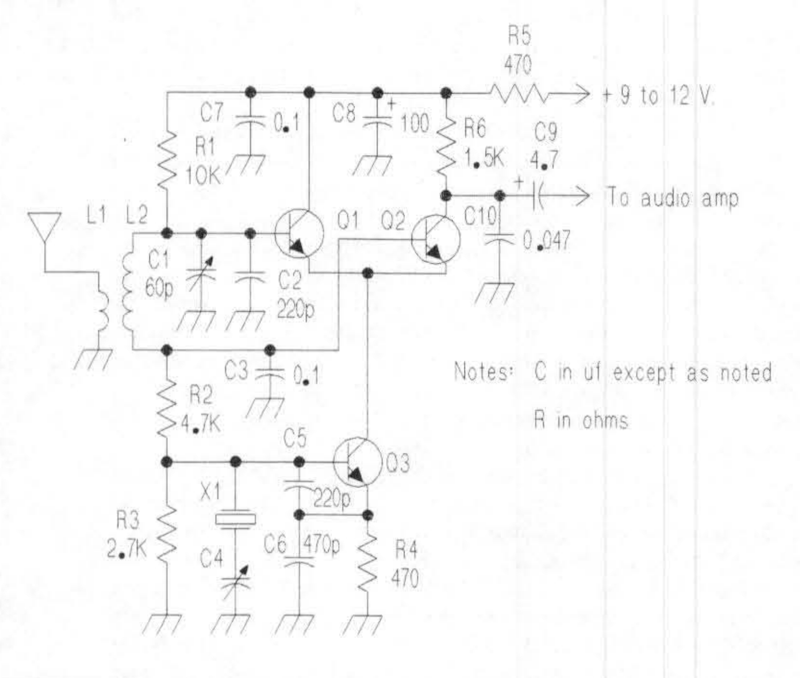


Figure 1—The CPR/Mon Receiver. (N2CX drawing.)

action.

Now if Q3 were not connected as an oscillator, differential pair Q1/Q2 would be a simple amplifier providing an amplified output across R6 that was the difference in ac voltage between Q1 base and Q2 base. In fact that happens here, too but there are also sum and difference signals produced by mixer action. The mixing occurs because the currents fed into Q1 and Q2 emitters comes from Q3's collector. And since Q3 is connected as an oscillator its collector current varies as a sine wave at its oscillation frequency. Now how does this cause mixing? Well, the gain of a transistor is proportional to its collector current - more current, more gain. So if you vary its current with a sine wave, its gain changes in synchronism with that sine wave, modulating its amplification. This is a mixing action!

Q3 is an ordinary crystal oscillator using C5 and C6 as a voltage divider for feedback and the crystal operates near its parallel resonance providing an inductive reactance. This circuit is often referred to as a "crystal Colpitts". Trimmer C1 allows the oscillator frequency to be varied slightly to set the proper pitch of the received signal. For receiving W1AW code practice sessions on 80 meters, an inexpensive television color burst frequency crystal works fine. The nominal crystal frequency is 3.579545... MHz and W1AW is on 3.5815, so the trimmer is needed to pull the frequency up slightly.

For other 80 meter frequencies the xtal needs to be replaced by one at the desired frequency. 3.56 MHz xtals can often be purchased from QRP suppliers and 3.6864 MHz is a common computer clock frequency. R2 is the collector load for the mixer where mixer output can be taken. The mixer output contains local oscillator feedthrough, the sum and difference between received signals and the desire signals and an amplified version of the RF input signals. Since all we want at the output is the audio difference frequency and all the unwanted signals are much higher in frequency, C10 is used to shunt all but audio signals to ground.

The only parts that are not commonly available are coils L1 and L2 and tuning capacitors C1 and C2. The Ham Radio article used a T50-2 toroid with two windings. The tuned side, L2 used 50 turns of No. 30 magnet wire and the antenna link, L1, was 8 turns of the same wire. Our club project went the cheap method. We used some old 100K carbon composition resistors as coil forms. The windings in this case were again 50 turns and 8 turns, but we had to use 36 gauge wire for L1 to fit the form. L2 leads were soldered to the resistor leads at either end of the resistor. L1 was wound using some small gauge hookup wire.

Lest you roll your eyes in wonder, using the resistor was not as bad as it sounds. RCA had scrapped "lots" of them in modernizations so they were available and the coils were used as a low Q tuned circuit so the high resistance carbon core had little effect.

The rest of the tuned circuit was formed by C1 and C2. The coil needs about 250 pF to resonate and 250 pF variables are tough to find these days, so a combination of fixed and variable caps was used. Radio Shack used to carry a 60 pF trimmer and a 5-420 pF trimmer, though they dropped them several years ago. You can use capacitor of your choice that will give some adjustment range around 250 pF. You just connect up an antenna and peak for best signal.

What else do I need?

The above describes the heart of the receiver, but its audio output is very low. The original project used a Radio Shack "LGA" to provide needed amplification and a small loudspeaker. (LGA—so-called "little gray amplifier" per WA8MCQ, although they changed the color to white years ago and is now a "little white amplifier.) The audio amplifier sold back in the early 80's with the RS part number 277-1008 had a fairly spacious cabinet with enough room to tuck a small board containing the CPR front end inside. These days the same part number is available but the case size allows no extra internal room. But the CPR mixer/amplifier can be built on a scrap of PC board or perforated board and mounted externally in a small case. This also has the advantage of keeping the input jack of the LGA handy to use as a booster amp and speaker for QRP rigs or as a handy test bench item.

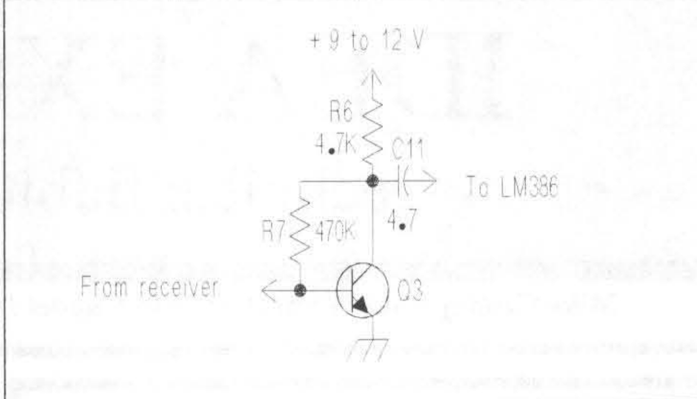


Figure 2—Extra audio oomph for the CPR/Mon receiver (N2CX drawing)

You needn't even use the RS amplifier. A suitable replacement can be built using an LM-386 and a handful of parts to do the job. However in this case you will need to add a little extra audio amplification between the mixer/oscillator and the '386. Figure 2 shows a one-transistor stage that will do the job well.

Results

I dug out my old club kit receiver and recrystalled it for 3.6864. With a 20 foot piece of wire laying on the dining room floor, a number of Novice stations were heard as well as some QRP'ers who frequent that part of 80. And with an outside 80 meter antenna, Knight-Liters all up and down the east coast were copyable during their Sunday evening net. I would recommend using a tuner with an outside antenna to give some added front end selectivity if nearby AM broadcast stations come blasting through!

—DE N2CX

HANG— DON'T STRETCH—YOUR ANTENNA

From ***Chris Kirk,*** *NV1E of Shrewsbury, MA (cdcpcsm@aol.com)*—Most hams string their wire antennas between a couple of trees, where the antennas often end up being broken by gales or ice storms. But the guy ropes that are tied to those antennas almost never break. Why make the antenna do double duty—not only radiate but hold itself up? Why not string a rope between a couple of trees and simply tie the antenna to the rope, so that the elastic rope bears all the strain in gales and ice storms while the brittle antenna wire hangs from

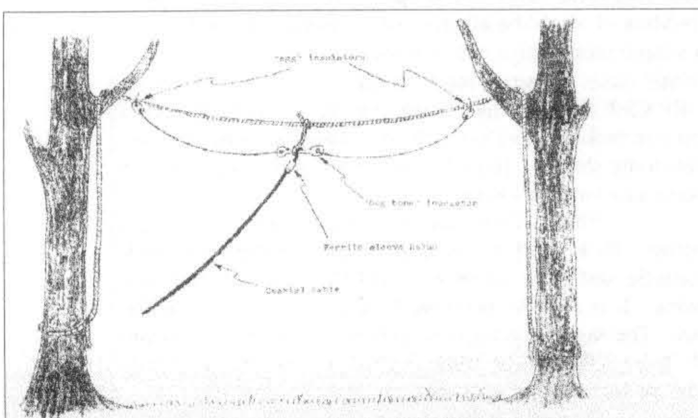


Figure 3—Hanging your antenna instead of stretching it. (NV1E drawing)

the rope and merely radiates? I have therefore arranged my 80 meter wire dipole as shown in Figure 3.

To construct this antenna, a long rope is first strung between a couple of trees and then lowered to the ground. A short length of rope (about 18") is used to tie a "dog bone" insulator to the center of the longer rope, and the end of the coaxial cable is secured to the center of the dog bone insulator. One end of each half of the dipole is secured to an eye of the insulator, and connecting wires are then soldered between the dipole and coax. The other end of each half of the dipole is then secured to an egg insulator, each of which is bound to the rope with nylon cable ties. There should be a little slack in each half of the dipole. The rope, with antenna attached, is finally hoisted and secured.

I've used this arrangement for several years now and it has endured ice storms, squalls, blizzards, and even the remnants of hurricanes. So if you want to raise a wire antenna and not have to worry about its staying up, hang it—don't stretch it.

—DE NV1E

PHONE JACK FOR ISOLATED LINES

Frank Brumbaugh, W4LJD *(formerly KB4ZGC) is still down in Salinas, PR and still churning out the ideas!*—It's easy to add a phone jack to rigs like the MFJ-9420 and SGC's SG-2020 that use floating audio lines to the speaker and which cannot be grounded. Figure 4 shows a standard monaural jack, but the mounting portion which contacts the shell of the plug must be insulated. Plugging in the phones mutes the speaker. Although those little jacks enclosed in black plastic are, I believe, available where the mounting is isolated from the innards, I wouldn't bet the farm on it. Also, those don't seem to last too long.

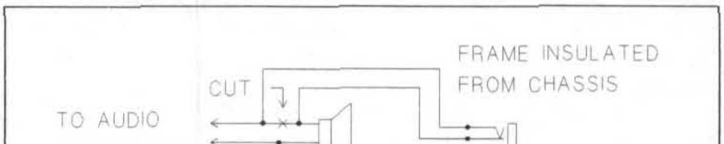


Figure 4—Adding speaker jack to rigs with floating audio lines that cannot be grounded.

—DE W4LJD

MOTORBOATING IN LM386 AUDIO AMPS

Late last year, someone asked for help on the homebrew mail reflector (homebrew@qth.net) about a problem with motorboating in a Radio Shack computer speaker set, and here are some of the replies.

From ***John Nogatch, AC6SL*** *(jtn@te-cats.com)*--I recently ran into the same problem with a version of the Pixie transceiver, while running it off a small 9v battery. Several things were tried, but putting a larger electrolytic capacitor on the LM386 power supply pin was the cure for the motorboating; the cap is physically larger than the LM386. Running it off a better DC supply would also help.

From our features editor, ***Larry East*** *(w1hue@amsat.org)*--Before going this "brute force" route, try the following: Add a 1 to 10uF bypass cap from pin 7 to ground (if you don't already have one there). The purpose of this cap is to decouple the high gain input stage from the power supply. If the supply is not particularly "stiff", you can get feedback to the input (hence "motor boating") if pin 7 is not properly bypassed. To be most effective, the bypass cap needs to be at least 1 uF (a 3.3 or 4.7 uF tantalum is a good choice). Many designs using the LM386 leave pin 7 open, or only use a small (0.01 or 0.1 uF) bypass cap. A very BAD practice!

AC6SL *followed up with this*--"I remember more of what was discovered in the case of the LM386 motorboating: 1. Reducing the gain by removing the external feedback resistor had little effect. 2. Increasing the bypass capacitor on pin 7 had no effect. 3. Adding the RC trap on the output, which is shown on some application notes, had no effect. 4. Increasing the power supply capacitor helped a lot. 5. Replacing some of the cheap electrolytics with good tantalum caps eliminates the problem. This includes the bypass cap on pin 7 of the LM386. I always thought the selection of bypass caps was non-critical; I was wrong!

Finally, ***W1HUE*** *followed up with this in private e-mail*—Tantalums have much lower internal inductance than electrolytics and thus make much better bypass caps -- even at audio frequencies. They are also more stable. I have cured instabilities in low quiescent current CMOS voltage regulators by using a 1uF or so tantalum output bypass cap in place of a 10uF electrolytic. I personally use dipped tantalums in place of electrolytics now in just about everything I build except when I need a bypass (or audio coupling) cap >50uF or so. The only thing that electrolytics are really good for, in my opinion, is for doing "heavy duty" filtering in power supplies. They are much better at handling high surge currents than tantalums and are VERY much cheaper when you get to the 1000+ uF sizes needed in power supplies. But I use tantalums (or monolithic ceramics for RF) for power-bus bypassing at the circuit board level. *[Just make sure you install tantalum caps with the correct polarity. If reversed, they will self destruct in short order, and leave a nice mess. This has been reported for years, and I've seen it personally when I did it deliberately during some experiments. —WA8MCQ]*

A SIMPLE SWR METER FOR QRP LEVELS

Here's a neat little circuit found on the web page of the Minnesota QRP Club (www.qsl.net/mnqrp/) which is run by Claton Cadmus, KA0GKC. The author is ***Bob Liesenfeld WB0POQ***, *wb0poq@visi.com.*

This article describes a simple SWR meter that I have built using readily available parts. Note that no attempt has been made to ensure accurate power readings, as I am usually aware of the approximate power level I'm running. I simply wanted a circuit that would fit in a small enclosure, and give me an indication of 'minimum' swr. This circuit does the trick. It is based on the ever popular WM-1 made by Oak Hills Research, with a few changes. *[The WM-1 itself combines features of the GQRP Club's Stockton Wattmeter and the W7EL QRP wattmeter described in the February 1990 issue of QST and also in the ARRL book, QRP Classics. While it was popularized in the QRP world by the "Stockton wattmeter" article in SPRAT several years ago, by*

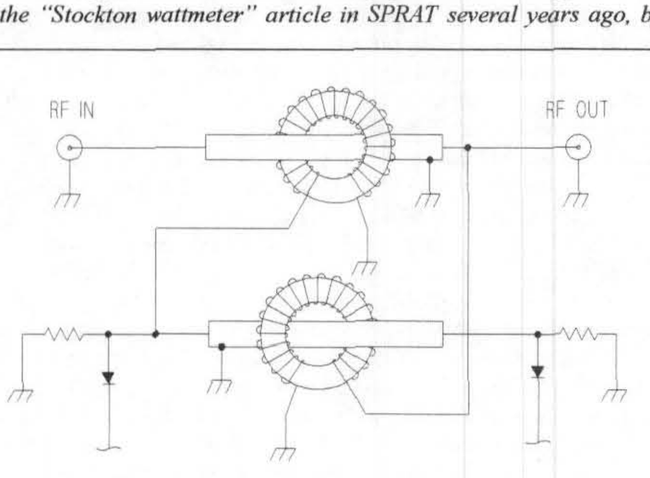


Figure 5—coupler portion of the QRP SWR meter. Be sure to ground one end of each piece of coax, and only one end. (WA8MCQ drawing)

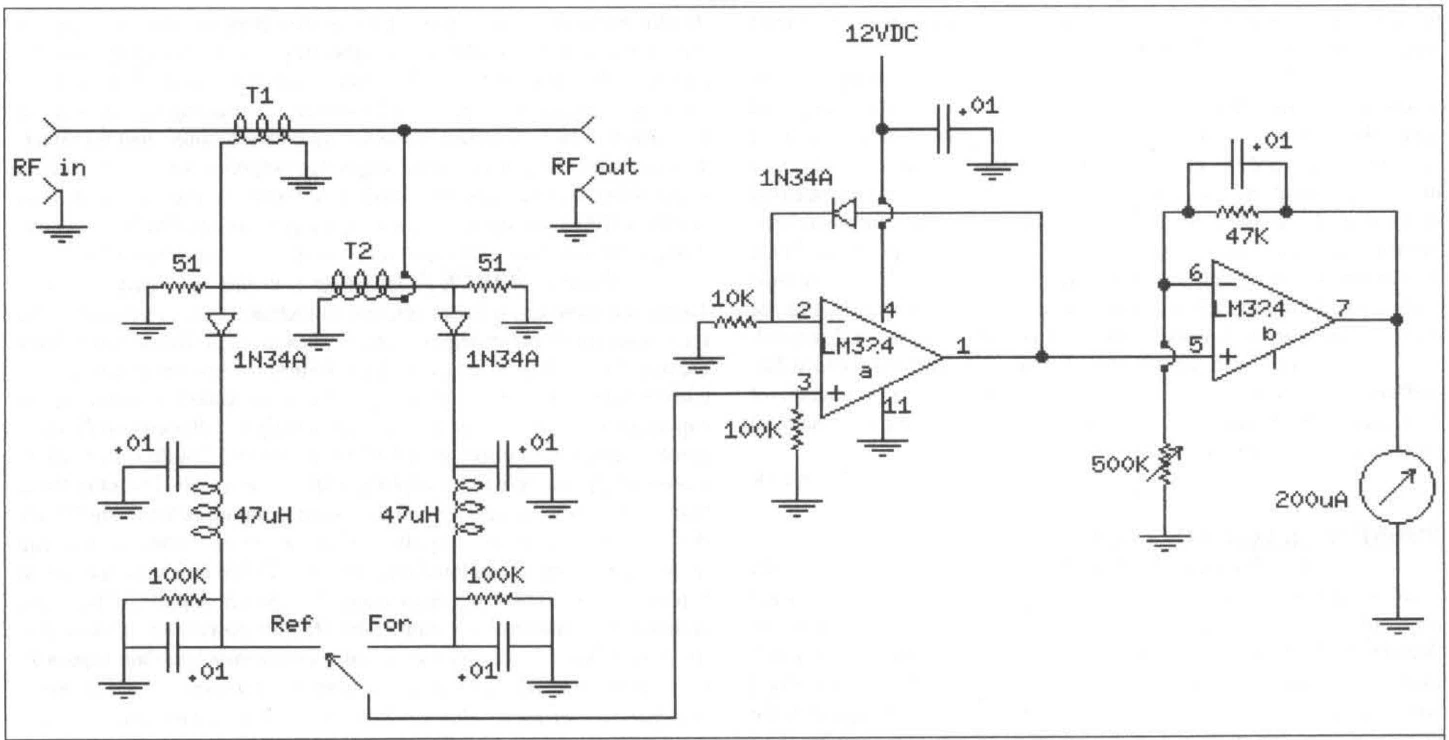


Figure 6—Overall circuit of the QRP SWR meter by WB0POQ. (This drawing was imported from the web page of the Minnesota QRP Club.) Details of the coupler (T1 and T2) are shown in Figure 5.

David Stockton, GM4ZNX, this particular coupler circuit has been around for quite some time. It has appeared in QST and Ham Radio magazines, Hewlett Packard journals, and even in a US patent application in the 1960's! A very good description of it's operation can be found on page 157 of Introduction to Radio Frequency Design by Wes Hayward, W7ZOI, available from ARRL. --WA8MCQ]

I built this circuit up dead-bug style, as I do most of my homebrew stuff. A little planning results in a compact, and symmetrical layout. (Symmetry is important for the section containing T1/T2).

Note that T1 and T2 are somewhat unusual. Start with a FT50-61 core. Wrap 24 turns of enameled wire on it (size not critical as long as it fits). Spread the turns out to cover most of the core. Next take a 1 inch long piece of RG-58/U and strip about 1/8 inch of the jacket off both ends. Remove the braid covering the dielectric on one end, and twist the braid on the other end into a pigtail. Slip this prepared cable through the prepared toroid, and connect one end of the enameled winding, as well as the braid to ground. The other end of the enameled winding connects to the anode of D1 as shown. One side of the center conductor of the coax attaches to the input connector J1, while the other end goes to the output connector, J2.

Take another FT50-61 core, and create another assembly as above. Connect one end of this core's enameled winding to the output connector, while the opposite end goes to ground. One end of this core's length of coax attaches to the anode of D1, while the other end connects to the anode of D2. Don't forget to ground the pigtail of this core's coax braid. This whole process is easier to do than to describe!

The purpose of the lengths of coax, is to provide a single turn primary (a wire passing through a toroid acts as a single turn) while the shield grounded at one end only, acts as a Faraday shield, (see any older ARRL Handbook for a description of this forgotten technique) which reduces the 'capacitive' coupling between windings.

[While it's important to ground one end of each piece of coax, it's also important to ground ONLY one end. I was always curious why it was done that way, so I did some tests a few years back on several couplers. It turns out that if both ends are grounded, the frequency response of the coupler stays about the same but the output is lower across the entire range, which means that you get reduced sensitivity. That's not a major problem at QRO levels, but when you're running QRP it makes a big difference. —WA8MCQ]

I used an LM324 IC as it can be had at Radio Shack and runs off a single supply. The values shown in this part of the circuit are for a 200uA meter movement I happened to have. A different meter may require changing these values somewhat. The rest of the parts can be had from Radio Shack or Dan's Small Parts.

To use, connect your TX to J1, a 50 Ohm load to J2, set the switch to 'forward' and adjust R for approximately full scale deflection on key down. Switching to 'reflected' should show very little or no deflection. If not, check your wiring.

This circuit should work with QRP rigs in the HF bands, although I have made no attempt to try it on other than 20 and 40.

—DE WB0POQ

EASY AUDIO FILTERING FOR THE PIXIE

Here's a recent QRP-L post from **Charlie Panek, KX7L** *(charlier@lsid.hp.com)*--I recently threw together a Pixie to play with, and put it on 20 meters (but that's another story, which will be printed in NorCal's QRPp). I haven't had a QSO with it yet (last weekend was one of *those* weekends), but I did get to listen a bit, and I guess I've been spoiled by good crystal filters. What with all the digital stuff going on up several kHz, and rag chews down around 14.050, I had quite an earful!

I got to looking at the data sheet for the LM386, and a little circuit labeled "Audio Amp with Bass Boost" got me thinking that it would be easy to add some filtering to the thing. So it's as simple as this:

Change the 10 uF cap between pins 1 and 8 to 4.7 uF. This puts the low frequency -3 dB point at about 200 Hz

Put a 2k ohm resistor and a 6800 pF cap in series, and wire the unconnected ends between pins 1 and 5 (the output). This rolls off the high frequency gain; the upper -3 dB point is about 1.6 kHz

I also tried reducing the output coupling cap from 10 uF to 1 uF. This reduces the gain below 200 Hz, but the value you need will depend upon your load (I had 500 ohm headphones.)

The result is still no 6 pole crystal filter, but it's an improvement and doesn't complicate the rig very much. The center frequency

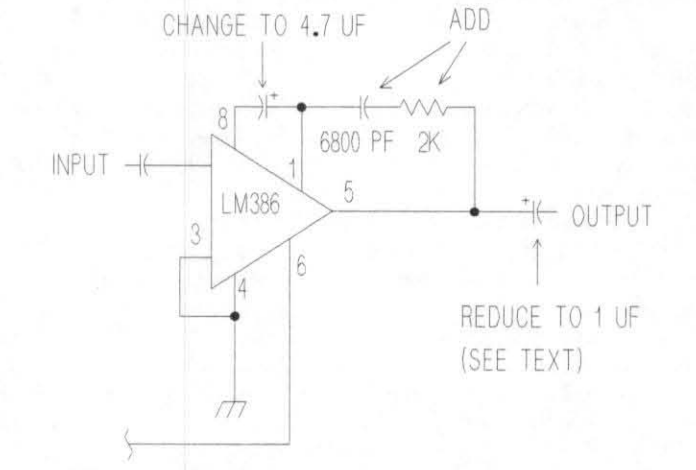


Figure 7—Adding a bit of filtering to the Pixie

of the resulting "filter" is about 600 Hz. If that's too low for you, try a 2.2 uF cap between pins 1 & 8 and reduce the 6800 pF cap to 4700 pF.

—DE KX7L

SST COYOTE KILLER —ONE EASY STEP

Wayne Burdick, N6KR *(svecbrdk@well.com), is the designer of more QRP rigs and accessories than I've been able to keep track of. He posted this fix to QRP-L for an audio howling that can occur in some SST transceivers (which he designed, and which is available through Wilderness Radio).*

A long, long time ago someone on QRP-L suggested that the cure for the SST's "howl" problem was to put an electrolytic cap between pin 7 of the LM386 and ground. He was right! Normally you don't need a cap here if you run the '386 from a regulated supply, which is why I left it out. But it turns out that the LED-based AGC circuit I'm using in the SST creates enough of a feedback loop that in some cases it causes trouble. The pin 7 bypass cleans it up.

Other suggested solutions took two or more parts, so this single cap method was the one I preferred. After all, I'm genetically programmed to try to keep parts count low and there isn't much room left on the SST's PC board.

I never could duplicate the problem at my QTH, so I enlisted the help of several SST owners to try this, and the results are in: we're three-for-three. Even 1 uF will do it, but I already use a 2.2 uF cap elsewhere in the rig, so 2.2 it is. A safety margin doesn't hurt.

So, if you still have a coyote in SST's clothing, kill that critter now with a "2.2" gauge. You can use any cap with a 10V or higher rating. The smaller ones will actually fit on the bottom of the PCB.

[Wayne later asked me to remind everyone that the latest version of the SST, currently being shipped by Wilderness Radio, already has this fix installed. —WA8MCQ]

—DE N6KR

A TON OF HW-9 MODS

Last year, ***Gary Surrency, AB7MY*** *of Chandler, AZ made several posts to QRP-L describing his work on the HW-9. I asked for his permission to use it here and he agreed, but he reminded me that Doug Hendricks (KI6DS) had asked him first, so Doug gets credit for publishing this first in a QRP journal. It appeared in the Winter issue of QRPp. I was going to serialize it in the Idea Exchange, but KU7Y suggested that I run it all at once so people don't have to wait a year to get the full story. I apologize to the readers who have already seen this on QRP-L or in QRPp, but a lot of you don't read either of those, and this information deserves wide exposure.*

If you have any comments or questions, Gary can be reached at gsurrency@juno.com.

And for those who don't already know about it, QRPp is the publication of the Northern California QRP Club (NorCal), an excellent QRP journal of considerable size with lots and lots of technical content. I highly recommend it. And for those of you with an Internet account, be sure to check out the NorCal web page, run by Jerry Parker, WA6OWR. The URL is www.fix.net/norcal.html. It has a lot of good info as well as links to many other QRP sites.

The HW-9 is a fine rig. However, it does have some problems as delivered by Heath. In this article, I hope to show how to improve the performance of the HW-9 and encourage others to try their own hand at problems areas that their rig may exhibit. Feel free to contact me with your own mods, or any questions that this material may create.

Please note that I find Molex IC pins to be invaluable when substituting components, as they can be individually installed for transistor, diode, capacitor, or resistor sockets. This saves damage to the PCB, and allows me to try different devices without reaching for the soldering iron each time, or removing or replacing the PCB between tests.

These socket pins come on a "tree" carrier that you can use for various IC pin counts, and are separated normally by snapping off the "tree" after installation. When used individually, they are a little more difficult to get installed straight without burning your fingers. I use a 1/4 watt resistor as a holding tool as I solder the individual pins.

KEYING

The first thing I noticed when I received my HW-9, which I did not build, was that the keying was pretty soft. This was especially true when looking at the trailing edge of the keyed waveform on an oscilloscope. There was just too much of a "tail" on the key-up portion of the envelope. Although the HW-8 Handbook has some ideas on correcting this problem, I chose my own method, and it is simpler.

It seems that capacitor C578, a 47 uF electrolytic, is way too large in value. I found I never needed to turn the Mute Delay control anywhere near its maximum, and so I began to examine this part of the schematic for ideas. By simply changing C578 from 47 uF to 10 uF, the key-up waveform edge became much shorter. After this change, I still have plenty of Mute Delay for all practical purposes, but I noticed the shortest setting of the control permitted a little T/R click to pass into the audio chain. It seems the large 47 uF original value for C578 delays the turn-off characteristics of the keyed line.

By changing R444 from 180 ohms to 1500 ohms, the proper range of Mute Delay is preserved, and the T/R click is eliminated. There is a click at full audio gain, but this seems unrelated to the Mute Delay time constant. It may be due to the DC coupling from U306 to Q303, but I don't think it is significant unless you are hard of hearing and like to run your audio gain full tilt!

I also observed the leading edge of the keyed waveform is a little fast on rise time, and sounds kind of "hard" when monitored on a local receiver. A quick improvement for this behavior can be had by changing C435 from 2.2 uF to 4.7 uF. The rising edge of the keyed RF waveform is a little slower now and sounds better. Try several sizes of caps if you want to see what affect it will have.

RECEIVE SENSITIVITY

Heath has always tended to use the MPF105 junction FET in a lot of their kits. This device has a very poor transconductance, as mentioned in an article I read in 73 Magazine on "How to Make a

HW-8 Come Alive", May 1996, by Gerald F. Gronson K8MKB. As he said, Heath couldn't have chosen a worse device for the RF amplifier in the HW-8. "A coupling capacitor would be a better choice than a MPF105", he writes.

This is also true for the IF amplifier preceding the crystal filter in the HW-9. Again, using Molex socket pins, I tried a number of FETs to see what could be achieved. Many higher gain FETs, such as the J310 and J309 seemed to have too much gain, and caused oscillation and instability without redesigning the entire amplifier stage and it's biasing, termination, etc. So I settled on a MPF102 (Radio Shack part number. 276-2062, $0.99) chosen from a number of devices I had on hand.

A good increase in sensitivity is the result, and I used the current measurement through source resistor R305 as a guide to selecting a proper candidate. I also monitored a weak signal on the rig's S-meter for best signal strength as I chose the best device. Re-adjust T301 and the AGC threshold control, R329 after making this substitution as described in the manual for proper S-meter behavior. Use care and a proper tool to tune the slug in T301 so it does not crack or crumble.

AUDIO IMPROVEMENTS

The HW-8 Handbook mentions that capacitor C336, a 2.2 uF electrolytic, is installed backwards for polarity. This is certainly true, and it should be reversed from what is shown in the manual, schematic, and PCB silk-screening. If you like, you can try a slightly larger cap for C336 (using Molex pin sockets!) to see if the audio quality is improved. I kept the original cap but turned it around.

A mention is made in the HW-8 Handbook about substituting a TL084C quad FET op amp for the LM324 used at U304. This is supposed to retain the high impedance of the active audio filter and is claimed to be a quieter device. I had some TL084C ICs, so what the heck? I did not see a noticeable improvement, but if your audio filter seems noisy or if the bandwidth is not what you think it should be, give it a try.

I noticed the active audio bandpass filter center frequency is not the same as the crystal filter's center frequency. I still have to address this problem, but if your rig seems particularly poor in this respect, check R354 and R359 to see if they are close to 1.5 megohms and matched in value. C339, C341, C344, and C345 all need to be matched in value for best filter performance. Heath used ordinary ceramic disk caps for these, and they have only 20% tolerance or so. Use a capacitor meter if you have one, and select four caps that are as close as possible to use in the filter. If you don't have enough of these, remove several other .001 uF disk caps from other places on the T/R board and select the four best candidates. Use the fall-outs for the other caps, since their circuits are not as critical.

Polyester or mylar caps have normally better tolerance, stability, and leakage than the ceramic disks used, so if you can get them - use them. I think the audio filter's center bandpass frequency should be shifted slightly lower than it currently is, so .0012 or .0015 uF caps might be a better choice here. I prefer not to parallel or series connect several components to get the value needed, so some parts searching is in order.

Using 1.8 megohm resistors for R354 and R359 might do the trick, but I haven't done the math or tried them since I didn't have any in my parts bins. Most other audio filters I have encountered do not use such high R and small C values. All new values for the filter might be the way to go, but the existing filter works pretty well - even if it is too high in center frequency for the crystal IF filter and my preferences. The S-meter and audio filter should peak on at the same frequency.

TRANSMIT STABILITY and POWER OUTPUT

I had no complaint about the output power level of nearly 7 watts maximum on bands 80m through 15m, but 15m seemed a little unstable. On 12m and 10m, the output was down slightly to 3 watts or so. On 15m, the CW Level control seemed to be non-linear when increasing and particularly *decreasing* the power level. I suspected some spurious behavior of the driver or PA stages. It turned out to be in the pre-driver stages.

In the original design, Heath used MPS6521 transistors (Heath p/n 417-172) for Q401 and Q402, the pre-drivers that precede Q404. Q404 is a 2N3866 (Heath pn. 417-205) that is more than adequate in power gain and frequency. However, there are ferrite beads on the base leads of Q401 & Q402. I have found this to usually indicate a problem area that needs addressing, rather than taking a Band-Aid (tm) approach!

Sure enough, here is where the instability and loss of power output on 12m and 10m was found. If your rig's output level drops suddenly from a constant level as you reduce the CW Level control - especially on 15m for some reason - then you need to look into this.

After installing Molex pin sockets on Q401 & Q402, I began the tedious search for transistors that were both more stable and had greater output on the two higher bands. After trying perhaps 100 devices of maybe 5 or 6 types, I finally found the right combination. Q401 seems to be not as critical as Q402 is, and almost any PN2222, 2N2222a or MPS2222a will work fine for Q401. However, Q402 is a different subject entirely. Nearly every flavor of xx2222x device I tried caused spurious output and instability - especially on 10m. The ferrite beads offered no help in reducing this problem.

I finally found (after some mumbling and cursing) one or two 2N3904 transistors that behaved well and gave decent output on 10m. Many of the 2N3904's I tried were simply "too hot" and caused a spur on the transmitted waveform between 3 and 5 watts output. The OHR WM-1 wattmeter also indicated a sharp increase in output level, due to increased harmonic / spurious output. The extra "trash" on the transmitted waveform was easily noticeable.

Apparently, without major changes in the circuit design, about 4 or 5 watts on 10m is the greatest output level that can be produced without excessive spurious content. I settled for this, using a prime MPS2222a (R/S pn. 276-2009, $0.59 ea) for Q401 and a MPS3904 (R/S pn 276-2016, $0.59 ea) for Q402. If you have several different manufacturing brands for the 2N3904 device, try them. Some behave quite differently from others, and you need to find one that is not too "hot" but has decent high frequency performance. Expect to spend some time trying quite a few before you find the correct device, and the Molex pins or sockets are a must for this selection process.

Note that the ferrite beads were of no help in reducing the spurs, and are not required or recommended with the transistors I recommend. The 2N4401 part mentioned by some was a poor performer compared to the 2N2222a / MPS2222a and 2N3904 / MPS3904 combination for Q401 and Q402, respectively. My final choices were *both* made by Motorola: Q401 is a MPS2222a and Q402 is a 2N3904, although Radio Shack lists it as a MPS device, it is actually branded as a 2N3904 device.

The final result is a broad range of adjusting the CW Level Control will produce from 7-8 watts on 80m through 12m, and about 4.5 to 5 watts on 10m, depending on the VFO setting. No instability or sudden changes in output level occur on any band, as it should be.

As mentioned in the HW-8 Handbook , I use and recommend NTE401 heat sinks for long life of the MRF237 PA transistors, especially if the ambient temperature is high (as in AZ on BUBBA day!) or if you enjoy long tune-ups, 5 watt operation, or rag-chewing. They will just fit if you adjust the position of T403 slightly. Use a small amount of thermal compound before pressing the heat sinks into place. The band switch shaft will just clear the new heat sinks, that have one more fin and are slightly larger in diameter. Use one of the original heat sinks on Q404 if you like (it's not really needed) and rest confidently that the PA transistors Q405 & Q406 are much cooler in operation. Be safe and hold the output level at 5 watts maximum.

I'm curious as to why Heath didn't design the PA stage as a push-pull output, as it is almost as simple as the parallel PA design they used. One day I might try to change it to push-pull as that would insure the two transistors share equally in the load, and second-order harmonics would be even less. Some biasing changes might be necessary, but the parallel scheme works just fine, although if the two MRF237's aren't pretty close in characteristics, one of them will "hog" more of the load than the other. If your rig's output is low on all bands, one MRF237 is probably toasted.

[end of first posting to QRP-L]

AGC MODS

The AGC is too fast for my tastes, and the S-meter tends to beat itself to death on CW signals as it jumps up and down on every CW character. There are a couple of ways to slow the AGC and S-meter operation. Either decrease the value of C317, a 3.3 uF electrolytic; or increase the value of R312. Or, do both! I decided to simply remove R312, a 47k 1/4 watt resistor that is the primarily discharge path for C317. This slows the AGC and S-meter quite a bit, and is easy to do. C317 then discharges through R311 and R309, as well as R316 and IF amplifier U301. Some discharge also occurs by way of D306 and the S-meter FET amp.

While trying several caps for C317, I found a 33 uF cap produced about what I wanted for the AGC time constant / S-meter behavior. But I concluded such a large value of capacitance might load the AGC output level of U302, causing a loss of proper attack time and AGC peak voltage level. I therefore decided on removing R312, which produces about the same affect on AGC time constant with no additional loading of the AGC circuit.

TRANSMIT / RECEIVE TRANSITION IMPROVEMENTS

Much of the improvement of the T/R switching is achieved by the mods to the keying circuit mentioned earlier. However, some additional improvements can still be had by addressing the receiver muting. Transistor Q303 is a MPSA20 (Heath pn 417-801) general purpose device. It lacks the low ON saturation voltage and switching characteristics needed in muting the audio input to U306, the AF power output amplifier.

Using Molex pins again, I tried a large number of NPN transistors for Q303. Most of the high gain, low VsatON devices performed better muting of the audio line and helped reduce the small T/R pops during fast QSK settings of the Mute Delay adjustment pot. Believe it or not, the best device turned out to be a spare Heath transistor I had for my SB-104A transceiver! It is a Heath part number, 417-233, or a 2N3643.

If you can't find something similar, look for a high beta audio transistor with 600ma to 800ma maximum collector current rating. The NTE replacement guide shows a NTE128 as a possible part. Run the audio gain at near maximum while keying the rig at the shortest Mute Delay settings to find the quietest transistor. Note that you should *not* turn the AF gain to its maximum setting, as this will induce another T/R pop that is practically impossible to eliminate without further modifications. This was mentioned earlier in the section on KEYING mods.

It is also *not* necessary to increase the CW Level so that the rig is transmitting, unless you think the additional current draw might introduce more T/R noise. I did not notice this with my rig.

I should mention that a 2N7000 TMOS FET could be used as a muting transistor, but unless a discharge resistor is added from the Gate to ground, once the Mute signal is applied to the 2N7000's Gate, it will "latch" and not turn off during the return to receive! I tried a 2N7000 on mine, and although it worked well at killing the audio pops during Mute, I decided the 2N3643 worked just as well and did not require another resistor as the 2N7000 would. Several mods have appeared in various publications about putting a series Mute FET in the audio lead to the input of the AF power output IC, but this requires more effort and modifications than just finding the "right" muting transistor for Q303.

HELP FOR THE BFO, VFO, ETC.

If you still can't get enough output on your rig after doing the pre-driver mods for Q401 and Q402, you might have low output from the BFO circuit. Note on the schematic how the output level of the BFO is varied by the CW Level Control on the front panel. Diode D143 is used to shunt a portion of the BFO signal to ground before it is introduced into the SBL-1 bilateral diode ring mixer. This is a rather unconventional yet effective way to control the transmitted power level.

