





## BayCom Modem

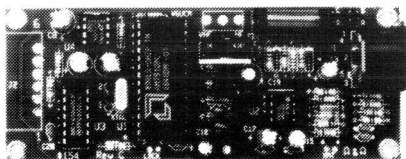
Low Cost Packet for PC / Clones

**Features:** Software-based PACKET that makes your computer emulate a TNC. Modem connects from serial port to RIG. Watchdog timer & reed relay PTT standard. Operates from 12VDC @ 100ma, wall power supply included. Uses crystal controlled 7910 chip, VHF and HF. Lock & TX LED indicators. Free copy of Version 1.40 English software included.

Kit ..... \$59.95      Enclosure ..... \$10  
Assembled & Tested in Box ..... \$79.95

## DigiCom > 64 Modem

Low Cost Packet for the Commodore



**Features:** Software-based PACKET that makes your computer emulate a TNC. Modem connects from cassette port to RIG. Watchdog timer & reed relay PTT standard. Power derived from Computer. Uses crystal controlled 7910 chip, VHF and HF. Lock, TX & RX LEDs. Free copy of Version 2.03 software included.

Complete Kit Only ..... \$49.95  
Assembled & Tested ..... \$69.95

## WEATHER FAX

Satellite & HF FAX for IBM / Clones



Shown with optional 20 LED Tuning Aid

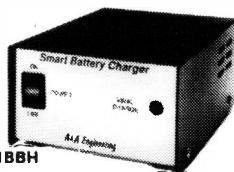
**Features:** Processes WEFAX, VIS & IR NOAA, METEOR, APT, 240 LPM & HFWEFAX. JV Fax 7.0 compatible. Connects to Computer Line Printer Port. The software was created by Dr. Ralph E. Taggart, WB8DAT. For details see Chapter 5, Fifth Edition of the *Weather Satellite Handbook*.

Complete Kit Only ..... \$159.95  
Assembled & Tested ..... \$189.95  
Optional 20 LED Tuning Aid ..... add \$ 40.00

## Smart Battery Charger

JUN 87 QST

BY WARREN DION N1BBH



**FOR GEL-CELLS or LEAD ACID BATTERIES.**  
**Features:** Precision temperature tracking voltage reference & three mode charging sequence. Standard kit is for 12V @ 1/2 or 1 Amp, user selectable. Can be connected to the battery indefinitely, will not overcharge. Weighs 2 pounds and measures 4" W x 5 1/2" D x 2 1/2" H. Finished enclosure included in kit.

Complete Kit Only ..... \$59.95  
Assembled & Tested ..... \$79.95



CA Residents add 7.75% sales tax. S&H: \$5.00 (insured). Foreign orders add 20%. For more info or price list, send legal size SASE (55¢) to:



**A & A Engineering** 2521 W. La Palma #K • Anaheim, CA 92801 • (714) 952-2114  
FAX: (714) 952-3280

# Important

## MOVING OR CHANGING ADDRESS?

If you change your address without notifying us directly before the forwarding provision expires, the Postal Service will likely remove the cover from your issue of *Hambrew*, put a change of address label on the cover with your new address, and discard the remainder of the issue. Then they will send the cover back to us. We cannot replace issues lost in this fashion without charging for the issue and the first class mail to replace it. Please notify us in advance of your new address to avoid this situation.

# • Contents •

Letters	4
Building the NorCal Sierra: <b>Cameron C. R. Bailey, KT3A</b>	7
NorCal 40 and Sierra: <b>Stan Cooper, K4DRD</b>	9
NorCal 40 Update: <b>Wayne Burdick, N6KR</b>	12
A Single-IC Half-Watt Transmitter: <b>Lew Smith, N7KSB</b>	14
Ceramic Resonator NE602 VCXO: <b>Roger Wagner, K6LMN</b>	21
Toroid Turns: <b>Don Callow, VK5AIL</b>	23
Elenco 6m/2m Receiver Kit	28
20/20 Hindsight	30
The Rig That Never Got A Chance: <b>G. DeGrazio, WFØK</b>	34
Good Things Come In Small Packages: <b>Josh Logan, WX7K</b>	36
Hambrew Visits MXM Industries: <b>Bruce Muscolino, W6TOY/3</b>	40
Thoughts on Theory: <b>James G. Lee, W6VAT</b>	43
Classified Ads	46

### Photographic Credits:

Pg. 6: Jörn Nielsen, SM5IFO; pp. 7, 8, 9, 10, 11 outside back cover (top): Stan Cooper, K4DRD; pg. 12: Cameron CR Bailey, KT3A; pp.14, 15, outside back cover (center): Lew Smith, N7KSB; pg. 27: Roger Wagner, K6LMN; pp. 40, 41, 42: Bruce Muscolino, W6TOY/3; All others: Hambrew

# ***hambrew***

COPYRIGHT 1995, Smoking Pencil & Co.  
All Rights Reserved

## **FOR AMATEUR RADIO DESIGNERS AND BUILDERS**

SUMMER, 1995 • VOL. 3, NO. 3

Publisher.....George De Grazio, WFØK

Copy Editor.....Christine La Fortune

### *Writers, Editors and Contributors:*

*Fred Bonavita, W5QJM; Wayne Burdick, N6KR; Jörn Nielsen, SM5IFO; Roy Gregson, W6EMT; James G. Lee, W6VAT; Cameron C.R. Bailey, KT3A; Roger Wagner, K6LMN; Don Callow, VK5AIL; Josh Logan, WX7K; Bruce Muscolino, W6TOY/3; Stan Cooper, K4DRD; Bruce O. Williams, WA6IVC; Dick Pattinson, VE7GC*

Ads & Subscriptions: (303) 989-5642 • Editorial Office: (303) 989-5642

*Hambrew* (ISSN 10773894) is published quarterly by Smoking Pencil & Co., Publishers, Offices at 13562 West Dakota Ave., Lakewood, Colorado 80228.

Second-Class Postage paid at Denver, Colorado. POSTMASTER: Send address changes to *Hambrew*, P.O. Box 260083, Lakewood, CO 80226-0083.

*Hambrew* is sold by subscription only.

\$10 per year (domestic), \$21 (foreign), \$15 (Canada and Mexico)

We welcome submission of articles, photos and manuscripts (S.A.S.E. for return)

## • LETTERS •

### From The Publisher

First, a big thank you for the positive input on the push for new projects for the 6 meter band. We have received many letters of support, some of which are published in this issue. What we need to keep this going are projects and more projects-and the word is getting out. No-code techs should find this especially interesting, and we are also beating the bushes for a 500 milliwatt to 1 watt CW transmitter or transceiver for 6m as well. Can you help?

The correspondence is pouring into our office, and I have a very difficult time responding to questions about articles in back issues and other general questions, as I must prioritize the subscription and magazine production chores. Please forgive me if I cannot respond to each and every letter and question- I do try, but the load is increasing!

One query which seems to repeat comes from folks who missed their renewal and are not able to access a sold-out issue when they do renew. "Do you have copies of articles in back issues available?" I regret to say that we do not. Perhaps we can get something like this going in the future, but for the present it is not time nor cost effective to implement this service.

As we are on a tighter budget since reducing our subscription rates, we do not produce huge numbers of extra copies of the current issue at press time. This means that the extras have been selling out fairly promptly after the mailing of the current issues. If you don't wish to miss an issue, please renew at your earliest convenience! I also must apologize for the 800 number advertising. We no longer have an 800 number available (budget again!), and some cards and advertising accidentally got out with our disconnected number- this has been corrected for the future, and I'm sorry for any inconvenience to our loyal subscribers. Have a great summer! 73, George

We are in the process of closing down the electronic component part of our business. We will no longer sell components. We are expanding our line of QRP kits. Therefore if possible, it is best to call to check stock before placing your order for components.

Thank you

Oak Hills Research

(Forwarded by Roger Wendell, WBØJNR)

I'm on a campaign to try to nudge one or more kitmakers to produce a 6-m QRP CW XCVR. So far, NN1G has responded favorably. Here's the logic: There are a lot of no-code tech's now. They have 2 m H.T.s. They can't practice on the air, so they use their PCs and tutor programs to study CW. This makes them hate CW even more! Can you imagine having a CW QSO with a program? Sick! As a former no-coder myself, I can tell you the best way we can advise them is to have a CW QSO with another ham — hundred of miles away!

The magazines have yahoos for 6 m (all mode, too) for only \$700. Let's give the no-coders a real ham experience. Shoot some CW skip! They'll be hooked soon.

An article I would like to see: how to build a CW QRP rig (1) milli watts; (2) three-watt rig, from an old CB radio.

Please, more from Bruce, WA61VC. Excellent! And more high-band receivers, 20m, 17m, 15m.

Keep up the good work and 72's,  
Jim, KJ5TF

Thanks again for the very enjoyable, impatiently waited for, eternally saved, and often re-read publication. Enclosed is my subscription renewal.

Ed Miller, KC4MHM  
Tallahassee, FL

Now at last have I some time to sit down and write a letter to you. In your letter sent with the first issue, you asked if I had some projects. I have: the latest project is a QRP transceiver that I bought from A&A Engineering that

works very well. But as always, there is something you must change or add. In my case, I had problems in matching the antenna, so I built a matchbox and a powermeter. Now I am working with a frequency counter for that rig, and I hope that it will work when the summer comes. Last summer I used the rig on a backpacking trip in the north of Sweden. I used the sun to charge a NiCd battery and it worked very well.

I have showed *Hambrew* to members in my club so you might get some more subscribers from Västerås in Sweden. And I will subscribe one more year. I am sending some pictures of my QRP rig, sun panel, and myself and am looking forward to the next issue.

Best 73 de SM5IFO,

Jörn Nielsen

*Readers will appreciate the solar HF station which Jörn shows us on the following page! Hambrew is fast becoming a truly international periodical. We couldn't be happier!*

I recently called to ask about my Winter 1995 issue, and about an hour later the mailman delivered it — what service!

I was disappointed in the change in the magazine's paper because the photos are so grainy. You lose enough detail in the photos to make some of them a waste of time.

That's my complaint, but I must add that I want *Hambrew* to survive, and I can put up with change to be able to continue enjoying the great articles in this publication. My main motivation for recently getting involved in

ham radio is to construct my own ham gear and realize the satisfaction of successfully communicating with something I made myself. I need *Hambrew*!

I am currently building my first kit, the MXM Simple Transceiver, which I learned about from the review in the Spring 1994 issue.

Thanks for your efforts, and good luck in making *Hambrew* a long-lasting success.  
Steve Maclure, KC7DSM

My subscription doesn't run out until the end of the year, but I want to renew now, while I'm thinking of it. I am a life member of ARRL, so I receive *QST* regularly. I enjoy that magazine very much. When I first subscribed to *Hambrew*, I was looking to see if it would be something for me. I'm more of an armchair builder than anything else. Once in a while I actually get my feet wet, and sometimes what I build even works. But I have always enjoyed the reading...I'll stick with *Hambrew*!

Thanks for a really good magazine.  
Don Bauer, WB7TPH  
Phoenix, AZ

I was pleasantly surprised when the new issue of *Hambrew* arrived. I have been playing around with 6 meters for several months now. I have been licensed for about 15 years but never gave 6 much thought. I have built the Ten-Tec converter to receive and have made a 6-meter beam. I have been asking the question, does anyone make a kit for a 6 to 10 transverter? I thank Ten-Tec for the 6-meter transverter because I would have to lug around my TS-520 as the exciter. Why not put to use the thousands of Uniden/Realistic 10-meter monobands as the exciter? They are just lying around gathering dust now that we are in the bottom of the cycle. They are small, portable, and have SSB with CW. Strapping a transverter to the back of one would be a natural.

I am not too versed in the converter/transverter theory, but I will be tinkering with some ideas and others should, too. It should not be too hard to build a solid-state transverter with about 5 watts out, SSB, CW, and 12 volts for power.

(Letters continued on inside back cover)

## **HAMBREW SUBSCRIPTION RATES:**

◄ DOMESTIC: \$10/YR.

◄ CANADA/MEXICO:  
\$15/YR. (FIRST CLASS)

◄ INTERNATIONAL:  
\$21/YR. (FIRST CLASS)

### **BACK ISSUES:**

AUTUMN '93 TO

AUTUMN '94: \$6 EA.

SUBSEQUENT ISSUES:

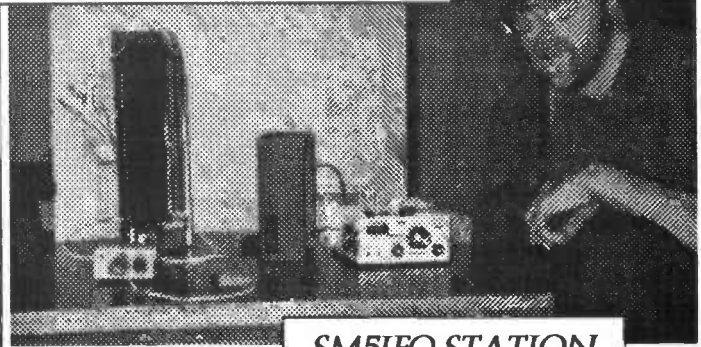
\$3.50 EA. MAILED 1ST CLASS

WINTER, SPRING '95 SOLD OUT

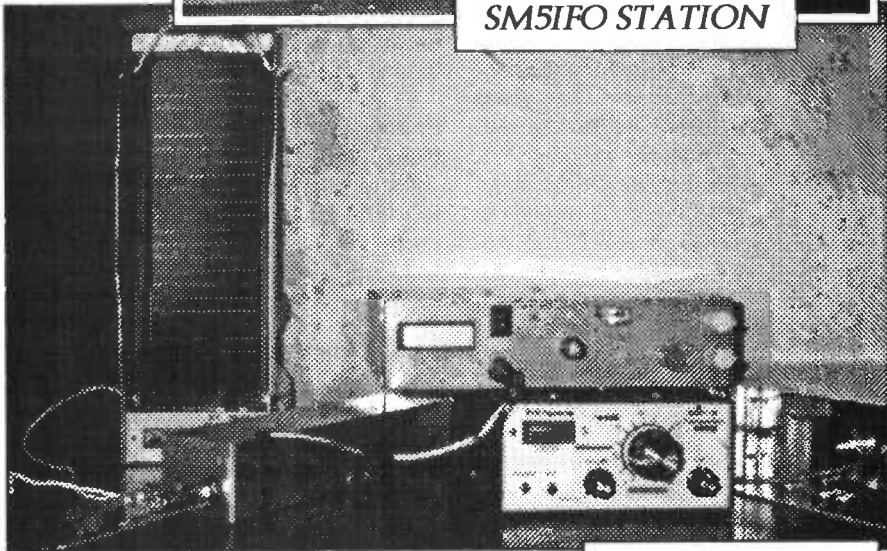
Jörn Nielsen, SM5IFO, shows us his Solar/Ni-Cd-powered QRP station built around the A&A Engineering Transceiver. Also note the matchbox and power meter.

Thanks, Jörn!

(photos this page: Jörn Nielsen, SM5IFO)



SM5IFO STATION



### MOVING?

Notify us  
of your new address -  
don't miss a single issue  
of *Hambrew*!

## Back Issues of *Hambrew*

To keep your **Hambrew** collection complete, we still have a number of back issues available. Our Inaugural Issue was Autumn, '93.

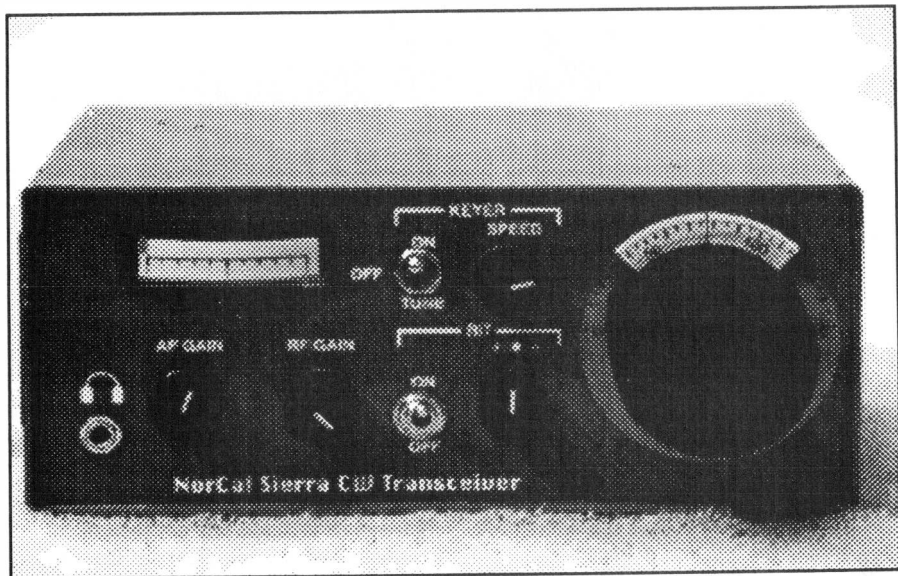
Back issues up to and including Fall, '94 are \$6 each, issues published after Fall, '94 are \$3.50 ea. mailed in an envelope via first class mail. The Winter, '95 Issue is sold out and is now a collectors' item. Supplies of the other back issues are limited.

