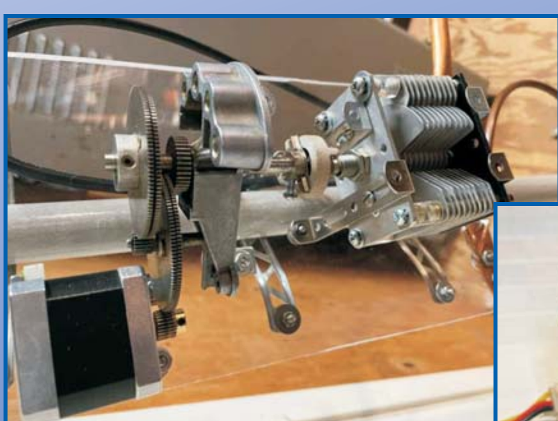
Your Construction and Operating QRP Sourcebook

QRP Quarterly

Volume 65 Number 4
October 2024

Journal of the QRP Amateur Radio Club International

AH6CY Makes a Remote Tuning System for a Transmitting Loop



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- *W4OP Upgrades the (tr)uSDX Transceiver*
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QRP ARCI℠ is a non-profit organization dedicated to increasing worldwide enjoyment of radio operation, experimentation and the formation and promotion of QRP clubs throughout the world.

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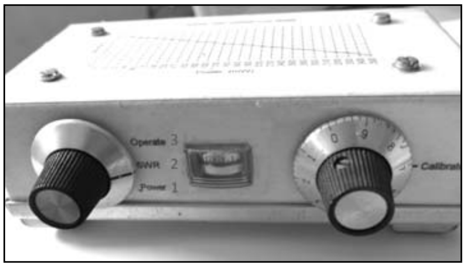

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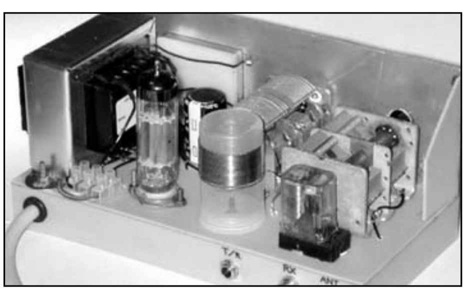

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Keep your QRP ARCI membership active!

Which includes maintaining your subscription to *QRP Quarterly*.

See the information on page 40, or at: www.qrparci.org

***QRP Quarterly* advertising information is included on the inside back cover**

About Our Club

QRP ARCI is a club for low power enthusiasts worldwide.

We produce a professional quality magazine (*QRP Quarterly*), organize an annual conference at Dayton (Four Days In May or FDIM), and sponsor various QRP contests and awards.

Our aim is to promote QRP and a variety of related activites. Many of our members enjoy home construction, kit building, antenna experimentation, backpacking and portable operation. Minimalist radios built in small tins are very popular but we also enjoy the very latest high performance radios such as the Elecraft KX3, the new SDR rigs, and great kits like the QCX from QRP Labs, kits from 4 States QRP Group, and the uBitx rigs.

QRP ARCI is an affiliated Club of the American Radio Relay League

From the Editor

Mike Malone—KD5KFX editorqrparci@gmail.com

Hello to all and Happy Fall! This time of year is what I consider to be the finest time to be in Texas... as long as you aren't a deer. The pleasant, crisp feel of the air on a Saturday afternoon while working on some little project combine with the smells of Autumn to create lasting memories. This is the time of year that I don't mind running power tools or throwing wire in trees. In short, fall weather is maker weather.

Recently, I have been working with microcontrollers and bread boards again. The power of a $4 Raspberry Pi Pico or the amazing possibilities of a $5 ESP32 board, combined with my enormous pile of electronic refuse have created a redneck "elector" set. The creativity of hams with Arduinos and SIS boards is astounding and the parts are priced within my reach. While working and contemplating the meanings of electrons and RF, a question came to me... a chicken or the egg question. Did my hobbies lead me to the "Hands On" imperative? Or did my "Hands On" imperative lead me to my hobbies? Seemingly mundane hobbies such as electric RC park flyers opened into fun creativity, building with foam insulation board and hacking Qualcom Lipo cell packs and cell phone chargers to allow 20 minute flight times. Playing guitar led to building amplifiers and guitars. Ham radio led me to QRP, where there are more builders than appliance operators. This issue has several articles that shout the hands on imperative loud and clear. Enjoy the articles, they were a pleasure for me to read and I think you will like them too.

72, Mike, KD5KXF

A Note to Prospective Authors

QRP Quarterly always needs useful, interesting stories and projects. It is the best place to share your ideas, and to learn from other active QRPers!

As you look at each issue, you can see that there is a wide variety of content—SOTA and POTA adventures, reminiscences of the past, reviews of new radios and accessories, and construction projects of all sorts.

Many of you have stories (large or small) that fellow QRP enthusiasts might find interesting. We'd like to present them to the QRP ARCI membership!

To begin, you can just run an idea past the Editor (or one of the Associate Editors) with a quick e-mail. See the staff list on the left. It's even better if you can put together an outline, or maybe a rough draft of your idea for an article. Our staff will help you as much as needed with preparation. We do professional editing, and also clean up drawings and touch up photos. An interesting, readable magazine is our goal.

Thanks in advance from the editors of *QQ*!

From the Desk of the President

David Cripe—NMØS president@qrparci.org

Greetings QRP Friends:

Although Dayton is still months away, now is the time to start mixing those creative juices. On the Thursday of Hamvention week, we gather some of the best minds in QRP for an 8-hour symposium on QRP topics. Please consider sharing your talent and experience at FDIM 2025 by giving a talk and writing it up for publication in the *FDIM 2025 Proceedings*. The topics are wide open. It can be your latest construction project or techniques; an antenna project; operating techniques or experiences — you name it. All that is required is for you to present the talk at the FDIM 2025 Technical Symposium at the Fairborn Ohio Holiday Inn on Thursday, May 15, 2025.

In addition, we will want you to document your subject for publication in the *FDIM 2025 Proceedings* and also for the possible publication in the *QRP Quarterly*. There are only eight time slots available, and some of these are already filled, so it won't be possible to use every idea. If interested, please send a short description (one paragraph) of your proposed talk to me by January 1, 2025. You may send them by e-mail or US Mail (just look up my callsign).

Call for BoD Nominations

The QRP ARCI has 6 Board of Director positions, which have terms of 4 years. Two of them expire in April of 2025 and we'll have elections soon.

Want to be on the Board? — Anyone interested in running for one of the expiring Director positions, should send a brief resume by e-mail to the President, David Cripe NMØS, nm0s@arrl.net. Send a paragraph or two telling why you want to be on the Board and include your qualifications, plans, and whatever you feel is appropriate. These will be published in the January issue along with a ballot, and the membership will vote. Results will be reported in the April 2025 issue, with the new terms starting on the first of that month. Since the deadline for the January *QRP Quarterly* is late November, you have a limited amount of time to respond. (If this October issue comes out late we'll make allowances to give interested people sufficient time to respond, although we can't push the deadline by too much!

If you do express interest in being on the ballot, I will send confirmation. If you don't hear back from me shortly, please assume that I did not get it and send it again. We want to make sure that no one is denied a spot on the ballot because e-mail wasn't received.

Qualifications: Candidates must be active members, i.e., current subscribers to the *QRP Quarterly*. They must also have an active e-mail account, since all internal QRP ARCI business is conducted through that medium. Don't forget, the deadline for getting your name on the ballot in the January issue is middle/late November. Send your resumes by email to nm0s@arrl.net, and make sure you receive a confirmation.

73 de NMØS/QRP
Dave Cripe, NMØS
President, QRP ARCI
nm0s@nm0s.com

●●

Upcoming QRP ARCI Contests

2024 QRP ARCI Top Band Sprint

Date/Time:
December 5th 2024, 0000Z - 0300Z (7 to 10PM EST Wed Dec 4)

A very rewarding multi-mode contest on 160m. Put up a vertical or operate with a wire in the park. With a little bit of planning YOU can work a 160m contest with QRP !

Mode:
SSB, CW or Mixed Modes. Work stations once per mode if entering the Mixed Mode category.

Exchange:
Members: RS(T), State/Province/Country, ARCI member number
Non-Members: RS(T), State/Province/Country, Power Out

QSO Points:
Member = 5 points
Non-Member, Different Continent = 4 points
Non-Member, Same Continent = 2 points

Multiplier:
SPC (State/Province/Country) total for each mode (CW or SSB).

Note—for the Mixed Mode category, the same station may be worked for SPC credit on CW and SSB; e.g., same N.A. station on CW and SSB would be worth two S/P/C multipliers.

Power Multiplier:

For SSB QSOs:	For CW QSOs:
>10 Watts = x1	>5 Watts = x1
>2 - 10 Watts = x7	>1 - 5 Watts = x7
>500mW - 2 Watts = x10	>250 mW - 1 Watt = x10
>100mW - 500mW = x15	>55 mW - 250 mW = x15
100mW or less = x20	55mW or less = x20

Suggested Frequencies:
CW: around 1810 kHz
SSB: around 1910 kHz

Score:
Final Score = QSO Points (total for one mode OR both modes if entered in the Mixed Mode category) × SPCs (total for one mode OR both modes if entered in the Mixed Mode category) × Power Multiplier

Categories:
Entry may be SSB, CW or Mixed Mode

Antennas:
Entry may be A1 or A2

A1: Single Element Antenna
If you are using a single element antenna such as a dipole, inverted V, loop, or a vertical you can enter the A1 category.

A2: Multiple Element Antenna
If you are using a multi element beam, or any antenna that has more than one driven element or uses reflective or directive elements you are in the A2 category.

Online Log Submission:
Submit logs at: http://www.qrpcontest.com

Deadline:
Entries must be posted on or before 19 December

2024 QRP ARCI Holiday Spirits Homebrew Sprint
December 8th 2024, 2000Z - 2300Z

A popular short contest which encourages homebrewers to put their rigs on the air. Bonus points for homebrew receivers, transmitters and transceivers. Extra bonus for those operating from a portable location.

Mode: HF CW Only.

QSO Points:
Member = 5 points
Non-Member, Different Continent = 4 points
Non-Member, Same Continent = 2 points

Multiplier:
SPC (State/Province/Country) total for each mode (CW or SSB).

Power Multiplier:
>5 Watts = x1
>1 - 5 Watts = x7
>250 mW - 1 Watt = x10
>55 mW - 250 mW = x15
55mW or less = x20

Suggested Frequencies”:

160m	1810 kHz
80m	3560 kHz
40m	7030 kHz (also listen at 7040 kHz and 7100 to 7125 kHz for rock bound participants)
20m	14060 kHz
15m	21060 kHz
10m	28060 kHz

Score:
Final Score = Points (total for all bands) × SPCs (total for all bands) × Power Multiplier + Bonus Points.

Bonus Points:
If operating a HB Transmitter add 2000 points per band
If operating a HB Receiver add 3000 points per band
If operating a HB Transceiver add 5000 points per band
Homebrew is defined as: “if you built it, it is homebrew” — from scratch or kits with components soldered to the board(s), NOT modules plugged together.
If you are operating PORTABLE using battery power AND a temporary antenna, add 5000 points to your final score. You can NOT be at your shack operating from battery power using your home station antenna to qualify for this bonus.

Entry Categories:
Entry may be All-Band (AB), Single Band (e.g., SB-160, 80,40,20,15 or 10), High Bands - HB (10m, 15m and 20m) or Low Bands - LB (40m, 80m and 160m)

Antennas: Entry may be A1 or A2

Log Submission: http://www.qrpcontest.com

Deadline: 23 December

QRP contesting is not only fun, it’s a great way to get active and meet new QRPers or old friends!

The extra activity during a contest is a good opportunity to try out new radios and accessories, and especially, to evaluate new antennas. The “big guns” in major international contests do this, too (in addition to their competitive efforts).

The Resistive SWR Bridge

Ian Keyser—G3ROO and Tony Fishpool—G4WIF tony.interalia@gmail.com

There has been an awful lot of water under the bridge since we last saw this device mentioned in QRP circles. It used to get mentioned now and then in George G3RJV's "Practical Wireless" series as a means of being easily able to measure SWR at low powers.

Time has passed and there have been many new QRPers join us. This idea might have been missed as they absorb the tribal knowledge that some of us older hands take for granted.

The Resistive SWR Bridge is very analogue. Not an Arduino in sight and it is easy and inexpensive to build. It can be very sensitive and is therefore highly suited for QRP operation.

A big advantage to this SWR meter is that when the bridge is set to position 2 to enable tuning of the Antenna System Matching Unit (ASMU), the transmitter P.A. stage will always see a lower SWR than is present at the load.

Indeed, if it's a dead short or open circuit, the transmitter will only see a 3:1 SWR.

Other complex antenna impedances may present a higher SWR to the antenna socket, but the rig will always see one that is lower and therefore provide some protection to the P.A. transistor in your home brew transmitter.

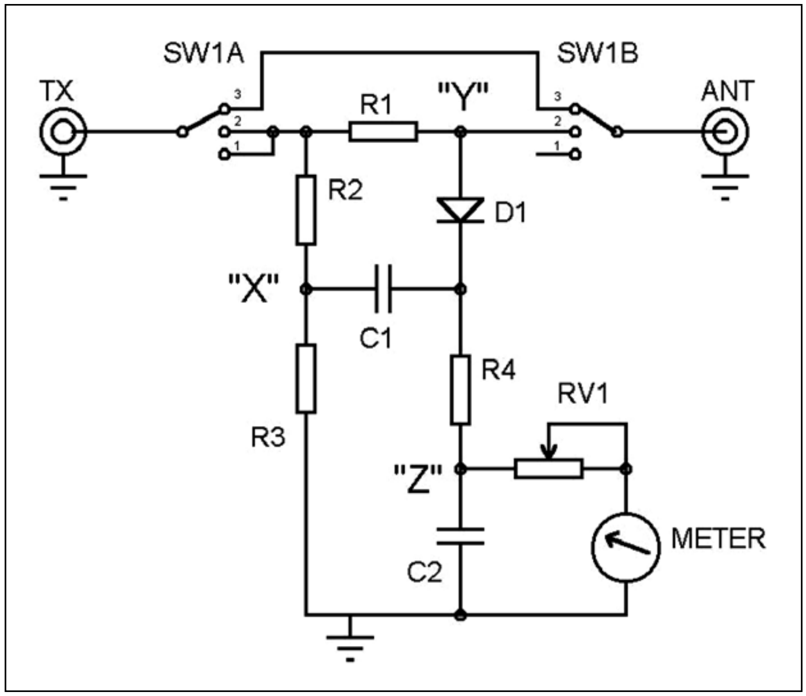


Figure 1—Schematic of the resistive SWR bridge.

A disadvantage is that because the design relies on using a resistive bridge, the transmitter output should be limited to the power level the resistors can safely dissipate. Please note that inductive (i.e. wire wound) resistors should not be used.

Ian G3ROO explains how the bridge works. See the schematic in Figure 1:

In the interest of simplicity we will assume that the meter draws no current and there is no phase difference between points X and Y.

When RF is applied to the input of the 'bridge' the potential at point X will be at half the total RF potential applied to the bridge, and this will remain so at all times. D1, C1, R4 and C2 form a peak voltage detector. Reading the potential at point Y in relation to point X.

We will consider three possible scenarios,

1) In switch position 1 no load (i.e. antenna) is applied and so the bridge is now reading the peak RF input voltage via R1 [50 ohms].This position can be used to adjust VR1 for Full Scale Deflection.

2) In switch position 2 and with an antenna load with high impedance the RF potential at point Y is very nearly the same as the input RF voltage. In this instance the peak DC voltage at point Z will be almost half the peak RF voltage applied (RF volts input – RF volts/2 [point X]).

Alternatively, if the antenna load impedance was very low (say 1 ohm), RF volts at point Y is almost zero so the peak detector will again read about half the RF input voltage (RF volts input/2 [point X] – point Y (zero volts [almost]).

Between the above two extremes, if the load impedance is 50 ohms, the voltage at point Y will now be half input RF voltage. As now point X and Y are at half RF input voltage the potential difference between them is zero. This is the point of 1:1 SWR, and as we deviate from this ideal, the voltage detected will rise until the two other scenarios are reached.

3) Having tuned the ASMU (with the switch in position 2), to indicate 1:1 (zero volts), the switch should now be moved to position 3 to remove the bridge and it will connect the ASMU directly to the transmitter. To leave it in circuit in position 2 would divide the R.F power between the antenna and the resistors in the bridge.

The aspect that catches most out is the fact that the meter is connected to ground and not to point X.

The reason for this is that as far as the meter is concerned it is only interested in indicating the DC component. If it is connected to earth, VR1 has only to be reduced in value by the value of R3 to give the same reading. In practice, as VR1 is going to be in the order of kilo ohms compared to the 51 ohms of R3, this error can be ignored.

Figures 2 and 3 show the unit that I built probably 25 years ago. I have added numbers on the switch positions to align with the description above.

Position 3 is the through or "operate" position. You will note that I labelled position 1 as "Power". This is where you transmit and rotate the right hand knob until full scale deflection is indicated. The reason that I labelled it "power" is that it occurred when I built it that for different powers applied, the numbered knob would be in a different position. So I got busy with an oscilloscope, varied the power input applied and then came up with a table of data for my unit.

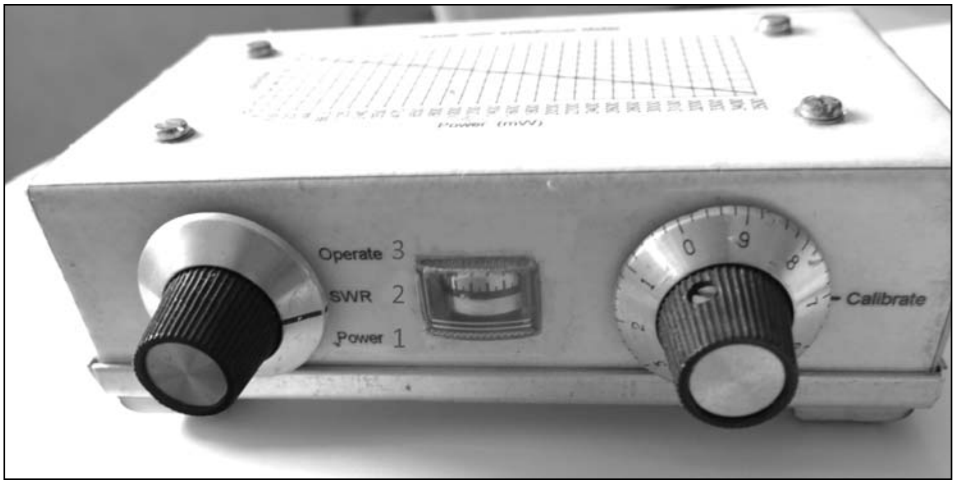
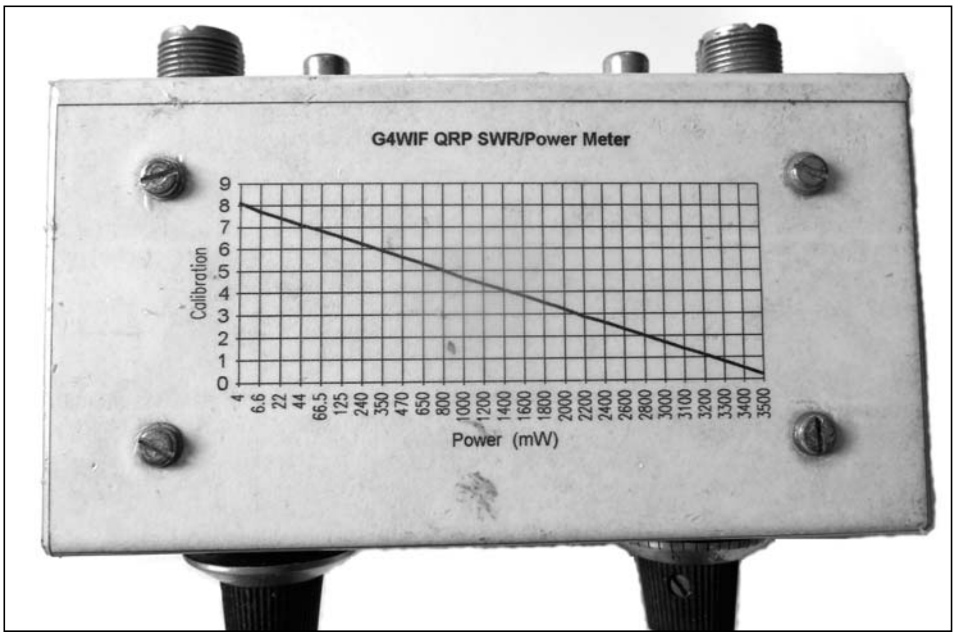


Figure 2—Front panel view.



Then I created a spreadsheet and finally that graph which I pasted on the lid. Of course, at very low powers, the diodes were going to be very non-linear, however my spreadsheet had the function to render a straight line while automatically adjusting the X Axis. As you can see, the left hand side of the graph reveals this non linearity.

So my unit allowed me to get a good feel for the power level by transferring the number observed on the knob position over to the graph when the meter is indicating full scale. Switching to position 2 indicates reflected power on the meter and of course, you adjust the AMSU for a dip to show minimum SWR.

Parts List:

RV1	10K
R1/R2/R3	51 ohm (2W)
R4	1K (0.5W)
C1/2	10 nF
D1	OA91 (or similar, such as a Schottky diode)
Meter	1 mA full-scale
SW1	2 pole, 3 way.

Figure 3—The top of the unit, showing the power calibration chart.

Do You Have QRP ARCI Operating Awards?

QRP ARCI provides a number of awards, each of which encourages low power enthusiasts to accomplish a wide variety of goals. We invite you to review the various awards at www.qrparci.org and make a commitment toward earning your own special award. A number of applicants apply for several different awards at the same time, which is fine. We hope you will review your log and determine if you might be eligible for any awards at this time.

Please note that awards are free of charge for active members (maximum of 5 awards per year) — another significant benefit of active membership!

—Preston Buck, NØGLM, QRP ARCI Awards Manager
Email queries to: awards@qrparci.org

Early Russian QSLs and the Start of DXCC

Bob Rosier—K4OCE
k4oce.qrp@gmail.com

European Russia	**UA1KBA (UA)**	Turkmenistan	UH8CS (EZ)
Franz Josef Land	**UA1KED (R1F)**	Uzbekistan	UI8AI (UJ)
USSR Antarctic	**UA1KAE**	Tajikistan	UJ8AJ (EY)
Asiatic Russia	**UAØTD (UA9-Ø)**	Kazakhstan	UL7QF (UN)
Rare Zone 23	UAØYT	Kyrgyzstan	UM8IE (EX)
Kaliningrad	**UA2KAW (UA2)**	Moldova	UO5AW (ER)
Belarus	UC2OC (EU)	Russian North Pole Expedition: UPØL *	
Azerbaijan	UD6AX (4J)	Lithuania	UP2CZ (LY)
Georgia	UF6CA (4L)	Latvia	UQ2FJ (YL)
Armenia	UG6EA (EK)	Estonia	UR2BV (ES)
Ukraine	UY5ZM (UT		

* Famous Russian Ernst Krenkel
Note: the letters in parenthesis after the calls are the present prefixes.

Early USSR Regions (and the stations I worked).

Here are some vintage (1960s) QRP QSLs from the former Soviet Union. This was before the collapse that occurred on Christmas day 1991. In those early days, QSLs could only be sent and received via Box 88, Moscow and every card going out or coming in to Moscow was examined. A poor grade of paper was used for QSLs, and many cards had the call signs hand stamped on a generic postcard. It often took months or even years to get a QSL card back. The bulk of cards received from Box 88 went first to the main ARRL Bureau, then they distributed them to the appropriate State QSL bureaus within the United States.

Most Russian stations ran either 40 watts or 200 watts, so this must have been the two classes at the time. I noticed that the majority of the Soviet station were using Ground Plane antennas. I was copying most 40 watt stations at around an S5 to S6. If a 40 watt stations were to drop its power to 5 watts, the signal level would be in the S3 to S4 range which would still be a perfectly readable signal. My 20 meter home-brew Minirig ran 7 watts input, 4.8 watts output and that's what I was using at the time. An advantage at that time was that there were far fewer hams and a lot less QRM.

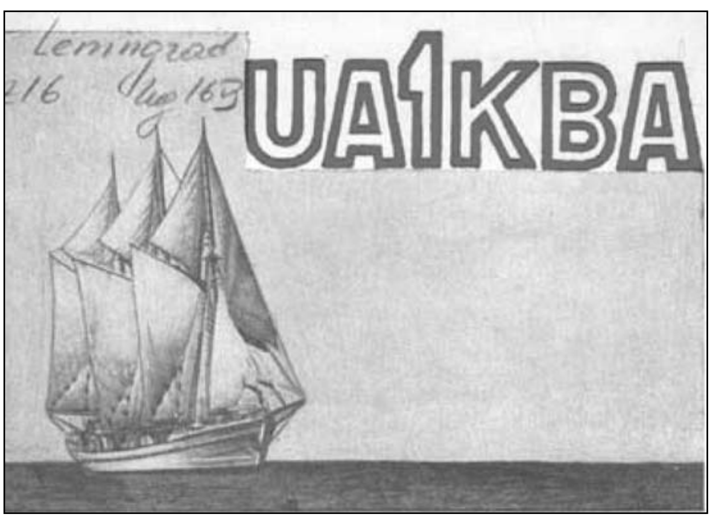
The accompanying table is a list all of the early Russian Entities. The five that are highlighted are what still exists today, but I imagine Russia would like to take back the 14 that have became independent entities after the Soviet breakup.