Since Heath commonly used the MPSA20 (Heath pn. 417-801) device in many kits and circuits such as the BFO in the HW-9, I figured it was probably not the ideal device for RF applications. Once again, some improvement can be gained by selecting a better device for some of the BFO stages. There are a couple of choices here to obtain increase BFO drive - both for the transmitter stages and also for the receiver's Product Detector. You can either pull out several of the Heath 417-801 transistors and select the best ones for critical circuit locations, or use another device altogether if you don't mind replacing the original Heath parts.

Since I had some Heath 417-801 spares from my SB-104A rig, I decided to pick a few of them for the BFO that gave me the most output without making any other changes. If you remove several 417-801 transistors from your HW-9, you can select the ones that perform best where they are needed. Otherwise, use MPS2222A, 2N2222A, or 2N3904 transistors that are widely available.

Using Molex pin sockets for Q113, Q114, and Q115, try several different transistors for the greatest and cleanest output of the BFO. Monitor the BFO level using the Heath provided RF detector at test point TP104, and / or the S-meter during transmit as it monitors relative power output. You should not increase the Boo's output to the point that spurious output is developed from overdriving the SBL-1 mixer and succeeding transmitter stages. You wouldn't want to undo all the work just done in the pre-driver stages by applying too much BFO injection!

I found a couple of 417-801 Heath transistors that were much better than the original devices in the BFO stages. The most critical device is Q113 for decent BFO injection to the receiver Product Detector, U303. For the transmitter BFO injection, Q114 seemed to be more a factor than Q115 (as you might expect!), and the increased BFO signal made available allows the CW Level Control to be adjusted to a lower setting for good output and smooth control of the PA output level.

In fact, the additional BFO output actually seems to make the CW Level Control more broad in its adjustment. This is probably due to a greater available amount of BFO RF into D143 at lower settings of forward bias from the CW Level Control, rather than when it is almost biased completely off for greatest PA power output when only low BFO drive is present. D143 must have a more linear affect on the output level while it is still partially forward biased versus when it is nearly completely biased off.

The MPF105 used for the BFO oscillator turned out to be more than adequate, and so it was not replaced. After selecting your favorite part for Q113 - Q115, be sure to re-adjust the BFO frequency, and BFO filter inductor L137 as outlined in the manual.

Low VFO output can be corrected with a 2N3906 at Q106, or try several Heath 417-234 transistors (2N3638A) if you have them. My

VFO does not exhibit much drift, and other info on tracking down excessive drift is covered in the HW-8 Handbook.

I used a 5.6K resistor across Transmit Return control R131 to make it less touchy to adjust. Just tack it onto the outside leads of the trim pot from the top the PCB. If 5.6K is too small, try a 6.2K resistor instead. The object is to make the adjustment of the Transmit Return voltage very broad, rather than the difficult adjustment it previously was. Another method would be to use a smaller control than the 50k pot Heath provided, and adjust the ratio of R127 / R131, but the parallel fixed resistor across R131's terminals is easy and neat.

VFO DRIVE PROBLEMS

The small vernier drive used to tune the VFO cap has low torque, and the VFO cap is often mis-aligned with the drive mechanism, causing binding and slippage of the dial. I checked the VFO cap shield for squareness, and it seemed OK. However, the VFO capacitor itself seemed to be non-perpendicular from the rear mounting surface to the shaft. Many HW-9s have one of the VFO shields removed, since this makes the shields more rigid to flexing, with the result being the dial and shaft will bind.

Also, if the vernier is not properly mounted and the hex nuts at EACH end of the vernier tightened properly, there is not enough torque to overcome VFO drive friction. Be sure the vernier nut closest to the small pinion that is part of the VFO variable cap is snug. If that is satisfactory, tighten *only* the front hex nut on the vernier to secure it to the VFO shield. It is wise to leave the three mounting screws on the rear of the VFO slightly loose and rotate the VFO through its entire range of rotation before final tightening of the vernier drive and the VFO capacitor mounting screws. Find the location of the VFO cap mounting that results in least binding.

If it still binds, either place thin shims between the VFO capacitor and the rear of the VFO shield, or leave the VFO cap mounting screws just slightly loose, but not too loose. Try turning the VFO cap to the point of greatest binding, and then make small movements in the vernier drive and/or VFO cap mounting screws until it frees up a bit.

I was able to retain the second VFO shield (which I had to fabricate, since it was missing from my HW-9) and find a workable adjustment of the shield and VFO mounting screws. The slide-on second VFO shield is useful in making the knob and tuning shaft "feel" more rigid, as without it, the single "U" - shaped VFO shield is inadequate for overall VFO rigidity. A "box" shape is many times more rigid than a "U" shape, so use both shields if you can without excessive dial slippage. The rotation of the dial should be light and free of binding if you can get it all to work out properly. It is a poor design, and *very* temperamental to assemble.

[end of second post to QRP-L]

HW-9 VOLTAGE REGULATOR

Change U402 from a 78L08 to a 78L09 regulator, and replace D409 with a jumper wire. This will give you a nice solid 9 volt regulated supply with better regulation and slightly cooler operation of U402, as it isn't dropping as much voltage. I thought I could hear a very slight "chirp" on the transmitted signal before I made this change, and the original setup only provided about 8.6 volt with the diode in series with the regulator's ground pin. The diode is not in the error feedback loop of U403, so the regulation is not what it should be. The additional few tenths of a volt and better regulation are welcome in the VFO, second IF filter/amplifier, and AGC circuits.

Notice that as Heath designed the radio, the BFO isn't operating from a steady regulated source. Many critical circuits in the rig are powered direct from the poorly regulated 12 volt main supply, rather than an accurately regulated source. I will later describe mods to the PSA-9 power supply to correct poor regulation that can also contribute to frequency shifts during transmit. If you use a different power supply to run the radio, be aware that its stability under load needs to be good to keep the signal from chirping, as the BFO and HFO do not like an unsteady DC source. Frequency stability from these circuits is crucial to signal quality.

IMPROVING THE PSA-9 MATCHING POWER SUPPLY

Heath really did a bad job on the power supply for this great little rig. The original design has three series-connected 1N4149 diodes in the ground lead of a LM78L12 three-terminal 100 ma regulator. This is to compensate for the approx. 0.7 volt drop in the current-boosting transistor that is added to increase the output current capacity to 1 amp, and to also boost the output voltage to 12.6 volts or so.

This is bad practice for good voltage regulation, since the added diodes and series current-boost transistor are all outside of the LM78L12 regulator's error amplifier, which in itself is a pretty good device. It's just plain bad design, and whoever at Heath designed this should have known better. Heck, an ordinary LM7812 would be simpler and much better regulated, but I wanted to have the ability to adjust the output voltage and still have good regulation.

Enter the LM317T three-terminal adjustable regulator, (R/S p.n.276-1778, $1.99) I stripped all of the parts off of the smaller terminal strip in the original design, and saved the diodes in the bridge rectifier. I decided to use a 4700 uF 35v filter cap instead of the 2500 uF 50v cap Heath provided. The Heath cap is probably adequate, but I had the Radio Shack electrolytic (R/S pn. 272-1022, $3.95) and felt the added filtering couldn't hurt.

Since I like a narrow range of voltage adjustment, I employed a 100 ohm trimpot for the fine voltage adjustment, and used fixed resistors to set the limits of voltage ranges. A 150 ohm 1/4 resistor is used from the output pin of the LM317T to the adjustment pin, and after doing some calculations and a few trial and error tests, I used a parallel combination of a 2.2K and 3.9K resistor between the adjustment pin and the 100 ohm trimpot that connects to ground. The resulting range of adjustment is about 13.1 to 14.1 volts, with 13.6 volts near the trimpot's center setting.

MAKING THE MODS TO THE PSA-9

Mount the 4700 uF 25 v (or re-mount the original 2500 uF 50v cap) electrolytic on top of the larger terminal strip to provide room to work on the new regulator circuit that is built on the small terminal strip. Remove Q1, and the small terminal strip from the power supply. Remove the pilot lamp assembly and save it for later re-installation. Strip all of the parts from the small terminal strip, and save the 100 uF cap for later re-use. The 1N4149 diodes, the 1 ohm 2w resistor, and the 1500 ohm 1/4 resistor can all be discarded or tossed into the junk box. Clean all of the solder, flux, and crud from the small terminal strip using a Solder Sucker or Soder Wick and acetone and prepare it as follows:

Cut the terminal strip so that it has only 7 lugs, with 4 on one side of the ground lug and two on the other side of the ground lug. Mount it with the 4 lug side towards the left edge of the power supply chassis as viewed from the front panel. This is flipped from the way it was originally mounted. You may want to pre-mount most of the following parts to the terminal strip temporarily mounted on the outside bottom of the chassis for convenient access to the lugs.

If you have another value for the trimpot, you'll need to experiment with the fixed resistors between it and the adjustment pin to get the 13.6 volts or so I think is ideal for the HW-9. Use another pot of 3K to 5K in place of the fixed resistor for a coarse control and use the small value trim pot you'll keep for the fine adjustment. Set the range with the 3K or 5K pot with the 100 ohm to 500 ohm fine adjust pot in its center setting. Then, measure the value of the 3K to 5K pot with an ohm meter and select a fixed resistor or combination of fixed resistors to match the measured pot value.

I soldered some 16 gauge wires to the LM317T 3-terminal regulator and covered the connections with insulating tubing. It is mounted in the same hole as Q1, (Heath pn 417-852, TIP31) the pass transistor was bolted, using the same insulating mica washer and nylon shoulder washer. I soldered the input pin of the LM317T to the positive terminal of the 4700 uF 35v (or 2500 uF 50v cap if you keep the Heath part), and connected the adjustment and output leads of the LM317T to the first and second lugs of the small terminal strip, as viewed from the front of the power supply, left-to-right. The 150 ohm resistor is connected from lug 1 to lug 2, and one end of each of the parallel combination of the 2.2k / 3.9K resistors are also soldered to lug 1, with the other ends soldered to lug 4.

The 100 ohm trimpot (a CTS blue knob miniature trimpot, like the ones Heath uses in the HW-9) is soldered facing up across lugs 4 and 6, with the center (wiper) lead in the bottom hole of lug 5. Bend the outer terminals of the pot so they are flat against the terminal lugs, and at a right angle.

I re-used the 100 uF electrolytic cap C2 from the old circuit for transient load suppression. The negative lead connects from lug 7 to lugs 6 and 5 (ground). The positive lead goes to lug 2 and 3 (output). Also run a wire from the bottom hole of lug 2, which is the output, to the fuse mounted on the back of the case. The pilot lamp is retained and connected to lugs 2 (output) and 7 (ground).

I heavily painted the terminals of the AC power slide switch with some red fingernail polish, so I would be less likely to touch 110v when adjusting the trimpot to the desired output voltage. You could also use some insulating sleeving if you re-dress the wires on the switch lugs slightly.

I noticed some voltage drop across the original 1 1/2 amp output fuse that reduces the loaded voltage regulation. I replaced it with a 2 amp fuse that had less series resistance and caused less voltage drop under load. A better solution would be to move the fuse to the unregulated side of the LM317T chip, between the filter cap and the input terminal. This would eliminate all fuse-induced voltage drop, and still provide the desired protection from short circuits across the output, and would also protect the LM317T and rectifiers better.

The new regulated supply is adjustable from about 13.1 volts to 14.1 volts, with 13.6 volts near the center of adjustment. Output current is more than 1 amp, typically 1.5 amps, and the ripple is below 1 mV on my DVM under a load of 1.5 amps using a 8 ohm load resistor. The output voltage as measured between the power supply chassis and the input to the fuse does not measurably change from no load to 1.5 amperes. The only measurable voltage drop is in the wiring and connections to the HW-9, and this is only approx. 0.2 volt during transmit. The HW-9 now has a very stable power supply that is ripple-free and well regulated, further reducing the chance of any frequency shift of the BFO, or HFO, since they are supplied from the 12 volt (13.6 volt actual) PSA-9 DC supply.

REMOVING THE VFO CAP AND RESTORING THE POTS

I find it easier to remove the screws securing the back panel and middle shield to the sides of the chassis to permit room to remove the VFO capacitor. Leave the middle back panel screws alone, and spread the sides slightly to allow both the T/R and Oscillator boards along with the middle shield to slip back an inch or so. Then the VFO cap will come out easily if you have removed the tuning shaft extension and the four 4-40 nuts from inside the VFO shield.

If the pots for some or all of the front panel controls have gotten dirty or feel poor, you can unsolder the wiring and remove them to be cleaned. By prying up the tabs that hold the back of the pots together, the resistance element and shaft can be removed. Clean the wiping contacts and the resistance elements with Q-tips or a toothbrush and Soft-Scrub (tm). Rinse everything well under water and dry. I use silicon grease on the shaft and shaft bushing to get that nice "feel" when rotating the pot. The RIT pot needs to have a little grease on its back cover to allow the center detent to act properly. Replace the pot cover and gently squeeze the tabs back in place with some large needle-nose pliers. This may save you some money on new pots, and will generally restore the pot's function to new condition.

SUMMARY ***[But not the final one—there's more after this!]***

If you try some or all of these mods, please let me know how well they did or didn't work for you. I welcome your comments or observations. Note that Heath made several errors on the schematic, and that all of the active audio filter ceramic disc caps should be identified as 1000 pF (.001 uF), even though C339 and C341 are shown as 100 pF. Also, R354 is shown as 15 megohms, when it is really 1.5 megohms as R359 is. I am still trying to find out what device Q403 is, as the manual fails to mention it in the Semiconductor Identification Chart. It is only identified as a Heath part number 417-865, for which I have no information. There are surely more errors and omissions in the manual and schematic if you look for them.

Thanks for the interest in improving the HW-9, and try these ideas if you get a chance. I think you will like the results. For more info on improving the crystal IF filter, see the ARRL's Hints and Kinks for the Radio Amateur, 13th edition, pages 1-4 and 1-5. I have the Kenwood IF filters to do this mod, but I think I'll use the radio as-is for a while before getting out the soldering iron again. ;-)

[end of third post to QRP-L]

After his three part post to QRP-L, Gary later followed up with this additional material—

VFO DRIFT FIXES

I've found some more areas of the HW-9 that need addressing. Everybody knows how badly the HW-9 drifts, so I have read everything that I could find that was been printed about curing the drift. I now have it down to at least tolerable levels, though some additional improvement is a definite possibility once I get some more capacitors with other temperature compensation values.

Note that most HW-9's drift upward in frequency, some as much as 3 kHz over an hour or so. Changing a single cap in the VFO circuit can counteract the drift, or at least it did on my rig. Receiver and transmitter frequency drifts upward,while the actual VFO freq. is downward. So to begin with, here are some things to try:

Remove the VFO inductor shield for L118 and paint the inside of it with some flat black paint. Clean the paint off the solder tabs and outside of it with a cloth soaked in paint solvent so it can be re-installed. Allow the painted shield to dry thoroughly while you do the following steps.

Remove L118 - the VFO inductor - and check it to see if it is epoxy coated. Some HW-9's had this inductor coated with epoxy and they are reported to have the worst drift. Mine seemed to only be coated with RF shellac, as it has that characteristic smell that used to be common with all the old tube radio equipment inductors and chokes.

Whether or not it has epoxy or shellac coating, you can still try the following measures to see if you can stabilize it a bit. Use a hair blow-dryer, heat it up to a good temp but watch that you don't get it so hot that the cardboard form starts to turn color. My hair dryer would not go that high in temperature, but you should be careful with the inductor since you probably can't get another one. Once you have it good and hot, set it aside for 30 minutes or so to cool. Repeat this process at least four times.

Next, look at the components inside the VFO coil shield area, and move any caps and/or diode D118 so that no parts touch the coil shield when it is replaced.

Check your junk box to see if you have a 33 pF or 36 pF N150 to N220 disc cap. Replace C184 with this value. I used a 36pf N220 in mine and the VFO freq. drift has decreased to only 400 Hz (downward in freq.) in the first thirty minutes, stabilizing within a few Hz after 30 minutes. Try another N-value if you don't get good results with this recommendation.

I noticed that by taking a plastic drinking straw, and blowing gently on *only* NPO caps C186 and C188 there was a big decrease in VFO frequency. So although they are NPO's - they don't seem to be very temperature stable.

They are also outside of the VFO inductor shield, so they are exposed to a different environment than the caps within the VFO inductor shield. With the HW-9's cover on this might not pose such a problem, but I would like to try some other NPO's for these caps or maybe some that have negative temperature coefficients. Just be aware that these caps are a potential problem for temp. stability since they are exposed and have a large influence on the VFO freq.

Compensating C184 inside the VFO inductor shield is not a cure-all, but it helped a lot with my rig. I would recommend not adding dial or meter lamps to the rig, since that would present a large source of heat that would adversely affect the temp. stability.

HW-9 T/R CIRCUIT CHANGES

There was a mod by S.W. McLellan, ND3P, to the T/R switching circuit that appeared in QEX for October 1990 and was later reprinted in the ARRL's "QRP Power" book. It is fairly involved, but is said to increase the sensitivity on 12m and 10m. Plus, it also cures a problem of transmitted RF getting into the receiver circuits, particularly the receiver R12 power source. At RF output levels just a little above 1/2 watt to 1 watt, D407 starts to rectify some of the transmitted RF and places a negative potential on the positive R12 line that goes toward ground potential on transmit and should stay close to 0.4 or 0.5 volts. The rectified RF drives the R12 line more negative and upsets the base - emitter junction of Q103 in the VFO RIT circuit. This is a bad thing.

If you listen to the transmitted signal of the HW-9 on another receiver while you vary the rig's output with the CW level control, you will detect a big change in the transmitted frequency. Not only that, the RIT control that is supposed to be deactivated during transmit has a considerable effect on the transmitted frequency! Because of this, your TX offset that is supposed to be determined *only* by the BFO being pulled 700 Hz lower in frequency won't be correct at all. And this problem varies from band-to-band with different power levels. What a pain this is!

In addition, the TX return adjustment provided by R131 is badly upset by the negative R12 voltage applied to Q103's base. If you put your digital voltmeter on Q103's emitter, you will see what I'm talking about. The rig's frequency wanders all over the place with CW level adjustments and RIT position during transmit. Here's how to fix it. One way is simple, the other is not.

You can elect to do the full T/R mod as suggested by ND3P in QEX or the reprint in QRP Power. This requires removing the T/R printed circuit board and adding some genuine PIN diodes, a transistor, and changing a few additional parts. It is pretty difficult to do, but the reward is said to be improvement sensitivity on 10m and 12m. I decided to pass on it because of the complexity involved.

There is simpler fix I have come up with. Clip and lift one end of R132, a 10K 1/4 watt resistor on the OSC printed circuit board. Try to leave a little bit of lead between the resistor lead and its body, and the clipped end at the PCB. Solder a 1N4148 or 1N914 silicon diode between the clipped leads, with the cathode (banded) end facing toward Q103's base lead. You're done! Now if you check the freq. while changing the transmitted output level with the CW Level control, the transmitted frequency is rock stable. Similarly, the RIT control during transmit will have *no* effect on the transmitter's frequency at all. Success!

Note that the TX Return adjustment with trimmer R131 is stable now, and it does not change the voltage at the measurement end of R127 when you set it with your DVM and vary the CW Level control. Put a 5.6K or 6.2K resistor across R131 if you want it to be less critical to adjust.

The addition of the diode in Q103's base lead prevents the R12 voltage that goes increasingly negative during higher RF output levels from upsetting Q103 and varying the voltage on RIT diode D118. The rig sure is stable now, at any power level and on all bands. No doubt this fix makes the rig sound better on the air, and when you change the RIT control during a QSO, your transmitted frequency will stay put.

BFO TX OFFSET ADJUSTMENTS

With the transmitted frequency now stable, regardless of power level or RIT position, you might want to check the TX offset frequency to see if it is 700 Hz as it should be. Using a freq. counter or separate receiver, check the freq. at TP104 on the OSC board. Set it to 8.831400 MHz with L135 through the hole in the metal shield.

With the CW Level turned down to prevent the PA transistors from overheating, check to see if the freq. changes to 8.830700 MHz during transmit. Or, if you are using another transceiver to check the frequency, you'll need to allow a small amount of transmitter output in order to hear the HW-9's signal while using a dummy load. See if the transceiver you use for calibration has a 700 Hz TX offset and adjust it if necessary. My TS-570D tracks its CW sidetone with the TX offset freq., so it is easy to match the HW-9's received audio frequency with the TS-570D's sidetone and then listen to the HW-9's signal on the TS-570D for the same audio note. No re-tuning of either rig's tuning knob should be needed when the BFO (TX) offset is correct.

If the TX offset is not close to 700 Hz, you'll need to change capacitor C205 under the BFO shield. I used IC socket pins and selected a 75 pF silver mica cap from seven or eight I had on hand until I got a 717 Hz TX offset. You could also use a combination of a smaller fixed cap of 47pf or so, and a tiny trimmer of 6-30 pF if you want to set it to exactly 700 Hz.

MORE ABOUT THE HW-9 T/R CIRCUIT

While I was investigating the problem of poor RF isolation in the T/R switching and the effect it has on the R12 control voltage, I noted some things worth mentioning. Diode D407 is under a great deal of stress. On my rig, the output on 80m can be as high as 8 or 9 watts if you aren't careful with the CW level control position. This much RF voltage can possibly destroy the 1N4149 diode used at D407, since it is essentially across the PA's at T403 right before the output filter network. If D407 fails (and it did fail once in my rig), it shunts all of the PA output and the PA transistors are in danger of destruction. If this happens, you will hear the power supply groan a loud buzz, and the output on the relative power meter will go very low. If this happens, stop transmitting immediately and change D407!

I put some IC socket pins on the PCB where D407 goes, and tried some diodes to see which ones allowed the best RF isolation and best receiver sensitivity without modifying the bias circuitry as Heath designed it. A number of 1N4148's and 1N4149's (the same as Heath's pn. 56-56) were tried. Some got pretty warm when the output level exceeded 5 watts. Normally, you wouldn't exceed 5 watts in operation - but you might during tune-up or on 40m and 80m where a lot of output is available. I suggest you check your HW-9 by touching D407 after (not during, or you'll get a small RF burn!) a few seconds of 5 watts or greater output. If D407 is warm to the touch, you have a problem. You are also potentially losing some RF on 10m and 12m that is needed. The risk to D407 is greatest on 80m, where the RF output is maximum.

I tried several diodes in place of D407, including 1N4007's and even some 1N5767 PIN diodes. The 1N4007's got very hot and leaked too much RF into the receiver and the R12 control circuit. The 1N5767 PIN diode failed quickly when the output went past 4 or 5 watts, since it is not biased adequately with the given circuit. I finally found a 1N4149 or two that remained cool, even at RF levels of up to 9 watts on 80m. No other changes were made.

Rather than redesign the whole circuit or do the ND3P mod, I settled on a hand-selected 1N4149 diode for D407. It leaks only a little RF during transmit into the R12 control circuit, and the diode added to Q103's base described earlier corrects that problem. The receiver sensitivity is good, but if your HW-9 lacks sensitivity look at possible low BFO injection into the product detector. Low BFO output at the TX /OUT point on the schematic will also limit the transmitted output level, as will low VFO output. Check these areas, and the previous HW-9 mods I wrote about concerning the transmitter stages.

You might want to put a voltmeter on your HW-9's R12 level and verify it does not go dangerously negative during full transmitter output. That could potentially harm some other components, although a reverse-biased diode across R12 to ground would hold it to -0.6 volts - just in case. That might occur at high SWR levels or if you happen to accidentally transmit into an open load. Just keep in mind that excessive RF passed through D407 represents a loss of desired transmitter output, and possible problems with other areas of the transceiver.

MOD THE MUTE CIRCUIT

You should definitely do the mod to the mute lead of U301 that ND3P suggests, as this quiets another source of audio pops and prevents the S-meter from incorrectly displaying AGC voltage during transmit. It is simple, and easy to perform. See either the ARRL's book "QRP Power", or QEX for October 1990.

SUMMARY

With the added VFO stability and lack of frequency shift under varying RF output and RIT operation, I know you will enjoy your HW-9 much more. Much credit also goes to the contributors of the HW-8 handbook, and other articles found in QST, QEX, etc. Those sources are a good place to look if you want additional information on improving your HW-9.

—DE AB7MY

TESTING A RADIO SHACK RF CHOKE

From me, **WA8MCQ**. KI6DS asked me to do some tests on those 100 uH chokes that Radio Shack sells, part number 273-102C, and cost about a dollar. They are about a quarter inch in diameter, 1.3" long and have two layers of wire. This was in conjunction with the redesign of the DeMaw Tuna Tin 2 using modern components; the original (as well as the subsequent Sardine Sender?) used some of these coils with turns removed and he wanted to know how they performed. (The redesign will be using toroids instead but he was curious.)

The forms are what is believed to be roughly equivalent to type 61 ferrite material, and one thing I found was that they are somewhat fragile. The leads are glued into holes in the ends of the forms, and if they get too much handling they can break out of the form. A little bit of 5 minute epoxy will fix them up if that happens.

Here's the info that I already sent to Doug (with a few changes). If I made errors in some of my assumptions or techniques, or if anyone wants to add anything about the technical topics discussed, I'd be more than glad to hear about it and share it in a future Idea Exchange.

I bought two and checked them out on an HP 8753C network analyzer. (That's a piece of equipment that falls into the class of Dead Serious and Very Expensive Test Equipment That RF Engineers Sell Their Grandmothers to Get Access To.) One was left stock, and the other was measured stock and then with various amounts of wire peeled off. I first stripped off the top layer, leaving just the 27 turns (or so) of the first layer; then I checked it again at 20 and 15 turns.

The bottom line is that the stock choke really shouldn't be used on any ham band higher than 1.8 MHz since it's self resonant frequency is about 2.6 MHz, and the 15 turn version makes a dandy choke at least as far as 14 MHz. (I had the analyzer set for a sweep from 0.3 MHz--lowest possible setting--to 50 MHz, a good practical range to check this coil over. The instrument itself will go as high as 6 GHz.) The use of two layers wound directly over each other is a killer. (Remember the big RF chokes in the old days, the three pie type, and how the wire was wound in a criss-cross fashion? That's done to reduce distributed capacitance and it does it very well indeed, as some later tests showed.)

Originally I typed in this paragraph, before actually trying to do it: "If you still want me to strip the original winding and put 100 turns of #28 on the form as you requested, let me know and I'll be glad to do it. I'm presuming that was with the intent of possibly using it as a choke at RF, and it's pretty obvious that it would make a poor one, with a self resonant frequency well below any possible ham band. On the other hand, it might be good for the broadcast band or LF, but I can pretty much guarantee that it would be nowhere near enough inductance to be useful in any audio filtering application; the permeability of the core is far too low for that. If you want me to do it, let me know."

Surprisingly, after actually trying it, the results weren't all that much different from the stock coil. I wound 70 turns on the core, about all it would take in a single layer. N2CX told me the spool of wire he gave me was #28, but according to my dial calipers and the wire charts in the ARRL handbook it looks more like #27. Unlike the stock coil, I wound those 70 turns in a single layer. The results are detailed below, but the bottom line is that it's pretty similar to the inductance of the stock coil but with vastly lower distributed capacitance.

THE UNMODIFIED CHOKE

The stock, unmodified RF choke, with two layers of wire, as measured at home on my Boonton 260A Q meter has an "apparent inductance" (L_{app}) of 114 uH at 790 kHz (one of the standard frequencies at which the inductance can be read directly from it's calibrated dial). The Q was 37 at that frequency. Corrected for the distributed capacitance (Cd) which was later measured at 43 pF for the stock coil, that is reduced to an even 100 uH. (At 790 kHz it resonated with 360 pF, but the actual resonating capacitance was 403 pF when Cd is factored in. That's 360 pF external to the coil, plus 43 internal picofarads.)

The highest frequency at which it could be measured on the Q meter was 1.865 MHz, which is where it resonated with the tuning cap in the 260A set to the minimum of 30 pF. That gave an apparent inductance of 242 uH, corrected to 99.7 uH when Cd was factored in. Coils with large amounts of Cd can give very misleading indications when measured by resonating with small external capacitances, since Cd becomes a very significant part of the total resonating capacitance. (This is a problem whether you're using something like a Q meter or just a dip meter and a handful of capacitors.) In this particular case it is especially misleading, since Cd of the coil (43 pF) is greater than the external capacitance; while the resonating capacitance in the Q meter is 30 pF, the total amount of capacitance is 73 pF.

I'm no expert in metrology so I won't attempt to interpret or explain some of the readings I got on the network analyzer at various frequencies, except to say that the indicated inductance changes quite a bit with frequency, climbing rapidly as it approaches the self resonant frequency. For example, at 300 kHz it shows 81 uH, 92 uH at 1 MHz, 100 uH at 1.2 MHz, 120 uH at 1.5 MHz, 216 uH at 2 MHz and 400 uH at 2.25 (which is getting close to self resonance).

The important thing is the self resonant frequency, which is something that should not be approached when using the coil, and that is a disappointingly low 2.5 or 2.6 MHz. Above that, the coil appears capacitive, of varying impedance, up to about 12.2 MHz when it once again goes over to inductive but at a vastly lower inductance (single digit microhenries), back to capacitive between 19.2 and 43.9 MHz, and finishing up the sweep to the top frequency of 50 MHz as inductive.

I originally believed that using an RF choke to feed power to the final of a QRP rig operating at a frequency that is above the self resonant frequency of the choke is inherently bad (RFC in Figure 8). But after swapping a bit of e-mail with W7ZOI and talking with some of the RF engineers at work, as well as doing some tests on the network analyzer, I've decided that's not necessarily true. As always, the impedance of the choke at the operating frequency should be much higher than the impedance of the circuit (I've seen rules of thumb between 4 times and 10 times), but as long as the impedance is high enough it doesn't matter if it is inductive or if the coil has gone above self resonance and appears capacitive (as long as the transistor remains stable).

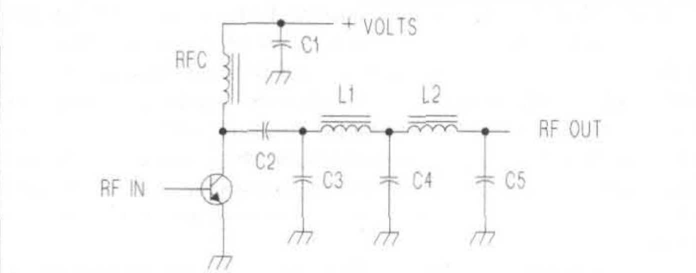


Figure 8—Typical HF QRP rig final amp and filter

ONE LAYER STRIPPED OFF

With the top layer of wire stripped off and about 27 turns remaining in a single layer, the indicated inductance on the 8753C was around 22 uH at 3.5 MHz, rising to 25 uH at 7 MHz, and 32 uH at 10.1 MHz. As inductors get closer to their self resonant frequency, the indicated inductance starts ramping upward. As I said, I can't really explain or interpret that until I talk with someone at work who uses the analyzer a lot, to find the practical significance of it. The important thing is that with 27 turns the self resonant frequency was up to a respectable 17 MHz.

DOWN TO 20 AND 15 TURNS

I pulled off more wire to get 20 turns, and the 8753C gave about 12 uH at 3.7 MHz, 13.6 at 7 MHz, 15.6 at 10.1. The self resonant frequency was 21.8 MHz. At 3.7 MHz it was showing a net reactance of 290 ohms, and 600 at 7 MHz, both of which easily meet the rule of thumb that says that an RF choke should have at least 4 times the impedance of the circuit (presuming 50 ohms).

Finally, down to 15 turns. (As I pulled off turns, I kept them close spaced.) The self resonant frequency was a respectable 26.8 MHz. It held at 8 or 9 uH through 7 MHz, 10 at 10.1, 11.6 at 14. That 8.5 uH on 80 meters provided about 197 ohms, which is at the limit for the rule of thumb, but on 40M it was almost 400 ohms (9.0 uH).

I measured the second stock coil and it was also self resonant at about 2.6 MHz.

MEASURING DISTRIBUTED CAPACITANCE

At home I measured the Cd on the remaining stock coil and the one with 15 turns, using the "approximate method" given in the Boonton manual (which they say gives results accurate to 2 pF). I didn't bother doing the more exacting and complicated method. The "approximate method" involves setting the Q meter to 50 pF, varying the frequency to get resonance, then going to a different frequency, varying the capacitor to obtain resonance, and plugging numbers into a formula. If the second frequency is made to be exactly half the first one, the formula is simplified a bit; the distributed capacitance is found by subtracting 200 (which is four times the original 50 pF) from the new resonating capacitance (which will be over 200) and then dividing that by three.

As I said earlier, the Cd of the stock coil, which had two layers wound directly over each other, was about 43 pF. "Real" RF chokes from the Old Days have criss-crossed wire to keep the Cd lower. The 15 turn coil, with a straight, single layer winding showed 3.3 pF. On the other hand, every single layer powdered iron toroid for use at HF that I've ever measured has been "down in the noise", usually getting readings of 1 or 2 pF, readings which really can't be trusted anyhow since the stated accuracy of the method is +/- 2 pF. As far as I'm concerned, for all practical purposes, powdered iron "HF toroids" can be considered to have no Cd. It's there but not worth worrying too much about.

On to the bare form wound with 70 turns of wire—it measured 5/3 pF, or 1.7 pF, hugely better than the double layer, stock coil of approximately the same inductance. At 790 kHz it resonated with 343 pF, or about 118 uH. Since Cd is not even 2 pF, the apparent and true inductance are essentially the same. As a cross check of the procedures, since I did this on a later day, I went back and measured the stock coil again, and got 41 pF, essentially the same as the other day.

Why did the 70 turns have less Cd than the 15 turns? My guess is that it's because the wire size was a smaller diameter, essentially resulting in smaller plates in the "capacitor". Although there were more turns, the wire size was smaller by a sufficient margin that the Cd was less.

I wasn't able to measure the self resonant frequency of the form with 70 turns on it at the time but expected it to be reasonably high. Calculations using the approximate values of 100 uH true inductance and 43 pF Cd for the stock coil comes out to a hair over 2.4 MHz, in the ball park of the measured value on the HP8753C. Due to the resolution of the analyzer and touchiness of the dials, the figures I pulled from it for self resonant frequency have a bit of fudge factor built in. For the 70 turn coil, factoring in the 1.7 pF of Cd makes it about 117.7 uH, resonated with its own 1.7 pF for an estimated self resonant frequency of about 11.3 MHz. Not extraordinarily high, but hey, it's a 118 uH coil after all! And that is hugely better than the 2 1/2 MHz for the stock Radio Shack coil of roughly the same inductance. I later put it on the network analyzer and found it self resonant at about 8.3 MHz.

The bottom line as stated above remains the same, that to get a good RF choke at HF, made from this particular part, I'd recommend at the very least pulling off that top layer of wire, and I highly recommend chopping about half of the remaining turns from that bottom layer. (But even better: use toroids instead.)

TESTING THOSE COILS FROM THE OLD DAYS

I later scrounged up a couple of old, criss-cross wound coils. One was a single pie RF choke on a nonmagnetic rod and the other was wound on a cardboard coil form with a tunable slug. The core of the choke was 1/4", the winding was about 0.32" long, 0.420" outer diameter and approx. 0.090" in depth, with wire size of #36 or #38. At 646 kHz it measured 1214 uH, 8 pF of Cd, and a corrected inductance of 1046 uH. A huge amount of wire, but very small wire and criss-cross wound, and thus a respectably low Cd, much lower than the Radio Shack coil. Later testing on the 8753C showed self resonance at approximately 1.7 MHz, essentially the same as the calculated frequency of 1.74 MHz.

The coil on the form with a tunable slug gave an apparent L of 3564 uH at 377 kHz, corrected to 3126 uH after factoring in the Cd of 7 pF. The size was similar; the core is about 0.28" dia, the winding is 0.274" long, about 0.487" outer diameter and 0.110" deep. The wire on this one is also #36. As with the choke, this one had low Cd due to the cross-cross winding technique. In both cases it's hard to tell how many layers are on them, but they both appear to have something like 6 to 8 layers. This one self resonates at about 2.3 MHz. (That's a little over twice the calculated value for some reason.)

DISTRIBUTED CAPACITANCE: Figure 9A shows an ideal inductor; it has inductance and nothing else, but real inductors have a certain amount of capacitance between the turns, as shown in Figure 9B. The net effect is shown at 9C, which is an inductor with some capacitance in parallel with it. (Real inductors also have some resistance in series with the inductance, not shown here.) This is known as Cd, or distributed capacitance.

Among other things, Cd can make an inductor appear to be larger than it is. If you measure the value by paralleling the inductor with a capacitor and measuring the frequency at which it resonates (a common technique), Cd can give distorted results. Say that the inductor resonates at some frequency with 30 pF connected to it, but

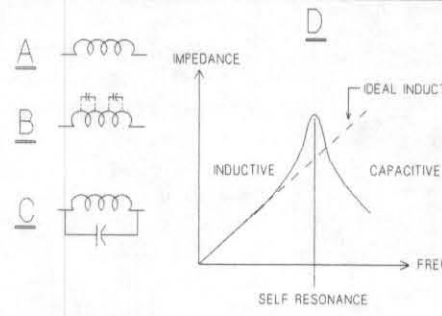


Figure 9—Distributed capacitance, and impedance vs. frequency for ideal and real inductors.

that Cd is 43 pF (such as the Radio Shack RF choke). It is actually resonating with 73 pF but you think it's only 30 pF. Plug the capacitance and frequency into the proper formula to get the inductance, and the indicated inductance—resonating with 30 pF—will be significantly different from the actual inductance (resonating with 73 pF).

An inductor will be self resonant at some frequency which is determined by the "true inductance" and the distributed capacitance. Figure 9D (found in an old ARRL handbook) shows the relationship between frequency and impedance. With an ideal inductor, the impedance just keeps on going. But make it a real inductor with some distributed capacitance resonating it, and sooner or later you reach a frequency where the impedance peaks, and then starts coming back down—and now it's capacitive instead of inductive. (And even Figure 9D is simplified compared to what the Radio Shack choke does! It flip flopped back and forth several times between capacitive and inductive. Keep in mind that this isn't a defect in the Radio Shack part, but just simple physics and electronics. Any identical part would exhibit the same characteristics.)

Going back to the application shown in Figure 8, even if the choke has passed it's self resonant frequency it can still be usable. The important thing is that the choke impedance remains substantially higher than the circuit impedance. As frequency goes up beyond resonance the impedance will come down and at some point will become unacceptably low, so staying below the self resonant frequency is a good, safe rule of thumb to go by.

QRP-L, THE "QRP DAILY"

The traffic load on QRP-L has increased greatly over the years, as has the subscriber base. As of February 1998 when this was written, the list of direct subscribers is over 2100, and an unknown number (variously estimated at a thousand or more) read it through indirect means. It's common for it to run into the high double digits of postings per day, and it has hit over 100 a few times. It's not for everyone—quite a number of people have subscribed and then unsubscribed since they find it takes too much time to keep up with it. But for those who want a good, healthy dose of QRP every day, this is a great place to get it!

To subscribe to the free Internet QRP forum, started up several years ago by **Chuck Adams, K5FO,** send e-mail to

listserv@lehigh.edu

and leave the subject blank unless your system requires something. In the text, put

subscribe QRP-L <your name> <your call>

That's your real name and real call, not your e-mail address—it gets that from the headers. The name and call are for the benefit of people who look at the subscriber list; unlike some mail reflectors, the one at lehigh.edu also gives names (or whatever you type in) in addition to e-mail address—which can be quite cryptic in some cases.