## KIT REVIEW

# Building The NorCal Sierra

Cameron C. R. Bailey, KT3A

8 Spruce Lane, Manchester, PA 17345

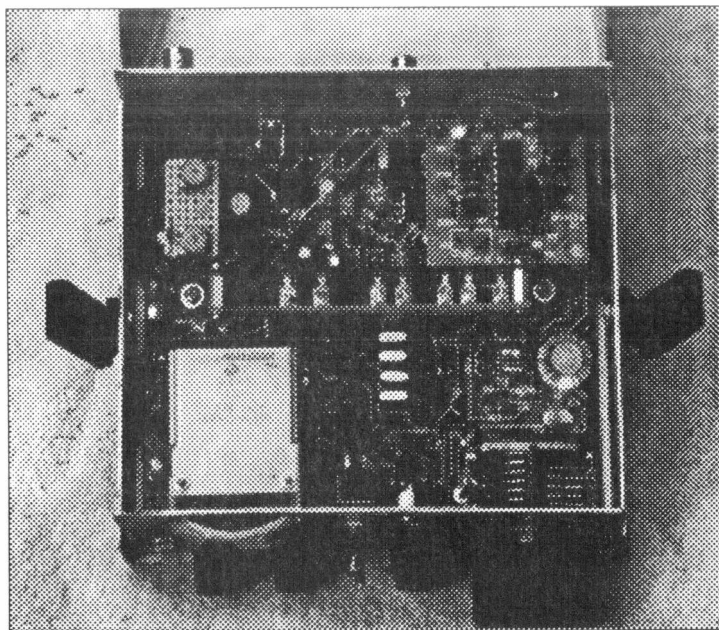


*The NorCal Sierra has a great-looking front panel with screened control indicators  
(Photo: Stan Cooper, K4DRD)*

The Northern California QRP Club membership has grown by leaps and bounds. The membership is now over 1000, and one reason is the offering of club kits. Prior to the Sierra was the NorCal 40. A single band varactortuned superhet transceiver. The club took on the ambitious task of putting together a transceiver similar to the NorCal 40 but with plug in modules to select the band of operation. The result was the Sierra. There were only over a hundred of these offered to club members and they went fast. The following are some of my comments on the building of the Sierra. Most of the design credit goes to Wayne Burdick, N6KR, who has done well in the Sierra.

Total construction time for me was about 40 hours. I am slow but steady. This kit is not for first time builders. The most difficult task is to wind the toroidal cores. You have to like doing them to enjoy building this one. The 20 meter plug-in band module has 8 of them to wind. The VFO is air-variable capacitor tuned. The core used in the VFO takes about 60 turns of #28 wire. I used red GLPT insulating varnish on the VFO core, as I wanted stability. I had to wind a few extra turns to get it to cover the exact range as required by the front panel dial. This took the most time.

The manual that came with the kit is great. It assumes you have built a kit before. Instruc-



*The NorCal Sierra inside: Note the quick-release latches on either side and the perfectly fitted board in the case.*

*(Photo: Stan Cooper, K4DRD)*

tions like “install all resistors, then capacitors”, etc., are common. Where details were critical, there was enough information given to save you trouble. In the manual there are several modifications described, a feature which I really liked about this kit. For people that love to mod, this one is designed to be modified. That is something left out of most commercial kits.

The easy part is the pc board. It is double-sided and has plated through holes. This is to ensure good solder connections. The board is silkscreened to show all referenced parts. You must remove silkscreen that covers some of the circuit pads as well. All external controls and jacks are attached to the board. This eliminates chassis wiring and leaves room for other additions inside. The controls/jacks then serve as a means of securing the front and rear panels to the rig. I liked this also.

The chassis bottom is secured to the board with stand-offs that attach to the circuit board 50 pin jack. The top of the rig is easily removed by locking and unlocking fasteners on the side. Changing bands takes only about 20 seconds!

The plug in module contains most of the

bandpass filtering required to change bands. There the pre-mix reference oscillator, transmit and receive mixer filter adjustments are made on the module. I have found my 20 meter module to be somewhat touchy on some of the adjustments. The filter to pass the difference frequency of the pre-mix oscillator (PMO) and the VFO was most sensitive to tune. I don't know if the other modules are the same way. There is information to make modules for bands from 160 to 10 meters.

The rig puts out about 2 watts on most bands. It uses a 2N3553 for a final. QSK is solid state. Current draw on receive was about 20 ma.

Painting and labeling are up to the builder also. All holes are pre-drilled.

They even left an extra for the keyer modification. Building the Sierra is just like homebrewing as a group. It may need this modified or that peaked, but you are doing it as a group. I've built a lot of test equipment for my former employers and I enjoyed putting this one together. Expect to hear the Sierra on any band!

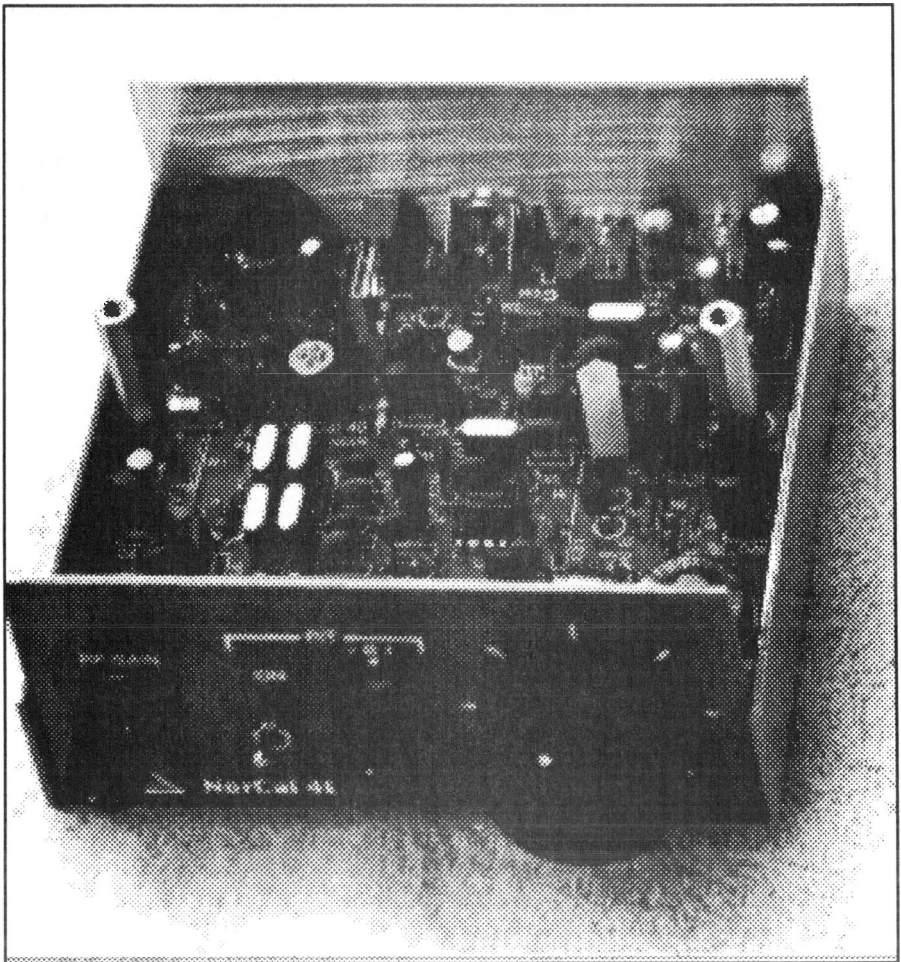


MORE ON THE NORCAL PHENOMENA

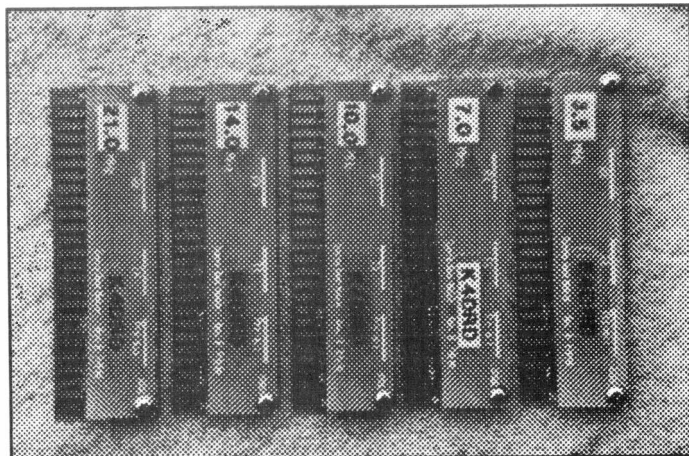
# *NorCal 40 & Sierra:* **Two Great Rigs**

**Stan Cooper, K4DRD**

3214 Countryside Drive  
San Mateo, CA 94403



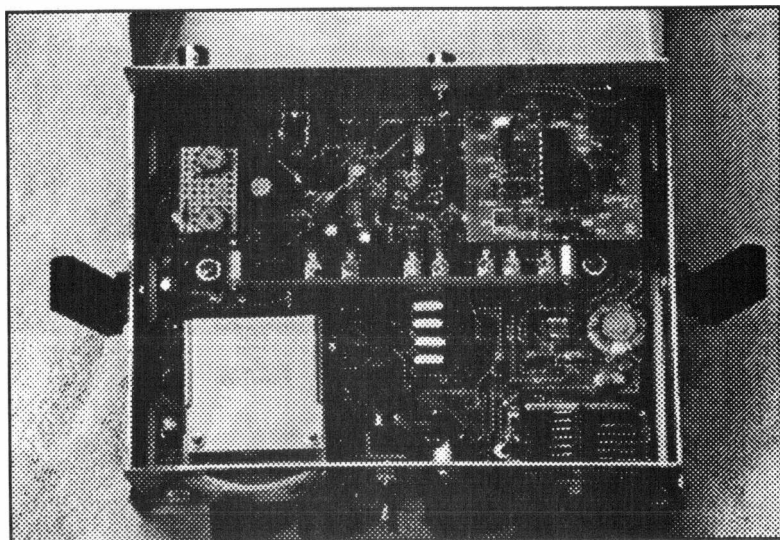
*Plug-in band  
modules for the  
NorCal Sierra  
(Photo by  
K4DRD)*



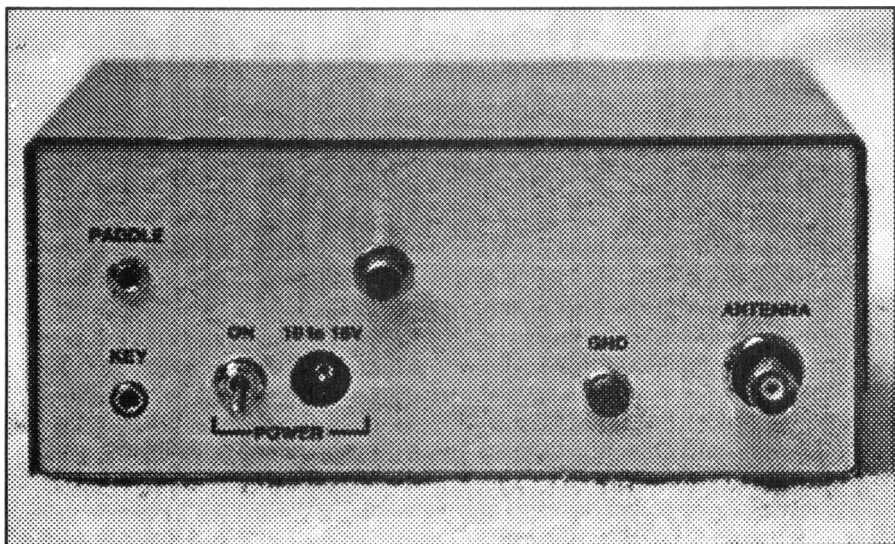
Enclosed are pictures of my NorCal 40 and NorCal Sierra transceivers built from kits supplied by the Northern California QRP Club. Both kits went together without a hitch and have provided many enjoyable QSOs. Both rigs are very stable, have sensitive superhet receivers with 400 Hz selectivity, and feature

full QSK as well as receiver incremental tuning (RIT).

The NorCal 40, a single band rig for forty meters was the first club project and became an instant success. Club members who had built the NorCal 40 but wanted to operate on other bands as well without building separate



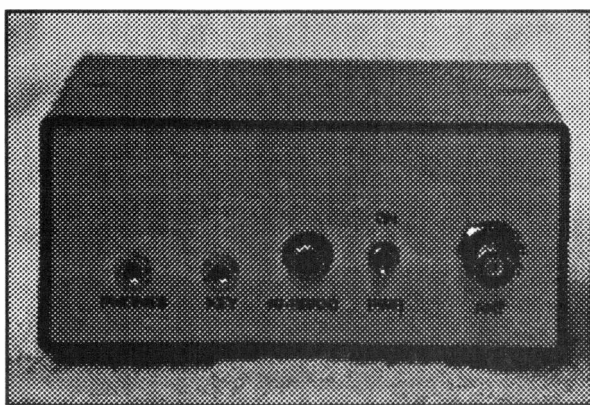
*Interior of the NorCal Sierra. A Curtis Keyer board is installed  
at the upper right (Photo by K4DRD).*



*NorCal Sierra rear apron (photo by K4DRD).*

monoband rigs, asked NorCal 40 designer Wayne Burdick, N6KR, to come up with a multiband version of the 40. Wayne's response was a rig which uses plug-in modules for the different HF bands. He called it the Sierra. The Sierra is more sophisticated than the NorCal 40 in a number of ways, and a new version of the NorCal 40, the NorCal 40A, incorporates some Sierra features.

The initial run of 120 Sierra kits sold out very quickly and the club has yet to put together another run, although there's a rumor kits may become available again later this year. For information on NorCal membership, the club's quarterly journal ORPp, and kits produced by the club, readers should contact Jim Cates, WA6GER, 3241 Eastwood Rd., Sacramento, CA 95821.



*NorCal 40 rear apron (photo: K4DRD)*

### *Built a Kit Lately?*

Send us a couple of photos and a review! Let us know how it went together and how it works...we'll pass the word!

# NorCal 40A Update

Wayne Burdick, N6KR

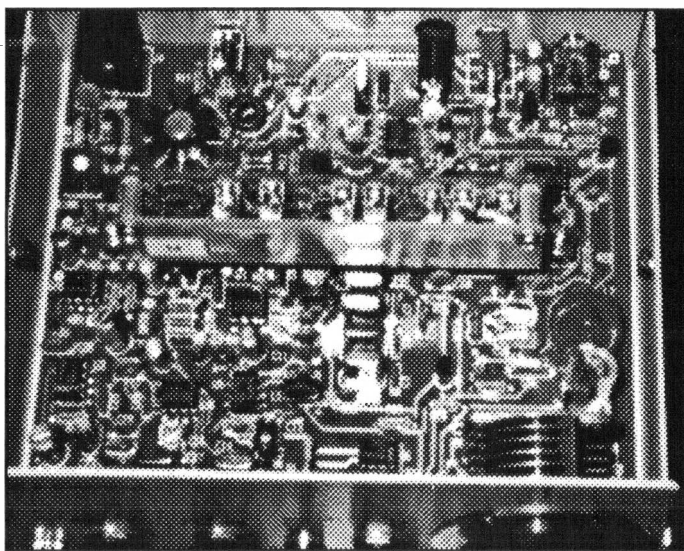
Once the Sierra field-test was underway, the NorCal QRP Club re-released its single-band 40-meter transceiver kit as the NorCal 40A, with a number of enhancements. However, to keep this volunteer operation from getting out of hand, NorCal has now turned over the '40A to Bob Dyer, KD6VIO, owner of Wilderness Radio (415-494-3806). Wilderness will handle the Sierra, too, starting late this year.

It's gratifying for me to note the stages of evolution that the NorCal 40 has gone through. We originally conceived the rig — over burgers and fries — as a good-performance superhet transceiver with an ultra-clean, no-wires layout that anyone could build. Then came the '40A, which added a double-sided PC board, panel-stabilizing toggle switches, and top-cover latches, just like the Sierra. Receiver

sensitivity and AGC range were both improved by nearly 10dB, and a larger, more stable VFO pot was added.

For the commercial release of the '40A, I was fortunate to be in "minor tweak" phase. With a few component changes and additions, the new rig offers 10dB more receive image rejection, better-sounding AGC and QSK, and a bit more output power — up to 3 watts at 14 volts. Alignment and construction are even easier, and the case is now supplied professionally painted and silk-screened.

Even though the '40A is no longer handled by the club, the same spirit of cooperation and collaboration prevails. Specifically, Wilderness — like NorCal — encourages builders to customize the kits to suit their needs.



*NorCal Sierra interior, showing the band module at center  
(photo: Cameron C.R. Bailey, KT3A)*

---

# NORCAL SIERRA SPECIFICATIONS

---

*Note:* These specifications are preliminary. Also, performance may vary widely on different bands, with different settings of the drive control, and with different builders. Unless otherwise noted, measurements were made with a 13.0V supply and 50Ω load at the antenna jack.