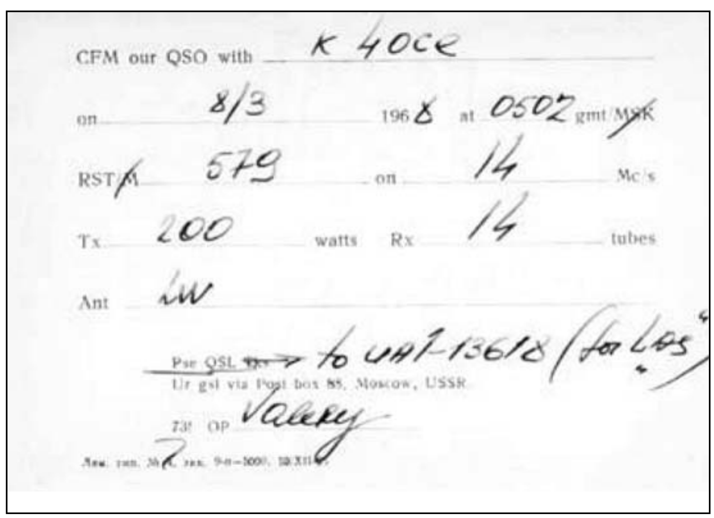
The International Telecommunication Union (ITU) allocates call sign prefixes, and Russia was assigned UAA-UZZ and RAA-RZZ. It was often easy to spot a Russian station by the chirpy signals... hi. That's not as bad as the South American station I once worked that drifted down the band during its transmission. I just followed him down the band with the receiver knob in one hand, pencil in the other.

DXCC History

The DXCC award was first announced in the September 1937 *QST*, and 7 hams worked the 100 countries by the end of that year. You could send in 75 cards and get published in *QST*, and when you reached 100, they published your call again as being in the "Century Club". WWII caused the shutdown of all HF on December 8, 1941. At that point, there were 156 hams with the required 100 countries. November 15, 1945 was the official new start date for giving country credits. ARRL decided to start the DXCC process from scratch making a new start date of November 15, 1945. It seemed a little unfair for those who had achieved the goal back before the war. In December 1946, Charlie Mellen, W1FH, had the necessary 100 cards and received the first postwar DXCC.

I had worked 100 entities with QRP by May 1969, but it took until the fall of 1971

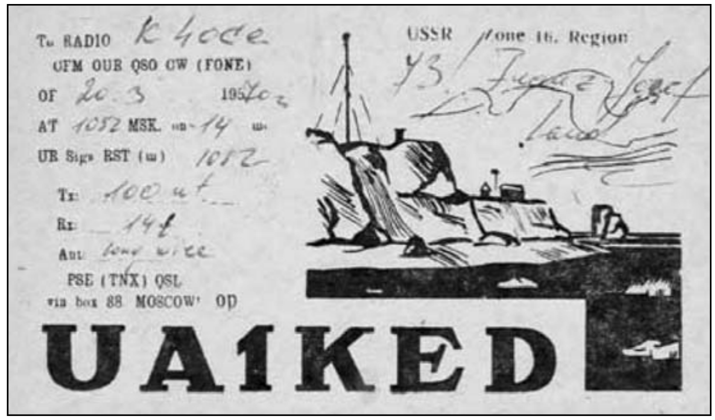




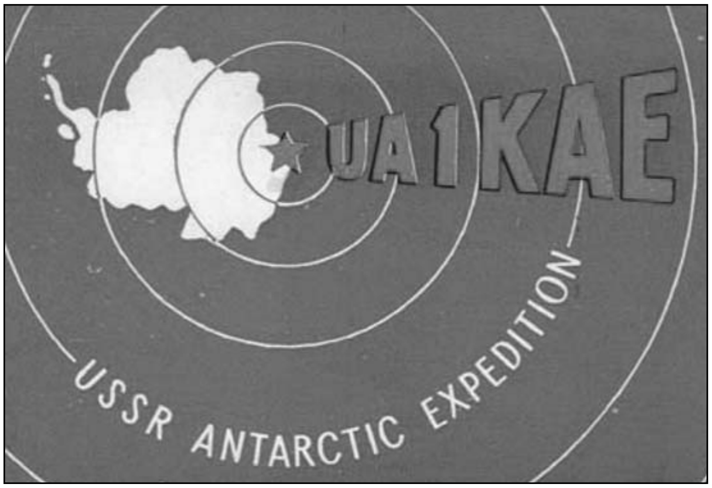
European Russia (UA)

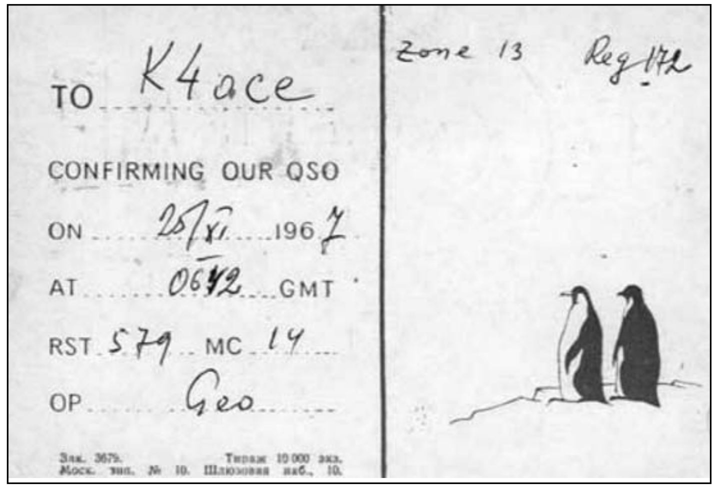
before I had all the cards in hand. Getting the required QSLs turns out to be the biggest challenge for DXCC. Since CW DXCC didn't exist at the time (added January 1, 1975). ARRL checked off MIXED for all my CW contacts. On the new format at Logbook of the World, I had MIXED checked for all 100 contacts, but the CW or PHONE columns were both blank. It looks a little strange.

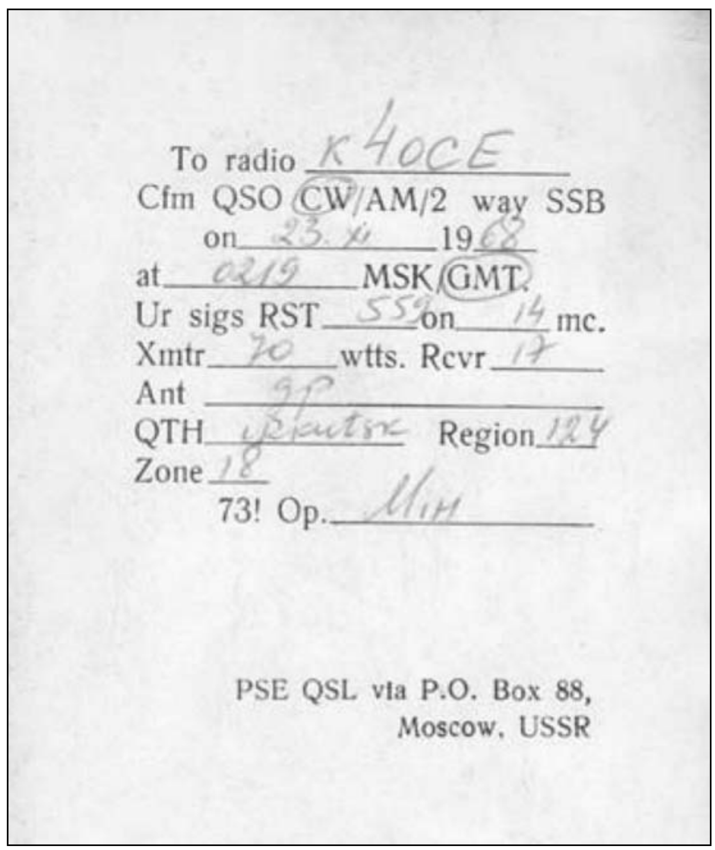
USSR Antarctic QTH (below)—No one owns Antarctica, but several countries have bases there. Unlike the Arctic, the Antarctic has penguins, but no polar bears. The Arctic is mostly ocean surrounded by land, whereas the Antarctic is a landmass surrounded by ocean.



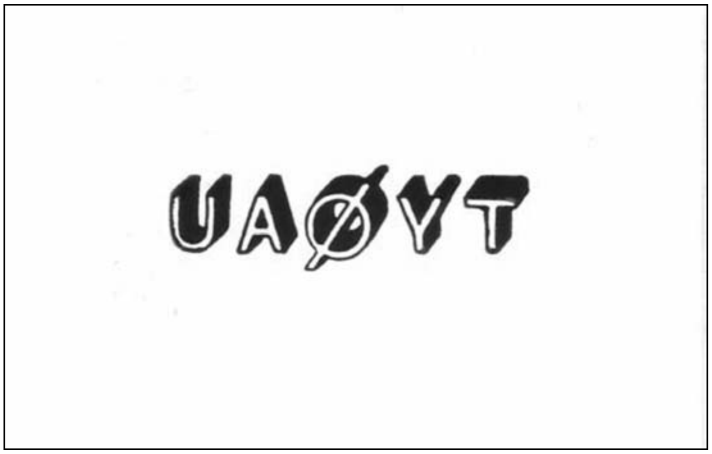
Rare Franz Josef Land (Now R1F)

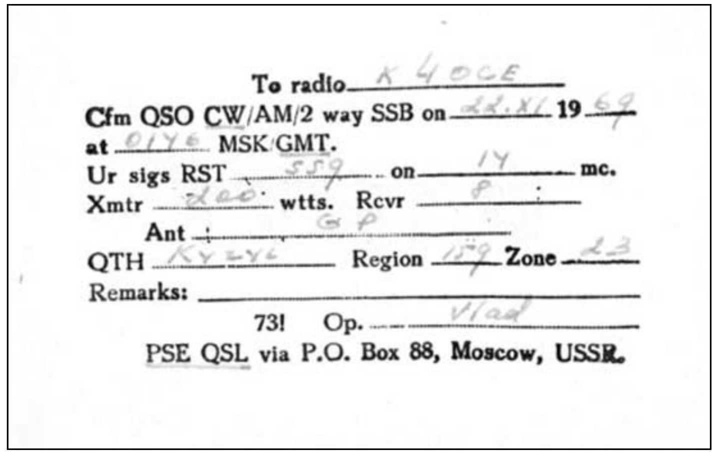




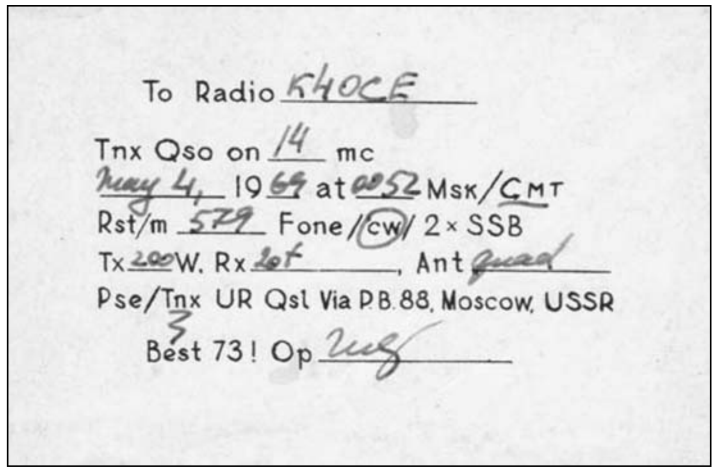


Asiatic Russia (UA9, UAØ)

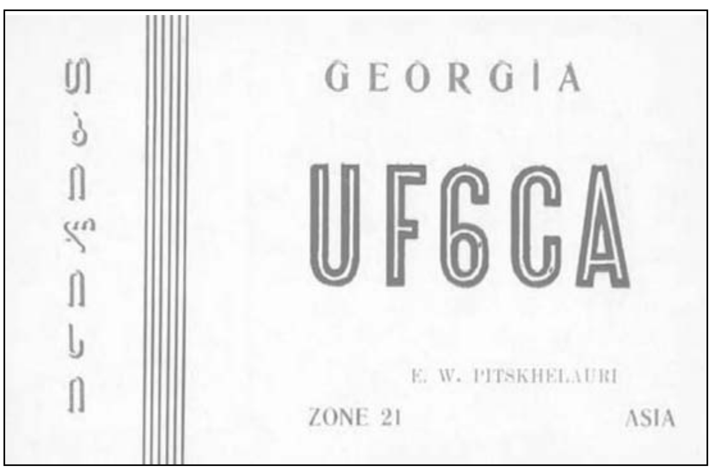


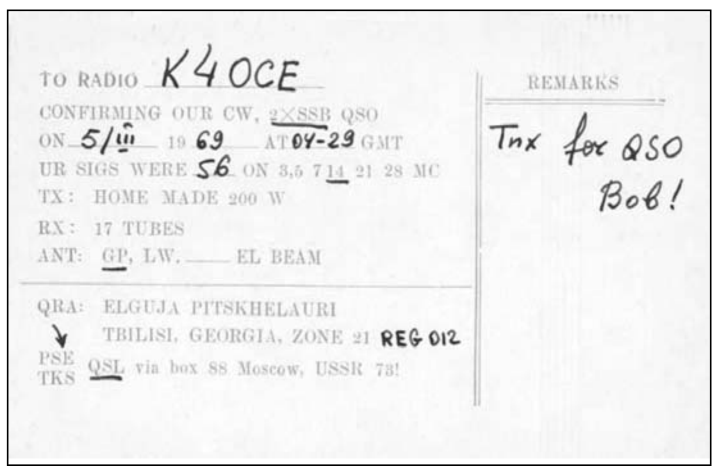


Many hams don't realize that a station with a UAØ prefix, and a suffix starting with a "Y", is in the rare Zone 23 as the card above shows. Still true today.



Kaliningrad: Still a Russian naval base; strategically located between Lithuania and Poland on the Baltic Sea.

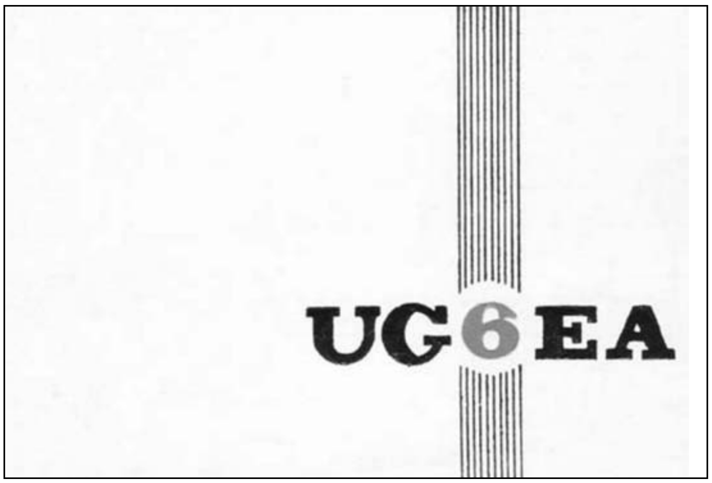




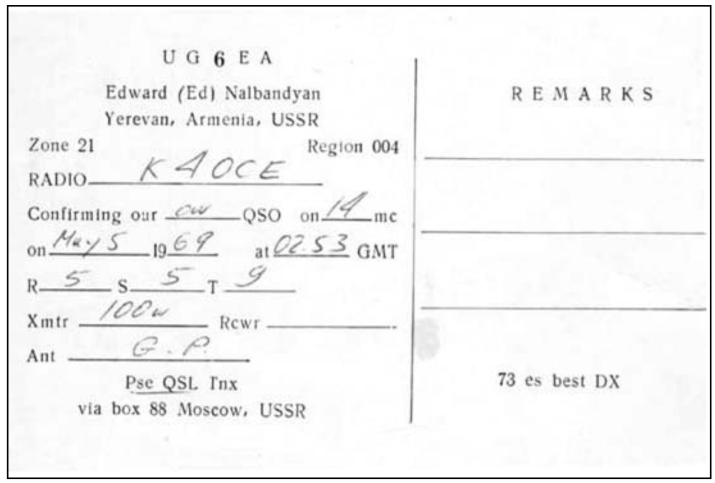
Georgia (now 4L)

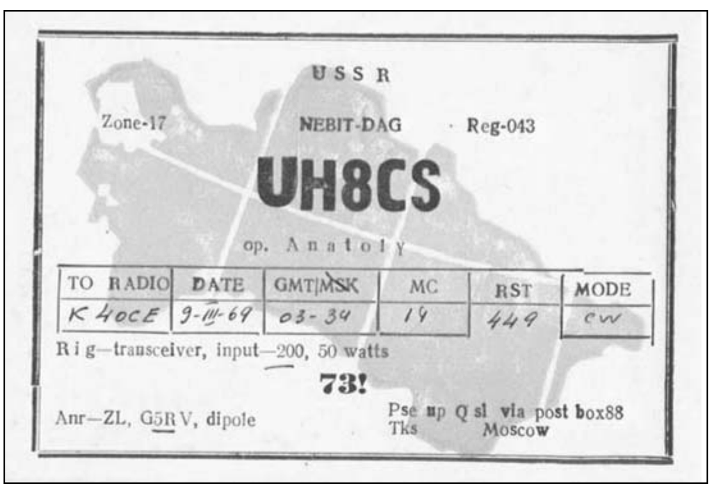
Belarus (now EU)

Azerbaijan (now 4J)

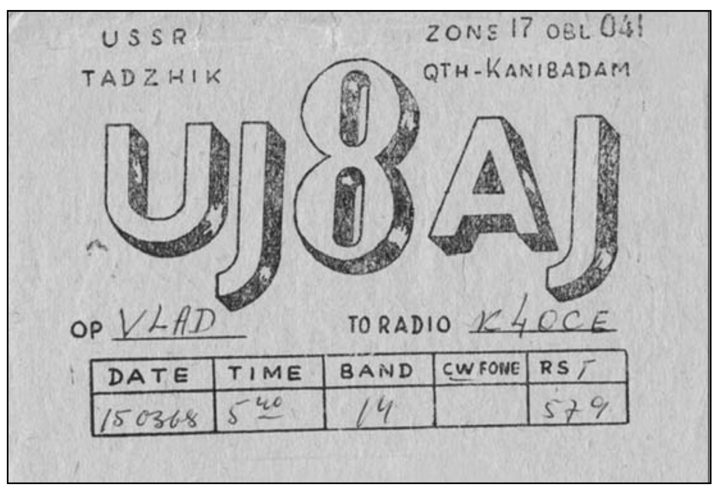


Armenia (now EK)

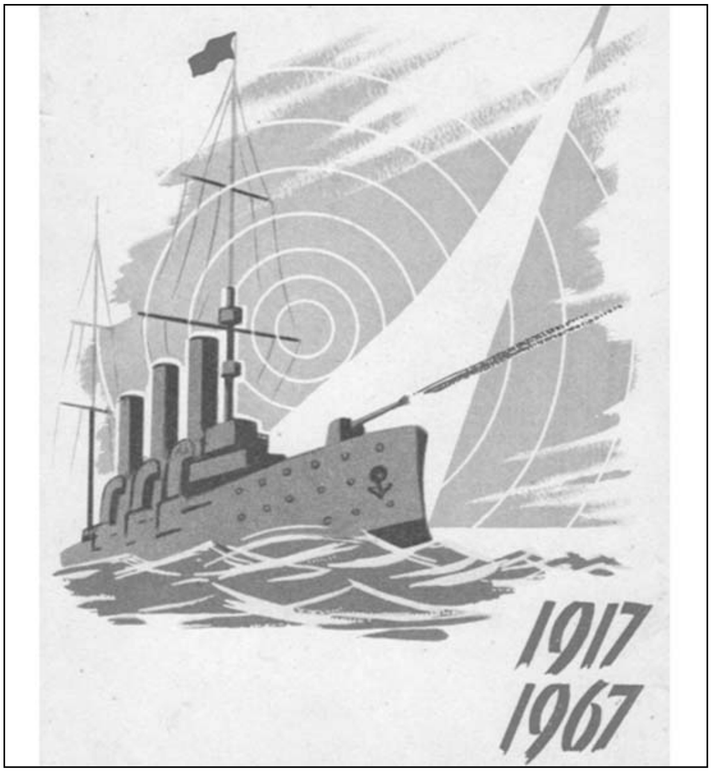


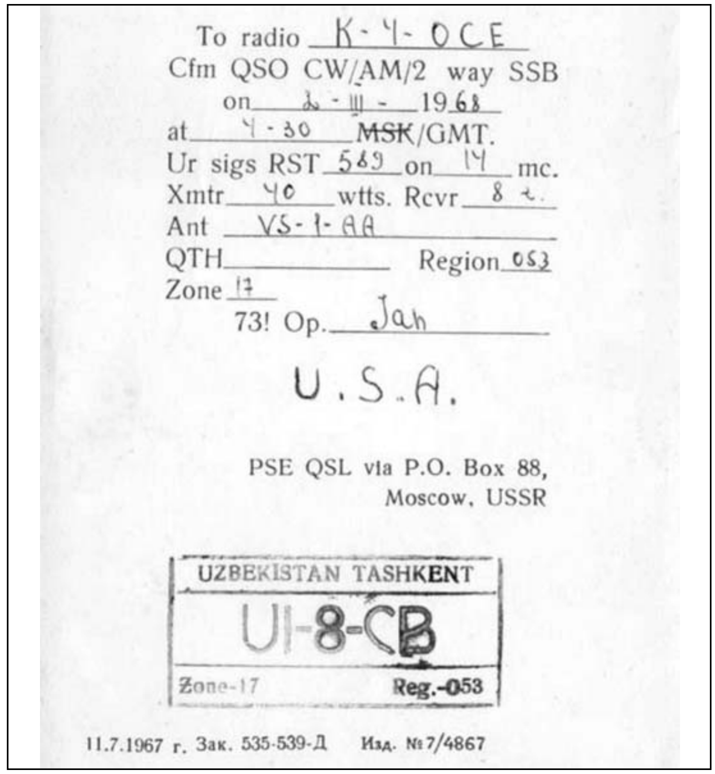


Turkmenistan (now EZ)

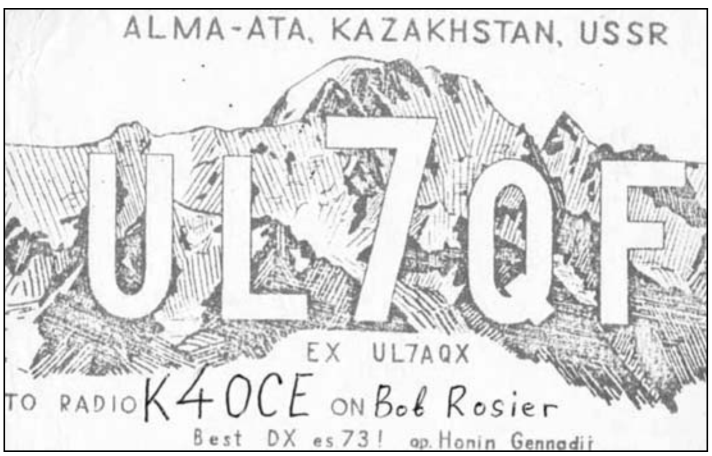


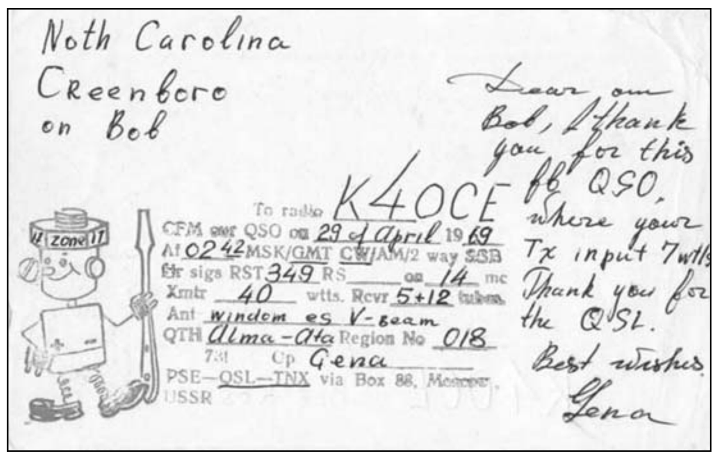
Tajikistan (now EY)