At one time this would result in your being signed up immediately, but not any longer. Apparently there has been trouble on the Internet with people signing up for mail reflectors with bogus or falsified e-mail addresses. Now when you try to subscribe to QRP-L (and many other mailing lists), you'll get an automated reply saying that someone tried signing up with your address. It instructs you to return a "conf-cookie" code, which it supplies, to verify that the request really did come from you and that you do want to subscribe. Send that code back in e-mail, and after it gets that verification from you it adds you to the list

Save the automatic "welcome" message you'll get after your subscription (free) is processed and read it thoroughly. And pay special attention to the part about enabling the Daily Digest function, which will still give you all the traffic but as a single, huge daily e-mail message instead of several dozen individual messages PER DAY cluttering up your mailbox; I couldn't live without it! The digest also includes a handy index at the top so you can decide which postings look interesting and skip the ones on topics you don't care for.(To reduce online connection time, download the digests and read them offline later with a word processing program.)

By the way, those of you using juno.com with its infamous file size limit of about 60K who want to get the daily digest don't need to worry. Just send e-mail to Jim Eshleman, N3VXI who administers QRP-L and he'll fix you up with an alternative that splits the daily digest into two smaller chunks that juno.com can handle. (His address is LUJCE@lehigh.edu.)

THE FINE PRINT

Your inputs are always welcome! Send them via e-mail, FTP, floppy disk, typed or handwritten. And don't worry about the drawings, if any, since I redraw the majority of them in KeyCAD, so hand drawn schematics, etc are perfectly acceptable.

—qrp—

Review: EMTECH ZM-2 QRP Antenna Tuner

Bob Kellogg, AE4IC **4708 Charlottesville Rd, Greensboro, NC** **email: ae4ic@nr.infi.net**

The ZM-2 Antenna Tuner Kit from EMTECH is a revised version of the ZM-1 originally offered by EMTECH. The main enhancement over the ZM-1 is the incorporation of an SWR indicator (an LED). The ZM-2 is an ideal accessory for QRPers. It's small, versatile, easy to build, easy to operate, and it's very efficient. The photograph shows the completed unit which measures just 5 in. × 2.5 in. × 1.5 in. It is easily the smallest full featured tuner on the market today.

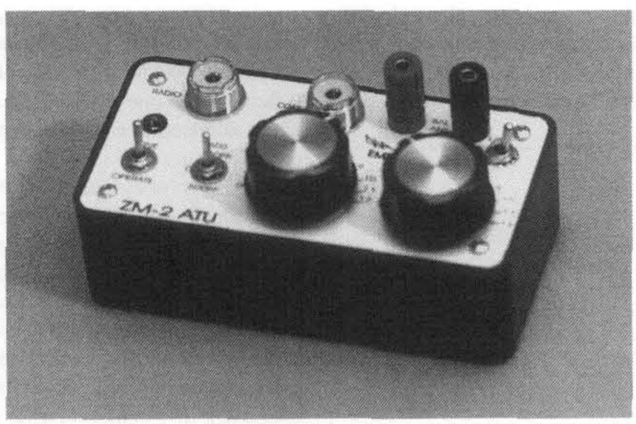
Specifications And Design

The Z-Match design of the ZM-2 contributes to its versatility.[1] The ZM-2 will match balanced ladder line, unbalanced coaxial cable and long wire antennas with equal ease. It will match loads on all amateur bands from 80 meters through 10 meters. Its maximum power handling capability is 15 Watts, so it is truly a QRP tuner.

Controls and connections are all located on the top (or front, depending on your point of view) panel of the ZM-2. Any antenna configuration can be accommodated using the sockets, binding posts and controls mounted on the panel. Fifty Ohm input from the transmitter goes to an SO-239 socket

<u>Balanced output</u>

The ZM-2 output is balanced when the LINK switch is *not* in the GND position. Balanced lines are connected to the top panel five-way binding posts spaced to match common 450 ohm ladder line.



<u>Unbalanced output</u>

Flipping the LINK switch to the GND position converts the output from balanced to unbalanced. A wire antenna can be connected to the red five-way binding post and the counterpoise (if used) or ground to the black post. There is also an SO-239 output socket for use with coax.

Construction

Building the ZM-2 takes a couple of evenings of spare time. The case and all parts are included with the kit. Color-coded wire makes winding the toroids a piece of cake. In my opinion, the ZM-2 is a good kit for the first time builder. I built mine in four stages, as follows:

<u>(1) Inductors</u>

The instructions for winding the main tuning inductor and the small inductor for SWR measurement are very clear. The tapped main coil is wound with color coded wires, so it is difficult to lose track of which wire is which. Large drawings of the toroids illustrate the winding process. I wound both toroids one evening while watching TV.

<u>(2) Top Panel</u>

The kit includes a pre-printed pressure sensitive label for the aluminum panel. This full size label provides dial markings and socket and switch position identification.

A template is supplied with the kit that can be used to locate hole positions. Drilling the thin aluminum plate must be done carefully to assure accurate hole size and location. I used the template to locate hole centers and dented each with a sharp punch. First I drilled 0.125 in. pilot holes, then I used larger bits to enlarge the holes as required. I used a wood block to back up the drill. A rat-tail file cleaned up the holes and did the final shaping.

Finally, I put the panel label in place. It is a paper label, so I put two-inch clear Scotch™ label tape over it to protect the printing. This also gives the panel a nice shiny finished look.

<u>(3) Mounting Components</u>

Most of the larger parts are switches, jacks and variable capacitors which mount to the front panel. These parts all screw in place or are mounted with a nut and lock washer. My kit contained screws for the variable capacitors that were a little too long. I had to put washers behind the panel to keep the screws from bottoming out against the capacitor plates (this problem has been corrected, according to designer Roy Gregson). I mounted my LED in a 0.25 in. plastic holder obtained from Radio Shack. The remaining parts consist of the two wound inductors, a few small resistors, a capacitor and a diode.

<u>(4) Final Wiring</u>

There are two pictorial diagrams in the manual that make wiring the ZM-2 a snap. "Rear View 1" shows the rear of the front panel and indicates how to make the major connections. "Rear View 2" shows how the main toroid inductor and the parts of the SWR indicator are installed. Wiring is done point to point between the parts mounted on the front panel. The main toroid mounts directly between the variable capacitors and the output binding posts. Installing the SWR circuit components is the only awkward part of the assembly process; there are more connections than there are solid solder tabs. Some connections must be made in the air. This works well enough, but it is out of place with the rest of the design.

Operation

Operation of the ZM-2 is simpler than many tuners. There are just two large knobs to adjust, and the ZM-2 will achieve a match at only one position of the knobs. Since the best match occurs at only one position of the controls, the most efficient match possible is obtained. This is in contrast to the popular C-L-C matching units which may indicate a match at more than one position of the controls, but only one will result in the most efficient match. With the ZM-2, the best possible efficiency is guaranteed when a match is achieved.

The LED SWR indicator circuit built into the ZM-2 absorbs considerable power. Therefore it is switched into the circuit to tune, and out of the circuit to operate. There is a small TUNE/OPERATE switch on the top panel for this purpose. This technique has the advantage of limiting the SWR as seen by the transmitter to a maximum of about 2:1 while tuning.

<u>Finding a Match</u>

Connect the rig using a piece of 50 ohm coax to the SO-239 jack marked RADIO. Set the LINK switch to match your balanced or unbalanced antenna configuration as described above (GND for unbalanced). Switch the OPERATE/TUNE switch to the TUNE

[1] For an excellent description of how the Z-Match works, see the discussion in the **HF Antenna Handbook** by Bill Orr, W6SAI. An article describing a version of the Z-Match by Charlie Lofgren, W6JJZ, appeared in the July 1995 issue of the **QRP Quarterly**.

position (be sure to return it to the OPERATE position after tune-up). Key the transmitter. An LED is used as a visual indicator of SWR and at this point it will probably be glowing bright red. Turn the large knobs alternately watching for the LED to become dim. When the LED goes out, the match is 1.1:1 or better. Note: The tuning can be quite sharp on some bands, so turn the controls slowly.

If the LED does not go out and the left tuning knob is fully counter-clockwise, more capacitance is needed on the input side of the circuit. There is a three position ADD switch on the top panel marked 250pF, 0, 500pF. This switch adds the indicated capacitance to the input circuit and may enable a match.

If the LED doesn't go out but does get noticeably dimmer, you have obtained the best match but the SWR may be greater than 1.1:1.

Test Results

I tested the ZM-2 using the technique described by Frank Witt, AI1H, in his April and May 1995 **QST** articles. This method tests tuners under a wide variety of load conditions and over all amateur band frequencies. There were five tested conditions:

(1) Range – This is the number of SWR/frequency combinations, within the advertised frequency range of the tuner that could actually be tuned to 1.1:1 SWR or better. The ZM-2 matched 140 out of 144 combinations tested.

(2) Efficiency – This is the number of SWR/frequency combinations, within the advertised frequency range of the tuner, which resulted in less than 20% (approximately 1 dB) of power loss. The ZM-2 was 80% efficient or better on 60 out of its 140 matches. This may not sound very good, but I have tested many tuners, and this is the best report of any manual tuner I've tested. The meter on your tuner may indicate when it has made a match, but it gives no indication of the efficiency of that match.

(3) Average loss – The average loss of the ZM-2 for all of the SWR/frequency combinations that would match to 1.1:1 or better was 22%. Again, this is very good compared to other tuners. An average figure can contain extremes. I've tested tuners that had 98% loss at a particular SWR/frequency combination while indicating 1.0:1 match. The maximum loss for the ZM-2 was 48% when matching a 16.0:1 SWR on the 12 meter band. Losses were lower than the 22% average with the ZM-2 when the SWR to match was less than 4.0:1 on frequencies lower than 24 MHz.

(4) SWR Bandwidth – Once the tuner matches the antenna system, how far can we tune away from that match before the SWR exceeds 1.5:1? The ZM-2 range was greater than 5% on 61 of the 144 tested SWR/frequency combinations. (5% of 7.2MHz is 360kHz.) This is about average among the tuners I've tested.

(5) Balance – Is the output really balanced? Yes, the output SWR was within 1.5 between the lines on all test conditions with the ZM-2.

Summary

Overall, the ZM-2 is one of the most versatile and efficient tuners I've tested. It has a very broad tuning range, making it ideal for tuning all band antennas.

The ZM-2 kit sells for about $50 and is available from:

EMTECH
3641A Preble Dr.
Bremerton, WA 98312
phone: 360-415-0804
email: roygregson@aol.com

Hi All. For the past few issues there has been a word misspelled in the advertisement of The American Radio QRP Key Mfg. Co. I wrote the ad myself and can blame no one but me. My apology to anyone who might have been upset by this. Ron, KU7Y

The American Radio QRP Key Mfg Co.

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MILLIWATTING: 10dB BELOW QRP

Bob White, WO3B   bobwhitewo3b@geocities.com

Rumors of this column's demise have been greatly exaggerated. I always wanted to be able to use that line but I am sorry it was at the expense of the QQ readership. My move of the family from east to west and increased responsibilities at work have kept me away from this wonderful hobby of ours, but never fear. I have returned!

New QTH

The days of WO3B's 571 foot loop antenna are a thing of the past. The only way that I would be able to put that piece of wire up here at the new QTH is if I used all the trees on the whole block. I should have realized there would be a problem here when I saw that the lot sizes were measured in square feet instead of acres. It was time for a new antenna and since I only signed a one year lease on the new QTH, I was looking for something that would be easy to put up and take down. With no room for any wire antenna on a band lower then twenty meters, I opted for the GAP Titan vertical. It gives me operations on 80 through 10 meters using only a small space in the backyard and will leave next to no trace of having been there when I remove it. Installation time was two days. One afternoon to dig a four foot deep hole and cement in a four foot PVC sleeve, one day of drying time for the cement, and two hours to assemble the antenna, and mount it to the twelve foot steel water pipe which would slipped into te PVC sleeve. The antenna has been self standing in this configuration since November with no ill effects noted from the El Nino storms.

ARRL CWSS

The GAP was up and it was only one week prior to the ARRL CWSS when the XYL informed me that she would be having guests the following weekend, (we are talking CWSS weekend now), and that I would be watching the kids while she took her friends sightseeing. She knew she wouldn't be able to get me out of the house that weekend, but at least I would feed the kids. I normally bump the power up to 5 watts for CWSS and try to spend the full allotment of time on the air, but I resigned to the fact that I would not be able to be competitive this year without neglecting the kids. So, I decided to just try for the 100 contacts required to keep my string of CWSS pins going.

I figured that there was no time like the present to finally run CWSS using milliwatts. With SS Category Class B being 1500 watts and Class A 10 dB down from that at 150 watts, I figured that the proper level for a milliwatter would be 10 dB down from the 5 watt Class Q. So my first CWSS from the new QTH was run at 500 milliwatts output power. The rig was a TS940s running directly into the GAP Titan.

Operating for 9 hours and 45 minutes I managed 104 contacts spread over 44 sections. Seventeen of the contacts were in my own section (SCV) and I bet I could have gotten the full 100 contacts I was looking to make out of the SCV section if I had tried. Twenty meters was good for 11 contacts total between CO, BC, SCV, AK, WI and WWA. 40 meters netted 19 contacts between AB, SCV, WWA, WY, CO, OR, NTX, WMA, STX, OK, EB, and SNJ. The only other band I used and my big performer was 15 meters with 74 contacts in 37 sections (MDC, NLI, VT, CT, KY, SCV, VA, NTX, STX, IL, WI, PAC, CO, OK, EB, SD, SDG, IN, MN, IA, EMA, MO, WV, NNJ, SC, WNY, RI, SFL, EPA, TN, NC, PR, SK, ND, LA, WTX). Not a bad jump start for a 500mW WAS.

Do I miss my loop? You bet, but the GAP let me operate at milliwatt levels from just a slip of a back yard. Was it harder to be heard? Right again, but proper centering of my signal in the receiving stations bandpass normally got me a contact.

Milliwatting Reports

Brice Anderson, W9PNE, reports spending 7 hours of operating during the CQ WW DX contest at 15mW with a modified Argonaut 515. Brice had 32 QSOs with 21 countries in 3 continents. His best DX contacts were JH5ZJS, ZD8Z, ZP5XF, CX5X, and HC8N. He also had 3 KL7 QSOs.

Brice has now worked WAC and 35 countries with 15 mW, 50 countries with 20mW, 70 countries with 100mW and 94 countries with 250mW. Brice is now 79 years old and hoping to finish off his 15mW DXCC as the bands start to heat up again. Brice holds a 50mW WAS and is 22 states into his 15mW WAS. Brice feels that it is easier to work DX than stateside with low milliwatts. Brice uses a TH5DX for an antenna on the upper bands.

Well it's nice to be back. Please note the new snail mail address on the back cover when sending in reports. --QRPp-- WO3B

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Dave, WA4NID, Membership Chairperson

Please use the FORM provided in this publication (or a photocopy) when preparing your application for membership or renewal of subscription. Provide ALL the requested information. PLEASE TYPE OR WRITE LEGIBLY. Be sure to clearly indicate if this is for a renewal or new member. DO NOT JUST SEND A CHECK IN AN ENVELOPE! If you don't use the supplied FORM, then PLEASE at least include all the requested information. Problems arise if these directions are not followed. Please NOTE THAT FUNDS GO TO KEN AND INQUIRIES TO ME! (See the FORM).

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Please note that application forms must be RECEIVED and entered into the database by the first of the month PRIOR to the month of issue of the QRP Quarterly, for the changes to be reflected in your mailing label! This means that you should renew early. We are trying to implement a reminder program (thanks, Chuck K5FO!), but you should NOT DEPEND ON THIS! Check the label as it indicates the last month that you will receive an issue. RENEW BEFORE THAT MONTH! (January 1998 labels lacked this data but this will be corrected).

For information on the QRP ARCI awards program, contest schedule, links to QRP web sites, and other club resources, check our web site. We now have our own "custom" web address, thanks to efforts by Jim W4QO and Bob K2UT. Access our site using www.qrparci.org and please provide ideas and material for updating these pages! Topics relating to QRP ARCI and also QRP in general are welcome. Thanks!

Have fun with QRP!   Dave WA4NID

Zero Beating and Offsets in Two-Way Communication — an Intuitive Approach

Preston Douglas, WJ2V 216 Harborview North Lawrence, LI, NY 11559
email: pdouglas12@aol.com

This article is based on a talk given by Preston at the "Four Days in May" symposium held in conjunction with the 1997 Dayton Hamvention. The whole business of getting one's transmitter onto the correct frequency to call another station has been confusing for beginners — and some "pros" as well — for generations. A graphic model is presented that can be used to untangle the confusion. — W1HUE

Let's first understand what we mean by Zero Beat. The term comes from music, where audio frequency is called "pitch." When two musical instruments are playing notes that are slightly out of tune, but very close to the same pitch, an audible "wowing" sound is generated by the slightly out of sync sound waves; sometimes they are adding and sometimes subtracting from each other. (Like windshield wipers that are ever so slightly off sync so they slowly drift from working in the same direction to working in opposite directions.) The wowing/fluttering sound is called "beating". As one instrument is tuned, so it approaches a perfect match to the other, the beating sound slows until it stops altogether. When the beating stops, the instruments are "zero beat," and they are tuned to precisely the same pitch or frequency.

In radio, it is desirable to have the transmitters of both sides of a contact on precisely the same frequency. This will mean that the least spectral space is used for each contact. Consider a station calling CQ. The best and most logical place to call him is, as accurately as possible, on the same frequency he is using. If you call the station on his frequency, you will be zero beat with him. Did you get that? In the context of radio, "zero beat" means the two "instruments" (transmitters) are tuned to the same frequency, just like musical instruments. OK, you say, but how do I do that zero beating thing, and what do offsets have to do with this?

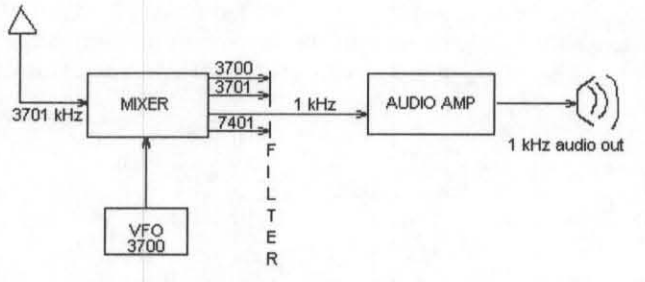

Figure 1. Block diagram of a Direct Conversion receiver.

Well, you will need to know more about receivers and transmitters before you can answer the questions about offsets for yourself. Let's consider a simple receiver type favored by homebrewers, the Direct Conversion (DC) receiver. Figure 1 shows the block diagram of a typical DC receiver. In a DC receiver, the local oscillator (VFO) signal is mixed with the incoming signal to directly produce an audio output signal. The general principle of mixers is that the output products of any mixer always include the two original signals, plus the sum and difference of those two signals. Thus, the *two* input signals to our receiver are 3700 and 3701, and the *four* output products are 3700, 3701, and 7401, and 1 kHz. Only the 1 kHz product signal is in the audio range, so we can hear that mixer product when it has been amplified by a simple audio amp. So, a DC receiver is just a single oscillator, a mixer, and an audio amp. Connect them up with a bit of filtering and you have a working model. Compare Figure 1 with the "Neophyte Receiver" in the February 1988 issue of **QST** for a good example of this setup.[1] In the Neophyte, the VFO and mixer are both on the same IC chip!

Now, recall that the mixer products are the original two, plus the sum and difference frequencies. Which one is the one you hear? You hear the 1 kHz *difference* product. So, here is one way you might start thinking that there must be a *difference* between the incoming signal and the receiver's VFO. In fact, if both the incoming signal and the receiver VFO were at 3700, there would be no difference product. Now, consider the products when the incoming signal is 3699. We would again get a difference frequency of 1 kHz, so there are two possible ways to get the same audio signal in the mixer products. In fact, we get the original 3699 signal, the VFO's 3700, the sum at 7399, and the difference of 1 kHz. So you see that there is another combination of signals that produce the same audio output. This is characteristic of DC receivers, and is often considered a drawback in such simple systems.

Now, let's look at a graphic representation of what you hear when you listen to one of these DC receivers. If we tune a DC receiver's VFO to 3700, we can represent that receiver's signal response with a graph that looks like Figure 2. The whole key to understanding the concepts of zero beating and offsets of transmitters and receivers can be derived from the study of this graph:

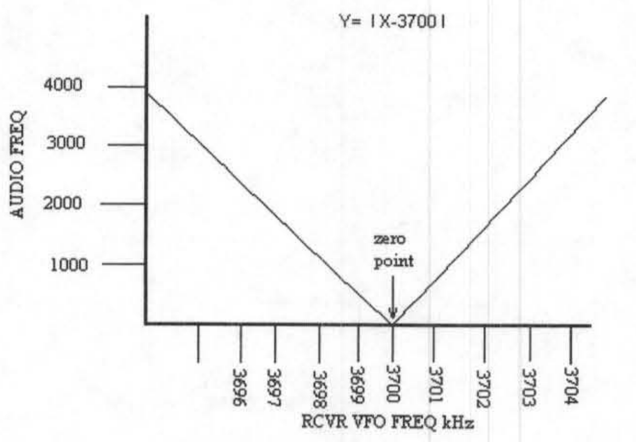

Figure 2. A DC receiver's audio output frequency as it tunes across a signal at 3700 kHz.

The "V" shape represents what you are able to hear as you would listen to a DC receiver tuned to 3700 kHz. A signal may be represented by a vertical line on the graph. Moving the tuning knob would be the equivalent of moving the whole "V" left or right. Changing the frequency of an incoming signal is equivalent to moving the vertical line left or right. The diagram in Figure 2 is simple, but taking a few minutes to see how it relates to your receiver will be an eye opener.

---

1 Another popular Direct Conversion receiver similar to the *Neophyte* is the *Sudden*, designed by the Rev. George Dobbs, G3RJV.

This graph represents the audio response of a DC receiver whose VFO is set to 3700 kHz. You can see that as the frequency of an incoming signal approaches 3700 kHz from either side, the pitch of the audio output will fall until the difference between the VFO frequency and the incoming signal is equal to zero. At that point there is no audio, because there is no difference product on the output of the mixer. At this point, we have learned that the incoming signal is zero beat with the VFO of the receiver. On the graph in Figure 2 we have designated the point at the bottom of the "V" as the "zero beat" point.

OK, now we already have looked at this from two perspectives. The block diagram analysis and the graph have shown the same thing. That is, in order for us to *hear* a signal in the audio spectrum, the incoming signal must *not* be on exactly the same frequency as the receiver's VFO. That incoming signal must be on either side of the zero point, perhaps about 1000 Hz away. Take a look at Figures 3a and 3b.

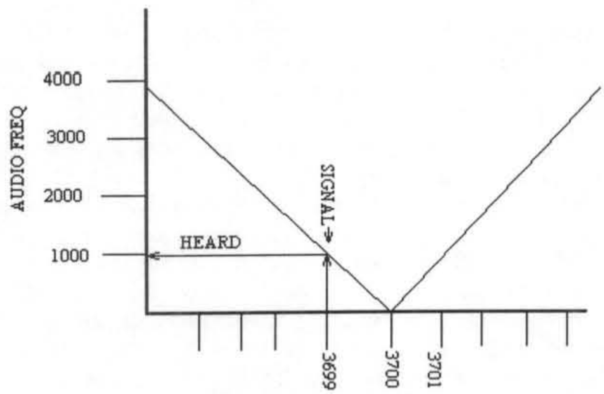

Figure 3(a). DC receiver tuned 1kHz above a signal.

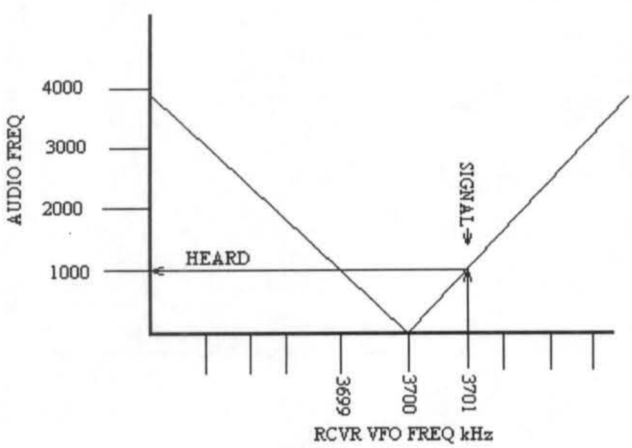

Figure 3(b). DC receiver tuned 1kHz below a signal.

You see the problem now? The receiver VFO is on 3700. The other fellow calling you is either on 3699 or 3701. If you want to set your transmitter smack on the other guy's frequency, you need to put your transmitter on a slightly different frequency from the setting of your receiver's VFO. That's the offset, as illustrated in Figure 4. That's the problem with trying to take the receiver's VFO and using it as the transmitter VFO. Unless something is done to change its frequency on changeover to transmit, the transmitter will not be tuned to the same frequency as the incoming signal. There are simple rigs out there with just this problem. For example, the unmodified "49-er" has this problem, and contacts are a little harder with this simple transceiver because it has no provision to compensate for the need to offset the VFO when it changes over to transmit.

Compounding the problem, DC receivers can hear a signal on either side of the "zero beat point" we defined above. Thus, even if an operator figures out how to offset his transmitter from his receiver VFO, he still has to offset it in the right direction.

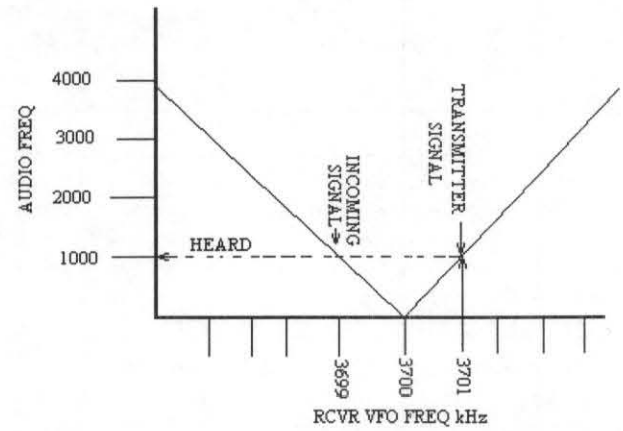

Figure 4. Incorrect TX/RX frequency offset.

Remember, a DC receiver will hear a signal on either side of zero – at two places on the dial, about 2 kHz apart. Figure 4 shows a receiver hearing its *twin* transmitter on one side and the incoming signal on the opposite side of that zero point. Both signals sound the same, despite being on different sides of the receiver VFO. What is needed is a way to determine on which side of the receiver's VFO (that is, which side of "zero beat") both the incoming signal and the transmitter's signal are located.

If a signal is heard below the zero point, we say it is on the lower side (or lower sideband). On the V graph this is the left side: By just rocking the dial a bit, you can tell which side of the zero point any signal appears. Older "twin" rigs, homebrew transmitters, and even some transceivers have a "spot" switch that turns on the transmitter VFO, without any amplifiers, so it can be heard in the receiver. The transmitter signal can then be zero beat with the incoming signal, keeping in mind that both signals must be on the same side of the receiver's zero point, if they are truly on the same frequency. In a DC receiver, if they both rise, or both fall when the receiver VFO is moved up a hair, then they are on the same side, and all is well. The reader may test his/her understanding of the above by sketching the same situation as Figure 5, except with the signal on the other side of the zero point.

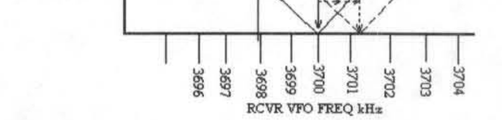

Figure 5..If the incoming signal is lower than the VFO frequency, the audio pitch rises as the receiver is tuned up in frequency.

Now, study Figure 6. Can you see how this represents a DC receiver with a narrowed audio frequency response? Notice that the receiver will only respond to signals in the audio range from 1 kHz to

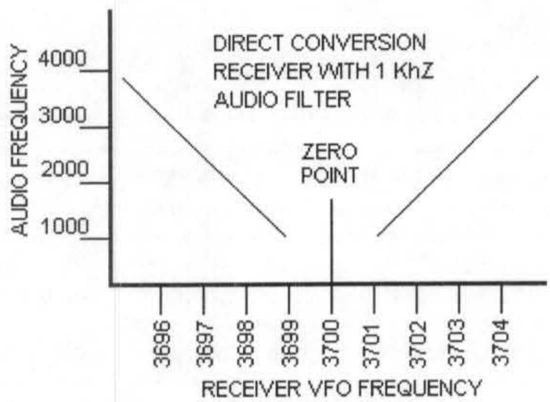

Figure 6. Response of a DC receiver with a bandpass filter.

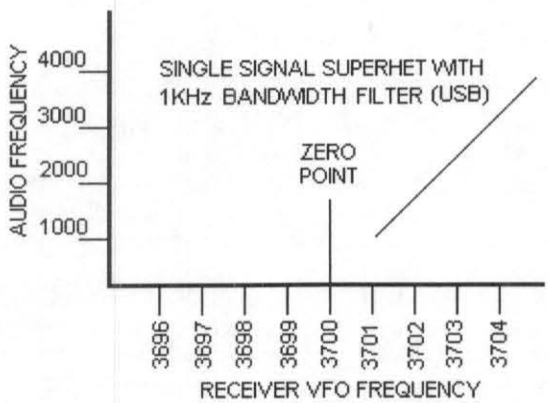

Figure 7. Superhet receiver response with a bandpass filter.

4 kHz. Still, there are two sides to the receiver's response. We mentioned that the side above the VFO is called the upper sideband, and the side below is the lower sideband.

The difference between the simple DC receiver we have been using as the basis for the discussion above, and the more sophisticated superhet receiver is that the superhet is able to cut off one side of the, receiver's response to signals. That is, either the response above the zero point (upper sideband) or response to signals below the zero point (lower sideband) will be cut off. The cutting off is done by filtering in the intermediate frequency (IF) stage, and the result, using our "V" graph, is shown in Figure 7.

Figure 7, like most of the illustrations we have looked at, over-simplifies some factors. For one thing, sophisticated readers will object that there is no representation here of the slope or roll-off of filter responses. For our purposes, though, these considerations needn't be included, as the results are entirely valid using the simple models. This illustration is a useful model of the response of a "single signal" receiver with a 4 kHz bandwidth, set to receive the upper sideband.

At this point, the reader should be equipped to understand what it means to zero beat a local transmitter with a distant one. There's a lot more to learn. But with ham radio, there always is!

Appendix

Here's a handy table that you may use to help you determine if an incoming signal is on the upper or lower sideband of your receiver. You can use it, for example, to see whether your main station rig uses upper or lower sideband when it is in the CW mode. Some rigs, while automatically switching to lower sideband reception on 160, 80, and 40m for voice, revert to upper sideband for CW reception on all bands. Does yours? Use the following table to help you find out:

Truth Table for Determining Sideband of Signals

		Dial Direction: UP	Dial Direction: DOWN
Pitch Change	UP	LSB	USB
	DOWN	USB	LSB

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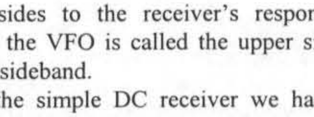
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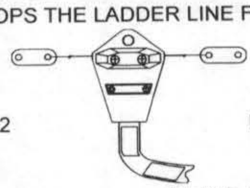
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QRP in JAPAN

by MINOWA, Makoto 7N3WVM 7n3wvm@qsl.net

This article was prepared at the request of Monte "Ron" Stark, KU7Y to introduce how QRP is done in Japan.

1. JARL(*) QRP Club

Let me start with the JARL QRP club. It was founded more than 40 years ago, in 1956, by only seven members. The number of members is now about 150. The first president was the late I. Shimizu, JA0AS, who was also known to many homebrewers as one of the inventors of the wide range "Super VXO," which I will describe later in this article.

The requirement for membership is to own a measuring instrument that is capable of measuring the input or output power of a transmitter. This requirement might sound somehow too tight. However, that is not so. The key is the word "input power".. Yes, you may simply have a DMM to measure the DC voltage and current of your transmitter final.

The club's newsletter is called THE QRP NEWS and is issued monthly. THE QRP NEWS is written in the Japanese language but there is also a short digest in English. I understand that THE QRP NEWS is sent to QRP ARCI every month. [I wonder who receives it? Ed.]

I should not forget to mention H. Shono, JA1AA, a former president of the club. As his call sign tells you, he is a real number-one OT, but he is still an active QRPer. He holds many QRP records. We are very proud of this 80-year-old gentleman.

2. Which Band ?

As in the U.S., Japanese QRPers like the 40m CW band. For example, the on-air meeting frequency of the JARL QRP club is 7.003MHz. However, a large number of QRPers also like to operate the 6 meter band with SSB and AM(!). On weekends, many 6-meter field operators go to mountain tops around Tokyo, and make contacts across this metropolis. Many of them are QRP and homebrew QRP rigs are most prominent on this band.

3. Awards

The JARL QRP club issues some QRP awards. The unique one is the "1000 km/Total Power Award." This award is issued for a contact that represents successful communication over more than 1000 kilometers per sum of consumed power in transmitter and receiver. It is a rather tough requirement. If your transceiver has an output power of 5 Watts but consumes, say, 12 Watts in transmission mode and 1 Watt in receiving mode, then its total power is calculated to be 13 Watts rather than 5 Watts. Therefore, energy saving designs are encouraged in both your transmitter and receiver. The present record is 410,000 km/Total Power achieved by JA1XB on 40 meter CW, earned with a total power of 0.96 milliwatt to his homebrew rig. Maybe some of you are not familiar with the metric units. 410,000 km is about ten times the circumference of the earth along the equator.

4. Contests

The JARL QRP club does not host its own QRP contests. Recently, we got good news that the JARL decided to introduce a new entry class for QRP operators to major JARL contests. We have previously had no such entry classes for QRPers in the JARL contests.

There are several contests that are interesting to QRPers. An example is the Nasu CW Contest hosted by the Nasu CW Club. Its QSO points favors low power operators. For example, a 1W station earns 33 points per contact while a 1kW station gets only 8 points.

On the technical side, the club hosted in 1994 a building contest called "QRP Oscillator Contest." The objective of this contest was to build a crystal oscillator with low power consumption and as unique in design as possible. Surprising results included a 3.5MHz oscillator with a dual gate MOSFET that required only 0.0155 volts and 2.85 uA of power, and an oscillator producing an output power of -42dBm without any power supply; it used the rectified audio output of a "crystal radio" as power source.

5. The QRP Day

A big QRP-related event of last year was the operation of a special memorial QRP station 8J1VLP for the QRP day, June 17th. The suffix VLP stands for "Very Low Power." It was agreed in the IARU Region III Conference in 1985 that June 17th should be proclaimed as a yearly QRP day with the goal that all amateurs use low power on this day. It is hoped that the other regions will join in and make this a worldwide QRP day.

8J1VLP was operated from May 25th until June 30th from several QTH's all over Japan including field operations. Unfortunately, DX contacts were only 2% among a total of 5446. We hope we make more DX contacts next time by advertising it, probably through the Internet.

6. Homebrew and Experiments

I will mention two technical achievements by Japanese QRPers. The first one is the wide range super VXO. The super VXO was invented in 1980 by T. Okubo, JH1FCZ, and the previously mentioned I. Shimizu, JA0AS. As shown in Figure 1, it uses two crystals of identical nominal frequency in parallel instead of the single crystal of a conventional VXO. It can be pulled considerably more than a conventional VXO. With the circuit of Figure 1, a frequency coverage of about 100 kHz was obtained with L=10uH, C1=C2=150pF, X1 and X2 put together in parallel and RB=100K. On the other hand, a conventional VXO with a single crystal can be pulled at most about 25 kHz. A carefully optimized super VXO is acceptably stable, and therefore Japanese homebrewers usually do not use LC VFOs for their transceivers anymore. Unfortunately, this magic does not work for low frequencies like 3.5 MHz and 7MHz. In those cases, one can mix a high frequency super VXO with a fixed frequency crystal oscillator, which is usual in the desin of superheterodyne rigs.

The second technical achievement is the HENTENNA. The HENTENNA is a tall, rectangular antenna fed along the two vertical sides. The name HENTENNA is a shortened form of HEN-ANTENNA. HEN is not refer to a female chicken, but is a Japanese adjective that means strange, odd or unusual. Indeed, it has many strange properties. It is, contrary to the first impression of the shape, a horizontally polarized antenna. The basic design of the HENTENNA is shown in Figure 2. Unusual is that the dimensions are not critical. One does not need to cut and try the lengths. One may simply move the feed points up and down for the minimum SWR. Although the design is simple and its size is relatively small, its gain is said to be comparable to a four-element Yagi-Uda antenna. This is the strangest point. The HENTENNA was developed in the 1970's by members of the Sagami Club, which was not necessarily a QRP related club. The leading member of the developers was again JH1FCZ, then and now a very active QRP experimenter. This antenna is widely used by 6-meter enthusiasts in this country. I hope this antenna will become known to hams of the other hemisphere of the world, too.

7. QRP Rigs

Some QRPers here use, of course, Yaesu, Kenwood and ICOM rigs. Some of them are modified for operation with reduced power for QRP. However, some QRP-dedicated rigs such as the MX-7S and P7DX sold by Mizuho are also commonly used. I hear the name Mizuho is also known to U.S. QRPers. We also have some QRP kit makers like FCZ Lab., AITEC and Circuit House. They sell mainly 6 meter transceivers because of their popularity.

The FCZ Lab. also sells a series of square-can coil units called FCZ Coils for every ham band, from 160 meters through 2 meters. The FCZ Coils are very useful for homebrewers, especially for those who are not good at winding toroidal coils.

Recently, QRP kits from U.S. companies become in fashion among some QRPers here. They enjoy importing such kits and building them. These include the SW30/40/80, OHR-100/400, GM20, GM40 and NorCal kits.

I like homebrew rigs. I have only homebrew rigs, no commercial ones. There are many other active QRP homebrewers who operate only homebrew rigs. A kind of "standard" homebrew rig exists among Japanese QRP homebrewers although it is a rather old one. A 40-meter CW transceiver originally designed by T. Masuzawa, JH1HTK, has been reproduced by many QRPers and used actively. This rig is called the JH1HTK model.

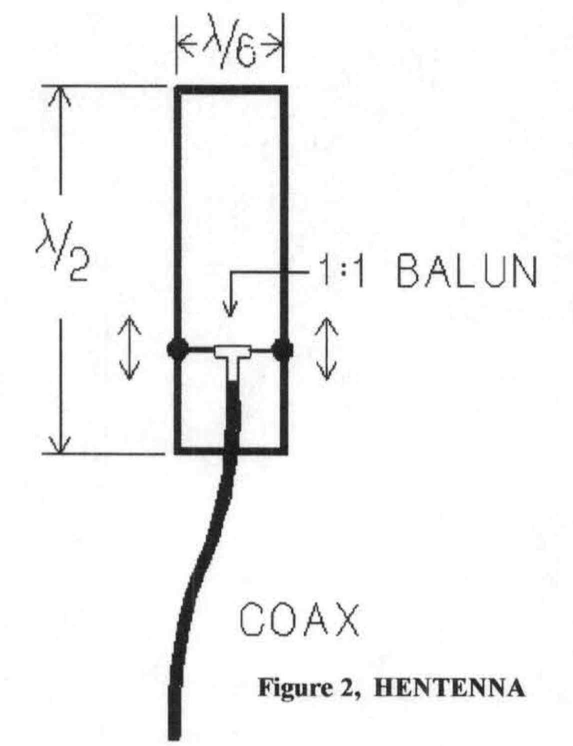

Figure 2, HENTENNA

8. QRP, why?

Now I should come to the conclusion of this article. I have summarized the answers to a question I asked a number of Japanese QRPers, "QRP why?" "Because QRP power is enough for experiments", "To get rid of TVI", "Homebrew or kit building is easier for QRP than QRO" and "Because I am fed up with QRO operations with commercial rigs" are major answers to the question. Some people even added, "Because QRP is cheaper." However, the answer: "Because of the surprise I get with every QRP contact. I cannot believe it every time that I contact a distant station with such a tiny power" was more or less common to most of them, maybe common to you QRPers in the US , too.