## *General*

Size	Cabinet: 2.6" (H) x 6.3" (W) x 5.3" (D) Overall: 2.8" (H) x 6.6" (W) x 7.0" (D) Band Module: 1.25" (H) x 4.0" (W) x 0.5" (D) Approx. 2 lbs.
Weight	
Power Requirements	10 to 15 VDC; reverse-polarity protection
Receive	35mA; 35-70mA when using speaker
Transmit	275-400mA at 2 watts output (varies with band)
Frequency Ranges	(bands shown in bold are available as complete kits) 1.800-1.950, <b>3.500-3.650</b> , <b>7.000-7.150</b> , <b>10.000-10.150</b> , <b>14.000-14.150</b> , 18.000-18.150, <b>21.000-21.150</b> , 24.800-24.950, 28.000-28.150
VFO Operating Range	2.935 to 3.085 MHz (150 KHz), with 8:1 vernier drive
Calibration	5 KHz increments typical accuracy, ± 2KHz
Drift	<100 Hz in first 30 minutes from cold start (RIT off, 25°C, top cover installed)

## *Transmitter*

Power Output	1.5 to 3 watts, depending on band
Spurious Products	-40dB or better (typical)
Final Amp Efficiency	60-75% (typical)
Load Tolerance	1.5:1 or better SWR recommended; will survive brief operation into high SWR
Transmit Offset	500-1,000 Hz, adjustable; equals TX monitor pitch
Transmit-receive delay	0.3 second nominal; can be changed (see text)

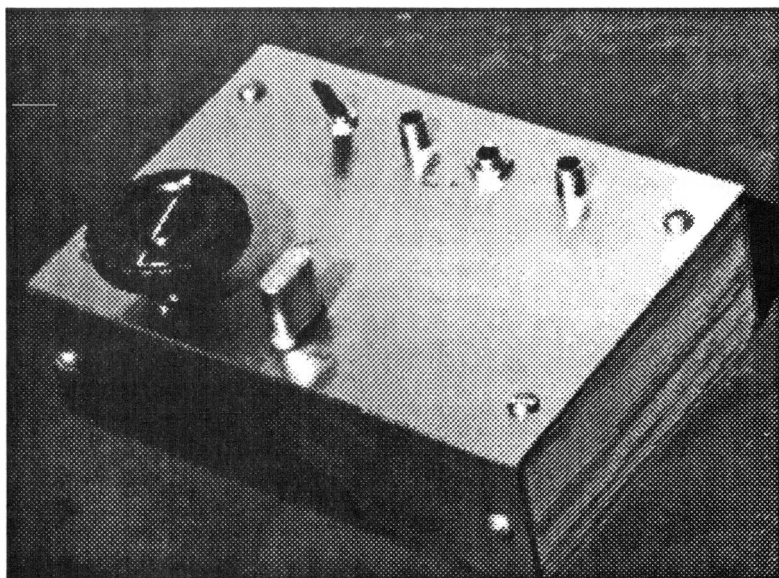
## *Receiver*

Sensitivity	Better than 0.5uV for 10dB S+N/N
Selectivity	-6dB @ 400 Hz, -32 dB or better @ 1 KHz
AGC Range	60 to 80 dB (est.)
I.F.	4.915 MHz; 4-pole Cohn crystal filter plus single-crystal filter following I.F. amp
R.I.T. Range	± 2 KHz; can be increased (see text)
Audio output	0.5 watts max into 8 to 32Ω load; requires stereo plug

# A Single-IC Half-Watt Transmitter

Lew Smith, N7KSB

4176 N. Soldier Trail  
Tucson, AZ 85749



*1/2 watt transmitter in homebrewed wood and PCB box  
(all photos, this article: Lew Smith, N7KSB).*

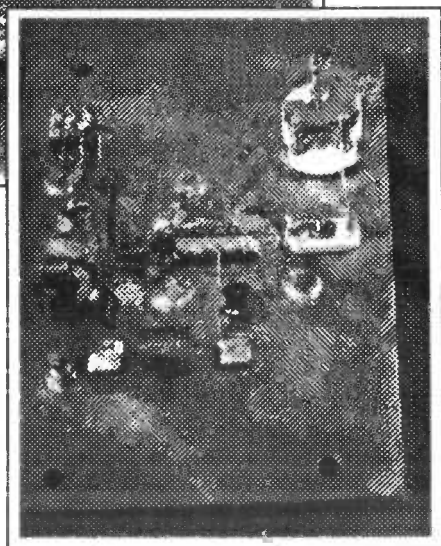
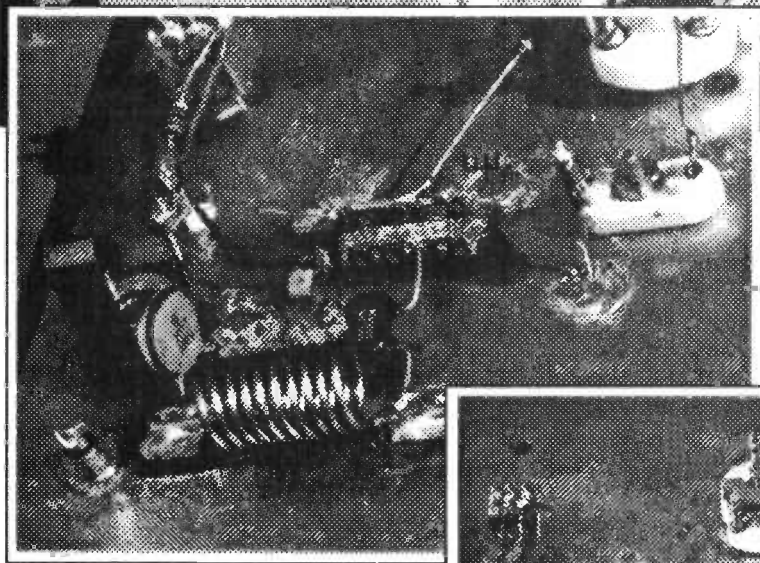
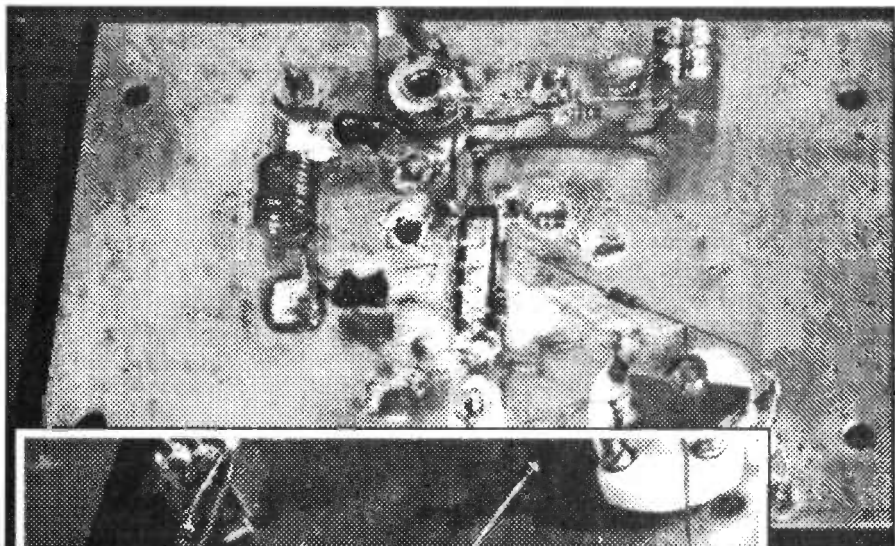
The single-IC half-watt transmitter shown in figure 1 is easy to build and fun to operate. It is a QSK version of a 10/15/20-meter rig<sup>1</sup> that was used to work 33 countries on all continents. Since 10 meters is almost dead in the present phase of the sunspot cycle, the circuit has been changed to emphasize 20 meters. Component values are given for other bands, but note that the QSK feature cannot be used on 10 meters.

The circuit uses a 74HC240<sup>2</sup> octal three-state inverter integrated circuit. One inverter is used as a variable-frequency crystal oscillator. Four other inverters are wired in parallel to operate as the final amplifier. Pins 19 and 1 key the oscillator and final. The resistor, capacitor,

and diode network connected to pin 19 turns the oscillator on before the final is activated to improve keying.

The inherently low even-order harmonic output of the 74HC240 simplifies the output filter. This filter consists of a series-tuned LC (C2 and half of L1) plus a second LC section (C1 and the other half of L1). The second LC section also transforms the output impedance to 50 Ohms.

Power can be obtained from an IC regulator (TO-220 style LM317T or 7808) or from six AA-size NiCd batteries. If an IC regulator is used, be sure to bypass its input and also its output with 10 $\mu$ F electrolytic capacitors to



*Top: The IC is at the center right, with the coil mounted on pads on the left. The oscillator components are toward the bottom of the photo.*

*Middle: "Mesa" point-to-point construction. Note coil mounted on "mesa"-type pads. Since this photo was taken, R1 was added and some component values were changed.*

*Bottom: same angle as the middle photo.*

prevent potentially destructive turn-on transients.

QSK operation with this circuit requires two antennae. A short indoor-wire antenna is usually sufficient for reception. If you prefer a common antenna for both transmission and reception, and are willing to forego QSK operation, the antenna switching connection shown in figure 2 can be used.

In the common antenna configuration, spotting is done by merely pressing the key. Since the spotting switch shown in figure 1 is no longer needed, it can be rewired as the antenna switch of figure 2. Note that in this configuration, the transmitter output is grounded during

probably make you grab the receiver volume control shortly after throwing the switch to transmit; you may want to devise a better means of muting the receiver during transmission.

### Construction

This project used a modified ground-plane construction technique that I call "mesa/point-to-point." This method is a compromise between the elegance of microwave stripline surface-mounted circuit boards and the freedom to make modifications found in "ugly" construction.

Mesa/point-to-point is somewhat similar to surface-mount technology in that coils, tran-

### *N7KSB Single IC Transmitter Component List*

- C3, 4, 5 ..... 0.1  $\mu$ F monolithic ceramic
- C6, 8 ..... 47 pF ceramic
- C7 ..... 20 pF air variable or 59 pF poly film variable
- D1 ..... 1N4148
- R1 ..... 330 k $\Omega$
- R2 ..... 10 k $\Omega$
- R3 ..... 220 k $\Omega$
- R4, 6 ..... 47 k $\Omega$
- R5 ..... 470  $\Omega$
- U1 ..... 74HC240
- X1 ..... fundamental-mode crystal

	10m	15m	20m	30m	40m
C1, C2	220pF	330pF	470pF	680pF	1000pF
L1	6T	7T	9T	11T	13T
Airwound #18 or #20 wire, 3/8" inside diameter, 1/2" long					

spotting. This has been done because the IC dissipates excessive power (1.5 watts) when the transmitter feeds an open circuit.

The QSK mode results in too much chirp on 10 meters. On that band, the spotting switch of figure 1 must be used as a T/R switch to keep the oscillator continuously running during transmission. The howl of the oscillator will

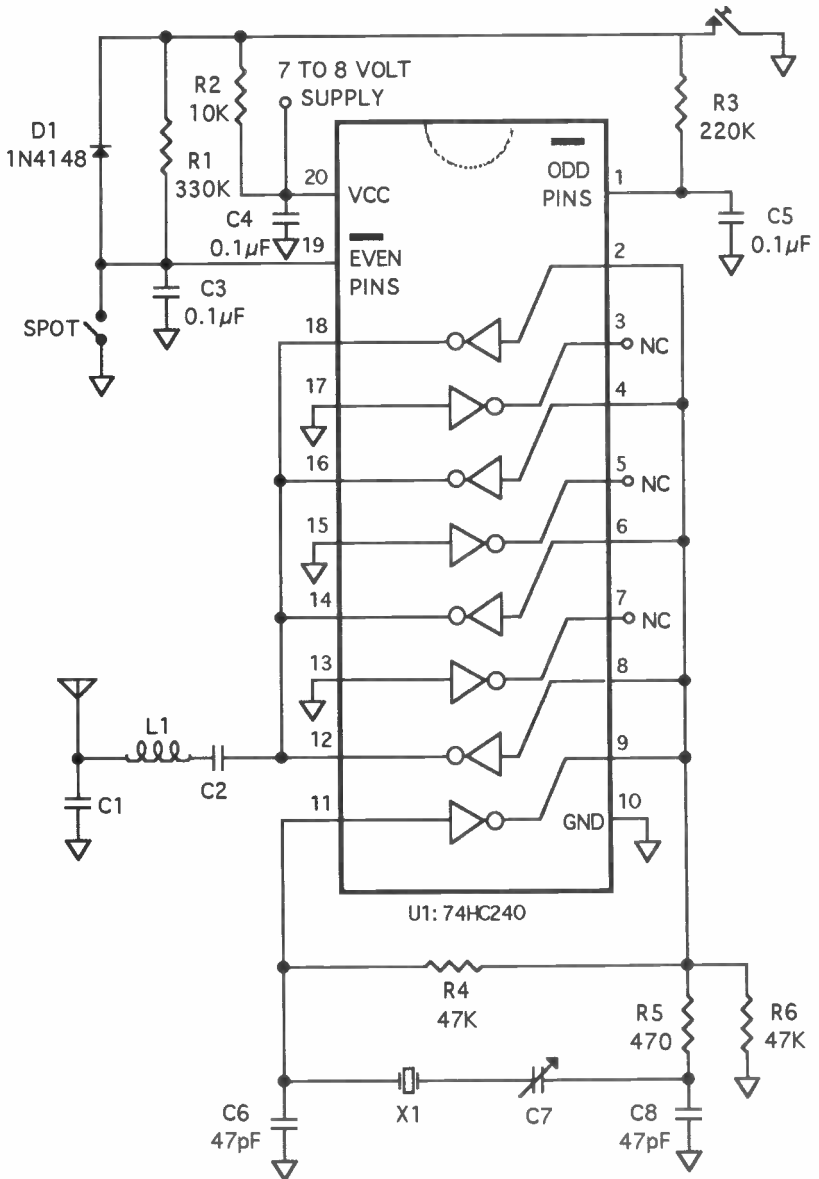
sistors, and potentially ugly-looking junctions are terminated on solder lands. The difference is that mesa/point-to-point uses 3/8" x 3/8" pieces of printed circuit board material as solder lands. These 3/8" x 3/8" "mesas" allow every component to be neatly wired in a point-to-point fashion.

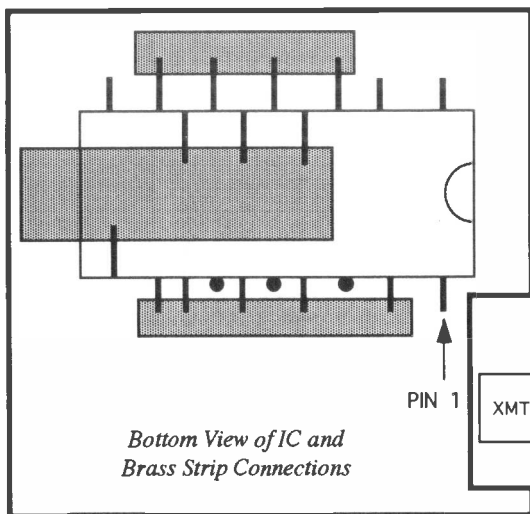
ICs mounted dead-bug style look much bet-



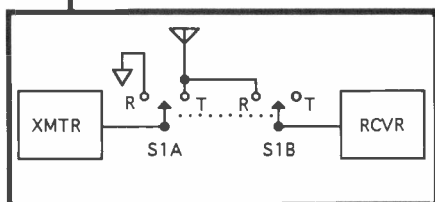
# N7KSB HALF-WATT, SINGLE IC TRANSMITTER

Figure 1





*Figure 2 (below): Antenna Switch  
for Common Antenna,  
Non-QSK Operation*



ter if strips of brass are used to connect common pins. For this project, pins 3, 5, and 7 were clipped short. Next, pins 10, 13, 15, and 17 were bent over and soldered to a piece of brass laying on the "belly up" side of the IC. A second brass strip was used to join pins 2, 4, 6, 8, and 9. A third strip connects pins 12, 14, 16, and 18.

Keep the connection from pin 10 to ground as short as possible. Similarly, the leads from pin 20 to C4 and from C4 to ground must be kept short. The IC should be epoxyed dead-bug style to the ground-plane PCB for heat sinking.

### Debugging

Use a dummy load (a 47- or 51-Ohm half-watt resistor will suffice) while checking out the transmitter. Test for chirp and oscillator start-up at both ends of the tuning range. Satisfactory operation on 10 meters may take some experimentation. If the oscillator does not start reliably, add a 22pF capacitor in parallel with R5. If that capacitor causes chirp, replace it with 10pF. In especially difficult cases, C6 and C8 may have to be changed to 22 pF.

On 20 meters, C7 tunes the oscillator over an 8KHz range. When using a 20pF variable capacitor and a crystal specified for a 20pF parallel load, oscillation occurred 5 to 13 KHz

above the frequency marked on the crystal.

Power varies as the square of the supply voltage. Expect 0.5 watt ( $\pm 10\%$ ) output with an 8-volt supply. The output can be tweaked slightly by gently stretching or compressing L1 by 1/16", or at most, 1/8". Overall efficiency is approximately fifty percent.

### Results

The half-watt, single-IC transmitter is a surprisingly good performer. Using a vertical antenna, this 20-meter version was used to work New Zealand, Mexico, and the four corners of the continental U.S. in the first week of operation.

