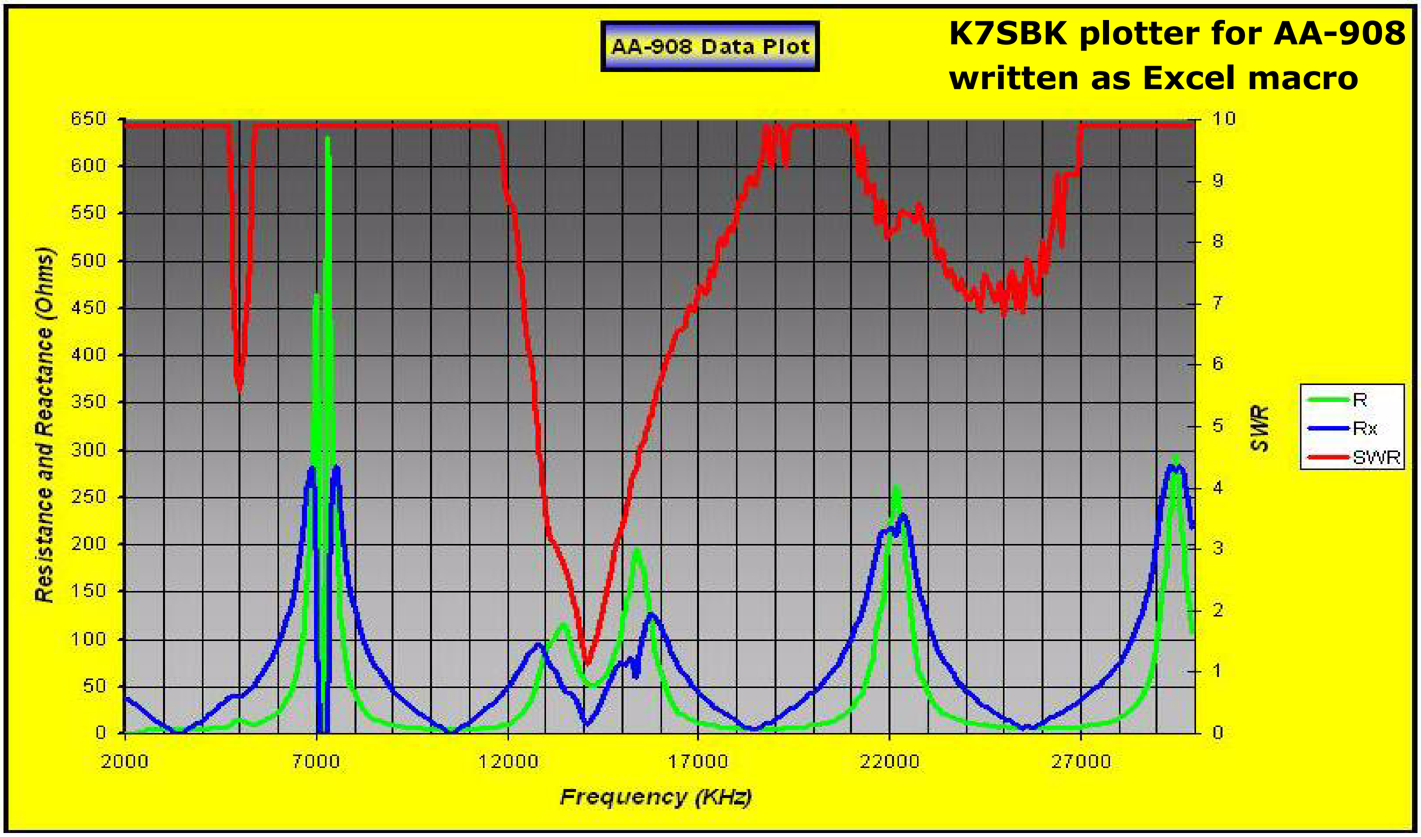
Issue # 5 Spring 2005

AmQRP.ORG HOMEBREWER

JOURNAL OF THE AMERICAN QRP CLUB



Super-Sized Issue

72 projects you can build today!

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PARC Antenna Tuner
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TABLE OF CONTENTS

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Welcome!

We have an incredibly exciting issue of Homebrewer Magazine this time, as you may have already noticed. It contains seventy-two unique homebrew construction projects and even more great material in the form of reviews, contesting results and contributions from our regular columnists. All of this is provided in more than 400 full-color, high-resolution pages!

This is our second issue in the new CD-ROM format and most of the kinks now worked out. Most notably, all article material is in PDF format, allowing everyone to view the content on any computer, regardless of type or operating system. We even went back and re-formatted issue #4 this way to allow subscribers to also have that past issue in the nicer format.

We again included all previous issues of Homebrewer Mag on this CD. So you have the full set of issues 1-5 here on this disc making this issue additionally special; this is the last time these prior issues will be included.

I am particularly thrilled to have so many contributing authors from our QRP community this time. This is a testament to the value and usefulness of our efforts with the magazine. I urge you to especially see the articles by giants in our midst: Paul Harden NA5N, Mike Czuhajewski **WA8MCQ**, Joe Everhart **N2CX**, Jim Fitton **W1FMR**, Charlie Lofgren **W6JJZ**, and Wayne McFee **NB6M**. Some authors continue to pump out great material that I'm sure you will enjoy: Dave Ek **NK0E**, Dave Ottenberg **WA2DJN**, Ron Carr **WA1VGB**, Fred Bonavita **K5QLF**, Jerry Haigwood **W5JH**, Phil DeCaire **WB7AEI**, Terry Fletcher **WA0ITP**, Ron Stone **KA3J**, Jim Giammanco **N5IB**, and Doug Wilson **WA0SVL**. Our regular columnists also have great stuff this time: Richard Fisher **KI6SN**, Rich Arland **K7SZ**, Joe Everhart **N2CX**, and Ken Newman **N2CQ**. First-time author Frank Roberts, **VE3FAO**, has a terrific feature article you should see. Other first-time contributors offer a plethora of interesting projects to keep you busy in the shack this summer: Dar Piatt **W9HCZ**, Wade Lake **KR7K**, Verner Blindheim, Nancy Feeny **NJ8M**, Bob Hillard **WA6UFQ**, Mike Hasenfratz **WA6FXT**, Ron Pfeiffer **N1ZSW**, and others. We are so fortunate to have the involvement of such a fine group of authors, and I thank them all from the bottom of my heart.

This issue also contains extra material on the CD that is impossible to provide in other magazine formats. George Murphy **VE3ERP** graciously allowed us to distribute his wonderful collections of HamCalc software utilities, and Ron McConnell **W2IOL** allowed us to do the same with his Great Circle software. To help you in using these software tools, we have also included some instructional articles concerning them. Another "extra" is that we have the audio soundtrack from three of this year's Atlanticon presenters (**KK7P**, **K7SZ** and **K8IQY**), and you can listen to these hour-long **audio tracks** while viewing the slides we saw earlier this spring in Timonium, Maryland. Pretty neat!

As with the last issue, we've included the recaps of all previous **Atlanticon QRP forums**, including this year's event and the massive photos albums of each of them in a nice easy-to-use photo browser. And remember that popular presentation many of us have used to explain what QRP is all about at local our clubs? This **Why QRP?** presentation has been updated and is included on this issue's CD.

So sit back in your computer chair and enjoy digging through Homebrewer #5 – it should take you several months to do it all! Print out selected articles an take them to the "reading room" or put the files on your PDA for remote study, as N2CX does. We believe Homebrewer CD Magazine is a unique and valuable contribution to our hobby and all of us writers and editors are very proud to produce it for you.

72, George N2APB n2apb@amqrp.org

AmQRP.ORG HOMEBREWER

Frank Roberts, VE3FAO

PARC ANTENNA TUNER PROJECT

Take two popular and highly-successful circuits, build them Manhattan-style, and package it in an enclosure to match the SW-40+ transceiver – what do you get? A terrific homebrew club project that everyone can use!

This project was developed for the Peel Amateur Radio Club (PARC) by Frank Roberts, VE3FAO. It is based on designs by Joe Everhart N2CX, Tony Brock-Fisher K1KP, D.A. (Mike) Michael W3TS, and Ulrich Rohde KA2WEU/DJ2LR.

The Peel Amateur Radio Club Antenna Tuner Project is a combination of an Antenna Tuner and an SWR indicator from previously published articles.

The antenna tuner is based on an article by Ulrich Rohde KA2WEU/DJ2LR published in QST December 1974. This design was later modified and published by C.A. (Mike) Michael as the “Super Tee Tuner” in the March/April 1992 issue of “72”, the New England QRP Club newsletter, the June 1992 issue of QRP Quarterly, and finally the Autumn ‘92 issue of SPRAT, the Journal of the G-QRP Club.

The SWR Bridge and indicator is based on an article by Tony Brock-Fisher K1KP published in the June 1995 issue of QST. The design was adapted to QRP operation by Joe Everhart N2CX. It was used in the popular Rainbow Tuner kit offered by the New Jersey QRP Club and later published in their “QRP Homebrewer” journal – December 2001. Joe Everhart has given our club kind permission to use his design as part of this project.

These two circuits have been combined by Frank Roberts VE3FAO and fit into a case that matches the one used for the Small Wonder Labs SW40+ kit. A special thanks goes to our daughter Janet VE3BVR for producing the computer graphics used on the front and rear panels.

PART 1
BUILDING THE CIRCUIT BOARD

INTRODUCTION TO MANHATTAN STYLE CONSTRUCTION

This method of homebrewing equipment was popularized by Jim Kortge K8IQY when he won first prize at Dayton's "Four Days in May" QRP conference for his 2N2/40 Manhattan Style transceiver. When building equipment in this style, you glue small pads cut from scrap PCB material onto the surface of a blank printed circuit board where each connection is going to be made. You then tin the pads and solder the components to them. The PCB substrate becomes a ground plane for all ground connections.

STEP 1: Cutting the PC Board and Pads

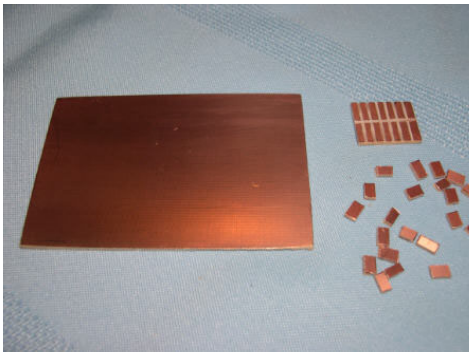
(a) Cut a piece of clean single sided printed circuit board material into the following sizes:

1 piece 3" x 2"
1 piece 3/4" x 5/8"
1 piece 5" x 1/8"

(b) Using side cutters, cut the 1/8" strip into 21 pads each 1/8" x 3/16".

(c) Groove the surface of the 3/4 " x 5/8 " piece of pcboard material to form 14 separate isolated sections. These sections should be of equal size in two rows of 7 to match the pin configuration of a 14 pin IC socket.

(d) Roughen the surface of the 3" x 2" circuit board using # 220 emery cloth so the pads will adhere when glued.



STEP 1 COMPLETED

STEP 2: Placing the Pads.

(a) Drill a 1/8" mounting hole in two corners of the 3" x 2" piece as shown in the PCB Template Drawing.

(b) Check that the mounting holes match the PCB template and trace the pad positions onto the circuit board.

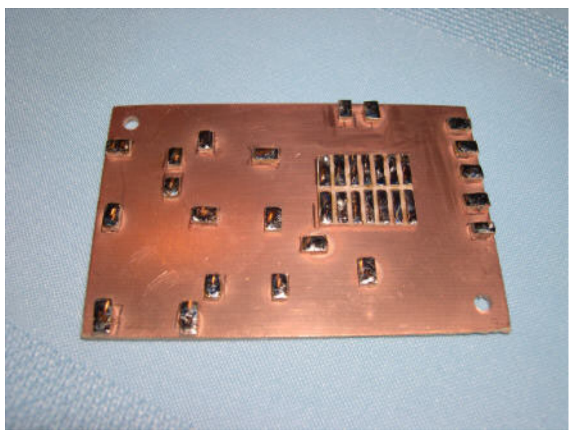
(c) Glue the pads to the 3" x 2" PC board using the PCB template drawing as a guide.

NOTE: *The "Super Glue" used in this step sets in seconds. Close the tube immediately after each application to avoid spillage and take extra care not to get glue on anything except the board and pads. Particularly your skin!*

HINT: *Keep a piece of fine sandpaper handy to remove any copper burrs and square up the corners of the pads. Ensure the bottoms of the pads are perfectly flat and rough to make a good seal to the board.*

(d) Tin all the pads including the 14 pin positions of the IC mounting pad.

HINT: *After tinning the pads, check for shorts between the pads and ground as well as between adjacent sections of the IC pad before proceeding.*



STEP 2 COMPLETED

STEP 3: Installing the PC board interconnecting wiring

HINT: *Use solid wire to avoid strands from shorting to ground***.**

(a) Install inter-pad wiring as follows using shielded hook-up wire:

Q2 Collector pad to C5/R13 pad
Q2 Base/R11 pad to R12 pad
U1 Pin 8 to R5/R18/C4 pad

U1 Pin 4 to U1 Pin 6
U1 Pin 8 to U1 Pin 10

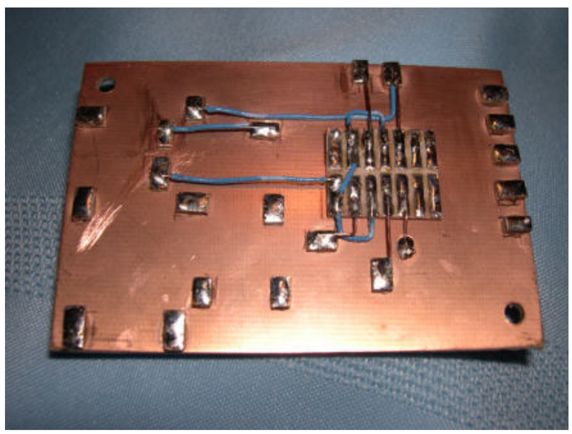
NOTE: *The Pin 6 to Pin 8 jumper is made right on top of the IC pad and will be hidden by the socket. Cut it to size, then slide the insulation off and solder Pin 6. Then slide the insulation back on and solder Pin 8. Ensure that it does not short to Pins 7 or 9.*

IC Pin 6 to IC Pin 8

(b) Install inter-pad wiring as follows using unshielded hook-up wire:

U1 Pin 3 to C5/R13 pad
U1 Pin 5 to R9/R10 pad
U1 Pin 9 pad to R7/R8 pad
U1 Pin 11 to R6/R7 pad
U1 Pin 12 to ground

HINT: *You may have to raise the temperature of your soldering station to make a good connection to the ground plane.*



STEP 3 COMPLETED

STEP 4: Installing Resistors and Diodes.

HINT: *Measure and confirm the value of each resistor before installing, particularly the 1% resistors.*

HINT: *Install all resistors in their prone position so the colour codes can be read from left to right or from bottom to top.*

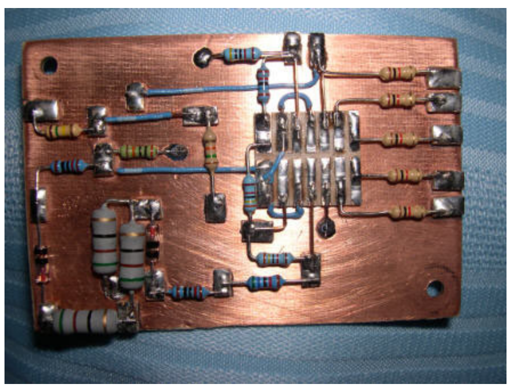
(a) Using the circuit board layout drawing and schematic as a guide, install the resistors as follows:

R1	51 ohm 1W	green-brown-black-gold
R2	51 ohm 1W	green-brown-black-gold
R3	51 ohm 1W	green-brown-black-gold
R4	10K 1%	brown-black-black-red-brown
R5	10K 1%	brown-black-black-red-brown

R6	56K 1%	green-blue-black-red-brown
R7	34K 1%	orange-yellow-black-red-brown
R8	34K 1%	orange-yellow-black-red-brown
R9	26K 1%	red-blue-black-red-brown
R10	40K 1%	yellow-black-black-red-brown
R11	150K	brown-green-yellow-gold
R12	15K	brown-green-orange-gold
R13	1K	brown-black-red-gold
R14	1K	brown-black-red-gold
R15	1K	brown-black-red-gold
R16	1K	brown-black-red-gold
R17	1K	brown-black-red-gold
R18	200K 1%	red-black-black-orange-brown

Using the circuit board layout drawing and the schematic guide, install the following diodes:

D1	1N60	Cathode to R4/C1 pad
D2	1N60	Cathode to R5/C2 pad



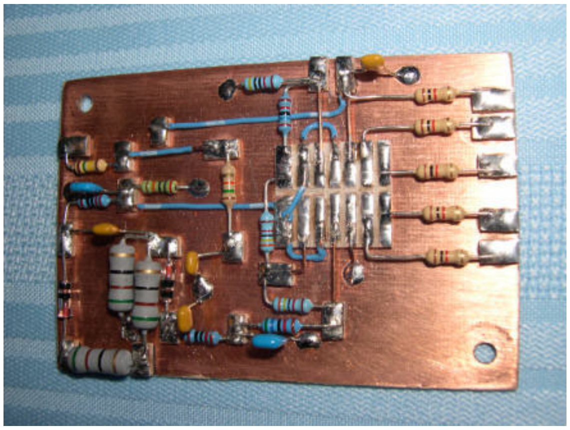
STEP 4 COMPLETED

STEP 5: Installing the Capacitors

HINT: *Install the capacitors so the printed value faces the outside of the PCB or away from other components. This will assist in reading their values during testing and/or troubleshooting.*

(a) Using the circuit board layout drawing and the schematic as a guide, install the following capacitors:

C1	.047 uF	(473)
C2	.047 uF	(473)
C3	.001 uF	(102)
C4	.001 uF	(102)
C5	.047 uF	(473)
C6	.047 uF	(473)



STEP 5 COMPLETED

STEP 6: Installing the remaining PCB components

(a) Install the semiconductors.

NOTE: *Use the layout drawing to determine the orientation of the following components:*

Q1	MOSFET	VN10
Q2	PNP Transistor	2N3906

(b) Install the IC socket and IC as follows:

NOTE: *Align the notch as shown in the layout diagram so Pin 1 will be at the top right corner.*

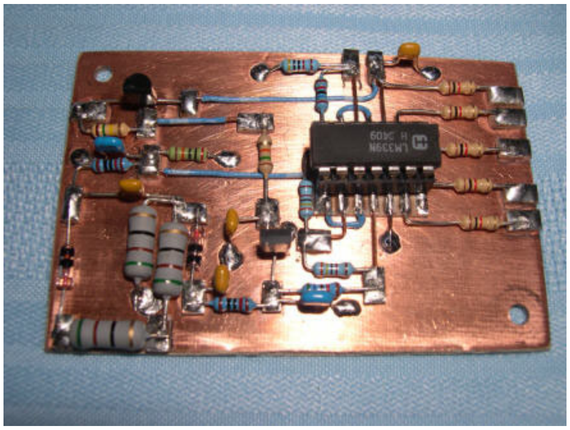
HINT: *Carefully bend each pin out to either side of the socket. This will assist in soldering and give a low profile to the socket.*

Tin the underside of every pin first, then solder the two opposite corner pins and check the alignment of the socket before soldering the remaining pins.

NOTE: *Check the IC socket with an ohm meter to make sure there are no solder bridges and that adjacent pins are not shorted together.*

Using the appropriate static discharge precautions, install U1 – LM339 IC into the socket.

NOTE: *The notch or Dot indicating pin 1 should be on the right.*



STEP 6 COMPLETED

This completes the Manhattan Style Construction part of the Antenna Tuner. Put the board aside while you continue with the rest of the project.

PART 2
WINDING THE TOROIDS AND COILS

NOTE: Each time the wire passes through the core it counts as one turn. Draw each turn snuggly against the core to ensure tight windings and do not overlap turns.

HINT: *Count each turn by placing a check mark on a piece of paper. Remember to count the first pass through the core as one turn.*

WINDING L1 (8uH)

L1 is wound with 36 turns of #24 magnet wire on a T68-2 Red core. (.68" diameter)

Cut off 30 inches of #24 wire and thread it through the toroid so that about 1/2" is extended then start to wind on the other 35 turns. When you have completed winding 36 turns on the toroid, check the turn count by using a small screwdriver or your fingernail to ensure it has the correct number of passes through the center of the core.

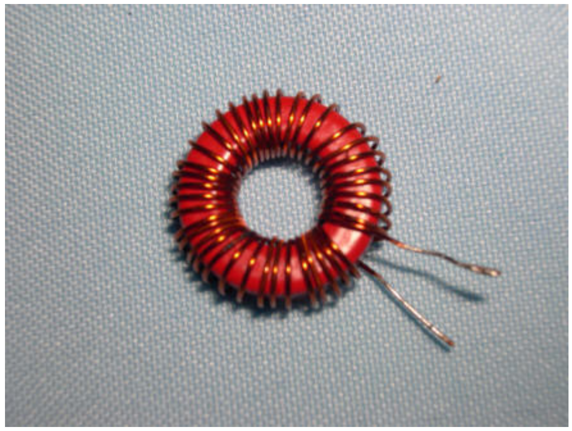
HINT: *Do not trim off excess wire until the inductor is measured. In this way you will not have to rewind the entire toroid if the inductance needs to be increased by adding a turn or two after measuring.*

With a hobby knife carefully scrape all the insulation off the short lead coming from the toroid and about 1/2" off the end of the longer lead. Make sure all the insulation is scraped off the leads.

Spread the turns so they are evenly spaced around the toroid and both leads are opposite each other.

Test L1 by measuring its inductance. L1 should measure approximately 8 uH. The inductance can be decreased by either spreading the turns around the core, or removing one winding. Alternately, the inductance can be increased by compressing the turns or adding one winding.

Now trim both leads to the same length and make sure the insulation is scrapped off both leads, then tin them.



L1 COMPLETED

WINDING L2 (4 uH)

L2 is wound with 25 turns of #22 magnet wire on another T68-2 Red core.

Cut off 22 inches of #22 wire and wind 25 turns on the T68-2 core in a similar manner as L1. Evenly space the turns around the core.

Test L2 for an inductance of 4uH. Cut off both leads to 1/2 inch. Scrape off the insulation and tin them.

WINDING L3 (2 uH)

Cut off 16 inches of #22 wire and wind 18 turns on a T68-2 Red core.

Test L3 for an inductance of 2 uH. Prepare the leads as before.

WINDING L4 (1 uH)

Cut off 12 inches of #22 wire and wind 12 turns on a T68-2 Red core.

Test L4 for an inductance of 1 uH. Prepare the leads as before.

WINDING L5 (0.5 uH)

Cut off 10 inches of #22 wire and wind 9 turns on a T68-6 Yellow core.

Test L5 for an inductance of 0.5 uH. Prepare the leads as before.

WINDING L6 (0.25 uH)

L6 is an air wound coil made from 9 inches of # 14 gauge solid copper wire. Form L6 by bending the copper wire around a 7/16 inch piece of dowelling or a 7/16 inch drill bit shank for 5 turns.

NOTE: *The original design called for 1/2 " diameter coils, but 7/16 inch will provide a better physical fit in the small case.*

Test L6 for an inductance of 0.25 uH. The inductance can be adjusted by squeezing the turns together to raise it, or spreading them apart to lower the inductance.

WINDING L7 (0.125 uH)

L7 is another air wound coil made from 7 inches of # 14 gauge solid copper wire. In a similar manner to L6, form the wire around a 7/16 inch core for 3 turns.

Test and adjust the coil for an approximate inductance of 0.125 uH.

NOTE: *Make sure that you do not short the turns of the coils together as this wire is not insulated.*

TOROIDS AND COILS COMPLETED

WINDING THE BALUN T1

T1 is a 4:1 ratio trifilar wound transformer wound on a BLN 43-202 binocular style core.

***NOTE:** Trifilar means that 3 separate wires are wound together to make up the transformer. The easiest way to accomplish this is to twist the wires together using a hand drill before winding the transformer.*

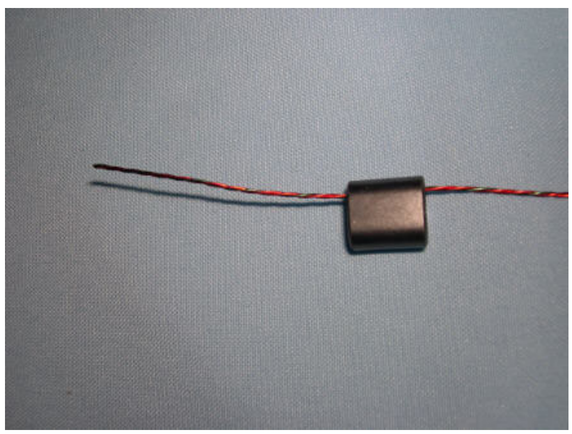
Cut two 11 inch lengths of red-color-coated # 26 gauge magnet wire.

Cut 11 inches of green-color-coated #26 gauge magnet wire.

Clamp one end of the red pair along with one end of the green wire together in a vise. Stretch them out so you can clamp all three wire ends in a hand drill chuck. Keep the wires taunt while operating the drill twisting all three wires together. Continue to twist them until there are about 3 to 4 turns per inch evenly spaced along the length of the combined wires.

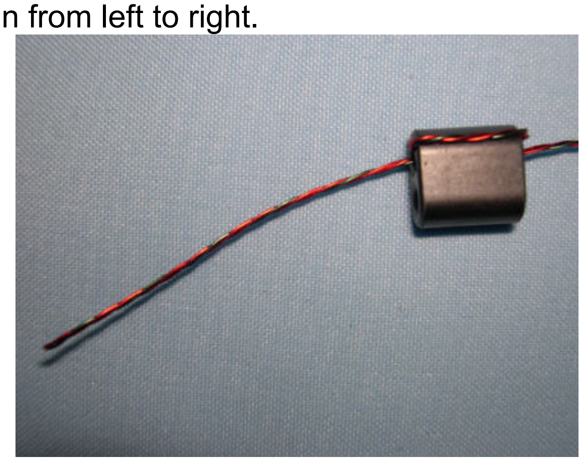
Referring to W3TS's sketch, wind 6 turns on the 43-202 binocular core as follows:

(a) Orient the core so that one of the holes is on top of the other and turn the core so that the side is facing you. Thread the twisted wire bundle through the upper hole from left to right leaving about 2 inches free.



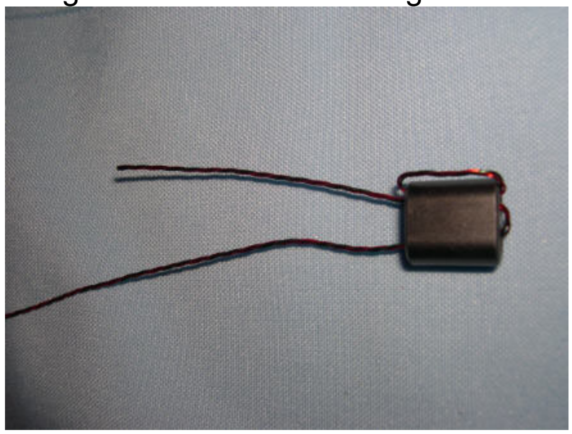
TURN 1

(b) Bend the wires over the top of the binocular core and feed them through the upper hole again from left to right.



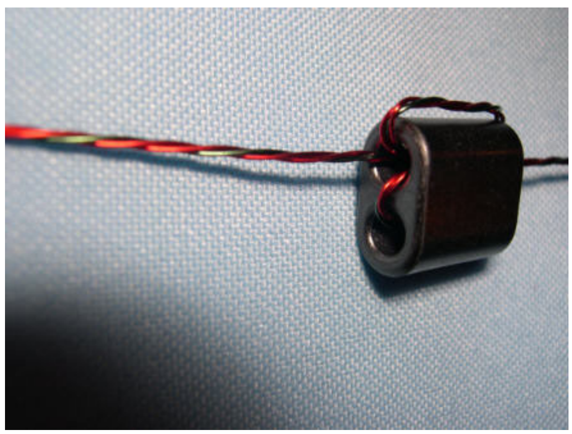
TURN 2

(c) Feed the wires through the lower hole from right to left for turn 3.



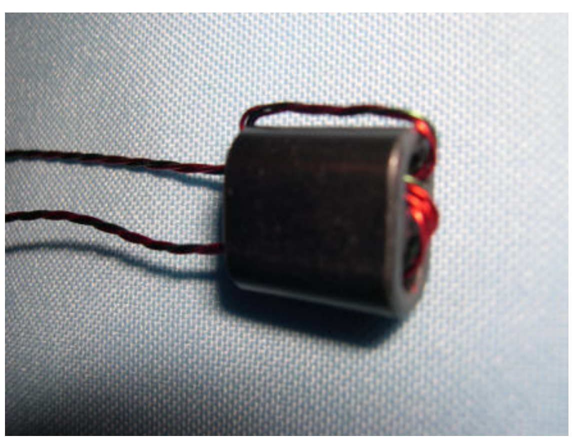
TURN 3

(d) Go back up and feed the wires through the upper hole from left to right for turn 4.



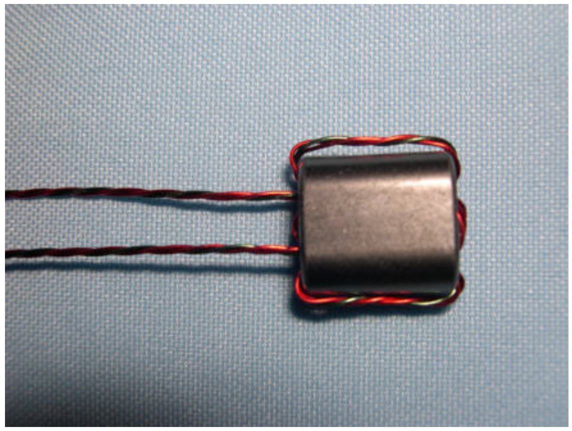
TURN 4

(e) Turn five is made by feeding the wires through the lower hole again from right to left.



TURN 5

(f) Finally bend the wires under the core and feed them through the lower hole from right to left completing the transformer.

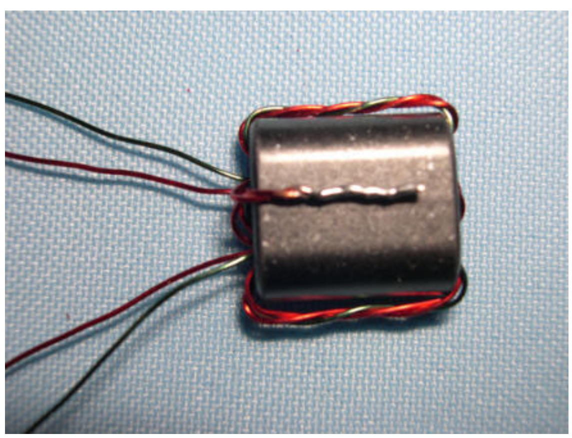


TURN 6

Cut off all but 2 inches from the twisted leads, then untwist each 2 inch bundle. The green wire is the secondary of T1. The primary is made up by joining the two red wires in series. Scrape 1/2 inch of enamel from the ends of the four red leads. Using an ohm meter, identify each of the red windings – we will call them “a” and “b”. Cut “a” coming out of the upper hole in T1 to 3/4 inch. Cut “b” coming out of the lower hole in T1 to 3/4 inch. Scrape the enamel from these short leads for about 1/2 of an inch then twist and solder them together. Fold the soldered joint back over one side of the transformer. Ensure it does not overlap the end of the balun. Trim if necessary.

NOTE: *Using your ohm meter, ensure there is continuity between winding “b” coming from the upper hole and winding “a” coming from the lower hole.*

This completes the set of Toroids, Coils and Transformer used in the Antenna Tuner project.



T1 READY FOR INSTALLATION

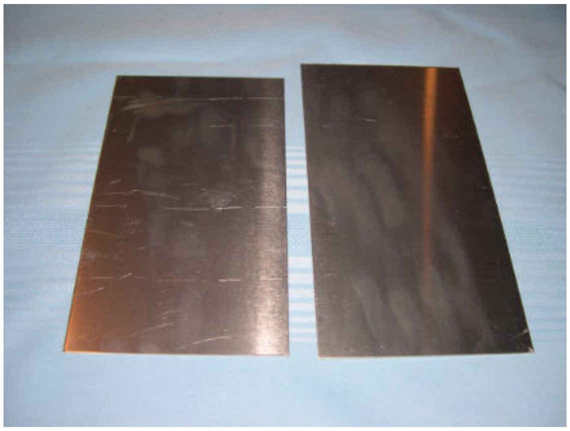
PART 3
FABRICATING THE CASE

The case for the Antenna Tuner can be purchased from Ten-Tec (p/n TG-24) or fabricated from sheet aluminum. If it is made from sheet metal, it is easier to drill all the holes in the front and rear panels before bending the metal to shape.

STEP 1: Cut out two pieces of .050 inch aluminum.

(a) The first sheet for the base is 7 1/4 x 4 1/8 inches.

(b) The second sheet for the top should measure 7 7/8 x 4 1/8 inches.



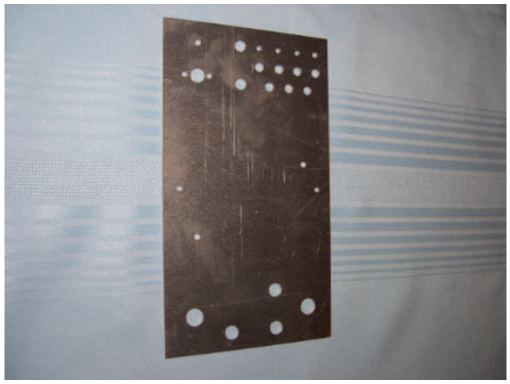
STEP 1 COMPLETED

STEP 2: Drilling holes for the components.

(a) Using the drawings in the appendix, measure and drill each of the holes for the front and rear panel of the base.

NOTE: *Take particular care to orient the holes in the base so they are in the correct position when the case is bent to shape.*

(b) The holes in the bottom of the base to mount the brackets and the printed circuit board are made later on during assembly of the project.



STEP 2 COMPLETED

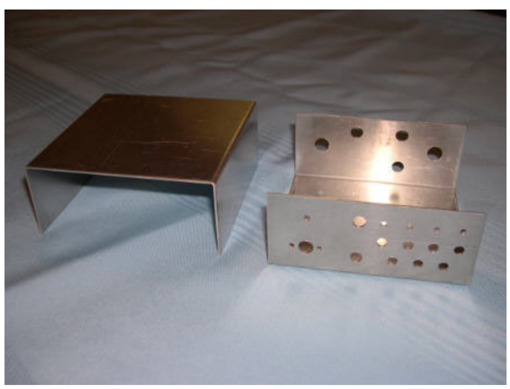
STEP 3: Forming the case

(a) Scribe a line 1 3/4 inches from each end of the drilled base.

(b) Using a break, form the front and rear panels 90 degrees to the bottom by bending the metal at the scribed lines.

(c) Scribe a line 1 13/16 inches from each end of the top piece.

(d) Using a break, form the sides by bending the metal 90 degrees at the scribe lines.



STEP 3 COMPLETED

STEP 4: Adding graphics to the front of the case.

(a) Cut out the scaled front panel label sheet in the appendix. The top and bottom should be cut along the lines, but allow an extra 1/8 inch on each side of the graphic so it can be wrapped around the edge of the front panel.

(b) Align the graphic over the holes drilled in the front panel and bend the edges around the case to hold it temporarily.

(c) Cut out a piece of adhesive film to cover the front panel and overlap all sides by about 1/4 inch.

(d) Trim the top corners such that the adhesive film will not overlap when formed around the edges of the case.

(e) Cut each lower side of the adhesive film so the sides can fold around the front panel and the lower edge will fold under the case.

(f) Carefully lower the adhesive film onto the graphic sheet and wrap the edges around the front panel.

HINT: *Do not peel backing off the adhesive film until you are ready to place it on the case. When the adhesive has stuck to something once, it will not be able to be re-applied.*

STEP 4 COMPLETED

STEP 5: Adding graphics to the rear of the case

(a) In a similar manner to the previous step, add the rear graphics sheet to the rear of panel of the case.

STEP 5 COMPLETED

PART 4
FINAL ASSEMBLY

STEP 1: Installing the XMT/TUNE Switch S9

(a) Identify the DPDT toggle switch S9. This switch looks similar to S8, but has only two positions and does not have a center off position.

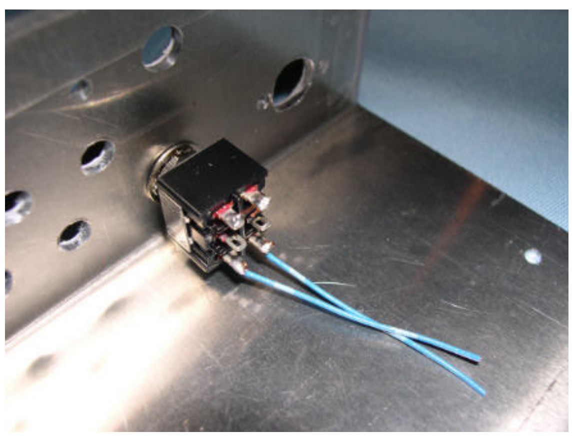
(b) Looking at the switch from the rear orient it so the two rows of 3 contacts are vertical. Solder a bare jumper wire between the top contacts of each row.

(c) Solder 1 1/2 inches of insulated hook-up wire to each of the bottom contacts of the vertical rows.

(d) Mount S9 into the location as indicated on the case drawing with one nut and a washer on the inside of the case and a nut on the outside.

(e) Adjust the inside nut so a minimal amount of thread is showing past the outside nut.

HINT: *Use a nut driver to secure all switches to avoid damaging the front panel.*



STEP 1 COMPLETED

STEP 2: Installing the coax connector J1

(a) Prepare a 5" length of RG174/U coax cable by removing 1 inch of outside insulation from each end. Separate the center wire and the braid.

HINT: *Bend the coax at the point where the insulation ends (1 inch from the end) and separate the braid so* you can extract the center conductor.

(b) On each end cut off 1/2 inch of the center conductor, then strip it back 1/4 inch. Tin the bare wires of the center conductor and flatten the braid.

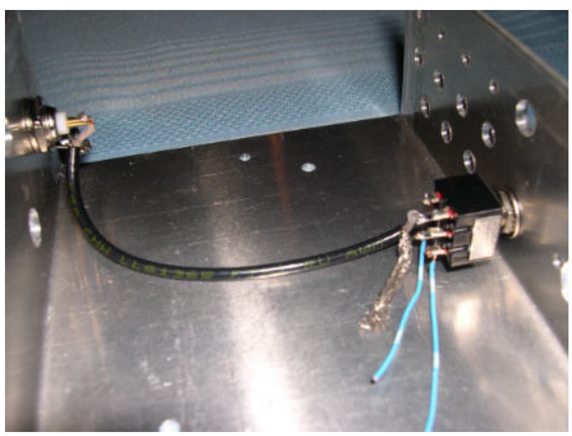
HINT: *Do not apply excessive heat to the conductor as the insulation melts easily. Try to apply a heat sink to the insulation while soldering.*

(c) Remove the mounting nut and solder lug from a BNC coax connector and solder the center conductor of the coax to the center pin of the connector.

(d) Feed the coax and the connector through the rear of the case at the location for J1 indicated on the case drawing. Feed the soldering lug and mounting nut along the coax until they reach the connector. Tighten the connector.

(e) Bend the soldering lug 90 degrees away from the rear of the case. Form the coax cable so it will run along the bottom of the case under the printed circuit board and solder the braid to the soldering lug of J1.

(f) Angle the coax toward switch S9 and solder the center conductor to the center lead of the left row of contacts (looking at the rear of switch S9). Leave the shield free as it will be connected later.



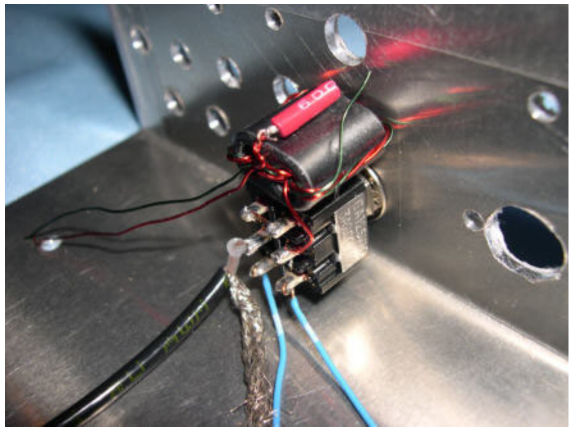
STEP 2 COMPLETED

STEP 3: Installing the 4:1 Balun T1.

(a) Looking at the back of the front panel, lay T1 on the top of S9 so the holes are at right angles to the front of the case. The 4 wires should come out of the holes on the end away from the front of the case and the join in the primary windings should be on the top of T1 as it lays on S9. Add a piece of heat shrink material, or insulating spaghetti to the joined primary windings.

(b) Cut the red lead coming from the right hand hole so it reaches the center pin of the right hand row of contacts on S9. Allow enough length to go around the upper contacts without shorting.

(c) Scrape, tin and solder this lead to the right center pin of S9.



STEP 3 COMPLETED

STEP 4: Installing Switch S5 (SPST) and Toroid L5 (0.5uH T68-6)

(a) Looking at the SPST switch S5 from the rear, orient it so the 3 contacts are vertical.

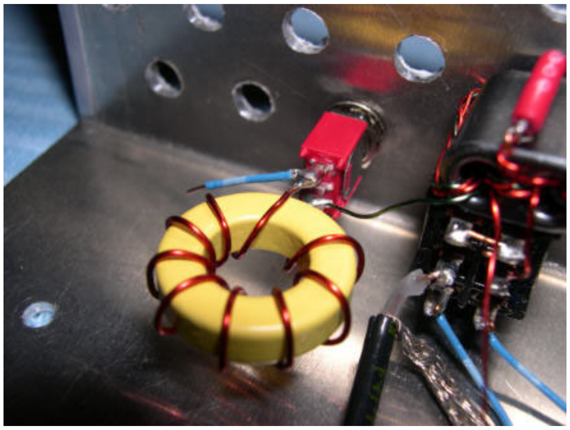
(b) Prepare a 3/4 inch length of insulated hook-up wire by removing 1/8 inch of insulation from each end. Solder the hook-up wire to the upper contact and orient it so it goes to the left.

(c) Form the leads of L5 so they can be connected between the upper two contacts of S5 and the toroid is positioned horizontally to the switch. The leads should be as short as possible to support the core without it sagging. Solder the L5 leads to S5.

(d) Referring to the case drawing, mount S5/L5 combination to the front of the case in the same manner that you mounted S9.

HINT: *Do not tighten the mounting nut all the way so you can turn the switch on its side to access the center pin for soldering. Don't forget to do the next step as you will not be able to access the switch later on.*

(e) Trim, tin and solder the green wire coming from the left hole of T1 to the center pin of S5.



STEP 4 COMPLETED

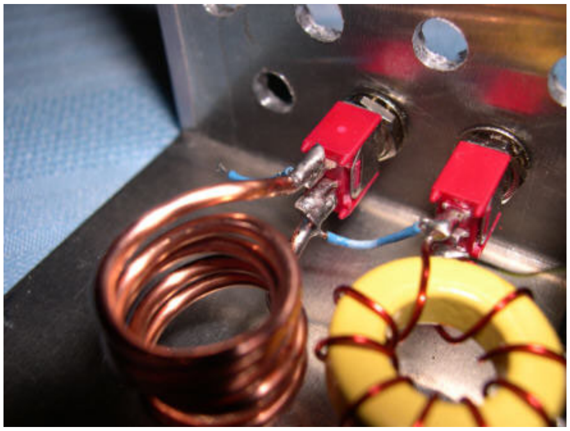
STEP 5: Installing Switch S6 (SPST) and Coil L6 (0.25 uH)

(a) In a similar manner as S5, prepare and solder a 3/4 inch length of insulated hook-up wire to the top contact of S6 and orient it to the left. (looking at the rear of the switch)

(b) Form the leads of the L6 coil and connect the coil between the upper two contacts of S6. Position the coil horizontally to the switch.

HINT: *Cut off the lower pin of the switch to provide better access.*

(c) Mount the S6/L6 combination and attach the insulated hook-up wire coming from the S5 upper contact to the center contact of S6.



STEP 5 COMPLETED

STEP 6: Installing Switch S7 (SPST) and Coil L7 (0.125 uH)

(a) Prepare a 3/4 inch length of insulated hook-up wire and solder one end to the top contact of S7.

(b) Form the leads of L7 and install it on the upper two contacts of S7 orienting the coil horizontally.

(c) Mount the S7/L7 combination and attach the lead from S6 to the center contact of S7.

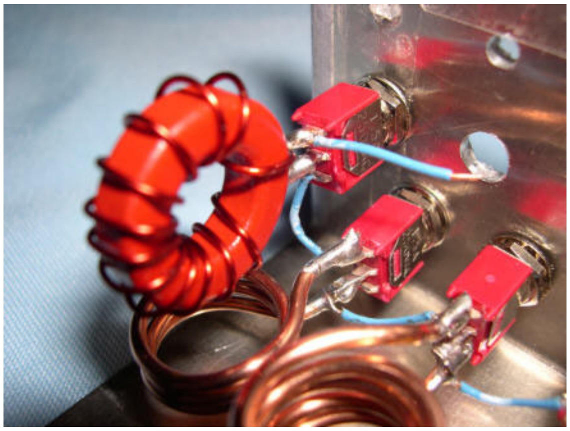
STEP 6 COMPLETED

STEP 7: Installing Switch S4 (SPST) and Toroid L4 (1uH T68-2)

(a) Prepare a 3/4 insulated hook-up wire as before and solder it to the upper pin of S4. This time it should be oriented to the right.

(b) Form the leads of L4 so it can be soldered to the upper two contacts of S4. This time the toroid should be mounted vertically.

(c) Mount the S4/L4 combination and attach the lead from S7 to the center contact of S4.

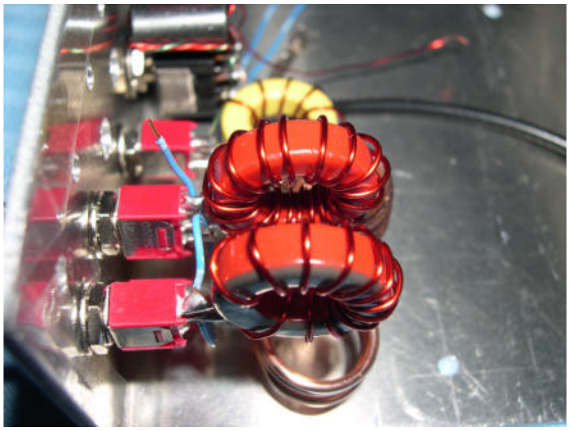


STEP 7 COMPLETED

STEP 8: Installing Switch S3 (SPST) and Toroid L3 (2 uH T68-2)

(a) Preparation and installation of Switch S3 and Toroid L3 is identical to that of Switch S4.

(b) After installing the combination attach the lead from S4 to the center contact of S3.



STEP 8 COMPLETED

STEP 9: Installing Switch S2 (SPST) and Toroid L2 (4uH T68-2)

(a) Follow the same procedure as S4 and S3 to prepare and install S2.

(b) Attach the lead from S3 to the center pin of S2.

STEP 9 COMPLETED

STEP 10: Installing Switch S1 (SPST) and Toroid L1 (8uH T68-2)

(a) Use the same procedure as S4, S3 and S2 to assemble and mount the combination of S1 and L1.

NOTE: *Due to the thinner wire on L1 it will be necessary to mount it very closely to the switch and keep the leads taunt. This will prevent it from sagging onto Toroid L5.*

(b) Attach the lead from S2 to the center pin of S1.

STEP 10 COMPLETED

STEP 11: Installing Switch S8 (DPDT Center Off)

(a) Identify the DPDT Switch S8. This is a 3 position switch with a center off position.

(b) Looking at the switch from the rear, orient it so the two rows of contacts are vertical. Each row will have a top, center and bottom contact.

(c) Connect all 3 contacts on the right row together with bare hook-up wire forming a buss. Solder center contact.

(d) Solder C102 (330 pF) capacitor between the bottom contact on the left row and the bottom contact on the right row.

(e) Solder C103 (330 pF) capacitor in parallel with C104 (330 pF) capacitor between the top contact of the left row and the top contact of the right row. This forms a 660 pF capacitor.

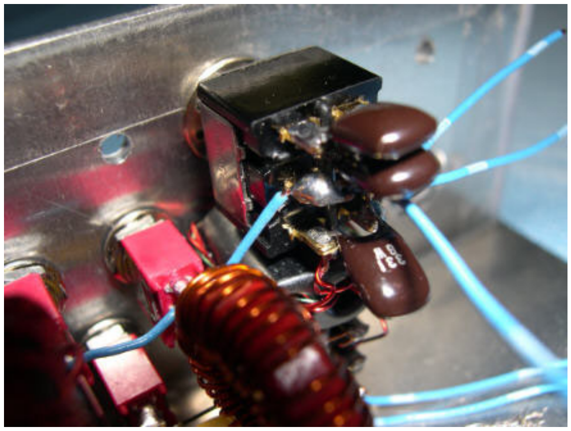
(f) Solder a 1 1/4 inch piece of insulated hook-up wire to the buss just below the center pin of the right hand row. Orient the wire to the right.

(g) Solder a 2 3/4 inch length of insulated hook-up wire to the buss just above the center pin. Orient the wire straight out from the switch.

(h) Connect a 1 1/2 inch piece of insulated hook-up wire to the center contact of the left row. Do not solder at this time, but orient the wire to the right between the buss and the back of the switch.

(i) Install S8 in the case and solder the lead coming from the top contact of S2 to the center contact of the left row on S8.

(j) Looking at the rear of the front panel, strip and solder the green wire coming from the right hole of T1 to the buss on the right side of S8.



STEP 11 COMPLETED

STEP 12: Installing Capacitor C101 (365 pF Variable)

(a) Look at the variable capacitor from the back. You will notice that all but one of the tabs come out of the rear part of the capacitor. Orient the capacitor so that the single tab coming from the front section is at the top. We will not be using this frontal tab except for referencing the top.

(b) C101 is made up of four tuning capacitors each with a trimmer. Initially adjust all 4 trimmers to minimum capacity by turning their screws until the plates are fully unmeshed. Bend the two tabs on the left side so they lie flat against the back of the capacitor and overlap each other. Do the same with the right hand tabs. Bend the two center tabs so they stick straight out from the rear of the capacitor.

(c) Mount the capacitor C101 to the front panel with the single tab coming from the front section at the top using 2 – 2.6mm x 4mm metric machine screws.

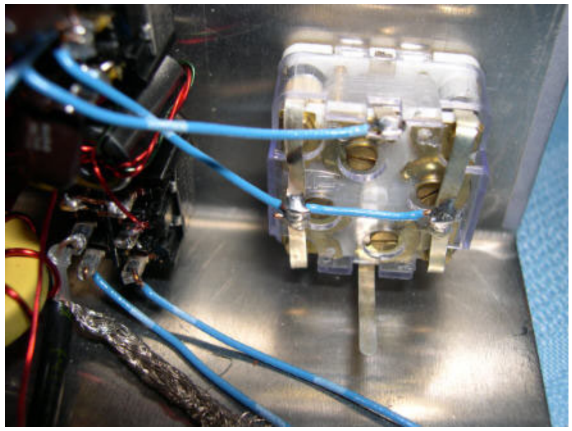
(d) Strip and solder the hook-up wire coming from the buss on S8 to the tabs on the left side of C101.

NOTE: *You should solder this joint so that the 2 tabs are also soldered together.*

(e) Solder a piece of insulated hook-up wire to the two overlapping tabs on the right side of C101 so that the 2 tabs are also soldered together. Solder the other end to the tabs on the left side of C101.

(f) Connect the piece of hook-up wire coming from the left center contact of S8 to the top center tab coming out of the rear of C101. Trim off the excess tab.

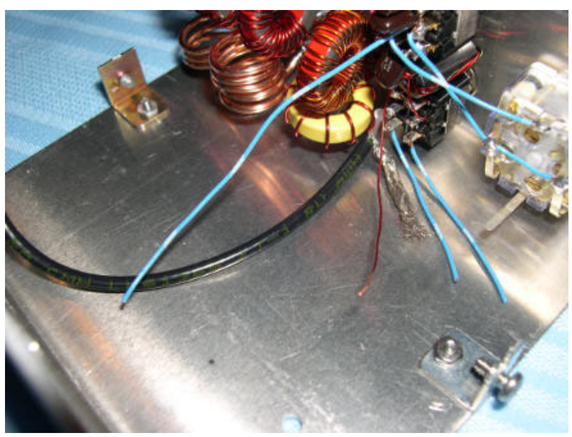
(g) Cut off the center tab coming from the front center of C101.



STEP 12 COMPLETED

STEP 13: Install the Case Brackets. (If they are not pre-installed)

(a) Using 2-56 x ¼" screws, washers and nuts, attach "L" shaped brackets to the base of the case in the center of either side. Align the brackets so the vertical section with the tapped hole is even with the edge of the case. If you are fabricating your own case, drill holes in the center of each edge using your brackets as a guide.



STEP 13 COMPLETED

STEP 14: Installing the Manhattan Style Printed Circuit Board.

(b) Install two 4-40 x 3/8" machine screws in the two remaining holes in the case base. If you are fabricating your own case, use the PCB as a guide to drill the holes. Allow room for the battery case. (See Step 15). The screws should be installed from underneath the case and held in place by 4-40 nuts and lock washers that will act as spacers.

(c) Ensure the RG-174 coax cable is positioned so that it will be under the printed circuit board.

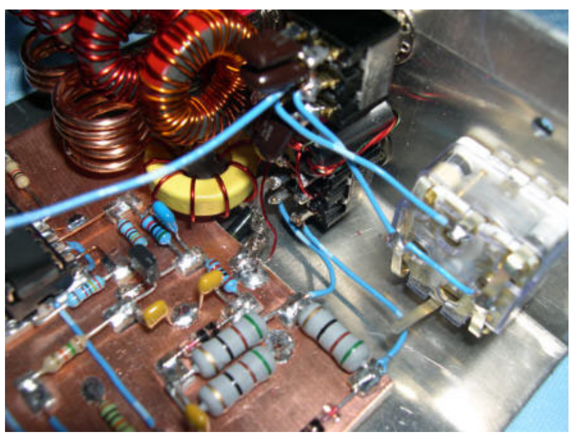
(d) Install the printed circuit board onto the machine screws with the notch in the IC socket to the right when facing the front of the tuner. Place a 4-40 nut on each of the machine screws to secure the circuit board.

(e) Solder the braided shield from the coax connector to the circuit board ground plane just behind S9.

(f) Strip and solder the Red wire primary of T1 coming from the left hole to the circuit board ground plane at the same point as the braid.

(g) Solder the insulated hook-up wire from the lower left contact of S9 to the R1/R3 pad of the circuit board.

(h) Solder the insulated hook-up wire from the lower right contact of S9 to the R3/D2 pad of the circuit board.



STEP 14 COMPLETED

STEP 15 Installing the “N” type Battery Holder.

(a) Prepare two 1 1/2 inch lengths of stranded wire by stripping and tinning each end.

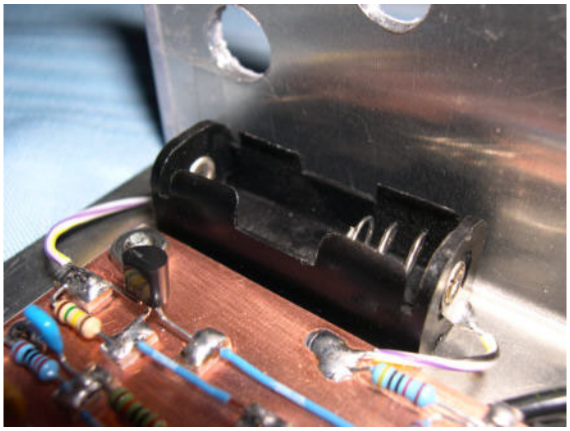
(b) Attach the 1 1/2 inch lengths to the soldering tabs on each end of the battery holder.

(c) Glue the battery holder to the base of the case.

NOTE: *Since the photo of the battery holder was taken, it was suggested that the holder can be mounted adjacent to the left side of the circuit board, between the pcb and the edge of the cabinet. This will make changing the battery a lot easier.*

(d) Solder the free end of the positive lead to Q2/R11 pad.

(e) Solder the free end of the negative lead to the circuit board ground plane.



STEP 15 COMPLETED

STEP 16 Installing the LEDs.

(a) Identify the Cathode lead for each LED. The Cathode lead is the shorter one adjacent to the flat spot on the base of the LED.

(b) Cut all but 1/8 inch off of each of the Cathode leads.

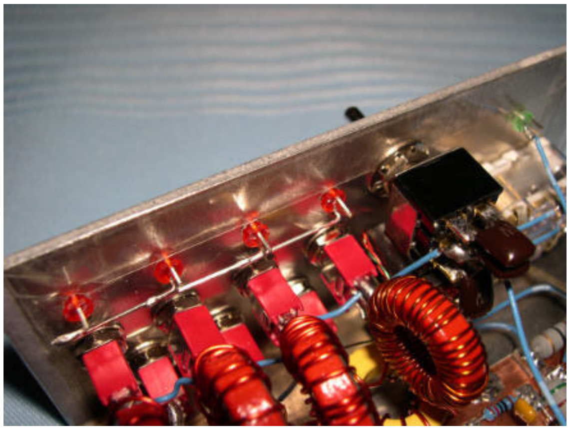
(c) Make sure the Cathode leads and flat spots are facing up, then press fit each of the 4 Red LEDs D5, D4, D3 and D7 into the case in the four holes above the inductor switches S1, S2, S3 and S4 respectively.

(d) Bend the Anode leads to the right (facing the tuner) and overlap them. Trim them back so they overlap each other by about 1/8 inch. Solder all the overlapping leads to form a solid buss. Trim off the excess lead from D7.

(e) Locate the Green LED D6 and trim off all but 1/8 inch from both leads. Solder a 2 inch piece of insulated hook-up wire to the Cathode of the Green LED.

(f) With the flat spot indicating the Cathode lead facing down, press fit the Green LED into the hole directly above the variable capacitor C101.

(g) Solder the other end of the hook-up wire coming from the Cathode of D6 to the circuit board where resistor R2 is grounded.



STEP 16 COMPLETED

STEP 17: Preparing the Ribbon Cable

HINT: *Since a picture is worth 1000 words, study the picture of the completed cable before trying to interpret the following instructions.*

(a) Cut a 10 inch piece of 6 conductor ribbon cable.

(c) Separate one of the outer conductors for 1/2 inch from one end. It doesn't matter at this time which end you use.

(d) Prepare the end by stripping, twisting and tinning 1/8 inch of the separated conductor.

HINT: *The insulation will melt easily, so it is suggested that you use a heat sink (pliers or tweezers) to clamp the end while tinning.*

(e) Orient the cable so that the prepared outer lead is at the top and the tinned end is on the right. We will call the top conductor number 1 and arbitrarily assign numbers to the others from the top down.

(f) Separate conductor #2 from the right side for 2 inches.

(g) Cut off 1 1/2 inches then strip, twist and tin 1/8 inch of the conductor.

(h) Separate the next conductor #3 for 2 1/2 inches from the right hand end.

(i) Cut off 2 inches of conductor #3, then strip, twist and tin 1/8 inch of the end.

(j) Separate conductor #4 for 3 inches from the right end.

(k) Cut off 2 1/2 inches of conductor #4 and prepare 1/8 inch of the end as before.

(l) Separate 3 1/2 inches of conductors 5 and 6 from the right end.

(m) Cut off 3 inches of conductors 5 and 6 from the right end.

(n) Separate conductors 5 and 6 from each other for 1/2 inch and prepare both the ends.

(o) Separate 2 inches of conductor #1 from the left side of the ribbon cable.

(p) Cut off 1 1/2 inches of conductor #1 from the left side.

(q) Separate 2 1/4 inches of the left side of conductor #2

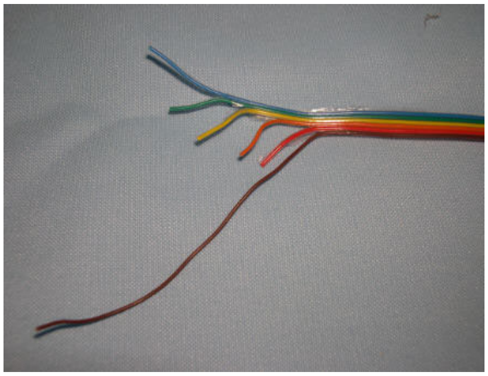
(r) Cut off 1 3/4 inches.

(s) Separate 2 1/2 inches of conductor #3. Cut off 2 inches.

(t) Separate 2 3/4 inches of conductor #4. Cut off 2 1/4 inches.

(u) Separate 3 inches of conductor #5. Cut off 2 1/2 inches.

(v) DO NOT cut the left side of conductor #6.



STEP 17 COMPLETED

STEP 18: Installing the Ribbon Cable

(a) Solder the right end of conductor #1 to the anode of the Green LED D6 located above the variable capacitor.

(b) Solder the right end of conductor #2 to the cathode of Red LED D5.

(c) Following along the cable, solder conductor #3 to the cathode of Red LED D4.

(d) Solder conductor #4 to the cathode of Red LED D3.

(e) Solder conductor #5 to the cathode of Red LED D7.

(f) Solder conductor #6 to the buss connecting the anodes of all the Red LEDs.

(g) Fold the ribbon cable to form a right angle so it is flat against the front of the case and conductor #1 is on the inside of the case. Route the cable down the front and along the base of the case.

(h) Trim to the correct length and solder the other end of conductor #5 to the R14 pad.

(i) Following along the cable, trim and solder conductor #4 to R15 pad.

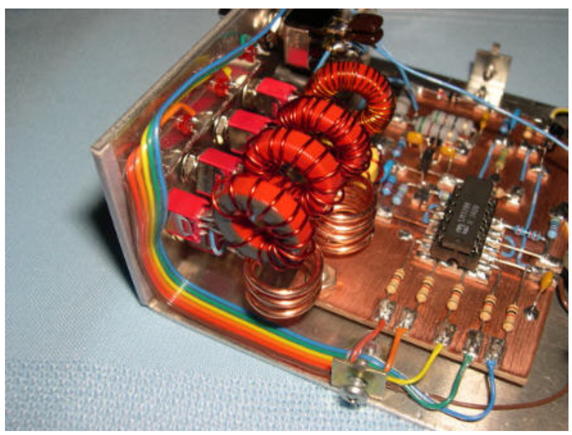
(j) Trim and solder conductor #3 to R16 pad.

(k) Trim and solder conductor #2 to R17 pad.

(l) Trim and solder conductor #1 to R13 pad.

(m) Route conductor #6 around the back of the circuit board. Trim and solder it to C5/R13 pad.

(n) Lay the ribbon cable as flat a possible against the bottom of the case.



STEP 18 COMPLETED

STEP 19: Installing the Banana Jacks

(a) Looking at the rear of the case, mount the two black banana jacks J4 and J5 above one another to the left of the center using the lock washer and large nut supplied on the jacks.

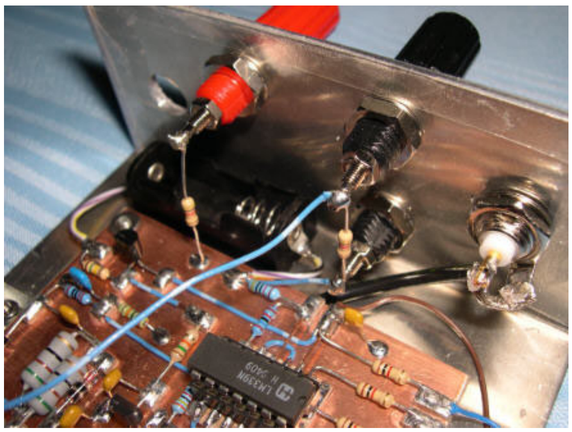
(b) In the same manner, install the red banana jack J3 in the hole just to the right of center and even with the upper black banana jack. Align the holes in all jacks so they are vertical.

(c) On the inside of the rear panel install R102, a 4.7 K resistor between J4 and J5. Do not solder at this time.

(d) Add a jumper wire between J5 (the lower end of R102) and the ground plane of the circuit board. Solder both ends.

(e) Connect the insulated hook-up wire coming from the buss on switch S8 to the upper black banana jack J4 along with the upper end of R102 and solder.

(f) Solder R101, a 4.7 K resistor between the red banana jack J3 and the ground plane of the circuit board.



STEP 19 COMPLETED

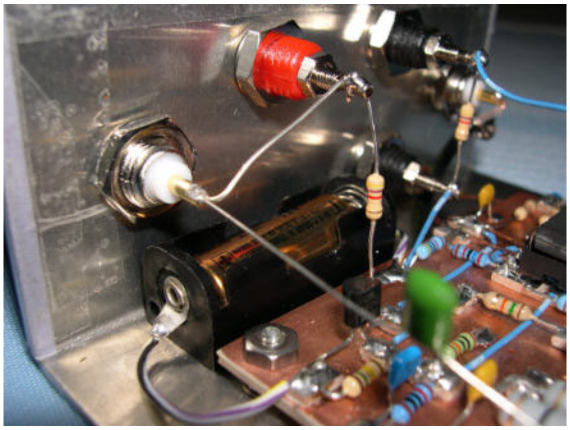
STEP 20: Installing BNC Connector J2

(a) Mount the BNC connector (without the soldering lug) J2 in the remaining hole on the rear of the case.

(b) Form a piece of solid un-insulted hook-up wire to join the center pin of J2 and the Red banana plug J3. Solder only the end connected to J3.

(c) Solder C105, a 470 pF capacitor to the BNC connector along with the bare hook-up wire.

(d) Solder the other end of C105 to the lower tab coming out of the rear center of the tuning capacitor C101.



STEP 21 COMPLETED

STEP 21: Installing the Tuning Knob for C101:

(a) Remove all the burrs from the extension shaft for C101 with #220 emery cloth or sand paper.

(b) Using a 2.6 mm X 12 mm metric machine screw, attach a 1/4 x 3/8 inch extension shaft to C101.

NOTE: *Be careful to ensure the extension shaft is aligned with the short shaft of C101. Tighten the machine screw fairly tight so it does not come loose when rotating the capacitor counter clockwise.*

HINT: *Using Loctite™ on the end of the metric machine screw will help to keep the extension from loosening. Be careful not to get any on the capacitor bearing.*

(c) Turn the shaft fully clockwise and install the Knob so the white indicator marker is pointing to the right.

STEP 22: Assembling the Jumper Cable

(a) Cut a 3 1/2 inch length of stranded hook-up wire.

(b) Strip 1/2 inch of insulation from each end.

(c) Assemble a banana jack on each end of the hook-up wire.

STEP 23: Completing the Case

(a) Install the peel and stick feet symmetrically on the four corners of the bottom of the base.

(b) The finishing of the top cover is left to the creativity of each builder. Install the finished cover using two self taping screws.

COMPLETED TUNER

NOTE: *Before proceeding to the next step, take a few minutes to verify that all parts have been installed correctly. Pay particular attention to diodes, transistors, LEDs and switch assemblies. Check for cold solder joints using a magnifying glass.*

PART 5
TESTING AND OPERATING

STEP 1: Initial Settings.

(a) Connect a 2K 1W resistor across the Balanced Output Terminals (J3 and J4). Do not use the jumper for this test.

(b) Place all 7 inductor switches in their down (bypass) position.

(c) Set the +330 /+0 /+660 switch to the +0 position.

(d) Set the TUNE/XMT switch to the TUNE position.

(e)

(f) Position C101 at “10” (fully counter-clockwise).

(g) Connect a transmitter’s output to the input jack J1.

NOTE: *The transmitter should be set for about 1 to 2 watts output. The tuner can handle power ratings from 200 mw up to 5 watts. We will be using the 40 meter band for this test, but other bands could be used with similar results.*

STEP 2: Initial Tests

(a) Install the battery into the “N” type holder with the negative terminal contacting the spring. Check to make sure that none of the LED’s are lit. If they light, remove the battery and go to Step 4a.

(b) Key the transmitter on the 40M band for no more than a few seconds. The green LED should turn on to show that RF power is being applied. Some or all of the red LED’s may turn on. If the green LED does not turn on, check the switch setting in Step 1 or go to Step 4b.

(c) Set the inductor switches labeled 1 and 2 to “on” thus adding 3 uH. The tuner should be able to achieve a 1.5:1 SWR by rotating the variable capacitor C101 while briefly keying the transmitter. You will notice that the LED’s will start to extinguish from right to left as you get closer to finding a match. When the last red LED goes out the SWR is less than 1.5:1. If only some of the LED’s are extinguished you can add or subtract inductance a fraction of a uH using the lower row of inductor switches. Check Steps 4c and 4d if you have difficulty achieving 1.5:1 SWR.

Typical Settings for 2K Dummy Load

BAND	CAP pF	IND uH
160 M	+660	8
80 M	+330	5
40 M	+0	3
30 M	+0	2
20 M	+0	1
15 M	+0	.75
10 M	+0	.375

Typical Settings for 51 Ohm Load

BAND	CAP pF	IND Uh
160 M	+330	6.5
80 M	+330	2.5
40 M	+0	.5
30 M	+0	.25
20 M	+0	0
15 M	+0	0
10 M	+0	0

HINT: *When the variable capacitor C101 is near the maximum (10 on the dial) try adding another 330 pF and re-adjust closer to its minimum capacity (0 on the dial).*

(d) Exchange the 2K resistor for a 50 or 51 ohm resistor. You will now find that only the fractional uH inductance switches will be necessary to achieve less than 1.5:1 SWR ratio on 40 meters.

STEP 3: Operating the Tuner with your Antenna.

(a) Remove the test resistors and connect your antenna to the tuner. If you are using a coax feed or an end fed wire antenna, add the jumper between the two black binding posts (J4 and J5). For balanced antenna feed lines, connect them between the red binding post and the top black one (J3 and J4).

(b) Set all inductor switches to the down (bypass) position and the capacitor switch to +0. Put the TUNE/XMT switch in the TUNE position.

(c) Briefly key the QRP transmitter while rotating the variable capacitor through its range. If none of the LED's go out, start adding inductance by using the switches in a binary fashion. Use the following tables if you are not familiar with the binary code.

(d) If you are using a multi-band antenna, tune it for each band and make a notation of the switch settings so you can tune your antenna quickly when changing bands.

Binary Code for Upper 4 Switches

uH	0=off 1=on
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001
10	1010
11	1011
12	1100
13	1101
14	1110
15	1111

Binary Codes for Lower 3 Switches

uH	0=off 1=on
0	000
.125	001
.250	010
.375	011
.500	100
.625	101
.750	110
.875	111

STEP 4: Troubleshooting.

(a) LED's LIGHT WHEN POWER IS APPLIED WITHOUT RF. This will occur if Q2 is conducting. Check the following:

1. Verify that the voltages on Q1 and Q2 are correct according to the voltage chart at the end of Step 4.

(b) GREEN LED DOES NOT LIGHT WHEN RF APPLIED. This generally means that RF is not being rectified and applied to the Gate of Q1, or the bridge circuit is not receiving power. If the Transmitter is operating properly, check the following:

1. Switch settings, particularly the TUNE/XMT switch, are set correctly.

2. Battery voltage is 12 V at R12/Q2 pad.

3. If you have a scope available, verify the transmitter is delivering RF to the input of the bridge circuit board at pad R1/R3.

4. Check other key voltages (See the voltage chart at end of Step 4).

(c) GREEN LED IS OK BUT RED LED's DO NOT LIGHT. It would appear that RF is reaching the bridge circuit, but the problem lies in the comparator U1. Check the following:

1. Pin 3 of U1 (LM339) should be at or near 12 v when RF applied.

2. The anodes of all red LED's should be at or near 12 v when RF is applied.

3. Check other key voltages on U1 (See the voltage chart at end of Step 4).

(d) NOT ALL THE RED LED'S TURN OUT WHEN ADJUSTING TUNER WITH 2K DUMMY LOAD ATTACHED. The most likely cause of this problem is in the tuner section of the project. Remove the RF input, the antenna or dummy load and the jumper for coax if installed, then check the following:

1. Carefully check the wiring of all coils and switches in the tuner section.

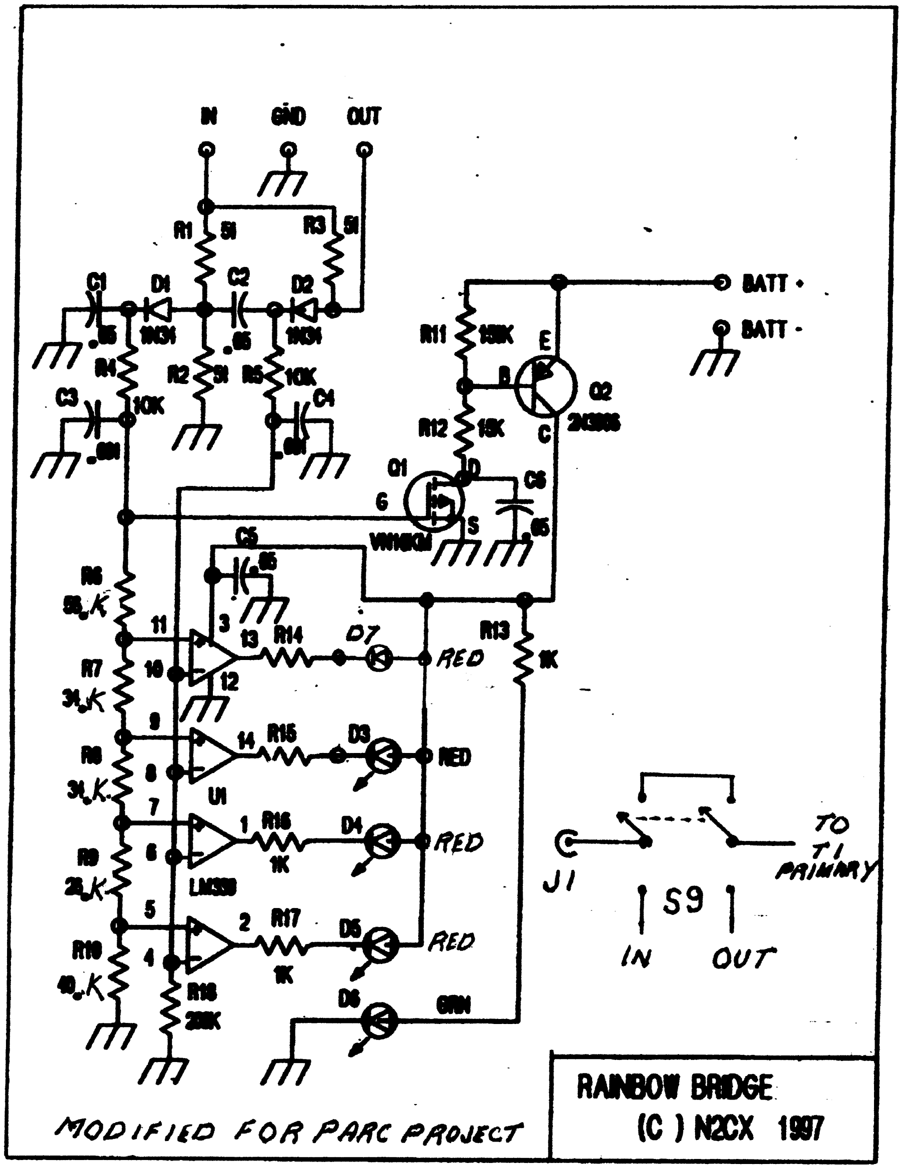
2. Set Switch S8 to +660 and all the inductor switches in the down position. Measure the continuity between the top two pins of S8. It should be less than 1 ohm. If this measurement is high, there is likely an open circuit in the Coil/Switch chain.

3. Perform the same check as above, only turn all the inductor switches to the up position. The reading will be a little higher by about 0.2 ohms. If there is a very high measurement, then one of the inductors is open. Close the switches one at a time until continuity is restored and the faulty switch/inductor combination identified.

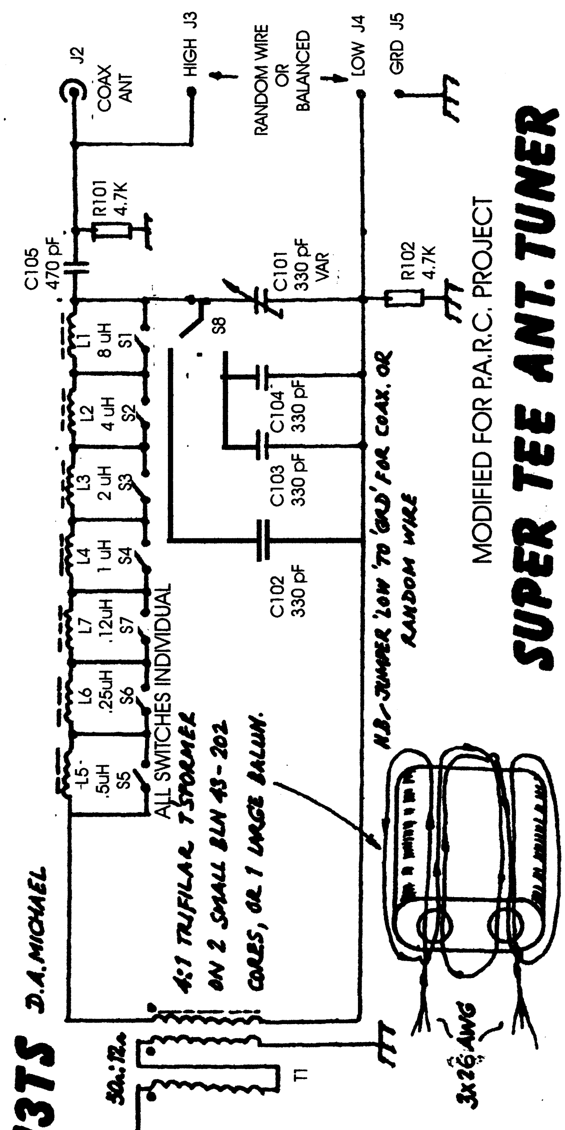
4. Measure the resistance between either of the top pins of S8 and the ground plane of the pcb. The reading should be between 2K and 3K. A high reading will indicate an error or short in the wiring of C101 or the antenna connection circuitry. A low reading will indicate an error or open circuit in the same wiring.