9. Acknowledgments

I thank following QRPers for their useful information to help prepare this article; JA1AA, JE1JDD, JF1OZL, JH1FCZ, JH1HTK, JH1WTH, JI1NZL, JK1APL, JK1OLP, JL1AHE, JL1EUP, JL1KRA, JM1OOP, JE2CDC, JL2ADF, JN2FSE, JS2GMY, JH7JAM, JA9CZJ, JA9MAT and JA9TTT.

Footnote (*)
JARL: Japan Amateur Radio League

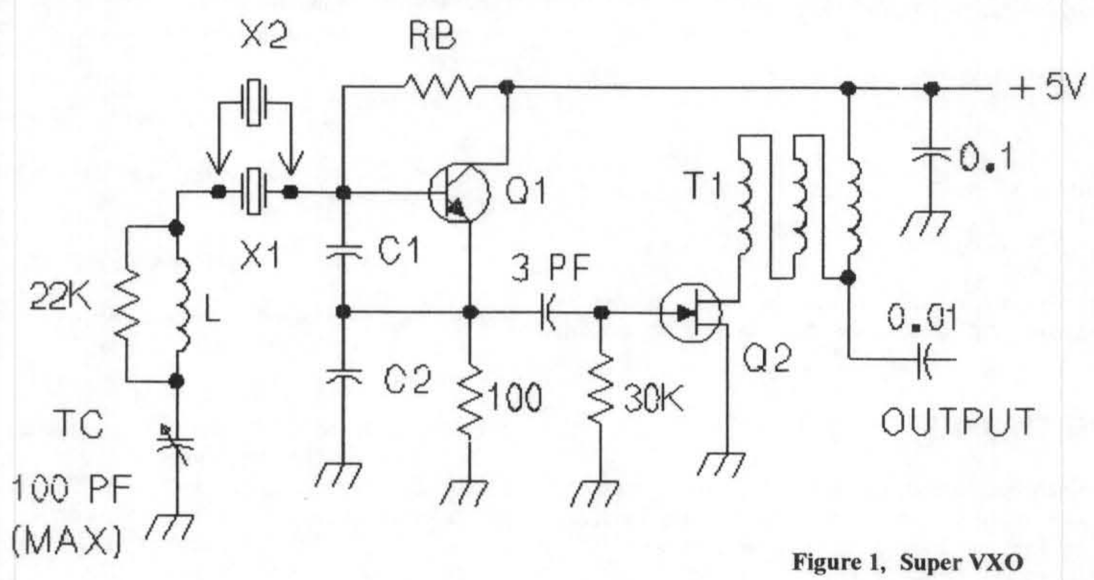

Figure 1, Super VXO

TRANSMITTER OUTPUT NETWORKS

John Moriarity, K6QQ, Box 88, Palomar Mountain, CA 92060
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INTRODUCTION

There seems to be ongoing confusion regarding the purpose of transmitter output networks. Some writers, both in print and on the Internet, state that their purpose is to "match the output impedance of the final amplifier transistor (or tube) to 50 ohms". This is exactly wrong! This article will show you why, and help you in the design of your own rigs. Nothing new will be covered, but all basics deserve to be reviewed from time to time.

CIRCUIT FUNDAMENTALS

We all know (don't we?) that the power dissipated in a resistor can be found by measuring the voltage across it, the current through it, and then multiplying the two:

$$P = V*I. \qquad (1)$$

If you know the value of the resistor, it only takes a voltage measurement, since by Ohm's Law:

$$I = V/R \qquad (2)$$

Not too hard so far. Now, if we substitute Equation (2) into Equation (1), we get

$$P = V*(V/R) \qquad (3)$$

$$\text{or, } P = V^2/R \qquad (4)$$

This is true for DC or AC, but since we are going to work with RF (AC), V in the equations above must be an "rms" voltage. It is going to be more convenient to use "peak" voltage. For a sine wave, peak voltage is found to be 1.414 times the rms value. (Remember that 1.414 is the square root of two.) Solving for Vrms:

$$Vrms = Vpeak / 1.414 \qquad (5)$$

Substituting Equation (5) into Equation (4) gives

$$P = (Vpeak^2) / (2*R) \qquad (6)$$

and rearranging,

$$R = (Vpeak^2) / (2*P) \qquad (7)$$

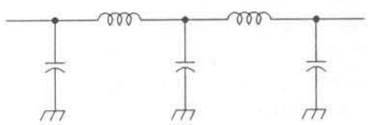
Since the peak AC voltage will be near the dc supply voltage Equation (7) tells us what the load resistance must be to develop "P" watts.

OUTPUT NETWORKS

What are output networks for? Usually two things. Most important, they are designed to transform the load resistance (usually 50 ohms) to the value any final amplifier device ***must*** see to deliver the desired power according to Equation (7).

Second, they are usually used to filter the output to bring harmonics within legal limits. There are many different types of networks that can be used. Most commonly in modern QRP rigs you will find what is called a "ladder" network (Figure 1). This refers to its appearance; parts are either in series or shunt with the signal path.

Figure (1) A ladder network



This schematic, with slightly different component values, could be a Butterworth filter (no ripples), Chebyshev filter (equal ripples) or one of several other filter types. Figure (3) shows values for a half wave filter for 40 meters, taken from "Solid State Design for the Radio Amateur". This type is often used in QRP rigs because it is less critical of exact component values. Information on designing these filters can be found in the "ARRL Handbook", and "Solid State Design for the Radio Amateur" (by Hayward and DeMaw). Surely you own both of these books.

NETWORK DESIGN

O.K., Here's the good part! Let's say we want a four watt transmitter. We have a 12 volt battery to power it with, and an antenna that looks like 50 ohms at the frequency we want to use. The junk box contains a 2SC799 transistor that was intended for a CB rig, so it is probably a good choice. We plan to use the usual grounded emitter circuit. When fully driven, the transistor collector can't swing to more than 12 volts (peak). Using Equation (6), we find that

$$P = (12v*12v)/ (2*50 \text{ ohms}) = 1.44 \text{ watts}.$$

Well, that's nowhere near enough, so what now? Use Equation (7):

$$R = (12v*12v)/ (2*4 \text{ watts}) = 18 \text{ ohms}.$$

That's a nice round number. What do we do with it? We have to transform the 50 ohm antenna to 18 ohms (or less) if we want four watts output.

The filters in the ARRL Handbook are intended for equal impedance at the input and output, typically 50 ohms. It is possible to design filters which, by themselves, transform 50 ohms to a different value, but it's a bit trickier, and not frequently done (correctly) in amateur practice. (If you have the capability to do this, go for it!) It's probably easier just to use the 50 ohm filter with a transformer. The transformer takes care of the impedance, the filter takes care of the harmonics.

Remember that impedance is transformed by the square of the turns ratio. For example, a turns ratio of 3:1 transforms impedance by 9:1. In our case, we want to transform by 50:18. Taking the square root of 50/18 gives 1.67, or a ratio of 1.67:1. Obviously we can't easily wind a transformer with that ratio, but we can scale it up to get something more practical. Multiplying by three gives us 5:3, a nice ratio of whole numbers.

Figure (2): 18 ohm to 50 ohm transformer

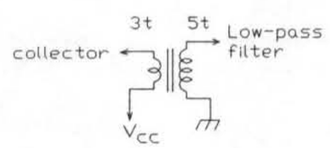


Figure (2) shows our transformer. For best results, this should be wound on a ferrite core. To make our transformer, we need either a way of measuring inductance, or the data sheet for the core, to be able to tell how many turns are actually required. The rule of thumb is to have the winding reactance at least five times the load resistance. Let's say our transmitter is going to operate on 40 meters. Then the 18 ohm side should have a reactance of at least 5*18 ohms, about 100 ohms. Since $X_L = 2*pi*f*L$,

$$L = X_L / (2*pi*f)$$

so L = 100 / (2*3.14*7,000,000), or about 2.27 microhenries. (For a single band rig it can be twice this much or more, without any problems.) A test winding of three turns on an Amidon FT37-43 core gives 4.4 microhenries, close enough. We wind the five turn winding, and we're done. What wire size? What do you have? It's not critical, as long as it will carry the current and fit in the core. The finished amplifier will look something like Figure (3).

SUMMARY AND CONFESSION

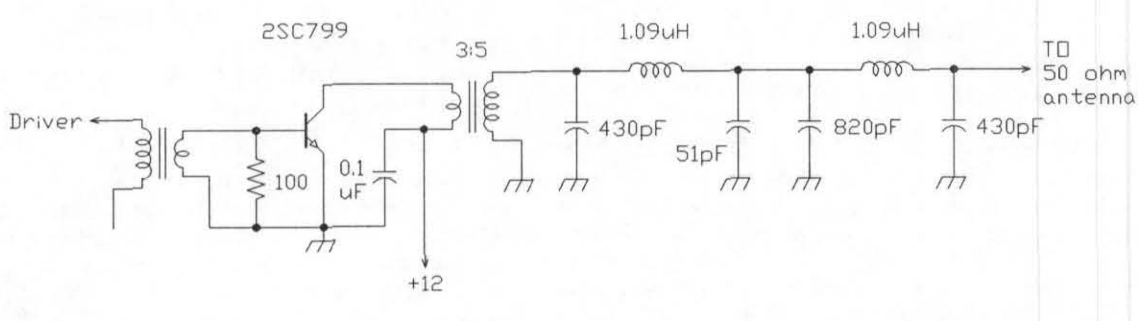
Notice that after selecting the output transistor, it never came up again during the design of the output network! The design depended only on the supply voltage and the required output power. We didn't match the transistor to the antenna, we transformed the antenna resistance to the load needed for the transistor to make the power we wanted.

Does this work? Of course it does! Have I told you everything? No. If we built this amplifier, it would not deliver four watts. Why? Because we neglected several things in our simplification. First, the transistor can't swing the whole 12 volts. When it is fully turned on, there is still a small drop from collector to emitter. This varies, but can be several tenths of a volt. Ideally then, the peak voltage in the calculations should be (Vsupply – Vsaturation. Another thing we didn't talk about is the fact that the transistor conducts for less than half the cycle, but our calculation was based on a full sine wave. How can that work? The output network is made of L's and C's, energy storage devices! This causes a "flywheel" action, and fills in the missing part of the cycle. Not perfectly, of course, because we have to filter the harmonics.

Next, there are always losses in the filter and transformer. Be careful when you choose your low pass filter. Make sure you know how many dB loss it has at the cutoff frequency. Butterworth filters, for example, usually have the "cutoff" frequency specified as the –3dB point, so choose one a proper amount above the highest transmitting frequency. In practice, the amplifier would be designed for 1.5 to 2 times the output required, just to overcome these losses and hopefully have a small reserve. Why not design it for 20 watts, and just cut back the drive? That would work, but the efficiency would drop. After you have built a few output stages, you will develop a feel for it.

Don't be afraid to experiment, that's what ham radio is about!

Figure (3) Complete amplifier



A 2 to 50 MHz Microwattmeter

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Introduction

A few years ago, I built a milliwattmeter designed by LA8AK. That design used a CA3140 as a logarithmic amplifier and had an input range of -30dBm to +6dBm and a frequency range well over 400 MHz. I used that instrument a lot, but kept looking for something more sensitive having a frequency range more fitting for HF work, mainly to use for measuring filter characteristics and the output of oscillators. Last year I saw the specifications for the Analog Devices AD606 and this chip seemed to offer everything I wanted: Sensitivity, frequency range and even an output for measuring frequency.

I offer the following description more as a building/programming experience rather then as a tried and proven recipe for duplication. If you want to build this instrument, you will probably want to modify the schematic and the microcontroller program to suit your particular needs and availability of parts.

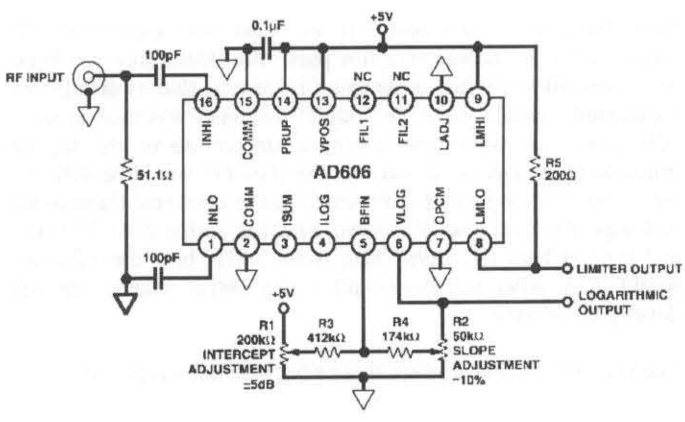

Figure 1 Basic circuit for the AD606.

The AD606

If you want to build a simple microwattmeter, all you need is the AD606 and its data sheet (1).[1] The AD606 is a logarithmic amplifier/detector that has an input range of -75 to +5 dBm. The input is converted into a logarithmic output voltage of approximately 0.5 to 3.5 VDC. The specs say the chip can be used to over 50 MHz. The chip has a 200mV limiter output for determining input frequency. The Analog Devices data sheet shows a basic application (Figure 1) that requires only nine other parts. Even this simple circuit will allow you to use the AD606 as a logarithmic detector in combination with a sweep oscillator to determine filter characteristics or to measure the output level of oscillators.

I built this basic circuit, but without the intercept and slope controls, and started testing. (You could add the intercept and slope potentiometers to bring Vlog-out into the range you want.) First results seemed very promising; see Figure 2. I used an MFJ-259 antenna-analyzer as a signal generator with a HP-255D 0-120dB attennuator to produce input in the range 0dBm to -80dBm. I assumed that the MFJ-259 had 0dBm output. Although Figure 2 shows only one curve, measured at 10MHz, I noticed some frequency dependency in Vlog-out.

Now, if you carefully calibrate this instrument and make calibration charts for various frequencies, you are ready. All it takes to make a measurement is to apply an input signal, measure Vlog-out with a DVM, consult your chart for the appropriate frequency and you can determine the input level in dBm. This was my plan, until I read about microcontrollers...

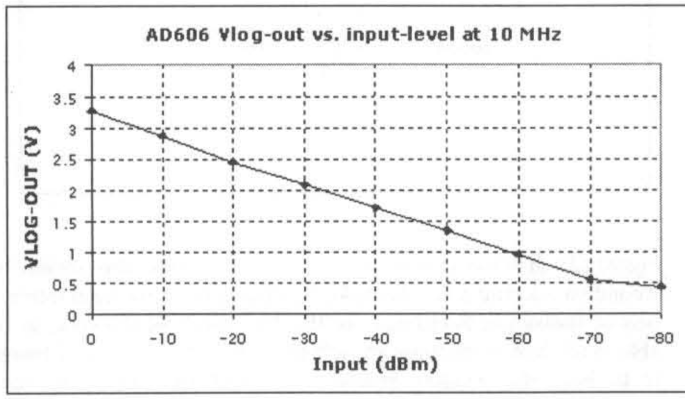

Figure 2. AD606 Input/Output response at 10MHz.

The PIC 16C84

Microcontrollers can perform a multitude of useful tasks and can make things possible that are not easy to realize in discrete hardware. Many ham-radio related designs use Microchip controllers and in particular, the PIC 16C84. It made me wonder if I could use such a device in my microwattmeter, so I started gathering information about microcontrollers. It appeared that the 16C84 was particularly easy to program, was relatively cheap, and almost all necessary software could be found on Microchip's Internet site (2). The 16C84 has 1024 program words in EEPROM and is thus re-programmable. It also has 64 bytes of EEPROM that can be read and written from within the program.

I started building a simple programmer. This is a device that takes assembled code and writes it in the 16C84-program code space. I used David Tait's design and associated DOS program, "PP.EXE" (3). This worked well so after writing a few programs that could switch LED's on and off I began to think of how I could use the 16C84 to:

- Measure the level of Vlog-out using an ADC.
- Convert this level to dBm.
- Display this level on a liquid crystal display (LCD).
- Use the limiter output of the AD606 to determine frequency and possibly use that information to correct for the frequency dependency of Vlog-out.

Development of the microwattmeter

I had already tested the AD606 in a basic circuit on a breadboard. As the gain of the AD606 is very high and an input sensitivity of -75dBm means approximately 40µV across a 50-Ohm resistor, I decided to build the microwattmeter in a small tin box. In the tin box I soldered a double-sided piece of copper board. I used one side of the board for mounting all power supply lines and filter capacitors. On the other side, I mounted all other components in a sort of dead-bug style, although I used sockets for all IC's except the ADC which was an SMD. The input of the AD606 is directly connected to the input BNC connector with a 100pF capacitor keeping the input lead as short as possible. The AD606 is in its own screened compartment to keep interference from the

1 References are listed at the end of the article.

microcontroller to a minimum. An inside view of the completed instrument is shown in Figure 3.

I started with attaching a two line, 16 characters per line LCD to the 16C84. I used Peer Ouwehand's (4) routines to control the LCD. These LCDs usually use the Hitachi HD44780 controller and thus a lot of routines for controlling these displays are available for most types of microcontrollers. These displays are I/O "hungry"; they need eight lines for sending data and three lines for controlling the display. The 16C84 has 13 I/O pins, so this leaves only two pins for a counter. As I wanted to control an ADC as well, I converted the LCD routines to use four data lines. A data transfer then involves sending the four upper bits, followed by the four lower bits. It takes twice the amount of time to transfer a byte to the LCD but as LCDs and the humans reading them are slow devices anyway, it does not matter.

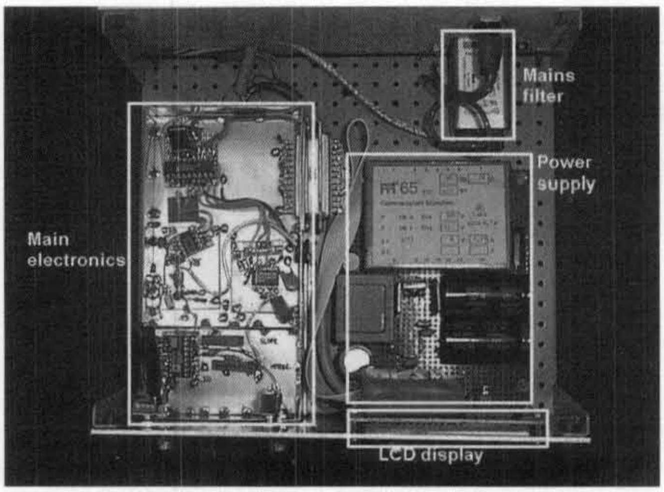

Figure 3. Inside view of the completed instrument.

The extra four I/O lines made it possible to control an ADC. I used a MAXIM MAX186, simply because MAXIM sent me one as a sample. The MAX186 is a 8 channel 12-bit ADC with an input range of 0-4.096 V or 0.001V/step. This was excellent for the AD606 Vlog-out range of 0.5-3.5V or 80dBm. The effective resolution would then be 0.03dBm per step. You do not really need a 12 bit ADC; for a 10 bit ADC with a range of 5V the effective resolution would be 0.13dBm which is more than adequate. Even an eight bit ADC with 5V range would do with an effective resolution of 0.52dBm per step.

Interfacing the MAX186 to the 16C84 was easy, thanks to the clear instructions in the data sheet. I only used one of the eight channels available, so I did not need to send commands from the 16C84 to the MAX186 to select a channel. I only needed to control the chip-select, data and clock line. This left me with one spare I/O line, which I planned to connect to a switch to enable me to select either ADC voltage read-out for calibration purposes, or to display the calculated level in dBm.

The counter proved to be the more difficult part of the instrument. The 16C84 has an asynchronous eight-bit timer/counter connected to the T0Ckl input pin. The input pulses need to have a minimum 'high' width of 30ns and 'low' width of 20ns. Therefore, the width of the 'high' pulse limits the usable input frequency range to about 30 MHz. As I wanted a range of over 50 MHz, I was forced to use an external prescaler. I selected the Motorola MC3393P, configured to divide by 16. The eight-bit counter cannot count to more than 256. Fortunately, the 16C84 has a built-in eight-bit prescaler with a software selectable range of 1:2 to 1:256. The eight-bit counter and the eight-bit prescaler together form a 16-bit counter. Counting in a one millisecond period would mean a one kHz frequency resolution and a maximum frequency of 2^16 or 65535 kHz. I selected a counting period of 1.6 ms, which, together with the external MC3393P prescaler, gives a frequency resolution of 10 kHz. Range is not a problem, with the external prescaler frequencies of 30x16=480 MHz could be counted, were it not for the MC3393P's maximum input frequency of 140 MHz. There was one problem left: The internal prescaler of the 16C84 cannot be read by the microcontroller software. The usual and well-documented solution is to use one I/O line directly connected to the T0Ckl pin. This extra pin is used for two purposes: First, it serves as a count gate. This pin is normally configured as an output and made low, preventing any input pulses from reaching the counter input. It is configured as an input during the 1.6 ms count period. Input pulses can then reach the counter input. After the count period has ended, the pin is configured as an output and made low again. Subsequently, the content of the prescaler register is determined by first reading the contents of the counter register and then repeatedly 'pulsing' the extra pin high/low and checking if the content of the counter register has incremented. Once this happens, we know that the count result is *(256-E)* in the 'low' eight bits and *(C-1)* in the 'high' eight bits of the 16-bit count result. *C* is the contents of the counter register and *E* is the number of extra pulses needed to have *C* incremented once.

This all sounds terribly complicated, but programming examples can be found on the Internet (2). The arrangement I finally settled on could determine the AD606 limiter frequency reliably up to 110 MHz. I wrote a program version to measure the AD606 Vlog-out in Volts and display this together with the frequency on the LCD. The limiter output of the AD606 needed some amplification, especially at low input levels. After much experimentation, I settled on using a J310 as buffer and a Philips NE5200 as amplifier. Any type of amplifier will do as long as it can trigger the MC3393P over the needed input-level and frequency range. Figure 4 shows the final version of the schematic.

The next step was calibration. Every spring, the VERON (the Dutch 'ARRL') organizes a three-day camp where homebrewers are offered the use of a vast range of professional test equipment. I brought my half-finished instrument, and measured Vlog-out of the AD606 at several frequencies and input levels using a Rohde & Schwarz SMG signal generator. I also measured the output level of my MFJ-259 at several frequencies with a HP435 Power Meter, so that I could use the MFJ-259 later to perform this calibration again. I used a spreadsheet program to plot the AD606 response.

Frequency response deteriorates rapidly above 40 MHz. I then decided that I would use the 16C84 program to correct for this decrease in response. I again measured Vlog-out at several frequencies and input levels using the MFJ-259 and a HP255D attenuator. I again entered all data in a spreadsheet and calculated for each frequency the regression factors *a* and *b* for the function $L = a \times Vlog\text{-}out + b$, where *L* is the level in dBm.

I needed four bytes for each frequency's *a* and *b* factors. I had selected 13 frequencies or 12 frequency ranges, needing in total 13x4 + 12 = 64 bytes to store all factors in the 16C84 EEPROM. The program was modified to select the *a* and *b* factors used in the calculation of

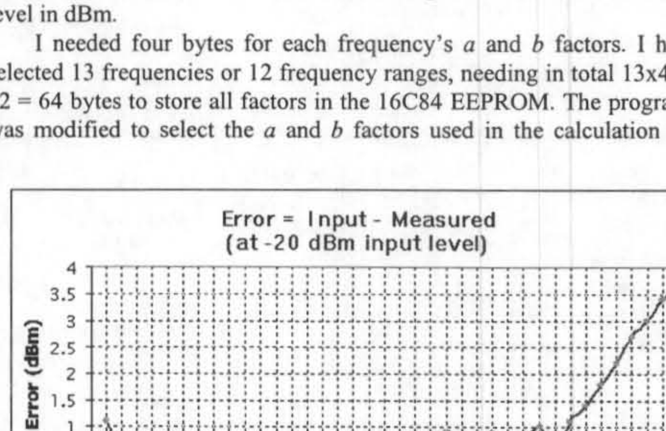

Figure 5. Instrument frequency response.

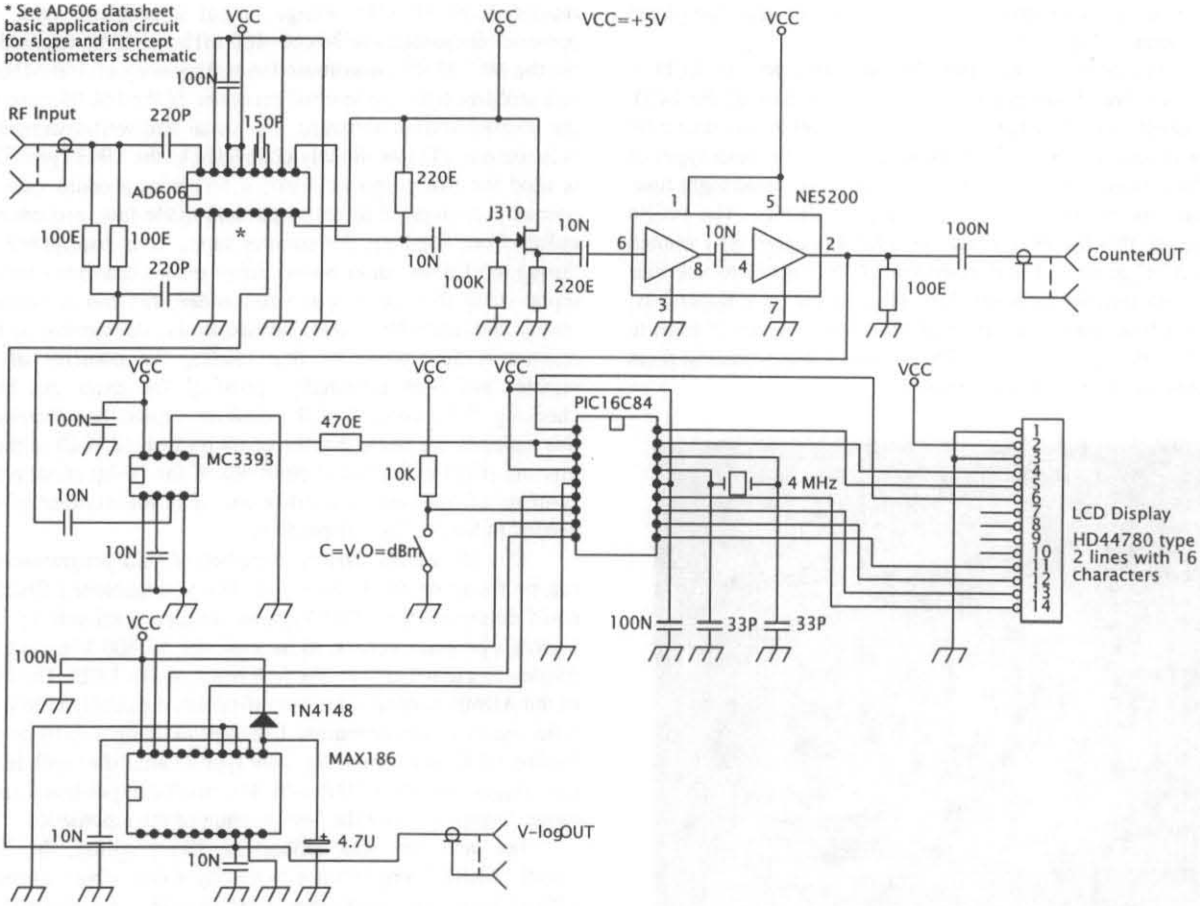

Figure 4 Schematic of the microwattmeter. Note: "E" designates "Ohms", "N" means "nano-".

Level in dBm for the appropriate frequency range. The resulting frequency response error curve is shown in Figure 5. The response is now good up to 50 MHz, although the curve has noticeable 'bumps' where the program switches from one set of parameters to another. Of course, the error increases with frequencies above 50 MHz because there the last set of parameters remain in use. Also, the response is approximately 0.5 dBm 'high'. This may have been caused by an error in the previously determined output level of the MFJ-259. For ultimate accuracy, I use a switch to have ADC readout in Volts. I then use the calibration charts developed earlier to determine input level.

The microcontroller program

Program flow is quite simple; see figure 6. The program begins by initializing variables and setting up the ADC and LCD. It then enters a continuous loop. First, the Voltage/Level switch is read. Then, the frequency is determined. The ADC is read 16 times, results are summed and divided by 16 to filter out some degree of noise. If the switch is set to 'Level', the *a* and *b* factors for the appropriate frequency range are read from EEPROM and the level is calculated with two significant digits after the decimal point. As a display resolution of 0.01dBm is too much precision for this type of instrument, the result is rounded to one digit after the decimal point and displayed on the first line of the LCD. If the switch is set to 'ADC Volts', the voltage is displayed on the first line. Frequency is displayed on the second line of the LCD.

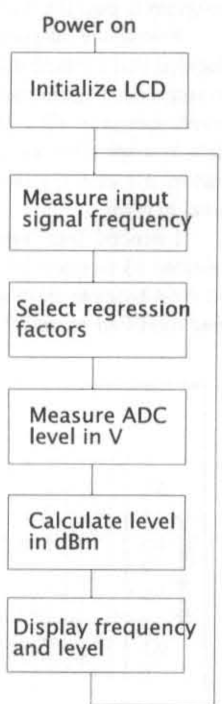

Figure 6 Program logic.

I used Microchip's MPLAB to write and simulate the various pieces of software. This was my first assembler program and it shows in the code. I ended up with only a few program words to spare. With more experience, I would probably have been able to optimize a lot of the code and perhaps squeeze in a few more features.

Conclusion

The Analog Devices AD606 is a good choice for the accurate measurement of RF input levels in the range -75 to +5 dBm at frequencies up to 50 MHz. It is not a cheap part, but it has good linearity and a usable limiter output. Using a microcontroller in combination with an ADC and an alphanumeric LCD makes a reasonable correction for frequency dependency possible. If you need a higher frequency range, the Plessey (5) SL3522 (500 MHz), SL2524 (1.3GHz) or the Analog Devices AD641 (250 MHz) seem to be good choices although they may be difficult to obtain in small quantities.

The source code of the 16C84 program is available at: http://www.geocities.com/CapeCanaveral/Lab/pa3ckr.

References

The items referenced in the text can be obtained from the following Internet WEB sites:

(1) http://www.analog.com
(2) http://www.microchip.com
(3) http://www.man.ac.uk/~mbhstdj
(4) http://www.iaehv.nl/users/pouweha/lcd.htm
(5) http://www.gpsemi.com

What CW Tone do you prefer?

by Jon Iza, EA2SN ea2sn@jet.es

Daniel, 9V1VZ (mailto:daniel@pandora.lugs.org.sg) started a thread on the QRP-L with the above mentioned subject. After several posts on the same subject I jumped into the discussion with some information I've gathered over the years. Here it goes.

I've read with interest the thread on CW tone and have been following threads like that for several years, so here I go with my two pesetas.

Most of the rigs have pitches around 750-800 Hz being the filter/BFO/LO system adjusted in such way that when transmitting, the carrier is shifted "exactly" the same amount and in the right direction. If you try to listen at a lower pitch, your carrier will get shifted and may get out of the receiver passband of the other station.

The problem is that, after the rig, there is a couple of ears and a brain doing a nice hybrid mechanical and electrical (analog and digital) signal processing to change those funny noises into a (hopefully) meaningful, wise sentence.

It seems that 800 Hz, or even higher values, like the one used on the Heathkit "Green Boxes", 1000 Hz (posted on the list by George, W5YR) was picked because that's close to the highest "sensitivity" of the human ear, following the well known Fletcher-Munson curves. But that doesn't mean the highest "selectivity".

In 1989, G3XJS, GW0DYT and G8PG did some research on the subject and published a report entitled "Project Frequency Band", evaluating the use of LC passive filters on DC receivers, instigated by no other than Ed Wetherhold, W3NQN, ARRL's technical advisor on passive filters. They used filters with several center frequencies and bandwidths, finding that the the filter centered at 450 Hz was more useful than the one centered at 750 Hz, but having both added flexibility (Hawker, 1989a)

If you have been lucky enough to built any filter using the nice kits Ed makes (also provided by the GQRP-Club for European hams), you probably remember in his leaflet there were details for filters centered at different frequencies, many of them at low pitches (one of the consequences of the above mentioned report).

Later on, G3VA reported on a different experiment done by Tony Tuite, an ex-RAF operator, carried out with ten well seasoned operators (over 50 years old). They were set up to listen to CW at 18-20 WPM and to note the preferred pitch. Six of them said 750 Hz, but the real pitch was close to 500 Hz. Three said 600-700 Hz, and they were 475 Hz. And one had perfect pitch and was 50 Hz close to the frequency he noted of 500 Hz. When the transmission speeded-up to 25 WPM, they tended to increase the pitch to 600 Hz (100 higher than at "normal" speed) (Hawker, 1990)

Another source of information for me was Magin, EA3LL, one of our best EME operators in Spain, who tried my W9GR DSP (version I) on his station. He was disappointed with the unit, not for having a 30 Hz filter centered at 750 Hz, but for not having a CW filter centered at 400-500 Hz. He told me EME operators use very low pitches, around 400 Hz, because it is way less tiring to listen to for hours than with higher tones.

That reminds me of another note made by G3VA on a paper by E. Zwicker and R. Feldtkeller "Das Ohr als Nachrichten empfaenger" (The ear as a receiver of information) dated 1967, where they stated the ear has 24 sub-bands between 300 Hz and 20 kHz, being the sub-bands narrower (100 Hz) at the low end of the band, and wider (2 kHz) at the top. It looks like a CW desired signal can be masked if there is an interfering signal "within the same sub-band" even though the ears can differentiate and filter tones 50 Hz apart, or even less. The final recommendation of the authors was to use low pitch signals (300-500 Hz) (Hawker, 1989b).

On the same subject, Ken, K6HCP noted that weak-signal operators preferred low pitches and, most interesting, the use of low pass filters!! (Holladay, 1975) He wrote that the brain copies signals by comparing signal against signal, or signal against noise. Narrow filters exclude some signals AND noise which can make detection more difficult. Ade Weiss, W0RSP, made a very good post about several subjects. One included a quick note about a OT from 160 who used to decode signals by listening to the "different noises". More recently, John, K3PGP has posted on the CW list that he uses, for weak signals, a wide 2.1 kHz filter and an in-between-the-ears, 'organic' filter, getting solid copy down to -17 to -20 dB below his noise floor, stating narrow filters are tiring. Previous work was done by W2IMU, who carried out several experiments using a 3 kHz wide receiver and a CW signal of varying level. The signal was "detected" with a -20 dB S/N ratio (signal 20 dB below the noise), callsigns were copied at -9/-12 dB S/N and at 0 dB S/N (signal equal to noise) the copy was 100%. It looks like the copy of the callsigns was possible because the brain was using a receiving bandwidth of 50 Hz or so, increasing the S/N ratio (less bandwidth, less noise). From a graph in the article, it looks like the critical bandwidth goes through a minimum of around 20 Hz at a frequency close to 400 Hz (which now may be wrong, after the new research done on the field).

Based on a German magazine article from 1979, DJ4SB and DJ1ZB published in Sprat No 58 (1989) the maximum selectivity of the human ear peaks at 300-400 Hz...

If it were not enough with all these ramblings, another thread started recently on the Ten-Tec list. Most of you know very well that Ten-Tec rigs have a fame of being excellent for CW work, and are used by top CW operators (including one who sent a bitter letter complaining the CW keyer installed on the Omni was only going to 69 WPM... :-) Well, it looks like many of them really like lower pitch for CW receiving, and they have lobbied the Ten-Tec filter maker to prepare a special order of CW filters specified for lower pitch. (Remember what I've said at the beginning of the post?) That way, they will be using a low pitch on receiving, and the CW carrier when transmitting will be just on the right spot for the other station to go easily through its filter bandpass. (This is a problem with multifilter rigs, since one cannot change the shift between the BFO and the bandpass center frequency of one filter without altering the response curve of the other filters. In our QRP rigs with just one filter we can do whatever we want, and set the shift as low as needed)

While preparing the special order, they asked the list the same question as here: What CW tone do you prefer?, and the replies were interesting. Most of the operators settled for a frequency very close to 550 Hz +/- 50 Hz, with some outliers. After reading my notes, I wonder how many of those measurements where well done.... maybe they are all close to 400 Hz. It looks like 25+ ops are going to spend 125-150 bucks on a special-order filter to enjoy their rigs more...

So it looks like the CW and weak-signal operators prefer low pitch tones for reception of signals. It may be food for thought for the designers, to "tweak" their designs and allow for lower tones.
Enough for now, Be well, jon, ea2sn A phone operator!

P.S.

Scott, NF3I, posted a long detailed study on how many "waves" per dit will be sent at 40 WPM for different pitches. I have exchanged several emails with Gary Bold, ZL1AN, who writes on the NZART Break-In bulletin about CW, on the very subject. My hypothesis was that at high speed CW, the ear must have inertia problems, "starting" and "stopping" the eardrum with each dit or dah. Elaborating on that, I would say the eardrum has to pick up several "waves" to identify the signal amongst other signals and noise... But when you know that there are folks around able to do 100+ WPM, the hypothesis goes down the sink.

As quoted by G3VA from a paper in Nature, it seems that the hair cells from the ear can detect motions of atomic dimensions and respond more than 100,000 times a second. (Hudspeth, 1989) one wonders: How the heck can we do it? Leon, G1HSM, made a comment that if the auditory system was twice as sensitive as it is, it would be possible to listen to the random movement of air molecules!! It seems that the brain is doing a lot of signal processing, and some of the hairs have embedded crystals which resonate at different frequencies, filtering the others. It seems they are still many things to discover.

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Vectors and Bitmaps:

How to publish output from drawing programs.

by Adam B. Kanis, N2BRT, adam-kanis@uiowa.edu
http://genome33.ped-gen.uiowa.edu/hamradio

Many times there is more than one tool that can handle a particular job, but more frequently there is one best tool. Using CAD programs, such as schematic and PC board design software, the goal is usually not to view your design only on your computer screen. We usually want to output it to paper, export to another program, or share our creations with others on the world-wide-web. After watching a thread on the QRP-L mailing list, I realized that many people are not using the right tools to publish their work.

With so many different CAD programs out there, on so many platforms (DOS, Windows, Mac, Unix), and so many drawing programs, it would be impossible to give step-by-step cookbook instructions for how to publish output that more than a handful would be able to use. Instead, I hope to present the factors that should help you figure out what needs to be done with a particular situation facing you.

A few basics first. CAD programs, and some drawing programs, use vector drawing methods. That is where the data for the object drawn is in the form of instructions such as "draw a line 3 cm long, at a 45 degree angle, then draw a circle with a 1 cm radius centered where the other line ended." If you were to try to follow these instructions using pebbles 0.5 cm in diameter, you could do it, but the results wouldn't look as good as when you got to use tiny sand particles to "draw" the image with. The resolution of the sand drawn image is much higher, and gives much more detail - BUT THE INSTRUCTIONS ARE THE SAME - a very flexible system. Of course, the same instructions sent to a printer that can draw with 1200 dots per inch (dpi) resolution, would give even better results.

