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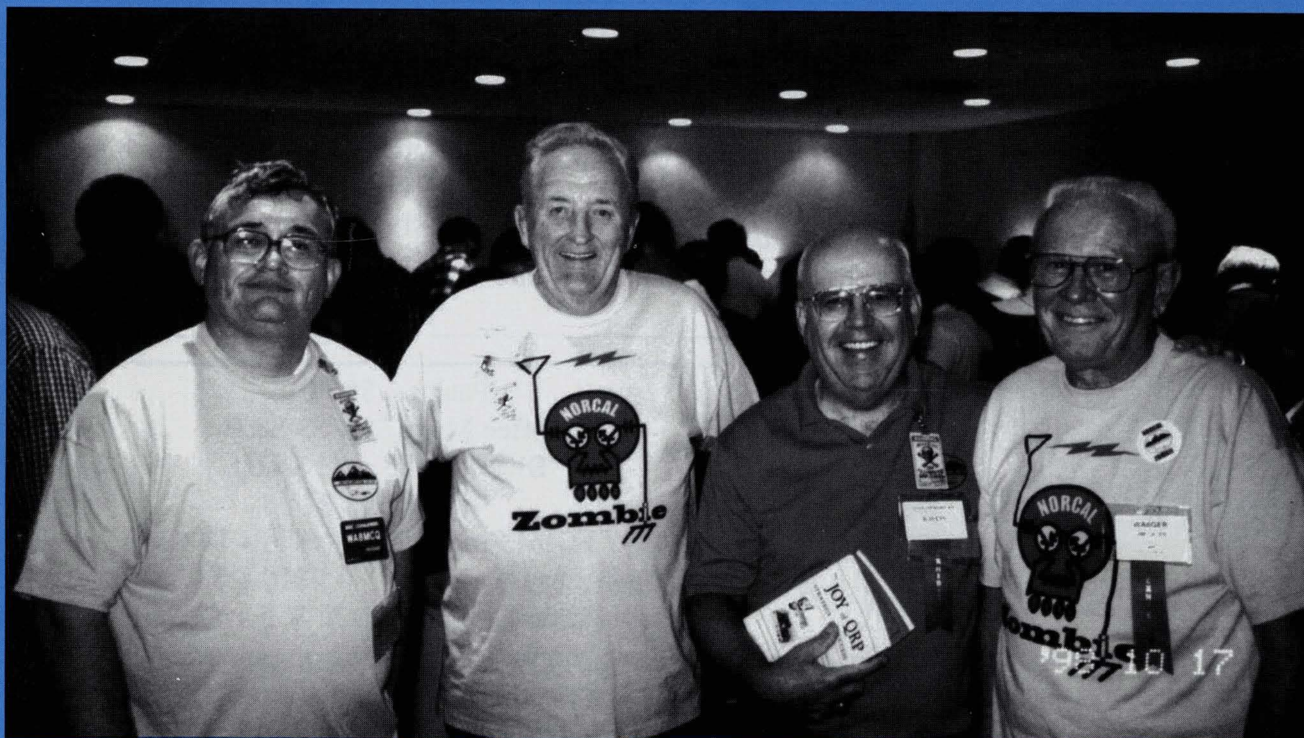

The cover photo this month was taken during a break in activities at the hospitality suite of the NorCal-sponsored "Pacificon QRP Forum" in October. QRP ARCI representatives join the guiding lights of the NorCal Club in a rare photo op. Shown (L-R) are: Mike Czuhajewski, WA8MCQ; Monte Ron Stark, KU7Y; Doug Hendrick, KI6DS; and Jim Cates, WA6GER.

You 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.

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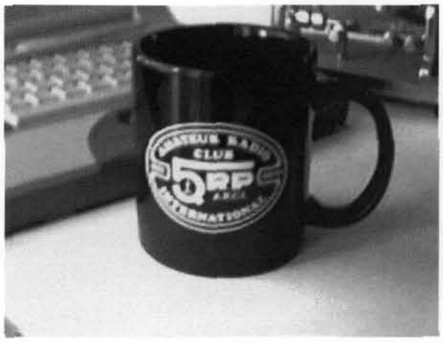

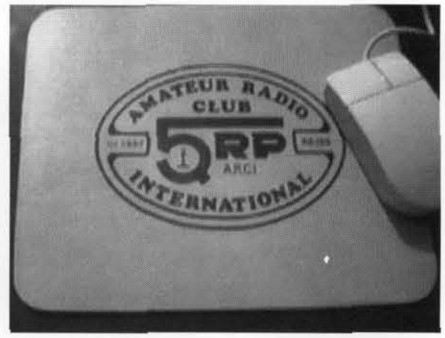

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This is the **official** coffee mug used by top QRP Fox Hunters, contesters and casual operators found near the normal QRP Frequencies. Kelly Green on White and the Logo on both sides. (Coffee, tea or milk not included.)

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From the Editor

George Heron, N2APB

Brace yourself – we're bringing in the new year with an explosive new issue of QQ! The reader survey results stated that you want more of everything, and we're doing just that. Our editors and contributors have been busy providing a lot of great material, and you'll notice several related themes: operating from unusual places (on bicycle, and on tailgate); PIC-microcontrolled equipment; and analysis techniques for circuits and antennas. And you might notice an overt effort to provide a greater presence of the QRP vendors in our pages, thus providing us all with more visibility of parts and kits.

My thanks go to ex-managing editor Ron, KU7Y and MikeC, WA8MCQ for their support as I take the reigns here at QQ. And thanks also to many of you for the super contribution of article material – to get your project or experiences immortalized in these pages, just contact any of the QQ staff (see back cover) and we'll be pleased to assist.

Guest Editorial

We're trying a new slant with the column this month and providing a forum within which others can comment on significant current issues in our QRP ranks. This month's "guest editorial" was written by Rich Arland, K7SZ as a result of some protracted and acerbic discussion recently seen on the QRP-L reflector. Rich's guidance is very appropriate for each of us in QRP, whether we are sending e-mail, ground mail, or discussing real-time at club meetings.

Rich Arland, K7SZ is certainly no stranger to the QRP scene. Many years licensed as K7YHA, he has been a QRPer since 1965 and holds QRP ARCI number 2388. Rich is also a longtime G-QRPer and was even a resident member for a time, courtesy of a USAF assignment in the UK. He served three terms on the QRP ARCI Board of Directors from 1987 to 1995.

Arland wrote the QRP column in Worldradio magazine from 1987 to 1994 and also their satellite column from 1994 to 1996. He had five articles on QRP published in QST and two in CQ – some within the last year or two – and wrote the preface for the ARRL's "QRP Power" book which was a replacement for "QRP Classics." He also published three books on QRP through Tiare Publications, Low Power Communications Volumes 1, 2 and 3. Lesser known is that he recorded a multi-part audio series on QRP which is still aired yearly on well known shortwave station HCJB as part of their regular amateur radio programming.

This long and rich experience gives K7SZ a good perspective on where QRP has come from and where it's heading.

"What is a True QRPer?" – Rich Arland, K7SZ

As you may know, about a year ago I curtailed much of my QRP activity and my club affiliations for personal reasons. Every now and then I would catch a thread on QRP-L [the Internet QRP mail reflector] regarding what "Real QRPers" were supposed to be or what they were supposed to use, or not use – all rather childish, when viewed in perspective. The last round of what makes a "Real QRPer" on the reflector got me mad, sad and frustrated, in that order. I was going to post a blistering e-mail response but decided to write to you instead, hoping that this letter might find its way into the QRP Quarterly, where it would not be easily "deleted".

I want to quote from chapter eight of my book, "Low Power Communications", Vol-III to hopefully put everything in perspective and finally lay this "Real QRPer" stuff to rest. In place of "Real QRPer" I use the term "True QRPer"... they are interchangeable.

"I've come to realize that, for me, low power communications has become much more than just a hobby. It has become a way of life. I have met some fascinating amateur radio operators and made some lifelong friends in the process. Never, ever, have I stopped learning.

"QRP seems to bring out the nice guy in all of us. True, there are some QRPers with very over-inflated egos, but thankfully they are in the minority. Personalities aside, QRPers are a breed unto themselves. Their dedication to performing seemingly impossible communication feats places them in a unique fraternity. Nothing is impossible for the True QRPer. He is a master of propagation and antenna theory. He is constantly striving to make his station more efficient and his operating skills are honed to perfection. The True QRPer is an outstanding listener and can pull the weak ones out of the noise. He tenaciously plies his craft on the bands, at club meetings, during contests, at Field Day and at hamfests, constantly trying to educate the mainstream ham radio population in the art and science of low power communications. Ever on the alert for converts to the low power community, the True QRPer is always willing and happy to give the newcomer help and advice.

"The True QRPer is not driven by ego or need to be top dog. Instead, True QRPers engage in low power communications for the challenge and fun. Most QRPers have a keen competitive spirit, which drives them in their DXing and contest activities. But the True QRPer never loses sight of his main goal - to show others the fun and challenge of using low power communications on the amateur bands."

I wrote those passages over 3 years ago. I am saddened that there are so many QRPers currently on the reflector who feel that they must judge others by what type of antenna they are using (GOD forbid you should use a beam!), what rig they use (don't ever tell anyone you are using an FT-1000D cranked down to 5 watts!) or that they do not care to build any gear, but are driven by the joy of OPERATING instead!

There is growing dissension among some within the QRP fraternity that is going to tear this great hobby apart if someone does not clue them in. Cut the crap, folks. QRP is a great hobby; stop trying to kill it off! Newcomers to the QRP fold who read these mundane, inane, insipid comments like, "Real QRPers don't use beams", etc. question whether or not they want to become involved with QRP at all. This is something the hobby cannot tolerate. We grow or we die. It is that simple. I have heard QRPers described as an arcane and eclectic group. We must attract new people into the hobby and we cannot afford these labels.

We are communicators. What we communicate and how we communicate can be our salvation or our curse. What we do not need are divisive comments and hostile attitudes from divergent factions within the hobby. Look at what you are doing and saying on the reflector and decide, BEFORE you push the "send" button, whether you want several thousand QRPers to read your thoughts /comments. As the old saying goes, "If you are not part of the solution you are part of the problem".

One final thought: A True QRPer loves the hobby, and wants to give something back to it. He wants to leave the hobby in better shape than he found it. How do you measure up? Are you on your way to becoming a True QRPer or a Real Dork? The choice is yours."

I feel much better, now!

73 Rich, K7SZ

Notes from the President

Mike Czuhajewski, WA8MCQ

CHANGES IN QRP ARCI

As announced earlier, George Heron, N2APB has succeeded Monte "Ron" Starke, KU7Y as the managing editor of the QRP Quarterly, and this is his first issue. Dave Johnson, WA4NID, resigned his position on the Board of Directors in order to devote more time to his other duties of membership chairman and webmeister of **www.qrparci.org**. Preston Douglas, WJ2V, was elected to replace him. Byron Johnson, WA8LCZ has been incommunicado for some time due to his current job. Monte Stark, KU7Y, was elected to be an acting member of the board in his absence. Congratulations to all on their new positions.

The current members of the Board of Directors are KU7Y, WJ2V, K8DD, K3TKS, N0EB and KT3A.

THE ADVENTURE RADIO SOCIETY AND THE "SOJOURNER"

The ARS is a relatively new QRP specialty group which already has over 300 members around the country, and which publishes an electronic magazine (e-zine) called the ARS Sojourner. ARS is a specialty QRP group, for people who like to take their rigs into the field and operate. This includes (but isn't limited to) backpacking and the like. They have sponsored several operating events, such as the Spartan Sprints, Flight of the Bumblebees and Top of the World.

They make heavy use of the Internet and e-mail for coordinating their activities. You can check out their web page at **www.natworld.com/ars**. The Sojourner started in May 1998 and the back issues can be viewed online. The executive editor is Rich Fisher, NU6SN, and he's also the membership chairman.

From their web page-- "Our Purpose and Philosophy: ARS promotes a sense of adventure by supporting radio operation from beautiful and remarkable places. We sponsor events that encourage the use of human-powered travel, in its myriad forms, to reach outdoor operating sites. We support the development of imaginative equipment and antennas." If this sounds intriguing, check out their web page and sign up. (They even allow sluggards like me to join, who don't backpack with QRP rigs but still find their aims and activities interesting.)

PLEASE DON'T DUMP ON THE AUTHORS!

It's not at all uncommon for authors in the QRP Quarterly to get no feedback or thanks for their work (both articles and columns). Some folks aren't bothered by this, while others take the lack of feedback seriously. For instance, W7ZOI wrote a short lived but excellent experimenters column for the QRP Quarterly circa 1985 but quit after 4 issues. He told me once that it was because he received no feedback from the readers, so had to assume that no one really cared. Feedback from other authors over the years expressed concern that they put large amounts of time into articles and received not one word of thanks from anyone. It's not enough to read and enjoy the articles; if something is really good, please take the time to tell the authors about it! They put a lot of time into them (and get no pay), and if they don't get warm fuzzies they may well stop writing and go somewhere else. (And many have.)

Here's the dark side of writing for the QRP Quarterly--a well known person had an excellent, well researched article a while back and he did get feedback from several readers but it was extremely negative at every level. He said that whenever his material appears in some other QRP journal or on QRP-L, he gets lots of e-mail thanking him for it. But his article in the QRP Quarterly did not generate a single "thank you"; instead he got many e-mails pointing out his spelling errors, challenging many of his statements, and even going so far as to call him an idiot. He even had two people mail him copies of his material with red marks all over pointing out the errors in spelling, punctuation, etc.

He believes this indicates either that our readers are not interested in his efforts or that he is *persona non grat* due to his association with other QRP groups. He went so far as to say that he believed the critical e-mail was an orchestrated effort, although he would not tell me the identity of the people so I couldn't look into that. He did say that he saw no point in writing anything further for the QRP Quarterly until he could be reasonably assured that it would be appreciated and not generate mean-spirited attacks.

What is the moral of these two stories? If you like something in the QRP Quarterly, tell the authors about it every now and then, or they may stop writing for us and write for someone whose readers DO give them warm fuzzies. And if you don't like something in the QRP Quarterly, for God's sake, don't attack the authors! We have enough trouble getting material as it is. I've mentioned the W6TOY position many times--that it's silly to write an article for a non-paying magazine if you can send that same article to someone who will give you money for it--and that I agree with that.

Fortunately, a lot of people still send us things that they could have sold to a paying magazine, but feedback from former editor Monte Starke KU7Y, indicates that this has cost us a number of articles and authors. You can look in ham magazines over the last several years and see a number of authors who once appeared in the QRP Quarterly or other QRP journals but now write for money. Nothing wrong with that, but it doesn't help us. And the combination of no pay and blistering attacks is unbeatable.

People, don't dump on the authors. It benefits no one, and does considerable harm to the authors, the QRP Quarterly and our readers.

EMTECH STILL IN BUSINESS

In October we noted the passing of Roy Gregson, W6EMT It now appears that his QRP company, EMTECH, is still alive and well, under his son Scott Gregson, KC7MAS (emtech@steadynet.com). The web page is at **www.emtech.steadynet.com** and the mailing address is

EMTECH
1127 POINDEXTER AVE W
BREMERTON, WA 98312

RENEWAL POLICY

There has been some confusion over the QRP Quarterly renewal policy in the past, that we will not accept renewals for more than two years at a time. This has apparently been misinterpreted by some, who have submitted more than one renewal (for two years) within a single year, to give them subscriptions that extend far into the future and lock in the current rates for several years.

Our policy is that we will not accept renewals that extend the expiration dates more than two years (approximately) beyond the current date. Printing costs rise over time, postal rates do nothing but increase, and thus our costs can only go up. We cannot afford to be saddled with a large number of long term renewals at yesterdays rates; that effectively makes everyone else subsidize those bargain renewals, and that's not fair to everyone else.

We do allow a certain amount of leeway. If your subscription expires in, say, 9 months, you can send in a renewal for up to two years, putting your expiration date a little over 2 years away. However, you cannot send in a renewal for 3 or more years, and you also cannot send in another two year renewal six month later. Either of those would put the expiration date well past the two year point. Those who do will have their "excess" renewal money refunded.

Link-Coupled Antenna Tuners
Part 4: Series Circuits and Reactance

L. B. Cebik, W4RNL *1434 High Mesa Dr., Knoxville, TN 37938* *email: cebik@utk.edu*

Every ATU circuit – network or link-coupled – has limitations. No circuit can match every possible load to the typical 50-Ω transmitter line. Two of the limitations are reactance in the load and very low values of load resistance. In this episode, we shall look at both of these problems and typical routes of solution. There is a third limitation associated with trying to design a tuner to cover all of the amateur bands. We shall deal with that one in the next installment, when we pass along some notes on components, construction, and measurement.

The Effects of Reactance

So far, we have dealt exclusively with resistive loads. Our purpose has been to keep the calculations – however approximate they may be – within reason. But inevitably, one has to admit that typical loads have both resistive and reactive components.

Arithmetically, we have two ways of handling reactance as part of the load. For some purposes, it is better to treat the two components together as a complex number typically shown as $R \pm jX$, where both R and X are given in Ohms. In other applications, we can separate the two. When it comes to ATUs, reactance can usually be treated separately at the load end of the design.

Figure 1 shows once more our basic link-coupled tuner circuit. We have opted initially to use a simplified tapped inductor scheme for matching lower resistive loads to the full tuned circuit. As a first step, let's consider once more a 1500 Ohm resistive load connected in parallel with the resonant parallel L-C circuit. At 7 MHz, with a secondary inductor of 12 µH (with a reactance of 528 Ohms at that frequency) and a primary inductor of 1.2 µH (53 Ohms reactance), the resonant capacitance in the secondary was 43 pF. We chose our 1500 Ohm resistive load (R_L) to go with an assumed k of 0.6 for a mutual reactance (X_M) of 100 Ohms. The secondary loaded Q was 2.8 or so to obtain about 54 Ohms for R_A.

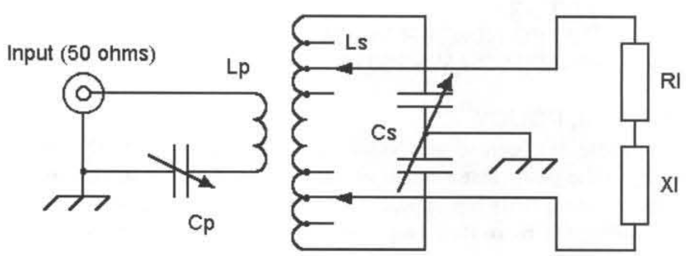


Fig. 1 Tapped-inductor coupler with the load R +/- jX.

However, Figure 1 shows a complex load impedance with the series values $R_L \pm jX_L$. Normally, complex antenna feedpoint impedances and impedances to be found along the length of a given feedline are specified in series terms. In order to evaluate the situation, we need to convert the complex load into parallel equivalents, using the standard conversion equations:

$$R_P = \frac{R_S^2 + X_S^2}{R_S} \quad (1)$$

and

$$X_P = \frac{R_S^2 + X_S^2}{X_S} \quad (2)$$

where R_P and X_P are the parallel equivalents to the series values R_S and X_S, shown as R_L and X_L in Figure 1. Figure 2 shows the equivalent circuits, using for the moment only the secondary of the ATU circuit.

Note that X_P is in parallel with X_{LS} and X_{CS}, the reactances of the secondary coil and capacitor, respectively. If the equivalent parallel load reactance, X_P, is inductive, then the total inductive reactance is the parallel combination of X_{LS} and X_P. Likewise, if the equivalent parallel load reactance is capacitive, then the total capacitive reactance is the parallel combination of X_{CS} and X_P.

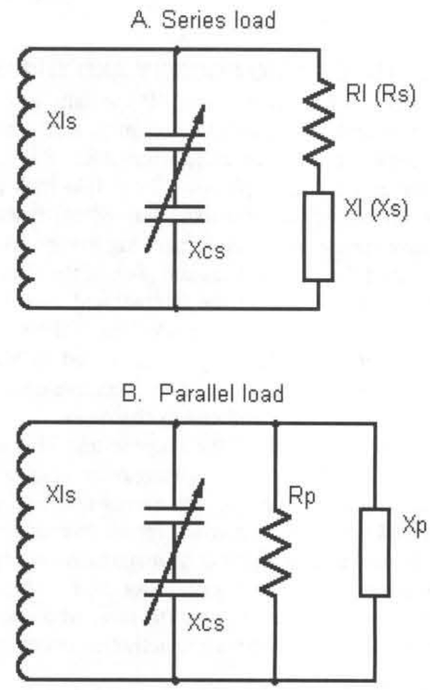


Fig. 2 Equivalent series and parallel loads.

Since calculators have a convenient inverse (1/X) key, it is normally much more convenient to convert parallel reactances to parallel susceptances, which simply add, in order to obtain the value of the parallel combination. In other words,

$$\frac{1}{X_T} = \frac{1}{X_P} + \frac{1}{X_{XS}} \quad (3)$$

where X_T is the total parallel reactance, X_P is the parallel equivalent of the series load reactance, and X_{XS} is either X_{LS} or X_{CS}, as is appropriate to the combination being evaluated.

Table 1. Total parallel inductive (X_{LT}) and capacitive (X_{CT}) reactances with load reactances.

R_L=R_S	X_L=L_S	R_P	X_P	X_{LT}	X_{CT}
1500	-500	1667	-5000	528	-477
1500	-200	1527	-11450	528	-505
1500	200	1527	11450	505	-528
1500	500	1667	5000	477	-528

All values are in Ohms.

Table 1 illustrates what happens to the parallel combinations for our standard 1500-Ohm resistive load when there are various series reactive loads, X_L, of moderate proportions.

With modest ($X_L < 1/3\ R_L$) reactive components to the load, the parallel equivalent resistive load across the tuned circuit does not change very much. The values of reactance that now compose the tuned circuit are sufficiently different to require adjustment of the variable capacitor to restore resonance. Where the reactive load is capacitive, the capacitor must show less capacitance and more capacitive reactance to make up for the loss occasioned by the parallel equivalent capacitive load reactance.

Where the reactive load is inductive, the capacitor must show more capacitance and less reactance to resonate with the reduced inductive reactance occasioned by the parallel equivalent inductive load reactance. However, these values are not the optimum to effect a transformation to 50 Ohms in the primary. Hence, other adjustments of the tuner components may be needed to effect a good match, including moving to a different tap of the coil.

When the load is transformed from a lower value to a higher value needed by the secondary tuned circuit to effect a transformation to a desired primary impedance, not only is the resistive component increased in value, but so too is the reactive component. For most cases, the chief effect of this transformation is to reduce the effects of the secondary variable capacitor in compensating for the changes in total parallel reactance. This effect is especially pronounced with inductively reactive loads which, when treated in parallel equivalent form, move the inductive reactance of the tuned circuit components well off their optimum values. The capacitor setting required may result in a considerable offset, resulting in a resonant frequency (in terms of $X_{LS} = X_{CS}$) significantly removed from the operating frequency. The result will often be higher circulating currents within the tuned secondary circuit and lower efficiency of power transfer to the load. However, these losses are ordinarily very small if a high Q coil is used and the loaded Q of the circuit is held low.

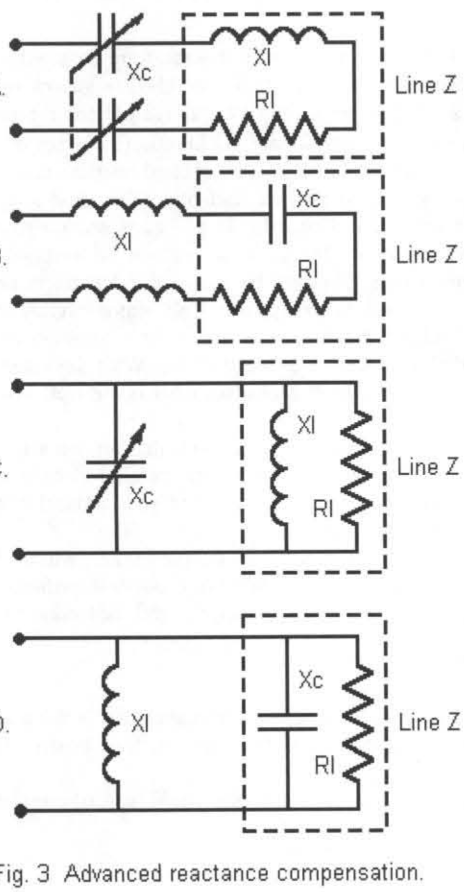


Fig. 3 Advanced reactance compensation.

The conditions of maximum efficiency cannot always be achieved, especially if the ratio of reactance to resistance in the load becomes great. Moreover, the higher the Q of the secondary circuit, the smaller the frequency range over which a single set of adjustments are usable. These conditions hold true whether one is using a tapped inductor or a capacitor divider as the means of effecting a match with a wide range of load values.

Advanced Compensation for Reactance

As we earlier noted, we can separate the resistive and reactive components of the load impedance presented to the ATU terminals. In doing so, we can think about compensating for the reactance before it becomes part of the secondary tuned circuit values. Figure 3 shows several ways of handling the situation.

In 3A and 3B, we treat the reactance at the terminals in its series form. If the reactance is inductive, we insert a mechanically linked pair of capacitors – one in each side of the line – to provide an equal but opposite value of capacitive reactance. If the reactance at the terminals is capacitive, we insert a pair of series inductors in the line to provide equal but opposite reactance. The net reactance is zero, and the tuner sees a resistive load.

Series compensation is normally mechanically difficult, especially with the use of variable components. First, each side of the line must be broken to insert the proper compensating component. Dual components are necessary to preserve line balance. Second, mechanically linked components are bulky – inductors even more so than capacitors. Series compensation is rarely used.

In 3C and 3D, we treat the reactance in its parallel equivalent form. This conversion permits us to place either a coil or a capacitor across the line to provide an equal but opposite reactance value to cancel the parallel equivalent reactance presented by the load. Very usually, single ended components are employed in this function. Because of slight imbalances in the structure of such components, the line balance may be slightly disturbed, but ordinarily not enough to hinder circuit or transmission line operation. The switching or tapping methods should remove both sides of the compensating component when it is not in use.

The use of advance reactance compensation is necessarily reserved for very high load reactances that challenge the ability of the variable capacitor in the secondary circuit to effect a match or which unduly raise the Q of line or the coupler circuit. Series reactances in this range normally convert to parallel equivalent low to moderate reactance values that are within the range of reactance compensation by good quality everyday components. When series reactances are themselves low to moderate, most coupler designs can easily accommodate them. In addition, their parallel equivalent values may be beyond the range of compensating components.

For example, in Table 1, a series reactance of 200 Ohms is easily handled by the coupler design used in our running example. However, compensation by parallel components is another matter. If the load reactance is capacitive, it would require a compensating inductance of 260 µH, and if the load reactance is inductive, it would require a compensating capacitor of 2 pF at the 7 MHz operating frequency. Needless to say, neither of these are practical values to find in variable components.

Feedline Length

An alternative means of reducing the reactance at the terminals of any coupler is to change the length of feedline from the antenna to the coupler output terminals.

Every feedline is also an impedance transformer all along every 180-degrees of its length. If the antenna feedpoint impedance exactly matches the characteristic impedance (Z_O) of the feedline, then the impedance along the line is constant at the value of line Z_O. If the antenna feedpoint impedance differs from the Z_O of the line, then the value of impedance, in terms of $R \pm jX$, varies all along each 180-degree length of line. This is true, whether the antenna feedpoint impedance is purely resistive or a combination of resistance and reactance.

With a complex feedpoint impedance that does not match the Z_O of the feedline, there may be some line lengths that present easy combinations of $R \pm jX$ for a given coupler design to handle and other lengths that present values that may exceed the coupler design limits. Hence, selecting something close to an optimum line length may enhance the ability of the tuner to compensate for the reactance and maximize power transfer to the feedline.

Let's use a challenging antenna case to see how this works. A certain antenna presents a feedpoint impedance at 7 MHz of 1828 + j1826 Ohms. Assuming that we are using 450-Ohm parallel feedline with a velocity factor of 0.95, we can obtain the following table (Table 2) of impedance values along a 180-degree length of line. (Similar tables at five-degree intervals can be obtained using a program included with the VE3ERP HAMCALC [1] collection. The values assume lossless line, but for planning use with antenna tuners, the accuracy will be more than adequate.)

Table 2. Resistance and reactance along a 450-Ohm feedline for a typical antenna.

Line Length		Impedance	
Degrees	**Feet**	**Resistance**	**Reactance**
0	0.0	1828	1826
10	3.7	3173	-1291
20	7.4	857	-1513
30	11.1	334	-970
40	14.8	179	-662
50	18.5	116	-469
60	22.3	85	-333
70	26.0	69	-226
80	29.7	60	-136
90	33.4	55	-55
100	37.1	55	22
110	40.8	57	101
120	44.5	64	187
130	48.2	77	285
140	51.9	100	407
150	55.6	146	571
160	59.3	249	820
170	63.0	545	1245
180	66.7	1828	1826

If the line length must be more than 1/2 wavelength, just add increments of 66.7' to the lengths listed to get just about the same values. But now that we have the table, what do we look for?

We are seeking a length of line where the reactance values are low. Achieving a zero level of reactance is unnecessary, but values under 200 Ohms would be well within the range of virtually any coupler. Notice that the reactance passes through zero in two places. However, reactance curves are not orderly sine waves. Between 0 and 10 degrees, the reactance rapidly changes from a high inductive value to a high capacitive value. Since this makes finding the right length difficult, we shall avoid this transition. Between 90 and 100 degrees, the reactance passes slowly through 0 degrees. Hence, the exact line length becomes far less critical. At 7 MHz, the ideal length is close to 36 feet long, but plus or minus seven to ten feet either way would not challenge the coupler.

Since almost any multi-band antenna can be modeled with reliable ballpark accuracy on all intended bands of use, it is possible to develop a full set of feedline charts plotting the excursions of resistance and reactance. Simply plug the modeled feedpoint impedance for each band into the impedance transformation program and print out a chart. By examining the reactance progressions for each band, it may be possible to find a minimal number of line lengths that will permit an easy match for the coupler.

Under very fortunate circumstances, you may find a single line length that will physically work with the antenna in question and also provide reasonable reactance levels for the tuner. If two or more lengths are requires, then switching or manually adding in the required line lengths for the band or bands that need them becomes the next order of business. Of course, all of the rules for treating parallel line carefully apply to this system. Hence, the actual switching system becomes a challenge for the creativity of the individual station operator. Line switching is often very much cheaper and less complex than installing and switching pre-coupler compensating inductors and capacitors.

Low Impedances and Series Connections

Because parallel-tuned secondary capacitor-divider load input ATUs are capable of matching loads from less than 50 Ohms up to several thousands of Ohms, we have focused primarily on parallel connection of the load to the secondary of the coupler. However, there are antennas which present loads in the 5 to 100 Ohm range which can often benefit from a series secondary in the coupler. Figure 4 shows a typical arrangement.

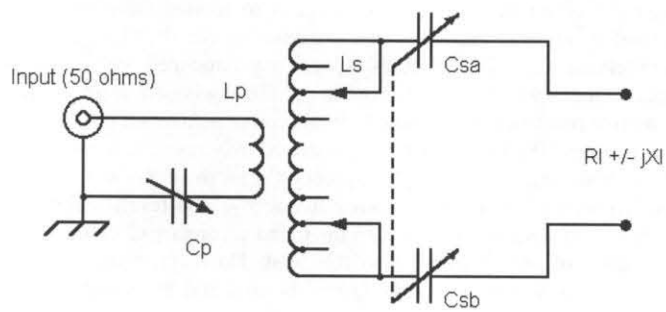


Fig. 4 Series-secondary inductive coupler.

Typical inductor and capacitor values are so similar to those for parallel tuners that we can retain our chosen values in the running example: 12 µH for the secondary and 1.2 µH for the primary. Their respective reactances are 528 and 53 Ohms. The series reactance of the capacitor will likewise be 528 Ohms at ideal resonance, and hence, each section must be able to provide half this value, just as in the parallel tuner. For a total capacitance of 43 pF, each section must be able to reach 86 pF. However, the capacitor cannot be a simple split stator-common rotor model, but must be a pair of independent units mechanically driven as a unit. Some apparent split stator models are actually of this design and use a jumper for achieving a common rotor, which is then grounded for balance across the line. With the series connection, the capacitor sections must each float (that is, be well insulated from a common ground).

From one perspective, the equations that drive a series circuit look quite different from those that drive the parallel circuits we have been examining. Yet, as an exercise in "what goes around comes around," let's look at these equations.

For a series tuned inductively coupled tuner, where the secondary is presumed to be resonant, the input or primary impedance is a function of the reactance of the mutual inductance and the load resistance:

$$R_A = \frac{X_M^{\,2}}{R_L} \qquad 4$$

where R_A is the coupled primary impedance, X_M is the reactance of the mutual inductance, and R_L is the value of the resistive load, with all values in Ohms.

Once more, X_M is related to the coefficient of coupling (k) in this way:

$$X_M = k^2 \sqrt{X_{LP} X_{LS}} \qquad 5$$

[1] This is a collection of ham radio related programs written in BASIC for IBM-PC™ compatible computers. The programs can be downloaded form a variety of FTP sites (for example, ftp.lehigh.edu /pub/listserv/qrp-1/tools/hcal-30.zip) or obtained directly from VE3ERP.

where X_{LP} is the reactance of the primary inductor and X_{LS} is the reactance of the secondary inductor, both in Ohms. This equivalence allows us to replace the term X_M^2 in equation (4) with its counterpart:

$$R_A = \frac{k^2 X_{LP} X_{LS}}{R_L} \qquad 6$$

where all terms have the same meanings as previously noted.

Unlike a parallel tuned circuit, the loaded or working Q of a series-tuned circuit is

$$Q = \frac{X_{LS}}{R_L} \qquad 7$$

If we replace the terms X_{LS} and R_L with Q, we obtain

$$R_A = k^2 X_{LP} Q \qquad 8$$

which is the same equation we used for analyzing parallel-tuned circuits in the last two episodes.

Series-tuned couplers are normally used with low coefficients of coupling to effect matches of low impedances to the coupler input impedance. If we let the desired value of R_A be the same as the value of the primary inductor reactance (about 50 Ohms),

$$k = \frac{1}{\sqrt{Q}} = \sqrt{\frac{R_L}{X_{LS}}} \qquad 9$$

where all values are as previously defined.

Using equation (9) with our running example circuit values, we can develop a small table (Table 3) of reasonable values of k to effect a 50-Ohm match with various load resistances.

Table 3. Values of k for a 50-Ohm match with various loads when X_{LS} = 528 Ohms.

Load Resistance (R_L)	Loaded Q (X_{LS}/R_L)	Required k for 50-Ohm match
100	5.3	0.44
50	10.6	0.31
25	21.1	0.22
10	52.8	0.14

The table clearly shows the progression of values, but also shows a rapidly increasing Q as the load resistance to be matched goes down. High Q has the same effect with series-tuned circuits as with parallel-tuned circuits: the required settings become very narrow and must be changed with small excursions of the operating frequency.

Additionally, the presence of reactance in the load has the effect of requiring the tuning capacitor to be reset to restore resonance. Where the load reactance is capacitive, the overall component reactance at resonance can be maintained, because shifting the capacitor to a higher capacitance setting reduces its reactance to compensated for the line reactance: the net capacitive reactance is the same as the inductor's reactance at resonance. However, if the load reactance is inductive, it adds to the reactance of the secondary coil. This situation requires a change in the capacitor setting to a smaller value to match the combined inductive reactance to restore resonance. The effective reactance at resonance is higher, thus increasing the circuit Q and increasing the inconveniences (and possible problems) associated with high Q.

The most convenient way in most typical amateur circumstances to rid the load of its high reactance with a series tuned coupler is to alter the line length. However, in doing so, we can usually find a line length with a higher load resistance as well as a lower load reactance. Since parallel tuned coupler designs are available for loads of 50 Ohms or even slightly less, the end result has been a gradual decline in the use of series-tuned coupler circuits.

In the end, the parallel-tuned link coupler, with either a tapped secondary or a capacitor-divider for handling a wide range of load impedances, is the circuit of choice for inductive couplers. The tapped secondary version, while useful for manual operation in multi-band units, is often used with single-band couplers, say, for 160 meters. Once the right settings are found, no further manual changes in taps are normally needed during operation. Such tuners are also cheaper to build, since soldering taps to coil turns is normally less expensive and easier to accomplish than finding a suitable differential capacitor for the alternative load network.

For multi-band couplers, the capacitor divider provides continuous front panel adjustment for changes of load impedance. With a multi-section ceramic wafer switch to set the inductor size for each band, along with the tuned circuit variable capacitor and the optional series input capacitor, this design can be reset from band to band quickly as one changes operating frequencies.

We have now looked into the basic theory and fundamental circuitry of inductively coupled ATUs. The remaining questions we need to examine concern component values and ratings, construction practices, and measurements to assure best results. Perhaps we can do all this in just one more session.

Edited by W1HUE

IDEA EXCHANGE

Technical tidbits for the QRPer

Mike Czuhajewski WA8MCQ 7945 Citadel Drive, Severn, MD 21144 wa8mcq@erols.com [new!]

NEW E-MAIL FOR WA8MCQ

Please note the new e-mail address above. My old address of wa8mcq@abs.net will have been closed by the time you read this.

RF SENSING POWER SWITCH--Joe's Quickie #28

***Joe Everhart**, N2CX of Brooklawn, NJ originally submitted Part 1 of his Rainbow Power Meter article as one of his Quickies, but I decided it was far too long and should be handled as a feature article. This put him into panic mode briefly since he didn't want to break the long string of Quickies in the Idea Exchange, so he whipped this one out to take its place.*

In coming up with neat features for the Rainbow Bridge and Tuner, I decided that a handy addition would be to make it turn on only when an RF signal was applied. This eliminated the need for a power switch. Folks who have not built the Rainbow Tuner but liked the RF sensing power switch have inquired about its operation to use it as part of their own projects, so it might as well be the subject of a Quickie!

There have been a variety of RF sensing circuits over the years ranging from some very simple ones to a couple of real kludges. They generally use a signal diode to convert RF to a DC signal, which then operates a transistor or integrated circuit switch. The simplest use a bipolar transistor, which gives a soft turn-on characteristic. An intermediate performance switch might use a CMOS logic gate to give a sharp threshold with added complexity. At the other end of the complexity spectrum are switches using IC comparators or op-amps.

Since the bridge used in the Rainbow was a simple resistive type its accuracy is limited at low RF levels, so it was desirable that the switch not turn at very low power levels. In that design the detected RF signal is picked off inside the bridge so the DC level is about half the peak voltage of the RF input. I won't bore you with math, but the DC level is about 1.5 volts for a 100-mw RF input. The RF at this power level is also where the bridge starts to become reasonably accurate. And it just happens that an inexpensive MOSFET, the VN10KM turns on at about this voltage. (Actually I hunted around for an FET that would switch on reliably at this low DC level.) The FET in turn is used to apply base drive to a PNP transistor that provides the final switched DC power.

Figure 1 is the schematic diagram for just such a switch. RF input is applied to detector diode D1 which rectifies the sine wave into a dc output. Note that the full peak voltage is available here so the lowest turn-on power is about 50 mw. Capacitor C1 charges to the peak value of the RF input. The resulting DC is applied to the base of FET Q1 through a voltage divider. Actually the whole divider is not always needed but using it lets you add flexibility that will be discussed later.

When Q1's gate voltage is high enough (about 1.5 volts) it starts to conduct supply current through its drain (tube guys think "plate"!). This current in turn causes PNP transistor Q2 to begin conducting. Since its emitter is connected to the positive supply voltage, it switches the DC supply to whatever is connected to its collector. Resistor R3 limits the current that Q1 pulls through Q2 to prevent it from burning up! R4 is not at all critical so long as it is larger than R3. It keeps Q2's internal leakage from turning it on. C2 prevents stray RF from affecting Q1 and Q2.

When Q1 and Q2 turn on fully (at perhaps 2 volts on Q1's gate), Q2 becomes saturated, almost a short circuit between its emitter and collector. With the component values shown, it can supply about 1 to 15 mA, depending on the Q2's current gain.

The beauty of the circuit is that it draws no DC current until switched on and it loads the RF input down very little due to the high input impedance of FET Q1.

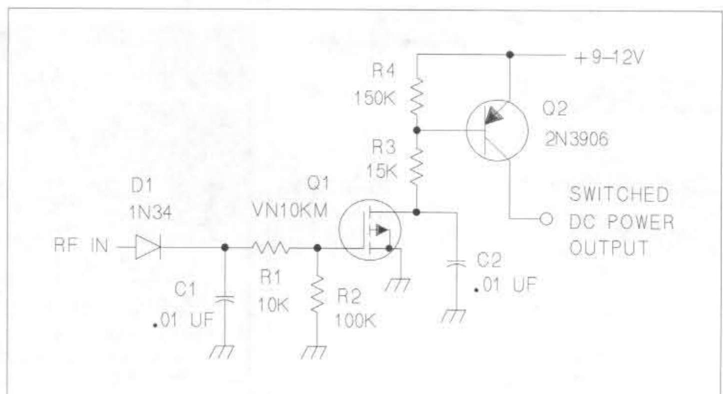


Figure 1—RF sensing power switch

Modifications

The basic circuit is fertile ground for tailoring to other uses. Most involve using different components or tweaking the values of those shown. The original circuit uses 1N34 Germanium diodes since their inherent low forward drop gives good operation at low RF levels and they are readily available from your local Radio Shack. A more modern choice would be to use hot carrier (Schottky) diodes which are physically stronger, though more less available and more expensive.

Resistors R1 and R2 discharge capacitor C1 when the RF input is removed. Otherwise , the FET would remain on until capacitor leakage drained away the charge. Larger values for those resistors and C1 will give more "hang" time for the circuit when RF goes away. If you use a good mylar (polyester) capacitor, R2 can probably be increased to several megohms with no ill effects. And the ratio of R1 to R2 makes a voltage divider to minimize the DC applied to Q1's gate. By making R1 larger, you can increase the RF level it takes to turn on the switch. You may also want to increase if you use more than 5 watts of RF so that you don't exceed Q1's gate to source breakdown voltage.

As discussed above, Q1 is a VN10KM device. It was selected due to its low turn-on voltage. It is carried by many hobbyist parts vendors (I got mine from Dan's Small Parts). More common low-turn-on FETs are the 2N7000 and the VN2222. However their "on" voltage may be 2 volts or more, limiting the circuit's usefulness for low RF power (below 100 mw or so).

In the interest of economy a PNP bipolar transistor was used for Q2. In fact it might prove interesting to use a P-channel enhancement mode FET in its place. If you use a device rated for high current, it can supply its rated current rather than the 10 mA of the current design. And C2, R3 and R4 could then be raised substantially to give a much longer power turn-off delay after the RF input is removed. However if you try this modification, C2 should be placed across R4; otherwise, Q2 will turn on every time the DC supply is connected as C2 charges.

While the switch was originally intended to be used with a CW signal to turn on an SWR bridge at HF, it is useful for a whole bunch of other things. Obviously anything that turns on when you transmit is fair game such as an "ON THE AIR" indicator sign, a CW keying monitor or a DC supply to a meter monitoring RF power. It is not restricted to HF since the simple diode detector will work well up into the UHF region. And it is not limited to use with CW, either. Using an extended hang time will make sure that it works with SSB as well. As the old headache remedy used to say "try it – you'll like it!"

—DE N2CX

"SHOE GOO" FOR HOLDING TOROIDS

T.J. "Skip" Arey, N2EI *(tjarey@home.com) had this tip on QRP-L recently*--I have had great success using the sneaker repair product "Shoe Goo" to set toroids. Somebody asked if I checked this goo out for RF transparency. After much explaining to the XYL, I placed a large clump of it on a paper towel (after letting it dry) and put it in the microwave for about 5 minutes. It did not exhibit any heating so I guess it fits the bill for most applications.

I use this substance because it comes out of the tube flexible but thick when compared to other products. It pretty much stays put and has a slow enough drying cycle that it allows for adjustments. It also serves as an excellent "shock mount" for most toroid applications as these can be a weak link in a design because of the thin wire that is often used in the application. *[The same company makes a number of similar "goo" products that can also be useful in the workshop. —WA8MCQ]*

—DE N2EI

BATTERIES FOR HEWLETT PACKARD AC VOLTMETER

I talked about the Hewlett Packard 403B AC voltmeter in the last issue. ***Larry East, W1HUE****, sent me some e-mail about it, and I shot off my mouth and told him how cheap I could find them here. He called my bluff and asked me to find one for him at that price, and I finally did. Unfortunately, the batteries were bad but he agreed to accept it anyhow. Here's what he had to say about it, originally posted to QRP-L—*

This is indeed a handy little meter - not just for making receiver noise measurements [as mentioned in October —WA8MCQ], but for lots of other applications as well. It has a relatively flat frequency response from less than 5Hz to at least 1MHz, and full-scale ranges from 1mV to 300V. However, there is one important point that should be kept in mind when considering purchasing one of these meters at a flea-market: The 403B uses four 6V NiCd battery packs for power, and these can be expensive to replace.

Yes, it does have an AC power supply, but it is just a constant-current charger for the batteries; all AC filtering and voltage regulation is done by the batteries. No batteries, no operation. The four battery packs each contain five "button cells" approximately 1-in. in diameter by 11/32-in. thick. Such packs are available from several suppliers, but tend to be a bit pricey; I recently purchased some for $11 each and that was the best price I could find (I was quoted $18 ea. from another supplier).

However, individual NiCd button cells of the proper size are on sale for $0.64 each in the most recent TechAmerica flyer (Cat. No. 960-0080). The cells have solder tabs, so with a little effort and some 1-in. shrink tubing, you can make you own replacement packs - for a lot less than $11 each! (If I'd only known...) *[And even the regular price is just over a dollar each. —WA8MCQ]*

—DE W1HUE

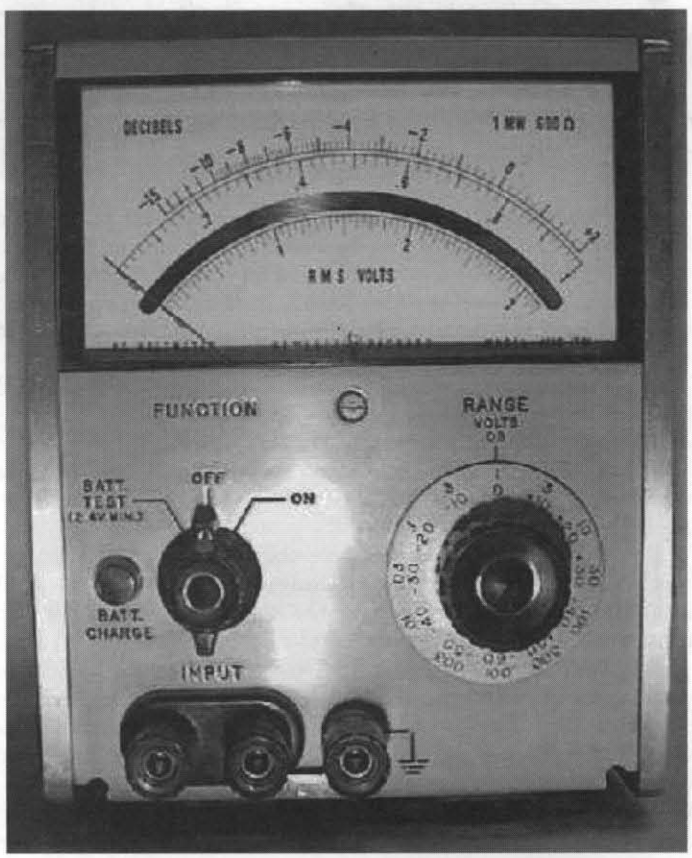
UPDATE ON SAMLEX POWER SUPPLY FIX

Larry East, W1HUE*, (w1hue@amsat.org), has more to say on his recent modification to this unit*—Since my simple fix for the voltage over-shoot problem in the SAMLEX PSA-305 power supply was published in the October '98 QRP Quarterly, I've made two additional mods: one to further eliminate the "over voltage" condition when power is turned off and another to reduce the over-current protection circuit's sensitivity (the thing will trip when you apply a capacitive load!). The mods can be downloaded from the QRP-L WEB site at

http://qrp.cc.nd.edu/qrp-l/hints/w1hue/samlex_mods.html

or I can supply a printed copy in return for an SASE.

—DE W1HUE



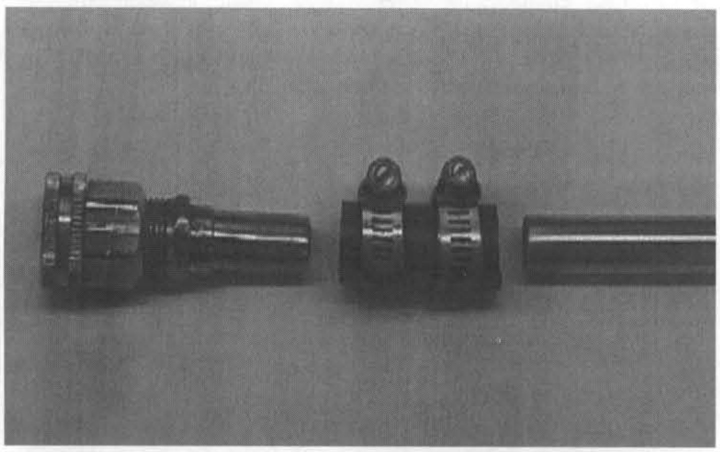
HP403B AC voltmeter (W1HUE picture)

EASY GROUND ROD INSTALLATION

From our Features Editor, ***Larry East, W1HUE*** *(w1hue@amsat.org)*—Do you dread driving ground rods because the dirt in your backyard is close to the consistency of concrete? (Probably not if you live in wetter regions of the country…) Well, here's a trick that I ran across years ago (perhaps in the "Hints-N-Kinks" column in **QST**) that makes the job considerably easier: Use a "water drill"!

This consists of a length of pipe through which water is forced—just point the open end of the pipe at the ground, apply a moderate amount of pressure and it practically pulls itself down into the ground! (Well, you do have to work the pipe up and down a bit and start over if you hit a rock!) An eight to ten foot length of 1/2-in. copper water pipe makes an excellent ground rod and can easily be "driven" into the ground using this method.

You can run water through the pipe by simply cutting the end off an "expendable" piece of 5/8 in. ID garden hose and attaching it to the pipe with one or two hose clamps, or you can do as I did and make a fitting that can be used over and over (see photo below). My fitting consists of a female hose to female pipe thread adapter, a male pipe to 1/2 in. pipe solder fitting, a short length of 1/2 in. copper pipe, a short length of 5/8 in. ID heater (or garden) hose and two hose clamps. All of the pieces can be obtained from any well-stocked hardware store. I made the fitting shown in the photo at least 15 years ago and have used it to install numerous ground pipes.



After the pipe is in place, I insert a short length of 1/2 in. wood dowel into the upper end to keep ground clamps from crushing it and epoxy a copper pipe-cap over the end (you may have to crimp the pipe slightly to hold the dowel in place). Keep in mind that when a ground rod is used for lighting protection, ground wires should be securely clamped (or braised) to the pipe, *not* soldered.

—DE W1HUE

MORE ON ARRL SPECTRAL PURITY TESTING

QRPer ***Ed Hare, W1RFI*** *of the ARRL lab sent me some comments for publication on the subject after reading the October issue. He also posted them to QRP-L:*

I read with interest the piece about spectral-purity measurements in the October, 1998 "Idea Exchange." Let me offer some additional information about the way the ARRL Lab tests and reports on items in the QST "Product Review" column.

Most "Product Reviews" do not contain published graphs of overall spurious emissions. The ARRL Lab does, however, perform extensive testing of radios for Product Review, including a measurement of spurious emissions on all bands. Several years ago, we used to routinely publish such spurious-emissions test result plots, but determined that, in most cases, these data were pretty "boring," showing very little more than what could be described numerically in the test-result table. An example of a recent spurious-emissions graph is show in Figure 2. [Ten-Tec 1340 40M CW transceiver, 4 watts.]

In virtually every case, commercially manufactured transmitters, including QRP transmitters, meet FCC spurious-emissions limits. These are generally adequate to protect against harmful interference, so the absolute value of spurious emissions is generally not a major consideration. For example, for an HF transmitter running more than 5 W output, the FCC regulations require that spurious emissions be attenuated at least 40 dB. For a 100-watt transmitter, no spurious signal can be greater than 10 milliwatts. For a 5 W HF transmitter, spurious emissions must be attenuated 30 dB, to 5 milliwatts or less. Although I have worked 30 states with 10 milliwatts, it is very unlikely that such a signal would cause harmful interference to other users on HF. It is, in my opinion, also unlikely that many people would base their purchase decisions on whether a transmitter had 5 milliwatts vs 0.5 milliwatts of spurious emissions. Generally, knowing that the unit is FCC legal is generally enough; in other cases, the "worst-case" result in the Product Review test-result table gives sufficient information.

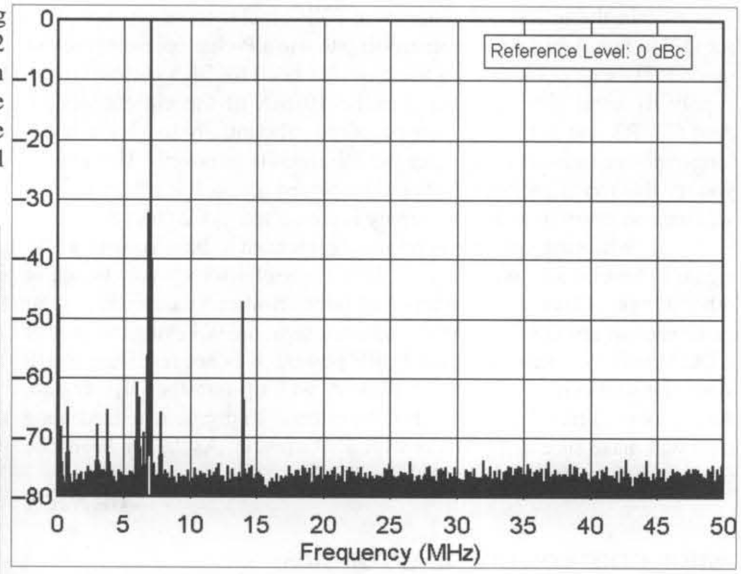


Figure 2—Spectral plot of TenTec 1340 40M CW transceiver as seen in ARRL lab (4 watts output)

Not publishing spurious-emissions results allowed us to devote more page space to what most hams DO want -- more discussion about the features of the unit being reviewed. We do make exceptions; the August issue of QST included a "full" spurious-emissions plot of the FT-847 because there were a lot of mixing-product spurs at or near -40 dBc. We felt that this plot conveyed important information that would not be well summarized in either the entry in the test-result table or in an explanation in the article text. This is shown in Figure 3.

We do publish the worst-case plots on transmit-composite-noise and transmit IMD tests. These are performance criteria that are often important to a purchase decision, and subtle differences in the results can have a big difference on a unit's performance. This is best presented as a graph because the results are generally complex enough that they cannot be easily numerically summarized. For example, the caption for transmit IMD results summarizes the 3rd- and 5th-order products, but the graphical information about the higher-order products tells you whether the transmitter will splatter up and down the band.

Perhaps some of the confusion comes from the fact that we (correctly in my opinion) call the transmit IMD and composite-noise plots "spectral displays." The captions define the type of test performed and the frequency range over which the measurement was taken. (I have, and will, consider any ways we could change the captions to help reduce any misinterpretation of the results, however.)

Of course, my colleagues in the QRP community are certainly not typical hams (and darn proud of it!), so they are generally more interested in technical test results than "average" hams. The ARRL Lab tests spurious emissions and transmit IMD on all bands, and composite

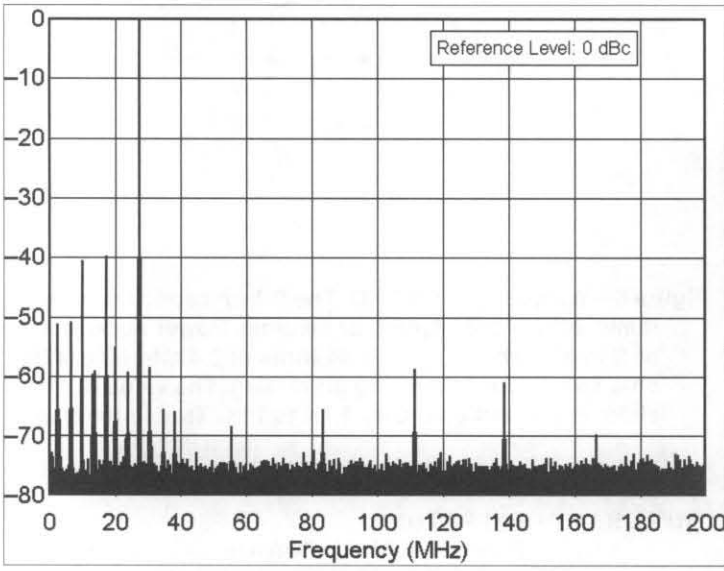


Figure 3—Spurious emissions of FT-847 as seen in ARRL

noise on 80 M and 20 M for multiband rigs. Although we can't devote the printed page space to publish all of these results, we have offered an "Expanded Test Result Report" for many of the big-ticket radios we have tested (and will continue to do so). These have been available in print from the ARRL Technical Department Secretary ($7.50 for ARRL Members).

But don't spend your money yet! The ARRL members-only Web page ***(http://www.arrl.org/members-only/)*** features a reprint of all ARRL "Product Reviews" since January, 1990. (We are working on earlier years.) The "Expanded Reports" are also available for download.

Now for the surprise! In response to what I read in the "Idea Exchange," although we cannot prepare a complete report for all of the radios we test, we are going to publish the full set of spurious emissions, transmit IMD and composite-noise testing as expanded test reports on the Web version of the Product Reviews. These will appear in future reviews and, as we can, we will add them to some of the past reviews, as well (we will take requests!). We have just published the additional graphs for the Ten Tec Model 1340 from the September, 1998 QST and for the SGC SG-2020 from the October, 1998 QST. Go to URL ***http://www.arrl.org/members-only/prodrev/*** to download the Product Review articles and expanded-report graphs!

We have added one more bonus -- the ARRL Laboratory has published the "ARRL Laboratory Test Procedures Manual," describing the specific methods we use to perform transmitter and receiver tests in the ARRL Lab! Although it is specific to our test equipment, I think that many will find it interesting. It, too, is published on the ARRL members Web page at http://www.arrl.org/members-only/prodrev/testproc.pdf

I trust that our offering these test results and documentation of our test procedures through our Web page will be of value to our members and will help everyone understand more about ARRL's Product Review procedures.

Note: To check into the ARRL members-only web site, go to http://www.arrl.org/members-only/ Have your ARRL membership ID #, from your QST mailing label, available the first time you check in. You can then assign yourself a password for future use. And, let us know what you think of the site!

72 from ARRL HQ, Ed Hare, W1RFI, ARRL Laboratory Supervisor, w1rfi@arrl.org.

MODIFY SWR METER TO READ RF POWER

A very long time ago there was a popular SWR meter called the Monimatch. You still see this type of meter at hamfests on rare occasions (both homebrew and a Heathkit version) but the design fell out of favor years ago. One reason is that it is very frequency sensitive, requiring more and more power to get a full scale reading as you go down in frequency. The reason for that is the sensor. A piece of coaxial cable with the shield removed was run between the input and output connectors, and it had two wires or metal strips attached to it for coupling. Figure 4 illustrates the basic idea; two meters are shown, although it could also use a single meter with an SPDT switch.