DC Voltage readings using the SW-40+ Transmitter at 2 Watts

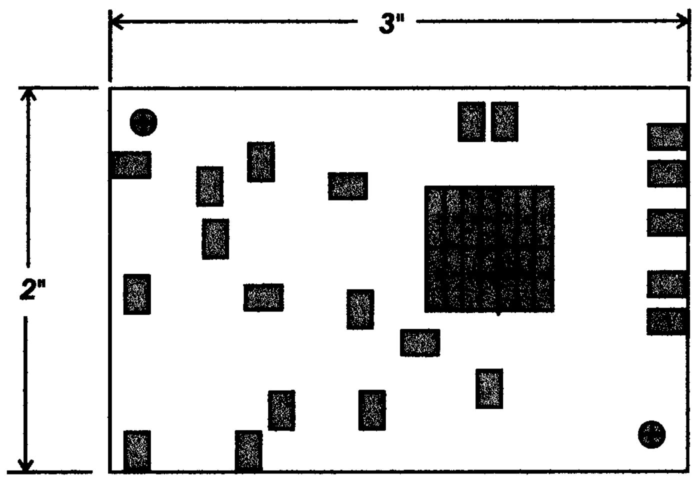
	XMT OFF	<1.5:1 SWR	>5:1 SWR
BATT +	12.8 V	12.0 V	10.7 V
Q1-G	0	6.3	7.3
Q1-D	11.9	0	0
Q2-B	12.1	11.1	9.7
Q2-C	0	11.8	10.2
U1-1	0	10.6	0.4
U1-2	0	10.6	0.4
U1-3	0	11.9	10.0
U1-4	0	0. 6	7.0
U1-5	0	1.3	1.5
U1-6	0	0. 6	7.0
U1-7	0	2.1	2.4
U1-8	0	0. 6	7.0
U1-9	0	3.1	3.7
U1-10	0	0. 6	7.0
U1-11	0	4.3	5.0
U1-12	0	0	0
U1-13	0	10.6	0.4
U1-14	0	10.6	0.4



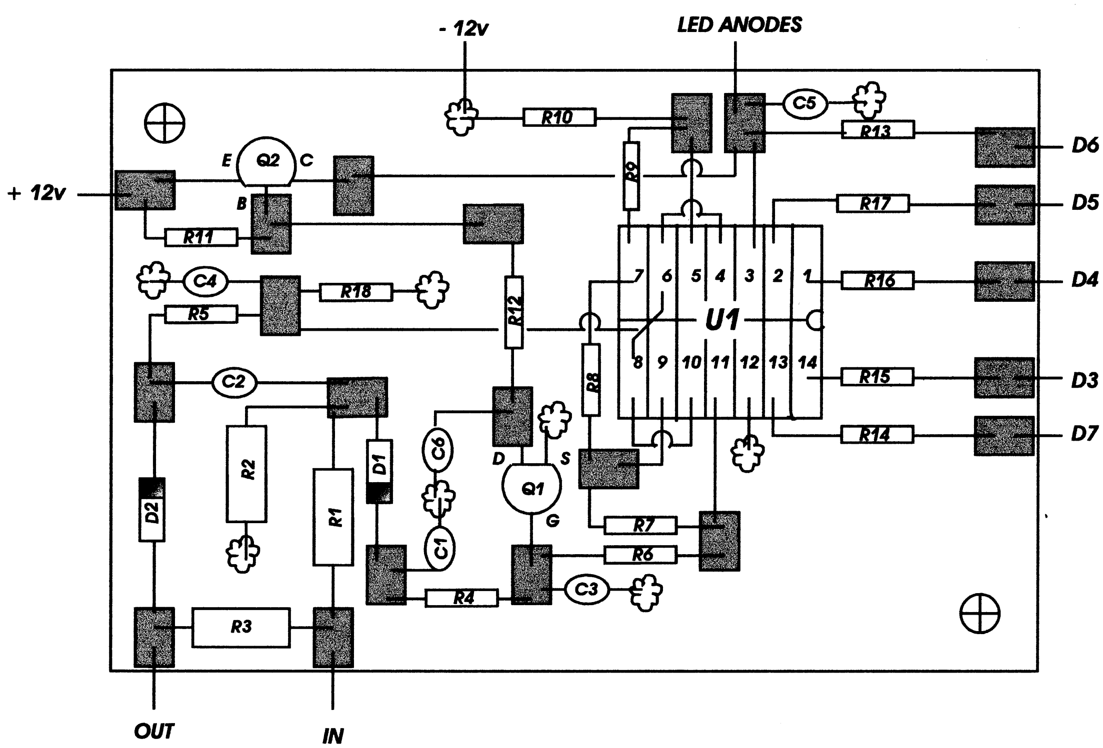
Rainbow Schematic


W3TS
D.A.MICHAEL
FROM S9
50Ω:12Ω
T1
4:1 TRIFILAR T'SFORMER
ON 2 SMALL BLN 43-202
CORES, OR 1 LARGE BALUN.
3x26 AWG
ALL SWITCHES INDIVIDUAL
L5 .5uH S5
L6 .25uH S6
L7 .12uH S7
L4 1 uH S4
L3 2 uH S3
L2 4 uH S2
L1 8 uH S1
S8
C102 330 pF
C103 330 pF
C104 330 pF
C101 330 pF VAR
C105 470 pF
R101 4.7K
R102 4.7K
J2 COAX ANT
HIGH J3
RANDOM WIRE OR BALANCED
LOW J4
GRD J5
N.B.-JUMPER 'LOW' TO 'GRD' FOR COAX, OR RANDOM WIRE
MODIFIED FOR P.A.R.C. PROJECT
SUPER TEE ANT. TUNER

PCB Layout Template

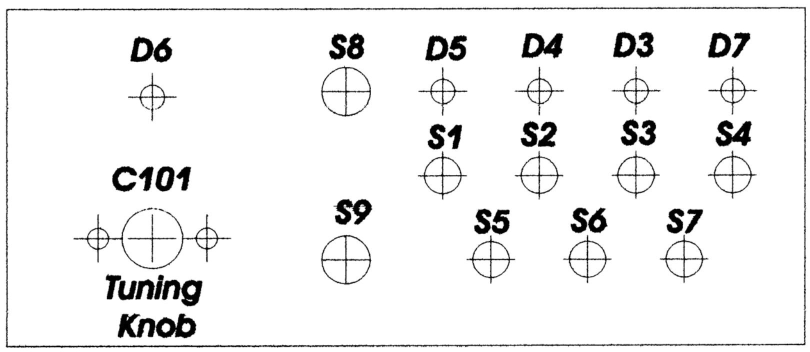


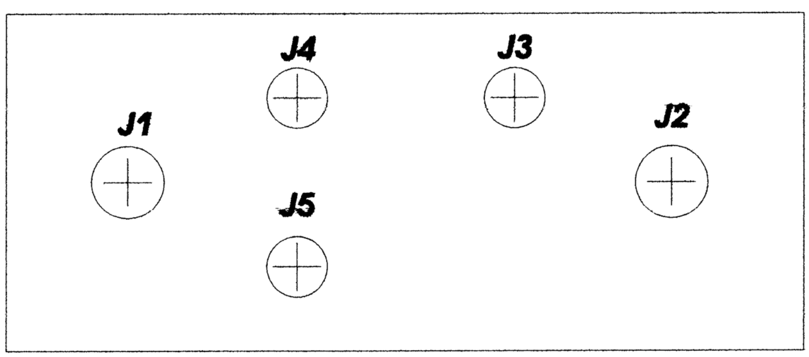
PARC Antenna Tuner
Circuit Board Layout



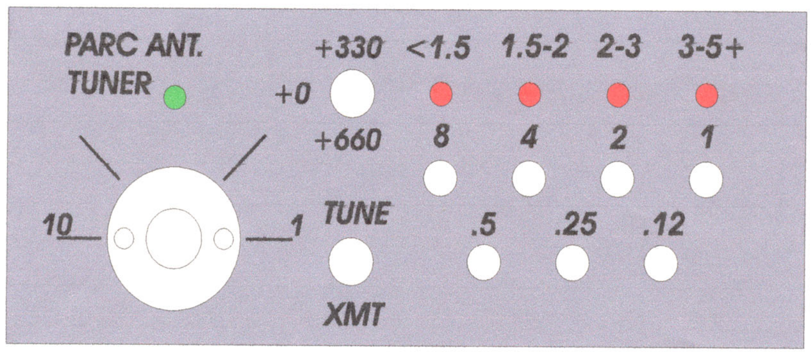
F. ROBERTS VE3FAO

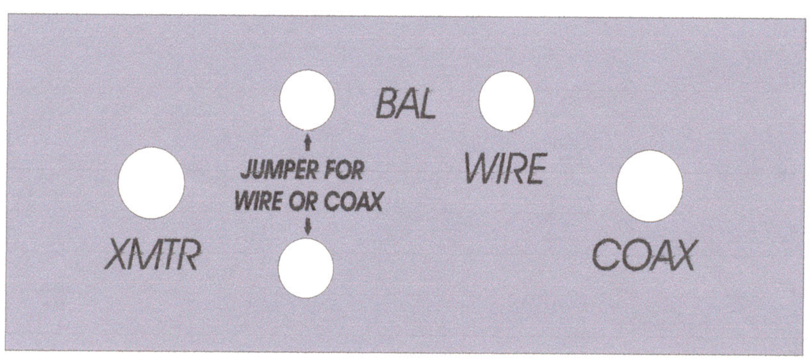
PARC Antenna Tuner
Part Designations



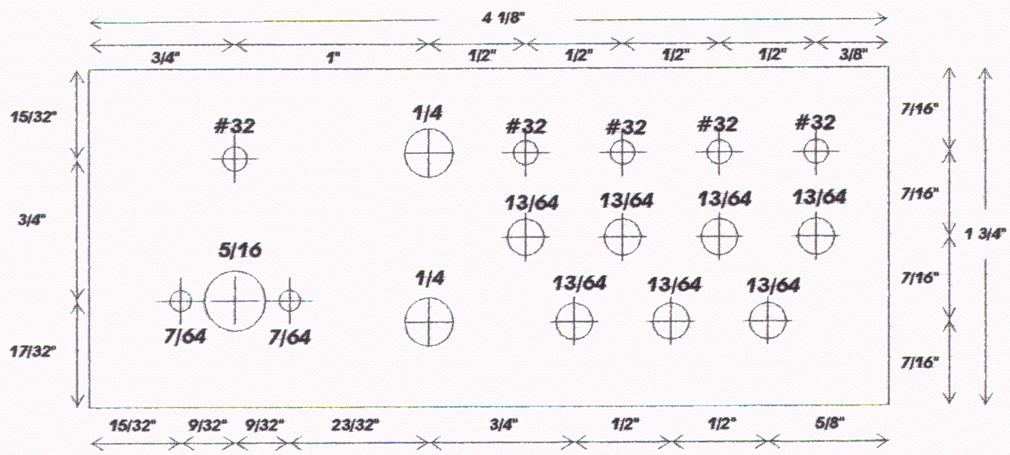


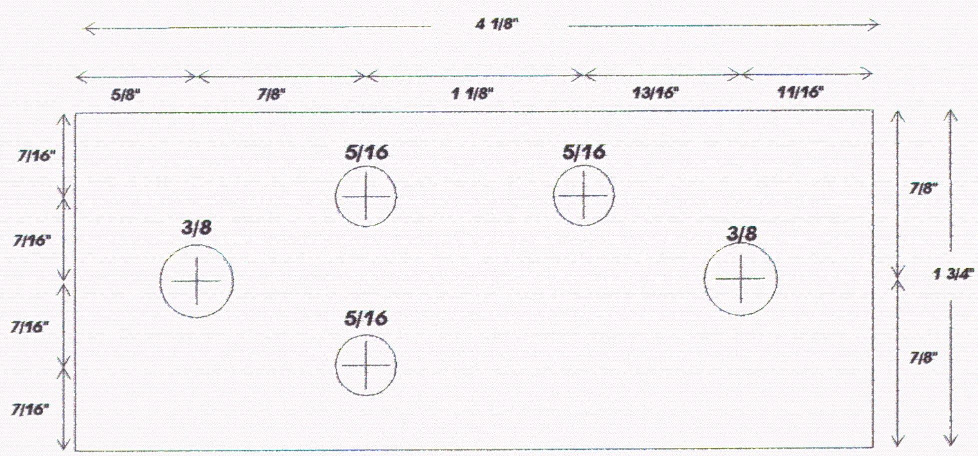
PARC Antenna Tuner Face & Rear Plate Graphics





PARC Antenna Tuner
Face & Rear Plate Measurments





PARC ANTENNA TUNER PARTS LIST

QUANTITY	DESIGNATION	DESCRIPTION
		RESISTORS ¼ W 1%
2	R4,R5	10K
1	R6	56K
2	R7,R8	34K
1	R9	26K
1	R10	40K
1	R18	200K
		RESISTORS ¼ W 5%
1	R11	150K
1	R12	15K
5	R13,R14,R15,R16,R17	1K
2	R101,R102	4.7K
		RESISTORS 1W 5%
1	TEST LOAD	2K
4	R1,R2,R3,TEST LOAD	51 OHM
		CAPACITORS
4	C1,C2,C5,C6	.047 MONO CAP (473)
2	C3,C4	.001 MONO CAP (102)
1	C105	470PF SM CAP
3	C102,C103,C104	330PF SM CAP
1	C101	330 MFD VAR CAP WITH SCREWS
		SOLID STATE DEVICES
2	D1,D2	1N60
1	Q1	VN10LP
1	Q2	2N3906
1	U1	LM339 IC
4	D3,D4,D5,D7	RED LED 3MM
1	D6	GREEN LED 3MM
		TOROIDS
4	L1,L2,L3,L4	T68-2 TOROID RED CORE
1	L5	T68-6 TOROID YELLOW CORE
1	T1	BN 43-202 BALUN

Page 1

MISCELLANEOUS PARTS

1		14 PIN IC SOCKET
7	S1,S2,S3,S4,S5,S6,S7	SPST MINATURE SWITCH
1	S9	DPDT MINATURE SWITCH
1	S8	DPDT CTR OFF SWITCH
1		1 INCH KNOB
1		L1028 12V "N" BATTERY
1		"N" BATTERY HOLDER
1	J3	RED BANANA JACK
2	J4,J5	BLACK BANANA JACK
1		RED BANANA PLUG
1		BLACK BANANA PLUG
1	J1	BNC CONNECTOR WITH LUG
1	J2	BNC CONNECTOR WITHOUT LUG
1		5" X 1/8" PCB PAD MATERIAL
1		3/4" X 5/8" PCB IC CARRIER
1		3" X 2" PCB
2		4-40 SCREWS, NUTS & WASHERS
1	C1 SHAFT EXTENSION	3/8" X 1/4" SHAFT EXTENSION
1	EXTENSION SCREW	2.6mm X 12mm MACHINE SCREW

WIRE

60"	#22 MAGNET WIRE
30"	#24 MAGNET WIRE
22"	#26 RED MAGNET WIRE
11"	#26 GREEN MAGNET WIRE
7"	RG174 COAX CABLE
10"	6 CONDUCTOR RIBBON CABLE
16"	#14 GAUGE COPPPER WIRE
6 1/2"	STRANDED HOOK-UP WIRE
48"	SOLID HOOK-UP WIRE
1	CASE WITH BRACKETS
4	CABINET FEET

Page 2

 HOMEBREWER Magazine is a quarterly journal of the American QRP Club, published on CD-ROM. Each issue typically contains over 200 pages of QRP-related homebrewing construction and technical articles intended for builders, experimenters, ham radio operators and low power enthusiasts all around the world. HOMEBREWER features include construction projects for beginners all the way up to the advanced digital and RF experimenters. Annual subscriptions are $15 (for US & Canada) and $20 (for foreign addresses). For information, contact editor/publisher George Heron, N2APB at n2apb@amqrp.org or visit HOMEBREWER Magazine home page at www.amqrp.org/homebrewer.

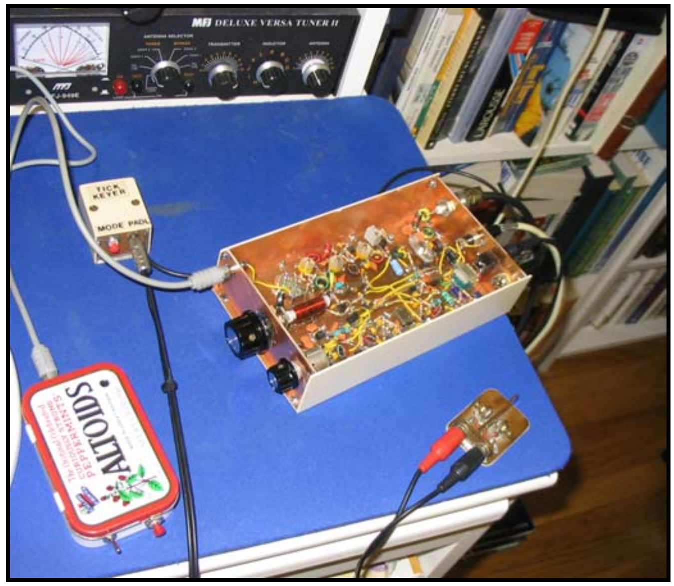
AmQRP.ORG HOMEBREWER

Wayne McFee, NB6M

A Nuts and Bolts Approach to RF Design ... Part 3

The Nuts and Bolts 20

If the rig in this picture looks familiar to you, it should! It looks a lot like the 40m Nuts and Bolts design that was detailed in the previous two installments. There is there is a major difference – this one is a 20m rig that was the product of taking that original design and bringing it a step forward. The result is a useful rig for one of the most popular HF DX bands.



As can be seen in the photo above, the construction layout and building method were the same as those used in the Nuts and Bolts 40. However, in order to put the rig on 20 Meters, several parts of the circuit required changes, and there were some additions, as well.

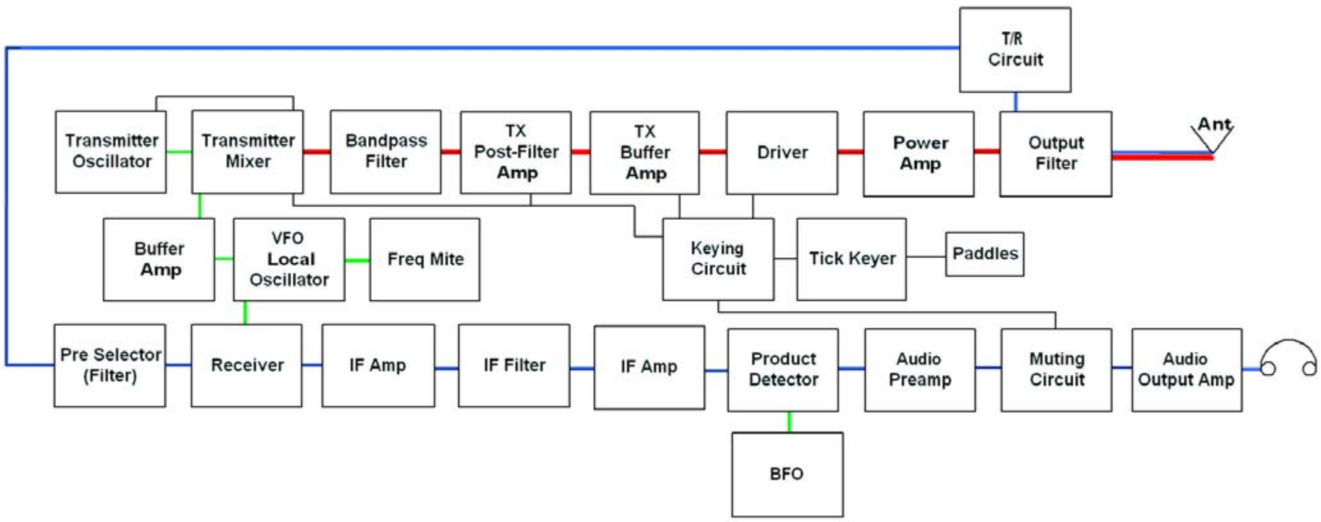
The 40 Meter transceiver described in the previous two "Nuts and Bolts Approach" articles is fun to operate, has a very clean transmitter signal and a nice sounding superhet receiver, and has a stable VFO, which provides coverage of the entire CW portion of the band.

It was even more fun designing it, building it, testing it, modifying and tweaking it so that it actually performed as desired. In this article, we will look at the changes necessary to make this basic design work, and work well, on a higher band.

Because 40 and 20 Meters have always been the two most popular HF bands, it seemed only natural to design and build a transceiver for 20 Meters, since the first Nuts and Bolts transceiver was designed for 40.

DESIGN REVIEW

What are the changes needed, in order to make the switch from 7 MHz to 14 MHz operation? In order to clarify our needs, let's go back and take a quick look at the basic structure of the Nuts and Bolts 40. Here is the Block Diagram.



Discrete Transceiver Block Diagram
NB6M 2003

Remember that we used a simple superhet design, the S7C, borrowed from "Experimental Methods In RF Design" [i] as the basis for designing this transceiver. An IF frequency of 4.000 MHz was chosen, and a 3 MHz VFO was used so that the transmitter mixer output and receiver mixer inputs would be on 7 MHz.

Looking at the block diagram above, the key things that make this transceiver operate well on 40 Meters are:

- T/R circuit tuned to 7 MHz
- Receiver Preselector Filter tuned for the 40 Meter band
- VFO frequency coverage of 3.000 to 3.165 MHz
- IF Filter frequency of 4.000 MHz
- BFO crystal frequency 4.000 MHz, with the oscillator frequency tuned so that a received LSB signal centered in the IF filter passband provides a 600 Hz tone in the headsets
- Transmitter Oscillator crystal frequency 4.000 MHz, with the oscillator tuned so as match the transmitter signal frequency to a received signal frequency that is centered in the IF filter passband.
- Transmitter Oscillator output filter, with a 4.5 MHz cutoff frequency (Chebyshev 5 element)
- Transmitter Bandpass Filter tuned for the 40 Meter band
- Impedance matching circuit (Pi Network) between the Transmitter Post-Filter Amplifier and the Transmitter Buffer Amplifier tuned to 40 Meters

- Transmitter output filter (Low-Pass, 7 Element Chebyshev) designed with an 8.5 MHz cutoff frequency, so as to provide great attenuation of any harmonics of the transmitter signal.

CHANGES NEEDED FOR 20 METER OPERATION

Beginning with the receiver, the basic changes we need to make are:
- Select appropriate IF and VFO frequencies
- Change the BFO crystal frequency to match the IF frequency
- Change the T/R circuit so that it is tuned to 14 MHz
- Change the Receiver Preselector Filter so that its passband centers on the lower half of the 20 Meter band

IF and VFO FREQUENCY CONSIDERATIONS

First let’s address the IF and VFO frequency selection. In the Nuts and Bolts 40, several different IF/VFO frequency pairs could have provided for 7 MHz operation. For those of us building crystal filters for ourselves, relatively cheap microprocessor crystals are available in a wide range of frequencies. Using these for the IF, the following are some of the mixing schemes giving coverage of the lower 150 KHz of the 40 Meter band:
- 4.915 MHz IF and 2.085 to 2.235 MHz VFO, mixing IF + VFO
- 10.000 MHz IF and 2.850 to 3.000 MHz VFO, mixing IF – VFO
- 4.000 MHz IF and 11.000 to 11.150 MHz VFO, mixing VFO – IF
- 9.000 MHz IF and 1.850 to 2.000 MHz VFO, mixing IF – VFO
- 12.000 MHz IF and 4.850 to 5.000 MHz VFO, mixing IF – VFO
- 4.000 MHz IF and 3.000 to 3.150 MHz VFO, mixing IF + VFO

Here are some of the factors that should be considered when choosing IF and VFO frequencies:

First, the IF and VFO frequencies should be selected so that they are not harmonically related to each other. This is done so that no strong birdies occur in the receiver, but, more importantly, so that bandpass filters can effectively screen out any harmonic output of the basic IF and VFO frequencies, to help ensure the spectral purity of the transmitter.

A second consideration is the type of VFO we are going to use. In this case, we are going to use an analog VFO, and it is easier to build a stable VFO for relatively low frequencies than it is for higher frequencies.

A third consideration is whether or not we would like to modify the basic design so as to provide dual, or multiple band operation in the future.
And, as always, we want to use parts that we have on hand, rather than buying more.

At the time the Nuts and Bolts 40 was being designed, the crystals on hand were 4.000 MHz and 9.000 MHz.

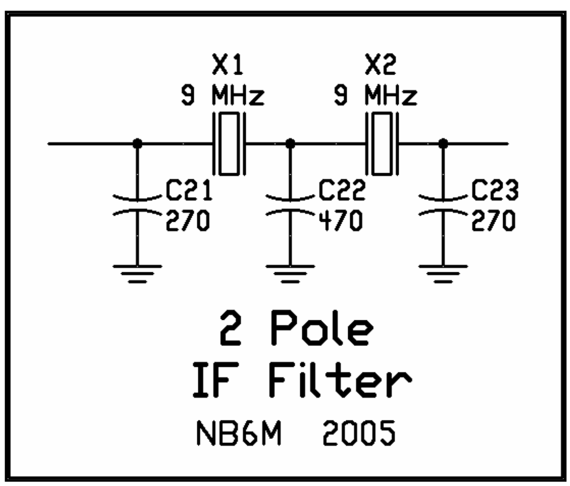
Using a 4.000 MHz IF and 11 MHz VFO was ruled out, due to the probable instability of the VFO. The 4.000 MHz IF and 3 MHz VFO were chosen over the 9 MHz IF and 2 MHz VFO scheme because of the fact that a 3.0 MHz VFO could be used with the 4.000 MHz IF, by the addition of a frequency doubler, to add 30 Meter operation at a future time.

Now that we want to change the design so as to put the rig on 20 Meters, and given that 9.000 MHz crystals were already on hand, using them seemed the right thing to do since a 9.000 MHz IF and a 5 MHz VFO would allow for the addition of modifications in the future which would give the rig the capability of operating on both 20 and 80 Meters.

IF FILTER DESIGN

The G3UUR method for measuring quartz crystal parameters, described in "Experimental Methods In RF Design" [ii], chapter three, under "Crystal Measurement and Characterization", were used in order to determine the Motional Capacitance and Motional Inductance of the 9 MHz crystals on hand.

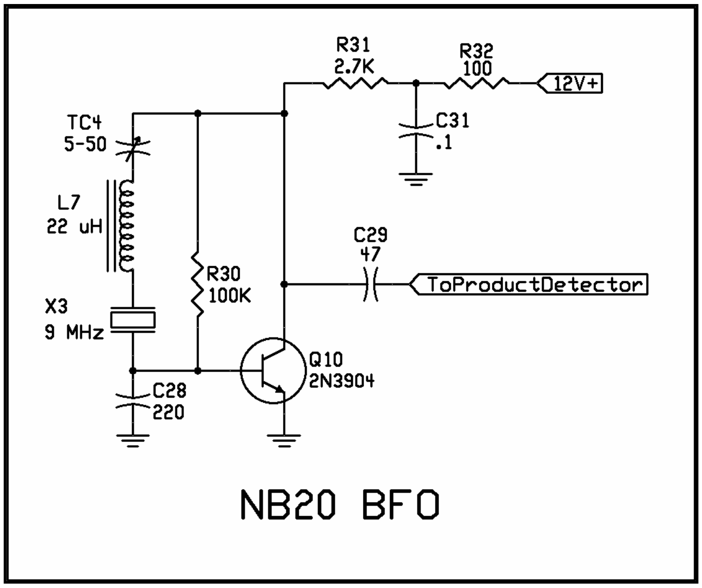
These figures were plugged into the crystal filter design program, XLAD [iii], a program provided with the book, "Experimental Methods In RF Design", in order to design the two-pole, 500 Hz bandwidth IF filter used in the receiver. The filter evaluation program, GPLA [iv], also provided with the book, was used to plot filter performance. Here is the filter used.



BFO CHANGES

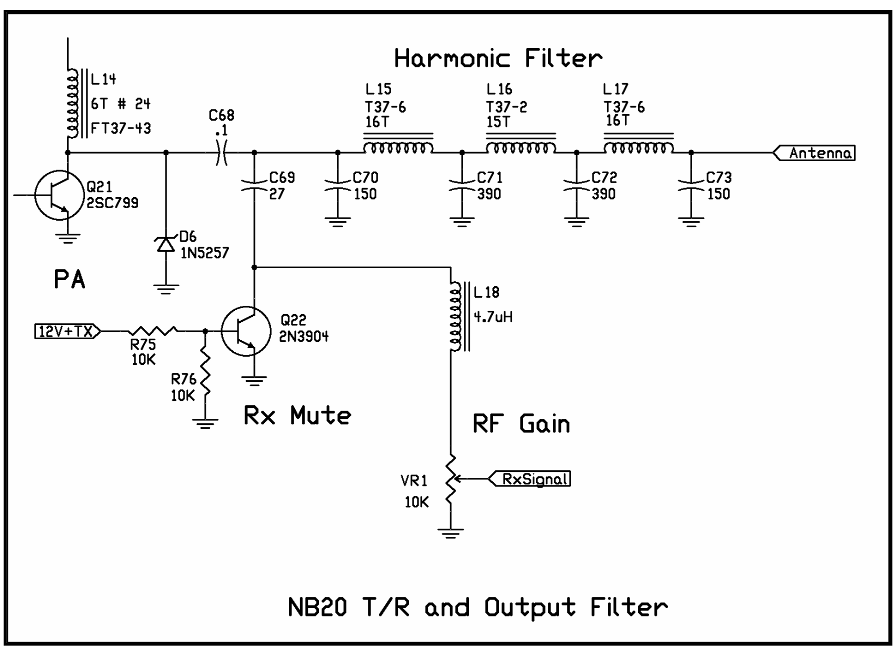
With the IF frequency chosen, and the IF Filter designed, BFO and TX Oscillator crystal frequencies fall into place, using crystals from the same 9.0 MHz batch on hand.

Trimmer capacitors were used in each oscillator, so that each could be finely tuned. The BFO circuit is below.



T/R CIRCUIT CHANGES

In the Nuts and Bolts 40, a 12 µH inductor was used in series with two capacitors paralleled to give a total of 43 pF. This combination provided a series resonance of 7.006 MHz, which, in this low-Q application, gives good coverage of the low end of the band.
In order to give us a series-resonant circuit for 20 Meters, a 27 pF capacitor and 4.7 µH inductor are used. This works out to resonance at 14.128 MHz. Again, because of the low-Q application here, that is close enough. The circuit below shows these parts as C69 and L18.



You will notice that the usual back-to-back arrangement of diodes, used to short the bottom end of C69 to ground on transmit, have been replaced here by a switched NPN transistor.

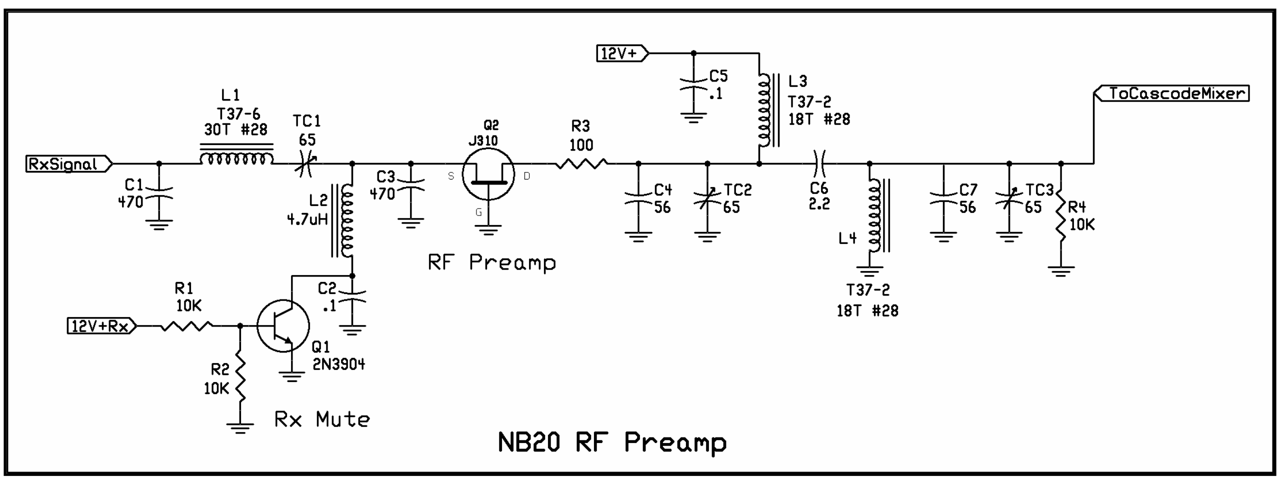
This change was an experiment, which resulted in the same amount of muting as was achieved using the diodes mentioned before. This setup seems a touch fussier, needing a 12V+Tx line run to it, so the back-to-back diodes seem simpler.

RECEIVER PRESELECTOR FILTER CHANGES

Because of the fact that more RF gain is needed in a 20 Meter receiver than one to be used on 40, the changes in the Preselector Filter were incorporated into an RF Preamp.

The RF Preamp selected is a 20 Meter version of the Low Noise Amplifier shown as part of the General Purpose Monoband Receiver[v] Front End, from "Experimental Methods In RF Design".

Because of the addition of an RF Preamp to the receiver, the 10K pot used previously as an Audio Gain control was removed from the audio circuit and moved between the T/R circuit and the input to the RF Preamp, to act as an RF Gain control. See the circuit above, as well as the RF Preamp Circuit below.



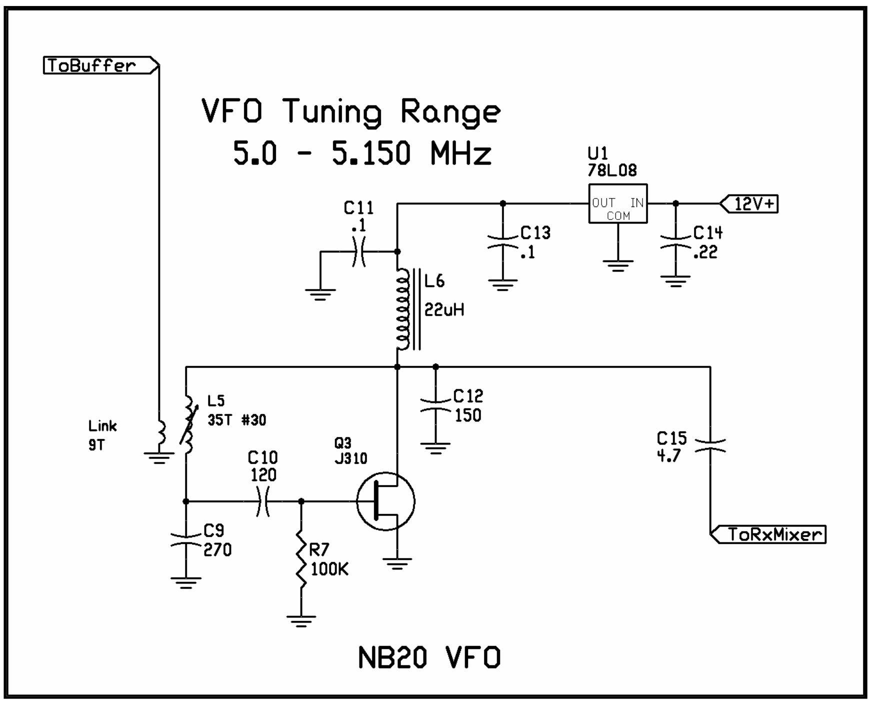
Appropriate changes were made to the second half of the double-tuned filter on the output of this preamp, because of the fact that the input of the Cascode coupled Mixer used in our receiver is a high impedance. The second half of the double-tuned filter shown as part of the general purpose receiver front end is designed to work into a 50 Ohm impedance.

Software is readily available to assist in designing double or triple-tuned bandpass filters, such as W7ZOI's DOS based Dttc[vi] and newer, Windows based DTC[vii] programs. However, in this case, the changes were simplified by the fact that, since the FET is working into the high impedance load presented by the first half of the existing double-tuned filter, it was only necessary to duplicate those values in the second half. Note L4, C7 and TC3 in the circuit above.

Q1 is kept turned on by the switched 12V+Rx line, providing a DC ground path for the for the FET source. When that voltage is switched off, on transmit, Q1 is shut off, effectively providing about 40 DB of signal attenuation, helping to mute the receiver.

VFO CHANGES

The same basic, Permeability-Tuned VFO circuit from the Nuts and Bolts 40 was used in this rig. A J310 JFET was used as the oscillator. Changes were made to the frequency determining components, in that a single NP0 capacitor of 150 pF was used from the Drain of the oscillator to ground, C12, and the number of turns on the tuning coil was reduced to 35 turns, as shown below. These changes resulted in a VFO tuning range of from just below 5.000 MHz to over 5.150 MHz, when an 8-32 brass screw was used as the tuning element. A #10 brass screw gave complete coverage of over 350 KHz.



As was done in the Nuts and Bolts 40, the value of C15 above was selected so as to present a 5 Volt, peak to peak signal to the Receiver Mixer. The number of turns of the link taking VFO energy to the buffer amplifier can be adjusted as necessary to provide appropriate output from the buffer.

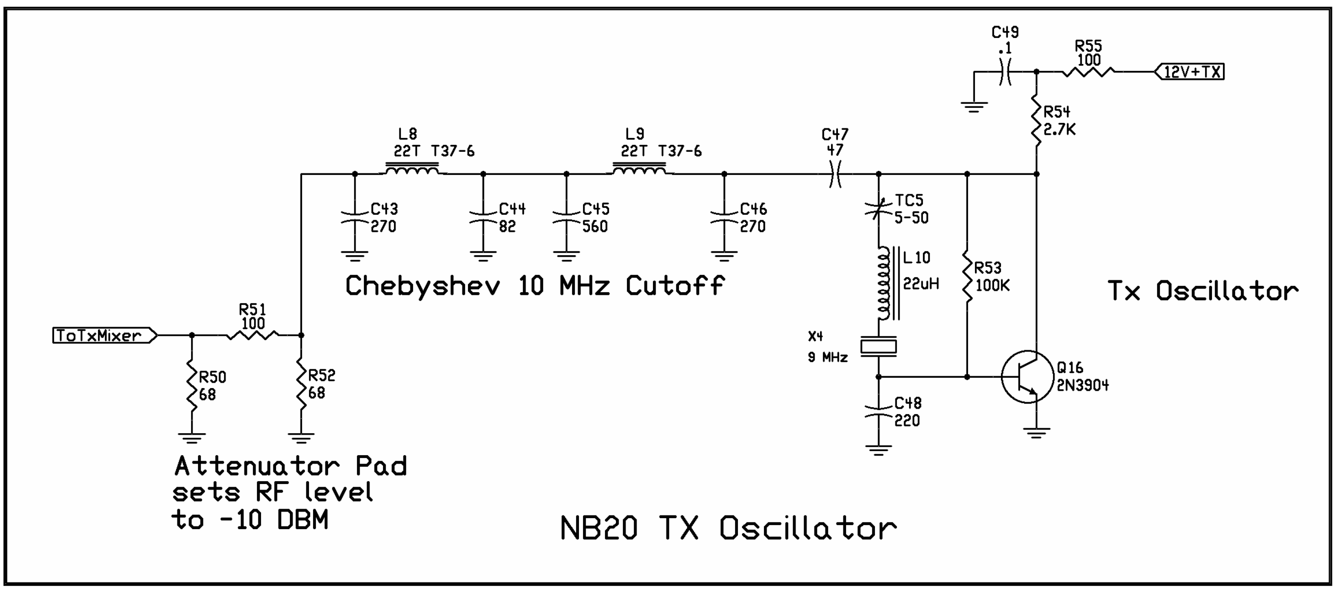
With the above noted changes, the receiver section has now been re-designed for the 20 Meter band. Now, let's take a look at the changes made to the transmitter.

TRANSMITTER CHANGES

The first change made in the transmitter was to change the TX Oscillator crystal frequency to 9.000 MHz. A 22 μH inductor was used in series with the crystal, along with a 5-50 pF trimmer capacitor, so that the exact frequency could be adjusted to match the frequency of a received signal, as heard in the audio output in the form of sidetone.

Remember, one of the design goals with the Nuts and Bolts 40 was to be able to hear the transmitter's signal in the receiver. This provides both an indication that the transmitter is working, and, when the BFO and Tx Oscillator frequencies are properly adjusted, a ready reference as to what audio tone on receive indicates that the signal is zero beat with the transmitter.

Also changed were the component values in the five-element Chebyshev filter used to prevent spurious output from the TX Oscillator from reaching the TX Mixer. This filter was designed using the computer program, LowHi[viii], from "Experimental Methods In RF Design". The new component values give the filter a 10 MHz cutoff frequency. See the TX Oscillator circuit below.



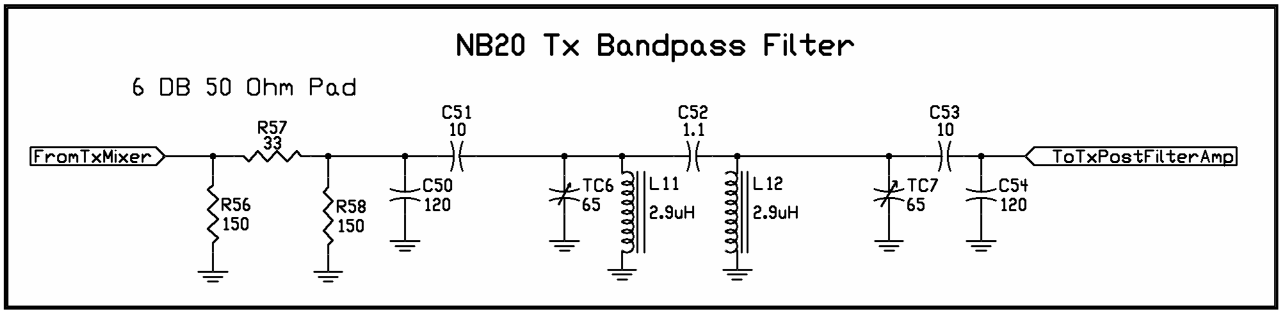
Note also that, as in the Nuts and Bolts 40, a 50 Ohm resistive attenuator was used in order to adjust the output of the TX Oscillator to the appropriate level. PI and T network resistive attenuator values are charted in the ARRL Electronics Data Book.

The next change in the transmitter is to the component values in the transmitter's double-tuned bandpass filter.

Again, software such as the above-mentioned Dttc program is readily available to assist the designer. One can plug design parameters such as desired bandwidth, center frequency, and termination impedance into Dttc, in order to receive both a circuit diagram and component values. Another program that can be used along with the before-mentioned DTC or LowHi programs is GPLA[x]. This program takes files outputted from the design programs and allows one to plot the results.

It goes without saying that for many of us who don't have an engineering background, these programs are invaluable.

Here is the new Transmitter Bandpass Filter circuit. It has a center frequency of 14.100 MHz, and a 250 KHz bandwidth.

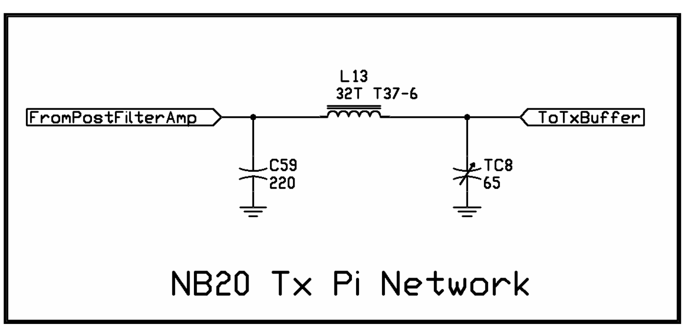


As in the Nuts and Bolts 40, the Tx Mixer output is terminated in a 6 DB 50 Ohm resistive pad.

Since the Transmitter Post-Filter Amplifier is broadband, no changes will be needed there. But we will need to change the impedance-matching Pi network between that amplifier and the Transmitter Buffer.

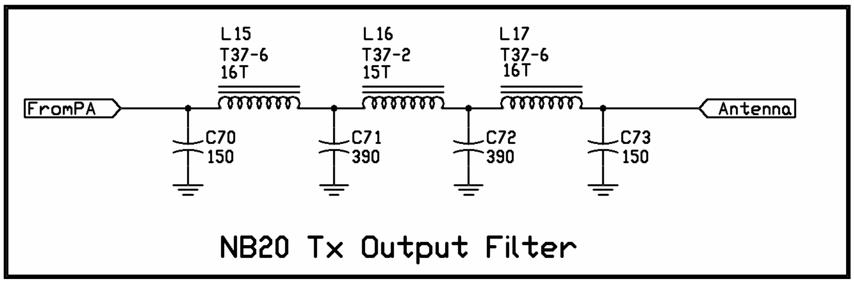
It is important to note that the impedance levels throughout the transmitter thus far, from the VFO Buffer and Tx Oscillator, through the Tx Mixer and the double-tuned filter and Post Filter Amplifier, have been kept at 50 Ohms up to this point.

The Pi network on the output of the Post Filter Amplifier transforms that 50 Ohm impedance to the 2.2 K Ohm impedance set by resistor R65, at the input to the Transmitter Buffer Amplifier. Using the software program, Zmat[xi], we find that the values needed to transform 50 Ohms to 2.2 K Ohms at 14 MHz are approximately 215 pF, 2.99 µH, and 46 pF. We will use 220 pF, 32 turns on a T37-6 Toroid core, and a 15-65 pF trimmer capacitor, as shown in the circuit below.



Because of the fact that the Transmitter Buffer, Driver Amplifier, and PA circuit are broadband, there is one last change to make in the transmitter circuit, and that is the final Output Network. In the Nuts and Bolts 40, we found that a seven element Chebyshev filter did a really great job of suppressing harmonics of the carrier frequency. So, as they say, "if it ain't broke, don't fix it". Using the program LowHi, once again, a seven element, Chebyshev filter with a 15.5 MHz cutoff frequency was designed.

The component values are shown in the circuit below.



NB20 Tx Output Filter

Filter response plotting in GPLA showed that setting this filter's design cutoff frequency at 15.5 MHz provided the desired harmonic rejection, and at the same time, did not attenuate the 14 MHz signal.

While, again, this seven element filter is a bit of overkill, the results are very comforting, in terms of spectral purity. The transmitter's two fundamental signal frequencies, the 5 MHz VFO signal, and the 9 MHz Tx Oscillator signal, are at –50 DBC. The second harmonic of the Tx output signal is at –60 DBC, with subsequent harmonics even lower in strength, as shown in the Spectrum Analyzer photo below.

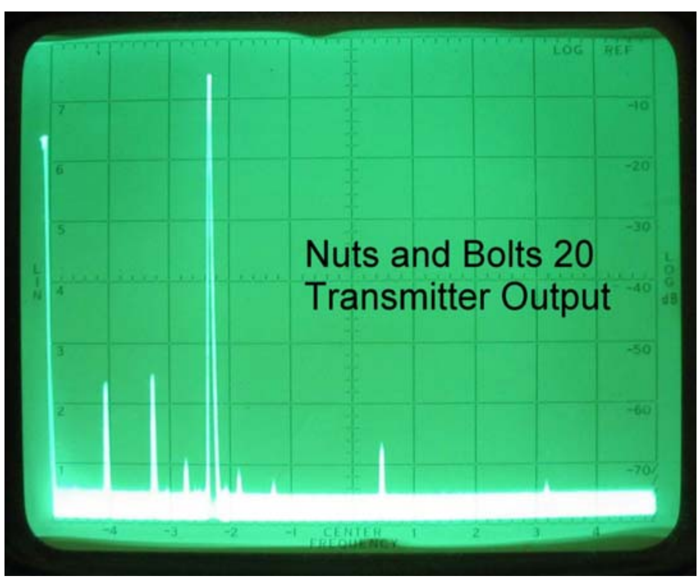
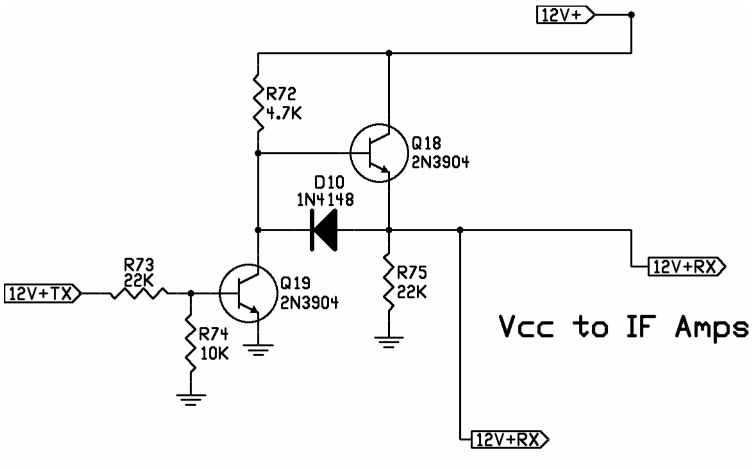


Photo by NB6M, test courtesy of WA6AYQ.

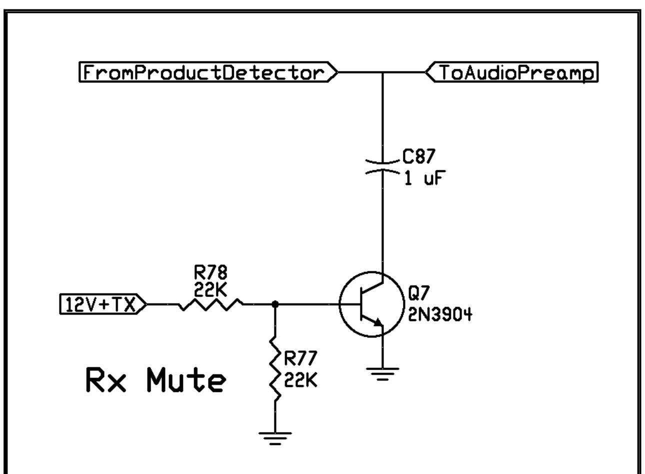
FINAL TWEAKING

The last item that needed to be addressed was the receiver's muting scheme. In the Nuts and Bolts 40, the two IF amplifiers were switch on for receive, and off for transmit, by the following circuit.



Mute Circuit 3

And, a secondary muting circuit, consisting of a 1 µF capacitor, shorting the audio signal going from the wiper of the audio gain pot to ground on transmit, was also used. The same setup was tried in this rig. The audio signal going from the Product Detector to the Audio Preamp was shorted to ground through a 1 µF capacitor, on transmit, by a switched 2N3904 transistor, as shown in the circuit below.

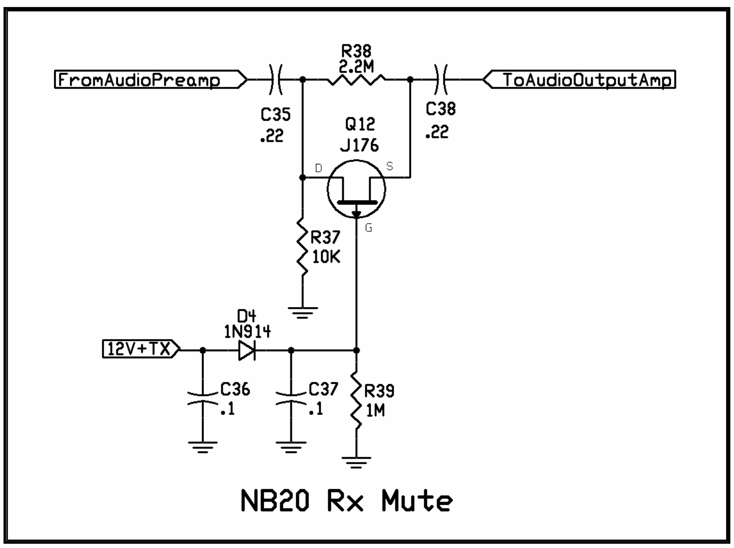


NB20 Audio Mute 1

It was soon apparent that in this receiver, with 40 DB of muting being achieved on transmit by turning the Receiver RF Preamp off, turning both IF amps off as well as using this audio mute circuit resulted in almost no sidetone being heard at all.

Next, the receiver circuit was modified so that only one of the IF amps was turned off on transmit. With that done, the sidetone was now a bit too loud. So, the value of the capacitor used to short audio to ground in the audio muting circuit was increased from 1 µF to 10 µF. This reduced the sidetone level considerably, but still not enough, as the sidetone was still too loud at high settings of the RF Gain control, and the sidetone did not have a good, clean sound.

The third modification to the muting scheme involved removing the above Rx Mute circuitry, and installing a J176, P-channel JFET switch between the audio preamp and the final audio output amp, as shown in the circuit below.



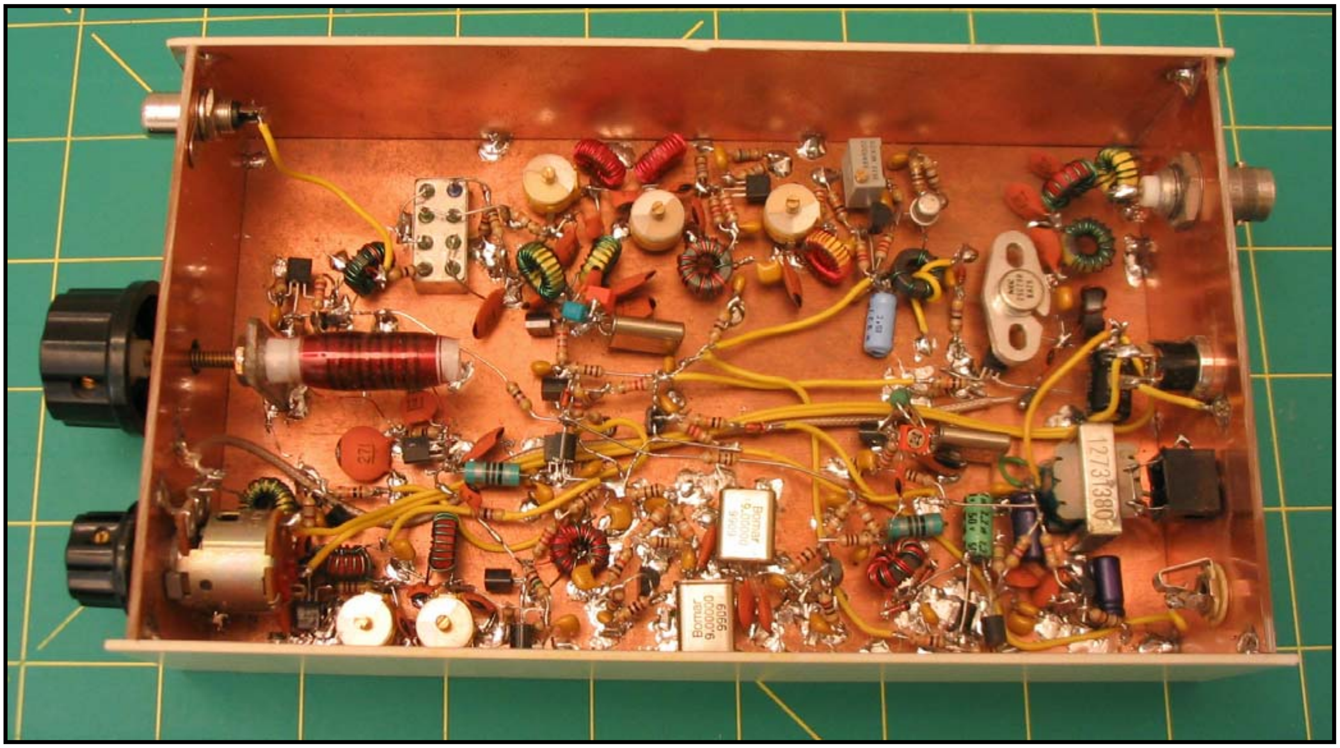
The J176 is switched off on transmit by the application of 12V+Tx. And, R38, 2.2 M Ohms in this case, can be adjusted in value to set the sidetone level.

It was found that with this muting circuit in place, neither of the two IF amps needed to be turned off on transmit. Having the receiver's RF Preamp switched off, and having the J176 circuit above switched off, provided for a very comfortably low level of clean-sounding sidetone. Therefore, the receiver IF circuitry was modified so that both IF amps receive 12V+ continuously.

The final, very satisfactory muting scheme involves just three key items. First, either the familiar back-to-back diodes or the switched transistor in the T/R circuit, shorting the Tx RF to ground on transmit. Second, turning the Receiver RF Preamp off on transmit, through the means of the transistor switch placed in the Source lead of the JFET. Third, using the P-channel JFET switch between the Audio Preamp and the Audio Output Amp, with its bridging resistor value adjusted so as to provide the desired amount of sidetone.

CONSTRUCTION

As can be seen in the photo below, this rig was laid out exactly as its predecessor.

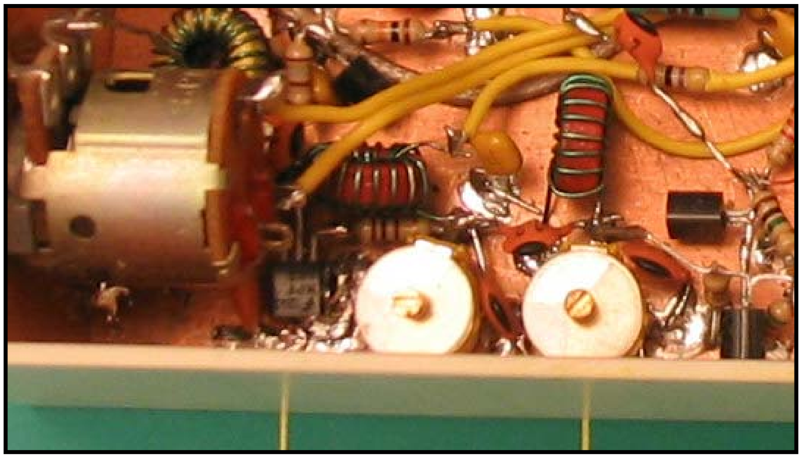


NUTS AND BOLTS 20 CONSTRUCTION OVERVIEW

See the construction photos and accompanying text from Nuts and Bolts Approach to RF Design, Part I [xii] for details of the construction of each stage.

The dual trimmer capacitors associated with the Receiver RF Preamp can be seen in the lower left corner, just to the right of the RF Gain pot. Visually, the addition of this amplifier is about the only striking difference between the NB40 and the NB20, other than the relative shortness of the tuning coil in this rig as compared to the 40 Meter version.

A close-up shot of the RF Preamp is below.



Nuts and Bolts 20 Receiver RF Preamp

Its muting transistor is at upper center, and the two transistors at lower right are part of the Cascode Mixer. The NP0 capacitor in upper right is the 4.7 pF cap bringing VFO energy to the mixer.

The photo below shows the BFO, and, just above the crystal, peeking out from under the Tx Final Amp transistor is the transistor switch used in the T/R Mute circuit.

Nuts and Bolts 20 BFO and T/R Mute

In both the BFO and Tx Oscillator, 22 µH inductors and 5-50 pF trimmer capacitors were placed in series with the crystal in order to accurately tune their respective offset frequencies.

A shot of the Tx Oscillator is below. The two toroid coils are part of the five element Chebyshev filter used at its output to help ensure spectral purity of the transmitter.

Nuts and Bolts 20 Tx Oscillator and Chebyshev filter

As can be seen from the pictures, Ugly Style construction is Three-Dimensional. With leaded parts, the resulting structure is quite mechanically stable. Both the NB40 and NB20 have survived long distance trips at the hands of the U. S. Mail Service, which, of itself, is testimony to their durability.

This type of construction could be made even more durable by the use of compounds such as RTV to fix toroid coils and other less rigid parts in place.

If you haven't yet tried this construction method, you will be pleasantly surprised at how quickly circuitry goes together. The only real trick to it is in soldering parts together in logical order so that one part isn't unsoldered when the next one is being installed. This technique will be quickly learned, with just a little practice.

CLOSING THOUGHTS

Re-designing the Nuts and Bolts 40 so as to put it on 20 Meters was a really fun project, which resulted in a rig design that performs well on all levels. The transmitter's output was left at 1.5 Watts because of the ready availability of an outboard Miniboots amp to boost the signal when needed. The spectral purity of the transmitter is excellent, much better than that required by current regulation. The receiver is sensitive enough to pull QRP signals through on 20 Meters, and the VFO provides stable coverage of over 150 KHz at the low end of the band.

And, after some experimentation, the receiver muting is clean and efficient, providing a nice sounding sidetone from the transmitter's signal.

The complete circuit for the transceiver follows, at the end of this article.

Today, more than at any other time in Amateur Radio history, we have both information and tools at our instant beck and call, through the medium of the internet. Currently available computer programs allow those of us who need a little help with the math to design segments of our projects that were beyond our reach before.

As you will be able to tell from the footnote references below, I have been very pleased with the arrival on the scene of the book, "Experimental Methods In RF Design". While it does cost a few dollars more than one might, at first, think of spending, I can only say that it is worth every penny, in terms of ideas and methods, as well as the included software programs.

For the homebrewer, EMRFD has taken "Solid State Design For The Radio Amateur" a huge quantum leap forward. I would like to express my thanks to Wes Hayward, W7ZOI, Rick Campbell, KK7B, and Bob Larkin, W7PUA, for giving us this wonderful addition to our reference library.

Using the methodology of the Nuts and Bolts approach, and these tools, many of us can either design and build rigs of our own, or modify existing designs so as to put them on the band of our choice.

If you are not yet comfortable with building in the Ugly Style, as these transceivers were built, use whatever method works for you. But, at the very least, give it a try.

Enjoy,

Wayne NB6M

* *

i. Hayward, Campbell, and Larkin. "Experimental Methods In RF Design", ARRL, 2003, pages 12.16 through 12.19

ii. Hayward, Campbell, and Larkin, "Experimental Methods In RF Design", ARRL, 2003, pages 3.18 and 3.19

iii. Wes Hayward, W7ZOI, © 2002, "Experimental Methods In RF Design", ARRL, 2003

iv. Wes Hayward, W7ZOI, © 2002, "Experimental Methods In RF Design", ARRL, 2003

v. Hayward, Campbell, and Larkin, "Experimental Methods in RF Design", ARRL, 2003, page 6.32

vi. Wes Hayward, W7ZOI, ARRL, 1994

vii. Hayward, Campbell, and Larkin, "Experimental Methods In RF Design", ARRL 2003

viii. Hayward, Campbell, and Larkin, "Experimental Methods In RF Design", ARRL 2003

ix. Doug DeMaw, "The ARRL Electronics Data Book", ARRL, 1988-96, page 5-2

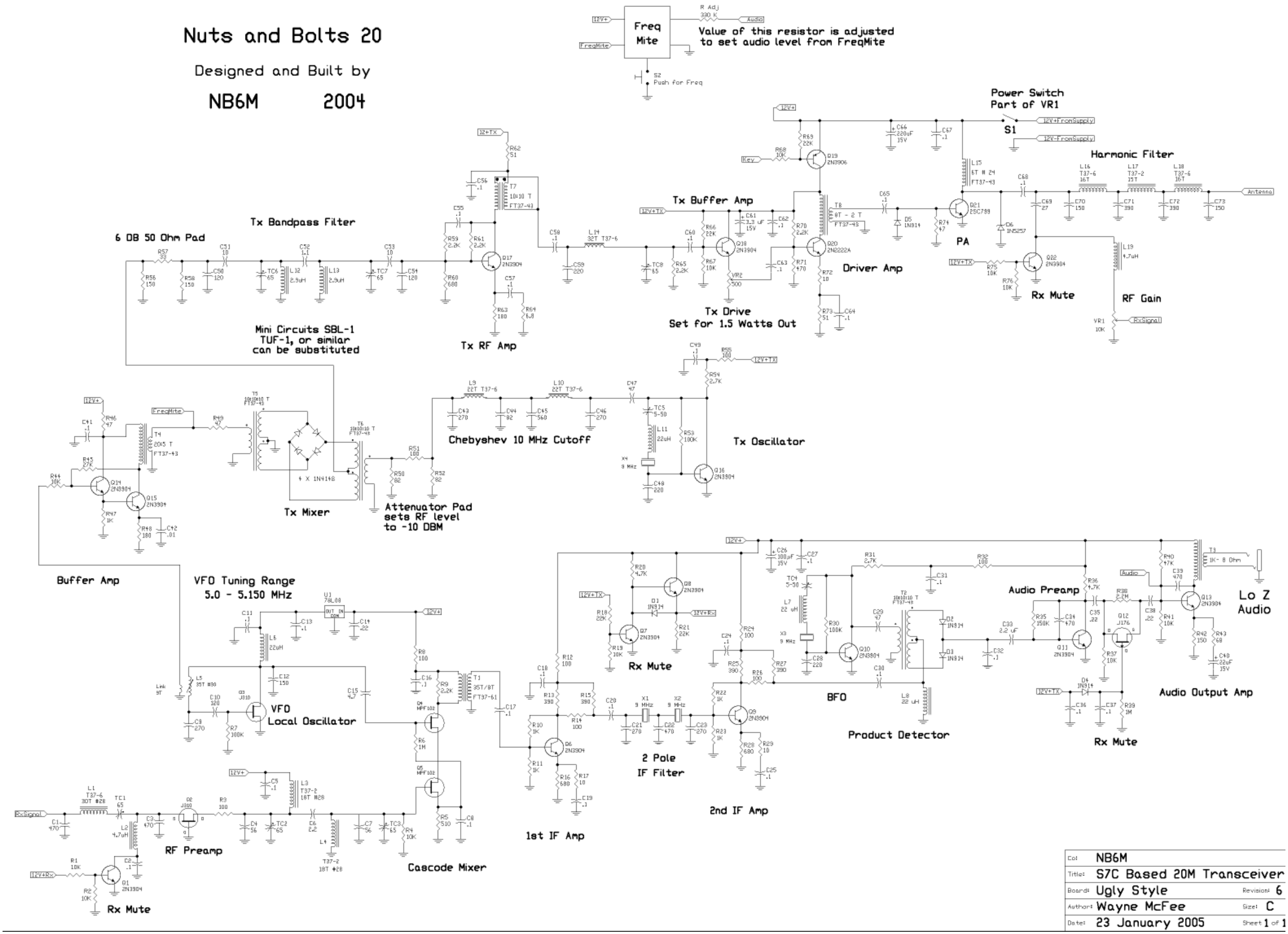
x. Hayward, Campbell, and Larkin, "Experimental Methods In RF Design", ARRL 2003

xi. Wes Hayward, W7ZOI, ARRL, 1994

xii. Wayne McFee, NB6M, "A Nuts and Bolts Approach To RF Design", AmQRP Homebrewer Issue #3, Winter 2004

xiii. Wes Hayward, W7ZOI, and Doug DeMaw, W1FB, "Solid State Design For The Radio Amateur", ARRL, 1977

Wayne McFee, NB6M may be reached by mail at 2379 Saint George Drive, Concord, California 94520, or by email at NB6M@aol.com


Nuts and Bolts 20
Designed and Built by
NB6M 2004
Freq Mite
R Adj 330 K
Value of this resistor is adjusted to set audio level from FreqMite
S2 Push for Freq
Power Switch Part of VR1
S1
Harmonic Filter
Antenna
Tx Buffer Amp
Tx Bandpass Filter
6 DB 50 Ohm Pad
Driver Amp
PA
Rx Mute
RF Gain
Tx Drive Set for 1.5 Watts Out
Mini Circuits SBL-1 TUF-1, or similar can be substituted
Tx RF Amp
Chebyshev 10 MHz Cutoff
Tx Oscillator
Tx Mixer
4 X 1N4148
Attenuator Pad sets RF level to -10 DBM
Buffer Amp
VFO Tuning Range 5.0 - 5.150 MHz
VFO Local Oscillator
Audio Preamp
Lo Z Audio
BFO
Product Detector
Audio Output Amp
2 Pole IF Filter
2nd IF Amp
1st IF Amp
RF Preamp
Cascode Mixer
Col: NB6M
Title: S7C Based 20M Transceiver
Board: Ugly Style
Revision: 6
Author: Wayne McFee
Size: C
Date: 23 January 2005
Sheet 1 of 1

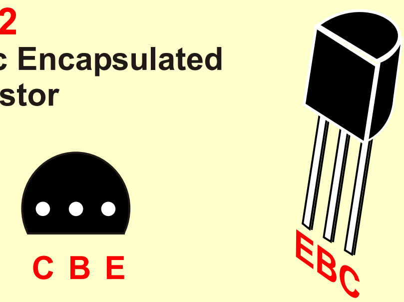
Paul Harden, NA5N

The Handyman's Guide to – UNDERSTANDING TRANSISTOR DATA SHEETS & SPECIFICATIONS

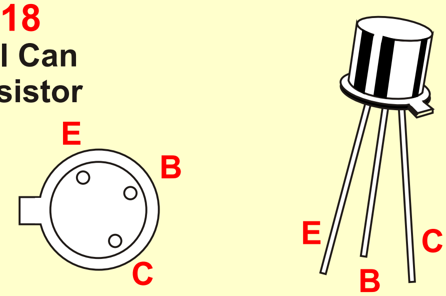
The QRPer's Favorite GENERAL PURPOSE NPN TRANSISTORS

2N2222
2N3904
2N4401
MPS2222
MPS3904

TO–92
Plastic Encapsulated Transistor

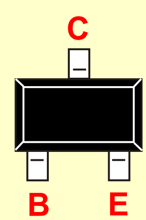


TO–18
Metal Can Transistor



SOT-23
Surface Mount Transistor

MMBT2222LT1
MMBT3904LT1
MMBT4401LT1



Introduction

The most common bipolar junction transistors (BJT) used by hobbyists and QRPers are the ***2N2222****,* ***2N3904*** *and* ***2N4401****. These NPN transistors have similar characteristics, and perform well at HF frequencies.*

This tutorial explains how to "read" the data sheets on these devices and understand the specifications – which will enable you to interpret data sheets for other devices as well.

The manufacturer's data sheets contains information in the following general categories:

1. Maximum (Breakdown) Ratings
2. "On" Characteristics
3. Small Signal Characteristics
4. Switching Characteristics

1. Maximum (Breakdown) Ratings

The maximum ratings are provided to ensure that the voltages and currents applied do not damage or cause excessive heating to the device. The maximum ratings for the 2N2222, 2N3904 and 2N4401are shown in **Table 1**. The voltages, currents and power dissipation listed should *not be exceeded* to prevent damage to the device.

VCEO is the maximum **collector-emitter voltage** and **VCBO** is the maximum **collector-base voltage**. Fortunately, these breakdown voltages are well above the typical 12v used in most QRP applications.

This is not the case with **VEBO,** the **maximum emitter-base voltage**, typically 5–6v. If exceeded, this can cause a physical breakdown of the base junction, destroying the

Table 1 – MAXIMUM (BREAKDOWN) RATINGS

		2N 2222	2N 2222A	2N 3904	2N 4401	MMBT 3904
Collector–Emitter	VCEO	30v	40v	40v	40v	40v
Collector–Base	VCBO	60v	75v	60v	60v	60v
Emitter–Base	VEBO	5v	6v	6v	6v	6v
Max. Coll. Current	Ic	600mA	600mA	200mA	600mA	200mA
Power dissipation	Pd	625mW	625mW	625mW	625mW	225mW

transistor. In a circuit, the biasing scheme sets the base-emitter voltage, VBE, to be safely below VEBO. However, in large-signal applications, VBE must include the DC base bias *and the peak voltage of the signal* to ensure VEBO will not be exceeded.

Rule of thumb for VEBO: VEBO(max) or Vbe(max) for most general purpose BJTs is 5–6v – the *maximum* emitter-base voltage. Don't forget to include the peak voltage of the AC signal!

Collector Current, Ic(max), is the other maximum rating to be closely followed. Collector current exceeding Ic(max) can damage the transistor, due to excessive current through the device, initiating thermal runaway – destroying the collector-emitter junction. The destruction of a transistor in this manner is technically called *catastrophic substrate failure* for good reason!

Rule of thumb for Ic(max): There isn't one! The only safe way to know the maximum Ic for a transistor is to consult the data sheets.

Most QRP circuits are usually biased for well below Ic(max). Vbe(max) and Ic(max) are generally a concern only in large-signal applications, such as RF drivers, PA stages, and some oscillator circuits.

Table 2 – DC "ON" CHARACTERISTICS

		2N 2222	2N 2222A	2N 3904	2N 4401	MMBT 3904
DC Current Gain, HFE						
Ic= 0.1mA, VCE=10v	HFE Min.	35	35	40	20	40
Ic=1.0 mA, VCE=10v	HFE Min.	50	50	70	40	70
	HFE Max.	150	150	200	—	200
Ic= 10 mA, VCE=10v	HFE Min.	75	75	100	80	100
	HFE Max.	225	250	300	—	300
Collector-Emitter Saturation Voltage, VCE(sat)						
Ic= 150mA, IB= 15mA	VCE(sat)	0.4vdc	0.3vdc	0.3vdc†	0.4vdc	0.2vdc†
Base-Emitter Saturation Voltage, VBE(sat)						
Ic= 150mA, IB= 15mA	VBE(sat)	1.3vdc	1.2vdc	0.85vdc	0.95vdc	.85vdc†

† Ic=50mA, IB=5mA on 2N3904

2. ON CHARACTERISTICS

These specifications define the DC performance of the device while it is forward biased (Vbe ≥0.7v), causing collector current to flow, or "on." The DC Characteristics in **Table 2** are not absolute design values, but rather *test values* as measured by the manufacturer. This is why the data is listed with the test conditions, such as "Ic=1mA, VCE=10v."

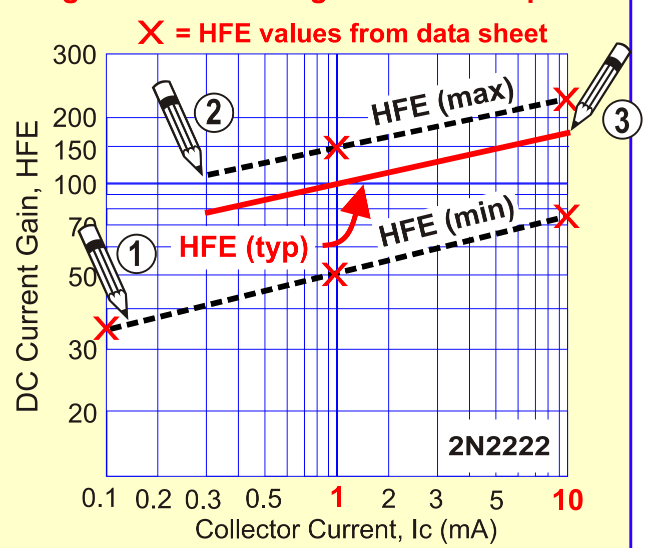
HFE is the *measured* **DC current gain** of the transistor (see *Rule of thumb for HFE*). It is used for biasing the device in the linear region – primarily class A. Most data sheets provide HFE at two different collector currents, usually 1 and 10mA. Since most QRP circuits are biased for Ic ≤5mA (to conserve battery drain), HFE at Ic=1mA is typically used.

Rule of thumb for HFE:
Conventions used in electronic literature:

HFE or **hFE** (upper case letters) is the ***DC Current Gain***
Hfe or **hfe** (lower case) is the ***AC current gain***

HFE also varies from transistor–to–transistor. This is why the data sheets list both HFE (min) and HFE (max). The manufacturer tested a large batch of 2N2222s and determined that hfe ranged from 50 (HFE **min**) to 150 (HFE **max**) at Ic=1mA, as shown on the data sheets (**Table 2**). Statistically, most transistors will fall between 50 and 150, or about HFE=100. This is why most design guides will recommend using a value of HFE=100 for bias calculations. Since the 2N3904 has a higher DC current gain, often HFE=150 is recommended for that device.

Fig. 1 – Constructing an HFE vs. Ic plot



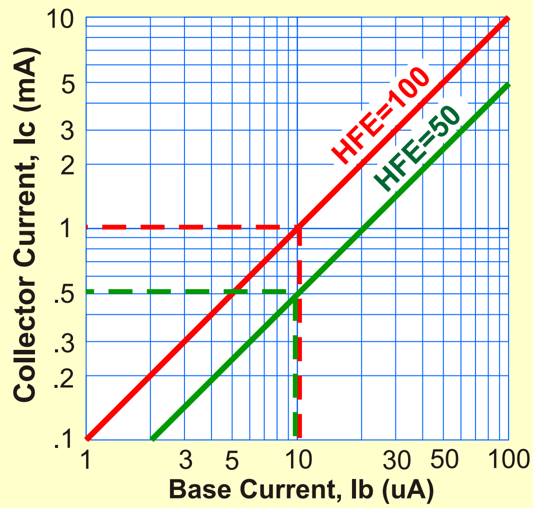
HFE min. and max, at Ic=1 and 10mA, can be plotted on a logarithmic graph (lines 1 and 2 on **Fig. 1**). The average value, HFE typ., can then be drawn (line 3, **Fig. 1**). This gives you HFE (typ) for various collector currents.

The value used for HFE is not critical. Using HFE=100, or even the conservative value of 50, will work 99% of the time. Therefore, one scarcely needs the data sheets for the DC characteristics, as the typical HFE = 100 at Ic=1mA is valid for most general purpose NPN transistors. **Fig. 2** shows **Ib vs. Ic** for HFE at 50 and 100.

Saturation voltages, VCE(sat) and **VBE(sat)**, defines the transistor behavior *outside* the linear operating region, that is, in the saturated region. This is of interest when operating the transistor as a saturated switch. The keying transistor in a transmitter, forming the +12v transmit voltage on key–down, is an example of a saturated switch.

Rule of thumb for HFE:
Most general purpose NPN transistors have a DC HFE = 100 (typ) and thus used in most biasing equations for DC and low frequencies.

Fig. 2 – Ic vs. Ib defines HFE



At Ib=10uA, Ic=0.5mA @ HFE=50
At Ib=10uA, Ic=1.0mA @ HFE=100

3. SMALL SIGNAL CHARACTERISTICS

The small-signal characteristics describe the AC performance of the device. There is no standardized industry definition of small-signal (vs. large-signal), but is generally defined where the *AC signal* is small compared to the DC bias voltage. That is, the signal levels are well within the linear operating region of the transistor.

The small signal characteristics include:

1) gain bandwidth product (**Ft**)
2) the AC current gain (**hfe**)
3) input and output impedances (**hie** and **hoe**)
4) input and output capacitances (**Cibo** and **Cobo**)
5) the noise figure (**NF**).

Table 3 – SMALL SIGNAL CHARACTERISTICS – Part 1

		2N 2222	2N 2222A	2N 3904	2N 4401	MMBT 3904
Gain Bandwidth Prod.	Ft (MHz).	250	300	300	250	300
Small Signal Current Gain, hfe						
Ic=1.0 mA, Vce=10v†	hfe Min.	50	50	100	40	100
	hfe Max.	300	300	400	500	400
Estimated	hfe Typ.	150	150	200	225	200
Ic= 10 mA, Vce=10v†	HFE Min.	75	75	—	—	—
	HFE Max.	375	375	—	—	—

† Measured at 1 KHz

The small signal parameters are the most important to understand, as they describe the transistor's behavior at audio and RF frequencies, and used in the circuit design equations. These parameters vary greatly from one transistor type to another, such that making assumptions (as we did with DC HFE =~100) can be risky. The data sheets must be used. The small-signal characteristics for **Ft** and **hfe**, from the data sheets, are shown in **Table 3**

Gain Bandwidth Product, or **Ft**, is defined as the frequency at which the AC current gain, hfe, equals 1 (0dB). See **Fig. 3** (next page). This is the maximum frequency the device produces gain as an amplifier or oscillator.

On RF transistor data sheets, Ft is not always given. Instead, the **power gain, Gp** (or **Gpe** for common emitter power gain) is tested at a specific frequency. Ft can be derived from this information as shown in **Table 4**. Equations *x* and *Gp(mag)* convert the power gain, in dB, to unitless magnitude, as is hfe.

Table 4 – Calculating Ft from Gpe

$$x = \frac{Gp(dB)}{10} \qquad Gp(mag) = 10^{x}$$

$$Ft = f\sqrt{Gp(mag)}$$

Example:
The data sheet for the 2N5179 lists Gpe=15dB at 200MHz. Determine Ft.

$$x = \frac{15dB}{10} = \mathbf{1.5} \qquad Gp(mag) = 10^{1.5} = \mathbf{32}$$

$$Ft = 200MHz\sqrt{32} = \mathbf{1130\ MHz}$$

hfe is the **ac small-signal current gain**, and dependent on both frequency and the collector current. Hfe is also known as the *ac beta*. Ft and hfe work together to define the overall AC gain of the transistor at a specific frequency, as illustrated in **Fig. 3**.

hfeo is the low-frequency hfe, often very close to the DC HFE. The values for hfe shown in the data sheets are normally measured at 1KHz and Ic=1mA (sometimes @10mA). Hfeo is fairly constant from the audio frequencies to about 300 KHz.

Beta cut-off frequency, f , is the "3db point" of hfe, where hfe= 0.707hfeo, or f =Ft/hfeo. F is seldom listed on the data sheets.

hfe drops fairly linearly from f to Ft at 6dB/octave.

F , and the hfe vs. frequency plots, are seldom shown in the data books. ***This is why learning to interpret the data sheets is important to determine the actual gain (hfe) a transistor will provide at a specific frequency.***

Design Example: Constructing an Hfe vs. Frequency Plot
Let's figure out what hfe will be for a 2N2222 on the 40M band, using both graphical and equational methods. It's really easy.

From **Table 3**, hfe=50 (min) to 300 (max). Let's pick hfe=150 as the average. Since hfe is measured at 1KHz, this is also **hfeo**. Draw a line on a chart to represent hfeo=150 (line #1, **Fig. 4**).

Calculate f and hfe @f as follows: (Ft=250MHz, 2N2222)

f = Ft/hfeo = 250MHz 150 = 1.7 MHz

hfe@f = .707hfeo = 0.707 x 150 = 106

Draw a dot at hfe@f on the chart (hfe=106 @ 1.7 MHz)

Or ... calculate hfe at the desired frequency, fo, such as 7MHz

hfe@fo = Ft/fo = 250MHz 7MHz = 36

Draw a line between f (or fo) and Ft (line #2, **Fig. 4**) to complete the hfe vs. frequency plot of the 2N2222 at Ic=1mA.

Therefore, at 7 MHz

ac gain is hfe = 36

How much signal gain will the 2N2222 provide at 144 MHz?

hfe = Ft/fo = 250MHz 144MHz = 1.7, or almost unity!

This is why general purpose transistors (Ft <400MHz) are not used at VHF for lack of useful gain above ~50 MHz.

Hfe vs. Ic. Hfe is also a function of Ic as shown in **Fig. 5**. This data sheet chart is used to adjust hfe at Ic other than 1mA, where hfe is measured. For designing battery powered circuits, Ic=1mA is recommended. Firstly, data sheet values can be used directly, saving additional calculations, since most parameters are listed for Ic=1mA. Secondly, these transistors have ample gains at Ic=1mA or less. The additional gain at a higher Ic may not justify

Fig. 3 – Common Emitter AC current gain vs. Frequency

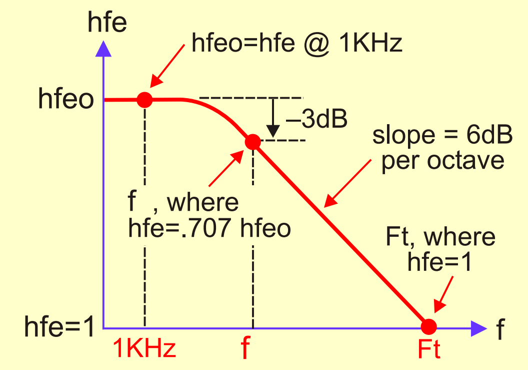
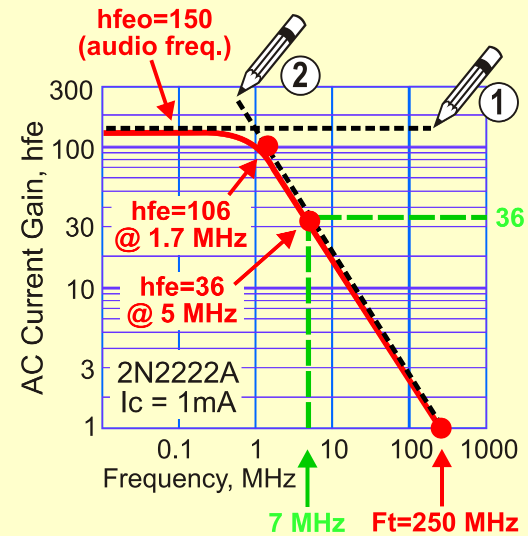


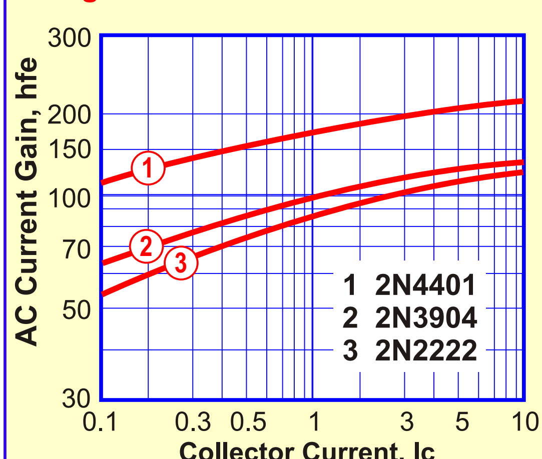
Fig. 4 – Constructing an hfe gain plot for the 2N2222 (Common Emitter)



For gain at any frequency, f < fo < Ft

$$hfe = \frac{Ft}{fo} \qquad Gain(dB) = 10\log(hfe)$$

Fig. 5 – Hfe vs. Collector Current



the increase in battery drain. I.e., two amplifiers at Ic=1mA will yield far more gain than one amplifier at Ic=2mA.

Table 6 shows hfe at different frequencies for the 2N2222.

Table 5 lists the remaining small-signal characteristics.

Table 5 – SMALL SIGNAL CHARACTERISTICS – Part 2

		2N 2222	2N 2222A	2N 3904	2N 4401	MMBT 3904
Input capacitance ‡	Cibo (max)	30pF	25pF	8pF	30pF	8pF
Output capacitance‡	Cobo (max)	8pF	8pF	4pF	7pF	4pF
Input Impedance, typ.†	hie (min)	2K	2K	1K	1K	1K
	hie (max)	8K	8K	10K	15K	10K
Output Admittance †	hoe (min)	5*	5*	1*	1*	1*
	hoe (max)	35*	35*	40*	30*	40*
Noise Figure †	NF (max)	4dB	4dB	5dB	4.5dB	4dB

† Measured at 1 KHz ‡ Measured at 1 MHz * mhos

Input impedance, hie, is the resistive element of the base-emitter junction, and varies with Ic. It is used for input impedance calculations, and not particularly useful in itself without considering Cibo.

Table 6 – 2N2222 Input Impedances

based on hfeo=150 — based on hfe and re — based on Xc(Cibo) || hie

Freq	hfe	Rin	Xc(Cibo)	Zin
3.5	71	1872	1516	1150
7.0	36	962	758	658
10.1	25	676	525	475
14.0	18	494	379	352
21.0	12	312	253	241
28.0	9	234	190	183
50.0	5	130	106	104
144	2	52	37	36

Rin=re(hfe+1)
where,
re=26/Ie(mA)
=26 @1mA

Zin(eq) = Xc||hie
where,
Cibo = 30pF
hie = 5K

Input capacitance, Cibo, is the capacitance across the base-emitter junction. For the 2N2222, Cibo(max)=30pF. The reactance (Xc) of Cibo is in parallel with hie (Xc||hie) – causing the equivalent input impedance, Zin, to be frequency dependent as shown in **Table 6**. As can be seen, Xc(Cibo) dictates the input impedance of the transistor, *not hie*. Cibo is thus important in estimating Zin at any given frequency. In selecting a transistor for RF, the smaller the value of Cibo, the better. In this case, the input *impedance* is called Zin, since it includes the frequency dependent *reactance* components.

Input resistance, Rin, for the common-emitter transistor, can also be estimated using hfe and emitter current, Ie, as follows:

Rin = re(hfe+1) where, re = 26 Ie(mA) (Ie Ic)

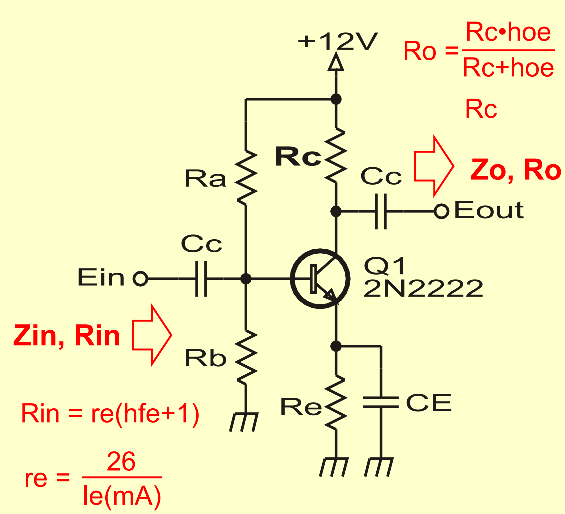
The results of Rin from the above are also shown in **Table 6** for comparison. This method is generally preferred since hfe and Ie are known with greater accuracy than is hie and Cibo. In this case, the input *impedance* is called Rin, since it only includes resistive components (no *reactance* components).

The differences between the two methods, while close, demonstrates the difficulty in determining with certainty the input impedance of a transistor.

Output Admittance, hoe, represents the output resistance of the transistor by taking the reciprocal of the admittance. For example, at hoe(typ)=10umhos, Rout = 1/hoe = 1/10umhos = 100K . Like hie, hoe is not particularly useful by itself.

Output Resistance, Ro, is approximately the parallel equivalent of hoe and the collector load resistance, Rc, or Ro = Rc||hoe. See **Fig. 6**. Since Rc tends to be in the 1–5K range, and hoe 20–100K , Rc will dominate the output resistance of the transistor. As a result, output impedance is usually estimated by: Zo Rc. Note that the output impedance is set primarily by circuit values (Rc), and not by the transistor's small-signal parameters.

Fig. 6 – Input/Output Impedances
basic amplifier configuration



Cobo is the **output capacitance**, and is in parallel with the output resistance. However, Cobo is <10pF in most general purpose NPN transistors and has little effect at HF. This parameter is important in RF transistors operating in the VHF/UHF spectrum, where the shunting effect becomes a significant component of the output impedance. Obviously, the lower the value of Cobo, the better.

Noise Figure, NF, is defined as the ratio of the input to the output noise, neither of which is easily measurable by the amateur. The transistor will add noise, then be amplified by the hfe of the device just as the signal is, forming signal plus noise output, or S+N. The excess in the S+N to signal power is due to the noise figure (NF) of the device.

For the QRPer, the NF of the transistor is not highly important on HF. See **Table 7**. Select a transistor with a low NF for the audio stage(s), however, as this is where it will be the most evident.

Transconductance, gm, is another parameter provided on some data sheets. If not provided, gm can be estimated by: gm = .038 x Ie(mA).

Table 7 – HF vs VHF Noise Figures

At HF – antenna and atmospheric noise is in the 20–30dB range, far exceeding the 10-12dB NF of a typical HF receiver. In other words, more noise is introduced to the receiver by the antenna and band conditions than the NF of the stages can introduce. For HF receiver applications, a NF of 4-6dB per transistor is sufficient. This is not the case at VHF.