### References

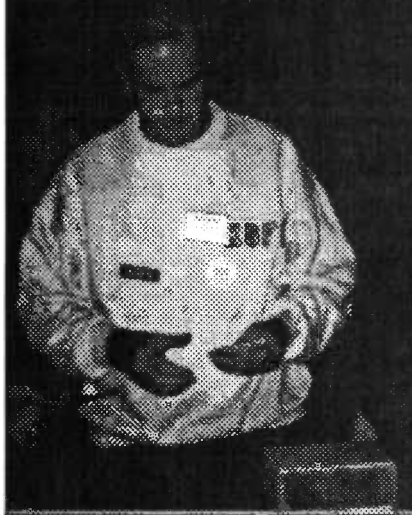
<sup>1</sup> "An Experimental Half-Watt CW Transmitter," Lew Smith, *Hints & Kinks*, page 84, November 1994 *QST*

<sup>2</sup> The 74HC240 can be purchased from:

Ocean States Electronics  
P. O. Box 1458  
6 Industrial Drive  
Westerly, RI 02891  
1-800-866-6626

Or you can purchase it from Mouser Electronics, which has four sales centers around the country; call them at 1-800-346-6873. Also, Technopak vacuum-packs the part for distribution by local electronics stores.

# DAYTON PIES

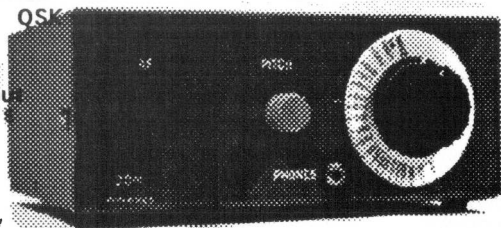


*The Dayton Hamfest was an astonishing amount of fun. Famous names in the HAM/QRP & homebrewing domains abounded. Above, Chuck Adams, K5FO (Fast Op) at the QRP Hospitality Suite. At right, Dick Witzke shows some of the fine projects available from OHR. Below: Bruce O. Williams (WA6IVC) (at left) and Wayne Burdick, N6KR.*



## Announcing The MXM Simple Transceiver

- Double-Conversion Superhet
- Electronic Instantaneous OSK
- Transmit Monitoring
- Superb Sensitivity
- Two to Three Watt Output
- Single-band Design
- Dual IF Filters
- Variable Bandwidth
- Variable Pitch
- 100-1500-Hz Selectivity
- Case & Tuning Capacitor Included
- 20-, 30-, 40-, or 80-meters



MXM Industries announces their new concept in QRP high-frequency equipment for the home builder, the Simple Transceiver! This revolutionary new design permits the experienced homebrew constructor to have the finest QRP station in existence today. Based on the MXM line of Simple receivers and transmitters, the selectivity and sensitivity of this design are unmatched by any other equipment at any price! The complete station is on a board that is only 3-1/2 inches by 4-1/2 inches in size—just right for that portable or backpack rig you've always wanted! The tuning capacitor, bandwidth capacitor and cabinet are included in the kit. The cabinet is 0.040-inch aluminum, 6-1/2 inches wide by 5-1/2 inches deep by 2-1/2 inches tall. All you need is a volume control, coax connector, and jacks for power, keying, and audio output, and you're on the air!

The Simple Transceiver is covered by the MXM warranty — If you can't make it work, send it back and WE WILL!

INTRODUCTORY PRICE **\$129.95** \$5 Shipping & Handling

©1994 MXM Industries

# MXM INDUSTRIES

Rt 1, Box 156C • Smithville, TX 78957 • 512-237-3906

## •time to renew hambrew?•

Check your mailing label for the expiration date of your subscription, and don't miss a single issue! *Hambrew* - The Builder's Choice!

\$10 per year mailed Second Class

**Hambrew • POB 260083 • Lakewood, CO 80226-0083**

**VISA or MasterCard: Call (303) 989-5642**

Name \_\_\_\_\_ Call \_\_\_\_\_  
Address \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

VISA  MC#

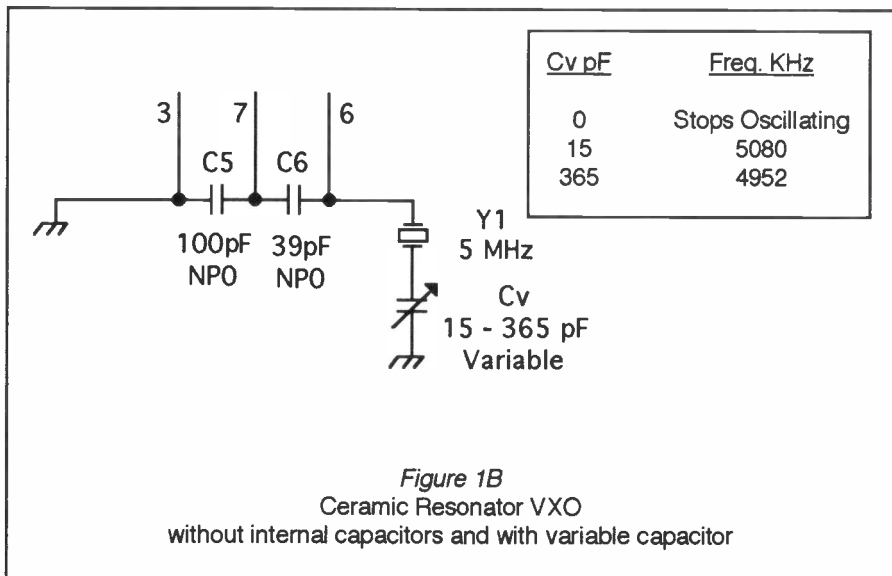
Exp: \_\_\_\_\_

Foreign Rates: \$21/year; Canada, Mexico \$15/year

# Ceramic Resonator NE602 VCXO

Roger Wagner, K6LMN

1045 S. Manning Ave.  
Los Angeles, CA 90024



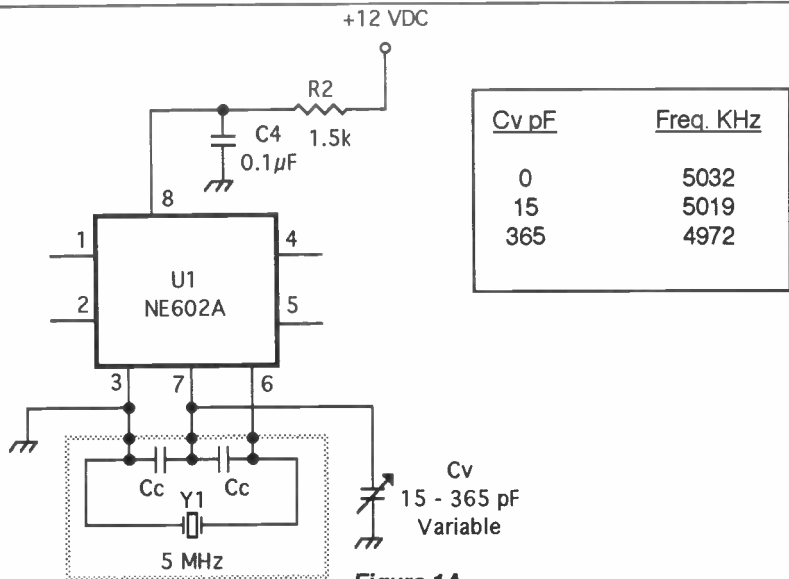
## Background

Recently I was reading through the June 1985 issue of *Ham Radio* magazine (now defunct) and saw an article entitled "Voltage-Controlled Oscillator Uses Ceramic Resonators by K2BLA." I thought maybe I could use one of these in my Simple Superhet Receivers to replace the VFO, which uses a varicap-controlled NE602 chip LC oscillator. Frequency drift after warm-up is less than 80 Hz/hour (toroid-inductor version), but I wanted a simple circuit with the stability of a crystal. We all know how difficult it is to rubber a crystal in a VXO much beyond 0.2% frequency shift. The author indicated he could bend one of these ceramic resonators theoret-

ically as much as seven percent.

I looked in the DigiKey catalog and saw that they carry Panasonic ceramic resonators for 0.5, 2, 3, 3.58, 4, 5, 6, 8 MHz, etc. (Other frequencies are available on special order and also from other vendors.) How convenient, since my monoband Simple Superhet Receivers for 80-20M use 4 and 5 MHz VCOs. Seven percent frequency shift at 5 MHz equals 350 KHz, or enough to cover the entire 20M band using the 9 MHz I.F. It looked like a perfect solution to provide the stability of a VXO with nearly the frequency swing of an LC VCO.

These ceramic resonators come in small plastic pill-type packages with two or three leads. Prices are \$.25 - \$2.00 each, depending



**Figure 1A**  
Ceramic Resonator VXO  
with internal capacitors and variable capacitor

on frequency, quantity, package type, and the supplier. A quartz crystal has extremely high Q of over 100,000 whereas the ceramic resonator has a Q somewhere between an LC-tuned circuit and the crystal, or around 500–5,000. Like a crystal, the ceramic resonator has equivalent series R, L, C, and parallel C parameters. Typical values are given in the magazine article.

### Test Circuits

The article featured conventional crystal-type oscillators and some interesting variations using discrete transistors but no ICs. Since the ceramic resonator is similar to the quartz crystal, I used the recommended Colpitts crystal-oscillator circuit for the NE602 mixer/oscillator. I purchased several of each 2, 4, and 5 MHz frequency and the two versions available for these resonators. The three-lead version has the built-in capacitors set up for a CMOS IC Pierce oscillator, but it is also useful for an NE602 parallel-mode crystal oscillator. These internal positive temperature coefficient capacitors correct for the large positive frequency drift with temperatures, character-

istic of the resonators. The two-lead version has no internal capacitors. I used both mechanical capacitors (condensor) and varicaps to control the frequencies. (See the three test-circuit diagrams in figure 1 and note the circuit simplicity of the oscillators. Also shown are the typical frequency shifts for the 5-MHz resonators.) The lower frequency resonators gave proportionally less shift and less temperature drift.

### Results

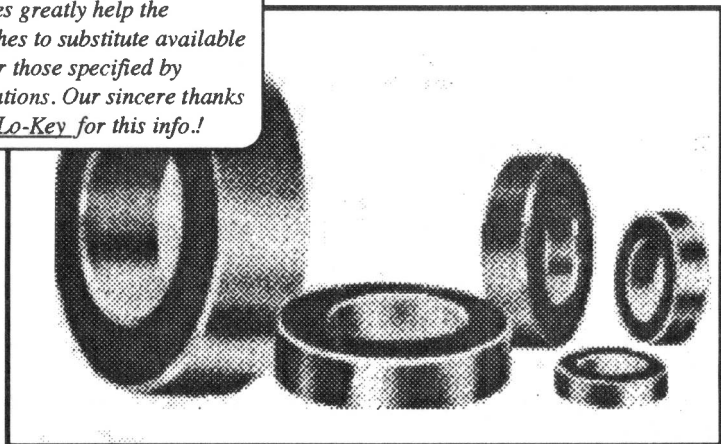
As expected, the temperature-compensated resonators with built-in capacitors had the least frequency drift with temperature and the least frequency shift (60KHz) with the variable capacitor. (Refer to figure 1A.) However, the best frequency shift in any circuit configuration was 128 KHz or 2.6% for circuit configuration in figure 1B. Of course, your favorite VXO crystal-oscillator circuit should provide even more shift. (Cont. on page 26) In a crystal/ceramic resonator parallel-mode oscillator circuit, one can theoretically move the crystal or resonator from its natural parallel-resonant frequency almost down to its se-

*Ed. Note: Don Callow, VK5AIL, is the highly regarded editor of the Lo-Key, the publication of the CW Operators' QRP Club of Australia/New Zealand.*

*This article and the chart on the following two pages greatly help the builder who wishes to substitute available toroids for those specified by overseas publications. Our sincere thanks to Don and Lo-Key for this info.!*

# Toroid Turns

## Don Callow, VK5AIL



Often, a circuit for a project specifies a toroid core, the number of turns of enamelled wire, and its gauge.

If you want to use a different toroid and need to obtain the same inductance — e.g., for a tuned circuit — what you *do not* do is to pick a core of different material and use the specified number of turns. The inductance depends greatly on the permeability of the material, so how do you estimate the number of turns?

The accompanying Table of Equivalent Toroid Turns may help. From it, you can work out the number of turns of wire to be wound on your core, for some of the common sizes of toroids.

### *Example*

Specified: 28 turns on a Neosid 4327R/1/F25 core.

How many needed on a Philips 14 x 9 x 5-mm violet-colored substitute?

- Both cores are of ferrite material; the Philips is catalogue number 4322-828-97180.

- From the table, 63 turns on the Philips core are equivalent to 100 on the 4327R/1/F25, size 12.7 x 6.4 x 3.2 mm. So you need:

$$\frac{20}{100} \times 63 = 12.6 \text{ turns}$$

- As usual, it pays to wind extra turns on the core and later adjust them as necessary by removing the one or more excess turns. And in any case, the table gives only a rough guide.

- So try starting with 14 or 15 turns on the Philips core.

It is quite easy to extend the table for other cores, as long as you know (or can work out) the inductance Index A1 in uH per 100 turns. If the figure you have is in mH per 1,000 turns, just multiply it by 10 and you have the figure in uH per 100 turns.

The figure in the table is equal to:

$$100 \times \sqrt{\frac{A1 \text{ of specified core}}{A1 \text{ of specified core}}}$$

For details, refer to the article "Toroid Turns," which appeared in *Lo-Key* #11, September 1986. It was reprinted in the Club's *Travelling Circuit Book No. 1* [no longer available], with the tables in an upgraded format. Table B — Materials is reproduced here.

TABLE OF EQUIVALENT TOROID TURNS Don Callow, VK5AIL				SUBSTITUTE TOROID																				
				IRON POWDER						FERRITE														
				AMIDON						NEOSID						PHILIPS								
				T-68-2	T-50-2	T-37-2	T-68-6	T-50-2	T-37-2	FT-50B	FT-50A	FT-50	FT-37	FT-50	FT-37	43	43	43	43	43	43	4322	4322	
SPECIFIED TOROID	IRON POWDER	A	T-68-2	17.5 x 9.4 x 4.8	100	108	119	110	119	138	≤	10	10	12	29	32	57	40	33	27	19	16	36	48
		M	T-50-2	12.7x7.7x4.8	93	100	111	102	111	128	≤	≤	10	11	27	30	53	37	30	25	18	15	33	45
		I	T-37-2	9.5x5.2x3.3	84	90	100	92	100	115	≤	≤	≤	10	24	27	48	34	28	23	16	13	30	41
		D	T-68-6	17.5x9.4x4.8	91	98	108	100	108	125	≤	≤	≤	11	26	29	52	37	30	25	17	14	33	44
		O	T-50-6	12.7x7.7x4.8	84	90	100	92	100	115	≤	≤	≤	10	24	27	48	34	28	23	16	13	30	41
	FERRITE	N	T-37-6	9.5x5.2x3.3	73	78	87	80	87	100	≤	≤	≤	≤	21	23	41	29	24	20	14	11	26	35
		A	FT-50B-43	12.7x7.9x12.7	≥	≥	≥	≥	≥	≥	100	141	148	165	409	454	807	571	465	385	272	222	508	685
		M	FT-50A-43	12.7x7.9x6.4	≥	≥	≥	≥	≥	≥	71	100	104	116	290	321	571	404	329	272	192	157	360	484
		I	FT-50-43	12.7x7.1x4.8	958	≥	≥	≥	≥	≥	68	96	100	112	277	308	547	387	315	261	184	150	344	464
		D	FT-37-43	9.5x4.7x3.2	858	926	≥	945	≥	≥	61	86	90	100	249	276	490	346	282	234	165	135	309	416
TOROID	O	FT-50-61	12.7x7.1x4.8	345	373	412	380	412	476	24	35	36	40	100	111	197	139	113	94	66	54	124	167	
	R	FT-37-61	9.5x4.7x3.2	311	336	372	343	372	429	22	31	33	36	90	100	178	126	102	85	60	49	112	151	
	N	4327R/1/F25	12.7x6.4x3.2	175	189	209	193	209	242	12	18	18	20	51	56	100	71	58	48	34	27	63	85	
	E	4327R/2/F25	12.7x6.4x6.4	248	267	296	273	296	342	18	25	26	29	72	80	141	100	81	67	48	39	89	120	
	O	4327R/3/F25	12.7x6.4x9.5	304	328	363	335	363	420	22	30	32	35	88	98	174	123	100	83	59	48	109	147	
TOROID	S	4327R/1/F14	12.7x6.4x3.2	368	396	439	405	439	507	26	37	38	43	106	118	210	148	121	100	71	58	132	178	
	I	4327R/2/F14	12.7x6.4x6.4	520	561	620	572	620	716	37	52	54	61	150	167	297	210	171	141	100	81	187	252	
	D	4327R/3/F14	12.7x6.4x9.5	638	688	762	703	762	879	45	64	67	74	185	205	364	257	210	174	123	100	229	309	

NOTES  
• The figures in the table are number of turns to be wound on SUBSTITUTE toroid for each 100 turns on SPECIFIED toroid. • ≥ means that the figure is equal or greater than 1,000; i.e., Substitute core needs at least 10 times number of turns of Specified core. • ≤ means that the figure is less than 10; i.e., Substitute core needs less an 1/10th the number of turns for Specified core.  
• No figures are shown in these two situations because substitution in probably not practical. • The dimensions given are outer diameter x inner diameter x height, all in mm.  
• Philips ferrite cores are shown only as Substitutes because I have not seen them specified in circuits.  
• Ferrite is not recommended for tuned circuits mainly because of poor temperature stability. Amidon iron powder mix #6 is very stable, with a temperature coefficient for inductance of about 1/300th of that for ferrite mix #43!