In October I introduced a web site called Harry's Homebrew Homepage, operated by ***Harry Lythall, SM0VPO / G4VVJ,*** *a Brit who works for Ericsson Radio in Stockholm. The URL is:*

http://user.tninet.se/~acz732k/index.htm

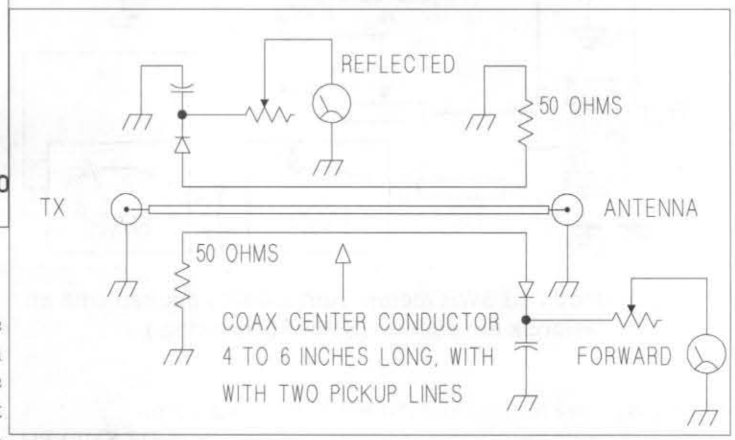


Figure 4—basic circuit of the Monimatch SWR meter (frequency sensitive due to the pickup used)

Harry shows a modification to one of these units which originally used two meters, one for forward and another for reverse. He retains the SWR feature by adding a switch to use one meter for both forward and reverse, and uses the second meter for a simple diode detector wattmeter.

One of the most difficult tasks of the QRPer is to measure transmitter output power with any form of accuracy. Low power meters can be rather expensive to say the least.

Figure 5 gives the circuit diagram of an SWR/POWER meter that can be built using an existing SWR/"POWER" meter. These instruments have two meters, one for relative power and the other for SWR indications. The problem with these meters is that the readings are very frequency conscious and there exists no point of calibration to set the in-built potentiometer. All this can be overcome.

Between the two meters on the front panel, drill a hole to mount a single-pole two-way miniature toggle switch and wire it in the circuit as shown, using the right-hand meter. This meter is usually calibrated in SWR. Now you can use the SWR bridge exactly as normal but using only one meter.

Add the extra components highlighted with an asterisk. Connect the diode to the existing left-hand (power) meter to give a true power indication. The values shown assume the meter is 100uA movement and the full scale reading required is 10 watts. Note that the scale follows a square law and although full scale deflection (FSD) is 10 watts, 10% FSD is equal to 100mW. This reading is accurate for almost any frequency from 1.5 MHz to 200 MHz. For 70cm (430 MHz) a correction capacitor can be placed across the upper RF voltage divider (R1); the value selected for the correct power at 432 MHz. My meter needed a 6.8pf correction capacitor.

If you change the additional resistor values you can have a 1 watt FSD scale which will give reasonably accurate indication down to less than 10mW. You could provide a switch (beside the SET/SWR switch) to switch between the two ranges.

Note that meaningful power readings can only be obtained when using a true resistive load (50 ohm dummy load, etc).

—DE SM0VPO

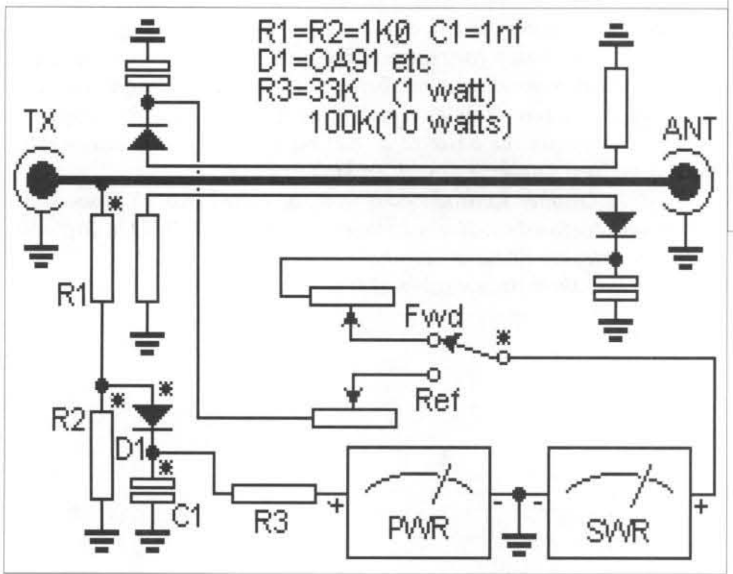


Figure 5—Modified SWR meter. Components marked with an asterisk are added. (SM0VPO drawing.)

WIDE RANGE CRYSTAL CONTROL ON 80M

SPRAT 95 from the GQRP Club, Summer 1998, had an interesting wide range VXO circuit. This was provided by ***Walter Farrar, G3ESP.*** *It uses a single transistor with two crystals attached, providing outputs at the sum and difference of the two frequencies. As usual, there is no free lunch—the unwanted products must be removed with a filter or tuned circuit somewhere beyond the oscillator but that's not difficult or complicated. The circuit uses a pair of crystals which result in an 80M signal that can be varied much more than the usual 80M VXO, but you can use any combination of crystals that will give you an output on any band you desire.*

The problem with trying to pull the frequency of an 80 meter crystal oscillator is that it can be moved only 2 or 3 kHz. At higher frequencies crystals can be moved much more, so why not take two high frequency crystals, one fixed and one variable, mix them and by subtraction get a low frequency generator with a large swing?

The circuit of Figure 6 shows it can be done quite simply. The crystals were on hand and gave a basic difference of 3582 kHz. As wired, I can tune from 3509 to 3587 kHz! The output was rock steady and drew 7.5 mA from a 9 volt supply battery. The transistor oscillates on two frequencies simultaneously, and the difference is taken from the emitter. This is only the bare bones of the system, which will need external filtering to remove the undesirable signals also present on the output.

Other crystals would give other outputs. For example, 8.8633 and 8.9985 should prove ideal for the new very low frequency band over here at 135 kilohertz.

—DE G3ESP

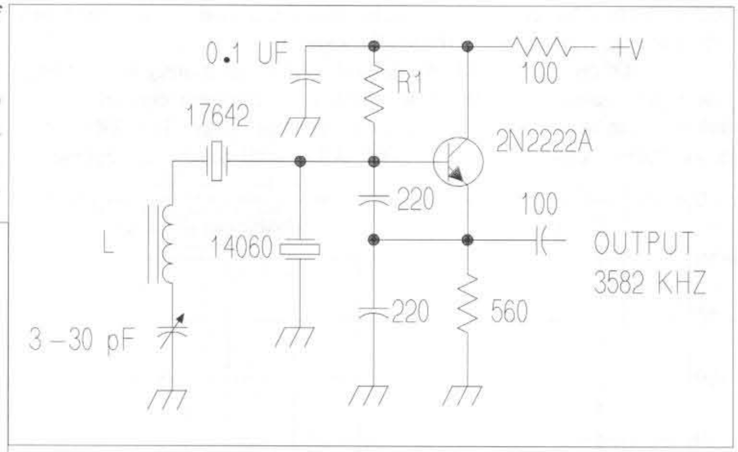


Figure 6—Wide range 80M VXO. The 0.1 uF capacitor is ceramic, others polystyrene or ceramic. Power supply can be 9 to 13.8 volts. Coil L is 44 turns of 0.4 mm wire (#26) on a T68-6 core (or try a 10 uH choke). The value of resistor R was not given; try 4.7K to 10K. Transistor type

SIMPLE RAMP GENERATOR

A regular feature in Electronic Design (a trade journal) is "40 Years Ago in Electronic Design" which gives a couple of highlights from the issue 40 years earlier. A recent issue showed a circuit from October 1958, submitted by ***J. Frank Brumbaugh****, who was Senior Marine Engineer at Heathkit. Currently known as* ***W4LJD*** *and living in retirement in Salinas, PR, Frank has been a contributor to the Idea Exchange for years, as well as having many articles published in the ham and electronics hobbyist press. His current submission is a simple but versatile ramp generator:*

Figure 7 shows a somewhat unusual but very simple positive-going ramp generator that is not only extremely linear and allows a ramp voltage excursion almost to the positive and negative rails, but also allows control of maximum ramp voltage excursion as well as the positive and negative extremes of the ramp. Actually, the ramp voltage is always above ground. Also, current drain is less than 15 mA at a voltage of 13.8 VDC so it won't overload your power supply.

Although the use of variable resistors in an op amp feedback circuit is unusual, in this circuit a judicious choice of resistors on the inverting input (R1 and R2) allows considerable manipulation not only of the extremes of ramp voltage between the rails, but also, in a limited way, the position of the average voltage around which the ramp varies above and below the average, and in some instances only above the average voltage which is essentially (but not necessarily) VCC/2.

Consider the following spot resistance values for R1 and R2 in the feedback loop, and their influence on not only the ramp voltage excursion but on the position of the ramp between the supply rails (VCC and ground).

As you can see, trimpots with or without limiting resistors allow sizing the ramp excursion and placing it almost as desired between the rails.

While this ramp generator would be most useful in the design of a sweep generator, it could find other uses on the service bench. Also, the op amp circuit, with the ease of controlling amplification, could be useful all by itself. Controlling amplification in the manner described does not affect the signal being amplified, essentially functioning as an invisible gain control.

Although probably any op amp could be used, modern JFET or BiFET op amps allow the ramp to very closely approach both rails where maximum sweep is desired,. Most are internally compensated and very low noise.

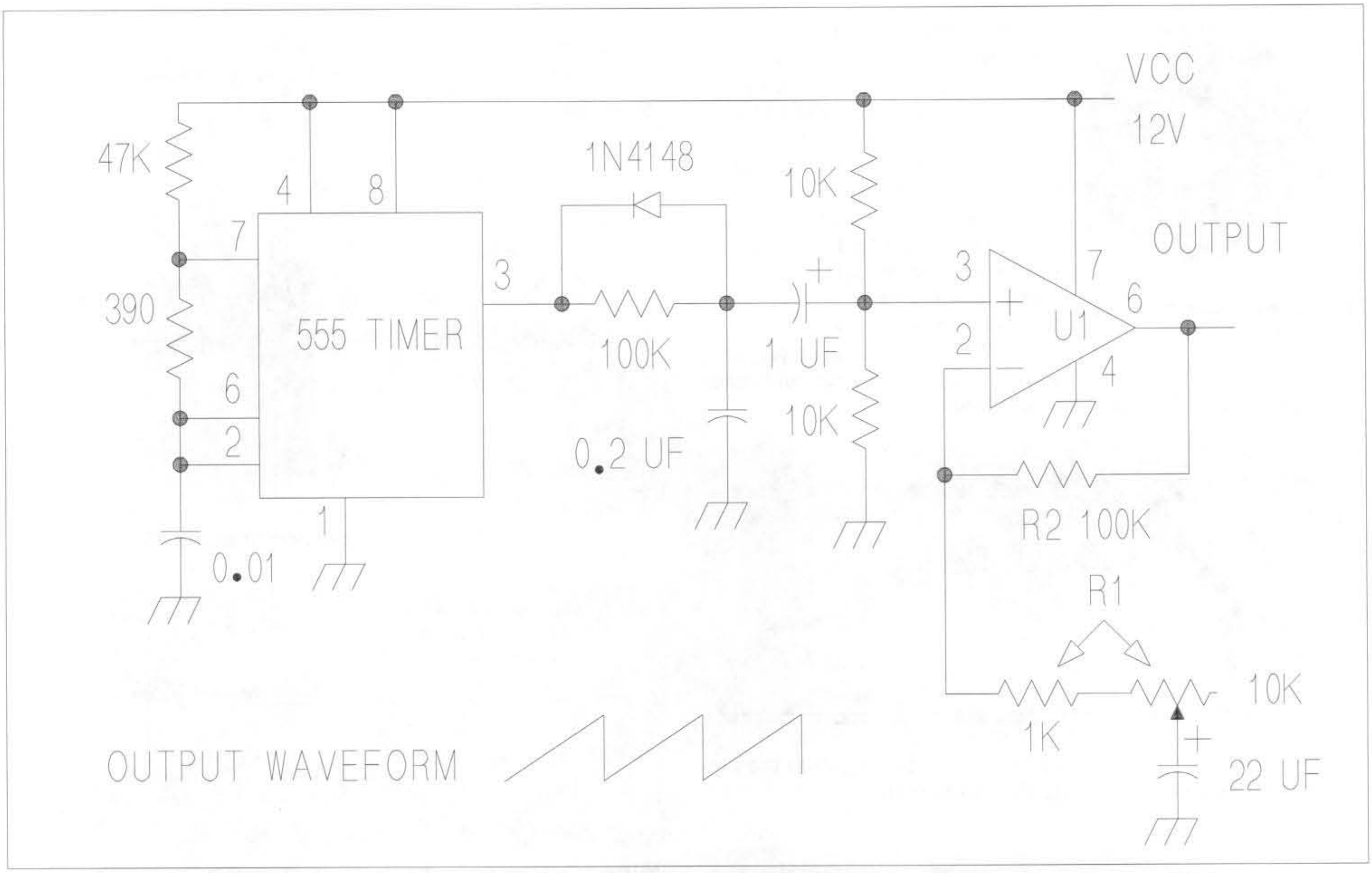


Figure 7—W4LJD ramp generator. U1 is a JFET or BiFET op amp, such asTL071, TL081, LF351, LF357, etc.

Incidentally, by using a 16 pin socket and plugging in the chips with pin 1 of the 555 at pin 1, and pin 1 of the op amp at pin 9—assuming an 8 pin DIP op amp—the various jumpers and interconnections can be made on the bottom of the socket before it is soldered to a PC board. This eliminates a great deal of wiring clutter and makes a much neater appearance. With resistors mounted vertically and monolithic caps used for all but the two electrolytics, the entire ramp generator will fit with room to spare in a 1 1/2 inch square space.

R1 value	R2 value	Ramp range
910	100K	+1 to +12V
910	47K	+5 to +12V
910	22K	+7 TO +10V

R2 value	R1 value	Ramp range
100K	910	+1 to +12V
100K	7K	+5 to +7V

—DE W4LJD

ON THE ROAD WITH FOAM INSULATION TUBES

Walt Dufrain, AG5P *(walter@inlink.com) had this tip in the October 1998 issue of The Peanut Whistle, journal of the St. Louis QRP Society, in an article titled "Mobile Foam". (SLQS was founded as a local QRP and homebrew group in 1987. They feel now, as then, that the QRP world is well-served by QRP-ARCI, NorCal, Michigan QRP, etc, and choose not to compete. They do not accept members from outside their area or accept outside subscribers to the Peanut Whistle. But they do allow me to share some of their technical goodies with the rest of the QRP community.) I scanned in the drawings; they're a bit "messy" since the scanner picked up a little bit of feedthrough from the other side of the page.*

Trying to operate from a vehicle in a portable setup is fun, but when it's raining or super cold, being able to "roll up the window" sure is nice. In trying to solve the problem, the sole survivor of all the materials that were investigated as the "closed cell foam tubes". The product (cross section shown in Figure 8) is the tubular, hollow core, foam tubing that is designed for insulating pipes and tubing. The pipe foam is available at most hardware and lumber stores and it already is slit along the entire length for slipping over pipe. Using the size designed for 1/2 inch pipe seems to be more than adequate for the task.

Now this is my kind of stuff; all you have to do is cut the proper length and slip it over the window, put the coax through and roll up the window. This gives a fairly weather- and watertight seal when parked or even driving down the road. It sure beats sticking the coax through the door or leaving the window down and having to listen to the wind and road noise. (See figure 9.)

Coax is great, but what if you prefer to use twinlead or ladderline? Have no fear, this foam pipe still shines but not without a little help from the Plexiglas family. The metal proximity of the car is addressed by using a small sheet of Plexiglas to provide isolation between the metal and ladder line. Stationary operation is not a problem. However, if you are going to be driving down the road, a little extra care should be taken to have a close fit of the Plexiglas and foam within the

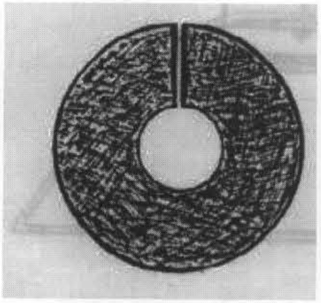


Figure 8—cross section of foam tube

window opening. Figures 10 and 11 show the details. And if you are driving a pickup truck, the back sliding glass window gives a neat way of exiting the truck cab, shown in Figure 12.

Now let's talk about security of the vehicle and using the mobile foam idea. This is NOT a permanent installation; do not expect the foam to keep car thieves out. My thought is that if the vehicle needs to be locked up, then the foam unit should be removed.

There are a lot more projects to accomplish with the foam, and coming in a future issue is "Mobile Foam Goes Home".

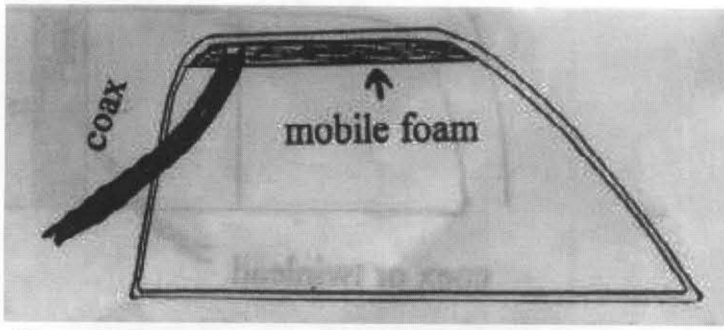


Figure 9—Foam tube on top of window seals against the elements and noise and lets the feedline in.

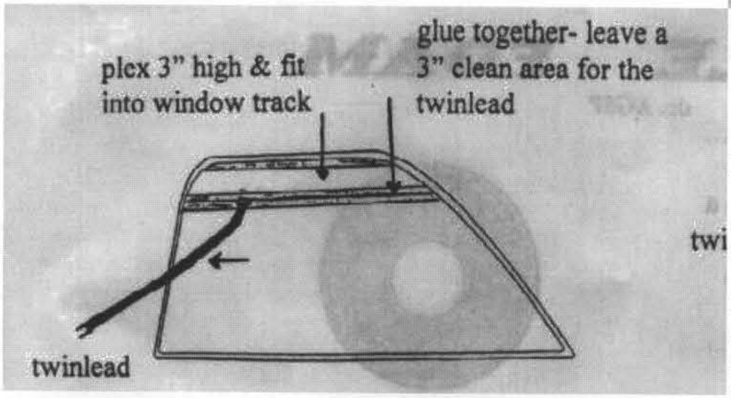


Figure 10—Piece of acrylic sheet (Plexiglas, etc) and foam let in twinlead or ladder line and keep it away from metal.

—DE AG5P

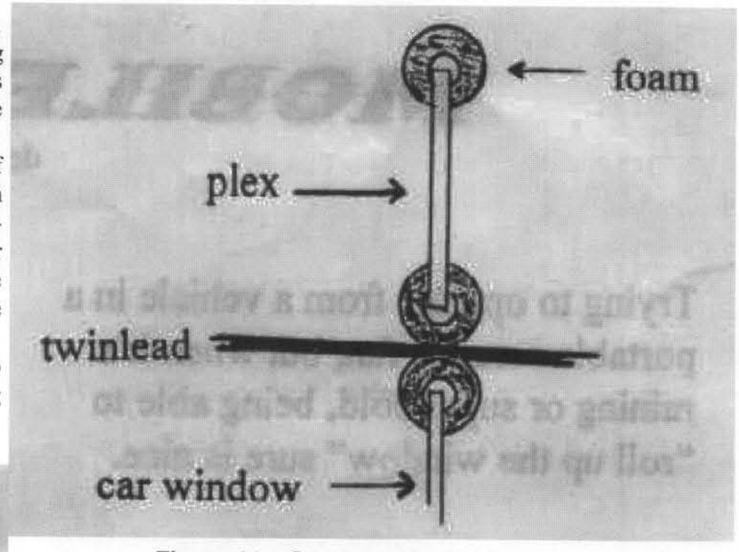


Figure 11—Cross section of figure 10

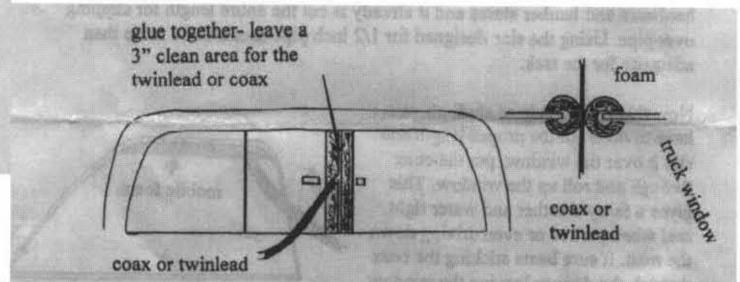


Figure 12—Feedline brought in through the sliding windows at the rear of a truck cab.

UNTANGLING PORTABLE ANTENNAS

After I asked for permission to use his tip on Shoe Goo, ***T.J. "SKIP" Arey, N2EI*** *(tjarey@home.com) passed this additional item—*

I have been making up a few dipoles for the field. I'm sure most folks have had problems with tangled antennas no matter how hard they try to keep things sorted out. When I was scrounging for wire for my 20 meter antenna I could only find pieces of insulated wire of two different colors (in this case one black and one red). Then it hit me. If you make one leg of the dipole one color and the other a different one it would make sorting out any tangles that much easier because you could clearly tell each wire from the other. I'm going to make this the standard practice for all my field antennas. Give it a try. Time saved untangling antennas can be time spent on the air.

—DE N2EI

IC SOCKET PINS CONNECT WIRES TO PCB

In a recent post to QRP-L, ***Claton Cadmus, KA0GKC*** *(cla@mcg.net) shared an interesting way of connecting wires to circuit boards—*

At our MN QRP club meeting, Bruce Stough AA0ED, told how he had removed the unneeded machine pins from the IC socket he used for his homebrew Pic Programmer to make it easier to get the chip in and out. Taking his advice, I did the same. The pins snapped out of the plastic from the bottom quite easily.

Playing with these now single gold plated pins I noticed the nice way they snapped together and apart again. The light came on! These would make great wire to circuit board connectors!

Solder a single machine pin in a hole in a circuit board where a wire is supposed to go. Now insert the end of the hookup wire in the hole of another single machine pin and solder it. Add a small section of heat shrink tubing over the top of the machine pin and up the wire a little and there you go. A real professional looking connection that will snap together. And they hold very well. Best yet, you can unplug the wire for mods or changes to the circuit board!. With a short piece of insulation off of a larger diameter wire you could even fabricate mini inline wire connectors. These things are great!

—DE KA0GKC

MINIATURE W2FMI BALUNS—NOT!

Jerry Sevick, W2FMI, is well known for his book Transmission Line Transformers, which goes into great detail regarding design and efficiency of these devices. If you don't already have a copy, I highly recommend it. (BTW, there were two editions published by ARRL. The second cost about twice as much as the first, but contained about twice as much material.) One "problem" that Danny Gingell, K3TKS, pointed *out years ago is that none of his designs are really "QRP" versions, and are wound on relatively large cores of at least an inch diameter. Danny asked me if it would be possible to replicate the Sevick designs on a smaller core. My response was that it was probably not practical due to the physics involved. Now, years later, someone has finally produced the definitive answer on making miniature W2FMI transformers, and verified my gut feeling: No.*

Someone on QRP-L mentioned that they made several W2FMI baluns, using the FT240 and FT125 size cores specified (2.4" and 1.25" diameter), and indicated that they were now interested in something smaller, such as on an FT50 core (1/2" diameter). Here's the answer from QRP-L regular ***Tracy Markham, N4LGH*** *of ByteMark, an Amidon Distributor (tracy@bytemark.com)--*

Being the 'Amidon Guy,' I wanted to be the Hero that introduced a quality, miniature QRP-balun. I failed miserably!!! I have spent hours on the phone with Dr. Sevick, and have determined the dimensions, materials, wire sizes etc. for several models. They just don't work as good as the big ones.

The problem lies in tolerances -- as wire diameters get smaller the tolerance for conductor spacing gets very tight, to the point of non-reproducibility.

Amidon BALUNs [balanced to unbalanced transformers] and UNUNs [unbalanced to unbalanced] are designed to have very high-efficiency and reproducible design. The designs with larger cores are not done with power in mind, but very high efficiencies. They happen to take a lot of power because they're large.

After winding about 150 BALUNs on various mixes of FT50, 87, 114, etc. cores I determined it is too difficult to get the windings accurate enough to have more than 80% efficiency. I got one to 88%, but could not do it a second time! *[Efficiencies on most W2FMI baluns are much better, in the 90's. —WA8MCQ]*

Remember that 'BALUNs' are not traditional transformers, but are transmission lines themselves. What sets the characteristic impedance of the transmission line, from which the transformation is calculated, is the ratio of conductor diameter to their spacing. As you use smaller conductors it gets more and more difficult to wind the transformer without varying the conductor spacing.

I tried using various methods to attach the conductors together. The best method was using strips of 'ribbon' cable but even then the strands could move slightly within their jacket and the impedance was not constant on the line. Useless for an efficient transformer.

Hundreds of fellows have purchased piles of cores from us [Bytemark] in pursuit of an efficient QRP BALUN. So far not one has made a bulk purchase, or called back with successful results. I personally think it can't be done both small AND efficient. If 80% is good enough for you, then you should have no problems.

I've noticed with QRPers that often a sacrifice in efficiency is worth a substantial reduction in size, cost, weight, etc. In this particular case I must disagree. When it comes to coupling the antenna to the feedline or the line to the rig, you want the best efficiency possible. Remember that the 20% lost in an 80% efficient transformer is lost on receive as well as transmit.

I love it when I get callers that only want a 'receiving' BALUN. I would think that one would want the greatest efficiency possible in a receiving transformer! Don't go with the minimalist approach here. Use as efficient a transformer as you can, even if it does look like it is oversized. Remember, a 7 MHz wave is over 30 feet long; give it some room in the transformer!

I have a bit of tech info online at

http://www.bytemark.com/w2fmi

The material is written by Dr. Sevick, W2FMI. It is intended as a 'Digest' of his popular book 'Transmission Line Transformers.' Good luck on your quest -- hopefully someone will finally break the reproducibility barrier, as I call it, of small AND efficient BALUNs.

—DE N4LGH

BETTER SIDEBAND REJECTION FOR THE ARGO 509

Long time QRPer ***John Collins, KN1H*** *(kn1h@juno.com) had this article in the October 1998 issue of the Peanut Whistle from the SLQS. The Ten-Tec Argonaut 509 has been around for a very long time, but is still a popular and widely used QRP rig.*

I've spent quite a lot of time getting my Ten-Tec Argonaut 509 working the way I want; the main problem being that the ultimate rejection of the crystal filter was always lousy. The unwanted sideband was only about 25 dB down from the wanted one. Of course, this means the unwanted sideband of a 100W station was about equal to the wanted sideband of a 1W station--very unpleasant in a QRP contest.

First, I figured that the little 4-pole filter was just no good so I acquired a Ten-Tec model 200 (2.4 kHz, 8 pole) and installed it instead. The termination is a little different, 220 ohms vs. 470 ohms, so I changed the resistor on the SSB board for a proper match. The results were depressing. The response was virtually the same, leading me to think maybe the 4-pole filter isn't so bad after all. Ultimately, I kept the 8-pole filter in there as it is quite a bit narrower.

The rejection problem turned out to be in the wiring between the boards, the layout of the boards, and in the excessively long ground leads. RF connections between the IF board, TX/RX mixer board and the SSB board are all made with plain old hookup wire. Some of it is quite long, making a great antenna and bypassing both the IF and the BFO energy around the crystal filter.

The following is what I did to cure the problem, each step making a small improvement.

1. Remove the IF, TX/RX mixer and SSB boards. Replace the following inter-board connections with miniature coaxial cable (type not critical). Ground shields at both ends using the nearest ground lug.

a) IF connection between SSB and IF boards
b) BFO connection between SSB and IF boards
c) 9 MHz connection between SSB and TX/RX mixer boards

2. On the IF board, cut the trace between C6 (22 pF) and the BFO pin and replace with a short length of mini coax. Cut the trace at both ends and ground the coax shield at both ends.

3. On both the SSB and IF boards, tie all ground foils together with short jumpers. (In my 509 there was a difference of 1.5V between the two ground foils of the IF board--we shouldn't rely on the sockets for grounding.) I also found it helpful to solder a short length of braid to the ground foils of both the IF board and the SSB board, then connect that to a ground screw after the boards are reinstalled.

After all that, the improvement was dramatic but still not perfect. I took a short length of wire, acting as an antenna and touched the ground pins of each board. While listening to a signal generator on the unwanted sideband I found a few points where the rejection went bad when the wire was touching the ground pins, indicating that they really weren't ground. In my case a short piece of braid between the SSB and TX/RX mixer boards solved much of the problem.

That's what I did to the 509 and it helped a lot. The same would apply to the newer 515 although mine was sold before I figured it out so I can't say I've tried it. I do know that it had the same problem.

I also have a Ten-Tec Argosy 525 which I have modified somewhat following the guidelines that were in Ham Radio magazine many years ago. I highly recommend checking that out, especially the audio roll-off modification which really quiets the receiver. I had no trouble with the filters in the Argosy as I used an 8-pole SSB and 8-pole CW filter, both of which worked great. Note that all signal and BFO leads are already in coax in this rig.

I really enjoy using the 509 now and can't think of much else that it needs. I put in a Curtis Keyer chip and an active AF filter. It's perfect to take in the camper on vacation, being all self-contained except for the antenna tuner.

--DE KN1H

AC VOLTMETERS AND WAVEFORMS

After I made my post to QRP-L on receiver noise floors and using an HP 403B AC voltmeter (which was also in the Idea Exchange in October), I got e-mail from ***Glen Leinweber, VE3DNL*** *(leinwebe@mcmail.cis.McMaster.CA)*--One of the potential problems with your analog meter system is that they always "fake " RMS measurement. But you knew that. And bet you also knew that the fudge factor is usually 1.11. In other words, a square wave would read 1.11 times higher in amplitude than it should. And noise (with an average-to-peak ratio lower than a sine wave) would read lower than its true RMS value on your meter.

So your MDS measurement with a non-RMS reading meter has a slight error: When reading pure white noise, it reads low. When you add a little signal, you're adding a sine wave which reads higher on your meter than the noise alone. What you really need is a true RMS meter that can cope with crest factors typical of white noise of 500Hz bandwidth....

WA8MCQ: I thanked him for the comments and told him that I was aware, in principle, of the waveform factor in doing RMS measurements but couldn't speak with any authority on the subject. I asked him to write a little more, and he sent this along--

Many newer meters claim "true RMS" measurements on their AC scales. What does this mean, and if I don't have it, how could my meter misread AC voltage?

Just how do we measure the amplitude of an arbitrary waveshape AC signal? One way is peak or peak-to-peak amplitude. That's the most extreme swing of the AC signal. This is important if you're interested in remaining within a breakdown voltage spec of a transistor, for instance. Even a momentary excursion above the breakdown voltage can spell disaster for transistors, FETs or diodes, or trigger a varistor into conduction.

But the more common way (and more versatile) of measuring amplitude is RMS which means root-mean-square. Why so complex? It gives a number that directly relates to the AC POWER. For example, if you apply 120v RMS to a light bulb, it'll glow with the same brilliance as 120v DC. And a 5W rig will dump just as much heat into your dummy load as 5W of DC power if those 5W of RF are RMS watts.

So RMS watts of an AC signal are exactly equivalent to DC watts. And one volt RMS or one amp RMS current will dump the same power into a resistor as one volt DC or one amp DC respectively. But RMS amplitude is horrible to determine. So nasty, that in the past, simple AC meters didn't even try. They "faked" RMS measurements. They used a simple diode detector to chop off the bottom half of the applied waveform, allowing current to flow thru the meter in only one direction. The meter's needle damped the current pulses, giving an average reading. Now all the meter has to do is arrange the scale on the front to look like "RMS".

Now for a sine wave where you've chopped off the bottom half, the average value is 2/PI times the peak value. That's 0.6366 times Vpeak. But for RMS, we want a number that's Vpeak divided by the square root of 2 (1.414), which is 0.7071 times Vpeak. What the diode gives is 11.1% different than the RMS value that we want. So the meter simply changes the scale, or fudges the internal scaling resistors to compensate for the 11.1% difference. All is well—for sine waves.

My Fluke 85 spec sheet says the following: "AC conversions are ac-coupled, average responding, and calibrated to the RMS value of a sine wave input". This means that the meter blocks DC from getting in, so that you can measure ripple voltages on a DC power supply easily. The average-responding bit says that it fakes RMS using the method described above with the diode. And the last bit says that the meter assumes you're always measuring amplitude of sinusoidal waveforms.

Now you apply a square wave. My meter reads high - how come? Your meter assumes you're always measuring SINE WAVES. And the 11.1% correction factor applies ONLY for sine waves. The RMS-to-peak relationship for square waves is 1:1. So your meter reads about 11.1% too high. For triangle waves, it reads too low. And what about noise? There is no way to measure the peak value of noise - its a fairly meaningless metric. But the RMS value of noise has value, since even noise could heat a resistor. Your average-responding meter reads quite low in this case.

One way to make a true RMS meter is to simply dump the AC waveform into a resistor, and measure its temperature rise. There are some very expensive meters that measure AC amplitudes over a very wide bandwidth this way. Another way is to drive an incandescent lamp with the AC waveform, and match its brilliance with a similar lamp driven from a DC source. The DC voltage is equal to the RMS voltage of the AC waveform.

But another way, is to go through the math of squaring the waveform, taking its average value, and then finding the square-root of that average. Some meters do it with analog multipliers, a low-pass filter and a square-root circuit. These circuits work well for audio, but can't handle high frequencies. Chances are good that if you have a "true-RMS" meter, these circuits are inside. Above 100 kHz, these analog circuits fail to respond accurately, so you can't use the meter to measure your QRP transmitter's output.

—DE VE3DNL

QRP-L, THE "QRP DAILY"

Started by Chuck Adams, K5FO in 1993, the Internet QRP discussion forum (mail reflector) is still going strong, with dozens of QRP postings and over 2500 subscribers. If interested in details, ask me via e-mail (wa8mcq@erols.com) and I'll tell all, including some alternate ways of reading it that DON'T clutter up your inbox with 50 to 100 additional messages each day. (The Daily Digest is a big help, but the HTML Archives are an absolute lifesaver!)

THE FINE PRINT

Got something you'd like to share with the rest of us? Send it in! Floppy disk, e-mail, handwritten on notebook paper, whatever—just get it to Severn and I'll handle the rest!

—qrp—

Review: The Oak Hills Research OHR-500

Steve Bornstein, K8IDN 475 East North Broadway, Columbus, Ohio 43214 email: saborns@aol.com

As QRP activity has increased, we are seeing more multiband QRP rigs on the market. The ease with which these rigs "travel" perhaps being one of the primary reasons. The year 1998 looks like it will see the introduction of new multiband QRP kits by Elecraft, S & S Engineering, Hands, and Oak Hills Research. This review is of the Oak Hills Research OHR-500 kit designed by Dick Witzel.

The OHR-500 is a major redesign of the discontinued 400 model. Like the 400, it tunes 150kHz of the CW portion of the 80, 40, 30, 20, and 15-meter bands and looks very similar to the 400 in its 5-in.× 8¼-in. × 8¼-in. enclosure. However, there have been many circuit changes and refinements that really make the 500 a new radio. While perhaps not ideally suited for the rank beginning kit builder, anyone with some building experience should not have a problem with the OHR-500. The radio consists of three circuit boards: Oscillator, Receiver, and Transmit/Receive. The Oscillator and Receiver boards mount on top of the chassis with the Transmit/Receive board mounted on the bottom. The excellent construction manual is step by step and leads the builder through the entire construction and alignment process. The manual contains an illustrated parts identification page, board layout pages, and a theory of operation section.

Construction

Construction begins with populating the three circuit boards. The parts for each board are individually packaged so inventory is simplified. My kit was complete down to the last lock washer, which is the usual case for OHR products. The assembly sequence goes by parts size, that is, resistors and diodes first, capacitors next, etc. The resistors are mounted in order of component size. The color code and part number is called out for each one. The remaining parts are also called out in step by step fashion in the manual. Incidentally, if parts are first sorted in a muffin tin, board assembly goes much quicker. I usually make it a practice to place the common values such as .01µf and .1µf caps in their own container. All integrated circuits are soldered directly to the board so make sure that you have their orientation correct the first time. There are a lot of toroids to wind, but a separate pictorial sheet describing their winding makes it very easy. OHR supplies wire that can be tinned with a hot soldering iron so that scraping and sanding of the coil leads is not necessary. The last steps in the population of each board are the installation of the wires that will later interconnect the individual boards and lead to the controls and jacks.

Assembly time will vary with your experience at identifying the individual parts and scanning the board for their locations. The boards are laid out from upper left to lower right, which makes finding the parts locations relatively easy. For the beginning builder the parts pictorial page will be very helpful. *Never, never* mount a part on the board unless you are absolutely sure you have the correct component. A good magnifying glass is essential unless you have very "young" eyes. Another useful eyesight aid is a head-mounted magnifier available at most hobby stores or Sears stores for about twenty bucks.

If you are on the compulsive side, you can populate a board in a long evening, say four hours or so. If you have limited work time there are many logical stopping points such as after one component type has been mounted or before winding the toroids. The step by step manual makes keeping track of your progress easy.

After all of the boards are completed, work on mechanical assembly and final wiring is completed. As explained in the manual, take a few minutes to take the sharp edges off the chassis sheet metal and clean it up a bit. This makes for a better looking finished product for those that take as much pride on the innards of their equipment as the outside. The manual has drawings to identify the proper holes for mounting spacers, etc. The OHR-500 and all the Oak Hills products are mechanically very robust with heavy gauge aluminum panels and chassis work.

All of the wire connections between boards and to the controls are accomplished next. If there is any one thing that divides the professionally wired radio from that of the inexperienced builder it's the way in which this wiring is accomplished. Take your time and note the way the wiring forms logical bundles with breakouts to their respective locations. When the wiring is complete, nylon tie wraps will make the radio look like it was built to Mil specs with a pre-made custom harness. I must confess to being a bit of a fanatic on this topic and have been accused of keeping the tie-wrap industry in business.

Alignment

A minimum amount of test equipment is required for the alignment of the OHR-500. Most amateurs will either have the necessary equipment or will know someone who does. (Oak Hills also provides an alignment service for $75.00). Required are: voltmeter, frequency counter, wattmeter, and dummy load. You will also need the use of another transceiver to properly set the CW offset. The need for an oscilloscope to measure low level RF voltages has been eliminated by the addition of rectifier circuits on board. A voltmeter with a 200mV range will suffice nicely. During alignment, you peak the trimmers for each band to obtain the maximum output measured at test points on the board. The VFO is set by adjusting a slug-tuned coil. The VFO in my radio lacked a little range but that was easily corrected by increasing the value of a capacitor. CW offset is set by adjusting a trim cap while in transmit and listening to the OHR-500 on another transceiver. Lastly, CW volume and pitch are set using trim pots.

Performance

How does the radio perform? I first checked the VFO for drift. My radio drifts about 300Hz during the first ten minutes or so and thereafter remained solidly on frequency. The specs call for < 400Hz in the first 30 minutes. The receiver sounds very clean and is much quieter than the receiver in the OHR-400, which was a very good. The audio filter in the rig is very effective on signals in its bandpass. If you are interested in installing an internal speaker or running an external one directly from the radio, the audio output is a very healthy two-Watts. Sensitivity of the radio is rated at 0.35µv for a 10dB S+N/N. The RIT has a center detent and a range of about ± 1kHz. The power control on the front panel will vary the transmit power from zero to full power very smoothly. My first contacts were on 20, 15, and 40 meters and all stations reported a very clean signal. The rig draws about 280mA in receive and a trifle over 1A in transmit. I have used my OHR-400 for my primary Field Day rig and plan to do the same with the 500. All in all the OHR-500 is an excellent performer and a good value at a price of $350. I expect to hear many of them on the air as more operators in the QRP community move up to multiband rigs.

The OHR-500 multiband transceiver kit is available from:

Oak Hills Research
20879 Madison St., Big Rapids, M 49307
Phone: (616) 796-0920 email: qrp@ohr.com

Edited by W1HUE

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by John R. Montalbano KA2PYJ *jrmont1@worldnet.att.net*

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Note: This article first appeared in the November 1997 issue of Nuts & Volts Magazine. It is being reprinted with permission of John Montalbano and T&L Publications .. ed

Introduction

It did not take long before I got tired of looking up frequencies in my Police Call book and laboriously typing 200 of them into the tiny keypad on the front panel of my new Radio Shack PRO-2032 scanner. I soon gave up the idea of taking the radio on business trips with me because that meant reprogramming the radio before and after each trip. Furthermore, once the radio was programmed I would forget what I had put where. I decided it was time to go where no unauthorized service person is supposed to go and peek under the cover of this baby to see how I could wiggle its channel banks from my PC. The result is this inexpensive computer interface that you can build for almost any modern scanner.

A service manual from Radio Shack revealed two feasible ways to control the radio. The channel setup information in the PRO-2032 is written and read from a battery backed-up static RAM. I could have hijacked the address and data signals to this device and controlled the writing and reading of channel information from the PC. I decided against this because it involved cutting several signal leads in the radio and switching between local and computer control of these signals. Furthermore, the resulting modification and software would have been useful only in this model scanner. I chose instead to take a more brute force approach so that my computer control interface and software could be used in almost any scanner. If you hand wire yours like I did, the hardware cost will be about $15.00 for the parallel interface version. A serial port version is also described.

The PROgramit software is available from my WEB page as shareware. The Win3.1/Win95 SW is rather novel in that it provides a simple interface for you to "teach it" how your scanner is programmed and how you have wired the interface to your particular scanner. Once that is accomplished, you can import frequency databases from popular sources, or create your own manually. You then populate a channel map database by dragging entries from the frequency database to the bank and channel in the channel map where you want that frequency programmed. You can choose to download to individual channels, entire banks, or the entire scanner. When you are done, you can disconnect the interface and carry off your programmed scanner.

Theory of Operation

Like most modern scanners, the PRO-2032 keypad is actually a matrix of switches. The CPU sequentially enables one row of the matrix at a time and reads back the columns to determine if a key in any row has been pressed (Figure 1). The interface described in this article makes use of a Harris CD74HCT22106 CMOS Matrix switch to parallel each switch in the hardwired keyboard in the scanner. In the PRO-2032 and most other scanners, this can be accomplished easily and without cutting any traces in the scanner. The switch is programmed to "press" any key on command from your computer. Software on the computer can then perform any sequence of keystrokes to accomplish programming one or more frequencies or setting the scan limits.

This article describes serial port and parallel port versions of the interface. The parallel port interface is a bit easier to build from scratch and is less expensive. I found it more desirable to add an inexpensive parallel port to my computer than to try to add a third serial port without causing interrupt conflicts. The parallel version requires that a 25-pin connector be mounted in some fashion to your scanner. I did not have a problem cutting a rectangular hole in mine, but if you are not that daring, you should consider the serial interface version.

The Software was designed to utilize a Standard Parallel Port (SPP). If your computer has its parallel port set for Enhanced Parallel Port (EPP), you may have to change it to SPP. You can download and run the program diag.exe from the WEB page to determine if the SW works properly with your computer. The program toggles all of the I/O bits used by the interface at a slow rate so that you can monitor them with a voltmeter, logic probe or oscilloscope. Further, the current SW for the parallel port version cannot be used on a Windows NT machine.

The serial port version makes use of an EDE300 preprogrammed PIC microcontroller from E-LABs to convert 9600 baud serial data from the PC to the parallel interface of the CMOS switch IC. Only two small mounting holes and a third hole for a round RCA jack need to be drilled in the scanner.

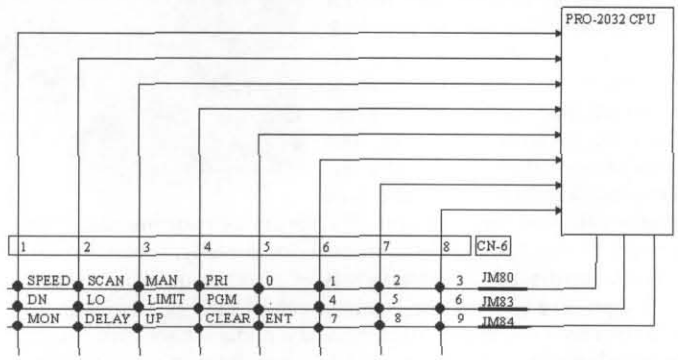


***Figure 1** - The keypad in the PRO-2032 is scanned by the CPU in a 4-row by 8-column matrix. CMOS switches in the PROgramit interface are connected across the intersection of each row and column (e.g. JM80 to CN-6 pin 8 in the PRO2032 for the "3" key.)*

Construction

The complete schematic for the parallel interface version of the project is shown at the end of this article in Figure 10. The circuit can be built from thru-hole components on a 2 - 5/8" X 3" piece of perfboard (Figure 2). I chose to mount the DB-25 connector on the PC board and then cut a whole in the chassis through which the connector is mounted . Be sure not to get any metal filings onto the scanner's circuitry if you go this route. You could also sneak a 25 conductor ribbon cable between the chassis and case to avoid cutting this hole. The board requires 5 Volt power which was easily obtained from the PRO-2032 power supply. In some scanners, a small battery powers some of the 5 Volt power buses even when power is turned off. In that case you will need to find a 5 Volt bus that is switched off completely, or connect the optional on-board 5 Volt regulator to a switched source of 7.5 - 14 volts.

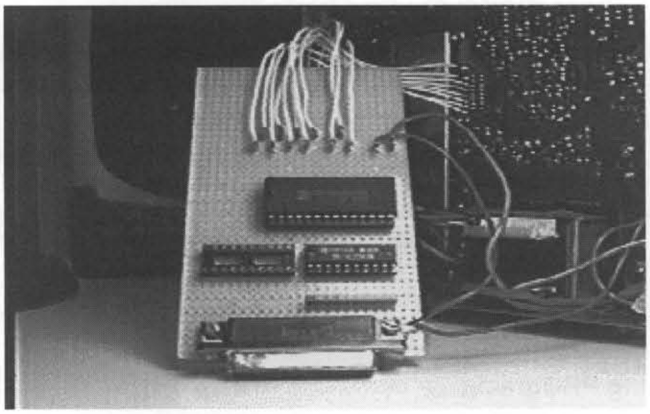


Figure 2 - The prototype was hard-wired using #30 gauge wire on a 2-5/8" X 3" piece of perfboard.

The complete schematic for the serial port version is shown at the end of this article in **Error! Reference source not found.**. I recommend that you use a female RCA connector for the data connection to the PC since you will be less likely to contact the center conductor to ground when inserting or removing the plug with power applied.

Installation

In the PRO-2032, eight wires connect X0 - X7 from the switch to the pins of connector CN6 on the wiring side of the scanner's PCB (Figure 3). Three more wires from the CMOS switch (Y0-Y2) connect to jumpers (Y80,Y83 & Y84) behind the display on the component side of the circuit board (Figure 4).

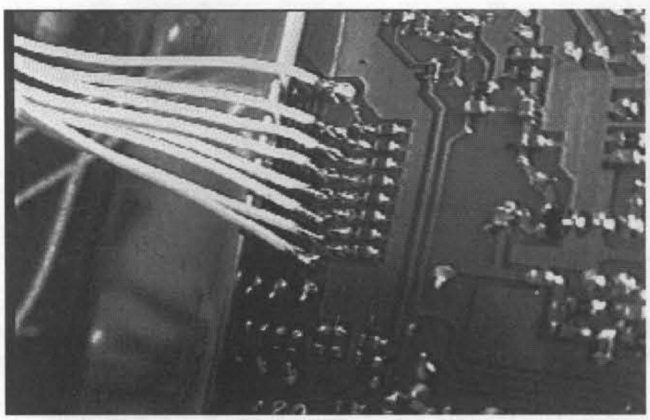


Figure 3. Eight connections are made to CN-6 on the wiring side of the circuit board in the PRO2032

Connections to other popular Radio Shack scanners are shown in Appendix #1. These are even more straightforward than those for the PRO2032. I will post instructions for additional models on the PROgramit WEB page. If yours is not shown, it does not mean that your scanner is not supported. You will simply need to identify the connections to the rows and columns of the keypad in your scanner from a schematic or by inspection of the scanner's PCB. It is not critical which "X" lead from the interface goes to which column or which Y lead goes to which row. The SW can be configured for the specific connections that you make.

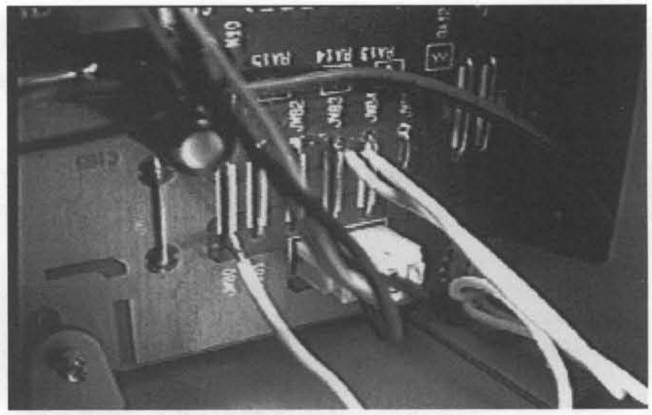


Figure 4. Three Connections are made to J80, J83 and J84 on the component side of the circuit board in the PRO2032

Software Configuration

Select Settings/Hardware Configuration from the menu bar. You will be presented with the screen shown in Figure 5.

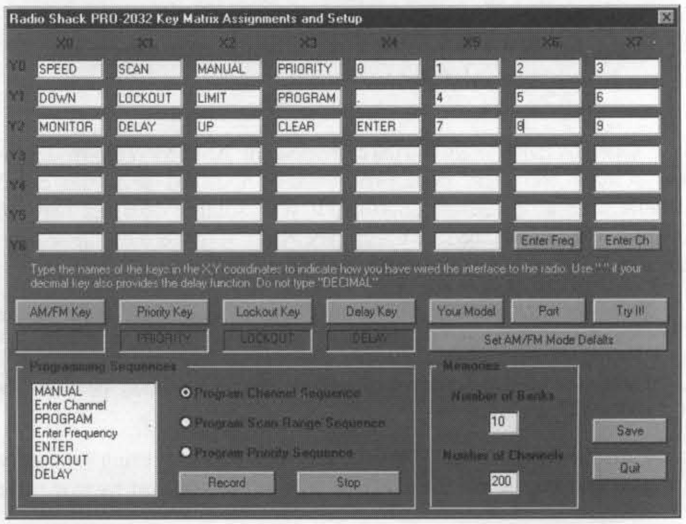


Figure 5 - You can configure the SW to work with almost any scanner using the configuration screen.

Follow these simple steps:

1. The 54 text entry boxes represent switches in the CMOS switch. You need to tell the SW what key on the scanner you have connected that switch to in your implementation of the project. For example, I have connected the CMOS switch at X4,Y1 to the LIMIT switch in my scanner.

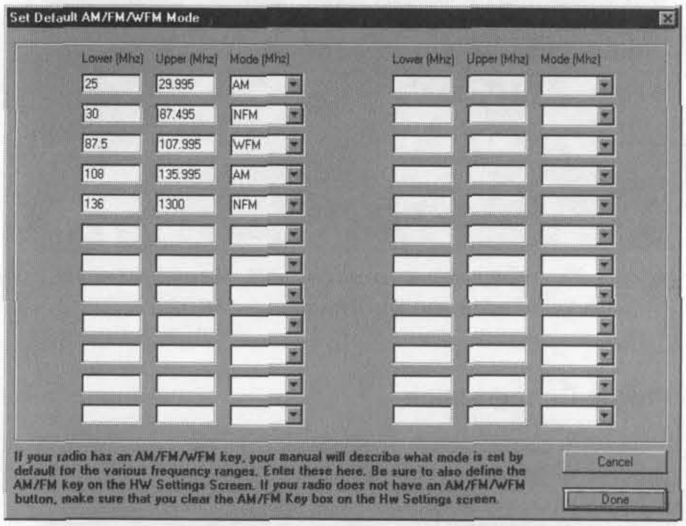
2. If your radio has a button that lets you program a priority channel, press the "Select Priority" button. Then choose the key from the matrix that represents your radio's "Priority" key.

3. If your radio has a button that lets you lockout a programmed channel, press the "Select Lockout" button. Then choose the key from the matrix that represents your radio's "Lockout" key.

4. If your radio has a button that lets you delay a programmed channel, press the "Select Delay" button. Then choose the key from the matrix that represents your radio's "Delay" key.

5. If your radio has a button that lets you select AM/FM/WFM reception modes, press the "AM/FM" button. Then choose the key from the matrix that represents your radio's "AM/FM/WFM" key. In radios that have this button, the mode is programmed to a default value based on

the frequency that you are trying to program. The default values for various frequency ranges can be found in your owner's manual. You will have to teach the PROgramit SW what these default values are. When you press the Set AM/FM Mode Defaults button, you will be presented with the dialog box shown in Figure 6



<u>Figure 6</u> - You will need to tell the software what the default modulation mode is for a given range of frequencies in your scanner model

Enter the range limits and the corresponding AM/FM/WFM modes for your scanner and press done. The values are stored in a file called ModeDefs.cfg in the install directory. If your scanner does not have an AM/FM/WFM button, be sure to clear the AM/FM text box on the settings screen by clicking on an unlabeled X,Y text box.

1. Enter the total number of channels supported by your radio in the "Number of Channels" text box.

2. Enter the total number of banks supported by your radio in the "Number of Banks" text box.

3. Press the "Your Model" button and enter a character string to identify your model scanner. This will be used on the caption bars of some menus.

4. Press the "Port" button and select which port you have connected to the interface. Also set the Delay Factor to an integer number between 3000 and 20000. The delay factor determines how long the interface will "hold down" the buttons on your scanner. You should try to use the smallest number that works reliably with your computer and radio combination.

5. Next, the software needs to know the key sequences required by your radio to program a new frequency into a particular channel. Press the "Program Channel Sequence" option button and then "Record" to begin. For the PRO-2032 wired according to the schematic in this article, I press "Manual, The Enter Ch Button, Program, The Enter Freq Button, Enter, Lockout, Delay". Press Stop when complete.

6. To teach the software the key sequences required by your radio to program a new search range, press the "Program Scan Range Sequence" option button and then "Record" to begin. For the PRO-2032, I then enter "Program, Limit, The Enter Freq Button, Enter, Limit, The Enter Freq Button, Enter, ScanUp". Press Stop when complete.

7. To teach the software the key sequences required by your radio to program a new Priority Channel, press the "Program Priority Sequence" option button and then "Record" to begin. For the PRO-2032, I then enter "Program, The Enter Freq Button, Priority". Press Stop when complete.

8. Finally, fill in the number of banks and the total number of channels that your scanner provides. That's it! The software knows how to wiggle the buttons on your scanner and you are ready to run the Computer Control Software.

9. Press the "Save" button and then press "Try It". Now, when you select the boxes in the matrix, the radio should respond as if you were pressing the same keys on the radio's keypad. If the radio does not respond, and you have carefully checked your wiring and installation, you may need to increase the "Delay Factor" until the radio responds reliably.

10. Press "Stop" and then "Quit" and you are ready to try the software's simple drag-and-drop interface.

Using PROgramit

Figure 7 shows the program's main screen. Your frequency database is displayed in the upper table. The lower table displays one bank of frequencies at a time as they would be programmed into your radio along with the station's owner and city.

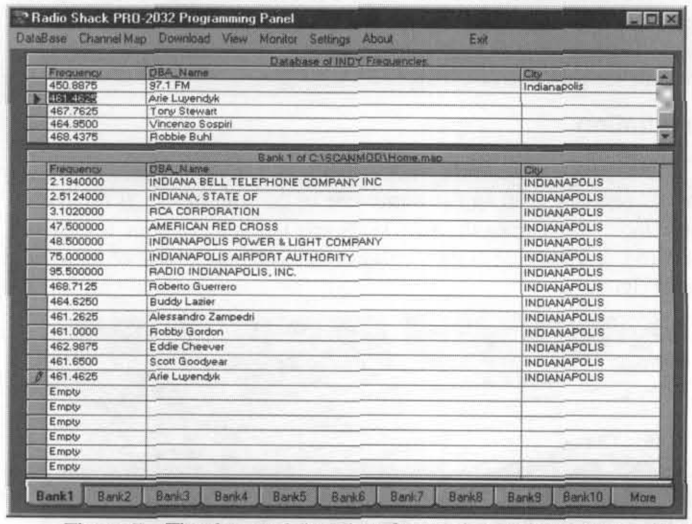


Figure 7 - The drag-and-drop interface makes changing your channel maps a breeze

I refer to the upper grid as the "Frequency Database" and the lower grid as the Channel Map. You can open existing Frequency Databases and Channel Maps, or create new ones from the "Database" and "Channel Maps" pull-down menu items. To program a frequency from the Frequency Database into the opened Channel Map, you simply drag it from one to the other. To get more information about a station in either grid, select the station and then right click anywhere in that grid. When you right click on the Channel Map grid, you will also be able to clear a channel or set its "Priority, Lockout, and Delay options if these are supported by your radio (Figure 8). When you have all the channels programmed the way you want them , you can choose to download one channel at a time, one bank at a time, or all of the banks at once. You can save as many custom Channel Maps setups as you want and recall them later to reprogram the scanner. From the menu bar, you can also quickly program the scanner to monitor a range of frequencies that covers aircraft, weather, 2M or 440 amateur radio.

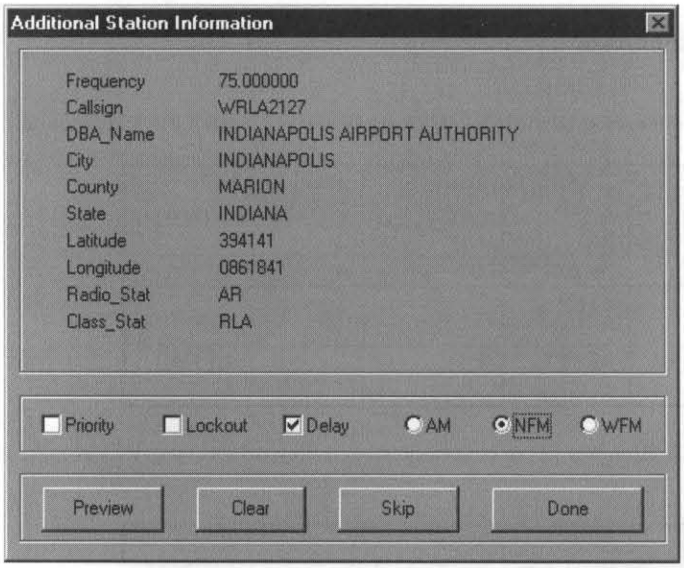


Figure 8 - Right click on either grid for additional station details

Selecting the "Manual" menu option brings up a customizable control panel for your scanner from which you can manually operate the scanner (Figure 9).

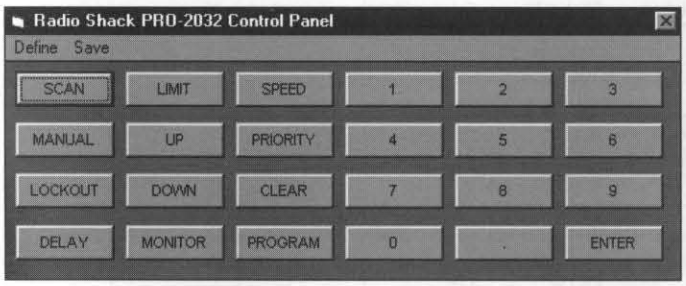


Figure 9 - You can customize the control panel to match that of your scanner.

Frequency Databases

With the advent of the CD-ROM and the Internet, it has become rather easy and inexpensive to find frequency databases to suit your needs. A few of these are listed in Appendix #2. Unfortunately, each author has chosen to use a different database structure, so you often need special SW to access these. PROgramit provides an Import feature to convert the most popular of these databases to the required format. Currently, the Probe, Percon and Scanware formats can be converted. By the time you read this, other formats will be supported including delimited ASCII text which can be produced by most any database access program.

PROgramit uses Microsoft Access for the underlying database, but you don't need Access to use the SW. The current version of the program provides you with some very basic editing functions that allow you to create and edit a Frequency Database. Table 1 shows the database format.

Conclusion

That should be sufficient information for you to put this simple project together and get it running in your scanner. Once you do, you will probably never want to program it manually again.

This project would not have come together as it did without the help of a group of people on the programit@qth.net list server who helped debug the early hardware and software. Many thanks to each of you. Others can join the list by emailing to majordomo@qth.net with the words subscribe programit in the body of the message.