At VHF/UHF – antenna and atmospheric noise is very low, often less than 10dB of noise power, making the overall system noise a function of the receiver, and the NF of the individual stages. At VHF/UHF, the NF of the transistors becomes very important, with transistors being selected with NF's in the 1.5dB to 2dB range not uncommon.

4. SWITCHING CHARACTERISTICS

The Switching Characteristics define the operating limits of the transistor when used in pulsed, digital logic, or switching applications. QRP switching circuits include T-R switching, CW keying and band switching circuits using transistors. These are really large-signal characteristics, since the transistor is being driven from cut-off to saturation in most switching applications.

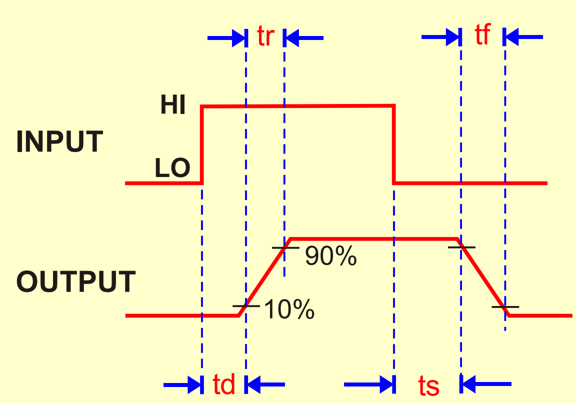
Table 8 – SWITCHING CHARACTERISTICS

		2N 2222	2N 2222A	2N 3904	2N 4401	MMBT 3904
Delay time	td	10ns	10ns	35ns	15ns	35ns
Rise time	tr	25ns	25ns	35ns	20ns	35ns
Storage time	ts	225ns	225ns	200ns	225ns	200ns
Fall time	tf	60ns	60ns	50ns	30ns	50ns

Fig. 7 illustrates the switching characteristics terms:
td, delay time is the time from the input L–H transition until the output begins to respond.
tr, rise time is the time it takes the output to go from 10% to 90% output voltage.
ts, storage time is the time from the input H–L transition until the output responds. This is usually the longest delay.
tf, fall time is the time it takes the output to go from 90% to 10% output voltage.

These switching times, in the tens of nanoseconds, are thousands of times faster than the requirements for QRP applications, and seldom a design criteria when selecting a transistor. It is presented here for completeness only.

Fig. 7 – Switching Characteristics



This tutorial should allow one to interpret the transistor data sheets, whether the complete data sheets from the manufacturer, or the abbreviated listings, such as found in the NTE Cross-Reference or in the ARRL Handbook. Many manufacturer's provide complete data sheets online. Understanding transistor specifications is essential in designing your own circuits, or identifying those "ham fest special" transistors and their suitability for your next project. Biasing transistors using these specs will be presented in a future *Handyman's* tutorial.

AmQRP.ORG HOMEBREWER

Mike Czuhajewski, WA8MCQ

The WA8MCQ

Toroid Charts

Mike Czuhajewski, WA8MCQ, Severn, MD wa8mcq@comcast.net .

Originally produced 1992; updated slightly and put into Microsoft Excel format in January 2005.

Don't read too much into the number of decimal places; they imply a greater precision than actually exists. Actual inductances will vary depending on winding technique, turns spacing and core to core variations in permeability. Note--this data was obtained by plugging numbers into the standard toroid forumulas; none of it is derived from measurements of actual coils.)

Chart 1: Turns versus inductance for some commonly used toroids (T25-2 to T68-2)

Chart 2: Turns versus inductance for some commonly used toroids (T25-6 to T68-6)

Chart 3: Turns versus inductance for some commonly used toroids (Ferrite Types 43 to 61)

Chart 4: Turns vs. Wire Length (leads not included)

These are calculated from core dimensions with 15% fudge factor added. (Experience showed that just using the core dimensions resulted in insufficient wire length; an extra 15% more than adequately compensates for it.) These are for the windings only and do not include leads; add 1 or 2 inches for leads. (Don't worry too much about the two decimal places; that's just a consequence of the calculation method used, and it is nowhere near that critical.)

Chart 1:

Core type	T25-2	T30-2	T37-2	T44-2	T50-2	T68-2
Al value	34	43	40	52	49	57
	Inductance in microhenries					
# of turns						
1	0.003	0.004	0.004	0.005	0.005	0.006
2	0.014	0.017	0.016	0.021	0.020	0.023
3	0.031	0.039	0.036	0.047	0.044	0.051
4	0.054	0.069	0.064	0.083	0.078	0.091
5	0.085	0.108	0.100	0.130	0.123	0.143
6	0.122	0.155	0.144	0.187	0.176	0.205
7	0.167	0.211	0.196	0.255	0.240	0.279
8	0.218	0.275	0.256	0.333	0.314	0.365
9	0.275	0.348	0.324	0.421	0.397	0.462
10	0.340	0.430	0.400	0.520	0.490	0.570
11	0.411	0.520	0.484	0.629	0.593	0.690
12	0.490	0.619	0.576	0.749	0.706	0.821
13	0.575	0.727	0.676	0.879	0.828	0.963
14	0.666	0.843	0.784	1.020	0.960	1.120
15	0.765	0.968	0.900	1.170	1.100	1.280
16	0.870	1.100	1.020	1.330	1.250	1.460
17	0.983	1.240	1.160	1.503	1.420	1.650
18	1.100	1.390	1.300	1.690	1.590	1.850
19	1.230	1.550	1.440	1.880	1.770	2.060
20	1.360	1.720	1.600	2.080	1.960	2.280
21	1.500	1.900	1.760	2.290	2.160	2.510
22	1.650	2.080	1.940	2.520	2.370	2.760
23	1.800	2.280	2.120	2.750	2.590	3.020
24	1.960	2.480	2.300	3.000	2.820	3.280
25	2.130	2.690	2.500	3.250	3.060	3.560
26	2.300	2.910	2.700	3.520	3.310	3.850
27	2.480	3.140	2.920	3.790	3.570	4.160
28	2.670	3.370	3.140	4.080	3.840	4.470
29	2.860	3.620	3.360	4.370	4.120	4.790
30	3.060	3.870	3.600	4.680	4.410	5.130
31	3.270	4.130	3.840	5.000	4.710	5.480
32	3.480	4.400	4.100	5.330	5.020	5.840
33	3.700	4.680	4.360	5.660	5.340	6.210
34	3.930	4.970	4.620	6.010	5.670	6.590
35	4.170	5.270	4.900	6.370	6.000	6.980

Chart 2:

Core type	T25-6	T30-6	T37-6	T44-6	T50-6	T68-6
Al value	27	36	30	42	40	47
	Inductance in microhenries					
# of turns						
1	0.003	0.004	0.003	0.004	0.004	0.005
2	0.011	0.014	0.012	0.017	0.016	0.019
3	0.024	0.032	0.027	0.038	0.036	0.042
4	0.043	0.058	0.048	0.067	0.064	0.075
5	0.068	0.090	0.075	0.105	0.100	0.118
6	0.097	0.130	0.108	0.151	0.144	0.169
7	0.132	0.176	0.147	0.206	0.196	0.230
8	0.173	0.230	0.192	0.269	0.256	0.301
9	0.219	0.292	0.243	0.340	0.324	0.381
10	0.270	0.360	0.300	0.420	0.400	0.470
11	0.327	0.436	0.363	0.508	0.484	0.569
12	0.389	0.518	0.432	0.605	0.576	0.677
13	0.456	0.608	0.507	0.710	0.676	0.794
14	0.529	0.706	0.588	0.823	0.784	0.921
15	0.608	0.810	0.675	0.945	0.900	1.060
16	0.691	0.922	0.768	1.080	1.020	1.200
17	0.780	1.040	0.867	1.210	1.160	1.360
18	0.875	1.170	0.972	1.360	1.300	1.520
19	0.975	1.300	1.080	1.520	1.440	1.700
20	1.080	1.440	1.200	1.680	1.600	1.880
21	1.190	1.590	1.320	1.850	1.760	2.070
22	1.310	1.740	1.450	2.030	1.940	2.280
23	1.430	1.900	1.590	2.220	2.120	2.490
24	1.560	2.070	1.730	2.420	2.300	2.710
25	1.690	2.250	1.880	2.630	2.500	2.940
26	1.830	2.430	2.030	2.840	2.700	3.180
27	1.970	2.620	2.190	3.060	2.920	3.430
28	2.120	2.820	2.350	3.290	3.140	3.690
29	2.270	3.030	2.520	3.530	3.360	3.950
30	2.430	3.240	2.700	3.780	3.600	4.230
31	2.600	3.460	2.880	4.040	3.840	4.520
32	2.770	3.690	3.070	4.300	4.100	4.810
33	2.940	3.920	3.270	4.570	4.360	5.120
34	3.120	4.160	3.470	4.860	4.620	5.430
35	3.310	4.410	3.680	5.150	4.900	5.760

Chart 3:

Core type	FT23-43	FT37-43	FT50-43	FT23-61	FT37-61	FT50-61
Al value	188	420	523	24.8	55.3	68
	Inductance in microhenries					
# of turns						
1	0.188	0.42	0.523	0.025	0.055	0.068
2	0.752	1.68	2.09	0.099	0.221	0.272
3	1.69	3.78	4.71	0.223	0.498	0.612
4	3.01	6.72	8.37	0.397	0.885	1.09
5	4.7	10.5	13.1	0.62	1.38	1.7
6	6.77	15.1	18.8	0.893	1.99	2.45
7	9.21	20.6	25.6	1.22	2.71	3.33
8	12	26.9	33.5	1.51	3.54	4.35
9	15.2	34	42.4	2.03	4.48	5.51
10	18.8	42	52.3	2.48	5.53	6.8
11	22.7	50.8	63.3	3	6.69	8.23
12	27.1	60.5	75.3	3.57	7.96	9.79
13	31.8	71	88.4	4.19	9.35	11.5
14	36.8	82.3	102	4.86	10.8	13.3
15	42.3	94.5	118	5.58	12.4	15.3
16	48.1	107	134	6.35	14.2	17.4
17	54.3	121	151	7.17	16	19.7
18	60.9	136	169	8.04	17.9	22
19	67.9	152	189	8.95	20	24.5
20	75.2	168	209	9.92	22.1	27.2
21	82.9	185	231	10.9	24.4	30
22	91	203	253	12	26.8	32.9
23	99.5	222	277	13.1	29.3	36
24	108	242	301	14.3	31.9	39.2
25	118	262	327	15.5	34.6	42.5
26	127	284	354	16.8	37.4	46
27	137	306	381	18.1	40.3	49.6
28	147	329	410	19.4	43.4	53.3
29	158	353	440	20.9	46.5	57.2
30	169	378	471	22.3	49.8	61.2
31	181	404	503	23.8	53.1	65.3
32	192	430	536	25.4	56.6	69.6
33	205	457	570	27	60.2	74.1
34	217	486	605	28.7	63.9	78.6
35	230	515	641	30.4	67.7	83.3

Chart 4:

Turns vs. wire length (leads not included)

These are calculated from core dimensions with 15% fudge factor added. (Experience showed that just using the core dimensions resulted in insufficient wire length; an extra 15% more than adequately compensates for it.) These are for the windings only and do not include leads; add 1 or 2 inches for leads. (Don't worry too much about the two decimal places; that's just a consequence of the calculation method used, and it is nowhere near that critical.)

Core	inches per turn (does not include leads)		Core	inches per turn (does not include leads)	
T12	0.19		FT23	0.26	
T16	0.23		FT37	0.5	
T20	0.29		FT50	0.68	
T25	0.37		FT50A	0.79	
T30	0.47		FT50B	1.37	
T37	0.49		FT82	0.93	
T44	0.61		FT87	0.95	
T50	0.67		FT87A	1.53	
T68	0.8		FT114	1.13	
T80	0.92		FT114A	1.7	
T94	1.16		FT140	1.73	
T106	1.57		FT140A	1.93	
T130	1.6		FT150	1.44	
T157	2.02		FT150A	2.01	
T184	2.66		FT193	2.22	
T200	2.13		FT193A	2.51	
T200A	3.16		FT240	2.3	
T225	2.24				
T225A	3.28				
T300	2.39				
T300A	3.54				
T400	3.51				
T400A	4.31				
T500	4.28				

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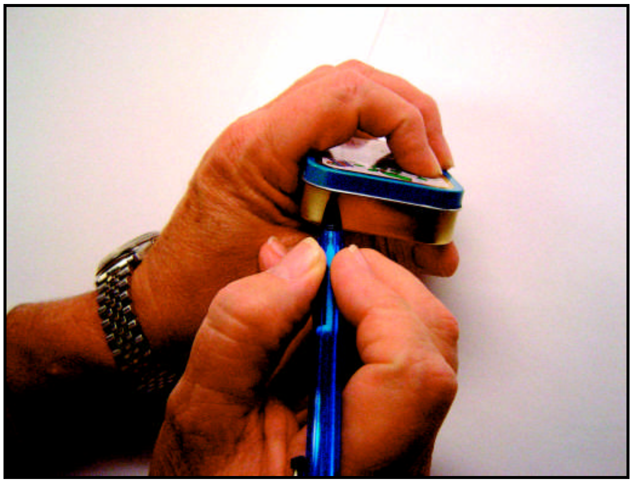
Darwin (Dar) Piatt - W9HZC

Make really neat holes in your Altoids tins!

So your Pixie II or Rockmite is complete, tested and ready for it's enclosure. Now comes the fun part, trying to make those tiny pesky, little holes in the sides. You'll need at least three, one for antenna, one for key, & one for headsets. If you include the modification for making the crystal shift, you'll need another for the switch.

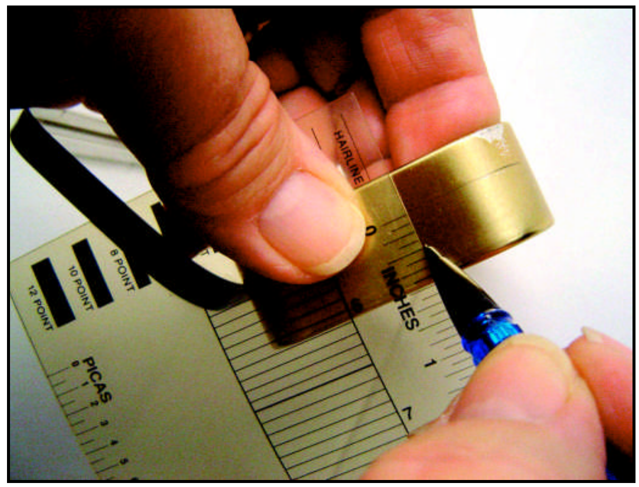
Trying to drill those with your handy cordless or even the drill press can be frustrating and should not be done when children are within hearing distance! After you read this article, you'll be making perfect holes every time.

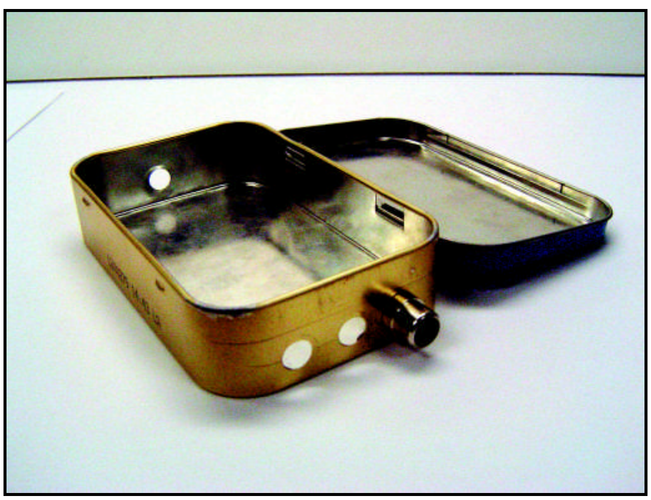
The secret? Just an ordinary, every day single hole punch meant for paper punching. I found a 'heavy duty' one made by the McGill Co. (Marengo, ILL).



Here is my procedure:
Step one - with the lid closed, draw a line along the bottom of the lid. This shows how much space you have to work with.

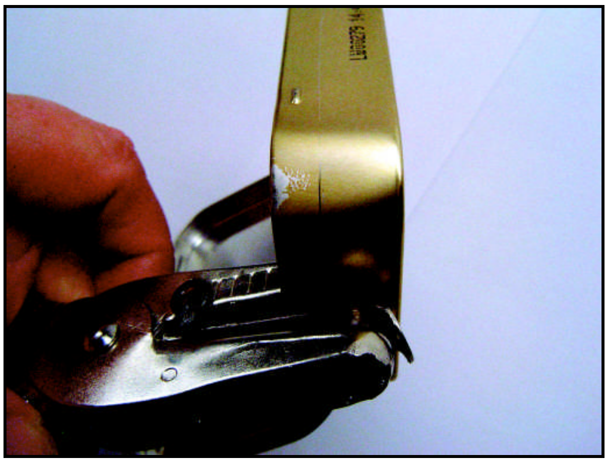
Step two - Measure between your line and the bottom of the tin and draw a second line. This will be the holes center line.





Step three - Divide the second line into three parts, starting with a vertical line in the middle then spacing equal distance out on either side. Don't try to put more than three holes in the end.

Step four - Duh! Punch the holes !!



Punches may be purchased in different sizes, I just took the key and headphone jacks to the store with me and punched some holes in a piece of paper until I found the one I needed. Some punches have little wire gizmos to help align the punch. You may need to remove these to be able to reach down into the Altoids tin. I'm still looking for one the size of a screw-in BNC. You'll have to carefully ream out one hole to fit the BNC or use the RCA jack as seen some of the photos.

That's it, perfect holes, every time

Good luck and happy punching..
De W9HZC, Dar Piatt

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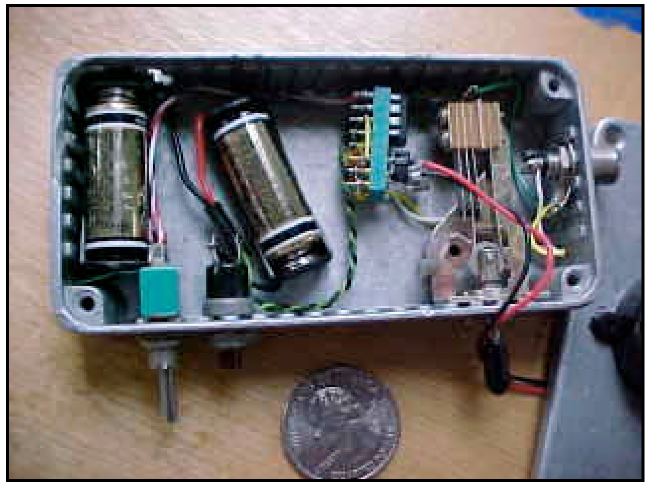
Jim Fitton, W1FMR

An Easy TiCK



The Easy TiCK is more compact than the standard TiCK on its PC board, which is roughly an inch square. If the Easy TiCK is stuffed in a rig, power can come from a separate battery or from the main power source, via a 3-Volt Zener diode.

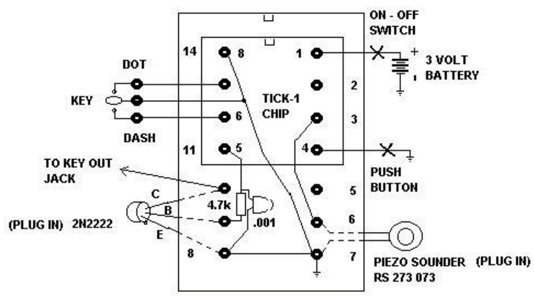
When it came time to replace my venerable Curtis 80488 keyer recently, I looked around for a smaller and more up-to-date model that I could easily tuck either in a rig or an outboard keyer assembly for use with several rigs.

I stumbled across the answer at a hospitality suite at Dayton: A TiCK-1 chip that came programmed for a variety of functions, was smaller than the Curtis version (8 pins versus 14 pins) and cost about one-third ($5 versus $17) of what I paid for a Curtis chip in the 1980s.

Rather than buy the whole kit (p-c board, components, chip and manual) I opted for the chip

CW keyer circuit using Tick keyer chip.

Bottom view



14 Pin DIP socket
Bottom view

NOTE:
TICK CHIP IS 8 PIN......DIP SOCKET IS 14 PIN....COUNT PINS CAREFULLY !
BATTERY = RADIO SHACK HOLDER FOR 2 AAA CELLS
OR 2 "N" CELLS AND HOLDERS FROM RADIO SHACK
PUSH BUTTON = MOMENTARY, NORMALLY OPEN SWITCH
KEY JACK = 1/8 " STEREO JACK OR KEY SWITCH, OR BOTH !
OUTPUT JACK = PHONO JACK
ON - OFF SWITCH = MINI TOGGLE SWITCH

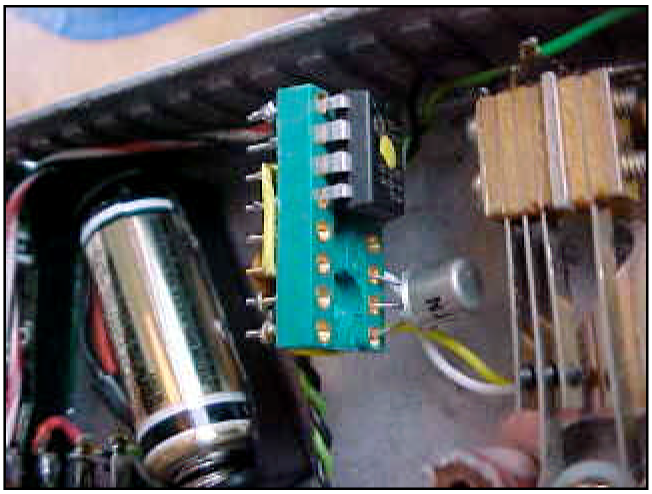
Press pushbutton	Hear "S"	Speed adjust .	Dit to Decrease, Dah to Increase
Hold PB (Push Button)	Hear "T"	Tune	Press Dit or Dah to end tune
Hold PB	P	Paddle	Press paddle you want to be the Dit
Hold PB	A	Audio	Dit to enable, Dah to disable sitetone
Hold PB	SK	Straight Key	Dit to toggle between Str. and Auto
Hold PB	M	Mode	Dit = Iambic A, Dah = Iambic B mode
Hold PB	K	Keyer Mode	Release PB = Back to normal mode

alone, figuring I'd do my own layout and board. The wiring sketch I produced looked amazingly like the layout of a 14-pin DIP socket, so I rearranged a few connections and found everything fit perfectly on the bottom of the socket.

An Easy TiCK was born.

In addition to easy wiring of components on the under side of the DIP socket, I found I could plug the keying transistor (2N2222) and the piezo element into the top of the socket for easy removal, if necessary. I used an Augat socket with machined pins, and No. 30 wire made connections a breeze.

The socket will accommodate standard TiCK-1 chip, which has no memory, or the TiCK-2 or -4, which do. The K1EL-K9 chip also can be wired on a DIP socket with the addition of a couple of small capacitors.



My home keyer is powered by a 3-Volt coin battery in a holder. A companion keyer for portable operations is built in a die-cast aluminum box and is powered by two AA cells. It is rugged and compact.

The Easy TiCK is more compact than the standard TiCK on its p-c board, which is roughly an inch square. If the Easy TiCK is stuffed in a rig, power can come from a separate battery or from the main power source, via a 3-Volt Zener diode.

More information on TiCK chips and key kits, see www.kangaus.com and data on the K1EL offerings can be found at www.k1el.com

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AmQRP.ORG HOMEBREWER

George Heron, N2APB
Joe Everhart, N2CX

Atlanticon 2005 … in recap

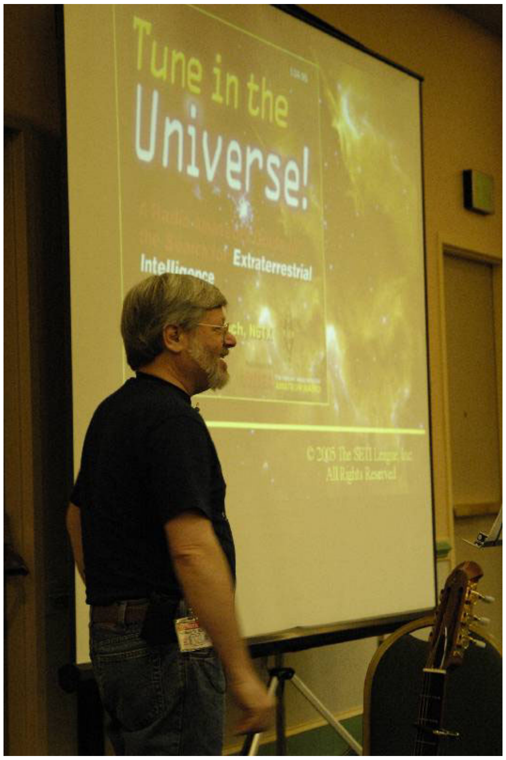
This year was 7th time for this annual QRP weekend, run by the NJQRP Club and sponsored by AmQRP, and what a great time was had by all.

Once again, Atlanticon was a terrific success and everyone had a really exciting time! Although it was raining like crazy outside most of Saturday, over 140 QRPers were warm and cozy in our spacious meeting room and heard from some of the smartest and most entertaining hams in our hobby.

A wonderfully-spacious banquet room at the Holiday Inn Select in Timonium, Maryland served again as this year's center for the all-day QRP presentations

The Presentations

Each of the presentations was a wonderful treat, but perhaps the most exciting highlight of the weekend were the presentations from our keynote speaker, **Dr. Paul Shuch, N6TX.** Paul was absolutely amazing! He is a longtime QRPer, and as part of the SETI organization, he develops advanced digital signal processing techniques in search for the ultimate DX - extraterrestrial signals that are very weak when received on Earth. Paul's presentation was a dazzling technical overview of the problems confronting humans searching for communications from other world, and some of the techniques to overcome those challenges. Much to the surprise and extreme enjoyment of everyone present, Paul would occasionally pick up his guitar and break into a song explaining more about the topic he was currently addressing! We heard stories about the NRAO (National Radio Astronomy Observatory) sung to the tune of John Denver's "Take me home Country Road". It was hilarious! All in all, there were some twelve songs presented like this as we all gained a much better appreciation of the technology and pioneers of this branch of science. All of us thank Dr. Shuch for spending his valuable time with us this year.



Dr. Paul Shuch, N6TX, aka Dr. SETI, shared a super-informative session that consisted of slide narrative and hilarious musical interludes

Joe Everhart, N2CX, actually led off the speaker lineup on Saturday morning with his usual eye-opening humor ... ask him sometime about the three QRPers and the three DXers on a train! First by necessity and later by inclination, N2CX has always been a homebrewer ... and he shared his insight and experience in the area of oscillators: different types, uses and ways to stabilize their frequency output. Joe's presentation was a natural extension of the "Crystallizer" - the Atlanticon Kit that all attendees receive in advance of the weekend. QRPers in attendance now know a great deal more about temperature control and uses of stable oscillators as a result of the N2CX eye-opener presentation. We are always blessed to have such a gifted RF designer and innovative thinker amongst us, and we thank you Joe for continuing to share so much with others in the hobby that you love.

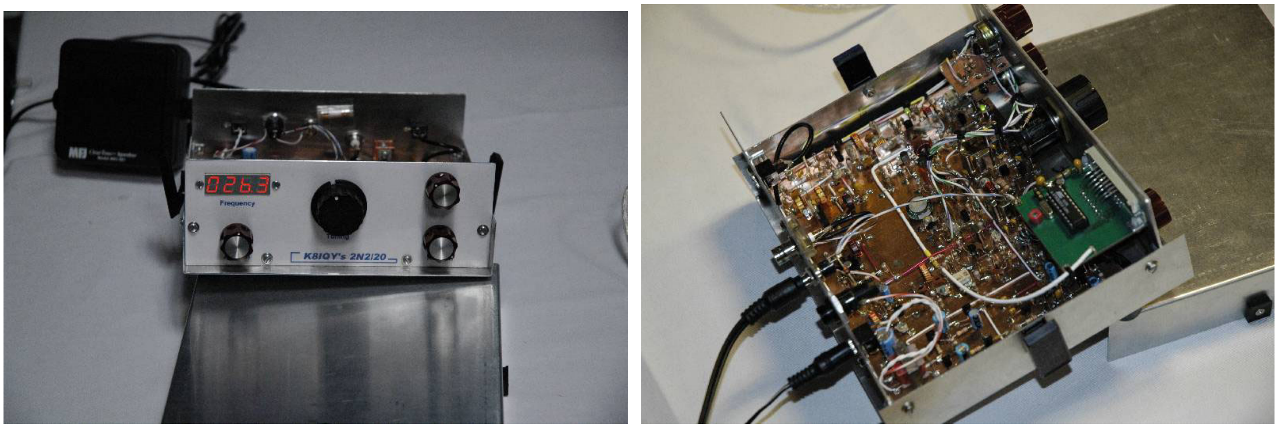
A thoughtful pause during Joe Everhart's N2CX presentation.

Lyle Johnson, KK7P was next up for presenting his material on Saturday morning. Lyle is the designer of the very popular DSPx Daughtercard used in the DSP10, Elecraft K2 and Micro908 products, and he described an approach for "Digital Building Blocks for Analog Radios" that utilize the power contained in these very capable DSP and DDS modules we homebrewers have available to us today. KK7P kept the discussion at a high level, yet provided enough detail and written material that gave the audience all sorts of insight as to the projects, kits, radios and equipment we'll soon start seeing (and using!) in proliferation. I was very pleased to have Lyle Johnson make his first appearance at Atlanticon this year, and I'm sure all those who were captivated by his fast-paced, subtle-humor presentation were too. Thanks for coming all the way from Washington State to join us this year Lyle! I think this is a start of a wonderful relationship ;-)

Lyle Johnson, KK7P delivering his Atlanticon presentation (left) and milling around during the evening social (right).

Jim Kortge, K8IQY returned by popular demand for yet another engagement as an Atlanticon speaker. Jim's presentation overviewed the design, construction, and performance of his 20-meter, discrete-component CW transceiver based on his previous award winning 2N2/40 design. Jim carefully reviewed where his new and revised circuits are employed, providing improved performance over the 2N2/40 while retaining the straight forward, Manhattan-style construction approach. K8IQY is a master craftsman of Manhattan-style construction projects and has contributed many solid and useful designs to our QRP community. He passed around components of his latest creation, and offered matched crystal sets to many of the homebrewers in attendance who wanted to build up his design. Thanks Jim!

Jim Kortge K8IQY delivering his presentation at Atlanticon



The subject of Jim Kortge's presentation: The 2N2/20 Homebrew Transceiver

Rich Arland, K7SZ is back ... and man, is he back! By popular demand again , our Master of Ceremonies and Wit did double-duty for us this year by emceeing the seminar series, as well as by making a presentation himself addressing the topic of "Emergency Communications for QRP" and the many options we QRPers have available when we go to the field. Now you must understand, this is the "New and Improved K7SZ" ... Rich has lost more 150 pounds and he looks fabulous! Rich's presentation showed us how ham radio, and even QRPers have a track record of coming to the assistance of our communities, especially after the 9-11 terrorist attacks. We especially benefited by seeing what constitutes his own "jump kit" of radio and survival gear in the event of needing to quickly take to the field with supporting communications. Rich's emceeing of the entire day's activities was expertly done and we all appreciated his efforts in making the seminar successful.

Rich Arland, K7SZ delivered an inspiring presentation on Emergency Communications (left), as well as performing as master of ceremonies for the weekend, introducing each speaker and presenting each with a plaque of appreciation (right).

The Grand Prize Drawing

Each year, at the end of our full day of QRP presentations, we have a grand prize drawing for some lucky winner. This year the prize was a DSW-II 40m DDS-based Transceiver Kit from Small Wonder Labs. After much drum roll and holding of breaths, the lucky winner was Dana Hager from the EPA-QRP Club. The really neat part of this is that Dana was not yet a ham but was scheduled the next day (Sunday) to take the exam for his license! We'll have to see how that worked out. Regardless, Dana has been involved with the QRP clubs for many years and was very appreciative of the prize he won.

Dana Hager, the lucky winner of the grand door prize drawing. (Dana was scheduled to take the exam for his first ham license the next day over at the hamfest!)

Saturday evening Contests

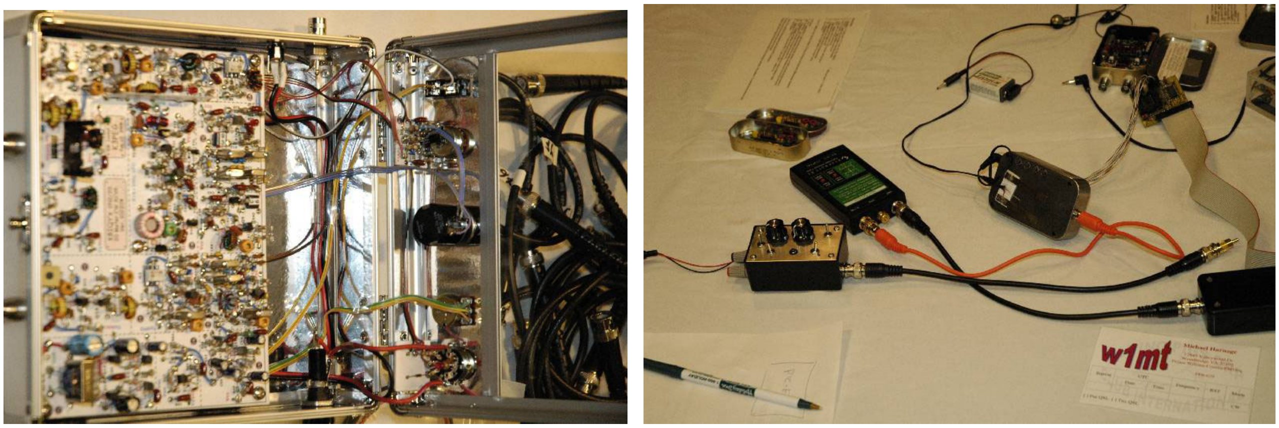
As you know, we sponsor two contests each year at Atlanticon and the winners in each category get some pretty cool prizes.

Contest Judging #1: Open Homebrew Construction

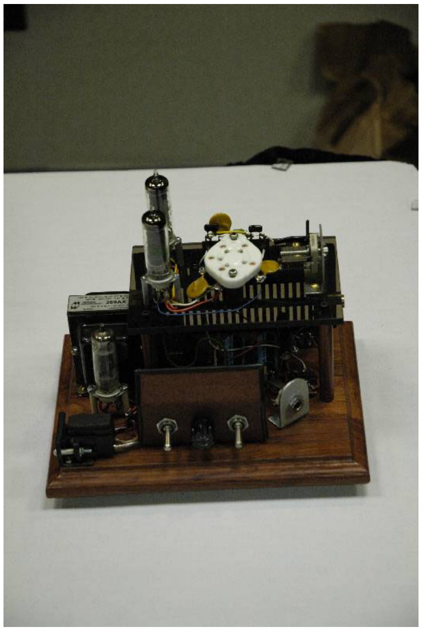
One of the contests was the open category of **"homebrew construction"**, whereby one brings along his latest, most innovative, or best-constructed project for display and judging. David Porter, AA3UR was this year's judge and he had a difficult time selecting the winners from among all the good entries.

The winners were …

#1 KD4PBJ Chris Waldrup, with his entry of a Vector Analyzer and R1 Receiver
#2 K3PEG Larry Przyborowski for a great-looking 2N2/20 Transceiver.
#3 AA2JZ Carl Herbert's PSK80 a la Junque.
#4 K7SZ Rich Arland did a fabulous job with his Tube Transmitter.
#5 W1MT Michael Harnage's ATS3 Software and Tenna Dipper was a hit.



K3PEG's winning 2N2/20 (left) and W1MT's Tenna Dipper (right)

K7SZ award-winning tube rig (left). Photo on right: 1st-Place winner Chris Waldrup KD4PBJ receiving prize from N2GO.

Contest Judging #2: Crystalizer Accuracy, Stability & Novel Construction

The second contest is the one based on the theme of the weekend: **the Crystallizer Kit**. The idea this time was to construct this small pcb-based voltage-controlled crystal oscillator and get it calibrated as much as possible to 10.000000 MHz (WWV) and then see how well you could keep it on frequency with changing temperature. I think everyone really learned a lot about the effort required to do this, as the crowd around Joe Everhart's measurement station was pretty thick watching the testing. N2CX made a precisely-calibrated, and stable fixture based off a "DDS VFO Calibration" article written by Earl Morris N8ERO (published in the Proceedings, and included in issue #5 of the Homebrewer Magazine), and Joe was able to measure each contestant's VXO while connected to this fixture. A pair of blinking LEDs indicated when zero-beat was established with WWV (i.e., the blinking slowed to a stop) and a calibrated frequency counter actually read off the beat frequency down to 1 Hertz. Again, at the time of this writing I don't have the list of those who were the top entries, but they included water-cooled VXO's, Micro908-controlled VXO, circuit boards insulated in Styrofoam, vacuums, cooled and heated environments monitored by thermisters, and one was even insulated in a cardboard box stuffed with dirty socks (thanks K7SZ ;-) We'll have pics and further details shortly on this contest as well, but for now we can tell you that the winner was Steve Holton, N1NB who had the VXO controlled by a nifty software algorithm running in his Micro908 controller. He dubbed it the "TC-908" for its temperature controlling control characteristics and we'll be publishing his novel approach soon in Homebrewer Mag. Congrats to all entries!

There were 13+ good entries in the bakeoff. They ranged from a sophisticated microcontroller-operated, compensated oscillator to several well-insulated devices (a delaying action at best), to several “bare board” Crystalizers. Ingenuity was the rule of the day.

The test itself consisted of using a frequency counter and a receiver based on the N8ERO WWWV calibration receiver to measure the frequency of each oscillator entry. Contestants were allowed to “tweak” their items on frequency at room temperature. The test setup monitored frequency as a hair dryer was used to expose the units tested to an elevated temperature for several minutes.

> **#1 Steve Holton, N1NB** brought a digitally-compensated Crystalizer using the Micro908. A thermistor, thermally attached to the Crystalizer board, fed the Micro908. It was pre-calibrated to feed back a DC signal at each temperature to tune the oscillator on frequency. Frequency held to within 1 Hertz. Steve also had a “gag” entry with a Crystalizer that was temperature-stabilized by a large aluminum block with

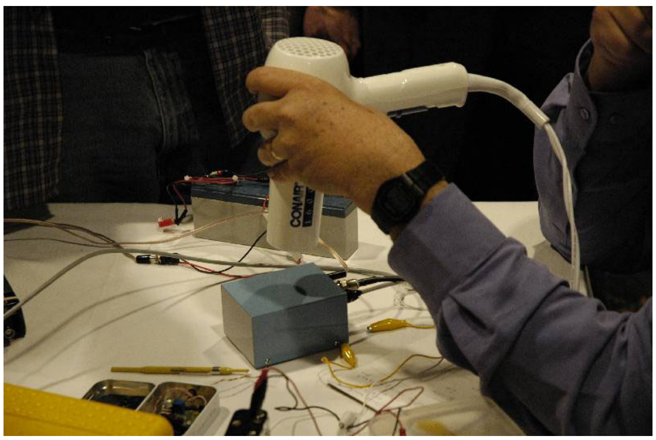
chilled water flowing through it. This held frequency quite well … and would have continued to do so, at least until the ice melted!

#2 Charles Hallock, AA3WS. It was a very well-insulated case which delayed the effects of external temperature changes.

#3 Jim Dicso, K2SZ mounted his Crystalizer in a sealed, insulated case with a Peltier-effect heater/cooler. There was no closed loop feedback but there was enough thermal mass to the assembly such that prolonged periods of added heat did not grossly change the oscillator frequency.

#4 Carl Herbert, AA2JZ had another example of a well-insulated case. Several minutes of heating resulted only in minimal temperature change, though given enough time *that* would change.

#5 Hank Kohl, K8DD. Hank's was the best in class of uncompensated Crystalizers that did not have insulated cases. Apparently the stack up of a good crystal and component temperature coefficients kept his frequency within less than 30 Hertz even when well-heated by the hair dryer!



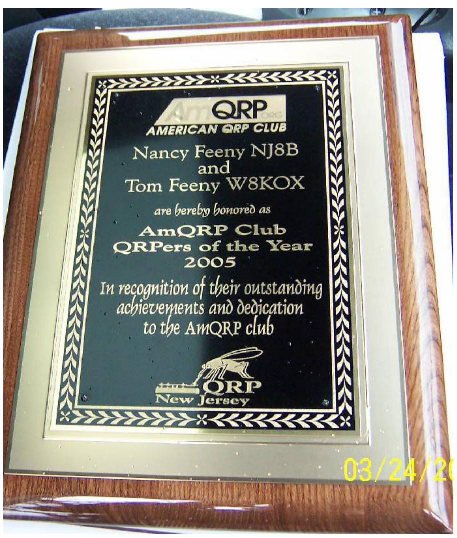
N2CX at the center of the Crystalizer "stress test & measurement" table. Joe applied a heat gun to contestant entries while monitoring the unit's frequency output against a precision-calibrated standard based on the N8ERO WWV Receiver (an article in this Homebrewer issue) his on Joe's own Atlanticon presentation.

First-place winner Steve Holton N1NB stands watch over the measurement and evaluation of his Crystalizer (blue box above) that was digitally-compensated by a program he wrote for the Micro908 (seen above with white front panel.)

Be sure to take a look through all the photos of the Saturday evening festivities to see some good shots of the contestants' entries. Congratulations to everyone who participated ... there were many winners in this contest!

AmQRP "QRPers of the Year" ... awarded to Tom W8KOX and Nancy NJ8B Feeny

As anyone who has ever opened an AmQRP kit in recent years knows, the quality and attention to detail involved with the actual kitting and packaging of the project is just superb. This is great part due to the detailed nature of the effort put in by AmQRP's main kitting engine, Tom & Nancy Feeny. These wonderful folks have completely revolutionized the kitting of our club-based kits by color-coding SMT components, carefully labeling other sub-bags and in general they provide astounding value to all of us QRPers. Recent kits to their credit include the DDS Daughtercard Kit, Micro908 Kit and its two Service Pack mailings, the Islander Pad Cutter and Amplifier, the IQ-VFO (board, partial kit and full kit), and more. Additionally, Nancy has been proofing the Homebrewer articles since issue #2, and recently has taken on a major part of the editing job for issue #5, whereby all of the articles have first been through her creative, eagle-eye before it comes to me for final composition and layout prior to disc duplication. Nancy has even started contributing original material to the magazine! We surprised the Feenys with the AmQRP "QRPer of the Year" plaque during Atlanticon and they received a standing ovation from the attendees. Thank you NJ8B and W8KOX!



The husband and wife team of Tom Feeny W8KOX and Nancy Feeny NJ8B Feeny were co-winners of the prestigious AmQRP QRPer of the Year award. Their contributions to every facet of AmQRP operation since its inception has benefited so many in the QRP community.

The NJQRP Club staff makes it all happen

As in previous years' weekends, Atlanticon could not be conducted without the tireless involvement of a good handful of club volunteers. With thankless jobs ranging from manning the check-in table, to handing out the Proceedings, to making the nice, laminated badges before hand (see the cool logo at the top of this page for an example of what the badges looked like), to setting up the AmQRP / NJQRP table each evening, to arranging/coordinating the lunches provided for everyone during the day, to the handling of door prize drawings throughout the day ... the list goes on and on. For all this, we sincerely thank Bryan Williams AA3UR, Michael Bower N4NMR, Ed Lyon N4LRR, Denis Albiser AB2PD, David Willmore N0YMV and David Porter AA3UR.

Brian Williams AA3WM (left) and Denis Albiser, AB2PD handled the badge programming details of the weekend. Bryan with the camer (right) handled much of the photography for us, along with David Porter. Ed Lyon, N4LRR and Michael Bower, N4NMR adeptly handled the registration and sign-in table, and David Willmore N0YMV filled in tying up many of the loose throughout the weekend. Thanks guys!

Prize Donors make it fun for everyone!

Atlanticon attendees regularly look forward to the door prize drawings throughout the day on Saturday, and to the prizes awarded during the Saturday evening contests. We couldn't make this happen without the generous contribution by some very altruistic QRPers and organizations ... the NoVAQRP Club, the EPA-QRP Club, John Grow VE3EQL, Howard Weinstein K3HW, Gil Kost and his "American Manufacturing QRP Company", Dave Benson K1SWL and his "Small Wonder Labs", and Elecraft. We thank each and every one of you for helping to make Atlanticon a success this year!

How do you guys do it all??

Someone asked a question during one of the Q&A periods during the day: *"How on earth can you guys provide all this for just the $10 registration fee??! We have incredible facilities, outstanding speakers flown in from all corners of the country, a free lunch provided for everyone, printed proceedings of all the papers, and even a kit!"* **The answer is really simple** ... the AmQRP and NJQRP members work their tails off during the whole preceding year on various fundraising activities in order to conduct QRP forums like Atlanticon. The proceeds from the Homebrewer Magazine subscription sales, and from all the kits and extra activities we do pour into making these QRP forum the best around and most enjoyable for all who attend. So the thanks for this more appropriately goes out to the designers, the kitters, the magazine article contributors and (especially) to all the QRPers throughout our community who buy these goods. Everyone's participation in these various activities helps support more and better kits, helps support a bigger and better magazine, and help support an even better Atlanticon (and possibly other) QRP forums every year. Thank YOU!

Hope to see you all next year at Atlanticon 2006!

PS: Be sure to check out all the photos from this fun Atlanticon weekend!

AmQRP.ORG HOMEBREWER

Terry Fletcher, WA0ITP

Audio Tester

If you need an audio tester for the bench, here's one that's effective, simple, inexpensive, and easy to build, all good ham radio attributes. It's not a complex project, and your workmanship doesn't have to be elegant. Mine sure isn't, but it is a useful addition to the bench.

The Idea

This project started out as a way to enjoy a few hours homebrewing. Knowing that it's better to build with a buddy, I decided to try and drum up some interest in a build day among the local hams. They immediately agreed to take on a new project. After mulling over several possible projects, and weighing need and complexity, we decided to build Jim Kortege's, K8IQY, Islander audio amplifier [1] to use on the trouble shooting bench. I'd say lab, but that would be an extreme gross exaggeration at my QTH.

Cleaning Up The Shop

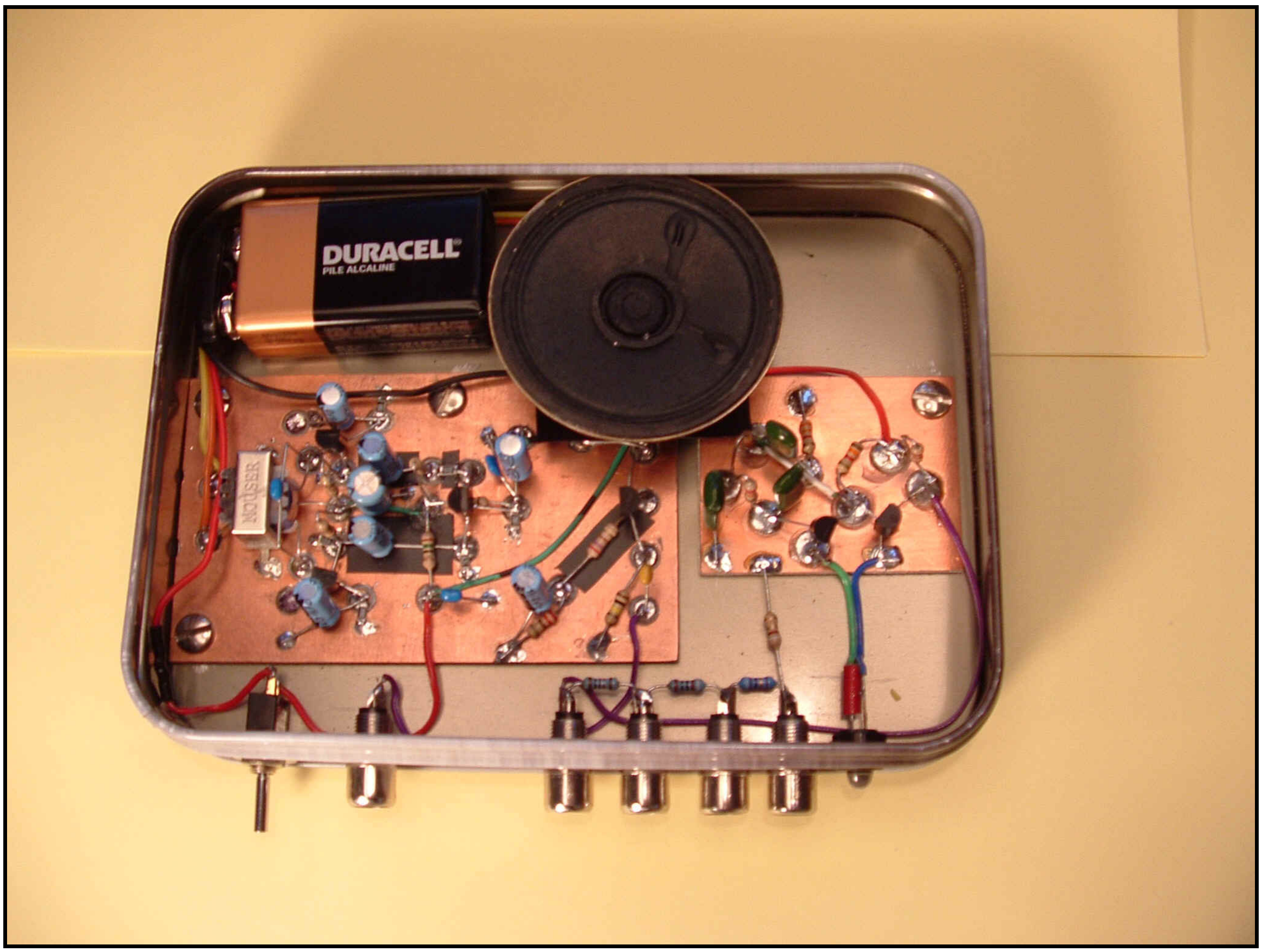
The Islander Kits were ordered from NJQRP, and we made plans for lunch. Food is a must for a good building day, right? Now came the hard part, cleaning up the shop. The good stuff was moved to the walls and the junk was pitched in the dumpster. When I could see the floor again, worktables were constructed on top of sawhorses. One of my Christmas presents was opened and placed on the workbench. Speaking if the workbench, it was a major hurdle, but eventually I found the top again.

Building It

The guys arrived about 10 in the morning, I perked the coffee and donuts miraculously appeared. Lunch was started (chili in a crock pot). Then I chucked up an Island Cutter in the Christmas present. We opened the kits and jumped right in cutting islands, sorting parts, and melting solder. From previous experience we all knew that building the boards is easier than putting them in an enclosure. So we concentrated only on getting the boards built that first day.

Perhaps the best result of the day was the camaraderie. Everyone left saying, "Let's do this again". Building alone is fine but building with like-minded friends is fun. Thanks to WAØWW, NØSM, WBØMBI. and WBØSWZ for helping jump start the project.

A few days later we gathered at WAØMWW's shop to continue. We had to breadboard an audio oscillator for a signal injector in order to check out the Islander board. While using it, a light came on my little head. Why not incorporate an audio oscillator and the Islander, in one enclosure and call it an Audio Tester, with the Islander functioning as a signal tracer? All agreed it was a good idea. For the oscillator we chose the latest version of Joe Everhart's, N2CX, Good Enough Oscillator (GEO) [2]. Another hour and the GEO board was born, thanks to the magic of Manhattan pads.



The GEO board is on the right. The speaker stays inside the enclosure and has adequate volume without holes in the lid.

Personal Touches

An FET preamp was added to the Islander board, K8IQY, kindly providing the design. It raises the input impedance to 100k so as not to load the circuit under test. The GEO circuit was built "stock", Both use the same 9-volt battery, and there is some oscillator feedback in the speaker. Another battery and switch would eliminate it. But it is at a very low level, hardly noticeable, so in the interest of simplicity, I'll live with it.

The GEO was calibrated to 2 vrms maximum output rather than 1 vrms as suggested in the article. . Why? No good reason, I just liked it better that way. That's one of the best things about homebrewing, make it your way!

Another little wrinkle was to use RCA phono jacks as the connections to the outside world. There are 5, one for the Islander input, and 4 for the "sorta" calibrated outputs of the GEO. Instead of using 4 output capacitors, one for each jack, I installed it inside the test lead phono plug. Switching output levels is then accomplished by changing the plug between the jacks.

A power switch was included, and the GEO led is positioned to act as a power on indicator.

Closing It Up

Part of the fun of building a small project is choosing an enclosure. I found an UNO card game in a Spiderman tin at a local BIG chain department store. The inside dimensions were 5.5"L x 4"W x 1"H, perfect - large enough but small enough.

As we all know, drilling these small enclosures has to be done very carefully, backing up the tin with wood and increasing the hole sizes gradually. I like to avoid drilling altogether, if possible. In Altoids and Whitman Sampler tins I usually use a paper punch. However, since this tin is made from a little heavier material, I thought I could drill it. But first I filled it with water and put it in the freezer overnight. The ice backed up the tin perfectly and by using stepped drill sizes, perfect holes resulted without resorting to clamps! The tin was, and still is, real cool. Neither of these techniques are original with me, I picked them up on an email list or in direct correspondence with other hams. Is QRP a great hobby or what?

Notice all the phono jacks. The signal injector and the signal tracer have different colored heat shrink tubing.

Finishing It Off

I like to make labels using Microsoft Publisher. It has both vertical and horizontal scales, and they are accurate. A box that the scales say is 2" square does indeed print out 2" square on the printer. For this enclosure, I put the functional labels on the edge of the lid, and a descriptive label on the bottom. The inside of the lid would also have worked well for a descriptive label. A good trick for laying out out the position and size of the labels is to place the enclosure on a piece of paper, draw around it making an outline, then mark the locations of the switches, jacks LED's, etc. This facilitates making measurements and selecting text box and font sizes in Publisher.

These labels were printed on pastel yellow paper, covered with clear contact paper to protect the print, and stuck on with double sided tape. A black marker was applied to the edges to blend the yellow edges with the black border.

Labels dress it up and finish it with a flourish.

So there you have it. If you need an audio tester for the bench, here's one that's effective, simple, inexpensive, and easy to build, all good ham radio attributes. It's not a complex project, and your workmanship doesn't have to be elegant, mine sure isn't . But it *is* a useful addition to the bench.

By the way, did you figure out what I received for Christmas?

72/3 Terry Fletcher, WAØITP

wa0itp@rew2000.com

http://www.qsl.net/wa0itp

Notes and References:

1. http://www.njqrp.org/islanderamp/index.html

2. QRP Quarterly, Vol. 44 Number 4, Fall 2003, p.p. 8,9

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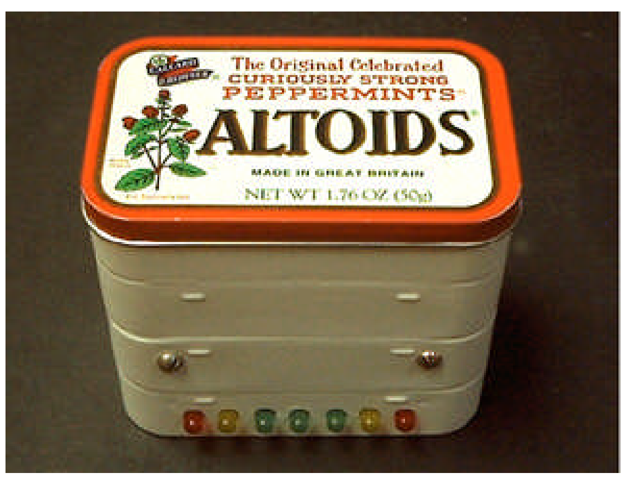
Doug Wilson, WAØVSL

The Back Packing Battery Pack (BP-BP Mark I) with Voltmeter

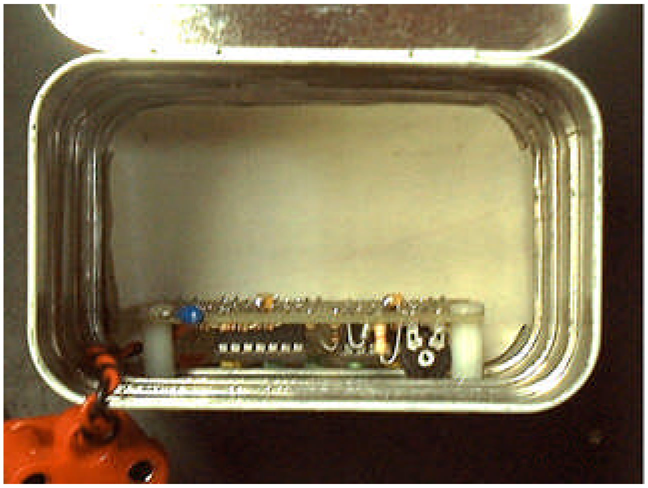
A simple and compact power source for backpacking. Easy to build, but it will take some time for the metal work.

The Back Packing Battery Pack (BP-BP Mark I) with Voltmeter

I have a 10 cell 'AA' NiMH battery pack (12V @ 1.6AH) that I use for backpacking. It needed a home! I also wanted a voltmeter built-in so I could keep track of it's condition and charging (I live in the woods, you have to keep chasing the sun with your solar panel..). Radio Shack didn't have any cases / boxes that suited me so I got thinking about that Super-Sized Giant Altoids tin I had and thought it might work. Bingo! The battery pack, LED voltmeter (http://www.rainbowkits.com/kits/vm-1p.html), switches and connectors all just fit!



Jumbo Altoids tin with LED voltmeter (early)



Inside view of tin ribs and voltmeter

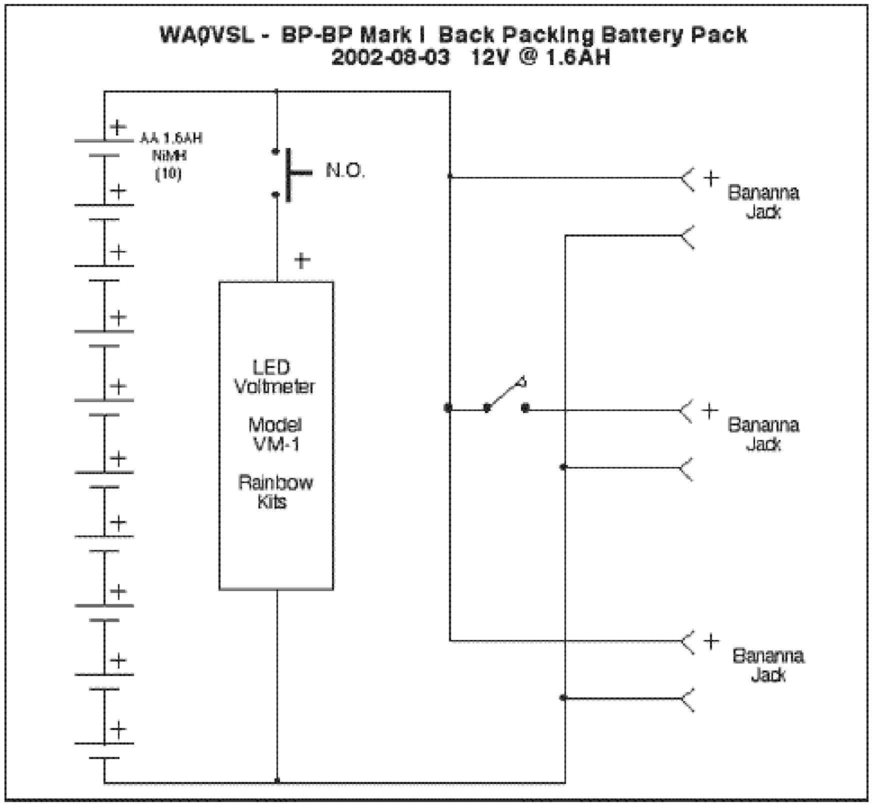
Actually, I'm telling a little white lie - don't go off to the market to find that jumbo-sized Altoids tin, I made it by cutting the bottoms out of 3 regular tins and soldering them all together with a 4th.. A lot of folks use the Altoids tins for QRPp rigs, so I started to think of them not as just a project box, but as a project form-factor. A four unit high box fit my needs perfectly.

Start by removing the lid of the bottom tin with pliers and flatten out the hinge tabs back into the space they were stamped out of. They should be below the outside surface when done, we will get back to them later. *Warning - the following steps produce LOTS of tiny flying, SHARP and HOT pieces of metal, USE EYE PROTECTION!!! The thin metal edges created are also sharp, be carefull! It is also a VERY NOISY process, USE EARPLUGS!* Now drill three 1/4" (6mm) holes next to each other in the bottom corners of the tin you are stacking on top, following the corner arc and leaving about 1/8" (3mm) between the tin wall and the holes. Small pilot holes are good in this thin material, and a reamer works well to enlarge the holes to the 1/4" size. Grind or mill out the metal between the holes, I use a conical milling bit in a Dremel Moto Tool®. You should now have four arc-shaped holes, one in each corner. Now cut in a straight line between the holes with mini tinsnips / heavy sissors (sheet metal nibblers tend to jam on this thin metal), also leaving about 1/8" (3mm) of lip. Voila, the bottom of the tin is gone!

Lay the tin down on some wood and tap flat any bends made by the cutting (I use the butt end of my Exacto® knife). Sand / grind all the paint off of the bottom you just finished and the top edge of the tin below. Stack the tins and hold them in alignment with big rubberbands. Tack solder the corners quickly and then remove the rubberbands. Flow solder into the gap all the way around the tins. The corners will wick in more solder as they cool, so you will need to reflow more solder there.. Now file and sand everything down smooth. *Tiny flying, SHARP and HOT pieces of metal warning again, just in case you missed the first one - USE EYE PROTECTION and EARPLUGS!!!* Use the Dremel tool with a milling bit to cut away the extra metal inside down to the factory rolled lip of the lower tin. Scrape and sand off any left-over burs. Repeat as many times as needed to get the height of box you want. The resultant ribs inside create quite a sturdy box for being made out of thin tin.

Now scrape away all the paint from around and on the former hinge tabs and flow solder into the depression to make it flush with the rest of the box. Sand / file away the excess solder. *Last tiny flying, SHARP and HOT pieces of metal warning - USE EYE PROTECTION and EARPLUGS!!!* Drill out ALL (I learned the hard way and had to repaint.) the holes needed for the project, deburring with the Dremel milling bit. Now you can mask off the bottom and lid and paint the box white again.

Checking battery pack fit.



Very simple.

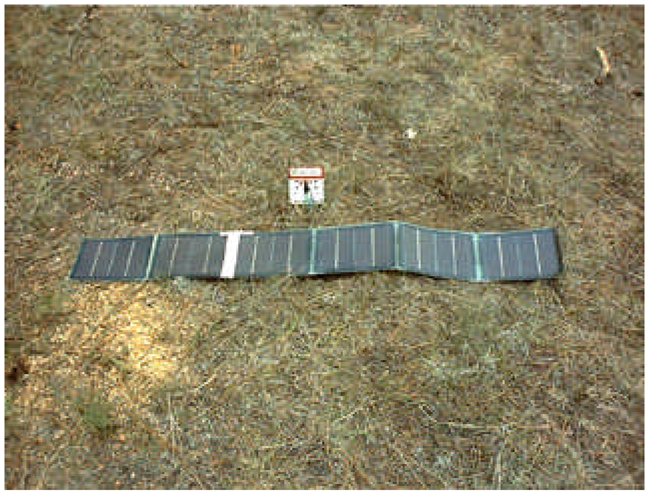
My battery pack has 3 bananna jack outlets. The middle one is switched for my camp light (uses 6 white LEDs!). The voltmeter presents a load to the battery (3-7 LEDs on at a time in typical operation), so I used a momentary normally-open switch for the battery check. In fact, I might replace the voltmeter with one of my own design using a bargraph IC that can be setup to display the voltage with a single LED lighting up at a time for lower current consumption. This one is fine for now, much better than dragging a DVM along.

Finished unit and voltmeter demo

Yes, the voltmeter is backwards, I wanted to be able to calibrate it (the black trim pot on the right side of the voltmeter board seen on the inside photographs above) without disassembly or drilling a hole in the bottom of the case. I also wanted the primary wiring at the top of the box in case field repairs are ever needed. I have added lettering to make all the functions clear.. I wrapped the battery pack in pipe wrapping closed-cell foam to act as a shock absorber and insulator from the sun's heat. With two small desiccant packs inside the battery pack weighs 12 Oz. total.

Battery pack wrapped in closed-cell foam

If you choose your solar panel capacity carefully (Solar panel amperage = (battery capacity in amphours / number of good sun hours per day) X 1.1) and monitor your battery, you should not need a charge controller. Just remember that a drained battery will take all the current you can give it (it won't like it, but it'll do it), so do not try using a high capacity (in respect to the battery) solar panel. Solar panels are not constant-current sources, so if you have a high capacity solar panel you should use a DC-DC current-limited power converter with a timer circuit. A little more weight to pack in but it will save those expensive NiMH batteries.



Out catching some rays with my Z-fold solar panel (an old project)

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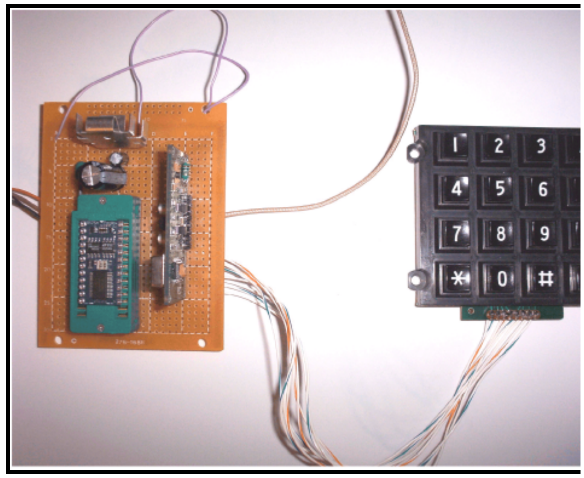
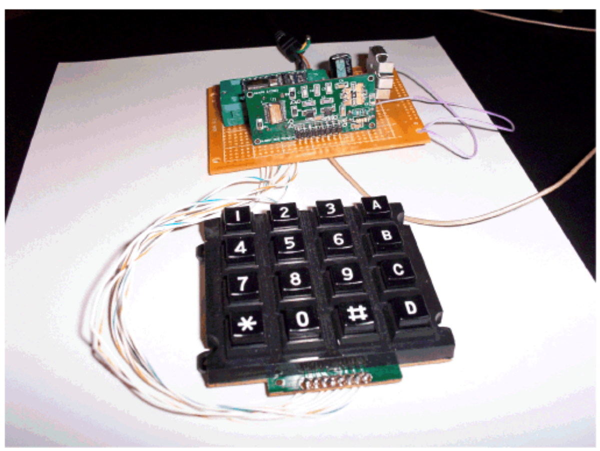
The journal of the American QRP Club ... for builders, experimenters, ham radio operators and low power enthusiasts everywhere.

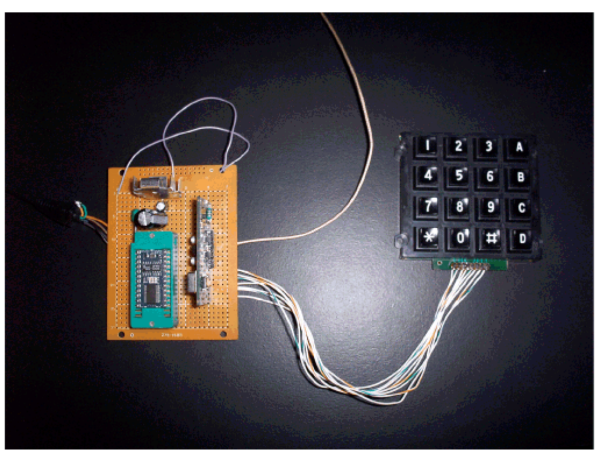
Wade Lake, KR7K

BS2 VFO Controller

This code was written using Parallax's new PBasic 2.5 and requires their new editor.







This code was written using Parallax's new PBasic 2.5 and requires their new editor.

AD9850_Loader.bsx

```
'{$STAMP BS2sx}
'{$PBASIC 2.5}
'
' AD9850/NJQRP DDS Daughtercard Loader  Version 1.
' By Wade Lake - KR7K
'
' The following Data table contains 32 bit hex values representing Frequency in Hertz.
' Digits 0-9 FOR the 1's, 10's, 100,s, 1000's,... 1,000,000's decimal places and digits 0-4
' for the 10,000,000's decimal place.  This totals 75 - 32 bit values.  The main idea is this:
' If you add one decimal places value to the next, keeping a running total, when all the decimal
' places individual values are added, the correct 32 bit frequency tuning word is calculated.
' This table is only valid for a reference oscillator frequency of 100MHz (Like the NJQRP DDS Kit).

DATA $00,$00,$00,$00,$00,$00,$00,$2b,$00,$00,$00,$56,$00,$00,$00,$81,$00,$00,$00,$AC,$00,$00,$00,$D7,
$00,$00,$01,$02,$00,$00,$01,$2D,$00,$00,$01,$58,$00,$00,$01,$83,$00,$00,$00,$00,$00,$00,$01,$AD,
$00,$00,$03,$5B,$00,$00,$05,$08,$00,$00,$06,$B6,$00,$00,$08,$63,$00,$00,$0A,$11,$00,$00,$0B,$BE,
$00,$00,$0D,$6C,$00,$00,$0F,$19,$00,$00,$00,$00,$00,$00,$10,$C7,$00,$00,$21,$8E,$00,$00,$32,$55,
$00,$00,$43,$1c,$00,$00,$53,$E3,$00,$00,$64,$AA,$00,$00,$75,$71,$00,$00,$86,$38,$00,$00,$96,$FF,
$00,$00,$00,$00,$00,$00,$A7,$C6,$00,$01,$4F,$8B,$00,$01,$F7,$51,$00,$02,$9F,$17,$00,$03,$46,$DC,
$00,$03,$EE,$A2,$00,$04,$96,$68,$00,$05,$3E,$2D,$00,$05,$E5,$F3,$00,$00,$00,$00,$00,$06,$8D,$B9,
$00,$0D,$1B,$71,$00,$13,$A9,$2A,$00,$1A,$36,$E3,$00,$20,$C4,$9C,$00,$27,$52,$54,$00,$2D,$E0,$0D,
$00,$34,$6D,$C6,$00,$3A,$FB,$7F,$00,$00,$00,$00,$00,$41,$89,$37,$00,$83,$12,$6F,$00,$C4,$9B,$A6,
$01,$06,$24,$DD,$01,$47,$AE,$14,$01,$89,$37,$4C,$01,$CA,$C0,$83,$02,$0C,$49,$BA,$02,$4D,$D2,$F2,
$00,$00,$00,$00,$02,$8F,$5C,$29,$05,$1E,$B8,$52,$07,$AE,$14,$7B,$0A,$3D,$70,$A4,$0C,$CC,$CC,$CD,
$0f,$5C,$28,$F6,$11,$EB,$85,$1F,$14,$7A,$E1,$48,$17,$0A,$3D,$71,$00,$00,$00,$00,$19,$99,$99,$9A,
$33,$33,$33,$33,$4C,$CC,$CC,$CD,$66,$66,$66,$66

 row   VAR Nib
 digit VAR Word
 test  VAR Word
 term1 VAR Byte
 term2 VAR Byte
 term3 VAR Byte      ' RAM Declarations
 term4 VAR Byte
 sum1  VAR Byte
 sum2  VAR Byte
 sum3  VAR Byte
 sum4  VAR Byte

 LOW 2

 start:

 FREQOUT 5,400,600,900                          'This is the section that actually loads the DDS.
 DEBUG CR, HEX sum4, HEX sum3, HEX sum2, HEX sum1  'The "Load Beep" is sounded indicating that a new
 SHIFTOUT 1,4,0,[sum1,sum2,sum3,sum4,$00]       'frequency has been calculated and is being loaded.
 HIGH 2                                         'I used pin 1 for Data (P1-3 on DDS board)and pin 4
 LOW 2                                          'for clock (P1-2 on DDS board) and pin 2 for freq.
                                                'update or "Load" (P1-1 on DDS board). These stamp
                                                'I/O pins were selected for my convenience. (my old
                                                'stamp has a few blown I/O pins from years of experimenting)
                                                'These could easily be changed to suit. Like, making the
 sum1=0                                         'pinout match the DDS Board pinout might be a good idea.
 sum2=0
 sum3=0
 sum4=0

 DEBUG CR, "Frequency in Hertz?  "              'This section first aquires the digits and then indexes
 GOSUB button_detect                            'the data table for the given digit value.  For each digit
 IF digit > "4" THEN GOTO start                 'the math subroutine is executed.  It reads the indexed
 digit=(((digit-$30)*4)+280)                    '32 bit hex values from the data table and performs 32 bit
 GOSUB The_Math                                 'addition to keep a running total.  Notice the IF THEN
                                                'statement at the 3rd line of this section, it is in the
 GOSUB button_detect                            '10,000,000's decimal place part of the code and does not
 digit=(((digit-$30)*4)+240)                    'allow a digit value greater than 4. Since the DDS board
 GOSUB The_Math                                 'does not work well much above 30MHz, allowing a 4 here is
                                                'actually overdoing it a bit.  Also important to know is the
 GOSUB button_detect                            'frequency must be entered starting with the most significant
 digit=(((digit-$30)*4)+200)                    'decimal place value.  If it is zero then the zero MUST be
 GOSUB The_Math                                 'entered.  This holds true for all leading zeros. For instance
                                                'If I were loading a frequency of 1.160MHz I would enter
```



```
GOSUB button_detect                             '"01160000" on the keypad or in the hyperterminal window.
digit=(((digit-$30)*4)+160)
GOSUB The_Math

GOSUB button_detect
digit=(((digit-$30)*4)+120)
GOSUB The_Math

GOSUB button_detect
digit=(((digit-$30)*4)+80)
GOSUB The_Math

GOSUB button_detect
digit=(((digit-$30)*4)+40)
GOSUB The_Math

GOSUB button_detect
digit=((digit-$30)*4)
GOSUB The_Math

GOTO start


The_Math:

IF digit=0 OR digit//40=0 THEN FREQOUT 5,300,900,900 ELSE FREQOUT 5,300,600,600    'A Beep is generated indicating
                                                                                    'that a digit has been aquired.
READ digit+3,term1                'This section is the 32 bit adding routine.
test=term1+sum1                   'It reads the values from the data table
IF test>=256 THEN sum2=sum2+1     'and adds them to the running total.
sum1=sum1+term1

READ digit+2,term2
test=term2+sum2
IF test>=256 THEN sum3=sum3+1
sum2=sum2+term2

READ digit+1,term3
test=term3+sum3
IF test>=256 THEN sum4=sum4+1
sum3=sum3+term3

READ digit,term4
sum4=sum4+term4
RETURN
                                               'If pin 6 is tied high at power-up then the digits can
                                               'be entered in the debug window or using hyperterminal.
button_detect:                                 'This is the subroutine that aquires the digit values from
                                               'a standard 4x4 keypad.  This is done using 8 I/O lines,
 IF IN6=1 THEN GOTO hyperterminal              'pins 8 thru 15 on the stamp.  8 thru 11 corresponds with
                                               '"C" nibble (predefined by the basic stamp) and are wired
 DIRC=%1111                                    'to the corresponding "Rows" on the keypad. Row 1 being port
 DIRD=%0000                                    'C's LSB. 12 thru 15 correspond with the "D" nibble and are
 OUTC=%1111                                    'wired to the "columns".
                                               '
 Waiting_for_button_press:                     '   Two important notes:
                                               '1) Pull down resistors are required on pins 8 thru 15 and
 IF IND=0 THEN GOTO Waiting_for_button_press   '   on pin 6.
                                               '2) When entering frequencies using a terminal, I found it
  find_digit:                                  '   easiest to just use the Basic Stamp software's debug window.
                                               '   If hyperterminal is to be used then the special cable
                                               '   used for stamp programming CAN NOT be used.  Only use
  row=IND                                      '   the 3 standard wires, TX, RX, GND.  No "loopback" wires
  OUTC=%0000                                   '   were needed in my testing.
  DIRC=%0000
  DIRD=%1111
  OUTD=%1111

  IF row=2 THEN GOTO column_row2
  IF row=4 THEN GOTO column_row3
  IF row=8 THEN GOTO column_row4

  IF INC=1 THEN digit="1"
  IF INC=2 THEN digit="2"
  IF INC=4 THEN digit="3"
  IF INC=8 THEN digit="a"
  GOTO loop1

  column_row2:

  IF INC=1 THEN digit="4"
```



```
IF INC=2 THEN digit="5"
IF INC=4 THEN digit="6"
IF INC=8 THEN digit="b"
GOTO loop1

column_row3:

IF INC=1 THEN digit="7"
IF INC=2 THEN digit="8"
IF INC=4 THEN digit="9"
IF INC=8 THEN digit="c"
GOTO loop1

column_row4:

IF INC=1 THEN digit="*"
IF INC=2 THEN digit="0"
IF INC=4 THEN digit="#"
IF INC=8 THEN digit="d"

loop1:
PAUSE 100
IF digit="#" AND INC=0 THEN GOTO start      ' If a "#" is entered the program accepts the frequency entry and
IF digit<>"#" AND INC=0 THEN RETURN         ' loads it, disregarding the remaining decimal places or "trailing zeros".
GOTO loop1                                  ' It works like an "enter" key for the keypad.  For example, if I
                                            ' were to load a frequency of 1.160MHz I could enter "0116#"

hyperterminal:

DEBUGIN digit                               ' If pin 6 is high the frequency is entered in through the serial
IF digit=CR THEN GOTO start                 ' port.  This section takes care of that.  The frequency can be
RETURN                                      ' entered without all the trailing zeros by simply hitting the
                                            ' "Enter" key.  Like with the keypad, all leading zeros MUST be
                                            ' entered.
```

AmQRP.ORG HOMEBREWER

Dave Ek, NKØE

Elmer 102: The Wilderness Sierra

Recently, I decided it was time to build myself a Wilderness Sierra transceiver. Its purpose would be to become my main rig for backpacking and other portable adventures (including Field Day, of course) and, of course, to provide me some entertainment in constructing it. What follows is the result of this little expedition.

Introduction

The recent Elmer 101 series on the Small Wonder Labs SW+40 was met with critical acclaim by the members of the Internet QRP Club. I personally learned most of what I know about ham radio transceivers from the experience of building the SW+40 while following the step-by-step instructions and analysis which was part of Elmer 101. Numerous subscribers to QRP-L are indebted to the authors of Elmer 101 for providing such an excellent learning experience.

Recently, I decided it was time to build myself a Wilderness Sierra transceiver. Its purpose would be to become my main rig for backpacking and other portable adventures (including Field Day, of course) and, of course, to provide me some entertainment in constructing it. After all, where's the fun in operating a rig you didn't build? But to make this even more fun, I thought I'd conduct my own Elmer session and see if I couldn't teach myself a few new things while I built this rig. What follows is the result of this little expedition.

I make no claims to be a design engineer, and it's not likely that skilled electronics designers in the audience will learn much from my experience. However, if you're still learning, like me, then perhaps you'll find this narrative informative and entertaining. You might note a resemblance to Elmer 101 in organization and style; be assured that this is no coincidence. After all, imitation is the most sincere form of flattery!

Please note that I'll refer frequently to the assembly and operating manual for the Sierra, rather than repeat what's in it. It's not my intent at all to replace what is already a fine manual provided by Wilderness Radio. My intent is only to supplement it with a "build a little, test a little" approach for assembly. Be sure to read through the Wilderness manual prior to beginning your construction.

Step 1: Jacks, Controls, and Panels

I chose to begin building by mounting and soldering all the jacks and controls which support the front and rear panels. That way, once I installed the panels themselves they would serve as a convenient support for the PC board during installation and soldering of the parts. This is the same way that the NorCal 20 is constructed.

Start with "Jumpers" on page 13 of the manual. Install the bare wire in the "G" holes in the first step, and solder. Skip over installation of W1 and W2 and jump straight to "Controls and Connectors". Follow the instructions there to install C54 (the main tuning capacitor). Continue through the manual to install J1, J2, J3, J4, R1, R17, R18, S1, and S2. Skip the One Last Look section for now (it's a bit premature, eh?). Complete the parts of "Chassis Assembly" on page 14 up through the first step on page 15. When you've completed these steps, you should have all panel-mount jacks and controls installed, and the front and rear panels installed. The panels now hold the board conveniently for soldering.

If you'd like, you can continue through this section by installing all the knobs and the tuning dial. I favor this approach personally because it's easier to handle the controls during testing steps if the knobs are in place. On the other hand, you can certainly defer this until later if you'd prefer. You can also install the latches and feet on the top and bottom covers at this time, but don't assemble the covers on the radio yet. We have a bit of soldering to do first.

Step 2: Voltage Regulation

Install the following components: U9, D6, C44

These three components are responsible for supplying the rig with a regulated 8V supply. Voltage regulation is important for oscillator stability, and the 8V regulated supply feeds several circuits in the Sierra. U9 is the actual voltage regulator IC. Its job is to take an input voltage between 10.5V and 23V and output a constant, regulated 8V. D6 will only conduct current if the power supply is connected with the correct polarity. This is to protect your rig in case you hook up the battery backwards. The purpose of C44 is to provide some prefiltering of the input voltage. It supplies a path to ground for any AC component of the supply voltage. It's worth noting that the output of the voltage regulator is also usually tied to ground with a capacitor for the same reason. In the Sierra, you'll see many instances of this at various points in the circuit.

Now, making sure that the power switch (back panel) is off, connect a 13.8V supply through J3. Get out your voltmeter and connect the ground to the ground jumper installed in step 1. Turn on S2 and use your voltmeter's positive probe to check the voltage into D6 (at the non-banded end). It should be the same as the supply voltage. Now check the voltage at the other end of D6. It will read about 0.25V below the supply voltage. Typical diodes have a voltage drop of about 0.6V, but D6 is a Schottky diode. Schottky diodes have a metal-semiconductor junction instead of the usual PN junction and have a smaller voltage drop across the junction.

Why would we want the voltage drop across this diode to be as small as possible? (Hint: the supply voltage, not the regulated voltage, is used to drive the PA transistor.)

Next, measure the voltage at the output of U9 (the lead closest to the front panel). You should read approximately 8V. If not, check the input (the lead closest to the back) to see if you are getting about 13.5V. If you have troubles with this part of the circuit, the best way to trace the problem is to find the point at which you no longer have the voltage you would expect. Possible problems are incorrect installation of D6 or U9, or a bad solder joint or solder bridge.

Step 3: The VFO

The variable frequency oscillator (VFO) is the heart of the frequency selection circuit in the Sierra. Variable capacitor C54 is used to vary the capacitance of the Colpitts oscillator circuit, and with it the oscillator frequency. Later, the output of the VFO is mixed with other oscillator frequencies to produce useful frequencies for transmitting and receiving signals.

This is pretty-much a classic series-tuned Colpitts oscillator. The ARRL Handbook and W1FB's Design Notebook both discuss this circuit, and none of that discussion is repeated here. It's worth noting, however, that it's fairly easy to calculate the approximate oscillator frequency of this circuit using

$$f = \frac{1}{2 \pi \sqrt{LC}}$$

where f will be given in Hz if L is in henries and C is in farads. There is only one inductor in the oscillator, L7, whose value is about 19 mH. There are six capacitors. C52, C53, and C54 are in parallel and an equivalent capacitance can be found by simply adding their capacitances. For the moment, let's assume that C52 and C54 are in their fully-meshed configurations, so that they have their highest capacitance values (24 and 40 pF, respectively). The equivalent capacitance of C52, C53, and C54 is then 244 pF. Combining this equivalent capacitance with C56, C57, and C58 in series gives the total capacitance for the oscillator of about 166 pF (remember that capacitors in series combine like resistors in parallel, and vice versa). Given that L is 19 mH and C is 166 pF, solving for f in the equation above gives 2.833305 MHz, which is right in the ballpark of what we would expect.

To construct the VFO section, install the following parts:

L7 (follow the instructions on page 13 of the manual)
C52 (follow the instructions for C52 on page 11 of the manual)
C53
C56, C57, C58 (these are the polystyrene capacitors--follow the instructions on page 9 of the manual)
C60
R19 (it can be installed either way)
R38

RFC3
D9
Q3

When you've installed all the parts, you can use an oscilloscope to examine the VFO signal. A good test point is the hole labeled "V" between C57 and C58 on the board. For my Sierra, I saw a very nice sine wave with an amplitude of about 2.5V peak-to-peak. I also used my commercial rig to tune in the VFO signal when both C52 and C54 were fully meshed (this works best if you use a short wire as an antenna and lay it alongside the Sierra). Mine came out at 2.8825 MHz. Why is it not 2.833305 MHz, like I calculated above?