<b>TABLE OF EQUIVALENT TOROID TURNS</b>  <b>Don Callow, VK5AIL</b>				SUBS									
				IRON POWDER									
				AMIDON									
				T- 68-2	T- 50-2	T- 37-2	T- 68-6	T- 50-2	T- 37-2	FT- 50B 43	FT- 50A 43	F 5 4	F 5 4
S P E C I F I E D T O R O I D	I R O N P O W D E R	A	T-68-2	17.5 x 9.4 x 4.8	100	108	119	110	119	138	≤	10	1
		M	T-50-2	12.7x7.7x4.8	93	100	111	102	111	128	≤	≤	1
		I	T-37-2	9.5x5.2x3.3	84	90	100	92	100	115	≤	≤	≤
		D	T-68-6	17.5x9.4x4.8	91	98	108	100	108	125	≤	≤	≤
		O	T-50-6	12.7x7.7x4.8	84	90	100	92	100	115	≤	≤	≤
		R N	T-37-6	9.5x5.2x3.3	73	78	87	80	87	100	≤	≤	≤
		A	FT-50B-43	12.7x7.9x12.7	≥	≥	≥	≥	≥	≥	100	141	1
		M	FT-50A-43	12.7x7.9x6.4	≥	≥	≥	≥	≥	≥	71	100	1
		F I	FT-50-43	12.7x7.1x4.8	958	≥	≥	≥	≥	≥	68	96	1
		E D	FT-37-43	9.5x4.7x3.2	858	926	≥	945	≥	≥	61	86	9
	R O	FT-50-61	12.7x7.1x4.8	345	373	412	380	412	476	24	35	3	
	R N	FT-37-61	9.5x4.7x3.2	311	336	372	343	372	429	22	31	3	
	I N	4327R/1/F25	12.7x6.4x3.2	175	189	209	193	209	242	12	18	1	
	T E	4327R/2/F25	12.7x6.4x6.4	248	267	296	273	296	342	18	25	2	
	E O	4327R/3/F25	12.7x6.4x9.5	304	328	363	335	363	420	22	30	3	
	S	4327R/1/F14	12.7x6.4x3.2	368	396	439	405	439	507	26	37	3	
	I	4327R/2/F14	12.7x6.4x6.4	520	561	620	572	620	716	37	52	5	
	D	4327R/3/F14	12.7x6.4x9.5	638	688	762	703	762	879	45	64	6	

# SUBSTITUTE TOROID

## FERRITE

## NEOSID

## PHILIPS

	FT-37-43	FT-50-61	FT-37-61	43 27R/ 1/ F25	43 27R/ 2/ F25	43 27R/ 3/ F25	43 27R/ 1/ F14	43 27R/ 2/ F14	43 27R/ 3/ F14	4322 -020 -971 80	4322 -020 -971 70
12	29	32	57	40	33	27	19	16	36	48	
11	27	30	53	37	30	25	18	15	33	45	
10	24	27	48	34	28	23	16	13	30	41	
11	26	29	52	37	30	25	17	14	33	44	
10	24	27	48	34	28	23	16	13	30	41	
≤	21	23	41	29	24	20	14	11	26	35	
18	165	409	454	807	571	465	385	272	222	508	685
14	116	290	321	571	404	329	272	192	157	360	484
10	112	277	308	547	387	315	261	184	150	344	464
10	100	249	276	490	346	282	234	165	135	309	416
5	40	100	111	197	139	113	94	66	54	124	167
3	36	90	100	178	126	102	85	60	49	112	151
3	20	51	56	100	71	58	48	34	27	63	85
5	29	72	80	141	100	81	67	48	39	89	120
2	35	88	98	174	123	100	83	59	48	109	147
3	43	106	118	210	148	121	100	71	58	132	178
4	61	150	167	297	210	171	141	100	81	187	252
7	74	185	205	364	257	210	174	123	100	229	309

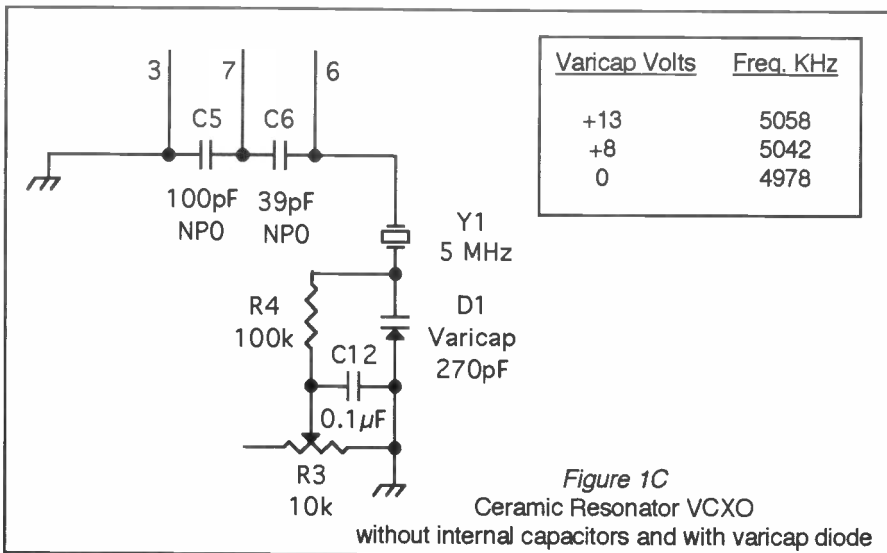
## NOTES

• The figures in the table are number of turns to be wound on SUBSTITUTE toroid for each 100 turns on SPECIFIED toroid. •  $\geq$  means that the figure is equal or greater than 1,000; i.e., Substitute core needs at least 10 times number of turns of Specified core. •  $\leq$  means that the figure is less than 10; i.e., Substitute core needs less an 1/10th the number of turns for Specified core.

• No figures are shown in these two situations because substitution is probably not practical. • The dimensions given are outer diameter x inner diameter x height, all in mm.

• Philips ferrite cores are shown only as Substitutes because I have not seen them specified in circuits.

• Ferrite is not recommended for tuned circuits mainly because of poor temperature stability. Amidon iron powder mix #6 is very stable, with a temperature coefficient for inductance of about 1/300th of that for ferrite mix #43!



rial frequency, or about seven percent for resonators. However, the capacitance loading on the crystal/resonator from the NE602 configured as a parallel-resonant oscillator, with its capacitor-voltage divider, must be kept to an absolute minimum to approach that maximum theoretical spread. I used much lower capacitor values than recommended for the NE602, with crystals to minimize loading the resonator. Normally, suggested starting values for an NE602 Colpitts crystal or resonator oscillator are given by  $C5(pF) = 1000/F(\text{MHz})$  and  $C6(pF) = 100/\text{SQRT}(F\text{MHz})$ . (Refer to figure 1 for capacitor locations.) The NE602 internal oscillator can handle a wide range of values outside these suggested capacitances. Always ensure clean oscillation at power-up, and pin 6 should measure 600–1000 MV. P-P for best mixer performance.

The article's author was primarily interested in developing a VCXO for a low-noise PLL oscillator. There the large temperature drift is not much of a problem. The temperature coefficient for the non-compensated resonators is on the order of +40 PPM/degree C or some +110 Hz shift/degree F at 5 MHz. This is not a lot in an air-conditioned room, but it's a real handful outdoors in the sun and wind. As temperature-compensating capacitors are usu-

ally negative (+frequency shift), I thought instead of employing the positive (capacitance) temperature coefficient in most varicaps on the order of +400 PPM/degree C. So circuit 1C was developed. It did reduce the drift to a more tolerable +85 MHz/degree F. I also liked the remote pot control of the frequency via the varicap featured in my radios.

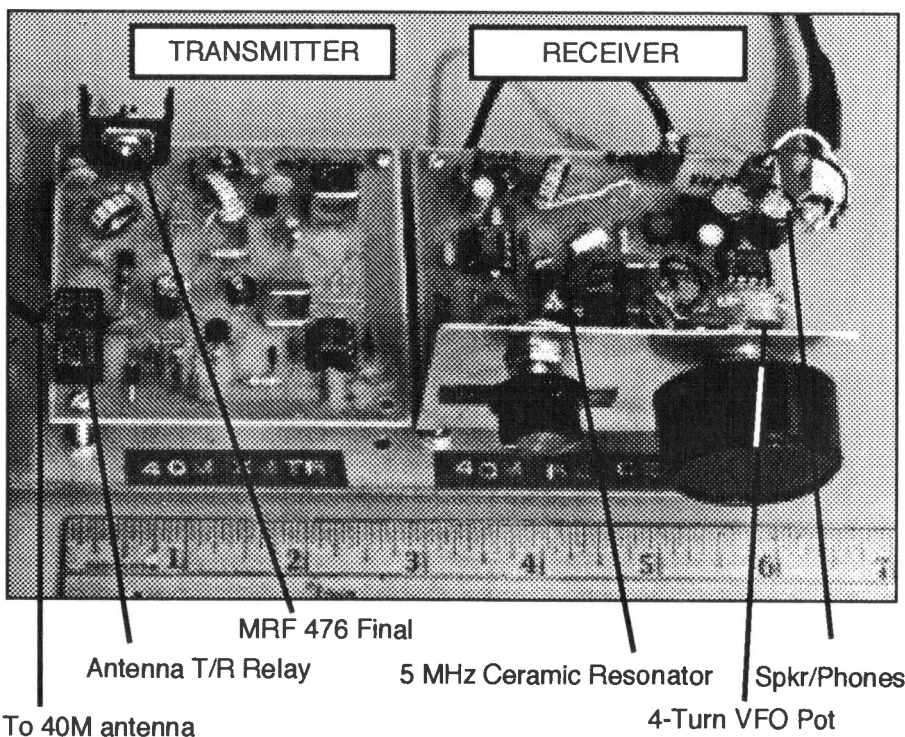
Other drift-compensation techniques reduced the drift even more, and they include thermistors and diode compensation in the power supply. With a varicap, frequency shift was not as great as with a variable capacitor, as I had only a regulated 13 VDC supply available. Higher varicap voltage = less minimum capacitance = greater shift. If you have such a limited voltage supply, it is mandatory for maximum shift to use the high tuning ratio (hyper-abrupt) varicaps like the Motorola MV1405 or MVAM109 with a 10:1 capacitance ratio from 1–10 VDC. Surprisingly, a simple 1N4001 rectifier used as a varicap gave a shift from 5046 to 5102 KHz or 56 KHz difference in the figure 1C circuit at 0 and 8 VDC respectively. My "brand x" 1N4001 rectifiers measured about 30 pF at OVDC bias.

If you want to cover the lower CW portion of 80, 40, 20M and the QRP calling frequencies as well, I suggest you purchase several of

the non-compensated type of the same marked frequency and select the resonator that just covers your frequency band of choice. For a superhet for 30M, try a 6-MHz resonator with a 4.096-MHz IF. Or try the 3.58-MHz for an 80M transmitter or direct conversion receiver. Although I've never tried it, I understand that the NE602 pins 4 and 5 will output the oscillator frequency if pin 1 is grounded through a

10K resistor and pin 2 is bypassed to ground with a capacitor. In this configuration, the chip can't function as a mixer.

Since the above is by no means the definitive article on NE602 ceramic resonator oscillators, I encourage you to locate some of these curious devices and do some of your own experimentation. Good luck and have fun!



To 40M antenna

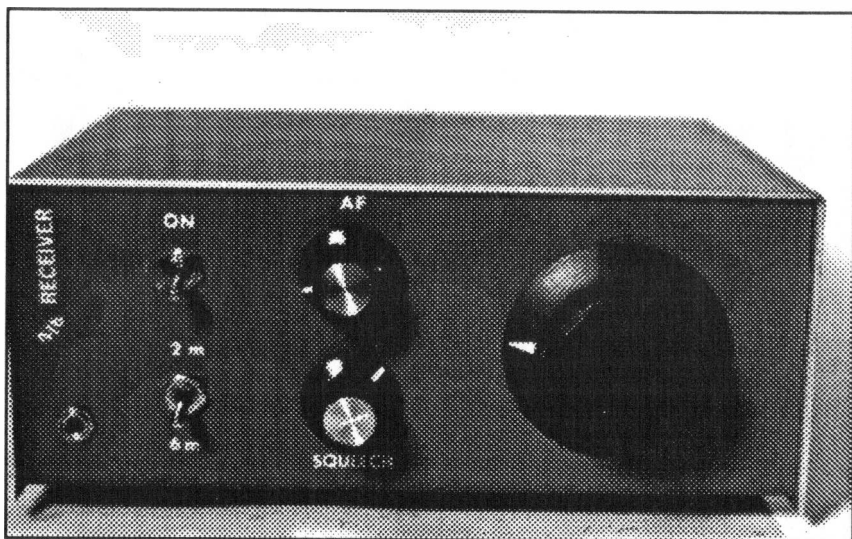
### New K6LMN Kit Available

Roger Wagner has a new "twin" for his 40M Superhet Receiver kit which appeared in the Autumn, '94 *Hambrew*. The new transmitter kit has 3 watts out on 40 meters and has QSK with an on-board antenna relay (5 millisecond switch time!). The relay is not included as part of the \$20 price of the transmitter kit. The receiver provides the VFO for the transmitter, and it receives during transmit, which provides the true-signal sidetone. Since the transmitter has its own 2 MHz BFO crystal offset from the receiver BFO at 800 Hz, there is no switching required to offset the receiver VFO- (K.I.S.S.)! 40 meter kits only are available from K6LMN, 1045 S. Manning Ave., Los Angeles, CA 90024. Receiver: \$20, Transmitter: \$20, Shipping & Handling: \$3.50 (one or both kits together). S.A.S.E. for information.



*Projects & Theory for 50 MHz*

## Elenco 6m/2m FM Receiver Kit



*The Elenco 6m/2m FM Receiver kit housed in a Hambrew-built Ten-Tec enclosure prior to construction of the frequency-indication plate. Elenco includes a different enclosure and all knobs and hardware as part of the kit (see text and photo, pg. 29).*

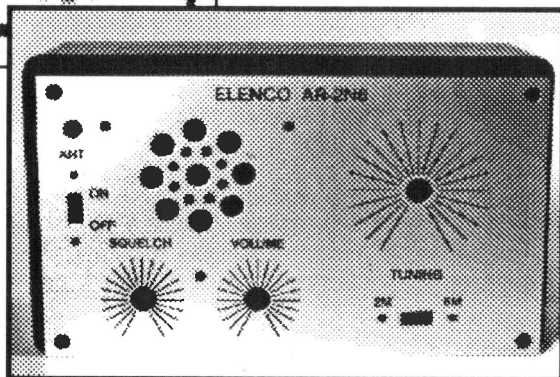
This receiver is available from C&S Sales, and is listed in its '94-'95 Catalog<sup>1</sup>. It is a narrow-banded FM receiver, and is billed as an educational kit. It does deliver on the educational end, and the assembly manual is one of the finest we've seen for clarity. The manual illustrates various components to be installed, each within an illustrated box with an arrow pointing to the component's position and place on the board, which saves searching around the board for component locations.

The kit is broken down into 4 modules ("blocks") for construction. At the end of each block, the builder gets an explanation of the theory of the operation of the circuit block, specifications and testing procedure, a trouble-

shooting guide and a quiz on the circuit. There were a few glitches with our kit: 1. a 470 pF capacitor was not provided, 2. A DPDT switch, essential for the band switching, was incorrectly substituted with a SPDT switch, which would not function for this purpose, 3. There was a difference between the illustrated front panel of the kit and the actual front panel supplied (see photos) - the front panel provided with the kit has a provision for the antenna lead to be plugged into the front panel, and 4. There were three components to be soldered to the underside of the PCB: incomplete instructions and illustrations were provided for the connection of two of them, although the builder can refer to the schematic



*Left: The AR-2N6 as advertised in the C&S catalog and on the cover of the assembly manual.*



*Right: The AR-2N6 front panel as delivered. The main chip around which the receiver is designed is the 24-pin MC3362P FM Receiver IC.*

for the solution to the directions for connection.

We decided to supply our own project case because of #3, above. The original design of the kit is to have the circuit board attach to the backside of the front panel *by the wire leads* to the variable pots and the two switches. These need to be kept very short in length. When we attached the PCB to the bottom of our substituted Ten-Tec case, over 39 pF of capacitance was added by the longer leads needed to the back of the new front panel. This threw the operating frequency down and out of the two bands, but by removing the frequency-determining capacitor (C6), the frequency ranges came back into their parameters.