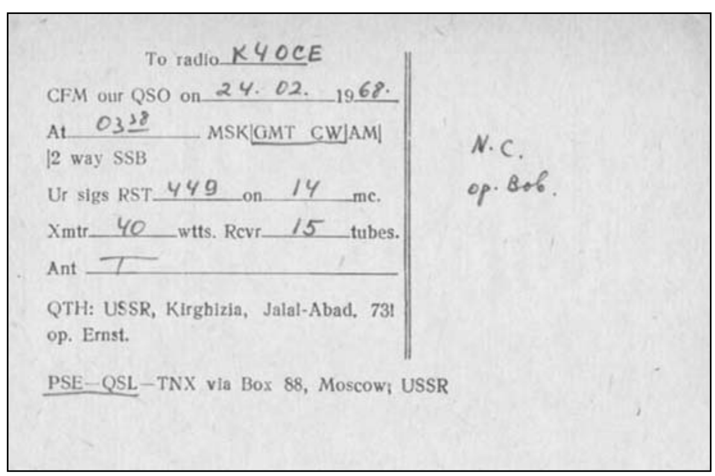


Uzbekistan (now UJ); was UI

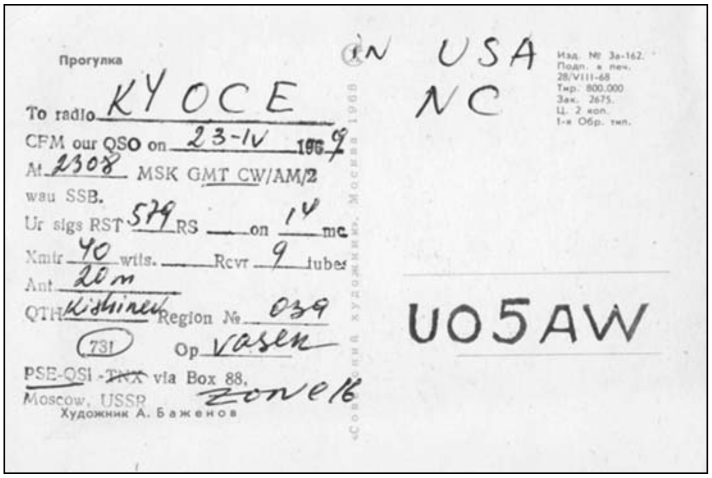




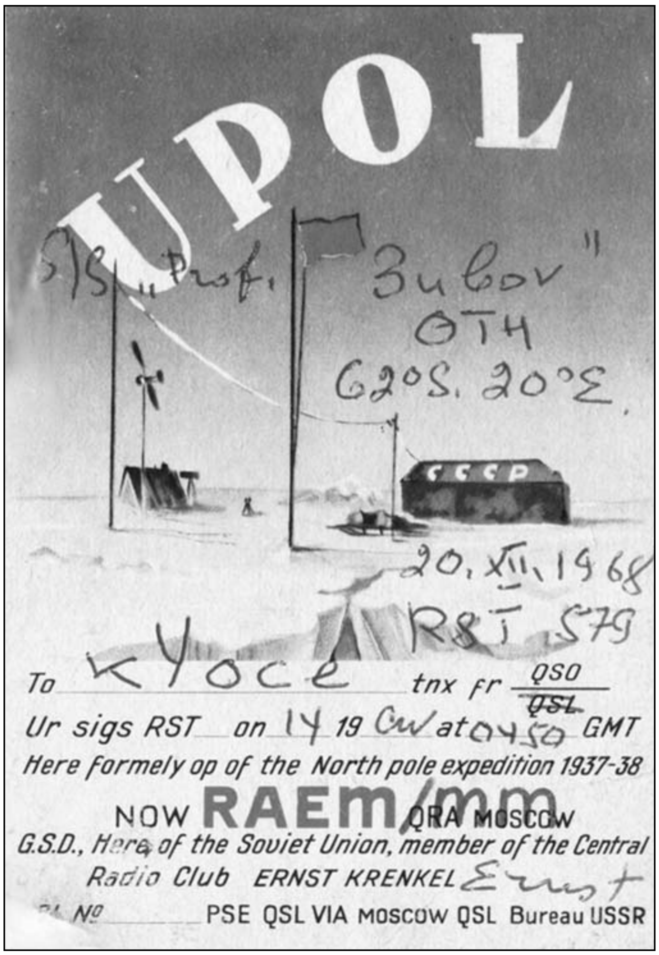
Kazakhstan (now UN)



Kyrgyzstan (now EX)



Moldova (now ER)



Ernst Krenkel's life was one of continuous adventure. I was fortunate to have worked him on one of his many North pole expeditions, and he even signed his name to my card. He was a Soviet hero.

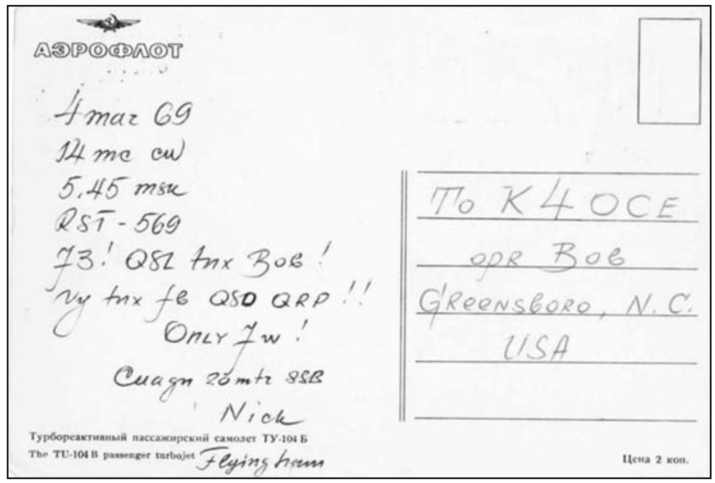
Ernst started in ham radio in its inception much like our Hiram Maxim (1AW). Yuri, RW3GA wrote an excellent Krenkel biography well worth reading. The PDF file can be found at:

http://www.g3zpf.raota.org/articles/ Krenkel.pdf

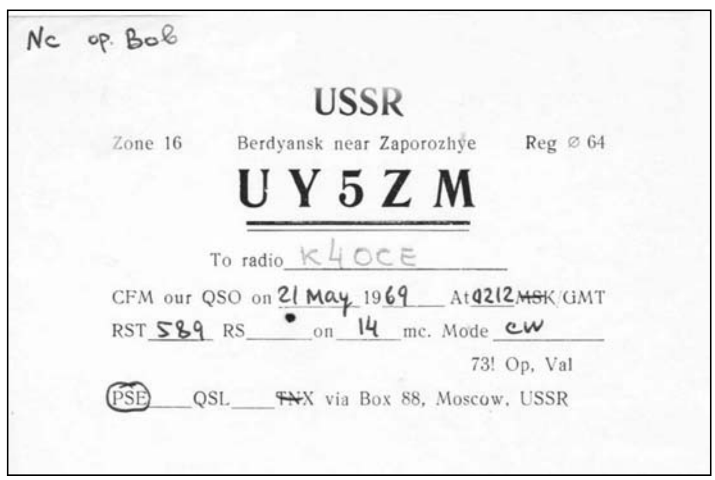
Yuri is still around with the new call R5GM. Look him up at QRZ. Great antenna farm.

Lithuania (now LY)

Latvia (now YL)



Nick was a commercial airline pilot in Estonia (now ES). He called himself "The Flying Ham"



Ukraine (now UT — and others, such as UR, US, UV, UW, UX, UY, UZ). Even with the war, I worked two Ukraine stations in the last DX contest. Perhaps some areas are less affected by the war?

Yes! You can work DX with QRP, as this article shows.

K4OCE operated primarily on 20 Meters, but DXCC countries can be worked using QRP power on all HF bands (including 160 meters), as well as 6 meters.

I Committed QRP and I Loved it!

Vaclav Ujcik—WD9HBC wd9hbc@gmail.com

OK, that probably got your attention. Well, I did do it and it was a LOT harder and also a LOT more satisfying than I could have anticipated or imagined. Not much went to plan (the hard part), but the fun was in rising to the challenge.

Oh, I had done some QRP in the past. When I built a K2, I originally ran it QRP until I was able to build up and add the amplifier. I usually (90%+) so far have run QRO. I've never had an opportunity to have much more than a dipole or vertical (I'm lookin' at you, retirement) and the verticals generally lacked radials due to being in rental properties while I moved around the country as an Air Force spouse.

I was first licensed in November 1977, was in college (no antennas) less than 3 years later, then 8 moves over the next 25 years before settling in an HOA (our first owned home) in central Illinois where I have a vertical with a couple of radials (ssssshhhhh, it's in the back of the house, below the top of the roof, not stealthy but not tall and the neighbors aren't complaining—although the HOA rules are a little non-specific about antennas other than "satellite" antennas. Go figure! Either way, I've just about always been at a disadvantage with marginal antennas and feel like I'm running QRP rather than 100 watts.

I did my first POTA activations last summer with a KX3 and a Buddipole at QRO (I really wanted to make sure I got credit for the activations). But, after seeing the KH1 and realizing that I could operate just about anytime/anywhere, I impatiently waited for it to arrive. I knew that this radio would give me no quarter about operating QRP and I was ready.

I received my KH1 (#692) in mid July and immediately set it up in my living room (set up, yeah that's what one does with a KH1) and heard a couple of stations. I have the Edgewood package, so everything I needed was immediately available. It's truly a marvel of engineering and thought. It even comes with a counterpoise (wait, what's that thing?) For someone who has generally only worked with dipoles or ground mounted verticals, the counterpoise (yes, I understand the theory, but there's nothing like hearing theory in action) made true reception possible as the noise level in the receiver went up appreciably and several more stations were copyable. What can I say? I'm an aeronautical/astronautical engineer who did not do well in my EE courses in college, although I already had my amateur license.

I then moved outside and made a couple of contacts with the KH1, logged into the nice little paper logger, dumped out the KH1 log memory (it's kewl, gotta make sure I figure out how to make notes). All of this was done with the KH1 whip, counterpoise, and, of course, QRP.

Then I realized that the weekend coming up was Support Your Parks weekend. POTA has been fun, both hunting and activating and last year's summer event was fun. This year I said "Self, why not take the KH1 to a POTA park and activate? There should be plenty of stations around and easy pickings to make the ten contacts needed for an activation." OK, some of you may already see the challenge.

Unlike my previous activations with the KX3, amp, and Buddipole, this one was going to be QRP all the way—a chair, water bottle, KH1. Rock Island State Trail is less than 5 miles (QRP distance) from my home. It's an old railroad track turned into walk/bike path. I was planning to set up at mile 0, just off the trail, in the shade. I charged the radio battery the night before and felt good. I also made about 20 contacts as a hunter, so I had a feel for the bands and conditions.

Slow forward, I'm at the trail, in my chair, water handy, radio out, antenna in, counterpoise out. Tuning around, I could hear some S7+ stations and was impressed. I spotted myself on the POTA site and sent CQ. Sent CQ again. And again. Nothing! Well, that's disappointing! OK, there's a guy CQ'ing just 500 kHz up. I call him and he gives me a 56. I give him 59. He's a SOTA in New Hampshire. Well, that's encouraging, I'm definitely getting out. Found a quiet spot, self-spotted, called CQ. No dice (well, actually no CW, but you know what I mean).

I wasn't in a rush so I checked the spots, tuned in and worked a couple of the activators that I could hear. No troubles, got them on the first or second call (yes, I'm really QRP). Good—radio's working.

Then, a walker catches my eye and walks over. He asks "are you a ham" and I reply yes and tell him I'm working POTA QRP with my brand new radio. His eyes light up and he then tells me he's a ham also, from Minnesota, just visiting and taking a walk. He hadn't heard of POTA, so I gave him one of the business cards I had printed up for just this type of thing which has my callsign, the POTA image, my email, and on the back the POTA "rules". Randy, KB3IFH, worked very patiently with me to get these printed up and they look fantastic. Hopefully I'll find that gentleman down the log sometime.

Back to the task at hand. Rinse, repeat, self-spot, call CQ. I tried probably 4 or 5 times. Also checked the Reverse Beacon Network and I'm not seeing anything there either. Well, that's interesting because the stations I've worked haven't had a problem working me. Look at the watch, plenty of time. Plenty of water. No rush. We'll just have to do this the hard way.

With four contacts already in the logbook, I now change strategy to search and pounce. Look 'em up on the spot page, tune there, try to call them after a CQ. Six contacts later I had a huge smile on my face. Activation complete, ten contacts, one SOTA and the other nine were park to park. All QRP. Pack up the radio, roll up the counterpoise, grab the water and the chair and head back to the car. Back at my home in about 2 hours start to finish.

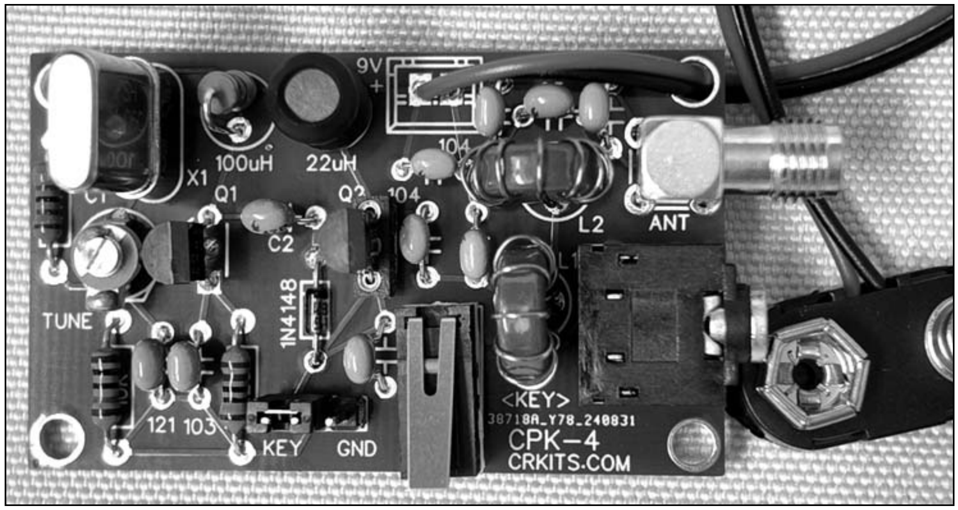
While I've never disbelieved the power of QRP, this experience cemented the challenge and the feeling of accomplishment of QRP, POTA, and basic CW skills (I was running 12 wpm). While I thought it would be easy to get ten contacts while CQ'ing near 14.060, apparently even the RBN wasn't finding me. I'm thinking there were some stations I wasn't hearing that were over my little signal. However, with the Support your Parks weekend activity in full swing, there were plenty of stations I could hear and work so I could complete the activation all done QRP with a radio that fits in the palm of my hand.

Well, there you have it, a tale of a first QRP POTA activation with the KH1. Talk to you more later, I'm going out to commit more QRP. GD es 72. ●●

CPK-4: A QRP Transmitter Kit

Adam Rong—BD6CR rong@ustc.edu

Back in 1990s when I was in college, I read a lot about QRP projects in *QST* magazines. 30 years later, recently I designed a new crystal controlled QRPP CW transmitter kit called CPK-4, and many people worldwide enjoy it. It puts 300-500 mW RF power at 9V, and the spurious suppression is better than -43 dBc. You can choose from 7030, 10106 or 14060. Of course, you can insert other crystals of the same band since the socket is supplied.



The assembled CPK-4 transmitter.

As you can see from the photo, it contains an onboard key, so the youngsters or beginners can enjoy the CW fun immediately. The 3.5 mm key jack can accept any straight key on hand. The jumper on the left side provides the possibility to key the oscillator stage or not. It is useful if you operate with a nearby receiver, say a Tecsun PL-330 or PL-368 portable SSB receiver, since you don't want to hear a tone all the time. However, keying the oscillator stage will generate chirp. Some people like it because it reminds them great old time. If you don't have a portable SSB receiver, you still can try with an AM receiver even at 5 kHz tuning step. You can use another CPK-4 as a BFO by setting the jumper on the GND side (so the oscillator is always on). Fine tune the trimmer capacitor to oscillate at a bit higher frequency and adjust the distance between this CPK-4 and the AM receiver so the sensitivity is acceptable. Use another CPK-4 as a regular transmitter.

What is the antenna solution? Modern AM radio receiver is sensitive enough even with the attached whip antenna. Just make sure you connect a resonant antenna to your CPK-4 transmitter. BA6QH in Wuhan made a few contacts on 20 meter band with his V dipole or vertical antenna. He operated at 12V so the power output is in TURBO mode. Don't worry too much as the final transistor has a spare and a socket supplied.

The schematic is simple to understand. The Q1 and X1 form a typical Pierce oscillator, and the trimmer capacitor C1 can fine tune the frequency. Q2 is a keyed class C amplifier. The LPF stage will help reduce the harmonics so it can comply with the regulations of FCC or SRRC in China.

What are the pros and cons compared to the Pixie 2? Mainly, the Pixie 2 is a transceiver while the CPK-4 is a transmitter only with higher RF output and better spurious suppression.

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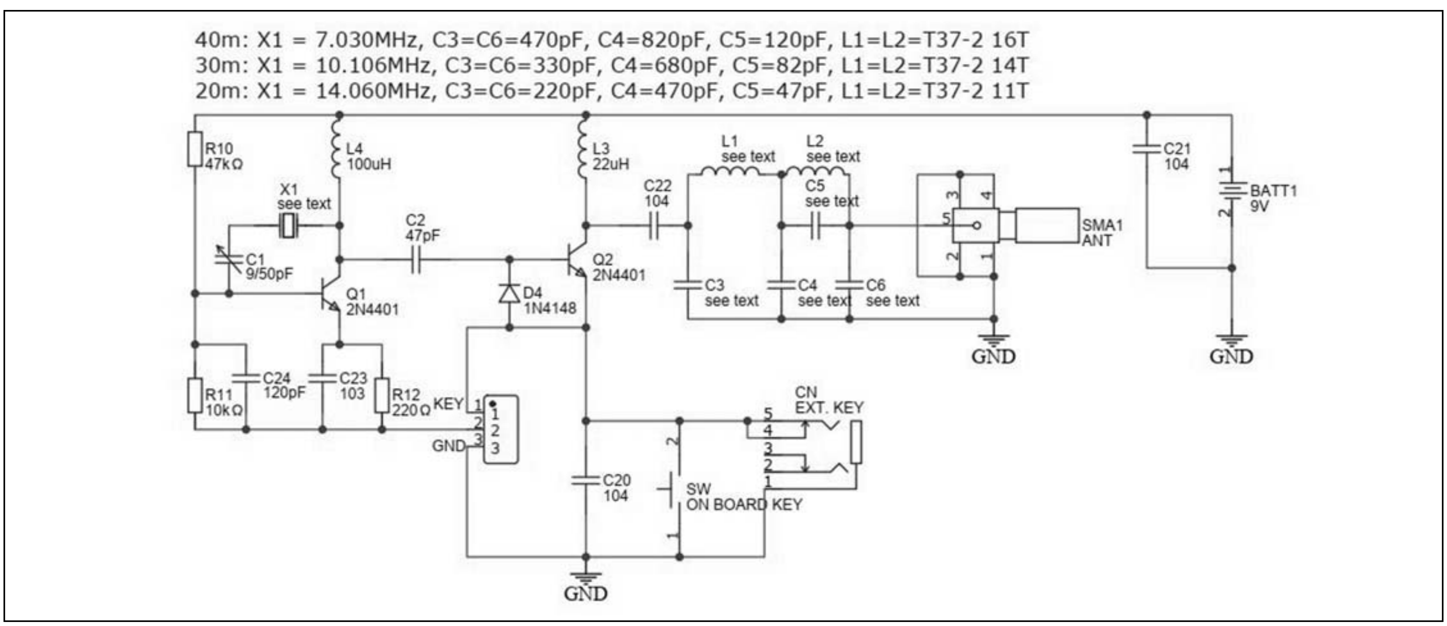

CPK-4 schematic.

An Easy-to-Use Remote Control for a Magnetic Loop

Hiroki Kato—AH6CY

The magnetic loop antenna has become very popular among portable QRP operators over the past 10 years or so. It is relatively easy to construct and, for its compact size, is quite effective. Many hams have been home-brewing theirs and there are now several commercial models available.

As many have discovered, there is one common problem in using the magnetic loop. That is, unless it is remotely tunable (as some expensive commercial models are), it is difficult to precisely tune for lowest SWR. This is because body proximity affects the tuning. If you tune the capacitor for lowest SWR while standing next to the antenna, as soon as you move away it can go slightly off-tune. The magnetic loop's tuning, by design, is very sharp, so radiation efficiency suffers even when slightly off-tune.

I have recently devised an inexpensive but very useable and easy-to-construct remote tuning system. The methodology is based on the phenomenon that when you connect two similar bi-polar stepper motors in parallel and manually turn one, the other turns exactly the same way with very negligible delay. Turning one motor generates sufficient electric current to turn the other. No external power source is needed.* See Figure 1.

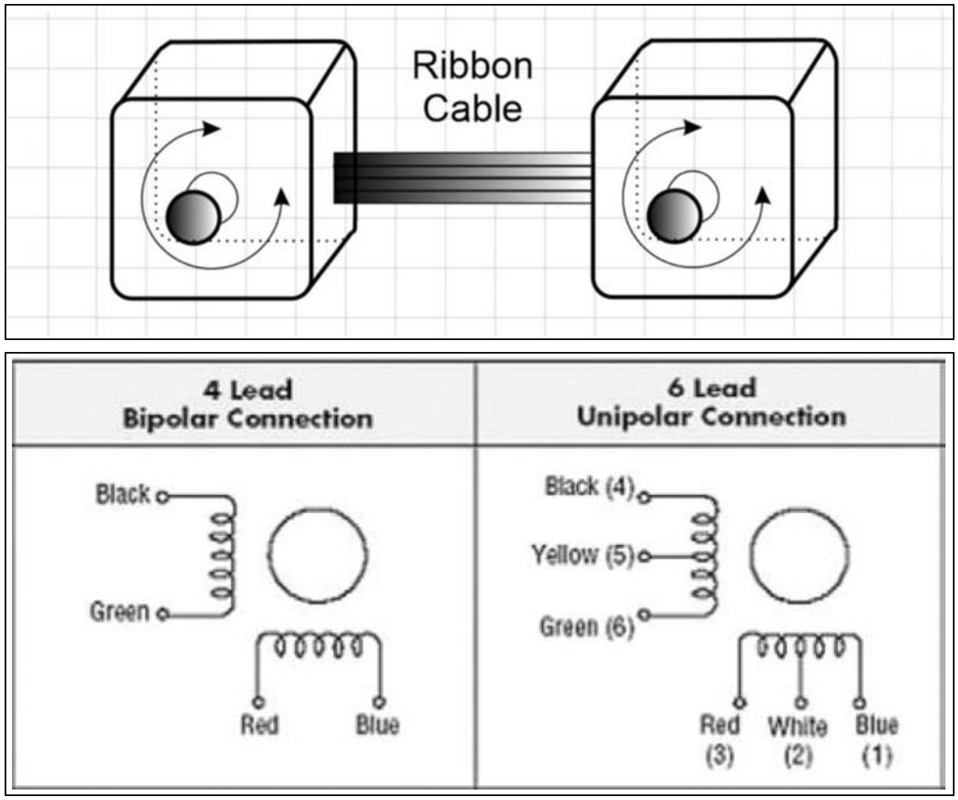

Figure 1—Top: turning one motor manually causes the other to turn likewise. Bottom: Basic motor wiring diagrams.

There are many varieties of stepper motors. My test motors are seen in Figure 2. For our purpose, you need only 4 wires to make bi-polar parallel connections, even when one or both of motors are uni-polar variety which have 5, 6 or 8 lead wires. Keep in mind that there are several color coding schemes used for lead wires by different manufacturers. When you connect two motors with different color set of wires, be sure to select the correct 4 leads. Figure 3 is a table of motor connections.

I have tested a number of combinations of motors to see how much torque I can get. In general, any two identical motors such as the NEMA17 and 5618X series of motors can produce sufficient torque to turn the motor. If you want to use different

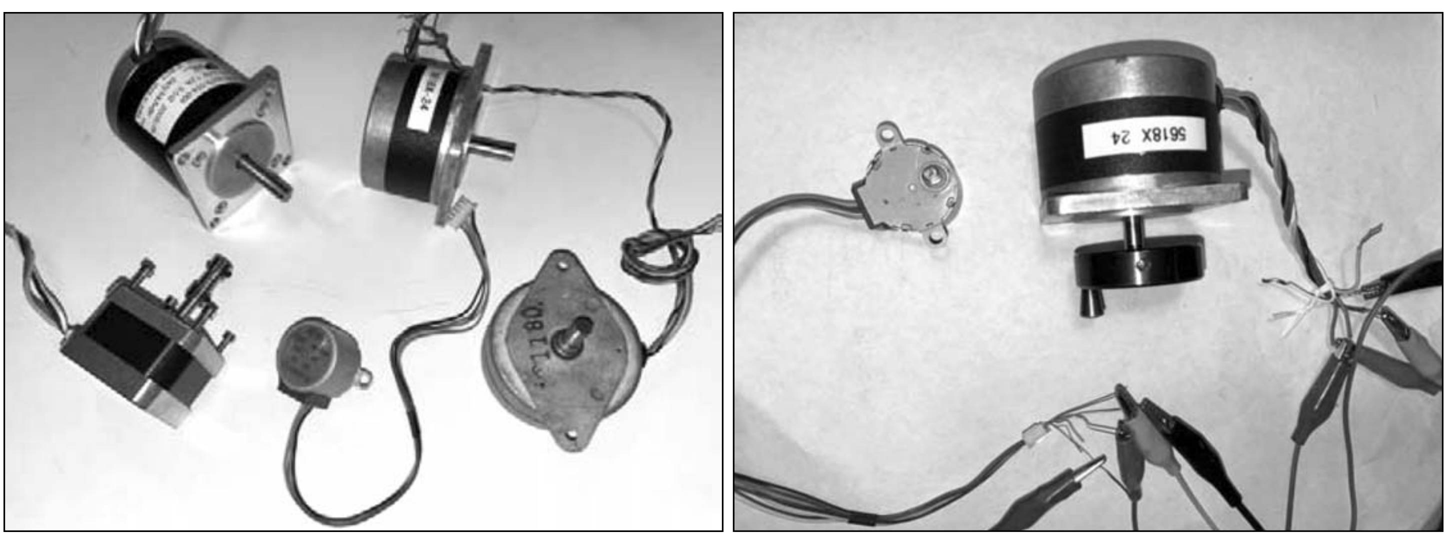

Figure 2—Testing the motors. Temporary connections are shown in the photo on the right.