Incidentally, using a commercial rig is a very convenient way to detect the expected signals in the transmit section of your Sierra. Often you'll need to run your makeshift antenna very near the part of the circuit under scrutiny. But DON'T connect the Sierra directly to the antenna of your commercial rig. Just put your antenna in proximity to the circuit. Simply zero-beat the signal in your commercial rig to determine the frequency.

We're not going to bother adjusting C52 yet, because the addition of the RIT circuit will affect the output frequency of the VFO. But feel free to monkey around with C52 and note its affect on the oscillator frequency. Try to predict what will happen, for example, if you reduce the capacitance of C52.

Step 4: The Pre-Mix Oscillator

n this step we'll assemble and test the components which make up the pre-mix oscillator (PMO). Much of this portion of the circuit resides on the Sierra's plug-in band module for each band. We'll begin with the band module for 40m.

Since the Sierra is a multiband rig, in order for the incoming signal (whose frequency varies by band, of course) to mix with the VFO frequency to form the IF frequency (which is always the same, regardless of band), the VFO frequency must be changed for each band. Rather than create a separate VFO for each band, we use a single VFO and mix it with the signal from a separate oscillator to create a signal of the desired frequency. This separate oscillator is the PMO.

Let's look at an example on the 40m band. Let's say we want to tune in a signal which is at 7.040 MHz. Since the Sierra's IF is 4.915 MHz, we need to mix the incoming signal with another having a frequency of either 2.125 MHz (7.040 – 4.915 MHz) or 11.955 MHz (7.040 + 4.915 MHz). In the Sierra, an 11.955-MHz signal will be supplied by the output of the PMO. In order to make the 11.955-Mhz signal, the PMO will mix the signal from the VFO (3.045 MHz) with the PMO's own oscillator (for 40m, this is a 15-MHz signal).

Now for a signal on 20m, say 14.040 MHz, we'll need an output of 18.955 MHz from the PMO to move our incoming signal to the IF. In this case, the PMO provides its own oscillator signal of 22 MHz, but everything else works the same as before.

You've probably guessed by now that the PMO's internal oscillator frequency is determined by parts which reside on the band module. This is indeed true—crystal X8 and variable capacitor C70 determine the internal oscillator frequency of the PMO. X8 determines the frequency, while C70 is used to fine-adjust the frequency slightly (pulling the frequency of the crystal).

The real heart of the PMO, of course, is the NE602 mixer chip. X8 and C70, along with the feedback network formed by C68 and C69, drive the frequency of the NE602's internal oscillator. The input from the VFO is sent through C59, which filters any DC component, and then through the low-pass filter formed by R22 and C61 to reduce the harmonics from the VFO. The NE602 mixes its internal oscillator signal with that from the VFO to get an output signal (actually several output signals—sums and differences of the two inputs and their harmonics).

The output of the NE602 is taken from pin 5, fed through isolation capacitor C63, and then through two parallel tank circuits formed by C64 and L8, and C66 and L9. These two tank circuits act as a bandpass filter to remove all but the desired PMO output frequency. C64 and C66 are trimmer capacitors and will be adjusted so that the bandpass of the filter is at the desired frequency (you can easily calculate the bandpass of the filter given its capacitance and inductance using the same formula that we used in step three to calculate the VFO frequency). Note that the bandpass filter is also located on the band module.

After passing through the bandpass filter, the oscillator signal arrives at Q2, which along with R23 and R24 forms a common-drain amplifier circuit. This amplifier has a high input impedance and low output impedance and probably serves to provide the proper impedance to downstream circuits. It also helps to isolate the PMO circuit from other circuits in the Sierra.

Let's build the circuit. First, install the following parts onto the main board of the Sierra:

C59, C61, C62, C63, C68, C69, C72
R9, R22, R23, R24
Q2
U7

Now install the following parts onto the 40m band module board. Pay special attention to the Band Module Assembly instructions beginning on page 16 of the manual:

X8
C64, C65, C66, C70
L8, L9

Plug the band module into the Sierra and apply power. Using a commercial receiver, look for the PMO oscillator signal around 15 MHz. Once you find it, use a tuning tool to adjust C50. Note how the oscillator frequency changes as you adjust C70. Next, tune your commercial receiver to about 12 MHz and search for the PMO output signal. Once you've found it, note how you can affect the amplitude of the signal by adjusting C64 and C66, the trimmer caps in the bandpass filter. Adjust these two caps as best as you can for maximum amplitude.

Finally, you should be able to verify that the PMO output frequency plus the VFO frequency is equal to the frequency of the internal PMO oscillator (15 MHz for the 40m module).

Step 5: The Transmit Switch and Transmit Mixer

We begin this step by adding the components which turn on the transmitter when the key is pressed. Q4, a 2N4126 PNP transistor, conducts when the keyline is taken to ground. When the keyline is grounded, current flows through R12C and R12D. The voltage drop across R12C makes the emitter more positive than the base, and this causes the transistor to conduct. Once the transistor is conducting, it can supply 8V at its collector to other parts of the circuit. Indeed, this line feeds U8, turning it on when when the key is pressed.

The rest of the circuit in this step will remind you of the PMO circuit in step 4. The transmit mixer consists of another NE602 mixer chip (U8), the components which make up the NE602 internal oscillator, another bandpass filter, and the transmit buffer transistor. Components C38, X7, RFC4, and C39 determine the frequency of the NE602 internal oscillator. C38 is used to tweak the frequency of the oscillator to fine-tune the transmit offset. The frequency of this oscillator is 4.915 MHz. Remember that, in the last step, our PMO output for the 40m band module was 11.915 when the VFO was at 3.085 MHz. In the transmit mixer we mix the PMO output and the internal oscillator output and take the difference of the two, which in this example turns out to be 7.000 MHz. This is the beginnings of our transmitted signal.

The bandpass filter at the output of U8 resides on the band module and is very much like that of the PMO. You might notice, however, that there are extra capacitors in parallel with the trimmer caps. Why? The simple answer is to increase the capacitance of the tank circuits making up the bandpass filter. Increasing the capacitance has the effect of lowering the resonant frequency of the filter. One could also have taken the approach of increasing the inductance of L3 and L4 or, I suppose, changing the trimmer caps to larger values. I suspect that the extra capacitor was cheaper and easier to find than a larger trimmer cap. If you wind L3 and L4 for yourself (36 turns on a small core) you'll find that you'd be hard pressed to get more turns on the core to increase its inductance, and there isn't room on the module for a larger core. So, adding the extra capacitor is the easy way to get the right bandpass.

The remaining part of the circuit consists of Q5, along with R11, R37, C82, and L11. These parts make up the buffer between the transmit mixer and the driver stage. The purpose of the buffer is to isolate the transmit mixer from the effects of successive stages. Like Q2 in the PMO, this amplifier has a high input impedance and low output impedance and probably serves to provide the proper impedance to downstream circuits.
To construct this circuit, first install the following parts on the main circuit board:

C29, C30, C31, C38, C39, C40, C42, C50, C82
D5
Q4, Q5

R11, R12, R37
RFC4
X7
U8
L11

Now connect a key to the Sierra and apply power. Use your DMM to measure the voltage at the collector of Q4. It should read 0V with the key up and about 8V with the key down. Now, hold the key down and try to tune in U8's oscillator at 4.915 MHz on a commercial transceiver. Once you find it, adjust C38 and note how the frequency changes. Note too, that the signal disappears when you let the key up. So far, so good.

Now, install the following parts on the band module: C32, C33, C34, C35, C36, L3, L4

Now plug in the band module and apply power again. With the key down, use your commercial transceiver again to try to find the 4.915-MHz signal. If you have trouble, try adjusting C32 and C36. Once you find it, adjust those two trimmer caps for maximum amplitude. Now see if you can find your 7-MHz signal in your commercial transceiver. This may take a bit of hunting unless you've calibrated your VFO and PMO already. Once you find it, adjust C32 and C36 again for maximum amplitude. If you have trouble finding the signal, try tweaking C32 and C36 a bit. I had a hard time finding the signal until a did a bit of adjusting of these trimmer caps.

Step 6: The Driver and Keyline Buffer

The driver section of the Sierra's transmitter provides the first real gain for the transmitted signal. Q6 provides amplification of the output of the transmit mixer for the final stage, the power amplifier. The keyline buffer section, made up of Q8 and Q9, turn on the driver stage when the transmitter is keyed, and at the same time they isolate the driver section from other parts of the radio which are keyed by the keyline.

Let's start with the keyline buffer circuit. MOSFET transistors Q8 and Q9 have the characteristic of turning on when the voltage at the gate is about 2.5 V greater than the voltage at the source. When they are on (conducting from drain to source) the resistance from drain to source is very low, on the order of a few ohms. Thus, these transistors make an easy-to-control switch, and this is exactly what they're used for in this circuit. When the transmitter is not keyed, there is no path to ground for current which would come from the 8V supply and pass through resistor R12B. Thus, the gate voltage is 8V, and Q9 is turned on. Current flows from drain to source in Q9, and nearly all of the 8V supply is dropped through R12A. This means that the gate voltage at Q8 is essentially zero, and Q8 is turned off. This isolates the driver Q6 from DC ground and essentially keeps it turned off because the emitter voltage is essentially the same as the collector voltage (8V), and is higher than the base voltage.

What happens when we press the key? Now current can flow through R12B, and the gate voltage of Q9 goes to zero, turning off Q9. Since current no longer flows from drain to source in Q9, the voltage at the drain of Q9 is now 8V. This, of course, means that the gate voltage of Q8 is now 8V, and Q8 is turned on. Now, since current can flow from drain to source in Q8, this allows Q6 to turn on and start amplifying the signal coming from the transmit mixer.

I think that the driver circuit is basically a common emitter amplifier. I'm not going to take a shot at detailed analysis of this amplifier, but a few things are easy to say. First, the operation of the trimpot drive adjustment is simple: if you increase the resistance which it presents to the circuit, more of the voltage drop will appear across it and less will appear in R13, R18, and T2, causing the output voltage through T2 to change. T2 itself is responsible for the power transfer from the driver section to the PA.
Time to build. Install the following parts on the main board:

D10
Q6 (don't forget the ferrite bead—see the manual for instructions), Q8, Q9
C51, C55, C71
R13, R14, R15, R18
T2

Plug in your band module and apply power. If you have an oscilloscope or an RF probe, connect it at the location on the main board of the base of Q7 (which hasn't been installed yet) and check for a 7-MHz signal on key down. The Sierra manual says to expect about 680 mV RMS at this location, but that will vary with the drive control setting, supply voltage, etc.

Step 7: The RX Bandpass Filter and Mixer

We're going to switch over now and work on the receiver for a while, starting with the point at which the signal enters the receiver from the antenna. It first encounters a bandpass filter made up of C1 and L1, located on the band module. Past that point is the RF gain control, simply a potentiometer which can be used to limit the amount of received signal which gets passed on to the receive mixer. Next is transformer T1, which transforms the impedance to whatever is being expected by the receive mixer. Trimmer cap C2 works with the secondary of T1 to form yet another band pass filter (note that T1 and C2 are both on the band module).

Finally, we arrive at the receive mixer U2. It's going to mix the received signal with the output from the PMO to generate a signal at the IF. For 40m, if we want to tune a 7.040 MHz signal, our VFO will need to be tuned so that the PMO output is (7.040 + 4.915 MHz) or 11.955 MHz.

One other item worth noting is the function of Q1. Q1 gets turned on (conducts) when the transmitter is keyed, because 8V is then applied at its base. This disrupts the Q of the tuned circuit made up of C1 and L1and provides a path to ground for the lion's share of the transmitted signal which would otherwise enter (and possibly fry) the receiver.

On to construction. Install the following parts on the band module: C1, C2, L1, T1

Now install the following parts on the main board: R2, R25, C3, C4, C5, C24, C46, U2

Next, prepare and install jumpers W1 and W2 per the instructions on page 13 of the manual. NOTE: INSTALLATION OF W1 AND W2 WILL MAKE INSTALLATION OF OTHER PARTS IN THE SAME VICINITY MORE CHALLENGING. As an alternative, you might try installing a temporary jumper between the W1 and W2 holes which are very near the band module. Or, you might use simple jumper wires temporarily tack-soldered instead of the RG-174 coax. (Okay, I admit it, I installed W1 and W2 without realizing what I was getting myself into.)

Finally, install a temporary jumper between the base and collector holes of Q7 (which we haven't installed yet). This allows us to steal some transmitted signal as a source for the receiver during testing.
Plug in the band module, apply power, and attach a scope or RF probe at the point on the board labeled "RX". Next, key the transmitter and begin adjusting C1 and C2 for a maximum amplitude. This results in the two bandpass filters being tuned for resonance in the 40m band.

Step 8: The Crystal IF Filter, ABX, and IF Amplifier

In this step we install and test the variable-bandwidth crystal IF filter and the IF amplifier. The IF filter is made up of X1 through X4, D13 through D15, R19B through R19D, and R31. D13 through D15 are varactor diodes, which act as variable capacitors. R31 is used to vary the voltage on these varactor diodes, which are reversed biased so as not to conduct current. As the voltage across them is varied, their capacitance varies as well. You might be accustomed to seeing crystal ladder filters like this in other radios. The capacitance of the capacitors between the crystal elements has an effect on the bandwidth of the filter. Using varactor diodes in place of capacitors allows us to vary the bandwidth of the filter simply by changing the bias voltage on the diodes.

C73 and RFC1, and C74 and RFC2, are L-networks used to match the impedance of the output of U2 with the crystal ladder filter, and then to match the crystal ladder filter impedance with the input to U5. C6 and C10 are probably there to modify the series-resonant frequency of X1 and X4 to fine-tune the filter performance.

The MC1350 (U5) provides amplification of the IF signal prior to injection into the product detector. X5, C12, C14, and D4 provide a bandpass filter at the output of U5. According to the manual, this is to clean up wide-band noise at the output of U5, which I speculate is the product of the amplifier itself.

This time all the parts are installed on the main board:

C6, C7, C8, C10, C11, C12, C13, C14, C73, C74, C76
D4, D13, D14, D15
L2
RFC1, RFC2
R10, R26, R31, R32
U5
X1, X2, X3, X4, X5

Plug in the band module and apply power. For this step, you'll need an RF probe or an oscilloscope. With the key down, repeak C1 and C2 for maximum amplitude at pin 5 of U2. Next, adjust the ABX trimmer pot for maximum amplitude at pin 4 of U5 to verify that you're getting a signal through the ladder filter. Finally, examine the signal at the location of pin 1 of U4. The signal should be considerably stronger here than at pin 4 of U5 (due to U5's amplification).

If you don't have an RF probe (cheap) or an oscilloscope (not cheap), you can still verify that things are working more-or-less correctly by checking DC voltage measurements against the table on page 30 of the manual.

Step 9: The Product Detector, AGC, and AF Amplifier

In this step we finish up the Sierra's receiver. We start with the product detector, which is U4, the NE602 mixer again. It mixes the 4.915-MHz IF signal with it's own oscillator signal which is different from the IF frequency by an amount equal to about 600 Hz (adjustable using trimmer cap C16). X6, along with C16, C17, and RFC5, make up the components which determine the frequency of U4's internal oscillator. C9 and C83 serve to filter the 8V supply for U4 and U1.

Q10 and Q11 make up a mute circuit, cutting off the audio out when the transmitter is keyed. Q10 and Q11 conduct under when the transmitter is not keyed because their gates are at the same or higher potential than their sources. This is because the keyline is held at 8V when receiving and is grounded during key down. When the key is pressed, there is a large negative voltage difference from gate to source, and the JFETs are cut off. This prevents signal from reaching the AF amp from the output of the product detector.

U3 is an LM386 audio amplifier chip and provides the final amplification for the receiver signal. The output is fed through R8, the AF gain pot, to the headphones. According to the manual, C37 and R4 help to give the amplifier a peak response around 600 Hz.

Part of the output is fed to the AGC circuit made up of half of U1, R3, R5, R20, R21, C22, C26, C76, and D1. U1A is an op-amp configured as a unity-gain voltage follower (or buffer) to isolate the AF amp circuit from the IF amplifier which it feeds. R3 sets the DC no-signal voltage level. Loud audio signals from the AF amplifier increase this voltage, ultimately causing more current to flow from the output of U1A to the AGC input of the IF amp. This causes the gain of the IF amp to be reduced to keep the overall audio output pleasant in volume. R5 and C26 affect the recovery time of the AGC circuit during loud transients.

Let's construct the rest of the receiver. First, install L5 and L6 on the band module, along with C47, C48, and C49. These parts make up the low-pass filter at the output of the transmitter, and received signals also pass through the filter from the antenna to the receiver.

Next, install the following parts on the main board:

R3, R4, R5, R10, R20, R21, R27, R28, R30

C9, C15, C16, C17, C18, C19, C20, C21, C22, C23, C25, C26, C28, C37, C83
D1, D2
RFC5
X6
U1, U3, U4
Q10, Q11

Whew! That's a lot of parts. Now, plug in the band module, attach a good external antenna, plug in your headphones, and apply power. You should hear some band noise in your phones. Re-peak C1 and C2 on the band module for maximum audio in your headphones. Set the AGC trimmer pot to about midway, and set the ABX pot full counterclockwise (maximum bandwidth). Now plug in a key and key down the transmitter. Does the receiver mute? It should, as long as the key is held down. Tune around the band for some signals. Here something? Congratulations! You have a working receiver! Play around with the AGC and ABX pots if you'd like. We'll save final adjustments until we get the entire rig built.

Step 10: The Sidetone Oscillator

We're nearing the end. In this step we construct the sidetone oscillator. Not much to say about this circuit. The other half of U1 is configured as an audio oscillator with a pitch of about 600 Hz. Trimmer pot R29 sets the volume of the sidetone. The sidetone signal gets injected into the input of the audio amp U3 during transmit. The sidetone oscillator is turned on when the keyline is grounded.

Install the following parts on the main board: R6, R7, C27, C41, C78, D3

That's it. Plug in the band module and key, set R29 all the way clockwise, set the AF gain about halfway, apply power, and key the rig. Here the sidetone?

Step 11: RIT

Again, not too much work is needed to add the RIT. The key component in the RIT circuit is D8, another varactor diode. Its purpose is to vary the capacitance of the oscillator slightly to change its frequency a bit for the RIT action. R33 and R34 form a voltage divider along with either R16 or R17, depending upon whether the RIT is on or off.

U6 is an LM393 dual voltage comparator. It's used to switch between R16 and R17, depending upon the position of the RIT switch. A voltage comparator works by comparing the voltage at the + input to the voltage at the – (or reference) input. If the + voltage exceeds the reference voltage, the output of the comparator will be high (about equal to its supply voltage). Otherwise, its output voltage will be low (ground).

Let's look at how the RIT behaves when switched off. In this case, 8V is presented to the + input of the comparator driving R17, and 3V is present as the reference voltage. This causes the comparator output to be high, at the same voltage as the other side of R17, and no current flows through R17. For the other comparator, the inputs are reversed, and the output is low. This allows current to flow through R16 and it becomes the contributing resistor to the voltage divider controlling the voltage across D8.

What about when the RIT is on? First, note that with the RIT on and the key down, the comparators behave just like the case when the RIT is off. This is good, because we only want the receive frequency to change. On the other hand, when the key is up, a zero voltage is present at the + input of the comparator for R17, and its output goes low so R17 conducts. R16 is now taken out of the circuit because its comparator's output is high. Now we can control the frequency of the receiver using R17.

By the way, the reason we waited so long to install the RIT was because it steals a 3V level from the IF amp, U5, which we didn't install until after we built the VFO and most of the transmitter.

Finally C77 is present to "swamp the output capacitance of U6," according to the manual. Without it, varying R17 would vary the frequency slightly even with the RIT off.
To construct the RIT circuit, install the following components on the main board: C77, R16, R17, R33, R34, D8, U6

Install a band module, attach a good antenna, apply power, and find a signal. Switch your RIT in and vary R17. Do you hear the signal changing pitch?

Step 12: The Transmit Power Amplifier

This is the final construction step. All that's left is to install the parts which make up the final amplifier for the transmitter. The power amplifier is Q7, a 2N3553 transistor. D7 is a zener diode which is in place to protect Q7 in case of less-than-optimal SWR.

L10 is often the subject of modification for Sierra owners in an attempt to eke more power out of the transmitter. L10 is often replaced with a transformer consisting of the same core with 12 bifilar turns. Once the turns are wound, the beginning of one winding is connected to the end of the other to form a center tap. This center tap is then attached to the collector of Q7, while the other ends are attached to 12V (like L10 is) and C46 (the lead of C46 which would otherwise connect to the collector of Q7 needs to be lifted and disconnected from the collector, and then connected directly to the newly-made transformer). The result of this is a better impedance match to the output low-pass filter.

Some builders also replaced the 2N3553 with other devices, such as the MRF237, MRF477, RCA SK9618, NTE342, or 2SC799. I personally did both the L10 mod and replaced the final with a 2SC799 and this resulted in 4W output on 40m using a 12.75V supply. I expect that this will increase with a higher supply voltage. In fact, the manual specifically mentions that the easiest way to get more power is to increase the supply voltage (up to 16V).

There are other mods which have been published or suggested. One is to replace the caps in the band modules with silver mica caps, but N6KR contends that there is little value in this. Others have modified the low-pass filter by taking a turn off one of the inductors. This does result in increased power as measured by the wattmeter, but no one to my knowledge has verified with a spectrum analyzer that the increased power is at the primary frequency and not an unwanted harmonic.

Now to build. Install the following parts on the main board: C45, D7, L10, Q7

That's it. At this point, you'll want to go through the complete alignment procedure beginning on page 19 of the manual. I used both an RF probe and a commercial rig to do these steps. The RF probe is very useful for peaking the filters, while the commercial rig is good for making certain your oscillators on the right frequencies.

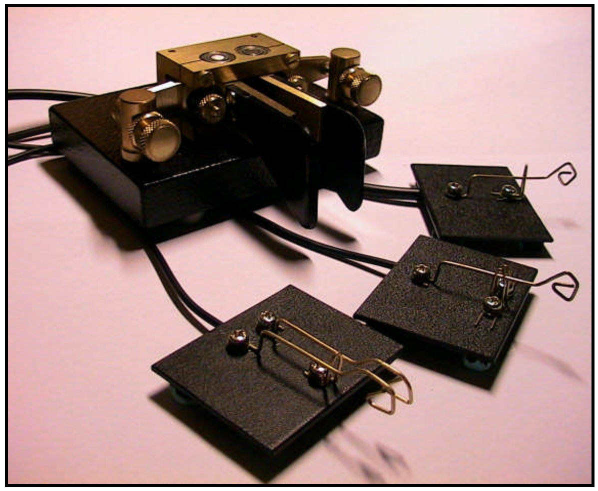
If you find that things aren't working the way you think they should, make sure you check out the troubleshooting section of the manual (page 29). The section on signal tracing can be very useful in localizing problems. Also, the table on page 30 shows the DC voltages at every pin of every active device in the radio. It's another good source of troubleshooting information.

AmQRP.ORG HOMEBREWER

Verner Blindheim

The "Clipper" Paddles

This "adventure" started when one guy talked on QRP-L about the "Ultimate Simple Lowcost Homebrew Portable Paddle". I started to think about the criteria for such a paddle and decided to make an attempt to design one.

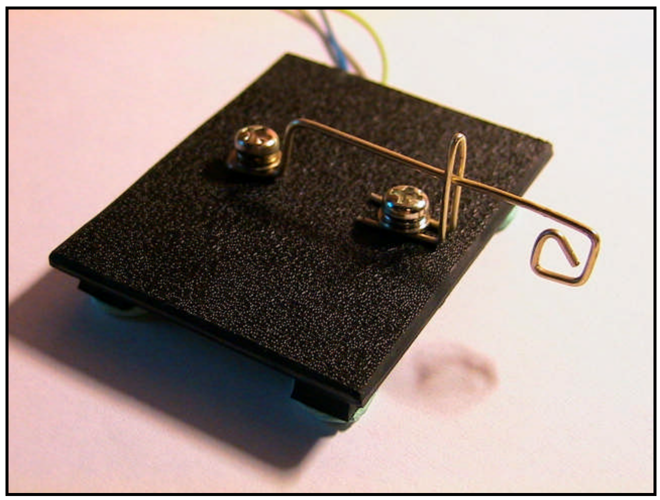


Clippers in front of my Kent paddle

Could this be the *Ultimate Simple Lowcost Homebrew Portable Paddle* ?

I am not a licensed ham yet but practicing morse. So I thought it would be nice to design a simple single lever paddle to take on my boat or on camping trips. I wanted this design to be the "Ultimate Simple Lowcost Homebrew Portable Paddle".

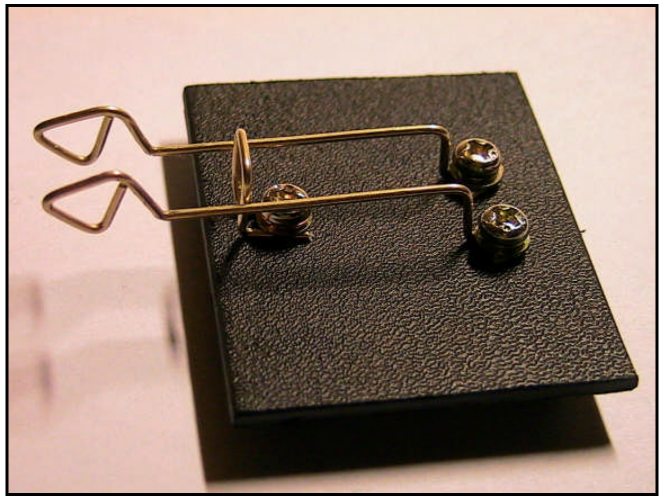
But to find building material that anyone would find was very difficult. One of the goals was to use material that would be available to many people at little or no cost. I made several attempts with different material. I kept simplifying the design. I tried to use pianowire used for model building, but later used small wires from inside an umbrella. This again led to the paper clips, and the "Clipper" was born. After the first single lever paddle I made a sideswiper and completed the series with the dual paddle.



Clipper SS

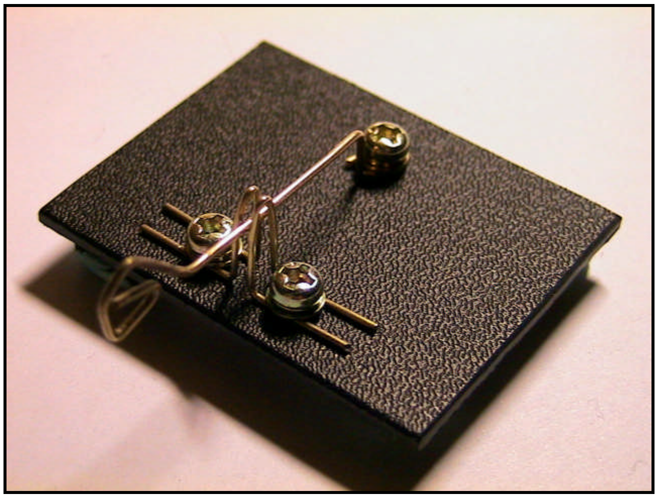
Sideswiper, double speed key or cootie key, single fixed contact point. Paddle runs inside contact point. Made of two small paperclips.

First of all: If you normally slap your paddles all over your desk, then look elsewhere. These paddles need finger tip control and a light touch. And because they are so small they can be difficult to operate if your fingers and hands are big.



Clipper DP

Dual Paddle, single fixed contact point.
Made of three small paperclips.



Clipper SP

Single Paddle, two adjustable contact points.
Made of three small paperclips.

General

All the paddles must have some kind of rigid base. Plastic, plywood or something like that. Thicker wood can be used but then you may have to attach the wires on top of the base and that is not as neat. It could be mounted on a conductive base but then some parts must be isolated from the base.

It is could also be possible to mount the paddle inside or on a base that could be held in one hand and operated with the thumb and index finger of the same hand, for single hand pedestrian operation.

If you are going to use the paddle on a desk it must either be fixed to the desk or as I prefer, stuck on using "blue tack". ("Blue tack" or "poster gum" or what ever it is called, is a chewing gum like substance that can be used to stick things to almost any non-greasy surface. I get it from book or office supply stores.)

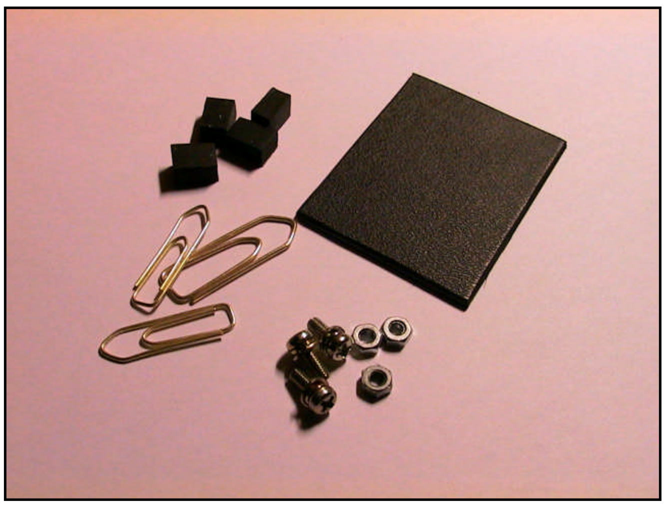
Some form of legs/pads must be used to get some clearance for the screws/nuts and wires on the underside of the base.

Parts

1. **Base**
   Plastic or plywood. Suitable plastic can be found as panels in old monitors, printers, tv's and other electrical equipment with flat surfaces. It needs to be about 3 mm thick.

2. **Paper Clips**
   For all paddles/handles I use 30mm long paperclips with brass look (Golden). The wire is 1mm thick.

   For the contacts on the SS and SP I use parts of 25mm paperclips. These wires are 0.8mm thick. The DP has one single contact point made of 1mm thick wire from an 30mm paperclip.



   Some of the wire I tried had very bad contact ability. So keep in mind that not all wires makes good contact when used for some time. I have tried different types of wire but found that this type of clips made the best contact, at least good for heavy use for several weeks.

   My paperclips are marked "Swedish TOP GEM CLIPS BINDERS."

3. **Screws/Nuts**
   I use screws from old electronic equipment, usually used to hold down the circuit boards. They have a nice golden colour tone and look good with the golden paperclips. On the underside of the base I use nuts from my local hardware store.

4. **Feet**
   I use feet from old keyboards, monitor stands, TV's and so on. Go through your junk boxes and I'm sure you'll find something. I cut the feet to about 6x6mm. The feet

does not need to be rubber because we need to use "Blue Tack" to fix the paddles to the desk anyway.

5. **Cable**
   Cables with plugs can be found on old walkman style headphones. Even new headphones / ear buds for a couple of dollars is often cheaper than getting a cable and plug separately. Check your "one dollar" store. Or maybe you can use the cable from an old computer mouse and attach a new plug. I now prefer to buy extension cable with a plug at each end. They are cheap and light and saves soldering the plug.

Building

Bases

<u>Clipper SS</u>

Cut out the base. I used 50x40mm but you can go much smaller. Drill two holes at the shortest centre line. The holes need to be about 20-25mm apart. The size need to fit the screws you are using. I use 3 mm holes and M3 screws.

<u>Clipper SP and DP</u>

Same dimensions as the SS, but three holes. Same distance between the holes on front/back, but the two holes on the same side need about 10-15mm between them. This spacing also adjusts the width between the paddles on the DP. These two holes are for the contacts on the SP and for the paddles on the DP. You can convert between the to paddle types in a matter of minutes. And remember: The SP can be used as a sideswiper by connecting the contacts together.

Paddles

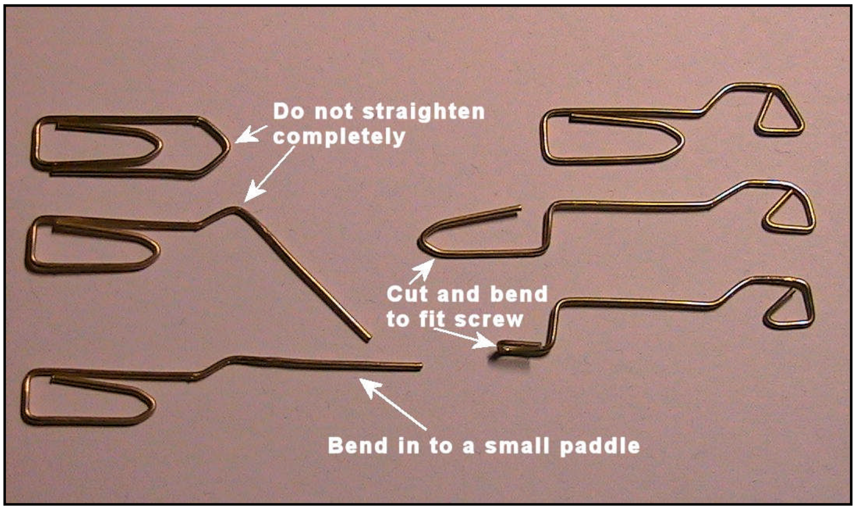
All paddles are the same, made the same way. But you may use thin or thick paperclips as you prefer. I use thick (1.mm) wire for all my paddles.

Start with a 30mm clip and straighten it like the photo. I use needle nose pliers for that. Try not to make marks on the wire. Be gentle while bending, Try to do it in several small stages to "ease" the bend out of the wire.

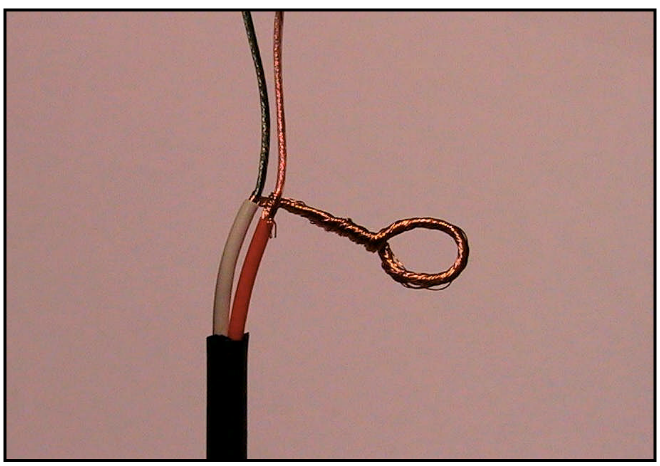
It is important not to take out the sharpest bend completely because you will weeken the wire and it can break at that point.

Preparing the Cable

The cables can be attached to the screws by some means of cable terminals, but I just make loops on the wire by folding the bare wire over itself to make a bend. Then twist the bend to form a nice small loop which I then solder to get a nice solid loop to fit the screw. This step saves a lot of time when adjusting because the wire doesn't fall off as it would if you try to just tuck the wires under the nuts.



In stead of using cable clamps to hold the wire against the base, just use a drop of glue. This is more than enough to support the paddles because the weight of the paddles are only about 10-20 grams without the cable.



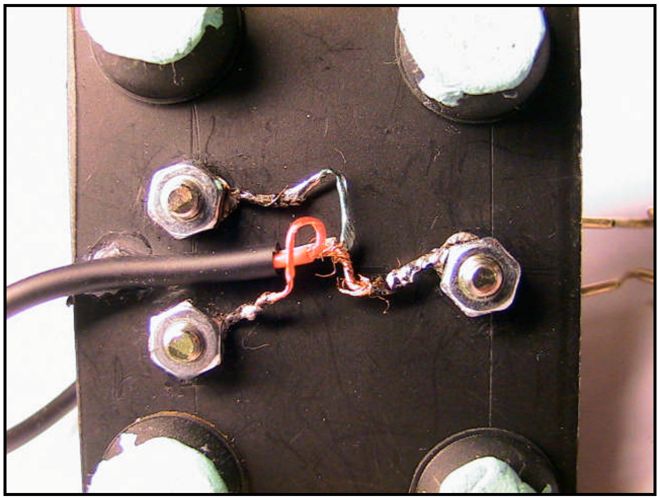
Screwing them together

Adjustment

On the DP, tighten the screws while holding the paddles against the contacts. Then bend the paddle slightly outwards at the fixing point. This provides a very small gap and nice action using a light touch.

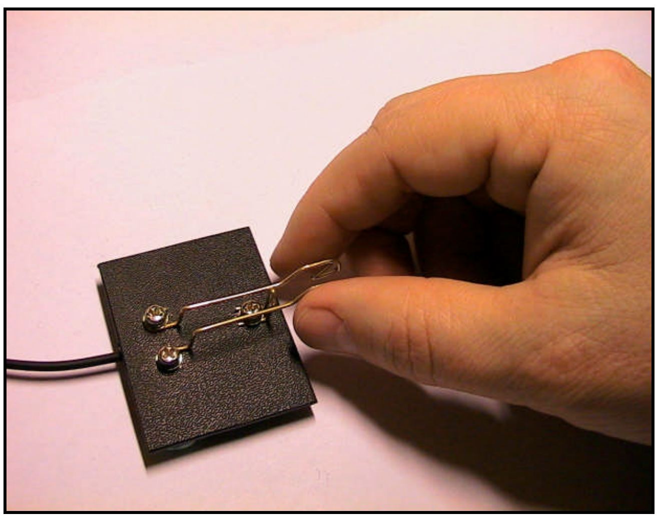
On the SP with the adjustable contact points, I tighten the screws first, then I press the contacts towards the paddle with needle nose pliers.

The SS is adjusted by either squeezing the contact points together with pliers, or prising them apart with a screwdriver. The SS needs a large spacing to make the pauses between the elements long enough. There are, of course, endless possibilities to make personal adjustments.

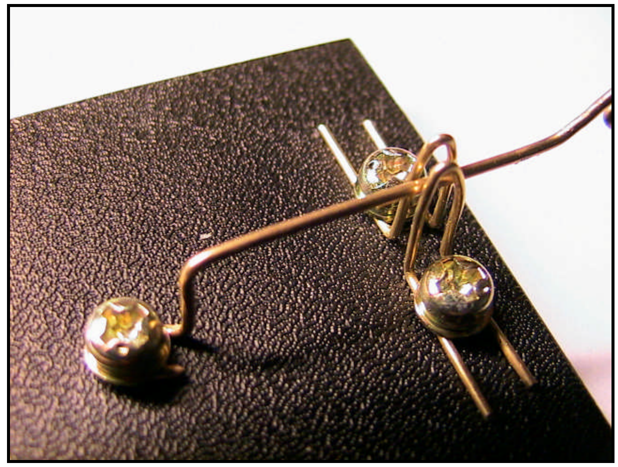


Screw the paddle(s) and contact point(s) on lightly at first. Attach the wires and tighten the nuts so the paddle can be adjusted.

The feet are glued to the underside. Then add a little "blue tack" to keep them on the operating surface.



Verner Blindheim
Soon to be LA ham.



Usage

I rest my whole underarm on the desk, letting my hand rest as I would hold a pen. My thumb and index finger is then placed close to the finger pads. This gives me a good starting position for operating the paddles.

The paddles should be perfect for QRP and QRPp rigs, and I'm sure they will be fine for Spartan sprints and backpacking too. At least they are very well suitable to use as a cheap paddle for CWCom or Morsemail. These are software for sending morse code over the Internet.

They are simple, cheap, lightweight and easy to make. In other words: "The Ultimate Simple Lowcost Homebrew Portable Paddle". Here presented as a sideswiper, single lever paddle and dual lever paddle.

Make one tonight! And e-mail me at verbli@yahoo.no to tell me about it.
I want to thank the nice people on CwCom Morsenet1 Ch 100 for their support.
Have fun!

AmQRP.ORG HOMEBREWER

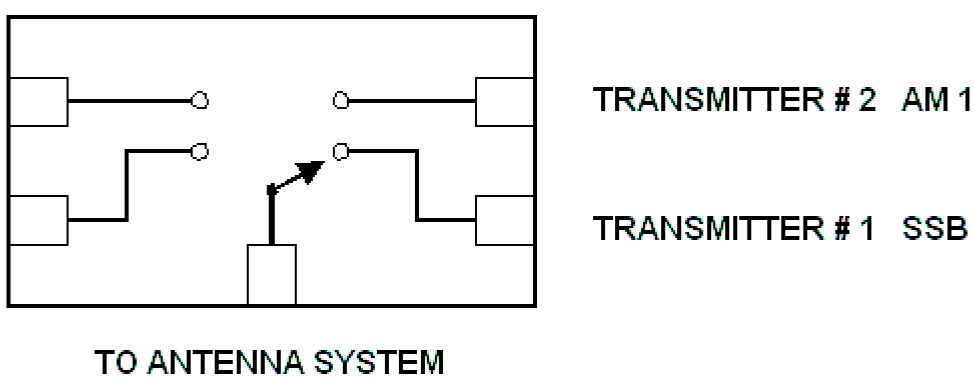
David Ottenberg, WA2DJN

COAXIAL SWITCH BOX

I recently planned to add another transmitter for AM operation to the ham shack. I looked at my setup and needed a coaxial type switch to make use of the additional transmitter with my dipole type antenna system.

I went to several catalogues and found that these type of switches were very expensive. Then I thought of another alternative. This was to check the parts box for a ceramic one pole four position switch, as well as an aluminum box and four SO-239 type coaxial connectors. I could then build a substitute coaxial switch for about ten dollars and it would allow me to intergrate more transmitters into the antenna system.

The following circuit is what I ended up with, for use in my ham shack. It will take from a few watts to about 100 watts of RF power. For more power, a larger switch must be used.



4 ea SO-239 connectors mounted on sides of the aluminum box.

I ea ceramic switch one pole four position mounted on front panel.

Hook up wire is center of RG-58 coaxial cable, with cover and shield removed from cable. About 2-3 inches in length.

Aluminum 4x4 box has front and rear covers. A small chassis with a front cover can be substituted in place of the existing type of box.

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AmQRP.ORG HOMEBREWER

Ron Stone, KA3J

DDS + Rockmite

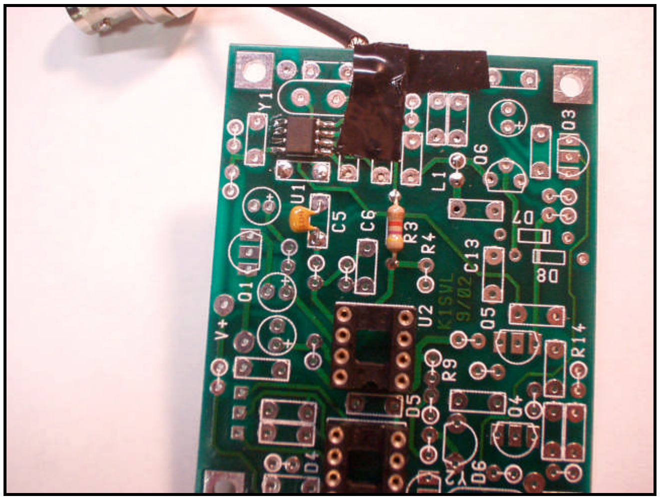
Thought you might be interested in seeing what I did with the DDS board. Perhaps this makes new application #4.

I call this rig the Supermite for Supehet + Rockmite. This project started off innocently enough. I originally intended to just broaden the front-end rx filter, add a VXO, set it up for multiband use, and make other tweaks - e.g., increase the power out, increase the audio output, etc. However, after making the rx changes , I still wasn't satisfied with its performance. It had some shortwave BC coming through, insufficient selectivity, hum susceptibility - the usual stuff you get with simple DX rcvrs. At that point, the DDS board came out and I thought it would be fun to use it with the Rockmite. I also realized that I only needed about half the space on my standard RS prototyping board for the PIC circuitry and the post DDS amplifier. So I figured why not add a crystal filer and BFO and turn the thing into a superhet? So off I went.

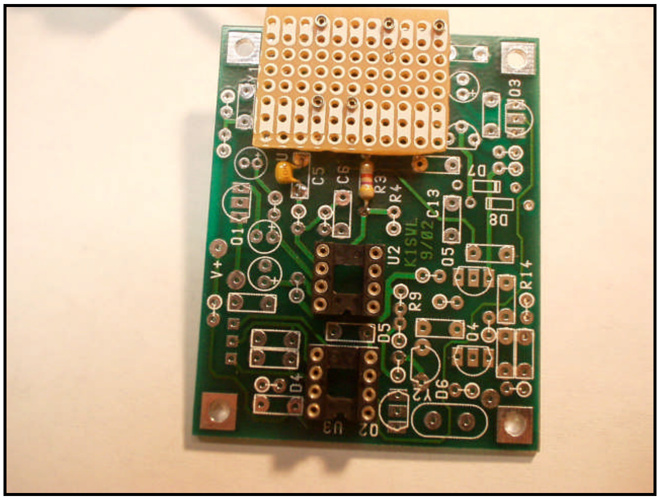
I got it working just in time for the CQ WPX contest and after that I got it in its case and took it on vacation a few weeks ago. I had a ball with it. Currently, I have it working on 20 meters and am now adding more PIC code and building additional filter modules for other bands. The rig currently has four tuning steps (10 Hz, 100 Hz, 1 kHz and 10 kHZ), frequency annunication, variable crystal filter controlled by a front panel switch, keyer, and I'm now adding the code to handle band switching, RIT/XIT, and the calibration functions. Even as is, the rig works quite well. The rx is very sensitive, has a ton of audio, has decent selectivity for both CW and SSB, and is easy to tune. The tx puts out about 1.5W. The main drawback of the rig is that it draws about 200 mA on rx and 550 mA on tx at around 15 volts. However, I still get 3-4 hours of use between charges using 1800 mAH AA NiMH batteries. The key advantage of this rig is that it has the potential to operate on all HF bands.

I did modify the DDS board a bit to get more output from the 9850 and decided to not use the MAR 1A. Instead, the signal from the DDS filter runs into a FET buffer and is subsequently amplified and buffered. I also should mention that I didn't need to cut any traces on the Rockmite board although I did mount a number of parts below the board. My other object was to get everything to fit in the nice LMB case that's only 3" by 5.5" by 1.25". I really wanted a nice pocket sized portable rig.

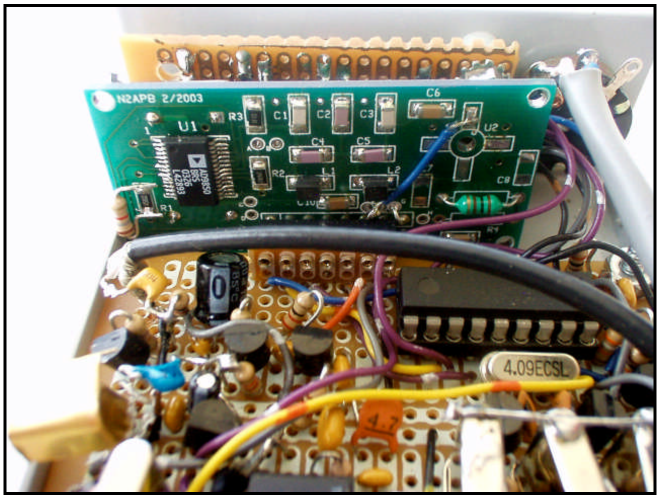
Anyway, the pictures tell most of the story. You can see how I taped off the Rockmite board to prepare it for the filter subboard, and then what it looked like with just the filter subboard in place. The picture of the inside of the rig shows the filter board mounted on the subboard (upper left hand corner of the picture). I also used a different connector on the DDS board consisting of half an IC socket. I did this so that it would fit in the case and still allow me the flexibility to detach if from the RS prototyping board.



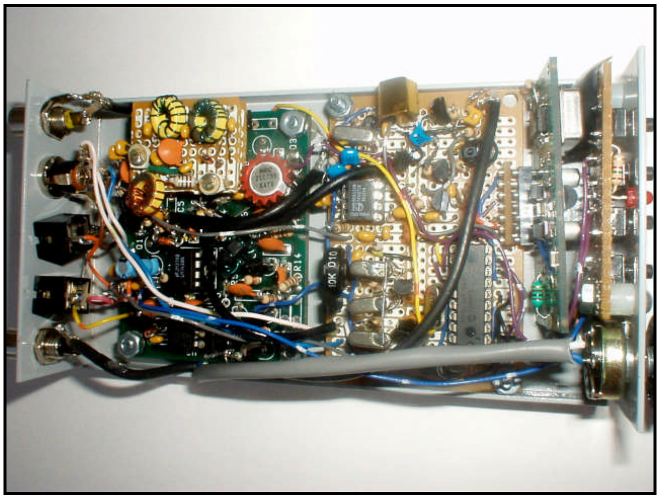
Rockmite Preparation



Rockmite with Subboard

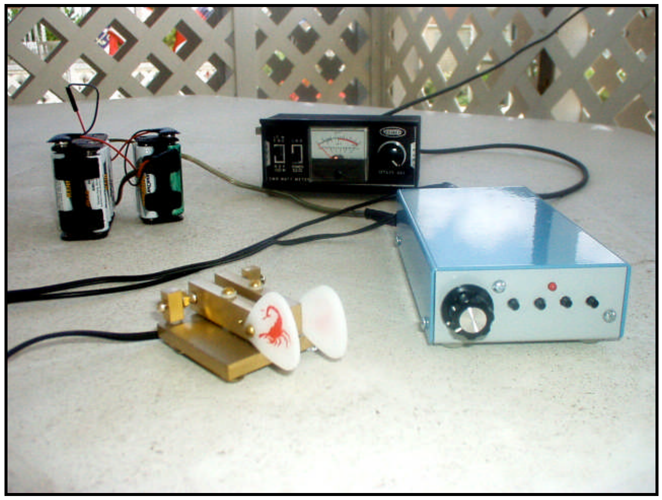


Supermite DDS Installed



Supermite in LMB Case

Supermite Rear



Supermite Portable Station

Ron Stone, KA3J
rsstone@juno.com

AmQRP.ORG HOMEBREWER

Joe Everhart, N2CX

The Disco Dazzler

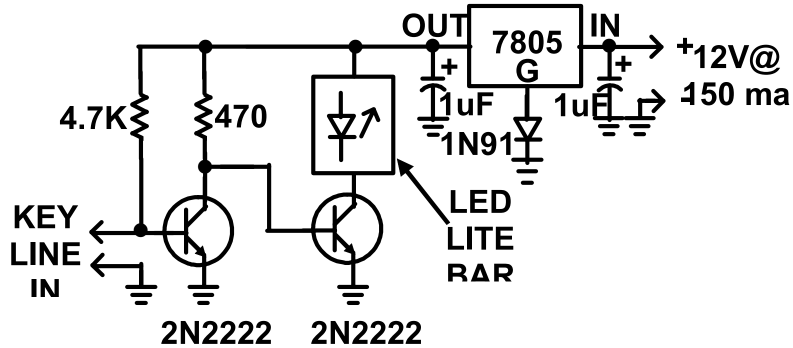
Dazzle and amaze your family, friends and pets with a high-output Morse code visual indicator

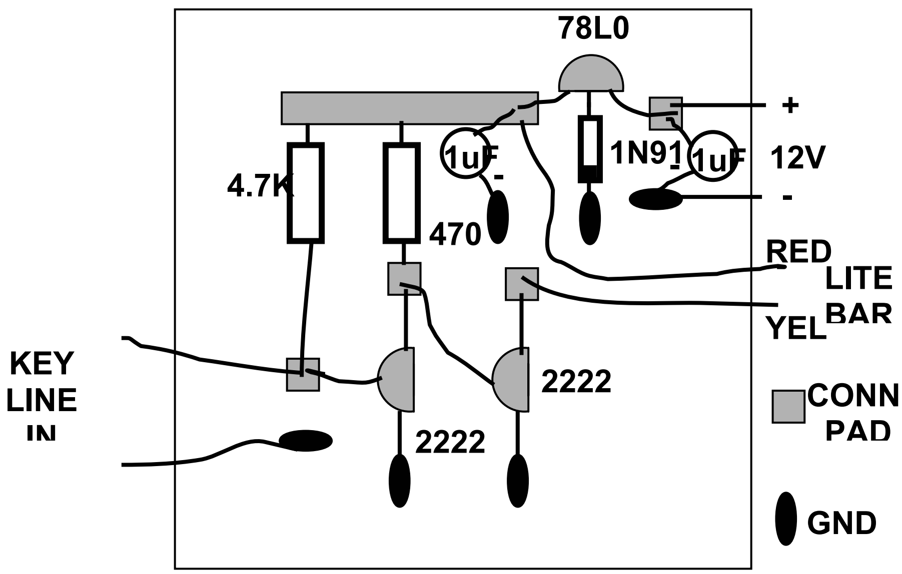
One of our NJQRP Club members provided us with a ton of nifty, high-intensity “light bars” not too long ago. While brainstorming with N2APB on what we could (legally) do with them, we came upon the concept for a simple drive circuit that was capable of driving the great number of LEDs from a keyline input or a Morse key.

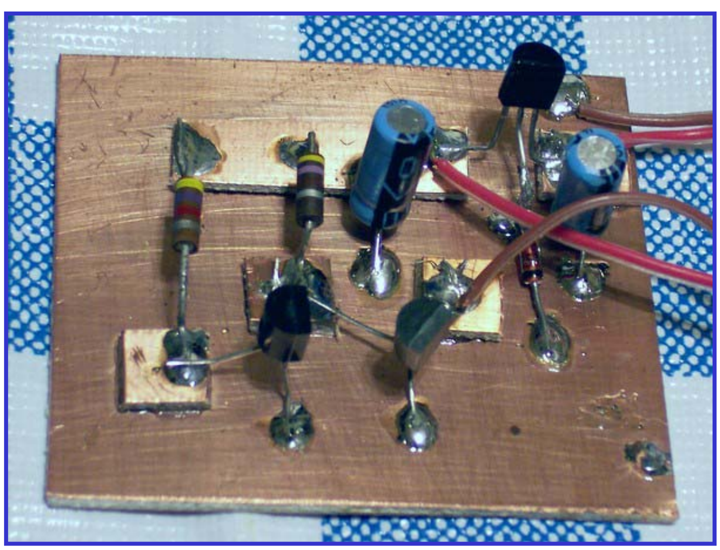
Dubbed the “Disco Dazzler”, we provided parts for the project to club members at the next meeting and many were constructed. Our NJQRP members reported finding many uses for this project …

- Visual “sidetone” indicator
- Use with the “Badger” at hamfests
- Key with memory keyer for visual beacon
- Call attention to your hamfest table
- Send basement cockroaches into hiding
- Impress small children and house pets
- Startle nosy neighbors
- Use at parties to enhance your nerd image
- Make that 18-wheeler on your rear bumper lock his brakes
- Amuse yourself by keying it in tune with Disco Duck (when no one’s looking)

Anyway, we thought that Homebrewer readers would find even more uses for the Dazzler. We still have a bunch of light bars available - see the AmQRP website www.amqrp.org for how you can get one, or contact Bryan Williams, AA3WM at sbw1@enter.net.


OUT
7805
G
IN
+12V@
150 ma
4.7K
470
1uF
1uF
1N91
LED
LITE
BAR
KEY
LINE
IN
2N2222
2N2222


78L0
+
12V
-
4.7K
1uF
470
1N91
1uF
RED
LITE
BAR
YEL
KEY
LINE
IN
2222
2222
CONN.
PAD
GND



Joe Everhart, N2CX may be reached by email at n2cx@amqrp.org, or by postal mail at 214 New Jersey Road, Brooklawn, New Jersey 08030

AmQRP.ORG HOMEBREWER

Fred Bonavita, K5QLF

DIY Open-Wire Feedline

We are hard-pressed these days to find a company supplying open-wire feedline. Here is a way you can make it yourself.

The time-honored tradition of rolling your own open-wire feedline in many ways has gone the way of the Edsel. There are a few still around, but they mostly are in the hands of collectors. Do-it-yourself open-wire line, while available from one commercial source [1], is not common these days, despite its acknowledged performance.

One thing that has hampered construction is a source for spacers. It has been about ten years since I stumbled across 3-inch ceramic spacers buried in a Fair Radio catalog. I bought a few dozen (they were four for $1) and built feedline. I discovered two important things about ceramic spreaders in the process: They are heavy, and they are fragile. The latter lesson was learned the hard way when I knocked three off my workbench onto the concrete floor of my garage, where they shattered. Still there is something nostalgic about white ceramic spreaders.

Of course, there is the early method of making spreaders from wood dowels that have been cut, drilled and boiled in paraffin to make them waterproof. More recently, sections of one-inch-in-diameter schedule 40 PVC pipe have been cut into appropriate lengths, cut lengthwise into strips, drilled as needed and pressed into service.

About a year ago, I came across lightweight plastic spreaders available from Waters & Stanton [2], a company in England that specializes in amateur radio gear. A package of 25 is £4.99, plus shipping. The two packages I bought, including shipping, came to about $18.

The open-wire line I made has a spacer about every two feet. It was necessary to keep the spreaders in place, so I cut off a couple 6-inch lengths of the No. 14 stranded antenna wire, peeled off a strand at the time, laced the strand through the mouth of the spreader over the wire, and wrapped it above and below the joint tightly. It was not necessary to solder the strand to the wire. The spreaders stayed put.

The accompanying photos show how this goes together. Thus far it has proven ideal for portable use with my W3EDP end-fed Zepp. I roll the whole thing around a kite string reel for quick grab-and-go use.

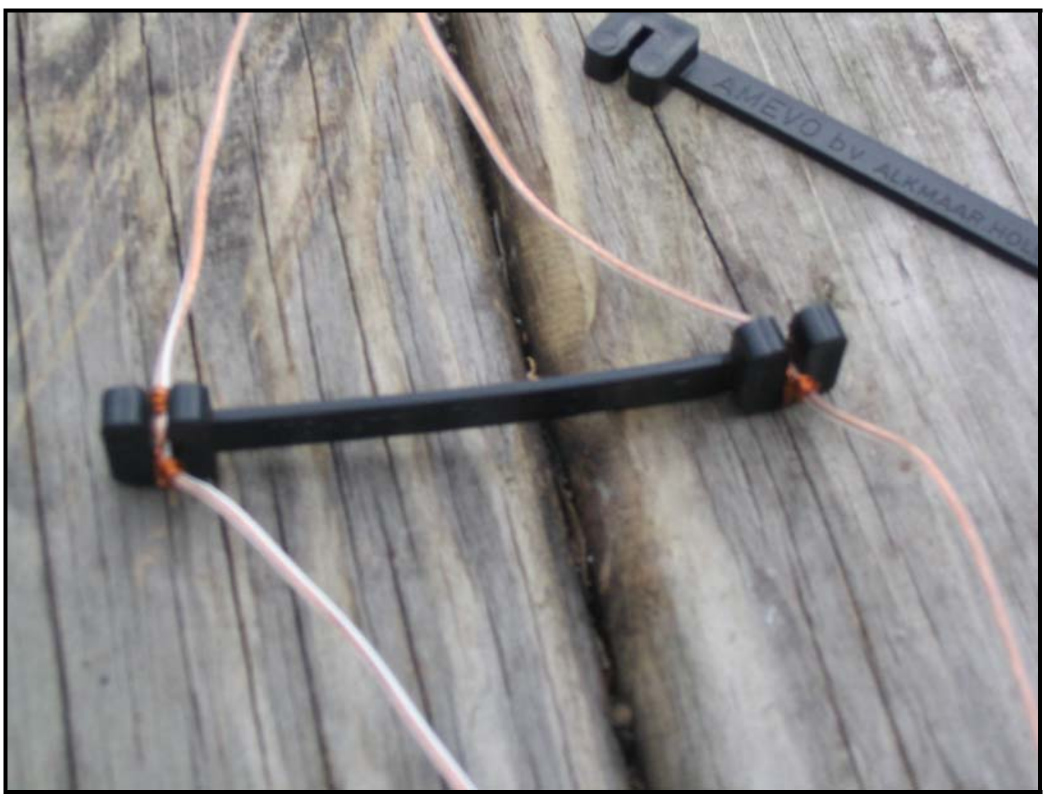
REFERENCES

[1] 600-ohm ladder line is available from Vintage Manuals at vintagemanuals.com

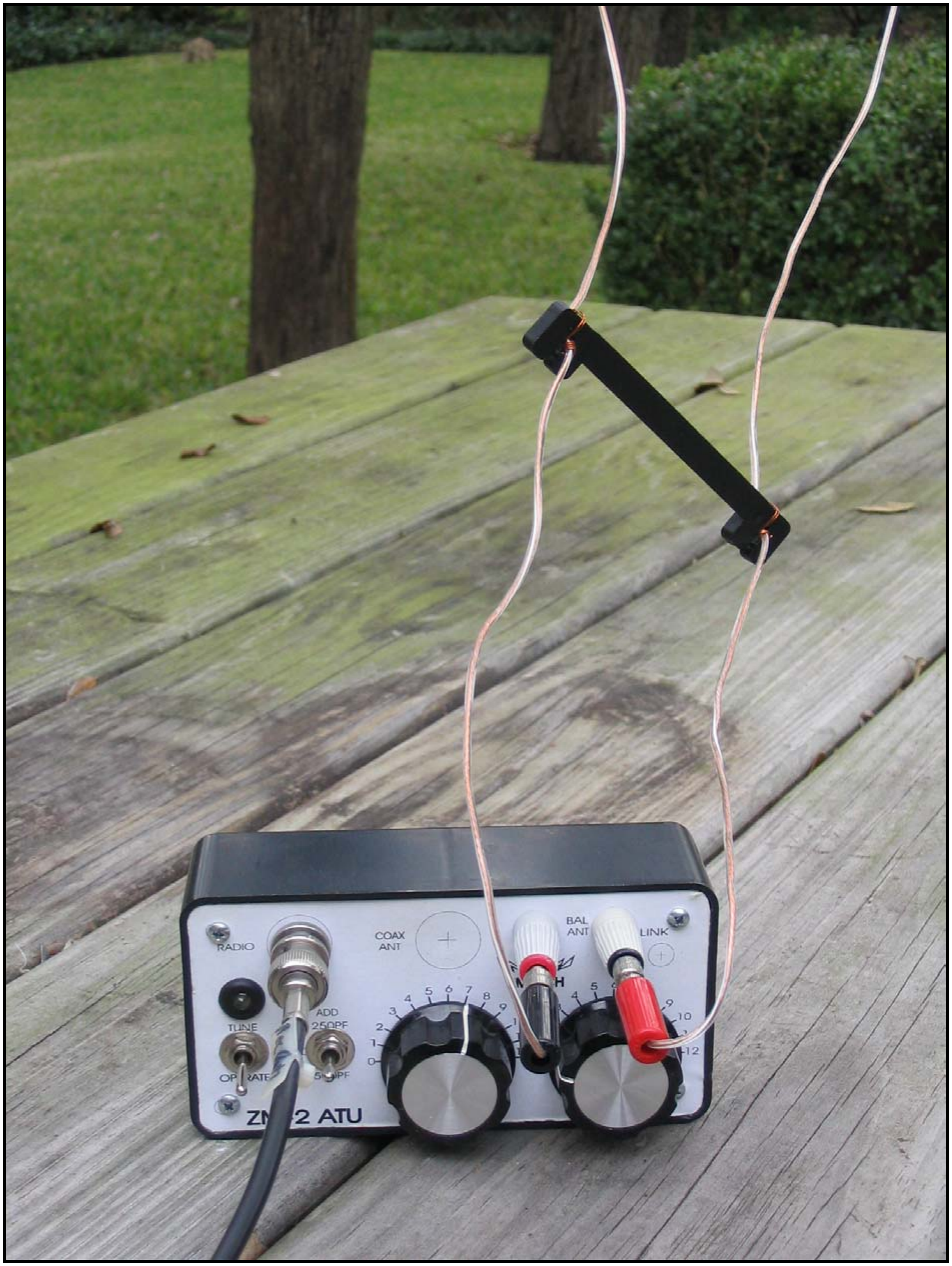
[2] Waters & Stanton is at wsplc.com The spreaders are item WS-2580. Some credit cards accepted.

W3EDP rolled on a kite string holder.

Spacers at work on two legs of W3EDP end-fed antenna



Legs of W3EDP held apart by lightweight spacers.



W3EDP plugged into EMTECH ZM-2 tuner and ready for action.

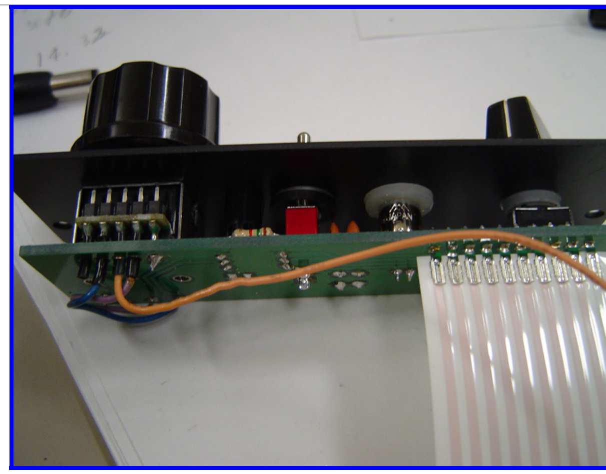
Fred Bonavita, K5QLF may be reached by email at k5qlf@yahoo.com

AmQRP.ORG HOMEBREWER

James Powell, K5BWW

DSW-20 Tuning Mods

Having used the really neat Small Wonder Labs DSW 20-meter transceiver so much, I actually wore out the mechanical shaft encoder! Although the DSW designer/owner Dave Benson, K1SWL was kind enough to send some replacement parts, I embarked on a quest to upgrade the rig's "feel" by instead using an optical encoder.



The DSW20 QRP rig is the best that I have ever used. I really like the band coverage and overall performance of this rig. I even operate this rig mobile feeding a ham stick 20M antenna and matching it with a L network. I have had a lot of QSO's while operating mobile with RST signal reports of 589 or better.

This past March I took a trip from my QTH in Cleveland, MS to Tucson, AZ to visit my son and his wife Jessica. I drove and constantly used the rig going and returning. However, during more than 60 hours of driving I scanned the band constantly. The life of the shaft encoder was rated around 15,000 turns and I feel that I more than exceeded this.

After I returned I removed the rig and installed it at the home QTH. I started to notice that I could tune up the band but I was having trouble tuning down. Sometimes it would work but most of the time it would not.

I contacted Dave Benson, K1SWL, who is the designer of the little rig and owner of Small Wonder Labs, and received some information to test the shaft encoder. It appeared to be working so Dave sent me integrated circuit U7 to try. Changing U7 did not help so I contacted Dave again and he sent me a complete front panel assembly.

I temporally wired the new mechanical shaft encoder and the rig tuned up and down. The problem was solved! The mechanical shaft encoder had worn enough to cause the timing to be off.

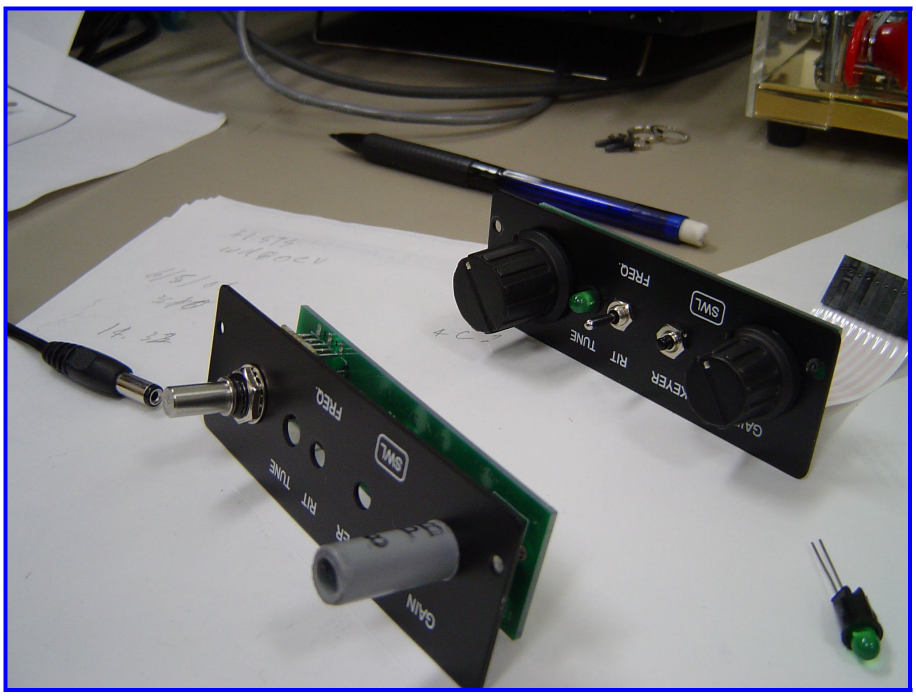
However, instead of just replacing the mechanical shaft encoder I decided to look around and see if I could find an inexpensive optical shaft encoder to replace the mechanical shaft encoder, thus improving the "tuning feel" of the rig and probably getting me at least 30,000 more turns.

After a lot of searching I found a miniature optical shaft encoder made by Agilent Technologies. The shaft encoder can be ordered in many combinations, front panel mounting, rear panel mounting, shaft length, etc. I finally came up with the specifications that I thought would work. I sent the data to Dave for his approval and got the okay to try it.

After I received the optical shaft encoder I temporally wired it up and bingo, it worked the first time! Since I had the complete front panel assembly I decided to build the new assembly using the optical shaft encoder.

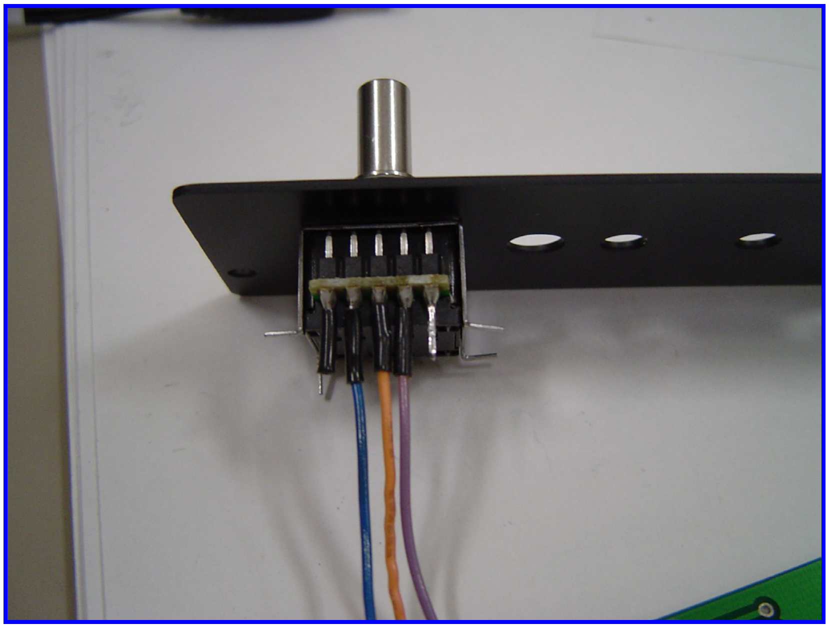
After laying everything on the workbench I started to get a feel for mounting the optical shaft encoder. Although some of the existing holes would work I decided to drill new holes and mount the shaft encoder so that the connections were opposite to the existing holes on the daughterboard. This way the daughterboard would be preserved.

The picture below shows the start of the layout. The gain control has some play around the front panel. I had a short piece of ¼" plastic plumbing pipe which fit perfectly on the gain control shaft. I used a reamer to enlarge the holes on the front panel for the optical shaft encoder and the gain control. This way I could make a bushing that would keep the gain control centered so I could mark the holes for the daughterboard that I had to drill to mount the shaft encoder. Now I had a way to keep things in alignment.



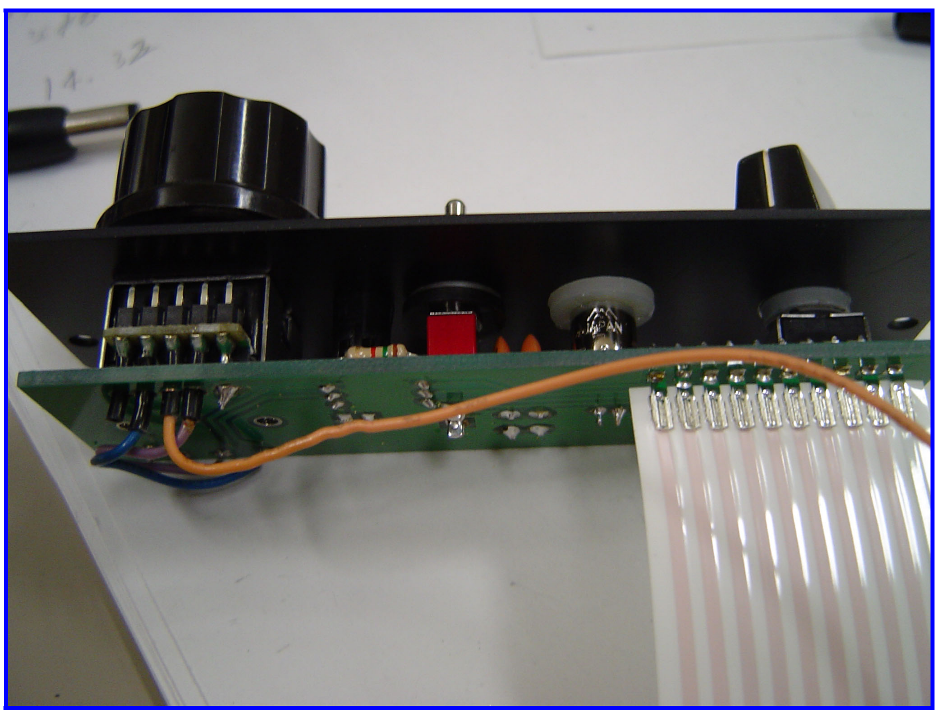
The start of the project.

The next picture shows the shaft encoder mounted. I soldered the wires and used small pieces of shrink tubing to insulate the terminals. The ground pin (1) is identified by a dot under it on the back side of the shaft encoder. After I had things in alignment, I measured the plastic pipe that is used for a bushing on the gain control and cut it and the shaft of the gain control to the correct length.



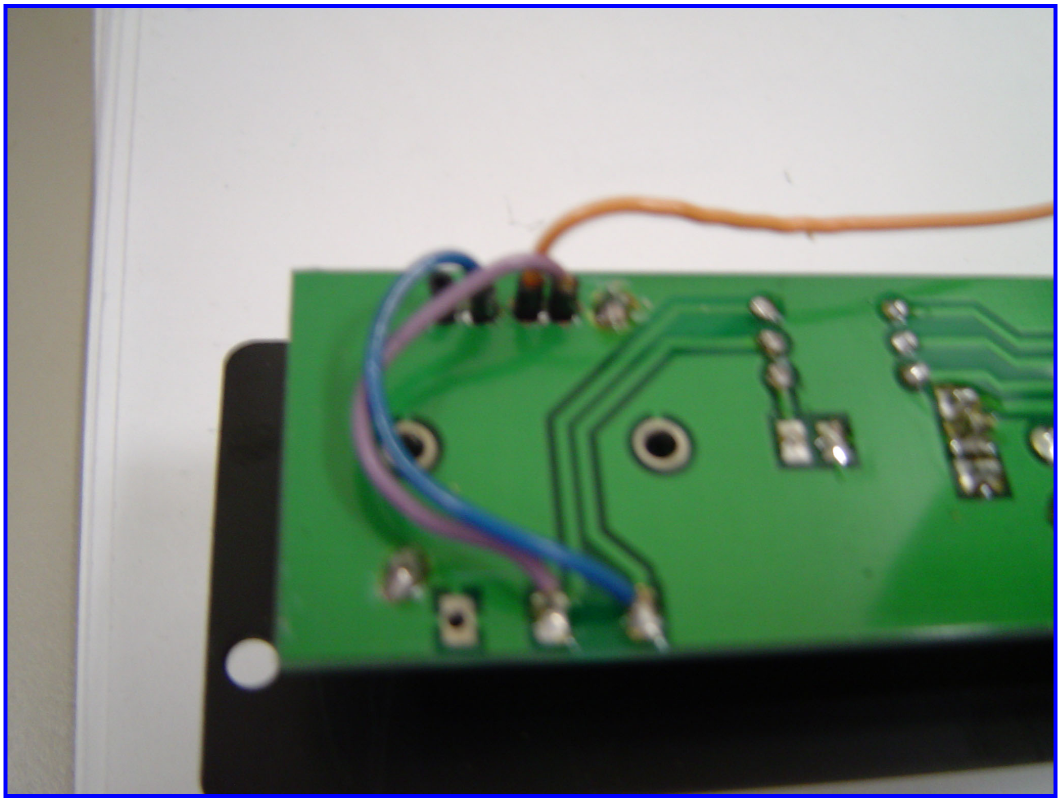
The new optical shaft encoder is mounted.

This next picture (below) shows the completed front panel assembly. The bushing can be seen on the gain control. I only soldered in one of the pins on the shaft encoder mounting bracket.



Completed front panel assembly.

The picture below shows the modification to the circuit board. Pin (1) is ground. Pin (2) is “B” which connects to “B” on the daughterboard. Pin (3) is +5V and is connected to U4 at the top connection of C107. I just soldered this wire to the motherboard. I may add a suitable disconnect for this wire later as I did not have anything that would work in my junk box. Pin (4) is “A” and it connects to “A” on the daughterboard. Pin (5) is case ground and it was left disconnected.



Modification of the pc board.

That’s it. The upgrade procedure is very simple and it greatly improves the performance. The hardest part is keeping the shafts in line so nothing binds. It took me around two hours to do the installation but I had to work out the details as I went. Give yourself time and work fresh. Although the existing board could be used it may be better to get a new front panel assembly from Dave.

The completed front panel assembly is shown below, ready to be installed. Agilent Technologies provides many combinations for the optical shaft encoder. I elected to use the optical shaft encoder that was free turning instead of the detent version. Also, the final receive current was 70ma. The additional current consumption may be a concern to some but I use a 10AHr battery for portable use.

Completed front panel assembly.

I am very pleased with the modification and performance. Again, I thank Dave for a fine rig and the support that I received.

Agilent Technologies: www.agilent.com, **p/n HRPG-AS32-14R**
14 in the part number represents a ½" long round shaft. A 3/10" long shaft may work better. If this is desired then use 11 instead of 14 in the part number. I had to try several knobs before I found one that would work with the ½" long shaft.

Description: HTS# 84719000000 Optical Mount Encoder

Authorized Distributors for Agilent Technologies:

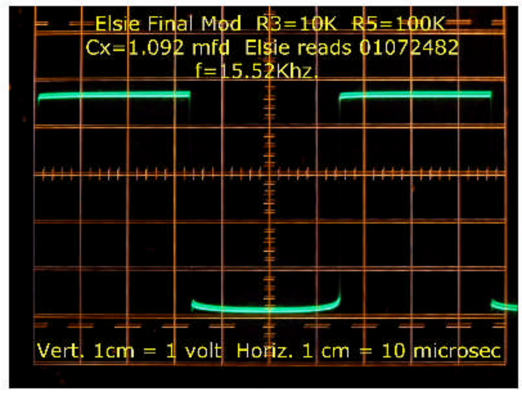
Arrow	1-800-777-2776
Avnet	1-800-254-2847
Future	1-800-477-6668
Newark	1-800-367-3573
DigiKey	1-800-344-4539

AmQRP.ORG HOMEBREWER

C. M. Dunlap Jr., W8LQ

Elsie 2 Mods

Several months ago N2PWP informed me of the Elsie kit availability. It sounded like a neat project so I ordered 2 kits from N2APB. I built the first one in the -2 configuration and it worked.........mostly!!!



For capacitance values above .15 mfd the readouts were anomalous, meaningless and random. When N2PWP built his kit he experienced the same problems. I wonder if you have noticed this effect during the design phase or if any finished circuit kit builders have reported similar performance.

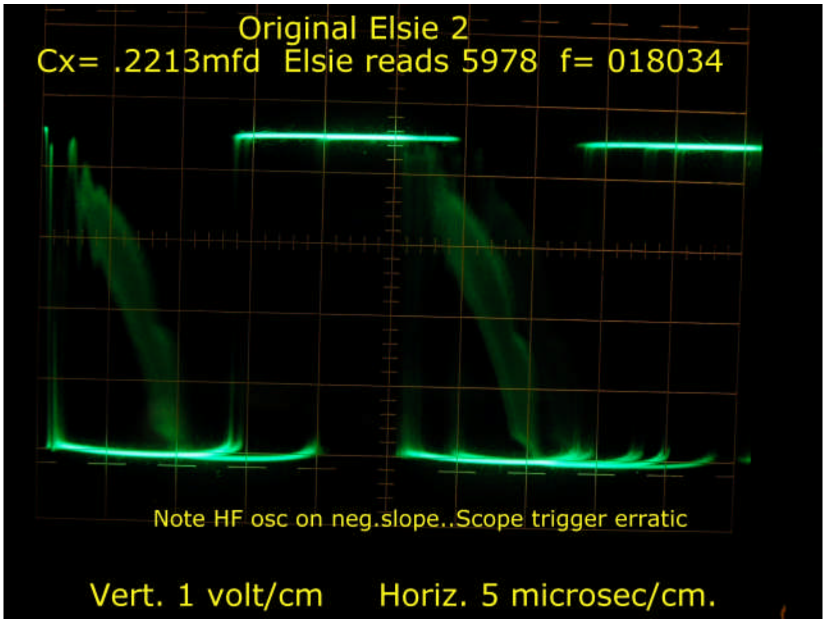
I built the second kit on a protoboard so I could learn some more about what makes Elsie tick, and why she doesn't tick like a Timex for high values of "C".

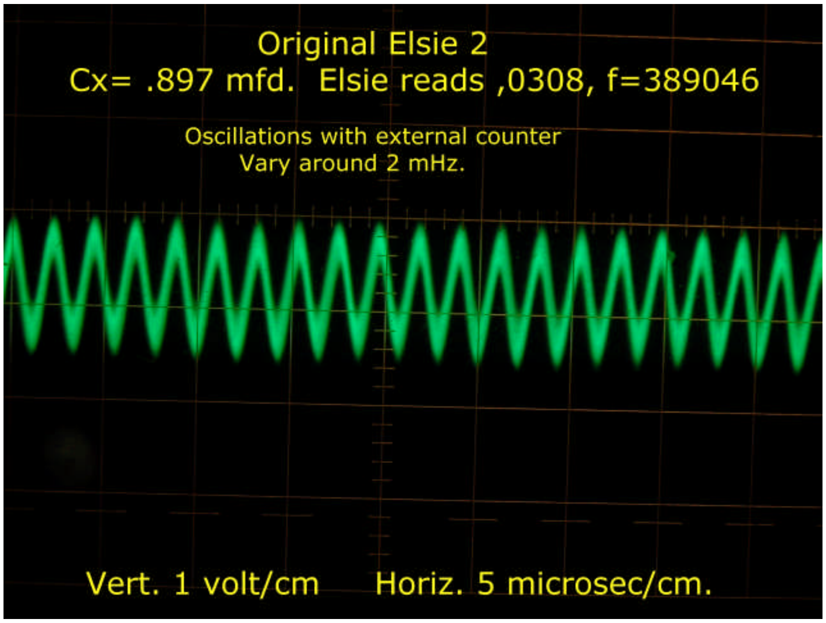
A frequency counter at pin 7 of the LM311 verified the Elsie "F" count with no Cx as 507 kHz. Things seemed steady up to Cx=.1392 mfd (read on my shop cap checker) but at .22 mfd the counter bounced around badly, and at 1 mike the counter tried to settle around 2 megahertz. Hung a scope in place of the counter and found some interesting waveforms rather than nice clean square waves seen at the lower Cx values.

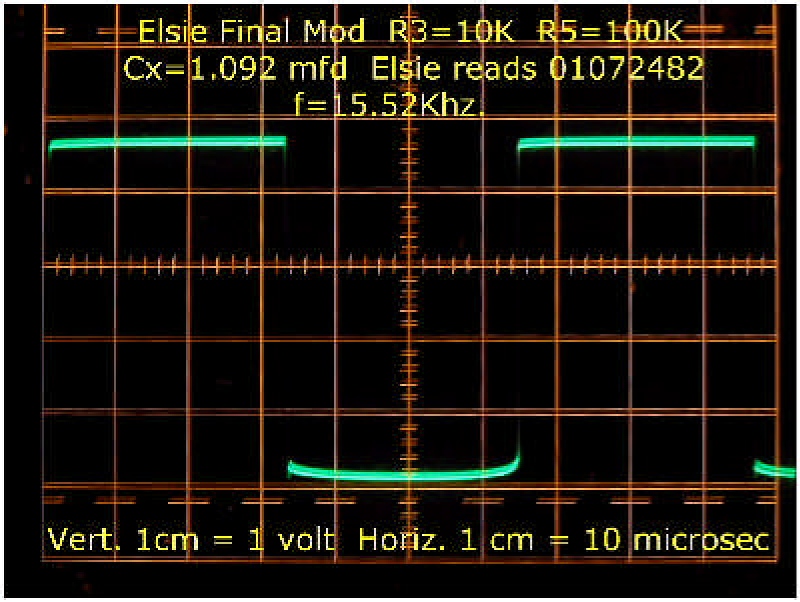
To make a long story short I found that changing R3 to 10 kOhms would clean up the trace except for jitter on the square wave above .68 mfd, with consequent improper readouts. Changed R5 to 62 kOhms stopped the jitter. Reading above .22 mfd. were low compared to the readings on the shop meter. (e.g., Elsie read .897mfd as 708424, with f=19.10 kHz.) Adding capacitors in parallel up to a total of 1.2 mfd would not drive the "F" count to below 18.82 kHz, after which Elsie started singing in the mHz. range. My handy calculator and handbook nomograph said I needed to get down to about 16 kHz for 1 mike at 100 microhenry. Played around with the feedback loops some more and at R5=100 kOhms everything settled down nicely, and readings were very close to the shop meter, e.g. 1.092 mfd on shop meter read 01072482 with Elsie, the "F" reading being 15.54 kHz.; the .001 mfd precision cap supplied with the kit read 1001 with Elsie!! Since these readings are "Close enough for government work" I buttoned up Elsie and gave her a select position on my test equipment bench.