For more information on the project, you can visit the PROgramit WEB page at http://www.qsl.net/ka2pyj or contact me via email at jrmont1@worldnet.att.net

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Table 1- Structure of Frequency Database tables:

NAME	TYPE/SIZE
Frequency	Text 12
Callsign	Text 10
DBA_Name	Text 40
City	Text 20
County	Text 30
State	Text 24
Latitude	Text 6
Longitude	Text 7
Radio_Stat	Text 4
Class_Stat	Text 4
Priority (Default = False)	Boolean 1
Lockout (Default = False)	Boolean 1
Delay (Default = False)	Boolean 1
Mode (0 = NA, 1 = AM, 2 = NFM, 3 = WFM)	Byte 1
Channel (Not Used)	Integer 2
PLTone (Default = Blank)	Text 5
Spare1 (Default = Blank)	Text 12
Spare 2 (Default = Blank)	Text 12
Spare 3 (Default = False)	Boolean 1
Spare 4 (Default = False)	Boolean 1
Spare 5 (Default = 0)	Double 8
Spare 6 (Default =0)	Double 8
NumFreq (Frequency String Converted to Double)	Double 8

Appendix #1: Connections for Some Popular Radio Shack Scanners

Radio Shack PRO-2035 and PRO-2042. Connections are to the 15 pin board connector labeled CN503 (Keypad end is CN601) Pin 15 is ground.

Pin # on CN503	X0 to Pin 5	X1 to Pin 6	X2 to Pin 7	X3 to Pin 8	X4 to Pin 9	X5 to Pin 10	X6 to Pin 11	X7 to Pin 12
Y0 to Pin 1	MAN	AUTO	RECT	LIMIT	PRI	1	2	3
Y1 to Pin 2	SCAN	PGM	L/OUT	UP	MODE	4	5	6
Y2 to Pin 3	TUNE	WX	L/OUT/R VW	DWN	STEP	7	8	9
Y3 to Pin 4	SOUND SQ	ENT	DEL	MON	RESET	0	.	CLEAR

Radio Shack PRO - 2004, 2005, 2006. The keypad connector is labeled CN601. This is a 13 pin connector between keypad and main PCB Pin 13 is ground.

Pin # on CN601	X0 to Pin 8	X1 to Pin 7	X2 to Pin 6	X3 to Pin 5	X4 to Pin 4	X5 to Pin 3	X6 to Pin 2	X7 to Pin 1
Y0 to Pin 9	X	MAN	PRI	LIMIT	X	1	2	3
Y1 to Pin 10	L/O RVW	SCAN	SPEED	UP	PRGM	4	5	6
Y2 to Pin 11	RST	DELAY	MODE	DWN	ENTER	7	8	9
Y3 to Pin 12	MON	L/O	STEP	DIRECT	CLEAR	0	.	X

Radio Shack PRO - 2026. The 15 pin board connector is labeled J201. Pin 1 is ground

Pin # on CN601	X0 to Pin 8	X1 to Pin 7	X2 to Pin 6	X3 to Pin 5	X4 to Pin 4	X5 to Pin 3	X6 to Pin 2	
Y0 to Pin 12	POLICE	FIRE	AIR	1	2	3	ENTER	X
Y1 to Pin 11	WX	MARINE	DELAY	4	5	6	CLEAR	X
Y2 to Pin 10	SCAN	PROG	L/O	7	8	9	0	X
Y3 to Pin 9	MANUA L	MON	PRO	LIM	DOWN	UP	.	X

Radio Shack PRO - 2032. The 8-pin board connector is labeled CN6.

Pin # on CN6 ----> Jumpers	X0 to Pin 1	X1 to Pin 2	X2 to Pin 3	X3 to Pin 4	X4 to Pin 5	X5 to Pin 6	X6 to Pin 7	X7 to Pin 8
Y0 to JM80	SPEED	SCAN	MAN	PRI	0	1	2	3
Y1 to JM84	DOWN	L/O	LIMIT	PGM	.	4	5	6
Y2 to JM83	MON	DELAY	UP	CLEAR	ENTER	7	8	9

Appendix #2: Sources for the master database:

1) The FCC WEB page at http://www.fcc.gov/wtb/databases.html
2) Contact Datafiles for information about Probe Software at datafiles@aol.com
3) Percon Corp.
4906 Maple Springs/Ellery Rd.
Bemus Point, N.Y. 14712
716 386-6013 (24 hrs. / 7 days a week)
4) Scanware Associates WEB page at and http://www.wvsc.wvnet.edu:80/~fcc/.

Parts List - Parallel Interface Version

Reference Designator	Description	Source
U1	74LS241	Digi-Key DM74LS241N-ND
U2	Harris CD74HCT22106	Digi-Key CD74HCT22106E-ND
U3 *	LM7805	Digi-Key NJM7805FA-ND
D1-D8	1N914 or 1N4148 Diodes	1N4148CT-ND
R6	4.7K ohm 1/8 watt	
R1-R5	47K ohm 1/8 watt	
C1,C2	0.1 uF Ceramic	Digi-Key 1203PHCT-NP
Female DB-25 right angle connector.		Digi-Key 325F-ND
Perfboard (Note 2)	approx. 2- 5/8" X 4.0"	Digi-Key V1119-ND

* (Optional) Used only when regulated 5V is not available in scanner.

Parts List - Serial Interface Version

Reference Designator	Description	Source
U1	MAX233	MAX233CPP-ND
U2	E-Labs EDE300	See Note
U3	Harris CD74HCT22106	Digi-Key CD74HCT22106E-ND
U4 (Optional)	LM7805	Digi-Key NJM7805FA-ND
RZ1	Resonator	See Note
D1-D8	1N914 or 1N4148 Diodes	1N4148CT-ND
R2-R6	47K ohm 1/8 watt	
C1,C2	0.1 uF Ceramic	Digi-Key 1203PHCT-NP
2 - pin serial connector of your choice. Suggest female RCA bulk-head mount.		Digi-Key 325F-ND
Perfboard (Note 2)	approx. 2- 5/8" X 4.0"	Digi-Key V1119-ND

Note 1:

EDE300 ($13.90) and Resonator ($1.50) available from:
E-LAB Digital Engineering, Inc., 1932 Hwy. 20, P.O. Box 246, Lawton, IA 51030-0246 USA http://www.netins.net/showcase/elab/
Phone: (712) 944-5344 FAX: (712) 944-5501
Visa, MasterCard, Prepaid, and U.S. COD orders are accepted. US orders please add $3 Shipping. COD add $4.75. Foreign orders add $4.00 Air Mail shipping or $9.00 for Global Priority shipping.

Note 2:

Etched, drilled, tinned and labeled printed wiring boards are available from:
Far Circuits, 18N640 Field Court, Dundee, Illinois 60118
Fax 847-836-9148
Be sure to specify Nuts & Volts Magazine, Month, year and "PROgramit PARALLEL INTERFACE" or "PROgramit SERIAL INTERFACE".
Programit Parallel Interface - $5.00
Programit Serial Interface - $4.50
Add $3.00 service charge for VISA/Mastercard order. Add $1.50 shipping per 4 boards. Illinois residents add 6.5% sales tax.

Note 3:

PROgramit Software and updates are distributed as shareware at the PROgramit WEB page. The author requests a one time $12.00 registration fee be mailed to:
John Montalbano, 5 Polly Way, Middletown, NJ 07748
Software is only available from the website.

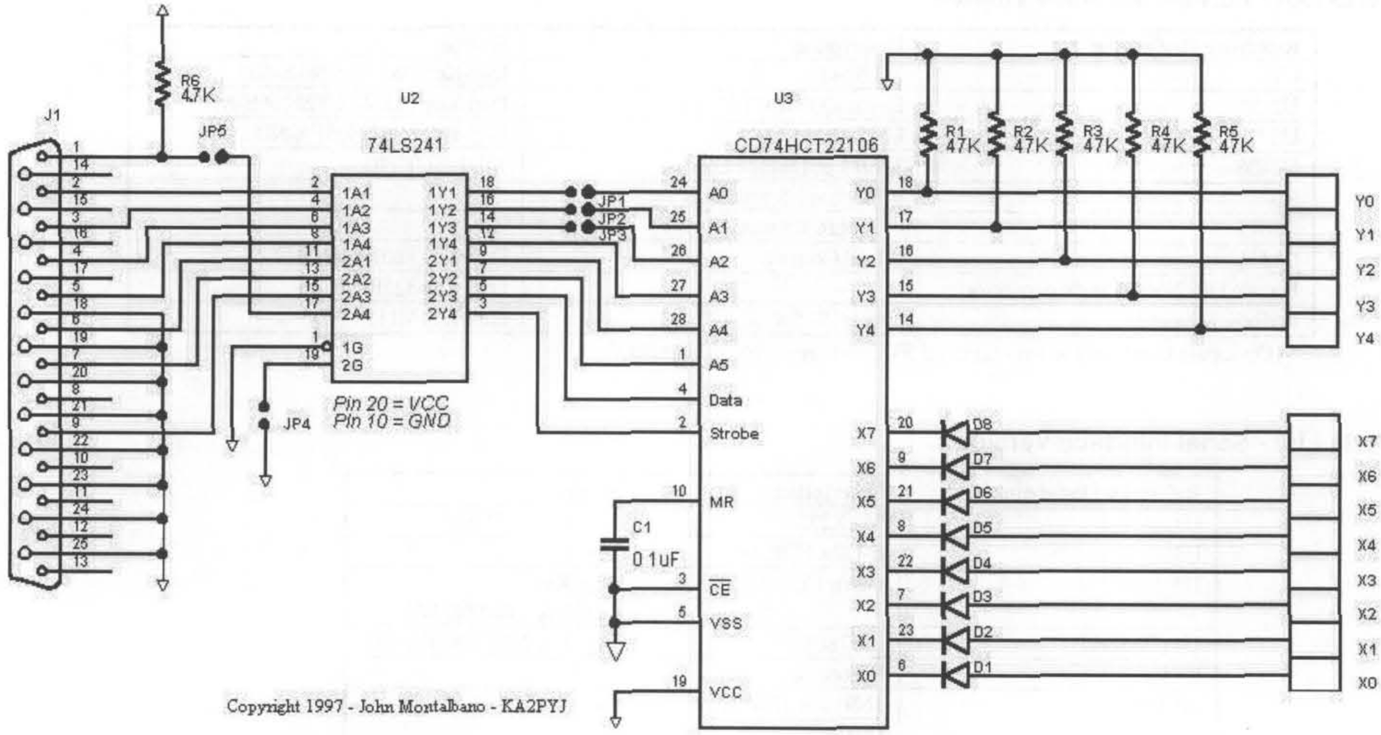


Figure 10. Schematic diagram of the parallel interface version of the project.

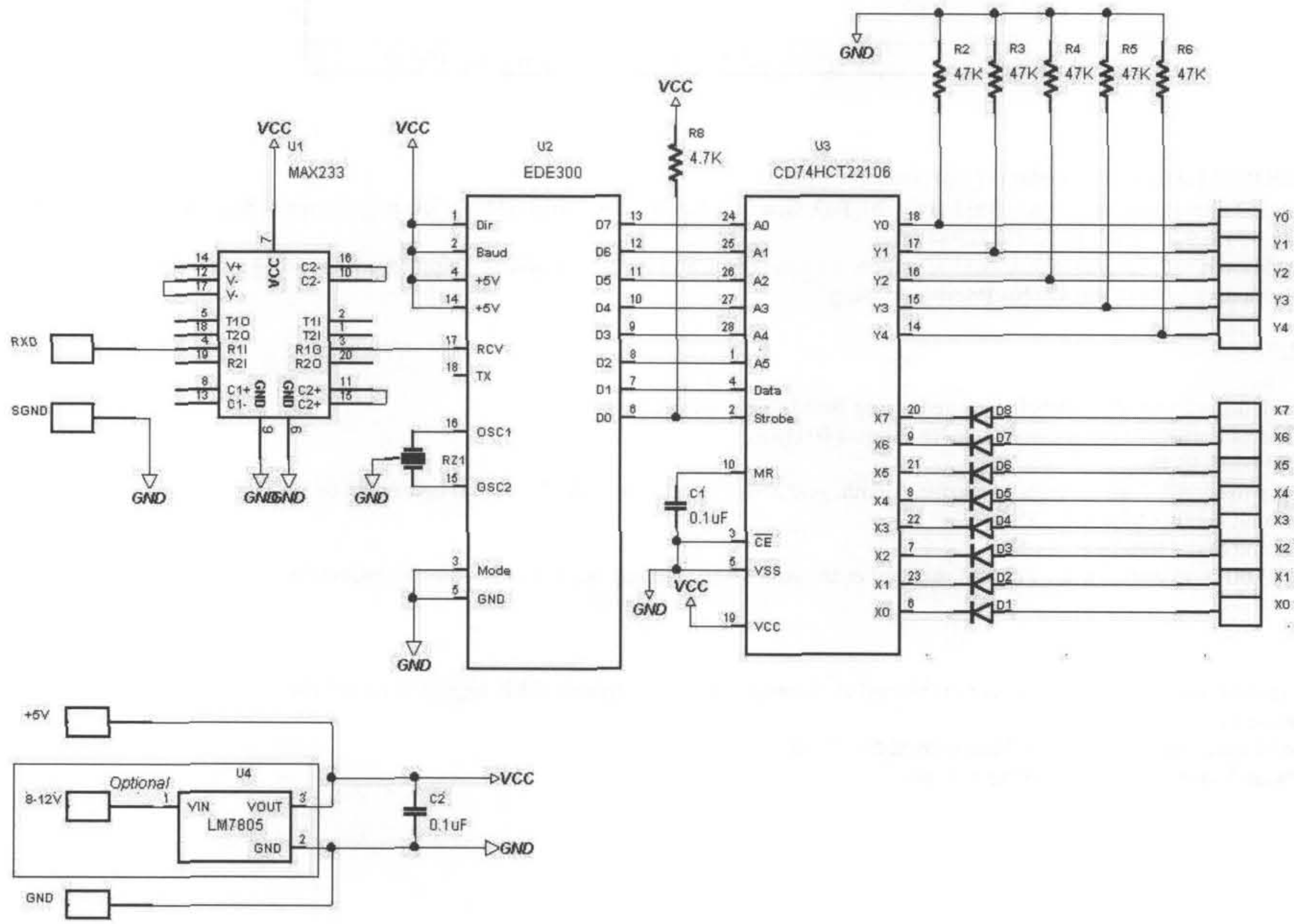


Figure 11 The complete schematic for the serial port version of the interface

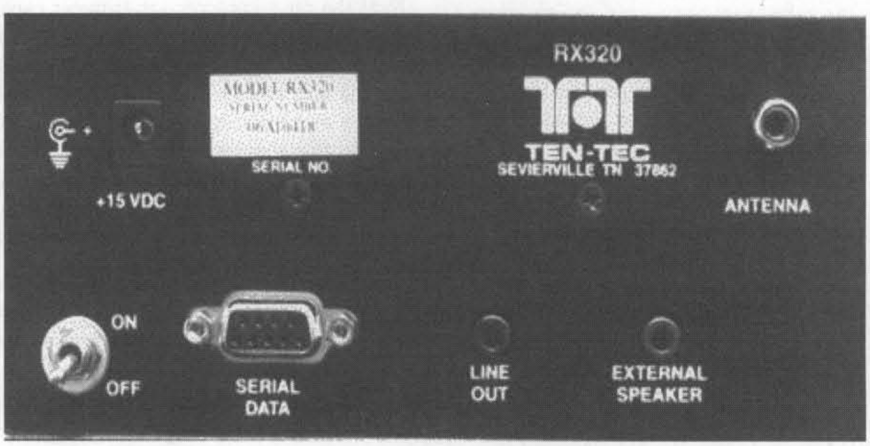
Review: Ten-Tec RX320 PC Receiver

Tom Cooper, W1EAT 143 Spruce St., Burlington, VT 05401 email: cooper@gmpvt.com

The Ten-Tec model RX320 is a triple conversion superhet receiver covering 100 kHz to 30 MHz that is different from most other radios in several ways. There is no front panel, tuning knob or other manual controls because, other than an on/off switch, all RX-320 adjustments are via a serial (RS-232) interface from your personal computer. Besides the radio itself, you get Windows® based control software, a serial cable with a 9-pin connector, a husky "wall-wart" type 12V power supply, a collapsible whip antenna, an RCA phono plug, a stereo audio cable to connect the line output to your sound card and a user's manual.

The IF frequencies are 45 MHz (crystal filter), 455kHz (ceramic filter) and 12kHz. This brings us to the next big difference in the RX-320. The analog 12 kHz IF signal is converted to digital and processed using programs (algorithms) stored in the radio in read-only-memory (ROM) by a dedicated Digital Signal Processor (DSP). IF DSP is available in quite a few "high end" transceivers and receivers, but the RX320 isn't a "high end" radio. It sells for $295, in the same price range as audio DSP "add-on" filters.

DSP is used to vary the bandwidth from 8000 to 300kHz, demodulate AM, USB, LSB and CW, and generate Automatic Gain Control (AGC). The ROM chip is socketed, so doing a firmware upgrade is something you can do at home. My radio came with ROM version 1.06.



Rear panel of the Ten-Tec RX320 *(WB9KZY Photo)*

From Ten-Tec's web page (www.tentec.com), you can download the latest version of the control program and a programmer's reference guide that includes a sample BASIC program. There is a lot of excellent info to be had here, and it's free.

Of course, the first thing I did was remove the top and bottom covers to see what was inside. It *is* a radio, after all. The cabinet is divided into two compartments. On top is the RF board and below is the DSP board. Both of these boards are very well made with a bunch of surface mount stuff on one side and the through-hole stuff on the other, over a ground plane. Without surface mount components, this would be a *much* bigger gadget. The construction quality is first-rate and it feels strong, like a metal brick.

Unlike all the other Ten-Tec things I've owned, this one has no schematic or technical documentation in the manual. It really is a "black box" for listening. And listen it does! It is no match for the Corsair II on CW/SSB on 40M in the evening (not a surprise), but it is surprisingly good in heavy QRM and QRN. I think an RF gain control or an attenuator would be handy, but I'll get along without them. I would say that it is a better CW/SSB radio than a Ten-Tec 509 or Triton, so it is perfectly useable as a ham receiver. The fast AGC is fast enough that you can monitor your CW signal with it.

I bought it mostly as an AM/SWL radio, and it really is great at "program listening". The DSP filters are so steep-sided that heterodynes are not a problem and a notch filter isn't necessary because there were no whistles from nearby carriers. The recovered audio sounds very clear, but there is a hint of harshness from time to time when using headphones, which need some series resistance (something <100 ohms, depending on the phones) to not be overpowered. I may have an impedance mismatch. In any case, it is so minor that it can only be heard by compulsives.

There is no speaker built into the unit, so I tried several speakers and headphones plugged into the "external speaker" jack. The sound of the radio is very dependent on the speaker, so try out several to find what you like.

Ten-Tec expects most users to use the line-level output jack connected to the line-input jack on your soundcard or stereo. I tried this and it works fine, but I like the sound of the direct speaker better because my soundcard adds too much bass to everything.

I had better luck with a 20' wire connected to the RCA phono antenna jack than I did with the built-in whip antenna. I also use my inverted-Vee's and other outdoor wires and the RX320 seems to handle the strong signals very gracefully. I got some local AM breakthrough that went away when I used my antenna tuner.

The Windows® based software is very easy to use and installed for me with no problems. The spectrum scope mutes the radio when it sweeps a range of frequencies, so you can't really see what you are hearing, but this and all the other features are done in software, so I expect improvements over time.

Using the programmer's info from the web page, I wrote my own control program that works from DOS. A 16 MHz 286 is a little slow, but useable, and I have an older laptop that I use as my "front panel" with the RX320. For some reason, I find the keyboard easier to use than a mouse.

Actually, there isn't any reason some enterprising soul couldn't build a real front panel with knobs and switches and use a microcontroller to generate the serial data! And power the whole thing from solar panels, too, if that is what you like.

This is a different kind of "home-brewing" that I hope becomes more common. It's sharable, too. Thanks to Chuck Olson, WB9KZY, you can download my program and read his impressions of the RX320 from his website (http://home.att.net/~jacksonharbor/rx320.htm).

Overall, I think that Ten-Tec has done a wonderful job here, and I can see that I'm going to have a lot of fun with my new toy.

The RX320 PC Receiver is available from:

Ten-Tec
1185 Dolly Parton Parkway
Sevierville, TN 37862
Phone: 800-833-7373
Email: sales@tentec.com
URL: http://www.tentec.com

Edited by W1HUE

"Add-On-Kit" for the Rainbow Tuner

By Joe Everhart, N2CX

Extend the range of your Rainbow Tuner to also work on 20 and 80 meters

Introduction

The NJ-QRP Club introduced my Rainbow Tuner design as a kit onto the QRP scene about 18 months ago. This project provided an SWR bridge with a colorful display of LEDs and a simple LC tank suitable for tuning a half-wave antenna on 30 and 40 meters. The kit sold like crazy and there are many happy users.

Many people wrote asking how to use the Tuner on other bands, and we published several application notes describing how to this. But still there was a need to take the recommendations a bit further and actually provide the parts and some construction/installation ideas as a further service to the many Rainbow owners in the field. Thus the simple and convenient Rainbow Add-On-Kit was born ... "AOK" for short!

Description

The Rainbow AOK is a set of components used to extend the operating range of the tuner portion of the Rainbow Tuner. The AOK is designed to work with the tuner by itself or as installed in the KE6RIE "Rainbow Enclosure". *(See Notes section. -ed)*

The Rainbow Tuner is a simple combined tuner and SWR indicator tuner designed for use with end-fed half wave wire antennas on 30 and 40 meters. The tuner portion is a tapped parallel-tuned resonant circuit that transforms the high impedance of the end-fed half-wave to 50 ohms so that common coaxial feedline can be used. Its tuning range is limited by the capacitance range of the compression mica trimmer mounted on its pc board. The KE6RIE enclosure kit is supplied with a panel mounted variable capacitor with a similar tuning range.

The Rainbow's tuning range can be easily extended to 20 and 80 meters by changing the effective value of the parallel tuned circuit components. This is accomplished by connecting either an inductor or capacitor to increase or decrease the tuned circuit's resonant frequency. The AOK components can be connected (individually) across the tuner's ANT and GND terminals to effect this increase in range.

A toroidal core and #26 magnet wire are used to make an inductor which will increase the tuning range to cover the amateur 20 meters band. A 400 pf mica compression trimmer is needed to enable 80 meter operation. Note that as with the "stock" Rainbow Tuner, the antenna used must be a half wavelength or multiple thereof to be within tuning range. This is discussed in the Rainbow Tuner instruction manual and in application notes that can be found on the NJ-QRP Club web site.

Component preparation

The AOK components must be readied for mounting before they can be used. These steps are similar to the procedures performed during assembly of the Rainbow Tuner but are much simpler.

The first step is to wind the toroidal coil. But relax! It's a single winding with none of the tedious taps you had to make for the Tuner's inductor! Simply wind 35 turns of magnet wire on a T68-2 toroidal core. Remember that you get one turn each time the wire passes thru the center of the core. There are no fractional turns with ferromagnetic core toroids! Cut each lead to about 2 inches and tin the ends with a hot soldering iron. Some brands of magnetic wire are heat strippable so no scraping or sandpapering is necessary. The finished toroidal coil should look like Figure 1 below.

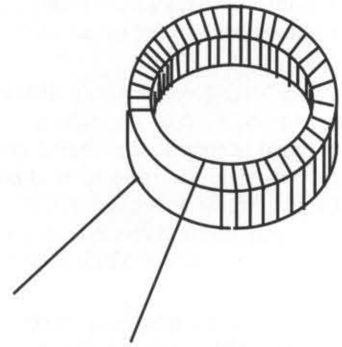


Figure 1 Toroid Coil

Next the mica compression trimmer capacitor must be prepared for mounting. Again, the procedure is similar to the one used in constructing the original Tuner. Use Figure 2 for reference. Begin by bending the tabs at each end of the capacitor so that they extend out horizontally away from the body of the part. Next cut off each of the side legs so that they protrude no more than about 1/16 inch below the body of the capacitor. Next cut off four 2-inch solid copper 20 or 22 Ga. leads (from bus bar or hookup wire that you have stripped of insulation). Tack solder one of these leads on each side leg and each end tab.

Now bend the leads on the end tabs downward so that they can be used both to mount the capacitor and to make electrical connections.

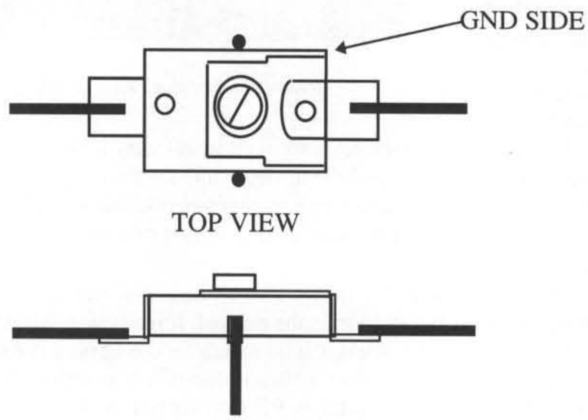


Figure 2 - Trimmer Capacitor Preparation

Connecting the AOK to your Rainbow Tuner

There are three basic ways (that come immediately to mind) for using the AOK components with your Rainbow Tuner. Check out each option and select the one that works out best for you!

Option 1 - 80/40 Meter "Stock" Rainbow Tuner

The first option allows you to convert your Rainbow Tuner from a tuning range covering 40 and 30 meters to 80 and 40 meter operation only. For this option you need only to replace the mica compression trimmer mounted on your Rainbow Tuner board with the higher-value capacitor from the AOK. The advantage of this change is its simplicity if you wish to operate only on 80 and 40 meters. However this method will not allow using the Tuner on any other bands. The prototype Tuner showed a tuning range of 3.1 to 7.6 MHz when modified in this way. Your mileage may vary.

Option 2 - "Stock" or KE6RIE Enclosure Rainbow Tuner with external AOK

This option allows extension of the Tuner's Range to 80 and 20 meters. No modification of the Tuner is needed, even if it is the stock pcb or if it's been mounted in the KE6RIE enclosure using the variable capacitor included with that kit.

You will need to mount the AOK components on a small piece of "perf board" such as Radio Shack 276-1395. The size of this perfboard is your own choice, though a comfortable minimum size is about 2"x2" inches. A sketch of one possible layout is shown in Figure 3. For clarity of presentation the scale is approximate.

Note which side of the trimmer end tabs touches the adjustment screw. This is the "ground" side. With the ground end tab oriented toward the toroid coil, mount the capacitor by running its attachment wires through its four mounting holes. When you are first laying out the board, be sure to drill a clearance hole so that the adjustment screw can protrude through the board. This allows the screw to pass through the board during adjustment. Bend over the capacitor leads under the board, cut to length and solder. Note that the two leads on the side of the capacitor have no electrical connection. They are for mechanical support only. Connection to the AOK components is via lugs secured to the board by four 4-40 or 6-32 machine screws and nuts. The components are wired to solder lugs below the board and external wires go to lugs on top of the board as shown. Self-adhesive rubber feet lift the board off the operating table both to protect the components and wiring and to keep them from being inadvertently shorted out.

To use the AOK components, connect the wires to the Tuner ANT and GND terminals one at a time. Use the "L" connections to extend the tuning range to 20 meters or the "C" connections for 80 meters. The wires can be connected directly to terminals on the Tuner or with minigator clips soldered onto the leads from the board used in Option 2.

Tuning on 20 meters is accomplished by adjusting either the capacitor on the Tuner pc board (for the "stock' tuner), or the variable capacitor in the KE6RIE enclosure configuration.

For 80 meters set Tuner capacitor to its maximum value and use the AOK trimmer to match the antenna. Tuner tap selection is via the usual method. Note that tap selection for lowest SWR may change from band to band and in some cases it may not be possible to obtain an SWR of 1.5:1 without trimming the antenna length, particularly on 20 meters. Generally speaking an SWR anywhere below 2:1 is acceptable.

Prototype "stock" Tuner measurements showed a tuning range of 6.5 to 18.1 MHz with the on-board capacitor. With the AOK external inductor (only) in parallel, coverage was 8.9 to 23 MHz. Using just the AOK capacitor externally, the Tuner was tunable to below 3 MHz. These tests were strictly bench tests with a resistive load so they may or not be exactly duplicated by others. However they do indicate the approximate tuning ranges that can be expected.

A prototype Rainbow Tuner in the KE6RIE case showed a range of 4.4 to 2.9 MHz using the internal capacitor. With the AOK inductor in parallel coverage was 8.3 to 16.7 MHz. With the external AOK capacitor set to 200 pf, tuning was 3.0 to 3.9 MHz.

Option 3 - "Loose" AOK Components

This option is not recommended, though it has been used as a "temporary" measure. You really don't need to mount the AOK components on a perfboard at all. Simply connect wire leads to the components and solder minigator clips onto the ends of the wires. They are then paralleled with the Tuner ANT and GND terminals using the alligator clips. However care must be taken to ensure that the external components are not in contact with any metal surfaces or wires and that they are handled carefully to avoid damage. The 40/80 meter CW station of the NJQRP group successfully employed this method for their 1998 Field Day setup. However after Field Day the components were mounted as in Option 2 so that the "temporary" measure did not remain permanent!

Option 4 - Switched AOK Components

The final option is a "cadillac" means of picking which AOK component (or none!) to use for a given situation. Simply put, you mount and connect the Rainbow Tuner and AOK component any way you want and used a toggle switch to select which is used. Figure 4. The switch is an SPDT switch with a CENTER OFF position such as the Radio Shack 75-325. In the figure the switch selects the inductor with the lever to the right, the capacitor to the left and neither in the center position. To minimize strays minimum lead lengths are recommended, say no more than a couple of inches.

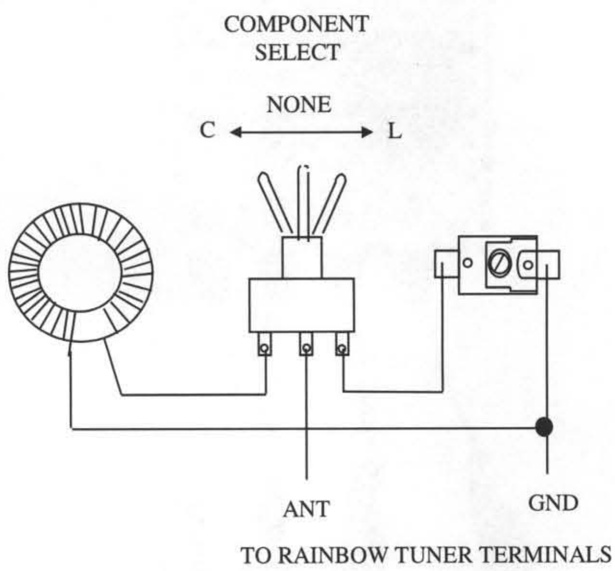


Figure 4 - Switched AOK Components

Sooooo, let's go to the field!

So there you have it! A simple, inexpensive way to modify your Rainbow Tuner for 80 meter and/or 20 meter operation, in addition to its stock operation on 30 and 40. We've had lots of success with the AOK prototypes built by some NJ-QRP members, and comments are that it's a great way to take the rig to the field. The Rainbow Tuner itself is such a nice portable tuner for the simple half-wave antenna, and one can easily take it on business trips along with such rigs as the eagerly awaited and spectacularly designed NorCal 20.

72/73,
Joe E., N2CX
from South Jersey y'all!

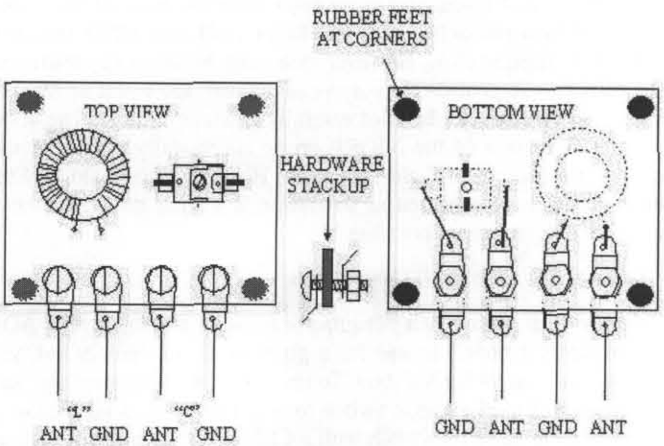


Figure 3 - AOK Components Mounted on "perfboard"

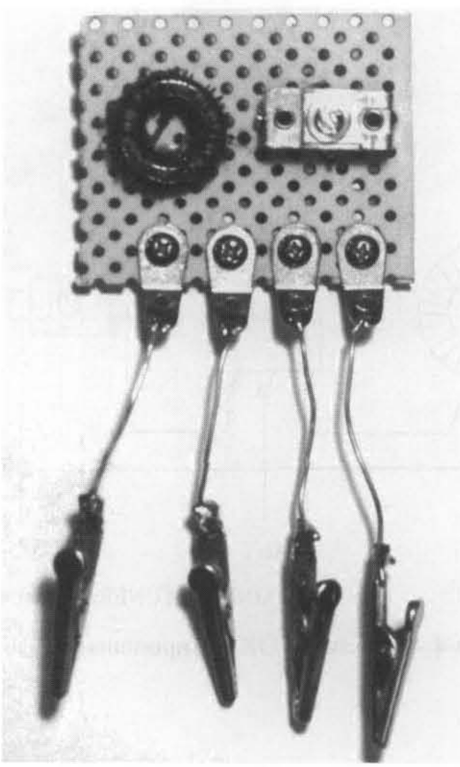


Figure 5: AOK Prototype

NOTES:

1) The Rainbow AOK is being kitted and provided by the NJ-QRP Club. The kit consists of one toroidal core, 80 inches of heat-strip magnet wire, a compression capacitor, and a clearly detailed set of construction and installation notes. Order by writing a check or M.O. to George Heron for $7.00 and send to NJ-QRP Club, 45 Fieldstone Trail, Sparta, NJ 07871. Availability is immediate and you can expect a one week turnaround.

2) The Rainbow Tuner kits themselves are completely sold out. The schematic, parts list, application notes, reviews and other information are all still located on the website of the NJ-QRP Club: http://www.njqrp.org/rainbow/rb_home.html

3) You can refer to the NJ-QRP Club website for further information concerning the AOK. See the link on the club's home page: http://www.njqrp.org

4) The "Rainbow Enclosure" is a fabulously-manufactured black-annodized and engraved aluminum case provided by Doug Hauf, KE6RIE of San Luis Machine Co. Doug sells these handsome enclosures for $29 + $5 shipping. See his website for ordering details: http://www.fix.net/~slmachco/

5) Technical questions may be sent directly to Joe Everhart, N2CX, 214 New Jersey Road, Brooklawn, NJ 08030. Joe's e-mail is: n2cx@voicenet.com

Eight Bands on Two Wheels!
Part 2: Operating QRP Bicycle Mobile

John Cumming, VE3JC *192 Wellington St., Delaware, ON* *Canada N0L 1E0*
Email: jbcumming@wwdc .com

In the October 1998 issue of the ***QRP Quarterly***, I discussed the mechanics of putting an HF multimode QRP station on two wheels. So over the winter you've been busy installing a mobile antenna, battery system, paddles, and handlebar rig case on your bicycle. What are you getting yourself in for, when the snow melts and you head out on the road? In this article, we'll talk about the tricks, traps, thrills, and frustrations of QRP bike mobile operation.

I should state up front that my knowledge of bicycle mobile operating has some big gaps. In twenty years on the air, I've never actually *worked* an HF bicycle mobile op myself! [1] So I have to depend on received signal reports and QSL card comments to know what a bike mobile signal *sounds* like. And there are many operators around who have much more experience than I have had "behind the handlebars," operating both sideband and CW. Later on, I'll give you some leads on how to get in touch with other similarly insane bike mobile hams. When I first share my interest in bike mobiling with other QRP operators, they pose exactly the same question we usually get from hams newly exposed to QRP: "Well, it *sounds* interesting ... but can you actually *work* anybody?" The answer (again, the same as for QRP in general) is that you *can* have many successful QSO's while bicycle mobile – probably more than you would expect given the limitations in power and antenna efficiency. A few days after assembling my QRP-PLUS / OUTBACKER bicycle mobile station, I set out for an after-supper ride around the countryside. It was really only a "test ride" to confirm that my antenna, paddles and rig were mounted securely, but when I heard G3MJX faintly calling CQ on 20 meters, I gave him a call. He persevered with my less than stellar signal and "gravel-road" fist, and we had a successful two-way QRP QSO. As I write this article, I have just returned from a bike ride into town to drop off a video. During the ride I had three enjoyable two-way QRP contacts on 40 meters, including a chat with Fran, KA3WTF, who knew exactly what my bike mobile rig looked like since a copy of the October ***QRP Quarterly*** was open on his desk!

You don't have to keep to paved roads when bicycle mobiling, but be alert for low tree

The most important consideration in heading out bicycle mobiling is *safety.* The operation of your radio equipment should not interfere with your control of the bike. A helmet-mounted mini microphone for SSB, and paddles mounted close to your brake controls, will keep you and your rig from a close encounter with the pavement! Earphones should not be used if they block out traffic sounds. A full water bottle, first aid kit, sunscreen, and bike lights (for twilight riding) are essential. While mobile operation from a bike may appear "hazardous" or impractical to some, it is in many ways easier than the four-wheeled variety. Stopping to make log entries or antenna adjustments is simpler, you don't have ignition noise to contend with, and sending CW with "both hands on the wheel" is certainly more practical on a bike.

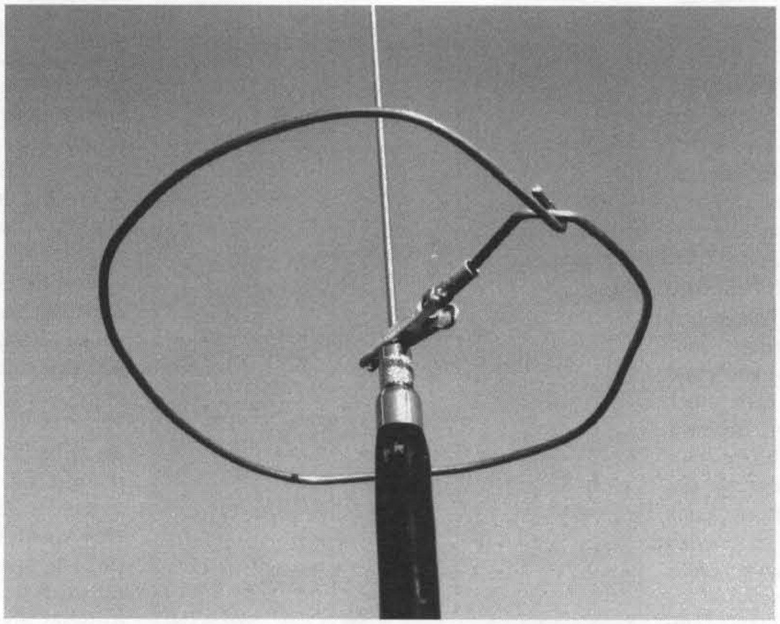
Where is the best place to go bicycle mobiling? Obviously, in the most exotic and beautiful location your budget and schedule will allow! I'd love to say that my bike mobile operating consists of frequent trans-continental expeditions, but the fact of the matter is it is usually done very close to home in evening or weekend rides. Whether you're heading around the neighborhood or across the country, paved rural roads with minimal vehicle traffic are the ideal routes for bicycle mobiling. Sending good code is significantly easier when riding on paved surfaces, and it is less likely that you will encounter an obstacle or pothole to send you and your rig into orbit. There is a "warble" in received audio from my QRP-PLUS when the bike is jarred while riding on rough roads. (I'm not sure of the reason for this phenomenon!) If possible, plan your route along roads without power lines (or with power lines on the opposite side of the road) to assure optimum reception. (Keep in mind, though, that bicycle mobiling is a great way to survey ambient electrical noise and QRN in the neighborhood, and to locate noisy insulators!). In spite of the problems with rough road riding, I enjoy getting off the beaten path and exploring gravel roads and mountain bike trails. Of course, it is important to always be conscious of the high antenna behind you – in an encounter between your antenna and a low tree limb, the limb usually wins!

While riding along, I generally scan across the selected band near the QRP calling frequency. Spinning the rig's main tuning dial requires one hand off the handlebar, but is no problem on smooth flat roads. If road conditions are poorer, the memory button on the QRP-PLUS can be used to toggle between two frequencies on the particular band. This feature is especially useful if I am monitoring a QSO on one frequency, waiting to "tail end" with one of the operators. When calling a station, I usually sign "de VE3JC/qrp/m". Attaching "/qrp/m" lets the other operator know why my signal may be weaker and possibly more inconsistent than he might otherwise expect. Subsequently, in my first exchange, I will let the other ham know my mobile operation is not "run of the mill" by sending "HR bicycle mobile." This usually catches the attention and interest of the other party, and requests for information and a "photo QSL" often follow. Because some hams who hear I'm "bike mobile" assume I'm riding the 650 cc variety, I always try to stress "bicycle" so they know I'm environmentally friendly.

[1] *John reports that he finally had his first successful 2xBike Mobile QSO with Russ, KB8U, on 40MCW on the afternoon of November 1, 1998. – W1HUE.*

I suspect that my transmitted signal while riding on the bicycle sounds different from a "normal" mobile signal, because the whip on the Outbacker antenna is in constant "side to side" motion. Ade, W0RSP, described my signal during the "Bubba Sprint" as having "a wavering instability like impedances were changing." (However, when I had trouble contacting other stations on that afternoon, I returned home to discover my battery was discharged, so I'm not sure whether my "easy to pick out" signal was due to bike mobile characteristics or to a 9.8 V supply to the QRP-PLUS!) If conditions are marginal, I will pull off to the side of the road while calling a station, to assure that my signal is as stable as possible. This also allows me to write down essential log information. Once contact is established, I resume riding.

What bands are best for QRP bicycle mobile operation? Since most of your bike mobiling will be in daylight hours during the summer months, you probably already have an idea which bands you would like to target. Given the greater efficiency of my Outbacker antenna on the higher bands, I generally enjoy operating on the highest band that's open. By making a quick stop in the shack to scan the bands before setting out on the bike, I minimize the time spent fiddling with the mobile antenna. (An automatic antenna tuner in conjunction with a random length whip or loop might permit "on the fly" band hopping, but I would want to make sure that relays in the tuner would not chatter while travelling on pot-hole laden roads! Anyone want to lend me their QRP LDG autotuner for some heavy duty testing?)



A capacitance hat made of an alligator clip and solid copper wire is attached to the Outbacker antenna for CW operation on 40 and 80 meters. The small hook at the end permits the hat to be attached without removing the whip, and prevents loss should vibration or wind dislodge the hat. (Photos by Andy Stockdill.)

Every true QRP'er loves to set "self-challenges" then goes about meeting the challenge and moving the bar a little higher. My initial bicycle mobile goal was to have successful CW QSO's on every HF band, to be able to claim true "eight band" status. Thanks to a few 10-meter openings, beautiful cycling weather, and the excellent ears of many operators, this was achieved fairly easily. Two-way QRP contacts were logged on most bands – including a check-in to the Sunday night Knightlites net, which yielded a 439 RST from Paul, AA4XX (don't try this without a bike light!). Next year, the bicycle mobile challenge will be WAS, CANADA-QRP, and (given enough kilometers on the bike) DXCC. Summer QRP contests and QSO Parties provide excellent opportunities to test your bike mobile equipment and operating skills. During the '98 "Bubba Sprint" and "QRP Afield" contests, I had a number of enjoyable QSO's. QRP Afield has a "rover" class and it should be quite easy to clean up in the rover class by going bicycle mobile.

As with "backpacking" portable QRP operation, it is important to keep the weight down when bicycle mobile – any accessories that add to your mobiling enjoyment without adding to the load are a real plus. Examples include a "multi time zone" wristwatch, for GMT, and the mini logbook available from Wilderness Radio (which fits conveniently in my handlebar rig-bag). The Wilderness Logbook has useful calling frequency and DXCC country information. I have added other information to the logbook, including a small chart showing the SWR curves for particular configurations of my antenna (reflecting variations in whip length, number of turns in the Outbacker "wonderlead", and the addition of an accessory capacitance hat). Topographical maps, grid square information, and detailed road maps showing all side-roads are also handy on longer trips.

One of the real benefits of bicycle mobiling is to get exercise and fresh air while still enjoying the fun of QRP. Instead of feeling "guilty" for locking yourself away in the shack on a beautiful summer day, you can take your shack with you and shed a few pounds in the process. Between QSO's, cycling provides a perfect environment for contemplating future projects or mulling over solutions to technical problems. As with the "home station", it's always fun to explore enhancements to your bicycle mobile equipment. One modification to my bike mobile since the October ***QRP Quarterly*** article is an add-on antenna capacitance hat for extended frequency coverage on 40 and 80 meters CW (see photo below). A future improvement will be the addition of a memory keyer.

As I indicated before, there are many bicycle mobile operators who would be happy to provide advice or share experiences. Various approaches to bike mobiling and alternative methods for mounting equipment can be found on the web. Russel Dwarshuis, KB8U, uses an SST tie-wrapped to a GPS mount on his handlebars, and describes his homebrew bike mobile paddles arrangement on his website (http://www.merit.edu/~rjd/bike_cw.html). A number of QRP bike mobiling enthusiasts subscribe to the QRP-L email reflector, (including Jim Kortge, K8IQY, who operates 40 and 17m SSB bicycle mobile using a Mizuho rig and a modified hamstick) and kindred spirits are sure to be found in the ***Adventure Radio Society*** (ARS). ARS promotes QRP operation from locations reached by human power, so operation *while* human powered certainly qualifies! A recent issue of the online ***ARS Sojourner*** contained an excellent article on bicycle camping and QRP. Any ham interested in cycling should definitely become a member of ***Bicycle Mobile Hams of America*** (BMHA). BMHA membership puts you in touch with a friendly and helpful group of bike-riding hams via regular HF nets, quarterly newsletters, email directories, and forums. While their focus is largely on VHF, their membership does include HF and QRP ops, and available newsletter back issues have many interesting articles on antennas, gear, and bike setup. I was able to attend BMHA's forum at Dayton '98, conveniently scheduled early Sunday morning for minimal conflict with QRP and bargain-hunting activities. BMHA can be contacted by email at hartleyal@aol.com, or you can visit their web-site at http://www.ragbrai.org/bmha/ bmha1.html. For a sample copy of the BMHA newsletter and other bike-mobile info, send an SASE to BMHA, Box 4009-RC, Boulder CO 80306-4009. Annual dues are $10

QRP bicycle mobiling is not expensive. If you presently engage in any "to the field" QRP activities you already have most of the required components. A small transceiver, a $20 single-band hamstick, and a garage-sale special bike will open up a whole new world of QRP adventure. Winter is the perfect time to give the bike a tune-up, fabricate antenna and key mounting brackets, and study road and trail maps for next summer's mobiling adventures.

See you on the bands – and on the bike!

Edited by W1HUE

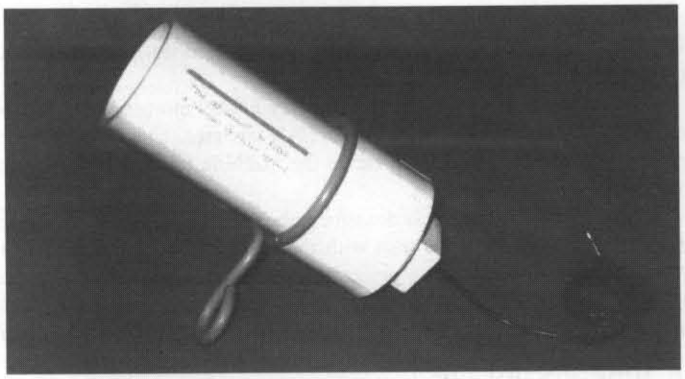
The QRP Cannon

by George "Danny" Gingell, Jr., K3TKS

A Resonant Speaker for CW Operation

This is my version of a resonant speaker for CW listening. The idea was suggested to me by Wally Millard, K4JVT, (SK) based on an article originally published years ago in QST.

It's constructed out of 2" PVC pipe and fittings so the materials are easy to come by. The tuning plug is made out of a 1-1/2" length of broom handle (1" dowel0 with four 1/4" deep slots sawn the length of the dowel. Each of these slots is fitted with a 3/4" x 1-1/2" piece of sheet aluminum or printed circuit board material.



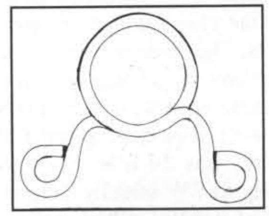
Construction

First take the 5-1/4" piece of 2" PVC pipe and insert it into the PVC adaptor. This adaptor allows connection of PVC pipe to threaded pipe.

The speaker rim will need grinding and filing to make it fit into the adaptor on the threaded side. Once the speaker is screwed into the adaptor you can make a 1/8" hole in the 2" PVC end cap and thread the speaker cord through the hole and connect it to the speaker terminals. Finally, screw in the PVC plug. (Dont forget to put a figure 8 knot in the cord to act as a strain relief. At this point you have the speaker mounted in the PVC tube (Cannon barrel) and are ready to make the tuning plug.

The tuning plug is made out of a 1" diameter wooden dowel. I used a piece of broom handle. The wooden dowel is 1-1/2" x 1" and you will make 4 slots lengthwise in the dowel. Press fit 4 pieces of 1-1/2" x 3/4" aluminum/tin or copper-clad PCB material into the slots. This X-plug will press fit into the barrel of the unit and is used to tune the port.

Finally, take the 18" length of #6 solid wire and wrap two turns around the PVC pip barrel. Using pliers, put a 1" curl in the ends and twist them 90-degrees to form a pair of legs. The wire stands the speaker up at one end, so the nickname "QRP Cannon" is self-evident when you view the finished product.



Usingyour Cannon

To use the QRP Cannon, simple adjust the plug assembly in or out of the barrel to set the peak response frequency. I've chosen 750 Hz but there's no reason you couldnt select your favorite. Youll need a longer pipe, of course, if you prefer a pitch much below the one I've chosen. This is a narrow filter and really cleans up QRM!

Parts List

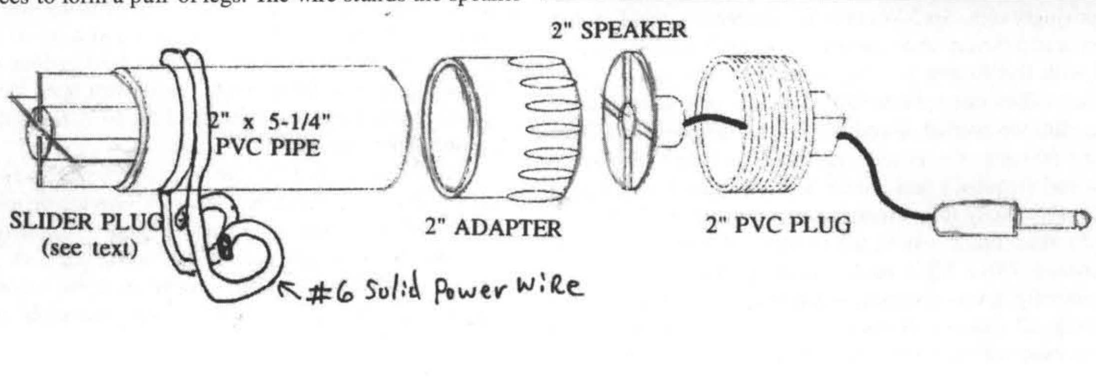
- 2" PVC pipe, 5-1/4" long (qty 1)
- 2" PVC adaptor, to convert to threaded pipe (qty 1)
- 2" PVC plug, matches the adaptor (qty 1)
- 2" speaker, thin rim is best (qty 1)
- 3-4 feet 2-conductor shielded cable with 1/8" molded plug, from cheap headphones, etc, best to match rig (qty 1)
- 18" length of #6 solid conductor wire
- 1-1/2" length of wood dowel or broom handle
- 3/4" x 1-1/2" aluminum, PCB or tin/sheet metal (qty 4)

Optional Additions:

- Diodes for adding the limiter internally (qty 2)
- 2" PVC adaptor (7/32" hole drilled in end to receive 1/4" tubing connector for stethoscope connection (qty 1)
- 1-2" of 1/4" copper pipe or stiff plastic tubing, length determined by experiment
- stethoscope, removed form inexpensive blood pressure cuff (qty 1)

K3KTS can be reached at 3052 Fairland Rd., Silver Spring, MD 20904-7117. E-mail: k3kts@abs.net

Editor's Note:
This article was originally published in July 1993 QRP Quarterly by K3KTS. However interest recently surfaced again and Danny has provided some additional detail and photos on his version. And another QRPer, Ed Loranger, WE6W, is taking his own version of the Cannon more toward a commercially-available reality. Stay tuned!
...n2apb



The Arkansas QRP Club (ARQRP) Nets

Bob Schill, N9ZZ 193 Northpointe Dr., Mountain Home, AR 72653 email: n9zz@centuryinter.net

Back in October of 1995 Jim, KJ5TF, and myself discussed getting a QRP club started here in Arkansas and we agreed it would be a good thing. We also realized that it was necessary to have a means available for the club members to communicate with each other and exchange ideas. The obvious approach was to start some sort of a net to allow the members to get together on a regular basis. Meetings were out, only because we were scattered all over the state at that time, now of course, we are scattered all over the country and then some. Needless to say 80 meters was the band of choice, but we decided to try SSB instead of going to CW initially. Jim and I tried it and it worked fairly well but unfortunately the high power stations really gave us a tough go of it once in a while. We did try other bands, but they were not doing well and the propagation was not favorable.

Ok, now that everything was failing we tried CW on 3.560 MHz, which worked out quite well. I was a bit apprehensive about running the net only because I was always in the dark about how a net should be run much less actually run one. We talked about this and it was decided that we would keep the net on an informal note. All those "Q" signals were difficult for me to remember and it was more confusion than anything else. So, informal it was going to be. I was relieved that we agreed on that. I could visualize all kinds of other problems during a net and they would be tough enough for me to handle, namely poor conditions, signals not right on frequency with my tight CW filter, and all coupled with the thoughts of not being able to copy everything properly. I am not in the habit of writing anything down when I copy which making rag chewing very nice, but now I will have to remember more and that means that I will have to write something down, at least the call sign, name, and signal reports. That really made me wonder if I could do a decent job at it.

"These nets are a great place to stay in touch with other QRPers and exchange ideas and at the same time encourage each other to try new things. QRP can be frustrating at times when the bands are poor and these are the times encouragement is important."

It was also decided that there should be some kind of time restraint on the length of the net. Arbitrarily we decided that 30 minutes was enough, or at least close to that. Then the members who checked in could do whatever they wished the rest of the evening, continue hamming, spend time with their families or whatever.

The big night came and off we went! I called "QST" three times and followed with "AR QRP". I did resort to one "Q" signal to identify myself; I used, and still do use, "QNN Bob Bob N9ZZ N9ZZ" followed with the request for checkins "QNI?". I must say that the room got awfully warm that first evening; the sweat was forming on my brow and I was pretty nervous. The signals began coming in and I wasn't sure how to respond to that so I tried recognizing the call and sending the wait signal "AS" and it worked beautifully. The calls came in nice and orderly and surprisingly clear for 5 Watts or less on a noisy band to start with. I was elated and relieved when the net was over; it worked great!

We stayed with this format and continued with the 80 meter CW net for over a year. Then our membership began to skyrocket and the realization hit us that we needed something for the members that were not able to use the 80-meter net. Forty meters was the logical choice, so we chose a time and frequency and gave it a try. It was slow going to say the least; we were lucky to get more than two or three checkins in an evening and to make things worse, the band was terrible. Static and lots of QRM around 7.042 MHz made operating the net extremely difficult and eventually it was dropped as a lost cause, at least for the time being. During all this the 80-meter net was thriving and even though conditions were not always the best, the nets were successful.

Not too long ago Bob, AB5ZD, suggested that we should have another band available to include the stations outside the range of the 80-meter net. He was right but with the past experience I thought it would be a bit of an exercise in futility. He tried it and it turned out to be successful. Band conditions have improved and I personally believe that his approach to the net and his ability to keep it informal helps a lot.

Now we are proud to report that the AR QRP Club has two nets going and so far they both are successful. The frequencies and times of our nets are as follows:

80M	Monday 7:30 PM CDT (0030Z Tuesday)	3.560 MHz
40M	Wednesday 7:30 PM CDT (0030Z Thursday)	7.052 MHz

When we switch to standard time the local time does not change, the UTC time changes to 0130 Z.

We also run a local net on VHF every Friday morning at 9:30 AM on 147.00 MHz, which is the Harrison, AR repeater. That club has been gracious enough to allow us to tie up the machine for about 30 minutes each Friday.

We follow the format as described above on the CW nets and once everyone is checked in we start with the first person on the list. He is greeted and given a signal report and from that point he can make any comments or announcements he wishes. It is always interesting to hear what others have experienced in the past week, whether it is a building project or DX or just plain operating results. Everyone is free to make any announcements about hamfests or members having health problems or whatever. We are interested in our members. If someone wishes to continue a conversation with another station after the net, those arrangements can be made on the net. And so it continues, down the list to the end. If there is ample time left we will go through the list a second time, but it has been some time since we have done that; usually we are running out of time. When that is the case we usually ask for any final comments and then close it down. The net control station is changed from time to time so you might have to listen-up to be sure who is running the net on any given evening.

These nets are a great place to stay in touch with other QRPers and exchange ideas and at the same time encourage each other to try new things. QRP can be frustrating at times when the bands are poor and these are the times encouragement is important. It is also nice to meet at hamfests and just talk and get to know each other face to face. Some great and continuing friendships have been made through the nets.

As far as I can tell the secret is keeping it informal. I believe there are lots of operators out there that are in the same boat as I am: afraid of all the strict rules of a net and remembering those "Q" signals, and perhaps not being able to copy solid and have to ask for repeats. The speed is set by the checkins; our goal is to include everybody. The CW speed is geared to the speed of the slowest operator that checks in, so if someone checks in at a slow speed the NCS slows down to his speed, or at least makes that effort.

It would be nice to have a net on 20 meters and also a SSB net on some band but at this time we don't have the people to run them. With band conditions improving some of these things may happen.

We do invite everyone to join us on our nets, member or not, you are welcome. If you are not a member of the Arkansas QRP Club, you might be contacted and invited to join. Our "club" features No Officers, No Dues and No Politics!

Good QRPing!

Edited by W1HUE

Component Alternatives for Homebrew Design and Construction

by Gary Breed, K9AY

... or "What! Another circuit using the NE602 and LM386?"

Introduction

When it comes to homebrewing, we tend to use what we know about. What we know usually comes from the work of others. The same ideas get repeated until someone steps in and shows us another way to get the job done. That's just what is intended in this presentation. .

I'll be describing some components you may not know about. Some of them offer better performance than more common types, some offer greater functionality in a single device, some require fewer external parts, and still others simply offer different choices for design.

RF Components

Whether you want to build a receiver, transmitter, tuner or test gadget, there are many ways to get the job done. We have all seen circuits using MPF102 or 2N4416 JFETs for VFOs, 2N2222s and 2N3904s as buffers, 2N5109 and 2N3866 as drivers, MRF475 and 476 amplifiers, MC1350 IF amplifiers, NE602 oscillator/mixers, and many others.

FM IF ICs — Back in 1990, I published a design using a Motorola MC3362 dual-conversion FM IF integrated circuit. This is a device with dynamic range performance about the same as a NE602, two oscillator/mixer stages with buffer amplifiers between them, a limiting IF and a quadrature detector. [Refer to Figure 1 at the end of the paper.]

There were a couple other articles in QST and elsewhere with this and other FM IF chips used in receivers, yet they haven't become commonly used. Maybe it's because they are advertised as "FM" ICs.