4 LEAD WIRES	1	2	3	4
Color Code 1	Red	Blue	Green	Black
Color Code 2	Brown	Orange	Red	Yellow
Color Code 3	Red	Red White Stripe	Green	Green White Stripe
Bipolar Driver	A	$\overline{A}$	B	$\overline{B}$

6 LEAD WIRES	1	2	3	4	5	6
Color Code 1	Red	White	Blue	Green	Yellow	Black
Color Code 2	Brown	Black	Orange	Red	White	Yellow
Color Code 3	Red	Black	Red White Stripe	Green	White	Green White Stripe
Bipolar Drive Half Coil Connection	A	$\overline{A}$		B	$\overline{B}$	
		$\overline{A}$	A		$\overline{B}$	B
Bipolar Drive Series Connection	A		$\overline{A}$	B		$\overline{B}$
[illegible]	A	A/C Comm	C	B	B/D Comm	D

Figure 3—Motor connection data.

Figure 4—The original AlexLoop.

motors, you need to test which combination works best.

My first construction presented here is a remote tuning system I built for the popular AlexLoop magnetic loop antenna which does not have a remote tuning capability**. I used a 5618X-24 stepper motor, which I had in my junk box, as a control motor and a small 24BYJ stepper motor (for 5V application) to turn the capacitor. The 24BYJ has a built-in 64:1 reduction gear which produces ideal precision and smoothness to tune the AlexLoop. The 24BYJ's shaft is 5 mm in diameter and the AlexLoop's capacitor shaft is 6 mm in diameter, so you need a 5 mm-to-6 mm shaft adapter coupler. The base support to attach the 24BYJ to the AlexLoop's tuning box is made of two Lego pieces. The 4-wire cable is a speaker cable for stereo connection and is 10 feet long. The 4-terminal wire connector is an old Jones connectors that I happened to have, but you can use any 4-wire connector. If you were to build this remote system using only the off-the-shelf components, you should be able to build it for about $20 total.

Figure 4 is the original AlexLoop. Figure 5 shonws the AlexLoop with the remote tuning system installed. Figure 6 shows the construction details.

My second home-brewed loop antenna with a remote controller was built with nothing but the repurposed parts from my junk box. While the AlexLoop is strictly for QRP operation — 10 watts maximum power — this loop can be used for 100 watts.

The capacitor is a vintage butterfly unit with 60 pF capacitance. The reduction gear (20:1) is a repurposed dial tuning mechanism from a BC348 WWII American military radio (Figure 7). The control knob on one of the motors is also from the BC348 radio. The motors are two bi-polar steppers salvaged from a broken 3D printer. The large loop is 3 feet in diameter and is made of 1/2" diameter soft-copper tubing. The small copper loop is from an old refrigerator.In Figure 8 you may also notice hardware from an old Erector set.

Figure 5—Here is the AlexLoop with the remote tuning system installed.

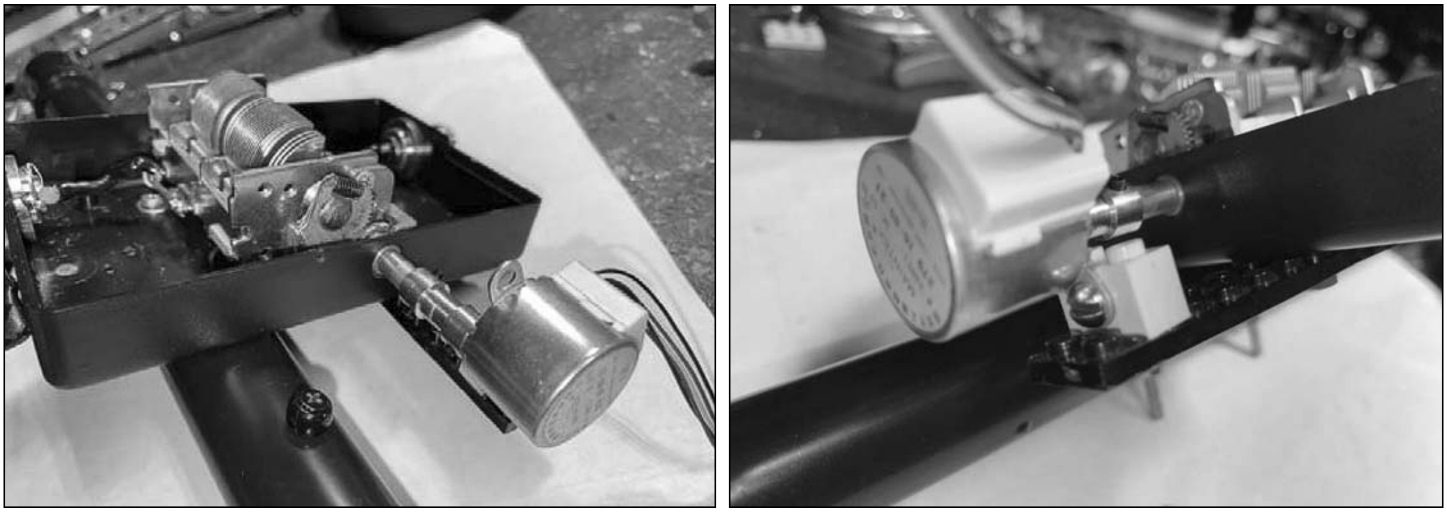

Figure 6—These photos show how the motor is attached to the AlexLoop.

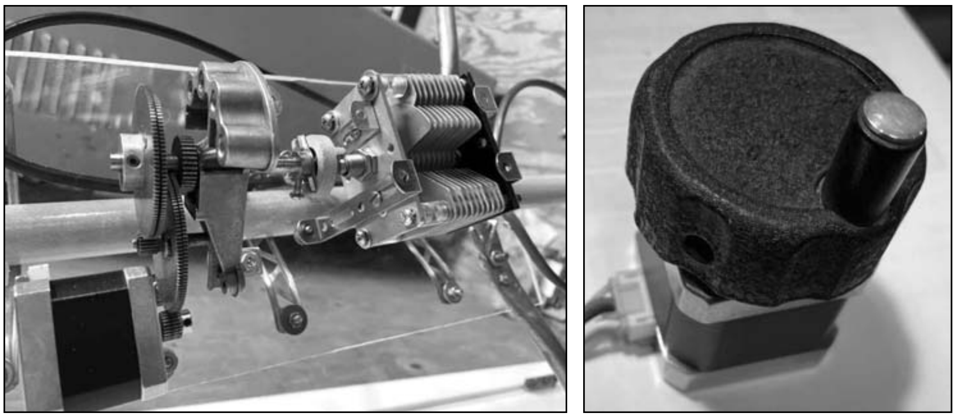

Figure 7—The 20:1 reduction gear and the tuning control knob are taken from a BC348 WWII military radio.

The home-brewed antenna covers the 17, 15, 12 and 10m bands. By using higher capacitance, you can easily extend the coverage to the 20, 30 and even 40m bands, bearing in mind that the lower the frequency the less efficient the magnetic loop antenna becomes, given the same size radiating (outer) loop. The diameter can be changed to suit the desired frequency coverage.

The antenna's remote tuning system turned out to be a pleasure to use: smooth, precise and effective. This one is going to be a keeper!

Notes

*I owe my friend Jeff Reagan, AJ6WX, credit for the discovery of this electromechanical phenomenon and his suggestion that it could be used for a remote tuning system.

**The latest model of the AlexLoop offers a remote control as an optional accessory. It costs $399.

***I wish to thank Eric Norris, NF6S, and his wife Cindy, David Varn, KM6RI, Rich Bonkowski, W3HWJ, Phil Sittner, KD6RM, John Swartz, WA9AQN, for their help to prepare for this article.

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Figure 8—Field test of the second loop in a public park in Palo Alto, California.

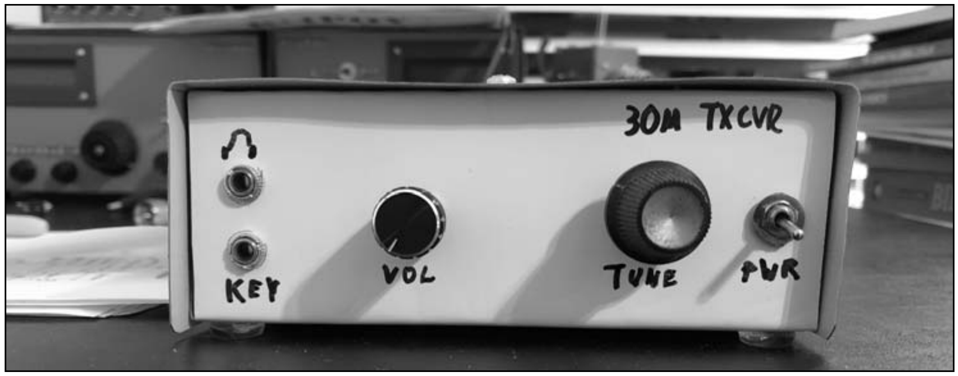
A Simple 30 Meter Direct Conversion Transceiver

Will Harris—KI4POV ki4povhomebrew@gmail.com

The SC-30 Project

Earlier this year, I found myself thinking about a beginner friendly homebrew rig, and what that would look like if I were designing for my younger self. There have been many designs published that aim to fill this role, with varying degrees of success. There is a balance to strike for such a rig between simplicity and functionality. On the one hand, the bare minimum requirement to make contacts might be little more than a crystal oscillator and a single FET regenerative receiver, but even experienced operators would find this an extremely challenging setup to use on a regular basis. Younger hams with less experience are more likely to be turned off by such an experience than motivated to keep pursuing homebrew and QRP. On the other hand, it's easy, as we design and build these rigs, to let "feature creep" get the better of us. A rig that is nominally targeted towards the beginner builder can end up having so many bells and whistles that the schematic becomes overwhelming for beginners, perpetuating the idea that homebrewing is only for an elite few.

A beginner-friendly homebrew rig, then, should strike the balance between being so simplistic that it ceases to be useful on the air (I'm looking at you, PIXIE…) and so complex that potential builders are scared away before even starting. What follows is my take on a simple CW transceiver that is practical for daily casual operating, but simple enough for the beginner builder. CW was chosen both for easier design and construction and for its efficiency at QRP power levels.



Front panel of the SC-30 transceiver.

Design Goals

As I thought about the specific design goals for the rig, there were a few features that I knew I wanted to include.

• *PLL frequency control* — My number one design criteria was to use the si5351a, along with an MCU like the Arduino or Pi Pico for frequency control. The si5351a has three outputs that can be independently controlled to output a square wave from 8 kHz to >150 MHz. It is both stable and frequency agile. No need to make new builders struggle with operating crystal-controlled rigs. From a construction point of view, building the Arduino/si5351a combo is scarcely more complicated than building a crystal oscillator, which is what I often see beginners instructed to do, and is much more useful.

• *Direct Conversion Receiver* — in the interest of simplicity, I opted for a direct conversion receiver. It provides ample sensitivity and a clean sound that is difficult to replicate with a superhet receiver. Also, it eliminates the need to worry about building or buying IF filters.

• *Solid State T/R switching* — Solid State T/R switching is a small detail that can make the difference between a CW rig that is a joy to operate, and one that fatigues you quickly. Nobody wants to listen to the constant chatter of a relay, or even worse, be constantly switching a manual switch.

• *At least 1 watt output* — Everyone seems to have a different power level that they consider the minimum to consistently make contacts. Hardcore Milliwatters might scoff at anything over 1 watt, while others may want 5 watts. My personal experience is that with 1 watt and a reasonable antenna, I can consistently make contacts with good signal reports, depending somewhat on the band and conditions (more on band choice later.)

• *30 Meter Band* — I needed to decide on what band to build for. 40 meters is a perennial favorite for QRP activity and with good reason. It's nearly always open. With the current sunspot cycle, higher bands like 20, 15, or 10 were also tempting. I ultimately decided on 30 meters, which I consider to be the perfect band for a rig like this. 30 meters, like 40, is open to somewhere nearly all day, and much less cyclical than 20. 30 Meter antennas are smaller and more manageable than 40 meter antennas. Also, 30 meters has a 200 W PEP output limit and no contests, making it an ideal band for casual QRP CW. For those that would prefer 40 meters,

	C1	L1	C2, C4	C3	C5, C6	C7, C9	C8	L2, L3	L4, L5
40 M	47 pf	11.4 uH	68 pf	8.2 pf	56 pf	470 pf	820 pf	3.9 uH	1.5 uH
30 M	33 pf	7.9 uH	27 pf	3 pf	33 pf	330 pf	680 pf	3.9 uH	1 uH

Table 1—Component values for 30M and 40M. For the 30 meter version, L1 is 39 turns wound on a T50-2 core. L2 and L3 are 27 turns wound on a T50-2 core. L4 and L5 are 14 turns wound on a T37-6 core. Note that if you use the popular toroids.info website to calculate the number of turns, it will recommend more turns than I used. I find that the online calculator tends to overestimate the necessary number of turns slightly. My recommendation is to wind the number of turns recommended by the calculator, then use an LC meter or a NanoVNA to adjust turn spacing or remove turns until the desired inductance is reached.

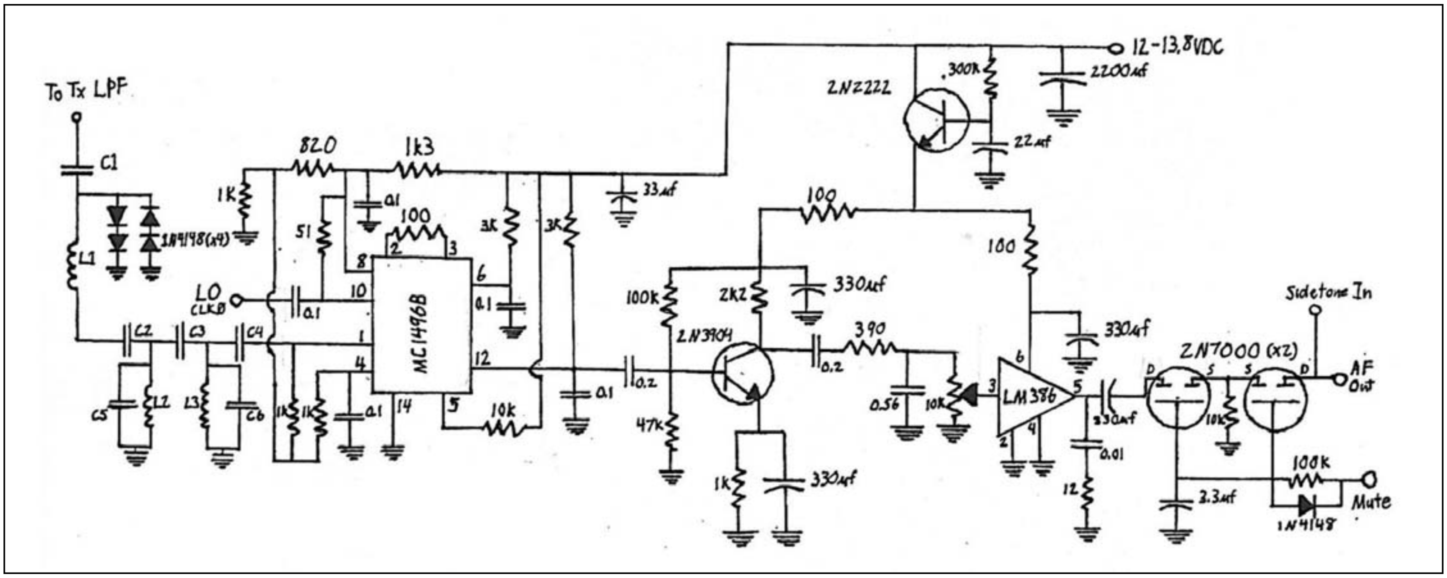


Figure 1—Schematic of the receiver section.

changing the band is a simple matter of rescaling the bandpass and lowpass filter, then changing a few lines of code. Alternate component values are provided in Table 1.

• *Use Commonly Available Parts* — As much as possible, I wanted to use parts that are cheap and readily available. All transistors are garden-variety small signal NPN or switching MOSFETs. All of the ICs are cheap and readily available from numerous sources. The MC1496 product detector, while probably not in everyone's junkbox, was chosen for its price and because it is much easier to get than the more well-known NE602.

The Receiver

With these basic goals in mind I started with some block diagrams and then built the receiver portion. The receiver starts with a 2nd order doubly terminated bandpass filter centered on 10.1 MHz. The signal then passes into the product detector stage, based around the MC1496.

The MC1496 is an older IC that essentially consists of a Gilbert Cell Mixer. It is functionally very similar to the NE602. I decided to use this part for a few reasons. First, it's cheap, and readily available in a through-hole DIP package. Second, it eliminates the need for winding transformers for a diode ring mixer. Third, it provides modest conversion gain, reducing the gain requirements for the AF portion of the receiver. Unlike the NE602, most of the biasing for the MC1496 is external, meaning that it does require more external resistors to set up. The schematic for the product detector section is pulled almost directly from the datasheet (Figure 1).

The audio section starts with a common emitter preamplifier that is fully bypassed at audio frequencies. The output from the preamplifier feeds into a very simple lowpass audio filter with a 3 dB rolloff at 730 Hz. The purpose of the filter is not so much to provide audio selectivity as to roll off the high frequency signals above 2 or 3 kHz. While it does little to nothing for selectivity, it does make the receiver much more pleasant to listen to.

The final amplifier is an LM386 with the schematic again pulled directly from the datasheet. There are undoubtedly better parts available, but the goal here was to utilize the most readily available parts. Importantly, the infamous gain boost capacitor between pins 1 and 8 is omitted. The extra gain is not needed, and omitting the gain capacitor greatly reduces noise.

Both the audio preamplifier and audio amplifier are powered from an active decoupling circuit borrowed from W7EL's "Optimized QRP Transceiver" schematic. This simply circuit helps prevent noise from the Vcc line being picked up and amplified by the high gain audio stages.

The Transmitter

For the transmitter section, I went back to the same design that I used for my main rig a couple of years ago. It is simple, easy to build, and relatively rugged. See Figure 2. The si5351a is keyed via the Arduino to provide the oscillator. This is then fed into a 74HC04 hex inverter as the buffer and driver amplifier. The signal is fed into the first inverter gate, whose output is then fed back into the other 5 gates connected in parallel. The output of the 5 parallel gates has an impedance of around 12-15 ohms as measured on my oscilloscope. This is sufficiently low to directly drive the base of the NPN Class C final amplifier. The final amplifier consists of 3 TO-92 2N2222a transistors in parallel running class C to a 50 ohm load on the collector. Each of the transistors has a small piece of copperclad PCB epoxied to the flat side of the case as a heatsink. The output from the collectors is then run through a 5th order Chebyshev lowpass filter to the antenna. This transmitter is broadband by design, and I have used this exact lineup successfully on 80-15 meters. Because of its broadband nature, low pass filtering at the output is a must.

The Digital Board

One of the keys to the simplicity of the schematic is to utilize the Arduino as much as possible for features that would otherwise require extra hardware. The Arduino controls keying, frequency output, sidetone, and sequencing for the T/R switching, besides controlling the si5351a. Most of these features are accomplished directly from the Arduino's I/O pins. The heart of this section is the Arduino Nano.

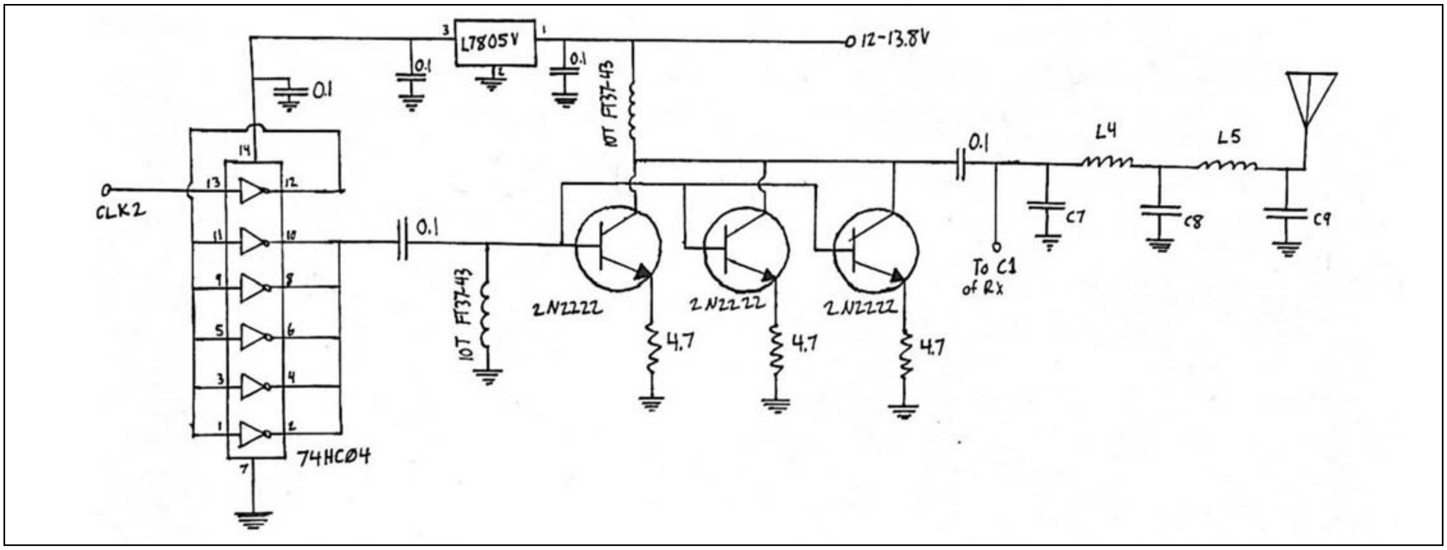


Figure 2—The transmitter circuit. See Table 1 for lowpass filter component values.

There has been a push recently to move away from the ATMega328P-based MCUs to more capable options like the ESP32 or the Raspberry Pi Pico and its variants. All of these MCUs are more than capable and would make fine substitutes. I chose the Nano because it;s what I had sitting in my junkbox, and I already had some code for it to drive the si5351a. The si5351a board is controlled by I^{2}C from pins A4 and A5, controlling the data and clock lines, respectively. Both boards receive power from a 5V regulator mounted on the digital board. The schematic is shown in Figure 3.

One obvious omission with this section is the LCD or OLED display to show frequency. I elected to use a different method of frequency output for this rig. I wanted the front panel to be simple and easy to fabricate. Round holes are easy enough for anyone with a hand drill, but the large square cutout for a display can be a bit more challenging! Also, I didn't want the current draw of a backlight or the inconvenience of having to tilt the panel to the right angle to read it. Instead, the frequency is sent in morse via the sidetone output when the center button is pushed on the rotary encoder. The code is set to truncate the first three digits, only sending the last one or two since they are the only ones that will change. For instance, “10.105” would be sent as just “5.” Similarly, “10.115” would be sent as “15.” I’ve found that this is both functional and unobtrusive for a small rig like this.

The Nano also controls muting and does some rudimentary T/R sequencing. When the transmitter keyed, the Nano first mutes the audio output through pin D7, then disables the clock output to the receiver product detector, then enables clock output to the transmitter, then enables sidetone. On key up, the process essentially happens in reverse. This helps keep the sidetone clean and free of any pops or thumps when keying.