The receiver has a squelch circuit which operates well, and has plenty of audio (LM386) which can be increased with a larger speaker. Perhaps because of our use of a DPDT toggle switch, there is some bleed-through of commercial FM broadcasts (i.e., coupling of inductances for each band across the switch), noticeable *when the squelch is off*.

Otherwise, the receiver is a good first project

for a beginning to intermediate builder, and might indeed be a good start for a no-code tech who wishes to get his feet wet with a first project. This particular kit would probably not be recommended for a communications receiver on any but a limited basis.

*1. AR-2N6 Kit: (144-148 MHz, 50-54MHz FM) \$34.95. 1245 Rosewood Ave., Deerfield, IL 60015. Inquiries: (708) 541-0710, Orders: (800) 292-7711*

---

## **6 Meter Articles Wanted!**

Six meters is a neglected band. We at Hambrew want to encourage building for and use of the 50 MHz portion of the spectrum. If interference is a concern, and in many cases it is, we encourage prudent filtration and operation on QRP levels, all modes. Please help us do our part to preserve the 6 meter band through your input. If you or someone you know has designed or built 6 meter equipment, we want to pass along the information.

---

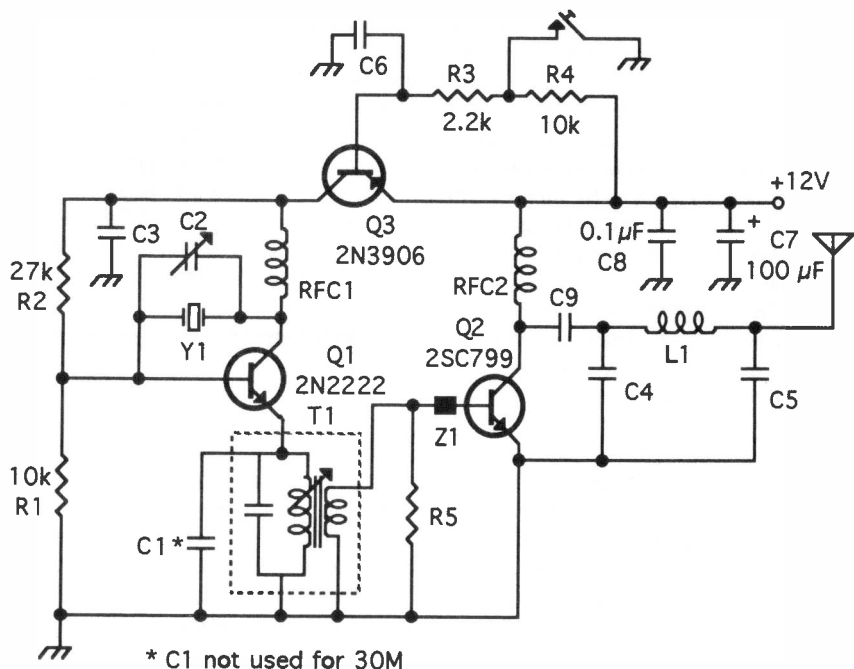


## The WA6IVC Hambrew Emergencyiver Transmitter Section

Bruce O. Williams, WA6IVC

Winter, '95

We are including a reprint of the schematic and parts list for this project as a service to readers who were not able to get a copy of the sold out Winter, '95 Issue.



**WA6IVC  
TRANSMITTER**

C1	56pF (40 meters), NP0 or silver mica 300pF (80 meters), NP0 or silver mica Not used for 30 meters
C2	0 to 100pF air variable or use switched fixed-values
C3	0.1 $\mu$ F monolithic or ceramic
C4, C5	470pF (40 meters), ceramic or silver mica 750pF (80 meters), ceramic or silver mica 300pF (30 meters), ceramic or silver mica
C6, C8,	
C9	0.1 $\mu$ F monolithic or ceramic
C7	100 $\mu$ F, 16V electrolytic
L1	14 T no. 24 enam. on T 50-2 toroid
Q1	2N2222 NPN general purpose
Q2	2SC799 NPN amplifier, or equivalent
Q3	2N3906 PNP general purpose, or equivalent
R1, R4	10 $\Omega$ , 5% carbon
R2	27k $\Omega$ , 5% carbon
R3	2.2k $\Omega$ , 5% carbon
R5	47 $\Omega$ , 5% carbon
RFC1	820 $\mu$ H molded choke
RFC2	15 $\mu$ H molded choke
T1	10.7 MHz IF transformer, Mouser PN42IF223 or 42IF123 (10mm)
Z1	Ferrite bead

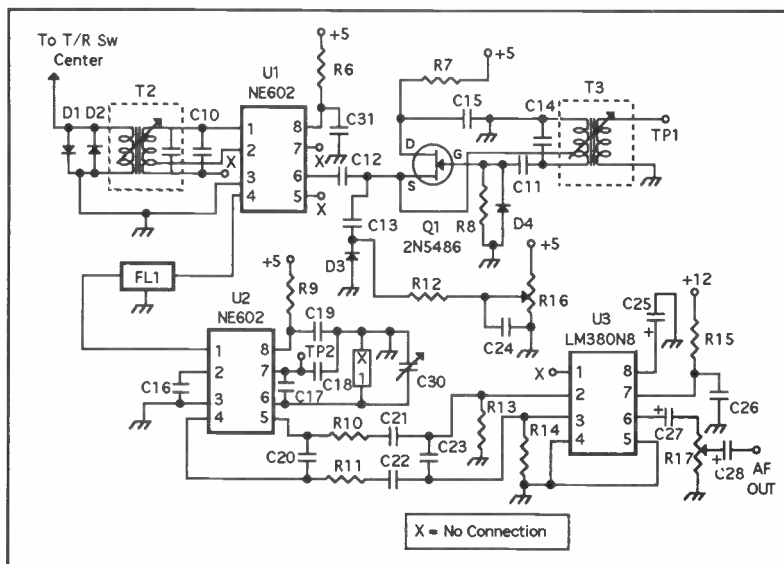
*We are working to provide an etched project board for the WA6IVC Hambrew Emergenceiver, and possibly a kit will be available as well. Let us know if you are interested in a complete kit for this project.*





THE WA6IVC  
HAMBREW EMERGENCEIVER

Spring, 1995



*The values for C21 and C22 were not given in the parts list.  
Their values are 0.22  $\mu$ F.*

**Neophyte Roundup Addendum:  
Photoelectric AVC Circuit**

**Dick Pattinson, VE7GC**  
Salt Spring Island, BC Canada

Here is an idea that I have not seen before and which I have tried out on the bench. It is one that could be used on the Neophyte receiver. It is a form of audio AVC and only uses two parts!

An LED is put in series with the supply voltage to pin #6 of the LM386, observing the correct polarity. A photoelectric cell is placed across pins 2 and 3. The LED is placed

physically against the photocell and all external light shielded from the arrangement by means of tape ore maleable plastic. Then, when a strong signal is received and the current through the LED increases, it will cause the PE cell resistance to decrease and thus control the amount of increased gain. The PE cell chosen must have a low resistance when illuminated. Not all cells are created equally in this regard.

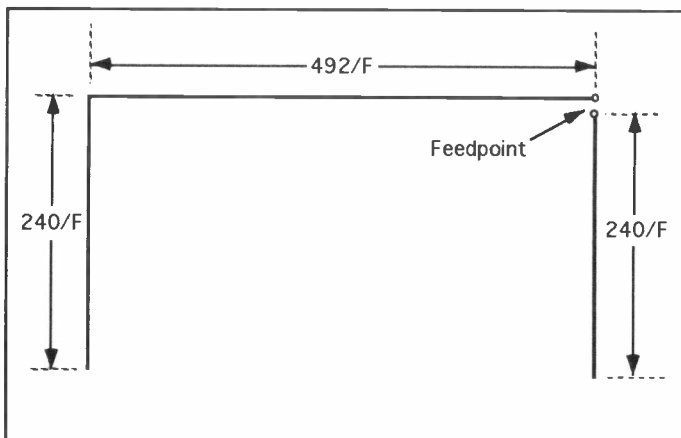
# Bet My Dollar On A Bobtail

Josh Logan, WX7K

20/20  
cont.



Spring, '95

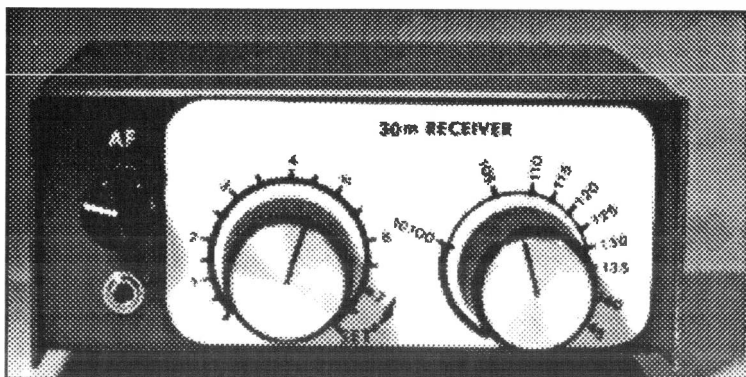


*The long element is the positive feedpoint of this antenna. The coax braid is attached to the shorter element on the right in this illustration.*

---

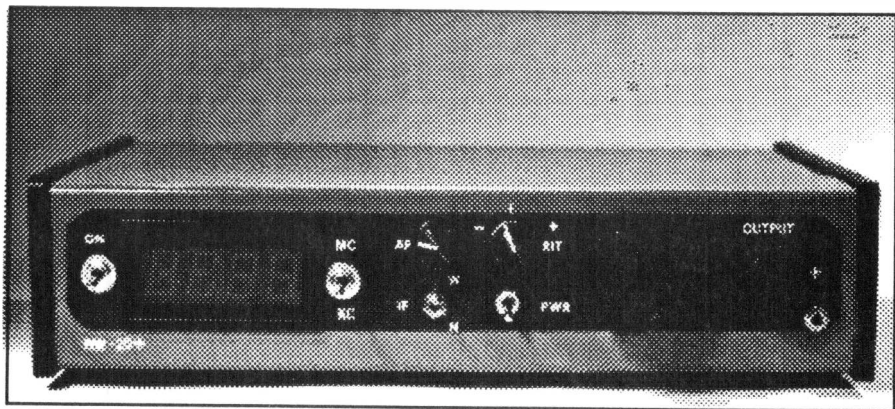
(Summer, Autumn, 94)

*Here is the Hambrew-built 30 Meter version of the Roger Wagner K6LMN SuperhetReceiver kit with bandspread tuning added.*



# The Rig That Never Got a Chance

George De Grazio, WFØK



*Digital readout with knob-tuning! Two kits combine to produce a nice rig that is fun to operate. The variable power output pot was relocated from the PCB to the front panel. The display can be turned off during operation to save power (350 ma in the current draw on receive with the display 'on').*

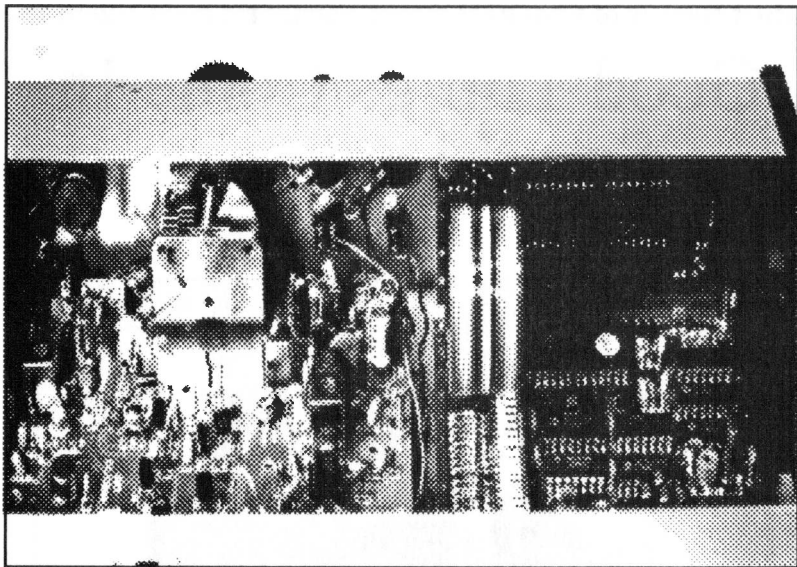
I first checked into the NW QRP group back in 1988 or '89, using a 2 watt 40 meter rig which I had built from a kit. I term it a "group" because the club was not yet officially organized. It became a weekly thing for me to try to slug a signal up to the northwest and get checked in. It was a great net- warm and friendly - made you glad to be alongside. Net control was Bill Todd, N7MFB, now the president of the club. Later, I received a note in the mail that the NW QRP had been formalized into a membership, so I joined.

One of the first rigs presented on the club's behalf was the NW 30/30 (*Hambrew*, Autumn, 1993), designed by the creator of the now legendary QRP Plus, Bruce Franklin, KG7CR. It was a nice circuit, featuring an IRF 510 PA. The response was good within the membership, and the quantity of kits prepared became exhausted. It was a success.

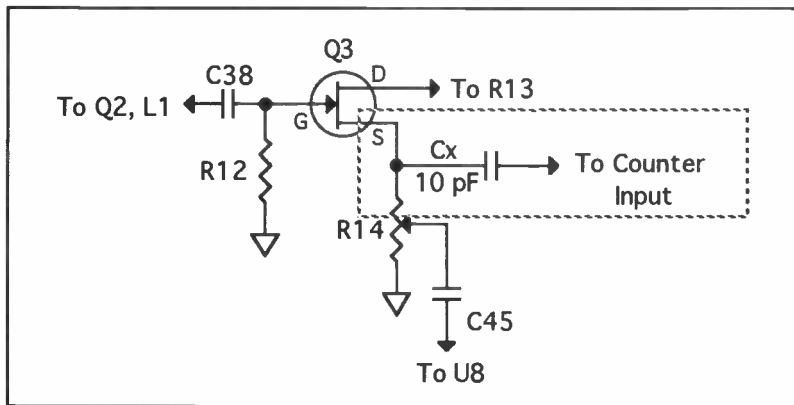
A club member from Bellevue, Roy Gregson, W6EMT, stepped up to the plate a

couple of years ago and designed the rig shown in the photo above: The NW QRP 80/20 (see the kit review in the Spring, '95 Issue of *Hambrew* by Josh Logan, WX7K). I ordered a 20 meter version from Dan's Small Parts and Kits last fall, planning to do a review. I didn't get the iron hot for it until early June, which was several months after Danny Stevig shut down (temporarily, we hope) the Small Parts and Kits business then located in Missoula, Montana. Since Danny was handling the boards and providing a kit version for either band, this put the kibosh to the distribution and momentum for the kit...a real shame, because its a beauty. The rig never got a fair chance in the building community.

I decided to build it anyway, continuing the original idea of combining it with the S&S programmable frequency counter kit to produce a QRP 20 meter transceiver with an accurate readout. Time was running short for the Summer issue, so I had S&S send along a



*There is just enough room in the project case for the two boards side by side. Care was used to determine that enough room was left for the ribbon-cable connectors between the counter board and the counter LED readout board behind the front panel.*



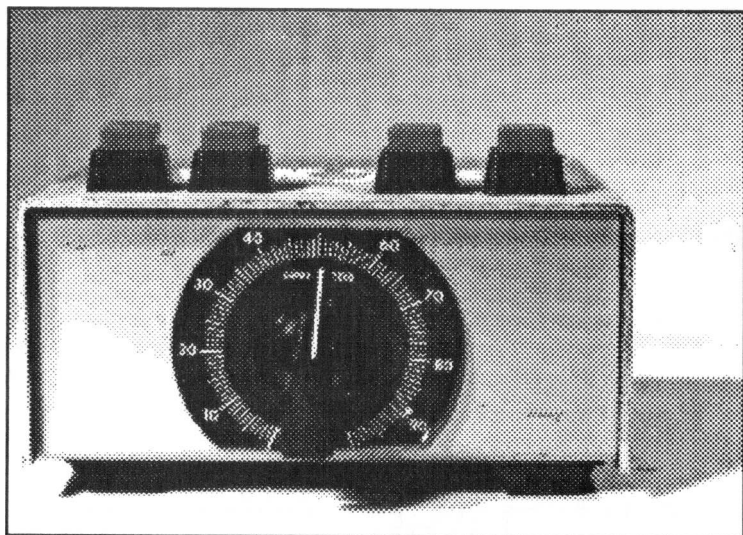
constructed counter. A Ten-Tec Model JG-10 project case (2 3/8" H X 10 3/8" W X 5 7/8" D) was selected for the side-by-side mounting of the two boards for the transceiver and the counter.

The combination is simply great: the transceiver works extremely well, and the readout keeps the op. accurately apprised of the operating frequency. August, ES1WN, in Tallinn, Estonia was worked with 2.5 watts output in a small pileup. The report was 559.