In these ICs, only the IF strip and quadrature detector have any direct application to FM, and you can work around that limitation with some success. In my published transceiver design, I didn't use the IF strip in that radio, but you *can* use the IF strip in SSB/CW receivers! Here is one way [shown in Figure 2 at the end of the paper]

Note that this is a superhet receiver with single-signal reception using a crystal filter. The IF strip is actually an audio preamp in this circuit. Larry, K0NA, was the first one to show me that the way the IF amplifiers are implemented in most of these FM ICs allows you to "cheat" and get a good amount of linear gain before they begin limiting. The IF has a differential (push-pull) input that is normally bypassed on the side opposite the IF input.. But, if you leave it unbypassed, some negative feedback is applied and you get about 40 dB of linear range before limiting. In an audio amplifier for a CW receiver, this is actually provides a more pleasant gain-control effect than audio-derived AGC! (I'll discuss the audio portion of this simplified receiver later.) Finally, if left alone, the quadrature detector just passes the audio through with little effect.

Figure 3 shows the IF amplifier portion of the MC3362, which is virtually identical to other FM receiver ICs. You can see the resistors that connect the "far end" of the amplifier section to the input.

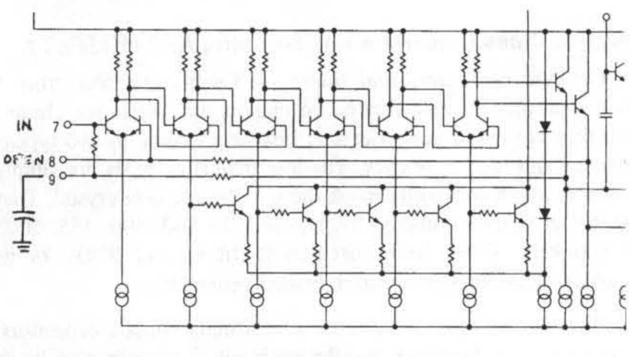


Figure 3. Detail of IF amplifier showing bypassing connections.

MMIC amplifiers — These are devices we see all the time in VHF, UHF and microwave circuits. Yet, nearly all of them are specified down to DC. Anytime you want 10 to 20 dB gain with only one resistor and one to three capacitors (depending on the rest of the circuit), these devices are by far the easiest way to get it. Mini-Circuits parts are carried by several homebrew suppliers, and these types of amplifiers are also made by Hewlet-Packard, NEC, Stanford Microdevices and other semiconductor companies. Philips, maker of the NE602, has lower-frequency versions than the typical microwave MMICs, the NE5204 (200 MHz) and NE5205 (400 MHz).

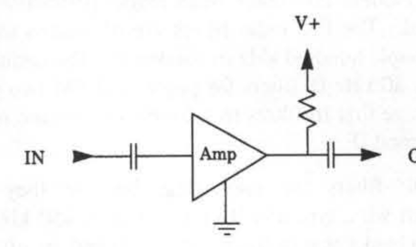


Figure 4. MMIC amplifier basic circuit.

Power FETs — Ham operators may not be familiar with some of the recent developments in power FETs. I'm not talking about the expensive specialized RF devices, but the garden-variety devices used in power control, switching power supplies, automotive systems and other common electronic power switching and control applications. Many devices can be used as RF power transistors, at least in the bands 30 meters and below. Some are actually good to six meters! The under-one-dollar IRF620, for example, has been designed into high-efficiency RF amplifiers up to 40 watts at 30 MHz. The drawback of these devices is that they really need power supplies higher than 12 volts to obtain the available performance. For home use where batteries are not the primary power source, this might work out well. A good homebrew project using power FETs might be a booster amplifier for times when 5 watts just isn't enough. As an example of what can be done, here is a schematic of a high power amplifier using devices from Advanced Power Technology (APT). These transistors are much less expensive than specialized RF power transistors. This amplifier will deliver over 200 watts with just two or three watts input. This is not a highly complex circuit for an experienced homebrewer to tackle!

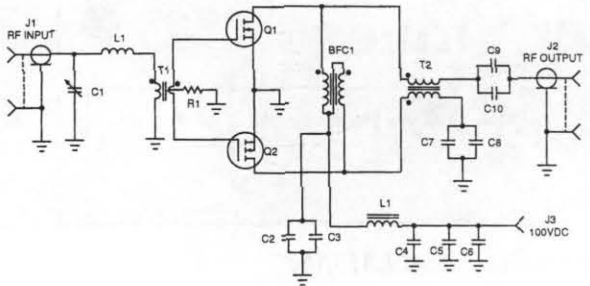


Figure 5. Class C power amplifier using APT MOSFETs.

Ceramic resonators and filters — Readily available from Digi-Key and surplus dealers, ceramic resonators and filters are cheap even when they are brand new! Ceramic resonators come in two types: low frequency and high frequency. The low frequency types are simply the resonator, which acts pretty much the same as a quartz crystal. They are available at round-numbered frequencies like 200, 400, 455, 500, 640 and 800 kHz. They can be used in IF filters and BFOs, or as the frequency-determining element in marker generators.

High frequency ceramic resonators usually contain capacitors that are part of a digital clock oscillator circuit. They can also be found without the capacitors. The capacitor versions can be used in BFO or marker circuits where they don't need much pulling. With the capacitor, they can used just like crystals in filters and VXOs. They are lower Q than quartz crystals and have some spurious responses that makes them a little harder to use, but they aren't particularly tricky. In a VXO, they can be pulled quite readily, but they have a bit worse phase noise than a crystal and those spurious responses can become a problem. Still, you need to a consider that a 10 MHz ceramic resonator without capacitors costs only 59 cents through Digi-Key!

Ceramic filters are interesting, as well. They come in AM, FM and communications types. (They also are available in SSB filters, but they are hard to get. You can sometimes find them in old SSB CB radios and as pull-outs from modern HF radios when higher-performance optional filters are installed.) The FM radio filters are of limited use to hams, since they are a couple hundred kHz in bandwidth. The communications types are typically 30 kHz IF filters for pagers and FM two-way radios. They can be effective first IF filters in a double-conversion scheme with 455 kHz as the second IF.

AM radio IF filters are interesting, because they are fairly narrowband to start with, typically 9 kHz at 455 or 450 kHz. They are cheap (around two bucks new in small quantities) and are often found in surplus component dealers' bins for fifty cents or so. Some time ago, I acquired a dozen or so 455 kHz AM filters and did a quick experiment to see if these filters could be cascaded for narrower bandwidths. I came up with the following circuit for a very cheap, but acceptable SSB filter with 3 kHz bandwidth or so. The individual filters must be closely matched for center frequency. The easiest way to do this is to monitor the output while adjusting a signal generator that is also connected to a frequency counter. This is a lossy filter, so a good IF amplifier is required. The coupling capacitors will vary according to the characteristics of the particular filters you use, but will probably fall between 300 pF to 1000 pF.

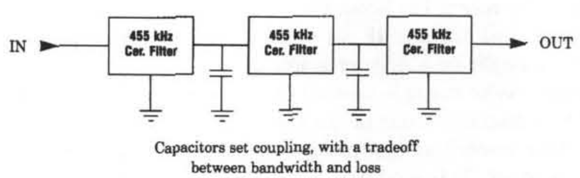


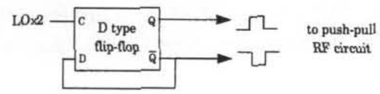
Figure 6. Three 455 filters cascaded to make a usable SSB IF filter.

Other RF components — more advanced experimenters might explore the various frequency synthesizer ICs, current-feedback operational amplifiers, and some of the IF ICs for digital personal communications equipment. These and other devices offer some interesting possibilities for very low cost, low parts count amateur radio gear. I've chosen not to go into a lot of detail on these devices in favor of presenting some others that are readily available to and usable by most experimenters.

Digital Components

Digital components have a definite place in amateur homebrew equipment, and not just in traditional "digital" circuits like frequency counters. They can be oscillators, dividers, switches, and even mixers. Here are some examples of digital components and there uses in ham gear.

HCMOS and ACMOS logic ICs — High-speed CMOS (HCMOS – 74HCxx devices) operates to 40 MHz or higher, or rather has transition times and propagation delays equivalent to a 40 MHz frequency. Advanced CMOS (ACMOS – 74ACxx devices) operates up to 120 MHz and has the added huge advantage of providing enough current drive for direct connection to 50 ohm circuits. Here are two circuit ideas that take advantage of the speed of HCMOS or ACMOS:



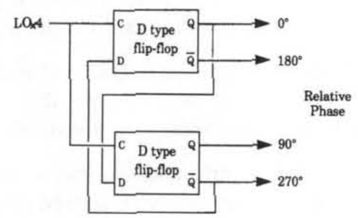


Figure 7 (top). A divide-by-two push-pull driver that can replace a transformer.

Figure 8 (bottom) A divide-by-four for phasing-method rigs.

Analog switches — a family of devices that cross over analog and digital are analog switches. They are included here because they typically are in a company's digital devices catalog, and they are intended to be driven by digital circuitry. The best RF analog switches are lateral DMOS (LDMOS) switches, which can be configured as individual transistors, ICs with four or more matched transistors, and may include additional digital driving circuitry. LDMOS switches make excellent mixers. Every modern HF radio uses FETs as switches in the first mixer, and LDMOS is the best type of FET for switching small signals. A while back, there were articles on the Siliconix (now TEMIC) Si8901 and SD5000 devices. These are still outstanding examples of the highest performance available in a mixer.

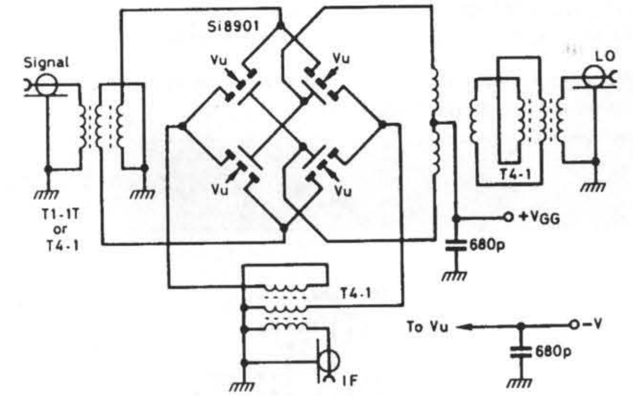


Figure 9. An analog switch mixer using the Si8901. The LO transformer can be replaced by one of the circuits shown in Figures 7 and 8.

Analog switches can also be used in their basic form — as switches. They can replace diode switching in most circuits and are easier to control (just apply a 5-volt logic-level signal). They are sensitive to very high signal levels, so they should be used in front-end and IF circuits.

Audio Components

The venerable LM380 and LM386 are still good devices. They are proven, and are quite easy to use. However, there are many alternatives that offer interesting alternatives. These include devices designed for two-way radios, automobile entertainment systems, portable cassette and CD players, and cordless telephones.

Motorola MC34119 and National Semiconductor "Boomer" Series — These are audio power amplifiers that have two prominent features. First, they are configured as push-pull amplifiers that do not need the large DC blocking capacitor used with the LM380/386 and others. The Motorola MC34119 has been around the longest, but National Semiconductor offers similar parts, including ones with more than the MC34119's 400 mW maximum power. The LM4871 is the latest member of National's family, delivering 1.1 watts of power using a 5-volt power supply. The basic internal circuitry of these two audio amplifiers is shown in the next two figures. Note that they are essentially the same.

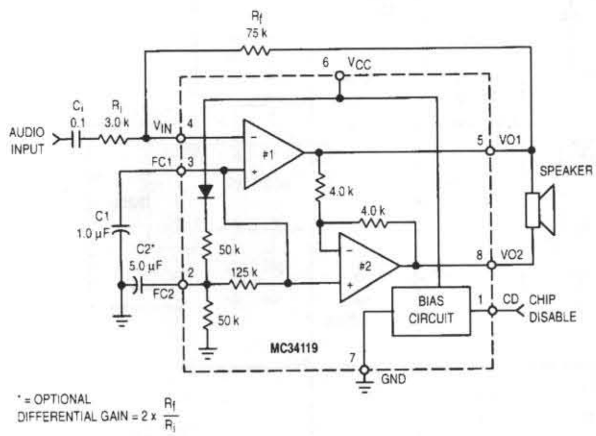


Figure 10. Application circuit for the Motorola MC34119.

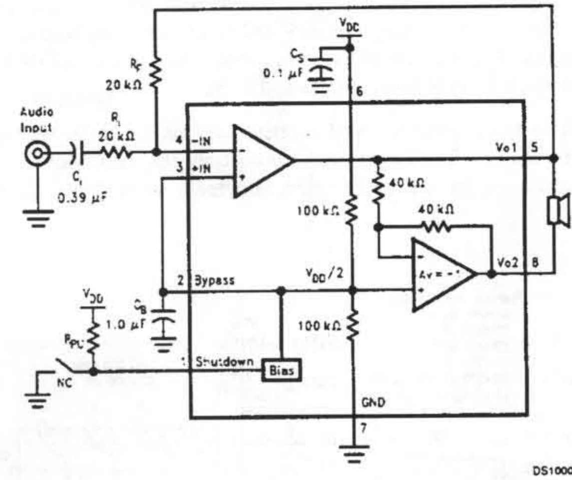
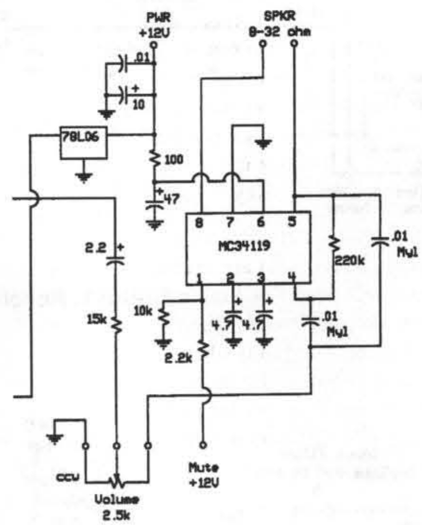


Figure 11. Application circuit for the National LM4871.

These amplifiers are internally designed as op amps, and many of the external configurations of op amps, including active filters, can be implemented. Go back to the audio portion of my two-chip superhet, an LM34119 is used as both a power amplifier and an active bandpass filter centered on 750 Hz, as shown in the detail next:



Get a copy of National Semiconductor's catalog for these products (available from Digi-Key and often seen at hamfests). There is a huge selection of amplifiers with such features as: DC volume control (good for audio AGC), DC tone controls, switchable inputs, power amplifier and microphone preamp on one chip, and a range of power levels and power supply voltages.

Other components

I just didn't have the time (preparation and presentation time) to cover a wider range of devices. Some others that come to mind are switched-capacitor filters (SCFs), pre-packaged RF transformers and couplers, power supply components and lots of other things that are rarely mentioned in amateur project descriptions.

However, I think enough ideas have been presented here to make it clear that homebrew designers have a lot to choose from when developing that next generation of QRP rigs. The technology of discrete components is toward smaller devices, but new components are clearly headed for the higher frequencies where cellular and PCS phones, wireless data, and other high-growth markets have their frequency allocations. Even the lower-frequency IF components have challenges for a homebrewer. While they are intended to reduce parts count, often that means that they are controlled by a serial data bus instead of being directly connected to volume controls and such.

Learning to program microcontrollers such as the Basic Stamp or PIC may be the next hurdle for active homebrewers. This should come as no surprise — In the early years, amateurs went from spark to vacuum tubes, from regenerative to superhet designs, from AM to SSB, from vacuum tubes to transistors, and then to integrated circuits.

We should always expect the next generation to come along about the time we have mastered the last one!

Editor's Note
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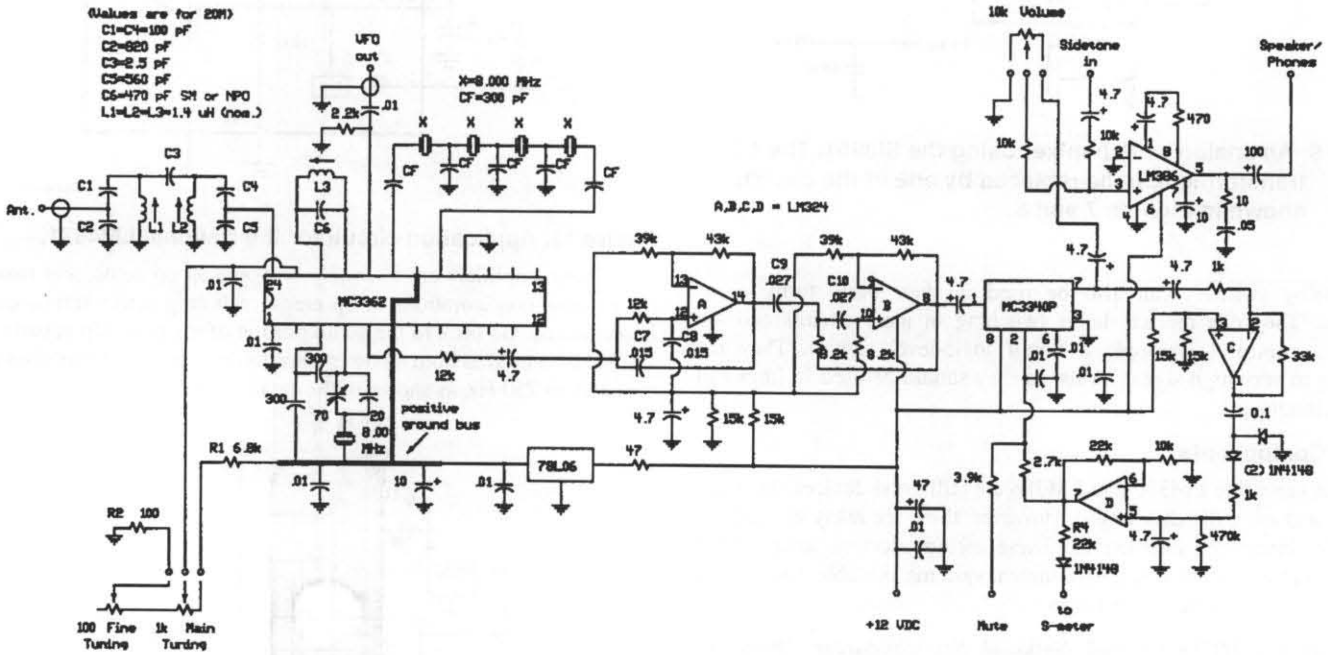

Figure 1. Receiver circuit from the K9AY transceiver.

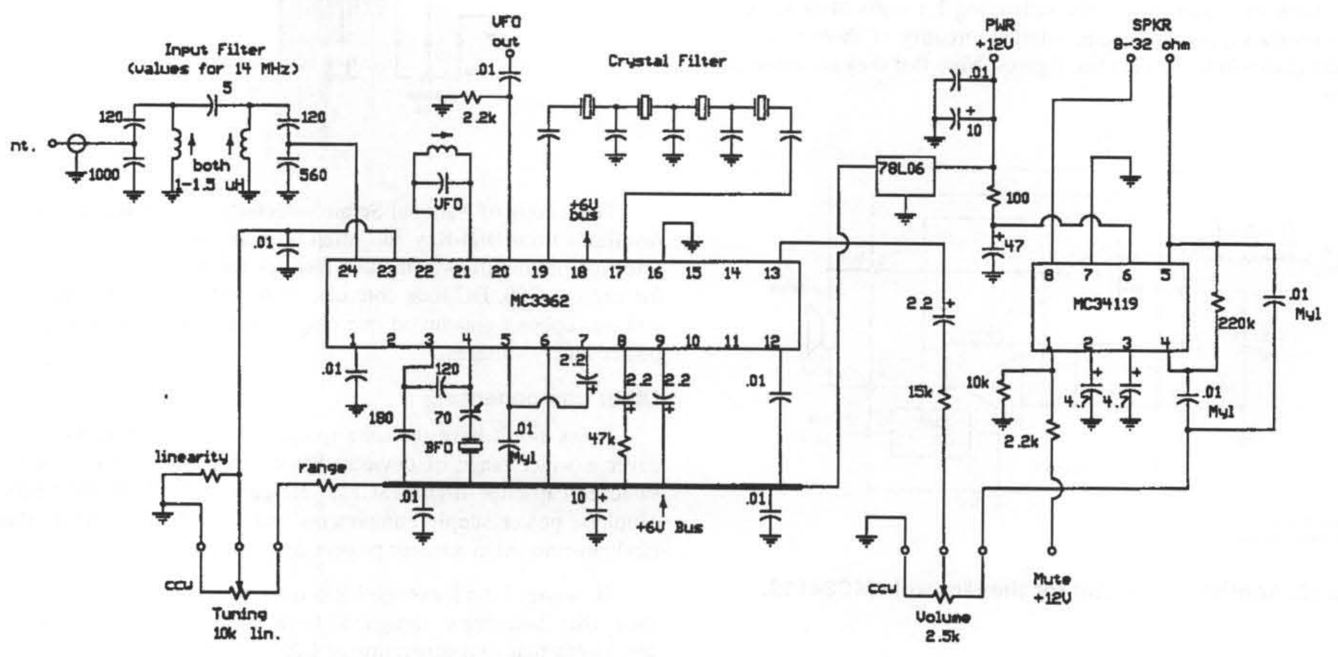

Figure 2. A two-chip receiver circuit similar to the original K9AY transceiver circuit.

Watt Goes Up Must Come Down – A Look At QRP Contesting

Jim Gooch, NA3V 2475 Miller Avenue, Huntingdon, PA 16652 email: gooch@juniata.edu

QRP contests, unlike the big international ones, are sociable and (pardon the pun) "low-key" events. Since we know we won't work stations by the bushel in a QRP "test," we ease up on code speed and repeat information when asked. But after the scores are toted up, it can be interesting to look at the emerging patterns; where are the geographical hotspots of QRP activity? What are the ingredients – besides aspirin and an iron constitution – that produce a high score?

Just for fun, I searched for some of these patterns in the results of the 1997 Fall ARCI QSO Party and the 1998 Spring ARCI QSO Party tallied by Cam Hartford and published in the ***QRP Quarterly***. These are 36-hour contests with nation-wide participation, so they should be fairly representative of QRP contesting. Cam's spreadsheet-like log summaries are loaded with information. So much information, in fact, that one could go overboard on statistics, plugging the data into complicated analysis schemes in the hopes of discovering the "key" variables of QRP contest scores. Luckily, I subscribe to the philosophy of Bob Wicks, W3HAH, of the QRP Society of Central Pennsylvania: "If it isn't fun we don't do it. If it isn't necessary we delete it." Statistics isn't fun and I deleted it. So, as befits QRP, the analysis below is low-powered and homebrew!

First, where do QRP contesters live? Well, a lot of them live in the Mid-Atlantic States. Thirty-three out of 157 (21%) U.S. and Canadian stations listed in the Fall QSO Party results have QTHs in MD, NJ, and PA. The percentage was nearly as high (19%) in the Spring Party. The overall QRP champ was PA, with 9% of contest stations out of a measly 4% of the U.S./Canadian population. NY and New England were pretty active, too. Special kudos go to RI, a state so tiny all its antennas are verticals, with more entries than some of its larger neighbors.

Heading west, OH and MI were hopping with contest signals, but activity slowly fell off through IN, IL, and IA, to near extinction in the QRPer's version of the Bermuda triangle: KS, NE, SD, ND and SK. Contesting perked up in the mountain and desert air of CO, UT, and AZ, died down again, and made a final rally in CA, OR, and WA. Even so, only 4% of the entries were from populous CA. Those west coasters, forever tinkering with their NorCal kits, forgot to get on the air.

Looking south, QRPers were noisy in VA and NC, but quiet down in Dixie (AL excepted). In fact, only N4BP, Bob Patten, showed the FL flag in the two QSO parties. Maybe hurricane Andrew flattened all the sunshine state's palm trees, leaving nothing to hang antennas from. Finally, we come to the wide-open spaces of TX, where the typical antenna farm is bigger than RI. Like FL, though, TX was curiously quiet in the two ARCI contests; Cam lists only one TX entry in the Spring QSO party.

When it comes to contest score, many factors come into play: operating time and operator skill, output power, number of bands worked, antenna(s), QTH topography, and others. In looking at these, I concentrated on the 60 out of 257 North American entries in the two contests that compiled big-league scores of 200,000 or above (some of the 60, of course, are repeats). A few contesters stuck it out for the entire 24 hours of permitted operating time, but most took a few hours off. Amazingly, four or five operators rolled up scores over 200,000 in only 4.5 to 6 hours at the key. Most impressive was Bob, N4BP, who piled up 111,000 points per hour during a marathon 22.5-hour stint in the Fall Party, on the way to his 2,500,000-point winning total.

It's obviously important to work as many stations as possible to boost one's score. How important are SPCs? For single band entries, the scarcity of SPCs definitely keeps the score down. In the Fall Party, K9PX, a 40M entry, got about half the QSO-point total of N4BP, but his total score was only a sixth as high due to fewer SPCs (52). The SPC ceiling for any one band isn't a lot over 60 – the 50 states and Canadian provinces, plus maybe XE, KP4, HP, and a little additional DX. However, no single-band entry reached 60 SPCs, although several on 40 and 20M got close.

All the blockbuster scorers were in Cam's A-4 to A-6 categories, the number indicating how many bands were worked in the contests. An op working both 40 and 20M with good antennas might double the single-band base of 60 SPCs. Eighty meters would net some close-in SPCs and 15M could be used to pull in some of the stations worked previously on 20M, plus single-banders and the odd DX. I doubt if 160 or 10M contributed many SPCs. So, then, how many SPCs are out there to snag? N4BP got 173 in the Fall Party, and a couple of other operators weren't far behind. The totals were smaller in the Spring Party, reflecting reduced participation. To run up a killer score, it appears, you have to make a clean sweep of 40 and 20M, snaring 100 or more SPCs, meanwhile bagging stray 80 and 15M SPCs, to round out the total. Somewhere there has to be a final ceiling. Will any QRPer ever break the 200 SPC barrier? I wonder...

We QRPers are masochists, denying ourselves the primal joy of raw radiated power. Among the sharks, we're voluntary minnows. We compensate for our puny RF-forts by erecting towering antennas – if we have the space. To no one's surprise, most of the really whopping scores in the QSO parties went to hams with two or more antennas, usually including a Yagi or two for the high bands. There were many combinations – Yagi plus dipole or Zepp, Yagi plus vertical, Zepp plus vertical, and an assortments of loops, slopers, long wires and phased antennas. Happily, goodly numbers of signals were captured by simpler systems – notably the 499,000 score of N1QY, who used a vertical and a trap dipole. Many QRPers suffer from the anemic condition known as monoantenna-itis. Even so, some fantastic scores were racked up by a few skillful contestants operating with single G5RVs, long wires, and dipoles. Pride of place goes to AE0Q, who finished third in the Fall Party with a lone Carolina windom, ahead of many a Yagi-equipped station. As for power, 76% of total entries listed 4-5 Watt outputs, 14% 1-3 Watt, and 10% < 1 Watt. Can a sub-watt peanut-whistle make a dent in that clamorous CW, RTTY warble and heterodyne howl? Yes!

Three intrepid milliwatters joined the 200,000 club: K3TKS in the Fall Party, W3TS (0.25W!) and N0UR (966,000 score!) in the Spring Party. K3TKS and W3TS had fairly sophisticated antenna systems to direct their squeaks; N0UR didn't say, but he has used loops and dipoles in other contests. It's possible to run up a good score with 4-5 Watts into a so-so antenna, or milliwatts into a good antenna. But milliwatts into a crappy antenna won't cut it.

If I had a fairy Godmother, I'd ask her to park my ham shack on a hilltop in Kentucky on the eve of an ARCI QSO Party. I figure that's the strategic place to haul in the maximum number of QRP contest signals. "While you're at it, old gal," I'd says, "plant me a Yagi for the high bands, a tall vertical for the low, fix me a comfy chair for my behind, and make the coffee black." "No sweat," she replies. Now I'm ready to skim the QRP-rich eastern and Midwestern states on short-skip daytime 40M for mucho points and SPCs. I can also reach most of the southern and prairie states from here. At night, New England, eastern Canada, and the Far West will roll in with the longer skip. Evening will bring in lots of the same stations on 80M. When things get slow, I can hop up to 20 and 15 and pick up some more SPCs.

Well, my fairy Godmother didn't come across, but she did retire my old low-band vertical to the garage and helped me put up a sway-backed little windom in a grove of trees in central PA. It'll have to do. See you in the next "test."

Edited by W1HUE

Stealth CW

By Stan Wilson, AK0B

Is that QRPp signal of yours invisible when it is buried deep within the noise? Would you like to give it a 20 dB boost without additional drain on the battery? Now is the time to turn your 5 watt QRP stealth signal into a 320 watt monster at properly equipped receiving stations!

Spooks take note, you are still invisible to those without the proper receiving filters. Sounds like science fiction, however, in your own high tech amateur laboratory (basement workbench) you can create a ***Coherent CW*** *(CCW) station that will be reliable, power efficient, definitely high tech, and fun to build and operate. Yes, your QRPp station could be considered a stealth operation.*

A Bit of History!

There are times when something is developed that is just too good to pass up. CCW is one of those items. CCW originally was proposed by Frederick E. Terman, 6FT in an article published in 1930. ("Some Possibilities of intelligence Transmission When Using A Limited Band of Frequencies.") Earlier, Bell Laboratories had run successful experiments on 50 Hz bandwidth signals that were synchronized. The technology for the most part then laid dormant until Ray Petit, W7GHM published an article in QST (Sept. 1975). Ray developed a sample and dump filter for CCW. CCW activity and circuits were reported in CQ (June and July, 1977) by W0RSP and later in QST (May and June 1981) by W6NEY. Charles Woodson, W6NEY published a CCW newsletter during the period of 1975 to 1981. W0RSP promoted CCW in his QRP Journal the Milliwatt.

In addition to the publications several stations modified, built and operated on the 80 and 20 meter amateur bands. James Mynard, K7KK; Andrew McCaskey, WA4MTP/WA7ZVC; Chas. Woodson, W6NEY and Ray Petit W7GHM were all involved in the experimental communications. The first amateur communications took place between McCaskey and Petit. McCaskey had modified a Ten-Tec PM-1 (QRP transceiver of the early 70's) for use in CCW. Woodson conducted numerous CCW/QRPp tests on the Japan to California path with JR1ZZR and JA1BLV. The CCW activity appeared to disappear in the early 80's. Recently, (1990) G3IRM, Peter Lumb started to pick up the slack and began to promote CCW in Europe with his Coherent CW Newsletter. As a result, G4VSO, G3FMW, DF3CT, OE1KYB, G3RHI, G3IRM and others have again started experimenting with the technology.

In recent years Petit invented Clover which is now being commercially developed by HAL Communications. CCW and Clover are not the same, although both are based upon minimum bandwidth keying and demodulation techniques.

CCW is the perfect mode for the home brewer and QRP enthusiast. You still need to roll your own. The primary item that appears to be the limiting factor in setting up a CCW station is the frequency standard. However, a suitable standard for home construction did appear in Ham Radio, February 1974 by K4EEU and recently DJ7HS has developed a kit for the Elektor standard - Deutschlandfunk 153 KHz. The improvement of electronic components over the past ten years now make it feasible to design and build your own. The improvement in the nation's military requirements has resulted in numerous specialized electronic measurement laboratories dumping high quality standards into the surplus electronic market place. The frequency standard can no longer be blamed for the true experimenter not getting on the air with CCW. Recently, an advertisement listed a new TCXO (10 MHz) spec at 5 Hz (max) stability/tolerance at room temperature.

What is Coherent CW?

First, it is necessary to define CW. Continuous Carrier (CW) is the turning off and on of a RF carrier to generate a binary pattern (1 & 0) that is recognized as individual characters. The characters are defined as what has become known as Morse Code. However, true Morse code and the code used by amateur radio operators is not the same binary pattern. The modulation technique is known as amplitude shift keying (ASK), where a sinusoidal carrier is pulsed so that one of the binary states is represented by the presence of the carrier and the other is represented by its absence. Coherent Detection or synchronous detection required the availability of a local oscillator in phase coherence with the incoming modulated CW carrier.

There are two different techniques of coherent detection: filter and sample and integrate and dump. The CCW filter (limited bandwidth) concept and design for use in amateur radio developed by Ray Petit is of the integrate and dump type. The signal is integrated over one bit period along with all interference, noise, etc. and sampled at the end of the timing period to determine if the binary state is a one or a zero.

Due to the limited bandwidth filter, the demodulation of the CCW signal provides a 20 dB improvement over a station running equal power and a wide band filter.

In an article by Peter Lumb, G3IRM, that appeared in SPRAT, the G-QRP club publication, he gave a very non-technical but exacting definition of CCW. "Briefly, CCW uses the idea that signals are sent at definite times and not at somewhat arbitrary times as in CW. All CCW dots, dashes and spaces are exact multiples of a basic time unit and occur within predictable time frames." "This includes any pauses during transmission. When received CCW signals sound like CW signals, except that they are sent very precisely."

Something is never achieved without paying something! In CCW the lower code speed results in major improvement in reliable communications. Although, the later versions of the Petit filter do allow for adjustment of baud rate (code speed), the effectiveness goes down with increase in baud rate. The standard for CCW stations is 12 wpm or dots (bits) of 0.1 second in length. The effective bandwidth of a 12 wpm CCW signal is about 9 Hz. At 60 wpm this widens to approximately 45 Hz. At higher speeds the effectiveness of CCW to CW is lost.

The definition of CCW as put forth by Woodson (W6NEY) in 1975 is still a good one for amateur radio. COHERENT CW: "The technique of sending and receiving information in a binary code (i.e., Morse Code) in such a way that the frequency, pulse length, and pulse phase are known and used in the demodulation of the information transmitted."

A Practical CCW Station! *[... see Editor's Notes - ed.]*

An amateur CCW station would consist of the following:

1) A 1 MHz frequency oscillator (standard) that could be referenced to WWV to establish a known transmitting frequency. The stability of the oscillator has to be within a few cycles over a period equal to or greater than the length of the QSO.

2) The exact length of the binary pulse (dot) must be known. This is achieved by dividing the standard oscillator frequency down to 0.1 sec (10 Hz) intervals. (12 wpm)

3) If both the transmitting and receiving station referenced the phase of their operating frequency to the phase of the WWV, JJY, CHU, etc. then a method of adjusting the phase of the receiving filter would not be required since all stations would be locked to the same frequency and phase. However, an alternative is available. The Petit type CCW filter allows adjustment of the phase in 100 msec intervals of time. In order to synchronize the two stations, the transmitting station will send a 30 second period of dits while the receiving operator adjusts the phasing of the Petit CCW filter. Once adjusted, and the propagation path does not change appreciably, communications should be possible for several hours without further adjustment.

4) The transmitting oscillator must be stable and not be pulled (shifted) by the keying of the following stages. A heterodyne type of mixing oscillator with a buffer stage will meet these requirements.

5) A CCW filter based on the Petit design.

6) A frequency stabilizer locked to the station's standard for both transmitting and receiving.

7) Any amateur transceiver that could have its oscillators locked to the standard could be used. W6NEY used a stabilizer with his Heathkit SB-303. An excellent place for the experimenter and QRP operator to start is with the modification of NN1G's QRP transceiver.

CCW Keyer!

The standard electronic keyer must be modified for CCW operation. In the standard keyer, the starting of the oscillator is triggered by the closure of the key paddle. CCW (dots and dashes) must be in timing sync with the frequency standard. The CCW timer is running continuously, therefore, a delay may occur between the closing of the key paddle and the actual output of the dot (up to 0.099 sec).

Why Has It Taken So Long For CCW To Establish Itself In Amateur Radio?

Several factors influence the acceptance of a new or different technique. An excellent example has been the number of years required for TCP/IP to make major penetration into packet radio. Even in the 50's, SSB was not accepted overnight. CCW has many of the same problems in gaining a foothold as SSB did in the beginning. First, it is necessary to build at least a part of the station yourself. Low cost PC boards and/or kits are not available off the shelf. Second, just the though of a transmitter having a stability equal to 1 Hertz puts fear into most home brewers. Third, the majority of the amateur radio community resists making modifications to commercial equipment for fear of destroying the resale value. Fourth, the initial cost of the Petit filter was high. Limited production of any device results in an expensive item to produce. Fifth, the primary benefactor of CCW is the low power (QRP) enthusiast. A station with a signal level of S9+ on the other side of the world does not require CCW to communicate. Sixth is the limited CW speed. Improved performance occurs with reduction in speed. In the age of Packet, AMTOR, etc., the lower speed is not acceptable to some segments of our hobby. Seventh, but not the least is, the policy of the ARRL in recent years to produce amateur radio handbooks as technical reference manuals and not the construction manuals of earlier days of the League.

Measuring Frequency

In our review of the CCW techniques and methods one would note that they are all related to the basic frequency of the system. It must be known, to a reasonable accuracy, that the transmitt8ing and receiving stations are able to set their equipment within 9 Hz of each other on opposite sides of the world.

The beat frequency method is a simple method that is commonly used by radio operators to calibrate transmitters and to tune their receivers. This method allows a local oscillator (1 MHz) to be calibrated within 1 Hz. The beat note is obtained by feeding the local standard to a square wave generator and that signal is beat against the received WWV carrier. The BFO (beat frequency oscillator) on the receiver is not used.

Credits

 Considerable information is not original and was obtained from the following sources:

1) Charles Woodson CCW Newsletters (1975 - 1981)
2) CQ, June and July 1997, W0RSP
3) QST, Sept. 1975, W7GHM QST, May and June 1981, W6NEY
4) ARRL Handbook 1985
5) G3IRM Coherent CW Newsletter
6) SPRAT, #60, Autumn 1989, G3IRM
7) QEX, April 1994, VE2IQ
8) QST, February 1992, VE2IQ
9) QST, Sept. and Oct. 1952, W0
10) Ham Radio, Feb. 1974, K3EEU

Editor's Notes

This paper from Stan Wilson, reproduced here in QQ with his permission, was originally written for the St. Louis QRP Society's publication "The Peanut Whistle", circa 1990. It was also used as a handout reference at the 1998 FDIM technical presentation of CCW made by Peter Eaton, WB9FLW and George Heron, N2APB.

Since 1990, Coherent CW techniques have significantly evolved within a small circle of experimenters with Bill de Carle, VE2IQ and Peter Lumb, G3IRM at the center. VE2IQ has greatly advanced the state of the art with the development of his sigma-delta converter board described in reference 8 above. Coupled with a modest computer and Bill's COHERENT software program, the SD board (and a companion DAC) allows one to use CCW communication. Along with a special interest group called BPSK, de Carle has also extended the technology past CCW toward an improved technique called Binary Phase Shift Keying (BPSK). This evolution leaves CCW behind as an older and less-efficient communications mode, but still one worthy of study and experimentation.

The most complete set of online documents chronicling the evolution of CCW is located, with permission, at the site of the NJ-QRP Club: http://www.njqrp.org/ccw/

The design of a modern CCW QRP transceiver (using R2/T2/DSP/DDS technologies) will be described at the FDIM QRP Symposium at the 1999 Dayton Hamvention … ***n2apb***

"Four Days in May" 99 QRP Conference

May 13-15, 1999

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FDIM
Four Days In May™

at the Dayton Hamvention

QRP Amateur Radio Club, International (QRP-ARCI) proudly announces the fourth annual "Four Days In May" QRP Conference commencing Thursday, May 13, 1999 - the first day of four festive days of 1999 Dayton Hamvention activities. Mark your calendar for this extra bonus day and register early for this not-to-be-missed QRP event of 1999.

Thursday: QRP Symposium

Amateur radio QRP presentations, workshops and demonstrations will be the focus of the full day Thursday QRP Symposium to be held at QRP ARCI headquarters at the Days Inn Dayton South. Last year, this sold-out event had a "standing room only" crowd of 175 enthusiastic attendees.

Papers being Presented:

- ✔ "Vertical Antenna Design & Analysis", W4RNL
- ✔ "Constructing QRP Equipment", G3BPS
- ✔ "DSP-based Coherent CW Xcvr", N2APB
- ✔ "QRP Construction Tools & Tricks", G3RJV
- ✔ "Mixer Madness", WA2UNN
- ✔ "PIC-based SWR Bridge/Tuner", N2CX
- ✔ "Distortion Demystified", NN1G

FDIM QRP Symposium attendees will start their day with a wake-up coffee social and then plunge into a full day of multimedia QRP presentations by renowned QRP authors and designers. Copies of the Symposium Proceedings will be provided for all registered attendees. There will be a grand prize drawing for an Elecraft K2 Transceiver during the QRP Symposium. (Winner must be present.)

Thursday eve: Authors Social

Culminating this first day, will be an evening QRP ARCI Author Social for all to meet the QRP presenters.

Friday: ARCI Awards Banquet

The "Four Days in May" QRP extravaganza continues with the annual Friday night QRP ARCI Awards Banquet honoring QRP dignitaries for their service to the Amateur Radio community.

Friday eve: Vendor Social

Following the Awards Banquet, a special evening has been set aside for the FDIM QRP Vendor Social where prizes will be drawn. All are invited.

Saturday eve: Building Contest!

FDIM Saturday features an evening social for QRPers to meet the many regional North American and International QRP Club members - bring your banners! The evening culminates with a BUILDING CONTEST ... the categories are wide open so bring your latest kit, homebrew project, antennas, whatever! Judges will select winners for prizes, a feature article spot in the next QRP Quarterly, and will be candidate for project kitting, courtesy of the QRP ARCI.

The QRP ARCI "Four Days In May" 99 QRP Symposium will be the talk of the Dayton Hamvention! (See **FDIM FAQs** on next page.)

Banquet Reservations

Scott Rosenfeld, NF3I is handling the FDIM Banquet reservations. Follow these simple steps to get on the list to attend the Banquet:

- ❑ Write a check payable to QRP ARCI for the $25.00 for each attendee
- ❑ Provide the name, surface mail address, telephone number and e-mail address of each attendee
- ❑ Provide call sign(s) if available
- ❑ Provide a self-addressed stamped envelope if return confirmation desired.
- ❑ Send to Scott Rosenfeld, 2250 Paterson St 50, Eugene, OR 97405-2988 USA
- ❑ For more information, send e-mail to NF3I at ham@w3eax.umd.edu

Hotel Reservations

Hank Kohl, K8DD has once again arranged a special block of reduced-rate rooms to be held at the Days Inn Dayton South (DIDS) for FDIM attendees wishing to conveniently stay at the ARCI headquarters for the weekend festivities. Rooms are $72/night (+ tax) with as many occupants as desired. Let Hank know if you will be needing one of these special rate rooms. He can be reached at: QRP-ARCI Rooms, 1640 Henry, Port Huron, MI 48060-2523 USA. You can also contact Hank by e-mail at: k8dd@contesting.com

Symposium Registrations

Phil Specht, K4PQC is handling the registrations for the FDIM QRP Symposium. To register:

- ❑ Write check made out to QRP ARCI for the $10.00
- ❑ Provide name, surface mail address, telephone number, e-mail address, callsign of each attendee
- ❑ Provide a self-addressed stamped envelope if return confirmation desired.
- ❑ Deadline for reservations: May 1, 1999 ... seating is limited, first come, first served.
- ❑ Send to Philip Specht, 925 Saddle Ridge, Roswell, GA 30076 USA. e-mail: k4pqc@bellsouth.net

Vendor & Club Registrations

Jim Stafford, W4QO, QRP ARCI Vice President, will be the host this year for QRP vendor and club tables at all three evening sessions of the FDIM weekend. For registration information please write Jim at 11395 West Road, Roswell, GA 30075 or via e-mail: w4qo@amsat.org

Computer Control Korner

by George Heron, N2APB

#3 - Using Pulse Width Modulation to control your equipment

Pulse Width Modulation (PWM) has been around for a long time as a convenient way to control your world. Examples are many of where PWM is used: in R/C cars and planes (known as proportional control), in Huff 'n Puff VFO control circuits, in crystal ovens for temperature control; in power control applications; in creating a VCO control voltages; and in many other situations. We'll explore some practical amateur radio applications of these PWM techniques, especially as they can be implemented in software and by using a couple of the popular microcontrollers.

The Basics

PWM is sometimes referred to as Pulse Code Modulation (PCM) or Pulse Length Modulation (PLM)[1]. There are several variations on the technique but all involve a basic principle of controlling (and subsequently detecting) the "duty cycle" of a digital pulse train signal. This duty cycle is the amount of time the signal is at logic level "1" (high) compared to overall period of the signal. If you were to view an oscilloscope trace of a perfect square wave signal at any particular frequency, you would see a 50% duty cycle, meaning that the signal is high for 50% of the overall period of the signal.

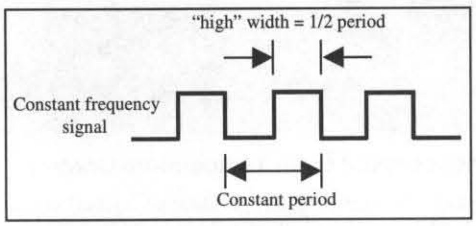


Fig 1: Signal with 50% duty cycle

Now view in the trace of another signal of the same frequency but different duty cycle:

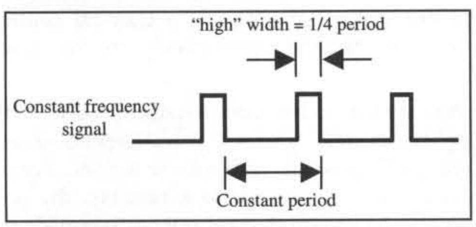


Fig 2: Signal with 25% duty cycle

So you can see that by purposely varying the width of the high time in a fixed-frequency pulse stream, and subsequently detecting that varying width, information can be conveyed across a communications channel, or between some electronics on a circuit card. Admittedly this is pretty simple stuff, but oftentimes elegant systems are built upon such simple concepts.

We will be considering a low pass filter demodulator of the PWM signal, and we will be varying the pulse widths of that fixed-frequency signal being applied to the LPF in order to create an analog control voltage. So in effect, we're creating a poor man's digital-to-analog converter (DAC) to control various modules in our QRP transceivers and equipment

Consider the high pulse widths as containing a certain amount of electrical "energy." (Area under the curve kind of thing.) The larger the pulse width, the greater amount of energy that is delivered to the receiving circuits. In fact, if an appropriate low pass filter were placed on this signal wire, the voltage seen across the capacitor would be proportionate to the positive-going pulse width.

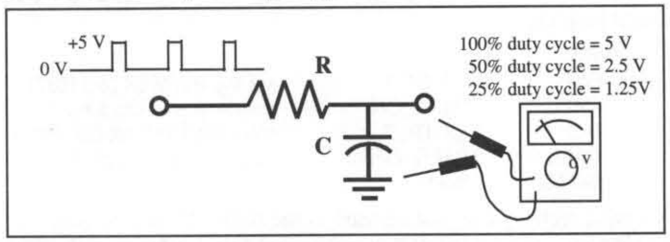


Fig 3: Low pass filter "averages" the energy contained in the pulses

As figure 3 illustrates, the voltage developed across the capacitor is essentially equal to the duty cycle of the pulse train times the difference of its logic levels.[2] So you see, this low pass filtering of the pulse train is key to producing a known analog voltage.

There are several important and interacting factors to consider when developing an analog control voltage in this manner:

- *the frequency of the pulse train* -- needs to be high enough to allow efficient performance of downstream filtering at the desired power levels;
- *the voltages of high and low logic levels* -- need to be known in order to provide accurate calculation of average analog voltage out of the LPF, based on the programmed pulse widths;
- *the RC time constant of the LPF* -- needs to be set through careful selection of the resistor and capacitor values. Too long a time constant (i.e., slowing the charging rate) will provide a slower response time for the analog output from the LPF to reach the targeted value;
- *the impedance of the load across the capacitor* -- whatever is connected to the capacitor (i.e., the circuit in need of the control voltage being generated) will affect the discharge rate of the capacitor. If the load is too heavy, and the RC time constant too short, significant capacitor discharge can occur from cycle-to-cycle causing noticeable ripple and possibly affecting the circuits being controlled.

Overall, each application needs to be considered separately and a careful balance needs to be maintained considering all these parameters.

Okay, so much for the basics -- let's now get into using the concept in real life!

Generating PWM

All this talk about the basics and we now finally get to the microcontroller (uC) aspects. This "poor man's DAC" is truly made for a microcontrolled piece of ham gear. There is often a shortage of I/O pins on the PICs and other uC's we use -- just can't get enough input or output pins onto those little ICs to suit our needs for display, switch input, paddle input, control lines out to the DDS chip, etc. So here's a way that one bit of an output port can generate an appropriate analog voltage in the range of 0-12V.

I'll give examples here for two popular uC's: the PIC16F84 and the Motorola 68HC705. And as it turns out, both of these devices have special, built-in functions to provide PWM output on some of their pins; but for the sake of clarity, I will first explain the process without using these special functions.

Generating a width-controlled digital pulse stream on an output bit of the uC is actually very straightforward. All the programmer needs to do is:

```
SET the bit
WAIT for an "on_time" period of time
CLEAR the bit
WAIT for an "off_time" period of time
LOOP and do again
```

The reciprocal of "on_time" + "off_time" determines the frequency of the resultant pulse train, and the relationship of "on-time" to the total determines the duty cycle. Implementing this algorithm in the PIC would look like:

```
PWM:
    BSF     PORTB, 7      ; set the PWM bit (pin RB7)
    CALL    TIMER_ON      ; subrtn to wait on_time
    BCF     PORTB, 7      ; clear the PWB bit (pin RB7)
    CALL    TIMER_OFF     ; subrtn to wait off_time
    GOTO    PWM
```

A similar technique would be used in the 68HC705 uC. In both cases it would be necessary to establish some careful timing loops in the TIMER subroutines in order to ensure accurate pulse width generation. Additionally, if a general purpose output scheme is desired, a perhaps-elaborate algorithm would need to be developed to determine the precise duty cycle. For example, the programmer might want to design a flexible PWM_OUTPUT routine that takes as an input variable percent a value between 0 and 100, indicating the desired duty cycle (and hence the percentage of total voltage output from the LPF.) This kind of flexibility would need to be provided in software to accurately calculate on_time and off_time based on the input percent.

The Motorola 68HC705 provides a wonderfully more elegant and built-in function to provide PWM output. It has two special purpose 8-bit registers called PLMA and PLMB which respectively provide two variable width pulse streams. The duty cycles of these two signals can be varied from 0 to 255, based on the programmed contents of their control registers. A value of $00 loaded into these registers results in a continuously low output on the corresponding output pin. A value of $80 results in a 50% duty cycle output, and so on to the maximum value $FF corresponding to an output which is at "1" for 255/256 of the cycle. There are two possible frequencies for the PWM signals, set from another control register. Based on the popular 4 MHz crystal used for the uC clock, these frequencies turn out to be 122 Hz and 1953 Hz. Thus, the code for getting the chip to output a 50% duty cycle pulse stream (corresponding to 50% of the voltage range available from the LPF) is:

```
LDA     #$80    ; load the desired percentage (in hex)
STA     PLMA    ; set the PLM control reg to start pulse stream
```

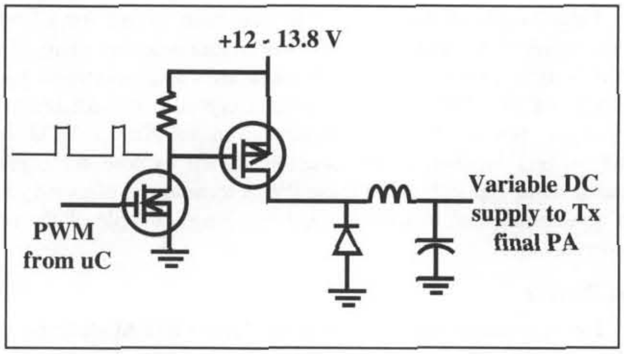
Couldn't be simpler! Similarly, additional programming would be needed to provide the flexible input necessary to translate the desired percentage to the PLM value, but it is quite trivial.

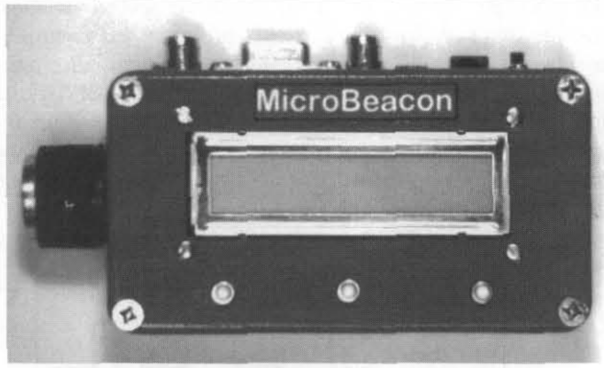
Application: RF Power Control

The MicroBeacon[3], a 68HC705-controlled memory keyer with display and beacon mode was designed and built over the last year as an NJ-QRP Club project. One of the features provided in the MicroBeacon is a very unique design for a programmable RF "attenuator" that is able to adjust RF output levels to provide multiple user-programmed power levels for use in beacon mode.

In this application of the PWM techniques, one of our club elmers and designers (Joe Everhart, N2CX in this case) turned around the typical filter-and-amplify approach to control the V+ supply to the output amp of a QRP transceiver. The concept is simple: provide less supply voltage to the final PA to provide less RF power output. Do this in a deterministic manner (i.e., through lookup table control of the V+) and you have predictable and controllable RF output for use in beacon transmitter tests.

Joe's design accomplishes this by using a low resistance FET transistor switched directly by the PWM pulse stream to provide a high-power pulse stream. A secondary, higher-power FET is also used. This output is then filtered by a low pass filter consisting of a high power choke and capacitor. The beauty of this circuit is its simplicity in terms of both the concept and parts count, and the fact that efficiency will be high. Loss is mainly due to drop across the FET switch and ohmic losses in the inductor.





Application: Crystal Oven Temperature Control

One way to control the temperature of a small crystal oven (or any other small chamber in need of temperature stabilization) is to pump current through some resistors (or a Peltier element) while measuring the temperature of the chamber. When the temperature has reached the desired setting, the current through the heating elements is reduced, thus maintaining that temperature. This is a classical control loop whose algorithm can be tweaked appropriately in the computer control program.

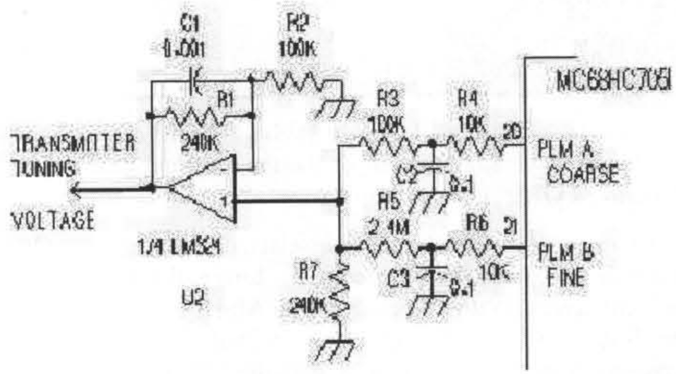
A circuit similar to the one described above in the RF Power Control application may be used here. Depending on the heating element used, the filter components may be omitted. For example, if one is using power resistors attached to a heatsink, the power amplified PWM pulses may be applied directly to them to provide the desired heat dissipation.

Either way, the method of generating and controlling the PWM pulse stream from the microcontroller would be the same, per the techniques described in the previous section. Curtis Pruess, WB2V will be providing some insight of controlling a temperature chamber in this manner for the next issue of QQ, based on his recent experiments for DDS temperature stabilization to be reported in QEX for Jan/Feb 1999.

Application: VCO Control

These PWM techniques for creating a poor man's DAC were precisely the ones used in the design of the Rainbow Antenna Analyzer[4], as presented at last year's FDMI QRP Symposium by N2CX, WA2UNN and N2APB.

In this case we utilized both PLMA and PLMB pulse train outputs to create a course and a fine digital to analog converter when summed, thus presenting a stable DC control voltage to the voltage variable capacitor in the transmitter's oscillator tank circuit.

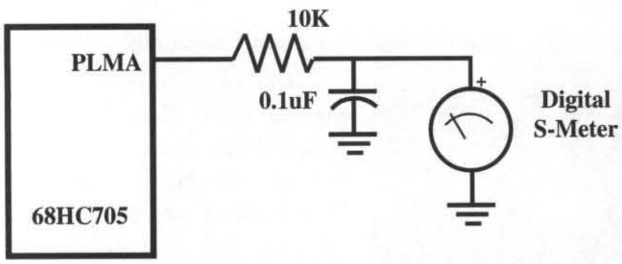


PWM techniques applied in the Rainbow Antenna Analyzer

The same low pass filter of 10K-ohms/0.01uF are used for each PWM output port, but the resistors going into the summing amplifier are of different value, thus producing different weights to the two analog voltages produced by PLMA and PLMB 8-bit PWM registers. These circuits ultimately produce a 0-12V DC signal with equivalent 16-bit granularity controlling the VCO of the RF board.

Application: Driving a Panel Meter

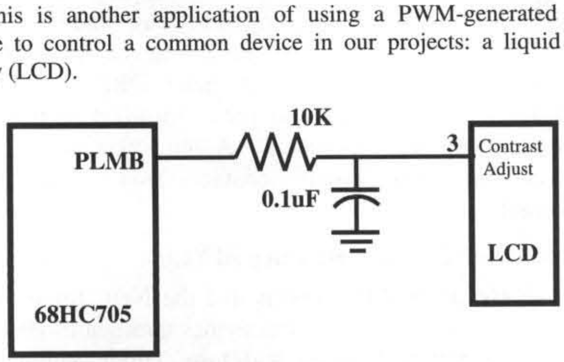
There are instances when a simple DC analog voltage can be conveniently used to drive panel meters. Such is the case in the example shown below, taken from the W5FN/W1GXN design of a Microprocessor-Controlled Multiband Transceiver[5].



In this simple circuit a PWM output of the 68HC705 microcontroller is used to generate a variable-width pulse train which, when filtered, produces a n analog voltage suitable for driving an S-meter. The designers found particular benefit in driving the meter directly under computer control, as contrasted to typical use of the meter within the AGC circuit, because of their ability to easily provide accurate readings across all bands. (The AGC voltage is read by one of the mircrontroller's A/D converters and a lookup table operation yields the correct value which is sent to the PWM register, through the filter, and to the S-meter.)

Application: Controlling LCD Contrast

This is another application of using a PWM-generated analog voltage to control a common device in our projects: a liquid crystal display (LCD).



Most of us are familiar with the need to use a 10K-ohm pot to provide positive bias to the contrast adjust input of the LCD unit. (This provides the correct bias on liquid crystals to allow correct viewing under ambient lighting conditions.)

The circuit shown here is borrowed from the same W5FN/W1GXN design as above in the digital S-meter example. In this case the PLMB output drives a low pass filter to produce the appropriate analog voltage to control the LCD used in their computerized front panel of the Hands transceiver. The operation of this circuit is simple in that the user is instructed to depress a keypad switch at power-up and keep it depressed while the microcontroller slowly increases the duty cycle of the PWM circuit to produce an increasing voltage to the LCD contrast input. When the LCD characters are able to be viewed properly, the user releases the keypad switch and the microcontroller stops increasing the PWM-generated analog voltage. This keeps the pulse stream constant and the corresponding analog voltage ever present to the LCD module.

That's it for now

I hope I've given you a few ideas on how to use Pulse Width Modulation in some of your projects. It's a simple technique that can make a design simpler-yet-elegant.

72, George N2APB

n2apb@amsat.org in Sparta, NJ

Notes

[1] Pulse Position Modulation (PPM) is a close relative of PWM but instead of the width of the signal being used to convey the information, short pulses are used to indicate the start or end times for "width" of the signal. Thus upon demodulation, the pulses themselves might signal the charge or discharge cycle for the logic in the receiver (or control another control logic employed.)

[2] The voltage levels of a digital pulse train are rarely 0 and 5 volts. Except for CMOS digital integrated circuits, a high logic level is around 4 volts and a low logic level is usually around 0.5 volts because of the totem pole output circuits within the ICs. It's best to actually measure the high and low voltage levels to ensure your calculations for output voltage from the low pass filter.