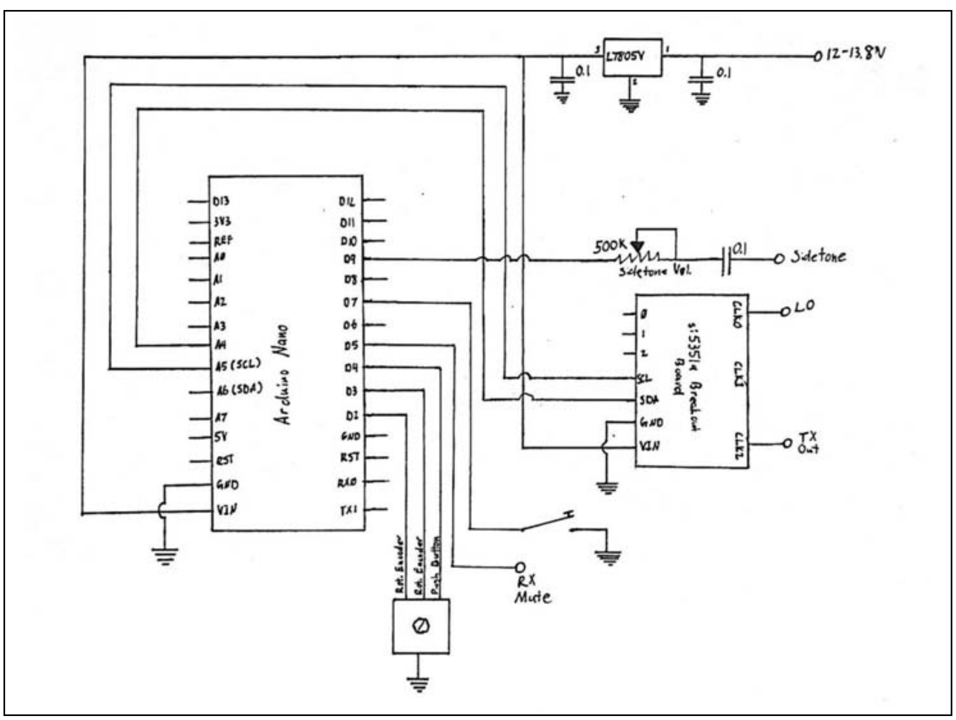


Figure 3—The digital/fequency control section.

Muting and Sidetone

Muting is handled by a pair of 2N7000 MOSFETs at the output of the LM386 audio amplifier. I found that when placed at the input of the LM386, which is more conventional, the LM386 was picking up RF on transmit and causing a noisy, harsh sidetone during sending. While a different layout or more isolation between modules might have helped this, I found that simply muting the output completely cured the problem. Sidetone from the MCU is injected right at the output of the mute switch. Sidetone volume may be adjusted from the trimmer pot on the digital board.

The Code

The sketch for the project can be downloaded from:

https://github.com/KI4POV/SC-30

I won't go into great detail here on the code, but I'll give some general comments on it. First, my code to drive the si5351a and read the rotary encoder is based on a sketch that Charlie Morris, ZL2CTM wrote and published on his blog. I've used his code as the base for nearly every rig I've built, adding and modifying to suit my needs. I've tried to comment the code well to make it readable and easy to follow.

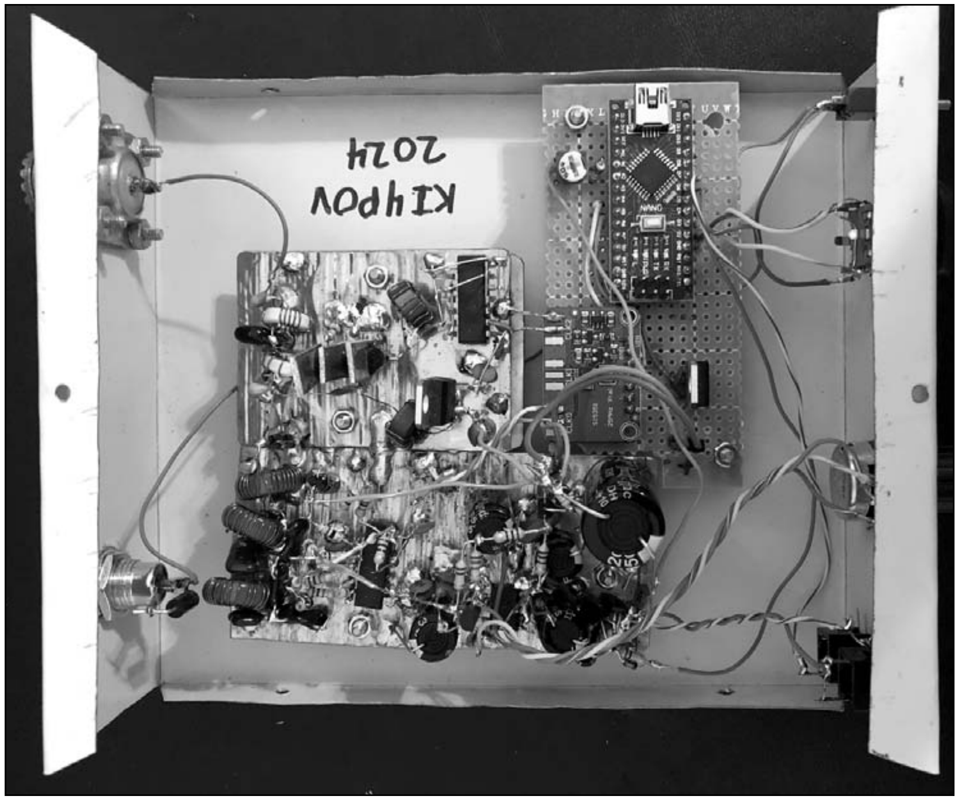
This sketch uses the Etherkit si5351a library written by Jason, NT7S, who deserves much credit for making this part easy to use for the average builder. I also used his Etherkit Morse library for the morse frequency output. I was not familiar with this library until I started doing research for this project, but this is a powerful library that has all kinds of applications for beacons, keyers, etc.

The tuning step is set to 50 Hz by default. For simplicity's sake, I have not included a way to adjust this externally as I found that 50 Hz was about the right step to tune through the band smoothly and not have it sound jumpy, but also tune across the band reasonably quickly. This can, of course, be changed in code to whatever tuning step you would like.

Construction

The accompanying photos show the inside of the rig from various viewpoints.

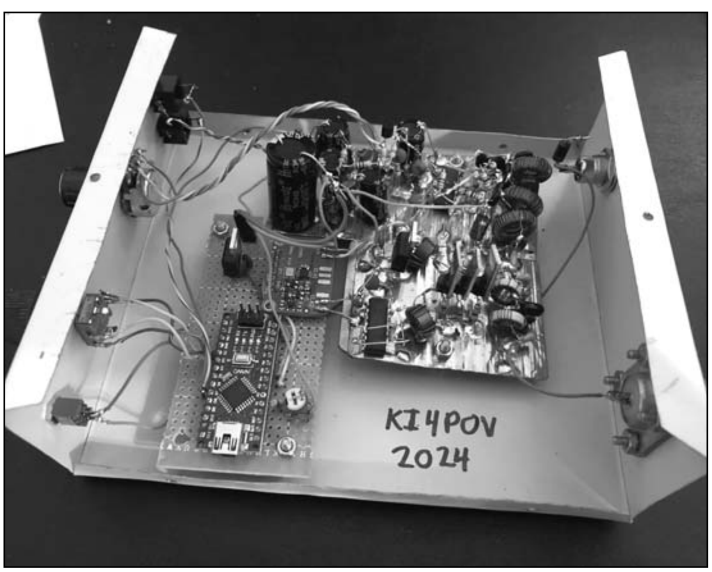
This transceiver was designed and built in three distinct modules: the digital board, the transmitter, and the receiver. I highly suggest that the rig be built in this order. Building the digital board first will give a tunable oscillator that can be seen on an oscilloscope or heard on the station transceiver. Once the digital board is completed, the builder has a choice of whether to build the transmitter or receiver board first. The transmitter board is far simpler, and can be built in an evening. This, combined with a simple manual T/R switch can be used with an existing receiver to start making QSOs with your own homebrew transmitter. The receiver can then be built on a separate board and attached to the transmitter board to complete the transceiver.

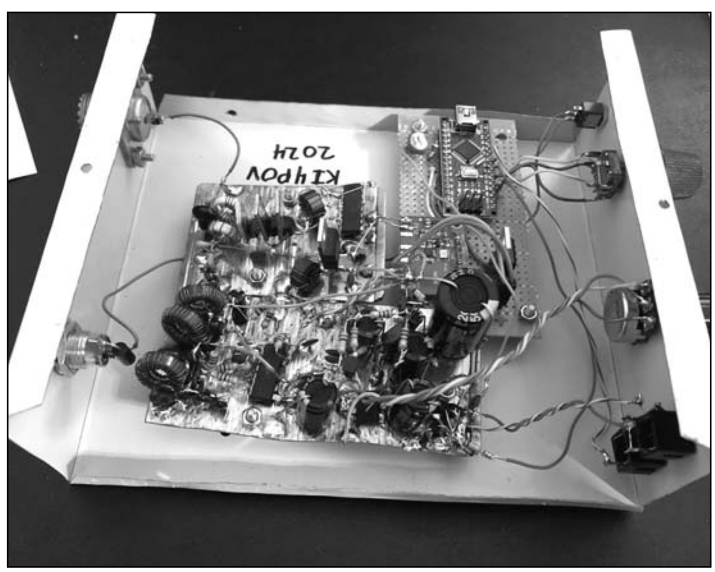


Both the transmitter and receiver boards are built "ugly" style, with the ICs on their back "deadbug" style. The digital board is built on perf board.

For the receiver section, I highly suggest starting with the LM386 audio amplifier. Once this stage is built, it can be tested simply by connecting a speaker and power. The builder should hear a hum in the speaker when touching the input on pin 3. Once that has been built and tested, the 2N3904 preamplifier stage can be added and tested in the same way.

While not terribly difficult, building





the MC1496 product detector stage is probably the most challenging part of the assembly. If this "beginner-friendly" build has a shortcoming, it is the need to set up external biasing resistors for the MC1496. Due to the physical layout of the IC, there are a couple of resistors that need to cross over the IC body. There are at least two ways to approach this. If the builder is comfortable with perf board construction, this shouldn't present any great challenge. I elected to build the section "dead-bug" style to integrate with the ugly construction for the rest of the RF sections. I recommend that the builder snip off pins 7, 9, 11, and 13 of the MC1496, which are all N/C, or no-connects. They serve no function and removing them makes the other pins better spaced and easier to solder to. Once that was done, I placed the chip on its back with the 8-14 pin side facing the audio preamp. Solder pin 14 directly to the ground plane to anchor it while you build the rest of the stage. For the resistors that need to cross over the body of the chip, some short lengths of insulated hookup wire make wiring much easier.

Operating

Operation of the transceiver is simple, but perhaps some brief explanation is in order for those who have never operated a direct conversion transceiver before. The transmitter frequency is the frequency that is output on the sidetone frequency output. The receiver frequency is offset 650 Hz higher to account for the necessary offset for CW. Because the receiver is direct conversion, the signal being tuned in will be audible on both sides of zero beat. In order to properly tune in a station, it is necessary to tune to the upper signal. This means either tuning from the top of the band down, or tuning through zero beat to the upper sideband. This sounds more complicated than it is, and anyone who has used a Heathkit HW-8 will be familiar with this operation. Once you are listening to the right sideband, the station can be zero-beated by pushing the frequency readout button and matching the station's tone to your sidetone. The code is set so that the receiver offset and the sidetone are both 650 Hz. Of course, because of the 50 Hz tuning steps, you may not be able to exactly match the other station, but I've found that 50 Hz is close enough for most operators.

This rig is a definite step up from the "toy" transceivers that we sometimes see. (Don't get me wrong, I enjoy those too!) I have had many solid ragchew QSOs within the continental US with this rig. My best DX so far has been Belgium when he replied to my CQ on what I thought was a dead band!

Conclusion and Further Ideas

My goal was to build a simple transceiver that prospective builders could build in modules. I estimate the total parts cost for this rig to be >$30 if all parts are bought new. A reasonably well-stocked junkbox would reduce that price significantly. I make no claims that this is the end-all be-all in performance, but it is functional enough to use on a regular basis without the frustration of being rockbound.

For the experimenter, the possibilities for expansion and modification abound. Some ideas include:

- Adding an LCD
- RIT
- Additional audio filtering
- Alternate product detectors (diode ring, cascode JFET, etc)
- Adding a keyer to the Arduino code

The basic architecture can be used as a testbed for all sorts of ideas.

I should acknowledge a couple of people before closing. While I did not consult him for the building of this rig, Pete Juliano has been a great resource for me (and many others!) and in particular has helped to bring the previously obscure MC1496 back into public consciousness with his use of it in several projects. The muting circuit used in the receiver is taken from G4TGJ's excellent webpage. I'd also like to thank Pete Eaton, WB9FLW, who encouraged me to finish this article and graciously provided his proofreading services.

One final note, I'm neither an engineer nor a programmer. I'm a pharmacist by day. For the readers who are thinking "there's a better way to do _____", you are almost certainly right. That being said, it does work, and hopefully will encourage prospective builders who don't have a professional background in electronics to venture into homebrew. ●●

A Note to Prospective Authors

QRP Quarterly always needs useful, interesting stories and projects. It is the best place to share your ideas, and to learn from other active QRPers!

As you look at each issue, you can see that there is a wide variety of content—SOTA and POTA adventures, reminiscences of the past, reviews of new radios and accessories, and construction projects of all sorts.

Many of you have stories (large or small) that fellow QRP enthusiasts might find interesting. We'd like to present them to the QRP ARCI membership!

To begin, you can just run an idea past the Editor (or one of the Associate Editors) with a quick e-mail. See the staff list on the left. It's even better if you can put together an outline, or maybe a rough draft of your idea for an article. Our staff will help you as much as needed with preparation. We do professional editing, and also clean up drawings and touch up photos. An interesting, readable magazine is our goal.

Thanks in advance from the editors of *QQ*!

Field Day at Barr Camp, Colorado

Paul Signorellli—WØRW w0rw777@gmail.com

Barr Camp is a wilderness cabin midway on the Barr Trail which goes from Manitou Springs, Colorado, to the top of Pike's Peak. They provide camping space for hikers, cook up breakfast and dinners, sell candy and supplies, and have a bunk house.

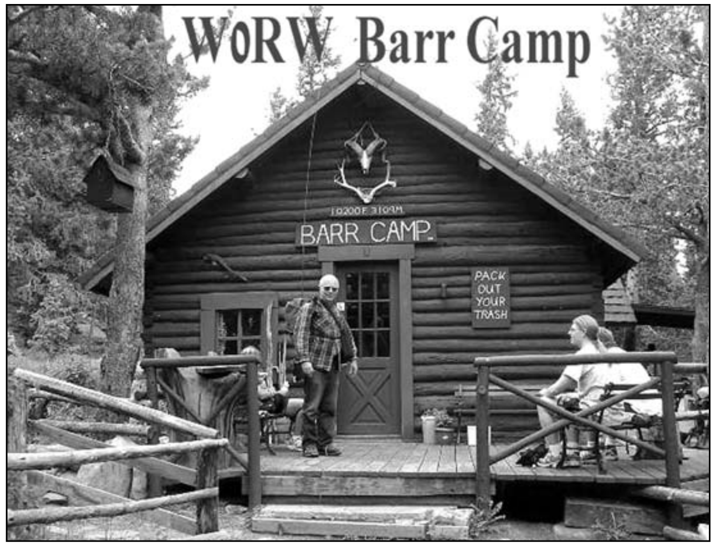
It is like a mountain oasis, There are picnic tables and a bench swing that is set by the stream to comfort the tired hikers. The cog railway took me up to the halfway station (Mountain View) and I hiked across the face of the mountain to the camp. When I arrived every one came by to inspect my radio operation.

I let them talk on the radio to several other hams on VHF. Then I set up my PRC319 on the picnic table and began working Field Day stations on 20M SSB using a 10 foot whip. Conditions were good and I worked a lot of stations.

There is a map and hiking information at the web site: https://barrcamp.com/

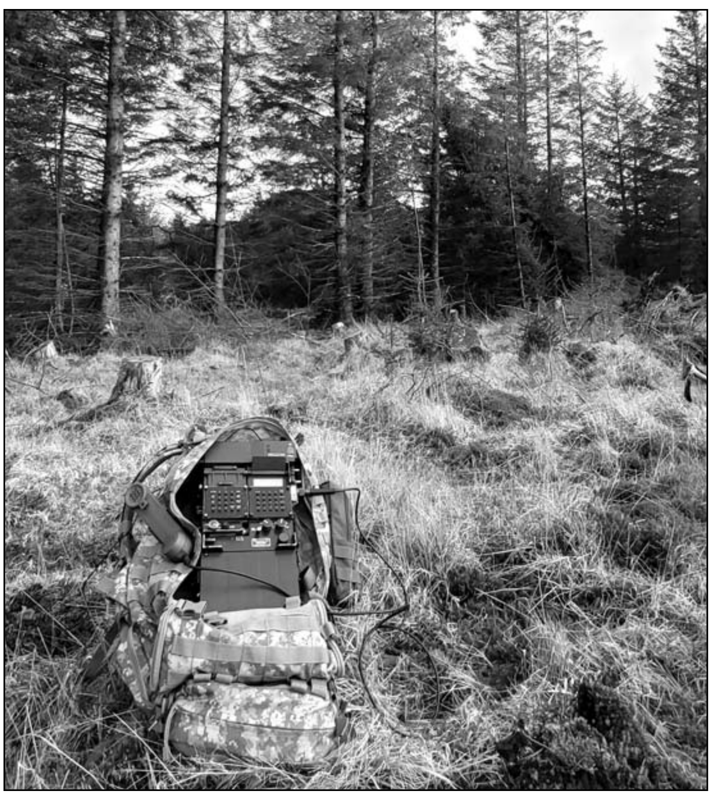
Barr Camp is approximately 6.5 miles from the trail head in Manitou Springs. Elevation gain is 3,800 feet, and the camp elevation is 10,200 feet (3,109 meters). You can expect a 20 degree temperature difference between the bottom of the trail and Barr Camp. Pikes Peak is an additional 6.5 miles from Barr Camp, and the trail climbs another 3,900 feet to the summit at over 14,000 feet (4,301 meters). Expect another 20 degree change in temperature and extreme weather changes such as high winds, thunderstorms, and snow.

There is no AC power or drinking water at Barr Camp, but there is a stream at the entrance to the camp from which you can treat or filter your own water. There are also two outhouses. ●●

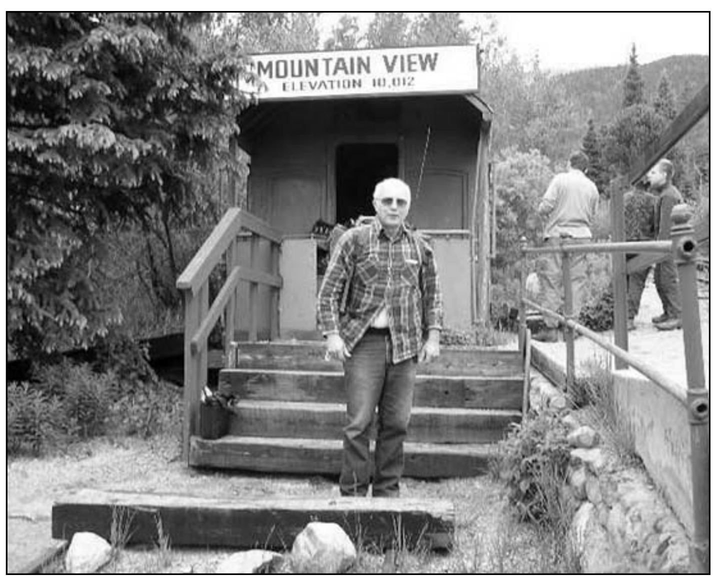


The Barr Camp wilderness cabin.

I took the cog railway up to the halfway point (below).



The PRC319 radio used for Field Day HF operation.



Mountain View is the halfway point.

Upgrading the (tr)uSDX Transceiver

Dale Parfitt—W4OP parinc1@frontier.com

Most, if not all of our readers are likely aware of the diminutive (tr)uSDX transceiver. This transceiver is a collaborative project by PE1NNZ and DL2MAN. The kit I purchased in April of 2022 was under $90 and was capable of CW/SSB/AM/FM and digital modes on 80/60/40/30/20M. Typical RX current drain is 80mA and TX drain of 500 mA. Newer versions can cover 80/40/20/15/10M or 20/17/15/12/10M. At 13.8 VDC the transceiver typically puts out 5W, and 0.5W if powered by 5 VDC. If you do the math you can see that the transmitter section is very efficient. This is due to running the P.A. in class E mode. The firmware is quite complete in that it allows for selecting filter bandwidths (50 Hz to 3 kHz), AF Gain, Two VFOs, Selectable AGC, RIT, Tuning steps, Keyer speed and options: Noise gate, SWR bridge, CW decoder and CW messages. By the way, the CW decoder is one of the best I have seen. The OLED display is small but entirely usable. There is a built in speaker and microphone. All of this in a 3.5×2.4×0.8" package. A photo of the (tr)uSDX is shown in Figure 1.

Full information is at: https://dl2man.de/

Building the transceiver was very straightforward using the online documents. If you do have a problem, there is a very active users group at: https://forum.dl2man.de/index.php

While I liked the rig, a few things occurred to me:

1. I did not really need a rig that was so small that it would fit in my shirt pocket
2. A dedicated AF Gain control (as opposed to the menu AF Gain control) would be handy
3. The internal speaker overloaded at even moderate audio levels
4. An internal battery pack would make portable operation a lot simpler. I can be forgetful.
5. Lighted pushbuttons would be nice for night time operation.
6. A sun shield would help in seeing the display when operating day time portable.

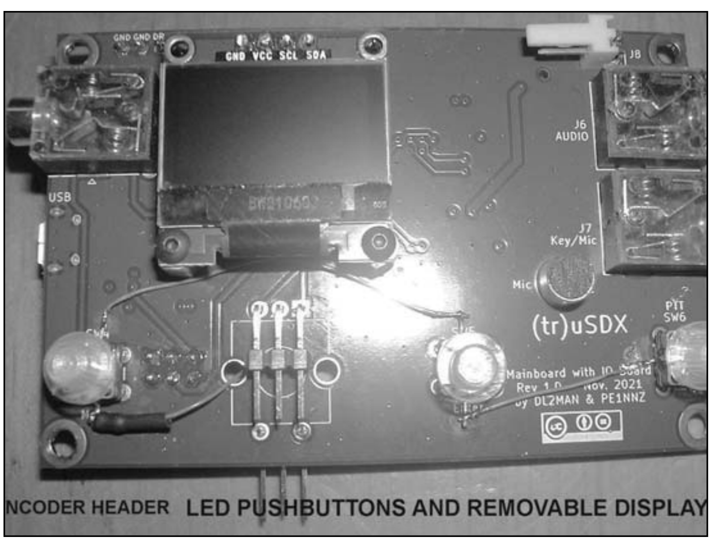


Figure 2—The digital PCB.

Figure 1—The (tr)uSDX transceiver.

The digital PCB is shown in Figure 2. I wanted to repackage the unit and include the upgrades listed above.

I selected an extruded enclosure from Lansing Enclosures in Ithaca NY, although Amazon, eBay, DigiKey etc. have similar units. The lettering was done using laser water slide decals and multiple clear coats with 1200 grit wet/dry sanding between coats. This makes the decal edges invisible. One thing I discovered was that because the top lid was clear anodized, no clear paint (to protect the decals) would adhere to the anodizing. Removing anodizing is an arduous process due to its hardness. Lesson learned. The final front panel can be seen below in Figure 3.

I already had on hand a small LM386 audio circuit board and found a nice elliptical speaker on eBay. The board was small enough to epoxy to the magnet on the speaker. This solved items 2 and 3 on my list.

I went back and forth several times in selecting an internal

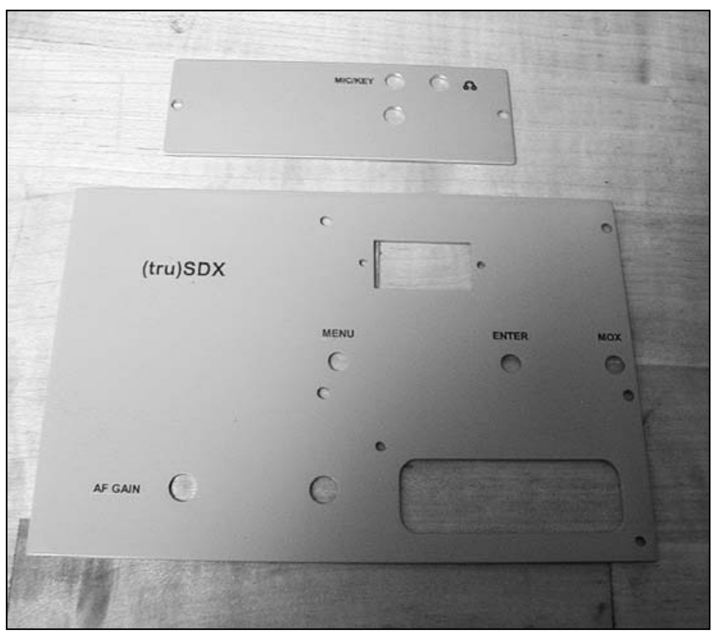


Figure 3—Final version of the front panel.

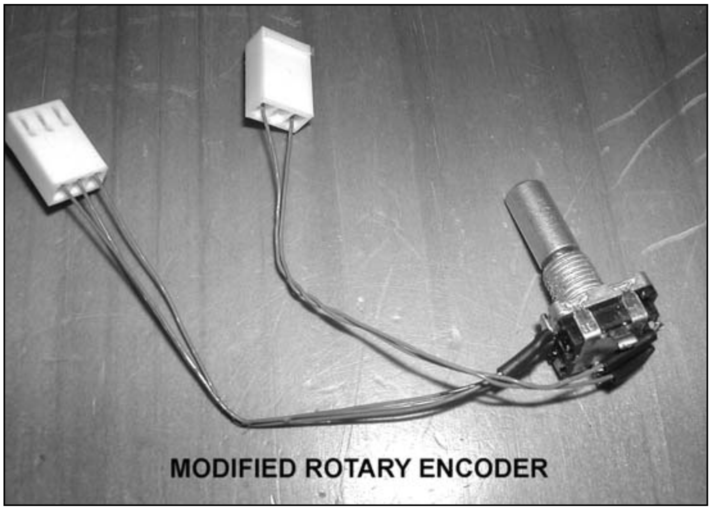


Figure 4—Connectors were added to the rotary encoder.