Of course, something, you (the sand artist) or the video card and computer system, must be able to convert the vector instructions ("make a 3 cm line"), and figure out how many (and which) pebbles, sand particles, or printer dots need to be used to make the line or circle of the correct size. These various ways of expressing the instructions with discrete "pixels" is making a bit-map of the vector instructions.

When we want to take a graphic image, like a schematic drawing, and touch it up in another drawing program, or publish it to the web, we need to make the output go to a file in a form that can be understood by the other drawing program, or by the common web-browsers in use. Without optional (and non-standardized) add-ins, web browsers don't know what to do with a vector based drawing instructions. They do have the ability to work with two common bit-map formats - the Graphics Interchange Format (GIF) and the Joint Photographic Experts Group (JPEG or JPG) format. Besides web-browsers commonly recognizing these formats, other graphics programs on different computer platforms (ie, Windows, DOS, Unix-variants, and Mac) can work with images stored in these formats. There are other formats as well that you should at least be able to recognize the names of - TIFF, PNG, BMP, PICT, and others. Vector based file formats are less standardized, but include at least two common ones found on most platforms: PostScrip (usually for printing) and HPGL (usually used for plotting). Both of these formats are ready for exploitation for our needs.

Besides just storing information about the image, these bitmap file formats can do another very useful thing, they can compress the information into a smaller file size than is required to display the images. This is very handy for transmitting via the internet, and for moving around on relatively low-capacity floppy disks. They do this by storing information about patterns. For example. Instead of storing 5000 data points each of the same value, the file could say "the next 5000 data points are this value". This type of procedure will result in no lost data, ie, when the image data is compressed into the file, and decompressed again, the result is identical to the starting data. This is the way a GIF file is stored.

JPG files on the other hand use a very complicated method describing regions of the image in a way that throws out some information for the sake of reducing file size. It turns out that it works real well for photographic type images with continuous tones where no 2 pixels next to each other are likely to be the same, making it unsuitable for the GIF type compression (the GIF image would store an exact replica of the data, but there would be no compression). However, when you try to compress a "line-art" type image, such as a schematic or PC board etching pattern, the JPG compression will distort things, mainly around the thin lines present. People talk about a "halo" being present.

Take home message: for line art such as schematics or circuit boards use GIF (or TIFF if it won't be going to a web-browser) file formats. For full-color or gray-scale photographs use JPG, but only at the last step of the process, since you lose image information the first time you put the file into a JPG format.

OK, so after all this intro, how do you get a schematic you've just drawn with your CAD program onto your web page? Here's the summary first, and I'll give suggestions on how to accomplish each step afterwards:

- Save your file in the default format for your program.
- Save or export the file to a vector based file format.
- Open or import the file in a program that can work with vector based images, and export or save to bit-mapped images.
- Do whatever touching up your image needs.
- Save it to the appropriate bit-map file format.
- Check your work by opening the file with different programs.

After finishing your artwork in the CAD program, save it. Do it now. Don't take chances. Next, you'll want to save another copy in a vector format that can be utilized in a graphics program that can export to a bitmap. The way to do this may be sneaky if there is not a featured way, you print it to a file in a vector format. For example, in ISIS, my PC schematic drawing program, there is no export facility. I just tell the program that I want to print to either a PostScript printer, or to an HP plotter, and that the output should go to a file, not to a serial or parallel port.

Next, open the file in your graphics program that knows how to open or import vector images. I use CorelDraw 6 under Win95, and it can import either the PostScript or the HPGL files written by the CAD program. I do what ever touching up is needed, including scaling the vector image to the right size - remember, vector images can be resized without losing quality. SAVE your work in the drawing programs native format, for me, that would be Corel's .CDR format. You'll want to do this because later you can call up the file in the drawing program without having to go through all the export/import steps.

At this point you have the artwork in a drawing program, in a vector format, ready to be exported to a bit-map for the web. Since we are talking about schematics, you'll want to use .GIF if it will be going to the web (for the sake of the limited web-browsers). If you have other uses for the image, feel free to use another format, such as TIFF. You're drawing program will hopefully have the ability to export directly to a GIF file (there are ways around that as well - later). There are some choices to be made that will impact size and quality of the outcome. Do you need black and white only, gray-scale, or color? Signing your name in color will make the whole image much larger, because everything will have to contain information for color. Generally, schematics should be in black and white only.

Now for the less scientific portions of the conversion. Resolution and the size of the image will depend on how much detail you'll need to preserve (back to the sand -vs- the pebbles). The more resolution and larger image size you pick, the bigger the file becomes, and sometimes more difficult for web-browsers to deal with. You'll need to play with converting to different sizes and resolutions, exporting the file, and looking at it in another program (you can use a web-browser, or a graphics file utility like ACDSee or Microsoft Imager). After you've done a few schematics of differing complexities, you'll get a feel for how many pixels you need to make the file image to give the best compromise between sharpness and file size.

Those graphics file utilities, too many to list, can help you out if your drawing program can not export to GIF. If your drawing program will export a TIFF format file, then you should be able to find a utility that can interconvert a TIFF and a GIF, and your problem is solved, albeit with yet another step.

I know somebody will flame me if I don't mention that there have been ugly legal battles over the use of the GIF format. I'm amazed the web-browsers got away with using it (JPEG has no such legal baggage), instead of using PNG, a format developed in response to the legal questions of GIFs. Sure, I'd rather use PNG IF: web browsers supported it directly, and more graphics programs and utilities could use it.

Let me know if you have any questions. The whole thing sounds much more complicated than it really is, and after you do one or two, you'll get the hang of it. If you have an image that you just can not get right, email me and I'll see if I can make any suggestions.

Adam B. Kanis, N2BRT

"THE JOY OF QRP" IS BACK

by Mike Czuhajewski, WA8MCQ

It's back!!! Over ten years ago, Adrian Weiss, W0RSP put out a book called The Joy of QRP. It quickly achieved cult status, sold out within a few years, and for years after that copies were quickly snatched up by QRPers whenever anyone was foolish enough to part with them. Long time QRPers who know of The Joy of QRP need no explanation, and for newcomers who haven't heard about it, all I can say is don't ask questions, don't think about it, just write out the check today and mail it out right away! You'll be glad you did. As KI6DS pointed out in a posting to QRP-L shortly after the announcement was made, there are only 1000 copies being printed up this time. However, between QRP-L, NorCal/QRPp subscribers and QRP Quarterly readers there are several times as many people as there are copies, so he and I don't expect them to last too terribly long.

Send a check or money order made out to Ade Weiss to:

Adrian Weiss W0RSP
526 N. Dakota St.
Vermillion, SD 57069

Prices are as follows: $23.00 First Class Mail (U.S), $26.00 Foreign, Seniors (65+): $15.00, Two copies: $40.00 (shipped to same US address). Package Deal: JOY of QRP and HISTORY of QRP (usually $15) = $33.00. US Funds only, make checks to Ade Weiss.

Disclaimer--I have no financial interest in the book, and will not benefit in any way from its sales. (I can't say that I have no association with W0RSP himself though; but you'll have to buy either this book or his other, A History of QRP in the US, to find out what it is!) Also, the QRP ARCI is not associated with this offer in any way.

--DE WA8MCQ

QRP Quarterly Reader Survey

Edited by Joe Gervais, AB7TT, vole@primenet.com

A journal without feedback from its readers is a ship without wind in its sails. Bad metaphors aside, we really do value your input, so to that end we'd like you to fill out this questionnaire and send it back to us. Please note that this is a survey, not a vote. We want to hear what's on your mind! So if you can, please fill this out and send it to Ron (KU7Y) at the address listed on the back of your QRP Quarterly. You can make a copy if you don't want to tear up your QRP Quarterly, of course, or send us email. Thanks much, and see you on the air!

NAME ______________________ CALL ______________ ARCI# __________

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2) Would you be willing to pay more (a few dollars) for your QRP ARCI membership in order to have QRP Quarterly sent via first class mail? ___ YES ___ NO

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7) What could QRP ARCI do to be a better club for you?

8) General Comments/Feedback

Introduction to SMT
Building a Colpitts oscillator and Buffer

by Laura Halliday **ve7ldh@direct.ca**

Introduction

Amateur radio has traditionally shied away from surface mount technology. There is a perception that SMT is impossible to work with for anybody with normal-size hands or normal eyesight, and that is impractical without expensive professional tools. On further investigation, many prove to be curious, but just don't know where to start, or what to start with.This article is a little push in that direction—an introductory SMT project.

I've been experimenting with SMT for some time, and decided long ago that any PC board I etch will use SMT (I use ugly construction, perfboard and wire wrap for the leaded stuff). One idea I find intriguing is building classic, well-proven circuits with new components and techniques, to see how they respond to up-to-date construction.

Here is an example: a classic Colpitts oscillator, followed by a shunt-feedback buffer. If the circuity looks familiar, it should—these circuits were analyzed in *Solid State Design for the Radio Amateur*, and are reproduced by permission of the ARRL.

The parts in this project may not be familiar, so let's first discuss where to get them, what they look like, and how to handle them.

Getting parts

The electronics industry has adopted surface mount technology in a big way—look inside almost any piece of electronics equipment today! Distributors supply these parts, which means that most distributors stock SMT components. The only catch is that since these distributors are equipped for OEM orders, they may insist that you buy, for example, 50 chip resistors, when you only wanted one. This isn't as bad as it sounds: they're cheap, you can easily justify a group project, and you may fry some of them when you first try installing them. In fact, I suggest that you *do* fry some, to see how hard it is to do. These components are tough!

Some electronics stores carry lines like SURFPAK and miniReel. If you are lucky, one will be near you.

Hams have stripped junk equipment for parts for decades. With the rapid pace of change in the electronics industry, equipment becomes obsolete faster than ever before. We hams remain the beneficiaries of this.

My favourite source of components is junk cellular telephones, which are routinely available to haul away (or rescue from a dumpster). They are loaded with resistors and capacitors, useful ICs and RF components, and may even come in a useful case. While they have many transistors in them too, this is not as good as it sounds. Read on...

Parts identification and markings

Surface mount components are small, so there is very little room available for markings. Manufacturers use codes, some of which are industry standard. Some of them aren't. Some components aren't marked at all.

Many components—especially resistors and capacitors—are made in standard sizes. Sizes useful for home construction include 0805, where a component is 0.08 inches long, by 0.05 inches wide. In metric terms, the numbers are 2.0 by 1.2 millimeters, hence 2012. The next larger standard size is 1206 (3216), which actually feels large and cumbersome once you are accustomed to working with the smaller sizes.You can buy components from most distributors down to 0402 size. If you can use these components for home construction, I envy you.

Surface mount chip resistors are almost always labelled, and the labels are a numeric version of the usual resistor values. A 10k resistor, for example, will be labelled 103.

Surface mount capacitors may or may not be labelled. If they are, they will may carry a code like resistors, or they will use a condensed code that is explained in the *Component Data* section of recent edtions of the ARRL *Handbook*. In this code, a letter specifies the significant digits, while a number provides the multiplier. For example, W2 is the marking for a 680 pF capacitor.

Physically large capacitors, especially electrolytics, are labelled with the standard numeric codes (e.g. 105 is 1 uF).

Active devices are a problem! A transistor in an SOT-23 package has no room for more than a couple of numbers or letters. Worse, the codes are not standardized. A device in an SOT-23 package labelled 1A may be a surface mount 2N3904 (Motorola's part number is MMBT3904LT1). But it may be something else. If you can identify the manufacturer, their data sheets will give the codes.

Sadly, this means that junk equipment is not a good source for transistors. If you can test and identify them, great! Otherwise, you will need to buy them like everybody else.

Integrated circuits in small packages like SOT-223 are labelled (or not) just like transistors. In larger packages, they may be labelled with a complete part number. Or an abbreviated part number, like M2401 for a Motorola MRFIC2401.

Installing parts

Professional SMT assembly and rework uses fancy professional tools with fancy professional price tags. We hams usually end up hand soldering parts, which isn't actually all that hard.

You need a soldering iron with a tiny tip. If the tip is too big, attack it with a file. If in doubt, make it smaller.

You need good light.

You need to be able to see what you're doing. If it helps, borrow or invest in a magnifier of some sort.

To solder a component, begin by tinning one pad on the circuit board. A little blob of solder will do.

Position the component.

Holding the component down, melt the solder blob you have just made. You will feel the component settle into place. Some use a toothpick to hold components down. I use a long fingernail.

Solder the other connection(s) to the component.

You're done!

Professional assembly uses reflow and wave soldering. These are relevant to us because they affect how you remove parts from junk boards.

Wave soldered boards are immediately identifiable by the little blobs of glue under the components. When the board was made, the parts were held down by that glue, then the board was immersed in a bath of molten solder. To remove the parts, be prepared to give them a firm push—the glue isn't very strong.

Reflow soldered boards are made by treating the boards with a sticky mixture of solder flux and ground solder. This is sticky enough to hold the parts in place while the board is run through a hot air machine that activates the flux and melts the solder. Surface tension pulls the parts into perfect alignment. These boards are much easier to strip: use a hot air gun, wait until the solder melts, bang the board on the bench, and collect the parts that fly off. A gentler approach is to use a solder sucker, or solder wick, or even use two soldering irons like tongs to melt the solder at all the connections and lift the part off.

Experiment!

Hams who are serious about SMT can use a variation of reflow soldering, with solder paste from a syringe (sold for SMT rework) and a source of hot air, like a small torch with a hot air attachment.

A sample project

Here is a sample SMT project I'd like you to try.

When selecting the VFO I present here, I bore several things in mind.

The project must be small. This is a project to get a taste of SMT construction, and see what all the fuss is about. It is not a multi-year research project.

It must be cheap. If it fails, you haven't lost much.

It must do something useful. Why bother otherwise?

It must work well enough to show why surface mount is important. This project succeeds; all the SMT VFOs I have built have been exceptionally stable. They are also small enough that I routinely mummify them in bubble packing for that last extra bit of thermal stability.

This project shows a peculiarity I have observed with other SMT oscillators. The stray lead inductance is far smaller than a leaded version, so they tune somewhat higher in frequency than you would otherwise expect. Not much. But enough that you may need to do a bit of cut and try to get the tuning range you want.

I chose a bipolar oscillator because SMT FETs are not always easy to find. The transistor I use is a Zetex FMMT5179, in effect, an SMT 2N5179. The buffer transistors are MMBT4401s, but any decent NPN transistor with a high enough F_t should do. Try it!

Using a Colpitts oscillator eliminates the need for tapped coils. You can buy SMT inductors in the right inductance range, like the Toko 5CCD series. But they are expensive, and do not have as high Q as a good toroid. Try one if you like. There is room on the board.

Similarly, air-variable capacitors are not always easy to find. If you would like to try varactor tuning, please do so, and consider reporting the results.

I claim no originality for the electronics. They are a combination of the Colpitts VFO and shunt-feedback buffer amplifier analyzed in *Solid State Design for the Radio Amateur*, and are reproduced with the kind permission of the ARRL. The component values in the tuned cicruit are for a 5.0 MHz oscillator. Please consult *Solid State Design* for other values.

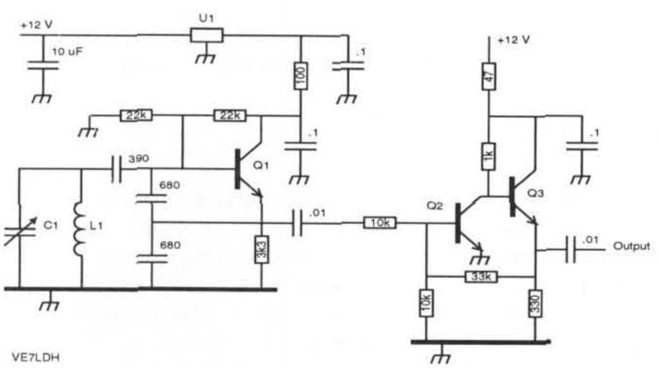

Figure 1: Colpitts oscillator schematic

PCB layout

This is the full-size PCB layout.The finished size of the board is 30 by 50 millimeters. In case you're curious, I laid my prototype out with drafting tape, from a pencil sketch.

Figure 2: PCB layout

This is the parts overlay, at a somewhat larger scale. I usually mount L1 and C1 off the board.

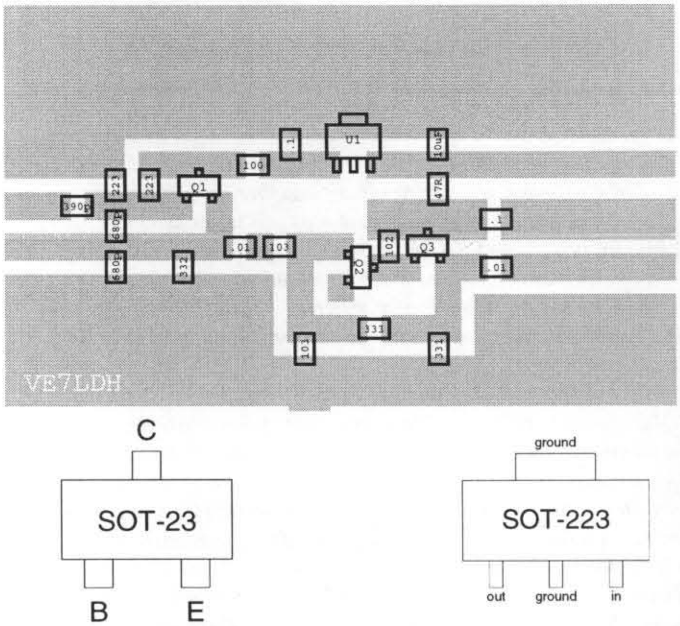

Figure 3: Parts overlay, with base diagrams

PCB connections

The external connections to the PCB are as follows:

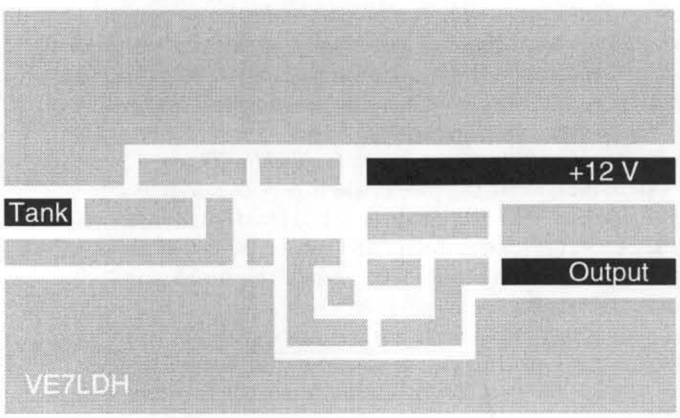

Figure 4: external connections

Ground connections

These areas of the PCB need to be grounded. I favour double-sided PC board material for this, since it's easy to drill a hole and solder in a wire.

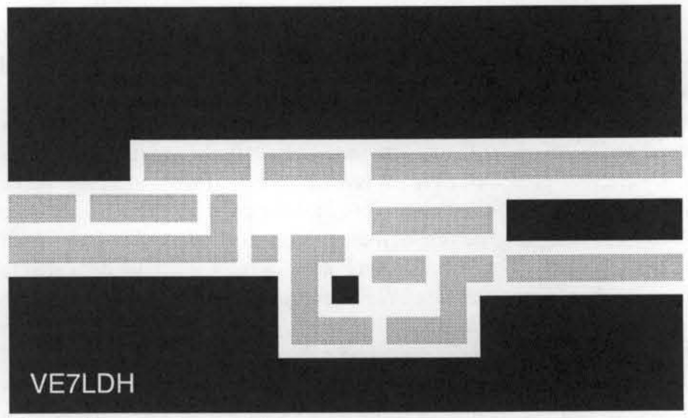

Figure 5: ground connections

Parts list

SMT resistors and capacitors are widely available through distributors like Digi-Key and Mouser.

The semiconductors I used are, with their Digi-Key part numbers:

FMMT5179	FMMT5179CT-ND
FMMT4401	FMMT4401CT-ND
78L06	NJM78L06UA-ND

Suggestion

Many of the parts I've used only come in packages of 10 or more. Why not consider a group or club project?

Summary

See? It wasn't that bad. Once you're used to it, you may even find you prefer SMT over those big clunky leaded components. Every time I have applied SMT to a project, the results have been positive. What other discoveries await us?

Back Issues of The QRP Quarterly Available

George "Danny" Gingell, K3TKS, is now handling sales of back issues of the QRP Quarterly for the club. He currently has copies of all issues back to the beginning of 1995 and a few assorted issues for earlier years. Back issues are $2.50 to $7.00 each (depending on the issue) plus shipping. Four issues can be shipped Priority Mail in the US for $3.00. Contact Danny before ordering to make sure he has the issues that you need. (Please include your call, QRP ARCI number and telephone number in all correspondence.) Danny can be contacted as follows:

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The Back to the Future Project
The Tuna Tin 2 (Doug DeMaw, W1FB)

by Doug Hendricks, KI6DS ki6ds@dpol.k12.ca.us

Doug DeMaw, W1FB, was one of the founding fathers of QRP building and design. He authored several hundred articles for QST, and several books that are still used daily by QRPers throughout the world. NorCal has decided to honor Doug with a tribute that we think he would have enjoyed, the "Back to the Future" project. We will update a series of projects that were first presented over 20 years ago with modern available parts, and also will provide circuit boards to fit those parts for those who wish to build these designs. The first of these projects is the Tuna Tin 2, designed by Doug himself. The "Back to the Future" project is hereby dedicated to the memory of Doug DeMaw, W1FB, enjoy.

The Tuna Tin 2 was originally designed by Doug DeMaw, W1FB in 1976. It appeared in QST, and was subsequently built by hundreds of QRPers, who were attracted to the project by the relatively easy parts availability. In fact, at the time of publication of the article, you could stop by the local Radio Shack and pick up everything needed except for the crystal.

When I looked at the article in the summer of 1996 and decided to build another Tuna Tin 2, I discovered that all of the parts were not available from Radio Shack. I contacted Dave Meacham, W6EMD, and he agreed to look at the article and update the parts to modern, available parts sources. Because we were changing the physical size of some of the parts, it meant that a new board would have to be layed out. That was to be my contribution to the project. The board was layed out and the new schematic drawn with Circad which is available free on the internet at http://www.holophase.com. The free version is demo version that is not crippled and is very useful for the average ham. You have the ability to printout circuit board patterns to a laser or inkjet printer with the demo version. About the only way the demo version differs from the full version is in the ability to generate Gerber files and PCX output. Holophase even has a special price for hams, $295 vs. $995 for non-hams. Contact them for details.

Circuit Details:

W1FB did a great job describing the circuit, so I decided to use his description from page 15 of QST, May 1976.

"A look at the schematic will indicate that there's nobody at home, so to speak, in the two-stage circuit. A Pierce type of crystal oscillator is used at Q1. Its output tickles the base of Q2 (lightly) with a few milliwatts of drive power, causing Q2 to develop approximately 450 milliwatts of dc input power as it is driven into the Class C mode. Power output was measured as 350 milliwatts (1/3 W), indicating an amplifier efficiency of 70 percent.

The collector circuit of Q1 is not tuned to resonance at 40 meters. L1 acts as a rf choke, and the 100 pF capacitor from the collector to ground is for feedback purposes only. Resonance is actually just below the 80 meter band. The choke value is not critical and could be as high in inductance as 1 mH, although the lower values will aid stability.

The collector impedance of Q2 is approximately 250 ohms at the power level specified. Therefore, T1 is used to step the value down to around 60 ohms (4:1 transformation) so that the pi network will contain practical values of L and C. The pi network is designed for low Q (loaded Q of 1) to assure ample bandwidth on 40 meters. This will eliminate the need for tuning controls. Since a pi network is a low-pass filter, harmonic energy is low at the transmitter output. The pi network is designed to transform 60 to 50 ohms.

L1 is made by unwinding a 10 uH Radio Shack choke (No. 273-101) and filling the form with No. 28 or 30 enamel covered wire. This provides an inductor of 24 uH. [Note: this part is no longer available from Radio Shack, so W6EMD subbed a 22 uH inductor here.] *In a like manner, unwind another 273-101 so that only 11 turns remain, (1.36 uH). The 11 turns are spaced 1 wire thickness apart. Final adjustment of this coil (L2) is done with the transmitter operating into a 50 ohm load. The coil turns are moved closer together or farther apart until maximum output is noted.* [Again, this part is not available, so W6EMD subbed a toroid, T37-6 (yellow) with 21 turns of #26 wire.] *The wire is then cemented into place by means of hobby glue or Q dope. Indications are that the core material is the Q1 variety (permeability of 125), which makes it suitable for use up to at least 14 MHz.*

T1 is built by removing all but 50 turns from a Radio Shack No. 273-102 rf choke (100 uH). The ferrite core in this choke seems to be on the order of 950, in terms of permeability. This is good material for making broadband transformers, as very few wire turns are required for a specified amount of inductance, and the Q of the winding will be low (desirable). A secondary winding is added to the 50-turn inductor by placing 25 turns over it, using #22 or #24 enameled wire. The secondary is wound in the same rotation sense as the primary, then glued into position on the form. Tests with an RX meter show this to be a very good transformer at 7 MHz. There was no capacitive or inductive reactance evident. The primary winding has an inductance of 80 uH after modification. [Although the RS 273-102 is still available, W6EMD also replaced it with a toroidal transformer, as it just looked better and as long as you have to wind a toroid, you might as well wind two.)

Increased power can be had by making the emitter resistor of Q2 smaller in value. However, the collector current will rise if the resistor is decreased in value, and the transistor just might "go out for lunch," permanently, if too much collector current is allowed to flow. The current can be increased to 50 mA without need to worry, and this will elevate the power output to roughly 400 mW.

One of the goals of this project was to provide readily available parts plus an easy source for circuit boards. I layed out the board and sent the artwork to Fred Reimers at FAR Circuits, 18N640 Field Court, Dundee, IL 60118, who is making boards available for $5 plus $1.50 shipping and handling for up to 4 boards.

I suggest that you do the metal work on your chassis before you start stuffing and soldering the parts on the board. You will first have to drill a hole to accommodate the connector that you have chosen for your key jack. You may use 1/8", 1/4" or phono here. The choice has been left to the builder. But whatever connector you choose, make sure that it is mounted in the center of the rectangle shown for J1, as J1 must be insulated from ground, as it is the means for applying 12V to the circuit. 12V is connected to one side of the jack, and when the key is closed, the resulting short circuit connects the 12V to the circuit.

W1FB wired his Tuna Tin 2 on a chassis made from a Tuna can, and I suggest that you do the same. He mounted his on the bottom, using a set of nibbling tools to cut all but about 1/4" of the bottom out, leaving the 1/4" rim to solder to. I decided to mount my board on standoffs that are connected to the bottom of the can and hold the board up to the edge of the rim. I then was able to put rubber feet on the bottom of the can. If you chose my method of mounting, you will need to drill 3 mounting holes in the board and then matching holes using the board as a template.

After you drill the mounting holes in the base, you will need to drill the holes for the 3 phono connectors and the SPDT toggle switch in the sides of the can. I mounted the Switch directly opposite the middle connector, and mounted the three connectors on the same side of the can about 1 1/4" apart. See Fig. 1 for a diagram that shows the placement of the connectors and the switch. W1FB chose to put his switch between the antenna and the receiver connectors, but I thought that I would like to have the power and antenna connectors on the back of my rig and the antenna switch on the front.

Next wire the chassis as shown in the diagram. I used pieces of wire about 4" long to make the connections between the connectors and the board. See Fig. 1 for the wiring diagram.

You are now ready to install and solder the parts. Refer to the parts list and the layout in Fig. 2. Be sure to check the schematic too. When you have finished, you are ready for the smoke test. Apply 12V power to the power connector, hook up a dummy load or 40 meter antenna to the rig, connect a key to the key jack, switch to transmit, and hit the key. You should hear a tone in a nearby receiver that is tuned to the frequency of your crystal.

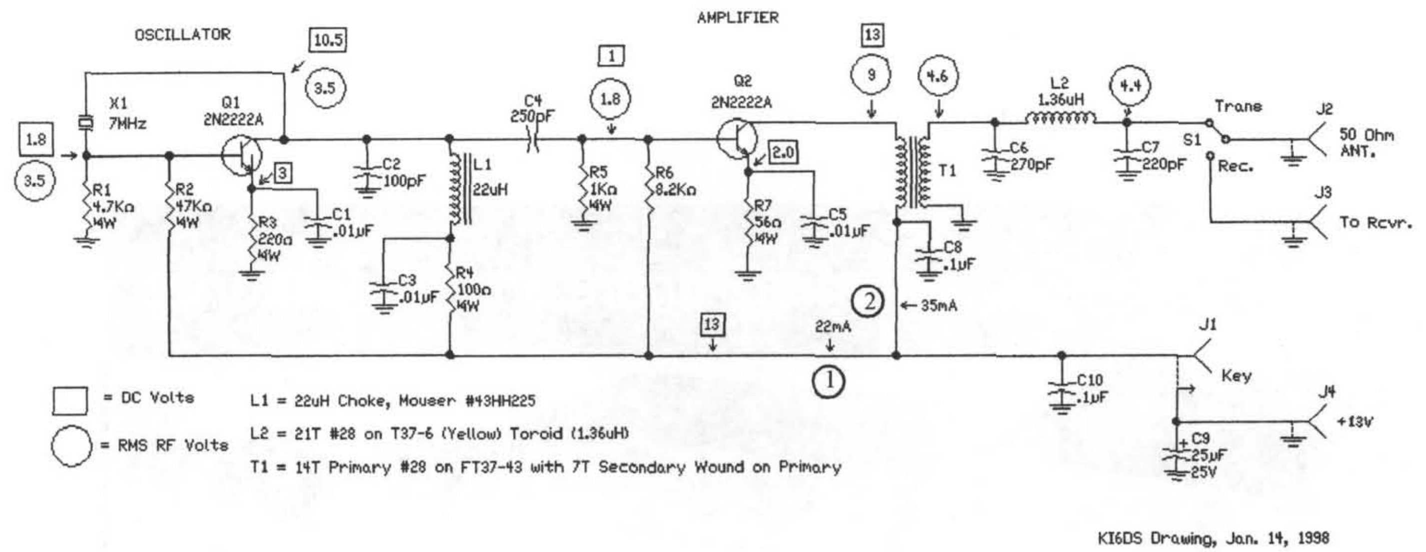
If you have trouble getting your rig to work, DeMaw even had a trouble shooting section to his original article that is repeated here from page 16, QST, May 1976.

The voltage shown in the schematic will be helpful in troubleshooting this rig. All dc measurements were made with a VTVM. The rf voltages were measured with an rf probe and a VTVM. The values may vary somewhat, depending on the exact characteristics of the transistors chosen. The points marked 1 and 2 (in circles) can be opened to permit insertion of a dc milliammeter. This will be useful in determining the dc input power level for each stage. Power output can be checked by means of an rf probe from J2 to ground. Measurements should be made with a 51 or a 56 ohm resistor as a dummy load. For 350 mW of output, there would be 4.4rms volts across the 56 ohm resistor.

Operating voltage for the transmitter can be obtained from nine Penlite (AA) cells connected in series (13.5 volts). For greater power reserve one can use size C or D cells wired in series. A small AC operated 12 or 13 volt regulated dc supply is suitable also, especially for home station work.

I would like to thank all of the NorCal members who helped with the updating of the Tuna Tin 2 transmitter, Dave Meacham, W6EMD for doing the engineering, Dave Adams and Gary Diana for providing prototype work, Brad Mitchell, Jerry Parker and George Heron for Web page production.. It is the first in a series of old time rigs that will be updated by NorCal. We will also do the Herring Aid 5 Receiver, the Chopped Beef VFO, and the Codzilla Amp, all updated with modern available parts and circuit boards, but still keeping the flavor of the original design. I hope that you build and operate these rigs. 72, Doug, KI6DS

Tuna Tin 2 Transmitter
Designed by Doug Demaw, W1FB
Updated Parts by Dave Meacham, W6EMD



Parts List for Tuna Tin 2 Transmitter

C1 .01uF
C2 100 pF
C3 .01uF
C4 220pF
C5 .01uF
C6 270pF Silver Mica or Disc (100V)
C7 220pF Silver Mica or Disc (100V)
C8 .1uF
C9 22uF/25V Elect. radial or axial (mounted off board)
C10 .1uF
L1 22uH (Mouser 43HH225 or 7 turns #26 on FT37-43 Toroid)
L2 21T #26 on T37-6 Toroid (yellow)
Q1 2N2222A (Metal Case)
Q2 2N2222A (Metal Case)
R1 4.7K
R2 47K
R3 220 ohm
R4 100 ohm
R5 1K
R6 8.2K
R7 56 ohm
T1 14T Pri. 7T Sec. on FT37-43 Toroid
X1 40 meter crystal in HC49U style case.

All resistors are 1/4 watt, all capacitors on the board have .25" hole spacing. You will also need stranded hook up wire, 1/8" or 1/4" key jack, 3 RCA Phono jacks, 1 SPDT Switch, 1 empty Tuna can. Note that C9 is mounted off board between J4 and ground.

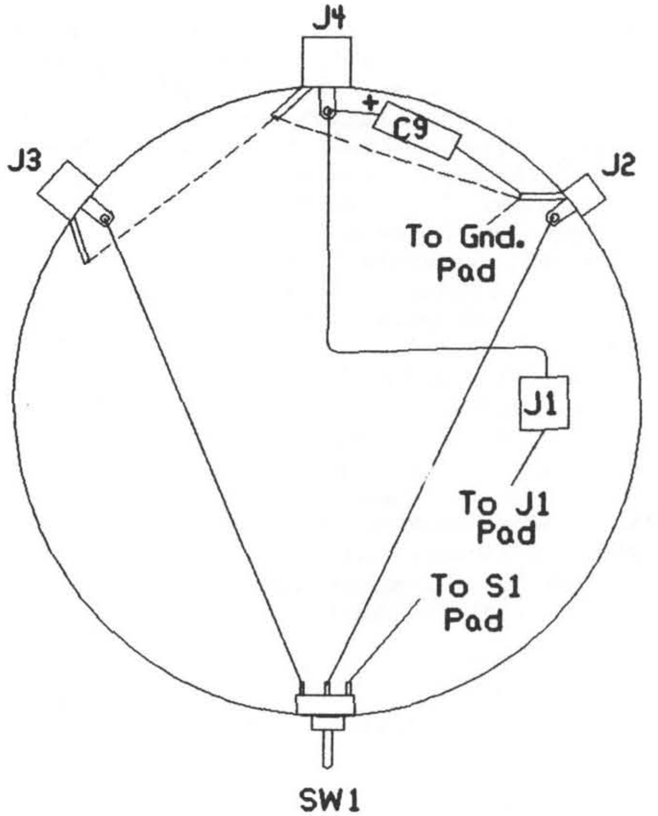


Fig. 1

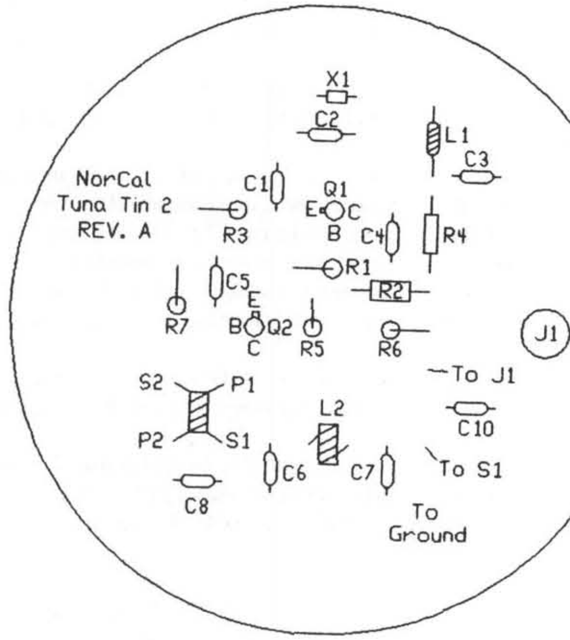
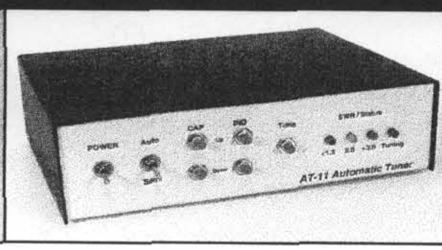
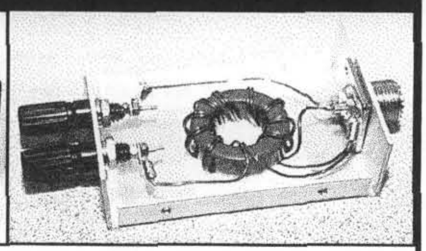


Fig. 2

LDG Automatic Antenna Tuners and Accessories





QRP AutoTuner

Tunes 6 to 800 Ohms. 0.1 to 10 Watts.
12V@190 mA. Board Size: 4.3 x 4.4
Case Size: 6.3 x 5.2 x 1.3

$100 Kit $6 shipping
$125 Kit/Enclosure $8 shipping
$159 Assembled $8 shipping

AT-11 AutoTuner

Tunes 8 to 600 Ohms. 5 to 100 Watts.
12V@500 mA. Board Size: 6 x 8
Case Size: 6.5 x 8.5 x 2.5

$150 Kit $8 shipping
$180 Kit/Enclosure $10 shipping
$219 Assembled $10 shipping

BA-1 4:1 Balun Box

4:1 Balun for Ladder Line
and Long Wires.
Case Size: 2.5 x 3.5 x 1.3

$25 Kit/Enclosure $6 shipping

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ELECTRONICS

LDG Electronics
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St. Leonard, MD 20685

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Fax: 410-586-8475
e-mail: ldg@radix.net
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Cheap and Easy RTTY

by Bill Jones, KD7S kd7s@psnw.com

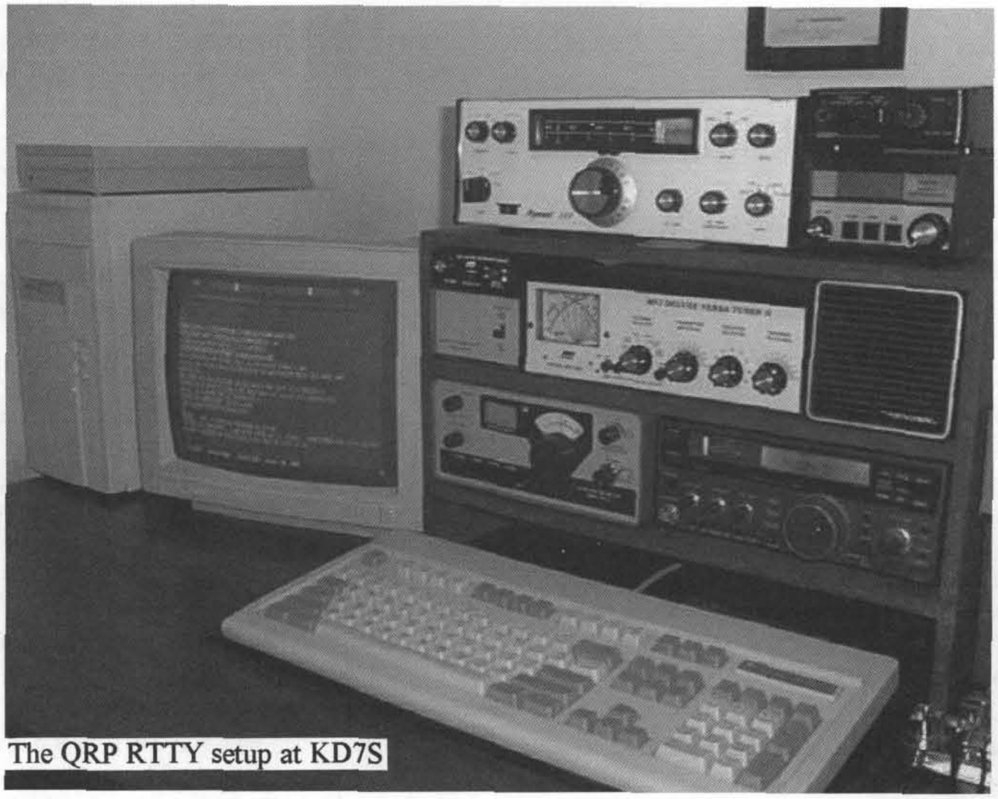
There is more to QRP than just CW or SSB. If you haven't tried RTTY (Radio TeleTYpe) with your QRP rig, you're missing out on an awful lot of fun. Watching a string of letters and numbers march across a computer screen in lock-step with the warbling tones from your headphones is almost magical.