[3] The NJ-QRP MicroBeacon project is described in detail in three separate issues of QRPp (Spring and Summer '98, and Winter '99). The project uses the Universal Micro Controller card (UMC) described in Oct QRP Quarterly. Partial kits for the MicroBeacon may be obtained from the NJ-QRP Club. For details, see the Jersey QRP website at: http://www.njqrp.org/microbeacon/beac_home.html

[4] Information and current status of the Rainbow Antenna Analyzer project can be found at the NJ-QRP website: http://www.njqrp.org/mbrproj/analyzer.html

[5] The "Microprocessor-Controlled Multiband Transceiver" is a computerized front panel for a transceiver, documented in QEX for December 1995 by Tim Ahrens, W5FN and Rand Gray, W1GXN of Aero Electronics. The project is offered as an optional module in the Sheldon Hands transceiver: RTX-210. Further information on these products can be obtained from Bill Kelsey, N8ET of KangaUS (kanga@bright.net).

QRP Clubhouse

Bob Gobrick, N0EB (VO1DRB & UN7/N0EB)

Welcome to the **QRP Clubhouse**. What's the secret password? Why "**QRP**" of course! Happy 1999 to all **QRP Clubhouse** readers and the best of QRP DX to you. Winter is a great time to get some good operating in and with the bands starting to heat up, it is a great time for snagging some DX contacts with your low power gear. It is also a good time to do a little show-and-tell of your latest projects at your local QRP Club meeting so as to encourage others to get on the air and enjoy the fun.

One thing noticed here at the **QRP Clubhouse** is the number of QRP Clubs organizing and putting on some nice QRP Forums at their local hamfests. In this issue, you will read about the work of the **New Jersey QRP Club** and their planned "Atlanticon 99 QRP Forum", a campground style Carolina's QRP-Fest organized by the **Grand Strand QRP Society and the KnightLites**, and the **Iowa QRP Club** at the Des Moines hamfest. These are just a few of the many QRP Club activities out there that are drawing more hams into QRP. If you would like to see your local QRP Club put on a hamfest QRP forum then drop these folks a line for some helpful hints. The **New Jersey QRP Club** even offers a sample Microsoft PowerPoint QRP presentation that you can download from their Website. Start planning now for the 1999 Hamfest season and your own QRP Forum.

To assist your hamfest QRP table setup contact **QRP Amateur Radio Club, International** Publicity Officer **Jay Miller WA5WHN** (see address on back cover of QQ) and he can assist you with QRP ARCI literature as well as getting some consignment QRP goodies from the **QRP Toystore** (QRP mugs, pins, mousepads etc.)

And finally, start making your Club Caravan plans to attend the **QRP ARCI** Fourth annual **"Four Days in May" Symposium** held at the Days Inn Dayton South hotel on May 13-16, 1999. Bring your QRP Club banners for display at the Symposium, Banquet and Hospitality Suites. It will be a FUN QRP event.

Nothing could be finer than to be in Carolina...in November CAROLINA'S QRP-FEST"

Iowa QRP Club is Everywhere in Iowa

The **Iowa QRP Club** had three tables set up at the Des Moines hamfest and they drew a good crowd of interested hams and eight new members to their booth. This follows their successful first hamfest earlier this year in Sioux City. Great job guys! **John Burnley NU0V** reports that the club participated in the hamfest "Experts Row" which brought together Elmers from the many aspects of the hobby (DX, QRP, Building, etc.) There was even the surprise visit of **Ade Weiss W0RSP** driving down from South Dakota at the spur of the moment and donating his **"The Joy of QRP"** book as a doorprize.

Congratulations to the recently elected slate of Iowa QRP Club officers - **John NU0V** President**, Larry WB0RMT**, Vice President, **Jerry WB0T** Secretary, and **Mark KQ0I** Treasurer. The Iowa QRP Club went the "formal" route for club management so they could qualify with the FCC for a QRP Club call.

The **Iowa QRP Club** has just published their second "**Iowa QRP Journal**" in the form of an electronic newsletter. The Journal is a mixture of general news as well as some feature articles. Of interest to many is a nice article by **Adam Kanis N2BRT** on a "Simple PVC Base for the St. Louis Vertical", **Lee Johnson WT0D** on "An Inexpensive Paddle Set for Portable Operation" and a kit review of the **KnightLite's** "The KnightSmite" by **John NU0V**. For information on joining the **Iowa QRP Club** drop a note to **John Burnley NU0V**, 8204 Sutton Drive, Urbandale, IA 50322 or email at burnley-ia@worldnet.att.net

Carolina's November QRP-Fest

The gang from the **Grand Strand QRP Society** and the **KnightLites** sure do know how to have some fun. As reported by **Don W3RDF** and **Paul AA4XX** the gang put on a full day free QRP event at Jones Lake State Park Campground (must be nice to have balmy weather in the middle of November - N0EB). Ten complete QRP stations, using a variety of QRP gear, were set up for all visitors to operate and enjoy the fun. The park pavilion was the gathering point for QRP Roundtable talks, an Antenna Workshop and an on-going day long Show-and-Tell. The gang even had something for those who could not attend. A ten meter QRP beacon was activated at the campgrounds and prizes awarded to the most distant station copying the beacon. A fun event for all. For information on 1999 events contact **Don W3RDF** at DLShips@aol.com

New Jersey QRP Club Elmers Busy all Year

George Heron N2APB reports that the **New Jersey QRP Club** has had a very active slate of activities throughout 1998 and into 1999. The **N2CX**-designed **Rainbow Tuner** club kit has finished its third production run and no more units will be sold. Good news for the more than 500 Rainbow Tuner owners - an

Add-on-Kit to extend the band coverage to 20m and 80m is now available. (See the AOK article elsewhere in this issue.) **Bob Applegate K2UT** is the project manager for the club's **MicroBeacon** project, a club designed microcontroller-based keyer with beacon mode; Bob reports that the MBeacon is complete and ready for kitting. And finally, the **Rainbow Antenna Analyzer,** highlighted at last year's **QRP ARCI "Four Days in May" Symposium,** is now in process of being kitted and soon to be available for sale. This was an ambitious project by **N2APB, N2CX and WA2UNN** and the many **New Jersey QRP Club** elmers - congratulations guys!

The other big news is that the **New Jersey QRP Club** will be sponsoring the "**Atlanticon 99 QRP Forum**" next spring in Maryland. A great line up of guest speakers are on the roster and this super event should complement the **NorCal QRP Pacificon West Coast QRP Forum**. Good luck to the New Jersey QRP Gang on this great event. For more information about the **New Jersey QRP Club** activities check out their website at http://www.njqrp.org.

CQrp Reviews

The November issue of the **Columbus (Ohio) QRP Club** newsletter "**CQrp**" has a neat little article on a homemade resonant speaker for CW operation. This has been a very popular topic on the QRP-L and **Steve Bornstein K8IDN** is one of the first to put in down on paper. The **CQrp** also has a first look review of the new **Oak Hills Research** OHR-500 Five Band QRP Transceiver. This looks to be one super CW rig and we should be hearing a lot more about this nicely priced rig. For information on joining the **Columbus QRP Club** drop Steve Bornstein K8IDN an email at Saborns@aol.com or write him at 475 East North Broadway, Columbus, OH 43214.

CQC Packed

I don't know how **Colorado QRP Club** Editor **Rich High W0HEP** and President **Marshall Emm N1FN** do it but every two months the QRP Clubhouse receives another 40 page issue of "**The Low Down**" and it is always filled with good QRP articles. The November 1998 issue was no exception. **Paul Hardin NA5N** has an article on "The Solar Cycle and Solar Storms or Solar Effects to H.F.", **L. B. Cebik W4RNL** gives us Part 11 of "Antennas from the Ground up - Great Expectations or What Happens Along a Length of Feedline", **Rich Hall N7XNL** has a piece on the **Small Wonder Labs** GM-20 Assembly Musings, a book review by **Rick Brown K0SU** on **Dave Ingram K4TWJ** new book "QRP Now" and lots more. The Low Down is a newsletter that every QRPer should have on their bookshelf. For more information on joining the Colorado QRP Club drop a line to Rich High W0HEP, PO Box 371883, Denver, CO 80237-1883 or email at W0HEP@aol.com

NorCal NC-20 Debuts

Doug Hendricks KI6DS reports that the 500 presold **NorCal QRP Club NC-20** World Class 20 Meter CW Transceiver should be ready for domestic distribution by the time this January 1999 QRP Quarterly reaches your doorstep. **Dave Littlefield AD6AY** - the NC-20 Designer, has been diligently working on the final details with the rest of the dedicated NC-20 team. Since an additional 500 of these rigs will be distributed to hams around the world, with the help of the **G-QRP Club**, there is high priority to make sure everything works correctly on the domestic production run. For more information about the **NorCal QRP Club** drop Doug an email at ki6ds@dpol.k12.ca.us or 862 Frank Ave, Dos Palos, CA 93620.

Lo-Key - Once Again - Chock Full of QRP Goodies

The September 1998 issue of the Australian "**CW Operator's QRP Club**" **Lo-Key** newsletter arrived at the **QRP Clubhouse** mailbox just chock full of QRP circuits. **Leon Williams VK2DOB** leads off with "The 80-2-40 VFO" which is a neat little VFO that starts out as a 3.58MHz ceramic resonator and by employing a digital doubler circuit, provides an output on 40M. Following that **article Keith Searle VK4BKS** shows a circuit using 3.579 Ceramic Resonators to minimize BCI on the front end of his Direct Conversion NE-602 receiver. **The CW Operator's QRP Club** have made use of ceramic resonators in many of their designs and these units have proven to provide stable performance in a simple circuit and they are CHEAP. Hopefully we will be seeing more of their use in circuit design over on this side of the big pond. For information on the CW Operator's QRP Club drop **Kevin Zietz VK5AKZ** (treasurer & Secretary) an email at kevin.zietz@adelaide.on.net or 41 Tobuck Ave, St. Marys, SA 5042, Australia.

Michigan QRP Club 5 Watter

The September 1998 issue of the **Michigan QRP Club** newsletter the **5 Watter** has a trilogy of articles by the famous **Michigan QRP Club** writer **C.R. "Rock" Rockey W9SCH**. The first article is "Who Says That You Must Have High Power To Work DX?", followed by "Where, Oh Where, Has the Ether Gone?" and ending with "How About Some Loop-Lore?" Some thoughtful reading. For information about the Michigan QRP Club contact President Tim Pepper, K8NWD, 654 Georgia, Marysville, MI 48040 or email at trpepper@aol.com

Correction - Emtech NW Rigs

In my last column of the QRP Clubhouse I made a reference to the late **Roy Gregson W6EMT** designed **Emtech** NW rigs as being similar to the **Rick Littlefield K1BQT** designed **MFJ** Rigs. I received a nice note from **Fred Bonavita W5QJM** asking about my reference. Roy's Emtech NW series of rigs where of his own design but he also borrowed from designs of the day as seen by sub-circuits used in **W7EL** and **NN1G** designs. The point I was trying to make is that the new **MFJ 90's Newsletter** has a lot of **MFJ** designs and modifications that can be applied to the **Emtech** rig. Also the good news is that Roy's son, Scott has taken over the business so hopefully we will see the NW rigs around for a long time.

Well that is it for this issue of the **QRP Clubhouse**. 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@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"**

Audio Power – From the Acoustics Side

By Dennis Blanchard, K1YPP

Most amateurs can understand what happens to a radio signal from the time it starts in the oscillator, gets amplified and multiplied, transfers to the outer world vial the antenna, is received at the distant station, is detected and amplified and sent on to the loudspeaker. It's at this point that most amateurs feel their work is done and they can now go have a coffee. What about that electro-mechanical transducer, the loudspeaker, and in many cases the microphone as well? The sound has to get from the electrical state to the acoustic state and back to the electrical state in the brain.

To understand how this can happen some knowledge of acoustics is needed. Acoustics can get complicated, so I'll keep it simple.

Each evening some weather reports on the evening news give the barometric pressure in millibars; this is nothing more than a means of measuring air pressure. As far as acoustics is concerned, millibars is a rather large pressure, so it is more common to work with microbars. (This sounds like using Decibels instead of Bels, doesn't it?)

What is a microbar? Well, a microbar is considered to be the minimum audible level of sound that the average person can hear. To be more exact its 0 dBa. I've taken the liberty here of adding the "a" to indicate we're discussing audio, or decibels audio. 0 dBa is equal to a pressure of .000204 dynes, which is another unit of measurement.

You may wonder how much is a dyne, well, it takes 27805.5 dynes to give an equivalent of 1 ounce of pressure per square centimeter!

This means of course that the typical human ear can hear sounds as low as 7.32×10^{-9} ounces per square centimeter! [This corresponds to about 10^{-14} Watts/cm^2. - *ed.]*

At the other end of the scale we start to feel pain in our ears at 105 dBa, which is a sound pressure level (SPL) of 36.3 dynes or 0.0023 ounce. If some of you old timers would clean your ears once in a while, it would be like raising that bean another 200 feet (61 meters).

The ears are very delicate receivers indeed! It was once stated that if you took all the audio power in the air at a full football stadium in one afternoon, it would be enough energy to warm a cup of coffee!

So, how does all of this relate to amateur radio equipment? If you have ever looked at a microphone specification sheet you have no doubt seen something like -66 dB REF 1V/dyne. What the manufacturer is saying is this: If you have this microphone exposed to an audio signal of 1 dyne (which is 73.81 dBa, approximately normal conversation levels of speech) it will produce a voltage into a matched impedance that is -66 dB down from one volt. How much is that? Well, dragging our minds through the coals, it's:

$$-66 \text{ dB} = 20 \text{ LOG (Voltage Ratio)}$$

Divide both sides by 20:

$$-3.3 = \text{LOG (Voltage Ratio)}$$

Anti-log of both sides:

$$\text{(Voltage Ratio)} = 0.5 \times 10^{3} = 0.0005$$

In other words, the microphone will provide 0.5 millivolts output at normal levels. In the case of an electret or condensor microphone a typical impedance would be 1K - 5K ohms. This is a good signal because electrical noise is fairly low with these devices. Now all you have to do is amplify it to the desired level. Most electrets have an FET built right into them to build up the signal before it travels very far and picks up additional noise. Actually the FET is there to isolate the capacitance of the element, but the gain helps.

Microphones have fairly good response ranges, even the cheap ones, but this is not so with loudspeakers. Loudspeakers, especially in most amateur radio applications, are terrible things. Their response curves look more like West Virginia road maps!

Only in very recent times have there been any improvements by the amateur fraternity. There are several folks on the QRP list on the Internet doing serious experiments and several years ago there was a product manufactured by Skytec in California. The Skytec product was designed with an end result resembling that of a good active filter, excellent for CW reception. This is really a band-aid for that CW receiver that is spilling out garbage from 30 Hz to 10 kHz. It cannot fix a sick front-end, but it certainly can filter out much of the noise.

Unfortunately, most amateur radio equipment designers worry more about the aesthetic beauty of the speaker cabinet than its function in life.

It does not, repeat, does not, take much power to make lots of audio noise. A telephone dial tone is approaching 0.5 milliwatt, and you can hear that across a quiet room. Hi-Fi buffs have amplifiers that now rival anything amateurs have for finals on 20M. What does one do with 500 watts of audio? Your ears can't take that sort of punishment for any length of time, how about "worked all states" on audio. There are folks today that have these super high-powered audio systems in there cars, pumping lots of Rap drum beats into their ears. The audio stores get these guys coming back to complain that the system isn't as loud as it used to be, they have to run the volume all the way up. The truth is, their equipment is fine, but their ears are gone!

An amateur receiver only needs 1 or 2 watts of audio unless it is to be used in a particularly noisy environment. A good stereo system should work well with 50 watts of power (this is real power, not all the hocus-pocus power measurement schemes that the marketing guys use). Anything more than this, in most cases, is wasted power.

It may not be easy to create audio enclosures that will operate over a specific band of audio frequencies, but the benefits are great, and much more work must be done in this area.

Dennis, K1YPP
e-mail: jadepro@jadeprod.com

Hamfest Portable Station

By Jim Nestor, WK8G

The fun started when Joe, N2CX, sent me an e-mail request to fill in for a fallen comrade at the South Jersey Radio Club hamfest. Joe and George, N2APB, had agreed to conduct a forum session on QRP and they thought it would be a good idea to have a real live QRP station operating in the flea market area.

I felt a bit like a missionary setting out for a foreign land to convert the "heathen" QRO ops as I started making my checklist. Actually, the hamfest was only forty minutes from home, but I expected the rest to be true.

Since the 'fest was only two days away, I didn't have time to get too fancy. I decided to use my "Roadside Rest Stop" setup with a few modifications. Perhaps I should elaborate.

I started by installing an Alinco DX-70T more or less permanently in my Chevy Blazer with the idea of operating HF mobile in-motion. I cranked down the power from the DX-70T to a maximum of 25 watts, but usually run it at a QRP "legal limit" of 5 watts.

I mounted an LDG QRP autotuner in the very back of the truck as close as possible to the Hustler mobile antenna mounted on the spare tire rack on the back. Although the tuner is commercially rated at 10 watts, it has safely handled the 25 watts without complaint.

Using the tuner with the Hustler resonators doesn't make too much sense, although it does allow me to check out a different band without stopping and switching resonators. I've had some interesting QSOs that way. But that was not the real idea.

In fact, I've found that I don't operate much at all while I'm driving. I tend to tune around and listen a lot, and occasionally work somebody on SSB. I don't care much for that mode, but neither do I feel comfortable operating CW while bombing down the highway at warp speed. I can copy the code in my head but am not too secure in my ability to tickle the paddles and steer at the same time. I also have trouble chewing gum while walking.

Instead, I find that most of my mobile operations are accomplished while parked at rest stops along the highway. When we stop for the family to "go potty" or have a picnic, I sneak in a few contacts.

This works OK with the little Hustler antenna, but since I'm stopped why not put up a better skywire? Here's what I've worked out.

As soon as I stop, I retrieve my trusty Black Widow 20' fiberglass fishing pole from the back of the truck. It's the same one used for the St. Louis Vertical, but has no windings or anything else on it. I fabricated a base for it with a Hustler quick-disconnect fitting just like the ones I use to rapidly switch resonators without a wrench.

The quick-disconnect on the Black Widow connects in just a second and holds the pole upright on the back of the Blazer. I attach a length of hookup wire to the tip of the pole and connect that to a 4:1 balun attached to the QRP autotuner inside the Blazer. While I'm at it, I connect a counterpoise wire to the other side of the balun and drape it on the ground beside the vehicle.

I've experimented with vertical wires from 16-20 feet long and they all seem to work on the "high bands" and tune up quickly with the autotuner. The best performer so far has been a 33 foot wire which I ran up the pole and extended toward the front of the Blazer in an inverted L fashion.

The whole setup takes a couple of minutes and definitely improves my firepower. Inside the Blazer, I use a set of homemade paddles and an Atomic keyer. For those who don't remember, the Atomic was the predecessor of the Tick and has a couple of memories. Mine is built in an Altoids box with some magnetic material on the bottom which holds it snuggly to the top of the Alinco rig.

For longer periods of operation, such as camping trips, I connect the rig to a 34AH deep cycle battery placed on the floor behind the driver's seat.

That was the basic station I decided to take to the hamfest. Since it would have been a bit rude to sit inside the truck to operate, I had to convert to more of a Field Day mode of operation.

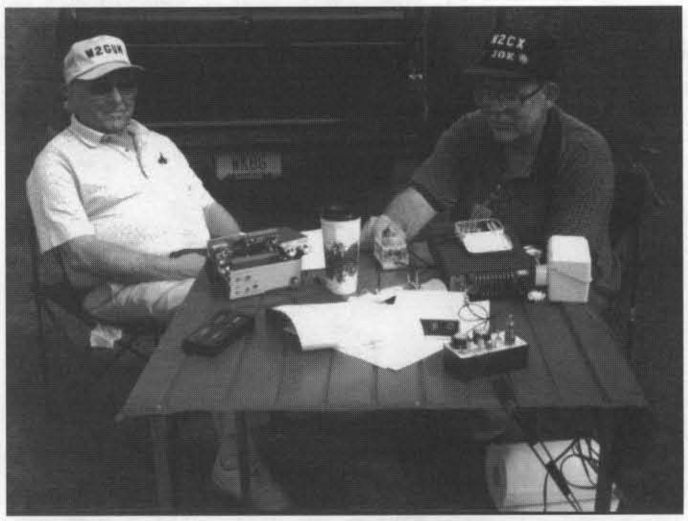


Figure 1: Tony Colaguori, W2GUM and N2CX at the station

The first ingredient was an operating table and chairs. The table I used is a rollup model purchased from a camping store. It collapses down to about six inches in diameter, and opens out to a stable platform about three feet square. Costs about $35 and is downright handy.

The chairs also collapse into a bag even smaller than the table, but "pop out" into comfortable units sturdy enough to hold my grande derriere. I've seen them at discount houses for around $15.

With the table and chairs situated right behind the vehicle, I put the rig on the top and the battery underneath. There's plenty of room for additional "show and tell" items on the table. More about that later. It's a good idea to have extra chairs so visitors will be inclined to sit a spell.

This trip, I didn't actually use the Black Widow rest stop antenna to operate. Joe, N2CX had gone down to the site the night before and erected a 20 meter delta loop to make sure we had a decent antenna for the demonstration. I did setup the Black Widow during the demonstration and it generated lots of interest.

As luck would have it, another ham's van was sporting one of the new German fiberglass poles he bought at Dayton. It was a whopping 33 feet tall! I have to admit to a twinge of pole envy. The neighbor was using his to support twinlead J-poles for VHF, but I had visions of a quarter wave vertical for 40 meters, or even an inverted V at almost 40 feet up. Gotta get me one of those...

But I digress.

Once the basic station was set up and operating, it was time to start reeling in some folks from the flea market area. In the remaining space on the table, I arranged a few props.

We didn't have a club banner, but did manage a sign announcing that this was a QRP demonstration by the New Jersey QRP Club. Since that time, I have learned that QRP ARCI will actually loan an official banner for just this purpose.

I also added some of my favorite QRP toys to the display. This included a Sierra with KC-2, Wilderness 40A, SST-20 with matching paint job and labels and a surface mount Tick keyer inside, and an LDG QRP autotuner. The little brass Schurr paddles gleamed in the morning sun.

I showed off my "PTS" (Personal Travel Station) which consists of a 20 meter SST, a matching HB tuner, batteries, antenna wire, tiny paddles and ear buds, all carried in a little toiletry bag. It's small enough to fit inside my briefcase.

Once the goodies were spread, and the rig tuned to a CW contest frequency, the real fun began. Folks began to cruise by at a safe distance. Then a few inched closer to ask a question like "What kind of rig is that?" or "How much power you running?" They were hooked ...

Figure 2: (L-R) N2APB; Jim Nestor, WK8G; W2GUM; N2CX

For about thirty minutes, Joe, George and I answered questions and showed off the gear. Club members Bob, W3BBO and Tony, W2GUM stopped by to join in the conversations. Then Joe and George went inside to do the forum presentation. They borrowed a couple of the little rigs to show. And I was left all alone.

About that time, WK2G noticed my call plates (WK8G) and stopped to comment on the similarity of our calls. Interestingly enough, he is also an avid CW op and I encouraged him to try some QRP CW. Over the next 30 minutes, he managed to work all kind of "good stuff" on 20m CW. First a little DX, then a nice rag chew with an Old Timer out in 9-land. Impressive to the folks who gathered to listen.

Whilst WK2G was operating, the crowd continued to grow and the questions came fast and furious. "I'm a CW op. What about the new SGI 2020?" "What's this K2 I'm hearing about?" "Tell me about your club..." "is there any kind of QRP mailing list?" and on and on.

By the time the guys came back and reported that they had a good turnout at the forum, I was getting hoarse and handed off to them so I could cruise the flea market.

Around noon, the tailgaters began to pack up and leave. Eventually, we lowered the delta loop and packed up the station. We stopped at a nearby diner for lunch and a post mortem of the day's activities.

Of course there was a few things we "shoulda done" and some we "coulda done" and one or two we'll definitely do "next time". But the bottom line was that we had fun, and felt that our visitors had learned something about QRP. They may even be a few "converts".

My recommendation: try it, you'll like it!

Jim Nestor can be reached by e-mail at: Jim.Nestor@ey.com

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.

Transmission line have been a big mystery because we have never been told how to look at them. We look at a capacitor and know instantly all about it. Same goes for coils, resistors, and switches. But a transmission looks for all the world like some ordinary pieces of wire--and in a pinch, we can use them as a source of wire.

Do not be fooled. Transmission lines--or feeders, feedlines, cable, etc.--are not ordinary wire. They have conductors, but so too do capacitors, coils, switches, etc. But like all those components, transmission lines use conductors to do a job--actually a lot of jobs.

So I shall not tell you anything new about transmission lines. It is all in the books. What I want to do is simply reorganize all that information so that we have some good ways to look at transmission lines. Once we have that fixed in our heads, transmission lines will never be mysterious again. In fact, they will become our friends, if not the love of our lives.

We shall along the way note some handy and some not-so-handy formulas for calculating stuff. You should be familiar with what they are trying to tell us, but at the same time, you should not have to fill pages with calculator outputs. Let two programs do that. One is HAMCALC (Version 32 or higher) from VE3ERP has a number of programs to do all the work for you. Another handy program is TLA, from N6BV of ARRL. We shall note how to use these cheap but rich resources along the way.

1. The first way to look at transmission lines: with a tape measure

The most fundamental property of transmission lines is length. Know how long your transmission line is. It does not matter if you use feet or inches, meters or centimeters, cubits or furlongs: they all convert back and forth.

Oddly, the majority of hams I know cannot tell me how long their transmission line is within 6 inches. This vacuum proves that no one ever told them that measuring is the first step to making friends with the line.

Obviously, the best time to measure a transmission line is before you install it. Include the connectors--they are part of the overall length.

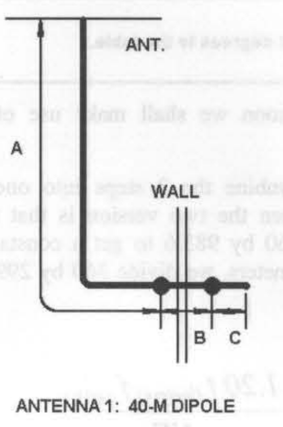
Why know the length? First, the obvious: the line has to reach from your shack to the antenna. Second reason: if it breaks or goes bad, you need to know how much replacement to buy.

Third reason: there is a lot that just knowing the length will tell us--when we are ready to learn it and need to know it. Every other piece of information about transmission lines gets used some of the time, but length gets used all the time. So always know how long every piece of transmission line is in your system. Short pieces: measure to some fraction of an inch. Long pieces, measure within a couple of inches or so.

Now make a sketch and a chart, as suggested in **Figure 1**. Note that every sub-length is listed, as well as totals for a given run between points. Revise the chart whenever you make any changes in the feedline system. Store this chart where you keep all of the instructions and other plans for your station equipment, but keep it handy for reference.

2. The second way to look at transmission lines: with an protractor

Notice that there is a blank line on form. The length in feet (or meters) is not all the length information we want on our chart. We also



Antenna: Dipole	Feeder: RG-213	
Run	Length ft	Total ft
A	63' 6"	63' 6"
B	4' 7.5"	68' 1.5"
C	6' 9"	74' 10.5"

Notes:
A-B connector: outside disconnect
B-C connector: inside disconnect
C connects to XCVR

Figure 1: Looking at a transmission line with a tape measure.

want the electrical length of the feeder. Electrical length is normally given in electrical degrees (sometimes radians, which we shall skip today). Getting the electrical length is a 3-step process, once you know the physical length.

1. *Velocity Factor (VF)*: Look at **Table 1**, which provides some significant data on a few common types of feeders, both coaxial and parallel. For the moment, we are interested only in the column labeled "velocity factor." This column tells us how long that a length of the feeder is in terms of its relationship to a wavelength of RF energy. Since the example in **Figure 1** uses RG-213, we need only a glance at the table to see that its velocity factor is 0.66.

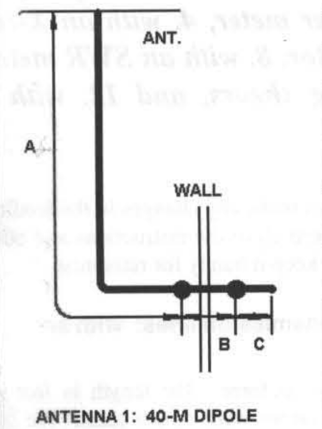
VF tells us that any wavelength of energy in the cable at any frequency is only 0.66 as long as the same wavelength in free space. Conversely, the effective length of the cable is simply its physical length divided by VF. 74.875' (or 22.82 m) divided by 0.66 is about 113.45' (34.58 m) long.

2. *A Wavelength at a Desired Frequency*: Since a free space wavelength at 1 MHz is about 299.8 m or 983.6' long, we can find the length of a wave at any frequency in MHz by dividing the base number by the desired frequency. Let's say that our 40 meter dipole is cut for 7.15 MHz. 983.6 (299.8 m) divided by 7.15 yields 137.56' (41.93 m).

3. *Converting to Degrees*: To change the result into electrical degrees, just divide the effective length from step 1. by the length of a

wavelength in step 2. and multiply by 360 (the number of degrees in one cycle). So 113.45/137.56 (34.58/41.93) equals 0.825, times 360 equals 296.9 degrees.

Let's enter this data in our record chart, as in **Figure 2**. For the



Antenna: Dipole	Feeder: RG-213	
Run	Length ft	Total ft
A	63' 6"	63' 6"
B	4' 7.5"	68' 1.5"
C	6' 9"	74' 10.5"
L (deg)	@ 7.15 MHz	296.9 deg.

Notes:
A-B connector: outside disconnect
B-C connector: inside disconnect
C connects to XCVR

Figure 2. Adding the length in electrical degrees to the table.

moment, this is for curiosity, but soon we shall make use of the information.

For our notebooks, we can combine the 3 steps into one big formula. The only difference between the two version is that for a physical length in feet, we divide 360 by 983.6 to get a constant of 0.366; while for physical lengths in meters, we divide 360 by 299.8 to get a constant of 1.20.

$$L_{(degrees)} = \frac{0.366\ L_{(feet)}\ f_{(MHz)}}{VF} = \frac{1.20\ L_{(meters)}\ f_{(MHz)}}{VF}$$

Of course, if we know the electrical length of a feeder and its velocity factor and frequency of operation, we can turn these formulas around to get the physical length:

$$L_{(physical)} = \frac{L_{(degrees)} VF}{f_{(MHz)} K}$$

where K = 1.20 for a result in meters and K = 0.366 for a result in feet. Do not lose this, because it will come in handy later. If you do lose it, you can get the results from one or more of the programs on HAMCALC.

3. The third way to look at transmission lines: with a lost-power meter

Everyone seems to hate transmissions lines, if for no other reason than that they eat up some of the transmitter's power. Well, if that is what bugs you, **Figure 3** shows a way to avoid the power losses of transmission lines. The final amplifier is directly coupled to the antenna (with an RF preamp for receive, all automatically switched). The losses in the interstage feeder cable are made up for by setting the gain of either the ground amplifier or the final amplifier just a bit higher so that the output achieves a set level. We should not have to redesign the output filter of the amplifier too much to make it match most common 50-ohm ballpark antennas. We do, however, have to feed DC power to the amplifier, along with the signal.

If this scheme is impractical for your situation, then you must resign yourself to using feedlines from your transmitter-output/receiver-input to your antenna. With that act of resignation comes a job: understanding feeder line losses and reducing them to a practical minimum.

The first step in the process is understanding what power loss means in practical terms. **Figure 4** is designed to help. It graphs actual

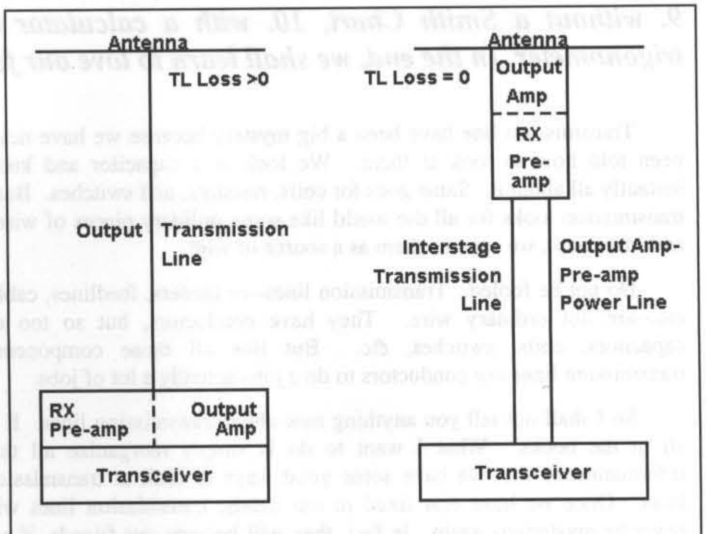


Figure 3. A sure way to avoid transmission line losses.

power loss with the loss registered in decibels (dB). If we arbitrarily let 6 dB equal 1 S-unit, then you have to lose about 75% of your power before your signal goes down by 1 of those S-units.

All of this is fine for the QRO operator, who has power to spare. However, QRP operators often work on the differences between no registration on the S-meter and a faint tick of the needle, that is, in the 1 dB differential between no signal and something that can be heard and copied. Even though 1 dB represents about a 20% power loss, that 20% can be composed of lots of little losses that add up. Hence, it pays--within certain practical limits--to minimize every potential power loss.

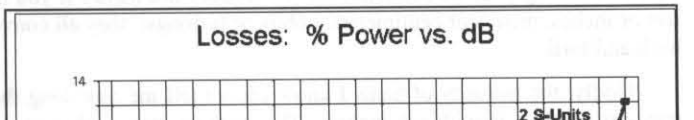


Figure 4

Let's peek back at **Table 1**, our list of typical feeders. Starting with the coaxial cables, we notice that the fatter the cable, the lower the loss, for any given characteristic impedance (Zo). Hence, if you want to use coaxial cable, try RG-218 or one of the hardlines.

The other option is to use one of the parallel feedlines, which are quite light and have low losses. Since their Zos are not the semi-standard 50 ohms, you will need an ATU to match whatever impedance the line presents to your transceiver.

Notice that the loss figures are given for perfectly matched systems at 3.5 MHz and use 100' of line. Now, the line length calculations is very linear. Double the length of line and you lose twice as much power; halve the line length and lose half the power.

Suppose we freeze the line length at 100' and change frequency or change SWR. What happens? We are told that the losses increase with frequency and with SWR, but by how much?

Figure 5 shows the losses from 80 to 10 meters for RG-213 for SWR ranging from 1:1 to 5:1. This will give you an idea of the rate of loss increase from both frequency and from SWR for a standard 0.4" diameter coaxial cable.

Compare **Figure 5** with **Figure 6**. The second graph is for standard 450-ohm plastic covered window line over the same frequency spread and SWR range. Incidentally, 5:1 is about the SWR for a low-hanging dipole (80-90 ohms feedpoint impedance). First, notice that the shape of the curves are quite similar to those for the coax. This means you can use these curves to extrapolate reasonable loss values from other cables you use, knowing the matched loss value.

Figure 5

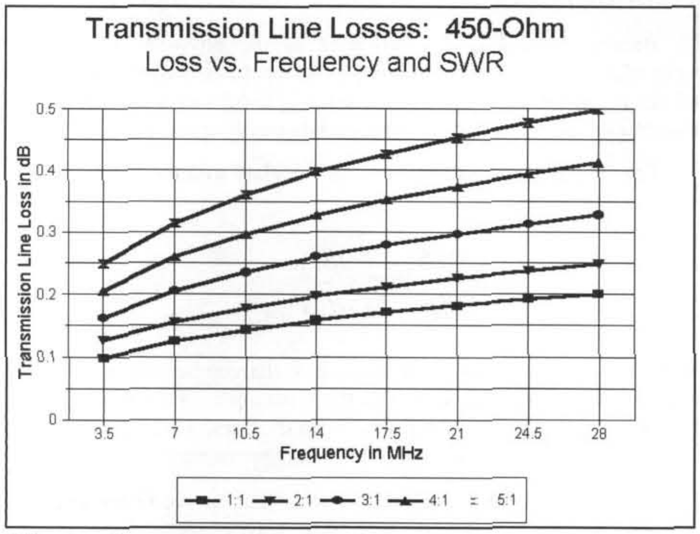


Figure 6

However, let's not neglect the loss figures on the vertical axis of the graph. They are quite different for the two types of cables. **Figure 7** shows the 1:1 and 5:1 SWR figures for the two cables. Note that the parallel transmission line has a lower loss per 100' at a 5:1 SWR than RG-213 with a 1:1 match. In fact, the parallel transmission line losses would be less, even with a 10:1 SWR (except under certain rare conditions that your ATU could not handle anyway). Referring back to **Table 1**, only hardline rivals parallel transmission line for low losses, but with a large penalty in handling difficulty and weight.

Lowest-loss recommendations:

1. Use parallel feedline unless physical situations dictate otherwise.

2. Use the shortest feedline possible (consistent with solid installation).

3. Do not throw away expensive coax recently installed: save any change-over for the next time lines get old.

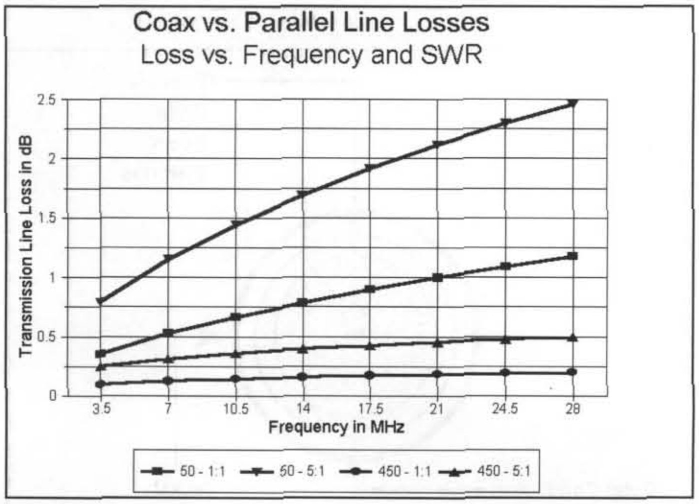


Figure 7

4. The fourth way to look at transmission lines: with an X-ray machine

What makes transmission lines lossy? What makes them work? These are the same question. To answer it, we must step back and take a brief look at common 2-wire transmission line construction. (There are multi-wire transmission lines, but hams rarely encounter them.) Contrary to some ancient ideas, it takes 2 wires minimally to make a transmission line.

Figure 8 shows a cross section of some common parallel transmission lines. The basic idea is to keep the two lines exactly parallel for their entire length. So we use spacers or some windowed or closed insulating material to lock the wires in place.

Figure 9 shows some common coaxial cable construction, where the two wires are not identical. Rather, there is a center conductor, solid or stranded, and a concentric outer conductor. What is in between can be a solid or foam dielectric, air, or an inert gas. The outer conductor can be a braid or solid. Needless to say, a stranded center conductor with a braid is more flexible than the same size coax with a solid conductor and a solid outer conductor.

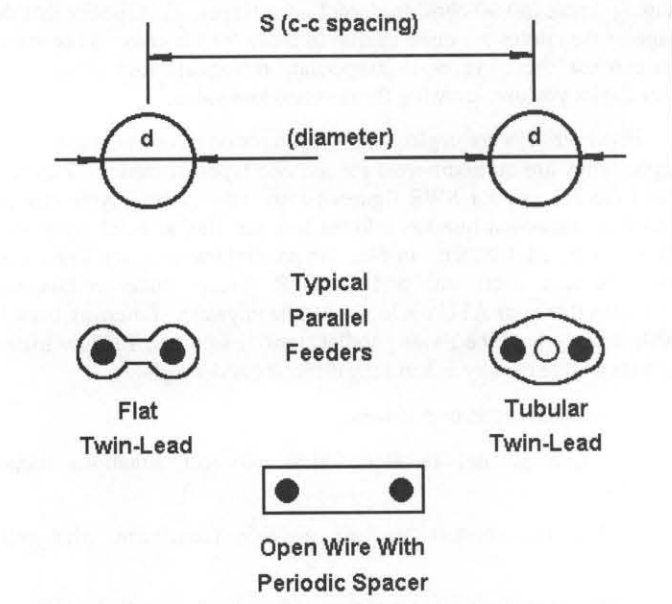


Figure 8. Cross-sections of typical parallel transmission lines.

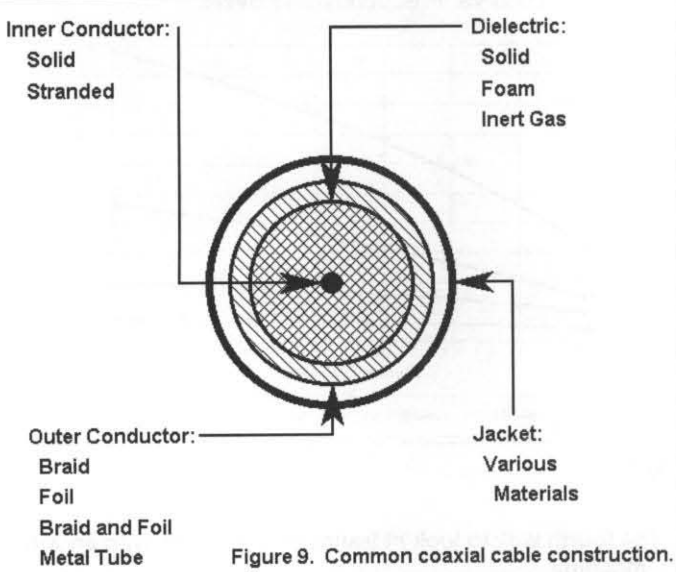


Figure 9. Common coaxial cable construction.

Note that as long as I am treating the cable as a transmission line, I try never to use the word "shield." Too, the outer jacket serves no electrical purpose, but may serve both physical and chemical purposes. All jackets hold the outer conductor tightly in place and keep it from corroding. Some jackets protect from moisture, others from UV sunlight, others from chemical salts, and a very few from all three. In fact, the jacket alone can change the prices of identical transmission lines inside by a factor of three.

5. The fifth way to look at transmission lines: with a ruler and LCR meter

Every transmission line has some physical dimensions. They are not accidental. They determine the characteristic impedance of the transmission line. Let's look at the two types of line and see how we determine the Zo.

First, any length of wire has a inductance. For two wires parallel or concentric to each other, the total inductance for any arbitrary length is the sum of inductances of the two lines in series.

Second, any two lengths of wire parallel to each other show a capacitance, like plates. The capacitance of a fixed arbitrary length of parallel wires is a function of the wire sizes, the space between them, and the nature of the insulation or dielectric between them.

Figure 10 shows the two phenomena and prepares us for some old fashioned formulas.

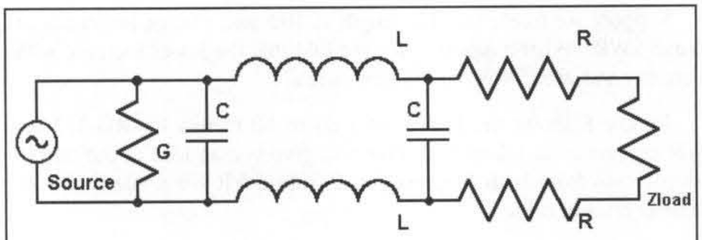


Figure 10. Equivalent circuit of a transmission line.

First, for any transmission line, it is primarily the L and C per unit length that determine the characteristic impedance, Zo:

$$Z_O = \sqrt{\frac{L}{C}}$$

However, this equation is only approximate. For the record, let's look at the "big" formula:

$$Z_O = \sqrt{\frac{R + j2\pi fL}{G + j2\pi fC}}$$

where R is the series resistance per unit length and G is the shunt conductance per unit length--the unit lengths used for L and C. For most calculations, ignoring R and G does little harm, but for maximum precision, they are needed. They actually tell us that the Zo of virtually any line is not 100% resistive, but has a slight phase angle that shows up as those little remnant reactances in the Zo column of **Table 1**.

Because L and C are functions of the physical sizes of the conductive materials from which we make our transmission lines, we do not need to know the actual values of L and C per unit length to make a transmission line. We can use sizes and distances apart instead.

For parallel transmission lines, we calculate with the formula

$$Z_O = \frac{276}{\sqrt{e}}\log\left(\frac{2S}{d}\right)$$

where S is the center-to-center spacing of the conductors and d is the diameter of the conductors, both in the same units. The term "e" is the dielectric constant of the material between the lines, where a vacuum has a value of 1 and most solid material have higher values.

Too often, the version of this equation that we see in books leaves out the dielectric constant, and that leaves some gaps in our understanding. For example, with only air as a wire spacer, we cannot make a 50 or 75 ohm parallel transmission line, since it would require that the wires overlap. However, if we divide 276 by a higher number, resulting from the use of a dielectric with a high constant, then we can build our 75-ohm parallel line. However, even though we can, no one in the US does.

For a coaxial transmission line, we use this formula:

$$Z_O = \frac{138}{\sqrt{e}} \log\left(\frac{D}{d}\right)$$

where D is the inner diameter of the outer conductor and d is the outer diameter of the inner conductor, both in the same units.

Both these formulas are handy. However, it is more likely that you would build a parallel transmission line (with an air dielectric with a constant of 1) than it is that you will build a coaxial cable.

6. The sixth way to look at transmission lines: with a thermometer

So why is transmission line lossy? Because the wires and the dielectrics are not perfect. Wire has resistance. The larger the wire diameter, the smaller the resistance, but it never goes to zero. Some energy is always lost as heat in the wire. Remember that we are using HF/VHF frequencies with our feedlines, so the skin effect has a marked influence on the current-carrying capabilities of the line. According to researchers, most of the losses in transmission lines up through UHF frequencies are a function of the current-carrying capacity of the wires.

Conclusion: whatever the type of feeder, use the largest wire diameter your system can physically withstand.

There is a second reason for power loss: Every dielectric leaks. Energy get across the space between the wires, trying to bake the insulation instead of proceeding to the end of the line. However, dielectric losses begin to dominate only above UHF frequencies.

How do we know lines leak and resist? Because we can measure the increase in temperature, even with a perfect match.

But why does SWR increase losses? We have not even said what SWR is, but we do know that when the SWR is 1:1, the voltage and current are everywhere the same along the line, except for the basic resistance and leakage losses. However, when the SWR is greater than 1:1, voltage and current change along the line, reaching peaks and nulls, as shown in **Figure 11**.

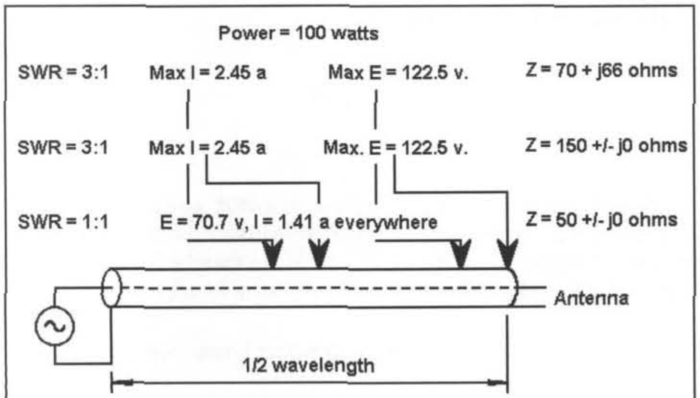


Figure 11. 1:1 and 3:1 SWR voltage and current maximums.

Even with a mild SWR of 3:1, the current reaches peaks 3 times the 1:1 value. Because wire has a certain resistance per unit length, the higher current results in higher resistive losses for a given voltage.

Likewise, for an SWR of 3:1, the voltage peaks reach 3 times their 1:1 value. This voltage stresses the dielectric further, increasing the leakage. In fact, using a high enough power and a high enough SWR, it is possible to burn a hole in the dielectric of a coax cable. It is not the hole that causes problems. It is the little burnt path of semi-conducting carbon that shorts the cable. Of course, QRP operators would never do anything like this--unless they were using RG-174 on 10 meters and forgot to connect the antenna.

7. The seventh way to look at transmission lines: with a field detector

Having seen how transmission lines lose some energy, let's understand how they deliver so much of it to the antenna--the load.

First, remember that the characteristic impedance of a transmission line is not its resistance. It is a resistive impedance, meaning that it is a product of two reactance so situated that they result in a zero phase angle (or darn close). The only energy dissipation is through the loss mechanisms described.

Second, resistive impedances control energy but do not dissipate it. **Figure 12** shows how. Think of each wire as trying to be like the antenna at the end of the line. The antenna is a transducer that permits the development of a field that can spread without limit. All of the energy in the current distribution along the antenna wire is lost, since the field is in a form that allows no retention or recapture.

It is not incidental that every conductor in every circuit is trying to establish and maintain a field that spreads without limit. Hence, we have to shield, shorten leads, bypass, and take other measures to keep our circuits from radiating--or from radiating prematurely.

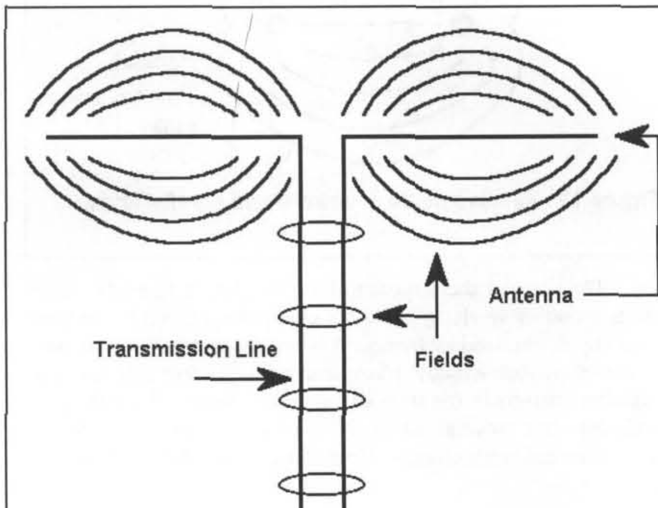


Figure 12. Antenna vs. transmission line fields.

The wires in the transmission line are trying to do the same thing. However, the two conductors, with equal and opposite polarity voltages and currents confine the field to very narrow spaces, mostly between the conductors. The energy stands on the line and is propagated down the line. The transmission line is a field (or wave) guide that is highly efficient.

If you terminate the line with an antenna--any device that permits the field to expand without limit, all but the little dissipated energy in the lines reaches the antenna. If you short circuit or open circuit the line instead, it all returns to the source.

Figure 13 shows us once more the cross section of a coax cable and a parallel transmission line so that we can compare the fields. Because the outer conductor of the coax cable encloses the field between conductors, we get the so-called "shielding effect." All this means is that very near metallic objects have little or no effect on the fields between the transmission line conductors.

The parallel transmission line is not so fortunate. Although the fields are narrowly confined, they are not perfectly confined. Hence, bringing a conductive object near one line can disrupt the balance in currents and voltages that are crucial to proper operation of the line. Energy coupled to this external object is energy not in the nearer line, which leaves an excess in the other line. This is a good way to convert both the nearby object and the feedline into an unintended antenna.

Hence, keep parallel transmission lines away from conducting

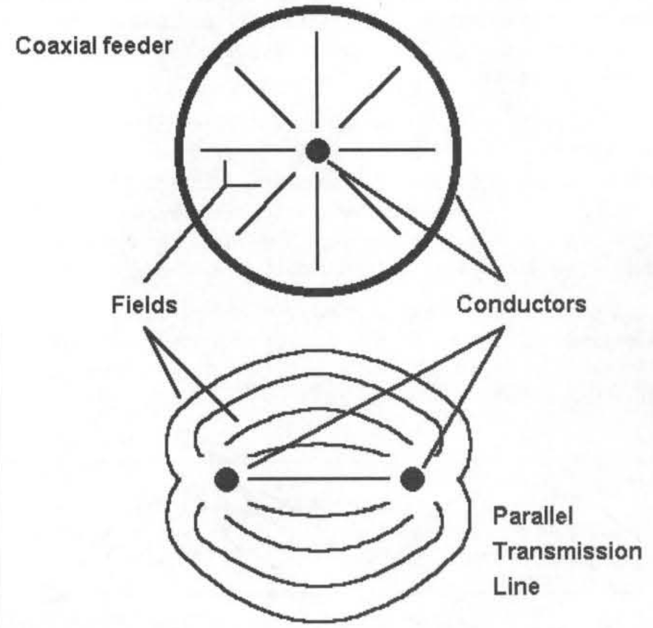


Figure 13. Relative fields of coaxial and parallel lines.

objects. Do not nail them through their insulation to posts. Instead, invent nonconductive clamps. Do not clamp them down to the window sill with aluminum window frames. You might get away with it, but you might also turn your window frame into an inefficient antenna and rob the efficient antenna in the trees of valuable power. Space the parallel transmission line several times its widest dimension from nearby conductive or unknown objects. How many is "several?" The more, the better.

8. The eighth way to look at transmission lines: with an SWR meter

By this point, I can feel the impatience growing. A shout is welling up in your throats. you can almost not restrain yourself. Well, let it out:

"WHAT ABOUT SWR?"

I give up. Let's see what SWR really is. SWR is one way to register the mismatch between the ultimate load and the transmission line characteristic impedance. If the load impedance and the characteristic impedance of the transmission line are the same, then the SWR (or VSWR, more correctly) is 1:1.

SWR is not a measure of how well the antenna works. Low or high SWR numbers can occur for antennas with identical far field patterns operating with essentially the same efficiency.

SWR is a measure of what conditions exist on the transmission line. Those conditions exist all along the transmission line (with a little allowances for the losses we have seen). Hence, those condition appear in one or another form at the end of the transmission line you wish to connect to the transmitter. When the SWR is 1:1, those conditions presented to the transmitter are easily predicted. When the SWR is not 1:1, all bets are off.

Except: remember that we had you measure your transmission line. That will come in handy in just a bit.

Here I want to clear up just one common misconception and then move on to stuff more important than SWR. SWR is not simply the ratio of the antenna impedance to the Zo of the transmission line. Sometimes that ratio is not even close to the SWR.

Consider the following antenna impedances, all of which are presented to a 50-ohm coaxial cable: 1. 100 ohms resistive; 2. 70.7 ohms resistive and 70.7 ohms reactive (inductive for convenience; and 3. 100 ohms reactive. All cases result in an impedance magnitude of 100 ohms, one at zero degrees phase angle, the second at 45 degree phase angle, and the last at 90 degrees phase angle.

Although we are not yet sure why, we know the 100 ohms resistive case results in an SWR of 2:1. However, some may be surprised to learn that the second case shows an SWR of 3.27, while the third shows an SWR of -209.6 (yes, really a negative number). Why? The correct equations for SWR and impedance tell why.

To calculate SWR, let's define two arbitrary terms, A and B. In doing so, we shall let R_L be the load or antenna resistance, X_L be the load or antenna reactance, and Zo be the characteristic impedance of the line, ignoring that little reactance remnant in **Table 1**.

$$A = \sqrt{(R_L + Z_O)^2 + X_L^2}$$

and

$$B = \sqrt{(R_L - Z_O)^2 + X_L^2}$$

The only difference (although it is a big difference) is the + vs. - at the resistive ends of the expressions.

$$SWR = \frac{A + B}{A - B}$$

Actually, equation 9 is less interesting than equations 7 and 8. They tell us that the resistive and reactive parts of the load impedance are separately handled within the equations, so that the reactive portion is not part of the standard way in which we calculate impedances.

9. The ninth way to look at transmission lines: without a Smith Chart

Do not misunderstand me: the Smith chart, invented and improved by P. H. Smith between 1939 and 1944, is a very useful tool. Some folks have gone so far as to claim that it is indispensable and the only thing they need to understand transmission lines. Were Smith around today, he would be the first to say that you have to understand transmission lines first before you can understand what the Smith chart is telling you. In fact, everything that a Smith chart can tell you can be independently calculated without knowing the SWR. Most computerized Smith Chart programs actually perform independent calculations and then convert them to graphical-geometric Smith chart plots.

We can calculate the voltage, current, and impedance along any length of transmission line, obtaining both the magnitude and phase angle. In fact, any two of the three will do, since the impedance is simply the voltage divided by the current (with due attention to the phase angle). **Figure 14** provides a view of the excursions of voltage, current, and impedance magnitudes (without reference to phase angles) along a 450-ohm transmission line from an extended double Zepp antenna. Its purpose is only to demonstrate that these values do not vary in many instances in nice, clean sine waves--nor even symmetrically within a half-wavelength span of line. For simple matching purposes, pure impedance curves tend to be most helpful. If we know the impedance and its phase angle, we can easily convert that to series values of resistance and reactance.

I shall bypass the temptation to toss out three more equations at you. Besides the fact that they are messy, all of the work has been done for lossless lines in one of the programs in the HAMCALC collection. There, you can specify any feeder Zo and VF, along with antenna-end values of R and X and some desired power level, and then see the value of voltage, current, and impedance (in both Z and R+/-jX forms) at any

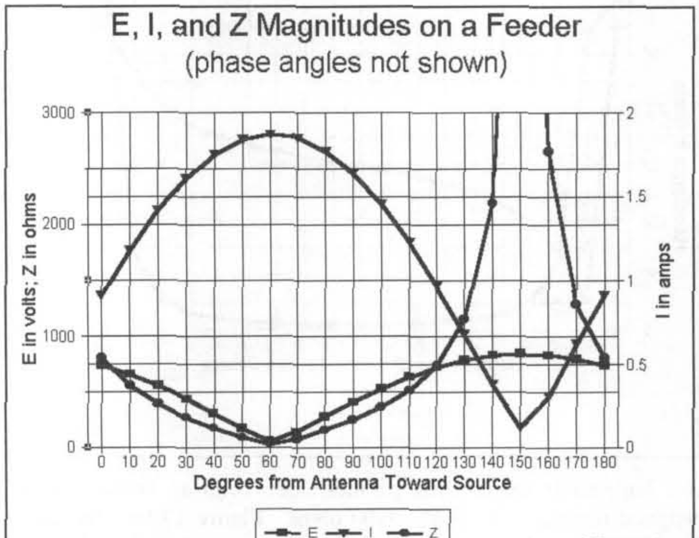


Figure 14.

distance from the antenna or in a chart taken every 5 degrees along a line. If you can do without the chart and want losses thrown in, then use TLA by Dean Straw.

The big chart is handy for checking out what happens along a transmission line and for graphing the results. We are all taught that the impedance values repeat themselves every 180 degrees or half wavelength of transmission line. Unfortunately, most sources fail to teach us that voltage and current repeat their values only once every 360 degrees or full wavelength of feedline. That sort of neglect kept us in the dark about a number of interesting questions for nearly a half century, for example, how the element phasing of the ZL special really works.

10. The tenth way to look at transmission lines: with a calculator and a graph

Because we can vary the length of our feedline, even if *lengthening* it creates just a little more loss, we may often find it useful to understand what happens to the resistance and reactance as they continuously change every 180 degrees of line. The program, "Transmission Line Performance" in HAMCALC will provide figures for 180 degrees, and if you want to see what happens in the next 180 degrees, take the last figures in the columns, and plug them in as initial figures for a new chart.

Let's look at a few graphs made up from the tables to see what happens to the resistance and reactance in some typical scenarios. But first, let's go back to **Figure 2**, where we entered the electrical length of our hypothetical RG-213: 296.9 degrees. Since this is close to 300 degrees and my graphs use values for each 10 degrees, we shall use that nice round number. However, the graphs cut off at 180 degrees. Since all impedance phenomena repeat every 180 degrees, we simply subtract 180 from 300 to get 120 degrees. The values that appear at the 120-degree mark are the one's most likely to show up at the end of our coax.

We can begin with **Figure 15**, a graph of resistance and reactance for an antenna impedance of 150 +/- j0 ohms. This is a resonant antenna with an SWR of 3:1 relative to our RG-213, with its characteristic impedance of 50 ohms. Because the antenna is resonant, note the nice symmetry of the curves--and be sure to read each from the correct Y axis: left for resistance and right for reactance.

First, it is not the case that everywhere along the lines, the R +/- jX values yield an impedance of 150 ohms. Instead, everywhere along the (lossless) line, the SWR is 3:1. Second, note that the reactance can reach well above 60 ohms (capacitive or inductive, depending on the length of the line). Third, at the 120-degree mark, we read an impedance of about 21 + j25 ohms.