Figure 5—Front panel view of the upgraded unit.

battery pack; Lithium Ion or Nickel metal hydride. In the end I decided on NiMH because it is easy and safe to charge. The downside is that it is lower in energy density than Lithium ion. But I had sufficient room for a 12V, 1.6Ah pack from Batteryspace.com that would yield many hours of operation without requiring a charge. The mating charger was ordered from Batteryspace at the same time.

Some time ago, I had purchased some small LED illuminated momentary pushbuttons. While the switch pins were the same format as the original switches, I bent up the LED pins and surface wired them. I selected a series current limiting resistor for the pushbutton LEDs so they only draw several milliamps total yet are very visible at night.

The sun shield for the OLED display was fabricated on my mill from 1/4" thick aluminum plate. It is attached to the front panel by a pair of 2-56 screws into blind tapped holes on the rear of the shield. Those of you with 3D printers can undoubtedly print something even more effective.

The tuning encoder was removed from the PCB and a 3 pin right angle header was installed. This allowed me some flexibility in where to mount the tuning encoder on the front panel. See Figure 4.

I also make use of an external microphone. In this case an Astatic D104M6B hand held active microphone with an integrated gain pot.

As purchased the truSDX makes no provision for microphone gain. QRP SSB can be difficult enough. Having the ability to properly set the mic gain as high as possible without distorting can make a real difference in success.

The final change I made was adding a female SIP header to the main board for the OLED display. This not only allows for a quick change if a display goes bad (unlikely) but also allowed me to precisely set the height of the display against the front panel. So the header mating can be adjusted up and down a bit and the bottom edge of the display is now ridigly held at the desired height by (2) spacers and 2-56 button head cap screws and nuts.

The resulting rig is a real joy to use and constantly amazes me. While I am an inveterate CW op, I am fascinated while watching the internal CW decoder do its thing. Way back in 1973 I built a CW decoder from a *QST* article. It used some 25+ TTL IC's, and displayed a single crawl line of CW on a TV screen. As I recall the PCB alone was about 5" X10". The firmware was very clever, self adjusted for speed changes and arithmatically averaged received dot, dash and space lengths to accommodate hand sent CW. It did not work right off and as a result I learned a lot about digital ICs and the firmware. Today I compare that box to all that is done inside a tiny microprocesor and a color display.

Makes me feel a tad old. ●●

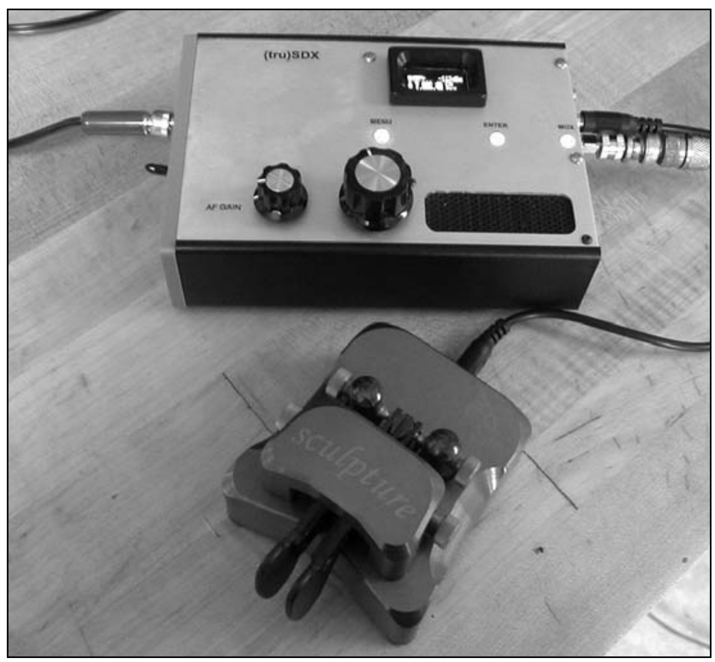


Figure 6—An overall view of the finished upgraded transceiver, ready to operate with a CW paddle. The new lighted switches are also visible.

Top 10 Junkbox Projects

Hans Summers—GØUPL http;//hanssummers.com

This article was a presentation at FDIM 2024. It is re-published in QQ so it can be seen by all member/subscribers. —Editor

In recent years I have been honored to present a seminar at FDIM and have talked about the design of various QRP Labs products. The products seemed to get ever more complex, up to last year's QMX announcement and design description.

After so much complexity gave me an ever-growing headache, I thought this year it would be nice to do something completely different! So let's talk about junkbox projects, the kind of project you can build with old parts you have in hand, or perhaps need to purchase a couple of parts for less than, say, $10. A project you could finish in an evening or a weekend, without any microcontrollers to program, or even any computers involved at all. Let's go back to basics!

Accordingly these are some of my favorite junkbox projects, perhaps you will enjoy building one too. If you haven't ventured away from kits before, or even done any electronic construction at all, herein are also some tips to get you started, and where to find stuff.

What's a junkbox project?

Firstly we need to consider what to define as a junkbox! This is our hobby so let's not get too bogged down in formal definitions. Many of us have old components lying around. They might be things that are found in old equipment we kept "because it might be useful someday", or perhaps old dismantled consumer items, or new unused parts that are leftovers from previous projects. Or, dare I say it, some parts from old projects we couldn't get working? I certainly have a more than a few of those…

So let's include ALL that and more. Because it's seldom that you'll see a small project described, and have every single one of its required components in hand. Often you have to buy something. I'll include say, a few parts which could reasonably be found for under $10 total, in the definition.

What if I have NO junkbox at all?

I've been collecting junk since I was about 3 feet high. To this day, I can't walk past a discarded old television in an alleyway without wanting, wherever at all possible, to pick it up and take it home, dismantle it for parts. Sometimes if it's being lying in the dirt for too long, you have to take it home and hose it down first, but that's OK. Most components don't mind getting wet, as long as you let them dry out before applying power.

For those of you who are just contemplating getting started in doing some construction for the first time, nowadays there are lots of resources for stocking up on bits and pieces.

Dayton hamvention is certainly a good place to start! The best hint for dealing with the fleamarket, is to look at the boxes UNDER the tables; they often have $1 written on them or FREE! and this is where you can sometimes find some very inexpensive sources of components.

If desoldering old components doesn't sound like your thing, and pristine new ones seem more attractive, go to: http://aliexpress.com or http://ebay.com or http://banggood.com or even http://amazon.com and enter search terms such as "Capacitor assortment", "Resistor assortment", "Transistor assortment" (or "capacitor pack" etc) and prepare to be amazed. For a few 10's of dollars you can get a complete ready-made well-populated junkbox with most of what you could ever need!

For specific parts needs, don't be afraid to order from Digikey http://digikey.com — it's a myth that postage makes it far too expensive. Digikey has no minimum order value and for small packages 3-day USPS shipping starts at $4.99.

Special components for our QRP transceivers

Despite all the above, there are some things you're unlikely to find in a junkbox, unless you have them left over from earlier QRP projects.

Crystals: Many simpler types of transmitters use a QRP frequency crystal (3.560, 7.030, 14.060 etc) and these are not frequencies you're likely to scavenge from any old piece of consumer equipment. The best US seller I know for this is KC9ON see https://kc9on.com/shop/ who has a pack available for $8.50 that has all the QRP crystal frequencies, a real bargain! The pack contains 3.560, 7.030, 7.040, 7.110, 10.106, 10.116, 14.060, 21.060, 18.096, 24.906 & 28.060 MHz. If specific bands are your interest or even single crystals, he has those too.

Capacitors: NP0 (or sometimes called C0G) ceramic capacitors are a type of inexpensive ceramic capacitor having a low temperature coefficient. This makes them particularly suitable for use in VFOs, where you want to minimize drift. However, less well known is that they are also required for transmitter output low pass filters! The NP0 characteristic is obtained by a certain type of dielectric called Class-I dielectric. Lower performance capacitors X7R and X5R are Class-II dielectrics. These are quite lossy at RF and result in low pass filters which have poor performance, attenuating a part of the transmitted signal and converting it to heat. That's why we need NP0 capacitors wherever possible.

Whilst you can buy sets of NP0 capacitors from eBay, AliExpress etc., I have not tried these personally and would worry about the uncertain quality. My favorites are Vishay brand and TDK brand NP0 capacitors from Digikey. As an example, look up part number BC1016CT-ND at Digikey, this is a 180pF 50V capacitor, one of the parts we use in QRP Labs kits. 50V rated capacitors are adequate for QRP projects.

For low pass filter designs you can use the QRP Labs LPF kit values http://qrp-labs.com/lpfkit or the G-QRP technical pages https://gqrp.com/technical2.htm

Toroids: Powdered iron toroids are a feature often seen in QRP projects. Compared to solenoidal (tubular) wound inductors, toroids have self-shielding, field-containing characteristics which make make them relatively immune to nearby components. To calculate the required number of turns for a given inductance, use https://toroids.info/ which can calculate any of the common powdered iron compositions. Typically type -2 material (red) is used for low HF and type -6 (yellow) for high HF. Lower losses at high HF can be used with even lower permeability cores like type -10 (black) and -17 (yellow/blue).

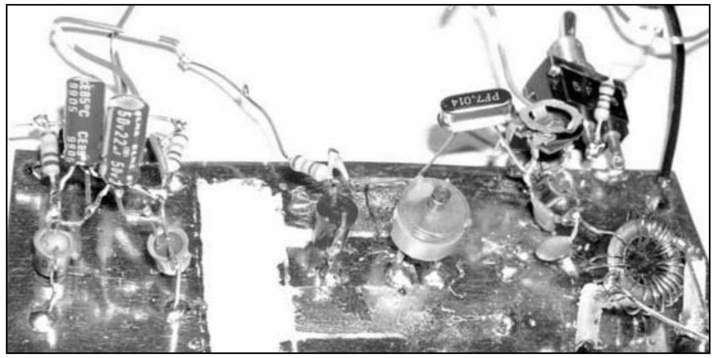
A great source of micrometals toroids is http://kitsandparts.com. I would caution against AliExpress and eBay etc non-micrometals toroids because I have found them to be of lower quality (less consistent permeability, dimensions and more lossy, particularly -2 material toroids). As for the capacitors, you don't want to be losing power unnecessarily in your filters.

The conventional rule of thumb for solenoidal inductors was that they should have at least 3 diameter's worth of empty area around them, so as not to alter their inductance value or pickup interference. Having said that, there's nothing wrong with winding inductors on an old plastic pen, or any convenient former, using an air core. Just remember that you probably can't make such a compact project. For many junkbox type projects that's perfectly fine! There are many online calculators where you can enter the coil dimensions and calculate inductance, such as https://www.66pacific.com/calculators/coilinductance-calculator.aspx and https://www.extremeelectronics.co.uk/calculators/solenoid-inductance-calculator/

Construction Techniques

For RF projects I don't much like plug-in solderless breadboards. There's a lot of parasitic inductance and capacitance which can get confusing at RF. When plugging in recycled components particularly, they often have some solder left on the leads which can create intermittent connections at all the worst moments. I prefer to use construction techniques involving unetched copper-glad circuit boards as ground plane, with all ground connections soldered to this groundplane. The result is excellent for RF, and you can even make it look quite good if you try. Best of all, you can change things easily while you are experimenting.

Unetched PCB is easy to find on eBay etc and is just fine.



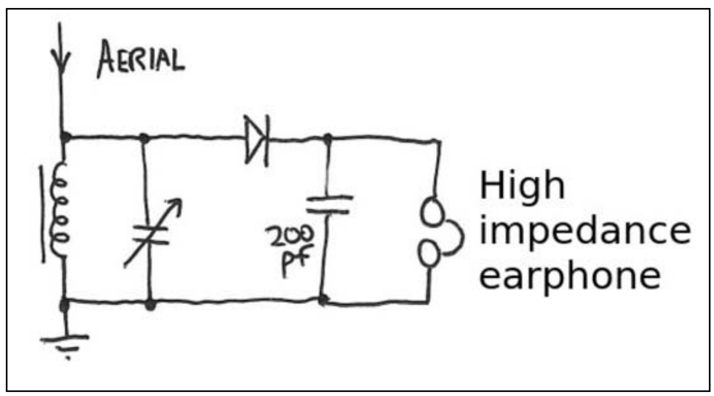
There are two types, SRPB is a kind of compressed paper material, it's quite brittle. Nowadays proper FR4 fibreglass board which is used in most professional quality PCBs is inexpensive and commonly available. You can cut it and drill it without fear of it cracking. It makes great front panels and enclosures too.

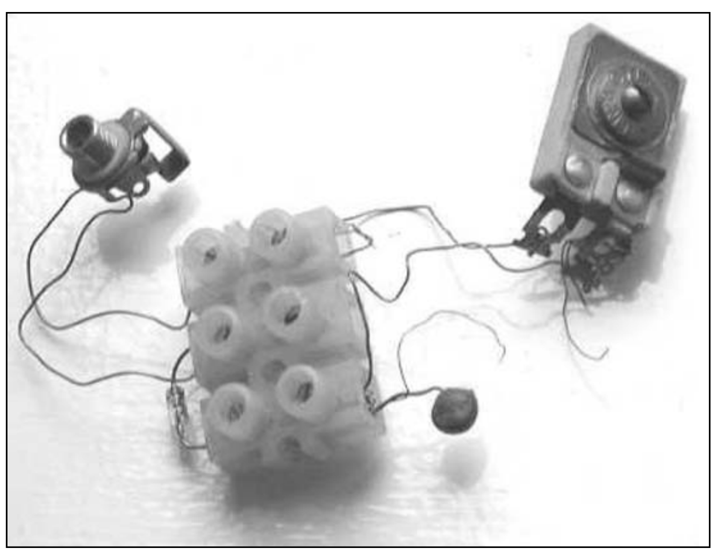
If stuck without some unetched PCB and you want to get really hard-core about the whole junkbox concept – you can even use recycled food cans as a circuit substrate! These usually are made of steel but coated in tin, which is very easy to solder to.

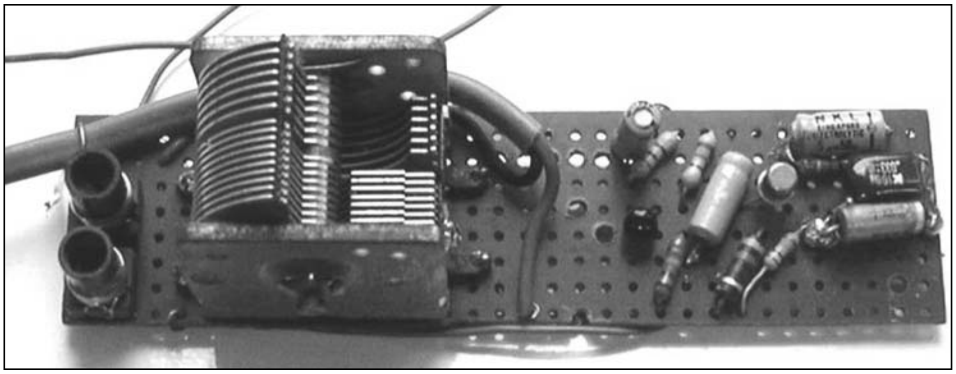
The Projects

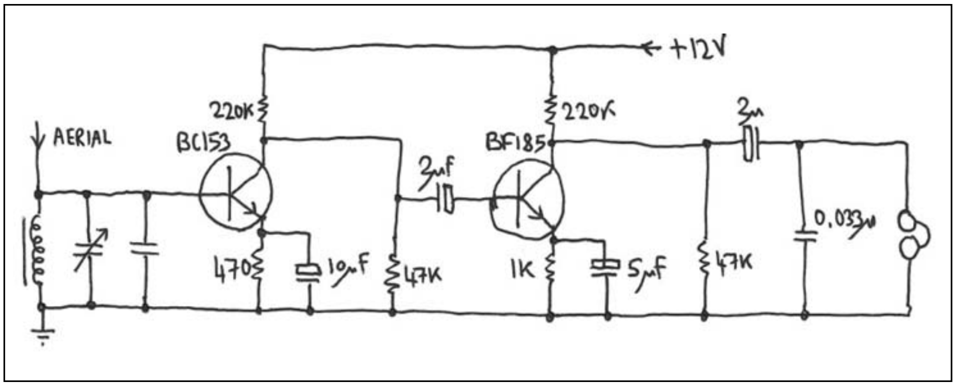
Now on to the projects, and I hope you find something that piques your interest. The sSelection presented here is sufficient to make a complete functional QRP station with various combinations of the projects.

10. Simple broadcast band RX









My first ever radio receiver project was a crystal receiver kit, on my 6th birthday. There's a coil on a ferrite rod former (not pictured), a variable capacitor tuned by a screwdriver, the all-important high-impedance earpiece, germanium diode, and a capacitor. It's pretty much just a tuned L-C circuit and a rectifier (the diode and capacitor). But with a few meters of wire this can actually receive medium wave broadcast stations! That was really amazing to me at the time. You'll quickly realize that the the volume is low and only the strongest stations can be heard.

An evolution of this circuit is to add a simple transistor amplifier. I was using the following as a shortwave broadcast receiver still well before reaching my teens. Which accounts for some serious "design" defects; yet, it worked! The schematic above is reproduced faithfully for historical accuracy despite the defects.

The schematic shows the actual components I used. 100% recycled junkbox components throughout, and absolutely nothing is critical. Almost anything you do, will work. The variable capacitor was scavenged too, with inductor values found by experiment. For an antenna I had around 150 feet of wire strung down the garden. It was surprisingly effective.

http://hanssummers.com/simple

9. Simplest possible dummy load and power meter

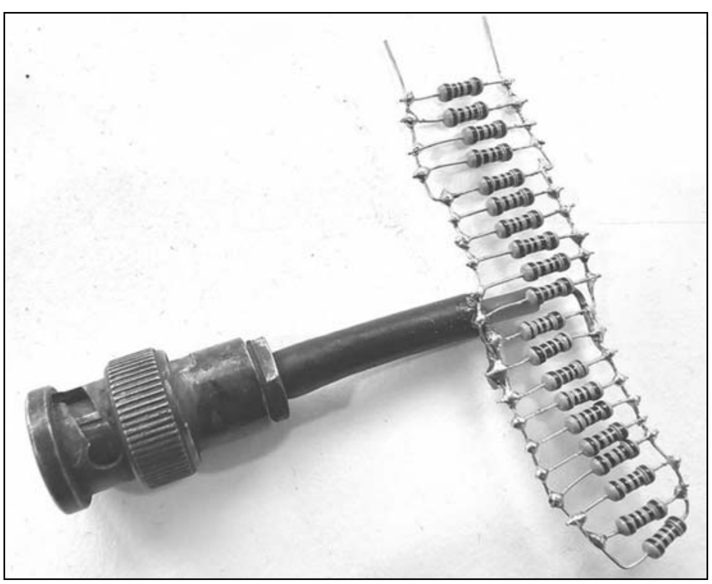
A dummy load is very useful when testing transmitters. The first thing you'll want to know about your transmitter is what the power output is. You'll never get a reliable value when using an antenna. So you need a good 50-ohm dummy load.

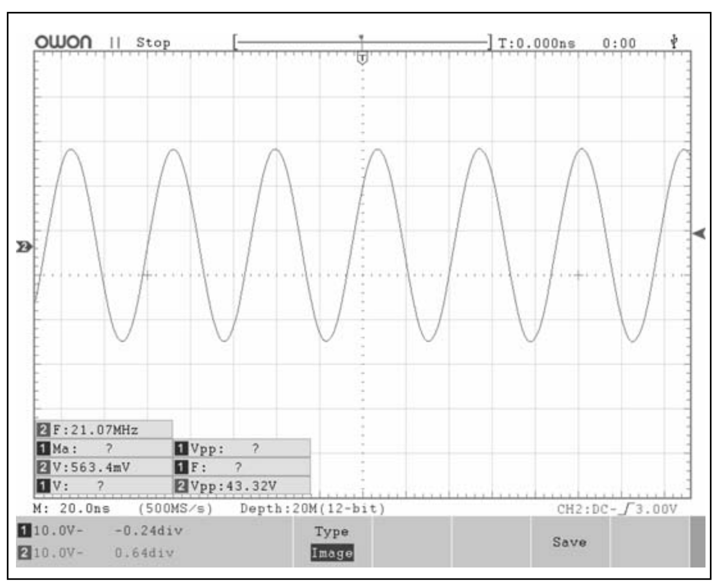
Nothing is simpler. Just get 20 1K ¼-Watt resistors and solder them in parallel. The resulting resistance is 50-ohms. Being ¼-Watt resistors, 20 of them in parallel will manage 5W, perfect for QRP. If you wish to use it with a radio having a BNC output connector, cut a BNC jumper cable and solder across that. If it's for use with your own junkbox radios you can do what you like. Now we are in a position to start thinking about measuring the power output of the transmitter. If an oscilloscope is available, connecting a 10x probe across the dummy load will allow you to measure the peak-peak voltage. Then use the formula:

Power = Vpp * Vpp / 400

So in this particular case showing a 15m (21 MHz) transmitter output, Vpp is shown on screen as 43.32V. This equates to a power of 4.7W.

If no oscilloscope is available, a simple half-wave rectifier using just a single 1N4001 diode and 0.01uF capacitor (or any other convenient diode and similar capacitor: nothing is critical) may be used, then a DMM in DC 20V setting to measure the voltage. It's measuring peak voltage rather than peak-peak voltage. The graph below (top of next pge) can be used to find





the power corresponding to the indicated DMM reading. It won't be as accurate as a 'scope, because the diode has a certain voltage drop and a non-linear characteristic, and all that varies from one diode to another too. But you can see that at 4.7V the indicated 17.58V is pretty close to what you could estimate from the graph.

8. Simple power meter

After building your junkbox transmitter you'll want to measure its power output. You can use the dummy load + DMM method as shown previously; if you want a standalone power meter it's also quite easy to build.

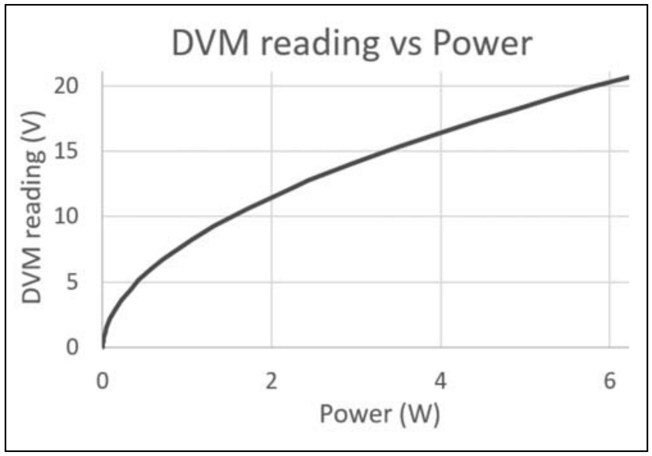
The diode type isn't critical. The 100K trimmer is used for adjusting the full scale deflection range of the meter. Fixed resistors and some trial and error could be used. For calibration you'll need to refer to some other measurement; an oscilloscope measuring peak-peak voltage is best if you have an oscilloscope available; or the DMM method from the previous section could be used. In the picture you'll see a meter I calibrated for about 0 to 350mW.

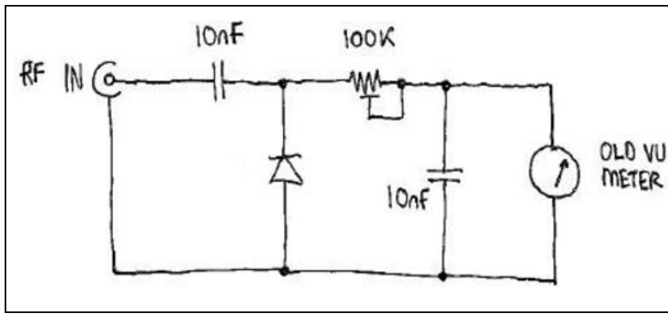
More: http://hanssummers.com/powermeter

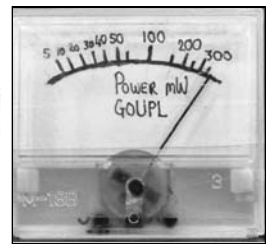
7. L-match ATU and SWR meter

An L-match ATU is about the simplest type of ATU you can build and requires a switched inductor and a single variable capacitor. For this project all the components except the enclosure, were junkbox salvage.

The inductor was wound on a piece of 35mm diameter plastic pipe about 90mm long (not critical). The antenna side has 48 turns with a tap every 4 turns, selected by a 1-pole 12-way rotary switch. The transmit winding is 16 turns on the "cold" end of the coil, as shown in the schematic.