I put QRP-RTTY to the test during the ARRL RTTY Roundup contest in January. I used my Icom IC-728 transceiver throttled back to four watts along with a roof-mounted vertical antenna. When the contest was over my station log showed I had worked 36 states, half the Canadian provinces and numerous DX stations during four hours of casual operation. The "fun factor" was off the scale at the high end.

WHAT DO YOU NEED TO GET STARTED IN RTTY?

Getting on the air with RTTY is unbelievably simple and could end up costing less than a set of iambic paddles. In fact, it could even be free depending upon what equipment you already have in your shack.

The basic equipment you need for receiving and transmitting radio teletype signals consist of (1) a transceiver capable of single sideband operation, (2) a personal computer, (3) an interface between the computer and transceiver, and (4) software. Most of us already have the transceiver and computer so it's usually just a matter of finding a hardware interface and a program.



The QRP RTTY setup at KD7S

Probably the quickest way to join the fun is to buy a commercial multi-mode controller and its matching software. Controllers are available from companies such as MFJ, Kantronics, Hal, plus others. While these full featured, high performance devices are readily available, the prices start at around $400 and go up from there. Fortunately, there are less expensive ways to get on RTTY.

One very inexpensive way to explore RTTY is with HamComm. HamComm is a computer program designed to send and receive RTTY, AMTOR and CW using your SSB transceiver. Although the program is shareware, it is very sophisticated, stable and bug-free. The best part is that registration is only thirty dollars. The registered version also allows you to copy (but not transmit) PACTOR.

The HamComm documentation includes a schematic diagram for an extremely simple homebrew interface that connects your transceiver to a computer. A commercial controller isn't needed. Parts for the interface are available from your local Radio Shack store and the whole thing can be built for around ten dollars. While the basic homebrew HamComm interface won't match the performance of its commercial equivalent, it will provide many solid contacts under good conditions.

A much better HamComm style interface is available in kit form from Terry Mayhan, K7SZL. Terry runs a website on the Internet that deals with HamComm exclusively. You can learn everything you ever wanted to know about the program from Terry's site as well as download the latest version. The URL to K7SZL's website is: http://www.accessone.com/~tmayhan/index.htm.

If your computer has a sound card, there is an even easier (and better) way to get on RTTY. Rob Glassey, ZL2AKM has just released an upgraded version of his program called BTL (Blaster TeLetype).

BTL uses your computer's sound card as a data controller. Performance rivals many commercial multi-mode controllers in every respect except price. The DSP filtering provided by BTL and the accompanying sound card is nothing short of amazing. I have printed (teletype talk for copied) signals I could barely hear in the headphones. QRM from adjacent signals rarely disrupts copy from the desired signal.

So, how much does BTL cost? For a limited time Rob is offering the latest version to hams for......nothing. That's right, it's free. He does go on to say that this will probably be the last free version, however. Anyone wishing to send a thirty dollar registration payment may do so with the understanding that it will go toward supporting his continuing work on this already outstanding program. Like HamComm, BTL is software worth paying for.

BTL is available on the Internet at the Blaster TeLetype Home Page. The URL is:

http://www.geocities.com/SiliconValley/Heights/4477/index.html#btl.

If you're looking for a change of pace, join the growing number of QRPers who have discovered the joy of RTTY. You will not only meet some very interesting people but it's just possible you may add some new countries to your QRP logbook as well.

73, Bill, KD7S

Review: OHR-100A 30M Transceiver Kit

Chuck Adams, K5FO PO Box 181150, Dallas, TX 75218 email: adams@sgi.com

Here is a quick overview of the new Oak Hills Research OHR-100A transceiver kit for 30M. The basic facts:

MFR:	Oak Hills Research 20879 Madison Street Big Rapids, MI 49307 Phone: (616) 796-0920 (See WEB page at http://www.ohr.com/)
Designer:	Dick Witzke, KE8KL
Model:	OHR100A
Size:	14.8cm x 13.5cm PC-board 6.25in x 6.25in x 2.7in case size (Sorry for the change in units; couldn't find a ruler.)
Weight:	23.6 ounces for assembled kit with case
PC board:	Double sided plated-through, solder-masked and silk-screened PC board
Manual:	19 pages 8.5x11" double sided manual plus 12 pages parts listings, schematics and illustrations
Power :	12 to 14VDC
RX Drain:	70mA
TX Drain:	850mA on transmit for 5W output at 13.6V
Ant Connection:	SO-239 connector
Pwr Connection:	Coaxial DC Power Jack
Key Connection:	RCA Phono Jack
Ear Phones:	1/8in Stereo Phone Jack (internal jumper for mono)
Speaker:	1/8in Phone Jack for external speaker (speaker not supplied)
Modes:	CW only
Kit:	Yes. Complete with case and internal parts.
Band:	30M reviewed; 40M, 20M, and 15M available.
LO/VFO:	Oscillator with 19.100-19.170MHz out (10.100-10.170MHz tuning range)
Drift:	Less than 300Hz in 20 minutes from a cold start with cover removed at 65 °F. Zero drift thereafter. Measured with WWV receiver and Heath IM-2410 counter.
Dial Range:	Marked 0 to 70
RX:	SuperHet
XMTR:	Rated 5W. Measured 2W into dummy and 2W into antenna at 12.3V.
IF Filter:	Four crystal filter at 9.000MHz
Selectivity:	About 1500Hz-350Hz variable from front panel.
RIT:	Yes. Up and down about 1 KHz each way.
Gain controls:	Audio and RF controls on front panel.
AGC:	No
RF preamp:	No
RF attenuator:	No
Builtin SPKR:	No
Meter(s):	No
Sidetone:	Sine wave generated at audio levels. Adjustable level and adjustable frequency.
VFO:	Yes. Covers 70KHz or a little more of the bands.
Output:	5.0W adjustable (with internal pot adjustable through hole in rear of case) to lower levels down to 0 output.
Internal Keyer:	No
QSK:	Yes
Front Panel:	Tuning 10.1 to 10.170MHz, Audio Gain, RF Gain, Variable Bandwidth for IF, and RIT.
Rear Panel:	ANT (SO-239), power, OSC out (RCA phono), Key (RCA), Speaker out (1/8in jack), and Phones out (1/8in jack), and hole for power adjustment (pot can be reached with a small straight bladed screwdriver)

The Power, 2 RCA Phono Jack, 2 1/8" (3.5mm) stereo jacks and trim power for power adjustment are all PC board mounted. The front controls are all chassis mounted and connected with to the pc board through the use of molex connectors (like in the previous OHR100 series).

Price:	$99.00 plus $5.50 S&H for the US; call for pricing for DX shipping
Availability:	Direct from Oak Hills Research at above address. May also be available from some dealers.
Options:	None at this time. DD-1 for extern digital display additional.
Date of Review:	November 29, 1997

Additional technical information for the more technically inclined:

1. Vackar VFO running from 5.100 to 5.170MHz mixed with 14MHz to get the 19MHz range.
2. 9MHz IF with four-crystal Cohn filter variable from 1500-350Hz.
3. NE602 first mixer in receiver with MC1350 followed by another NE602 and a 14-pin LM380N-8 for audio for headphones and a 14-pin LM380N for speaker. Phones disengage the speaker output.
4. Transmitter chain uses NE602 followed by couple of NPN amp stages and 2SC2078 for the final PA.
5. Reception is on lower sideband, i.e. you tune down in frequency and the received tone goes up. Dial tunes left to right for increasing frequency.

The PC board shop that Oak Hills Research uses has got to be one of the top ten in the world. The quality is outstanding. Green solder masked and with the white silkscreen is a joy to work with and doesn't cause a great deal of strain on the eyes. The registration and alignment of the silkscreen along with the crisp fine print makes the assembly process a joy.

This kit, as the other OHR kits over the years, has step by step check 'em-off-as-you-go instructions. For the inexperienced builder there is a pictorial on winding toroids (there are 11 in this kit) and there are two pages of "parts pictorials" showing drawings of each part. This is like the old Heathkit manuals, and in fact Dick Witzke uses an illustrator that used to do the Heath manuals.

I went through the assembly process without a single hitch. The instruction manual is complete and fairly detailed so there shouldn't be any trouble for the builder. Use a good 25W soldering iron with 63/37 or 60/40 0.031in. diameter solder suitable for electronic assembly. Don't use any larger iron and use the best small tip you can find.

The parts are first class. The tuning pot is a sealed 100K part made by Precision in Canada. A real nice pot and I like the feel. It is wirewound and will last longer than the carbon deposit type pots that I have used on other rigs. If you buy the digital display, then you may want to get a ten turn pot (there is plenty of room) and have additional fine increment tuning.

I fired the OHR-100A up and aligned it in short order; nothing was installed incorrectly and no problems were encountered. Having a frequency counter or the OHR DD-1 display will help in the frequency alignment. A general coverage receiver or another 30M rig can also be used. Dick has two built-in RF probes in the 100A, i.e. 1N34A diodes in place on the board with test points that allow you to peak the transmit and receive chain signals without a scope. A neat idea. Works great just using a DVM for the alignment. So you don't need a 'scope to set it up.

As I don't have a 13.6V supply, so I used a 12.3V gel-cell and was able to get a little more than 2W output. A little more voltage is needed to get the 5W output, but I don't use that much power anyway.

This puppy keys QSK smooth. I had the GM-30 listening to it key at 50+ wpm; smooth and clean.

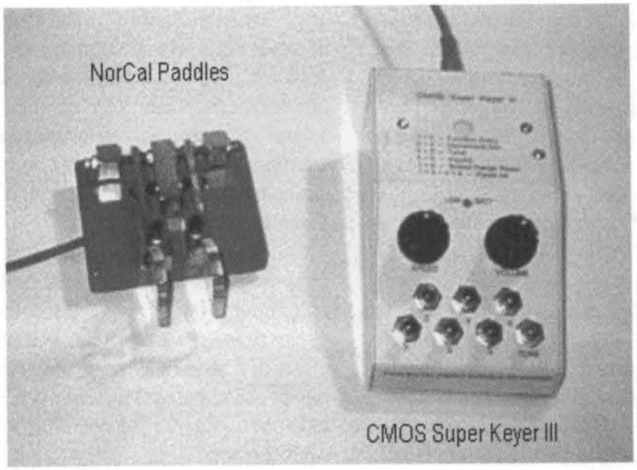
The receiver is great and can hear anything the Corsair I or the GM-30 can hear on 30M. So this is a rig that is definitely *not* short on performance.

Review: NorCal Paddle Kit

Larry East, W1HUE 1355 S. Rimline Dr., Idaho Falls, ID 83401 email: w1hue@amsat.org

The Northern California QRP Club (NorCal) has come up with a unique kit: All the hardware required to assemble a high quality iambic paddle key! The key was designed by Wayne Smith, K8FF, and was the winner of the 1997 NorCal Design Contest. When Doug Hendricks, KI6DS, of NorCal first saw the key, he just knew that it had to be NorCal's next kit project. Doug contracted with a local machine shop to provide the machined parts, wrote a three page construction manual, and talked Paul Harden, NA5N, into producing an excellent full page exploded drawing of the paddle.

All machined parts and miscellaneous hardware (machine screws, nuts, washers, etc.) are supplied in the kit. The paddle base is a 3 in. × 2-3/8 in. × 1/2 in. thick steel plate. The paddle parts are made of brass, with clear plastic handles. The machined parts are not "finished" and a fair amount of elbow grease is required to polish them if you want a professional looking end result. Although the work can be done with simple hand tools (including a good file and a supply of fine emery cloth or paper), a small bench vice, a grinding wheel and a polishing wheel can be used to good advantage. Mechanical assembly is simple and progresses fairly quickly, but some "fine tuning" has to be performed along the way to shorten some of the machine screws (this is where a grinding wheel comes in handy) and file the length of a couple of bearings for proper clearance. The time consuming part involves filing and sanding the base to remove the rough edges and polishing the brass pieces. This is where some Jeweler's Rouge and a buffing wheel come in handy. The plastic handles also have to be cut to shape using a hack saw and the edges sanded and polished. (Careful; the plastic chips easily!)



Contact spacing is adjusted with a series of set screws held in place with brass nuts. No springs are used in the key; tension is adjusted by varying the space between set screws in each lever arm and a bar magnet embedded in the center post between the arms. The end result is a paddle with a very nice feel to it.

The accompanying photo shows the final product of my efforts along with my CMOS Super Keyer III (1). My only complaint is that the paddle handles are too far apart for my liking. However, I understand that the design has now been modified slightly to provide closer spacing for the handles. Unfortunately, the "original" kits (like mine) cannot be retrofitted to accommodate the new paddle arms that provide the closer spacing. Oh well — I guess I'll get used to it!

A few words of caution to would-be builders of this kit: First of all, be very careful not to file the bearings too much! If you do, the lever arms will bind. But all is not lost if this happens; a new set of bearings can be ordered directly from the machine shop that supplies the parts to NorCal. The other caution is in lubricating the bearings: If too much oil is used, it is possible that electrical contact to the paddle arms will be intermittent resulting is lost "dits" or "dahs". In an attempt to circumvent this problem, I coated the bearings with a thin layer of conducting grease (2) followed by a single drop of sewing machine oil. I haven't experienced any intermittent contact problems, and the arms work very smoothly. Graphite or a thin oil containing graphite could also be used, but that stuff can be a bit messy.

The kit can be obtained from Jim Cates, WA6GER, for $30 plus $5 shipping in the US. Like all NorCal kits, this one will be available only for a limited time so you should contact Jim (or check the NorCal WEB page at http://www.fix.net/norcal.html) before sending any money. Jim's address is 3241 Eastwood Rd., Sacramento, CA 95821 and his email address is wager@juno.com.

Notes:

(1) The keyer is available as a board-level kit (no enclosure or off-board parts are provided) from Idiom Press; see their ads in **QST** for current price and ordering information.

(2) I used some conductive grease that came with a vertical antenna that I purchased several years ago. Similar grease can be obtained from electrical supply houses; be sure to use a type that is compatible with copper.

The Back to the Future Project
The NorCal Herring Aid 5 Receiver

by Glenn Torr, VK1FB glenntorr@ozemail.com.au

This article describes changes made to the "Herring-Aid Five" receiver presented by Jay Rusgrove, then WA1LNQ, in the July 1976 issue of QST to allow the design to be duplicated with readily available components. The original circuit was designed so that the constructor could obtain all the parts from Radio Shack and many of these parts are no longer available.

In keeping with the theme of using food containers as chassis for these designs this receiver was built onto an oval shaped Scottish Herring can hence the name. Construction was similar in general layout to the Tuna Tin 2.

The first change necessary was to get a PCB which suited the new component foot prints and allowed for changes to the circuit where needed, to this end Doug Hendricks, KI6DS, laid out a new PCB using CirCad. Prototypes of this board were generated by Gary Diana, N2JGU. The new board is rectangular which will allow the constructor more flexibility in the choice of chassis or enclosure.

The parts substitutions were made in such a way as to have as little impact on the original design as possible. The main changes have involved the substitution of toroids for the original solenoid style inductors. This then lead to the addition of trimmer capacitors, as inductance adjustment was no longer practical by squeezing up or stretching out turns. Audio transformers T1 and T2 were replaced with readily available equivalents as were the semiconductors.

The Receiver

This receiver is a "minimal" direct conversion design in which the designer has traded a little performance for ease of construction with the then widely available components. I think the most unusual part of this receiver is the use of a single unbalanced BJT as the mixer in a 40 meter receiver, I imagine this unusual choice would cause severe problems where broadcast station interference was present. As the designer of the original receiver noted audio bandwidth was left wide enough to allow for the reception of SSB and AM signals. The up side of this is that it allows for the use of the receiver for these modes, the downside is that it compromises the receiver's CW performance.

The Circuit

The incoming 40-meter signal is coupled to the source of Q1 via a tuned circuit consisting of L1, L2, TC1 and C1. Q1 is a grounded gate RF amplifier and has its source tapped down L2 to preserve the Q of that tuned circuit. The output of the RF amplifier is coupled to the Mixer by another tuned circuit consisting of C2, TC2, L3 and L4. These tuned circuits provide all of the 7 MHz selectivity. Q2 then mixes the VFO with the incoming RF and the resultant Audio signal is amplified by Q2 and coupled by T1 to the audio gain control. Q3 and Q4 are conventional common emitter audio amplifier stages; the audio output is coupled to low impedance phones by T2. The VFO consists of Q5, which operates as an un-buffered voltage tuned VFO. Ordinary silicon diodes such as 1N4148 are used as varactor diodes in this circuit. The tuning pot provides a voltage variable from 0 to approximately 800 mV, which allows the oscillator to tune approximately 100 kHz at 7 MHz.

Construction

Note: The description by Doug, KI6DS and Dave, AD6AY of their debugging of an early prototype which appears on the NorCal page is invaluable companion reading to this section. I commenced by building and adjusting the VFO. The VFO was designed to cover a range of any 100 kHz of 40 Meters for 180 degrees of rotation of the tuning potentiometer, which suits the vernier drive originally, used. I first wound L7 which consists of 45 turns occupying about five-sixths of the T-50-2 toroid. L6 consists of 5 turns immediately adjacent to the top of L7 and noting the phasing in the circuit. L5 consists of 4 turns over the ground end of L7. VFO output with the pot at the low frequency position (ground) is fairly low so as only 180 degrees of pot travel is used I set the pot to about 20 degrees up from ground and then adjusted the frequency to be 7.000 MHz with TC3 (across C4). If necessary a turn or two can be added to or deleted from L7 to achieve the desired range, it may be easier to replace the relevant capacitor, C19, with a slightly different value. This gave my receiver a range of 7.000 to 7.100 MHz. If the oscillator does not oscillate try reversing the terminations of L6.

The 180 degree requirement can be addressed either by using a vernier drive similar to the original or constructing a frequency scale with 7.000 MHz at 9 o'clock, 7.050 MHz at 12 o'clock and 7.100 MHz at 3 o'clock and simply ignoring the unused portion of the tuning pots travel.

The rest of the receiver can now be constructed. L2 consists of 45T on a T-50-2 toroid, tapped up 5 turns from ground; L1 consists of 4 turns over the ground end of L2. L3 consists of 45T on a T-50-2 toroid with L4 consisting of 20 turns across L3. When completed C2A and C4A can be adjusted for best signal strength using live signals or an appropriate signal source such as a 40-meter QRP transmitter into a dummy load. C2A and C4A should each allow 2 peaks in incoming signal level per 360-degree rotation of the trimmer. If only one peak is obtained it may be necessary to add a turn or two (if the peak corresponds the plates fully meshed) or remove a turn or two if the peak corresponds to the capacitor plates fully unmeshed. Alternatively it may be easier to increase or reduce (respectively) C2 and C4.

Performance

The performance of the Herring-Aid Five is better than I expected however it has some limitations due to the earlier mentioned design tradeoffs. Additionally the receiver is able to copy SSB signals; this is a useful feature for the beginner but is a limitation when using CW. I have been unable to find Scottish Herrings in VK and in any case I prefer to build this type of equipment on a wooden base with a front panel for the controls so that I can see and play with the circuit at any time

Conclusion

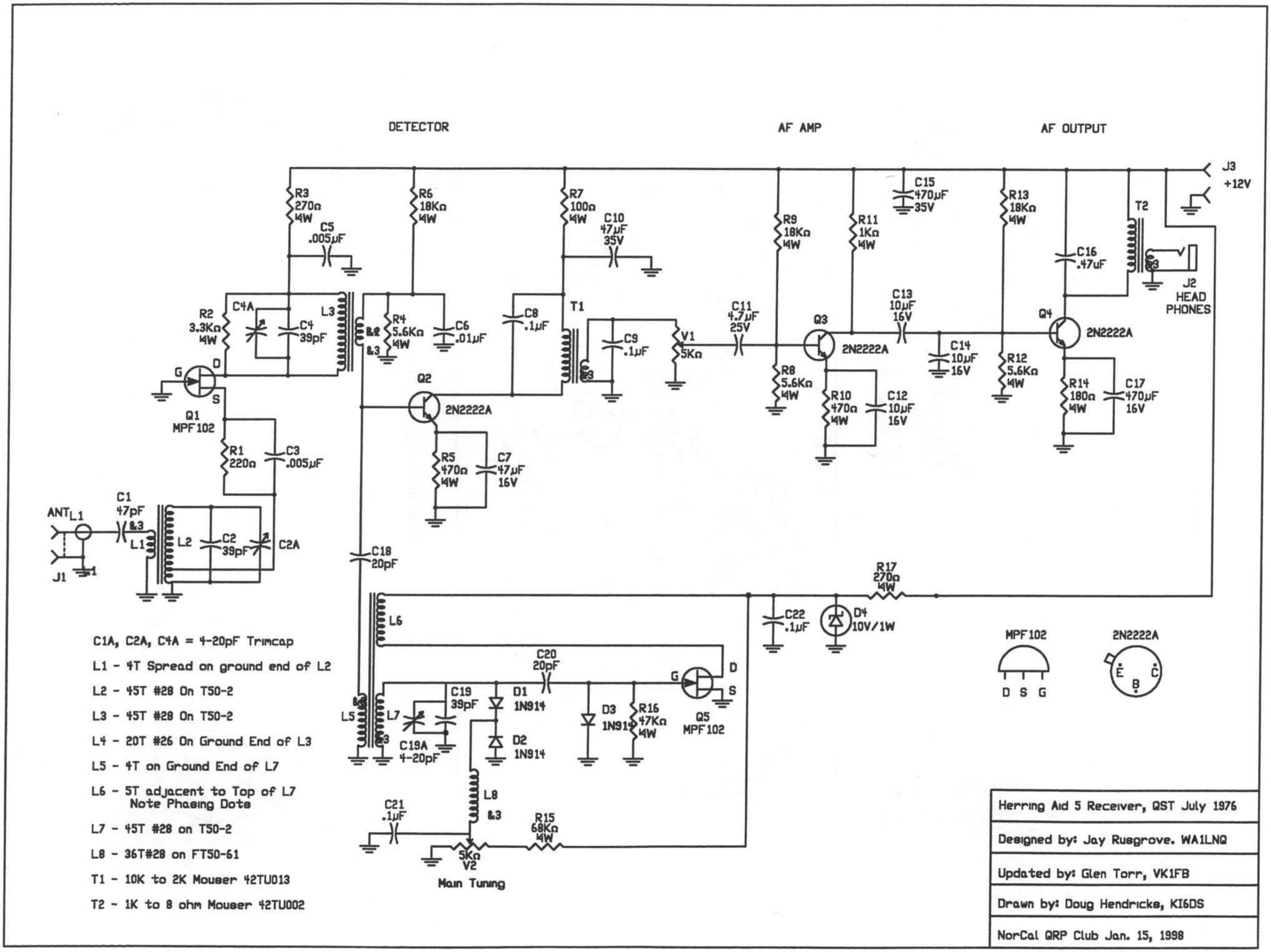
This receiver offers a number of attractions. It allows you to experience the performance of the humble single BJT mixer. Nothing is hidden in IC's; all voltages are available for observation. It provides a platform to experiment with one circuit block while leaving the others constant. The effect of a modification is more clearly seen e.g. a high gain IC audio amplifier could be constructed outboard and audio fed to it from the audio gain pot to observe the benefit or otherwise of higher audio gain on overall performance.

I have made numerous decisions and assumptions in converting this design to modern parts and have not explained these decisions in any detail. Please feel free to contact me with any suggestions, questions or observations. I am not an expert but rather a keen learner and I make no claim that modifications I have made are the ultimate. I have enjoyed "playing" with this circuit and believe there is a lot of fun to be had "Back in the Future."

I would like to thank Jay Rusgrove for the fine original design and article, Doug Hendricks, KI6DS, for his tireless work in laying out the PCB and co-ordinating the project, Gary Diana, N2JGU, for prototyping the PCB, Dave Fifield, AD6AY for his work with Doug on one of the prototypes and his suggested improvement to L4 and finally Doug DeMaw, W1FB (SK) for giving us so much. 72, Glen Torr VK1FB

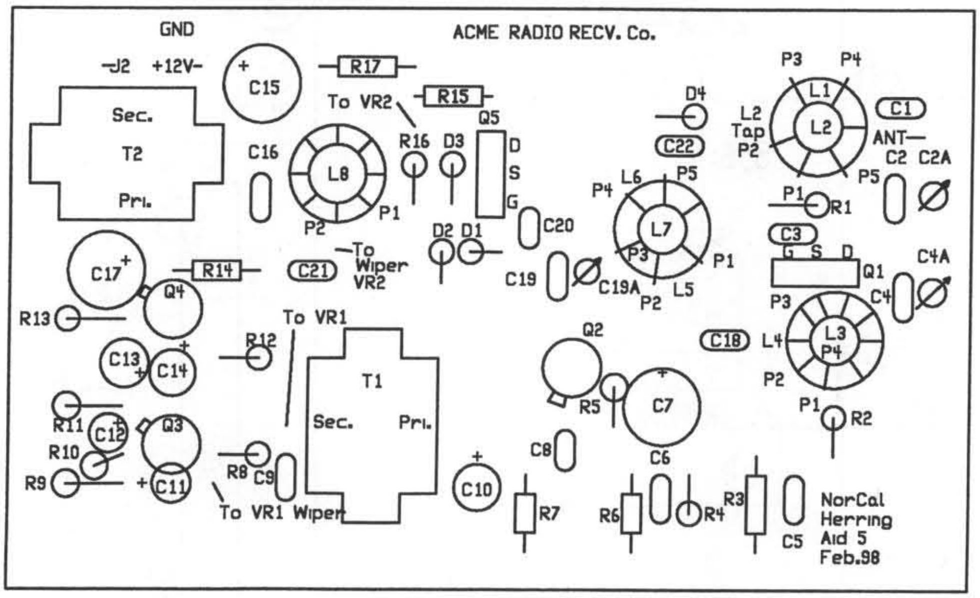
Herring Aid 5 Parts List

3	C2A,4A,19A	4-20pF Trimcap
2	C18, C20	20pF

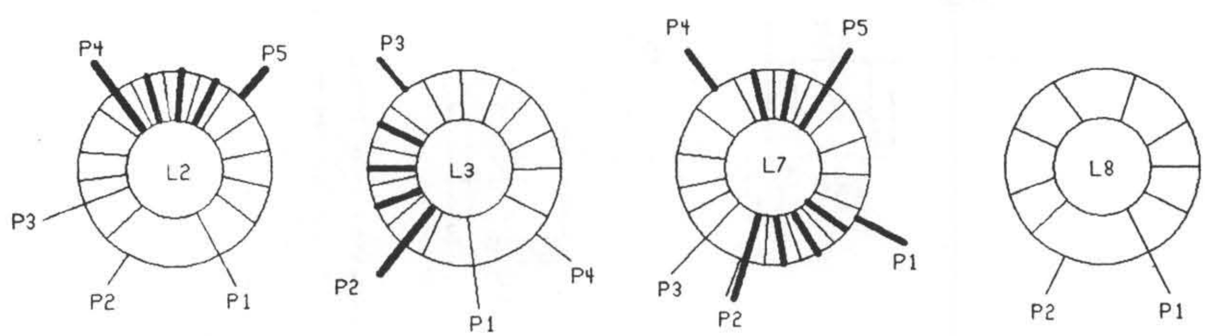

DETECTOR
AF AMP
AF OUTPUT
J3
+12V
J2
HEAD
PHONES
ANT
J1
Q1
MPF102
Q2
2N2222A
Q3
2N2222A
Q4
2N2222A
Q5
MPF102
T1
T2
V1
5KΩ
5KΩ
V2
Main Tuning
D4
10V/1W
C1A, C2A, C4A = 4-20pF Trimcap
L1 - 4T Spread on ground end of L2
L2 - 45T #28 On T50-2
L3 - 45T #28 On T50-2
L4 - 20T #26 On Ground End of L3
L5 - 4T on Ground End of L7
L6 - 5T adjacent to Top of L7
Note Phasing Dots
L7 - 45T #28 on T50-2
L8 - 36T#28 on FT50-61
T1 - 10K to 2K Mouser 42TU013
T2 - 1K to 8 ohm Mouser 42TU002
MPF102
D S G
2N2222A
E B C
Herring Aid 5 Receiver, QST July 1976
Designed by: Jay Rusgrove. WA1LNQ
Updated by: Glen Torr, VK1FB
Drawn by: Doug Hendricke, KI6DS
NorCal QRP Club Jan. 15, 1998

2	C2, C4, C19	39pF SM
1	C1	47pF Disc
2	C3,5	.005 uF
1	C6	.01 uF
4	C8,9,21,22	.1 uF
1	C11	4.7uF/25V Elec.
3	C12,13,14	10uF/16V Elec.
1	C7	47uF/16V Elec.
1	C10	47uF/35V Elec.
2	C15,17	470uF/35V Elec.
1	C16	.47uF
1	D4	10V/1W Zener
3	D1,2,3	1N914/1N4148
3	L2,4,7	T50-2
1	L8	FT50-61
2	Q1,5	MPF102
3	Q2,3,4	2N2222A
1	R7	100 ohm
1	R14	180 ohm
1	R1	220 ohm
2	R3,17	270 ohm
2	R5,R10	470 ohm
1	R11	1K
1	R2	3.3K
3	R4,8,12	5.6K
3	R6,9,13	18K
1	R16	47K
1	R15	68K
1	T1	10K-2K Transfmr. Mouser 42TU002 or 42TM002
1	T2	1K-8ohm Transfmr. Mouser 42TU013 or 42TM013
2	VR1,2	5K Pot

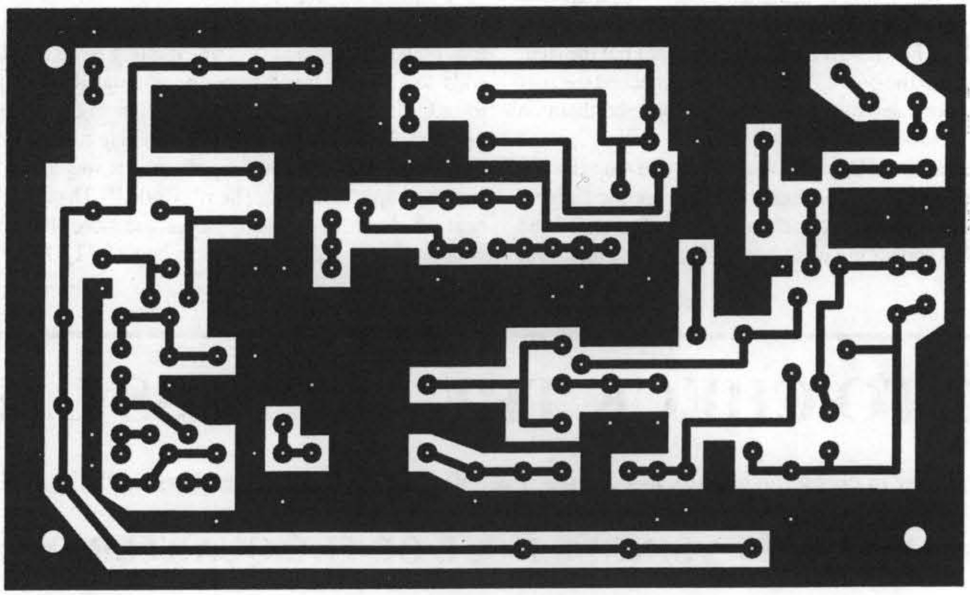
Misc. Connectors for headphones, power and antenna, knobs, case, stranded hookup wire. Circuit boards for this project are available from FAR Circuits, 18N640 Field Court, Dundee, IL 60118. The cost is $7.50 per board plus $1.50 S&H for up to 4 boards. Order the NorCal Herring Aid 5 Receiver Board.



Parts Layout for NorCal Herring Aid 5 Receiver



Coil Winding Data for the Herring Aid 5 Receiver



PCB Layout of Herring Aid 5 Receiver (View from component side, Xray View)

Troubleshooting the Herring Aid 5 Receiver

by Doug Hendricks, KI6DS & Dave Fifield, AD6AY

I finished the Herring Aid 5 prototype on the board that Gary Diana made for me on a Thursday night. Plugged in the power, hooked up the antenna, put the headphones on and expected to hear that wonderful hissing sound that you expect from a receiver. Nada, nothing!! Egads, it doesn't work. I looked at the parts, check it twice, checked the toroid connections, but alas, nothing helped. What to do?? I called Dave Fifield, trouble shooter extroidinaire and a good friend. I asked him if he would have time to look at the rig if I were to drive over to San Jose. Dave is a good friend and can't say no, so he said sure come on over, but it had to be about 4 PM or so on Sunday as he had a huge list of honeydo's to finish for the XYL.

With that in mind, I packed up the board, the schematic, the layout, the parts placement drawing and the original article and drove the 125 miles one way to Dave's house. (One advantage to having lived in western Kansas, distances don't mean a lot. Ask anyone who has lived in west Texas, the Oklahoma Panhandle or anywhere out west. We are used to driving.) When I arrived Dave greeted me at the door and we sat out to debug the receiver (Dave doing the work, I was watching and listening as he very patiently explained what he was doing and why).

One problem we had was this was a new layout, done by me, and it was not tested. I watched as the old master himself went to work. He told me that he was going to use the "Paul Harden, NA5N" method. He would start at one end of the schematic and check each section. I sat down and watched as Dave did the following.

First of all he checked for 12 volts at the supply and then for 9.1 volts on Q5. (The schematic calls for a 10V zener in series with a 270 ohm resistor, but Dave had suggested using a 9.1V zener in series with a 390 ohm resistor over the phone when I couldn't find a 10V zener.) Had the 12 volts at the supply, but oops, there was only 1 volt or so at the drain of Q5, which is the FET in the VFO. Dave turned to me and said, this is not good, we must have 9 volts or so. Something is loading down the circuit. He then checked the layout against the schematic, R16, D3, C22, R17 and D4 were all soldered in correctly and in the proper position. Dave had a bewildered look and asked where I had gotten the transistor. I replied that it came from my stash, but it was not the MPF102 called for but rather a J310. (I thought they were interchangeable, and as I was soon to find out, they are not always.) Dave replaced the J310 with an MFP102 and bingo, 9.1 volts, just as it should be.

Next he said that we would see if the VFO was VFOing. He hooked up the scope, and nothing, not a sine wave in sight. He looked at the circuit, checked all the parts and determined that the coil was wound out of phase, so he reversed the leads for L6, and again, like magic, bingo we had an oscillator. He measured the frequency, and it was at 6.8 MHz, which was a little low. It was easier to lower the capacitance in the circuit by changing a cap than it was to change the turns on the toroid, so Dave replaced a 39 pF with 5 pF and we measured the high end. Oops, now it was at 11.2 MHz for the high end. He looked at me, and I know that he knew, but he asked what value we should try next. I suggested 22pF as it was inbetween the two values that we tried. He soldered it in and voila, the top end was about 7.8 MHz and using trimcap C19A he was able to set the bottom of the tuning range at 6.998 MHz, which was close enough for us. One thing, the 5 pF that we tried first was a regular disc ceramic, it drifted several hertz per minute, but when he replaced it with a 22 pF Silver Mica, the vfo was much more stable. The point is use NPO's, Silver Micas or Polystyrene's in VFO's not 20% disc ceramics.

Ahhh, now we had a vfo, and Dave hooked up the signal generator at 7.040 MHz and he listened for it. It was there!! But weak, very weak. The mds of the receiver was only at -80dB, not very good. Lousy in fact. Dave said not to worry, that we had some tweaking to do. The circuit has two tuned circuits that need to be peaked and are set by peaking a trimcap in each circuit (C2A and C4A). The first one came up very nice with two peaks, which is what you are looking for when you use a trimcap. Bruce Florip wrote a nice article on this in a past issue of QRPp. But the other one only had one peak. Dave explained that this meant that the circuit was not reasonat at 7MHz. So he tried removing capacitance (again much easier than adding or removing turns) and it worked. Soon he had two peaks in the adjustment. He adjusted both of them back and forth, as they were interactive. Finally he was satisfied. Now, lets see what it does. Only -100 dB of mds. Terrible. Dave read the original article and saw that Jay

Rusgrove got an mds of -130 dB!! Something was wrong.

Dave looked at the circuit, and then he asked about the transformers. Were they the same? No one was a 10K to 2K and the other was a 1K to 8 ohm. He checked them out for proper placement of the primary and secondary and they were correct. Then he asked if I was positive that I put the right transformer in the right place on the board. I wasn't so we checked the part numbers with a Mouser catalog, and sure enough, I had reversed them on the board.

Dave had me repeat after him, "Doug, I am a dummy. Doug, I am a dummy." That is supposed to exorcise the dummy demons or the badgers or something. Dave unsoldered the parts, exchanged them and tested the rig. Maybe -110 dB. But still something was wrong. Then Dave looked at the bias resistors on the 3 2N2222 transistors and he said, "Ah Hah! I see the problem." One of the bias resistors was 560 ohms instead of 5.6K, it does make a difference. He switched it out, and tested the receiver. He still wasn't satisfied. Then he sat down and studied the schematic. He decided that we weren't getting enough coupling at L3 and L4. This was one of the coils that was changed from the original Radio Shack modified part to a toroid. He rewound it and changed it from L3 at 45 Turns and L4 at 5 turns to L3 at 45 turns and L4 at 20 turns. He resoldered the toroid, and what a difference. Dave tested the mds, and it was at -123 or so. Very good for such a simple receiver. The rig works!! Thanks to Dave for doing such a neat job, and helping me to learn some more about trouble shooting. I can't wait for the Elmering sessions to begin. 72, Doug, KI6DS

TIME TO CHECK THE ADDRESS LABEL

Please remember to check the address label to see if you need to renew your membership in the QRP ARCI.

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APPLICATIONS MUST BE RECEIVED AT LEAST 30 DAYS PRIOR TO THE COVER DATE TO RECEIVE THAT ISSUE!