I am attaching some scope pictures, labeled with the mod versions so that you can see what I am talking about.

Would be interested in any comments you might have. Thanks for a fun-to-build, useful project! Vy 73.....






Elsie Final Mod R3=10K R5=100K
Cx=1.092 mfd Elsie reads 01072482
f=15.52Khz.
Vert. 1cm = 1 volt Horiz. 1 cm = 10 microsec

AmQRP.ORG HOMEBREWER

Leon Heller, G1HSM

Enhance ELSIE

An improved-construction, pc board-version of the popular L-C meter project from the Atlanticon 2004 QRP Forum

Some time ago I decided to build my own version of the ELSIE LC tester, originally designed as an AmQRP kit. Rather than use the Manhattan construction technique as in the kit, I designed and made my own PCB, using Pulsonix software. I mentioned this in a posting to the QRP-L mailing list, and was asked if I would design a PCB for an enhanced ELSIE kit. It sounded like an interesting project, so I agreed to help. An ad-hoc project team was put together consisting of myself, George Heron N2APB, David Willmore N0YMV, Joe Everhart N2CX, and Paul Maciel AK1P. George acted as project manager.

I quickly created a draft schematic based on my version of the standard ELSIE circuit and circulated it for approval. After a couple of iterations it was approved and I started on the PCB design. George sent me one of the original ELSIE kits so that I could see the actual components that we would use, and suggested a suitable Hammond enclosure. I was unable to fit the components onto a PCB for that enclosure, so we decided to use the next size up. Things were still a bit tight, but by mounting the resistors vertically and only using two of the PCB mounting holes I was able to squeeze everything in. I took a lot of care over the parts placement on the PCB so the routing was quite straightforward. Design rules (PCB track widths and separation and pad/hole sizes) were selected to minimise PCB fabrication costs. For ease of construction I made the board double-sided with plated-through holes. Several iterations were gone through before everyone was happy with it, and an order was placed for a small number of prototype boards, one for each of the project team. I generated the Gerber photo-plotter and Excellon drill files and emailed them to George who sent them off to the PCB fabrication company. Paul then started placing orders for the parts for the prototypes, so that everyone could build a prototype for himself.

As soon as the boards arrived Paul built a prototype up in stages, testing each stage as he completed it. A few problems showed up, but they were relatively minor and fixed very easily:

- Pin 3 of U4 was connected to ground, shorting Vcc to ground.
- Display segment pins d and e were swapped.
- Emitter of Q1 was unconnected, it should be connected to ground.
- 1N5187 footprint - pads were too close and holes too small.

- Copper pour around L and C croc (alligator in US) clips could short to ground.
- Board was slightly too large for the enclosure.

I modified the design as the problems were found, ready for the production run of the PCBs later this summer.

To sum up, I found working on this project a very enjoyable and instructive experience. Me being in the UK with everyone else in the US wasn't a problem, given the speed of communication afforded by the Internet. Everyone was very helpful and the project went ahead very smoothly.

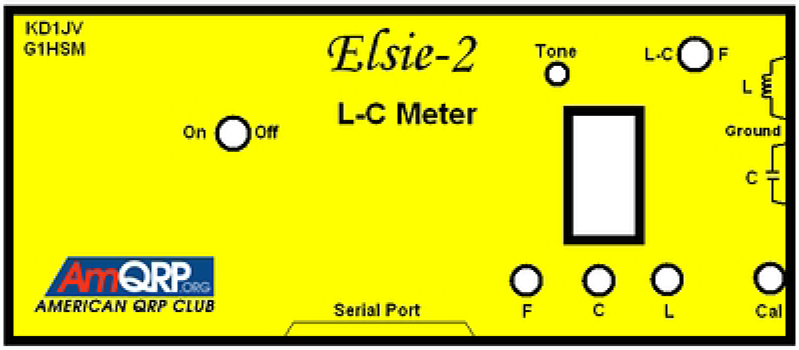
NOTE: *Although we've been heading this project toward kit status, we're not quite ready at the time of this article publication. Working in cooperation with G1HSM, the AmQRP intends to be having the kit ready for general sale later this summer. Stay tuned to the AmQRP web pages for details on availability.*

Leon Heller, G1HSM may be reached by email at leon.heller@dsl.pipex.com

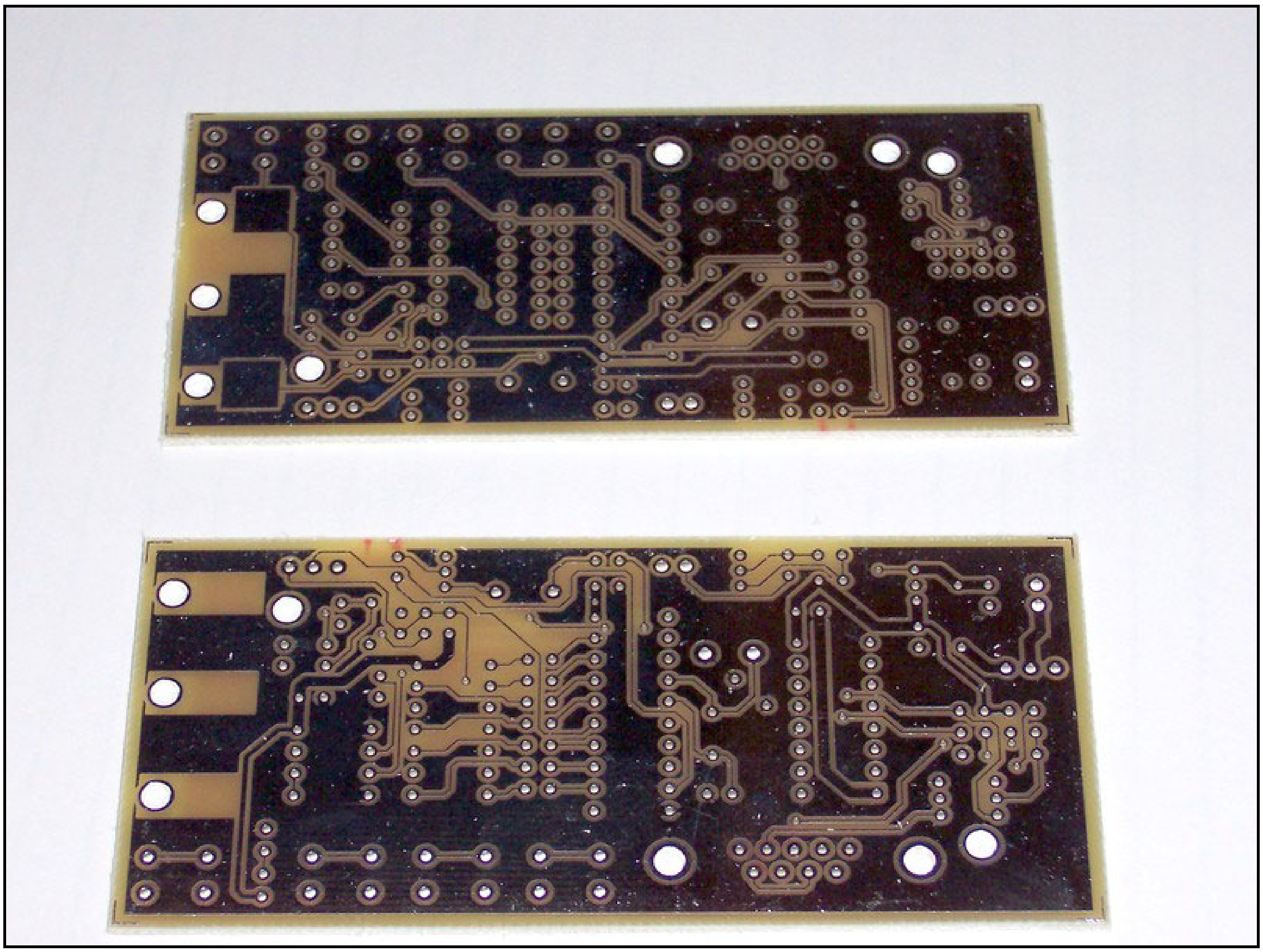
Completed prototype of the Elsie-PCB project, nicely enclosed in the Hammond 1595 plastic case.

Side view of the Elsie-PCB enclosure, showing the connector for serial connection to the PC (primarily used for data collection during use.)

End view of the Elsie-PCB enclosure, showing how the alligator clips protrude through the end panel to allow easy clip-on of the inductor or capacitor under test.



Front panel overlay graphic used in the prototype. We expect to make some ni9ce and inexpensive self-adhering plastic labels for this project, similar to what we used for the Micro908 front panel.



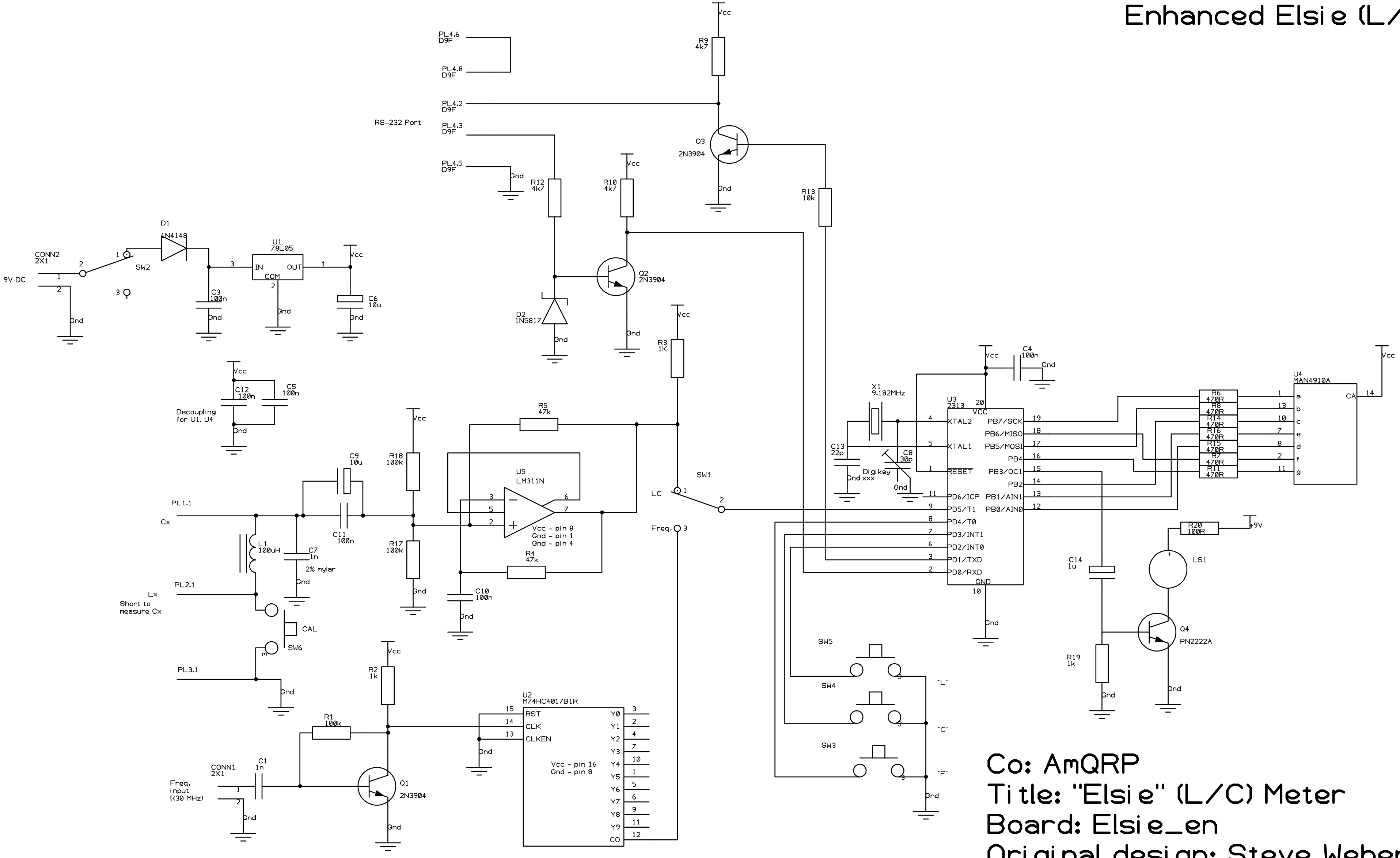
Prototype pc boards used in the project. The controls and connectors are designed to all reside on the pcb, thus allowing the unit to be debugged on the bench and later just dropped into the Hammond enclosure. (The production pc boards will be solder-masked and will have silkscreened labels.)

ELSIE-PCB Parts List

QTY	Designator	Description	Mouser	Digi-Key	Other
3	R1, R17, R18	Resistor, 100K, 1/4W (brow n, blak, yellow)		100KQBK-ND	
2	R4, R5	Resistor, 47K, 1/4W (yellow , violet, orange)		47KQBK-ND	
2	R13, R19	Resistor, 10K, 1/4W (brow n, black, orange)		10KQBK-ND	
3	R9, R10, R12	Resistor, 4.7K, 1/4W (yellow , violet, red)		4.7KQBK-ND	
9	R2, R3, R6, R7, R8, R11, R14, R15, R16,	Resistor, 100, 1/4W (brow n, black, brow n)		1.0KQBK-ND	
1	R20	Resistor, 1K, 1/4W (brow n, black, red)		100QBK-ND	
1	C1	Capacitor, .001uF, 2% polypropylene ("1000")		P3102-ND	
2	C6, C9	Capacitor, 10uF, 16V, electrolytic, 16V (Blue)	140-XRL16V10		
6	C3, C4, C5, C10, C11, C12	Capacitor, 0.1uF, 50V Z5U 20% ("104")	80-C317C104M5U	P4910-ND	
1	C13	Capacitor, 22pF, 50V, NPO, 5%, disc ("22")	140-50N2-220J		
1	C8	Capacitor, trimmer, 5-30 pF			136979
1	L1	Inductor, 100uH, molded (axial lead)		DN2568-ND	
3	PL1.1, PL2.1, PL3.1	Alligator clips			ALG-M
1	Conn2	Battery clip, 9V			BST-3
1	skt-1	IC socket, 8-pin			N/A
1	skt-2	IC socket, 14-pin			ICS-14
1	skt-3	IC socket, 16-pin			ICS-16
1	skt-4	IC socket, 20-pin			ICS-20
1	U5	IC, comparator, LM311 (8-pin DIP)		LM311NNS-ND	
1	U1	Voltage regulator, 3-term, 78L05 (TO92)		NJM78L05A-ND	
1	U2	IC, counter, 74HC4017B1R		74hc4017	
1	U3	Microcontroller, Atmel AT90S2313 (20-pin DIP)		90S2313-10PC-ND	
1	U4	LED, 7-seg	604-SA04-12EWA		
1	D1	diode, 1N4148	512-1N4148		
1	Q4	transistor, PN2222A, NPN		PN2222A-ND	
3	Q1, Q2, Q3	transistor, 2N3904, NPN	511-2N3904		
1	X1	Crystal, 8.192 MHz, 20pF	559-FOXS081-20		
1	SPKR	Speaker/piezo, miniature		433-1020-ND	
2	S1, S2	Sw itch, toggle, SPDT, mini	10TC610		
4	S3, S4, S5, S6	Sw itch, pushbutton, N.O.	612-TL1105DF100Q		
1	pcb	printed circuit board			
1	enc	enclosure, Hammond, 5.5 X 2.6 X 1.1	1593YBK		

(See the Enhance Elsie schematic on the next page.)

Enhanced Elsie (L/C) meter



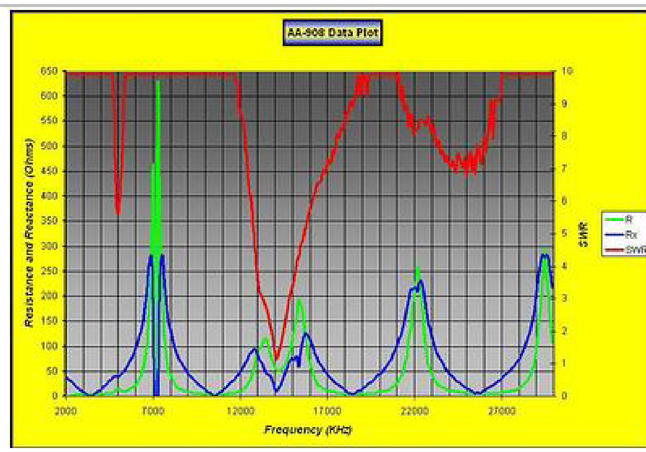
Co: AmQRP
Title: "Elsie" (L/C) Meter
Board: Elsie_en
Original design: Steve Weber, KD1JV
Modifications: Leon Heller, G1HSM
Drawn: Leon Heller, G1HSM
Rev. A4
Date: July 12, 2004

AmQRP.ORG HOMEBREWER

Al Gerbens, K7SBK

Excel Plot Generator for "Antenna Analyst "

If you have a Micro908 "AA-908" antenna analyzer, here is a little spreadsheet that packs a lot of punch. Just point it to the data set produced during an automatic scan, and your antenna's performance will pop right out!



Al Gerbens, K7SBK wrote a wonderful little Excel macro program that takes the scan data produced by the Micro908 AA-908 and automatically generates a plot of the SWR, Resistance and Reactance. By a simple keystroke and pointing to the data file, the macro generates a colorful scaled graph like to one above that shows the results from Al's multiband dipole.

Al describes his project ...

> *The Teraterm 'log' function allows you to write an AA908 data file to anywhere on your PC and name it anything you like very easily.*
>
> *I created an Excel workbook, containing a macro, that goes and gets these files and imports them into Excel. It then plots a graph of the data and the macro subsequently terminates leaving you inside Excel to do what you want with the graph and data.*
>
> *It can handle multiple data sets on separate Excel sheets and then the whole thing can be saved as a workbook containing the graphs and datasets.*
>
> *The workbook and its macro is written in Excel 2003, but I don't know how backward compatible it is.*

You can load and run the Excel worksheet with some sample data files, located in the Software section of this CD-ROM.

OPERATION

1) Getting the AA908 scan data into the PC

When you bring up TeraTerm, select "Log" under the File menu and select a filename and location where you want your data file to go. Then just get your scan data from the AA-908 in the normal way ... connect it to the PC with your serial cable, select the Data Option "Send during scan" on the AA-908, and then hit the Scan button! The data sent to the PC and shown on the screen will be saved to the file you specified when you close TeraTerm.

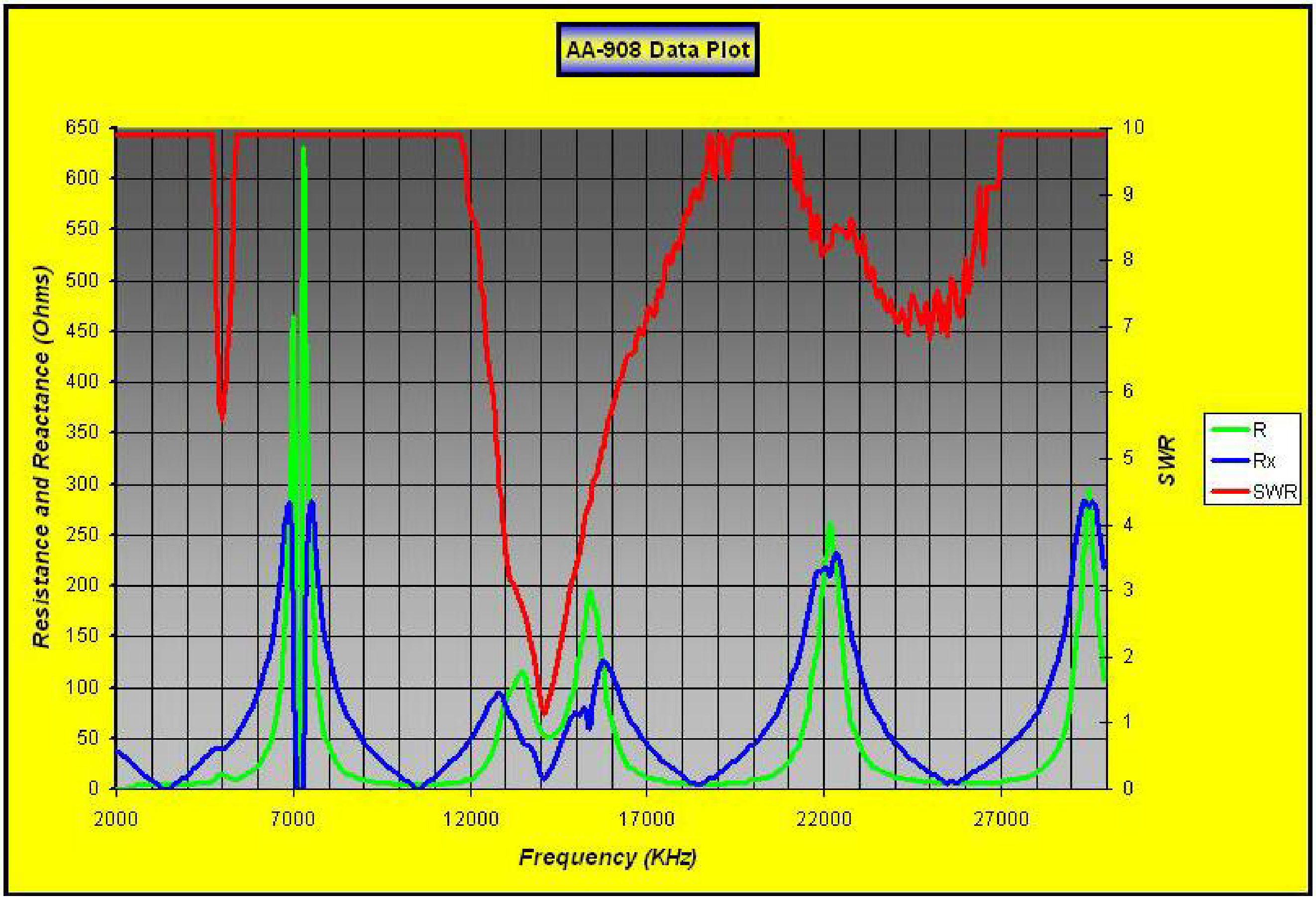
2) Displaying the plot of your antenna scan

Double-click on the AA908plot.xls file on your PC, which will bring up Excel and load the worksheet. (You may need to select the "Allow macro execution" button if it pops up in Excel when you run the program.) A message will be shown in the workbook saying "AA908 Data Plotter: CTRL m to select input file". Press Control and M at the same time and a dialog box will come up for you to navigate to the data file you just created from the scan. Once you select it, a chart of the scan data will be displayed. You can print the chart or save it as a unique filename, like the name of your antenna or date of the scan.

Caution: Don’t change the read only property on the workbook file and then save a ‘used’ workbook back on top of it - Al says it can result in a real mess :-)

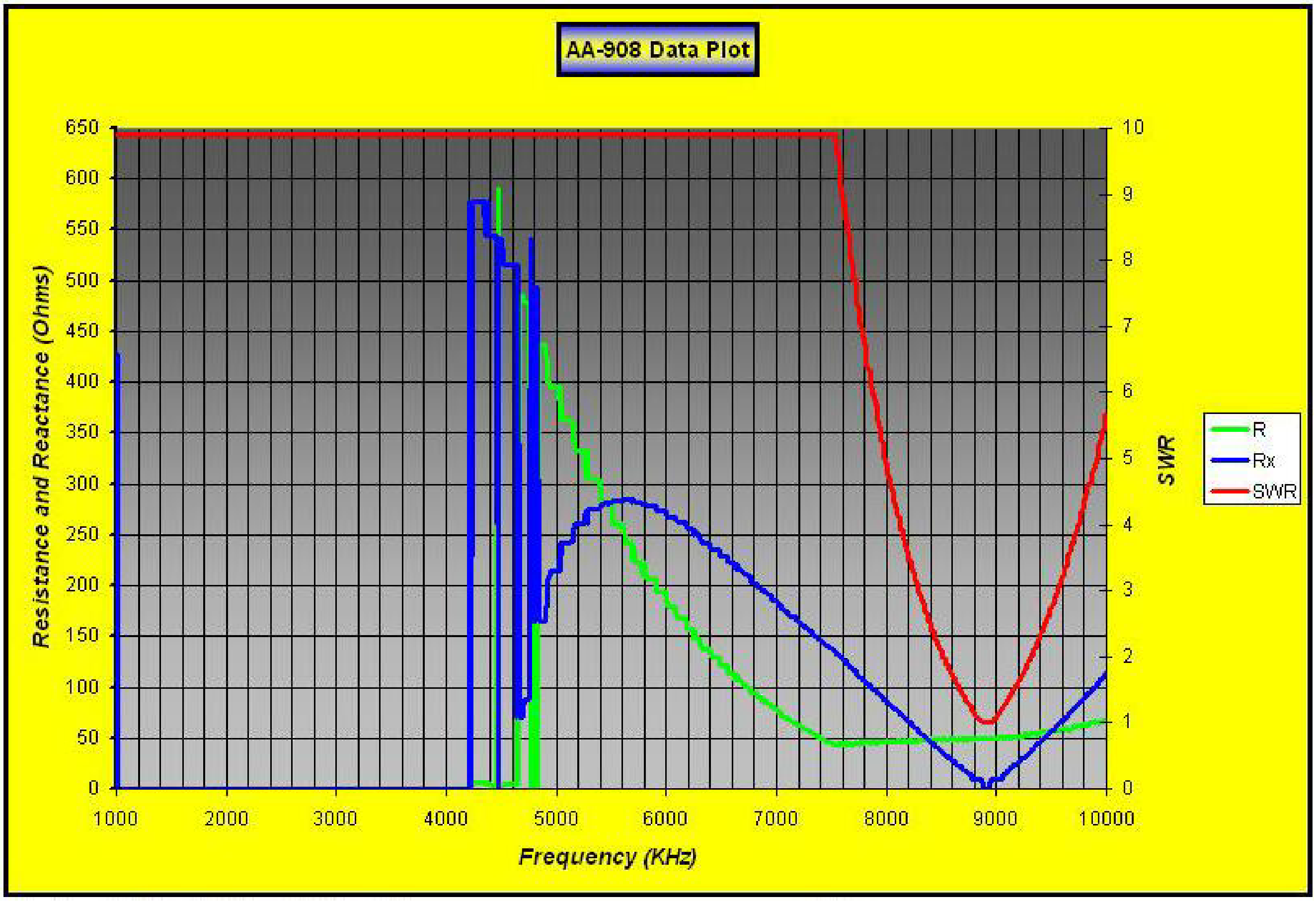
Thanks a ton for your effort Al. This is yet another neat accessory program for the Antenna Analyst and it is a great way to archive graphic results of one's antenna work.

Al Gerbens, K7SBK may be reached by email at agerbens@msn.com



2-30 MHz scan of K7SBK multiband dipole using AA-908 and his Excel Plot macro

Note all the useful data shown in the plot: major resonance at 14 MHz, interesting minor resonances at the SWR dips at 5 and 24 MHz, interesting behavior of resistance and reactance at various frequencies, and especially on either side of the resonances.

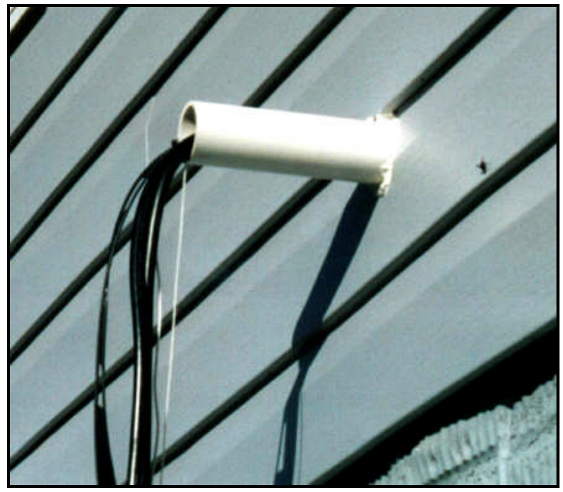


This is a plot of the dummy antenna that N2APB uses during AA908 development.

AmQRP.ORG HOMEBREWER

Joe Everhart, N2CX

The Feeder That Came in From the Cold



A recent discussion thread on the qrp-l reflector discussed various options for practical methods of bringing an antenna feedline into a house. In particular, the question was "how do you bring an open-wire feedline into a house?"

This article will summarize a number of those solutions to put as much info as possible into one place. Each description will be brief but there *will* be illustrations to assist in visualizing them. The original message text will be paraphrased so this piece will not be boringly long. However topics will include a number in parenthesis to link to the original e-mails. A corresponding numbered list at the end of the gives the original author, date and time. You can read the messages on the qrp-l archives at http://listserv.lehigh.edu/lists/archives/qrp-l/other.html. Any errors in interpreting those messages are my own so you may want to read the originals to get the "straight scoop!"

Actually the beginning message by NR3E (1) asked how to get a balanced Radio Shack speaker wire lead into a house. But the same methods can be used with any balanced feeder.

First let me set out some points that I think are significant in properly bringing the feedline inside. Not all of these will be addressed for each method, but you should consider them in your installation!

- The method used should have a minimum effect on the antenna system. This means that we don't want to unduly degrade:

SWR (not too bad for open wire feeder if you use a tuner)
Radiation pattern (mainly no feeder radiation)
Attenuation
Received noise
- While we are at it we have to keep in mind:

No damage to building

No effect on home security systems

Maintaining a good weather seal

Minimzing the possibility of critter ingress (bugs, rodents, etc.)

Preventing a fire or safety hazard

Lighning protection

- Aesthetics are important. *All* antennas and feedlines look good to a ham but family members and neighbors usually have different standards for attractiveness. Whichever scheme you use should be unobtrusive, hidden from view, or disguised to look like something "normal", not sloppy or outrageous like a Dr. Frankenstein or Rube Goldberg creation.

Now here's a listing that I have separated into three categories:

Wall or window frame penetrations

- Radio Shack (RS 15-1200) TV feeder tubes (1). These are 13 inch long plastic tubes that can be run in a hole drilled through a house wall or window frame - see Figure 1. Their inner diameter is only big enough to hold a 300 ohm ribbon feeder or coaxial cable. Something larger is needed for open wire or ladder line. The tube should slope downward to the outside and be sealed with duct seal or (ugh!) tape to keep weather and critters outside.

- PVC pipe with an i.d. suitable for the feedline in use can be used the same way as the TV feeder tubes (7,8,13). The tube can be stuffed with some RF-inert material although I have used a pipe cap on the inside end with a slot cut in it to pass the feeder that is then sealed with airplane model cement - see Figure 2.

- Clothes dryer vents are another solution (5,18). For open wire, ladder line or ribbon feeders it's best to use a plastic type and like the thru-wall tubes it must be properly sealed. This method can be a kind of "stealth" entry since those looking at it may not realize that it is more than a dryer vent.

- A very thin, insulated parallel feeder can be fabricated by using a good quality plastic sheet and copper foil tape (3,6) - see Figure 3. With non-metallic window frames the impedance "bump" of such a feeder no longer than a foot should be negligible if a tuner is used. The feeder is thin and flexible enough to fit *under* a closed window sash.

- Suitable holes can be drilled into a wall or window frame for threaded rod or ceramic chassis feedthrough insulators (4,14) - see Figure 4. The feedthrough method is probably best since an air gap around the threaded rod gives insulation - ordinary building materials are not very good RF insulators.

- Holes large enough to pass two parallel runs of coax cable can be used. boxes inside and outside use SO-239's connected to the coax cable (18) - see Figure 5. Loss for this short coax run will probably be ok, at least for QRP.

Window pane penetrations

- The window pane itself can be drilled wth a carbide bit and the feedline can be passed directly through these holes (9). The glass provides a very good insulator. With a metal window frame it is best to keep the feedline away from the metal. A rule of thumb might be a separation of twice the feeder conductor separation - see Figure 6.

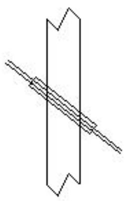


Figure 1

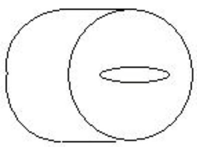


Figure 2

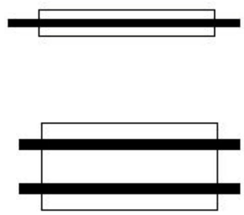


Figure 3

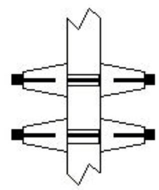


Figure 4

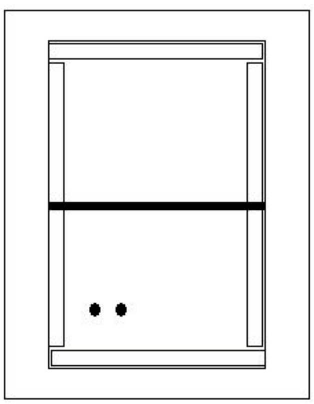


Figure 5

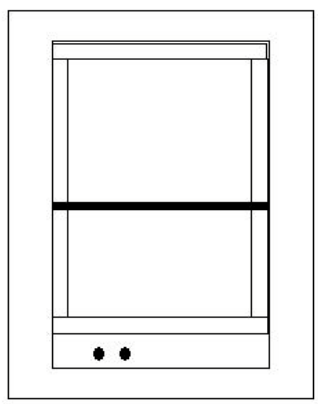


Figure 6

A variation on the above that I have used is to replace the glass in the window with plexiglas or polycarbonate suitable for windows. Plastic is much easier to drill than glass.

- You can also use a 5 or 6 inch high piece of plastic that the width of the window (12). Drill holes in it or use banana jacks or feedthroughs. To put it in place, open the bottom of the window and place the plastic strip under the bottom sash. I use this method with a metal storm window.

Other means:

There are lots of other ways though most are probably best suited to coax cable entry.

- Sometimes there is clearance under the house eaves that can be used, particularly if there are vent louvers or access holes.

- Gable end or attic vent louvers or pipes are another potential access location. However take care that a ventilation fan doesn't shred your feeder!

- You may find room in access holes for plumbing or air conditioner lines. Be sure to seal the holes well. Access holes for phone lines, cable TV and AC power feeds may be poor choices because of the potential for interference.

Lighning safety

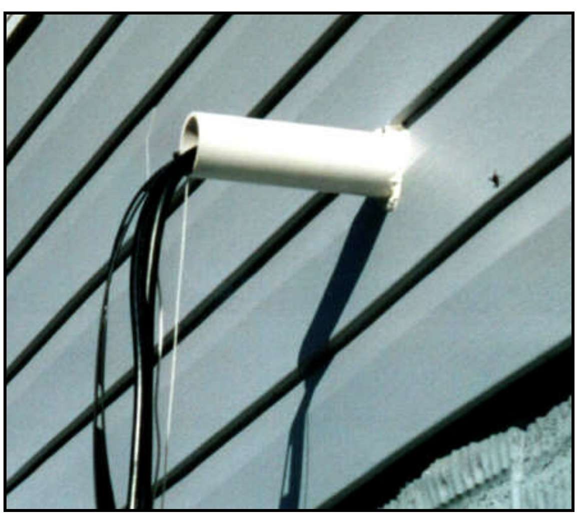
This can be a big subject however it *is* important. You can check the ARRL Radio Amateur's Handbook and Antenna Handbook for ideas. Methods mentioned in the qrp-l thread include:

- Use a knife switch to disconnect the feedline and ground it when not in use (9, 16,20).

- Use large-value resistors to bleed static charges off the feedline (11,17).

- Use spark gaps or spark plugs (12,15,17).

- Disconnect and ground the feedline when not in use. W4RNL summaries protection methods quite well (17) and stresses one point I feel important - whatever protection method you use, keep the lightning *outside* your house!



Email message list.

Here is a listing of the qrp-l messages related to the feeder-into-the house thread. Not all of these are referenced above, but you may care to read them since they discuss topics not covered above.

(1) Date: Wed, 8 Dec 1999 10:23:47 -0600
From: "David Kreinberg" kreinbd@ccgate.dl.nec.com
Subject: Getting feedline into house

(2) Date: Wed, 8 Dec 1999 11:48:35 -0500
From: "Mike Yetsko" myetsko@insydesw.com
Subject: Re: Getting feedline into house

(3) Date: Wed, 8 Dec 1999 12:29:11 +0000
From: "Steven Weber" kd1jv@moose.ncia.net
Subject: Re: Getting feedline into house

(4) Date: Wed, 8 Dec 1999 11:21:30 -0600
From: Karl Kanalz KKanalz@excel.com
Subject: RE: Getting feedline into house

(5) Date: Wed, 8 Dec 1999 09:23:17 -0800 (PST)
From: Monte Stark ku7y@dri.edu
Subject: Re: Getting feedline into house

(6) Date: Wed, 08 Dec 1999 19:31:28 +0200
From: Arjen Raateland Arjen.Raateland@vyh.fi
Subject: Re: Getting feedline into house

(7) Date: Wed, 08 Dec 1999 11:05:36 -0700
From: Jerry Haigwood w5jh@swlink.net
Subject: Re: Getting feedline into house

(8) Date: Wed, 08 Dec 1999 16:03:57 -0500
From: Pete Burbank plburbank@kih.net
Subject: Re: Getting feedline into house

(9) Date: Wed, 8 Dec 1999 21:52:27 -0000
From: "Walt Amos" waltamos@surfree.com
Subject: ANT: regarding getting open wire inside...

(10) Date: Wed, 08 Dec 1999 23:17:53 -0500
From: "T.J. \"SKIP\" Arey N2EI" tjarey@home.com
Subject: Re: Getting feedline into house

(11) Date: Wed, 8 Dec 1999 20:31:54 -0800 (PST)
From: Monte Stark ku7y@dri.edu
Subject: Re: Getting feedline into house

(12) Date: Thu, 9 Dec 1999 00:12:31 EST
From: K5KW@aol.com
Subject: Ladder Line Static Bleed

(13) Date: Thu, 9 Dec 1999 03:26:48 -0500
From: Howard D Rubin n3fel@juno.com
Subject: Re: Grounding shack equipment

(14) Date: Thu, 09 Dec 1999 04:36:09 EST
From: w4pj@w4bkx.ampr.org
Subject: Re: Getting feedline into the house

(15) Date: Thu, 9 Dec 1999 06:44:59 -0600
From: Karl Kanalz KKanalz@excel.com
Subject: RE: Getting feedline into house

(16) Date: Thu, 9 Dec 1999 09:52:40 -0500
From: "Charlie Fitts" cfitts@neca.com
Subject: Re: Getting feedline into house

(17) Date: Thu, 9 Dec 1999 10:17:11 -0500 (EST)
From: "L. B. Cebik" cebik@utkux.utcc.utk.edu
Subject: Parallel feedlines and static discharge

(18) Date: Thu, 9 Dec 1999 12:55:37 -0800 (PST)
From: Curt Milton wb8yyy@yahoo.com
Subject: Re: Getting feedline into house

(19) Date: Thu, 09 Dec 1999 14:40:26 -0700
From: Doug doug@wtp.net
Subject: Re: Parallel feedlines and static discharge

(20) Date: Thu, 09 Dec 1999 17:16:40 -0500
From: Pete Burbank plburbank@kih.net
Subject: Feedline etc

Ron McConnell, W2IOL

Great Circles, Grids & Coordinates "GCGC"

DOS program calculates ellipsoidal geodesic path for antenna bearings/azimuths, distances, Maximum Usable Frequencies, and QRP Miles-per-Watt using Lat/Long or grid squares.

GCGC & DX: DOS executables, notes and sources | GCB: DOS executable, F77 souce & notes | GCGC: Linux G77 source

Great Circles, Grids & Coordinates ("GCGC"), is a freeware DOS command line program that calculates the ellipsoidal geodesic path for antenna bearings/azimuths (true and magnetic), distances (km, mi, nmi), Maximum Usable Frequencies (MUF), QRP Miles-per-Watt using Latitude/Longitude or Maidenhead/IARU Locators (a.k.a. grid squares).

For the GCGC zip package (link above)
"Read1st.txt" describes how to get started.
"Read2nd.txt" describes the included files.
"Geo-web.htm" has many geographic links.

The DXCC+ amateur radio call prefix, country, city, latitude/longitude, CQ/ITU/Time zone, continent, ... data base is up-to-date. GCGC is Y4K compatible.

Command Line Input Format

Latitude/Longitude input can be in degree (ddd.dddddd), degree-minute (ddd mm.mmmmm) or degree-minute-second (ddd mm ss.ssss) N/S/W/E formats. Degree º, minute ' and second " symbols are not used for input. Lat/long input is encoded to only as many grid locator characters as needed to use all the data.

Grid Locator input can be 2, 4, 6, 8, 10 or 12 characters, in the formats:
AA, AA##, AA##aa, AA##aa.##
AA##aa.##AA or AA##aa.##AA##
The "." is optional. Upper and lower case are optional.

Command line parameter input syntax is as free-form as practical. Assume the GCGC package is unzipped into a c:\gcgc directory.

Examples:

```
C:\gcgc>g   n 40 46.958 w 74 41.368  me79if.22

C:\gcgc>g   + Paris fn20ps77 0.3 p 100 #

C:\gcgc>g   VY0 +   40.78264 N 74.68948  W   150 f

C:\gcgc>g   53 n 0 e   0.5 p
```

Where:
"+ Paris" retrieves Paris, France from the DX database
"VY0 +" retrieves Nunavut, Canada
"150 f" = solar flux of 150.
"# 100" = sunspot # of 100.
"0.3 p" & "0.5 p" = 0.3 & 0.5 Watts for MpW.

The user can store a default "home" (#1) location latitude/longitude (or grid locator) as the first line of ASCII text file "home.dat." Then the input of only one remote (#2) location

c:\gcgc> g   n 51.3 w 1.2

will retrieve the home/base location.

For an example of a non-amateur radio application, if the lat/long for the Kaaba (N 21º 25' 30" E 39º 49' 24') in Mecca is stored as the default home location, then the azimuth or return bearing from Sta. 2/Home to Sta. 1 and magnetic bearings corresponds to the Qibla, the sacred direction, as read on a map or on a compass with an accounting for the local magnetic variation/declination.

Great Circle (Spheroid/Ellipsoid) Algorithms

GCGC uses Thaddeus Vincenty's Inverse (lat1/long1 & lat2/long2 to get azimuth & distance) and Forward/Direct (lat1/long1 & azimuth 1-2 & distance 1-2 to get lat2/long2) ellipsoidal model algorithms. WGS-84 (NAD-83) is the default datum with a choice of about 25 more datums as options.

The US NGS Fortran IV code was used as the basis.

High Frequency (3-30 MHz) Radio Propagation

MaxiMUF is the MUF routine, based on Radio Netherlands Maximuf3.bas which is based on BBC External Services F2 layer height algorithms by Raymond Fricker.

Magnetic Bearings/Azimuths

The horizontal component of the World Magnetic Model (WMM) is used for magnetic variation/declination to offset true geographic bearings to obtain magnetic bearings (+/-1º).

The WMM 2005 coefficients for years 2005-2009 are included   The older 2000-2004 coefficients will remain accurate enough for most purposes for most purposes.

DOS and Windows Operating Systems

GCGC works in a DOS window under Windows and on DOS palmtop PCs such as the HP-95/100/200 and Fujitsu Poqet PC. It does not work with Windows CE.

For Windows XP, use Start and Run to run "cmd.exe" to open a DOS emulation window with a "C:\" prompt.

For older Windows, use "command.com" instead of "cmd.exe." If you use DOS frequently, create a shortcut to "cmd.exe" or "command.com."

For Linux, the DOS executable _may_ work with DOSEMU or WINE. Download gcgclinx.zip below by clicking on the text, not the globe. The package contains the current beta Linux source. Reports of Linux tests, successful or not, are of great interest.

To download the GCGC zipped package below, click on the text, not the globe. Unzip gcgc-dos.zip into its own "GCGC" directory. It contains the DOS executable, necessary data files, read1st, notes and several "homework" text files. The f77 source is inside as "gcgc-for.zip."

Skim file "read1st.txt" to get a feeling on what can be done and how.

THANKS!!

To faithful GCGC beta testers, Russ Garnet, WA0UIG, and Ken Brown, N4SO making GCGC into a useful thing, Bob Brown, NM7M for MaxiMUF3.bas, and to Cliff Segar, KD4GT, and his special YL for dumping the crude draft of "Grids: 20 to 12.doc" into MS Word and cleaning it up.

GCGC was inspired by Steve (K5OKC, ex-N5OWK) Sampson's neat little command line great circle distance/bearing program gc.c.

GCGC & Linux

As of March 25, 2003, the g77 Linux version calculates bearings and distances, but skips any requested MUF. There seems to be some difference in the way f77 and g77 handle command line prompt responses. ?? The dos <-> linux linefeed/carriage return thing?

Thanks to Joop Stakenborg, PA4TU at The ham radio Linux site http://radio.linux.org.au for this effort.

DX Database Search

The "DX" (dx.bat") command will search the ASCII text "DX_W2IOL.pre" country/city/state/timezone/etc database, as

c:\gcgc\dx London

will find London, England and Londonderry, Kiritami. Note that an uppercase "L" is required, unless one does something like

c:\gcgc\g ondon

which will also work. If the target has two (or more) words, use double quote marks, as

c:\gcgc\dx "Los Ang"

will find Los Angeles. This database has more information than the stripped down ASCII text country/city latitude/longitude database "qxdxqths.cou" used by GCGC. The ASCII text file "dxnotes.txt" contains some verbose detail on the fields in the database. An option to disable the problem location traps (antipodes, geographic poles, Pt. 1 = Pt 2, same longitude...) has been added to gcb to enable studying the behavior of the algorithms close to problem points. Mainly the spherical ones crash, or worse, get the wrong result.
Extended Maidenhead/IARU Locators

There is an informal agreement to extend the definition of Maidenhead/IARU Locator grids, as AA##aa##AA##, beyond the standard six, AA##aa by continuing with alternating number and letter pairs to encode longitude and latitude. Number pairs would be 0 to 9 for a divisor of 10. Letter pairs would be A to X (a to x) for a divisor of 24. Use of the extension is optional and only on a need basis for a given application. Standard up-to-6-character locators will serve for the majority of applications.

8-character Grid Locator capability per Ekki PLicht, DF0OR's RadioDistance program was added 2003 April 30.   Eight-character grids are currently used for some VHF/UHF/SHF work in Germany and maybe elsewhere. The greater resolution and accuracy in antenna bearings and distances is useful for locations in the same 6-character grid sub-square, such as FN20ps.

A 12-character locator, like FN20ps.77GU31, corresponds roughly to an area 3m by 2m or 9 ft by 6 ft at 40º N/S. You need one of these to locate your shack and several more to locate your HF antenna. They will be your own personal grid locators. Perhaps the center of the antenna would be the best choice as the place where RF comes and goes. :)

Note that 10-characters are solid when obtaining latitude and longitude with GPS receivers with WAAS capability. 12-characters are a bit shaky without averaging with current GPS receivers. Improved civilian GPS is being planned.

By the point one is converting latitude and longitude and grid locators to the 11th and 12 characters, roundoff errors with finite length digital arithmetic, even double precision, are starting to show themselves.

Locator input:
GGCC and gcb accept a "6.6" format with a "."/dot/point/period between characters 6 and 7 for grid locators than 6 characters, as FN20ps.77GU31. The "." is unofficial, w2iol-only, and is optional. FN20ps and FN20ps77GU31 still work.

Locator output:
GCGC and gcb insert a "."for grid locators longer than 6 characters.

GCB (Great Circle Bearings [& distances])
The little w2iol "gcb" program started as a little program written for the US National Ski Patrol in 1983 and is now used as a test vehicle for candidate ideas for GCGC.

Download gcb.zip below by clicking on the text. The package contains the DOS executable and f77 [& g77?] source.

gcb converts latitude and longitude to 12-character grid locators and vice versa per the "A to X, divisor = 24" definition of characters 9 & 10 and any later letter pairs. It calculates bearings (azimuths) and distances using two different spherical earth models: great circle (a.k.a. orthodrome, shortest distance) and rhumb lines (a.k.a. loxodrome, constant azimuth) and five ellipsoidal models: Vincenty, Sodano, Pittman, Thomas/Gougenheim/Forsythe inverse and Andoyer distance inverse with Cunningham's azimuth.

Michael E. Pittman's inverse, Emmanuel Sodano's geodesic inverse distance algorithm paired with Cunningham's azimuth on the spheroid (ellipsoid) have been added to gcb. Sodano and Andoyer are non-iterative, closed form alternatives to Vincenty's iterative geodesic inverse. Pittman has the same accuracy capability as Vincenty.

gcb works in a prompt & response mode:
as in gcb asks: "Latitude? n/s dd mm ss.s ?" to which the user types "n 40 46 57.6" without the quotes, and with no degree "º," minute "'" or second ' symbols. Leading zeros (0) and zeros for zero value parts are needed, as in gcb asks: "Longitude? w/e ddd mm ss.s ?" to which the user types "w 074 00 21.3"

This is in contrast to the more free form command line parameter input for GCGC.

An option to disable the problem location traps (antipodes, geographic poles, Pt. 1 = Pt. 2, same longitude,...) has been added to gcb to enable studying the behavior of the algorithms as the locations approach problem points.

A Sodano-only, lat/long-only version of GCB is available.

===============

Comments, suggestions, and especially error reports for GCGC, dx and gcb are welcome.

Double your money back if not satisfied.

Cheers, 73,

Ronald C. ("Ron, "Doc") McConnell, PhD
w2iol@arrl.net

WGS-84: N 40º 46' 57.6" W 74º 41' 21.3" (+/-0.1")
FN20ps.77GU96 (+/-)
NAD-27: V +5058   H +1504

==========================

GCGC has been accepted by the US National Geodetic Survey as one of their two "User Contributed Software" packages so far.

<http://www.ngs.noaa.gov/PC_PROD/PARTNERS/GCGC/index.shtml>

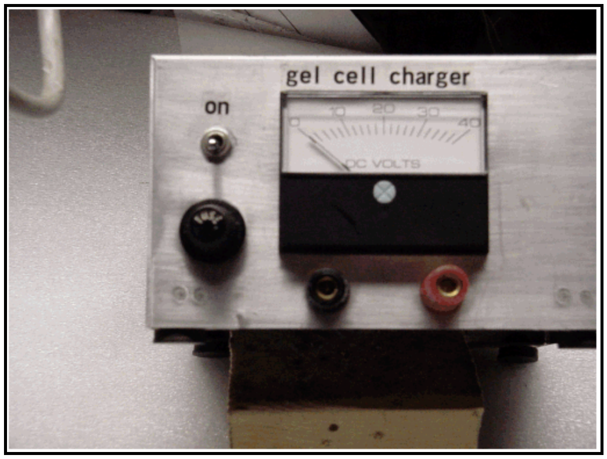
The latest version is always here on this website.

==========================

David S. Ottenberg, WA2DJN

Gel Cell Charger

I recently was checking one of my gel cell batteries and found that it was down to 10 volts instead of the rated 12 volts at 7ah.

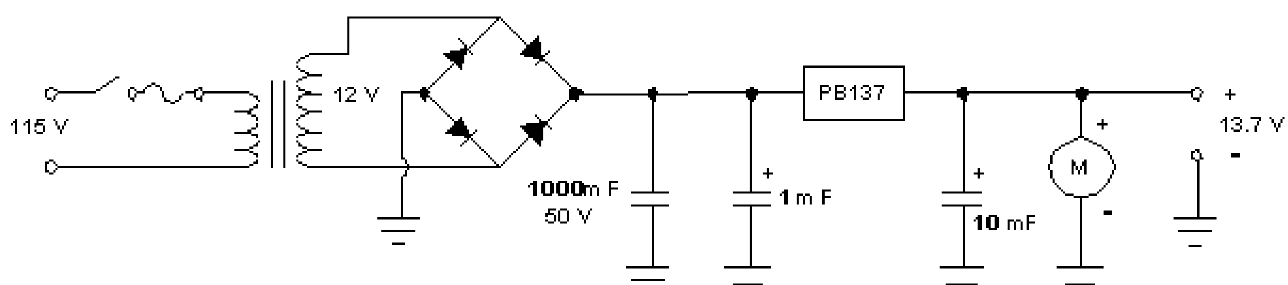


I talked to some of my friends about different types of battery chargers and my friend Ed Roswell, K2MGM, told me about a new type of positive voltage regulator chip. This chip is 13.7 volts at 1.5 amps and has thermal shut down, internal current limiting and is designed for battery charging.

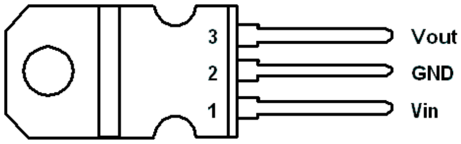
He sold me a few of the regulator chips to build up a battery charger, and so I started in to make the circuit from the spec sheet and see what developed.

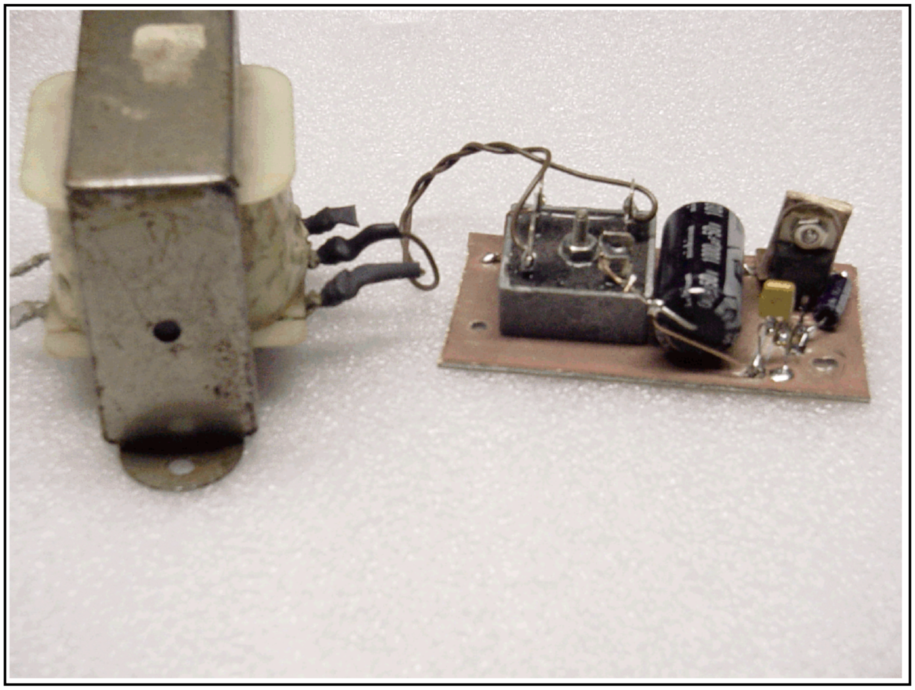
The regulator chip is a PB137 made by ST Microelectronics and is sold by Mouser Electronics, part number 511-PB137ACV. Priced at .50 ea. It comes with a data sheet.

I used a 12 volt transformer, a diode bridge, 1000 mfd at 50 volt cap, a 1 mfd cap, 10 mfd cap and the voltage regulator. I put all of the circuit on a piece of pc board, mounted in a box, and used a DC meter to read the output voltage. The charger works very well and will keep my batteries in good working order.



PB137 CONNECTION DIAGRAM (top view)

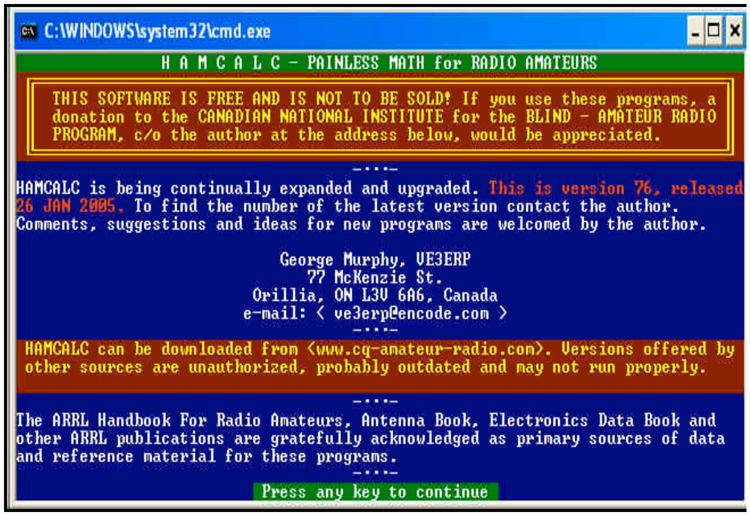




George Murphy, VE3ERP

HamCalc

Free software for WINDOWS or MS-DOS containing over 300 "Painless Math" computer programs for radio amateurs and professionals, used worldwide as a design, reference and learning tool since its introduction in 1993.



Most programs can be run in either Metric or Imperial/USA units of measure. Contains much information not readily found in current popular handbooks and literature. Easy to install, use and understand by non-technical hobbyists.

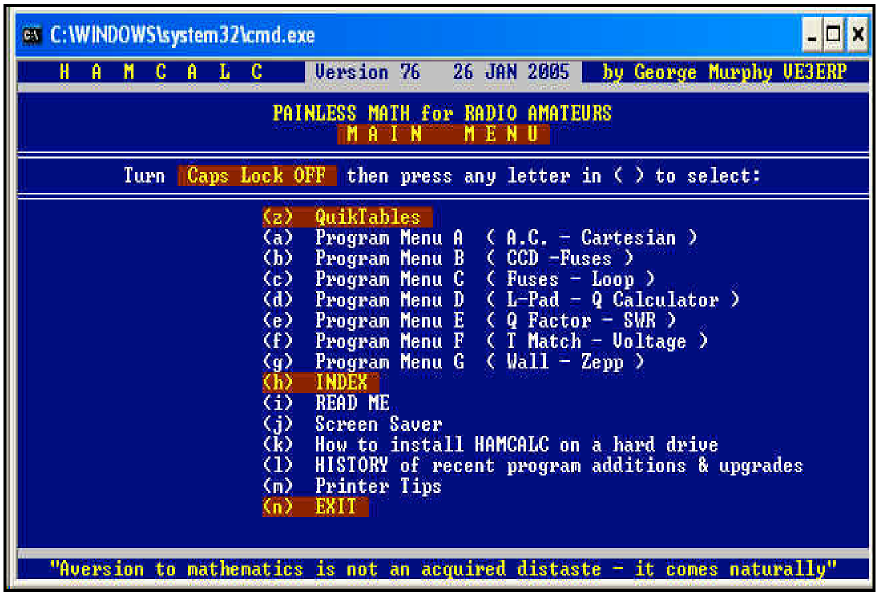
HamCalc does not support mouse operation. Menu selections are by keyboard entry (usually a single keystroke).

Call up individual programs from either the Program Menus or the INDEX option on the Main Menu. When you exit HamCalc you are automatically returned to WINDOWS Desktop.

HAMCALC can be downloaded from <cq-amateur-radio.com>. Versions obtained elsewhere are unauthorized, probably outdated and may not run very well. To find out the latest HAMCALC version number at any time, contact the author at: <ve3erp@encode.com>
The latest version, HAMCALC 76, was released Jan. 26, 2005 and is now available as a free download at <www.cq-amateur-radio.com>. Scroll down the opening page and click on HAMCALC in the red box at the bottom of the left side.

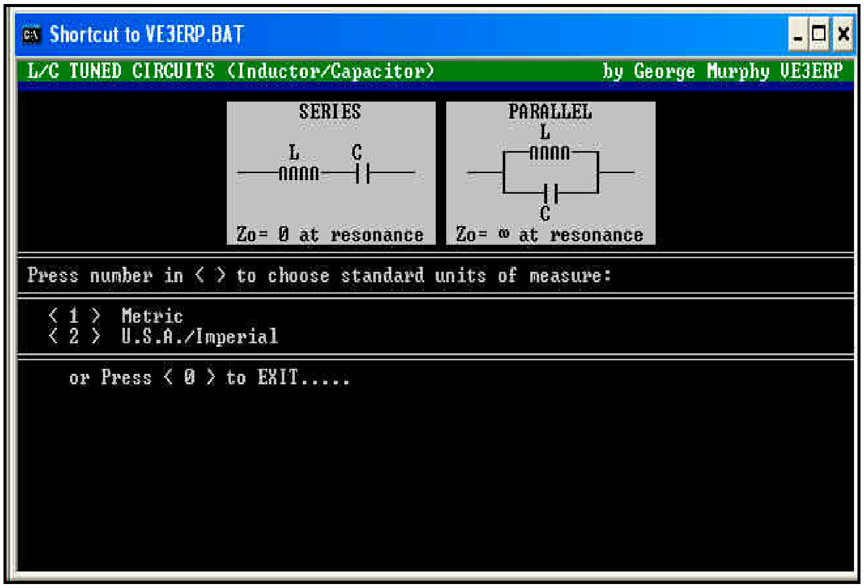
-73- Murph VE3ERP

When running HamCalc, the first screen that you see after pressing any key is:

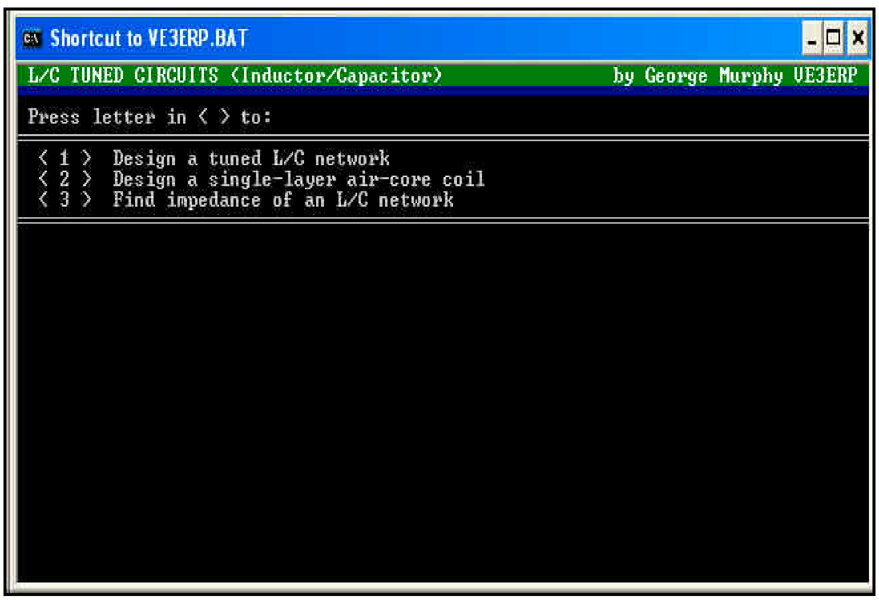


Selecting Program Menu <f> brings up the following screen:

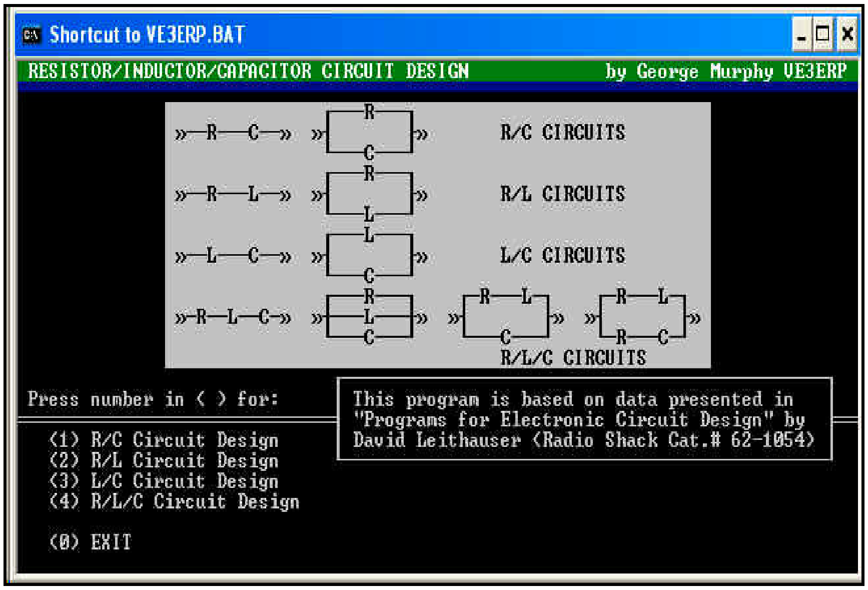
As an example, the parallel L/C circuits on the DDS Daughtercard were chosen for analysis. Selecting <34> (Tuned Circuit Design - L/C network) brings up the following:



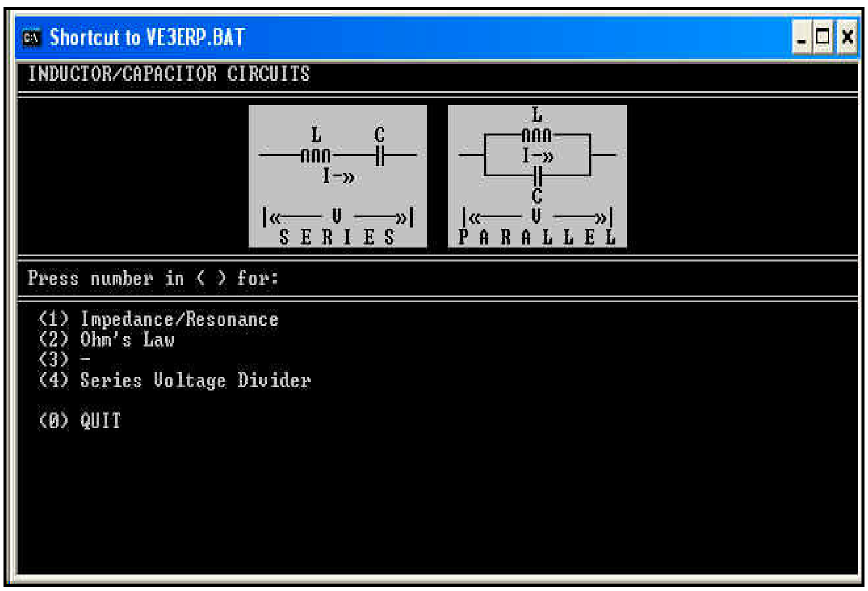
Select <2> for U.S.A./Imperial units of measure. This brings up the following screen:



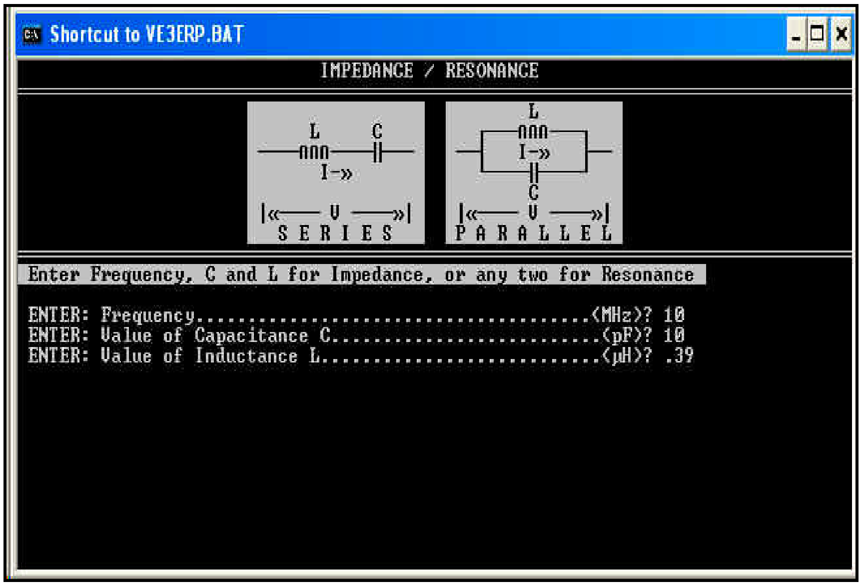
Select item <3> (Find impedance of an L/C network). This brings up the following screen:



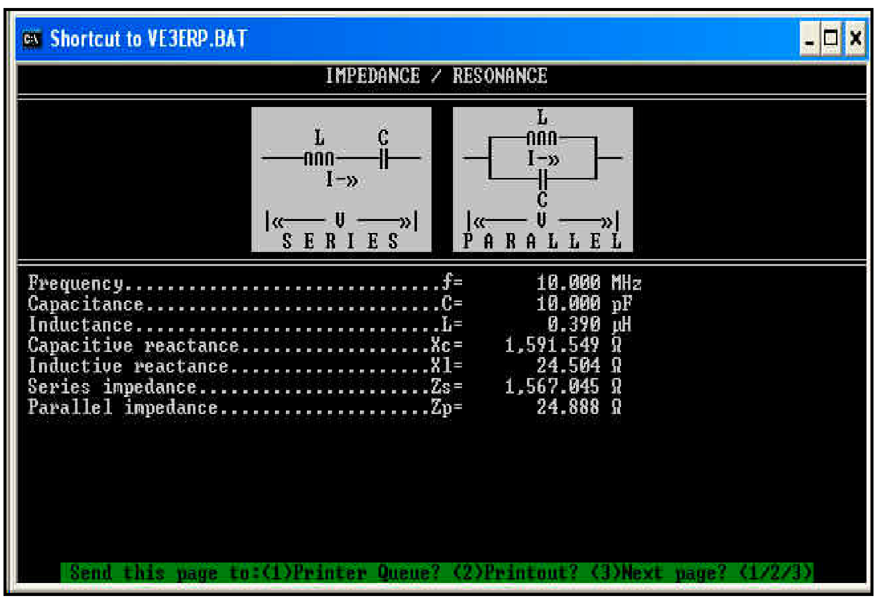
Select <3> (L/C Circuit Design). This brings up the following screen:



Select item <1> (Impedance/Resonance). This brings up the following screen. Enter in values for frequency (in MHz), capacitance (in pF), and inductance (in µH):



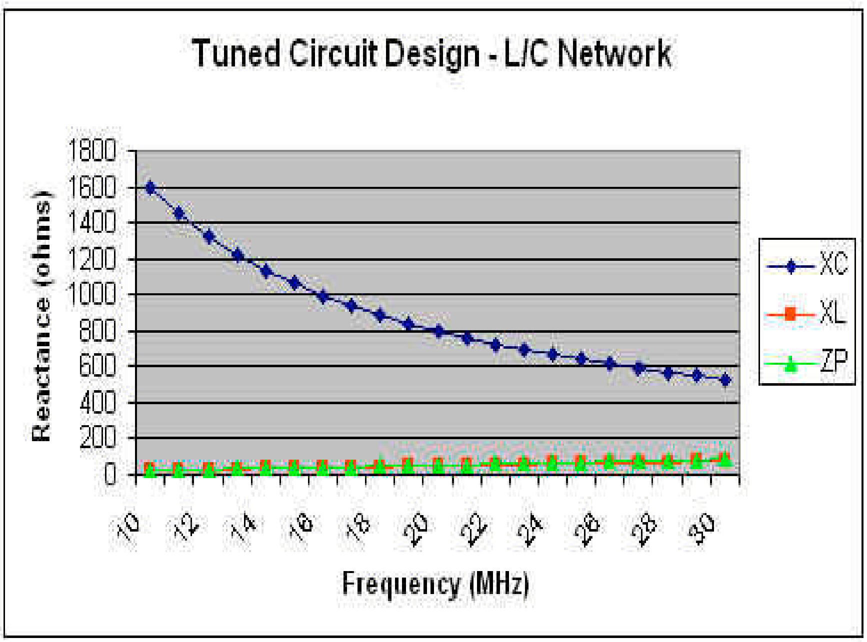
Using the values for L1 (0.39 µF) and C4 (10 pF) on the DDS Daughtercard, we get a parallel impedance of 24.888 ohms at a frequency of 10 MHz:



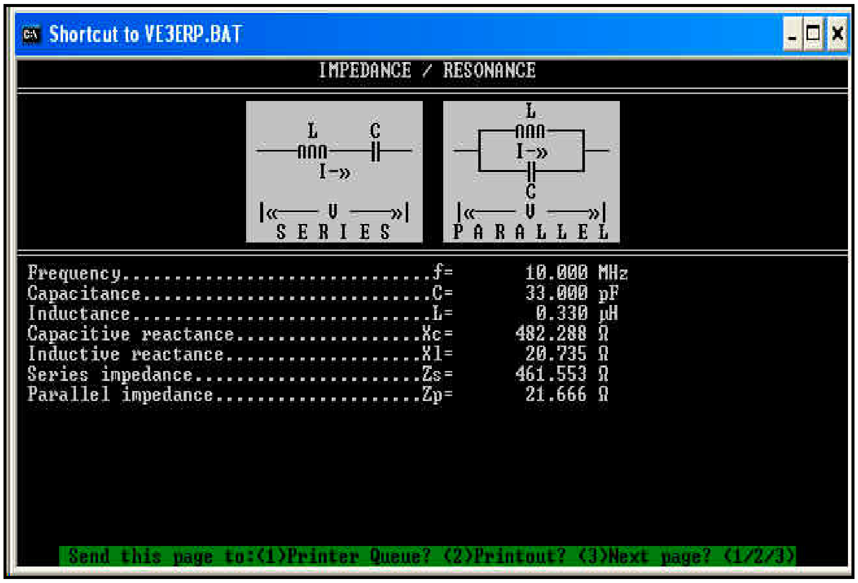
Repeating this procedure by entering <3> followed by <1>, values for capacitive reactance (X_C), inductive reactance (X_L), and parallel impedance (Z_P) were calculated for frequencies from 1 to 30 MHz:

Freq.	X_C	X_L	Z_P	Freq.	X_C	X_L	Z_P	Freq.	X_C	X_L	Z_P
1	15915.490	2.450	2.451	11	1446.863	26.955	27.467	21	757.881	51.459	55.208
2	7957.747	4.901	4.904	12	1326.291	29.405	30.072	22	723.431	53.910	58.251
3	5305.164	7.351	7.362	13	1224.269	31.856	32.707	23	691.978	56.360	61.358
4	3978.873	9.802	9.826	14	1136.821	34.306	35.374	24	663.146	58.811	64.534
5	3183.099	12.252	12.300	15	1061.033	36.757	38.076	25	636.620	61.261	67.784
6	2652.582	14.703	14.785	16	994.718	39.207	40.816	26	612.134	63.712	71.113
7	2273.642	17.153	17.283	17	936.206	41.658	43.597	27	589.463	66.162	74.527
8	1989.437	19.604	19.799	18	884.194	44.108	46.424	28	568.410	68.612	78.032
9	1768.388	22.054	22.332	19	837.658	46.558	49.298	29	548.810	71.063	81.633
10	1591.549	24.504	24.888	20	795.775	49.009	52.225	30	530.516	73.513	85.339

These were then plotted out for frequencies from 10 to 30 MHz:



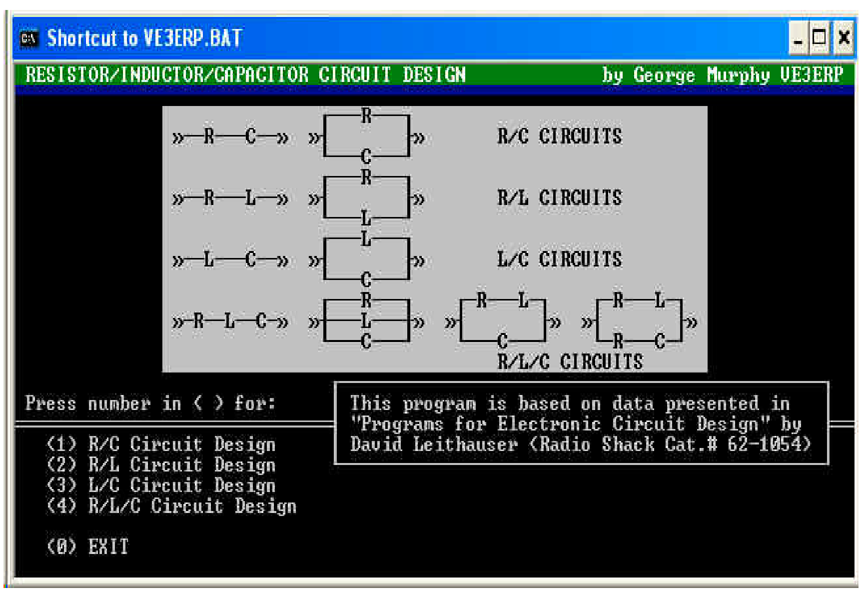
Using this same procedure, the values for L2 (0.33 uH) and C5 (33 pF) for the DDS Daughtercard gives us a parallel impedance of 21.666 ohms at a frequency of 10 MHz:



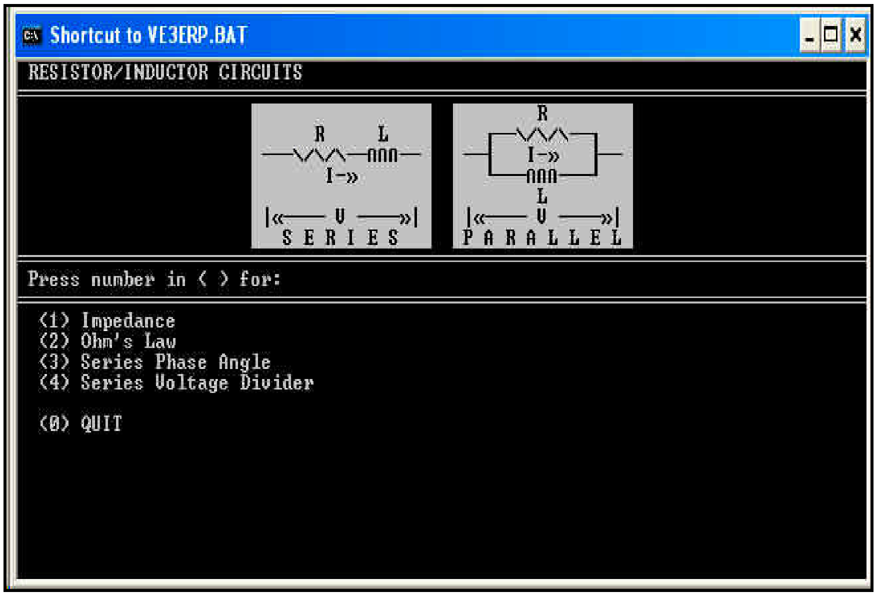
As in the above example, the frequencies using these values may also be plotted out.

Again selecting <34> (Tuned Circuit Design - L/C network), selecting <2> for U.S.A./Imperial units of measure, and selecting <3> (Find impedance of an L/C network), we next calculated the inductive reactance, series impedance, and phase angle for the series combination of R4 (47 ohms) and L3 (100 µH).

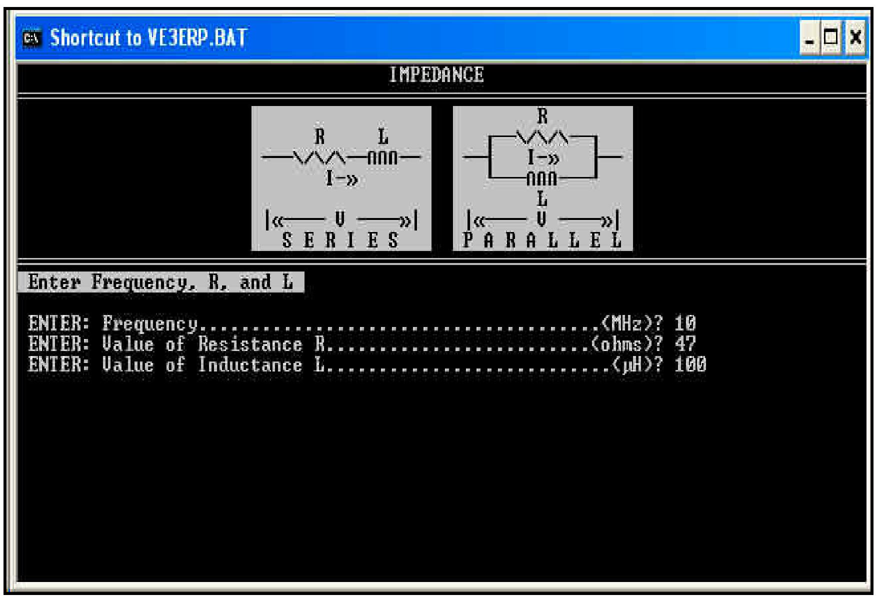
This time, we selected item <2> (R/L Circuit Design):



Next we selected item <1> (Impedance):



This brought up the following screen, at which point we were prompted to enter frequency (MHz), resistance (ohms), and inductance (µH):

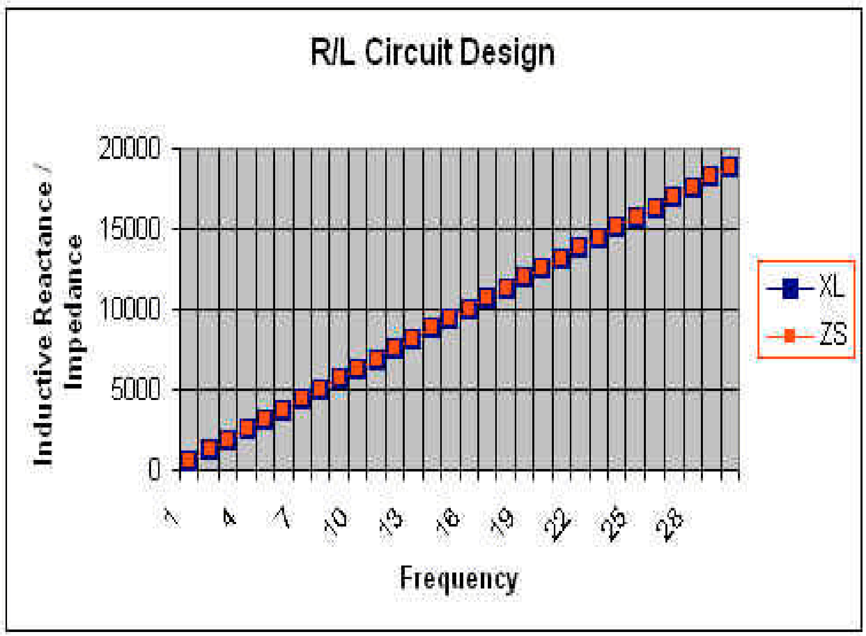


At a frequency of 10 MHz, HamCalc calculated an inductive reactance (X_L) of 6283.186 ohms, a series impedance (Z_S) of 6283.362 ohms, and a series phase angle of 89.571°:

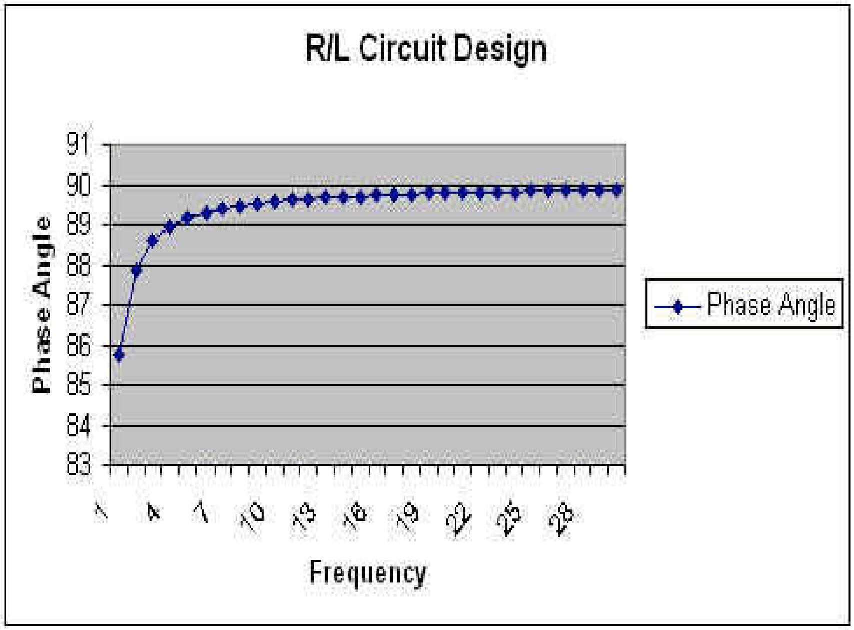
Repeating this procedure by entering <3> followed by <1>, values for inductive reactance (X_L), series impedance (Z_S), and series phase angle (°) were calculated for frequencies from 1 to 30 MHz:

Freq.	X_L	Z_S	Angle	Freq.	X_L	Z_S	Angle	Freq.	X_L	Z_S	Angle
1	628.319	630.074	85.722°	11	6911.505	6911.664	89.610°	21	13194.690	13194.780	89.796°
2	1256.637	1257.516	87.858°	12	7539.823	7539.970	89.643°	22	13823.010	13823.090	89.805°
3	1884.956	1885.542	88.572°	13	8168.142	8168.277	89.670°	23	14451.330	14451.400	89.814°
4	2513.275	2513.714	88.929°	14	8796.460	8796.585	89.694°	24	15079.650	15079.720	89.821°
5	3141.593	3141.944	89.143°	15	9424.779	9424.896	89.714°	25	15707.970	15708.040	89.829°
6	3769.912	3770.205	89.286°	16	10053.100	10053.210	89.732°	26	16336.280	16336.350	89.835°
7	4398.230	4398.481	89.388°	17	10681.420	10681.520	89.748°	27	16964.600	16964.670	89.841°
8	5026.549	5026.769	89.464°	18	11309.740	11309.830	89.762°	28	17592.920	17592.980	89.847°
9	5654.867	5655.063	89.524°	19	11938.050	11938.150	89.774°	29	18221.240	18221.300	89.852°
10	6283.186	6283.362	89.571°	20	12566.370	12566.460	89.786°	30	18849.560	18849.620	89.852°

The inductive reactance and series impedance were plotted out for frequencies from 1 to 30MHz:



The series phase angle was also plotted for frequencies from 1 to 30 MHz:



The above examples use just two of many programs found in HamCalc. Most of these programs ask you to input data. If you are asked to enter some data that you don't know, or that you want the computer to tell you, just press the <ENTER> key to by-pass the question.