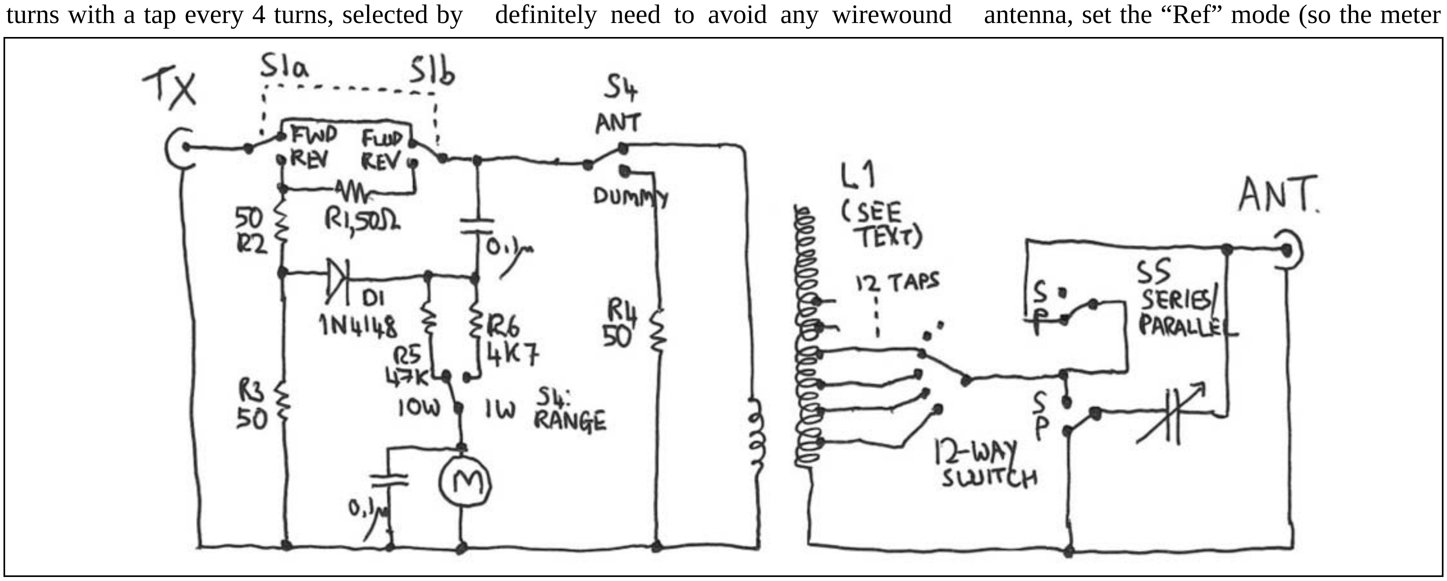


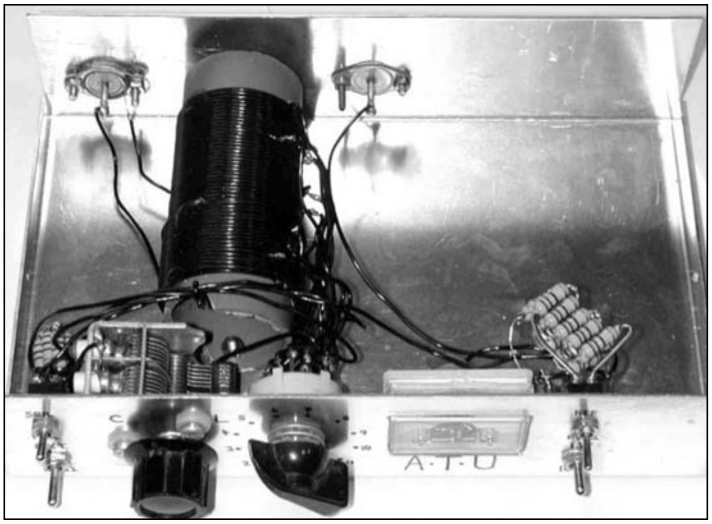


The resistance bridge dummy load is used only during tune-up, and the meter then shows the reflected power, During normal transmit operation, the meter shows power output. The 50-ohm resistors in the SWR bridge need to be capable of handling 5W QRP power, so again you could simply parallel 20 ordinary ¼-Watt 1K resistors. Or if larger powered resistors are available, various series/parallel combinations could be used; such as five 10-ohm 1W resistors in series. But remember that carbon film resistors will be best; you definitely need to avoid any wirewound resistors which will also have an inductance, that will mess up the functioning of the SWR bridge. Parallel combinations of resistors (20x ¼-W 1K for example) are better than series combinations, because a parallel combination REDUCES the stray inductances.

The ATU also has a DPDT switch to select a Series-LC or Parallel-LC combination, which is suitable for matching different types of reactive antenna loads. On my build I also had a 1W / 10W full scale power switch.

The ATU has always served me very well with a variety of random longwire antennas on 80-20m bands. To tune the antenna, set the "Ref" mode (so the meter





shows reflected power), choose a middle inductance L-tap with the 12-way switch, and sweep the variable capacitor C from one end to the other (180-degrees rotation). You'll find that at some setting of the capacitor, the reflected power will dip. Then try again with another L-tap selection. There will be an optimum L-tap switch setting that produces the deepest and sharpest null of the reflected power. Hopefully the needle will drop almost near to zero. That's when your antenna is best matched! You can see what works best, Parallel or Series-LC configuration. With a little practice it takes only a couple of minutes to tune the antenna and you don't need any fancy equipment like antenna analyzers or VNA's.

There's also a funny story about this ATU. I was licensed in 1994 but didn't do anything until 2002 by which time my Morse was rather rusty. The all-homebrewed, mostly junk-box station was set up, only on 80m on 3.560 MHz, and imagine how nervous I was. The ground connection was a crocodile clip on the heating radiator, the antenna was a random wire in the attic. I CQ'ed for hours and hours and nothing happened. Blaming conditions (as we tend to do!) I tried again the next day with the same result. Perplexed, I wrote to the G-QRP club forum, then on YahooGroups. I mean, I know QRP is supposed to be hard, but is it really supposed to be THIS hard? And OK so I did homebrew this station, but did I really do SUCH a bad job?

Larry G4GZG kindly listened out for me as did a number of others, and Larry replied to my CQ with a 559 report starting my ham career with a fabulous DX of, well, 12 miles…

Scratching my head still I went back and checked the entire station. Finding, to my horror – that I had mislabelled the Fwd/Rev DPDT switch on the ATU! So when I thought I was tuning up in "Ref" mode, I was really transmitting into the antenna, and adjusting the L-C match for MINIMUM radiated signal, and worst possible SWR. Then to operate, I was in Reflected power mode, with much of the power dissipated in the resistive SWR bridge and the rest improperly matched to the impedance of the wire!

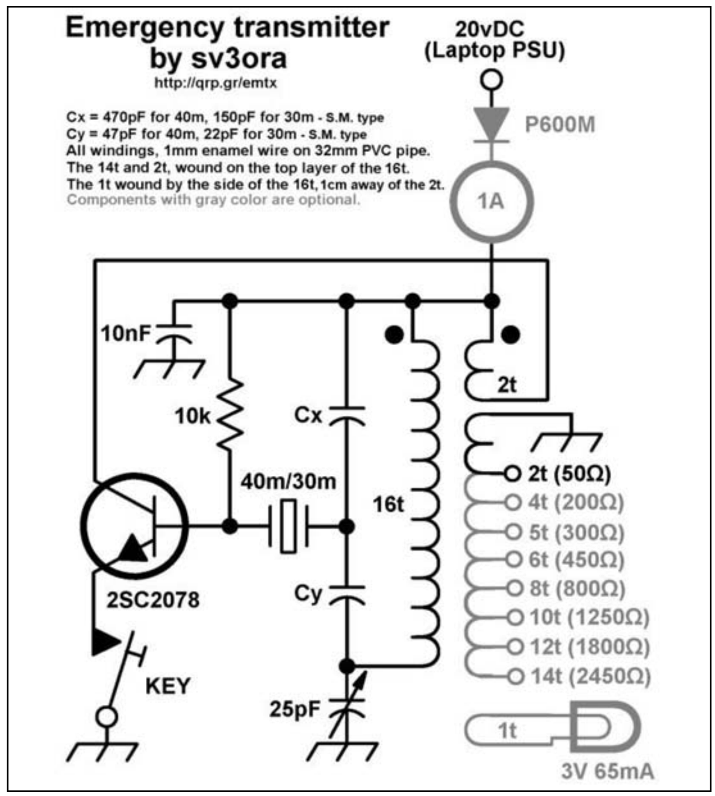
Shocked, I hastily corrected it and tried again. Of course, suddenly everything became MUCH easier and now I could QSO with stations around Western/Northern Europe. As well as further afield in UK.

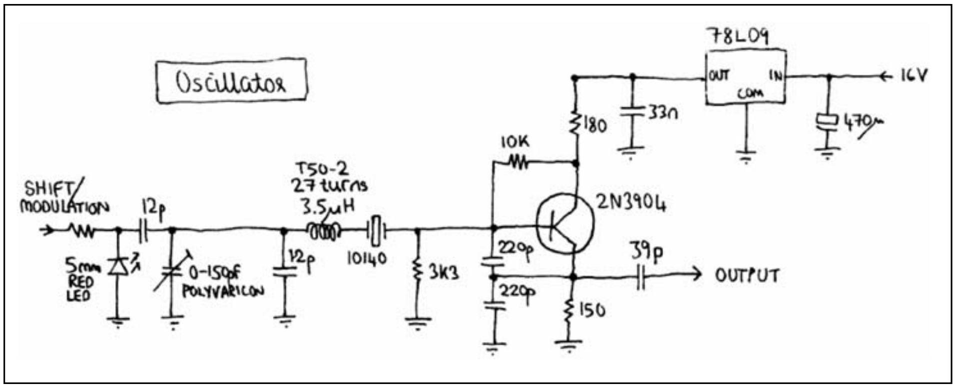
More information: http://hanssummers.com/atu

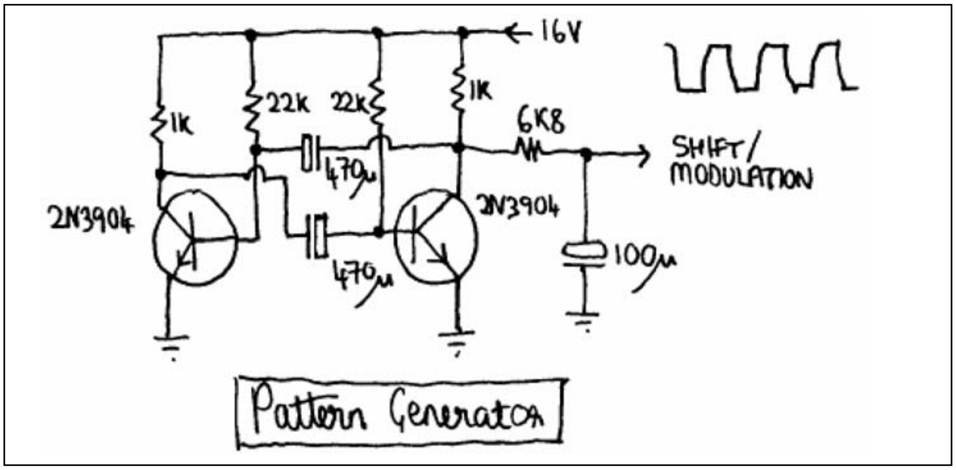
6. EMTX: Emergency Transmitter

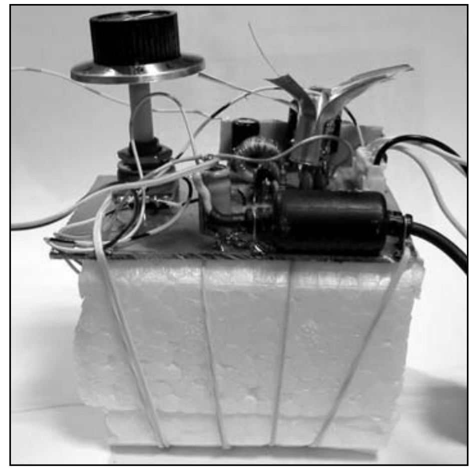
Next up is a great project by my friend Kostas SV3ORA. He has a fantastic website which will be sure to inspire you: http://qrp.gr/index.htm – filled with lots of simple to build, low parts count discrete-component projects. Perfect for the junkbox theme!

Kostas' EMTX design is a minimalist 5W transmitter for 40 or 30m, using less than 10 components! The 2SC2078 transistor he









specified was a common choice for old CB transceivers. You can find these in the junk boxes under the tables at the Dayton flea-market sometimes, for a $1. Lots of other similar NPN power transistors would also work fine. The 2SC2078 with 20V DC supply gives over 10W output. Lower supply voltages, lowering the output to around 5W (with say 12V or 13.8V supply) would be more "QRP" and also reduce chirp due to the crystal heating.

See Kostas' page for lots more information: http://qrp.gr/emtx/ - he did a really beautiful construction job of his EMTX, very professional looking!

My own implementation is admittedly in a state of somewhat poor repair or I should say, ongoing experiment. I build it on an empty 1kg enameled copper wire spool. All junkbox parts.

Kostas has another page about the transmitter too, where he describes some extensions like AM modulation and touch keying – I have not tried any of these – see http://qrp.gr/minimaltx/

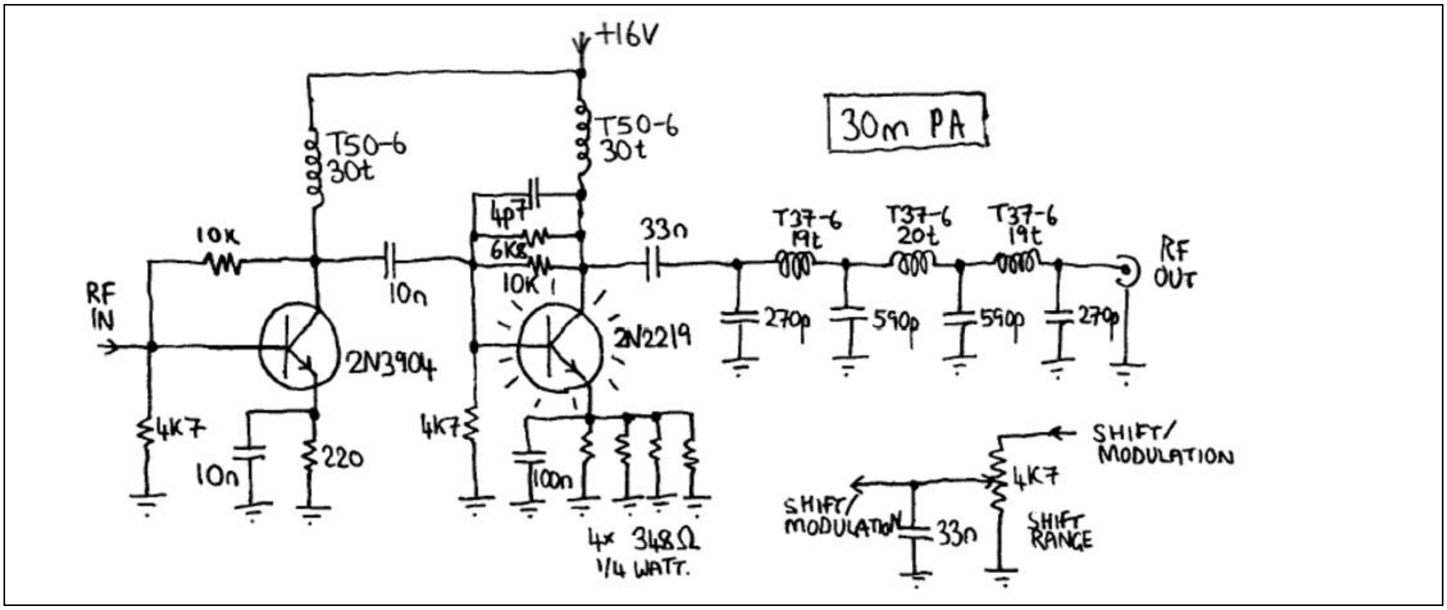
5. Junkbox QRSS beacon

QRSS was one of my first loved niches of amateur radio. Very slow Morse, which due to its slow speed is decoded at the receiving end by Fourier transform software such as Argo or SpectrumLab or others. Other than the 10.140 MHz crystal, the rest of the circuit was made up of entirely junkbox components and designed as I went along.

The first section is the oscillator; as was my habit for many years, I used a 5mm red LED as a poor-man's varicap/varactor diode! They work very well. In this case the "varactor" diode applies a small frequency shift to the oscillator, providing frequency shift keying modulation capability. The circuit is just a Colpitts oscillator. The 9V regulator in the supply, and encasing it in polystyrene for thermal insulation, help keep the frequency stable which is very important for QRSS transmissions.

The power amplifier has a driver and PA stage followed by a G-QRP Labs design Low Pass Filter, the same filters later became QRP Labs kits http://qrp-labs.com/lpfkit and produced about 350mW of RF power, when using 16V from an old laptop power supply to run it.

Frequency shift keying (FSK) modulation was generated using this simple astable multivibrator circuit. Nothing about the transistors used is critical! The components shown provide for a few seconds keying in each state. Later 2200uF capacitors were added parallel to the 470uF capacitors, increasing the total cycle time to about 25 seconds. The "height" of the FSK is 3 or 4 Hz. The antenna was just an indoor attic dipole! The screenshot above shown, is a fragment of the Argo screen capture of David VK6DI via longpath (approx 25.500 km / 16,000 miles). A funny story goes with this project. In June 2006 I went to visit David VK6DI at his home in Perth Hills, a 45 minute drive outside Perth, West Australia. I stayed with David and his XYL for more than 3 weeks. On my arrival some time after midnight after a 24 hour flight (with Singapore stop) from London, I met David waiting for me at the airport. We drove out in the pitch black to his house. After London, I'd never imagined such blackness and so many starts. On arrival we went straight upstairs to his shack, switched on his monitor and there was my junkbox beacon signal clear on the screen,



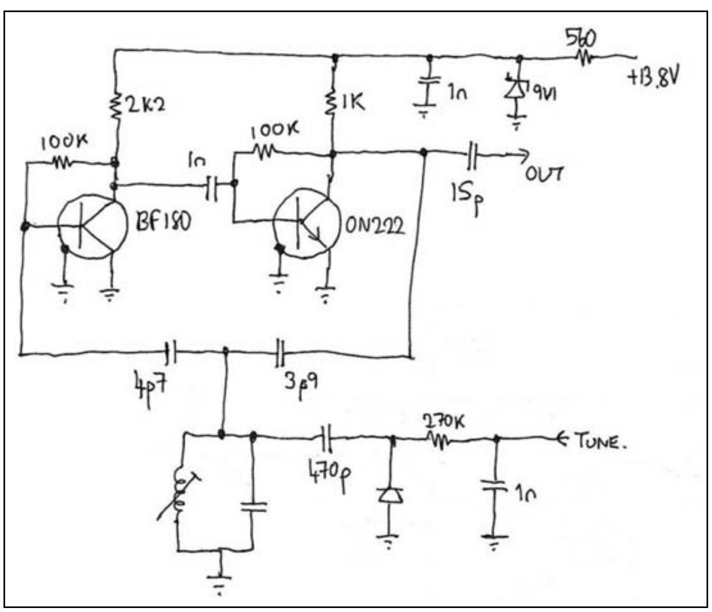
from the other side of the world!

More on this project: http://hanssummers.com/qrssjb

4. VFOs

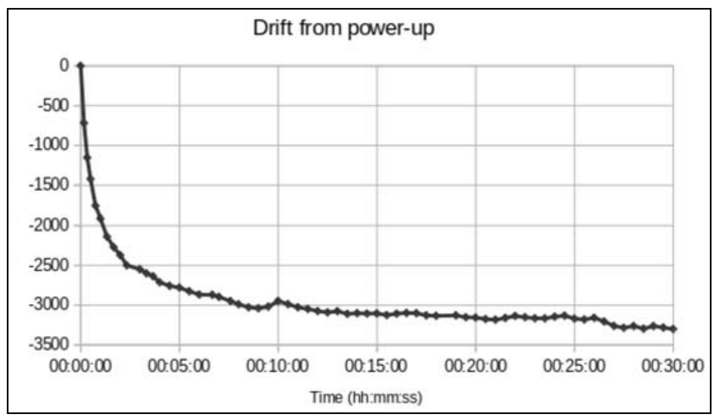
There'll come a time perhaps, when you don't want to be limited to the QRP frequency crystals you have, and want to build a VFO. There are a great many different VFO topologies, each with relative advantages and disadvantages. A key requirement is frequency stability. You want to tune to a station and for the VFO to stay on frequency, not drift around with minor temperature changes. For this NP0 (near-zero temperature coefficient capacitors) are a good first step; but the oscillator circuit type is also important.

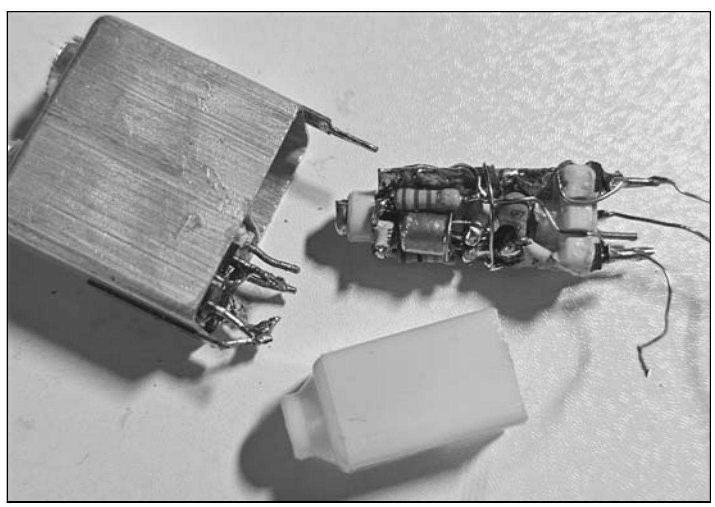
One of my favorite oscillator circuits is the "Franklin" oscillator. It consists of two transistors not one, and a very lightly coupled parallel resonant inductor-capacitor (LC) tank circuit in between them. The fact that the resonator is so lightly coupled to the oscillator transistors means that any unwanted effects from the transistor parameters changing with temperature are minimized. The primary determinants of oscillation frequency (and drift) are the inductor and capacitor themselves.



It's possible to create very low drift oscillators by experimenting with different types and combinations of inductor and capacitor. Some capacitors have a slight positive temperature coefficient, some slightly negative. For example: a powdered iron toroid has a positive temperature coefficient. Use of a parallel capacitor with a negative coefficient can substantially cancel out the drift overall.

A real tuning capacitor is better for stability than a varactor diode. But if you haven't got one to hand, a varactor diode and





potentiometer for tuning can be a reasonable substitute. The example is an oscillator I built using ONLY components salvaged from an old 1970s-era transistor television

Note—the use of the 9.1V zener diode at the supply input; having a stable supply voltage is also important for oscillator frequency stability. I used a diode for varactor tuning and the tuning voltage came from one of the multi-turn trimmer potentiometer's used for the television's preset tuning. Practically speaking, one would follow the VFO circuit with a transistor buffer circuit.

The television had a number of double intermediate transformers (IFT) in aluminium cans. I used the coil of one of these, for the inductor in my oscillator circuit. In the other "half" of the dual-IFT I removed the coil former and built the 2-transistor VFO circuit in a 3-dimensional "ugly" style construction.

The graph shows the measured drift from power-up. There's quite a significant downward drift in the first 15 minutes but thereafter it's quite usable. There's room for more experimental improvement of course. The component values used, put the VFO on 7MHz.

3. Simple frequency counter

Now as soon as you've made a VFO, the next thing you want is an indication of frequency. A frequency counter can be a complex project but for a simple indication, you can create something remarkably useful just with a couple of common logic chips! They may not be already in your junkbox but obtaining them is a matter of a couple of $.

I got the idea from Onno PA2OHH, his simple frequency counter project shows the frequency on an 8 LED display, see https://www.qsl.net/pa2ohh/sfreq.htm.

In Onno's design, the least significant of the eight LED's indicates 1.5kHz, and the most significant indicates 200kHz. In this way, the display can indicate 0 to 400kHz in steps of 1.5kHz, for example, frequency from the lower band edge e.g. 7.000 MHz. The operator adds up the lit LED's to obtain the frequency (which is surprisingly quick to do mentally, particularly after some practice). Onno used three logic chips to achieve this.

I was quite intrigued by Onno's design and realized that one of the three logic chips (the latch) could be eliminated, further simplifying the design. Additionally by some other changes (the quartz oscillator frequency becomes 4.096 MHz), the accuracy of the indicated display could be improved. In my revised design the price of removing the latch chip was that several "logic gates" were required; however these can be conveniently implemented with a few diodes and resistors.

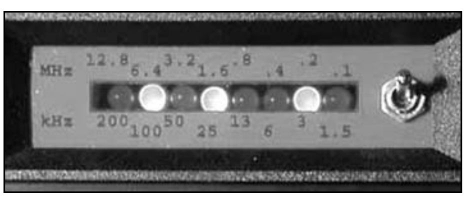
In my design the indicated range is reduced to 0 to 99.5kHz in 0.5kHz steps; so a narrower range but with finer resolution. This suited my circumstances but larger steps (and wider range) could be achieved too with the same basic principles. My LED's indicate 64, 32, 16, 8, 4, 2, 1 and 0.5 kHz.