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Kanga US carries a wide range of **QRP kits** from the simple easy to build **SUDDEN** Receiver and the **ONER TX** to the **Hands Electronics RTX 210** - a multi band multi-mode microprocessor controlled transceiver. **Kanga US** imports kits from two of the major QRP kit manufacturers in the **UK - Kanga Products and Hands Electronics. Kanga Products** has for many years been producing kits like the **ONER** Transceiver and the **SUDDEN** Receiver. This year at **Dayton** two new kits were introduced in the **ONER** line - the **ONER Stockton power meter**, and a **ONER Keyer**. Also introduced were the **FOXX** Transceiver and the **Spectrum Wavemeter**. All four new kits sold out on Friday afternoon. All will be stocked by **Kanga US**

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CONTESTS

Cam Hartford, N6GA

Results: Fall QSO Party
Results: Holiday Spirits Homebrew Sprint
Announcing: Spring QSO Party, The Hootowl Sprint, MW Field Day, Summer Homebrew Sprint

UPCOMING EVENTS

ARCI Spring QSO Party	April 11-12
QRP To The Field	April 2
Hootowl Sprint	May 24
Michigan Memorial Day Sprint	May 25
PA TAC	June 6
Field Day	June 27-28
Michigan July 4 Sprint	July 4
Summer Homebrew Sprint	July 12
Flight of the Bumble Bees	July 25

1997 QRP ARCI FALL QSO PARTY

The Fall QSO Party saw a resurgence of the higher bands, especially 15 meters. Many of the entries contained remarks about how 15 was open, but underpopulated. And many of our European friends used 15 as a highway to stateside QSOs.

Speaking of Europeans, we had more entries from across the pond than in any recent QSO Party, tangible testimomy that the Spots are happening.

If conventions in Texas, New Mexico and California kept the overall number of contestants down, there's no telling from the results. It was, by all measures, one of the biggest we've had in recent years. QRP Lives!

SOAPBOX: Low bands not as active this year from NE, no 160M activity when I listened - **KC1DI;** What can I say? It's fun, fun, fun every time - **N4ROA**; Worked CT1ETT, he was at 750 mW - **K8ZAA**(using MFJ Loop!); Highlight was working WØRSP, had never heard him on before in my meager QRP career - **WJ7H**; Great to heat good sigs on 15m again - **G3XJS**; I got WY and ID and that's not easy from here, even QRO! Surprisingly the W1s and W2s were nowhere to be heard - **PA3ASC**; I think 10 M was probably open more than we thought - **AA7KF**; Highlight was having WQ8RP answer my CQ on 160 M and working JA on 15M, 2 X QRP - **NØUR**; The usual big signals for small power plus good conditions add up to Fine Business! - **NØAX**; Great turnout. Elbows got a bit bruised, but a gal has to hold ger frequency - **N8UOO**; I started out thinking I would be a single band entry I wound up submitting an all-bander; guess the bands are perking up! - **KD2IX**; Between SET and Honey Do's managed 75 Qs on several bands - **AE4EC**; Great band conditions, lots of DX answered my CQs. Windy and cold on the hill in Wyoming but no snow this year - **AE0Q**; #*?%%$#@ RTTY contest. It always amazes what kind of score I can get when I put in the seat time - **WZ2T**; Operated from the K5VT contest site. What a thrill using a contest antenna system - **WA7LNW**; Why would anyone bother with QRO when QRP is so much fun? - **AE4IC**; My best effort yet! - **AD4ZE**; Low power, low key, no stress and totally enjoyable - **K5TF**; Good conditions, much fun! - WA9PWP; Worked G, DL, PA3, EA and CT all QRP/QRP - **W3KC**; Fun contest with some unexpected DX: OM7AG, GW3PRL, F6UIG - **KB2JE**; The conventions must be keeping TX, NM and CA stations off the air - **N2CQ;** It was really fun to hold a frequency on 15 M and run stations with only 4 watts - **WA1QVM**; Great fun, bands weren't bad, lots of members on - **K4AT**; Picked up a couple new states towards WAS goal - **K5HQV**; This is the first time I participated, and enjoyed it immensely! - **VE3LA**; Condx FB on 15, next spring should be great - **K4NK**; Good to hear so many members on, sorry I couldn't have spent more time - **VE3JC**; Great band conditions, 40 and 15 meters are getting back to normal - **NEØC**; Great fun to use direct conversion RX and 1 watt - **K2JT**; This was my first QRP contest. It was a blast! - **WI9M**; Best contest in a long time. AAll bands in great shape - **KA1TQM**; Since Spring 97 test, tree supporting one end of the antenna blew down, and lightning struck tree supporting other end, melting off 30' of the antenna... - **W2QYA**; Had a great time! - **AA3GM**; I heard the most stations in the last five minutes of the contest, but they could not hear me under their noise - **WB6FZH/KH6**; Ernie, W8MVN, vaporized my antenna. Well almost. - **KJ5MG;** Worked enough new members to get a "500" sticker for Operating Acheivement certificate - **K4AHK**; I was shooting for 50 Qs, got twice that, including Alaska and Panama - **N4UY**; Scout needed additional filtering to handle all the QRM on 40 M - but I did not have any! - **KD5KP**; First attempt at milliwatt contesting - I love it! - **N3IUT**; Propagation was much better than last year - **VE6GK**; Busy weekend: VE exam, JOTA scouts visited, had to go out to dinner when condx good, but had fun - **W7LNG**; Had a blast! All worked with HW-9 and long wire. Got 6 new states for 2xQRP WAS - **N3XRV**; This was my first ARCI QSO Party. It was a great and relaxing contest indeed! - **W3MWY**; Overall a fun time until marauding RTTY station moved on the freq and deliberately jammed 7040 for a long time - **WØTID**; Finally got the antenna up higher but wasn't able to work the time I wanted to. Had a ball anyhow - **AC5JW**; As president of the QRP ARCI, I feel an obligation to actually get on the air twice a year; the Michigan contest is the other time - **WA8MCQ**; Wish I could have worked a little longer! - **KBØWQT**; I wonder how many milliwatt stations were on 80M this year? I logged **AB4PP**, who was running 250mW, with the help of the Jones filter in the

Argo ii - **KF8EE**; What a marvelous night for a contest, under the cover of October skies - **WB2KKX**; After 6 yrs experimenting, further antenna refinement not economically feasible! - **W8MVN**; Does anyone in Montana operate 40M? - **K9PX**; Conditions didn't seem as good as last year but I also cut my power from 4 watts to 2 watts - **WJ9B**; Had fun as always - need to hear the West Coast better - **W3ERU**; This contest stunk. I had to chase away a skunk to adjust the antenna! He was 599+20! - **K2UD**; Man, some of those other guys were loud! - **WA4CHQ**; Nice contest, lots of activity - **W8TIM**; Portable ar Moraine State Park in Western PA; an experience and a half! - **N3DQU**; Nice to hear W1AW in the contest - **W7BXZ**; It was great to hear some activity from our QRP friends in Europe - **W7CNL**; Tried QRPp level this time. Amazing what a little RF will do - **VE4AKI**; Signals from West Coast were stronger than from East or Midwest! - **OM2ZZ**; See all QRPers in the next contest - **LY2FE**; Had a ball in my four hours working the East Coast and England. 15M is back! - **KF7MD**; Worked my other three team members on at least 2 bands each. Operated from N8PR's QTH - good antennas and quiet location. - **N4BP**;

1997 FALL QSO PARTY

QTH	CALL	SCORE	PTS	S/P/Cs	PWR	BANDS	TIME	RIG	ANTENNA
AB	VE6GK	37,828	193	28	5	A-3	1.5	?	YAGI @ 65'
AK	AL7FS	37,758	186	29	4	H-2	3	TS450S	YAGI @ 40'
AL	K4KJP	60,984	198	44	2.5	A-3	4.5	SIERRA, SPRINT	40M DIPOLE, 550'HORIZONTAL LOOP
	K4ZM	57,057	209	39	2	A-4	4.5	SIERRA	550' HORIZONTAL LOOP
	W4DEC	17,850	150	17	3	15M	3.75	OHR 400	YAGI @ 70'
	WA4KEJ	4,900	70	10	4	H-2	4.5	ARGO 515	2 EL WIRE BEAM 20M, HORIZ. LOOP
AR	AB5SE	200,970	495	58	5	A-4	4.5	?	?
AZ	WA7LNW	754,845	1027	105	5	A-4	13	TS-440	YAGI @ 105', 40M YAGI @ 60'
	W7BXZ	110,432	272	58	5	20M	13	TS-130SE	DIPOLE
	N7JXS	50,127	231	31	4.5	H-2	?	FT-757GX	VERTICAL
BC	VE7CQK	219,170	505	62	5	A-4	?	?	?
CA	N6MM	201,096	456	63	5	A-3	6	SIERRA, OHR400, OHR100	40M MOBILE WHIP, VRS BEAMS
	KO6KA	43,750	250	25	3	15M	5	ARGO 509	DELTA LOOP @ 35'
	K6FP	13,230	105	18	5	A-3	3.7	IC-706	INVERTED VEE
	N6GA	3,080	55	8	2	20M	1	SST-20	SLOPER OUT HOTEL WINDOW
	W6SIY	3,060	51	4	0.25	L-2	5	TUNA TIN 2, PIXIE (80)	40/20 DIPOLE @ 18"
CO	K0FRP	1,481,676	1701	124	4.5	A-5	14	TS-850	PHASED 80M LOOPS, 10/15/20/40 YAGIS
	K1EQA	172,221	417	59	5	A-3	16	ARGO 556	INVERTED VEES @ 8'
	KF7MD	34,545	235	21	4	15M	4	TS-680	VEE BEAM & YAGI
	N0IBT	18,729	471	57	5	A-4	15	TS-870	DIPOLE
	KB0WQT	3,591	57	9	4	A-2	2.5	IC 706	VERTICAL
CT	KA1TQM	81,144	276	42	4	A-4	14	HW-9	DIPOLE AND VERTICAL
	W1AW	43,680	195	32	4.5	A-2	1.5	HW-9 W1VT, OP	YAGI, DIPOLE
DE	K3AS	10,920	104	15	5	A-3	2.5	CENTURY 21	60' END-FED WIRE IN ATTIC
FL	N4BP	2,505,559	2069	173	5	A-6	22.5	IC-706 MK11	YAGIS @ 35',65',105', 40M YAGI, 80 4-SQR
GA	K5TF	644,000	920	100	5	A-4	16	IC-735	DIPOLE 80, 40M LOOP 40-20-15
HI	WB6FZH	21,168	126	24	4.5	A-4	?	CENTURY 21, HW-8	VERTICAL NEXT TO KANEOHE BAY
IA	KQØI	26,425	151	25	5	A-3	6	TT 580 DELTA	SHORT DIPOLE
ID	W7CNL	104,181	313	41	5	20M	10	ARGOSY II	YAGI @ 45'
IL	N9ZXL	187,131	469	57	4	A-4	19.5	TT CENTURY 21	DIPOLE @ 30', YAGI @ 43'
	KB9FKO	36,582	201	26	5	A-4	15	HW-9	40M INV VEE (MORE LIKE CORKSCREW)
	W9CUN	23,352	139	24	5	L-2	3	TT 580 DELTA	40 & 80 HORIZONTAL LOOPS @ 8'
	KB9IUA	11,844	94	18	5	A-3	3.5	CENTURY 22	66' END FED WIRE
IN	K9PX	380,380	1045	52	5	40M	17.5	TAC-1	80M LOOP
	WD9CTB	274,364	568	69	3	A-4	11	IC-706	VERTICAL, INVERTED VEE
	W9FHA	94,752	282	48	5	A-4	4	TS-870	C-3 YAGI, INVERTED
KS	WØTID	64,435	263	35	5	A-2	3	OHR CLASSIC	40M DIPOLE @ 60'
KY	K4AT	364,420	685	76	4.5	A-4	10	TS-870	80/40 DIPOLE, VERTICAL
	AE4VQ	2,058	42	7	5	15M	3	?	?
MA	N1QY	499,359	903	79	5	A-4	20	OMNI 6	R7 VERTICAL, TRAP DIPOLE
	WA1QVM	366,898	718	73	4	A-4	23	QRP+	G5RV IN WOODS BEHIND CONDO
	K1CL	131,698	409	46	4	A-3	7	FT 840	G5RV @ 30'
	K1RC	78,960	282	40	5	A-4	2.5	?	?
MAN	VE4AKI	52,920	147	24	0.2	20M	14	TS-440	SLOPING DIPOLES
MD	W3KC	512,589	951	77	3	A-4	15	ARGO 509	88' CF ZEPP, 50' CF VERTICAL
	K3CHP	398,713	721	79	5	A-4	24	QRP+	YAGI, VERTICAL
	WD3P	242,109	567	61	5	A-3	8	TS-570, MICRONAUT	DIPOLES
	K3TKS	220,860	409	54	0.9	A-4	11	QRP+	80M AND 40M HORIZONTAL LOOPS
	W3ERU	146,034	549	38	4	40M	?	TS-850	40M LOOP
	W3MWY	132,888	452	42	3	A-2	22.5	ARGO 556	80' RANDOM WIRE @ 50'
	W6TOY/3	80,934	282	41	4.9	A-4	4.75	TS-130V	200' LONG WIRE
	N3XRV	19,240	125	22	4	A-3	12	HW-9	A COUPLE HUNDRED FT OF WIRE IN
	WA8MCQ	8,288	74	16	5	A-2	1.5	TS-430S	40M DELTA LOOP
	KE3FL	1,470	35	6	5	40M	1	?	?
	NF3I	420	20	3	5	20M	0.2	?	?

QTH	CALL	SCORE	PTS	S/P/Cs	PWR	BANDS	TIME	RIG	ANTENNA
ME	KC1DI	139,720	499	40	4	L-2	12	SCOUT	520' HORIZ LOOP, 230' VERT LOOP,
MI	WA8RXI	156,156	507	44	2	A-2	12.5	OHR SPRINT, EXPLORER	DIPOLE, YAGI
	K8ZAA	77,280	276	40	5	H-3	16	QRP+	MFJ LOOP
	WB8NYV	42,800	214	20	0.9	40M	6	SW 40	DIPOLE @ 35'
	W8TIM	23,690	103	23	0.9	40M	2.5	SW-40	DIPOLE
MN	NØUR	807,030	1098	105	5	A-6	12.5	IC 735	LOOP, DIPOLE, INVERTED VEE
	W3FAF	34,398	182	27	2	H-2	2.5	TS-130V, R4C	YAGI @ 45', 160M INV VEE @ 45'
MO	KØLWV	139,482	369	54	5	A-4	8	TS-520	80M LOOP
	KCØM	81,396	306	38	5	L-2	?	?	?
MS	K5HQV	329,966	637	74	5	A-4	?	FT-1000	135' DIPOLE
NC	AE4IC	731,136	1024	102	5	A-4	22.5	SIERRA, NW-80,-40,-20	400' HORIZONTAL LOOP
	AD4ZE	720,720	1040	99	5	A-4	17	TS-850	80M DIPOLE
	AC4QX	449,400	856	75	5	A-4	17.5	TT DELTA II	G5RV
	WJ9B	272,734	847	46	2	40M	18.5	SIERRA	YAGI @ 70'
	AE4EC	111,090	345	46	4	A-5	9	ARGOSY	CAROLINA WINDOM
NH	AA1MI	38,976	174	32	5	A-4	7	FT-990	VERTICAL
	NO1E	12,180	116	15	1.5	40M	3.1	NORCAL 40	DIPOLE
NJ	KB2JE	492,800	800	88	4	A-4	11.5	QRP+	G5RV @ 30'
	N2CQ	465,381	801	83	5	A-4	8.5	TS-850	CF ZEPP, YAGI @ 40'
	K2JT	151,800	345	44	1	A-4	4.5	HW-8	DOUBLET, VERTICAL
	N2WF	89,096	296	43	5	A-3	8.5	OHR-400	50' DIPOLE **30'**
	KG2LO	76,923	333	33	5	A-3	?	CORSAIR	?
	N2TNN	67,592	284	34	5	A-4	9.5	?	?
	W2JEK	51,744	231	32	3	A-4	4	FT-840	15&40 DIPOLE, 20 GP, 80 EF HERTZ
	WA2YBI	50,715	207	35	4	A-2	10.3	FT 840	VERTICAL, INV VEE
	N2YVF	40,068	318	18	4	40M	10	ARK-4	DIPOLE
	KB2SGM	36,743	181	29	4	A-3	8	ARGOSY	YAGI AND DIPOLES @ 35'
	AC2JW	16,891	127	19	5	A-2	7	QRP+	INV VEE @ 25'
NM	K5AM	18,816	128	21	5	20M	1	HB TCVR	YAGI
NV	AE7AA	16,478	107	22	5	A-3	9	SCOUT	66' RANDOM WIRE
NY	WZ2T	757,764	1116	94	4	A-4	24	TS-940	40M LOOP @ 60',80/40 TRAP DIPOLE
	N2TO	317,135	697	65	5	A-4	16	TS-520SE	VERTICAL, DIPOLE @ 43'
	KD2IX	225,498	546	59	5	A-5	21.5	IC 729	160 DIPOLE, R7 VERTICAL
	K2UD	65,100	372	25	5	40M	12	ARGO 515	END-FED MARCONI
	W2QYA	26,460	126	21	0.9	A-4	7	HW-8	90' INVERTED VEE
	WB2KKX	17,444	178	14	5	80M	7	ARGOSY II	80M DIPOLE
OH	W8MVN	434,728	1109	56	5	40M	18	ARK-40, R-8 RX	PHASED SWITCHABLE LOOPS @ 60'
	N8UOO	342,076	643	76	5	A-5	?	CORSAIR	80M LOOP, YAGI
	NE0C	188,552	481	56	5	A-4	17	ARGO 556	VERTICALS
	K8UCL	60,452	254	34	2	A-3	14.5	HW-8	ATTIC DIPOLES
	KF8EE	31,017	211	21	5	80M	5	ARGO II	RANDOM WIRE
	W8VQ	24,311	151	23	5	80M	1.5	OHR 400	WINDOM DIPOLE @ 25'
OK	KJ5MG	295,596	612	69	4	A-3	20	HB XCVR EACH BAND	80M DIPOLE
	AB5UA	180,796	587	44	5	20M	10.8	GM-20, OHR-400	YAGI @ 50'
	AA5CO	18,193	113	23	4	40M	4.5	ARGO 556	INV VEE @ 35'
ON	VE3ELA	295,001	629	67	3	A-4	17	HW-9	END-FED WIRE @ 25'
	VE3JC	234,325	515	65	4	A-4	8	IC735	TRAP DIPOLE @ 20', YAGI @ 40'
	VA3SB	32,300	190	17	0.95	40M	5	TS-850S	INVERTED VEE
OR	AA7KF	1,896,048	1782	152	5	A-6	22	TS-940, FT-990	FIXED WIRE BEAMS @ 85'
	W7LNG	30,618	162	27	5	A-3	3	TS-850	80 DIPOLE, 40 GROUND PLANE, YAGI
PA	K7SZ	707,553	1021	99	5	A-8	24	SIERRA	YAGI, EXT DOUBLE ZEPP
	N3IUT	121,600	304	40	0.9	A-3	12	QRP+	9 EL YAGI
	N3RN	74,368	332	32	5	L-2	5.25	SCOUT, TAC-1	DIPOLES
	WA3SRE	70,560	294	24	0.95	80M	10	ARGO 515	40M LOOP AS LONG WIRE
	K3WWP	69,888	416	24	5	80M	6.5	HB 6Y6 FINAL	RANDOM WIRE
	W3TS	30,360	138	22	0.9	L-2	1.5	HB SUPERHET TCVR	80/40 INV VEES @ 60'
	N3LAZ	24,586	153	23	1	20	8	VCO, PROGRESSIVE RCVR	G5RV @ 50 FT
	AA3GM	23,856	142	24	5	A-4	5.5	ARGO 556	VERT, 20, 40 & 80 HAMSTICKS
	K3NVI	19,404	126	22	5	A-3	8	TS-120V	VERTICAL, INVERTED VEE
	N3DQU/3	5,775	75	11	4	40M	7	MFJ 9040	HB HELICAL
	N3CZB	315	15	3	4	20M	2	MFJ 9202	HB INDOOR LOOP
RI	K8ZFJ	56,050	295	19	0.8	40M	11	TS-670	G5RV
	WA1OFT	41,580	180	33	5	H-2	9	IC-706	R5 VERTICAL
SC	K4NK	243,530	490	71	4	A-4	16	ARGO 509	YAGI, DIPOLES
	W2UX	47,628	252	27	5	40M	?	?	?
SD	WØRSP	75,369	291	37	4	A-4	?	?	?
TN	N4QZU	19,250	110	25	4	40M	4	TT SCOUT	G5RV @ 40'
TX	KD5KP	161,196	404	57	5	A-3	11.5	SCOUT 555	80M DELTA LOOP @ 35'
	K5ZTY	47,817	207	33	5	A-4	3	OHR-400, HW-8	YAGI, G5RV
	WA8GHZ	15,295	115	19	5	40M	?	TRITON 4	40M INV VEE

QTH	CALL	SCORE	PTS	S/P/C	PWR	BANDS	TIME	RIG	ANTENNA
UT	NC7W	859,446	1077	114	4.8	A-4	11.5	?	YAGI @ 70', VERTICALS 40/80
	WJ7H	18,515	115	23	5	H-3	3	QRP+	YAGI @ 40'
VA	N4ROA	366,730	806	65	5	L-2	12.5	SIERRA, TT OMNI-C	DIPOLE
	K4AHK	193,648	494	56	4.9	A-3	15.3	IC 735	ATTIC DIPOLES
	K3SS	181,636	499	52	5	A-4	14	FT-757	DIPOLE @ 35'
	N4UY	172,767	433	57	5	A-3	11	TEN TEC SCOUT	40M AND 20M DIPOLES
	KK4R	167,979	421	57	5	A-4	7	IC 735, OHR100 (20M)	134' DOUBLET
	K4GEL	157,437	441	51	5	A-3	?	HB TRANSCEIVER	4 EL QUAD, DELTA LOOPS
	WA4CHQ	54,510	237	23	0.75	40M	13	HB 40M TCVR	VERT RANDOM WIRE
	N3OS	28,224	192	21	3	40M	4	TT OMNI-C	MINI QUAD
	W3MGL	9,114	93	14	5	40M	6	ARGO 556	DIPOLE 40, 80/40 VERT, G5RV
VT	W1VT	87,080	311	40	4.9	A-3	3	HW-9	40/20 DIPOLES, COMMON FEED
	AA1PB	41,860	260	23	3	40M	?	OHR EXPLORERII	250'END FED WIRE
WA	NØAX	367,192	632	83	5	A-5	?	FT-990	80M SLOPER, YAGIS & QUAD @ 50'
	WA2OCG	30,450	174	25	5	H-2	6.5	IC 737A	R7 VERTICAL
	W7DRA	2,160	120	18	100	A-2	?	HB ARC-5, 810 PA	?
WI	N9AW	815,850	1110	105	5	A-6	11	FT900	80 DIPOLE, 40 LOOP, YAGI
	NK9G	651,882	913	102	5	A-6	11	ARGO 515, TS-440	160/80 LOOP, DIPOLE 40, YAGI
	WA9PWP	563,220	894	90	5	A-4	13	ARGOSY II	CAROLINA WINDOM 80, VERTICAL
	WI9M	88,683	309	41	5	A-4	5.5	IC 706	G5RV @ 50', YAGI @ 55'
	AE9K	88,046	331	38	5	A-3	12	TS-430	VERTICAL
	WD9AIB	16,380	117	14	0.5	A-3	3.1	QRP+	?
WY	AEØQ	1,732,185	1755	141	5	A-4	24	ARGO 556	CAROLINA WINDOM
DX STATIONS									
DL	DJØGD	1,960	40	7	3	15M	1.5	ARGO 509	R5 VERTICAL
DL	DK7VW	35	5	1	5	20M	0.1	HW-9	DOUBLET @ 15M
JA	JH3XCU	16,758	133	18	5	H-2	3	QRP+	4 EL YAGI @ 40M
LY	LY2FE	1,736	31	8	5	20M	2	?	?
OH9	OH9VL/2	200	10	2	0.5	15M	1	HB VXO TX, 21 MHZ	20M DIPOLE
OM	OM2ZZ	2,450	50	7	5	20M	2	IC 706	YAGI @ 12 M
PA3	PA3ASC	2,380	34	10	5	H-2	2	ARGO 509	YAGI @ 40'
PAN	HP1AC	49,210	185	38	5	A-3	6	K9AY-20, K1BQT-15, TS-430	YAGI, LONGWIRE
UK	G3XJS	31,304	172	26	3	H-2	4	CORSAIR II	YAGI @ 27'

TEAMS

FOUR CORNERS	N4BP, AE4IC, VE7CQK	3,455,865
TEAM WISCONSIN	N9AW, NK9G, AE9K	1,555,778
NJQRPEANUTS	N2TO, KB2JE, N2TNN, N2CQ	1,342,908
MARYLAND MILLIWATTS	K3TKS, WA8MCQ, W6TOY, NF3I, N3XRV	329,742

MULTI-OP, MULTI TRANS, FIXED

WQ8RP	K8DD, AC8W, N8CQA	637,980

PORTABLE STATIONS, SINGLE-OP

AEØQ	1,732,185
W1VT	87,080
WA4CHQ	54,510
N3DQU/3	5,775

MULTI-OP, SINGLE TRANS, PORTABLE

AB4PP	AB4PP, AA4XX, WA4NID, WF4I	436,905

MULTI-OP, MULTI-TRANS, PORTABLE

RACCOONS	K4ZM, K4KJP, WA4KEJ	122,941

TOP TEN

N4BP	2,505,559
AA7KF	1,896,048
AEØQ	1,732,185
KØFRP	1,481,676
NC7W	859,446
N9AW	815,850
NØUR	807,030
WZ2T	757,764
WA7LNW	754,845
AE4IC	731,136

SINGLE BAND

80M	WA3SRE	70,560
40M	W8MVN	434,728
20M	AB5UA	180,796
15M	KO6KA	43,750
LO-BAND	N4ROA	366,730
HI-BAND	K8ZAA	77,280

Adventure Radio Society announces new "TOP OF THE WORLD" Contest

This event is linked to the June ARRL VHF QSO Party, which is scheduled for June 13, 14 and 15, 1998. You may operate the entire ARRL event and designate any period of four contiguous hours for Top of the World. Or you may limit your operation to any four contiguous hour period of your choice. In either case, follow the rules of the ARRL event.

Operations will comply with the definition of QRP in the ARRL rules (CW, SSB or FM, 10 watts output or less). All participants in Top of The World will reach their sites by human power -that is, they will walk, bike or boat to their sites. The distance traveled to the site is at the participant's discretion.

1997 HOLIDAY SPIRITS HOMEBREW SPRINT

QTH	CALL	SCORE	PTS	S/P/Cs	PWR	BANDS	TIME	RIG	ANTENNA
AK	AL7FS	13,167	99	19	4	A-3	3.25	QRP+	YAGI @ 40', INV VEE
AL	K4AGT	19,784	132	16	5	20M	4	OHR-100	DIPOLE
AZ	AB7TT	46,881	193	31	4	H-2	4	QRP+, SIERRA	HB VERTICAL
	W7BXZ	10,206	81	18	5	20M	4	TS-130SE	DIPOLE
	KK7JU	2,268	54	6	5	40M	2	ARGO 556	
CA	W6ZH	116,450	325	38	3	A-6	4	SIERRA	10/15/20/40 YAGIS, 160/80 VERTICAL
	N6GA	14,380	67	14	0.95	15M	1.5	SIERRA	YAGI @ 35'
	WE6W	9,788	114	6	4	40M	4	OHR-100	DIPOLE
	W6SIY	5,180	12	1	0.25	40M	1.5	TUNA TIN II, NEOPHYTE	80/40M DIPOLE @ 18'
	N6WG	4,047	97	6	5	40M	?	OL' KENWOOD	?
CO	NØIBT	22,701	141	23	5	A-3	4	TS-870	DIPOLE
	K1EQA	21,504	128	24	5	A-3	3	ARGO 556	40M INV VEE @ 8'
CT	N1EI	35,150	101	15	0.9	A-4	4	SIERRA, NC40A	20M DIPOLE, 40M DELTA, 80M INV L
FL	AE4MZ	5,476	17	4	1	40M	2.5	SW-40	INV VEE @ 25'
GA	N4TUA	1,715	35	7	5	A-3	2.5	KENWOOD	80M DIPOLE
IA	WBØT	6,664	68	14	4	A-2	1.5	ARGO 525	TNT WINDOM @ 48'
IL	N9MDK	26,420	170	18	3	40M	2.5	TEN TEC 1340	G5RV
IN	K9PX	83,330	373	30	5	40M	4	TAC-1	80M LOOP
	N9JXY	20,120	84	12	0.22	40M	3.75	NC 40A	R7 VERTICAL
	K9DIY	315	15	3	5	A-2	1	CORSAIR I	INV VEE
JP	JRØBAQ	28	4	1	5	40M	1	TS-440V	YAGI
KS	KGØUA	15,589	131	17	5	A-3	3	?	?
KY	K4AT	23,667	147	23	4	A-3	2.75	TS-870S	VERTICAL, 80/40M DIPOLE
MA	WA1QVM	17,208	109	16	4	A-2	3.5	QRP+ 20M, SST 40M	G5RV
MAN	VE4AKI	22,100	95	18	0.95	20M	3.5	SWL GM20	SLOPING DIPOLES SE & SW
MD	W3KC	86,795	285	41	3	A-4	3.75	ARGO 509, BACKPACKER II	80M CF ZEPP, 40/20/15 VERTICAL
	WD3P	56,456	186	28	2.5	A-4	4	SIERRA	DIPOLES
	W3MWY	9,506	97	14	3	A-2	4	ARGO 556	DIPOLE, INV VEE @ 35'
MI	W8TIM	10,120	92	11	0.9	40M	3	SW-40	DIPOLE
	K8ZAA	5,814	29	4	3	20M	2	HW-8	MFJ LOOP
MT	N7GS	18,566	114	17	2	20M	2.5	NN1G MK I	YAGI @ 50'
NB	VE9IC	2,632	47	8	5	A-4	2	SB 104A	80 DIPOLE, 40 LOOP, YAGI @ 55'
NJ	N2CQ	92,656	288	41	5	A-4	3.75	NW80, EXPLORER II, TS-850	?
	N2SMH	15,486	107	14	2.5	L-2	3.25	SIERRA	W3EDP LONG WIRE @ 40'
	KC2BDH	8,906	62	9	2	40M	2.5	NC 40A / KC1	CAROLINA WINDOM
	K2VS	7,220	37	6	0.75	40M	4	K9AY	G5RV @ 20' ON SAILBOAT MAST IN
	K2HPV	6,015	29	5	3	20M	1	TEN TEC 1320	80M DIPOLE
NV	KU7Y	124,950	245	34	0.24	A-3	3.5	?	?
NY	N2VPK	33,200	166	20	0.9	40M	2.5	SW-40	VERTICAL, 80 M DIPOLE
	KB2HSH	11,990	99	10	1	40M	3.25	RAMSEY QRP-40, HQ-170	CENTER FED ZEPP
	WB2KKX	11,500	65	10	1	80M	2.5	RAMSEY QRP 80	80M DIPOLE
OH	NR8I	30,478	115	13	1.4	A-4	4	SIERRA	?
	K8UCL	15,313	69	11	2	A-2	4	HW-8	ATTIC DIPOLES
	KF8EE	13,843	61	9	1.5	L-2	1.5	SW-80, SW-40	80' END-FED WIRE @ 15'
OK	KJ5MG	38,522	126	21	4	A-4	3	HB TCVR	80M DIPOLE
	AB5UA	17,220	94	13	0.9	20M	2	OHR-400	YAGI & VERTICAL
OR	WX7R	20,930	130	23	4.8	A-3	2.5	IC 735	LW VEE BEAM
PA	W3TS	237,760	392	53	0.9	A-6	4	HB SUPERHET TCVR	80/40 INV VEES, 160 TEE, YAGI
	NA3V	10,180	74	10	4.5	40M	2	OHR-100	VERTICAL
	N3CZB	315	15	3	5	20M	1	TT CENTURY21	INDOOR LOOP
SC	W3RDF	58,556	204	27	5	A-4	4	HW-9, TAC-1(80), TAC-1(40)	HALF SQR 20, VERTICAL 40, RANDOM
TX	K5ZTY	99,248	306	44	5	A-3	3	OHR-400, HW-8	YAGI, G5RV
	W5SB	69,300	300	33	5	A-2	3.75	FT-990	W8JKS @ 70', 160M DIPOLE ON 40M
	K5FO	32,800	139	20	0.9	20M	2.5	GM-20	LONG WIRE
	KJ5X	3,402	54	9	5	20M	2	TS-450S	20M LOOP @ 25'
VA	N4ROA	108,595	313	45	5	A-4	4	SIERRA, OMNI-C	2 EL QUAD, 5/8L WAVE 160M INVERTED
	K4GEL	59,884	229	28	4	A-3	4	HB MULTI-BAND TCVR	80 LOOP, 40M LOOPS, 20 QUAD @ 45'
	WA4CHQ	16,280	94	12	0.9	40M	4	HB TCVR	RANDOM WIRE VERTICAL
	WR41	11,279	69	13	2	40M	3	NC 40A	GUTTER ON APARTMENT
	N4UY	5,495	11	3	0.2	40M	1	PIXIE II, MRX-40	DIPOLE
WI	WA9PWP	6,295	37	5	5	H-2	0.5	RADIOKIT QRP-20, IC751	CAROLINA WINDOM

Take a look at the Soapbox comments for the Holiday Spirits HB Sprint, and for the Fall QSO Party for that matter, and you will see several excited people proclaiming this the be their "first contest ever" or "first QRP contest". You'll also note several "first milliwatt effort" comments. What these folk are finding out is what many of you have known all along - that QRP contests are an excellent way to step into the world of contesting, as well as being a wonderful proving ground for the nifty gadget you've just proudly completed.

What are HB contesters using these days? My curiosity overcame me, so I did a quick compilation of the gear used by the participants in this contest. Of 73 rigs mentioned in the results, 42 qualify as homebrew. The bulk of these are kits, as follows: Norcal/Wilderness - 13; NN1G/SWL - 8; OHR - 6; Heathkit - 4; S&S - 3; Tentec kit - 2; Ramsey - 2; Emtech, Tejas, Radiokit and K9AY all had one each. There were 5 rigs listed as homebrew, which I surmise means built from scratch.

The final two Mini-Titans deserve special recognition: N4UY enterd the fray running a Pixie II and an MRX-40 receiver, while W6SIY jumped in with a Tuna Tin II and a Neophyte receiver. Talk about devotion to their craft. Bravo, gentlemen!

Soapbox: My first milliwatt contest - had a blast! N6GA was my first ever milliwatt contact! - **N1EI** (I was running .9W also - instant 2xQRPp Km/W! - Cam); QSB made for some difficulty but new GM-20 XCVR came through with flying colors - **VE4AKI**; Wish I had more time - nice to hear familiar calls and meet some new ones - even had a couple of ragchews - **WBØT**; Did ARRL 160M contest Fri & Sat nite, but still had "contest energy" so spent 4 more hours sprinting - **W3TS**; Nice way to spend a cool, grey afternoon - **KJ5MG**; First contest QRP, hope to do it again - **VE9VIC**; Got half my Q's 1st hour, then thunderstorms - **W5SB**; From Alaska band was very poor the first hour, a blistering pace of 3 Qs/Hr - **AL7FS**; Was a bit disappointed in 40M turnout - where were ID and NM? - **N6WG**; First Homebrew Sprint and I had a ball. I am always surprised what QRPp (240 mW) and a good antenna will do - **KU7Y**; Great fun! Stayed on 15m long enough to prove it was open, even though it wasn't - **AB7TT**; No better way to spend a Sunday afternoon - **WA1QVM**; My second contest. I heard a lot of stations but didn't get through to many. Of course my antenna probably is like a leaky dummy load - **AE4MZ**; Had a blast! KD7S really stole the show with his 40mw signal - **WE6W**; Working W3TS on 10M was a boost at the very start. The VE9 was a neat addition also - **W6ZH**; Several stations could be heard but only one worked - **JRØBAQ**; It was a challengedoing a contest with fixed frequency, crystal controlled 200 milliwatt rig (Pixie) with wide receive bandwidth - **N4UY**; I really enjoyed my first arci contest, everyone was very patient with my small signal - **K2VS**; Holiday spirits and ARRL 160M contest makes a very full weekend - **K9PX**; Used HB straight key with button made from M&M. Didn't melt in my hand this time - **W7BXZ**; Great big QRM on 40, 80 much better. Wish I had switched over much sooner - **N2SMH**; Wow! I ran 28 stations in 1 hour at 900 mW. Now that is my idea of fun. That SW-40 with the OHR Scaf really work well - **N2VPK**; This sprint was really fun - even 15m was open - **W3KC**; This was my first attempt at an HF contest. QRPers always impress me with how patient, courteous and proficient they are - **KB2HSH**; Gotta get more band modules for the Sierra (80, 15) - **N4ROA**; Wish I could have operated longer. Was just getting used to my Norcal paddle! - **N7GS**;

TOP THREE

W3TS	237,360
KU7Y	124,950
W6ZH	116,450

SPRING QSO PARTY

Date/Time:
April 11,1998, 1200Z through April 12, 2400Z. Work a maximum of 24 hours of the 36 hour period. CW only.

Exchange:
Member - RST, State/Province/Country, ARCI Number
Non-Member - RST, State/Province/Country, Power Out

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

Multiplier:
SPC (State/Province/Country) total for all bands.
S/P/Cs may be worked on more than one band for credit.

Power Multiplier:
0 - 250 MW = X 15; 250 MW - 1 Watt = X 10
1 W - 5 W = X 7; Over 5 W = X 1.

Suggested Frequencies:

	GENERAL	NOVICE
160 Meters	1810 KHz	
80 Meters	3560 KHz	3710 KHz
40 Meters	7040 KHz	7110 KHz
20 Meter	14060 KHz	
15 Meters	21060 KHz	21110 KHz
10 Meters	28060 KHz	28110 KHz
6 Meters	50060 KHz	

Score:
Points (total for all bands) X SPCs (total for all bands) X Power Multiplier.

Team Competition: Competition between teams consisting of 2 to 5 members will be a separate category apart from individual entries. Team members will be listed as individuals and the team score will be the total of the members' scores. The team captain must send a list of team members to the contest manager postmarked at least one day prior to the QSO Party.

Entry may be an All-Band, Single Band, Hi-Band (20M, 15M, 10M and 6M) or Lo-Band (160M, 80M and 40M). Certificates to the top 10 scores, to the top score in each Single-band, Lo-band and Hi-band class, and to the top score in each class in each SPC. The contest manager reserves the right to recognize special significant entries with a certificate award.

Entry includes a copy of the logs and a separate summary sheet. Include duplicate check sheets with entries of 100 QSOs or more. Indicate total time-on-the-air, and include a legible name, call, QRP ARCI Number (if any) and address.

All entries must be received within 30 days of the contest date. Late entries will be counted as check logs. Members and non-members indicate their output power for each band. The highest power used will determine the power multiplier. Output power is considered as 1/2 of input power.

Include a description of homebrew equipment, commercial equipment, and antennas used with each entry.

Send an SASE for a summary and sample log sheets. Include an SASE with your entry for a copy of the results. Results will be published in the next available issue of the QRP ARCI Quarterly.

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

Entries are welcome via E-Mail to CamQRP@cyberg8t.com, or by mail to:
Cam Hartford, N6GA
1959 Bridgeport Ave.
Claremont, CA 91711

MILLIWATT FIELD DAY

Date/Time: June 27, 1998, 1800 UTC to 2100 UTC June 28.
Exchange: Class/ ARRL Section, per ARRL Field Day rules
Points: Same as ARRL rules, ie: Phone contacts count one point each, CW contacts count 2 points.
Bonus Multiplier: X 1.5 for fully portable setup.
Scoring: Multiply total of contacts by ARRL power multiplier, which would be X5 for an outputpower of 5 watts or less. Multiply this score by Bonus multiplier, if applicable.
Entry classes:
One watt, one operator.
One watt, two operators, one transmitter
Five watts, one operator.
Five watts, two operators, one transmitter.
Club class.