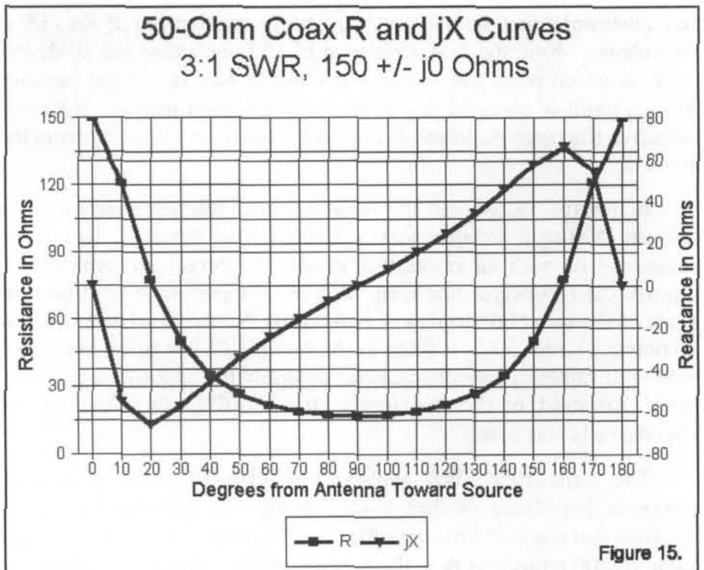


Figure 15.

This last figure tells us something important. The reactance figure is one that most network tuners can handle with ease, while the 2.5:1 ratio of source resistance (50 ohms) and presented resistance is fairly easily handled by almost any common tuner. So, if we can stand the cable loss of a 3:1 SWR, along with the slight tuner losses, we can easily match our antenna-feedline to the transmitter.

Now consider **Figure 16**. Here we also have a 3:1 SWR with our RG-213. Note that this SWR occurs with an antenna impedance of 70 + j66 ohms. At the 120-degree mark, we find an impedance of about 17 + j6 ohms. Although the reactance is low, so too is the resistance. Most network tuners will handle the job, but at slightly less efficiency than the previous case. Same SWR, but different tuning conditions and different impedance value.

Actually, **Figure 15** and **Figure 16** present the same curves, shifted by the reactance on the line. For a given line Zo, every curve with the same SWR will overlap every other curve of the same SWR, with only an adjustment down the line according to the relationship of R to jX at the antenna. Note the peak resistance of 150 ohms near the 20-degree mark, at which point the reactance is close to zero (the slight variance being a result of using 10-degree increments for our marks). Note that inductive reactance pushes peak resistance down the line away from the antenna.

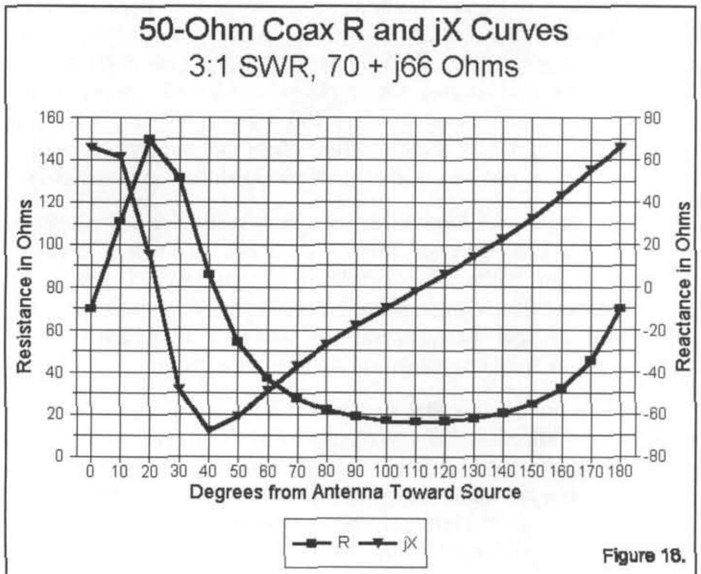


Figure 16.

In **Figure 17**, we see the resistance and reactance curves for a resonant 500-ohm antenna with a 50-ohm coax feeder--a 10:1 SWR situation. As with all resonant antennas, the curves are symmetrical through the 180-degree line span. It is most important to note for how much of the span (120 degrees or two-thirds) that the resistance is below 20 ohms. Our tendency is often to think of high SWR being associated with high values of impedance, when precisely the opposite is generally true: for most of the line length, the resistive component of the impedance is very low.

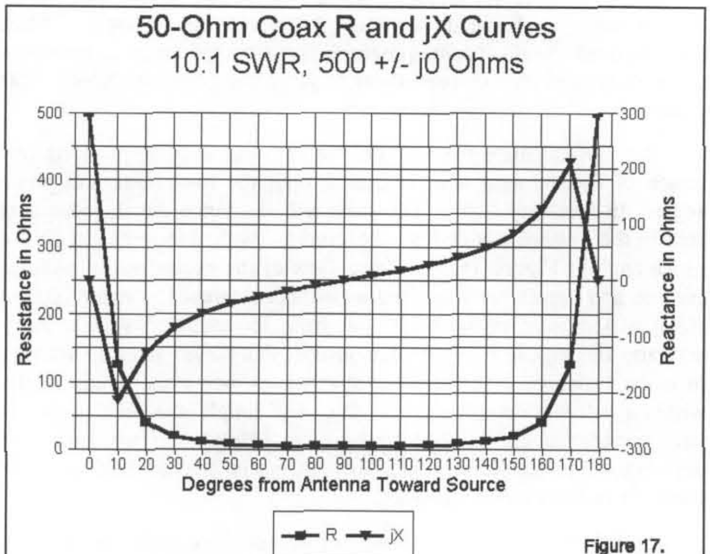


Figure 17.

The same 10:1 SWR applies to **Figure 18**, with an antenna feedpoint impedance of 300 + j243 ohms. It may not be readily apparent that this curve overlays **Figure 17** exactly. The peak resistance value of 500 ohms occurs at the 5-degree mark. Hence, the automated resistance Y-axis does not replicate. However, the reactance Y-axis scale shows the overlap of those curves.

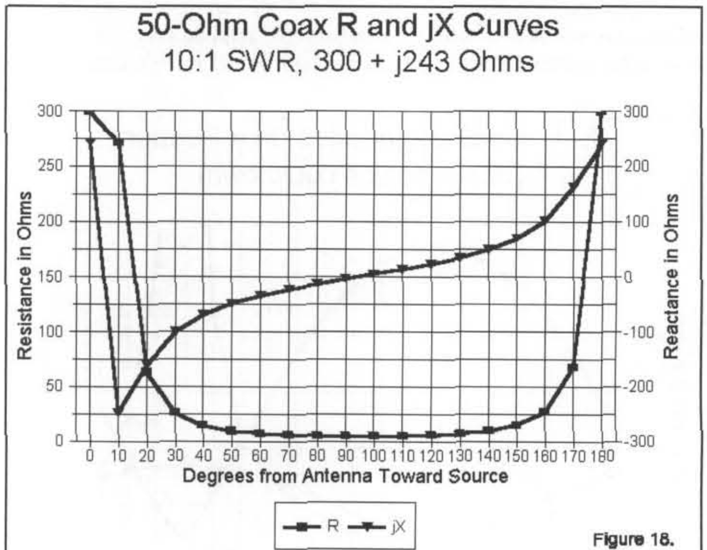


Figure 18.

Suppose that our 74' 10.5" of feedline had been 450-ohm "window" line with a VF of 0.95. Our line would be 206 degrees long, and we would look at the 26-degree mark on any relevant charts. The closest 10-degree point is, of course, 30 degrees. Using that number, lets see what happens if we use this parallel feeder with an antenna whose feedpoint impedance is 1000 - j100 ohms. **Figure 19** tells the story. Because the impedance is slightly capacitive, the graph is shifted toward the antenna end, with the first graphable resistance peak between the 175 and 180 degree marks. Although the reactance at the antenna is only -100 ohms, the reactance value along the length of line varies from +400 to -400 ohms. At the end of the line we ran (the 30-degree mark), the impedance presented to the ATU is about 450 - j375 ohms--a fairly easy matching situation for any truly balanced ATU.

There are numerous matching schemes that do away with the ATU proper. Instead, they try to use calculated or experimentally determined line lengths to intercept something close to a 50-ohm resistive point on the line and then add enough reactance across the line to yield a net reactance of zero. Unfortunately, here is an antenna and feedline combination on which that technique would fail. Notice that the resistive component of the antenna never falls below 200 ohms. However, since this value occurs just about where the reactance crosses the zero line, a 4:1 balun might work with a line length just under 90 degrees (or 270 degrees, etc.). Direct reactance cancellation at or near the point along a 450-ohm line of a current maximum works best if the SWR is middling (4:1 to 6:1) or the reactance holds a 2:1 (or lower) ratio to the resistance for higher resistance values. Otherwise, the resistance along the line may not approach 50 ohms or may occur in a

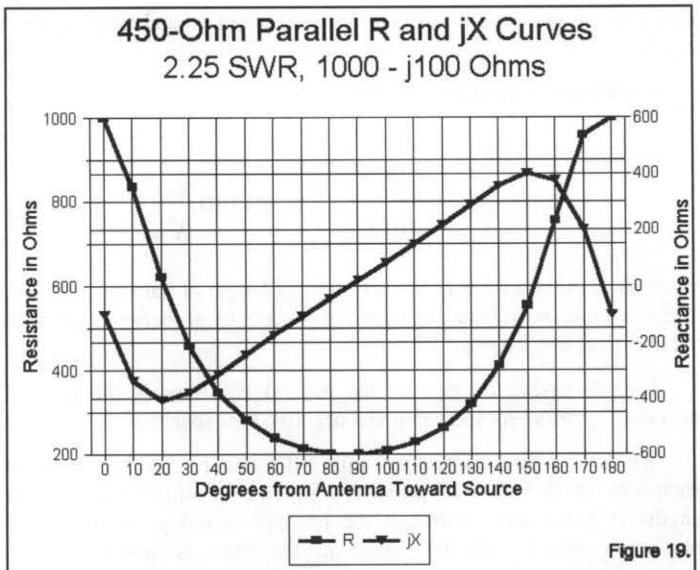


Figure 19.

region of very rapidly changing values, making tuning excessively sharp.

More common with antennas near (but not at) a multiple of a wavelength long is the situation exemplified by **Figure 20**. The antenna impedance of 1000 - j2000 ohms yields an SWR of 11.47. Notice the very brief spike in the resistance curve, with the remainder of the curve at a low resistance. This curve graphically demonstrates the danger of using a 4:1 balun between the feedline and a network tuner. Let's examine our 30-degree mark. Ignoring the 200-ohm reactance, which

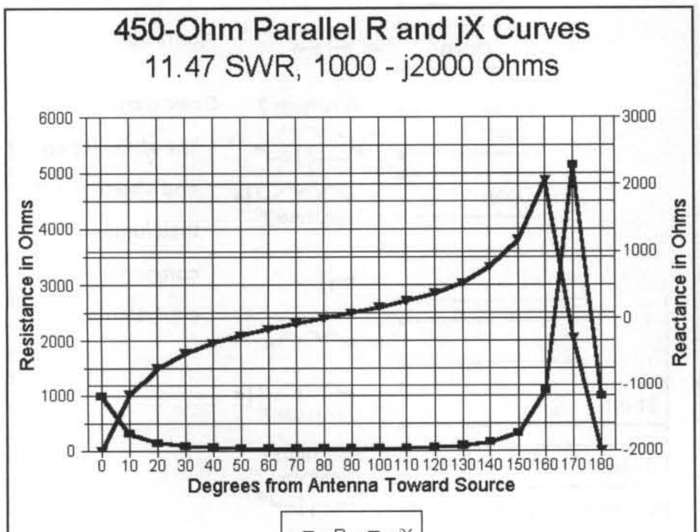


Figure 20.

tends to disrupt normal transmission-line transformer operation, the 90-ohm resistive component would simply be reduced to 22.5 ohms, a worse situation than would be the case with a 1:1 ferrite bead choke in place of the toroidal balun. At some points along the line, the resistive component will fall to under 10 ohms with the 4:1 system. Antenna situations like this one--which is quite common--make a good case for hauling out the old link-coupled antenna tuner.

We can close our series of examples with **Figure 21**, a 450-ohm line feeding an Extended Double Zepp (EDZ). Typically, these antennas show a feedpoint impedance of about 120 - j800 ohms (plus or minus about 20 percent, depending on the exact length of the antenna). Notice the very high spike in resistance and the very long series of very low resistance values. Also notice that there are two regions to the graph: a. a region from about 20 to 120 degrees where values change slowly and b. a region from 120 to 180 degrees where they change almost wildly. If you want freedom from ATU matches that change with weather conditions such as rain, ice, or even wind, choose a line length that ends up in the "slow-change" area.

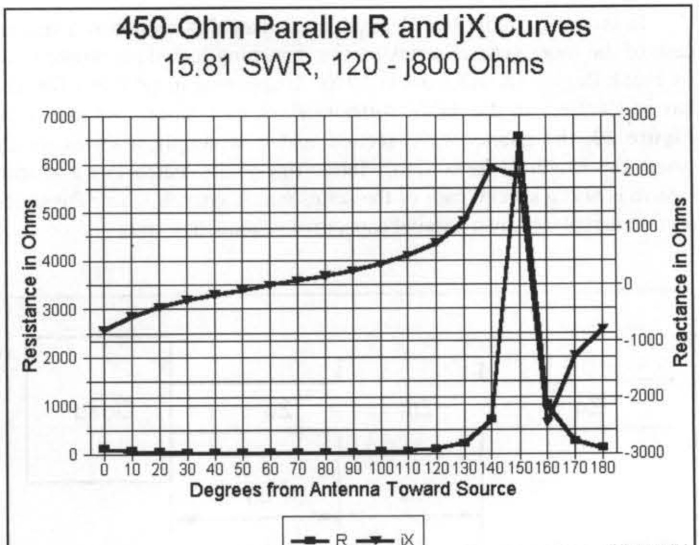


Figure 21.

The series of graphs can be extended indefinitely. However, if you study the examples given, you will begin to develop a fairly good intuitive feeling for what happens to impedance along a continuous impedance transformer called a transmission line. Add a program to calculate actual values for you, and you can convert your intuitions into intelligent decisions in the selection of feeder lines and line lengths for your installation.

11. The eleventh way to look at transmission lines: with pruning shears

As we have noted, a transmission line is a continuous impedance transformer. Impedance values repeat the value at the antenna feedpoint every 180 degrees (with a little adjustment for line losses). There is another magic mark along the way: the 1/4 wavelength or 90-degree point. At this point, however much the impedance departs in one direction from the line Zo at the antenna, it now departs by the same degree in the other direction.

Arithmetically, the relationships look like this:

$$Z_O = \sqrt{Z_1 Z_2} \text{ or } Z_1 = \frac{Z_O^2}{Z_2}$$

where Zo is the characteristic impedance of the quarter-wavelength matching section of line needed or chosen to do the matching job, Z_1 is the impedance at one end of the section, and Z_2 is the impedance at the other end of the line.

This property of transmission lines is most useful with essentially resistive loads (very low reactances). With coaxial cable, it solves the problem of matching some common antennas to our ubiquitous 50-ohm feedline.

Some common quad beam design have feedpoint impedances of 100-ohms. One can purchase an expensive 2:1 balun, but that is unnecessary. Since the two impedances, 100 ohms and 50 ohms have a product of 500, the square root is 70.7 ohms. A quarter wavelength section of any common 70-ohm cable, cut with respect for its VF, will effect the transformation.

Many good Yagi designs have feedpoint impedances of about 25 ohms. To use a 50-ohm coax cable as our feedline, we need a quarter wavelength section of the square root of 1250, or 35.4 ohms. We can make such a line with parallel sections of 70-ohm feedline.

In fact, the quarter wavelength magic matching section is a special case of the more general series-section matching technique worked out by Frank Regier, OD5CG, about 1970. It appeared in *QST* in 1978 and has had a place in the *ARRL Antenna Book* ever since. As shown in **Figure 22**, the quarter-wave section match is simply a series match where the length of L_1 is zero. Interestingly, the match-line and stub system is also a special case of the series match system, where the series section is replaced by a parallel capacitive or inductive stub.

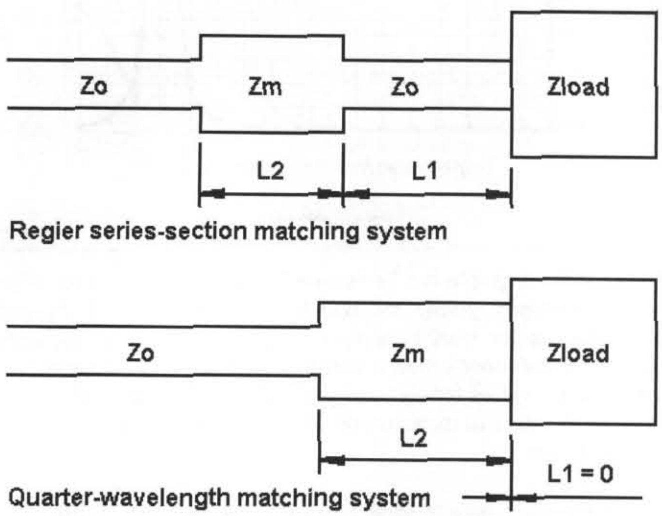


Figure 22. Series and 1/4 wl matching systems.

12. The eleventh way to look at transmission lines: with a trigonometer

If we do not understand transmission line stubs, the last sentence in the preceding section will seem mysterious. However, whenever we place a shorted or open-circuit length of transmission line in series with or in parallel across another line (or even an antenna), it acts like a capacitor or an inductor.

Figure 23 shows the basic relationships between transmission line length and its function as a circuit component. If the line is exactly 1/4 or 1/2 wavelength long, then it is resonant and has no reactance. However, at all other lengths, the line is either a capacitive reactance or an inductive reactance, depending upon whether it is open-circuited of closed-circuited (shorted). Notice that the lines change reactance types as they pass the 1/4-wavelength point.

The actual reactance is easy to calculate. For a closed-circuit line,

$$X_C = Z_O \tan L or L = \arctan\frac{X_C}{Z_O}$$

where X_C is the reactance of a closed-circuit length of transmission line, Zo is the characteristic impedance of the line, and L is the length in electrical degrees. Note that we shall have to use the conversion process we learned in section 2 to convert electrical length to and from physical length.

For an open-circuit line, we use

$$X_O = \frac{Z_O}{\tan L} or L = \arctan\frac{Z_O}{X_O}$$

where X_O is the reactance of the open-circuit length of transmission line. Again, we use the standard conversion process to go between physical and electrical line lengths.

In both cases, the sign of the X-term will specify the type of reactance: positive for inductive and negative for capacitive.

We use actual capacitors and inductors to produce desired reactances in circuits. In principle, we can substitute transmission lengths in every case, although the practice is bulky except in the microwave region. At HF, some of the most common uses for transmission line stubs are illustrated in **Figure 24**. The beta-match hairpin is simply a transmission-line version of the beta-match coil. Linear loaded antenna elements are transmission-line substitutes for loading coils. One-quarter wavelength stubs can replace lumped components in the formation of frequency-specific, high-Q filters.

The match-line-and stub system of matching an antenna to a feed line is especially interesting. Although there are some conditions that

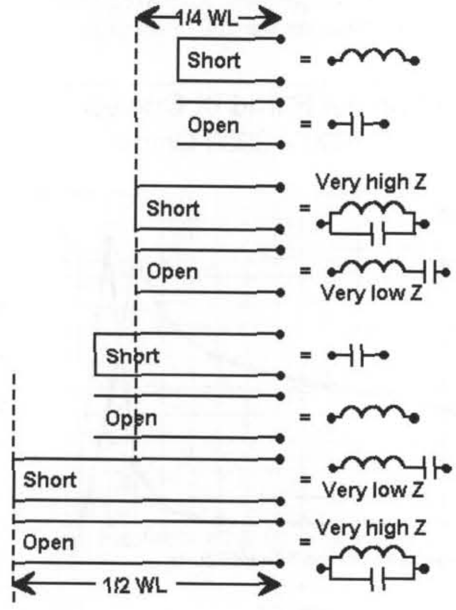


Figure 23.

Basic transmission line stubs (open and shorted) with their lumped-component equivalents.

will not permit a match, wherever one is possible, four are possible. HAMCALC has a program that will calculate matches for possible cases. Let's use such a match on our EDZ example with a feedpoint impedance of 100 -j800 ohms. Suppose we wish to connect this to a 50-ohm coaxial cable at 7.15 MHz. Let's specify 450-ohm, VF-0.95 window line for both the match line and the stub.

If we use a match line length of 21.02' (6.41 m), then we can attach a 2.65' (0.81 m) shorted stub or a 35.32' (10.77 m) open stub to effect our match to 50-ohm coax. With a length of 23.312' (7.11m), we can use a 62.69' (19.11 m) shorted stub or a 30.02' (9.15 m) open stub. All will work, but--of course--we normally choose the shortest combination of matchline and stub that will achieve the goal. For monoband

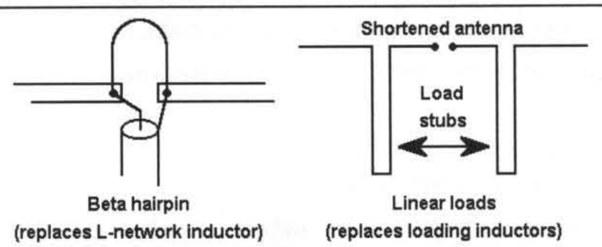
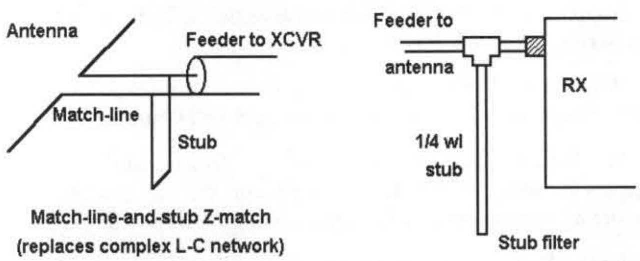


Figure 24. Some uses of transmission line stubs.



antennas with odd feedpoint impedances, the match-line and stub system is a handy tool indeed. Incidentally, the stub reactances are all (+/-) 57.7 ohms, and we could apply a capacitor or inductor across the line in place of the open or shorted stub, respectively.

A Baker's Dozen. More ways to look at your feeders

We have to end our story somewhere, and a dozen ways to look at your feeders (and love them) is a nice even number. However, we could go on (and on and on). For example, we need to look at transmission lines with kid gloves to make sure we do not mistreat them. We also need to look at feeders with a field strength meter to see if they are radiating like antennas. We should additionally look at feedlines with an underwater scope to get further depth in our coverage.

However, these 12 ways of looking at feeders will hopefully provide you with the means to sort out all the kinds of things you already know about feedlines so that you can feel more comfortable with them. The 12 ways are just a means of making sense out of a lot of information. I have said nothing new on the subject. Except, perhaps, that my feeders like to know that I love them.

A Note on More Advanced Equations

Although we have used only as many basic equations as may be needed to develop an intuitive feeling for transmission line operation, the reader should not assume that the omitted equations are unimportant. Rather, they would have bogged down the flow of this particular discussion.

For reference, here are a few equations of use. In the following, Er is the voltage at the antenna, Ir is the current at the antenna, Zr is the impedance at the antenna, Zo is the characteristics impedance of the transmission line, and L is the length in electrical degrees.

1. To determine the voltage (Es) anywhere along a transmission line from the antenna:

$$E_s = E_r \cos L + j\, I_r Z_O \sin L$$

2. To determine the current (Is) anywhere along a transmission line from the antenna:

$$I_s = I_r \cos L + j \frac{E_r}{Z_O} \sin L$$

3. To determine the impedance (Zs) anywhere along a transmission line from the antenna:

$$Z_s = Z_O \frac{\frac{Z_R}{Z_O}\cos L + j \sin L}{\cos L + j \frac{Z_R}{Z_O} \sin L}$$

Each of these equations has a real and an imaginary (j) part, which can be solved separately and recombined to yield a magnitude and a phase angle. Moreover, the voltage, current, and impedance at the antenna may also be a magnitude at a phase angle, thus requiring further subdivision of the equations. The techniques described by Keucken in *Exploring Antennas and Transmission Lines by Personal Computer* can be useful in setting these equations up in one or more of the common programming languages.

These equations are for lossless lines. Similar equations exist for lossy lines and involve the use of the value of Zo derived from the series impedance per unit length and the shunt admittance per unit length, along with sinh and cosh functions. For lossy lines, the impedance at some distance from the source is given by

$$Z_s = Z_O \frac{\frac{Z_R}{Z_O}\cos \gamma L + j \sinh \gamma L}{\cosh \gamma L + j \frac{Z_R}{Z_O} \sinh \gamma L}$$

where γ is a complex loss coefficient comprised of the matched-line loss attenuation constant and the line phase constant and L is given in units matching those of γ. These equations lend themselves to computer solution to speed computation and ensure precision, although the elegance of the Smith Chart lies in its ability to handle them graphically.

The relationships among the line characteristic impedance, Zo, and the voltage and current along the line (treated variously as forward and reflected voltage or current, or as maximum and minimum voltage or current) are too numerous to cover here. However, using Zo as the characteristic impedance of a lossless line, we can define the reflection coefficient, ρ, as follows:

$$|\rho| = \sqrt{\frac{(R_r - Z_O)^2 + X_r^2}{(R_r + Z_O)^2 + X_r^2}}$$

where Rr and Xr are the resistive and reactive components of the impedance Zr as used in the preceding equations.

SWR (voltage or current standing wave ratio) is simply

$$SWR = \frac{1+|\rho|}{1-|\rho|}$$

which may make apparent the direct calculation of SWR given in the main text. The fact that the reflection coefficient, and hence SWR, are circular functions is the key to understanding the construction of the Smith Chart. A simplified Smith chart is illustrated in **Figure 25**.

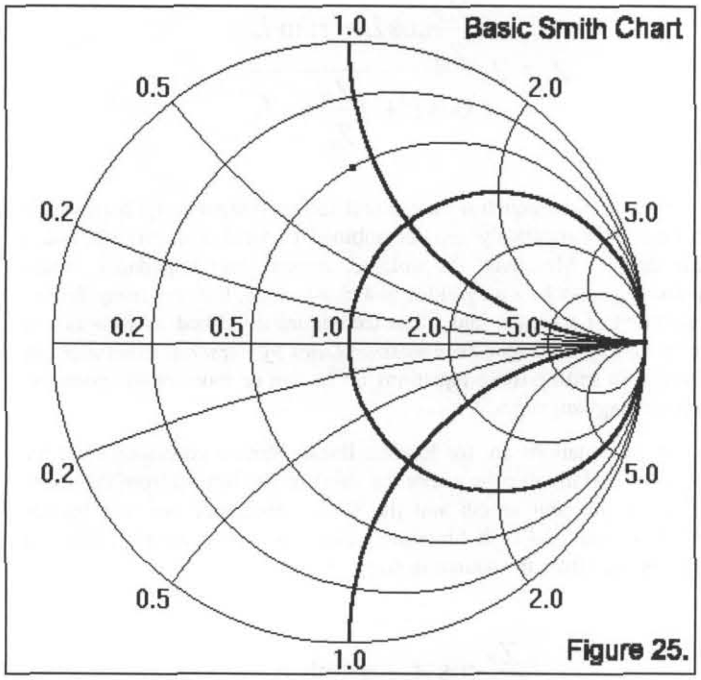


Figure 25.

As you delve into the variety of literature, you will encounter variations of both notation and form of the equations shown here for reference and others related to them. It is useful to keep a log of the variations in the texts to which you refer most often to ensure ease in following a set of calculations or discussion of the phenomena described by these equations.

References

The following software may be useful in calculating various problems with transmission lines:

HAMCALC, version 32, by George Murphy, VE3ERP, 77 McKenzie Street, Orillia, ONT L3V 6A6, Canada. Murph requests that users send him $5.00 to cover the cost of the disk, a mailer, and postage from Canada. Any excess over costs is donated to the Canadian National Institute for the Blind amateur radio program.

TLA, by Dean Straw, N6BV, comes with the current edition of the *ARRL Antenna Book* or can be obtained from the ARRL BBS.

MicroSmith, by Wes Hayward, W7ZOI, available from ARRL.

The following books and chapters may be useful to you in furthering your understanding of transmission lines.

R. Dean Straw, N6BV, ed., *The ARRL Antenna Book* (Newington: ARRL, 1997), Chapter 24.

Joseph J. Carr, *Practical Antenna Handbook*, 2nd Ed. (New York: TAB Books, 1994), Chapter 3.

Wilfred N. Caron, *Antenna Impedance Matching* (Newington, ARRL, 1989): one of the finest tutorials on Smith Chart use.

M. Walter Maxwell, *Reflections: Transmission Lines and Antennas* (Newington, ARRL, 1990): perhaps the best source book for overcoming misconceptions about transmission lines and SWR.

Jerry Sevick, *Transmission Line Transformers*, 2nd Ed. (Newington: ARRL, 1990): this and other of Sevick's books are authoritative on the subject.

For advanced reading, I recommend the following:

Richard C. Johnson, ed, *Antenna Engineering Handbook*, 3rd Ed. (New York: McGraw-Hill, 1993), Chapter 42.

John A. Keucken, *Antennas and Transmission Lines* (Starkeville, MS: MFJ, 1996), Chapters 16-25 (a reprint of a fine text). See also Keucken's *Exploring Antennas and Transmission Lines by Personal Computer.*

Frederick E. Terman, *Radio Engineers' Handbook* (New York: McGraw-Hill, 1943), Section 3.

Ronold W. P. King, *Transmission Line Theory* (New York: Dover, 1965); a highly theoretical work for the exceptionally curious.

Editer's Notes:

1) This article was first published in the FDIM 98 QRP Symposium Proceedings and is reprinted here with the permission of W4RNL.

2) L.B. Cebik can be contacted by e-mail at: cebik@utkux.utcc.utk.edu>

(Reference Table 1 on following page.)

Type or RG #	Belden #	Zo Ohms	Velocity Factor	Loss in dB per 100' @ 3.5 MHz
1. Coaxial Cables				
RG-58A	8529	50 -j1.29	0.66	0.762
RG-59A	8241	75 -j1.81	0.66	0.711
RG-8X	9258	50 -j1.03	0.78	0.511
RG-8A	8237	50 -j0.60	0.66	0.351
RG-213	8267	50 -j0.60	0.66	0.351
RG-8 (foam)	8214	52 -j0.60	0.78	0.289
	9913	50 -j0.52	0.84	0.242
	9086	50 -j0.52	0.84	0.242
RG-11A	8267	75 -j0.89	0.66	0.351
RG-17A		50 -j0.24	0.66	0.140
RG-218		50 -j0.24	0.66	0.140
2. Hardlines (solid jacket coaxial cables)				
1/2" hardline		50 -j0.23	0.81	0.111
1/2" hardline		75 -j0.41	0.81	0.132
3/4" hardline		50 -j0.15	0.81	0.074
3/4" hardline		75 -j0.31	0.81	0.098
3. Parallel 2-wire feedline				
300-ohm tubular xmt		300-j2.14	0.80	0.173
450-ohm "window" ladder		450-j2.16	0.95	0.098
600-ohm open wire		600-j0.95	0.97	0.032

Table 1. Some characteristics of typical transmission lines from TLA by N6BV.

Atlanticon 99

QRP Forum

March 26-27, 1999 in Baltimore, MD

Saturday: 8am-5pm

QRP talks delivered all day long by the most prominent luminaries in the QRP field:

- Dave Benson, **NN1G**
- Paul Harden, **NA5N**
- Chuck Adams, **K5FO**
- L.B. Cebik, **W4RNL**
- Joe Everhart, **N2CX**
- Steve Weber, **KD1JV**
- Bob Berlyn, **HB Electronics**

The QRP Forum Proceedings (containing all the papers being presented) will be made available FREE to the first 100 attendees!

Saturday Evening: 7:30pm

The Hospitality Suite opens again at the hotel with a "show 'n tell" for all your homebrew projects, with a "Building Contest" judging and prizes being awarded.

Hotel Registration

The Atlanticon 99 QRP Forum is being held at the Holiday Inn Select in Timonium. Located off Rt 83N exit 16A just north of the Rt 695 Beltway on the north side of Baltimore, the hotel is right across the street from the fairgrounds where the Timonium Hamfest is being held all weekend. Special room rates have been negotiated with the hotel for $69/night, for as many occupants per room as desired. Reserve your room ASAP for both nights (Friday 3/26 and Saturday 3/27) by calling the hotel at **(410) 252-7373** and mention "Atlanticon" to get the special rate rooms we blocked off. Don't delay on getting a room! They are going fast because of the hamfest!

Sponsored by the
NEW JERSEY QRP CLUB

"Atlanticon 99", the first major QRP forum of the season, will be held at the Holiday Inn Select, in Timonium, MD (just north of Baltimore) right across the street from the huge Timonium Hamfest fairgrounds.

The main theme of this weekend is FUN! Socialize with fellow QRPers from around the world, come listen to a full day of exciting QRP presentations delivered by experts in the field, and spend some time at the biggest hamfest on the eastern seaboard: Timonium!

QRP Forum is FREE!

There is no charge for attending the Atlanticon QRP Forum, or either of the hospitality suite evenings! The NJ-QRP Club is pleased to be able to give back to the QRP community and provide this kind of well-balanced and quality event for all to enjoy.

Great Prize Drawings!

We have a lot of very cool QRP prizes contributed by generous QRPers, clubs & vendors. Some of the prizes include: an SW40+ transceiver, an EMTECH QRP transceiver, a 44-Magnum transceiver, ZM-2 ATUs, QRPer Data Books, Ladder Grabbers, DX QSL Guides, and the grand prize is a NC20 transceiver graciously donated by the NorCal QRP Club! Drawings for these prizes will occur throughout the weekend and will be based on the number of the attendee's badge obtained at pre-registration. (Winners must be present to collect their prizes!)

Friday Afternoon: 3pm

Field excursion to the Space Sciences Institute for a guided tour of the Hubble Telescope Control facility, arranged & hosted by Paul Harden, NA5N.

Friday Evening: 7pm

Hospitality Suite opens for informal socializing with QRPers and vendors at the hotel. Show off your projects, browse the vendor booths, or just hang out and chat.

Forum Pre-Registration

In order to reserve a spot at the main event (Saturday's QRP Talks), you must contact Dave Maliniak, N2SMH and receive an "Atlanticon number" for the special, collector's edition badge being prepared for you. This number will also qualify you for the many cool QRP prize drawings occurring throughout the weekend. Space is limited to 100 seats, and they are going fast. Register soon! N2SMH can be reached at: 54 East Gramercy Place, Glen Rock, NJ 07452, e-mail: (dmaliniak@penton.com)

For More Information

- George Heron, N2APB, 45 Fieldstone Trail, Sparta, NJ 07871, E-mail: n2apb@amsat.org
- The Jersey QRP Website also contains the latest information and status of the QRP Forum. http://www.njqrp.org/atlanticon/
- The Timonium Hamfest website contains maps & more info about the weekend: http://www.gbhc.org/

The Rainbow Power Meter
Part 1: The Basics

Joe Everhart N2CX *214 New Jersey Rd* *Brooklawn, NJ 08030-2519*
n2cx@voicenet.com

This was originally supposed to be the first of a two-part Quickie for the Idea Exchange, but I later decided they really ought to be done as separate articles, so here's the first one. (And Joe quickly wrote up another Quickie to replace this one, so as to not break a long string of N2CX Quickies in the Idea Exchange.) This part gives the basics, and details will be presented in part 2. —WA8MCQ

When I thought about what to do for NorCal's 1996 Design Competition, I began thinking of a fairly simple QRP dummy load and power meter. But as things progressed, the idea of an integrated auto-reading SWR bridge and tuner looked more attractive. So the power meter concept fell by the wayside. However it is kind of a neat thing so I'll describe the design concepts and some of the schematic in this first part. The remainder of the circuit details will follow in the second. All right, let's get started!

Figure 1 shows the block diagram. A QRP dummy load is almost ridiculously easy to build using some inexpensive resistors. And the RF can be detected pretty accurately (at least for sine waves) with a one-diode detector. The DC output of this detector is the peak value of the RF sine wave. For RF levels above a watt or so this can be done with pretty good accuracy, so it can be the basis for a QRP wattmeter.

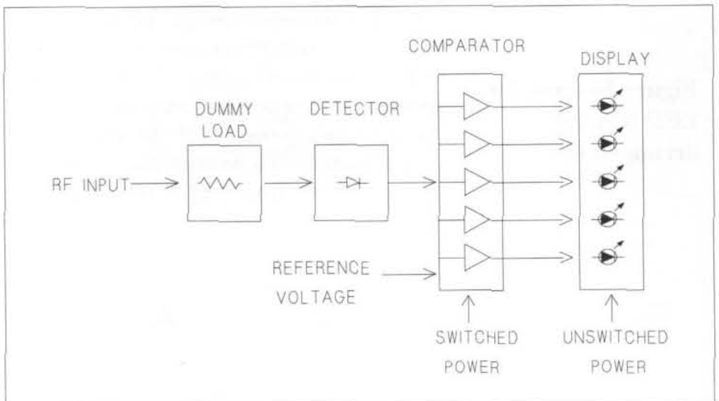


Figure 1—basic block diagram

The usual RF power meters use either an analog meter or numeric digital display to read this voltage and display the corresponding RF power. A simpler way to do the same thing if you don't need precise readings is to use a bar graph display.

The Rainbow power meter does just that. It uses some inexpensive, very accurate integrated circuit comparators to drive the display. Each comparator in the COMP block looks for a particular DC voltage from the DETECT section and lights up an LED in the DISPLAY for the RF power level that corresponds to that DC voltage.

Now for some more detail about that process, starting with the dummy load and detector. That circuit is in Figure 2. The dummy load consists of four 200 ohm metal film resistors connected in parallel. The result is 50 ohms. If the resistors are rated at 2 watts each, the combination of four will share the power so it can dissipate up to 8 watts maximum. Actually if they are mounted on a PC board in a closed box,

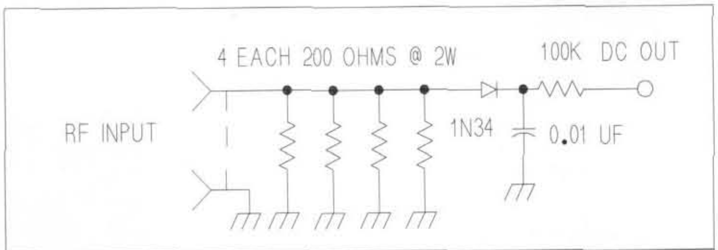


Figure 2—dummy load and diode detector

this rating is optimistic. But it should be adequate to handle the maximum QRP level of 5 watts for short periods.

For the resistors I recommend using inexpensive Panasonic 5% 2 watters available from DigiKey. The DigiKey P/N is P200W-2TR-ND according to the Oct-Dec 1998 catalog and they cost only $1.00 for five of them. (Hint - buy 10 of them and measure them with an accurate digital ohmmeter. Hook up four at a time and use the four that give you the closest to 50 ohms. The set of four that are next closest can be used for a second dummy load without any metering.)

The detector is an ordinary 1N34 germanium diode. The 0.01 uF capacitor on its cathode charges up to the peak value of the RF sine wave at its anode side. A 100 kilohm resistor provides isolation from downstream circuitry. Actually a hot carrier or Schottky diode would probably be somewhat better but is not as easy for the average hobbyist to buy.

The RF and resulting DC voltages can be easily calculated. The RMS voltage across the load is the relationship shown below where P is the power in watts and R is the dummy load resistance (usually 50 ohms). A little more calculation gives the peak voltage of the sine wave which will also be the DC output from the detector, VDC = 1.414 X Vrms. The RF voltages and DC voltages are tabulated below.

Power *(watts)*	RF Voltage *(Vrms)*	DC Voltage *(Vdc)*
5.5	16.58	23.45
5.0	15.81	22.36
4.0	14.14	20.0
3.0	12.25	17.32
2.0	10.00	14.14
1.0	7.071	10.0

$$Vrms = \sqrt{PR}$$

There is a small error in the detector's DC output due to the diode's forward voltage drop (about 0.2V) but this is small compared to even the smallest DC value shown above so it is ignored. Actually there are other errors that cause the detected voltage to deviate from the predicted value. However they are pretty consistent so that they do not seriously affect the linearity of the DC vs power conversion over the above range. The calibration procedure given in part 2 should take care of this consistent error.

The trick is to make the comparators in the COMP section respond to the appropriate DC levels. Actually this is easier than it may seem. The comparators used respond to the difference in input voltage across their inputs. Check out Figure 3A and 3B. The comparator has two inputs and one output pin. Think of it as a high gain differential amplifier (like an operational amplifier) optimized for a digital (on/off) output. When the input voltages differ the output is a very highly amplified replica of that difference. In an operational amplifier the output behaves like that, but the output is an accurate amplified version of the input.

Op amps usually have feedback resistors (Fig 3B) that limit their gain so that their output voltage is between the plus and minus (or plus and ground) supply voltages. Comparators (Fig 3A), however do not have this negative feedback so their output pins are at either the plus

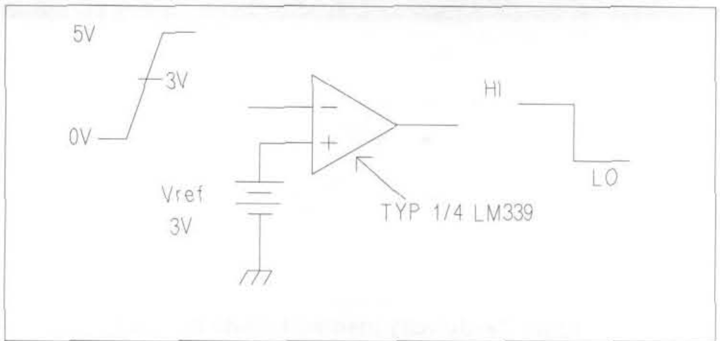


Figure 3A—voltage comparator

or minus supply voltage. Kind of like a one-bit analog to digital converter.

The comparator gain is so high that it only takes a matter of millivolts difference between the two inputs to switch its output from plus to minus. When the "+" input is higher in voltage than the "-" input,

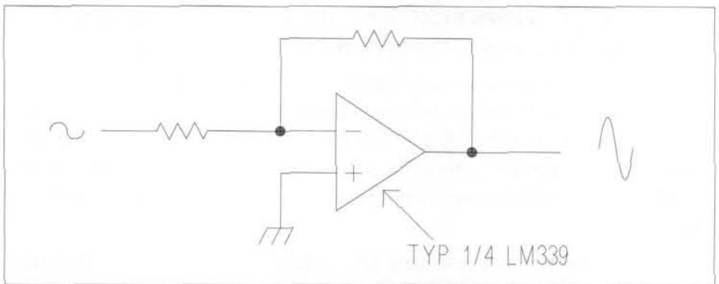


Figure 3B—operational amplifier (op amp)

the output is plus. When the "-" input is higher, the output is at the minus supply voltage or ground for the instance shown.

OK, this begs the question "what happens if the two inputs are exactly the same?" Well the answer is that you try not to get them exactly the same. And it is tough to do so since only a couple of millivolts is enough to make the output switch from the + to - state. Actually if they are within couple of millivolts the output will jump back and forth between high and low because of random noise. As has been mentioned, though, this is an unusual case.

The comparators are set up so that each has a fixed or reference input and another that is a fraction of the DC from the RF detector. In this circuit the reference voltage is set to 3 volts DC. The fraction of the DC sample is set by a string of precision resistors that form a voltage divider. The division ratios are set so that at each tap, the voltage will be equal to the reference for a predetermined power level. Figure 4 shows the resistor divider. A little math can convince you that when the detector DC is fed to the top of the chain, each tap behaves as described above. By using a regulated reference voltage (to be described in Part 2 of this series) and 1% resistors, accurate power measurement is assured.

Each comparator is fed to the cathode lead of a light emitting diode (LED) that lights up when its associated comparator output goes low. Each LED anode goes to the positive supply voltage through a

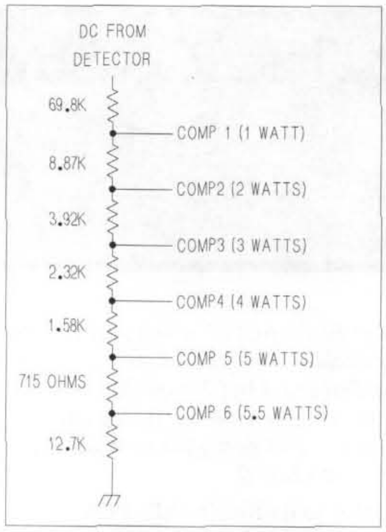


Figure 4—resistor divider

current limiting resistor. Since the comparators each switch low at a predetermined RF power, each indicates that power level.

Figure 5 shows a possible LED display arrangement. Blue, green, yellow, orange and red LEDs are arranged in a row to form a bar-graph display. For 1 watt the blue one lights, at 2 watts the blue and green are active, and so on up to 5 watts where all of them are on. This give both an accurate power reading at each level and a kind of linear display that can be useful for "peaking up" a transmitter's tuning. A sixth power level of 5.5 watts is displayed by having a dual current drive to the red LED. At 5 watts it lights with a partial intensity and becomes even brighter with 5.5 watts. With a little practice, this lets you set a transmitter to the "legal" 5 watt level without going over.

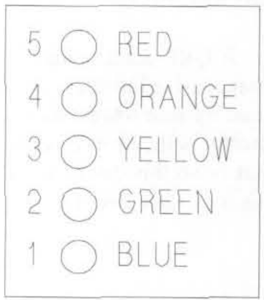


Figure 5—possible LED display arrangement

Another feature of the Rainbow Power Meter is that no on/off switch is needed. Figure 6 is the block diagram of the power switch circuitry. The DC signal from the detector is fed to the base of an FET with a turn on voltage of only a couple of volts. The FET, in turn feeds a transistor that supplies operating voltage to the comparator integrated circuits. The switched power is also fed to the reference voltage regulator which provides an accurate reference voltage over a wide power supply range. The LED anodes go directly to the power source since they will not draw any power until the comparators switch them on. So none of the components draw any power from the DC supply until RF

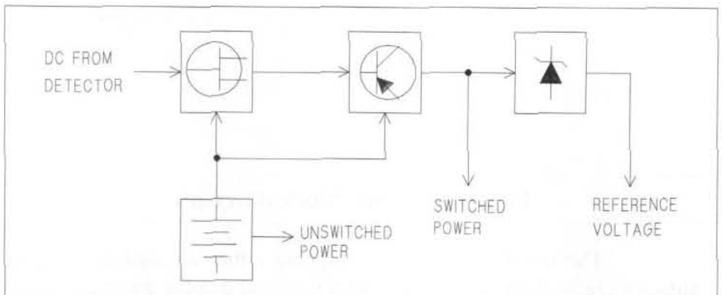


Figure 6—power switching circuitry block diagram

power is fed to the dummy load.

The final part of this article will give schematic diagrams for the circuits outlined in this piece along with additional circuit descriptions. In addition there will be a fairly complete parts list and some recommended sources for some of the less common parts needed.

Still QRP Really!

By Bruce Muscolino, W6TOY

Here we are again! First of all I want to thank all of you who checked in with "Get Well Quick" cards, letters, and messages! I am much improved though I don't know how. I finally had surgery on September 3rd, when I should have been preparing hot dogs! Instead of the advertised 5 or 6 days in the hospital followed by two weeks of physical therapy, I spent 5 weeks there due to complications. I could happily bomb the hospital off the face of the earth as it has taken more than 5 weeks to get the smell of the place off of me and return to somewhere near normal.

Well, normal in the sense that most systems are functioning normally and I am able to get around with a walker and a cane. I am able to climb the stairs at home (13 of them, I counted) by clutching the banister like there is no tomorrow! Walking without assistance still eludes me. Did you know when you're flat on your back for more than three days you start to loose muscle tone? Did you know what being flat on your back for 5 weeks does? Don't ask, but, let me say this – I will survive this operation and I will be back on the hamfest trail by next year's Timonium!

This time we are going to deal with two subjects near and dear to my heart. They are whining among QRPers and electronics knowledge. As you are well aware I don't approve of whining among amateurs – I believe all amateurs are created equal and should stand and fight for the things they believe in. To whine about the essential unfairness of other amateurs to QRPers is stupid and does not go towards respect for our kind. It is purely self-serving behavior that tends to set us further apart from the rest of the ham community!

Electronics knowledge is part and parcel of our hobby – yes, operating is important but our hobby is one of learning electronics and maintenance of operating skills! Lately two pieces of software have come to my attention that facilitate learning of electronics and application of the knowledge to real world problems – Electronic Principles and Electronic Workbench. Curiously, they are both produced by off-shore firms; Electronics Principles by a British firm and Electronics Workbench by a Canadian firm. I wonder what that says about the electronics industry in America?

Whining

The clearest example of whining among QRPers comes during contests. There is a tremendous speed disparity among QRPers – many are comfortable at speeds below 10 wpm while some are comfortable at 30-35 wpm. I think the vast majority of QRPers are comfortable below 18 wpm – I know I am. But that does not mean I am unhappy at 30-35wpm, only that I prefer operating around 18 wpm.

The place where this disparity shows itself most clearly is in contests. We have just finished Sweepstakes for 1988, a contest that tends to run in the 30-35 wpm range. The result was predictable – a number of QRPers got on the QRP List and ranted about the high speeds. They made it sound like they were unable to enjoy their hobby for this one weekend each year and that when they tried no one would listen to their calls.

Sweepstakes is an interesting contest – the biggest of the big guns in US contesting are involved. Serial numbers even after an hour or two tend to be in the 150 and higher range. These people are serious about their contest. I avoided Sweepstakes like the plague for the first 39 years of my ham radio experience, only joining in the fun two years ago when I learned that I could win a pin prize for making more than 100 contacts! I thought when I got in that it would be easy to work 100 stations.

Imagine me, plodding along at 20 wpm, with a straight key , as I did so many times in the 70s and 80s, expecting to be competitive. Wow, what changes had been wrought on contesting by computerized logs and high speed memory keyers! Now it was hardly necessary to write down anything (my station excepted!), just put it in the keyer and press buttons! Well, maybe it wasn't as simple as that but it seemed so from afar.

But, I didn't have any problem dealing with the 250 Hz filters in use or getting stations to come back to my 5 watts! I made 200+ QSOs in my first year and finished second or third among QRPers in Maryland. The following year I made about 160 QSOs and finished a bit further down the list. The first year I worked about 12 hours of the contest and the second year only 9. I found my tolerance for noise had seriously dropped off since the 70s!

This year I elected to stay out of Sweepstakes because my recovery from the hip surgery has left me not as sharp as I want to be. I hope this will go away over the next year because it is really a fun contest and now I'm getting my keyer ready to go!

I was greatly rewarded by reading the aftermath stories on QRP-L about how many guys did well and enjoyed their experience. This was from guys who worked as few as 15 stations to guys who worked 500+. There is a lot of fun to be had if you persist, and you're learning all the time. Take for instance the tight receiving filters – it is rather simple to tune back and forth across a guy's frequency and answer his CQs until he responds to you. I personally don't use 250Hz filters as they are just too much effort for me, but I can certainly find the 800 Hz offset frequency and call him there!

Another area where our provinciality is showing is in the area of phone as a QRPer. Do you work phone? I don't, at least not regularly, but I think I'll try for a Sweepstakes pin next weekend on phone! Might be interesting and easier on my head then trying to copy 35 wpm exchanges. I think I can do it and it will be interesting to find out. I admit my tolerance for noise is even lower here than on CW but who knows, it could make me a more complete operator! See you on the bands for Sweepstakes phone. You know, phone is not a bad thing, just different, and there's little doubt that rag chewing is easier!

Electronics

Learning about electronics ought to be one of the first priorities among hams. It is especially important among QRPers as technology is closer to the heart of our corner of the hobby than it is to most. We tend to operate closer to the heart of communications electronics than most. This is not to say the guys into digital communications are less technical then we are, just that the technical input in that area is more specialized than ours. They are worried about the technique of communication where we are worried about getting it done at all!

To this end I have been on the outlook for teaching aids available to QRPers that will facilitate the learning of electronics. I think I have found two in the programs called Electronics Workbench and Electronics Principles. These are not new programs; both are in their fifth release, and getting more complete and better as they go. And I have not noticed them only in the last few months either; I've just gotten around to requesting copies from the manufacturer to test.

In a sense they are complimentary programs – Electronics Principles is a teaching program and Electronics Workbench is more of an applications program. Principles teaches the basic and advanced theory of electronics. Workbench lets you apply the knowledge you've learned to a real world design, and when satisfied with the results of the design you've created, build it up as a PC board. Both are valuable programs to the experimenter which have real world applications to our hobby as well as to the electronics industry at large.

Electronic Principles

Imagine a program that breaks electronics down into 10 categories and then teaches the basics of those 10 categories to you one at a time. Imagine being able to select any one of the categories to review as you need them. There you have Electronics Principles. It breaks the field of electronics down into 10 discrete categories from DC Circuits to PIC Chips and shows you what's involved in each and how to solve various problems that are basic to each.

You navigate around in Electronics Principles in two ways – either by way of a main listing of circuits as shown in Figure 1 (this list is about 21 pages long) or from individual menus as shown in Figure 2. The categories are DC, AC, Power, Semiconductors, Op-Amps, Maths, Logic, Measurements, Microprocessors, and the PIC Chip.

The material is presented as individual screens, each consisting of a drawing with values inserted and then the opportunity to change those values to suit where necessary. For example, in the basic Tuned Circuits screen shown in Figure 3 it is possible to vary the capacitor or the inductor values and see the results on the screen. The individual screens each lead to a series of other related screens, as shown in pop-up menu in the lower right corner, all from the basic screen.

Another feature of Electronics Principles are the Calculations panel (Figure 4) and the Topic Notes panel (Figure 5). Under Calculations you are treated to a summary of the important calculations inherent in the example presented. In our case a sample calculation of resonant frequency is involved. The Topic Notes panel presents the circuit theory is easy to understand text. Both of these pop-up over the main screen. The circuits, the topic notes, and the calculations are easily printed to a Windows printer for inclusion in a document or in study notes.

Electronics Principles is available from EPT Educational Software, Pump House, Lockram Lane, Witham, Essex, UK. CM8 2BJ. E-mail information can be had from http://www.epsoft.demon.co.uk. The price in the UK is just under 100pounds. EPT Educational Software also produces an accessory program called Electronics Calculator which is a full featured electronics circuits calculator. This program sells for under 20 pounds.

Electronics Workbench

This is the other half of the picture, a program that lets you do something practical with your knowledge of electronics! Electronics Workbench is billed as "The electronics lab in a computer", and from what I've seen it fits that description more than adequately. Perhaps if I had had Electronics Workbench back when I was sweating my way through Electronics Labs in college more would have stuck! I know if I had had it I would have been more inclined to follow threads to completion rather than take the book's explanations.

I had only a demo version of the program to work with for this review so understandably some of my descriptions will have to wait until next issue when I have acquired the full version of the software. However, it is absolutely fascinating to watch the software work – it sheds light on even the most basic electronics principles for you.

Among the demo programs it offers is a simulation of the Op-Amp ua709 (Figure 6). It is fun and fascinating to see it work – you can actually watch the circuits operate with inputs and outputs specified by you The simulations are very good – the Op-Amp circuit is a simulation of the internal workings of the amplifier. You can actually change the frequency of the input to see the effect on gain (Figure 7).

Your design can be entered using either SPICE3 or by drawing the circuit; SPICE3 is quicker and easier though. When you have a circuit that is working like you want it to you can switch to the PC board portion of the circuit and lay out the board directly. To avoid mistakes all the components used in the circuit diagram are already on the circuit board so you are unlikely to forget any.

The program performs a number of analyses on your circuit including AC and DC Sensitivity, DC Operating Point, Distortion, Noise and others. The major difference between the Professional and the Student Edition is found in the Analyses performed on circuits. Virtual test instruments include a function generator, a scope, a multimeter, and for the digitally oriented among us a word generator!

Models being the heart of simulation, it is interesting what models are used. Something like over 4000 models are available for Version 5. These include analog SPICE3 models, ideal digital models of the 7400 and the 4000 series, and hybrid models like the 555 timer. It will be interesting to get the whole package and try out some of my favorite circuits. I can't guarantee I'll try them all before next time but I can probably guarantee they will appear along the way!

I just received the full version of Electronics Workbench two days before we went to press. I am anxious to start using it, but I wanted to also tell you about two other products I received along with it – Electronic Workbench Layout and Electronic Technician. Layout is what the name implies – I'm sure it will receive lots of use here at W6TOY. Electronic Technician is a package similar to Electronic Principles. I will be going through these two packages in the next few issues, along with some practical applications of all three! Stay tuned.

Electronics Workbench is available from Interactive Image Technologies Limited, 111 Peter Street, Suite 801, Toronto, Ontario Canada M5V 2H1. The personal, or entry level, version sells for $295.00. The email address for further information is http://www.electronicworkbench.com.