A hard drive is required for the installation of HamCalc. Once installed it can be run in WINDOWS or MS-DOS. HamCalc is written in GWBASIC but does not require MS-DOS to run. GWBASIC.exe is a stand-alone file that runs in WINDOWS and MS-DOS operating systems.

Using one or several of HamCalc's over 300 computer programs, one could easily analyze a simple circuit that many QRPers have.

Jerry Haigwood, W5JH

The "Ideal" Feedline Length for the 88-Footer

Is there an ideal feedline that will allow easy matching on all HF bands? Well, maybe.

Introduction

The 88 foot long doublet has enjoyed a bit of popularity over the past few years. Most of this popularity has come forth do to an article by L.B Cebik (W4RNL), "The 'Ideal' Back-Up Antenna for 80-20 Meters."1 In that article, LB suggests using the 88 foot doublet as an ideal backup antenna because of the 80-20 meter broadside pattern and associated gain on 20 meters. LB also suggests using 3 of these antennas in either a delta or 'Y' configuration for better coverage. Instead of using this antenna as a backup, many people have adopted it as their primary 80-20 meter antenna. Some people, like me, use this antenna on all HF bands 80-10 meters. It is also a popular portable antenna. The typical feedline used with this antenna is balanced, low loss, 450 ohm window line. And, the complex impedance of this antenna requires the use of an antenna tuner (transmatch). Is there an ideal feedline that will allow easy matching on all HF bands? Well, maybe.

Analysis

Recently, I purchased some type 553 balanced line from The Wireman.2 Like the standard 450 ohm window line, the type 553 is a low loss balanced line. Unlike the standard 450 ohm window line, the type 553 uses stranded wire and is flexible. The impedance of the type 553 line is 390 ohms and it can be substituted for standard 450 ohm balanced line in almost all applications. Using this feedline with a small flexible antenna wire makes a nice lightweight portable antenna. So now let me modify the original question. Is there an idea length of type 553 balanced line that will allow easy matching on all HF bands? I undertook some analysis to determine the answer. Using EZNEC3, I analyzed a center fed, 88 foot long antenna installed at a modest height (37 feet) above an average ground to determine the impedance at several frequencies. The impedance was fed into TLDetails4 and the feedline was analyzed. Table 1 shows the results of the analysis. The feedline lengths shown are the lengths required to convert the complex impedance of the antenna to a resistive load.

Table 1

Frequency (MHz)	Feedline Length(ft)	R ± j (at Antenna)	R ± j (at Feedline)	SWR
3.985	31.0	23.58 - j468.5	12.41 + j0.5	4.029:1
7.08	41.7	243.3 + j589.4	70.69 - j1.61	1.415:1
10.1	66.5	2798.0 + j1873.0	43.40 - j0.03	1.152:1
14.1	42.7	135.3 - j827.7	29.26 + j0.88	1.710:1
18.1	41.7	197.3 + j453.5	83.27 - j0.51	1.665:1
21.06	52.9	2459.0 + j1705.0	48.59 - j1.64	1.045:1
24.9	42.2	291.0 - j891.4	49.95 + j0.98	1.016:1
28.2	45.2	140.8 + j126.6	131.93 - j1.88	2.639:1

Note: The feedline length is based on a velocity factor of 0.898. Other type feedlines may have a different velocity factor and the length would need to be adjusted.

Even though the data shows several feedline lengths, there is a pattern. It appears that a feedline length of 41.7 feet will allow a close match on 2 bands (40 and 17 meters) without any antenna tuner. If you add an additional 6 inches of feedline, then the 12 meter band can be matched. Add another 6 inches to that amount and 20 meters can be matched. Hey, that’s 4 bands matched without an antenna tuner. Not too bad! If you add 11.2 feet of feedline to the original 41.7 feet then 15 meters can be matched. Adding 24.8 feet of feedline to the original 41.7 feet allows 30 meters to be matched. If you are only interested in a couple of bands, then you may not need the antenna tuner. Let's say you are interested in working 40, 20, and 17 meters as a portable station. You could build an 88 foot doublet and feed it with 41.7 feet of type 553 balanced line. Connect the feedline to a 1:1 balun or choke and use a short length of 50 ohm coaxial cable to the radio (see Figure 1). This set up would work for 40 and 17 meters. Add 1 extra foot of feedline and now you would be matched for 20 meters. That gives you 3 bands without an antenna tuner to haul out into the field, not bad, eh? (for our Canadian friends!)

Unfortunately, all is not that perfect if you want to match all HF bands. The 88 footer presents a high impedance on 30 and 15 meters. Even at the end of the 41.7 foot long feedline, the impedance is still too high to match with most antenna tuners. You will need to modify the 41.7 foot feedline length by adding the additional lengths I've mentioned above. A practical method for attaching extra feedline is by using Anderson Powerpole5 connectors. Powerpole connectors use silver-plated contacts that can handle large currents and are easily snapped together.

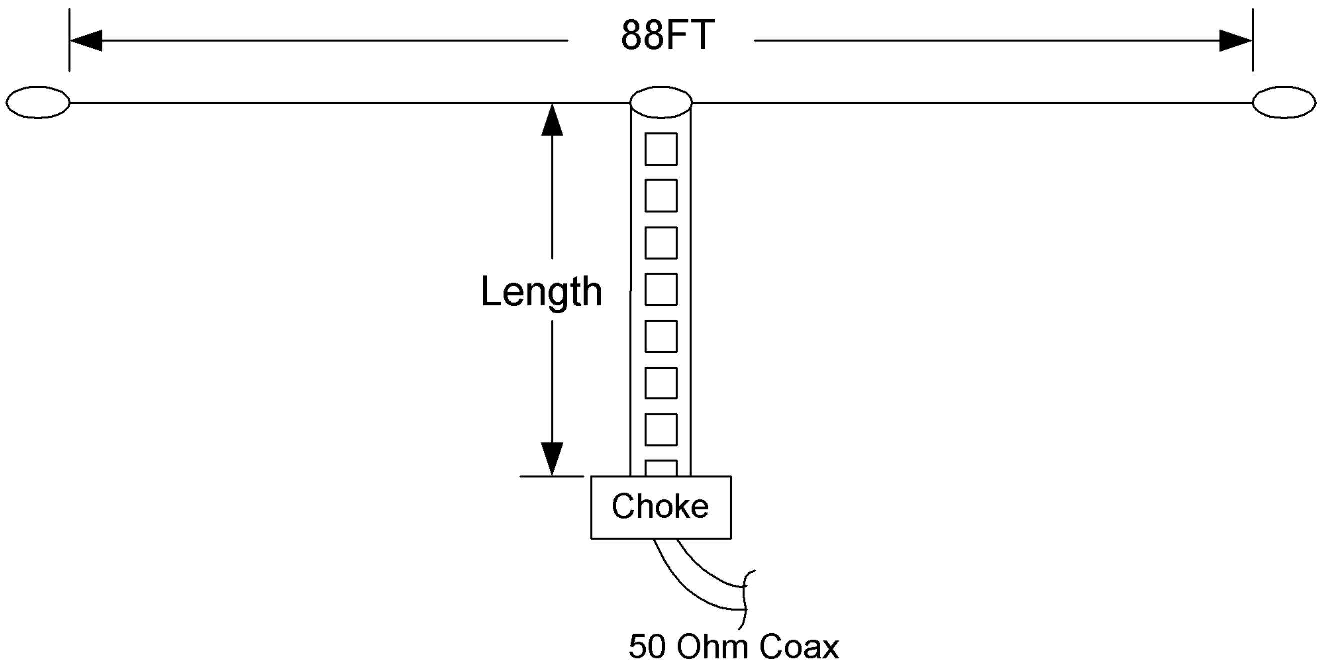


Figure 1

Conclusion

When installing any multi-band antenna that uses a tuned feedline, you need to be conscious of feedline lengths. Some feedline lengths will be harder to match than others. If you want to eliminate the antenna tuner on certain bands, it may be possible by adjusting the feedline length. For the 88 foot long doublet installed at a modest height, I recommend a feedline length of 41.7 feet (using type 553 balanced line). But, be prepared to modify that length on some bands.

References:

1. See URL http://www.cebik.com/88.html

2. Type 553 balanced line is available from:
   The Wireman
   261 Pittman Rd.
   Landrum, SC 29356

3. EZNEC is available from:
   Roy Lewallen, W7EL
   PO Box 6658
   Beaverton, OR 97007

   See URL http://www.eznec.com

4. TLDetails is available from AC6LA:

   See URL http://www.qsl.net/ac6la/tldetails.html

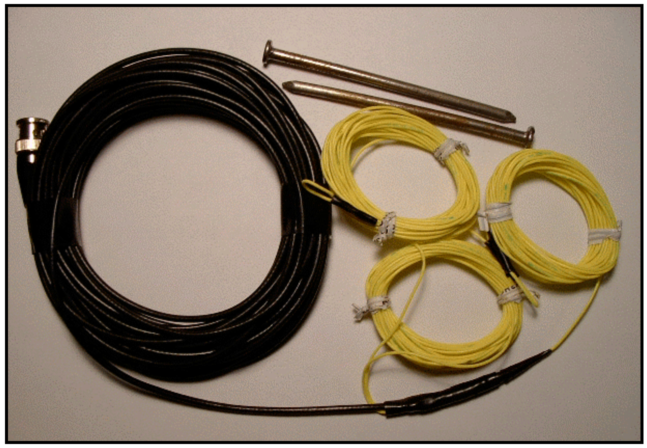
5. Anderson Powerpole Connectors are available from:
   Powerwerx
   401 S. Harbor Blvd, F-320
   La Habra, CA 90631
   (714) 570-3303

   See URL http://www.powerwerx.com

AmQRP.ORG HOMEBREWER

David Ek, NKØE

A Little-Known Antenna Gem: The Inverted Y



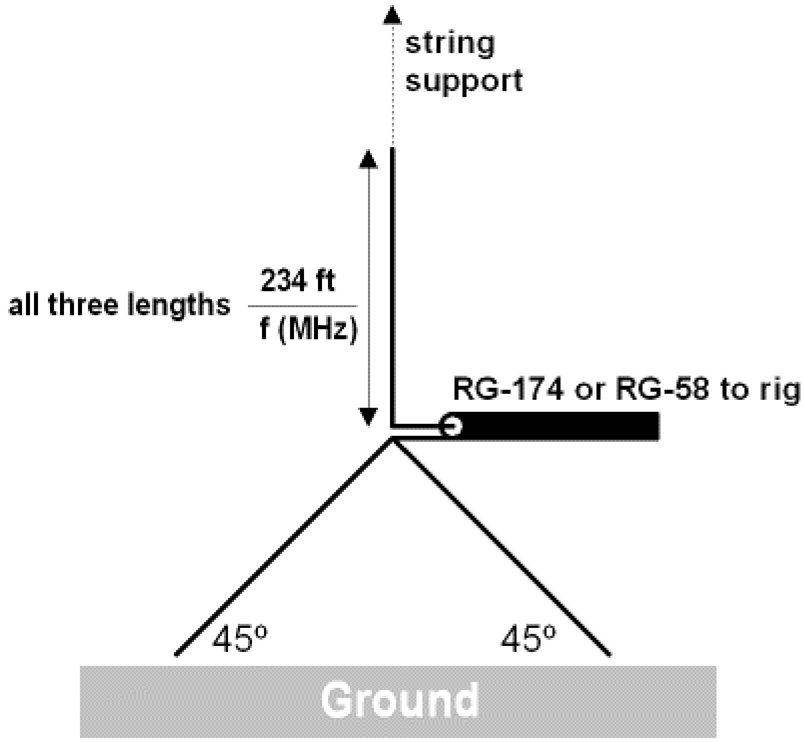
Being a QRPer and a backpacker, it's natural for me to want to drag a rig and antenna along with me when I tramp through the wilderness.

Of course, having to carry everything while I'm doing it naturally makes me want to make my backpack ham shack as light as possible. Many backpacking hams will pack a lightweight monoband rig, a random-wire antenna, and some sort of matching network to match the antenna to the rig. That's certainly a serviceable configuration, but it seemed to me that if I could carry an antenna that was compact and also resonant on my band of choice, I could eliminate the matching network and carry a little less gear.

My favorite rig for casual backpacking use is my SST for 20 meters—it's very compact, light on batteries, yet a good performer with a couple watts of output. I added a TiCK keyer (built inside the SST case) and use a lightweight paddle with my setup. A lightweight resonant antenna would be the final piece of the puzzle. But what sort?

My preferred antenna for my Field Day setup is a simple dipole or G5RV, but that requires quite a bit of feedline and can take a little bit of time to set up. Also, the SWR of a dipole will vary quite a bit depending on the height of the feedpoint and the geometry of the radiators. Thus, you can't count on a good SWR in the woods just because it was okay when you set it up at home. For casual operating, I'll take along an inverted Y antenna.

The inverted Y is a ground-plane vertical with two elevated radials that slope down at an angle of about 45 degrees. Coax is used to feed the antenna, with the center conductor connected to the vertical radiator and the shield connected to the radials. Although shunned as inefficient by many hams, vertical antennas with elevated radials offer some advantages over dipoles in the field when the goal is to eliminate the matching network, at least for the higher bands. First, it's much easier to put up a vertical than a dipole, since only one wire (the radiator) needs to be raised. Second, the feed point of the vertical is closer to the ground than for a dipole, so less feed line needs to be used. Third, it's pretty easy to put up the vertical in the same geometry and the same height every time you use it, making it more likely that the SWR will be consistent from one location to the next.



"Wait a minute!" you say. "Don't verticals require lots and lots of radials to be effective?" Well, yes if you're using a buried-radial ground system, but not for elevated verticals. The ARRL Handbook says that four to eight elevated radials work as well as 120 quarter-wave buried wires. Okay, I'm only using two here, but if you feel strongly about it you could easily add two more elevated radials without much of a weight penalty. One other advantage of elevated radials is that sloping them at a 45-degree angle theoretically makes the antenna feed point impedance about 50 ohms, providing a good match to the coax feed line.

For a 20-meter version of the inverted Y, the radiator and radials are about 16.7 feet long, and the feed point is about 12 feet off the ground. The top of the radiator is then about 29 feet above the ground—not so high as to be hard to raise. For lower bands, the inverted Y's dimensions are too long to be practical.

My field version of the inverted Y is constructed using 24-gauge teflon wire and is fed by RG-174 coax (more lossy, I know, but not terribly so on 20 meters, and I only use about 30 feet so the losses are acceptable). The antenna is raised using string attached to the top of the radiator that is then tossed over a tree branch or some other convenient support. The radials are staked to the ground using long nails (note that I don't make any attempt to actually ground the radials—the nails are simply to hold the wires in place). I cut the radiator and radials long, and then trimmed them for low SWR at 14.060 MHz. The whole works (antenna and feed line together) weighs only nine ounces.

At this point, I will confess that I haven't used this antenna extensively, but Steve N0MHQ has used his version quite a bit. Here's what he wrote to me when I asked him about his experience with the inverted Y:

"As you know, I've been using the inverted Y exclusively since you loaned me the one you constructed about two years ago. I love the design as it is simplicity itself. One string up a thirty foot tree and two nails in the ground. I don't know that it makes any difference if it's two radials are aligned north to south or east to west. Verticals usually are omnidirectional. You and Steve N0TU both have listened to my station during QRPTTF and FD and you both commented that the antenna hears well. I'm confident that it hears better than I do…I've been very happy with this antenna and with my limited CW skills it does everything I could ask for. Easy to build, easy to erect, hears better than me, very portable and lightweight."

If you like 20 meters, give this antenna a try. It's simple to construct and use, and its performance might pleasantly surprise you!

David Ek, NK0E

ekdave@earthlink.net

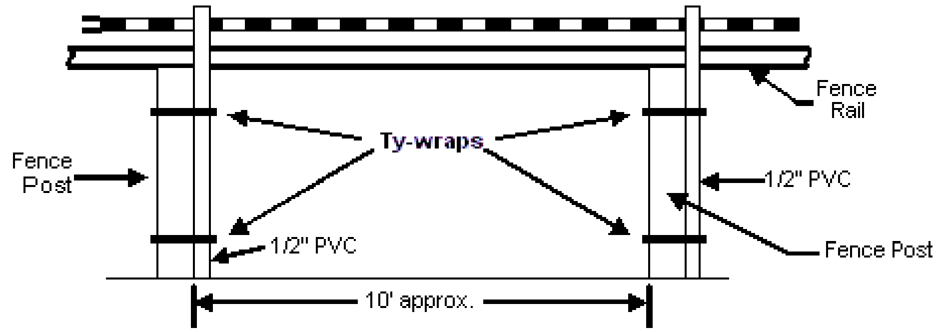
Lenny Wintfeld, W2BVH

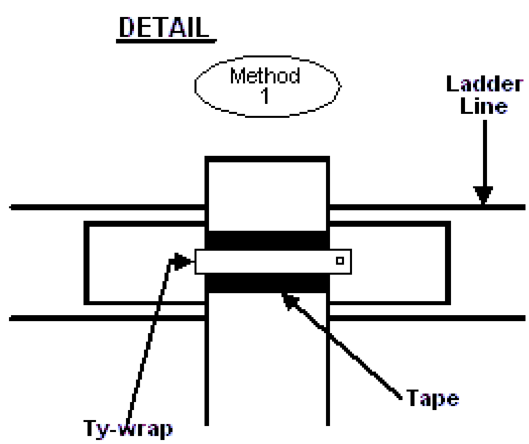
Standoffs For Ladder Line

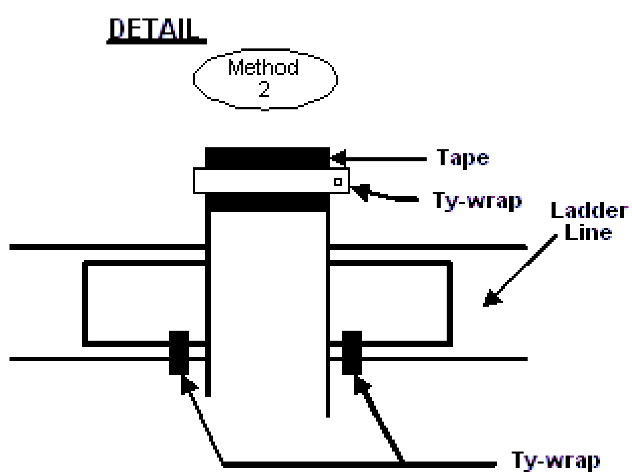
I recently replaced the 30 year old (rotted out and falling down) cedar stockade fence in my back yard with a new chain link fence.

While it was standing, the old fence served very well as a support for the 450 ohm ladder line I use to feed my 80 meter center fed zepp: I simply "wove" the line across every 20th picket or so. I couldn't route the feedline across the new fence in a similar way, since the new fence is all metal. Open wire feed lines like twinlead or ladder line would have their balanced fields disrupted by the metal in the fence.

W2BVH devised a fast, simple and inexpensive set of standoffs for running the feed line along my new fence. The stand offs consist of 5 foot lengths of 1/2" schedule 40 pvc pipe. This material is commonly available in 10 foot lengths at most home centers. (Please refer to the diagram) The pipe is sawn into 5 foot lengths and a 1/16" (or wider) saw kerf is put into one end of the pipe to a depth of about 2". Pipes are secured to every (or every other) stanchion (vertical pipe) of the chain link fence using ty-wraps. The ladder line is slipped into the saw kerfs and adjusted as needed. The line is then secured to the stand-offs using either of the methods shown in the diagram.


Fence Rail
Ty-wraps
Fence Post
1/2" PVC
1/2" PVC
Fence Post
10' approx.


DETAIL
Method 1
Ladder Line
Tape
Ty-wrap


DETAIL
Method 2
Tape
Ty-wrap
Ladder Line
Ty-wrap

Method 1 consists of wrapping tape around the pipe, passing it through the "window" in the ladder line. It can then be secured, if you wish, with a ty wrap.

Method 2 consists of putting a ty wrap around the lower wire of the ladder line; one ty-wrap on either side of the pipe. A couple of turns of tape are then taken around the top of the pipe, above the feed line. The tape may be further secured with a ty wrap as well.

The end result is a neatly dressed feedline running about 10" above the fence. Since the bottom of the pipes are resting on the ground, there's nowhere for them to slip. The tape/ty-wraps keep the line from popping out of the kerfs in the pipe and they also keep the feedline line from slipping through the kerf.

Using this method, it only took me about 15 minutes to re-run my feedline.

Lenny Wintfeld, W2BVH

w2bvh@comcast.net

AmQRP.ORG HOMEBREWER

Ed Roswell, K2MGM

Spreadsheet Calculations for the Design of Small Loops

Have you considered building a "Small Transmitting Loop" (STL), yet been stumped by the dimensional calculations? Well here is your chance to plug some numbers into an Excel spreadsheet to show all sorts of data.

```
Small loop Calculations; top row & power are
Area =          27.6    Freq =              14
in square feet.        in MHz.
Use Circle, Octagon, or Square Area.

Rr =          0.989  ohms,            =  [Radiatio
RL =          0.119  ohms,            =  [Loss Res:
Eff. =        0.892  ;                   loop condu
   or:       89.241  %      or:          -0.49
L(ind.)= 5.9286E-06   Henrys
   or:        5.929   microHenry.

   XL =      521.50   ohms
           Inductive Reactance.
   Ct =  2.1799E-11   Farads, or
              21.80      uuF (pF).
     Tuning Capacitance Required.
```

Link to Spreadsheet

A number of articles have appeared on the construction of small loops, which have advantages for QRP operation. It is not the object of this paper to go over all the design ideas and details, but to present the relevant formulas in a spreadsheet file that will predict what a given size and configuration of loop will do for you, and explain the entry of the parameters.

The spreadsheet formulas are all from the book by Ted Hart, W5QJR, (1)…I just put it into spreadsheet form. A construction article has also appeared in QST (2), and on the Elecraft web page(3). The formulas are given in the accompanying Microsoft Excel® spreadsheet file "**sm_loop.xls**". My experience in a six-foot diameter loop confirms the predictions, in that the expected narrow bandwidths are obtained, however hard they are to measure with my MFJ-259B analyzer on 20 meters! I am still working on a better gamma match for my loop, and want to do some amount of on the air testing.

Enter **Area** (in square feet), **Frequency** (Mhz), **Length** (S, in feet which is the Circumference) of the desired loop in the top row. The formulas for calculating the areas of square, octagon, and circular loops are given in the right-hand side bar. Also, there are conversions for diameter to circumference (and vice versa), and metric to English units that are used in the spreadsheet, and a table of standard U.S. copper pipe sizes (nominal sizes vs. true OD).

Values calculated are: **Rr**, which is the radiation resistance; **RL**, the resistance loss in the pipe; **Eff**, the efficiency; **L**, the loop inductance in Henrys and μH; **XL**, the inductive reactance; **Ct** is the value of the capacitor in Farads and pf to resonate that inductance of the loop; **Q** or Quality Factor; **BW** is the Bandwidth in kHz; **Cc** is the capacitance when used to match via a capacitance divider; otherwise a gamma or loop coupling can also be used, and this value can be ignored.

Inputting a power will show the voltage resulting across the tuning capacitor – one kW will give you over 11,000 volts in the sample shown!

Gain in dB over isotropic and a dipole are also given.

Note that current is not calculated in the loop, but can also be exceedingly high - hence the need to minimize loss in the conductor and its connections, using the pipe diameters shown, and with soldered, not bolted connections. High voltage, low loss capacitors such as vacuum variables, are also used when they can be found.

Sample starting parameters are given in the spreadsheet; after inputting new numbers, always save the spreadsheet to a new filename to avoid corrupting the formulas, in case you make a mistake and place a value in a wrong cell. It should work with Lotus 123 ® and I have transported it to Microsoft Excel ®; it originally was developed on VP Planner ®.

- *Ed Roswell, K2MGM,* ***e-mail:*** *eroswell@monmouth.com*

NOTES:

(1) Small High Efficiency Antennas, Alias the Loop, © Ted Hart, 1985 (Out of print, has previously been available in downloadable form, from www.antennex.com)

(2) QST, June 1986, p.33, Small High Efficiency Loop Antennas, Ted Hart, W5QJR.

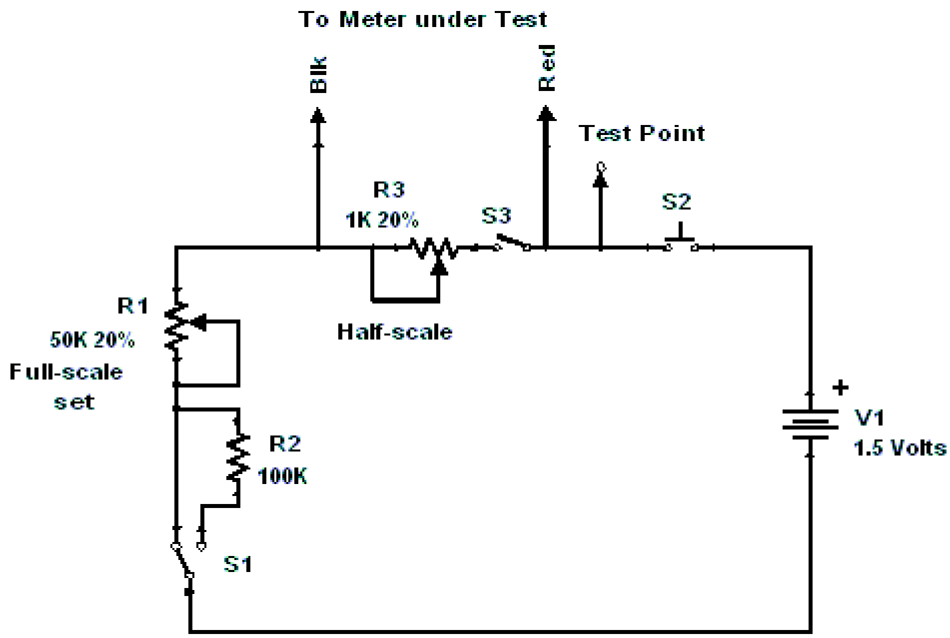
(3) http://www.elecraft.com, Click on Tech.Notes Articles, then on Miniature Magnetic Loops, by David Posthuma, WD8PUO.

	A	B	C	D	E	F	G	H
1	**Small loop Calculations; top row & power are variables to be input.**							
2								
3	**Area =**	27.6	**Freq =**	14	**S(length)=**	20	**Diam. =**	0.625
4	in square feet.		in MHz.		(circumference		(conductor diameter	
5	Use Circle, Octagon, or Square Area.				in feet)		in inches.)	
6								
7	**Rr =**	0.989	ohms, =	[Radiation. Res.]		**Side Calculations**		
8	**RL =**	0.119	ohms, =	[Loss Resistance				
9	**Eff. =**	0.892	;	loop conductor]		**Given meters =**		2
10	or:	89.241	% or:	-0.49	dB.	**Yields feet =>**		6.562
11	**L(ind.)=**	5.9286E-06	Henrys					
12	or:	5.929	microHenry.			**If S(circ.), feet:**		20
13						**Area is calculated thusly**		
14	**XL =**	521.50	ohms			**Circle:**	31.600	
15		Inductive Reactance.				**Octagon:**	27.600	
16	**Ct =**	2.1799E-11	Farads, or			**Square:**	24.800	
17		21.80	uuF (pF).					
18	Tuning Capacitance Required.					**Given Diameter =**		6
19						**Yield Circumf. =>**		18.850
20	**Q =**	235.26	Quality Factor					
21						**Given Circumf. =**		20
22	**BW =**	59.51	kHz			**Yields Diameter =>**		6.366
23								
24	**Cc =**	2.295E-11	Farads, or			**Copper Pipe Reference O.D.**		
25		22.95	uuF (pF)			**Nom.**	3/8"	0.500
26	for divider Coupling Capacitor, if used.						1/2	0.625
27							5/8	0.750
28	If Power=	100	watts, capacitor voltage				3/4	0.875
29	**is Vc =**	3503	volts.				1"	1.125
30							1 1/4	1.375
31	**Gain =**	7.51	dBi				1 1/2	1.625
32	(Radiation + Pattern Gain)						2"	2.125
33	[Dipole = 2.1 dBi]							
34	**Gain over dipole =**		5.41	dB.				
35								
36	Enter Area, Frequency, S (length, = circumference)					**E. Roswell, K2MGM 5/30/1998**		
37	Use area formulas from side for configuration					**[after W5QJR, 1985]**		
38	used. Get circumference from diameter or vice versa.							
39	Enter Power to get tuner Capacitor voltage.							

David Ottenberg, WA2DJN

Meter Checker Circuit
Erata to Erata

Ed Roswell made some changes in the Meter Checker circuit after hebuilt one. He found out that the original circuit was not accurate and redid the circuit.



Connect Red/Black test leads to meter (with shunts removed).
With S3 open, press/hold S2 and adjust R1 for full-scale reading on meter.
(set S1 to the range needed to obtain a full-scale reading)
With S3 closed, press/hold S2 and adjust R3 for half-scale.
Remove meter, with S2 open, measure ohms of R3 (= meter resistance).

Dave Ottenberg, WA2DJN

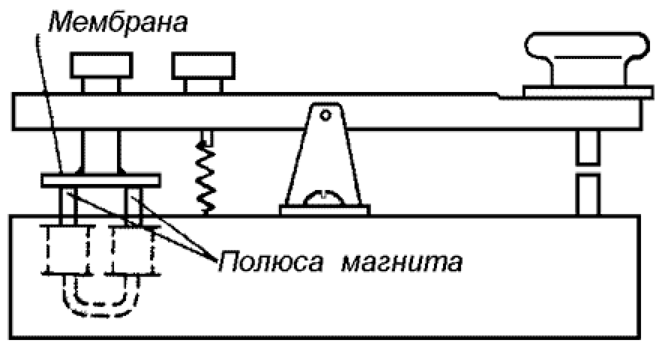
wa2djn@monmouth.com

AmQRP.ORG HOMEBREWER

Victor Besedin, UA9LAQ

Morse Key with AC-Generator

Looking for a Code Practice Oscillator but tire of the same ol'd approach? Check out this contribution from Victor. Using some Russian-based techniques he is able to create a useful training tool for local code classes.



In spite of development of the digital modes of amateur communication, still the old CW mode is a great fun and a professional pride. To work CW mode by hand and ear means that You know Morse-alphabet and can receive it and manipulate according to the rules of the style. With the help of CW are held the most distant "human-made" QSOs, the most beloved "manual" mode of the great majority of hams is also CW, my personal sympathy is this ancient, simple and reliable mode- CW, too. So many unforgettable hours were spent at receiving the heart-touching signals on HF and VHF! For it to stay alive, the mode must have the new generation prepared, and our own traditional capabilities must be maintained and improved, as well!

This simple project is devoted to all that are concerned with that great opportunity to be able to communicate by means of this universal language/mode, I mean Morse/CW.

The telegraph reliability is based upon simplicity: imagine that you have a transmitter and that you can send information simply switching it on and off. The ham who knows the Morse alphabet has an advantage against others, who do not at various occasions, when other modes are not possible. All the newer modes make equipment more complex and less reliable, costly (not available for all who desired), at last, CW-mode is created as if specially for QRP, do not forget it!

To produce all the equipment needed for radio class, there must be a great job to do. But for individual training you can produce the keyer (Figure 1) that needs no elements to supply the incorporated AF-oscillator that is needed for training. All the energy needed you produce by your own hand!

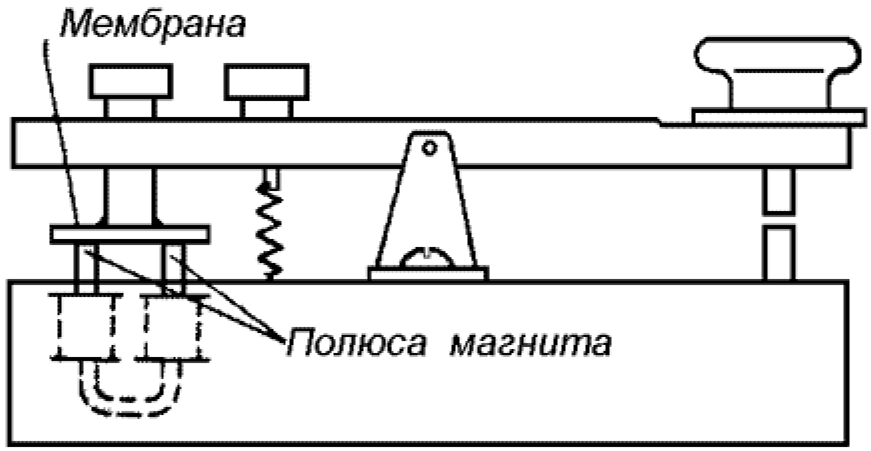


Figure 1. The CW-keyer – AC-generator.

The construction of the keyer consists of standard Morse-key having a box as a base. The pair of contacts (left ones in Figure 1) are replaced by an old ear-phones capsule (percussion cup): its membrane (at the center) is soldered to the adjusting screw. When operated, the membrane is raised and lowered. The electro-magnetic system of the earphone then produces electricity – AC with the frequency of manipulation. Electrical circulations are taken from the coil terminations of the earphone and put to diode rectifier and DC comes then to the cap of the filter which is used here as an accumulator of electric power. It is then fed to the AF-oscillator as a supply voltage via the right pair of the keyer contacts (Figure 1). The impedance of the coil of the electro-magnetic generator is low, about 65-130 Ohms. The earphone (telephone) capsule-lid was taken off with the membrane, the rest was installed into keyer's base through the hole and is fastened there with clamps and epoxy axial to adjusting screw. The membrane material is hard to solder, so cut a new membrane out of white iron (steel plated with soldering material), not less than 0.4 mm thick. The minimal diameter of the membrane must be able to cover the magnetic poles, plus a bit. The membrane must be strictly even and must lie flat on the poles and must be raised from the both poles at the same time. In order to minimize the sticky effect, put thin paper or scotch-band to the lower side of membrane. Note: the thinner the laying, the more power it will deliver to the AC-generator.

If you push the keyer's knob, you will raise the membrane from the poles. You will get a portion of electricity in one direction; lowering of the membrane gives the portion of electricity of opposite direction – so, as you see, it is the AC-generator. The frequency of AC-voltage depends on manipulation speed.

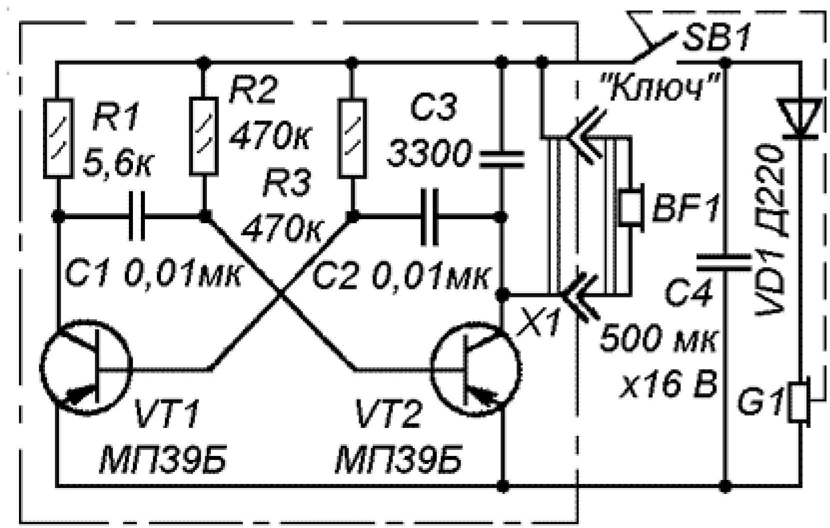


Figure 2. AC-generator supplies AF-oscillator for training purposes.

AF-oscillator (Figure 2) incorporates two germanium transistors VT1 and VT2. It represents by itself the symmetric multivibrator; its frequency depends on values of R2, R3, C1, C2. The load of AF-oscillator is high impedance earphones BF1 plugged into X1. Parallel to BF1 is soldered C3 to make the sound softer. If You want to connect the AF-oscillator output to AF-amp put 4,7…5,6 k Ohm resistor to port X1 instead of the earphones. The low impedance earphones can be connected to port X1 with serial resistor 1 k Ohm or more, but it will decrease the volume. Note: Be aware that some high impedance phones are produced from the low impedance ones with serial connected resistors; such earphones will work but too quietly.

The supply voltage is put to AF-oscillator via pair of contacts of the keyer SB1. The ear-phones produce then sound of definite frequency.

Part values of the AF-oscillator are defined to produce its minimal current consumption. It can work at supply voltages of at least 0.1-0.5 V. The consumption will be then: 25-75 μA. To get the desired power, AC-generator G1 produces AC voltage, which comes to rectifying diode VD1, then DC voltage comes to filter and accumulator cap C4. At the first touch C4 is empty and there will be no sound heard. Before training you have to manipulate quickly for some seconds then it'll work, as the AF-oscillator is supplied by the galvanic element. The intensive operation gives supply voltages to 0.8-1.5 V.

The AF-oscillator uses old-fashioned Germanium transistors of p-n-p structure with the highest possible β. If possible, choose transistors with minimum leakage from collector to base. VD1 must be as near to ideal as possible, with minimum forward and maximum return resistance. It can be a low power RF device, or impulse one. The oxide cap C4 must be low leakage one, for instance to higher voltage or low leakage types. Other caps are ceramic or other types. Resistors are ¼ or 1/8 watts. Earphones are high impedance types 1600-2200 Ohms with serial connection of the two halves (capsules). The supply power can be taken from other sources if needed -- galvanic element (it can be the old one), solar element [3], homebrew galvanic, net regulated, etc.

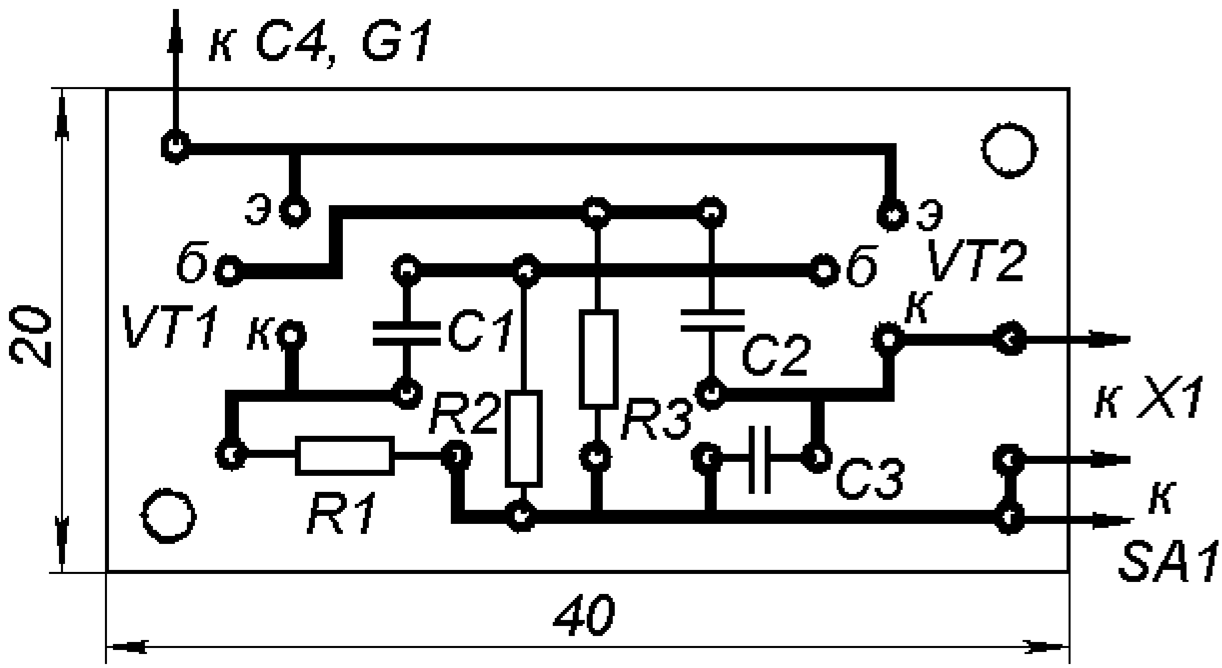


Figure 3. The board of AF-oscillator with parts' placement.

The parts of the AF-oscillator are mount on one side foiled PC-board (Figure 3). The board and other parts are situated inside the base box of the keyer (Figure 4).

Start testing of the keyer from cap's C4 charge. Manipulate the keyer fast and measure the voltage on C4. Its value must be not less than 0.1 V. If C4 is charged too long, change the polarity of capsule of AC-generator, use C4 with smaller leakage, use better diode VD1 and adjust better the mechanic system of AC-generator.

The AF-oscillator can be adjusted first separately from galvanic element. If you want to change the tone, change the values of C1 and C2 simultaneously. The values of R2 and R3 also change the tone but they influence the current consumption of the AF-oscillator.

All the extra supplying voltages are connected parallel to C4.

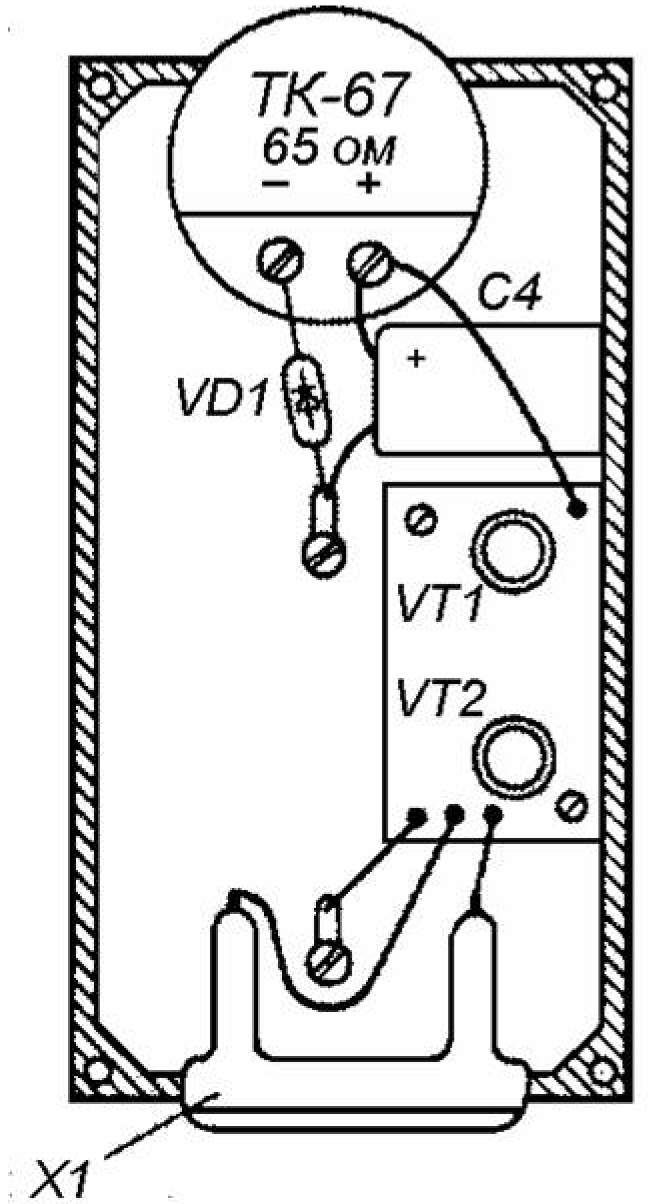


Figure 4. The lay-out inside the keyer fundamental (basement).

The Morse keyer is useful for personal training. To use the keyer for team receive training, you can connect the AF-oscillator's output to the input of an AF-amplifier or use another set mentioned below.

The set is based on the translation loudspeaker common to all who lived in USSR. Here is its schematics:

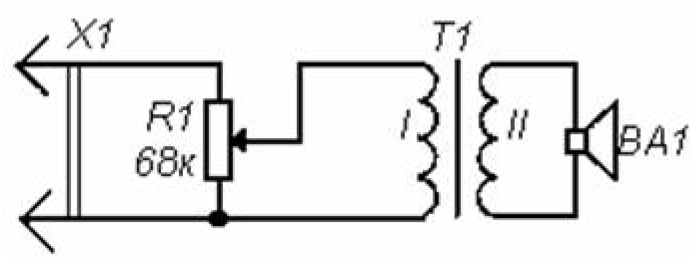


Figure 5. The loudspeaker for the radio translation line. T1 is step-down transformer from 12-30 V AF line to LS. (One powerful AF-amp translates BC to all the population of the city via wire net which leads the signal to every LS, such, as shown above schematically, situated in every house, kitchen or room, at working places – this is the Russian invention that is why such LS are common in use here).

Of course, You can run recordings put to some AF equipment or PC program for to have lessons in Morse alphabet receive. But there are cases with the absence of such conditions. Imagine that there are some people who have a lot of time free and want to know this code, one of them already knows it and can be the teacher but all the equipment is far away but only the small AF-oscillator as shown in Figure 6 and the keyer is there present. So the teacher can send and the audience can copy.

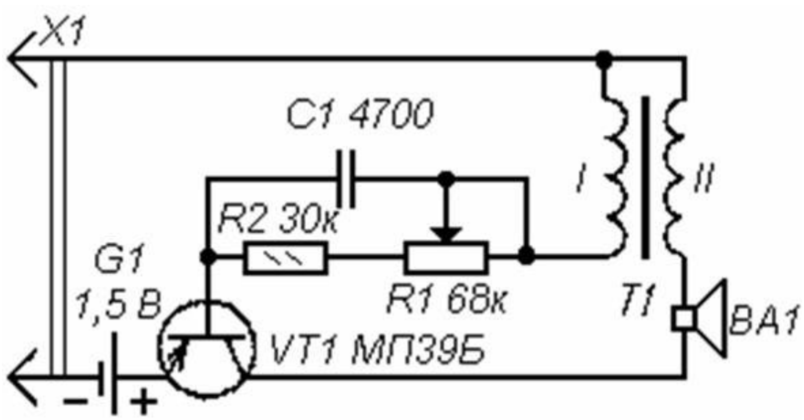


Figure 6. AF-oscillator for team training use, based on translation LS.

Add to the translation LS one Germanium transistor (VT1), one resistor (R2), one cap (C1) and one galvanic element and you'll get a loud-speaking AF-oscillator enough for training of the small audience or team (Figure 6). If you want still to save the direct function of the translation LS, add a 3-way 2-position switch to the AF-oscillator and you'll get something like what shown in Figure 7.

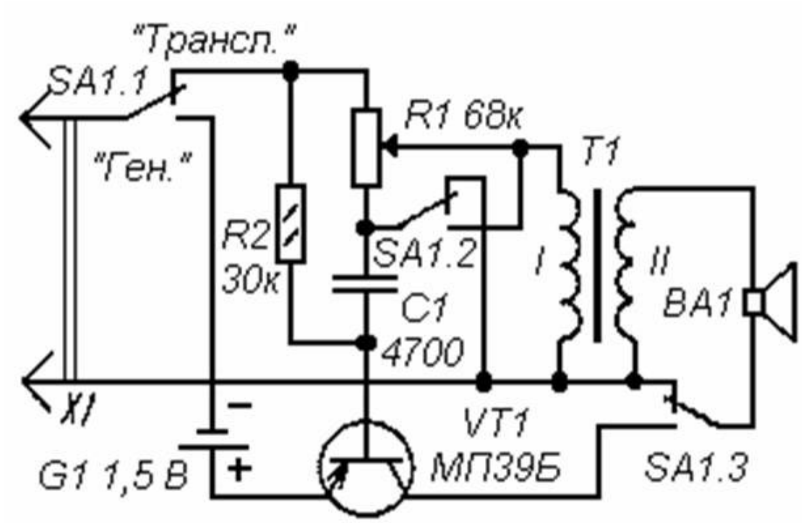


Figure 7. Universal combined AF-oscillator - LS for team training use.

As it can be seen from schematics (Figure 5), the translation LS consists of LS itself (BA1), down-step transformer (T1) and a pot (R1). LS is situated in a box which has a connecting cable with plug to join the translation line. When used as AF-oscillator, LS standard cable is connected to the key and the pot (volume control) is used to control the tone. SA1 is shown in Figure 7 as switched to LS. Oscillation occurs at positive feedback from collector to base chains of VT1 according to certain polarity of T1 windings.

The system needs few adjustments. If You do not hear any tone from LS when all is OK and supply voltage is connected in right polarity, change the polarity of one (any) of T1 windings. Parts of various types will function.

Cheerio! CUAGN CW! 73!

References:

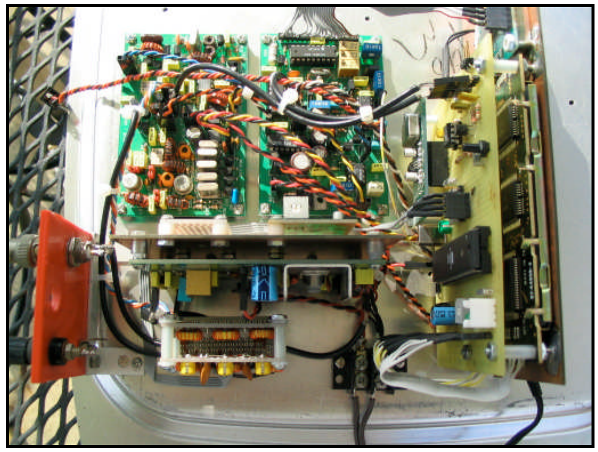
1. В. Беседин. Путь в эфир. Радио № 12, 1995 г, стр. 36, 37.
2. В. Беседин. Телеграфный ключ с генератором переменного тока. Радиолюбитель № 12, 1992 г, стр. стр. 35.
3. В. Самелюк. Солнечная батарея. Радио № 12, 1982 г, стр. 49.

Victor Besedin, UA9LAQ, may be reached by email at ua9laq@mail.ru

AmQRP.ORG HOMEBREWER

Jay Henson, AJ4AY

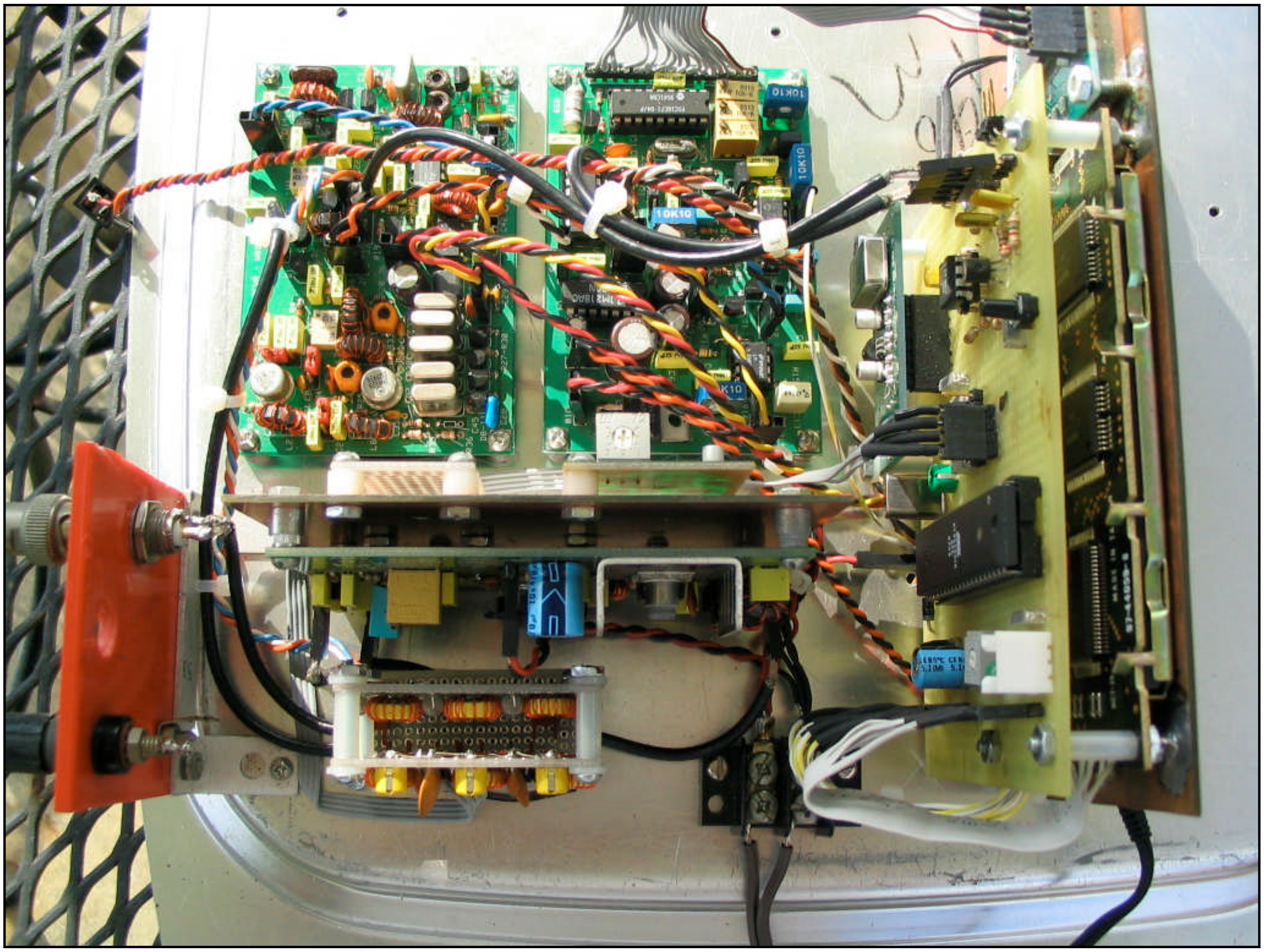
MultiPig + DDS Card



I have been really thrilled using the DDS card with an Atmel microprocessor. have attached two pictures of my MP+ rev JAY transceiver. The original MP+ is one of Diz's (W8DIZ) creations.

Picture 1 is the front of the rig. I added an Atmel AT90S8515 microprocessor for control of most of the radio functions and display of radio status on the left display. The right display is the freq counter readout.

Picture 2 is looking down from the top of the radio with the front panel to the right. The 40 pin Atmel microprocessor is mounted on the board attached to the rear of the front panel. Look just above it and the crystal can of the DDS card is visible. I soldered straight pins to the DDS card and plug it into a header attached to the microprocessor board. The DDS signal leaves the board on the 2 header plugs with the coax attached.



The 8515 program was written and compiled using BASCOM software. The hex file was loaded into the 8515 using AVR Studio ver 4 and an AVR ISP programmer. To make full use of the DDS daughtercard, I wrote the program to support two VFO's. Physically , there is only one DDS card. Logically, the program supports 2 VFO's (VFO A and VFO B), operation from either VFO, and split operation. Frequency changing is done via an encoder attached to the tuning knob. Pushing the tuning knob in will change the frequency steps from 10 (default), to 100, to 1khz and back to 10 hz. RIT is turned ON/OFF by pushing the RIT knob in and is always in 10 hz steps. The RIT control is also an encoder and has a limit of +/- 1 khz total RIT change, which is set in the software.

The DDS card performs flawlessly with the Atmel microprocessor. The BASCOM language allowed me to rapidly develp the program and perform tests/debugging as I went. I used assembler for a while (very short while) and decided there had to be an easier way and BASCOM is it. When all of the required mods to the radio were completed, there were a couple of minor code changes required.

My next project is going to be an ELSIE rev JAY. I hope to add LCD output to my version. Somehow, I don't think all of that code will fit in a single 2313, but whatever I do, it ought to be fun.

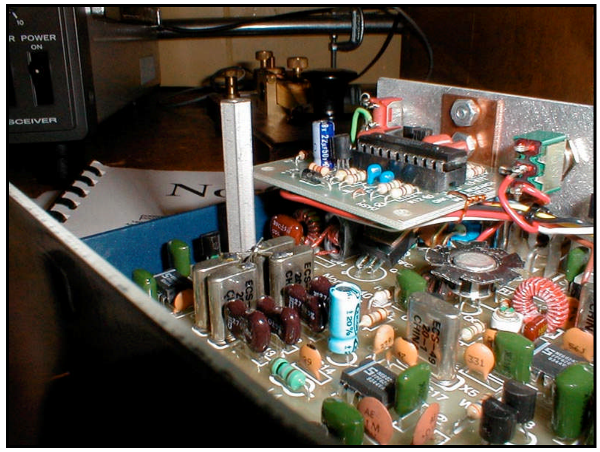
As I have said in the past, I appreciate all that you and the rest of the volunteers do to support us builders/tinkerers out here. Keep up the good work.

Jay Henson, AJ4AY
Mobile, AL
QRP-L 1372, FP -115

AmQRP.ORG HOMEBREWER

Dave Meacham, W6EMD

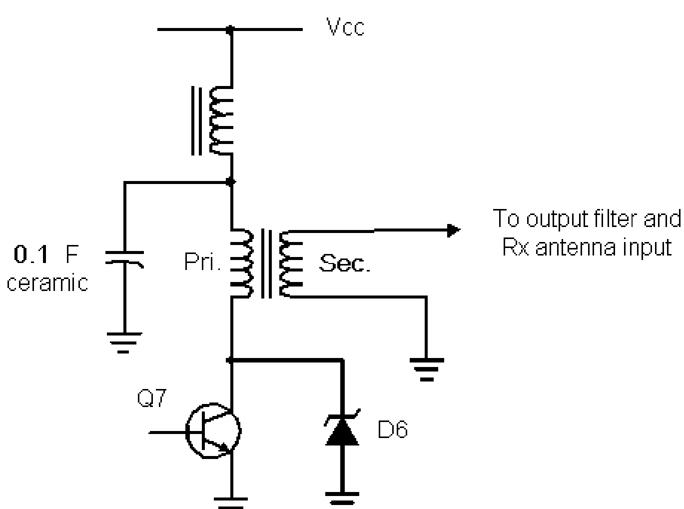
A Cool 5 Watts for Your NorCal 40



I wanted to be able to run my NorCal 40 at 5 watts output, key down, for extended periods without overheating problems.

I decided on the TO-220 PA package for ease of connecting a heat sink. Further, I wanted the mounting tab to be the emitter so I could ground it. The MRP-260 has these features but only 10 dB of rated gain. It is also pricey at $14.50 (R.F. Parts Co.). Well, I bit the bullet and I am glad that I did it! With a 13.8 Volt supply the rig will now deliver 5 watts for time periods measured in minutes, not seconds, with no overheating. As an example, a 5 MINUTE run yielded a barely warm PA and the same for the driver.

Key elements in this mod are a small, inverted top hat type of push on heat radiator for the driver and a copper heat conductor for the PA. The driver, incidentally, is a 2N5109 CATV transistor ($1.50) from OHR. It's pinout is wrong for the NorCal 40 board holes so you have to bend the base lead back and then down to the board (same as if you used an MRF-237 PA). The 2N5109 base view pinout going clockwise from the tab is emitter, base, collector. The huskier 2N5109 driver is necessary because of the low gain of the PA transistor.



Heat from the PA is conducted to the back panel by a piece of 0.040 inch thick copper sheet 5/8 inch wide by 2 inches long. Three quarters of an inch of the conductor is flat against the back panel, vertically, held by two 4-40 screws and nuts. At the bottom of the vertical section the copper is bent 90 degrees so it is horizontal, heading toward the front panel. At 1/2 inch away from the front bend another bend is made downward at about 45 degrees. At this point the width is tapered down to 3/8 of an inch to match the width of the TO-220 case. A 6-32 clearance hole is centered 0.40 inches from the end. A 6-32 screw (and nut) holds the heat conductor to the MRF-260 which is tilted toward the back panel with it's mounting surface up and positioned UNDER the copper strip. It's pinout is base, emitter, collector, left to right, front view, pins down. Mount it with the front facing the back panel. The base and emitter leads fit well into the original board holes, but the collector lead has to be bent toward the back panel at the board surface and angled toward U5 to fit into the original board holes.

A binocular-core output transformer is used per the KN6VO article in the June 94 QRPp (Pp 44-45). I changed the turns to 3:5 and used the same circuit as on p. 45. I mounted the core on edge with a wire strap, with the holes horizontal, between C46 and Q7.

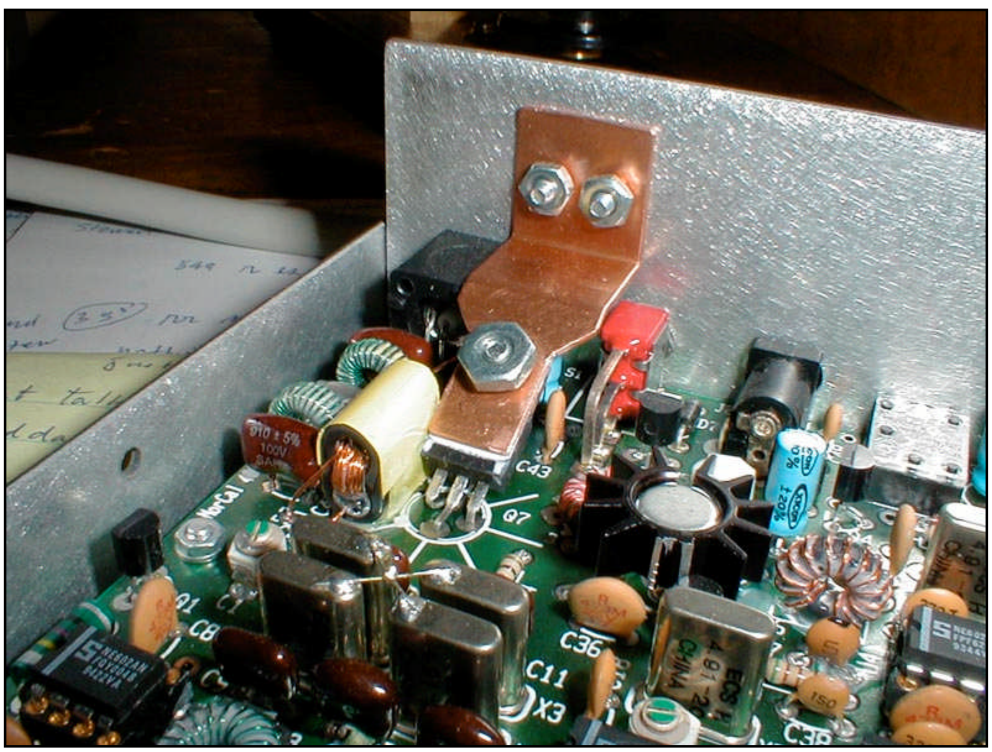
Other changes are as follows:

C45 = 370 pF (low 390) S.M.
C46 = 780 pF (510 + 270) S.M. paralleled
L7, 8 = 19 T #26 on a T37-6 core (yellow), 1.08 µH
Q6 = 2N5109
Q7 = MRF-260
R11 = 820 ohms
R12 = 3.3 ohms
R13 = shorted
R14 = 47 ohms
RPC1 (KN6VO schematic) 4.7 µH, 620 mA (Mouser 43LS476)

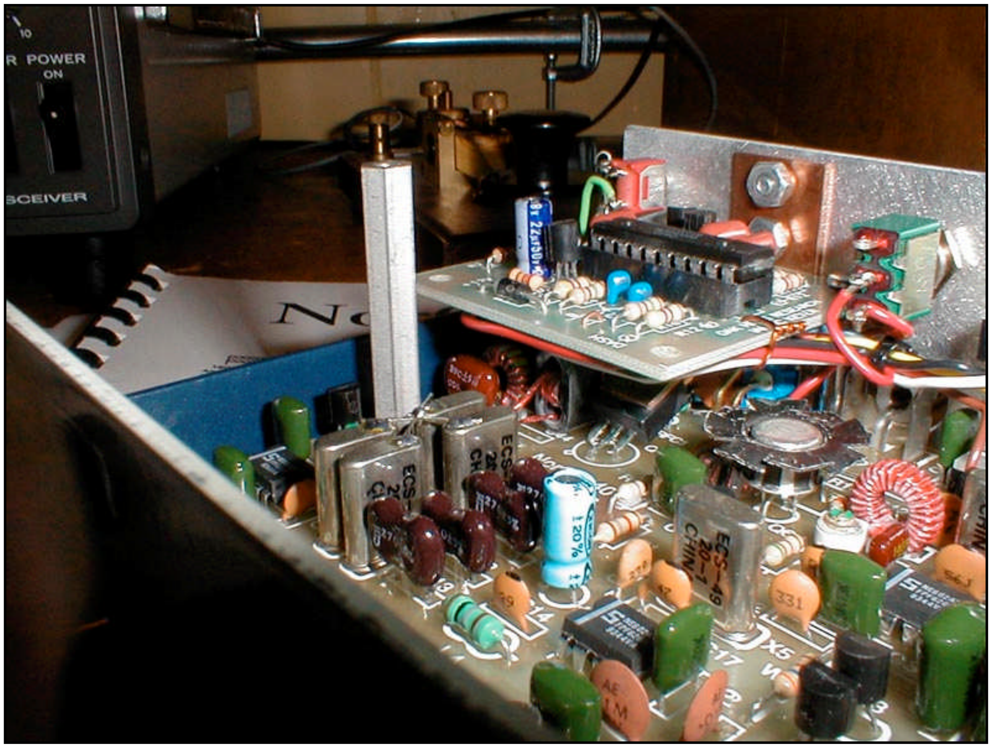
Current draw on transmit is 575 mA for an overall efficiency of 63%. Finally, my spectrum analyzer shows that all spurs and harmonics are 45 dB down or more.

"Note: The PA output transformer uses an Amidon binocular core, type BN43-202. Each loop of wire through both holes makes one turn.Transformer connections are shown in Fig. 1. This mod should work fine for all versions of the NorCal 40A, as well as for the NorCal 40."

Heatsink Screws



NC-40A Copper Bar



Q7 Position

72, Dave, W6EMD

AmQRP.ORG HOMEBREWER

Steve Fletcher, G4GXL

NorCal Keyer for Kids

These pictures show my 9 year old son, James, constructing his first project. He made all the soldered joints himself and it worked first time !

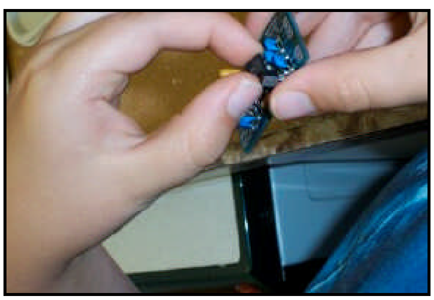
I took advantage of the AmQRP offer to supply a free keyer kit to kids recently.

I spent a few happy hours today showing my 9 year old son, James, how to solder, identify components etc.

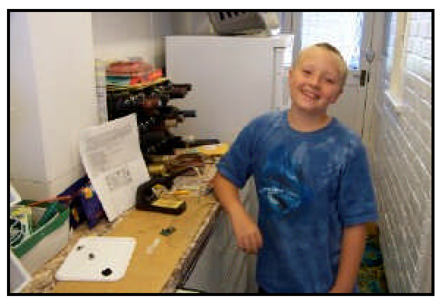
He had never touched a soldering iron in his life, yet completed the keyer and got it working first time. He made every soldered joint himself and had more help preparing the case than assembling the board.

Here's a few mug shots -

James's first whiff of rosin.



The micro-controller is inserted in the board.



About half done, time for a rest.

Here's my dad helping James prepare the case.

The completed circuit board.

I had to get involved . .

No fingers or animals were harmed in the construction of this keyer.

James connected the battery and it went 'di-di-dah-dit dah-di-di-dit' ! ! He's obviously delighted.

A pretty good result for a first project.

Please pass on my thanks to all involved with this initiative.

Regards and 73,

Steve, G4GXL

http://www.g4gxl.com/

Jon Iza, EA2SN

NorCal Cascade to ZA-land

Here is the picture of Marti OH2BH (left) holding the Cascade and manuals, and Pablo EA2NO (right).

I´m very happy to let you know the good news. During the past weekend, there was the Spanish National Ham Convention in Badajoz, SW of Madrid. Marti Laine, OH2BH, the famous DX-er gave a speech on the development of Ham Radio in Albania. They have been busy teaching classes for new hams, and on December 10 a test was scheduled. During the speech, he announced that Yaesu was going to give as a price for the student with the highest marks a brand new transceiver.

One of the attendants of the conference was Pablo, EA2NO, a good friend of mine, who was the VicePresident of the Spanish league URE for many years. Even though he likes very much to build high power linear amplifiers, I´ve been shovelling him with lots of QRP kits. One of those was the NorCal Cascade. He built it, and enjoyed it very much, although hi was not happy for some minor stability drift (My guess is that he was not worried, but he takes part in a "Geratrol" net on 80 meters where other colleagues are really picky... :-)
He had his kit, and manuals, and he jumped on the occasion to offer him to Marti, to be given as second price in Albania. Here is the picture of Marti (left) holding the Cascade and manuals, and Pablo EA2NO (right). I´m very happy and proud that I have so good friends.


Nor-Cal QRP Club
EST 1993
Construction Manual

AmQRP.ORG HOMEBREWER

Chuck Carpenter, W5USJ

NorCal Keyer Mounting

The enclosure is an Eagle diecast aluminum case. I like the finish on these better than the Hammond boxes and they cost a little less.

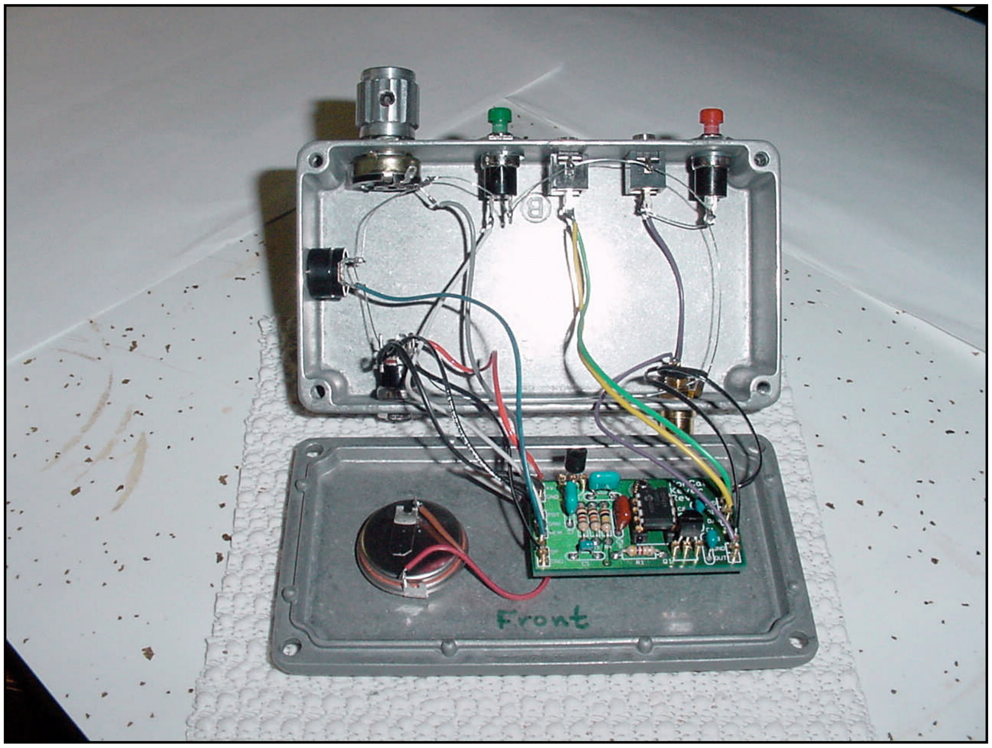
The Mouser part number for this box is 400-4591. They are a little pricy but I like the results and the more accessible assembly. I've built a couple of things in the "Tins" for the novalty but prefer a more substantial enclosure.

The box is painted with a gray paint that I like to use with most of my projects. The StKey and Tune button (for added convenience) are wired in parallel with the rig connector on the back. The "speaker" is fastened with clear nail polish to the left side panel centered over a hole. I have the board populated with machined DIP pins for the wiring, regulator and Q1 connections.

The 540 mAhr cell is held in place with double-sided tape. I use it for portable operation and plug the tinned lead ends into the DIP pins in place of the regulator. The regulator is used when I'm at a fixed setup with external power. The red lead on the cell is covered with a piece of plastic and tucked under the board until used. I considered a switching arrangement but this is easy to do.

Note that the hole in the PCB is thread-formed with a 6-32 screw and the board is mounted with a 1/4 inch nylon spacer. No nut is needed with this approach.

I would stress thread forming over thread cutting. Forming only upsets the metal and doesn't destroy the plated-thru hole.


Front


SPEED
CMD
PADDLE
St KEY
TUNE

NorCal Keyer Function Table - Keypress Combinations

Keys Used	**PAR** (press and release)	**PAH** (press and hold)
Mem switch	Send memory 3	Record memory 3, O? Beacons: BE and BA
Mem + dit	Send speed	Paddle set of speed, pot options, main menu
Mem + dah	Send memory 2	Record memory 2: M?
Mem + both	Send memory 1	Record memory 1: T?

NorCal Keyer Menus

CW	Menu Item	Pressing a dit	Pressing a dah
	Memory + Dit Menu (PAR mem to advance to the next menu)		
S	Speed set from paddle	Increase speed 1 wpm	Decrease speed 1 wpm
P	Pot / paddle speed control	Selects pot speed control	Selects paddle speed control
C	Calibrate pot speed control	Enters the calibration routine	Restores default pot calibration
B	Bug / straight key mode	Enables bug mode (dah = key)	Disables bug mode (default)
A	Iambic mode A or B	Enables iambic mode A	Enables mode B (default)
R	Reverse paddle mode	Reverse dit and dah switches	Returns dit and dah to normal
AU	Autospace on / off	Turns on character autospace	Turns off autospace (default)
	Memory + Dah Menu (PAR mem to exit)		
M?	Record memory 2	Records a dit	Records a dah
	Memory Switch Menu (PAR mem to advance to next menu)		
O?	Record memory 3	Records a dit	Records a dah
BE	Beacon mode - sends mem 1	Starts the beacon going	Exits the menu
BA	Beacon alternate mode	Selects alternate beacon sends of mem 1 and mem 2	Selects send of mem 1 only (default)
ST	Side tone on/off	Turns off the side tone	Turns the side tone on
	Memory + Both Menu (PAR mem to exit)		
T?	Record memory 1	Records a dit	Records a dah

Tune Mode: Send a series of at least 5 di dahs by simo pressing both paddles (key down, sidetone on). End mode by pressing a dit or dah.

Add spaces in text strings using the space character di dah dah dah dit. The spaces are not transmitted. Useful for delays in beacon messages etc.

W5USJ 03/21/04

Michael Melland, W9WIS

NVIS (Near Vertical Incidence Skywave) Antennas

The NVIS antenna is ideal for local and emergency communications on HF.

NVIS Antennas

I became interested recently with the concept of NVIS (Near Vertical Incidence Skywave) Antennas. Portablity and their unique performance envelope make them worth looking at for any amateur serious about reliable communications. Probably the biggest users of NVIS antennas are the military and FEMA.

What is NVIS?

NVIS, or Near Vertical Incidence Skywave, refers to a radio propagation mode which involves the use of antennas with a very high radiation angle, approaching or reaching 90 degrees (straight up), along with selection of an appropriate frequency below the critical frequency, to establish reliable communications over a radius of 0-300 miles or so, give or take 100 miles.

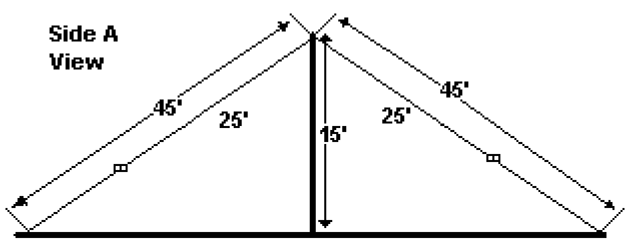
Although not all radio amateurs have heard the term NVIS, many have used that mode when making nearby contacts on 160 meters or 80 meters at night, or 80 meters or 40 meters during the day. They may have thought of these nearby contacts as necessarily involving the use of groundwave propagation, but many such contacts involve no groundwave signal at all, or, if the groundwave signal is involved, it may hinder, instead of help. Deliberate exploitation of NVIS is best achieved using antenna installations which achieve some balance between minimizing groundwave (low takeoff angle) radiation, and maximizing near vertical incidence skywave (very high takeoff angle) radiation.

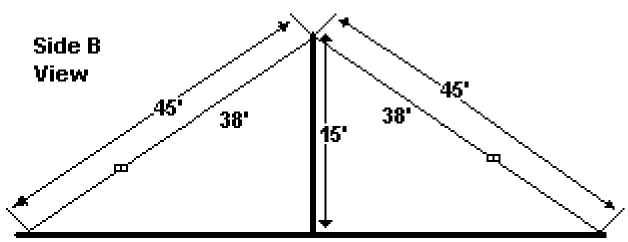
The most famous of the NVIS military antennas... seen during the War with Iraq in use by US Forces... is the AS-2259 NVIS antenna as manufactured by Collins Radio (as the 637-K1) and Telex Wireless (Model 1990) as well as Harris Communications. The most interesting thing about the AS-2259 is that the hollow 1.25" tube that makes up its mast also serves as a low loss feed line.

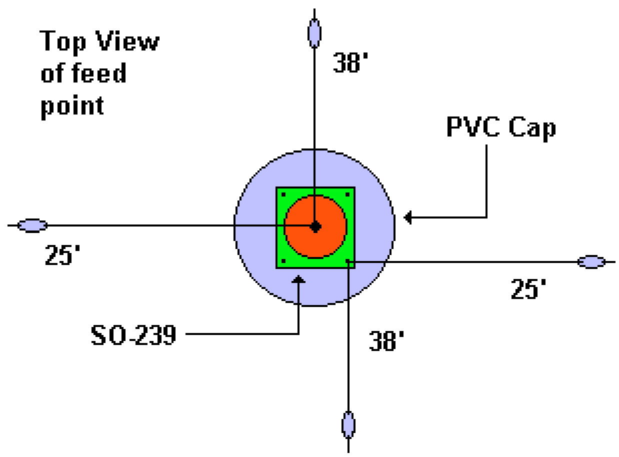
Build Your Own AS-2259 Type NVIS Antenna

Parts List

- 3 ea 1.5" PVC pipes 5' long
- 2 ea 1.5" PVC coupling
- 1 ea 1.5" PVC cap
- 4 ea egg type insulators
- 3 ea brass round head screws (1/2" 6-32)
- 2 ea brass round head screw (1" 6-32)
- 4 ea lock washers for 6-32 screws
- 6 ea brass hex nuts (6-32)
- 4 ea flat #6 brass washers
- 1 ea SO-239 chassis connector with solder pot center pin
- 1 ea SO-239 coax crimp on type
- 4 ea stakes
- 1 ea round metal stake 3/4" by 18"
- 4 ea heavy solder lugs to fit brass screws (you "could" use crimp on type)
- 4 ea plexaglass pieces, 1" X 3", hole drilled through each end
- ~150' copper antenna wire (braided/woven type like Davis Flexweave works best)
- ~60' nylon rope (Parachute type cord works great and is inexpensive)
- ~15.5' RG-58 coax







Construction Details

Drill a PVC Cap to accept SO-239 (7/8") and 4ea #6 screws, lock washers and nuts.

Make sure to center the SO-239 in the hole before drilling the 4 screw holes. Lock washers go under the nuts. 3 screws are 1/2" and the other is 1".

Cut off the head of a 1" #6 brass screw and solder it in the center post of SO-239
Cut antenna wires to length plus a little

Fit one end of each wire with solder lugs

Fit the other with the egg insulators and parachute cord or other non conductive rope

Drill hole in center of second end cap (3/4") and run round steel 18" X 3/4" rod through the center. This is the bottom section and the center stake helps when setting up the antenna.

Drill a 3/4" hole near the bottom of one end of one of the 5' pieces of pvc pipe. After drilling the hole run one end of 16' of RG-58 coax through the pipe and out the hole. Crimp a SO-239 on this end. Crimp a PL-259 on the other end. The long end is run through the pipes before erecting the antenna as a coax feed. Alternately you can just run a long piece of coax to the top but I thought this was quicker and easier.

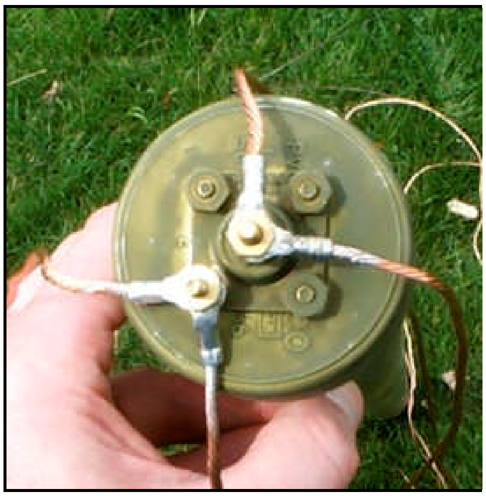
Install pipe coupling to one end of the pipe as seen above. Install a coupling to the remaining pipe as well.

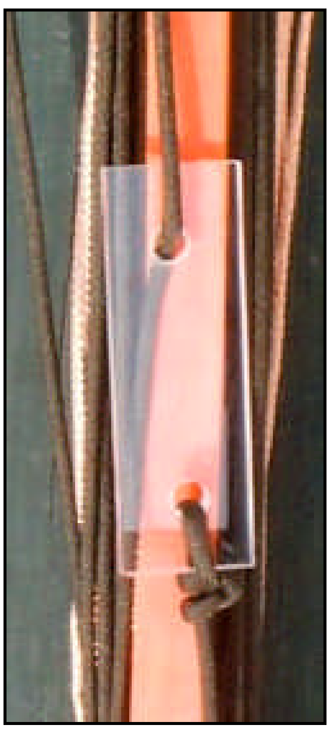
Put the top cap with SO-239 ontop of the top section of PVC pipe. Attach wire elements to the top cap as shown in the drawings, also illustrated below...

Drive the section with the bottom cap and spike into the ground. Assemble the other two sections together and then hoist onto the lower section. This is MUCH easier with two people but with practice tyou can assemble it yourself. Just be careful in case it falls over.... hehehe.

Extend the wires as in the diagrams and attach the guy ropes to the stakes. The stakes should be located 42.5 ft from the center mast of the antenna. Snug up the guy ropes to straighten the antenna mast using the Plexiglass pieces you made earlier... they make it easy to adjust the guys. Check out the phots to follow and you'll get a better idea. I bought power cord holders to wrap the wire and guys on and labeled each... they were only 2 for a dollar so they were really a deal and they help things really stay neat when I break down the antenna and store it in it's bag.

The antenna works NVIS mode from about 3.5 to 11 MHz. It's generally necessary to use a tuner with this type of antenna... then it's useful from 2 - 30 MHz.... the high bands are not NVIS however. If you build this antenna let me know how it works for you. I use a LDG Z-11 auto tuner with my Argonaut V and it works great !