The counter kit from S&S is a real beaut also. The components are mounted very closely to one another, and there are several multi-pin ICs, so building the counter would require great care to avoid solder bridges. In-line DIP switches "program" the counter for use with various LO frequencies as necessary for any given project with which one wishes to integrate the counter. The settings for this project are given in the chart in this article. See the schematic presented here (Cont bottom pg. 38

# Good Things Come In Small Packages

Josh Logan, WX7K

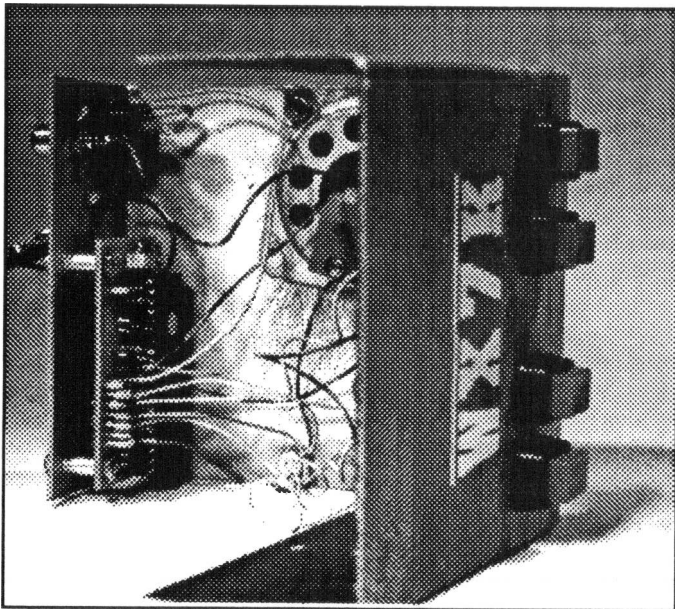


The design first built by Jeff Russell, KCØQ, and Bud Southard, NØII, is now called the CMOS Super Keyer II and originally appeared in the October 1981 issue of *QST* and several editions of the *ARRL Handbook*. There is currently a partial kit available from Idiom Press for \$48.00 post-paid (PO Box 1025, Geyserville, CA 95441). They make a very similar assembled model called the LogiKeyer that runs on 12 VDC.

This version runs on 3.0 to 5.5 VDC. I use four AAA rechargeable batteries externally mounted ( $4 \times 1.2 = 4.8\text{v}$ ). The partial kit comes with a small circuit board (about  $1\frac{1}{2}''$  by  $2\frac{1}{2}''$ ) and various components to all be mounted on the board including the heart of the machine, the microprocessor — a preprogrammed Motorola chip (MC68HC705C8P). In addition, you will need a cabinet (I used Ten-Tec TG24, 2" high, 4" wide, and 4" deep); four

SPST soft-touch push buttons; a small speaker; 100K ohm linear taper pot; four rechargeable AAA batteries; a 4-pack battery holder (attached with Velcro); and some jacks for your iambic paddle and key line to transmitter.

A brief word about the author/builder. I am 50 years old and began pounding the "holy" brass at age 12. I began on a straight key, then a vibroplex bug, then the quantum leap to a single-lever paddle and the famous W9TO keyer. That was in the late fifties, when cycle #19 was peaking, and the high bands were hot, hot, hot! Needless to say, the keyer got a lot of use chasing DX. Our journey through life takes many twists and turns: as fate would have it, I fell into inactivity for many years. Oh, I still had vivid dreams in Morse — you know those monster pile-ups! I suspect that I am a kind of radio Rip Van Winkle who, on some unconscious level, monitors the solar



*The PC board of the keyer is quite small; the design incorporates the Curtis "A" timing (see text), and includes a weight control and a lot of other features.*

flux and becomes radioactive once a certain flux level is reached.

I returned in the late eighties when things were getting hot again. Getting back into radio caused me to research any current state-of-the-art improvements in generating the mother of all digital — CW. Short of going directly to a keyboard, I concluded that learning one of the iambic dual-paddle methods would be the wisest move. (If you think you cannot learn new things, it's time to give up!) I learned the less popular Curtis "A" timing; it came pretty naturally. I used different iambic keyers and built a few, all using this particular timing.

So why have I settled on this particular design?

1. The preprogrammed Motorola chip emulates any of 10 different iambic timings, including the Curtis "A" timing that I love.

2. It offers iambic keying with options of dot and dash memories.

3. Four soft-sectored messages with space for 220 characters.

4. Messages may "call" others and contain functions.

5. Input queue to store multiple message activations.

6. Contest serial numbers — 001 to 9999.

7. Digital and linear analog speed control — 6 to 60 wpm.

8. Adjustable weight on code elements — 25 to 75 percent.

9. Built-in adjustable sidetone monitor in 10-Hz steps (500 to 800 Hz). Sidetone uses most of the power; turning off sidetone and using sidetone on transceiver greatly extends battery life.

10. Tune function for transmitter adjustment.

11. Selectable automatic character spacing.

12. Times pauses within messages.

13. Message loop capability for continuous replay. (As in beacon operation or calling CQ, pause 5 seconds and resume CQ.)

14. Break-in message to allow paddle-inserted text.

15. Ultra-speed mode allows messages at speeds of up to 990 wpm! For meteor shower propagation, send RST, QTH, etc., in one second!

16. Ultra-low power consumption for battery operation.

This design talks to the user in morse and takes commands via morse entered through your paddle! You can exactly duplicate any desired iambic timing, speed, and weight; there are other options that would take too much space to explain. Idiom Press provides great instructions and a fine study tutorial to show you, by doing, what this little keyer can do for you.

The circuit board is small, and magnification is very useful during soldering to prevent solder bridges, etc. It is straightforward. You will need to use some mounting hardware once you decide where you wish to mount the board.

I placed it on the back vertical wall of the Ten-Tec enclosure. If you use the sidetone in the keyer you will pull about 40 ma each time you key. I made a modification that I saw in "Hints and Kinks" that reduced the current drain down to 9 ma! Instead of an 8-ohm speaker I used a 200-ohm speaker and replaced Q2 with a Darlington transistor (BC517 or MPSA13 or MPSA14, thanks to DL3SZ).

Do I like this design? I guess so; I have a few models assembled now. It has been with me to field day, to QRP operation on mountain tops, to a family visit on the East Coast, etc. This CMOS II design has become a member of the family, and I recommend that you give it a try, only if you love CW!

*(Cont. from page 35)*

for the counter input tap point at the VFO of the transceiver. Check to see if the counter "pulls" the frequency during key-down transmit. If so, the value of the coupling capacitor Cx will need to be changed (i.e., lowered).

Roy hopes to have the boards available for the transceiver in the future. At least at that point a dedicated builder could gather up the parts and put the NW 80/20 together. It would be well worth the effort. We will keep you informed of the availability of the boards and parts for this rig in future issues. It would be great if the NW 80/20 could get a fair second chance.

*S&S Engineering Programmable Frequency Counter Kit (Model PC-1)*

*S&S Engineering*

*14102 Brown Road*

*Smithville, MD 21783 (301) 416-0661*

*Kit Only: \$69.95*

*Kit with case: \$99.95*

*Assembled & Tested: \$109.95*

*Assembled & Tested with case: \$139.95*

*Shipping & Handling: \$5.00*

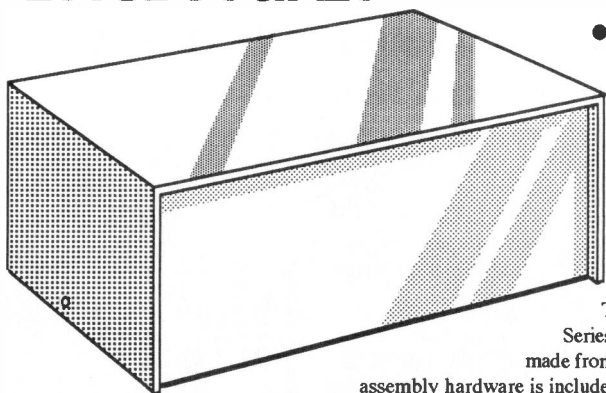
#### PC-1 DIP Switch Settings

<u>DIP Switch S4</u>		<u>DIP Switch S3</u>	
S4-1	Off	S3-1	Off
S4-2	On	S3-2	Off
S4-3	Off	S3-3	Off
S4-4	Off	S3-4	Off
S4-5	Off	S3-5	Off
S4-6	Off	S3-6	Off
S4-7	Off	S3-7	Off
S4-8	Off	S3-8	Off
S4-9	Off	S3-9	On
S4-10	Off	S3-10	On

This will enable an accurate readout of the NW 80/20 frequency in KHz. The MHz optional readout will *not* be accurate with this DIP switch program (We assume you will know which band you are on!). Just for the record and the fun of it, we have christened this version the NW 20+. Our thanks to Bill and Roy for having such a fine rig *and* club!

# TEN-TEC ENCLOSURES

- Affordable
- Sturdy



The new TEN-TEC Series TP enclosures are made from aluminum and all assembly hardware is included. The enclosure is supplied unpainted to be finished by the builder as required

Model	H	W	D	Mfrs. List	Our Price
TP-20	2 1/8	5	4 1/4	9.00	<b>\$7.65</b>
TP-45	2 3/4	6 1/2	5 1/2	12.43	<b>\$10.57</b>

————— (Add 3.00 S & H for first enclosure, .75 each thereafter) —————

*These prices good only for hambrew subscribers!*

**ORDER TODAY!**

*U.S. shipments only - Prices subject to change without notice*

The  
***hambrew***  
**WAREHOUSE**



**Phone Orders:**  
**(303)989-5642**

**P. O. Box 260083 • Lakewood, CO 80226-0083**

**Attention QRP Builders!** "Two Fer III" & "NG7D One Der"

Predrilled and Silkscreened G10 Circuit Boards Now Available

"Two Fer III": \$4.25 per board, "NG7D One Der"; \$4.00 per board

(Plus \$1.50 Shipping & Handling per four boards ordered)

Available from:

FAR Circuits

18N640 Field Court

Dundee, IL 06118 U.S.A.

I will be also offering an autographed, serial-numbered board set for the two projects for a nominal charge if enough readers show an interest. Details, information: SASE to NG7D, 622 West Alpine Ave., Santa Ana, CA 92707 (sorry, offer must be limited to U.S. amateurs).

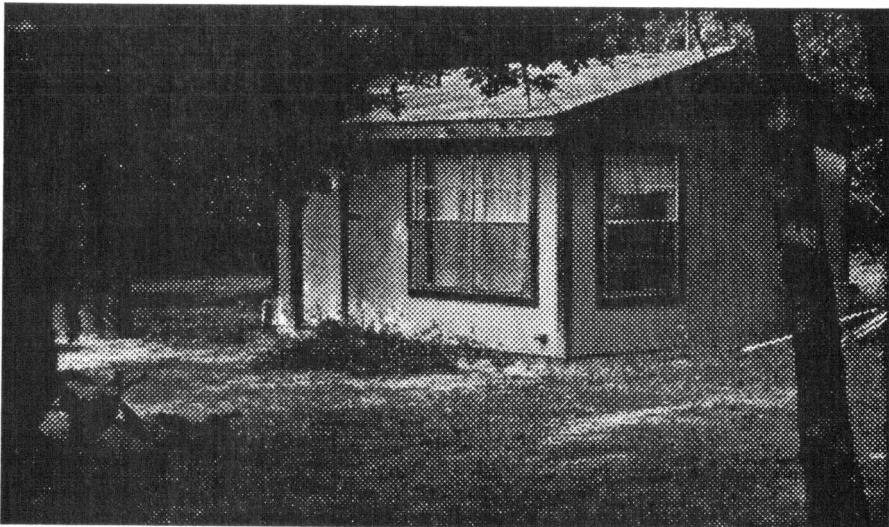


# *Hambrew Visits*

## **MXM Industries**

### **Bruce Muscolino, W6TOY/3**

**PO Box 9333, Silver Spring, MD 20916-9333**



*The MXM Plant in Smithville, Texas (all photos, this article: W6TOY/3).*

Bruce Williams, WA61VC is a personality who should be very familiar to most hambrew readers by now. Bruce writes a construction techniques column which has run since the magazine's inception and has been well received by readers. Bruce Williams, again, as most of you know is the owner, operator, and driving force behind MXM Industries and their line of high performance QRP radios. What nearly all of you don't know is that for about 12 years Bruce was my boss at pre-peace aerospace company in California. He was the Director of Product Support — I was the supporter of the products.

We sort of went our separate ways after he left the company. He went to work at for the American Radio Relay League, I continued my labors in industry until peace all but closed up all the shops. Of course, we stayed in touch

and were fortunate enough to visit with each other periodically as he came to California to see his children and as my travels took me to Connecticut. He even tried to get me a job at League Headquarters at one time - a job which I confess I was too dumb to take, but that's another story.

Eventually he settled in Texas and I settled in Maryland. He retired and I found myself between engagements- as they say. Unfortunately, our frequent visits became less frequent. However, late this summer, still between engagements and with a small surplus of time on my hands, cashed in some frequent flyer miles and took him up on a long standing invitation to visit. I spent two weeks in Smithville and I'm going to let you share some of it with me. I think you'll be fascinated by an inside look at a modern QRP guru and his

company.

Smithville is a small central-Texas town located about 50 miles south of the State Capitol of Austin. It's in an area of more or less gently rising and falling terrain the Texans call hill country. Although it did rain one day, and the heat and humidity were exceptional a couple of other days, in general the weather was beautiful while I was there.

Bruce's home, office, ham shack and plant are located on a one acre piece of farm land just outside the town limits. He and his wife, Charlene, live in a two bedroom home surrounded by trees and fields (and cows who occasionally mistake their yard for a pasture). MXM Industries (see Photo 1) is in a small building Bruce had especially built on their property, close to the house. The building serves as office, ham shack, development lab,

ceiver as kitted by Dan's Small Parts and Kits. I built them both while I was there along with an MXM 20 meter transceiver, and it gave me an ideal opportunity to compare among them with a real antenna (I live in a condo). There was no doubt the MXM gear was far and away superior, and I am not saying this out of loyalty or friendship. The NE-4040 is a nice radio, its QSK circuit and its receiver muting are absolutely seamless and among the best I've ever used - yes, even better than MXM's. But I can't decide whether the receiver's front end is stone deaf or there just isn't any audio gain at the back end. It hears a lot of signals, but even using an amplified speaker they're not very loud. I promise I'll spend some time troubleshooting the problem and let you know the answer. The NJ 20 meter transceiver has more problems than we had time to chase; I'll look



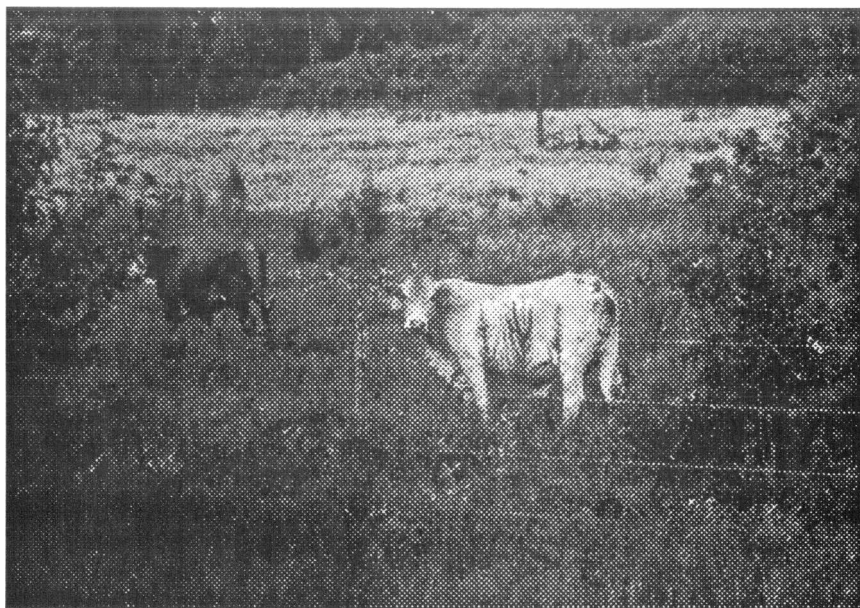
*Bruce O. Williams, WA6IVC, in the R&D and Quality Control Area*

and manufacturing facility. Pretty impressive for a small building!

To keep us occupied during my visit I took along a couple of projects I thought Bruce might be interested in, a New England QRP Club NE-4040, and an NN1G 20 meter trans-

into it too, as time permits.

The MXM 20 meter transceiver I built is a good performer. I spent a couple of afternoons playing with it using Bruce's dipoles and worked a few states and Mexico under what I'd call average no-sunspot band conditions.



*No, that is not a 2 meter Beverage antenna. The view from the MXM plant looks toward bovine neighbors.*

During my visit, Bruce had two projects in development: a Hambrew Emergenceiver (transceiver) for backpackers and hikers, and a QRP SSB transceiver. The Emergenceiver, as you have seen in the past two issues of Hambrew, is in the process of having PC boards etched! The SSB rig is a bit farther down the log, but I saw the SSB generator/filter section work. Time is what it needs.

Bruce stands squarely behind each of his radios. His philosophy is "if you can't make it work, we will". and, unless you've destroyed something through carelessness or "ham"-handedness, the repair charge is purely nominal. As a result of his industry background Bruce is more than casually aware of the problems that faulty hardware can cause. Many of you fly around in airliners whose automatic flight systems we serviced, and believe me, you won't believe what it costs to keep an airliner on the ground for a day. Bruce carried his industrial experience right across into MXM. One problem he encountered at the League was that many amateur radio designers don't consider other builders in their designs. They build one piece of equipment and

fiddle with it until it works. Then they write an article, in good faith, expecting their readers will just as happily fiddle with the same project until it works. NOT TRUE, especially in the kit business where if it doesn't work right the first time you've got an unhappy customer. Bruce spends a lot of time with each of his designs, building them over and over again to eliminate bugs. Apparently it pays off, because in spite of the "we'll fix it" offer, he gets surprisingly few takers, and he does get a lot of repeat buyers.