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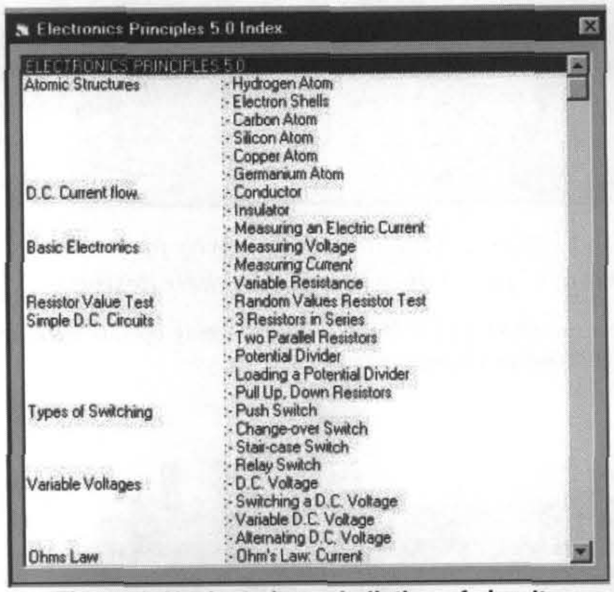


Figure 1: Navigate by main listing of circuits

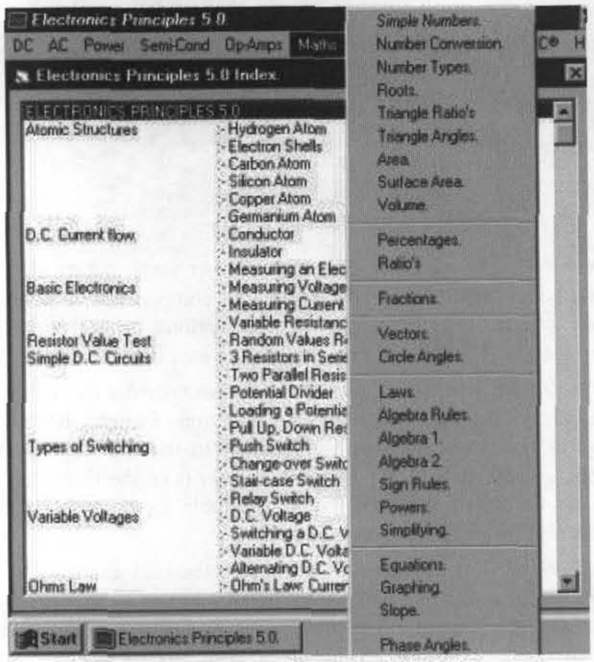


Figure 2: Navigate by individual menus

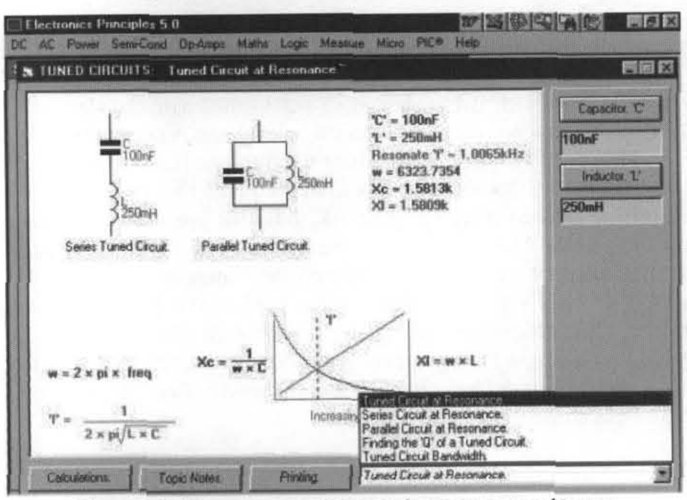


Figure 3: Vary component values to see effects

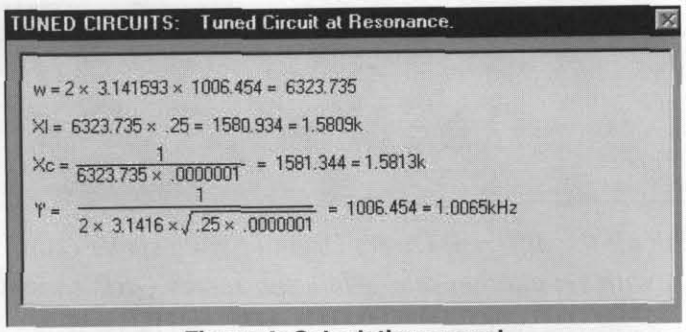


Figure 4: Calculations panel

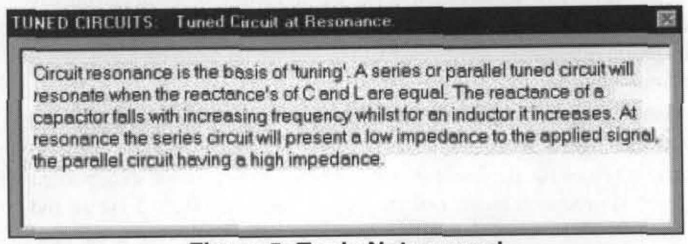


Figure 5: Topic Notes panel

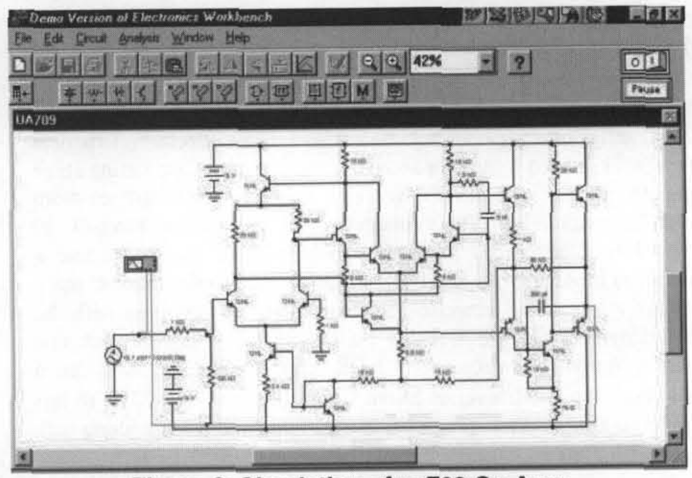


Figure 6: Simulation of ua709 Op Amp

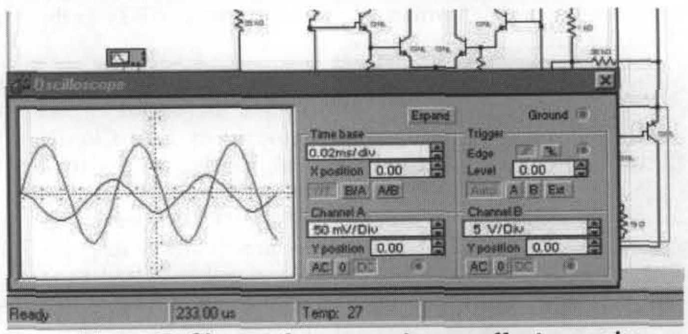


Figure 7: Change frequency to see effect on gain

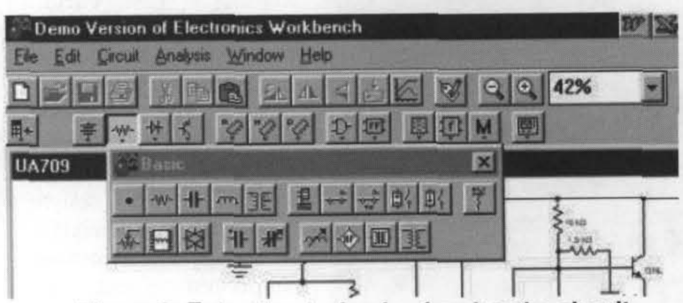


Figure 8: Enter the design by drawing the circuit

Yet Another DDS VFO – The NJ-QRP 9850 DDS VFO Project

by George Heron, N2APB

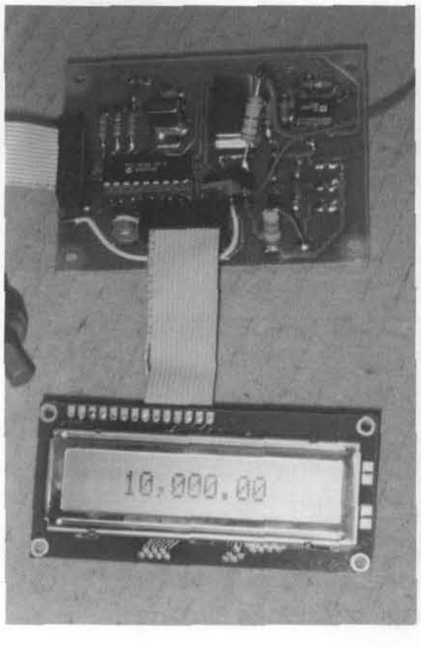
With all the different Direct Digital Synthesis VFOs products and kits available to us today, why play around with yet another one? Well, the Jersey QRP gang has a couple of interesting twists with their design.

For some time I've been interested in developing a general purpose, stable, accurate and feature-rich VFO for a variety of projects on my workbench. Additionally, as with most of my projects, I want this VFO to be optionally controlled by a PC via the serial port to allow even more functionality.

Lofty goals, you say? Well not really now with the availability of the *Direct Digital Synthesis* (DDS) chips on the market at almost-reasonable prices for the homebrewer[1]. These chips provide exceptional stability and precision control of the output frequency from 1 Hz all the way up to 60 MHz or so, depending on the specific DDS chip used. And these chips are digitally-controlled, meaning that a small microcontroller (like a PIC) can be used to program the registers in the DDS and provide many of the extra features I wanted.

Well the result is our "9850" project: an external, standalone, self-contained, fully programmable VFO that interfaces to the PC over an RS-232C serial line for optional control and data collection. This neat little project has been touted for some time as coming to the kitting stage this month, but for several reasons we've decided to hold it back from general kit availability. Preoccupation with the Jersey Fireball 40 project, limited resources to do yet-another-kit at this time, and a proliferation of AD9850-based DDS VFOs already on the market[2] make ours merely a learning exercise for those members involved with the project. However we are working on a version of this project that utilizes a much less expensive DDS chip (AD9832) built as a daughterboard to our Universal Micro Controller card[3] (UMC) – in this way we'll be able to offer some unique packaging and pricing along with the interesting features already present.[4]

The current 9850 DDS VFO design is based on the increasingly popular project designed and written up by Curtis Pruess, WB2V in the July '97 issue of QEX.



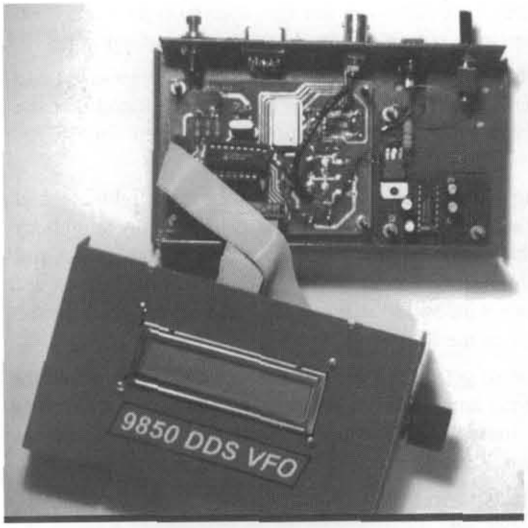
Curt's design uses a PCB developed and provided by FAR Circuits and holds a PIC1654 microcontroller and an AD9850 DDS from Analog Devices. Curt's design also accommodates a 16x1 LCD display with a shaft encoder input to control the frequency. The circuit contains an output pi-filter, and provides a very clean and stable output from 1 Hz to 20 MHz in multiple resolution steps. The Ham-Pic special interest group[5] focused on this design (including WB2V himself!) to provide numerous improvements such as source conversion to the PIC16F84, different tuning options and some calibration techniques to improve accuracy.

Some members in the NJ-QRP took some further steps to provide the project as a better-featured **external VFO** with components in a bag o' parts, along with some interesting packaging options, an optional RS-232C interface to a PC, and an intriguing human user interface.

The 9850 DDS VFO packaging shown above provides its electrical interfaces along the back side: (L-R) Function Switch, RS-232C connection to computer, 50-ohm VFO output to the transceiver, DC power input, and power switch. The shaft encoder is on the right side of the unit, and the whole unit lies flat on the table top in front of the operator for ergonomically convenient use.

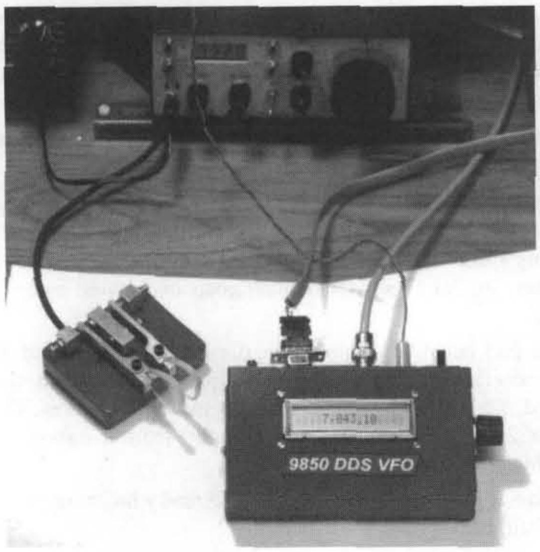
The DDS VFO is designed to be a well-featured external VFO suitable for use in the QRP shack. It outputs the LO or VFO frequency needed by the specific rig it's connected to, and displays the actual operating frequency, as shown in the picture during one of the December fox hunts.

This version of the 9850 DDS VFO was constructed in an LMB-139 clamshell aluminum case dimensioned just right at 3" x 5.5" x 1.5". The original circuit board from FAR Circuits is shown (in the photo below) on the left with flat cables going out to the shaft encoder and LCD. A small perfboard plugs into the PIC socket and contains the PIC and an additional TTL circuit (74LS164) serial-to-parallel shift register used to drive the LCD with fewer bits from the PIC.[6] This modification of the original design frees up some PIC bits that are used as serial control lines to the MAX232 chip on the perfboard in the lower right, which then interface out to the PC through the connector on the back panel. A 3-terminal voltage regulator is also held on this perfboard. As mentioned, this packaging and design is being re-done to provide everything on a single PCB containing the extra PIC circuitry, voltage regulator, RS232 interface circuits, and a newer (less expensive) AD9832 DDS chip.



In order for the external DDS VFO to operate properly with the *transceiver, it* was necessary to bring the transmitter's keyline out to the 9850 in order for it to shift 800 Hz away from the receive frequency *whenever* the rig was commanded to transmit by the key/paddle becoming active. When the PIC microcontroller senses the keyline input going low (active), it quickly programs the DDS chip with the transmit frequency; it then programs the DDS back to the receive frequency when the keyline is released. (A welcomed new feature coming in the AD9832 version is a dual program register architecture, allowing the Tx and Rx frequencies to remain in the registers. Thus the PIC merely has to switch registers instead of repeatedly reprogramming the 32 bits of the same register during T/R switchover. *Whew!)*

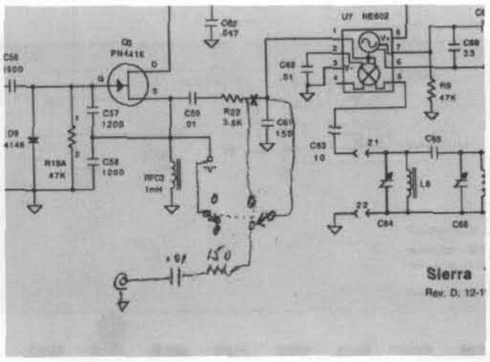
Here's the full system in operation at *chez* N2APB during that fox hunt. [Never did get the fox that night ... or all month. It's an established fact that there's an RF Black Hole in NJ.]



Note that a computer is not connected *in this setup; the only role of* the RS-232C cable connection in this configuration is to carry the keyline from the Sierra for T/R operation.

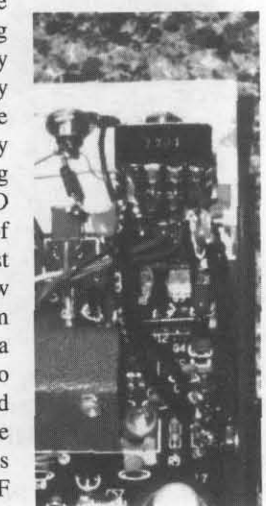
VFO signal connection to the Sierra was relatively straightforward. We were able to interrupt the internal VFO and switch in the external DDS VFO with one pole of a DPDT switch on the back of the rig. And with the other half of the switch we shunted one of the components in the internal *VFO's, essentially shutting it down so as to eliminate* any possible interfence from it.

Switching the external VFO in this way was simple, but it has the side effect of putting a constant display of 532.0 on the KC-2 display.



This was deemed an aceptable tradeoff, as the display on the external VFO was the one to watch. You can see in the photo the manner in which the internal VFO was interrupted and wired to the switch on the back panel.

One of the last features being worked on by club members is the connection to the PC for remote control of the transceiver with (for example) contest logging programs. This was a challenge offered by Ron Stark, KU7Y last year during the early stages of the project development. The simple computer interface protocols used by Kenwood, Yaesu and Icom are being programmed *into the 9850 DDS* VFO microcontroller to allow it to look like one of these rigs when controlled by contest programs such as TR, NA, etc. Right now there is a simple custom Windows program that allows remote control of the Sierra through this external VFO. It's pretty fun to operate, but its actually more fun to sit and manually control the DDS VFO while operating ... nothing like getting 10 Hz steps to get the received signal right in the IF *passband and in the center of the external* W9GR DSP audio filter set at 50 Hz!!



NOTES

[1] DDS chips are currently available from at least several sources: Analog Devices and Qualcomm. Prices for these little surface mount ICs range from $21 to $150 in quantity, although some recent announcements from AD indicate availability of a lesser priced AD9832.

[2] There is already a proliferation of DDS products on the market today. Companies and individuals such as S&S Engineering, KD1JV Designs, *Small Wonder Labs, G4OPE, Aero Electronics (for Kanga),* WD8DSB, WB2V, and yet others, all have products either in-process or already available, and some even have projects published and available in kit form. A comprehensive bibliography of DDS designs, articles, and projects can be found at the NJ-QRP website: *http://www.njqrp.org/dds/*

[3] The Universal Micro Controller card (UMC) was described in the Oct 98 issue of QQ. Circuit boards and pre-programmed 68HC705 microcontroller chips are available from the NJ-QRP Club. Write this author for details.

[4] We're actually not sure yet whether we should stay with the original PIC-based WB2V design that offers extremely simple program modification (via the PIC16F84's flash memory), or *utilize the* more flexible and more powerful UMC that uses the 68HC705 microcontroller.

[5] *The Ham-Pic e-mail reflector* is described By Claton Cadmus, KA0GKC in another article contained in this issue of QQ.

[6] This technique of driving an LCD by using two serially-clocked bits from the PIC (instead of using the bit-intensive parallel interface) is increasingly common among PICsters. The technique is described in the Ham-Pic resource website at: http://www.njqrp.org/ham-pic

Members' News

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With the start of each new year, Members' News has always taken a moment to reflect on the previous one, and to thank the many, many people who took the time and energy to share their stories with the growing readership of QRP Quarterly.

Here are the QRPers– their names and call letters – who made Members' News happen so successfully in 1998 – a banner year, indeed:

Neil Tanner, WA4CHQ; Frank Brumbaugh, W4LJD; Eric McFadden, WD8RIF; Dave Benson, NN1G; Bruce Rattray, VE5RC; Joe Gervais, AB7TT; Pierre Thompson, KA2QPG; Jim Hale, KJ5TF; Cam Hartford, N6GA; Scott Rosenfeld, NF3I; JP Keon, AB4PP; Joe Mikuckis, K3CHP; Michael Sealfon, WA2OCG; Joel Malman, WA1QVM; Preston Douglas, WJ2V; Paul Pendry, KL0DB; Hank Kohl, K8DD; Paul Stroud, AA4XX; Jim Lageson, N0UR; the Rev. George Dobbs, G3RJV; Bill Jones, KD7S; Russ Carpenter, AA7QU; Dick Swanson, N5JWL; Larry East, W1HUE; Jay Bromley, W5JAY; John Brunley, NU0V; Larry Boellhoff, W3MGL; Steve Gallchutt, N0TU; Gary Hanson, KJ5VW; Mike Gipe, K1MG; Steve Yates, AA5TB; Roger Gonzaga, CT1ETT; Randy Foltz, AB7TK; Mike Herr, WA6ARA; Larry Cahoon, WD3P; Dan Wolfe, N4ROA; John Reynolds, G3PTO; Neil Kiagge, W0YSE; Steve Modena, AB4EL; Bob Tellefsen, N6WG; and Jim Anderson, VE6JWA.

These great operators were the backbone of this column in 98. Their support is sincerely appreciated over the last, and– in some cases – years previous.

I thank them all very, very much. And invite all QRP Quarterly readers to share their stories of success, their challenges, even their failures with QQ's readership via MN.

It is the stuff that enriches our niche of the hobby so much.

ADDENDUM ON A PERSONAL NOTE: While we're on the subject of people and callsigns, you'll notice that the callsign at the head of this column is **KI6SN**.

After using the callsign nu6SN during a yearlong commemoration of the pioneering QRPers of the mid-1920s, I've reverted to KI6SN again – a call I'd held since 1987 and had become very attached to.

And what became of the "nu"? As they say, "the wheels are in motion." Updates when available.

– R.E.F.

The awesome power of Nature and QRP

Joe Riplinger, W4ONC, writes from Norfolk, VA, that "Mr. Murphy paid a visit to my QTH. An early morning storm was approaching so I unplugged the antennas from my Kenwood TS-520S and laid the coax on an open window sill. As I walked through the house I heard a tremendous explosion and saw a very bright white flash. There was no thunder so it was an extremely close strike of lightning.

"After the storm I decided to get on the air. Needless to say, I had no audio on the Kenwood. I then went into the den and found that the television's power supply was fried. In addition, my stereo and VCRs were also inoperative.

"The next thing I wondered was where that bolt of lightning had struck. It took a little hunting, but I found that it had hit my neighbor's 80-foot pine tree which is about 100 feet from my back door (all of my dipoles are in my pine trees). I assume that laying the antenna coax and connector on the open window sill still received enough energy from the lightning to incapacitate the Kenwood.

"I really wanted to get on the air so I cleaned off and attached the old Heath HW-8 to the antennas. For the next two days I intermittently got on the air and made the following (stateside) contacts: *Michigan, Louisiana, Maryland, Texas, North Carolina, Wisconsin, Ohio.*

"My DX contacts were: *Venezuela, Czechoslovakia Republic, Sardinia, Bulgaria, Poland.*

"And finally I had a good QSO with John, ZL1ALZ, in Auckland, New Zealand.

"I talked to John using 2 watts into a bobtail dipole up 20 feet. It is still hard for me to believe that in this short period of time using 2 to 4 watts of power to make these contacts.

"I am profoundly amazed at the awesome power of QRP. I will be working quite a bit of QRP in the future.

"Another bolt of lightning from the same storm struck a house two blocks away and it was destroyed by fire. Guess I was lucky!"

QRP fun on Top of the World

Russ Carpenter, AA7QU, writes from McKenzie River, OR, that for the Adventure Radio Society's Top of the World contest, in conjunction with the ARRL's September VHF QSO Party, he and famed QRPer **Wes Hayward, W7ZOI,** "spent a stunning Saturday on top of Mt. Scott, a 9,000 foot peak on the edge of Crater Lake, Oregon.

"There was brilliant sunshine and 360 degree views. Cater Lake was as blue as blue gets.

"We operated 50, 144 and 432 MHz SSB and CW, with gear and antennas that we hauled to the top in our backpacks. Our operating site was a tiny space on the top of a jagged pinnacle, with sheer drops on three sides. We hung on like mountain goats and moved around veeeery carefully.

"We had antenna problems on 6 meters, but 144 and 432 MHz were quite effective. Even though that part of the world is sparsely populated, we ended up with 25 contacts in 8 grid squares. On 2-meter SSB, our 2.5 watts received a 5 X 8 report from a station 275 miles away, which made us feel pretty good.

"What a great time! Wes and I are already hatching plans for Top of the World next spring."

Kudos for QRP, the Quarterly and its staff

R.E. Erts, W0SMY, writes from Omaha, NE, that he is a real fan of QRP Quarterly and certainly of Members' News. If the budget ever goes anemic, you can be sure that the Quarterly will be the last ham magazine to go.

"I discovered QRP about 20 years ago. I had been off the air for some time and wanted back on. One of the local ham store has a used HW-8 that I could afford and I bought it.

"I was not that taken by QRP and certainly not a CW fanatic, but I figured it would do until the budget could support some real hamming. I still have the HW-8, much modified, and if I had a penny for each hour

Lousy Propagation has given Frank Brumbaugh, W4LJD, the chance to do "designing and building."

of fun I have had with it, I am sure that my wife and I could take a world cruise and have change (left over) to spend.

"Am I going to stick with QRP? I am currently building the Wilderness Radio Sierra with all the bells and whistles.

"QRP is hamming as I remember it in the late '30s and '40s: homebrew, a bunch of really nice people, try it, if it doesn't burn up it might get out.' In short: Fun!

"I am in the world's worst antenna location, but nonetheless I get out. And CW? I am not one of the 35 wpm hot shots that you hear down at the bottom of the band. But I don't have to apologize for my fist and I can copy most of what I hear!

"I am set up for 10- and 20-meter QRP phone if the sun ever wakes up. But 90 percent of my hamming is CW.

"I am really pleased to see the advertisers in QRP Quarterly. That is a recognition that we have some attention and something to offer amateur radio.

"I am afraid that the magazine will approach that awkward stage where it is too large to remain a volunteer project and not quite large enough to support itself as a commercial project.

"It is the nature of the type of people who are QRPers to give all they have and all of you (QRP Quarterly staff members) deserve much more credit than you will ever get for the great job you are doing.

"Good luck to, and blessings upon the entire staff."

For the books: 'My best QRP Story'

Harvey Hunter, W8TXY, of Columbus, OH, writes:

"I sometimes work QRP by turning down the drive on my Ten-Tec Corsair to about 5 watts output.

"That's what I had done and had a nice QSO on 30-meters with Ralph, WB8DQT / QRP in Michigan.

"After that, I tuned around a bit and heard LU1ZC in Argentina working a pile-up. I worked him and received RST 5NN,' but of course everybody was receiving 5NN.'

"It was then that I noticed that I had forgotten to QRO after working the previous station, so I had worked him QRP ... my best QRP DX so far!"

Inside the shack of W4LJD in Puerto Rico

Frank Brumbaugh, W4LJD, writes from Salinas, Puerto Rico that he has "been doing a lot of designing and building because propagation is – and has been – lousy for months here.

The accompanying photograph shows – from left to right, bottom to top: (partially visible) homebrew regulated power supply; homebrew 6-to-60 watt low pass antenna tuning unit with cross-needle meter and bypass; ZM-2 ATU on top.

"In the next row is a meter that's switchable from 11-15 volts DC suppressed zero and 0-3 ADC, homebrew. On top is a homebrew field strength meter.

"Next row: a handy homebrew control box and key lines from two rigs to a key jack on its panel. It also switches audio output lines to another switch which supplies audio to the speaker., or through an internal 2-watt audio amplifier with gain control that normally is unused and bypassed. A headphone jack on the box panel mutes the speaker.

"My dual time clock sits on top.

"In the last row is my new SG-2020 with my QRP++ on top. And on top of that is a spare UTC clock.

"On the wall behind is a tape recorder, a homebrew AC line monitor (suppressed zero, 90-130 VAC), and a 7-outlet homebrew 12-volt distribution box."

Frank also reports that he suspects his "SG-202 is not quite up to snuff, and I have discovered some bugs in it. I've written SGC the details and probably will be sending it back for warranty service shortly. But it is going to be a terrific QRP rig. The most amazing thing to me is the fact that one can program absolutely everything the rig is capable of doing – including the kitchen sink – in each of the 20 non-volatile memories!"

Another QRP view from the Top of the World

Larry Cahoon, WD3P, writes from Upper Marlboro, MD: "Well we did it. My 10-year-old son, Eric Cahoon, KB3BUR, and I drove out to Skyline Drive in the Shenandoah National Park in Virginia this morning to do (the ARS Top of the World) contest portable/QRP style.

"I took along the 2-meter handheld and a homebrew dipole. I had the high power battery pack with the rig so we ran a full 5 watts. We climbed to the top of Stony Man Mountain, elevation 4,011, in Page County for the contest.

"The dipole was hung horizontal for a while, but then switched to vertical. That worked much better.

"For a bit over an hour's work at the top of the mountain, I ended up with 11 contains in three grids. I know I got Pennsylvania and West Virginia, likely also got Virginia and Maryland.

"Surprisingly I didn't get anyone in FM18 in the Virginia suburbs of the District of Columbia.

"Eric ended up with 4 QSOs – he would come over and help someone out when they asked for a 440 QSO which I did not have the capabilities for.

"We were eventually chased from the mountain by the lack of activity and the gnats that seemed to be everywhere. All in all it was a fun contest.

"The trip also added a bit of county hunting fun. I (had posted on QRP-L) a request for adjusting the TS50 to QRP levels and got some good replies. I decided to use the ALC adjustment a few recommended and that Bob, N4BP, has on his web pages.

"I trusted the MFJ tuner/dummy load for the power levels and had it set for 5 watts. I verified it when I got home with the WM-2.

"The MFJ wasn't so good. It only put out 2.5 watts. But it did get me to a mobile in North Dakota a few times, as well as mobiles in Virginia, Mississippi and Colorado all on twenty meters."

QRP SSB success

Joel Malman, WA1QVM, of Concord, MA, writes that "with all the phone based contests going on (during a recent weekend), I decided to have some QRP SSB contest fun.

"The rig is an Index QRP+ and the antenna is a full size G5RV hidden in the woods behind my condo. I tuned up the QRP+ in the middle of the 20-meter SSB band. With the rig in the CW mode and the WM-2 wattmeter says I'm running 4 watts so there is not much power output to the antenna on SSB voice peaks!

"I figured the only way this is going to work is to wait until the band has a chance to quiet down. I wait till 0230Z. Then I start to tune around 20 meters. The North American Sprint is still active and 20 meters is quite long.

"*Hummm*, there are W6 stations begging for a contact: 'Any station, anywhere,' they say. Nothing about how much power you have to be running.

"I call K6LA, not expecting that he will hear me. He does! First SSB QRP contact of the night: Massachusetts to California. It felt pretty good.

Next up K6NA, K4XS, WB0O, N6RT, and N5NU.

"Amazing: all QRP SSB, all within 30 minutes.

"*Geee*, this QRP SSB stuff is fun! Next up is EA6BH in the Worked All Europe contest. Got him.

"After I tried a few LY and RA stations, but the QRP signal was probably just too weak for them to hear. Later on I did work IR4TT on 15 meter QRP SSB, but that is probably just as far as the QRP signal seems to be able to reach.

"*Ahhh*, QRP ... what fun."

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 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:

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Afield for a bit of QRP fun

Alan Dujenski, KB7MBI, writes from Woodinville, WA that he and **Bob Farnworth, W7CD**, of Bellevue, WA, went out on September '98's QRP Afield contest to Marymoor Park in Redmond using a Kenwood TS-50 transceiver with a Butternut vertical, and an EMTECH NW-40 with an inverted V antenna.

They operated from 1800-2400 UTZ and racked up 10,368 points.

Best of all, Alan says, it was a great learning experience.

"Bob proved to be the workhorse and with his rig worked all bands but focused on 20 meters," he said. "I stayed with 40 meters on the EMTECH NW40.

"It was a bit cool but otherwise proved to be a super Pacific Northwest day.

"Several folks wandering through the park stopped by to check out what was going on. The forest of masts and wires was rather unusual in this placid park area. I am not sure about (other QRPers in the contest) but 40 meters was dead up until about the last hour. Then it was not that great. We worked for every contact on 40.

"I was very pleasantly surprised with the performance of Bob's TS-50. This is one outstanding rig.

"Lessons learned? Initially we were set up with the Butternut on 20 / 15 meters and phased St. Louis verticals (SLV) on 40 meters. Their interaction was unbelievable. Each radio totally blanked out the other during transmit.

"In an attempt to resolve the problem we tried an inverted V doublet with the apex atop one of the SLVs (a VERSA-TENNA). To our surprise this solved the problem.

"Although only about 20 yards apart, they proved to be compatible for the multiband operation. The ground mounted Butternut was a real winner for both transmit and receive.

"This proved to be one heck of a lot of fun. We kept it low key – *no pun here* – and broke from operations to chat with the curious onlookers who wandered in.

"We intend to see if there are some antenna improvements that can be made but we intend to keep one point in focus. Whatever we decide on it must be easy to set up and put away. It was nice to have the station capable of being all packed up and we were on our way in 30 minutes."

QRP success story, from the great indoors

Greg Harris, WB9MII, sends e-mail telling us that he joined QRP ARCI "not long ago and just received my first issue of the Quarterly.

"It is excellent.

"My shack consists of a Ten-Tec Century 21 at 5 watts, and MFJ 90 rigs for 20 and 40.

"The antenna right now is an indoor 20 meter dipole held on the wall with computer cable clips. I have worked anything I can hear on this setup, including European DX.

"My key is a Nye pump handle. I'm always on the lookout for new apartment-type antennas to try.

"I'm now searching for a design that will work on both 20- and 40-meters."

QRP vs. Newton (and Newton won)

Bob Tellefsen, N6WG, writes from Newark, CA that in QRP Afield that overall he "had a great time – once the antenna was up.

"Now that's a whole story in itself.

"I hauled my setup into the park in my usual handcart – card table, chair, rig, tuner, battery, lunch, water – the whole bit – for a nice outing.

"I decided to put up the antenna first, then set up the station at the end of the feedline.

"Here's where the going got a bit rough.

"In my infinite wisdom, I brought a slingshot to help get my line over a branch. Small miscalculation, in that I expected the lead sinker to pull up the white nylon cord I was to use for antenna support., The slingshot just didn't have the *oomph* to do it.

"Now I understand why at FD we always use light fishing line first, then pull the support line up after.

"Ok, Plan B time. As someone has said before, though, if Plan B were any good, it would've been Plan A.

"I tried swinging the weight around a few times and letting it fly toward the branch I had in mind. *Hmmm*. Low and very far to the left.

"OK, try again. Same results. I'm letting go too late, I guess. So I turn to my right to correct and try again. Still same results.

"Well if one weight can't quite lift the line, let's put a second one on.

"OK, now we're ready. A new cast and another miss. The next try completely missed the intended tree altogether and went into another tree on the other side of the road.

"By this time, I'm talking to myself, muttering, surely there must be a movie in this somewhere.

"Got another idea: Move up on the bank a bit and get a different angle on the throw. OK, big swing and release.

"Ladies and gentlemen, I can attest through personal experience that Newton was right about equal and opposite reactions. I threw so hard I overbalanced and tumbled down the bank. I got up, grumbling that this was counterproductive. Nothing was damaged but my dignity, so back to tossing fishing weights at my chosen tree.

"Finally I got it over a lower branch than the one I really wanted, but by now, I've had it. Got to get on the air.

"Station setup went smooth at least. Had my old QRP++ and LDG autotuner. I used a very tight lowpass filter I've cobbled together and spliced into the QRP++ audio section before the SCAF filter. Sure made a difference in selectivity.

"The antenna was a 40 meter dipole up maybe 25 feet, bit it matched OK on both 40- and 20-meters, so I was happy.

"Used the wattmeter to set up for 950 milliwatts, and I was in business.

"Spent most of my time on 40 meters (13 QSOs) and 20 meters (22 QSOs), and tried 15 meters occasionally. One contact there.

"Overall, 36 QSOs and 16 SPC. My score appears to be 9,728 points if I've figured out the scoring procedure correctly. I feel pretty good about that, for a 950 mW entry.

"Thanks to Doc, K0EVZ, for hanging in there until we made a complete exchange of it. I did have a nice short contact with WK8S, also running 950 mW.

"W0CQC was consistently loud all day. They were running from a mobile setup: Amazing.

"Anyway, I had a great time, and once my aching muscles recover, I'll be ready to go again.

Items for the Members' news column should be sent to Richard Fisher, KI6SN, 1940 Wetherly Way, Riverside, CA 92506. Photographs – either black and white or color – are welcomed. Please include a self addressed, stamped envelope if you would like the pictures returned.

Ham Radio, PIC Microcontrollers and You!

Claton Cadmus, KA0GKC *ka0gkc@mcg.net*

You've heard of the microcontrollers invading our ham radio projects: rigs, accessories, loggers? Well, here's how we're staying on top of this technology ... the Ham-Pic list!

There is something new on the Internet for us "Radio Design and Construction Enthusiasts" (I like that much better than "Homebrewer" don't you?) It's the Ham-Pic email list[1], a forum for the discussion of Microchip PIC microcontrollers [2] and their use in Amateur Radio. Now to most QRP computer users, this is probably old news as the list has been up and going since early October. So, I thought I'd also focus this article on how it all came about and what a difference you, as an individual, can make in the Amateur Radio community.

This new Internet Ham Radio resource was the result of an escalating chain of events. It actually started last summer, during the June meeting of the Minnesota QRP Society[3]. I had no idea at the time what it would evolve into. It was just an innocent but interesting discussion about Microchip PIC processors. Members Bruce, AA0ED and Craig, AA0ZZ had started working with these little versatile chips and were very excited about the possibilities they had to offer. A few more of us were familiar with the PIC construction articles in the various Ham publications. At the August meeting Howard, KB4UY came in with a bunch of free surplus LCD displays. This created some real excitement when Bruce discovered that these displays would work nicely with the PIC16F84. Ideas started to bounce off the walls. Ideas like a digital SWR meter, frequency counter, digital dial, and even remote rig control. It would seem that the imagination and about a kilobyte of program space were the only limits on what you could do.

One of the things I learned in these early discussions was that Microchip's PIC16F84 has several advantages to the experimenter. The PIC16F84 is an 18-pin chip and has 12 programmable inputs/outputs and can do a whole host of tasks. But most important, it's probably the easiest microcontroller chip to begin learning to program and use. It doesn't require a UV eraser because the memory is in EEPROM (electrically erasable program read only memory). This means that mistakes can be very quickly corrected or new ideas programmed in using the same chip and without the delay of waiting for the UV to erase the memory.

Later in September, via the club email list, I launched the idea that we form a PIC SIG (special interest group) within the club. The object of the SIG was to learn about programming the chips, applications for the PICs, and to share our experiences. This was indeed not a singular unselfish suggestion. The facts be known I really didn't know anything about microcontrollers and wanted to get some free help and guidance. I hoped to get the original four or five of us that seemed interested to go along with the idea. Wow, we ended up with twelve interested and eager members in our group! This is a good percentage of the entire club. It would seem the interest was much greater than I expected.

Our SIG started out by settling on a textbook, "Easy Pic'n" by Dave Benson [4]. (Sorry not NN1G, although our Dave Benson is very into this too!) This book has a series of lessons to guide you though the beginnings of using the PIC16F84 and came with high recommendations. Everyone in our SIG has come up with a chip programmer of some kind and we have distributed Microchip CD-ROMs for all the SIG members. These CD's contain the development and compiling software you need and are available for free from Microchip. Many projects are moving forward as of this writing and at least three of us are building DDS VFO's. I highly recommend this idea for your club and encourage you to start a PIC SIG of your own. There's nothing like having someone else to learn with.

Now this might in itself seem to be a good story, but as you know it doesn't end here. The MNQRP's email list is kindly supplied to us by QTH.NET. As we started to chat the topic up on the list, Al K3TJK, the owner of QTH.NET, happened to notice the increased traffic and the subject. Al was monitoring our forum because we had just made a few changes to how it worked. Meanwhile, George Heron, N2APB and I were in an email ragchew about PIC stuff including how fun it would be to have some sort of PIC email discussion forum. I was just about to email Al to ask if he'd consider sponsoring this new list when I received email from Al asking if I'd like to run a separate PIC list as he thought others outside our club would be interested too. I quickly agreed and became the newly formed Ham-Pic listowner. After an evening of setting it up and working the bugs out I emailed George that it was ready and to spread the word. I also posted an announcement on the QRP-L email list the next day. Within minutes of that announcement the flood began. As of this writing we are well over a hundred list members and still growing and I have yet to announce the list in the Amateur Radio newsgroups! The discussions are starting to get very interesting and there are many experienced and helpful Ham-Pic experts providing advice and adding to the forum.

To further enhance the email list, George has established a Ham-Pic web page at the NJQRP site[5]. This site has beginner information, code snippets, articles, the Ham-Pic list archives and hint and kinks about microcontrollers and how to have fun with them. Also on this site you'll find the code for the DDS VFO with versions for the PIC16F84 in two assembler formats. The web site is off to a great start and is an excellent resource on it own.

So what is this article really about? It's full of information about how to start your own adventure into the use of PIC processors. But more important, it's a story about how you can make a difference in Amateur Radio by just giving an idea a little push like I did.

73, KA0GKC

Footnotes:

1. To subscribe to the Ham-Pic list. Send an email to majordomo@qth.net Leave the subject line blank and in the body of the message type: subscribe ham-pic
2. Microchip, 2355 W. Chandler Blvd., Chandler AZ 85224 http://www.microchip.com
3. Minnesota QRP Society, http://www.qsl.net/mnqrp mnqrp@qsl.net
4. Easy PIC'n, Square 1 Electronics, P.O. Box 501, Kelseyville, CA 95451, (707)279-8881 http://www.sq-1.com, sqone@pacific.net
5. NJQRP http://www.njqrp.org/ Ham-Pic page http://www.njqrp.org/ham-pic

QRP ARCI Contest Awards

By Chuck Adams, K5FO

This month, let me go through the database and let me show you some interesting numbers. It is interesting to see just how many people have accomplished certain QRP milestones over the years.

The frst award to look at is the DXCC (DX Century Club) -- the certificate for working 100 or more countries. At the present time the count is at 138, although for some reason numbers 6 through 11 were never issued during the beginning of the awards. If anyone knows then drop us a line and let us know. We'll put it in the database. The frst DXCC award was issued in June of 1963. Nine were issued as two way QRP, AA2U has DXCC on eight bands, and N0JR has 300 countries.

For Worked All Continents (WAC), there have been 549 certificates issued. This is much easier to work than DXCC in some ways as it requires only six confirmations. But for band conditions to be right to some parts of the world, and for using only five watts to get through, requires constant vigil on the part of the one trying for this award.

For Worked All States (WAS), there have been 412 certificates issued. Twenty one of these for two way QRP and Zack Lau, W1VT ex-KH6CP, has done it from two different locations. I'd be the first to guess that he will now do it a third time using his new call. Burl Keeton, N5DUQ, has done WAS six times with one CW only and the remaining five on five different bands and single mode SSB. And to make it even more challenging he did 75 meters and 40 meters with 3W or less.

Then the most issued award, as it requires only one contact per certificate, is the one thousand miles per watt award. For this one there have been 1628 certificates awarded. Since I entered all the data into the computer I have been able to get the following information and a lot more, but there's too much to list. Here is a breakdown on the number of contacts by band and modes for the CW and SSB up to the end of October 1998:

BAND	CW	SSB	AM
160M	9	3	0
80M	41	5	2
40M	244	11	1
30M	31	0	0
20M	379	61	3
17M	5	3	0
15M	402	84	0
12M	3	3	0
10M	130	106	27

Here are the current CW distance records on each band from the database.

BAND	STATION	MILES PER WATT
160M	VE3DN	8,590
80M	AA2U	851,339
40M	AA4XX	1,909,502
30M	AA2U	1,612,500
20M	AA2U	16,181,168
17M	K4TWJ	49,380
15M	G0IFK	80,465,232
12M	N5SAN	2,056
10M	K7IRK	218,333,333

For SSB, the number are significantly lower, as expected:

BAND	STATION	MILES PER WATT
160M	G3VWK	13,300
80M	W8ILC	9,500
40M	KF5OW	7,360
20M	HI3JH	30,280
17M	N7TAU	2,467
15M	WB6UNH	19,250,000
12M	JR6XXI	3,225
10M	N4BP	1,684,000

Since I have expended a tremendous amount of time and effort on accumulating the data and entering it into the computer and there is no other way to show it in detail, I will put all the files on the web until my replacement shows up for the next issue of The Quarterly.

My web page is http://www.ticnet.com/k5fo and my email address is adams@ticnet.com.

I have enjoyed the work but it is time to move on let someone else have fun doing this. So, thanks to all for your support over the years and good luck to the next individual that gets the database. I will make sure that they get all the data. And hopefully I have not dropped anything over the years -- if so be sure to let me know ASAP. Blank lines in some places indicate that I am awaiting missing data from the applicant or it was missing from the original data.

dit dit de K5FO

DXCC RECORDS

NR	CALL	DATE	MODE	Band	
1	W5DCB	630622			
2	K4MPE	630717			
3	W5NXF	630718			
4	ZL1ARY	630819			
5	VK4TY	630829			
6	N/I				
7	N/I				
8	N/I				
9	N/I				
10	N/I				
11	N/I				
12	IT1AGA	631207			2xQRP
13	K8TNE	631228			
14	G8PL	640111			
15	DJ5VQ	640111			
16	K7UCH	640120			
17	WA2TQT	640228			
18	Rosen	640401			
19	I1SF	640414			
20	VK3AHQ	640615			
21	G3PEU	640622			
22	UA6LI	640918			
23	K2PKT	641024			
24	W9UZS	641117			
25	G3JFF	650106			
26	I1SF	650601	CW		2xQRP
27	K2KBI	650601	CW	20M	2xQRP
28	K0HUD	650629			2xQRP
29	N/I				
30	UA2AC	660412			
31	VK3XB	660619			
32	VK3KS	660619			
33	K0GJE	660830			

DXCC RECORDS (continued)

NR	CALL	DATE	MODE	Band		
34	DJ2UU	660924	SSB			2xQRP
35	G3MCN	661112	SSB			2xQRP
36	SP6FZ	670408				
37	F2GM	670805	SSB			2xQRP
38	ZL1QW	680106				
39	GI3SST	680518				2xQRP
40	W2ICO	680726				2xQRP
41	W4CRW	680918				
42	CT1MW	690528				
43	DJ9Z	690922				
44	OK2BPF	700723	CW			
45	K4OCE	700918				
46	OK2BNZ	701231				
47	K8BHG	721213				
48	W4KFB	740330				
49	F6DDR	750911				
50	KC4CS	820527	SSB			
51	N4BP	820613				solar
52	AD2Y	829624				
53	WB0URA	820724				
54	N1AIS	820808	SSB	10M		
55	KK9Q	821114	SSB	mix		
56	K4AHK	821113	mix	mix		
57	N8CQA	830129	mix	mix		
58	WD6EKR	830221	SSB	15M		
59	KA3CRC	830228	mix	10M		
60	WB4BBH	830401	mix	mix		
61	AD1C	830730	mix	mix		
62	AD1C	830730	CW	mix		
63	KA3CRC	830905	SSB	10M		
64	K9PNG	830905	CW	mix		
65	WB2IPX	831113	mix	mix		
66	AA2U	831113	mix	mix		
67	W6SKQ	831113	mix	mix		
68	WA1YLN	831204	SSB	mix		
69	WD9FSA	840731	SSB	10M		
70	WA9FWO	841028	CW	mix		
71	EA2SN	860215	SSB	mix		
72	KT1H	860505	mix	mix		
73	NM7M	860503	mix	mix		
74	K3IIZ	860531	CW	mix		
75	K9EIJ	860614	mix	mix		
76	W6SIY	861020	mix	mix		
77	AA2U	870228	mix	40M		
78	AA2U	870228	mix	20M		
79	AA2U	870228	mix	15M		
80	AA2U	870228	mix	10M		
81	NM7N	870702	CW	mix		
82	OK1DKW	871212	CW	20M		
83	W2JEK	880326	CW	mix	2W	
84	NU4B	880415	CW	mix	4W	
85	HI3JH	880709	mix	mix		
86	K6ZH	880826	mix	mix		
87	SM4KL	881015	mix	mix		
88	N5DUQ	881118	SSB	mix		
89	KA4TMJ	881118	SSB	mix		
90	KV4B	890311	mix	mix		
91	G8JR	890429	CW	mix		
92	N2HOS	890529	SSB	15M		
93	WE2P	890603	CW	mix		
94	WB3HLH	890702	mix	mix		
95	W5TTE	800814	mix	mix		
96	WD5GLO	891007	mix	mix		
97	WB0RXF	891015	mix	mix		
98	AJ1Q	891230	mix	mix		
99	KT1H	900102	mix	mix		
100	OK1CZ	900213	cw	10M		
101	OK1CZ	900213	cw	15M		
102	W5TB	900415	cw	mix		
103	OK2BAT	900416	SSB	mix		
104	AA2U	900520	mix	80M		
105	N0JR	900823	mix	mix	200-901230	300-950318
106	KA3CRC	900823	CW	mix		
107	ZS6PT	910302	ssb	mix		
108	SM5OCK	910407	CW	mix		
109	K3CHP	910519	mix	mix		
110	KA9BZM	911124	SSB	mix		

DXCC RECORDS (continued)

111	G4CFS	920119	CW	mix		
112	AA2U	920524	CW	30M		
113	AA2U	920524	CW	17M		
114	AA2U	920524	CW	12M		
115	WA2UUK	920829	SSB	mix		
116	W3ARK	920829	mix	mix		
117	SM6SLC	920829	CW	mix		
118	KR2Q	930213	mix	mix	300	
119	KN3ZAN	930510	mix	mix		
120	WU2J	930318	SSB	17M		
121	G0IFK	930901	mix	mix		
122	G4MQC	931115	CW	mix	100	
123	WU2J	931128	SSB	17M	150	2W
124	NN8R	940120	mix	mix		
125	K3FN	940410	CW	mix		
126	WA3ULH	941015	mix	mix		
127	W2PTF	950105	CW	mix		
128	W2PTF	950105	SSB	mix		
129	HB9DAX	950131	mix	mix		
130	DL2HCB	950715	CW	mix	100	
131	DJ0GD	961015	SSB	MIX	100	
132	W9NIP	961115	MIX	20M	158	
133	HL9BK	961205	CW	MIX	102	
134	KC1DI	961205	CW	MIX	100	
135	N3IUT	961212	MIX	MIX	100	
136	AA3MD	980201	CW	MIX	100	
137	K8UCL	980630	CW	MIX	102	
138	W8REW	980715	MIX	MIX	100	
138	SM5DQ	980815	CW	MIX	138	

WAS RECORDS

NR	CALL	DATE	ISSUE	POWER	MODE	FREQ
381	DL7UKT	960703	20	5.0	CW	MIX
382	K5FO	970110	50	0.95	CW	7
383	K5FO	970110	49	0.95	CW	10
384	K5FO	970110	50	0.95	CW	14
385	K5ZTY	970201	50	5.0	CW	MIX
386	K3ETS	970205	50	4.95	MIX	MIX
387	K3ETS	970205	30	4.95	MIX	14
388	K3ETS	970205	30	4.95	MIX	7
389	AE4VQ	970429	30	5.0	CW	MIX
390	DJ0GD	970730	46	5.0	MIX	MIX
391	K8UCL	970803	50	2.0	CW	MIX
392	KB0ROL	970915	20	5.0	CW	7
					(Novice,2xQRP)	
393	VE3JC	971015	50	5.0	CW	MIX
						(2xQRP)
394	N4EUK	971015	20	5.0	MIX	MIX
395	K4NK	971217	50	5.0	MIX	CW
396	AA8YO	980110	30	5.0	CW	7
397	AA3MD	980201	50	5.0	CW	MIX
398	WD4MSM	980210	50	5.0	MIX	MIX
399	AA1MI	980215	50	5.0	CW	MIX
400	AB5UA	980215	50	5.0	CW	MIX
401	WW5XX	980218	50	5.0	CW	MIX
402	WB8DQT	980221	50	5.0	MIX	MIX
403	KJ5XF	980315	50	5.0	CW	MIX
404	N3IUT	980315	50	0.90	CW	MIX
405	K8IDN	980418	50	5.0	CW	MIX
406	W5JAY	980420	50	5.0	MIX	MIX
407	K9OSC	980518	30	5.0	CW	MIX
408	N7IKC	980715	50	5.0	CW	MIX
409	KB0ZTN	980828	44	5.0	CW	7
410	KE2UK	980828	30	5.0	CW	MIX
411	N2TO	980906	49	5.0	MIX	MIX
412	HB9DAX	980915	50	5.0	CW	MIX

MILES / WATT RECORDS

NR	DATE	TO	POWER	WITH	POWER	MI	MI/WATT	BAND	MDE	QSO DATE
1555	961216	DL8KAZ	0.5	VK2RAS	QRO	8,906	17,812	14	CW	900404
1556	961216	EA8BLV	QRO	K5ZTY	2	4,667	2,333	14	CW	950910
1557	961216	K5ZTY	2	EA8BLV	QRO	4,667	2,333	14	CW	950910
1558	961226	N2TNN	0.09	AA4XX	5	396	44,000	3.5	CW	961111
1559	970113	KB5HRS	1.5	KB1FK	4	2,200	1,466	14	CW	961013
1560	970208	JI3GYF	3	VK2XT	QRO	4,780	1,590	21	SSB	941113
1561	970324	AB5UA	2	3B8CF	QRO	10,476	5,238	10	CW	960704
1562	970324	3B8CF	QRO	AB5UA	2	10,476	5,238	10	CW	960704
1563	970421	WA9MPY	RCV	WA3NNA/B	0.02	645	32,285	3.5	CW	960310
1564	970429	W7CNL	3	AE4VQ	1	1,690	1,690	14	CW	961019
1565	970429	AE4VQ	1	W7CNL	3	1,690	1,690	14	CW	961019
1566	970506	AF7E	5	ZL2VS	QRO	7,497	1,499	14	SSB	970703
1567	970601	WV6U	1.2	JR6SNF	QRO	6,118	5,098	21	CW	791006
1568	970602	WJ4P	0.5	AA7FC	QRO	1,635	3,270	7	CW	961002
1569	970602	WJ4P	0.4	KO6RU	QRO	2,291	5,727	7	CW	961009
1570	970602	WJ4P	0.7	WB1AGP	QRO	962	1,374	7	CW	961002
1571	970602	GM0NWI	5	VK1FF	100	10,262	2,052	21	CW	940125
1572	970603	W4LJD	8	GD0PLT	4.5			14	SSB	959418
1573	970603	W4LJD	5	K5AKP	QRO			21	SSB	959418
1574	970603	G0BXO	5	PY0TI	QRO	5,380	1,076	10	CW	960520
1575	970608	N5FOS	0.05	YS1ZRB	5	900	1,800	14	CW	960913
1576	970615	VE3MRX	2	G4HPV	2			21	CW	820822
1577	970620	JL1KRA	0.6	W6KP	500	5,508	9,180	7	CW	970323
1578	970615	G4HPV	2	VE3MRX	2	3,500	1,750	21	CW	820822
1579	970703	KB0WVO	1	KE6ZX	QRO	1,316	1,316	7	CW	970225
1580	970708	WD6HCO	2	ZL1BED	200	6,600	3,300	14	CW	800210
1581	970808	N0HJ	2	KH6AFS	3	3,254	1,627	14	CW	970719
1582	970815	NH6YK	2	VK7ZMF	100	5,606	2,803	50	SSB	921230
1583	970824	W6ZH	5	C91CO	QRO	7,007	1,401	7	CW	970222
1584	970915	N7MOB	4	KB0ROL	0.3	1,013	3,377	10	CW	970713
1585	970915	KB0ROL	0.3	N7MOB	4	1,013	3,377	10	CW	970713
1586	970918	KC6PJK	110	N6CHV	1	2,389	2,389	21	CW	970831
1587	970918	N6CHV	1	KC6PJK	110	2,389	2,389	21	CW	970831
1588	971015	AC6KW	2	LU3XQ	2	7,150	3,575	14	CW	961223
1589	971103	KE3FL	125MW	WZ2T	4	393	3,144	7	CW	971018
1590	971111	JA2KPW	1	UY5EG	QRO	4,872	4,872	21	SSB	971110
1591	971215	N2TO	1	N4FNG	1	1,007	1,007	21	CW	971006
1592	971215	N4FNG	1	N2TO	1	1,007	1,007	21	CW	971006
1593	971230	JR8DAG	0.1	8J1VLP	0.6	677	6,773	50	AM	970615
1594	971230	KB9LGJ	0.95	KU7Y	940MW	1,820	1,915	14	CW	971217
1595	980107	KT4OR	2	AB6WS	100	2,038	1,019	7	CW	971126
1596	980115	WB8DQT	4.6	VK2APD	100	9,425	2,048	10	CW	940710
1597	980120	AE4MU	5	EM1HO	QRO	6,740	1,348	7	CW	970930
1598	980127	KE2UK	4	UX0ZA	100	4,679	1,169	14	CW	971222
1599	980201	7K3POI	0.2	YC8UYB	100	2,464	12,320	21	CW	971116
1600	980201	N5ZGT	0.25	W7SQT	100	429	1,716	7	CW	960527
1601	980201	W7SQT	100	N5ZGT	0.25	429	1,716	7	CW	960527
1602	980210	WD4MSM	4	3B8CF	QRO	9,879	2,469	10	CW	970625
1603	980211	AB7TK	2	N2CQ	0.9	2,095	2,328	14	CW	970831
1604	980211	N2CQ	0.9	AB7TK	2	2,095	2,328	14	CW	970831
1605	980211	K8UCL	2	ZL1ALA	100	8,248	4,124	14	CW	970526
1606	980211	K8UCL	2	5Z4FN	100	7,935	5,290	21	CW	970310
1607	980212	W6JHQ	0.6	W7MN	50	857	1,428	7	CW	980122
1608	980215	KF6NWN	2	JA4CSH	500	5,610	2,805	7	CW	980112
1609	980214	W5JAY	0.5	NH6SV	100	3,912	39,120	14	CW	951124
1610	980215	W6JHQ	0.6	W9LUO	95	840	1,400	7	CW	980129
1611	980302	W6JHQ	1.5	JA3URF	200	4,836	3,224	21	CW	890207
1612	980315	K7GT	1.5	K4NAX	5	1,796	1,197	7	CW	980223
1613	980302	JR7HAN	2	LU4FC	QRO	11,200	5,600	7	CW	970315
1614	980420	W6JHQ	1.5	N2ZHF	100	2,400	1,600	21	CW	980331
1615	980501	7M3JAE	5	KC7V	QRO	5,870	1,174	21	SSB	951028
1616	980510	GW0VSW	4	VK2AYD	QRO	10,677	2,669	14	CW	980315
1617	980511	WB8NYV	2	ZS2BBG	QRO	8,582	4,291	14	CW	980225
1618	980526	N2JNZ	0.280	DF3RQ	QRO	3,922	14,007	21	CW	980511
1619	980626	AC5JH	0.250	WB0FVK	9	696	2,785	7	CW	980505
1620	980724	K9IQP	0.9	VK6HQ	QRO	10,944	12,160	10	CW	950208
1621	980808	N2WG	1	G3HQH	QRO	3,809	3,809	14	CW	980731
1622	980815	SM5DQ	4	ZL1BSG	QRO	10,554	2,638	14	CW	920409
1623	980820	KF0OV	0.3	K1GDH	5	1,187	3,957	10	CW	970505
1624	980916	N7GWU	5	SV1QN	QRO	5,173	1,031	14	CW	960309
1625	980916	KK7LC	100	AF4CM	1.75	1,840	1,051	7	CW	980911
1626	980928	SM5LWC	5	LU4GPL	100	7,056	1,411	21	CW	980720
1627	980928	KK7JU	5	3B8CF	100	8,473	1,694	14	SSB	980810
1628	981010	G3RWL	5	VK4XA	QRO	11,601	2,320	14	CW	980820

Alternatives to the 'ever so 'umble' PCB

by Dick Pascoe, G0BPS

A look at various methods of putting a circuit diagram together without the need of a Printed Circuit Board

Overview

Over the past decade or so it has become the norm for homebrew equipment to be made on a printed circuit board. This has partially come about by the ease of access to computers and computer design technology at low prices. Even as recently as the late 1980's I still laid up PCB's using sticky tape and sticky pads for most of my prototype work. A job that took several hours then now takes just a few minutes on the computer. Mistakes then meant lost expensive tape and perhaps pads. Even more problematical was the loss of time. Now a touch and click of the mouse button easily rectify mistakes.

But what happened before the advent of easy PCB manufacture? How did 'Joe Average' Ham make up his test circuits? And more to the point are these methods still relevant today? I hope to convince you of this in the next few pages.

We shall look at the various options open to the builder to convert an idea for a circuit into reality by using the various building blocks and techniques open to us as described below.

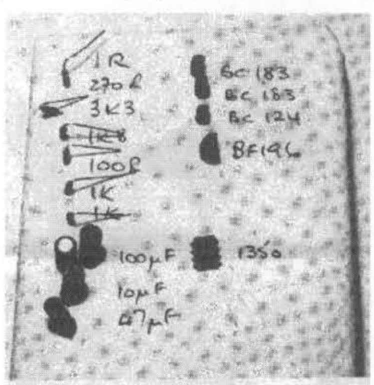
The options open to us include:

1. Ugly Bug (or Dead Bug) Style
2. Pad / Island Board
3. Cut / Island Board
4. Tag Strip
5 Bread Board
6. Strip Board (Vero board)
7. Blob Board
8. Routed Board
9. Nail Head
10. Choc Block

We shall discuss these in full, one at a time as we progress. But, perhaps we should remember.

Getting started

The first place to start is to gather all the components into one place, now is perhaps the time to discuss this motley collection of parts and how to identify them as we progress with the building.

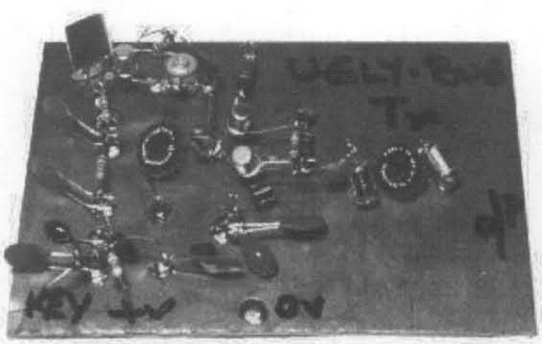


Many builders will be able to pick up a resister and after one glance announce it as a 8k2 resistor, other may have to refer to diagrams such as those published by various companies and magazines.

I try to teach builders to learn component values as they progress and one successful method I have used for some years is the polystyrene and paper method. We take a sheet of polystyrene about a foot square and cover it with a sheet of paper. The components are stuck onto this paper with the component value written beside it. As we progress with a circuit we find each resistor by checking with the paper. Initially this takes time to set out but with practice time is saved, as colour codes become more familiar.

Ugly Bug Style

Often referred to as 'Dead Bug' style depending on your country of domicile. Each of these headings conjures up a picture in the mind of the builder. We have all seen the pile of dead insects in the corner of the window some where. This method of construction follows that idea to its logical (or sometimes illogical) conclusion.



Think again of the pile of dead bugs and mentally change each one into an electronic component. This is what we are intending to achieve. There will be problems of course but these can easily be overcome as we progress.