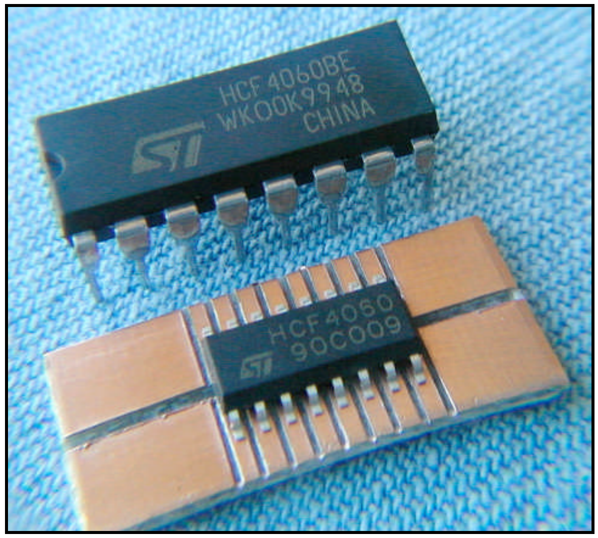
AmQRP.ORG HOMEBREWER

Jim Giammanco, N5IB

IC Pads - Manhattan Style

Make mounts for even tiny SMT components with this precision jig

Many circuits QRPers are building these days employ integrated circuit devices. Preparing mounting pads for the closely spaced connections of these devices can be tedious.



Introduction

Manhattan Construction, especially as practiced by Grandmasters like Chuck Adams, K7QO [1], and Jim Kortge, K8IQY [2], is a reliable and convenient method of circuit construction. Many circuits QRPers are building these days employ integrated circuit devices. Preparing mounting pads for the closely spaced connections of these devices can be tedious. A fair amount of precision is needed if the device leads and mounting pads are to align properly. Complicating the problem is the desire to employ smaller devices, such as surface mount components. While the leads of the common IC are spaced 0.1 inch, surface mount leads may be spaced 0.05 inch, or even 0.0256 inch.

Chuck Adams has described on his web page [1] a handy jig, based on the carpenter's miter box that allows 0.1 inch spaced IC pads to be produced quickly and precisely. This article expands on Chuck's design, presenting a device that allows cutting even closer spaced pads.

Theory of Operation

While "theory" of a miter box may sound pretentious, a brief comment is in order. This jig uses a threaded rod to advance a carrier into the cutting area. Thread pitch determines the distance the threaded rod will advance as a result of each full rotation of the rod. The 1/4-20 rod used here has 20 threads per inch (TPI), advancing 1/20 inch for each rotation.
Notice that 1/20 inch is 0.05 inch. So two rotations advance the rod 0.1 inch, the right spacing for the common IC devices. One turn is a 0.05 inch advance, correct spacing for SOIC surface mount IC's. And a half turn "fudged" just a smidgen advances 0.0256 inch, the spacing of tiny devices like the AD9850 DDS and other similar chips.

Materials

With the exception of the printed circuit board (PCB) stock and the knob, all of the other materials and tools needed should be found at hardware stores, home centers, or craft/hobby stores. The total cost should not exceed ten dollars (US).

miniature hacksaw, with 6" blade
hobby saw, example: Excel # 30450, 42 teeth/in, or Excel # 30490, 54 teeth/in
1 piece, 3/8" x 3" x 18" pine
1 - 1/4-20 x 5" threaded rod, or 1/4-20 5" carriage bolt
1 plastic knob, for 1/4" shaft
2 - 1/4-20 BRASS hex nuts
2 - #4 x 1/4" flat head wood screws
2 - #4 x 1/4" round head wood screws
PCB stock, 1/16" x 1" wide, about 7" long, or one 5" and one 2" strip
carpenter's wood glue and clamps

The pine board is sold at home centers such as Home Depot or Lowes as "hobby boards" or "craft boards," usually available in oak, poplar, or pine. Pine is perfectly adequate here, and the cost is under a dollar. Remember that the actual dimension of a 3" board is really about 2 1/2 inches. You could use any scrap wood, but hobby boards are convenient because they have straight, square edges and are sanded smooth on both faces.

Construction

Refer to Figure 1 and cut the 18 inch board into three 6 inch sections. Be as neat as you can, but these cuts need not be particularly straight, or even square. If no other tools are available, make the cuts with the minature hacksaw. Set one piece aside. It can be the base of a second jig later.

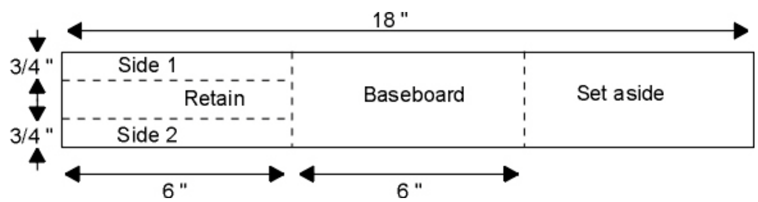


Figure 1. Dimensions and cutting guide.

Make two rip cuts, dividing one of the 6 inch pieces into three parts. Make the cuts 3/4" in from each factory edge. Once again, don't fret if you have to use hand tools and the cuts are not perfectly straight. Save the two outer pieces, the ones that have a square factory edge, and set the middle piece aside.

Glue a 3/4" strip to the baseboard, positioning it flush with the outer edge of the base, as shown in Figure 2. Be sure that the factory edge faces inward. Clamp it in place while glue cures.

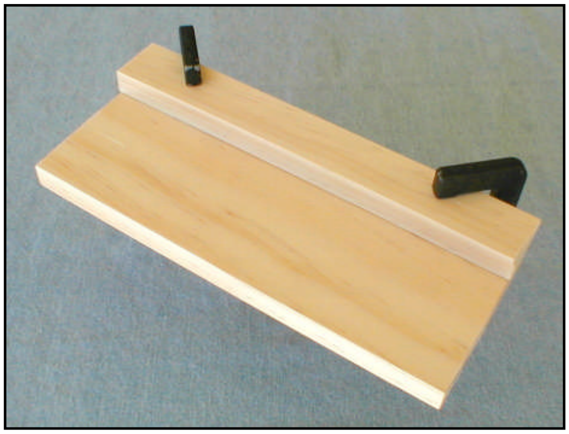


Figure 2.

While waiting on the glue, prepare a piece of PC board material 1" wide and about 5" long. The length is not critical, and even the width need only be approximate. But it is important that the long sides of this PCB strip be as parallel as possible. Cut them carefully and touch up the edges, holding them vertically and running them over some fine sandpaper placed on a smooth, flat surface.

Examine Figure 3 and, using the 5" PCB strip as a guide, position the other 3/4" wood strip on the base board, factory edge facing inward. Before any glue is applied, clamp it in place and verify that the PCB strip can slide smoothly between the two wood strips. A slightly snug fit is fine, sanding can fix that, but it should not wobble from side to side as it slides.

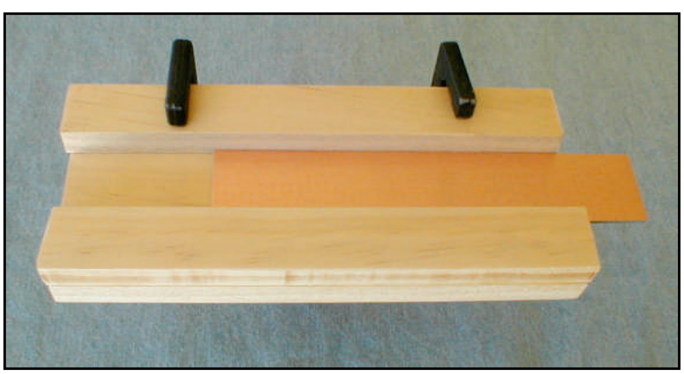


Figure 3.

Once you're sure that the PCB fits and slides smoothly end to end, apply glue and clamp the wood strip in place. Recheck the fit while the glue is workable and you can still reposition the strip if necessary. Set this assembly aside and allow it to dry completely. Leave the PCB strip in place while the glue cures, but be sure so much excess glue hasn't oozed out that it glues the PCB in place!

Now prepare the lead screw assembly. Cut a piece of PCB stock about 1 1/2" to 2" long, and just wide enough to fit between the wood strips on the base. You will be soldering the brass hex nuts to the surface of this PCB strip. A fairly robust soldering tool is called for, such as a 150 watt soldering gun.

Thread the hex nuts onto the threaded rod and dry fit the assembly as shown in Figure 4. Arrange the nuts so they are about 3/16" from the end of the PCB strip. This leaves room for a good fillet of solder all around the nuts. Notice the scraps of PCB stock used as shims to space the nuts from the wood strips and keep them parallel to the sides.

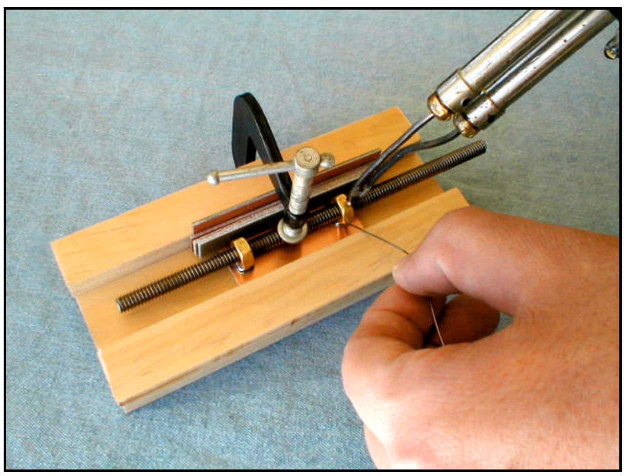


Figure 4.

Make sure the copper cladding on the PCB and the bottom surface of the brass nuts are clean. If available, apply a little rosin paste flux before positioning the nuts. Clamp the assembly in place and apply the tip of the solder gun to the top of the nut. Heat the nut until solder applied between it and the PC board begins to flow. Be sure the parts don't move while the solder cools.

Position the lead screw assembly with edge of the PC board even with one end of the baseboard. Drill two holes through the PC board and into the base board with a 1/16" drill to form pilot holes. Then enlarge the holes, in the PC board only, to 1/8" to clear the #4 wood screws. Fasten the assembly in place with two #4 round-head wood screws. Attach the knob to the free end of the threaded rod.

Refer to Figure 5 as you prepare the carrier. Cut the wood stop block from the stock that was left over when you ripped the two side pieces of the miter box. Fasten the block to the 5" PC board strip using a pair of #4 flat-head screws. Again, drill 1/16" pilot holes and enlarge to 1/8" for clearance. The screws must be countersunk so that the bottom of the carrier will slide smoothly through the miter box. If you don't have a real countersinking bit, a 1/4" drill bit can do the job.

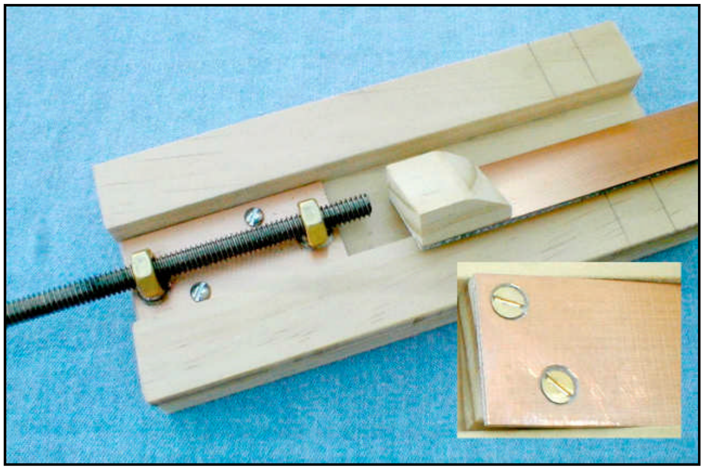


Figure 5.

Two guide kerfs should be cut into the miter box. One is cut using the mini hacksaw and the other using the hobby saw. These kerfs should be about 1/2" to 3/4" apart and not nearer than 1/2" to the end of the miter box. Make the hacksaw kerf closest to the end of the miter box. It is important that the kerfs are cut square to the inner surfaces of the miter box side pieces, and perpendicular to the baseboard. Use a guide block as shown in Figure 6. to maintain the saw blade square and plumb. The kerfs should not penetrate all the way to the baseboard. Place a scrap of PC board material in the miterbox and stop before a kerf reaches the scrap.

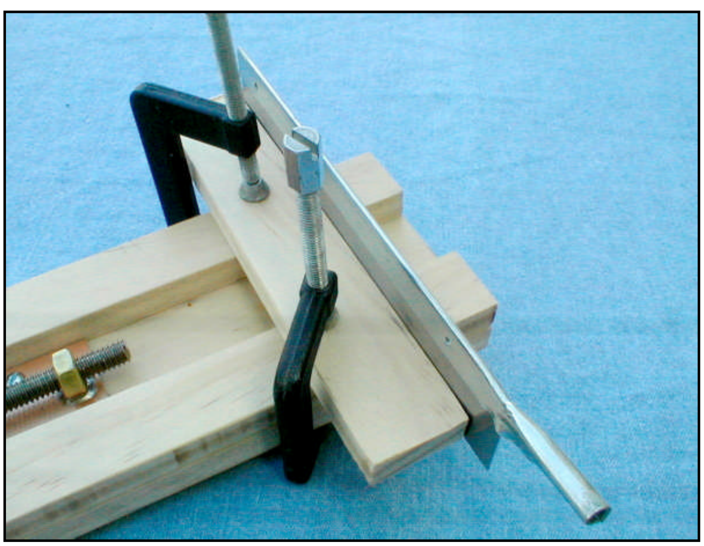
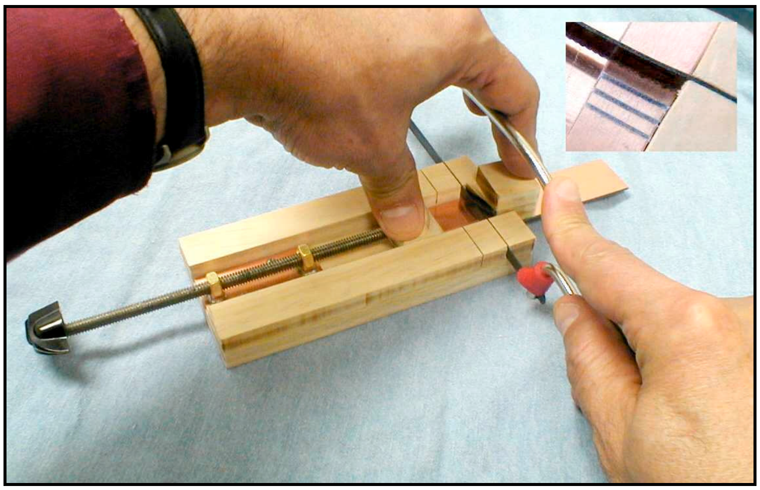


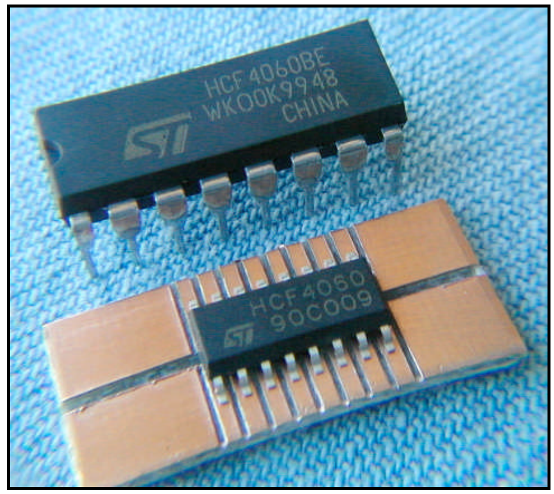
Figure 6.

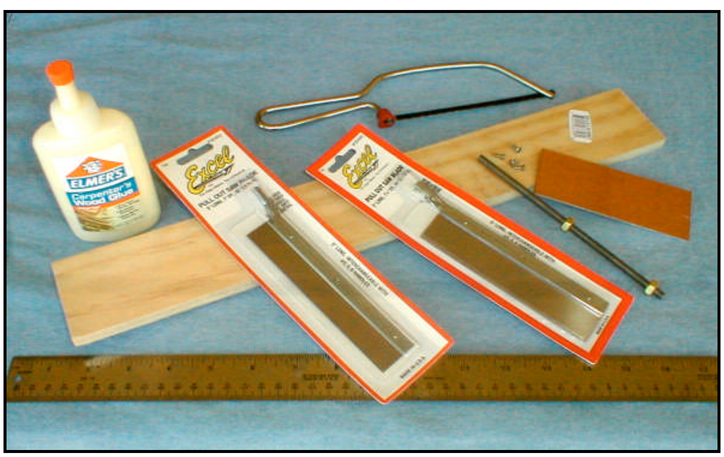
Operation

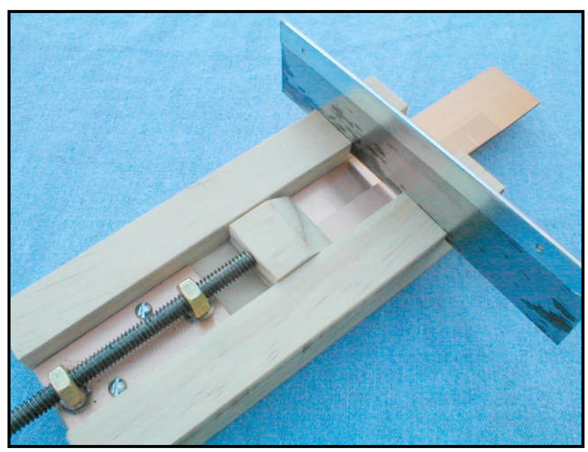
Righthanders will find it easier to orient the miter box with the lead screw to the left. The piece to be cut can be held in position with the left hand while the right hand makes the cut by drawing the saw back towards the operator. If desired a small push block can be fashioned to permit better control of the workpiece. If the entire surface of a blank pad strip is tinned with solder before the cuts are made the tinned pads will be very uniform.

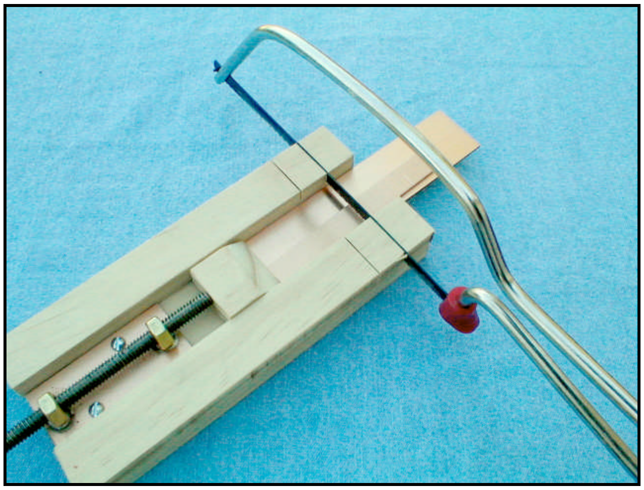
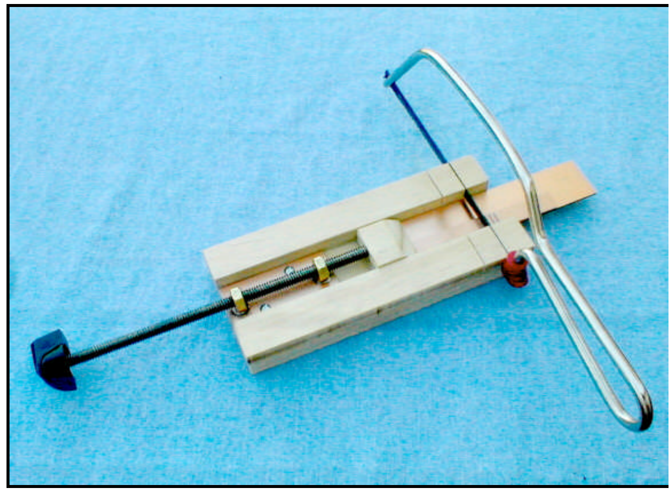
Use the hacksaw kerf with the mini hacksaw to make cuts for pads that are to be spaced 0.1". Use the hobby saw in its kerf for more closely spaced pads. After each cut advance the screw two turns for 0.1" spacing, one turn for 0.05", and just slightly more than a half turn for 0.0256" spacing (actually a half turn plus 9 degrees more).









References

[1] Chuck Adams's web pages: http://www.qsl.net/k7qo

[2] Jim Kortge's web pages: http://www.qsl.net/k8iqy/tips.html

AmQRP.ORG HOMEBREWER

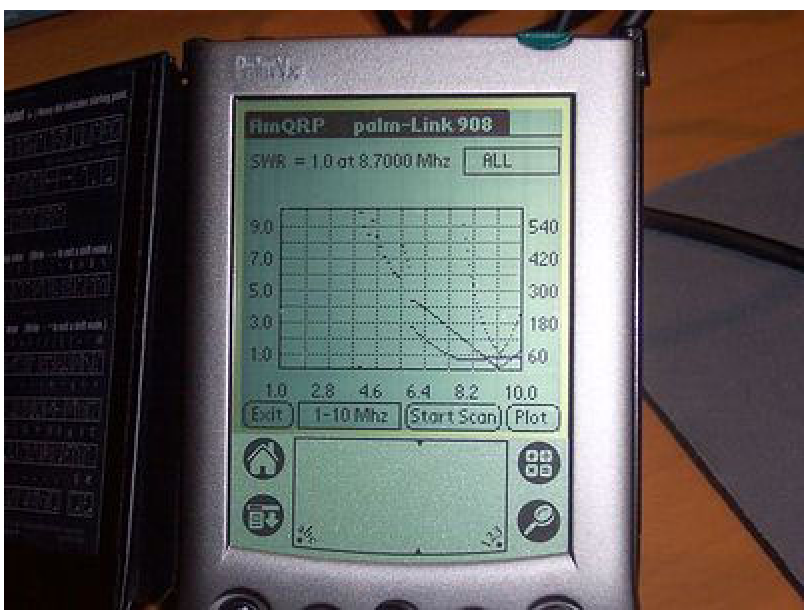
Ron Pfeiffer, N1ZSW

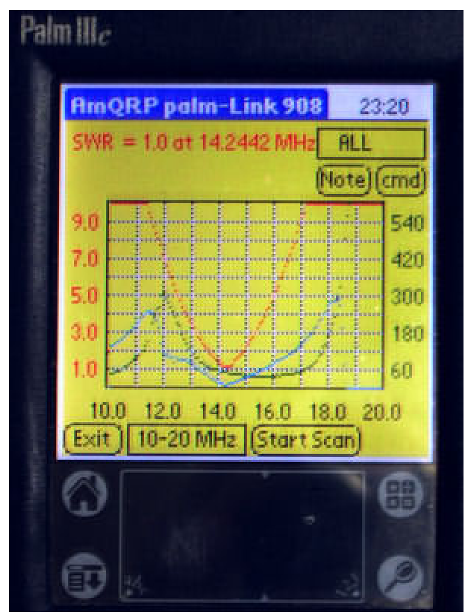
Palm-Link908

AA-908 data collection and graphing software for the Palm PDA

Ron Pfeiffer, N1ZSW created a Palm PDA software program to control and plot scan data of Antenna Analyst. Just connect the Palm to the Micro908 and control it just as done in the Link908 program for the PC.

Palm-Link908 is a software program that gets installed on your Palm PDA and presents a screen like the one shown below to display the SWR, Resistance and Reactance data collected by the AA908 during a scan. You can select to view SWR, Resistance, Reactance, or all three!





Palm-Link908 Program running on a Palm Vx (left) and a later version on a Palm IIIc (right)

Understanding the Palm-Link908 Screen

The screen capture above shows the results of a 1-10 MHz scan on an N2APB antenna that is resonant at 8.7 MHz.

Although the plot is a tad hard to see clearly on the PDA screen, you will see the same three distinct regions of the scan as on the PC version of Link908:

1. The "active" region from about 5 MHz to 10 MHz shows the SWR, Resistance and Reactance curves changing in relatively smooth manners, as would be expected as resonance is approached. You see the SWR curve showing a minimum at the resonant frequency, while the Resistance curve indicates close to 50 ohms and the reactance is close to zero
2. The "inactive" region from 1 MHz to about 5 MHz for Resistance (or to about 4 MHz for Reactance) are the frequencies where the impedance is greater than 600 and the R & X values are not able to be computed properly by the Micro908. So the instrument produces "zero results" at these points where "Z>600" is seen on the LCD display.
3. The "intermediate" region with the jagged transitions is where the impedance is approaching the Z>600 condition and the readings start to get out of range. This is normal and to be expected, as with most other forms of instruments approaching its range limitations.

Cabling:
Connection of the Palm PDA to the Micro908 can be a little tricky if you're not used to these things. In a nutshell, you need to connect by means of a "null modem", which swaps the data and control lines. Further, the standard Palm data cable used on the cradle or even the standard data cable is a 9-pin *female* connector ... same as that on the Micro908. Hence, you'll need a "gender changer", which is a male-to-male converter, or a cable with two male ends. The technique I used is shown below ... although a bit clunky, it works. There are some dedicated "gender-changing null modem adaptors" out there that would do everything in one small connector ... we'll find a vendor & part number for this.

Here's an easy **homebrew solution** to this unusual connection need. Paul M1CNK made an adapter from two 9-pin male connectors plus some 3mm PCB spacers. The connections are:

pin 2 to pin 3

pin 3 to pin 2

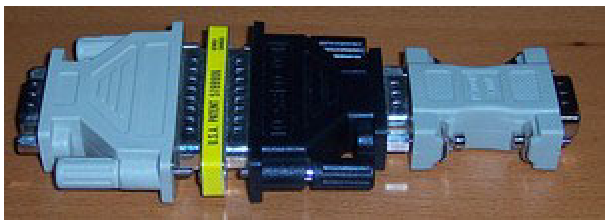
pin 5 to pin 5

Custom adapter made by Paul, M1CNK

But if you don't have those two DB9M connectors handy, you could try the following ...

This is my starting point for connection to the Palm Vx. It is the standard "cradle" that holds the PDA when connected to the PC during the data sync process. Most Palm PDA owners are familiar with this device, although the exact type differs from PDA model to model. But all of these cables terminate in a female RS-232 connector (unless you have a USB version, in which case you are out of luck for direct connection to the Micro908).

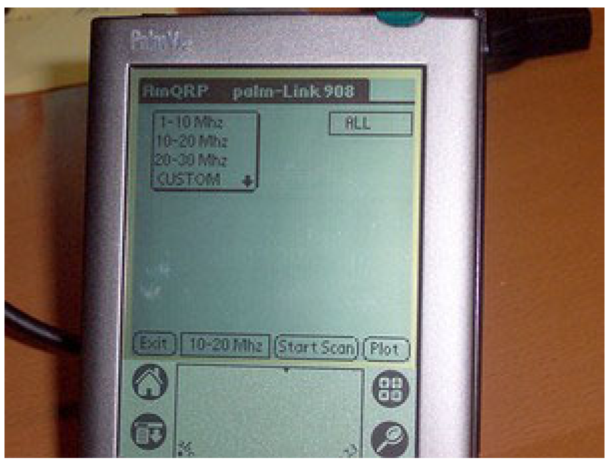
The first step is finding a "null modem" converter that swaps the data and control lines. This little adapter has a male connector on one end and a female on the other.



So the next step was to get a male 9-pin connector on each end ... I had some 25pin-to-9pin adapters that allowed me to use a 25pin male-to-male "gender changer" in between them. This is the thin yellow adapter above.

And here is the complete setup. Again, although a little clunky, it does work. A simple, small 9pin male-to-male null modem connector would really fit the bill nicely ... sort of like Mike WA6FXT's setup below!

Mike WA6FXT snapped a couple of nice photos of the connection to his Palm IIIc with the simpler connector arrangement using a null modem adapter (short white adapter) along with a 9-pin gender changer (shorter yellow adapter).



Here's a shot showing the initial screen displayed by the Palm-Link908 program. When you tap the band setting box at the bottom (currently shows "10-20 MHz"), a selection window will appear above, allowing you to select the same band as you have selected on the Micro908. Then, taping the "Start Scan" button will command the AA908 to start scanning as the Palm takes in the data sent over the serial connection.

Basic Operation:

1) Getting Started ...

a) You must have the AA908 version 4.1 (or later) software loaded. (See note in next section.)

b) The Micro908 must be connected, via a serial cable, to the Palm PDA running the Palm-Link908 software. (See description and pictures above.)

c) You must configure the AA908 to send data to the Palm PDA during the scan. That's the only way you can get data to come out of the AA908. On the Micro908, go to Config, dial up DATA OPTIONS, and select SEND DURING SCAN. Once you exit Config, this setting will be remembered for the next time you use the Micro908 AA908 software.

2) When you launch the L908 program on the Palm, a button will allow you to select the Band you will be scanning with the AA908. (Be sure it's the same Band setting as on the AA908).

3) The scan is started from the Palm-Link908 screen by tapping the START SCAN button and you will see the "Data Points" counter increment as the scan proceeds. Because of internal data buffering in the Palm, the Micro908 may complete its scan and display the lowest SWR found before the Palm-Link908 program has completed collecting the data.

4) When the scan is complete, the results will be displayed as selected in the box in the upper right corner of the screen (ALL, SWR, RESISTANCE, or REACTANCE).

5) After the data is plotted, you may select a different display mode (e.g., RESISTANCE) to see just that selected data set displayed.

Software

You must download and install the latest version of the AA908 software on your Micro908 in order to take advantage of the Link908 capabilities. This simple process is the same as you've previously normally done when downloading/installing updated software. Use the Latest Software links located on the Micro908 home page

You will need to download the Palm-Link908 prorgam and install it onto your PDA in the same way as done with other programs ... just place the plink.prc file into your Palm Desktop "Add-On" folder on your PC, then sync your PDA to your computer to transfer that file over to your PDA.

Download plink908.prc

Latest Capabilities: V1.1 ...

1. Fixed 80M byte sent to AA908 from band button.

2. Added version # on top line.

3. Added timestamp to scan files.

4. Tried to speed up scan processing.

5. Send scan data to pc/LINK908 has been made consistent. Now have Palm->PC and PC->Palm.

6. I can only display 120 of the 900 datapoints. I have added a plot mode button on bottom right where the old plot button was:

a. "Norm" displays original full scale.

b. "AR" displays the "active region" only, or my version of it.

c. "SWR" displays an expansion of the frequency range around the low SWR.

d. "Usr" expands a user chosen frequency. After depressing button when "SWR" displayed the full "norm" plot will be presented to the user and the button will now display "Sel". Use the stylus to pick frequency. The plot of the frequency selected will be displayed and the button will now display "Usr".

7. Added one more decimal digit to the frequency scale so the 160 meter plot has more meaning.

8. For users who will utilize this app a lot, I have added a mini-file system. The less you have to enter data in Palm PDAs, the better. You will still have to enter filenames when you create a new file, but for functions that reference files, a list will be displayed for you to select a filename. Also under the DATA main menu, a "delete" file function is added.

NOTE 1: When you first run V1.10 you will see a display that says there is no directory and a new one will be created for you.

NOTE 2: When you start the app a line will be displayed telling you how many files are in the directory.

NOTE 3: Mini file system has changed the format of the saved scan files and is not compatible with older scan files. I have provided a "convert" routine found under the DATA main menu.

9. I have decided that the firmware loader be a seperate app and will be coming soon.

Version 1.0 ...

1. Found and fixed scaling problem.

2. Added cmd button upper right for future upgrade.

3. Added Note button upper right. This feature allows you to annotate your scan. This button will display the current note. You can then edit it or leave alone. This note will be attached to the scan data when it is saved. Upon loading the file back in for viewing the note will be retrieved with it. You are also prompted for note entry when you "save" scan and when you start a scan. Just to remind you.

4. I deleted the Plot button as real estate on palm display valuable. Plots are automatically plotted after: scan complete, load file complete, or change display say from ALL to SWR.

5. Added time in top right bar.

6. When a display is present I have feature similiar to Link908. Press the stylus down in the plot area and the 3 variables will be displayed in the upper left as long as the stylus is depressed. The values displayed will be associated with the "x" coordinate so you do not have to press on any display line. Just place the stylus on the "x" coordinate(frequency). After you remove the stylus the values are removed and the original low SWR data is displayed.

NOTE: Sometimes after a button is used the first depression by the stylus will NOT get a display, just pick up stylus and place it down again and the values should be displayed.

7. Put code in to throw away empty lines of data and limit resistance and reactance values to no larger than 600.

More to Come!

The Palm-Link908 is an evolving project ... more capabilities will be added as time goes by.

1) Right now the ability is present to collect the data from the Micro908 over the serial port simultaneously when the instrument is scanning. Later, when the capabilities are present in the Micro908 to store the scanned data to local SEEPROM memory, the Palm-Link908 program will be able to load and display that saved scan data.

2) Remote Control of the Micro908 AA908 instrument will be possible when another screen gets activated in Palm-Link908. Later on, when pressing the Remote Control button, another screen will present buttons to set Configuration, select modes and a display area will act as a "remote LCD display" so you can control the instrument from your PC keyboard and see results right on the screen!

Support

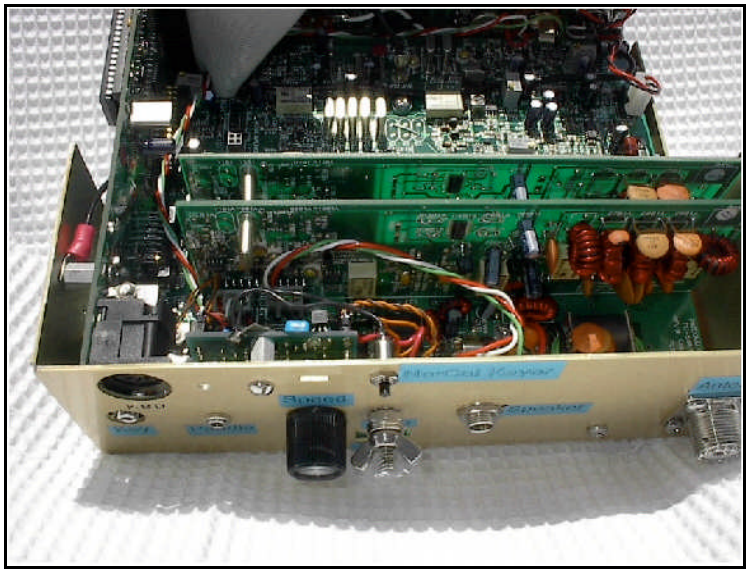
Ron N1ZSW and George N2APB are available on the Micro908 reflector to answer questions about installation and operation.

Again, thanks very much to Ron for his self-initiated contribution to the Micro908 project!

Mark Gustoff, WO7T

PATCOMM + NORCAL KEYER

Thank you NorCal and WB9KZY for the NorCal Keyer.

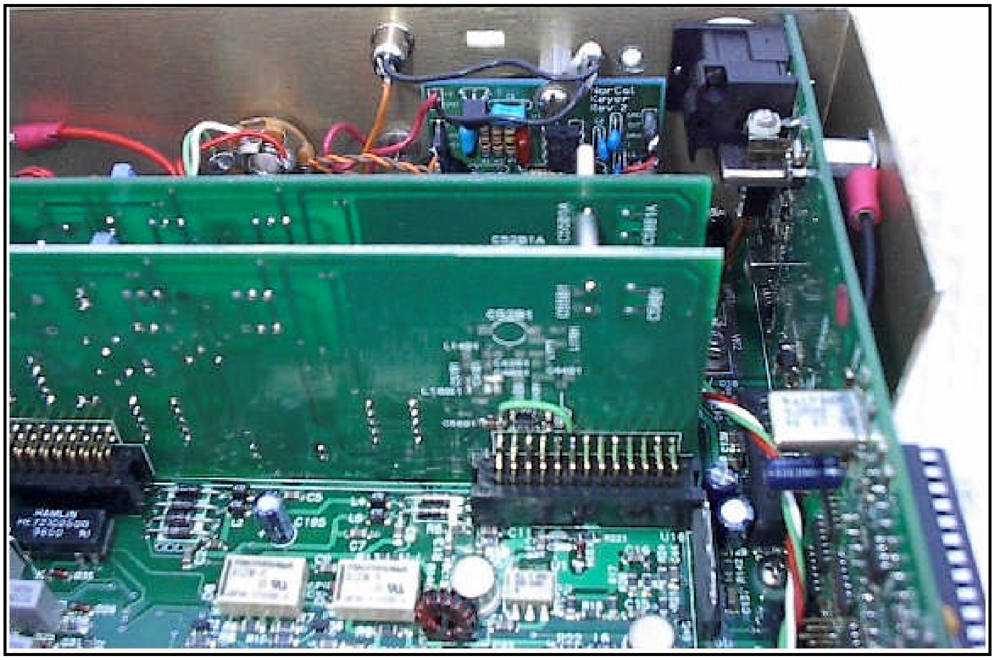


I've owned the Patcomm PC-500 for a couple years now, and it has been a fabulous radio with the exception of the internal keyer functioning. Despite some on board circuit changes and EPROM revisions, the internal keyer is abrupt and too sensitive to the paddle input sometimes leading to errant sending.

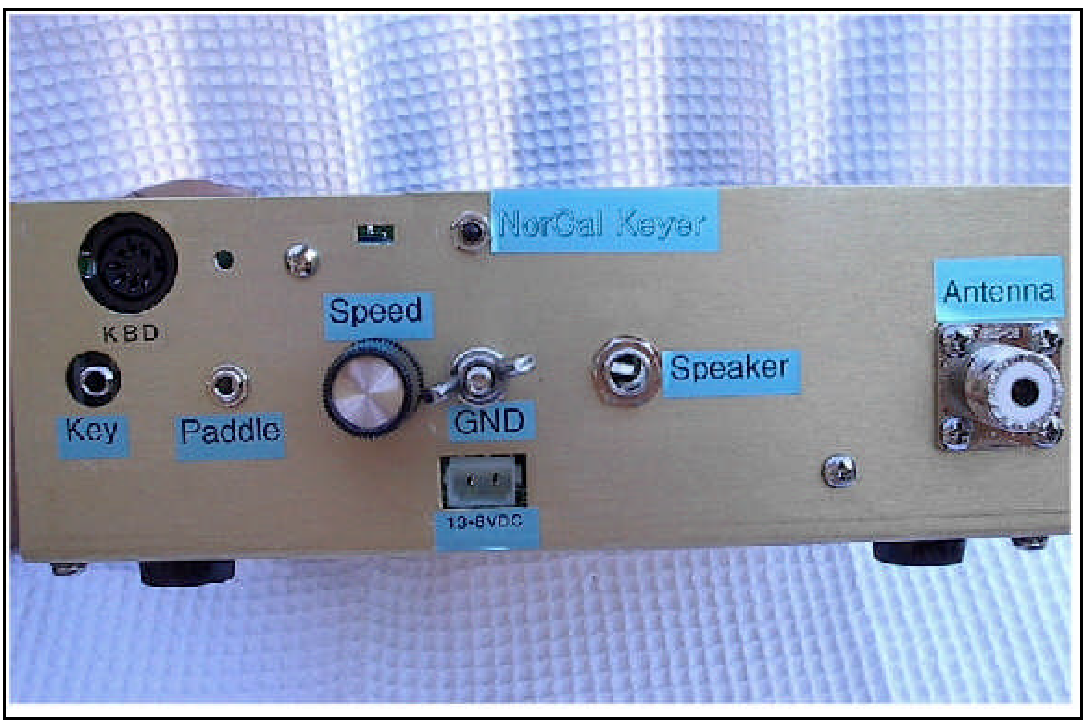
I found a place on the backside of the case for my PC-500 that allowed very convenient mounting of the NorCal Keyer board, as well as short run over to the solder traces for the usual key jack. Note: I did not have the VOX option board or I would have had to slide down the back panel a ways to reach open real estate.

I had to drill new holes for the board standoff, the speed pot, pushbutton/mem switch and the paddle stereo jack. All other jacks on the back panel were left alone. You can see from following picture, the NCK board nestles in nicely, but you need to do your layout work carefully.

In some cases 1/4" separates the board from contacts of switch or pot.



Below the keyboard connector on the circuit board mating perpendicular to the back panel, I used a drill bit to cup out a little half moon into the circuit board material (CAUTION - where there are no circuit traces), just to get a couple wires through to the backside of that board to tack solder onto pads for the existing key socket.



Finishing touches were a relabeling of the back panel, and a knob for the speed control. I dialed down the volume level of the radios sidetone, and just rely on the Norcal sidetone now. You toggle the radio into Manual key mode, plug paddles into the keyer jack while leaving the key jack open and the Norcal Keyer does the keying instead of the internal CPU. My PC-500 now pleasantly sends me a FB in CW each time I turn it on, and the performance is now on the mark with the usual smooth and clean performance the rest of you are seeing with this PIC-based keyer.

AmQRP.ORG HOMEBREWER

Robert J. Hillard, WA6UFQ

PC DDS VFO

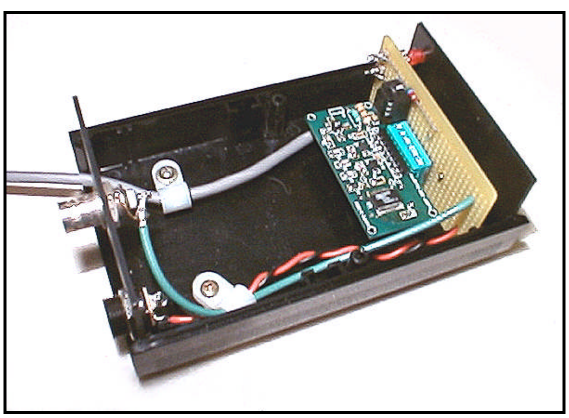
I was introduced to the NJQRP DDS Daughtercard when Lew N5ZE brought his recently completed unit to the Austin QRP monthly luncheon for 'show and tell'.

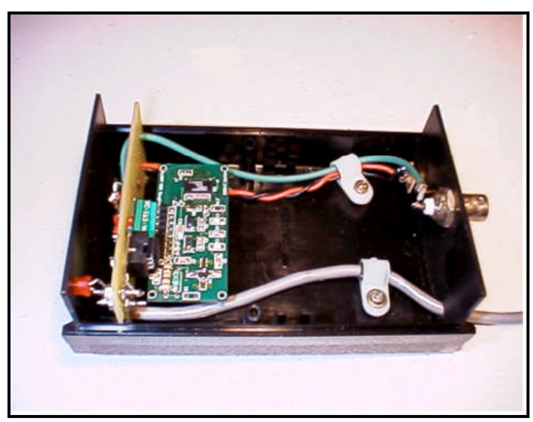
DDS VFO CONTROLLER

Visions of possible applications for the daughtercard raced through my mind, including a replacement for the VFO in my 70 cm SSB rig.

That night I went on line and ordered a sample AD9850 DDS chip from the Analog Devices site. It was just a matter of days and I had my sample chip. Once I had received the AD9850 chip, I sent off an order for the DDS Daughtercard kit. A few weeks later I received my kit and an evening later I had an assembled daughtercard.

I decided that installing the daughtercard inside my transceiver would take away from the versatility of the daughtercard. I instead decided to mount the daughtercard in a project box, and connect its output to my transceiver via a length of subminiature coax. With this configuration, I could use the daughtercard in numerous applications by simply connecting its output to whichever device I chose. In fact, with the 4.2 Vpp output of the MAV-11 device now shipped with the daughtercard kit, I could use a broadband hybrid power splitter to simultaneously distribute the output of the daughtercard to a number of my projects.

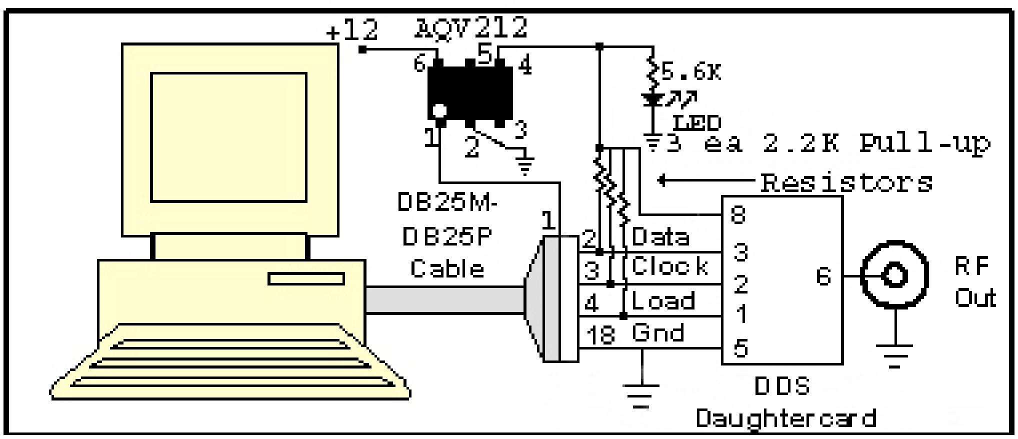




THE INTERFACE

The interface to the daughtercard is through the computer's LPT1 or LPT2 parallel port. Three data lines and a signal ground are required to communicate with the daughtercard. I have added a forth data line to control an Opto AQV212 solid-state switch (Digi-Key 255-1148-5-ND) that allows the daughtercard to be turned on and off from the computer. The Opto AQV212 is capable of switching loads of up to 400 ma. The forth data line is optional, as power to the daughtercard could also be controlled with a SPST switch. An LED has also been added to the interface to indicate power on.

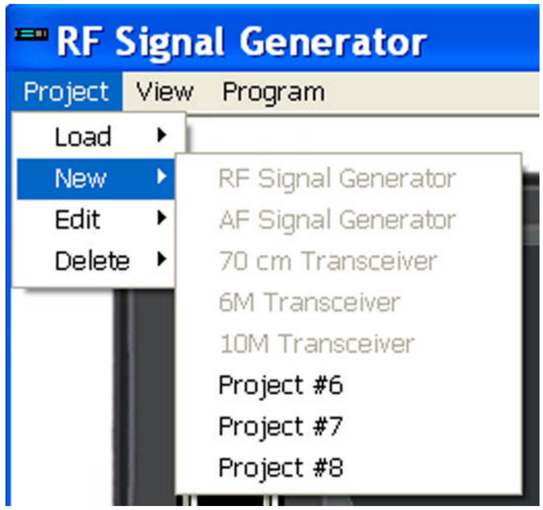
I have also added 2.2K ohm pull-up resistors on all three data lines. This assures reliable data to the AD9850 synthesizer chip from a computer with a weak printer port output. One of the computers in my shack suffers from this condition. Prior to the addition of the pull-up resistors, the output frequency of the AD9850 was unpredictable when the frequency was changed rapidly.



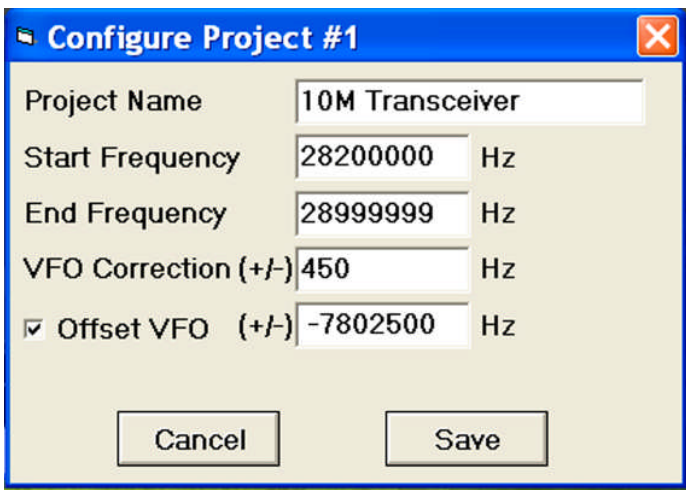
Using Microsoft Visual Basic 6.0, my goal was to develop an application that had the look and feel of an electronic device. The DDS CONTROLLER would have a virtual LCD display, as well as control buttons that functioned like the real thing. The DDS CONTROLLER also had to be programmable, allowing me to configure it to my various projects.

CONFIGURING THE DDS CONTROLLER

There are eight user-defined projects that can be programmed and saved to memory. These project configurations can also be edited, deleted, and selected for use from the Menu Bar. The most frequently used configuration should be programmed into Project #1, as it becomes the default project when the DDS CONTROLLER application is started. The eight project onfiguration files are saved to the C:\PROGRAM FILES\DDS_CONTROLLER folder as .DAT files (APP1.DAT – APP8.DAT).



A VFO CORRECTION field is included in the project's configuration to 'tweak' the display frequency of the DDS CONTROLLER. A positive or negative correction in Hertz is entered into this field.



If the project is to be a VFO for a superhet receiver/transceiver, a frequency offset can be programmed into the configuration. Clicking on the Offset VFO check box and entering the offset frequency in Hertz sets the VFO OFFSET. The offset is the frequency of the receiver's first IF, and is negative in value if the VFO's frequency is below the receive frequency. If a converter is being used in front of the receiver, then the frequency offset is the sum of the converter's local oscillator frequency and the receiver's first IF.

PWR KEY

If the solid-state switch option is used in the interface, clicking on the PWR key applies power to the daughtercard. The default project configuration (PROJECT #1) is then loaded into the

DDS CONTROLLER. The virtual LCD display is turned on, and commands are sent to the AD9850 synthesizer chip to set the output frequency to the project's START frequency. If the DDS CONTROLLER is active, clicking the PWR key removes power to the daughtercard and turns the virtual LCD display off. However the DDS CONTROLLER program remains in the computer's memory to become active once again if the PWR key is clicked.

STBY KEY

Clicking on the STBY key puts the DDS CONTROLLER in the stand-by mode. The output of the VFO is turned off, but the daughtercard remains active. Clicking on the STBY key a second time turns the VFO on and returns the VFO's output to the frequency in the display register.

SCAN MEM KEY

Clicking on the SCAN MEM key switches the DDS CONTROLLER to memory mode, and then steps its output frequency through each of the project's memory cells. If a memory cell is empty, it is skipped over. The dwell time for each step is initially set to 1 second, but can be changed by clicking on PROGRAM/MEMORY SCAN DWELL TIME on the MENU BAR. Clicking on the SCAN MEM key a second time returns the DDS CONTROLLER to VFO mode.

SWP KEY

When the SWP key is clicked, the DDS VFO begins sweeping from its START frequency to its END frequency. Initially the sweep is set to 1 Hz steps/msec, but can be changed by clicking on PROGRAM/SWEEP STEP or PROGRAM/SWEEP RATE on the drop down menu, and selecting the desired STEP or RATE. Clicking on the SWP key a second time returns the DDS CONTROLLER to VFO mode.

THE KEYPAD

Left clicking on the UP key causes the frequency of the DDS VFO to increment by the amount in the STEP register (10 Hz-100 Hz-1 KHz-10 KHz-100 KHz-1 MHz). Right clicking on the UP key causes the frequency to increment in 1 Hz steps. Holding down the UP key causes the frequency to continually increment.

The DN key functions the same as the UP key, decrementing the DDS VFO frequency. If the numeric keys are used to enter a frequency into the display register that is not within the range of the START and END frequencies of the project's configuration, the display will report an 'OUT OF RANGE' error and the numeric display will begin to flash. The CLR key is used to clear the display after any reported errors. The CLR key can also be used to abort the WRITE TO MEMORY function.

The ENTER key loads the frequency selected by the numeric keys into the AD9850 synthesizer's register. The ENTER key is also used in the M>V mode to load the frequency from the selected memory cell into the DDS CONTROLLER display register. In the V>M mode, the ENTER key is used to load the displayed frequency into the project's selected memory cell.

STEP KEY

The STEP key is used to increment the STEP register. The steps are 10 Hz-100 Hz-1 KHz-10 KHz-100 KHz-1 MHz.

M>V KEY

When the M>V key is depressed, the UP and DN keys are used to move through the project's ten memory cells. When the desired frequency is located, clicking on the ENTER key loads the frequency into the display register, resets the M>V key, returning the DDS CONTROLLER to VFO Mode.

V>M KEY

Clicking on the V>M key begins the 'save to memory' process. The UP and DN keys are used to select the target memory cell. Clicking the ENTER key loads the frequency into the selected memory cell.

DOWNLOAD AND INSTALL

DDS CONTROLLER is freeware, and is available on my web site at http://home.att.net/~wa6ufq/ddscontroller.html. Download the file to a temporary folder, then Unzip the file and run SETUP.EXE.

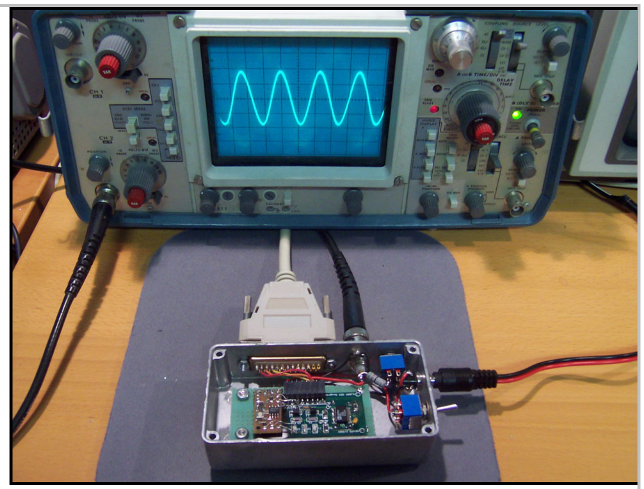
SETUP creates a DDS_CONTROLLER folder in your C:\Program Files folder, and then installs the DDS VFO.EXE file, as well as a number of sample project configuration files into this folder. These configuration files can be deleted, or written over with the EDIT function. The DDS Daughtercard is a handy device to have in your shack. Hopefully the addition of the DDS Controller will make it an even more valuable tool to have at your disposal.

If you have any questions, suggestions, or other features you would like to see in future versions of DDS CONTROLLER, please contact me at b.hillard@att.net.

Michael Hasenfratz, WA6FXT

PC Signal Generator

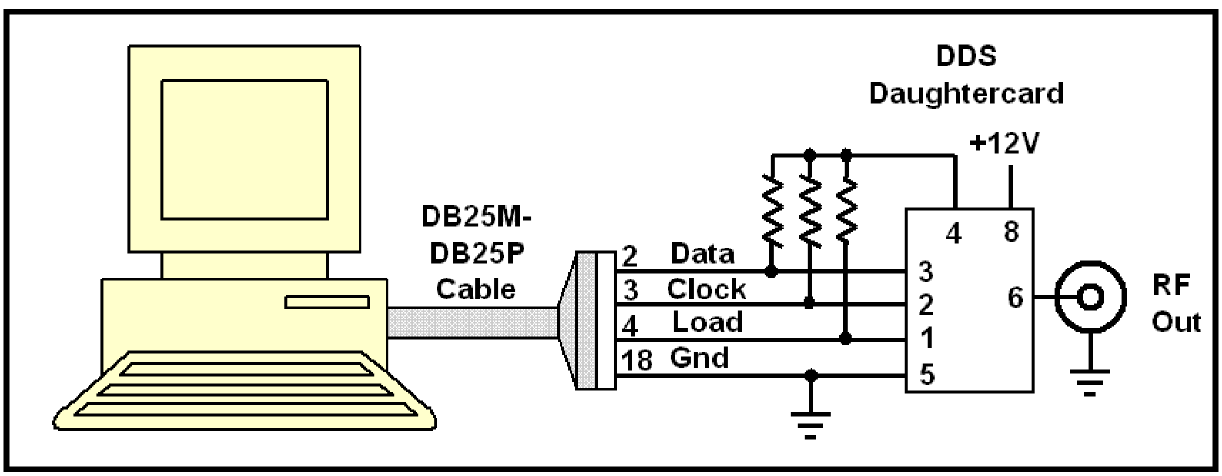
Control the DDS Daughtercard with a simple-yet-powerful software program running on your PC. Allows you to specify the frequency of the signal generated by the DDS Daughtercard when connected to the parallel port on your PC. Even proves for entry of start/end frequency limits for an automatic scan.



Here is yet another use for your DDS Daughtercard from the AmQRP Club … just wire it up to a 25-pin parallel port connector and run my program called DDSFreq. This Windows program presents a window with settings that can be entered for frequency, phase, serial port, and start/end frequency, which instructs the program to continually update the DDS programming register with the next frequency in the series.

HARDWARE CONSTRUCTION

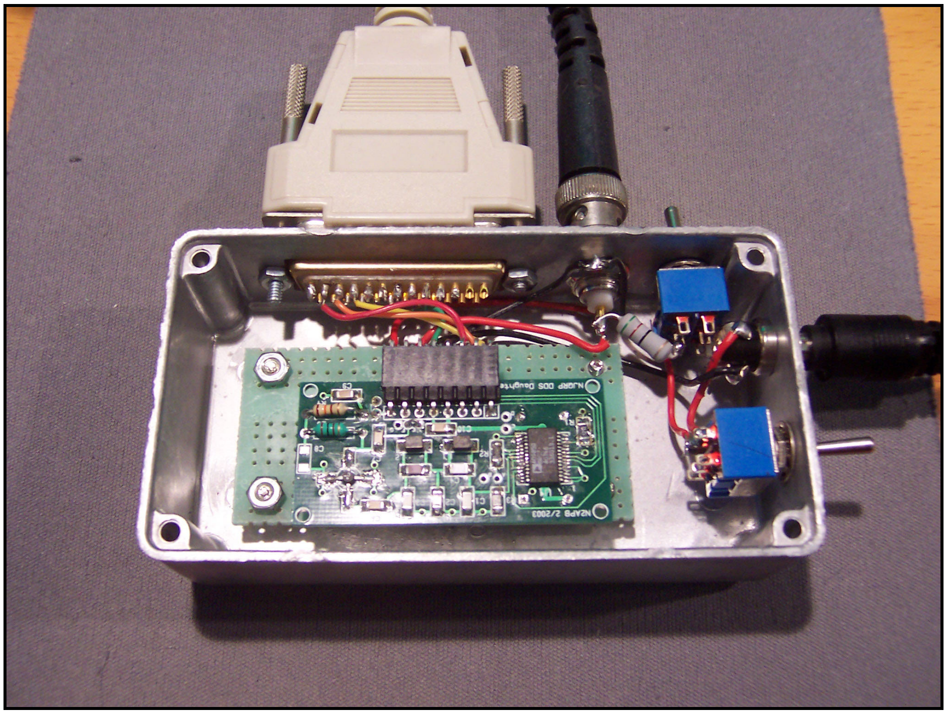
You'll first need to wire the DDS card up to the parallel port connector using the simple diagram below.



Schematic for controlling a DDS Daughtercard via the parallel port of a PC

There's really not much to the wiring, except that you'll need to supply power to the daughtercard. Also, 1K-ohm pull-up resistors are necessary, which was a problem some had in the first programs that tried to control the DDS card. These pull-ups require 5V, which is obtained from the onboard regulator of the DDS card, available on pin 4.

A convenient enclosure for this project is one of those small, die-cast aluminum boxes, which is just about the right size for the DDS card.

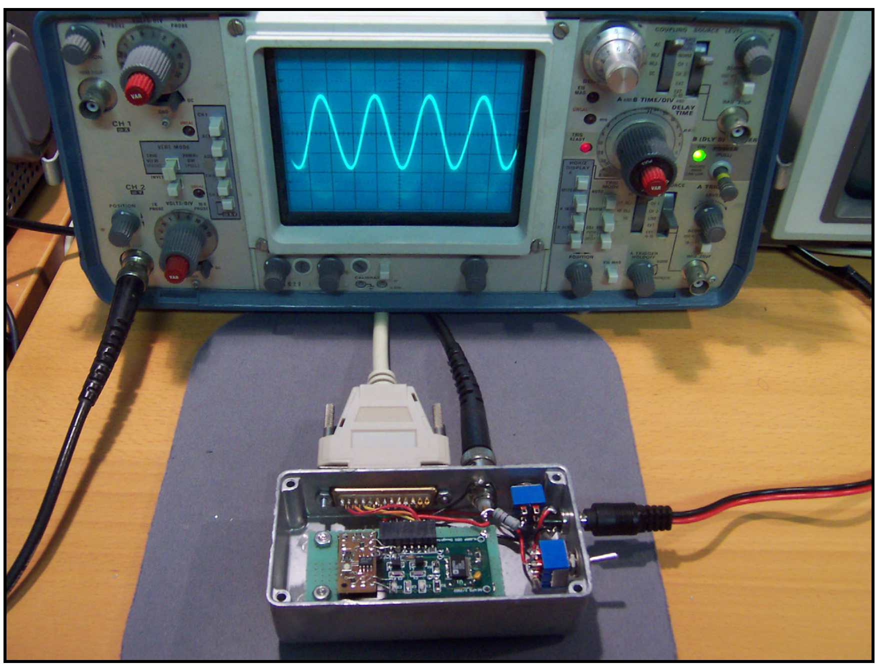


The enclosure houses the DDS card, pull-up resistors, external coaxial power jack and toggle switch, the 25-pin data cable and the BNC connector for RF output signal. The pull-up resistors are mounted below the "motherboard" which holds the right-angle connector for the DDS card. An extra toggle switch was provided next to the BNC connector in order to switch out the 50-ohm load resistor (can be seen in the photo) when the DDS signal connected to other live circuitry.

The finished, enclosed project

Side view of the enclosure shows the connectors for the parallel port cable (right), BNC for the RF output (middle), and the toggle switch (left) to switch in/out the 50-ohm load resistor when needed.

End view of the enclosure shows the +V power jack and switch.



The DDS VFO in operation on the bench.

SOFTWARE (Download software)

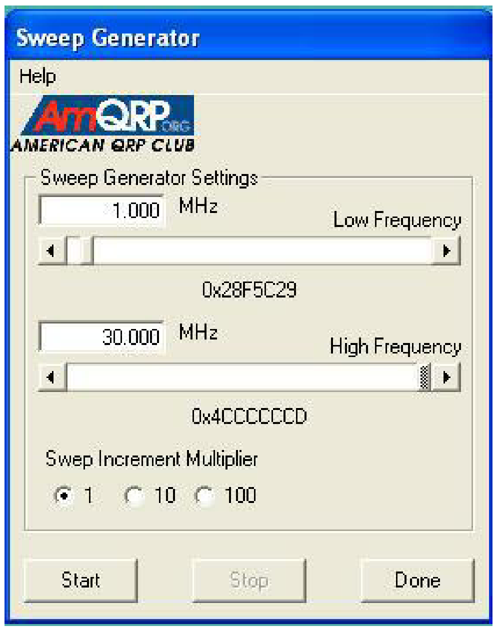
After installing the DDSFreq software, the window shown below is the first seen after starting the program. User input for frequency can be made in the numeric window showing 10.000, or the slider bar below that can also be dragged to show the appropriate numerical value for frequency in that same field. The DDS programming word is also dynamically shown beneath the slider – this is the 40-bit word that gets sent to the DDS chip every time a frequency change is made.

The phase ("Phs.") of the DDS signal is also adjustable using the vertical slider on the right side of this window.

The first window to appear when running DDSFreq provides control of the control word sent to the DDS chip.

IMPORTANT: Before you are able to control your DDS Daughtercard from your PC, you should enter your computer's parallel port address and the value being used for your DDS reference clock oscillator into the Properties window. From the main window above, pull down the Edit menu and select Properties, which then shows the window below. Most often your clock will be 100 MHz, and the address of your parallel port will be '378' as shown below. If your port is different than LPT1: then you will need to change that value to what you have. (Consult your Hardware Manager in the Control Panel to see the details about your LPT ports if you have trouble.)

From the main “frequency entry” window, you may also click the Sweep button, which will show the screen below, useful for entering the Low Freq and High Freq for your desired scan. You can also select the Increment Multiplier to indicate how granular your sweep will be. Once you click Start, increasing DDS control words will continually be sent to the DDS Daughtercard, causing the frequencies generated by the DDS card to rise at a certain rate. This is an interesting display on the oscilloscope, or while listening to the signal in a receiver. It is also useful for determining filter characteristics, crystal parameters, and other measurements.



CONTINUOUS IMPROVEMENT

I will continuing to improve this program, so please let me know how it works out for you. Also, I am making the source code available for those who wish to extend the feature set beyond what I have started. In this case, please share changes with me and we can make it all available on the AmQRP web pages for everyone’s benefit.

Michael Hasenfratz, WA6FXT can be reached by email at mikeh@tothe.net

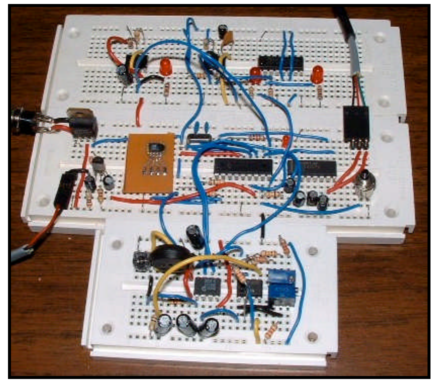
David Ek, NK0E

PIC-Wx

The PIC-based APRS Weather Station Project

... Part 7: Rain Measurement

Adding a Rain Gauge to this ongoing fun and educational project.



Hi Gang! I'm back with another installment in the PIC Weather Station project. This time, we're going to add a rain gauge. Mike Fenske VE7MKF was kind enough to send me a link to his web page where he shows how he's built his weather station based on my series of articles here in the Homebrewer. His page is at

http://www3.telus.net/ve7mkf/wxstation.html

Plus, he has a link to another web page describing yet another homebrew APRS weather station, complete with a homebrewed rain gauge. I'd been wondering myself how to build one, so this page was a great find. It's at

http://www.theworks.com/~wa6ylb/wxstn.htm

If you'd prefer to buy rather than build, check out this page for an inexpensive rain gauge that should also work (thanks to Nick Kemp for this tip):

http://www.fascinatingelectronics.com/index.html

Both of these rain gauges (as well as many other commercial ones) are of the "tipping bucket" variety. Figure 1 should give you an idea of how they work. The funnel collects and concentrates the rain so that it ends up in either the left side or the right side of the bucket. When that side of the bucket gets full, it gets unbalanced and tips, pouring out its contents and putting the other side of the bucket in place for filling. Each time the bucket tips, a magnet attached to the bucket passes by a magnetic switch, causing the switch to momentarily close. Our PIC circuit will sense the switch closure and increment a counter for each bucket tip. The PC software will ask the PIC circuit for the current tip count and convert that to an amount of rainfall by multiplying by a calibration value.

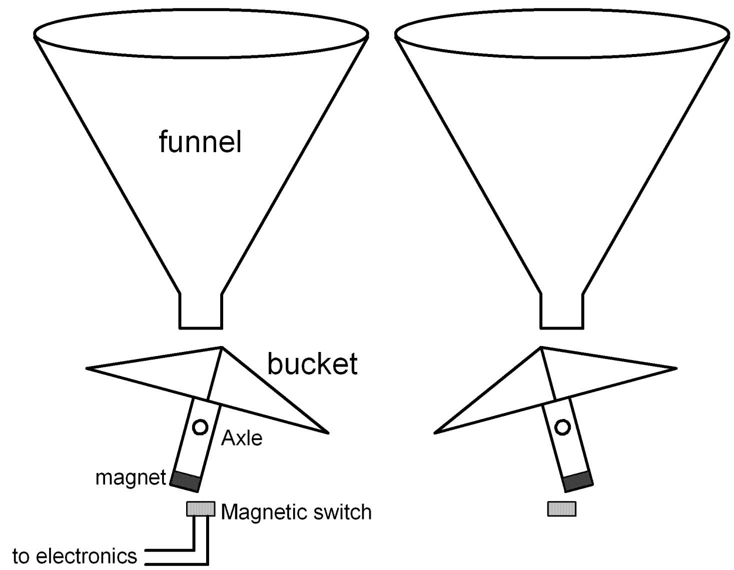


Figure 1: A Tipping Bucket Rain Gauge (showing the bucket tipped both ways).

Pulse Counting

It's a fairly simple matter to connect the magnetic switch from the rain gauge to a +5V supply so that we can drive one of the PIC's pins high whenever the switch closes. Then it's just a matter of watching that pin in the PIC code and incrementing a register each time the switch closes and then opens. Can it really be that simple?

Well, no—it's more complicated than that. The problem is that we have the PIC busy doing all sorts of things and it might miss the momentary switch closure. Our rain sensor is different from the others in that, for the other sensors, the PIC isn't doing anything while it's waiting for a command to read one of the sensors. But our rain sensor requires constant attention lest it misses a bucket tip and reads incorrectly. So, if a bucket tip happens to occur while the PIC is busy reading one of the other sensors, we need some way of remembering that information until the PIC can get to it. My solution to this problem was to use a flip-flop to latch onto the momentary pulse from the magnetic switch and remember it long enough for the PIC to have a chance to detect it.

Flip-Flops

No, we're not talking about the kind you wear on your feet—a flip-flop is an electronic circuit made from digital gates that has the ability to assume either of two stable states, depending on the input it's given. Figure 2 shows the most basic type of flip-flop, the RS flip-flop. It has two inputs, S and R (for Set and Reset), and two outputs, Q and No, we're not talking about the kind you wear on your feet—a flip-flop is an electronic circuit made from digital gates that has the ability to assume either of two stable states, depending on the input it's given. Figure 2 shows the most basic type of flip-flop, the RS flip-flop. It has two inputs, S and R (for Set and Reset), and two outputs, Q and $\overline{Q}$ ($\overline{Q}$ is always the opposite of Q; the bar over the top indicates it’s "NOT Q"). From the logic diagram in Figure 2, you can see that a momentary pulse on the S input causes Q to go high and stay high until a momentary pulse is received on the R input. In an RS flip-flop, R and S should not be allowed to go high at the same time because it results in an uncertain state for Q.

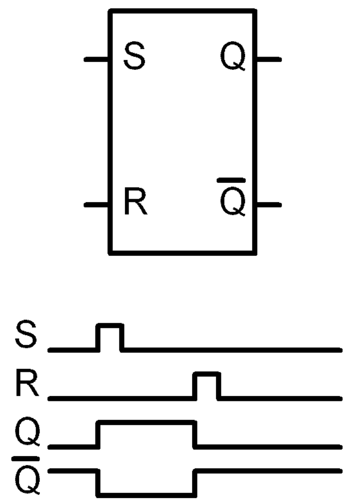


Figure 2: The RS Flip-Flop.

A more commonly-used flip-flop, the JK flip-flop, is shown in Figure 3. The JK flip-flop has three inputs: J and K, which function much like S and R in the RS flip-flop, and a CK, or clock, input. The difference between the operation of the RS and JK flip-flops is that the outputs of the JK flip-flop will only change state on the leading edge of a pulse to the CK line. You can see in the logic diagram that even though the J input goes high, the Q output doesn’t go high until the subsequent pulse on the CK line. The same is true for the K input taking Q low again—it doesn’t happen until the pulse occurs on the CK line.

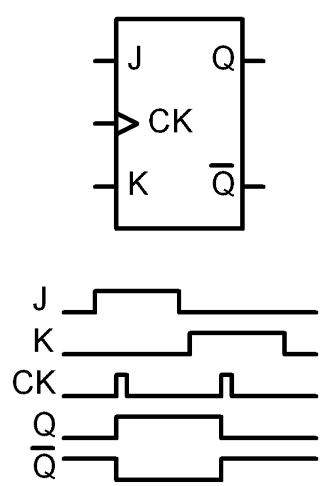


Figure 3: The JK Flip-Flop.

One other difference between the RS and JK flip-flops is that it's okay for both the J and K inputs to be high at the same time. In fact, that's a very useful state because it causes the outputs to toggle each time a pulse is received on the clock line. We're going to use this feature to latch onto pulses received due to momentary closings of the magnetic switch in the rain gauge. Then all our PIC needs to do is sense a state change on the corresponding input and increment its counter—something that it should be able to do at its leisure since we'd expect this to happen no more frequently than every few seconds.

Debouncing the Switch

There's one other little issue that we need to deal with. Switches have a nasty habit of "bouncing" when closed or opened. What is bouncing? The contacts don't close or open perfectly—instead, they bounce against each other a few times, making and breaking the connection until they come to rest. In many cases this is no big deal, but here it results in several pulses on the clock line each time the switch closes instead of just one. Obviously, this can royally mess with the accuracy of the rain gauge.

There are a number of techniques that can be used to debounce a switch. I happened to have a copy of Forest Mims' 555 Timer IC Circuits Engineer's Mini-Notebook laying around, and in it is a nice little circuit for debouncing a switch. If you examine the schematic for this installment (Figure 4), the first thing you'll notice is that I'm using a 556 instead of a 555. A 556 is essentially two 555's, and I'm using the second 555 for a purpose I'll describe later. Here, one half of the 556 IC (pins 1 through 6) is used in one-shot mode: a trigger pulse on pin 6 causes the 555 to generate a fixed-width output pulse on pin 5. R21 and C15 are the parts used to set the width of the output pulse (which is about 1 second here). Reducing the value of C15 to 1 uF will reduce the width of the output pulse to about 0.1 seconds. The key here is to make the output pulse width wider than the input pulse, but not so wide as to obscure the next input pulse. One second seemed like a good choice here. Figure 5 shows a logic diagram relating the input from the rain gauge's magnetic switch, the output from the 556 timer, and the Q output from the JK flip-flop. We now have a nice, reliable pulse train that should be easy to count with the PIC.

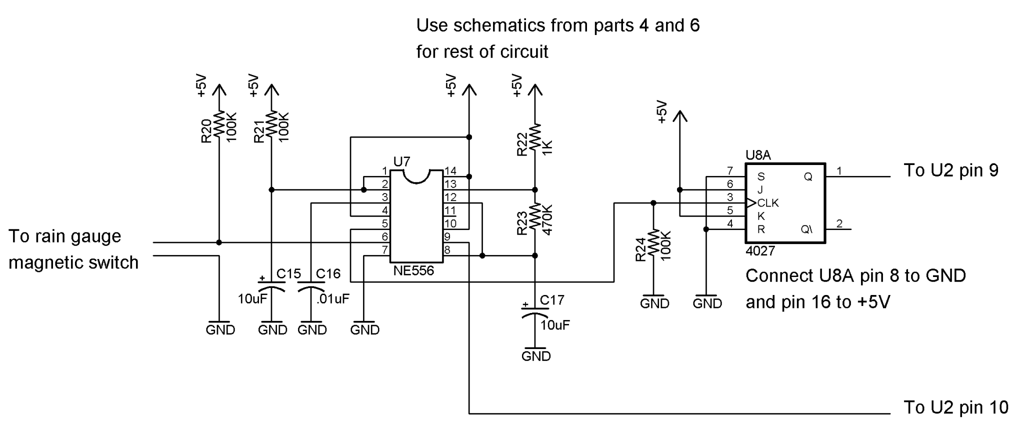


Figure 4: Schematic Diagram for PicWx Part 7.

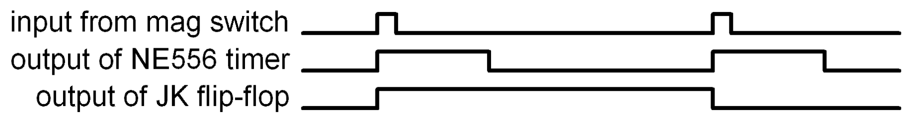


Figure 5: Rain Gauge Pulse-Sensing Logic Diagram.

Idle Processing

Now that we have a nice circuit for signaling the PIC whenever the bucket in the rain gauge tips, we have to teach the PIC to monitor that input and keep a counter of bucket tips. The PIC also needs to be able to report the counter value to the PC and reset the counter to zero on request. Let's begin with monitoring the rain gauge input. The input from the rain gauge is wired to pin 9 (RB3) of the PIC. Each time the input changes state (goes from low to high or high to low), the PIC needs to increment its rainfall counter.

The way we make sure to catch each state change is through a subroutine named Idle in the PIC code. Subroutine Idle is called whenever the PIC is checking for input from the PC, from subroutine GetAChar. So, Idle ends up being called very frequently, much more often than the state of the rain gauge input might change. Subroutine Idle calls another subroutine named RecordRainfall to do the actual checking of the rain gauge input. RecordRainfall remembers the previous value of the rain gauge input in a general-purpose register named RegSave, and compares it with the current value. If they are different, RecordRainfall increments the two-byte counter made up of RainHi and RainLo, saves the new state of the rain gauge input in RegSave and then returns.

To report the rainfall, the PIC responds to the 'r' command from the PC and simply sends back the current value of the two-byte rain counter (RainHi and RainLo) as a five-digit ASCII string, using the SendAsciiNum subroutine (just like for every other command). To reset the rain counter to zero, the PIC responds to the 'e' command and simply zeroes RainHi and RainLo (nothing is returned to the PC).

The Anemometer Revisited

I'm flattered that many of you have taken the time to follow along with this series and construct the PicWx station for yourselves. Some of you have even created your own variations. For example, Brian VE6OH wrote, "For the anemometer, I used a ball bearing PC fan with the CD disk and the 3 egg cups glued onto the fan hub top. I removed the fan blades, magnet and coil. Next I drilled holes in the side wall of the fan hub, then placed and aligned an optical sensor to pick off the pulses as the side wall holes turned past the IR led and IR receiver diodes."

I have to confess that I've never been completely happy with my implementation of the anemometer. One thing that I disliked is how I measured the wind speed in the PIC code. When the 'w' command is received, the PIC basically wastes 3 seconds to count the pulses being generated by the anemometer before it'll return a value to the PC. But seeing how I was using subroutine Idle to check the rain gauge input, I had to wonder how I could do the same thing to monitor the wind speed. The problem is that the wind speed needs to be measured over a fixed interval in time, and the only way I had up to now of measuring that interval was to have the PIC do it (to the exclusion of everything else). If I could somehow signal the PIC externally whenever it was time to stop one wind measurement and start another, then I could use subroutine Idle to do it.

The answer came to me when I pulled out the 555 timer Mini-Notebook and remembered that a 555 could be used to provide a continuous train of pulses (astable mode). If I could feed a steady stream of three-second pulses to the PIC from the 555, that would serve as a signal to the PIC to start a new measurement. If you examine the schematic in Figure 4, the second half (pins 9 through 13) of the 556 is configured to do exactly this. C17, R22, and R23 set the frequency of the pulse train. If t_1 is the width of the pulse, and t_2 is the time between pulses, then t_1 and t_2 are determined by the following formulas:

$$t_1 = 0.693\ (R22 + R23)\ C17$$

$$t_2 = 0.693\ (R23)\ C17$$

We want t_1 and t_2 to be the same, and they'll be essentially equal if R22 is small compared to R23. If we use a value of 10 uF for C17, then using 1K for R22 and 470K for R23 gives us a pulse width of about 3.25 seconds.

Triggering Wind Measurements

The output from this half of the 556 is fed into pin 10 (RB4) of the PIC. Subroutine Idle is used once again to monitor this line, and now the anemometer input line at pin 7 (RB1). After subroutine RecordRainfall is called to check the rain gauge, subroutine CountWind is called to check to see if the state of the anemometer input has changed. If you compare CountWind to RecordRainfall, you'll see that they are very similar in that they use the same exact method to count state changes and increment a counter. In the case of CountWind, the CountWindHi and CountWindLo registers are used to count the wind speed.

After subroutine CountWind is called in subroutine Idle, another subroutine called CheckWindInterval is called. CheckWindInterval monitors the RB4 line (from the 556). Whenever that line changes state, CheckWindInterval copies the contents of CountWindHi and CountWindLo into two other registers, WindHi and WindLo, and then zeroes out CountWindHi and CountWindLo to begin a new wind measurement interval.

Now, if the PIC receives the 'w' command, it simply grabs the data from WindHi and WindLo and sends it back to the PC as a five-digit string using subroutine SendAsciiNum. This is done immediately rather than waiting for a measurement to complete like was done before—WindHi and WindLo always hold the results of the most recent measurement.

One final thing—you'll notice that there is a call to WaitMS at the beginning of subroutine Idle. Without this call (which causes a delay of a millisecond), my wind measurements were all screwy—low wind speeds would give higher numbers than high wind speeds! I'm speculating that this was because at low wind speeds, the variation in the voltage of the anemometer input was less, and it was spending a lot of time in the voltage region where the PIC port would transition from high to low. This probably led to lots of extra transitions that weren't what we wanted to count (kind of like switch bounces). Waiting a millisecond between measurements seems to eliminate most of those.

Note that you might need to recalibrate your anemometer after this installment. I tried to make the measurement interval the same as before (three seconds), but there will probably be some variation in the new interval due to parts tolerances and such. Alternatively, you can try to fine-tune the value of R23 to match your original calibration.

Construction

Figure 4 shows the portion of the circuit we added for this installment. Refer to installments 4 and 6 for the remainder of the schematic. U7 is the 556 timer chip and U8 is the flip-flop, a 4027 dual JK flip-flop. U8 actually contains two flip-flops. Only one half of U8 is used here. The 4027 is a CMOS device and is especially susceptible to damage from static electricity, so use care in handling it. Both of these chips are inexpensive and readily available. Here are some catalog numbers:

Part	Digikey	Jameco
556	296-6504-5-ND	24328CL
4027	296-2044-5-ND	12888CL

When I built this circuit, I connected each of pins 1 and 2 of the 4027 to an LED in series with a 1K resistor to ground, so that I could see the outputs go high and low as I simulated the magnetic switch pulses by momentarily grounding pin 6 of the 556. I did the same thing with pin 9 of the 556 so I could watch the pulses signaling the wind speed timing intervals to the PIC. The LEDs aren't needed for normal circuit operation, of course. It's just an easy way to verify correct operation of the circuit.

Calibration and the PC Software

The web page showing the homebrew rain gauge also gives instructions on how to calibrate it. Ultimately, what you need to know is the amount of rainfall that corresponds to one bucket tip. This is the number you'll need to enter into the Settings dialog of the PicWx PC software. When you start the latest version of the software, downloaded from the Digital QRP Homebrewing web page at

http://www.njqrp.org/digitalhomebrewing/

just click the Settings button and enter the calibration value in the space provided. Hit the "Empty" button when you want to reset the rain gauge.

Wrapping It Up

Well, if you've been keeping track, we've use all of the PIC I/O lines except for RA4. The only thing I can think of to add at this point is a wind direction sensor, but I don't know how to do that with only one input line available. So, the next installment will wrap up the PicWx series by talking about some options for deploying the weather station outdoors, and hooking it up (finally) to my APRS software and getting the measurements out onto the APRS system. Hopefully, I'll also be able to announce the availability of PC boards for the project. Mine's all on solderless breadboards right now, and I'm sure not going to put those outside! Figure 6 shows my rat's nest, in case you're curious.

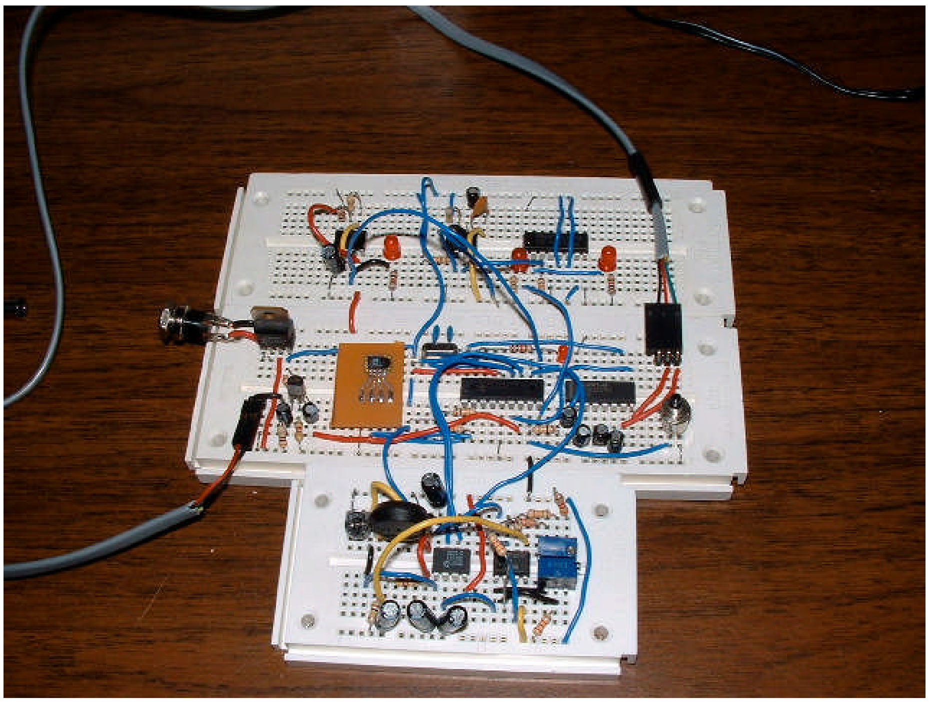


Figure 6: My PicWx project on its solderless breadboards.

Thanks for following along. I know it's been a long trip, but it's been a fun trip, too. Until next time, 73 de NK0E.