Awards: Plaques to the winner of each class.

Entry consists of a duplicate of the ARRL Field Day entry, consisting of Summary sheet and alpha-numeric listing of contacts by band (dupe sheet). All ARRL Field Day rules to be followed. All entries must contain complete name, call, address and must be postmarked no later than 30 days after the contest. Include descriptions of antennas and equipment used. Include an SASE for contest results. Entries may be submitted via e-mail to camqrp@cyberg8t.com or by mail to Cam Hartford, N6GA, 1959 Bridgeport Ave., Claremont CA 91711

HOOTOWL SPRINT

Date/Time: May 24, 1998; 8:00 PM to 12:00 PM **Local Time**

Exchange:

Member - RST, State/Province/Country, ARCI Number

Non-Member - RST, State/Province/Country, Power Out

QSO Points: Member = 5 Points

Non-Member, Different Continent = 4 Points

Non-Member, Same Continent = 2 Points

Multiplier:

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

Power Multiplier:

0 - 250 MW = X 15; 250 MW - 1 Watt = X 10

1 W - 5 W = X 7; Over 5 W = X 1.

Suggested Frequencies:

	GENERAL	NOVICE
160 Meters	1810 KHz	
80 Meters	3560 KHz	3710 KHz
40 Meters	7040 KHz	7110 KHz
20 Meter	14060 KHz	
15 Meters	21060 KHz	21110 KHz
10 Meters	28060 KHz	28110 KHz
6 Meters	50060 KHz	

Score:

Points (total for all bands) X SPCs (total for all bands) X Power Multiplier + Bonus Points.

Entry may be All-Band, Single-, High-Band or Low-Band. Entry includes copy of logs and summary sheet. Indicate total time on the air. Include legible name, call, address and ARCI Number, if any. Entry must be received within 30 days of contest date. Highest power used will determine the power multiplier. Send an SASE for sample log and summary sheets. Include as SASE with your entry for a copy of the results

The final decision on all matters concerning the contests rests with the contest manager. Entries are welcome via E-Mail to CamQRP@cyberg8t.com, or by mail to:

Cam Hartford, N6GA
1959 Bridgeport Ave.
Claremont, CA 91711

1997 SUMMER HOMEBREW SPRINT

Date/Time:

July 12, 1998; 2000 - 2400 Z. CW only.

Exchange: Member - RST, State/Province/Country, ARCI Number

Non-Member - RST, State/Province/Country, Power Out

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

Multiplier: SPC (State/Province/Country) total for all bands.

S/P/Cs may be worked on more than one band for credit.

Bonus Points: Points awarded for using Homebrew equipment,apply for each band on which Homebrew equipment was used: +2,000 HB Transmitter used; +3,000 HB Receiver used; +5,000 HB Transceiver used

Homebrew Definition: If you built it, it is considered Homebrew.

Power Multiplier: (Power Output)

0 - 250 MW = X 15; 250 MW - 1 Watt = X 10;

1 W - 5 W = X 7; Over 5 W = X 1.

Suggested Frequencies:

	GENERAL	
160 Meters	1810 KHz	
80 Meters	3560 KHz	3710 KHz
40 Meters	7040 KHz	7110 KHz
20 Meter	14060 KHz	
15 Meters	21060 KHz	21110 KHz
10 Meters	28060 KHz	28110 KHz
6 Meters	50128 KHz	

Score:

Points (total for all bands) X SPCs (total for all bands) X Power Multiplier + Bonus Points.

Entry may be an All-Band, Single Band, Hi-Band or Lo-Band. Certificates to the top three scores, to the top score in each Single-band, Lo-band and Hi-band class, and to the top score in each SPC. Entry includes a copy of the logs and a separate summary sheet. Indicate total time-on-the-air, and include a legible name, call, QRP ARCI Number (if any) and address.

All entries must be received within 30 days of the contest date. Late entries will be counted as check logs. Members and non-members indicate their output power for each band. The highest power used will determine the power multiplier. Output power is considered as 1/2 of input power.

Include a description of homebrew equipment, commercial equipment, and antennas used with each entry. Homebrew bonus points may not be claimed if a description is not included with the entry.

Send an SASE for a summary and sample log sheets. Include an SASE with your entry for a copy of the results. Results will be published in the next available issue of the QRP ARCI Quarterly.

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

Entries are welcome via E-Mail to CamQRP@cyberg8t.com, or by mail to:

Cam Hartford, N6GA
1959 Bridgeport Ave.
Claremont, CA 91711

Adventure Radio Society announces new "POWER OF ONE" Contest

This is a four hour event during the second Sunday of September, running from 10:00 PDT/11:00 MDT/12:00 CDT/1:00 EDT to 2:00 PDT/3:00 MDT/4:00 CDT/5:00 EDT. Thus, the hours of operation accommodate all four time zones.

No matter where you live, there is time to for Oners who chose to reach their sites with human power to travel to their sites, set up their stations, operate the contest, and travel back to their cars.

Both home-based and portable operations are encouraged. Portable Oners must use human power to reach their sites (walking, biking or boating). The distance traveled to the site is at the Oner's discretion.

The power for all participants is one watt. We operate CW on 40, 20, 15 and 10 meters, on the standard QRP frequencies. We want this to be a national contest, so we encourage long-range contacts by giving double points for 20, 15 and 10 meters. 40 meter contacts will receive one point. The same station can be worked on different bands for additional QSO points and multipliers. The exchange is RST, state/province/country, and your status ("HB" for home-based and "PQ" for portable.

Separate but equal prizes are awarded to the home-based and portable winners.

Details of this and all other ARS events can be found on the Adventure Radio Society web page;

http://www.natworld.com/ars

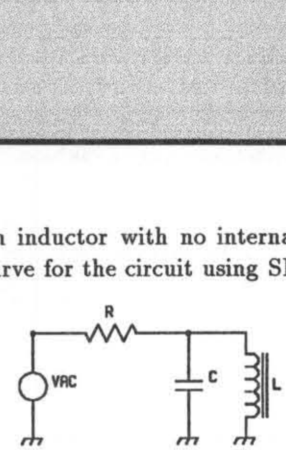
SPICE for QRPers
Part 2
Chuck Adams, K5FO

In the last issue of the Quarterly, I started this series on SPICE and it's use for some amateur radio applications. Sorry, I had not been forewarned of the format change and thus was using the larger font that I had used in earlier columns. This I have now corrected and it puts more pressure on me and any author to fill in the space between the margins. But the good news is that in the same space we can put more goodies to work on and absorb.

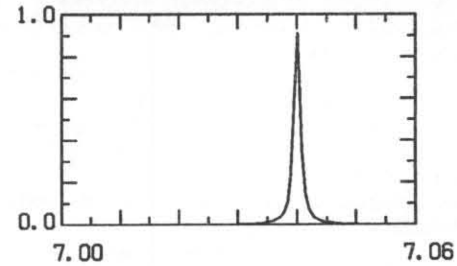
Let me add some information on the last installment whereby I listed a sample SPICE data file to analyze a five-element Chebyshev low pass filter. This type of filter is used as the final output filter for the PA of a rig. I went through some QRP books and took the capacitor and inductor values of filters shown in the books and ran them through SPICE3F4 and plotted five of them. That graph is shown as Figure 1 in this section of this issue of the Quarterly. I also used the values that I had just gotten from a kit and also plotted the attenuation curve on the same graph. That curve is shown as a solid line. The only curve better than it is for a filter that can not be built with off the shelf standard component values due to the odd values of the caps and inductors. If it was worth the time and effort of combining values for the caps and inductors that you can buy and find you could get close. I have not shown the capacitor and inductor values in order not to bias you one way or another. You should, if you have a running version of SPICE, start with the listing from last time and start using values that you can find or think up and test them. There are many combinations that will work in whatever rig you are building. Also remember that these are shown for forty meters and you are probably working on something for another band and anything that I printed here wouldn't be what you needed anyway.

So what do you see? Well, first of all you see that some filters are better than others and some of them are dangerous in that the suppression of the second harmonic of forty meters and above is not as much as is possible or desired. But also remember that this graph assumes that the twenty meter component has the same magnitude on the input of the filter for all the frequencies plotted from 1 Megahertz to 21 Megahertz that were computed. You should also note that the filters are fairly flat up to 8 Megahertz, but for constructed filters this will not be true due to more complex factors too tedious to discuss here.

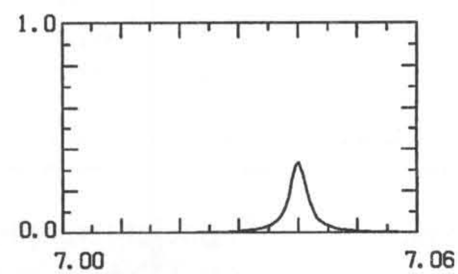
Let me take a few lines here and illustrate some basic fundamental principles for just a simple RLC network. Here is the diagram and lets pick values for L and C that make the circuit resonant at 7.040MHz, a very nice frequency by the way and a very popular one if you happen to visit on forty meters during the winter months during the early evening hours. What we will start out with is an inductor with no internal resistance and plot the response curve for the circuit using SPICE.



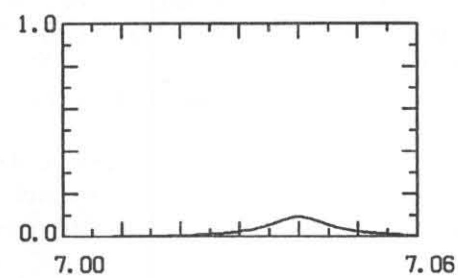
We get for this simple circuit a response curve by sweeping frequencies for 7.000MHz to 7.100MHz as shown in this figure.



But by adding some resistance in series with the inductor L we can simulate the internal losses due to wire resistance for the inductor. First by starting with a value of only 0.1 ohms, we get:



And then by increasing the internal resistance to 0.5 ohms, we get:



Although the value was small, we get a significant change in the Q of the L-C combination and the net voltage response across the L-C network in the overall circuit. This is of real concern in modeling real circuits and those experienced in doing this can tell you of a number of significant hours spent in fine tuning the models to match the actual circuits.

The point here is that with some computer tools like SPICE, using the version you have, you can check some values out before you commit to building something on the workbench. And one should be careful of published values to some extent and check them out. Some values aren't that bad but were done possibly in the early stages of development of rigs and then published. Later the author probably found better values through experimentation and the new value and improved values did not make it into print anywhere. It's not that the author made a serious error at the original time of publication, but he or she just went with what was known at the time.

While I'm at this point in the article, let me warn you of one difficulty that will occur with SPICE. The program is easy to get and a number of evaluation versions exist and public domain versions abound almost everywhere for any computer system both big and small. The biggest difficulty and to me the one that has taken some time is getting valid models for real world parts. The software vendors for SPICE go to a lot of trouble (and it is justified) to protect their model libraries. This is where the real value is. I am in the process of collecting all the models that I can off the Internet from the manufacturers, since they provide them free of charge in hopes that someone will use their part in something that will require millions of them to be used and bought. So be aware that not everything that you want to use in modeling will be available. Evaluation copies may generate the wrong model also so do be careful.

So with that in mind let us continue to use SPICE to model some interesting circuitry. The next thing that I want to look at is the diode and its characteristics. There are two classses of diodes that we usually use in most of our QRP work and those are germanium and silicon diodes. Germanium is used to detect low level RF signals in a RF probe. I have found 1N34As, 1N270s, and 1N1499s model numbers for germanium diodes in Dallas where I buy miscellaneous parts. I went searching everywhere for a Ge model for a diode and was not successful until Roy Lewallen, W7EL, sent me one via email. Here is a simple program to generate the characteristic curve for a germanium diode using these model parameters for the 1N34A..

```
*   Test of Germanium Diode Model

VIN 1 0 DC 1
VTST 1 2 DC 0
D1 2 0 1N34A

.PRINT DC V(1) V(2) I(VTST)
.DC VIN -1.0V 0.50V 0.01V

.MODEL 1N34A D( bv=75 cjo=0.5e-12 eg=0.67
+      ibv=18e-3 is=2e-7 rs=7 n=1.3 vj=0.1
+      m=0.27 )

.END
```

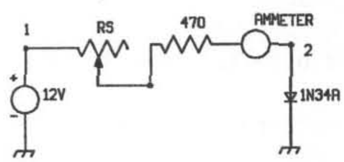
I also used the model for the 1N4148 silicon diode and it's parameters as shown below. Just modify the above program by substituting the 1N4148 values and reference for the 1N34A. I plotted the results of both calculations in Figure 2 but more than that I added some measurements taken with a simple setup at home. I have more work to do in this area to check the results and modify the values. I show them here in hopes that some of you can setup an accurate measurement facility to measure the same parameters. If you do so, please drop me a note or email to me what you find out. The parts that I used were from the spare parts bin and I'm not sure of their history, manufacturer, manufacturing dates, or if they were rejects. The issue here is to illustrate what the simulation will yield and that there may be a slight difference in the results versus real life and parts variations, but they are in the ballpark so to speak.

Here is the device model for the 1N4148 silicon diode for use in SPICE.

```
.model D1N4148  D(Is=0.1p Rs=16 CJO=2p Tt=12n
+       Bv=100 Ibv=0.1p)
```

Something else to consider about device modeling and calculations using any software. The software does not know at what point a real world device will self destruct. You can put a ten thousand volt battery across a five ohm resistor and get the mathematically correct results for Ohm's Law, but the power levels would be difficult to generate in the laboratory or on a workbench at home. So do be careful and read the manufacturers power limitation data for the device and be sure not to exceed those values. I can show with SPICE or other software a one ampere current through a 1N34A with a certain applied voltage but we all know that a 1N34A will not be capable of handling that much current for any length of time without being destroyed.

Going back to the measurement of the voltage vs current curve for the diode, let me show you my simple circuit.



I think the circuit is fairly obvious. But there is something that you must do in taking measurements. Measure both the battery or supply voltage and the voltage drop between points 1 and 2 in the diagram. By subtracting the two voltages you have the voltage drop across the diode provided that your voltage meter has a very high resistance on the order of 10 Megohms or higher. Be very careful if you don't have a modern meter or you are using a meter with a low impendance on the order of 20K ohms per volt. Your measurements will effect the current flow through the diode and the voltage drop across the diode will be in error. Do not measure the voltage drop across the diode by placing a voltmeter across it, as this too will give you significant errors in the measurements. Work out the details using Ohm's Law if you don't immediately see why this is true.

The purpose of the 470 ohm resistor is to insure that you and I don't allow the current to too large and destroy the diode. You can reduce the value to 300 or so ohms but this is up to you. Make sure that you don't exceed say 50 mA through the diode just to be on the safe side.

Something that you may want to test now that you have two models for diodes is an RF probe. Look at its behaviour over a wide frequency range and amplitude for the input. There are two types of RF probe configurations, one being shown in the ARRL Handbook and a peak reading type RF probe. What is even more fun is to build each type of probe and then compare measurements (carefully controlled and made) with predicted values from the software simulation.

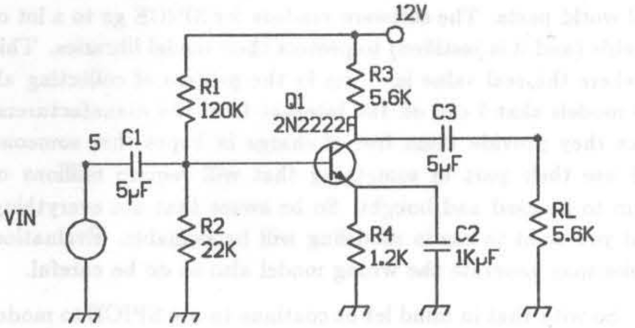
So far we have seen how to use resistors, capacitors, inductors, and diodes in circuits. The next logical step is to model the transistor. I'll start out this session with just the bipolar junction transistor. A number of model parameters are used and exist for the 2N2222, 2N2222A, 2N2907, 2N3904, 2N3906, and many many more. But we will use these listed here most often.

Here is a small SPICE program to generate the characteristic curves for the 2N2222A and Figure 3 shows the result of plotting the output from this program. Again note that there are some portions of the curve that if the voltage levels and current levels were physically applied the transistor would be permanently destroyed.

```
*
*  2N2222A characteristics
*
IB  0 1 DC 1MA
VCE 2 0 DC 12V
Q1  2 1 4 2N2222A
VT  4 0 DC 0

.PRINT DC I(VT)

.DC VCE 0 10V 0.2V IB 0 1MA 200UA

*  model parameters for a 2N2222A transistor

.model 2N2222A NPN(Is=14.34f Xti=3 Eg=1.11
+       Vaf=74.03 Bf=255.9 Ne=1.307 Ise=14.34f
+       Ikf=.2847 Xtb=1.5 Br=6.092 Nc=2 Isc=0
+       Ikr=0 Rc=1 Cjc=7.306p Mjc=.3416 Vjc=.75
+       Fc=.5 Cje=22.01p Mje=.377 Vje=.75
+       Tr=46.91n Tf=411.1p Itf=.6 Vtf=1.7 Xtf=3
+       Rb=10)

.END
```

After getting the models for the transistors that one typically finds in QRP literature you can now start modeling the fundamental circuits that you find in the literature and in commercial rigs, both assembled and in kit form.

Let me start you out with just a basic RF amplifier circuit typically found in many places such as IF amplifiers. This is one similar to ones found in many ham publications including the one found in Wes Hayward, W7ZOI, and Doug DeMaw's, W1FB, book *Solid State Design for the Radio Amateur* published by the American Radio Relay League. This one from L.H. Fenical's book has been modified to reduce the power consumption level and still provide a good gain and bandwidth. You can make many tradeoffs in playing with resistor values and capacitor values. These tradeoffs being in overall gain and bandwidth and total power consumption by the amplifier itself. SPICE makes an excellent tool for both determining desired frequency response of a circuit and at the same time determine the power level required for the operation of the circuit. I have shown the values here and also show a value for C2 that is difficult to come by for a real circuit, but the resulting response curve shown as a solid curve in Figure 4 would be nice, but not very realistic.



The SPICE data file for the above circuit would look like the following.

```
* Single Stage IF Amplifier using 2N2222A

VCC 1 0 12
VAC 5 0 AC 1

R1 1 3 120K
R2 3 0 22K
R3 1 2 5.6K
R4 4 0 1.2K
RL 6 0 5.6K

C1 5 3 5U
C2 4 0 1000U
C3 2 6 5U

Q1 2 3 4 2N2222A

.AC DEC 25 1 1E9
.PLOT VAC V(6)

.model 2N2222A NPN(Is=14.34f Xti=3 Eg=1.11
+       Vaf=74.03 Bf=255.9 Ne=1.307 Ise=14.34f
```

```
+        Ikf=.2847 Xtb=1.5 Br=6.092 Nc=2 Isc=0
+        Ikr=0 Rc=1 Cjc=7.306p Mjc=.3416
+        Vjc=.75 Fc=.5 Cje=22.01p Mje=.377
+        Vje=.75 Tr=46.91n Tf=411.1p Itf=.6
+        Vtf=1.7 Xtf=3 Rb=10)

.END
```

Sometimes I may forget and you will see some data files in SPICE with parts in lower case and some in upper case. Due to the history of SPICE and the fact that it started out in being written in FORTRAN, the data may be in either case and is not case sensitive and the data also follows the old card format style.

One of the things that you may enjoy doing and what makes programs like SPICE so valuable is the ability to modify values and almost immediately see the results. You may evaluate the design and the parameters of a circuit rather rapidly and without the tedious work of soldering and unsoldering parts to experiment. But you still must do some of this later in building the circuit that you think you are happy with and determining just how well you have modeled the final product.

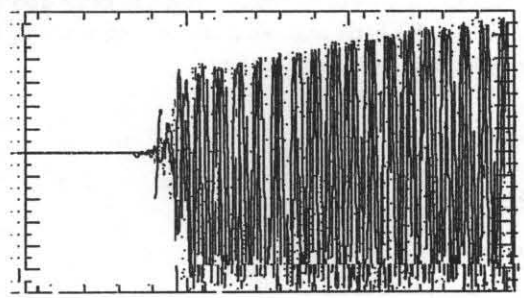
For the circuit above, you will note that C2 is not a practical value for a bypass capacitor, so you can rerun the circuit through SPICE with a value of say 0.1μF. I have done just that, with all other values fixed, and the resulting curve is shown in Figure 4 and is the curve shown with the plus sign symbol. You may also want to examine factors such as input and output coupling capacitors and load dependencies. Another thing that may be of interest is to examine the gain of the circuit as a function of the resistor value for R4. Try values in the range of 900 ohms to 2K ohms and note the change in the gain and the bandwidth. All this not shown here to save space and leave some fun for you.

In a number of the versions of SPICE that output graphical information using either the X-interface on workstations or using the PC display and the mouse have the capability to have you point and click on a point on the curve and the program will output the x- and y-values of the point. This is useful to find the 6-dB points and within a short period of time find the bandwidth of a circuit or filter. This sure beats the old fashioned method of plotting a large amount of data and then using the graph to determine the points. Computers have definitely spoiled us, but let us not remember that there still exists the other methods when a computer is not available.

There are a number of other functions in SPICE that I would like to point out, show the results of a couple, but unfortunately due to limitations in space and time I will not be able to go into all the details. It is for this reason at the end of this article I have listed some reference books. The average page count per book is around 250 or more. If I am allowed 8 pages per issue of the Quarterly, it would take 30 issues or seven years to cover all the material. So you can see than in two articles I'm obviously not going to cover enough material. But hopefully I have gotten your interest in investigating the possibility of using SPICE for some calculations and saving yourself some time and energy in experimenting with values in common circuits that you may be using.

For voltage sources in SPICE there are additional options to specify in detail phase relationships, pulse function for transient analysis, sine function, an exponential function for rise and fall times of a transient voltage, the ability to define a piecewise linear function, and a single frequency FM function for transient analysis. I think that covers just about anything you could or want to do in analysis.

The pulse function is needed if you want to study oscillator design. If you just input an oscillator circuit design into SPICE and do an analysis you will find it will not oscillate without inducing a transient voltage into the circuit. After a transient pulse gets a pertubation going the circuit will begin to oscillate. I took a simple Colpitts oscillator circuit and using a voltage pulse to induce oscillation and the transient statement to set time limits I was able to get the response shown in the figure below.



With the transient pulse you can use SPICE to look at time delays in a transmission line. With the AC analysis you may examine the power bandwidth of a transmission line balun for analysis at frequencies where the line is one-half wavelength long and frequencies above and below where the balun was designed to be used.

SPICE allows you to do noise analysis with a noise control statement. This allows the program to simulate noise from resistors and semiconductors in the ciruit and examine the effect at each frequency of AC analysis. This is useful in determining just how much noise may be expected in the design circuit just from the internal characteristics of the devices being used.

With the noise analysis, distortion analysis, an additional Fourier analysis may be done in conjunction with the transient analysis to determine the first nine frequency components of a waveform. These means that you can look at the power spectra distribution of the fundamental frequency of analysis and the first eight harmonics and plot the results to determine what the harmonic content of the circuit. This is obviously useful in designing and checking ciruits to reduce as much as possible high order harmonics and produce the best circuit possible for RF generation and amplification. We all want the cleanest signal possible in all our equipment.

One can do temperature analysis using the temperature control line. By default all circuit analysis done in SPICE is done at 27 C unless the program has set another value. This is useful to investigate the effects of resistance variation when temperature-dependent resistor parameters are specified.

Although SPICE was originally designed to be used mainly for the design and fabrication of analog and digital integrated circuits it is indeed a useful tool for everyday type study of amateur circuits. Most radio amateurs rarely design an entire piece of equipment from scratch but borrow and modify and research existing circuits and designs in hopes of improving upon them and coming up with something that has additional features and performance parameters. It is our quest for the next level of performance from both receivers and transmitters that keeps us plugging away at new designs and circuits. SPICE allows in many ways to cut and paste circuits together in the computer before we take out the parts bin, the parts catalogs, and finally the soldering iron to physically construct what was previously only ideas on paper and ideas in the computer.

Let me just list a small summary of the capabilities of SPICE and its derivative programs for your study. Maybe something in this list will be of interest to you and cause you to start using SPICE just a little and see if it can help you find the circuit that you have been looking for.

- Resistors
- Capacitors
- Diodes
- Zener Diodes
- Independent Voltage Sources
- Independent Current Sources
- Voltage-Controlled Voltage Sources
- Current-Controlled Current Sources
- Voltage-Controlled Current Sources
- Current-Controlled Voltage Sources
- Bipolar Junction Transistors (BJTs)
- Junction Field-Effect Transistors (JFETs)
- Metal-Oxide Semiconductor Field-Effect Transistors (MOSFETs)
- Inductors
- Mutual Inductance and Transformers
- Transmission Lines

And with these capabilities you may use SPICE to analyze any number of the following topics and circuits.

- Simple Ohms Law configurations too difficult or time consuming to do by hand.
- RF probe analysis
- IF and RF amplifiers
- AF amplifiers
- Operational Amplifier Circuits
- Oscillators
- Crystal Filter Designs
- Mixer Circuits
- Bandpass Filters, both low and high
- Power Amplifier Designs
- Multi-stage Amplifier Circuits
- Active Filter Circuits

I know that most people are using PCs and without a math coprocessor these simulation runs may take some time, but do be patient. Consider the amount of work the program is doing for you and you can appreciate the time it does take.

I would like to list some books that are available for additional reading on SPICE, PSPICE, and other versions of the same basic program that started out as public domain software and has become a commercial product for many companies over the years. It is too difficult a task to compare the different books as they each have something that is new and unique and not found in other books and there is some overlap. They are listed in alphabetical order by author and hopefully you can find a copy at your local public library.

Walter Banzhaf, *Computer-Aided Circuit Analysis Using SPICE,* (New Jersey: Prentic-Hall, Inc., 1989)

J. Alvin Connelly and Pyung Choi, *Macromodeling with SPICE,* (New Jersey: Prentice-Hall, Inc., 1992)

L.H. Fenical, *PSpice - A Tutorial,* (New Jersey: Prentice-Hall, Inc., 1992)

Ron Kielkowski, *SPICE Practical Device Modeling,* (New York: McGraw-Hill, Inc., 1995)

Robert Lamey, *The Illustrated Guide to PSpice,* (New York: Delmar Publishers Inc., 1995) Includes Version 6 of PSpice on floppy disk.

Franz Monssen, *MicroSim PSpice with Circuit Analysis,* (New Jersey: Prentice-Hall, Inc., 1998)

Muhammad H. Rashid, *SPICE For Circuits and Electronics Using PSPICE,* (New Jersey: Prentice-Hall, Inc., 1995)

Gordon W. Roberts and Adel S. Sedra, *SPICE, Second Edition,* (New York: Oxford University Press, 1997) Thomas W. Thorpe, *Computerized Circuit Analysis with SPICE,* (New York: John Wiley & Sons, Inc., 1991)

Paul W. Tuinenga, *SPICE. A Guide to Circuit Simulation & Analysis Using PSpice,* (New Jersey: Prentice-Hall, Inc., 1995)

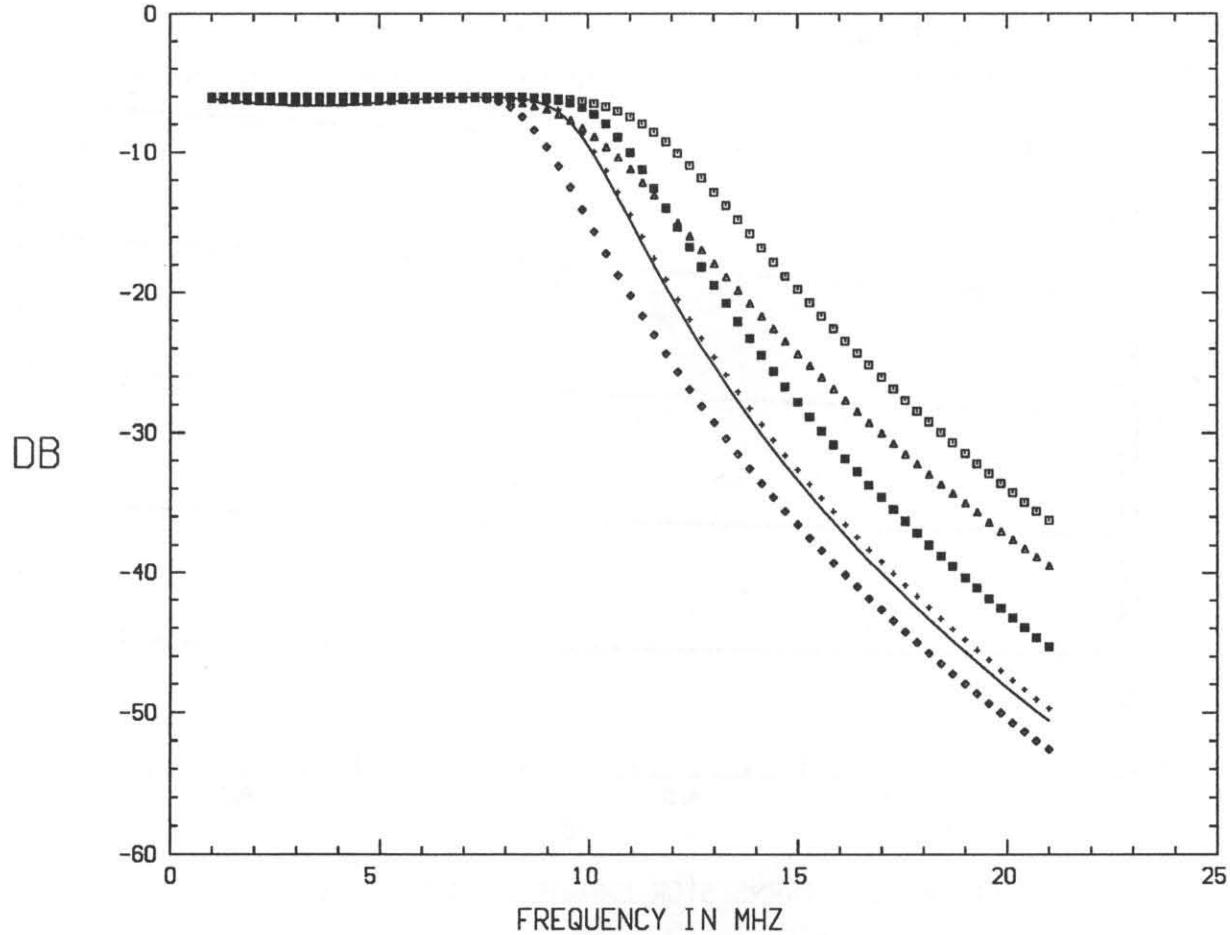


FIGURE 1. CHEBYSHEV CURVES FOR 40 METER FILTERS

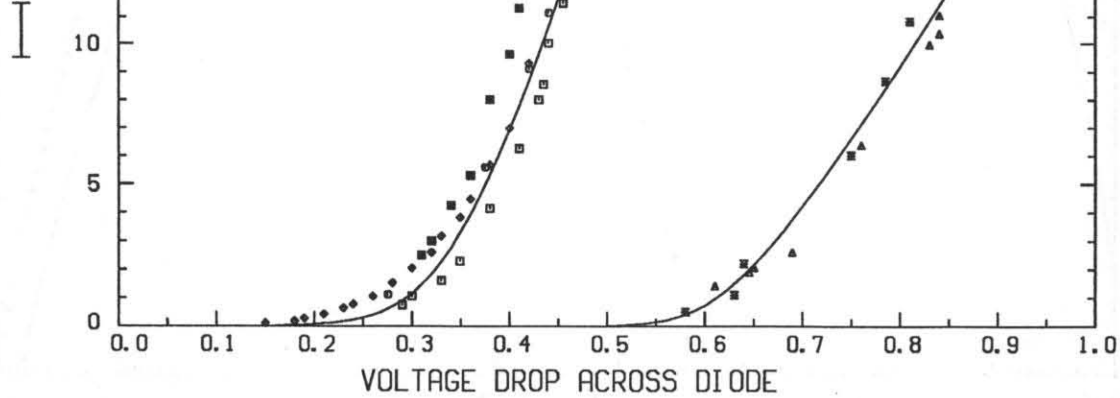


FIGURE 2. GERMANIUM AND SILICON DIODE CURVES

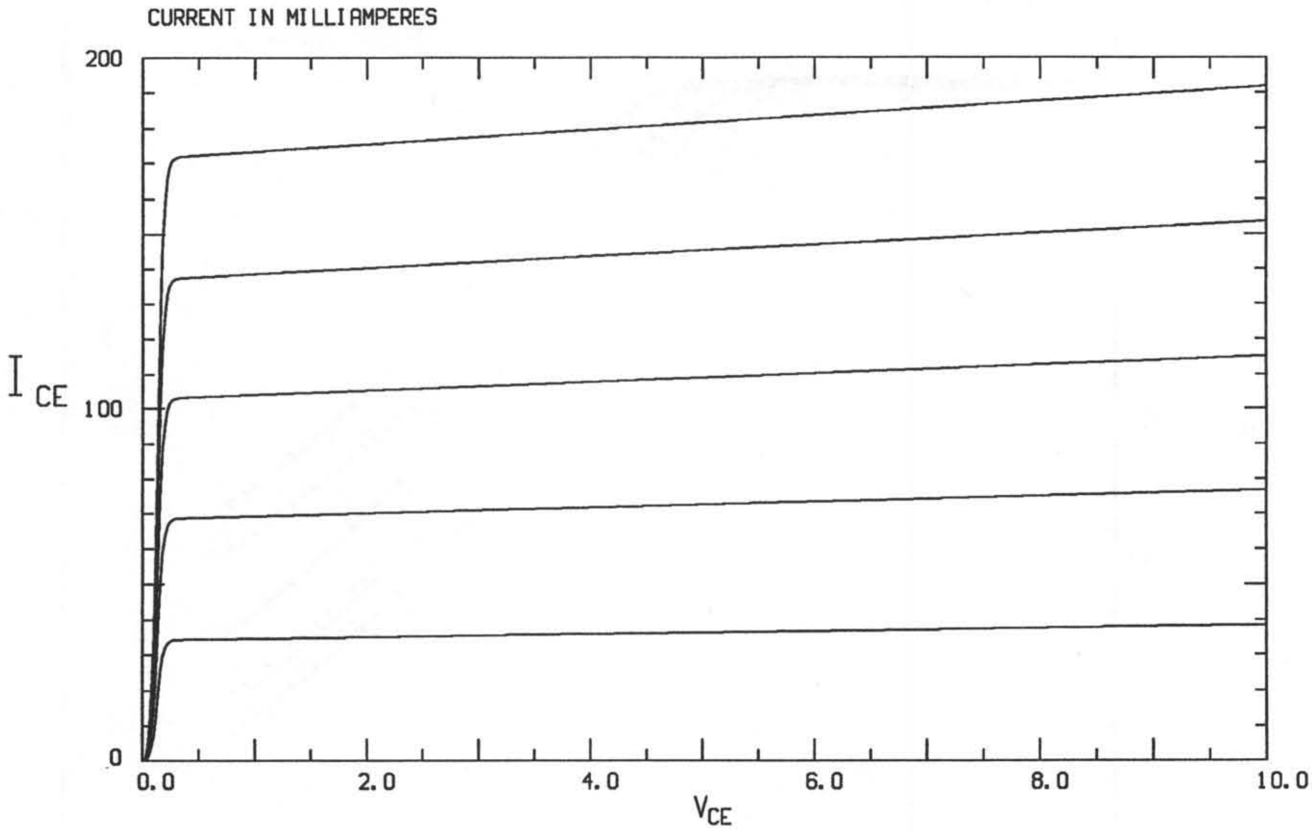


FIGURE 3. TRANSISTOR CHARACTERISTIC CURVE

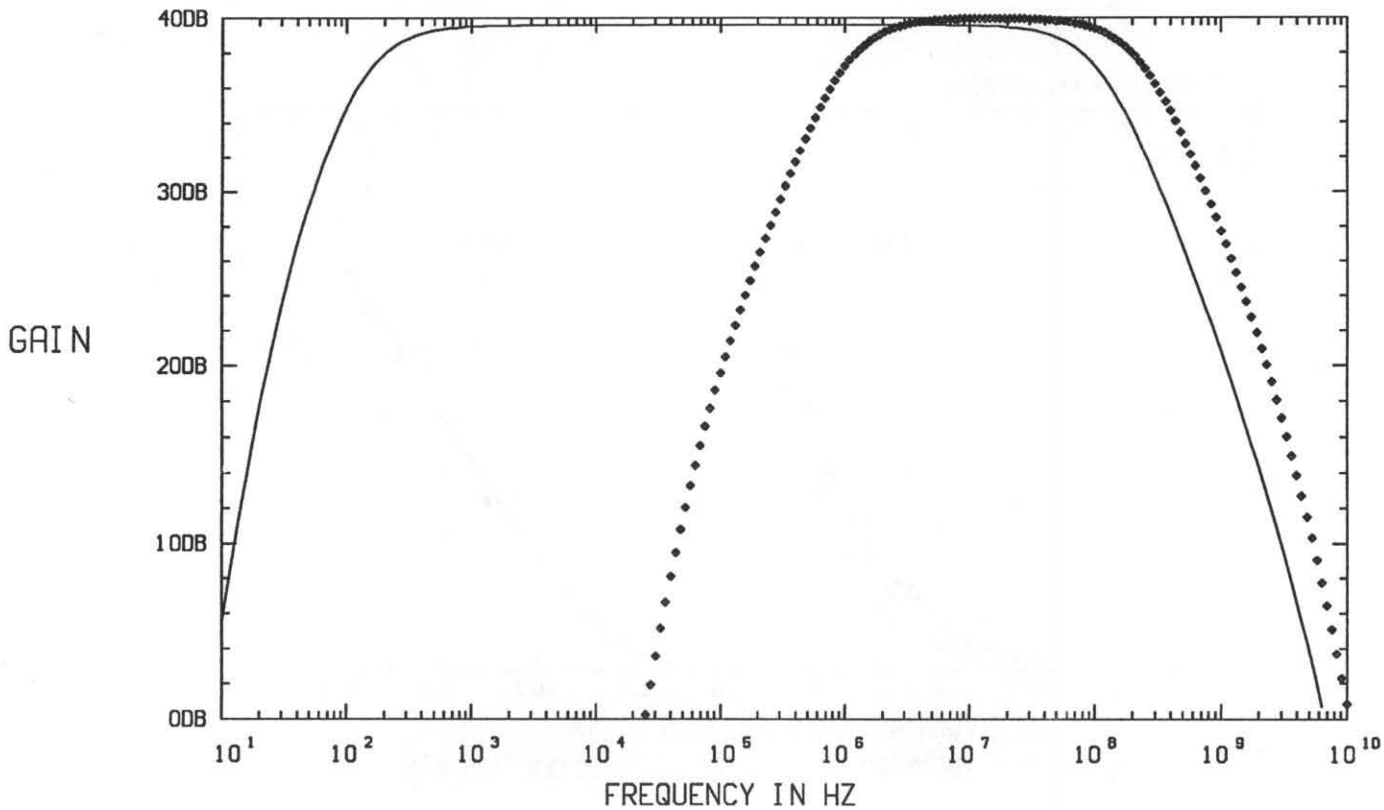


FIGURE 4. FREQUENCY RESPONSE OF RF AMPLIFIER CIRCUIT

The Last Word

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(With thanks to **L.B. Cebik** for all his help)

de **Ron, KU7Y**

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