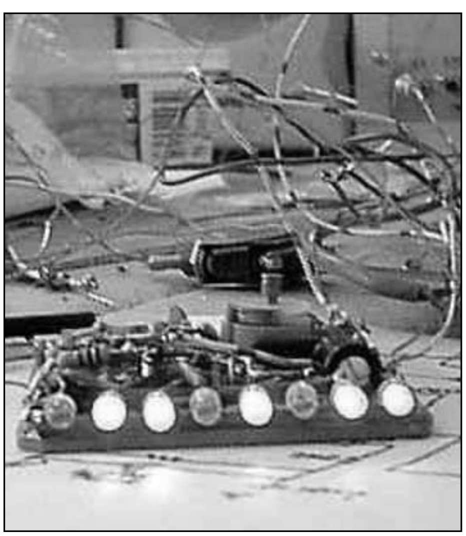
However by replacing the 74HC4040 with a 74HC390 and some other changes, it's possible to make it into a simpler to read counter having a BCD (Binary Coded Decimal) output. The LED's then indicate: 80, 40, 20, 10 for the left set of four (first decimal digit) and 8, 4, 2, 1 kHz for the right set of four (second decimal digit). The display range is then 0 to 99 kHz with 1kHz resolution (so the 0.5kHz indication is lost, the price of the BCD output).

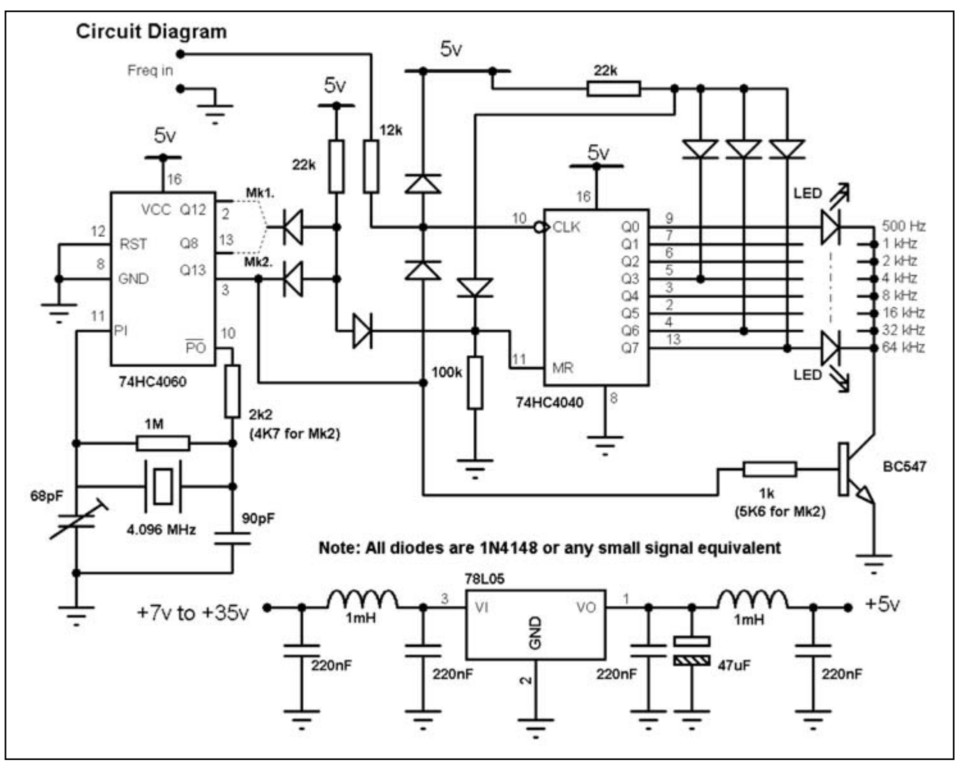
I built two versions of the frequency counter, one using 5mm yellow LED's made on unetched PCB dead-bug style. The other used miniature 1mm LED's with very low current consumption and built in a really miniature package for panel-mounting, shown here (top of next page) next to a paperclip.

There's even a version of this circuit which adds one more chip to provide a 455 kHz offset for receivers having a 455 kHz intermediate frequency. All with just simple logic chips and no need for programming microcontrollers!

My page on this project has lots more information and ideas: http://hanssummers.com/sfreq.html

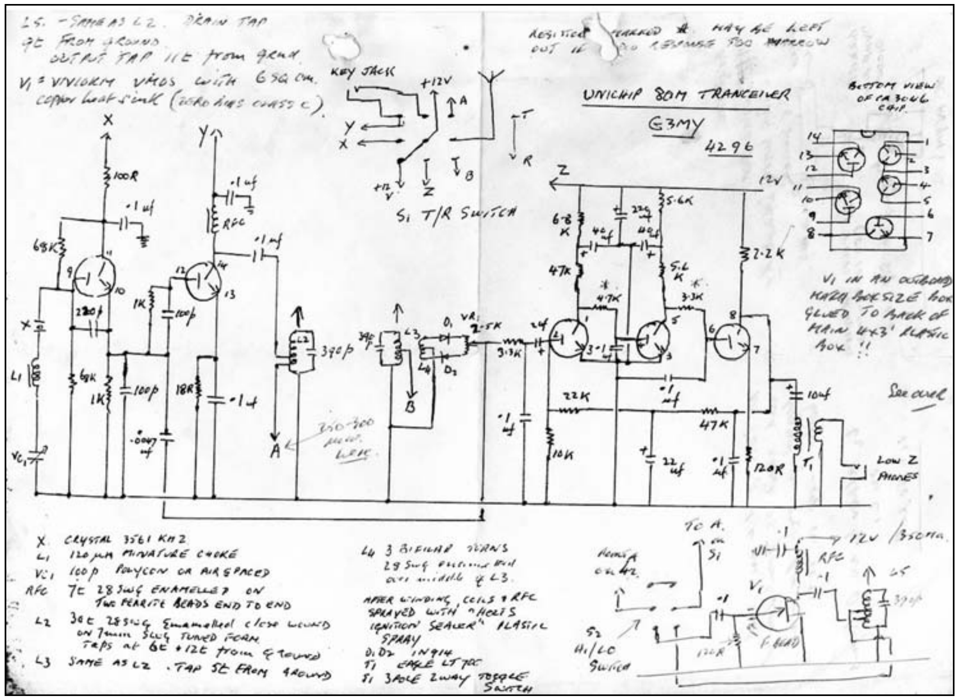






2. Unichip 80m transceiver

This project published in the GQRP club quarterly magazine *SPRAT* caught my attention! It's called "unichip" because the designer Mike G3MY (SK) used a single CA3046 or CA3086 chip to build a complete 80m CW transceiver. The CA3046 chip contains five matched NPN transistors, made available on the external pins as a differential pair and three individual NPN transistors.

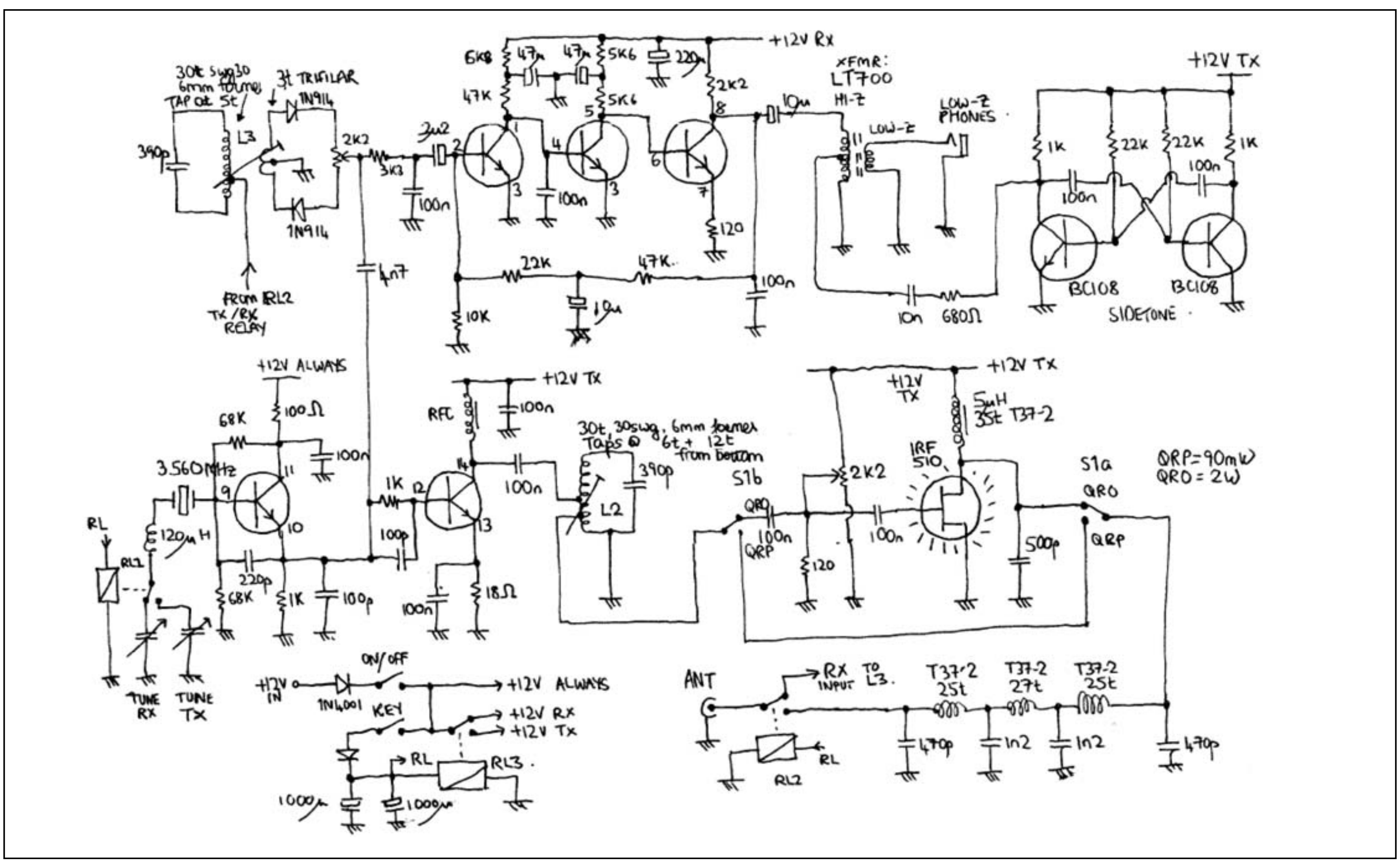


This is a scan of G3MY's original project description! For the junkbox constructor, the important point here is that there's NOTHING special about the CA3046 that requires us to use it! Any number of common discrete transistor types may be used instead, such as BC547. Practically any small signal modern NPN will do! Similarly though Mike specifies certain iron-cored tunable inductors there is nothing critical about these either and many other types will do fine. The audio output transformer could be replaced with a 6V power transformer, with the 6V winding being the "low-Z" side.

One transistor is used as the 3.560 MHz crystal oscillator. One as a buffer. There's a simple diode mixer. Then the other three transistors line up to amplify the audio.

The next schematic shows my implementation. I built it using a CA3086 chip. I measured only about 100 mW power output from the basic unichip circuit which given my very limited antennas at the time (and poor operating skill), made things excessively difficult. So in the end my unichip transceiver had a number of extras:

- IRF510 to boost the output power to about 1-2 Watts.
- Relay-switched polyvaricon capacitors so you could adjust the transmit frequency and VFO frequency independently, to get a good beat note on receive.



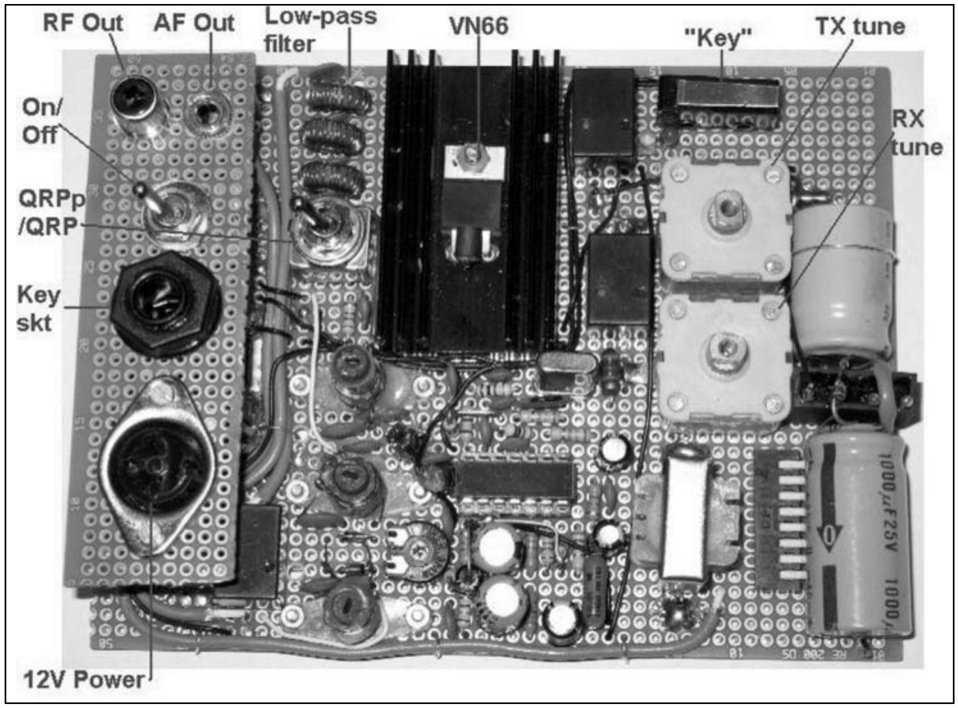
- Two transistors as an astable multivibrator to provide a sidetone on transmit.
- Low pass filter.
- Relay-implemented automatic semi-QSK replaced a manual TX/RX switch.
- Microswitch as Morse key – a feature I loved so much that it later got incorporated into the first QCX QRP Labs CW transceiver kit!

All that went onto a plated hole matrix board sized about 4 x 3 inches. This simple board forms a surprisingly effective 80m CW station and again note, that there are no special fancy components here, everything in this project is quite junk-box-ish. So why not give it a go?

In September 2005 I took the newly constructed Unichip (with only 2 QSO's to its name) with me on a business trip to Greenwich, Connecticut, USA. Also onboard was my ATU (featured earlier in this article). I operated on three successive evenings, for 2 - 3 hours each evening. The first evening I had no luck, which I eventually traced to an intermittent connection problem in the variable capacitor of the ATU. As long as I kept squeezing the capacitor, everything worked OK.

As an earth connection I used a PC power cord plugged into the wall, with the PC end socket cut off and a the earth wired to the rig. For an antenna I used 10m of ordinary twincore speaker cable (split to make 20m), and a 3m length of 4 twisted pairs network cable dismantled and joined (in pairs) end to end. This gave about 32m wire, which I threw over the low branch of a tree outside my upstairs window, and tied the far end to the top of a bush at about 6 foot off the ground. As a power supply, I used eight D-cell batteries laid in line and wrapped in the front page of the New York Times, with wires taped to each end and stood upright against an armchair. Headphones were just the dirt-cheap in-ear type.

With this incredibly basic setup and signing as W1/GØUPL, I had continuous ragchew QSO's, working 9 stations in total during the course of two evenings. They were: W1GUE, K1ARO, W3MNE, W1CFI, N2EY, AF4K, K4JYS, AE5X/2 and W2LJ. The furthest distant of these stations was Brian AF4K in Florida, at a distance of some 1500 miles! Not bad for 2W to a random bit of wire. The radio activity made otherwise boring evenings highly enjoyable.



One of these, John AE5X turned out to be only 5 miles away and worked at the Westchester Airport radar facility, right across the road from my employer. In a lengthy ragchew we described our appearance and agreed to meet for coffee the next morning at the golf club next door. John gave me a tour of the radar facility and I lent him the unichip transceiver for a while, he was quite impressed by the clarity of the received audio.

More on this project: http://hanssummers.com/unichip

1. ECL82 tube transmitter

Now at #1 the tube transmitter. It takes number one spot because it occupies a very special place in my heart. Not only do have a longstanding (illogical, incomprehensible, inexplicable) love of tubes, but this was also the transmitter I used for my first ever QSO in 2002.

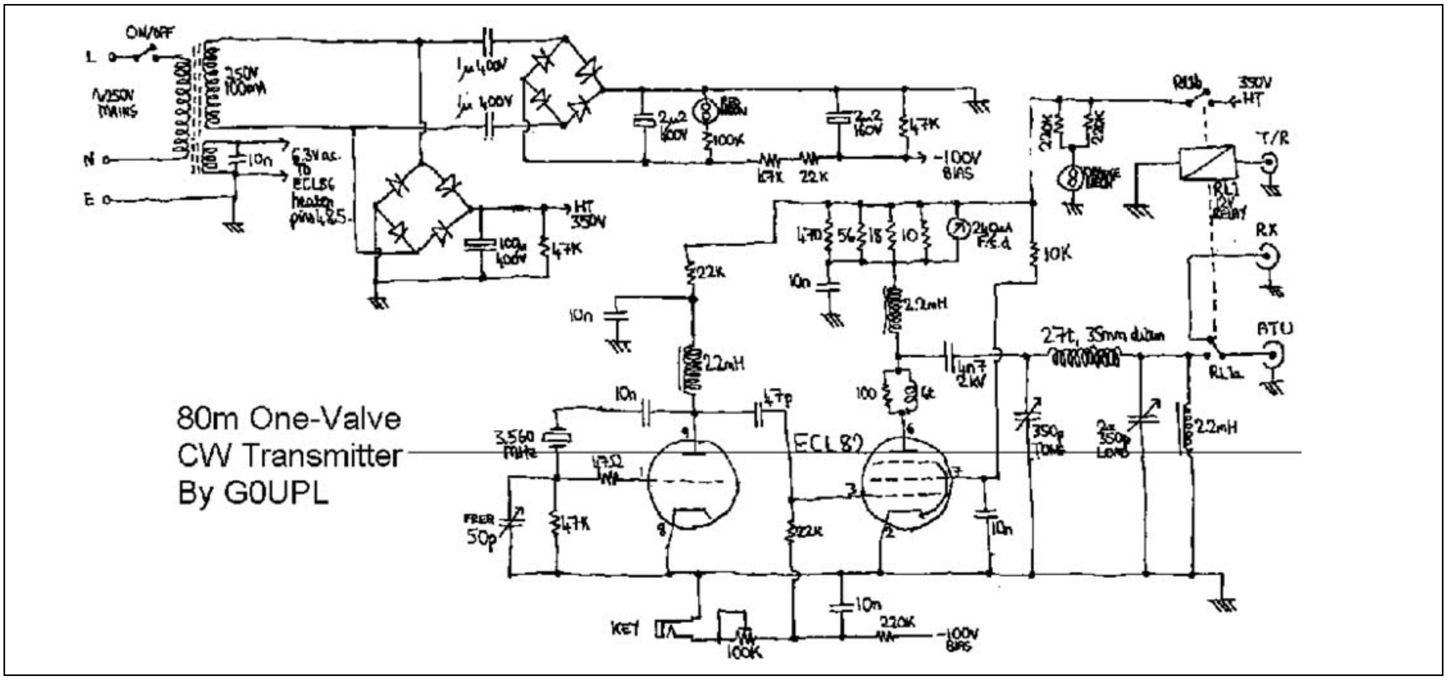
The tube I used is an ECL82 audio triode-pentode. It is a European type but there is a common US equivalent, 6BM8. If you look around carefully at hamvention, you'll find it easy to get a 6BM8 and it won't cost more than a $ or two.

SAFETY!

When working on any tube project, high voltages are normal so it's important to take safety seriously. Never use rectified grid power directly, always use an isolation transformer. Proper tube transformers for US use would have a 110V primary, 6.3V secondary for the tube heater filaments, and a secondary around 200-250V for the tube anodes. Again, you can find these at Dayton hamvention.

Another way is to use ordinary power transformers back-to-back to create an isolated high voltage supply. For example; say you had available a power transformer with 6V secondary (needs to be capable of at least 0.8A for the tube heater filament). You could use that directly for the 6BM8 heater filament. Then if you had another transformer with a 3V secondary, you could use that backwards to step the voltage up to 220V, for your B+ high voltage rail. Transformers aren't really designed for this "backwards" operation but it will work fine, just remember to use an appropriately rated transformer. For example if you need 50 mA at the B+ then that's an 11VA transformer (220V * 0.05A). But use a somewhat larger transformer say 15VA minimum, to provide some margin against the fact that they aren't really designed for backward use!

The primary safety measure is, switch the thing OFF and DISCONNECT before



fiddling with it! For tube circuits with high voltages, and large capacitors retaining charge, you also need to remember to wait a few seconds after disconnecting the power, for the capacitors to discharge. To help self-discipline myself, I always add a simple neon indicator across the B+ power supply. That will stay lit until the voltage rail drops below about 90V. It's a very useful reminder that a circuit is still powered, a WARNING! I also adopt the same habit when building low voltage circuits. Not for my safety, but for the circuit's safety! It's very nice to have this visual indicator that power is still applied.

This is my implementation of the transmitter which was originally designed by Jan SM5GNN and was also featured in the RSGB's monthly publication RadCom's Tech Topics column.

The triode section of the tube is the oscillator and runs continuously. The pentode section is the power amplifier and uses grid-block keying with a -100V bias to switch OFF the RF when not keyed. 100V on the key can be a little "shocking" if your key has exposed metal parts and you forget. You'll note that I didn't have a second high voltage winding available on my power transformer, to derive the negative bias voltage. My poor-man's approach is shown in the top section of the diagram; I used two 1uF 400V unpolarized capacitors in series with the transformer high voltage secondary, to provide DC isolation. Then another bridge rectifier and some resistors to get my desired 100V level; connecting the "positive" to the main chassis ground then means I have the required -100V bias voltage rail.

I built mine on a chassis made from single-sided PCB. My circuit includes a TX/RX switchover relay and the crystal frequency can be "pulled" down about 1kHz by the 50pF variable capacitor control on the front panel.

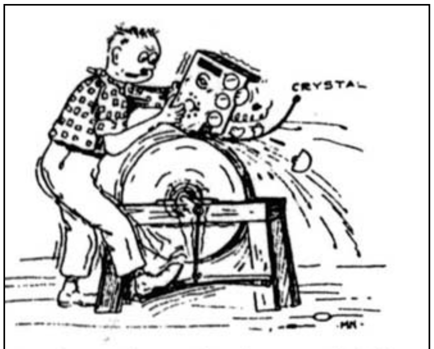
Again none of the components in the construction are critical, but you DO need to make sure you use resistors and capacitors adequately rated for the higher voltages and currents than we are used to seeing in low voltage solid state circuits. The coil was wound on a 35mm film can.

I had many hundreds of QSO's using

this transmitter, for the first several years of my ham radio career this was my only transmitter. The project went through several modifications:

More frequencies: Being limited to the 3.560 MHz crystal (80m QRP calling frequency) was sometimes frustrating particularly if QRM was on the frequency, or if I could hear lots of traffic just 2kHz below on the FISTS calling frequency 3.558 MHz, but not access it. So I added a 12-way rotary switch and more crystals!

What about when you want a frequency but can't find a crystal for that frequency? Way back in the July *QST* 1924 magazine they had this covered! Modern crystals are a lot smaller than the old days and so grinding the quartz to raise the frequency slightly is impractical. But you can do the opposite: apply some ink using an indelible marker pen (such as Sharpie) and the frequency can be lowered many kHz. This is how I made a crystal for 3.558 MHz from one for 3.560 MHz. There's more information on this on my website, http://hanssummers.com/penning.



.to change the wavelength......grind down the crystal

More bands: I originally built it for 80m. However it will work well on higher bands too, though the RF power output gets reduced a little. The additional bands were implemented simply by adding further taps to the pi-network output coil, with relay switching controlled from a switch on the front panel. I had it working well on 80, 40, 30 and 20m.

Bill G4KKI (SK) was a good friend of mine and he built one of these ECL82 transmitters too, we had many nice 80m CW ragchews from London to Manchester.

Overall this is really a fantastic project and for those who've never played with tubes, a great introduction. It's also one of those few projects which I've built, which actually worked first time I powered it up!

More project details: http://hanssummers.com/cwtx

Favorite Further Reading and Websites

1. A lot of other projects, some simple and junk-box orientated, are on my website http://hanssummers.com
2. "From Crystal Sets to Sideband" is a book by Frank KØIYE which is one of my absolute favorites; it's a great introduction to building your own station and equipment, from transistors to tubes, QRP to QRO, and mostly using simple building blocks and common components. Best of all the enthusiasm of his writing style is infectious! All free and downloadable at: https://www.qsl.net/k0iye/
3. Onno PA2OHH has a nice website at https://www.qsl.net/pa2ohh/ which contains many interesting amateur radio projects and again, I find them quite inspiring.
4. Half a planet away, and sharing a similar passion for simple projects and a callsign the same all but for one letter, the website of Miguel PY2OHH is another fascinating read, sure to get you in the mood for some junkbox project construction!

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