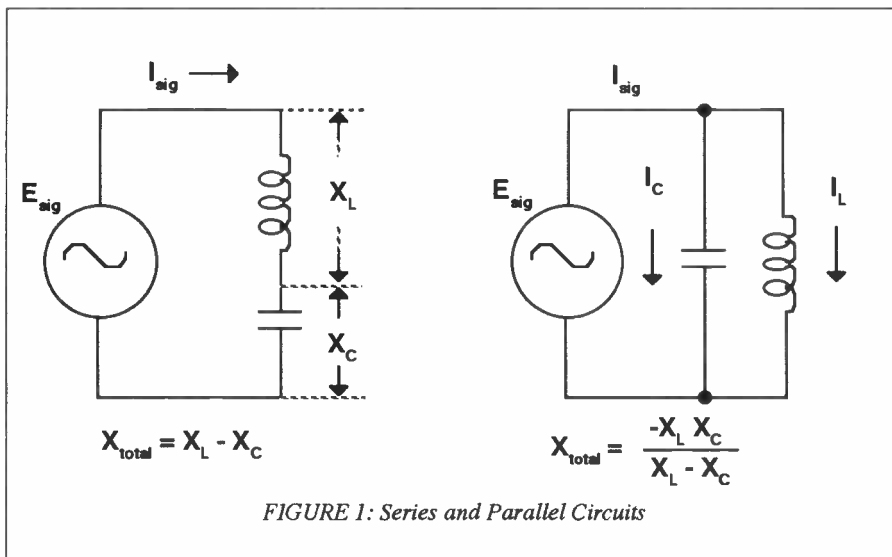
I'll admit I didn't tell you about where to get the best barbecue in the world, or at least central Texas, and I didn't tell you about our side trip to see the Army Camp where my father went through basic training. I visited there in 1943, at the age of 3, and I was surprised to find it still there, about 20 miles from where Bruce lives. I also purposely didn't tell you not to lay Pinochle, or Bridge, or Gin with Bruce and Charlene unless you bring extra money. I'll save those stories, and the tale (or is it the tail) of the Williams' cats for the next time I visit Bruce, Charlene, and MXM.

## DESIGN BASICS SERIES

# Thoughts On Theory

## The Concept of Duality

James G. Lee, W6VAT



Let's take a little side trip and talk about the concept of duality. You don't see it mentioned often in electronics, but an understanding of it can help you cope with more and more complex circuitry. As its name implies, duality refers to two separate, distinct entities which are related to each other. You use duality in ways you might not think of.

Duality is basically an analogy - such as "up versus down", "left versus right", and "input versus output". If an analogy is not accurate, it can be misleading. For instance, in elementary electronics, water flowing through a pipe is often given as an analogy of current flow in copper wire. Often the water pressure in the pipe is compared to voltage in such analogies. A problem occurs, however, when resistance is added to the water flow analogy.

The resistance to water flow in a pipe is *not* inversely proportional to its cross-sectional area as the resistance to the flow of current is in a copper wire.

Duality is a true analogy, and can help you understand circuit functions more easily. For instance, the most common circuits in electronics are series and parallel circuits. They are duals, and knowing the characteristics of one of them allows you to derive the characteristics of the other one. This technique is often used in antenna matching circuits. It implies a mathematical relationship between duals, and that is usually the case.

The table below shows several duals which should be familiar to you. Reciprocity holds between them as each is the dual of the other.

Current	Voltage
Resistance	Conductance
Inductance	Capacitance
Reactance	Susceptance
Impedance	Admittance
Series	Parallel
Short-circuit	Open-circuit

Resistance is the dual of conductance in that each is the reciprocal of the other. That is:

$$R = 1/G, \text{ and}$$

$$G = 1/R, \text{ where}$$

$$R = \text{resistance}$$

$$G = \text{conductance}$$

If you have ever solved the resistance equation for three resistors in parallel, you used the equations above to do it. First you took the reciprocals of all three resistors to get their conductances, which you then added together. Finally you took the reciprocal of that result to give you the total resistance. Mathematically you did it this way:

$$1/R_{\text{total}} = 1/R_1 + 1/R_2 + 1/R_3, \text{ or}$$

$$G_{\text{total}} = G_1 + G_2 + G_3, \text{ and so}$$

$$R_{\text{total}} = 1/G_{\text{total}}$$

The use of duals here allows simple addition to replace a more complicated mathematical expression involving division.

So if there are dual entities, so are there dual equations. For instance, Ohm's law (for DC) is  $E = IR$ , and it can also be expressed as  $E = I/G$ . Current can be expressed as  $I = EG$ , so the current through the three parallel resistors above can be written as:

$$I = E (G_1 + G_2 + G_3)$$

But not all duals are reciprocals, since the

dual of inductance is capacitance,  $C$ , and not  $1/L$ .

There are circuit duals as well. For every series circuit there is a parallel circuit which is its dual, and vice versa. This concept is very useful when dealing with tuned circuits. It is sometimes necessary to design matching networks for antennas and transmission lines. Knowing or being able to measure the series equivalent of a particular circuit allows a conversion to its parallel equivalent. In my last column I showed a graphical conversion of a series RC circuit into its parallel equivalent.

So let's look now at LC circuits. In FIGURE 1, there are two circuits - one a series circuit, the other a parallel circuit. In any series circuit, the current flow is the same through each element. In a parallel circuit the current splits between each according to its impedance value. High impedances draw only little current, and conversely, low impedances draw more current. In a series circuit, you simply add the values of the reactances - taking into account the fact they are vectors and must have their polarity (or phase angle) included.

For example, in the series circuit the inductive reactance  $X_L$  (a positive value) is added to the capacitive reactance  $X_C$  (a negative value). Or mathematically:

$$X_T = X_L + (-X_C), \text{ or}$$

$$X_T = X_L - X_C, \text{ where}$$

$$X_T = \text{the total reactance}$$

This is exactly the way series resistances are added, and parallel reactances are also done the same way as parallel resistances.

Thus the formula for parallel reactances is:

$$X = 1/B \text{ and}$$

$$B = 1/X, \text{ where}$$

$$X = \text{reactance, and}$$

B =susceptance.

$$R_p = (R_s^2 + X_s^2) / R_s, \text{ and}$$

For more than two reactances in parallel use:

$$X_p = (R_s^2 + X_s^2) / X_s.$$

$$1/X_T = 1/X_1 + 1/X_2 + 1/X_3, \text{ or}$$

$$B_T = B_1 + B_2 + B_3 \text{ so}$$

$$X_T = 1/B_T, \text{ where}$$

$X_T$  = the total reactance, and

$B_T$  = the total susceptance.

If there are only two reactances in parallel use the same formula as for two resistors in parallel, or

In the real world, certain circuits are more difficult to build physically. Certain component values may not be physically realizable, which means you need an alternate circuit. When I say a component is not physically realizable, I mean that its calculated value may be so large - or so small - that you cannot make one which will work in your circuit. This is particularly true as you go up in frequency. You simply cannot make coils or capacitors small enough to work. Every length of wire has an inductance, and just the lead length of a coil may be too large. Stray capacitances abound in every circuit and may require you to be very careful in the physical layout. Here the dual often lends itself to solving such problems by allowing you to transform the circuit into its dual.

$$X_T = X_1 X_2 / (X_1 + X_2).$$

Again you must take note of the phase of the reactances so if  $X_2$  is capacitive - as in FIGURE 1 - the above equation becomes:

Some problems arise when the dual of a circuit is drawn because of the duality between voltage and current. When a series circuit which has a voltage source is changed into its parallel equivalent, its voltage source must be changed into a current source. Most voltage sources are considered not to have any resistance (or impedance for AC sources). When converting the voltage source into a current source its conductance must therefore become infinite. This is why some duals are not physically realizable.

$$X_T = X_1 X_2 / (X_1 - X_2)$$

You see that if the values of  $X_1$  and  $X_2$  are equal and opposite in polarity, the expression  $(X_1 - X_2) = 0$ . This means the impedance of a series circuit becomes 0, and the impedance of a parallel circuit becomes infinitely high. This assumes only pure reactances and no resistance in either circuit. When the two reactances are equal and opposite, it is known as *resonance*.

If both circuits draw the same total current - at the same frequency - and have the same phase angle, they are equivalent circuits. Without going through all the mathematics, the formulas for a parallel-to-series conversion is.

But even if this all still seems a little vague, think about this. Every time you mail a letter, you apply the principle of duality. You put an address on the letter, along with your return address. This means you use the duals "to" and "from" whenever you mail a letter. The use of dual concepts and dual equations for them can often simplify a complex circuit and its mathematics. - W6VAT

$$R_s = R_p / [1 + (R_p/X_p)^2], \text{ and}$$

$$X_s = (R_s R_p) / X_p.$$

Similarly for a series-to-parallel conversion, you have:

# CLASSIFIED ADS

A Reader Service of **Hambrew** - No charge to subscribers to place one ham-related ad per issue, limit 15 words, 25 cents per word thereafter.

Commercial or non-commercial subscribers, no minimum. All ads must be related to amateur radio.

**Hambrew** does not vouch for nor guarantee the reliability nor legitimacy of any item or company represented herein. Deadlines: Sept. 1 (Autumn), Dec. 1 (Winter), March 1 (Spring)

June 1 (Summer). We reserve the right to deny publication of any ad. Copy To:

PO Box 260083, Lakewood, CO 80226-0083. Sorry, no phone orders on classified ads.

Prepay only.

**Need Manual for Yaesu FT208R HT.** If available, please xerox and send a copy. Will pay for costs. Ken Mahoney, K6OPG, 2036 Revere Ave. San Francisco, CA 94121, (415) 282-4807

**J.W. Miller slug tuned ceramic inductors,** used in the old QST homebrew projects. Very limited supply! SASE for list. Jeffrey Viola, 784 Eltone Rd., Jackson, NJ 08527

**CHASSIS AND CABINET KITS:** #10 SASE 5120-H HARMONY GROVE RD., DOVER, PA 17315. 717-292-4901 EVENINGS

**2N4416A FETs for sale.** Prime/JAN devices in ESD pack 10/\$6.00 PPD to KC5RT, 701 Oakridge, Liberty, MO 64068

**For Sale: Collins RE Mechanical filters** F-455-FA27-6810 2.7Kc at 455KHz PC Mount (not plug in). \$27.50 ea., Postpaid. Henry Mohr, 1005 W. Wyoming St., Allentown, PA 18103

**The History of QRP in the U.S. 1924-60** by Ade Weiss K8EFG/WØRSP. 208 pages, 56 photos/16 illustrations-WIFB: "I recommend this book for your Amateur Radio library, even if you never become a member of the fast-growing QRP fraternity..." WB8UUJ: "something to warm the cold winter nights with good memories.." \$12/1st Class (\$10 Sen. Cits.) AdeWeiss, 526 N. Dakota St., Vermillion, SD 57069

**Help Needed** Converting VHF marine FM xcvs to 2M ham band. One rig is binary PLL, MC145105, two other rigs are older and xtal type. Tnx. Jim Hale, KJ5TF, HC 65, Box 261-B, Kingston, AR 72742

**Builders! Hard-to-find ceramic rotary switches.** Ideal for bandswitching, antenna tuners, etc. Four wafers with single pole, five positions on each. Limited supply. \$5 postpaid. Limit one per person. Unfilled orders returned. Fred Bonavita, W5QJM, Box 2764, San Antonio, TX 78299-2764

**ELECTRONICS GRAB BAG! 500 PIECES OF NEW COMPONENTS: INDUCTORS, CAPACITORS, DIODES, RESISTORS. \$5 POSTPAID.** ALLTRONICS, 2300 ZANKER RD., SAN JOSE, CA 95131

**Simple QRP Kits: Communications-Quality** Receivers, Transmitters, Guaranteed to work! SASE for catalog: MXM Industries, Rt 1, Box 156C, Smithville, TX 78957 (512) 237-3906

**WANTED: SERVICE MANUAL/SCHMATIC** FOR JFD MODEL 7200 FIELD STRENGTH METER MARVIN MOSS, BOX 28601, ATLANTA, GA 30358

**Wanted-HF WØZLN club station** needs HF equipment reasonably priced or donated. Write University of Missouri Amateur Radio Club, A022 Brady Commons, Columbia, MO 65211

**FOR SALE: TEN-TEC Argonaut II QRP XCVR, XLNT, \$950/OBO.** Call Bill, KJ6GR, (310) 542-9899

**NOW ON 80 METERS! NEW, KNOB-TUNED WITH DIGITAL DISPLAY, SYNTHESIZED QRP Transceiver.** Complete kit only \$199.95. S&H \$7 (Continental US). **GUARANTEED TO WORK.** For info send SASE; Call/write to order: S & S Engineering, 14102 Brown Road, Smithsburg, MD 21783; (301) 416-0661

## CLASSIFIED ADS

**QRP Transceiver, QSK, 5 watts, superhet,**  
20 meters CW - \$115. Call Josh: (303) 988-  
8302 evenings (Colorado)

**K6LMN Simple Superhet Monoband**  
Receivers: 80-20m & 6m. S.A.S.E. Roger  
Wagner, 1045 S. Manning Ave., Los Angeles,  
CA 90024, (310) 474-2447.

**INVENTORY REDUCTION SALE-**  
Prices slashed on kits and all parts. Bill Hickox,  
Tejas Kits, 9215 Rowan, Houston, TX 77036

**WANTED: SERVICE MANUAL FOR**  
HEATHKIT TRANSCEIVER HW-100.  
WILL PAY CHARGES. W5ODR, (601) 388-  
3935, 2326 Pinewood Dr., Biloxi, MS 39531  
**NORCAL 40A NOW AVAILABLE** from  
Wilderness Radio. NorCal Sierra available  
late '95. Call 415-494-3806

**6 Meter Project Articles Wanted!** Help us  
give 50 MHz a shot in the arm! Send to  
Hambrew- we're raising the fallen 6m banner!

### • LETTERS •

*(Continued from page 5)*

Thanks, George, for the great issue with 6  
the focus. You and I, along with others, are on  
the same wavelength. Let's light some fires  
and see what we can come up with.

Phillip D. Hartzell, KAØKST  
Aurora, NE

Regarding the 6-meter focus, super idea.  
With the solar cycle moving up we should be  
ready for action. I'm sure that I'm not the only  
one who has seen one too many low-band  
rigs. The work at 54 MHz should make high-  
band design breakthroughs for 10 and 12  
meters a snap. At the peak of the last solar  
cycle, I built a "twofer" for 10 meters, and my  
first contact (600Mw, mind you) was the  
Alert Station near the North Pole; I was  
TI2QRP at the time. *(Great call!- ed.)*

A few years ago, I saw the spec sheets for  
the NE602 and, if I remember correctly, the  
IO will go pretty high, but some have discour-  
aged its use. I'm anxious to see the 10/6 dual-  
band receiver — the transmitter shouldn't be  
far behind.

Do you have an e-mail address? This snail-

mail will take weeks!

73,

Kris Merschrod, KA2OIG/OA4

Lima, Peru

*Hambrew can be reached at  
andromedo@aol.com. Thanks for your sup-  
port, Chris.*

I am very interested in the 6m/10m receiver  
project. The wife, N5UDJ, teaches high school  
physics with ham radio being part of the elec-  
tronics unit. In spite of physics' reputation as  
being a hard course, the enrollment has climbed  
to 25 percent of the senior class, and about 50  
percent of the class has gotten licensed this  
year. Now to find cheap equipment or build  
"stuff." I would like to encourage the building  
and 6 meters is a great band!

Keep up the good work with *Hambrew*.

73,

Jerome Doerrie, K5IS

Booker, TX



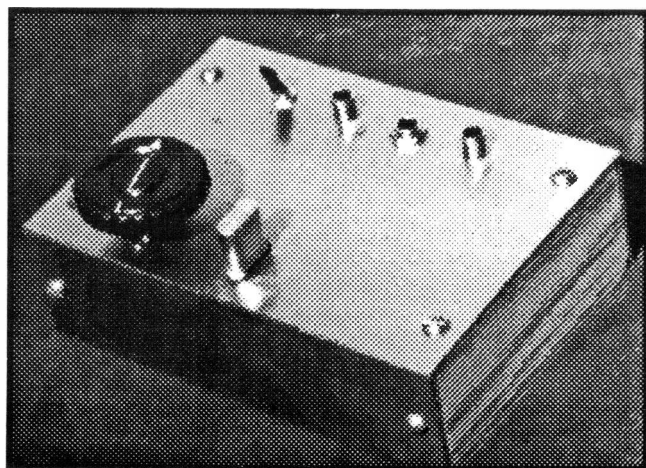
# In This Issue:

---



*Building the  
NorCal Sierra*

*N7KSB  
Single IC  
Transmitter*



*The Rig That  
Never Got A  
Chance*

*Plus:  
Much More!*