Back to the building. The easiest way to start is with a piece of PCB material. Take on single resistor in the proposed circuit that goes to ground (deck) and guess at where is should appear in the circuit in relationship to the piece of PCB material. Solder the resistor to the copper and ensure that it stands upright. This is the first of the mounts for the remainder of the circuit. Each component is added to the next and suspended from it. Of course there will come the point where it starts to droop and sag down to the board. If there are no other components that can be used to keep it up then a high value resistor such as a 1MegOhm can be used. It is unlikely that a resistor of this value will alter the operation in any way. But do remember it is there should there be any faults later.

The whole finished project will look just like a pile of dad bugs when completed, but also it will provide the facility to change components as you progress. To update, to change values, to get the very best out of the circuit.

Tag Strip

No, sorry folk's, no strippers here. What we do have is another building block / building style. The picture should show it all, but often that is not the case. We have a strip of paxolin or similar material with a row of solder tags clipped to it. Often this will appear as a strip with a series of 'wings' along it.

This is a valuable aid to design despite what it may at first appear to be. It is not an alien antique so if you see some at an hamfest grab a few strips.

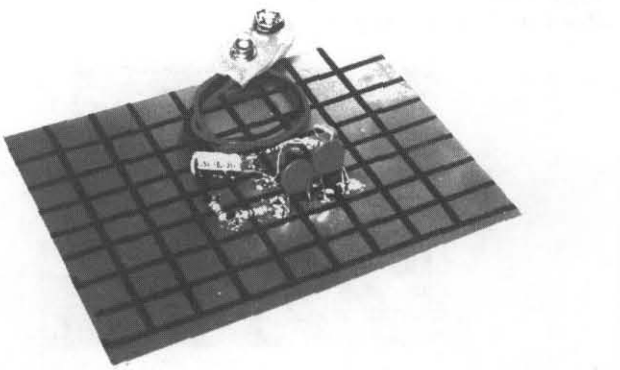
One single strip would make life difficult when trying to make a circuit work, but two, or even three can be put to use with great success. Each pair of 'wings' can be used to join components and often to join three or more. As discussed earlier it is easy to swap and change components, as is required. Three or more of these make any circuit easy to put together. A few fly leads may be required but al long as RF considerations are taken into account when putting one together then it should work.

In all of the designs I have shown today RF may be a problem, if so, short leads and even shielded leads may obviate these problems. Whatever you do care is essential. The picture shows the older type of resistor, don't discard these too soon they may still work and be of value to your test circuit. The fact that they are huge by modern standards doesn't mean that they are not of the required value.

The Pad / Island Board

This and the Cut Island board are two versions of the same thing, in each case a number of small islands are created on a board. If using pads, then a number of small pieces of PCB material are cut from a bigger board. Usually these will be of no more than 1/4in square in size. They are fitted to a baseboard, which may be of any material. PCB is often beneficial as the space between pads can be used as ground (deck). These pads may be fitted to the baseboard using any glue or other suitable sticky stuff!

These pads are then used to solder joining parts of the circuit together. Rather than as previous joining legs together they may individually soldered to a pad. Again the advantage is that each may be removed from the pad to change a component or value at any time.

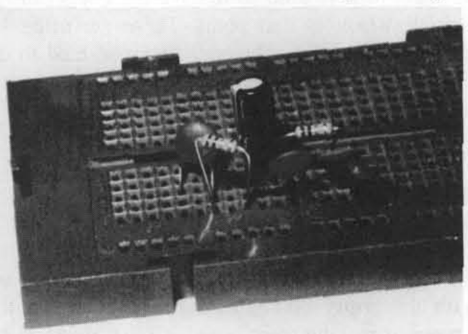


In the Cut Pad version a hacksaw is used to cut channels across the copper face of the board at regular intervals from left to right and then from front to back to provide a series of islands. These act exactly as the pads referred to above. Shielded wire can then be used to link a supply to the pads / islands required as can the earthy side.

Each of the above methods can be used again and again by heating the surface and lifting the solder.

Bread Board

Not as the name implies a slice of buttered toast. But a commercial method of linking circuits together to form a viable circuit tester. In this case we have a plastic unit of about 6 inches by 2inches with two banks of holes. Each bank is made up of five rows of forty-eight holes. On the face of it these are not connected but if the breadboard is turned over it will be seen that across each line of five holes is a metal bar linking them together. Outside, each row has a single bar linking a further row of forty holes in banks of five. Ideal for use as a power or ground rail.

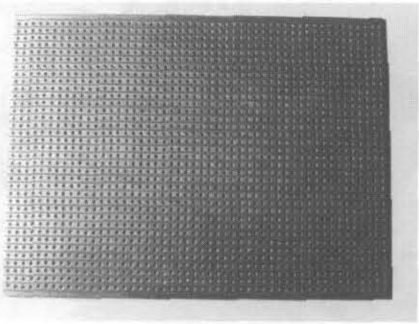


The beauty of this unit is that no solder is required, components are just plugged in and out as desired. Two or more boards can be linked together as required with the connectors on each side of the unit. For the compulsive builder this is possibly the best method of testing circuits under consideration and often used by me when offered ideas.

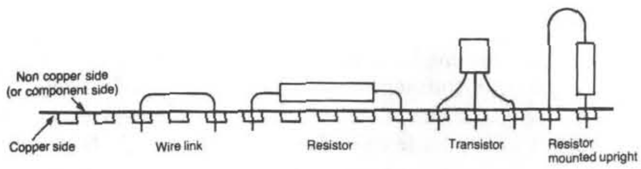
Surface Mount???

Stripboard (AKA Vero Board)

The board consists of a thin sheet, punched with holes spaced one tenth of an inch apart in all directions ie a one tenth inch matrix. The board may be plain or have copper strips or tracks on one side. Always buy the size required or slightly larger. Bigger boards can be cut and the offcuts saved for later projects.



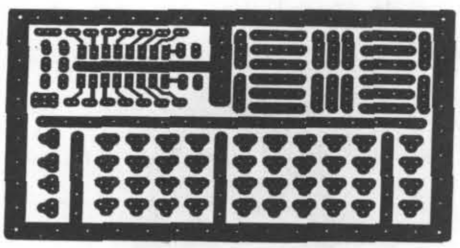
There will have to be times where the track will have to be cut, this can be done with a small sharp drill or a spot face cutter making sure that no copper remains. In use decide how the components are required to be fitted and rotate the board until it fits the requirement. You can even draw the circuit on the plain side of the board. If a break is made in the wrong place a small piece of wire can be used to bridge the break. Don't be tempted to use a large solder blob!



Again, this is a popular method of joining components together with the rows used to link components. Where a separation is required then a small hand drill is used to remove the copper around one hole thus stopping the track at that point. These are often seen in older modified Heath radio's where the constructor wanted to do one of the prescribed modifications to a rig. It is less often used now but still has its followers.

Blob Board

The late Doug DeMaw W1FB first introduced me to this method of construction when George G3RJV and I stayed with him at his farmhouse in Luther, Michigan in 1991. He explained to me how he had these commercially made for his company and sold them to builders. With his permission I had some made for use in the UK. There are several ways of making these boards so that they can be used again and again. The main criteria are that there is a power rail and an earth track around the board somewhere.



Pads for transistors in a triangular form and other pads for resistors and even IC's are useful. These boards are available commercially from several sources, I called my version a Blob Board, and others used differing names and sold them at amazing prices!

Pads are again used to fit components and again they can be changed with ease as required. A circuit can be drawn from the resultant layout by following components.

You can also make your own boards from this template for your own use, it is easy and very convenient.

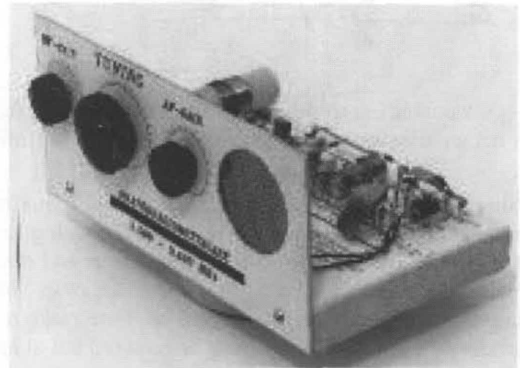
Nailhead

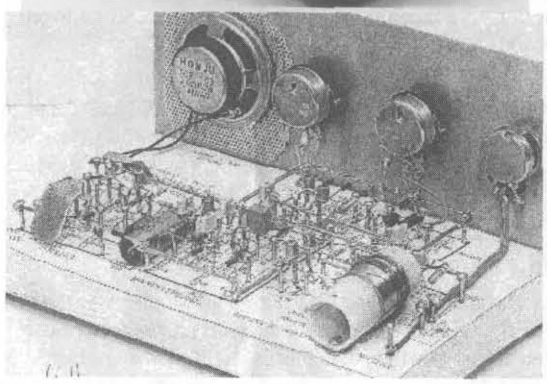
I had never seen this method of construction until Johnnie Apell SM7UCZ wrote an article for SPRAT, which later also appeared in QRPp. Johnnie, built his receiver by tacking components on nail heads. Rather a novel idea! Johnnie and his wife Birgita are regulars at the UK QRP convention at Rochdale. And they always turn up with loads of wonderful Swedish fish for us all to enjoy.

Johnnie designed his receiver around a simple circuit as can be seen in the diagram, where his design differed was that he printed his circuit in a manner that enabled the builder to lay the circuit plan on a sheet of timber, knock in a few nails and start building. The points for the nails were clearly marked on the paper and if followed the circuit could be built with ease.

I like the simplicity of this design, you put a transistor in the circuit with the base and the emitter clearly marked, the feedback resistors and load resistors, even the coupling and decoupling capacitors can be seen. The whole circuit can be followed with the actual intended purpose of each component seen and if necessary checked.

A brilliant, and dare I say it, a new innovation in circuit building. Unless you know better, of course!

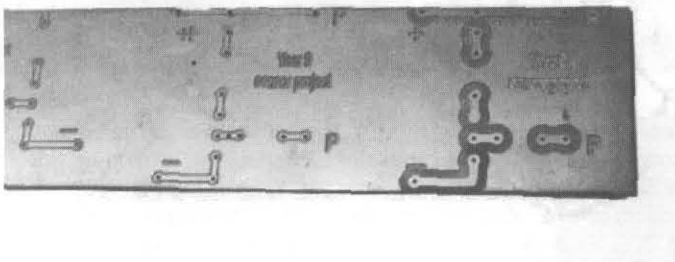




Routed Board

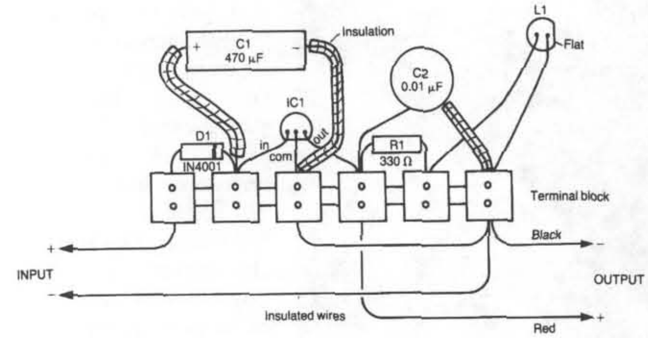
This type of layout is very close to an actual PCB, but instead of the routed lines being made by a machine a simple carver's chisel may be use with care. *I stress, with care! I don't want any loose fingers or thumbs flying around the room.*

The required pads / hatching is marked out with a pencil before cutting, each component is marked and the path of the track chosen with care. Finally the routing is done to allow the path to be followed.



This method is obviously very close to a real PCB, but there is still that element of originality with the board.

Choc Block



Finale

So, we have looked at several ways of making units without the requirement of a PCB, with modern technology a PCB is a relatively easy thing to manufacture for a 'one off 'project but less easy if several hundred or thousands are intended. There, careful thought is needed.

I have been involved in designing PCB's as a kit manufacturer for almost twelve years, in that time I have seen the technology change from time consuming plastic parts layout to simple computer generated designs that will do the job with ease.

With this in mind it may not be an encouragement to consider what I have covered today, suffice it to say that each of the techniques I have covered will work. They will work especially well in the design and testing stages of any projected circuit. Above all they will be fun. Fun to play with and fun to put together and pull apart.

Lets remember that this is above all a hobby, it is NOT the end of the world if a circuit fails to oscillate!

And like the frog, don't give up!

During this paper on PCB preferences we have not covered anything other than the simple alternatives to PCB's. There is a huge amount to be discussed on building techniques and equipment that can be used. I hope to cover that at a future date

Dick Pascoe, G0BPS can be reached at Dick@kanga.demon.co.uk

Editor's Note:
This paper is reprinted from the FDIM 1999 QRP Symposium Proceedings, with permission from the author.

Pacificon '98 Recap

By Monte "Ron" Stark, KU7Y and Mike Czuhajewski, WA8MCQ

Monte "Ron" Stark, KU7Y writes ...

For two years in a row I have been very lucky. Last year Paul Harden, NA5N flew into Reno and stayed with Carol and I prior to our driving over to the Pacificon extravaganza. When Paul got off the plane, he pulled the parts to a NorCal paddle out of his pocket and showed me how he had been shinning then on the plane!

This year it was Mike Czuhajewski, WA8MCQ who came into Reno and spent a couple of days with us before going to acificon. Mike even managed to catch a Fox while here, something he seldom does from home. I am happy to report that for one of those east coast fellows, he behaved himself nicely!

Friday we jumped it the truck (hey, everyone out here has a truck!) and headed west, up and over Donner Pass through some of the most beautiful country God ever made! Then it was into Sacramento and traffic. However, we made it without any problems and I parked right next to our room. Of course we didn't know that was where the room was going to be and we carried our bags at least 200 yards to the desk, only to carry them all the way back again!

When I went into the room, I knew right away that it wasn't Dayton's famous QRP place, the Dayton Inn South. Yesseree, there was HOT water and the air conditioner worked! And they both worked the whole time we were there.

The party was underway when we got there. Everyone was in the lobby waiting to go to dinner. Friends all over the place! Smiles! Handshakes! Then it was off to dinner. Found a place to park. Mike tells about the overflow. There were the eight of us at another table but at least two other tables of QRPers were also in the "outcast" area! Impressive turn out, I thought. And I have to say that the folks at Tony Roma's got the food out in good time. Good food, good friends, what more can we ask for?

Then it was back to the motel and time to descend on the NorCal room. Nor sure just who wound up sleeping there or if it ever got empty of visitors! But we had a blast. There was a steady stream of people in and out. I'd guess that there were close to 100 who came in at one time or another.

Got to bed late of course and in good hamfest tradition we got up early to get the best buys in the flee market. It was dark and chilly but I found some goodies that I just had to have. And Mike found some attenuators. (That's an inside joke!). Soon the talks began and things get blurry! I was so impressed with Roy Lewallen that I would up buying his EZNEC program and I am loving it. I failed to write down all the speakers and I apologize for not having the names handy. Paul Harden, NA5N is always interesting to listen to. He has the ability to take a very complex subject and put it into plain English that even I can understand!

The vendors had a hanger that was just a couple of hundred feet from the motel lobby. The Big Three were there as was Tom Schiller,

N6BT the owner of Froce12. He is now a NorCal Zombie complete with the badge! And yes, he does operate QRP at times. It was good to see many of the better known QRP vendors there. The K2 was drawing BIG crowds and it looked like it was performing like a real star! Wilderness Radio and Embedded Research were also drawing good crowds. Roy Lewallen's booth had a crowd every time I went past it. I finally had to stand in line to spend my money! It really makes me feel good to see the people that have taken the chance to become suppliers to our QRP needs be successful. Just think where we would all be if they were not there!

Saturday night was something else. This is my third Pacificon and this one had a much bigger crowd. Every time I see that I think back to when Chuck Adams, K5FO said that he thought we would be lucky if we ever got to fifty people on the QRP-L! QRP is growing by leaps and bounds. Doug Hendricks, KI6DS and Jim Cates, WA6GER are two of the major reasons behind this. The Dynamic Duo is really Doug and Jim!

And who will ever forget the super duper CW High Speed Embarrassing Contest? Was this Chuck's payback for the demonstration he gave last year with the Mode A keyer? This year a hand full of us tried to send some simple text with a keyer and paddles. Nothing fancy, just plain text. I know for a fact that at least one of the folks there (not me!) can send at close to 50 wpm because I've seen him do it. But I'm not real sure that any of us could have passed a 20 wpm sending test that night! No one could send a period! All my "and's" came out "es"! I would see "that" and hear "tt", see "for" and hear "fer"! I'll bet a cup of coffee that next year there will be a few well used paddles show up Saturday night and that some people will have been sending articles out of this magazine just to get in shape. After all, Chuck did warn us, didn't he?

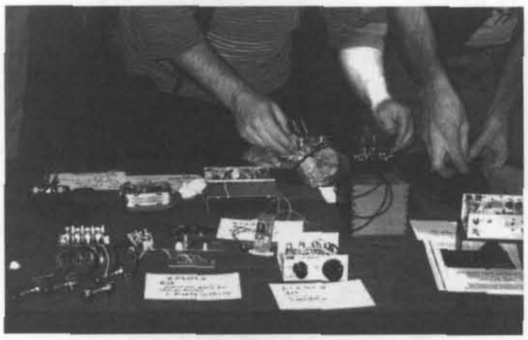
All too soon it was Sunday and time to leave. Mike and I had a really great time. I will be back next year for sure. On a scale of 1 to 10, I'd give Dayton a 7 and Pacificon a 9+ and that's not counting the better motel!

de Ron, KU7Y

Mike Czuhajewski, WA8MCQ writes ...

The bottom line is that this is becoming, or has now become, QRP Dayton West! The folks out there on the west coast could really use something like QRP Dayton and an FDIM that doesn't require a transcontinental trip ($$$) and this is it. The QRP camaraderie, the speakers, the large room stuffed full of QRPers in the evening, the building contest, the whole QRP thing, is just like the QRP Dayton experience. And the associated convention and tailgating are much smaller than Dayton (by a factor of 20 or more), so it's much easier to concentrate on the QRP part--not as many distractions. I didn't find myself wandering around like a zombie for several days like I do at Dayton (although I did wear my NorCal Zombie badge all the time!). Doug Hendricks, Jim Cates, Paul Harden and the rest of the crew put on a first class QRP show.

Although the associated convention and tailgating were vastly smaller than Dayton, there really wasn't that much difference in the QRP crowds. Doug told me how many bodies he promised the Pacificon committee that he could produce, and he more than delivered. Tons of QRPers.



It was encouraging to see such a turn-out for the Friday no-host dinner down the block at Tony Roma's. I was a member of the Tony Roma's Outcasts--there was no space left in the back room, which was stuffed with wall to wall QRPers, so 8 of us had to sit out with the general public in the main dining area. (At least we had room to eat without bumping elbows and we could hear each other talk!)

Lots of good talks during the day by a number of well known hams who NorCal flew in. And the book they gave away (free) to QRPers attending Pacificon had more than just the talks that were presented; there was lots of good material included. Doug brought 200 copies and those disappeared early on. He later remarked that he could have used another hundred, and I believe it. That's one of the benefits of the fabulously successful NorCal kit projects. As far as I know, every penny of profit from that gets poured back into QRP in some way -- it's a win/win enterprise.

And best of all, something that Dayton attendees can relate to, the air conditioning in the hotel worked the whole time! The first night, KU7Y and I agreed that we'd run it full blast all night just as a matter of principle, even though we almost froze to death.

And just like Dayton, I was quite glad that I wasn't one of the judges for the building contest! Lots of goodies and a very tough choice for them. I made the comment to Chuck Adams that I was glad it was him and not me, and he threatened to make me a judge at some future building contest. At one point I pointed out the sign on the wall to someone -- it said "maximum occupancy 90 people" -- and remarked that I hoped the fire marshal didn't wander by! He would have made a number of people leave the room.

And also just like Dayton, there were a number of people who I saw but never got the chance to talk to. But it was good meeting a lot of the west coast QRPers who I read on qrp-l all the time.

We didn't feel the need to fly the QRP ARCI banner that I brought along, but Monte and I did bring 50 or 60 copies of the October QRP Quarterly down to the building contest and they were quickly snapped up. I don't know how many were taken as samples and how many by people who still hadn't received their subscription copies. The QRP ARCI also donated a Small Wonder Labs rig as a prize.

I finally got to meet Mrs. Dobbs, who accompanied G3RJV (possibly for the first time to a QRP gathering in the States). It was just a 30 second encounter in the hallway on the last day, but at least I was properly prepared -- I had a loaded box of Altoids (containing mints, not radios!) in my hands and I observed proper QRP etiquette and offered them some.

On Sunday morning perhaps a dozen of us were gathered in the hotel lobby, and Bob Tellefsen, N6WG walked by. With a look of concern on his face he said "If a bomb went off here, it would wipe out half of QRP. Disperse! Disperse!" Well, if one had gone off Saturday night during the building contest, it would have wiped out 3/4 of the most well known names in west coast QRP!

I took a few pictures, and WA4NID put a half dozen of them at the QRP ARCI web site (www.qrparci.org).

As I said before, Pacificon has become a very viable alternative for those who cannot easily attend QRP Dayton. If you live anywhere on the left side of the country, by all means try to make it next year! And if you live on the other side of the country, it's worth going at least once.

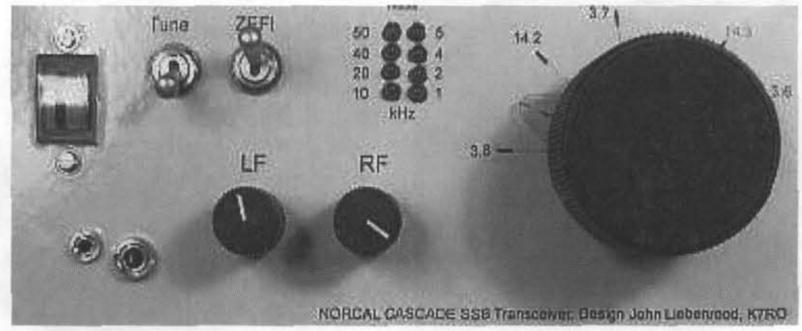
de WA8MCQ

The ZEFI Frequency Indicator

By Charlos Polma, PA3CKR

The ZEFI (Dutch: *Zeer eenvoudige frequentie indicator*) is a simple frequency indicator using a PIC 16C84 microcontroller for determining VFO frequency, including a correction for IF. The last two digits of the frequency in kilohertz are displayed using eight LEDs arranged as follows:

50 o o 5
40 o o 4
20 o o 2
10 o o 1



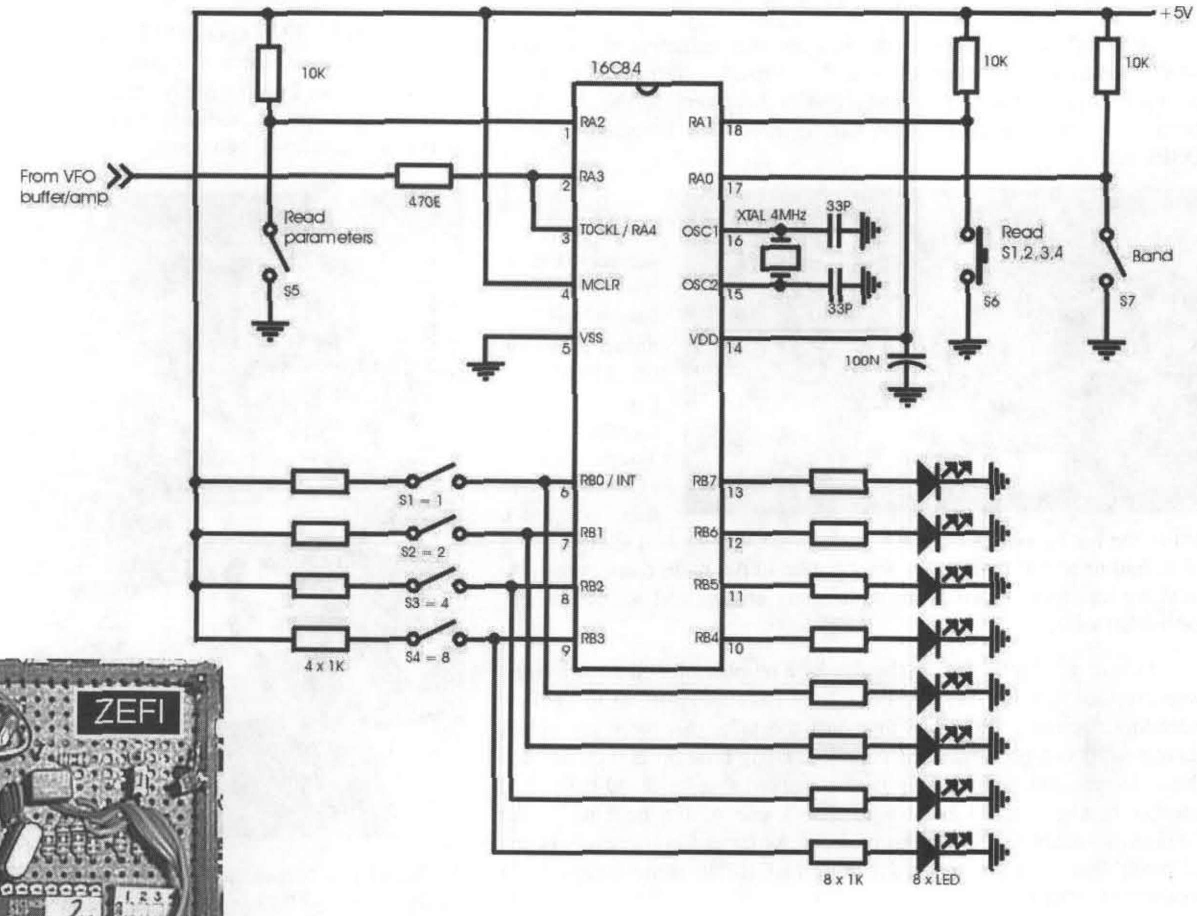
The microcontroller stores relevant parameters for two bands. Programming these parameters is explained in the source code.

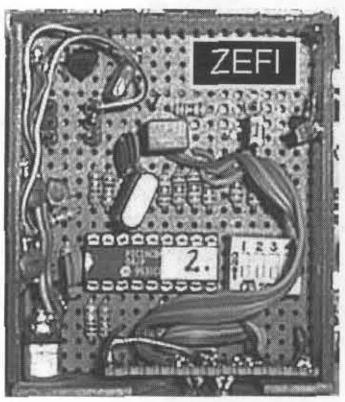
The schematic is quite simple. You will probably need some sort of VFO buffer/amplifier. I modified the amplifier that Wayne, N6KR, used for his KC2. This is not critical. Anything that isolates the ZEFI from the VFO and that has enough amplification to make the ZEFI count will do.

After trying out the circuit and program on a breadboard, I built the ZEFI into my NORCAL Cascade 80/20m SSB transceiver. The front panel has ample room for the eight LED's. I built the ZEFI on a small piece of Veroboard in a small PCB box to screen microcontroller noise.

I've place the software (for this project at my website: http://www.geocities.com/CapeCanaveral/Lab/9595/zefi.html

Files provided include source and ready-to-load hex files for both the 16C84 and the 16F84.





Twenty Years – A QRP Story

Les Shattuck, K4NK *112 Park Circle, Greensville, SC 29605* *email: k4nk@aol.com*

The year was 1978, the place northern New York near Plattsburg A.F.B. That's where I was bitten. You've all heard the story how some unsuspecting amateur is bitten by the QRP bug. This little fellow can affect you with years of stressful but joyful hamming. It all started with a trade of my Clegg 2-meter rig for an HW-7. The fellow who owned the HW-7 lived on base thus no antennas and I lived off base with a big tree, so the trade suited us both. The HW-7 was my only rig and it took some time to get used to it, but soon a few Q's on 40 meters and ... wow! This li'l rig does work! Each QSO was an experience and my QRP WAS list soon grew; I was hooked! I joined QRP ARCI and became member number 4152.

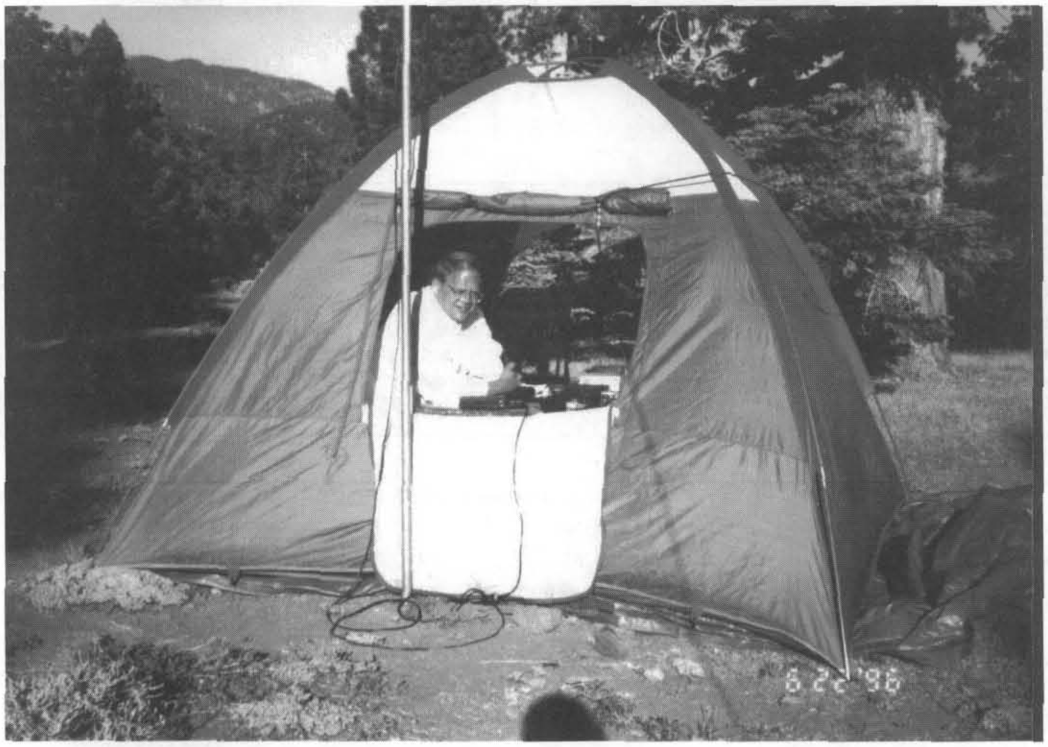
In 1978 and 1979, ARCI was going through a stressful time. Thom Davis and company were working hard to make ARCI a pure 5 Watt club. I endorsed this and enjoyed many CW QRP contacts with Thom and the gang. But this was just the beginning of my QRP career. Money was tough to come by, with three kids and a lot of bills, but somehow I managed to save enough to but a Ten-Tec Argo 509; with this rig even working DX was a breeze. I am an operator and never been much of a writer or the type to design QRP circuits. I just wanted to work the world QRP and that's what I did, earning one of the few QRP DXCC trophies from Ade Wiess when he was with ***CQ***. I now have 301 countries confirmed and still love the hunt.

Still I wanted more QRP; it was almost an obsession with me and I decided to throw my hat in the ring and run for office. In 1984 I ran for Vice President of ARCI and was elected. Well, maybe no one ran against me, but I was the new VP and ready to help get the club moving. I helped put on a great show at Dayton that year (though small compared to today) and a few years later I was elected ARCI President. I don't think my term was especially significant, but I did put my heart in to it. In those days without QRP-L and the Internet, it was a job keeping thing moving when you had a Board scattered across the country. After my term ended, I turned the club over to my VP and good friend, Jim Fitton.

Meanwhile I continued with my QRP operating accomplishments; by 1988 I had most cards for 5-band WAS and 2xQRP WAS, my DXCC count was in the high 200's and I was looking for a challenge. I had joined the G-QRP club some time earlier, receiving number 2209. I looked at the G-QRP awards program and was interested; these would be difficult from the states and I had found the challenge I was looking for. Of course I had always followed the ARCI and found myself becoming president again in 1994. The next phase of QRP was just beginning and I hung in there trying to keep things going the old way. The next phase I refer to is the advent of the QRP-L and the Internet. It probably has had the greatest impact on the QRP community. Now ideas could be exchanged quickly and info between ARCI officers was immediate. No longer did you have to wait for the ***QRP Quarterly*** to see what was going on. No more sending out letters via mail and waiting for a response from the directors. Computers effected me as well; while I still love to get on with my little rigs, I began to write and to build. I even completed several rigs and have an assortment of homebrew gear. I could use this new computer to help keep records of my QRP accomplishments. By 1995 I had 300 countries 2xQRP and was working on a 5-band DXCC. I had made G-QRP master a few years earlier and work hard even today to get 2xQRP QSO's with members of G-QRP toward the membership award. I currently have 250 members worked.

Yes, it has been a great 20 years! I have seen a small group of dedicated amateurs take a facet of or great hobby, point it in the right direction and watch it fly. I am proud to have been part of it!

Edited by W1HUE



Our very own Richard Fisher, KI6SN, editor of the Members' News column here in QQ, was QRV on 2 meters at the '96 Zuni Loops Field Day site. Besides running up an impressive number of Q's Richard took several orders for Whoppers & Quarter Pounders!

(Photo submitted by WA4CHQ)

Contests

Cam Hartford, N6GA

Results: Summer Daze SSB Sprint
Results: NE QRP Afield
Announcing: The Winter Fireside SSB Sprint
Announcing: The Spring QSO Party

UPCOMING EVENTS

Michigan CW Contest	*January 2-3*
Winter Fireside SSB Sprint	January 10
Az SQRPions FYBO	*February 6*
Colorado Winter Contest	*February 21*
ARCI Spring QSO Party	April 10-11

Dates shown for contests listed in Italics are tentative - check with sponsoring organization for correct details

1998 SUMMER DAZE SSB SPRINT

STATE	CALL	SCORE	POINTS	SPC	POWER	BANDS	TIME	RIG	ANTENNA
TX	WD5ICQ	2,737	23	17	5	A-2	4	OMNI-C	500' EF WIRE @ 50'
MA	WA1QVM	539	11	7	4	40M	2.5	QRP+	G5RV
VA	KB8IDW	490	10	7	4	A-2	1.5	TS 940 SAT	160 M DIPOLE @ 75'
OH	KF8EE	63	3	3	5	40M	1.5	ARGO II	RANDOM WIRE
SC	K4NK	63	3	3	5	20M	2	?	YAGI
SK	VE5QRP	28	2	2	?	?	2	?	?

Once again the turnout was rather small for the Summer Daze SSB Sprint. The new contest format hasn't appeared to help get the Sidebanders out of the woodwork, so I'm going to return us to the original plan, with just one 4 hour operating period. See the rules later in this column.

What few takers there were this time agreed that conditions were fair enough, but there just weren't enough operators. In their own words: Found a few stations to work on 40 meters. Didn't hear any contest activity on the higher bands - KF8EE; Had a great time, but where was everybody? - KB8IDW; Listened and called for hours and only heard two other stations - K4NK; No signals on 10, 15 and 20 until 2009Z when I worked WD5ICQ & K4NK, then nothing more - VE5QRP; Early session: No activity on 15 or 10, bad QRM on 20, 40 was the only place for activity. Late session: 40 was full of BC band QRM, 80 owned by local "OMs". Picked up a few on 160 - WA1QVM.

FEEDBACK

Cockpit error here in the Contest Manager's shack resulted in the omission of NJ QRP Club's score from the Milliwatt Field Day competition. The listing should have read as follows:

WQ2RP Score - 5955 CW Qs - 383 SSB Qs - 28 Ops - 9

My apologies to the entire NJ QRP crew. I know from first-hand experience what effort it takes to put together a large FD effort, and no one wants their efforts to go unrewarded. See you there next year!

Coincidentally, I noticed in the November QST Contest Corral that among the small miscues they had made in their contest listings, they had somehow missed 28 entries in the '98 RTTY Roundup, and had bungled the 10 Meter contest results so badly that they had to republish the entire listing!

I don't feel quite as bad as I did...

72/73, Cam

1998 QRP AFIELD

QRP Afield, sponsored by the New England QRP Club, was the first "Afield" type contest sponsored by and for QRPers. Since publication of the journal of the NE QRP Club, "72" has ceased, we make space here in the QRP Quarterly for the results. Here they are, along with comments from the participants. Some of them are very educational and entertaining!

CALL	NAME	SCORE	QSOs	S/P/Cs	POWER	LOCATION
ROVER CLASS						
VE3JC	John	2340	18	11	5W	Bicycle mobile nr Delaware, ON
K7GT	Grant	1050	15	7	5W	Yosemite Natl Pk, CA
N6RY	Terry	400	8	5	2.5W	Yosemite Natl Pk, CA
PORTABLE CLASS						
W0CQC	Marshall, Larry	24,480	90	34	5W	Park nr Denver, CO
N6MM	Harvey	17,407	64	34	3W	Angeles Nat'l Forest, CA
W0UFO	Mert	13,200	66	25	2W	Pine Co., MN
KI0AF	Mike	11,000	55	25	3.5 W	Missouri River bluffs, IA
KB7MBI	Alan / Bob	10,368	48	27	5W	Park- Redmond, WA
K7ZEN w/	Scott / Bruce	9728	32	19	0.9 W	Coconino Natl Forest, AZ
N6WG	Bob	9216	36	16	0.95 W	Park nr Hayward, CA
W1FMR	Jim	7056	42	21	2W	??
KG2H	Jim	4800	30	20	2W	backyard/ temp. antenna
VE3QDR	VE3KQN,VA3JE,VE3REP	4800	50	12	2W	Lake Ontario shore, ONT
NN1G	Dave	2760	23	15	3W	Green Mtn. Natl Forest, VT
KF2HC/1	Brian	2208	23	12	4W	Rome, ME
KB2SGM	Bob	1672	19	11	4W	backyard/ temp. antenna
K8GZ	Kaye	1584	11	9	<1W	nr Lancaster, OH
KW3U	Jim / Mike	1536	16	12	5W	Matamoras, PA
WD7Y	Ed	1440	30	6	4W	nr Lake Tahoe, NV
KI0G	Bob	1392	29	6	2W	Lookout Mtn, Garfield Co., CO
WA5WHN	Jay	1200	15	10	1W	nr Jemez, NM
KB9LCK	Chris	768	12	8	5W	park- Matton, IL
N9MDK/9	Greg	768	12	8	3W	Nashville, IN
WD8RIF	Bill	560	10	7	5W	Athens, OH
KJ6HZ	John	256	8	4	5W	Park - Cypress, CA
W3MWY	George (+Camille)	224	8	7	3W	backyd / temp. antenna
HOME CLASS						
N2CQ	Ken	16,224	104	39	5W	NJ
N4ROA	Dan	10,080	72	35	5W	VA
N5TW	Tom	7104	37	24	0.9W	TX
WE6W	??	6264	54	29	5W	CA
AC6KW	Jeff	5800	50	29	5W	CA
WA8RXI	Rick	4320	45	24	5W	MI
AB0GO	Dave	3072	48	16	2W	CO
NQ7X	Floyd	2856	34	21	5W	AZ
K4JSI	Cal	2520	35	18	5W	MD
K0EVZ	Doc	2304	36	16	2W	MN
AB8DF	Ed	2236	43	13	2W	MI
N0IBT	Dave	2016	28	18	5W	CO
K6RPN	Doug	1980	33	15	5W	CA
VE5VA	Pete	1664	16	13	<1W	Sask.
K8CV	Walt	1560	26	15	5W	MI
K1LGQ	Dennis	1488	21	12	<5W	NH
WA1QVM	Joel	1456	26	14	<5W	MA
AB5WX	Dave	1344	24	14	5W	TX
W5TB	Doc	1320	22	15	5W	TX
N2CX	Joe	968	22	11	3W	NJ
VE6EWM	Earl	864	18	12	3W	Alb.
AB7TT	Joe	748	17	11	5W	AZ
K2UD	Howard	748	17	11	2W	NY
KI7MN	Bob	748	17	11	2W	AZ
N3XRV	Chris	748	17	11	5W	MD
K5OI	Tim	640	16	10	4.9W	??
N7GS	Mal	520	13	10	2W	MT
N0QT	Jan	192	8	6	4W	CO
WA8HGZ/5	Jack	4	1	1	4W	TX

QRP Afield Soapbox:

VE3JC - John: Well I had to take my wife to the airport for an 1830Z departure, so I knew my qrp afield operation would be limited. But as soon as I got home, I hopped on the bike to head out "roving" mobile. Came back home later to fix supper for the kids, then back out on the bike for the last part of the contest. I managed 18 contacts in 3 1/2 hours on the bicycle - 8 on 20m and 10 on 40 m. Was really surprised I couldn't work anybody on 15. The weather here in southern Ontario was just fabulous. Mist was rising off the river as I biked home, and the last rays of a beautiful sunset disappeared just when the contest ended, as I rode into our driveway.

WA5WHN- Jay: It was a lot of fun. I was impressed as to how strong the signals were. I did copy the Europeans coming through, but they were not going to hear me, in between the RTTY/AMTOR/PACTOR modes. I had gone back to W7EL's antenna software. I had a sloper of 15 degrees off of the pine tree over looking the cliff pointing NE. My take off angle was under 20 degrees, on the main lobe. The NW20 was set for 5 watts, but that was a back up plan. The Sierra was @ 1 watt {WM-1 & Bird}. I had the 2 amp-hr. battery pack. I had to get back down the mountain, to meet the wife @ Camp Shaver, before sun down. Otherwise, I would have stayed and played some more.

K7GT -Allan(Grant); The Yosemite backpack trip was a blast and more success than learning experience this time. Set up camp , antennas , and got on the air at 5PM PDT Friday. First QSO out of the box was EA7AHA, getting a 529 report. Lots of other fun QSOs on 20, including UA6LAM. Tried to QSO with WE6W at about 10PM but got a 119 report with no call sign received.

Next morning, worked DS5USH and then JR5FAF (on 40 with the NorCal 40A at 2W) for 3rd and 4th new DXCC countries QRP. About 8AM worked WE6W, now both of us were 599! After breakfast, worked through the WSN QRP net and was able to relay in 3 of the 12 stations checking in for the session. Incredible hearing up there. The weakest checking in was S5 and at times W6SIY was 20 over and completely overloading the NC40A until I cranked the RF gain down to nil.

After an early lunch, began the QRP Afield proper. Worked everyone possible on 40 by about 1835. A non-contest QSO brought a report of chirp (indicating battery voltage problems). At about the same time, N6RY (the other op) reported that the MFJ rig was having a funny sidetone sound (more battery problems). So, I experimented to find that the MFJ would be ok as long as the transmissions were kept to no longer than about 15 seconds. Managed to work 6 QRP Afield stations that way on 20. Couldn't call CQ, though, as the rig would start gasping again.

I put the big battery pack from the MFJ setup on the NC40A, finding that it worked fine, and invited N6RY to see if he could generate some action on 40, the only viable option for us at that point. 15 minutes of CQing and listening brought nil (this is about NOON local time). So.. we pulled the plug and broke camp.

In summary, the trip was a great first true backpack QRP radio venture. Our site was splendidly beautiful, mosquitoes weren't all that vicious, no bears came sniffing through camp, and the sunset views while operating Friday night were magnificent. The morning was also splendid, with casual operating before the contest reclining against a Yosemite granite boulder.

Our location, of course, was just west of Harden Lake, on the south rim of the Tuolumne River canyon, elevation 7630'. Grid loc DM07dv. Tuolumne county and in that rare state of California. 5km from the trailhead and no more than 350 ft elevation gain either way.

WD7Y- Ed: My operation location was 18 miles south of Reno on the slopes of MT. Rose over looking Lake Tahoe. Arrived on site at 8 AM PST plenty of time for set up. I had my trees picked out having operated from this site in the past. Everything went smoothly, a good day for hamming in a wonderful setting. However, the band seemed to be a little poor- wish that there were more players on 40M, guess they were all on higher bands.

KB7MBI Bob (W7CD) and Alan (KB7MBI) Bob proved to be the workhorse and with his rig worked all bands but focused on 20M. I stayed with 40M on the EMTECH NW40. It was a bit cool but otherwise proved to be a super Pacific Northwest day. Several folks wondering thru the park stopped by to check out what was going on. The forest of masts and wires was rather unusual in this placid park area. I am not sure about the rest of you folks but 40M was dead up until about the last hour, then it was not that great. We worked for every contact on 40M. I was very pleasantly surprised with the performance of Bob's KNWD TS-50. It is one outstanding rig.

LESSONS LEARNED: Initially we were set up with the Butternut on 20/15 and PHASED SLVs on 40M. Ther interaction was unbelievable. Each radio totally blanked out the other rig during transmit. In an attempt to resolve the problem we tried an inverted vee doublet with the apex atop one of the SLVs (a VERSA-TENNA). To our surprise this resolved the problem. Although only about 20 yards apart, they proved to be compataible for the multiband operation. The ground mounted Butternut was a real winner for both transmit and receive.

This proved to be one heck of a lot of fun. We intend to see if there are some antenna improvements that can be made but we intend to keep one point in focus. What ever we decide upon it must be easy to set up and put away. **WD8RIF- Bill:** I participated during the last three hours of the QRP Afield from Highland Park in Athens, Ohio. Iwas joined by Drew McDaniel, W8MHV/9M2MC, and Mike Hansgen, AA8EB, although neither Drew nor Mike operated this event.

I arrived on-site about 5pm and quickly erected the W3EDP and set up the QRP Station in a Bag. I didn't try hard to make QSOs, but instead used this event as a chance to continue experimenting with the W3EDP antenna and the recently-built ScQRPions "N7VE LED SWR Indicator". Nevertheless,
over about two hours, I made ten QSOs on 15, 20, and 40 meters. The W3EDP performed well and tuned easily on these bands, but failed to tune on 80 meters. The N7VE indicator worked well on 15 and 20 meters but was found to be useless on 40 meters because of the metal cabinet of the MFJ-901B, into which I'd installed the indicator.

Despite the problems found with the W3EDP and my implentation of the N7VE SWR Indicator, this was a very fun event, and I look forward to next year!

W0UFO, Mert: I worked 66 QSOs portable from my cabin in Pine Co. MN using an MFJ 9020 at 2W to a dipole in the trees up about 25 feet but using comercial power. My first QRP Test- had lots of fun.

W1FMR, Jim: reported 42 QSOs using a 50' random wire worked against a trio of ground radials. He carried an impressive collection of tuners and other gear 3/4ths of a mile to his operating site

W3MWY- George: In the category of draining swamps and alligators, our operation was supposed to have been in the QCWA QSO party (held that same day). Since no QCWA'ers were heard during our great hour of demonstration to the picnicing members of QCWA chapter 20, Camille (W3EPR) and I got involved with the equally fun-filled QRP Afield test.

KB9LCK- Chris: Operated battery portable from Petersen Park, Matton, Il .-- Bagel capital of the world! 1/4 wave HB vertical, Norcal Sierra w/KC1, 32AH gel cells. Only on 20 meters, Murphy prevented operating 40, couldn't get tuner/swr bridge to cooperate. Tried EFHW but see above.

AB7TT- Joe: Fun stuff! Haven't been able to get on the air much, so this was a great chance to force myself to radiate. Couldn't figure out why my 5 watts were getting such poor reports compared to the sigs I was hearing. Found out a few weeks later that I'd turned the power down on my Sierra to just over one watt and forgotten about it. Oops. :) Farthest station worked was Dan N4ROA out in VA. Tried to find Jim AL7FS up in AK, but no luck. Nice to hear and work folks again! Thanks for another great contest.

K8GZ - Kaye: Adena Ridge off of Coonpath Road in Fairfield county, Ohio has good elevation, but wasn't available. On its north slope, 70 ft lower, was a clearing fairly free of poison ivy, surrounded by tall pine towers, I mean trees. I told myself, this is better than being on the ridge making like a lightning magnet. It had showered earlier and the static crashes told of more nearby. Several tries with the bow and arrow were needed to anchor the ends of my new 40 meter dipole, which was made of real copper wire, not the usual electric fence steel. The copper was a strand from a piece of salvaged 3/0 electrical cable. A tarp provided rain and sun shelter.

The previous day at work I had set the output of my SW-40+ to something between .9 and 1 watt. The multiplier made me do it and I'm not much of a contester (operator). Shortly after 1800Z I found that everything worked. I almost stopped there, but I heard others calling and patiently urging an exchange. I thank them for tolerating my fist of limited dexterity. It was an enjoyable learning experience and I hope to do it again soon.

Twenty meters was a bust due to conditions and a forgotten paddle adapter. After I tore down the station at 2400Z the rain returned. QRP life is good. Thanks to all making this possible.

KJ6HZ- John: The main question I have is if Murphy contributed significantly to planning, set-up and operating, do you have to enter as a multi-op? My plan seemed reasonable to begin with. I'd take my Ark 4 for 40M and my NW-20 for 20 and operate from a local park using the SLV and a 20M dipole.

As it turned out, I arrived at the park half way through the contest. As I unpacked the car, I started to realize that several key pieces of equipment were not present! Missing were the base for the Saint Louis Vertical, a coax adapter required for the ARK-4, my headphones, and most important, the cord that connects the keyer to the rig! Oh boy, this is going to be really interesting. Maybe those guys that advocate setting up the station at home and then packing it up are onto something after all!

The lack of phones precluded the use of the ARK-4, so that left me with only 20 meters. Oh well, without the SLV, I'd have had to cobble the 40M antenna together anyway. Fortunately I had put a speaker into the NW-20 after forgetting the headphones once before. (I suppose this says something about my capability to learn from experience, but I'll leave that one alone).

The keyer cable was a stickier problem, but I realized that I could key the rig directly with the paddles, using the "dit" lever. Not exactly ergonomic, but it'd have to do.

The dipole went up without a problem for once. I learned that a half full plastic soft drink bottle works really well for launching antennas. The neck of the bottle makes a secure place to tie the cord and you can adjust the weight to suit your throwing style. So for the last two hours of the contest, I worked several stations and had a really good time. I seemed to have a pipeline into Colorado, since most of the stations I heard were from there! W0CQC, KI0G, and AB0GO were really loud most of the time.

Learning to key my NorCal paddle like a straight key was interesting. I tried standing it on the side, but that wasn't very stable or comfortable. I reversed it and keyed it "side-swiper" style, but it's tough to avoid touching the moving parts when it's facing away from you. Thanks for everyone that deciphered the weird "fist"! I really wasn't using my left foot, honest! I've really got to build a keyer into my main "field" rigs before next time.

So despite my measly score, I had a really good time and learned quite a bit, as always! I'll be looking forward to the next one!

Bob-N6WG: Here's my QAF report. Overall I had a great time, once the antenna was up. Now that's a whole story in itself. I hauled my setup into the park on my usual handcart--card table, chair, rig, tuner, battery, lunch, water, the whole bit for a nice outing. I decided to put up the antenna first, then set up the station at the end of the feed line. Here's where the going got a bit rough.

In my infinite wisdom, I brought a slingshot to help get my line over a branch. Small miscalculation, in that I expected the lead sinker to pull up the white nylon cord I was to use for antenna support. The slingshot just didn't have the oomph to do it. Now I understand why at FD we always use light fishing line first, then pull the support line up after.

Ok, plan B time. I tried swinging the weight around a few times and letting fly toward the branch I had in mind. Hmmm. Low, and very far to the left. Ok, try again. Same results. By this time, I'm talking to myself. Got another idea, move up on the bank a bit and get a different angle on the throw. Ok, big swing and release.

Ladies and gentlemen, I can attest through personal experience that Newton was right about equal and opposite reactions. I threw so hard I overbalanced and tumbled down the bank. I got up, grumbling that this was counterproductive. Nothing was damaged but my dignity, so back to tossing

WINTER FIRESIDE SSB SPRINT

Date/Time:
January 10, 1999; 2000 - 2400Z
Exchange: RS, State/Province/Country, Name
QSO Points: All QSOs are worth one QSO point
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)
< 250 mW (< 500 mW PEP SSB) = X 15; 250 mW - 1 Watt (500 mW - 2 W PEP SSB) = X 10; 1 W - 5 W (2 - 10 Watts PEP SSB) = X 7; Over 5 W (Over 10 Watts PEP SSB) = X 1.
Suggested Frequencies:

	GENERAL		
160 Meters	1860 KHz	15 Meters	21385 KHz
80 Meters	3865 KHz	10 Meters	28385 KHz
40 Meters	7285 KHz	6 Meters	50128 KHz
20 Meter	14285 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 (20M, 15M, 10M and 6M) or Lo-Band (160M, 80M and 40M). 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. 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. 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

SPRING QSO PARTY

Date/Time: Apr. 10, 1999, 1200Z through Apr.11, 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.
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	50128 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.

Multi-Op Class: Submit list of operators and number of transmitters in simultaneous operation.

Portable Operation: Submit information on location of operation, list of operators and number of transmitters in simultaneous operation.

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.

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Cam Hartford, N6GA
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fishing weights at my chosen tree. Finally got it over a lower branch than the one I really wanted, but by now, I've had it. Gotta get on the air.

Station setup went smooth at least. Had my old QRP++ and LDG autotuner. The antenna was a 40m dipole up maybe 25 ft, but it matched ok on both 40m and 20m so I was happy. Spent most of my time on 40m (13 QSO) and 20m (22 QSO), and tried 15m occasionally. One contact there. Overall, 36 QSOs and 16 SPC. I feel pretty good about that, for a 950mw entry.

Anyway, I had a great time, and once my aching muscles recover, I'll be ready to go again.

Quality Recognition Program

Steven Pituch, W2MY

This program recognizes hams for their contributions to QRP by way of a special award that complements the QRP ARCI Hall of Fame award. Whereas the H.O.F. award recognizes lifetime achievements, this one recognizes the shorter term achievements that help the QRP movement. By way of the Quality Recognition Program, QRP ARCI hopes to encourage others to experience the joys of QRP operation, and to make their own contributions to QRP.

Any one may nominate an amateur for this award. Neither must be a QRPer. Sometimes a non-QRPer makes such a great contribution to Amateur Radio that it significantly helps QRP. The QRP-ARCI Board of Directors votes on each nomination.

The nominating sponsor decides what the award category should be. This is because the number of ways one can help the QRP movement is limitless, and the sponsor knows best how the award category should be described. It is very important for the sponsor to supply a detailed description of the nominee's qualifications. This description will be used to formulate the custom testimonial at the bottom of the certificate. Because of the unique information shown on each certificate, every certificate is individually made and is very special.

Since contributions differ, you are best qualified to succinctly describe the nominee's contribution. If the nominee is approved, this information will be used by the chairperson to help create a category/title for the actual award certificate, so this information is important.

Please be complete in your description of the nominee's qualifications for this award. If you don't supply sufficient information, the nominee may not be approved. Take as much space as necessary. Don't assume that the B.o.D. knows anything about the nominee.

The following form may be used to nominate someone for this award. There is also a copy of this form at the QRP-ARCI web site. Please send the nomination to me at spituch@fwc.com, or the following address.

Quality Recognition Program Nomination Form

Sponsor's Information:

Name:________________________ Call:____________

Street1: ________________________________

Street2: ________________________________

City: ____________________ State: ______ ZIP:__________

Country:________________

E-mail address: ____________

Nominee's Information:

Name:________________________ Call:____________

Sex: M / F

Street1: ________________________________

Street2: ________________________________

City: ____________________ State: ______ ZIP:__________

Country:________________

E-mail address: ____________

Award Category: ________________________

Nominee's Contributions:

Nominee's Qualifications:

Submit form to: Steven Pitusch, W2MY
20603 Prince Creek Drive
Katy, TX 77450
e-mail: w2my@aol.com

From the Membership Chairman

Dave Johnson, WA4NID

Hi gang, just a clarification and some reminders. Renewals are accepted for only one or two year periods, and renewal payments will only be accepted if you have one year or less remaining in your current subscription. For example: say it is April 1999. If your "Expiry date" is April 2001, you cannot renew at this time. If your "Expiry date" is April 2000, your one-year or two-year renewal can be accepted at this time. Note that if a renewal is sent in by late April to our treasurer W4DU, it will usually get to me in May! For renewals that cannot be accepted under this policy, I will instruct the Treasurer to make a refund payment to the applicant. Note that this gives everyone a window of more than one year in which to renew.

Be sure to address all inquiries about subscriptions to me (WA4NID) directly. The Treasurer does not keep records of payments, because these are kept in the database that I maintain. If you are inquiring about delivery please wait until the middle of the MONTH *FOLLOWING the issue month, because the delivery times for third* class mail vary greatly. I spend several hours every month answering email inquiries, and I am very glad to help, but many are premature! If you have questions about the status of a renewal, please also be patient as I do not have time to send notices of reminders to renew or to notify everyone of receipt of your renewal form. I will try to answer any questions but if possible please try to wait to check the mailing label on the next issue, for routine confirmation of renewals.

Remember to RENEW EARLY. Do not wait until after the expiry date that shows your last issue scheduled for your current subscription (usually included on the mailing label). Please send a proper form, or at least include all requested information (Not just a check in an envelope).

Also remember to get any changes of address to me promptly, as *the U.S. postal service does not forward the domestic third class mail.*

Feel free to send material for the web site to me. I try to keep things up to date but appreciate any help in pointing out errors, supplying data on upcoming QRP events or contests (does not have to be QRP ARCI sponsored), or suggestions for improvement. The web site is at http://www.qrparci.org

Have fun with QRP!

Dave, WA4NID, e-mail: consult@apismarketing.com
QRP ARCI membership Chair and web site manager.

DOWN IN THE SHACK at N2APB -- Tom Cooper, W1EAT (author of the RX320 Review in this QQ) stopped by during holiday travels to NJ and met up with N2APB and WA2UNN to check out some of the projects on the bench. At this point, Clark was in the final throes of his Jersey Fireball 40 circuit prototyping. **(L-R):** George Heron, N2APB; Tom Cooper W1EAT; Clark Fishman, WA2UNN

The Last Word

The QRP Quarterly invites readers to submit original technical and feature articles as a service to their fellow QRP enthusiasts. Although the QRP Quarterly cannot pay for submissions accepted for publication, it will acknowledge, with thanks, authorship of all published articles.

Due to space limitations, articles should be concise. Where appropriate, they should be illustrated with publishable photos and/or drawings.

Full articles should go to any of the volunteer editors for review. Information for columns should be sent directly to the column editor. See the back cover for addresses. Submit technical and feature articles with a printed copy and a copy on disk (if possible). ASCII text is preferred. Photos and drawings should be camera-ready or .tif format. Other formats can be used with prior approval.

Technical and feature articles should be original and not be under consideration by any other publication at the time of submission to the QRP Quarterly or while the QRP Quarterly is reviewing the article. If you contemplate simultaneous submission to another publication, please explain the situation in a cover letter.

Material for possible use in the QRP Quarterly should be sent to only one of the editorial volunteers, not to several at the same time. The QRP Quarterly editors and columnists will transmit the submission to others on the staff if they believe it better fits another category.

Accepting advertisements for publication *in the Quarterly does not constitute* endorsement of either the product or the advertiser.

Material cannot be returned unless accompanied by sufficient postage.

The act of mailing a manuscript constitutes the author's certification of originality of material.

Opinions expressed are those of the authors and do not necessarily represent those of the QRP ARCI, it's officers, Board of Directors, Staff or advertisers.

The QRP Quarterly will occasionally consider reprinting articles previously published elsewhere if the information is especially useful to members of QRP ARCI. If your article has been published, include the name of the publication and the issue it appeared *in. In all such cases, the QRP* Quarterly will obtain permission to reprint from both the author and the original publication and acknowledge the source of the material.

The QRP Quarterly will occasionally print information first appearing on QRP-L after obtaining the permission of the author and ascertaining that the information is not scheduled to appear in another publication.

Copyright of materials published in the QRP Quarterly remains with the author. Although the author retains the right to reuse *the material, the QRP Quarterly requests that* reprints of the material in other publications acknowledge first publication in the QRP Quarterly.

-- The Editor

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The following information is optional but helpful ...

Packet Radio Address: ________________ **Email address:** ____________________

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Please send a check or money order in US funds payable to "QRP ARCI" *(only)* to:
Ken Evans, W4DU, 848 Valbrook Court, Lilburn, GA 30047-4280, USA

If more convenient, a check or money order for 13.50 UK pounds payable to "GQRP" *(only)* may be sent to:
Dick Pascoe, G0BPS, Seaview House, Crete Road East, Folkestone, Kent CT18 7EG, UK

Dick Pascoe can also accept Visa or MasterCard at 14.00 UK pounds. *Do Not Send Cash!*

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