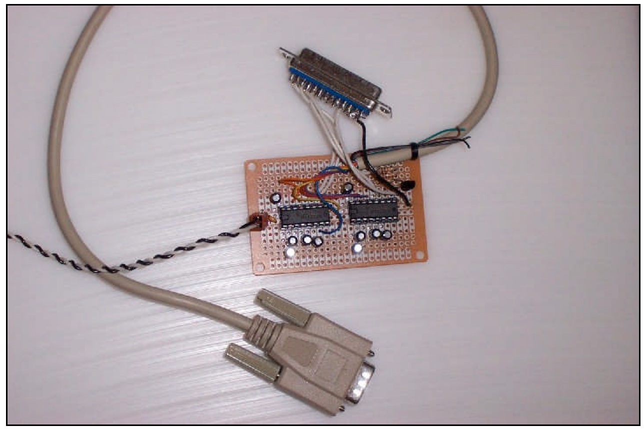
David Ek, NK0E

nk0e@earthlink.net

Trevor Jacobs, K6ESE

PIC-EL Parallel Port Adapter

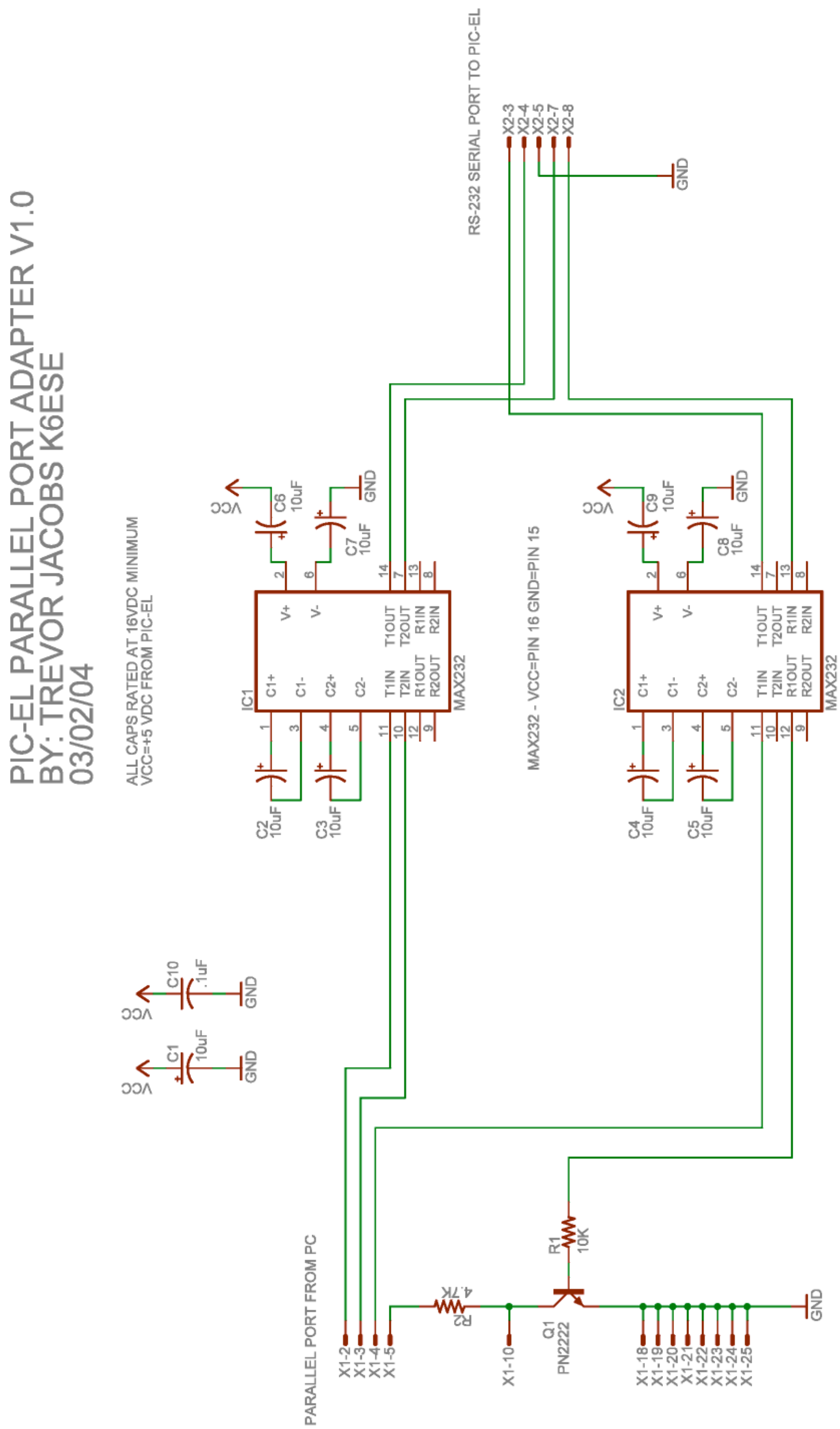
Most notebooks these days are no longer coming with built in serial ports due to the wide spread use of USB technology. I hope that some of you find this little project useful.



When the AMQRP Club announced that they were going to kit a board for PIC development, I just had to have one as I was just starting a project for the PIC16F84A. It seemed like it would be a lot cheaper and easier than rolling my own development board or buying a commercial one. The PIC-EL kit comes with everything to begin developing your own software on, and at a VERY reasonable price. It even comes with a nice LCD display, LED indicators, mechanical encoder, a speaker, and a port for the DDS Daughter Card.

Once I had it built and running correctly, I had no problems burning programs into the PIC16F84A from my main PC that has a built in RS232 Serial Port, but quickly found out that the USB to RS232 Serial adapter that I had for my Dell Notebook wouldn't work. I think that it's more of a USB Device Driver problem than a hardware issue. So, I searched the web for a possible solution. I could buy a PCMCIA card serial port adapter, but they are not cheap. I even found a web site with plans to take an old PCMCIA 14.4 Modem and convert it into a serial port, and I thought about doing this, but don't have an old modem. So, I figured that the easiest solution would be to set up the programming software (FPP) for a parallel port programmer and convert the TTL Levels of the parallel port to RS232 levels (+/-10 VDC) for the PIC-EL. I just happened to have a couple of TI MAX232N chips in my parts collection from another project, so thought I'd give this a try. The MAX232N is a 2 channel RS232 Line Driver/Receiver chip that does exactly what was needed, converting RS232 levels to TTL levels and vice versa. The MAX232N also makes a nice buffer to go between the PIC-EL and the PC's Parallel Port.

The total parts count is only 17 parts including a connector for the serial side and 1 for the parallel side. There are 10 caps, 2 resistors, 1 PN2222 transistor (used to pull the parallel port ACK line low) and the 2 TI MAX232N chips. I built the entire circuit on a little piece of circuit board from Radio Shack. Power for the circuit can be taken directly from the PIC-EL or another +5 VDC regulated supply. What I did is to connect two alligator clips to some hookup wire and soldered them to the GND and VCC lines on the adapter circuit. Then the alligator clips can clip onto the GND (TP-D) and +5 VDC (TP-C) test points on the PIC-EL to power the Parallel Port Adapter. Following is the PIC-EL Parallel Port Adapter Schematic V1.0.



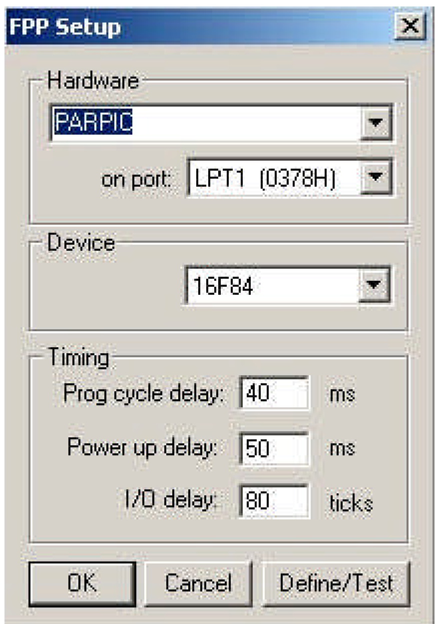
PIC-EL PARALLEL PORT ADAPTER V1.0
BY: TREVOR JACOBS K6ESE
03/02/04
ALL CAPS RATED AT 16VDC MINIMUM
VCC=+5 VDC FROM PIC-EL
MAX232 - VCC=PIN 16 GND=PIN 15
RS-232 SERIAL PORT TO PIC-EL
PARALLEL PORT FROM PC
IC1
IC2
MAX232
PN2222

Once you have built the adapter and verified all connections (watch out for capacitor pollarity!) hook it up to +5 VDC. Check between GND and pins 2 and 6 on the MAX232N chips for V+ and V-. You should see around +8 to +10 VDC on pin 2 and -8 to -10 VDC on pin 6. If you don't, go back and check your wiring, you probably made a mistake somewhere. Once you have checked the wiring and you are sure that the voltages are correct you can hook the serial port side up to the PIC-EL and the parallel port side up to your PC.

Setting up FPP

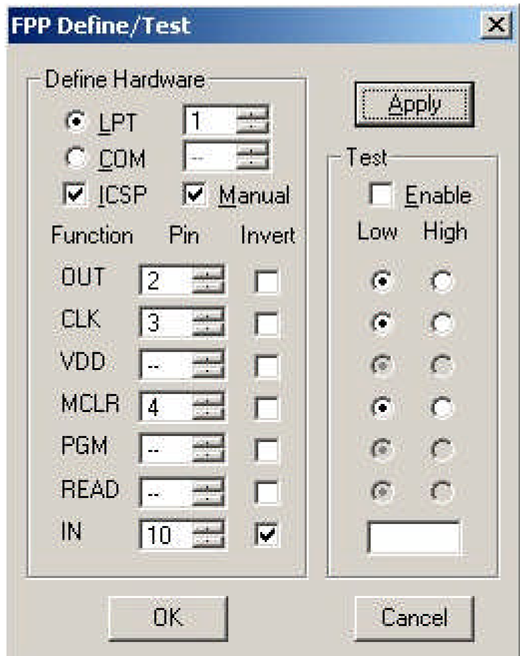
The next step is to set up FPP for the parallel port instead of the serial port. I'm assuming at this point that you have installed FPP and have a basic understanding of how to set it up. If not please go to the Elmer 160 web page, download and read lessons 10 and 11 which give detailed instructions on downloading and installing FPP.

Launch FPP, and once it is open click on the "SETUP" button. You should see a screen pop up similar to below:

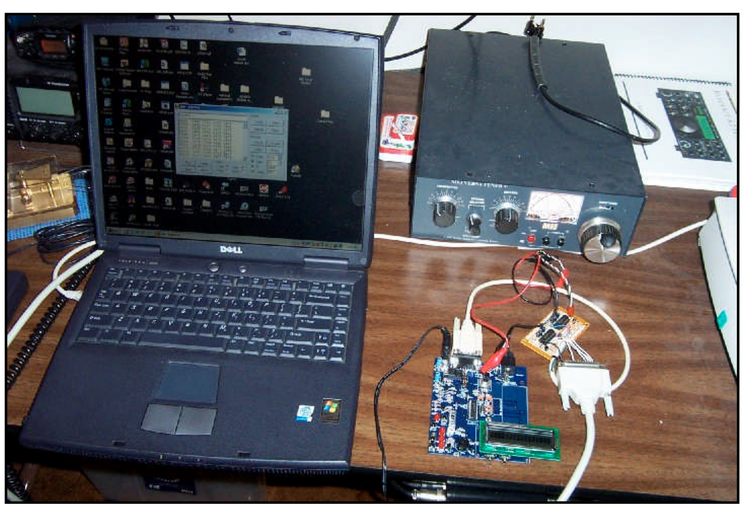


First set the hardware to "PARPIC" for the Parallel Port. Next pick which Parallel Port you want to use on your PC. Then select the device as a 16F84 if you haven't done so already. Next is the timing window. These are the settings that worked on my 1.2 GHz PIII Dell Notebook. The timing is slowed down a bit from my desktop machine (i.e. bigger numbers) and I think this is due to the much faster CPU in my notebook. FPP is an older program, so I don't think that it can handle the timing on a faster machine without doing this. On my main PC the timing settings were as listed in the Elmer 160 lessons and it worked fine with the adapter. My main PC is much slower though, a 550 MHz PII. Anyway, these timing setting work great on the notebook, so if you have problems on a fast machine try adjusting your timing to these settings.

Now, before you click the "OK" button (we're not done yet), click on the "Define/Test" button. You should see a screen like this:



Modify your settings to match this screen, and then click on the "Apply" button. If you click "OK" before clicking on "Apply" all your settings will revert back to the previous settings. Click on the "OK" button on the "Define/Test" menu and then on the "Setup" menu. You should now be back at the main menu. Once you have this set up and running you can proceed to test read and program the PIC16F84A on the PIC-EL. Now you're ready for the Elmer 160 classes and on to developing your own code!
This is a pretty straight forward project, so I'm not going to design a PCB at this time. It only took me about an hour to hook it up point to point on the little Radio Shack PCB, and there are no SMD devices either. Here's a picture of my test setup:



Most notebooks these days are no longer coming with built in serial ports due to the wide spread use of USB technology, so I hope that some of you find this little project useful.

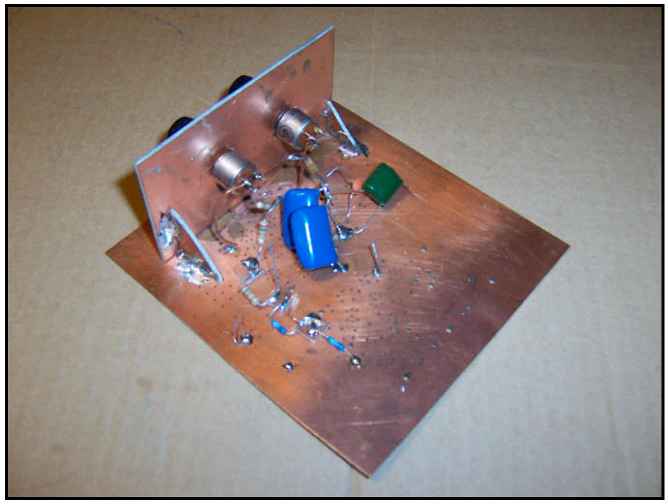
73's Trev

http://www.k6ese.com

AmQRP.ORG HOMEBREWER

Joe Everhart, N2CX

RF Power Meter Cookbook ... Part 4



This installment outlines test methods and simple circuits used to test RF power meters when you don't have access to expensive lab-grade equipment. N2CX focuses on testing below 30 MHz to demonstrate principles without resorting to special techniques.

When this series of articles began it seemed that a couple of installments would be sufficient to cover the subject. However in the course of writing it became obvious that the subject matter was large enough that more than two were needed to fully discuss the principles and applications. The last segment stated that this time around we would get to the final design. In working out the details of that design, a large amount of time was needed to do the preliminary testing required to check out the power meter performance to be sure that it was as expected.

This installment will outline some test methods and simple circuits that a homebrewer can use to test RF power meters and voltmeters without access to expensive or tough to find lab-grade test equipment. The focus will be on testing below 30 MHz to demonstrate the principles without the need for special techniques. The same ideas can be used well into VHF by minimizing the length of interconnecting leads and optimizing circuit layout.

When designing and building test gear homebrewers need to make maximum use of test equipment and components they have or can get easily. Best success comes when the basic instruments and parts have known performance that can be extended to other uses.

That sounds kinda abstract, so here are some examples to start with. We can buy reasonably good DMM's (Digital Multi-meters) for well under $100. They offer DC and AC voltage and resistance measurement accuracies on the order of 1%. In addition, inexpensive resistors and potentiometers can be used well into the HF part of the spectrum with good accuracy. Ordinary diode detectors can be calibrated using DMM's and some special techniques to accurately measure AC and RF voltages.

Using the above elements we will make some DC and low frequency AC measurements that can be done directly with the DMM to calibrate our test setup then use the calibrated test setup for RF measurements. Several test methods will be described in the following sections. They are complete in themselves though they may not apply to every situation. Sufficient description of the underlying principles is given so that the reader can adapt the methods shown to his own needs.

Diode Detector Calibration and Testing

The half-wave diode detector we discussed back in the second article in the series is a real workhorse. It allows us to easily measure RF by converting RF sine waves to DC. The DC output can then be read very accurately with a DMM. It suffers however from inaccuracy at low input levels due to inherent diode nonlinearity. However, for inputs of 1V rms or higher, it can be calibrated by measuring its output at various levels and making a calibration chart. The calibration chart is then used afterward to correct readings made using it to compensate for the non-linearity. That may sound like a chicken and egg situation, but it really is not. The key to making up the calibration chart is to perform the measurements at low AC frequencies where we can easily generate and measure the levels needed.

Figure 1 shows the test circuit used.

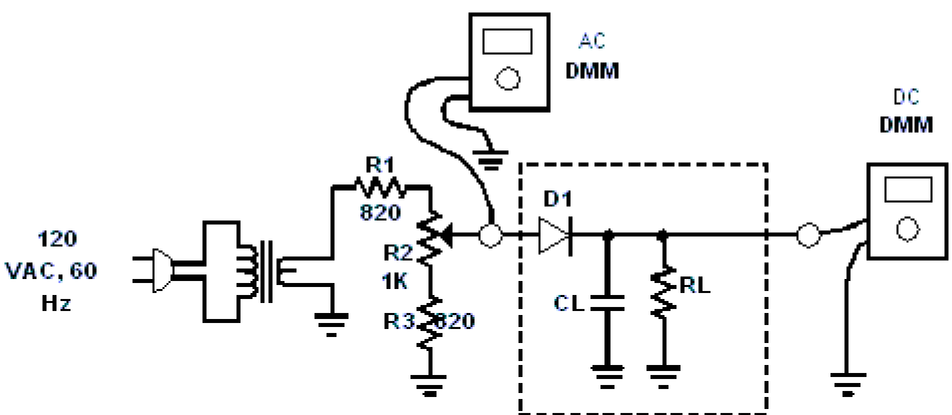


Figure 1 - Diode detector tester

The AC input is provided by a 24 volt filament transformer if you can find one or by two 12 volt transformers with their secondaries connected in series. The transformer supplies this AC voltage to a resistive network and potentiometer that give the test circuit an adjustment range of 0 to 24 V AC. The adjustment range is segmented due to the power rating of the potenti-ometer. Common potentiometers have a maximum power rating of only ¼ to ½ watt so the voltage across the pot has to be limited to no more than about 15.8V. The entire range can be achieved by shorting out one or the other resistors to keep the potenti-ometer from burning up. Either one or two meters are required. One of them is used to measure the AC voltage out of the potentiometer and the other is used to measure DC voltage from the diode detector being tested. The one measuring the AC voltage is used as test equipment while the DC meter is whatever will be used with the diode detector in its final application.

The detector being tested is shown in the dotted block in Figure 1. It is simply a diode, a filter capacitor and a load resistor. The filter capacitor is charged to the peak value of the input sine wave minus the diode drop and the load resistor allows the circuit to adjust itself to that peak value as the input voltage is adjusted. The detector diode can be either a germanium 1N34 or a Schottky diode such as a 1N5711. Schottky's have a somewhat higher forward drop than Germanium diodes but they have more repeatable character-istics and will allow use of much higher load resistors.

The value of the filter capacitor depends on the load resistor used. It must filter RF from the detector DC output. As a conservative figure the RC time constant (RL * CL) should be 100 times the period of the input sine wave. For example, at 60 Hz, with an Rl of 1 megohm, we want RC to be 100 * 1/60Hz so CL needs to be at least 1.67 m f. As a practical matter the capacitor must have a very high leakage resistance so it must have either ceramic or plastic film dielectric. Ceramic capac-itors this high in value are uncommon so a good choice is either a single 2.2 m f or two 1 m f Mylar capacitors in parallel. Likely the detector will already have an RF bypass cap such as a .01 m f or larger ceramic filter capacitor so simply connect the larger capacitor across the output terminal during testing then disconnect it when testing is completed.

A short step-by step procedure to test the detector might be:

1. Begin with no AC applied to the test circuit and connect the detector to the center arm of the potentiometer. Adjust the potentiometer so that the center arm is at the low end of its range.
2. Connect the DMM to the center arm of the potenti-ometer and set it read AC volts on the next scale above 25 V rms.
3. Connect a jumper across resistor R1 in the test circuit. This will limit the output voltage to about 12 V or so.
4. Apply AC to the circuit and adjust the potentiometer so that the DMM reads exactly 1V RMS.
5. Set the DMM range switch as appropriate for its most accurate reading.
6. Read and record the DC indication on the detector output meter.
7. Set the potentiometer so that the DMM reads 2V rms then read and record the DC output indication.
8. Repeat Step 6 at each one volt interval up to 12V AC. Reset the DMM range switch as necessary.
9. Remove the AC input voltage. Set the potenti-ometer to its lowest setting.
10. Remove the jumper across R2.
11. Reapply the AC input voltage.
12. Set the potentiometer for a 13VAC reading on the DMM then read and record the output meter DC reading.
13. Repeat step 11 at one volt increments up to 24V AC.
14. Remove AC input from the circuit.

At this point calibration readings have been made at one volt increments from 1 VAC to 24 V AC. The readings at the lower voltages may show some non-linearity and should become more linear at higher steps. The detector has now been characterized at 60 Hz and should retain its calibration up through 30 MHz if short leads and a clean layout have been made.

Compensated Detector Test and Calibration

The compensated detector described in earlier installments of this series uses and operational amplifier with diode feedback to overcome detector non-linearity at levels down below 100 mV input. It s behavior above about 1V input is predictable so testing can be limited to lower levels.

This requires a more sophisticated method. While the testing could be performed at 60 Hz, using a variation of the method above this requires multiple large value capacitors and the DMM can become inaccurate at low AC voltages. The answer is to do testing at a frequency in either the audio range or low RF range. If a suitable RF source with an adjustable 1V output is available, by all means use it with the circuit to be described shortly. If not, testing can be done at audio frequencies and performance at RF should be adequate.

A suitable RF source is a good quality RF signal generator (a DDS signal generator is ideal) or a low power transmitter. Either one needs to produce a signal of at least 1V rms with harmonics and spurious signals suppressed by at least 30 dB. The exact frequency is not critical though using 3.5 MHz lessens errors due to lead lengths and stray capacitance in the test setup. Make sure that either source sees its proper load impedance to preserve output signal purity. The test setup is rather high impedance so it should add minimal loading. If a low power transmitter is used the level delivered to the test circuit should be kept to no more than 3 or 4V rms. To gauge this, consider that a 1 Watt transmitter produces an output level of 7.07 V rms. So a 6 dB or greater attenuator will be needed to give the desired input to the test circuit.

Testing at audio frequencies can be done without too much difficulty though a high-purity sine wave audio signal source is needed that will produce at least 1 V rms into a 1000 ohm load. If such a signal generator is not available, one option is to use a PC running a program such as Digipan (Ref 1) to produce the audio sine wave output. Since the computer’s sound card will likely not have a high enough undistorted output level, a power amplifier such as the one in Figure 2 will be needed.

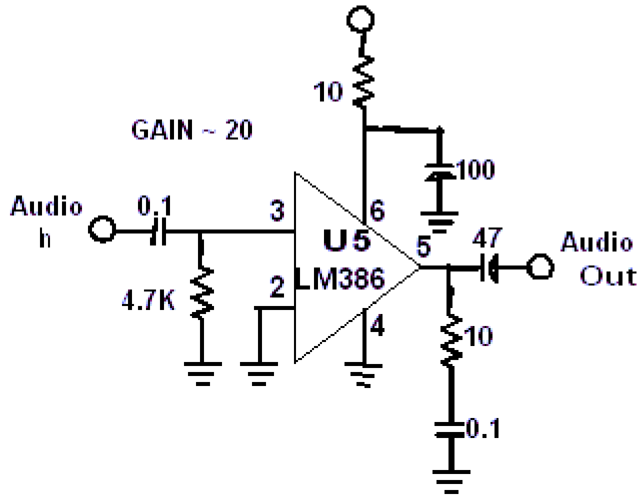


Figure 2- Audio power amplifier

For RF signal sources no further changes are needed. However if an audio test signal is to be used, the filter capacitor in the detector being tested needs to be properly selected to provide adequate filtering. The same guidelines as described in the Diode Detector Testing section apply. If a test frequency of 1 kHz is used with a RL of 1 megohm CL needs to be at least 0.1 m f. A ceramic capacitor is appropriate here.

The test circuit is shown in Figure 3.

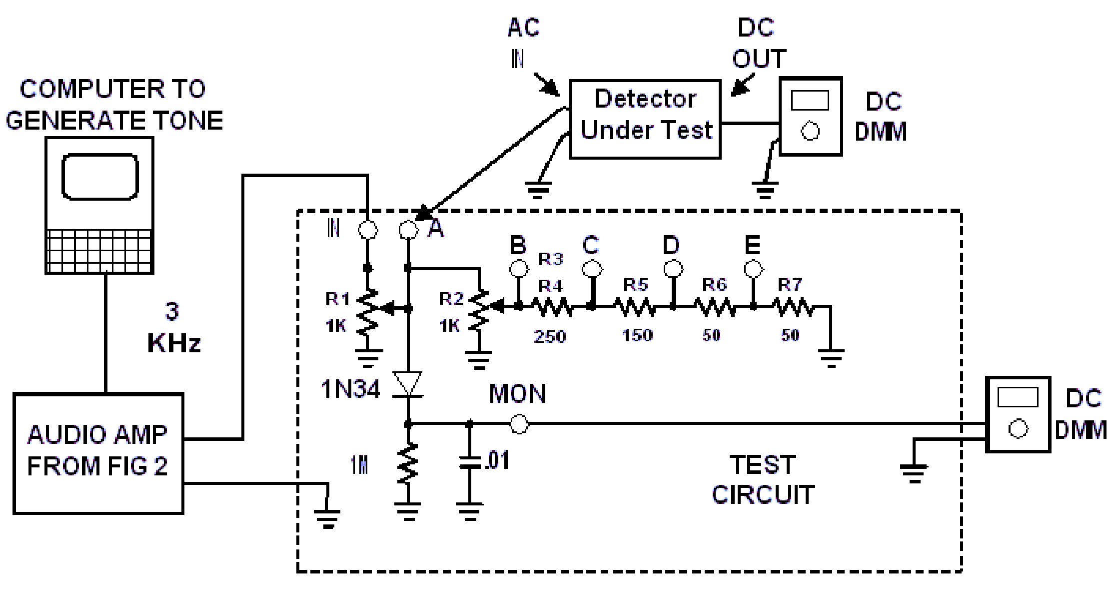


Figure 3 - Compensated detector tester

Signal inputs of up to about 3 or 4V rms can be handled with ease. The input signal is reduced to a standard 1V level by adjusting potentiometer R1. The exact 1V level is assured by measuring the DC output of the detector on point A, R1's center arm. R2 then serves as a variable attenuator to reduce this 1V level to calibrated fractions of 1.0, 0.5, 0.2 and 0.1V. It has a hand-calibrated dial to allow exact level setting. Finally, fractions of R2's output are selected by a resistive divider. Taps are provided at points B, C, D and E in the ratios 1.0, 0.5, 0.2 and 0.1 times the voltage at point B. The net result of the two potentiometers and the resistive divider string is an accurately settable attenuator. That can be set to produce outputs in 1-2-5 steps from 1V down to 0.01V. Measurement accuracy is reasonably good as high as 3.5 MHz with simple construction techniques.

There are only a couple of critical components in the compensated detector tester. Potentiometers R1 and R2 must be non-inductive good quality panel-mount devices. It is best to use a 1N5711 Schottky diode for the calibration detector. The 1megohm detector load resistor R2 can be any low power 5% device. Filter capacitor C1 should be a disc or monolithic capacitor. The resistive divider chain R4 through R8 can be either 1% precision film resistors or more common carbon composition or carbon film devices. If precision resistors are used, R4 and R5 can be a single 249 ohm unit, R6 is 150 ohms, and R6 and R7 are both 49.9 ohms. If common 5% resistors are used, selection of resistors needs to be done with a good DMM on its resistance range. In this case R4 is 100 ohms and R5 is 150. Select resistors so that the series combination is within 1% of 250 ohms. R6 is likewise selected to be within 1% of 150 ohms. Finally R7 and R8 are 51ohm resistors each selected to be within 1% of the nominal 50 ohm value.

Construction is likewise fairly non-critical. Figure 4 is a photo of a prototype tester. Note that lead lengths are maintained fairly short and the components are arranged in line as much as possible to minimize coupling of the input to output. The tester could be constructed to operate up to 30 MHz, but leads would have to be kept much shorter for minimum stray inductance and shielding between sections would be needed to minimize capacitive coupling.

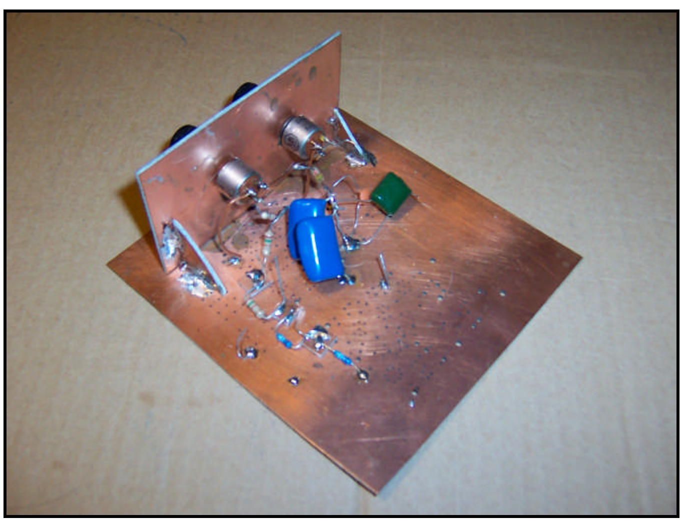


Figure 4 - Photo of Prototype Tester

The calibration detector connected to point A needs to have been previously calibrated at an input of exactly 1V rms as described in the previous section. It is important to note the DC output during that calibration step and to use the same high impedance DMM whenever this test circuit is used. This ensures that the 1V level at point A is always exactly the same value.

Potentiometer R2 also needs a one-time calibration. This needs to be done after the entire tester has been built. Use as large a pointer knob as you can get and tape a piece of clean white cardboard (cut from a 3x5" index card) to the panel. Set R1 and R2 to their highest settings and make a mark at the pointer setting for R2 on the homebrew dial. Label this mark as 1.0 on the dial. Take care to mark this precisely so that you can accurately set R2 to this setting while using the tester.

Connect a fresh 9-volt alkaline battery from point A to ground. Measure the exact DC voltage at point A with a DMM. It will be typically be somewhat higher than 9 volts. Now connect the DMM to point B, R2's center arm. Adjust R2 for a reading exactly half the measured battery voltage. Mark this point on your dial and label it 0.5. Now set R2 to read exactly two tenths of the measured battery voltage. Make another dial mark and label it 0.2. Finally set R2 for one tenth the measured battery voltage, mark the dial and label it 0.1. R2's dial is now calibrated.

The compensated detector test set is now ready for use. A set of steps will be given below to indicate how it can be used to check a compensated detector or other sensitive RF detector. The signal source for this test is assumed to be an audio tone at 3 kHz generated by a pc running Digipan software. As noted above, the pc sound does not produce a high enough output level so the audio amplifier in Figure 2 is used.

1. Ensure that the filter capacitor in the detector under test is sized appropriately for operation at 3 kHz. Guidelines have been provided above. The extra capacitance can be temporarily connected in parallel with the normal filter capacitor and removed after testing.
2. Connect the signal source, the test set and the detector to be tested as shown in Figure 5.
3. Set up Digipan to produce a sine wave output frequency of 3 kHz and set the PC audio output level to a setting that will provide about 2V input to the test set. You can use an AC range on a DMM for this setting since it is only approximate.
4. Set R1 and R2 on the test set to their highest settings.
5. Set R1 so that the DMM on the calibration detector reads exactly the correct pre-calibrated value corres-ponding to an audio level of 1V rms at point A.
6. Connect the detector under test to point A and note its DC output reading. This is the output for 1V rms input.
7. Connect the detector under test to point B and note its DC output reading. This is the output for 0.5V rms input.
8. Connect the detector under test to point C and note its DC output reading. This is the output for 0.2V rms input.
9. Connect the detector under test to point D and note its DC output reading. This is the output for 0.1V rms input.

10. To continue testing at levels of 0.1V down to 0.01V set R2 to the 0.1 mark and repeat steps 6 through 9. Output readings will be for voltages of 0.1, 0.05, 0.02 and 0.1V input to the detector under test.

Other combinations of output voltages can be achieved by appropriate use of the R2 dial and choice of the attenuator taps A through D.

Terminating Wattmeter Test and Calibration

Several methods can be used to test and calibrate a terminating wattmeter (Ref 3). Methods described here will be limited to QRP levels though they can be extrapolated up to power levels of 10 watts or so without special equipment needs.

The first order of business is to assure that the 50 ohm dummy load in the terminating wattmeter is indeed exactly 50 ohms. If not, the power indications will be incorrect. The DMM can be used to measure the load resistance. However all is not lost if the resistance is slightly off. You can either note the inaccuracy and continue or you can recalibrate the meter if there is a calibration adjustment in it. If not you can always make up a calibration chart.

Probably the simplest method to test a terminating wattmeter is to disconnect the wattmeter's detector from the dummy load and test the detector separately. The detector can be tested at 60 Hz using the first detector testing method described above. AC voltage values for this method are provided in Table 1. Voltages for other power levels can be calculated using the formula V = SQRT(50 * P). Be sure to size the detector filter capacitor properly for 60 Hz as ahs been described above and remove the capacitor when testing is done. Reconnect the detector to the load when testing has been finished.

Table 1 – Voltage vs power

RF Voltage	RF Power
1 V	20mW
1.58V	50mW
2.24V	100mW
7.07V	1W
10V	2W
15.8V	5W
22.4V	10W

A more direct way to measure the terminating wattmeter is to use a QRP transmitter whose output power is adjustable. However do not rely on power metering within the rig since it likely is not terribly accurate. The best way is to measure the voltage across the load with a calibrated RF detector.

The simple half-wave detector shown in the Diode Detector Testing and Calibration Section above is fine for this use. Build it onto a scrap of Vectorboard using short leads and bring out

1" wires terminated in minigator clips for the RF input. Simply calibrate its output voltage with a known DMM and record the results in a table similar to Table 2. Additional interim levels can be added if needed.

Table 2 – Detector Calibration Table

RF Voltage	RF Power	Measured DC Out
1 V	20mW	_______V
1.58V	50mW	_______V
2.24V	100mW	_______V
7.07V	1W	_______V
10V	2W	_______V
15.8V	5W	_______V
22.4V	10W	_______V

To perform the test connect the wattmeter to be tested the QRP rig and the calibrated detector as in Figure 5.

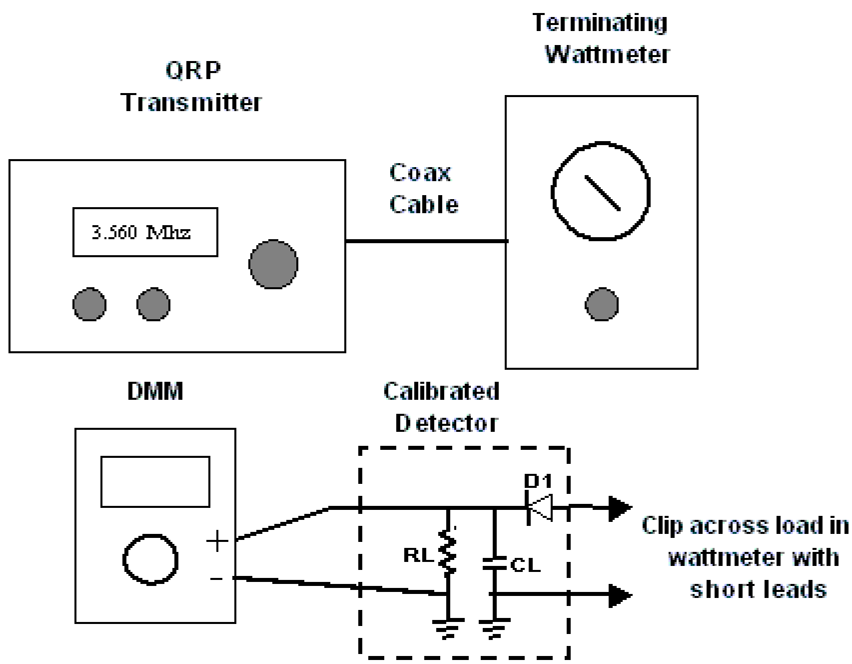


Figure 5 - Terminating Wattmeter Test Setup

Testing the wattmeter is a short, almost trivial process. The following steps detail testing from 0.5 to 5 watts. The test setup is not frequency critical so it can be done in any (or all) of the HF amateur bands.

1. Key the transmitter and adjust its output to get the DMM reading for the 0.5 watt level from Table 2. Note the wattmeter reading at the 0.5 watt input level.
2. Repeat the above step for inputs of 1, 2 and 5 watts.

Directional Wattmeter Testing and Calibration

Testing of directional watt-meters is easiest to perform using a QRP transmitter whose output level is adjustable as was used in the previous section. To measure the RF level through the meter, use either a calibrated termin-ating wattmeter or simulate one with a good 50 ohm dummy load and the calibrated detector described in the previous test setup.

A simplified test setup is shown in Figure 6.

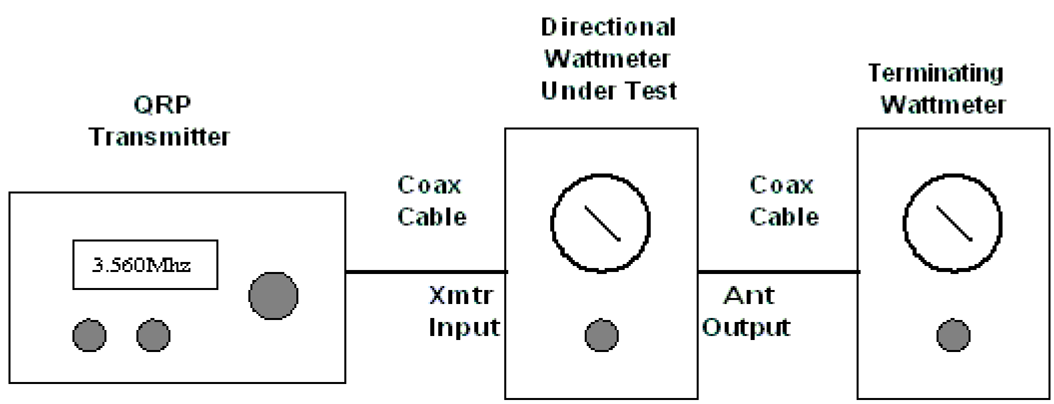


Figure 6 – Simplified Directional Wattmeter Test Setup

Testing is first done with the variable transmitter connected to the XMTR Input jack of the directional wattmeter under test and the terminating wattmeter connected to the Antenna Output jack. The directional wattmeter controls are set to read forward power. Transmitter power is set successively to the desired power levels and the directional wattmeter readings are noted. Finally reverse power testing is performed by connecting the transmitter to the directional wattmeter Antenna Output jack and the terminating wattmeter to the Xmtr input jack. The directional wattmeter controls are set to indicate reverse power. As before transmitter power is set successively to the desired power levels and the directional wattmeter reverse power readings are noted.

More detailed testing of a directional wattmeter will be presented in the next installment of the RF Wattmeter Cookbook where the final wattmeter design will be discussed.

References:

1. http:// mywebpages.comcast.net/hteller/digipan/

2. http://www.njqrp.org/dds/ index.html

3. Homebrewer #1, Summer 2003, RF Power Meter Cookbook, Joe Everhart, N2CX

Joe Everhart, N2CX may be contacted at 214 New Jersey Road, Brooklawn, New Jersey 08030. Joe may also be reached by e-mail at n2cx@amqrp.org

Ron Hege, K3PF

RF Gain Control - Rock Mite (20 Meters)

I tried a 100K pot between C 1 and D 1 as the Rock Mite instructions suggested for an RF control and found that gain variations were not smooth throughout the pot's travel.

The volume jumped from full loud to a noticeably lower level with a small change of the pot's resistance. Further pot changes did not reduce the volume much until I adjusted the pot near its extreme end. I checked the pot with an analog ohmmeter and it looked good. The problem was somewhere else. I tried a 50K, a 10K, a SK and a 1K pot and found that the 1K pot worked best. There was a smooth transistion as the volume went from full loud to minimum. I noticed some noise as I varied the pot, but it was not bad.

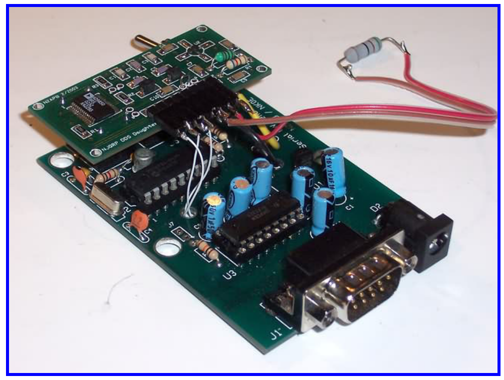
If you want to add this circuit to your Rock Mite, you must first cut away the PC board track between C 1 and D l. If you carefully look at the board, you will notice that there is a very short track between Cl and an unused pad. The unused pad is one that can be used for a 1K resistor if you have local broadcast station interference. That same unused pad also goes to Dl. So, cutting the short track between Cl and the unused pad will separate C 1 from Dl. Solder a wire from Dl tc one side of the new 1K pot. Solder another wire from Cl to the wiper. The other side of the pot goes to ground. My board had the 1k broadcast interference resistor already added in. I did not try the new RF gain pot with the 1K broadcast resistor removed. I checked for changes in the transmitter's RF output level with the new 1K pot in the circuit. I still had full RF output and the slight changes I saw as I varied the pot were insignificant.

Ron – K3PF

George Heron, N2APB
David Ek, NKØE
Craig Johnson, AAØZZ

Serial DDS Controller

Combine two existing projects, add some new PIC software, and what do you get? Why it's the SerialDDS !



The Serial DDS Controller is a low-cost, easy to homebrew PIC+MAX232+DDS circuit that communicates with your PC over its serial port and uses a dumb terminal program like HyperTerm to allow you to control a DDS Daughtercard. The PIC software presents a menu of commands on the PC screen to allow setting frequency, scan limits, step sizes, calibration and more! No special Windows programs required - just use the free HyperTerm on your Windows PC, or any other terminal program on your Linux PC.

DESCRIPTION

Someone recently asked a perfectly obvious question that should've had a solution before now -- "Why doesn't someone create a PIC driver that will take serial port commands from a PC and in turn drive a DDS Daughtercard?"

I had been thinking on this in the background all week and came up with a scathingly brilliant idea ... why not take two PIC projects we had done over the last year or two and combine the relevant portions of each to produce this solution?

So, being a natural project manager type of guy, I activated the AmQRP designer network once again and found some perfect help. Dave Ek, NK0E had previously designed the Serial CW Sender project that uses serial port driver software in a PIC to talk to a Palm PDA while in turn reading Morse from some paddles and driving Morse to a rig.

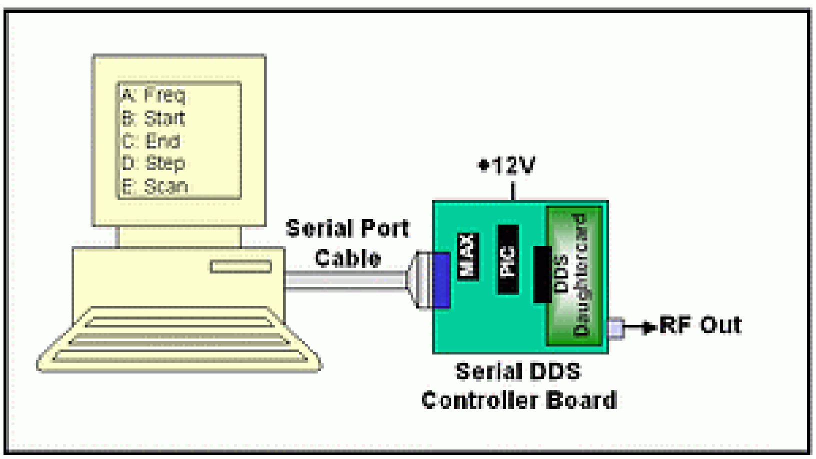
I also once again tapped Craig Johnson, AA0ZZ, the now-legendary designer of the PIC-EL board and the author of that wonderful "PEgen" VFO software that drives the AD9850 DDS chip on the PIC-EL board. Craig would be able to help us modify the DDS programming software in the PIC.

Well, it was a "duh" kind of moment for the three of us as we determined that the two programs (Sender.asm and PEgen.asm) would be relatively easy to combine into a single program, wherein we strip off all the Morse stuff from the Sender program and added it to a bare-essentials PEgen program without all the LCD, calibration, rotary encoder control, pushbuttons and eeprom code.

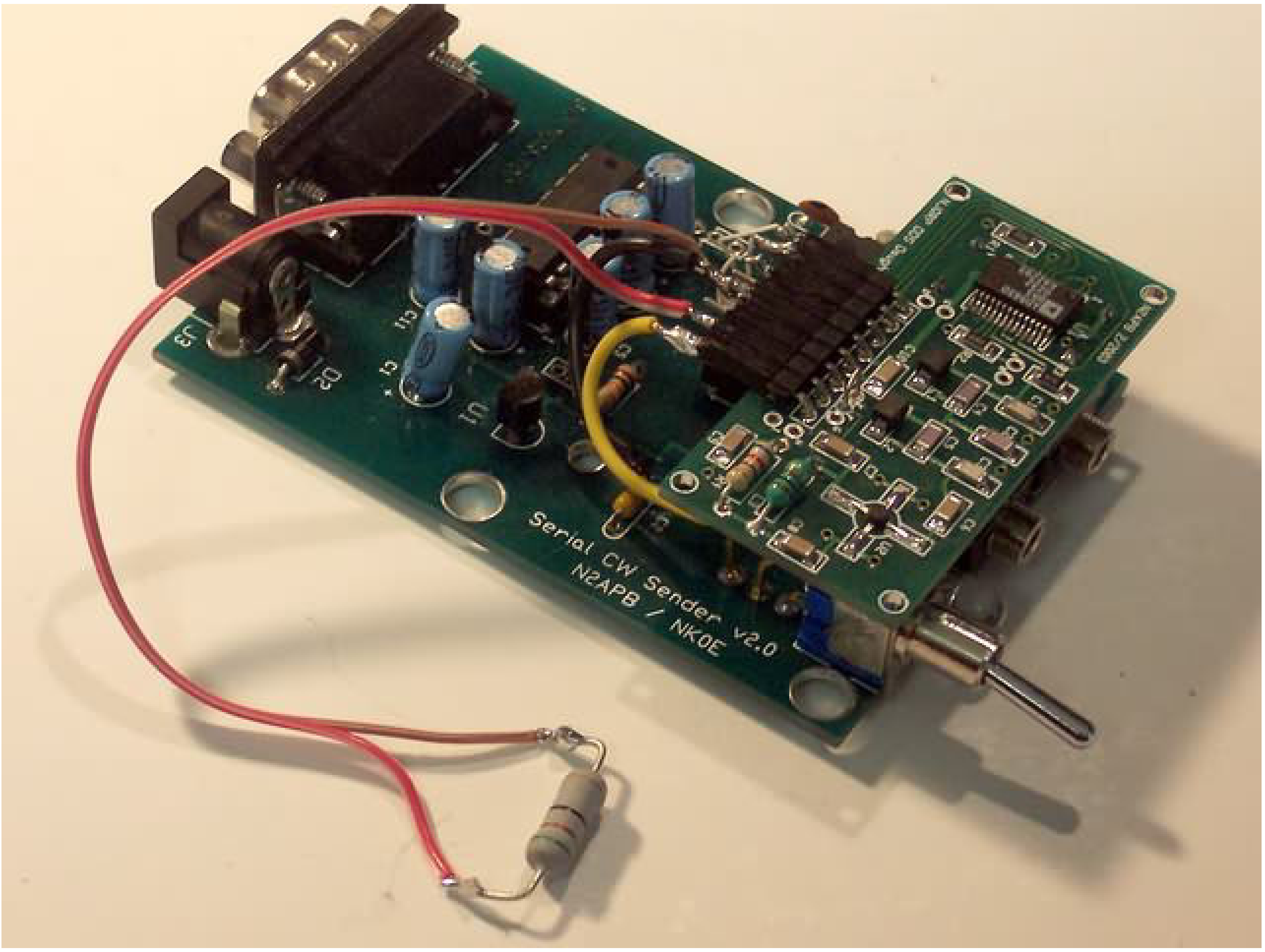
We call the combined program "SerialDDS" wherein the user enters an 'F' followed by 8 digits on a dumb terminal program (like HyperTerm or TeraTerm) running on the PC. Those eight frequency digits get turned into the DDS programming word and loaded into the DDS Daughtercard riding piggy-back on the Serial Sender. So all the user would need to do is plug the serial cable into the PC, bring up a terminal program, and the little "CLI" (command line interpretter) running in the PIC allows him to output specific frequencies via the daughtercard.

This hardware arrangement was also a stroke of serendipidy in that we have extra Sender pc boards available and the DDS card fits real nice on it. The Sender project is just *ideal* for this in that it already has the MAX232 RS232 driver IC and capacitors, the DB9M connector and a PIC .. rather general purpose indeed!

So these two original designers have come up with an inexpensive solution that allows one to use a PC to control the DDS Daughtercard, without using a special PC program! The PIC merely "talks" over the serial port to the generic terminal program running on the PC, and you see the menu of commands listing the various functions you can give to the Serial DDS Controller.



Connection to the PC is simple and provides the "user interface" by means of a terminal program such as Hyperterminal.



SerDDS pcb combination of the Serial Sender baseboard plus the DDS Daughtercard. The RF output comes out on the 50-ohm load resistor.

SOFTWARE COMMANDS

The PIC microcontroller is programmed to use the PC screen as its terminal, showing a list of commands available to the user. You can then enter commands and data via the PC keyboard to instruct the Serial DDS Controller to output a given frequency, set the start and end points of a range, set the step size, scan the range, calibrate the DDS and clock combination, save the settings to memory, recall the settings from memory, and reset all settings to default values.

The menu that gets displayed is shown below. Note that only some of the functions are currently working ... we're still enhancing the software to provide all the commands, and more!

A: Set Freq (Direct frequency entry from 00000000 Hz to 30000000 Hz)
B: Start Freq (Entry of a start frequency)
C: End Freq (Entry of end frequency)
D: Step Size (Entry of a step size)
E: Scan (from Start to Stop, using step size)

F: Show (show settings for start, stop, step)
G: Jog Up (using step size)
H: Jog Down (using step size)
I: Calibrate
K: Save (Save settings to EEPROM, 8 settings possible)
L: Recall (from EEPROM selective among the 8)
M: Help (display this single-word menu, without parentheticals)

For entering frequency (menu items A through D) the program will accept any number of digits up to eight and allows use of the backspace key to edit. You must hit a carriage return to finish the entry. If fewer than eight digits are entered, they are padded with leading zeros to make eight digits.

MAKING THE SERIAL DDS CONTROLLER

Construction of the project is very simple ... and you have at least two ways you can go.

1) Using the schematic provided on the project page you can build up the two ICs and the RS232 connector on a piece of perf board in several hours. Wire in the the DDS Daughtercard and your hardware will be all set.

2) You can locate one of the pc boards from our Serial Sender kitting days and tack solder the 3 control wires of the DDS Daughtercard to the pads of the PIC, just like I did in the photos.

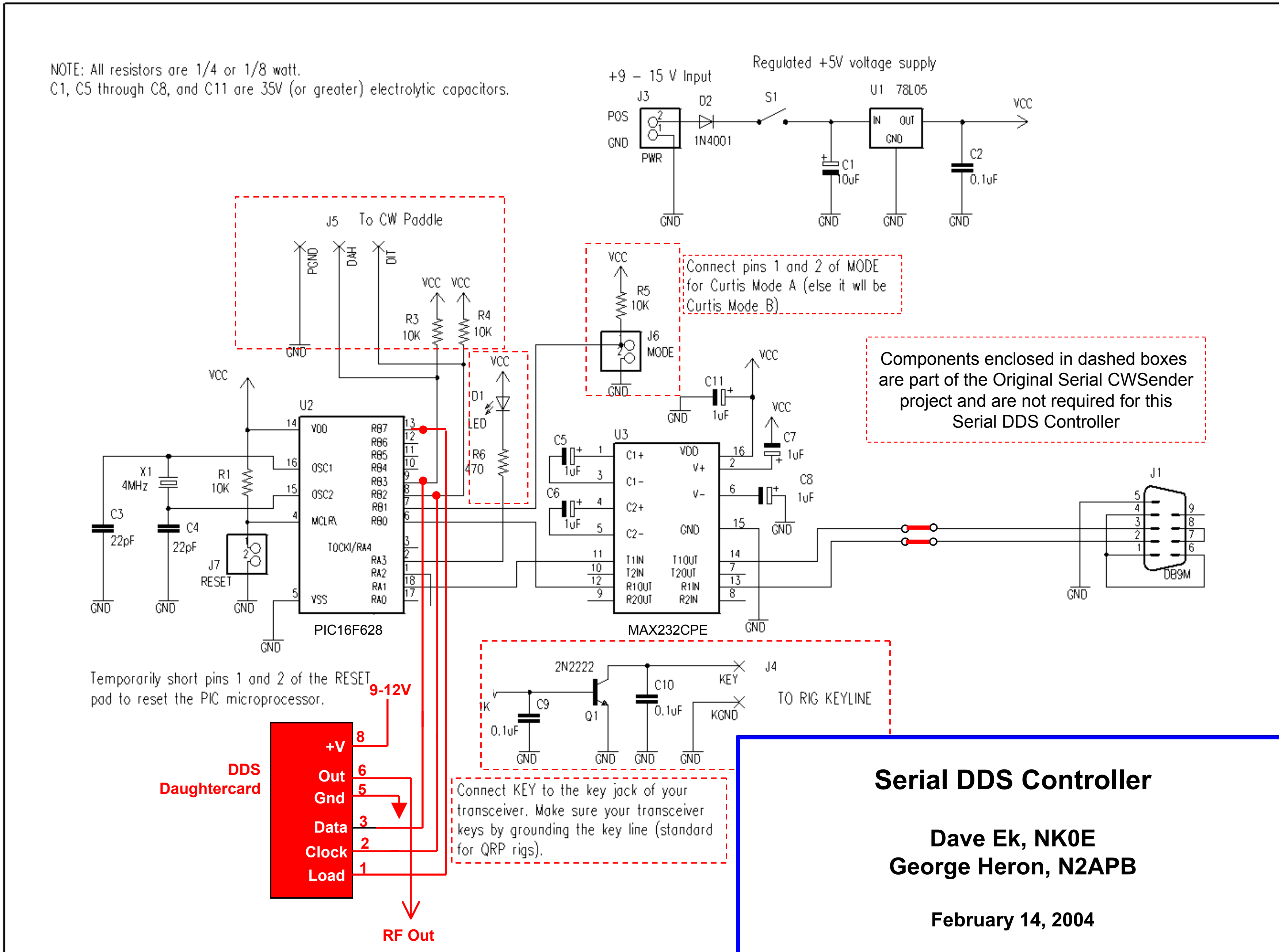
3) If you already have an NK0E Serial Sender project, such as the one in the photos here, you can tack solder the 3 control lines of the DDS Daughtercard to the pads of the PIC.

We would urge you to just wire up a simple board, burn the SerDDS software into a PIC using your favorite PIC programmer (use your PICEL board!), get the components from your junk box or using the Parts List here, place a small order to Mouser, Digi-Key and Jameco, and you'll be in business.

So, no matter how you accomplish it, just connect the three control lines between your DDS Daughtercard and the Serial CW Sender pcb, plug in the PIC containing the SerDDS software, type in any frequecy from 00000001 Hz to 30000000 Hz, and see the sweet result on your scope, receiver, speaker ... whatever!

PARTS LIST

Part	Description	Part Number
C1	10 uF 35V electrolytic capacitor	Mouser: 140-XRL16V10
C2	0.1uF monolithic or ceramic disc	Mouser: 80-C317C104M5U
C3, C4	22 pF monolithic or ceramic disc	Mouser: 140-50N2-220J
C5-C8, C11	1 uF 50V electrolytic capacitor	Mouser: 140-XRL50V1.0
D2	1N4001 diode	Mouser: 625-1N4001
J1	male DB9 connector	Jameco: 104942
J3	5.5x2.1mm coaxial power jack	Mouser: 163-5004
R1	10K ¼ watt resistor	Mouser: 291-10K
R6	470-ohm 1/4 watt resistor	Mouser: 291-470
S1	SPDT power switch	Mouser: 10TF130
U1	78L05 voltage regulator	Digi-Key: NJM78L05A-ND
U2	PIC16F84-04/P microcontroller	Digi-Key: PIC16F84-04/P-ND
U3	MAX232CPE level converter	Digi-Key: MAX232CPE-ND
X1	4 MHz crystal	Mouser: 520-HCU400-20
	18 pin IC socket	Mouser: 575-193318
	16 pin IC socket	Mouser: 575-199316
	pcb	AmQRP
	DDS Daughtercard	NJQRP

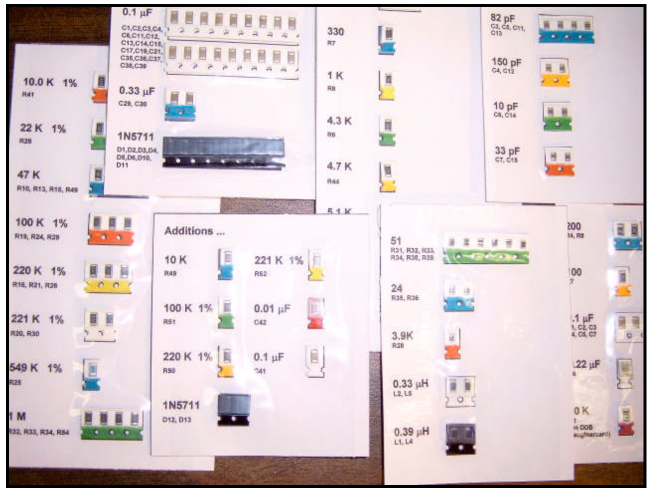

NOTE: All resistors are 1/4 or 1/8 watt.
C1, C5 through C8, and C11 are 35V (or greater) electrolytic capacitors.
+9 – 15 V Input
Regulated +5V voltage supply
J3
POS
GND
PWR
D2
1N4001
S1
U1 78L05
IN
OUT
GND
VCC
C1
10uF
C2
0.1uF
J5 To CW Paddle
PGND
DAH
DIT
R3
10K
R4
10K
R5
10K
J6
MODE
Connect pins 1 and 2 of MODE for Curtis Mode A (else it wll be Curtis Mode B)
Components enclosed in dashed boxes are part of the Original Serial CWSender project and are not required for this Serial DDS Controller
D1
LED
R6
470
C11
1uF
C5
1uF
C6
1uF
C7
1uF
C8
1uF
U3
C1+
C1-
C2+
C2-
VDD
V+
V-
GND
T1IN
T2IN
R1OUT
R2OUT
T1OUT
T2OUT
R1IN
R2IN
MAX232CPE
J1
DB9M
U2
VDD
OSC1
OSC2
MCLR\
VSS
RB7
RB6
RB5
RB4
RB3
RB2
RB1
RB0
TOCKI/RA4
RA3
RA2
RA1
RA0
PIC16F628
X1
4MHz
R1
10K
C3
22pF
C4
22pF
J7
RESET
GND
Temporarily short pins 1 and 2 of the RESET pad to reset the PIC microprocessor.
9-12V
DDS Daughtercard
+V
Out
Gnd
Data
Clock
Load
RF Out
2N2222
Q1
1K
C9
0.1uF
C10
0.1uF
J4
KEY
KGND
TO RIG KEYLINE
Connect KEY to the key jack of your transceiver. Make sure your transceiver keys by grounding the key line (standard for QRP rigs).
Serial DDS Controller
Dave Ek, NK0E
George Heron, N2APB
February 14, 2004

AmQRP.ORG HOMEBREWER

Nancy M. Feeny, NJ8B

SMT Cards

For those of you who wonder about how the SMT cards packed with the AmQRP Club kits are made, this article describes how it is done in detail.



INTRODUCTION

Surface mount technology (SMT) is becoming more and more common in our projects these days, much to the benefit of us homebrewers, as it makes for much more compact electronic boards and assemblies. The use of SMT components we now see in a growing number of our QRP kits, however, presents a real challenge to those who prepare those kits.

In the past, with through-hole components like 1/4W axial-lead resistors and radial-lead capacitors, it was easy for the kitter to just toss the component into the plastic bag, and then have the builder grab a component, identify it, and then attach it to the circuit board. On the other hand, the use of SMT components presents a problem in that they are so small as to be easily lost within the parts bag if no special precautions are taken by the kitter. Further, the component values and part numbers are much harder to see marked on the case, so the builder often cannot even differentiate the components even if/when they find them in the bottom of the parts bag!

Several different approaches to solving this problem have been attempted, but the one described here has been used successfully in a number of projects we've kitted up for the NJQRP and AmQRP clubs in recent years. Starting with the DDS Daughtercard, and following on with the Micro908 and the DDS AMP, builders have noted great ease with the organization, identification and handling of the SMT parts supplied in those kits. This is the story of just how the SMT cards are prepared ... perhaps you might give it a try for your own club's kitting of an SMT-based project!

MATERIAL NEEDED

The following material is used in order to make the surface-mount cards:

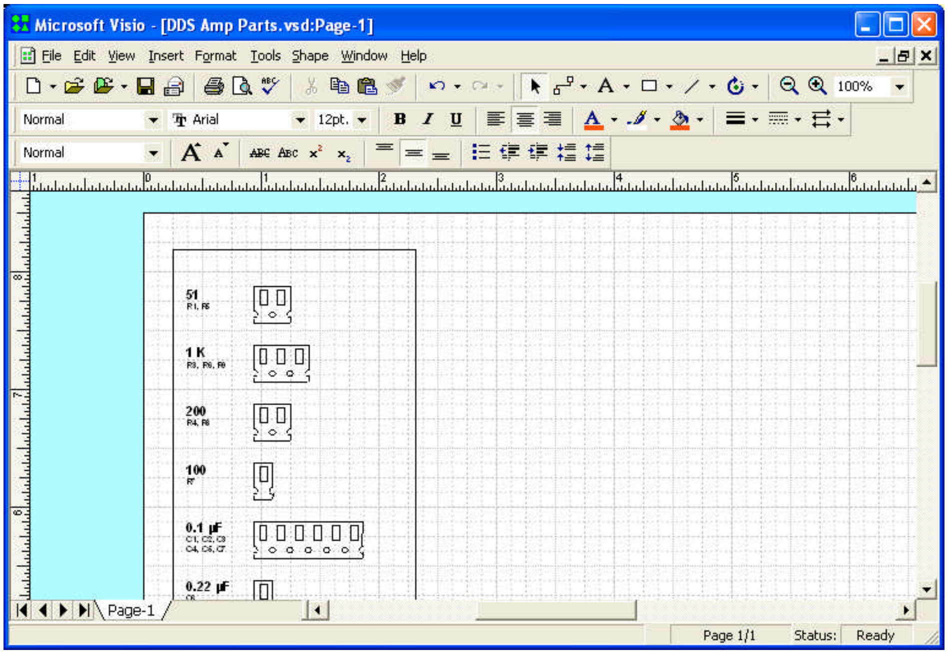
- 1 piece of wood, ½” H x 3” W x 24” L nominal size, ½ “ H x 2 ½” W x 24” L actual size
- 2 pieces of wooden dowel rod, 7/16” D x 5” L
- 2 rubber bands
- Roll of Scotch packaging tape, 1.89”, 3.1-mil thickness or equivalent
- Rubber cement
- Computer with drawing program loaded
- Color printer
- Heavy weight paper, 110 lb.
- Paper cutter
- Exacto knife
- Scissors
- Colored pens
- Individual parts bins

PREPARING THE DRAWING

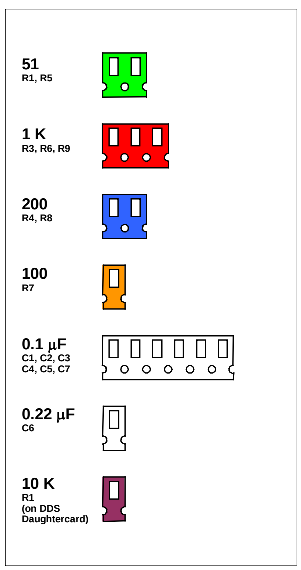
First, decide which parts to include on the SMT card. Resistors and capacitors size 0603 or 1206 are a natural, but other sizes may be used as well. SMT inductors, diodes, and other parts may also be included. The overall height or thickness of the individual part or its packaging is the determining factor. ***Caution:*** *Never include electrostatically sensitive components on SMT cards, paper can be highly conductive and you risk damaging the component.*

Using a drawing program (I use Visio but almost any drawing program that you are familiar with will do), draw the outline of the box that will include the surface-mount parts. I make it 2 1/16” W, with height determined by the number of components included.

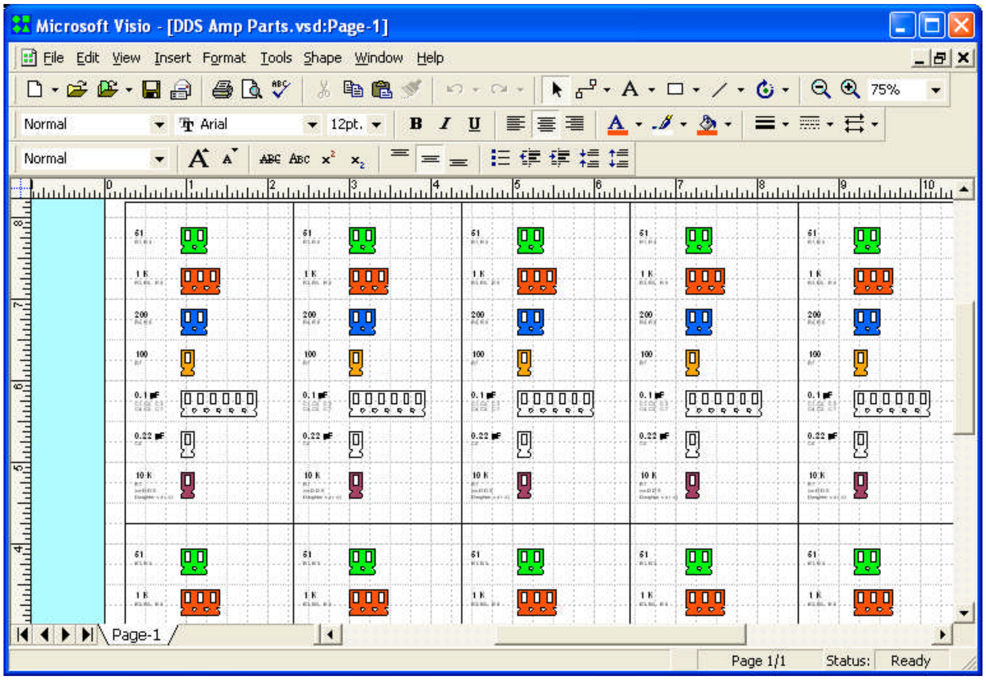
Next, draw the outline for the component packaging footprint, along with text describing reference designation and location.



Following this, decide on which color(s) to use, making each part a distinctive color to aid in identification.

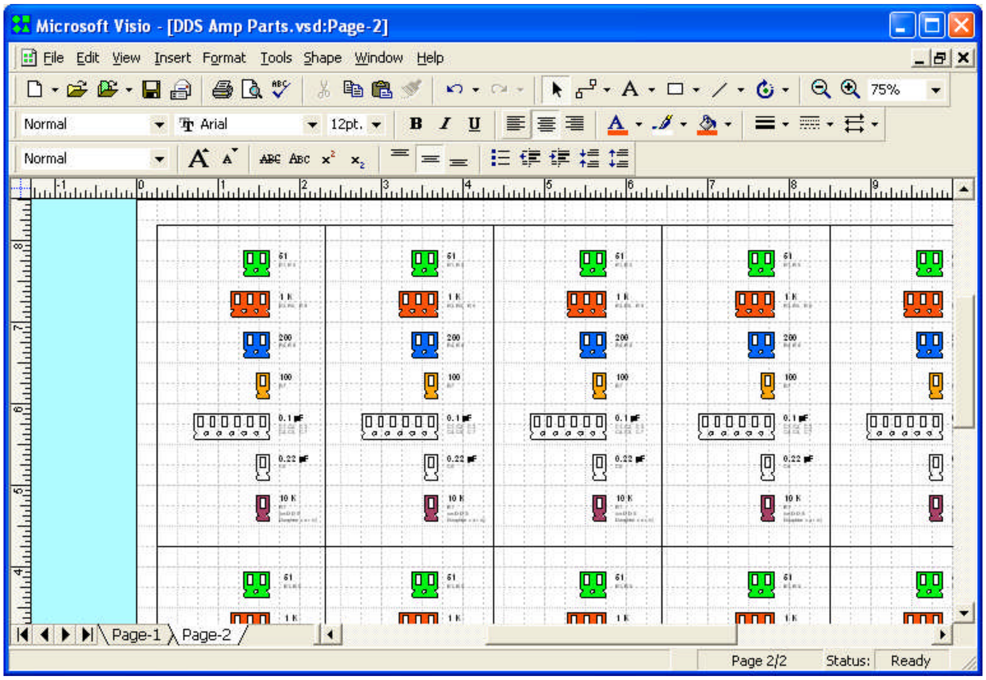


Copy the drawing that you have just made until it fills up one page.



PREPARING THE TEMPLATE

Taking the drawing that you have just made, make a mirror image. Select “flip horizontal”, adjusting the font if necessary.



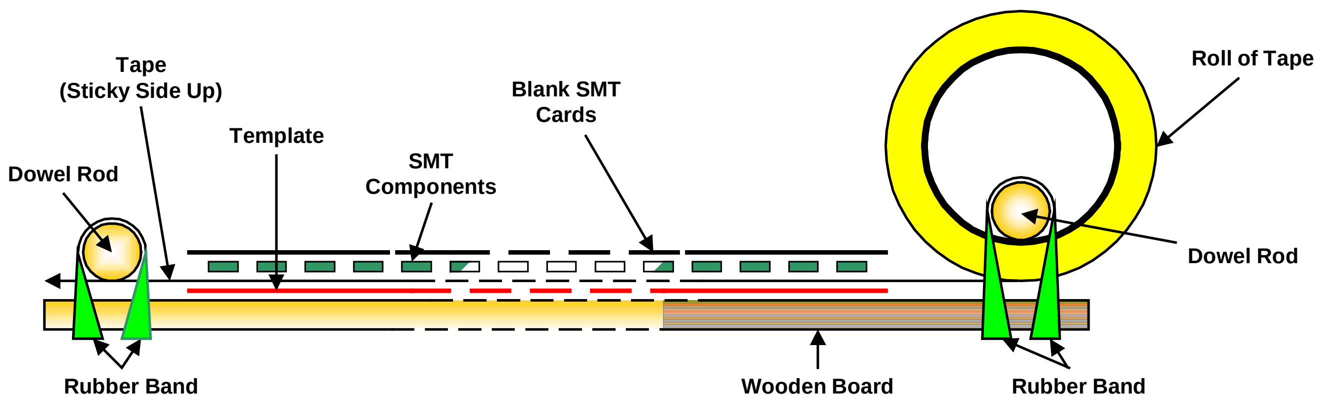
PREPARING THE FIXTURE

On the color printer, print out one copy of the reverse image on plain paper. Cut the image into strips. Using rubber cement, glue one strip onto the ½" x 2 ½" x 24" board, starting about 1 ½" from one end, with the top toward this end, centering it between the 2 ½" edges. Position a second strip below the first, gluing it down as well. Continue gluing down strips until about 3 to 5 inches from the opposite end.

Take one of the 7/16" D x 5" L dowel rods and place it against the top end, holding it on with one of the rubber bands.

Take the other dowel rod and place it through the roll of tape, then attach it to the opposite end of the board with the second rubber band.

Pull the tape until it is under the top dowel rod, as shown in the diagram. Place it between the sides of the template strip. The sticky side of the tape should be facing up.



PREPARING THE PARTS

Taking the roll of SMT components, choose the appropriate pen color and color along the bottom (paper) edge of the individual part. If packaged in plastic material, Wite-Out can be used if black or Magic Marker can be used if transparent. It is not necessary to color the part if only one of a particular type of component packaging is used.

Coloring the components

When all of the parts have been colored, using a pair of scissors, wire cutters, or other instrument, cut them apart into the number(s) a particular part is used. Put the cut parts into Individual parts bins. Line up the bins next to the fixture, in order used from top to bottom on card.

Lining up individual parts bins

PREPARING THE SMT CARDS

On the color printer, using the heavy weight paper, print up enough sheets to make enough SMT cards (total number of cards = number of cards on sheet x number of sheets).

Using the paper cutter, cut apart the cards on each sheet.

Cutting apart SMT cards

Cut unpopulated (blank) SMT cards

MAKING THE SMT CARDS

Place the cut SMT components on the tape, carefully lining them up with the part outline on the template. Put them face down, matching colored parts with the colors on the template. Do not press down too tightly in case minor repositioning is necessary.

Placing components on tape

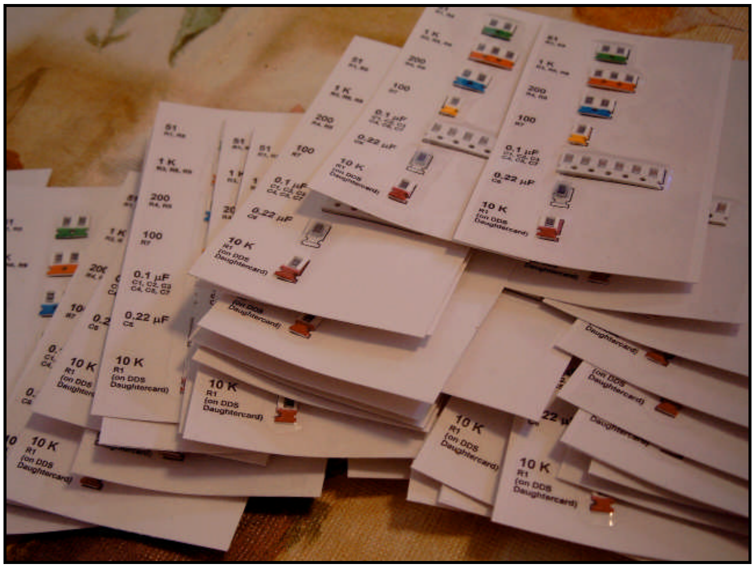
When all cards on the template have their parts, take one of the blank SMT cards and carefully place it down on top of the first group of parts on the template. Continue placing the cards down until all of the groups on the template are covered.

Placing cards over components

Using the scissors, cut below the last card to free the bottom end of the strip of SMT cards from the tape, then pull the top out from under the top dowel rod. You should now have one strip of SMT cards.

Cutting apart completed SMT cards

Again using the scissors, cut apart the completed SMT cards. Trim off all excess tape. Although not strictly necessary, the blunt end of an Exacto knife may be used to press the tape down around the SMT components (the sharp end may be used to remove an occasional hair or crumb from the tape before adding the card).



Completed SMT cards

PACKAGING THE SMT CARDS

When individually packaged, 4-mil poly bags, 6” x 12” cut into quarters or 6” x 9” cut into thirds are used, making 3” x 6” total size. These are then made into “pockets” in order to hold the SMT card. If other parts are to be included as well, these are also placed in the bag. This is then sealed using an impulse heat sealer.

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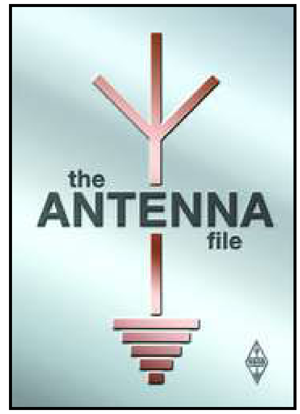
Fred Bonavita, K5QLF

The Antenna File: A Review

Now and then a good book on antennas slips in under the radar and lurks there until it is stumbled across. It goes overlooked because, among other things, it is under advertised or lumped with others instead of being touted on its merits.



Such is the case with The Antenna File (Radio Society of Great Britain, $34.95). First published in 2001 (it sold out), File is in its second printing (2003), and it's worth serious consideration by those who, like me, look for something new and different in antennas designs.

It's refreshing to get others' perspectives on aerials, and File does not disappoint in this. The diversity of the articles – and they come not only from the U.K. but from The Netherlands, France, Germany and Scandinavia, to name a few – shows others are designing, building, testing, and writing.

This is a compendium of pieces that appeared in Radio Communications, the monthly journal of RSGB, in the last decade of the 20th century. It picks up where The HF Antenna Collection, edited by Erwin David, G4LQI (RSGB, 1991), left off. File takes us beyond HF antennas and into VHF and LF with some interesting results.

Antenna compendia are not new. ARRL began its series in 1985 and brought out the seventh volume in 2002. It likely is aiming for an eighth.

Although no editor is credited with File, David's hand is conspicuous and welcome throughout. He assembles, translates and edits what appears to be a regular feature, "Eurotek, Ideas from Abroad," wherein he serves up a smorgasbord of aerial ideas from around the world.

For instance, there is an off-center-fed, nine-band variation of a Windom as updated by Oskar Hammerschmid, OE5OHL; a remake of the T2FD by Wolfgang Boettcher, DK5IQ, that does away with the power-guzzling terminating resistors in favor of a stub of 300-ohm twin lead; and a compact, five-band Lazy-H by Fred Brown, W6HPH.

A few aerials can make the reader wonder what the designer was thinking when they were hatched: a 20-meter, mobile "toroidal" antenna (think of a few feet of a "Slinky" laid on their side), by Roger Jennison, G3AJV; and a 30-element portable antenna for 2m by Jean-Pierre Morizet, F5OAU. Yes, that's "portable" and "30 elements" describing the same aerial.

The Antenna File would make a good addition to the well-stocked antenna library. It's available from the ARRL Book Store (item No. 8558) for $34.95 plus shipping and handling.

That's a little steep, but in this instance, it's worth it.

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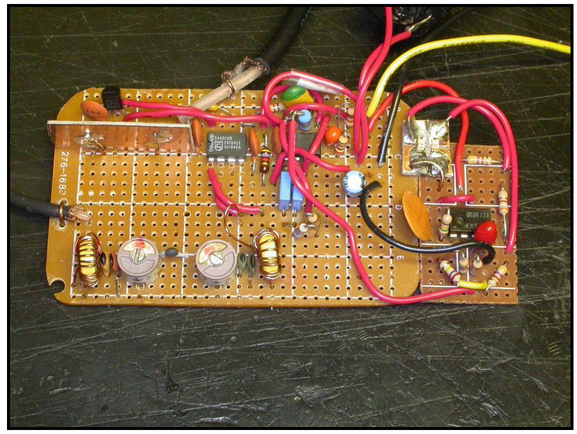
Earl Morris, N8ERO

Calibrating the AD9850 Frequency Generator

A receiver is tuned to one of the WWV signals at 10 or 15 MHz and the DDS set to output at that same frequency. The goal is to make the beat frequency, the difference between the WWV carrier and the DDS output, as low as possible.



The original WB2V DDS VFO project published in July 1997 QEX, and the DDS Daughtercard from the AmQRP both use the AD9850 DDS integrated circuit to make a super-stable frequency generator for the range of 1 Hz to 30 MHz. The accuracy and stability of the generated signal is based on a 100 MHz reference clock. Since these oscillator cans are not exactly on frequency, “siggen3” software provided by AA0ZZ can be used to adjust how the reference clock is used and thus allow one to calibrate the DDS signal to an external known-good reference signal.

But how is the calibration done? The stock answer is always "Zero beat to WWV". A receiver is tuned to one of the WWV signals at 10 or 15 MHz and the DDS set to output at that same frequency. As the frequency of the DDS is varied, sure enough a changing beat tone is heard. The goal is to make the beat frequency, the difference between the WWV carrier and the DDS output, as low as possible.

There is a limitation. Most receivers and also the human ear have very poor response below about 100 Hz. About the best you can do is find the 100 Hz beat on the low side and the 100 Hz beat on the high side. Hopefully the true zero beat is somewhere between. This is not very satisfying since the DDS can be adjusted in 1 Hz steps.

Thus I decided to build a receiver specifically for the purpose of calibration. I chose the WWV signal at 15 MHz since I already have a 20 meter (14 MHz) antenna up. In addition, there are fewer strong interfering stations at 15 MHz. Siggen is initially configured to calibrate against a 10 MHz signal, but this can be changed in software.

The schematic in Figure 1 shows a direct conversion receiver built specifically for the purpose of zero beating against WWV. This example is for 15 MHz. The only changes necessary for different bands are in the front end tuning. A sharply tuned front end is necessary to prevent strong signals from overloading the RF amplifier. A double tuned front end is used to select the band of interest. The 1.7 pf capacitor is used to couple the two tuned circuits. A smaller coupling capacitor gives more selectivity but at a cost of increased signal loss. A larger value degrades the sharpness of tuning.

WWV Receiver (15 mHz)

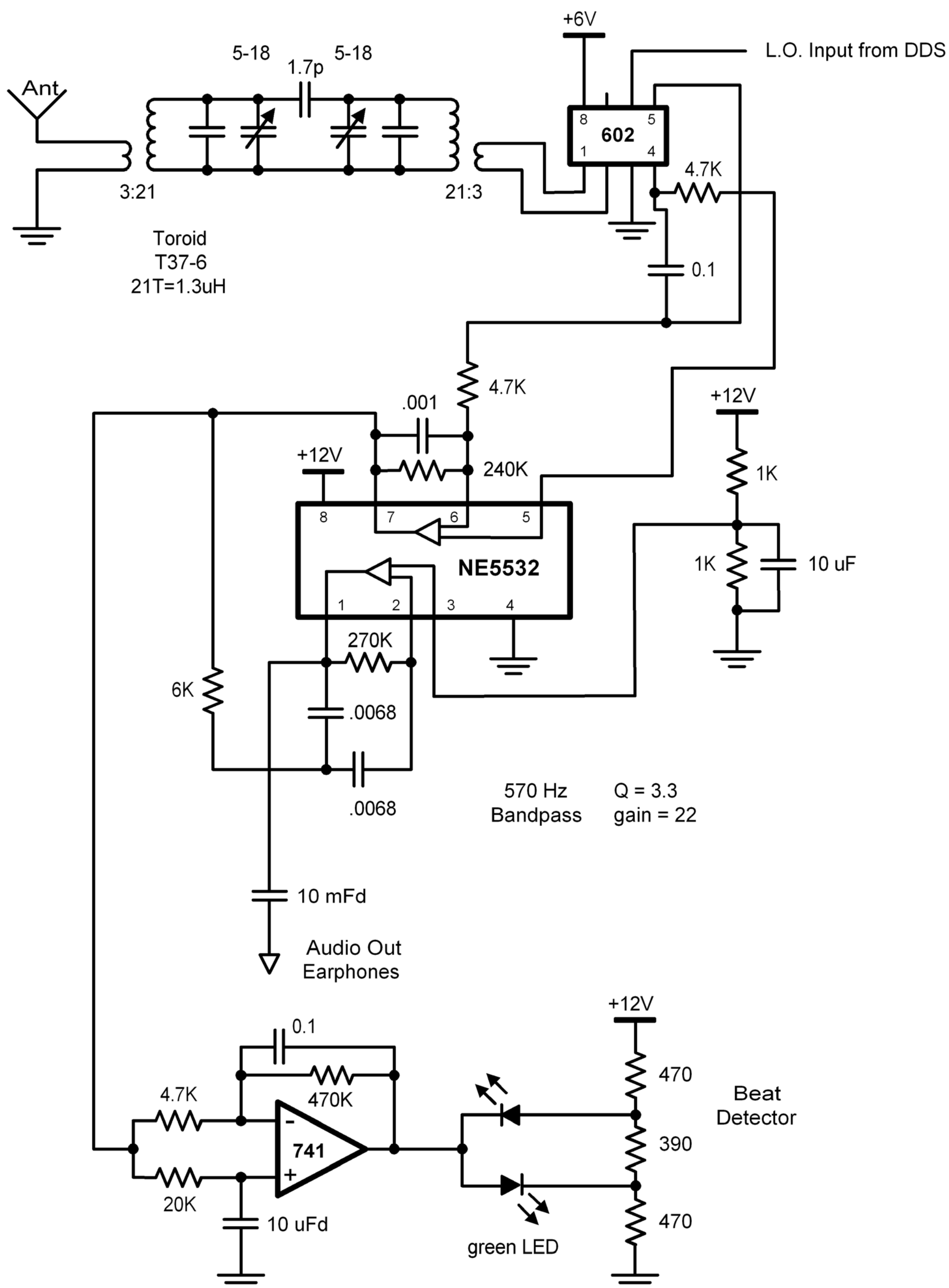
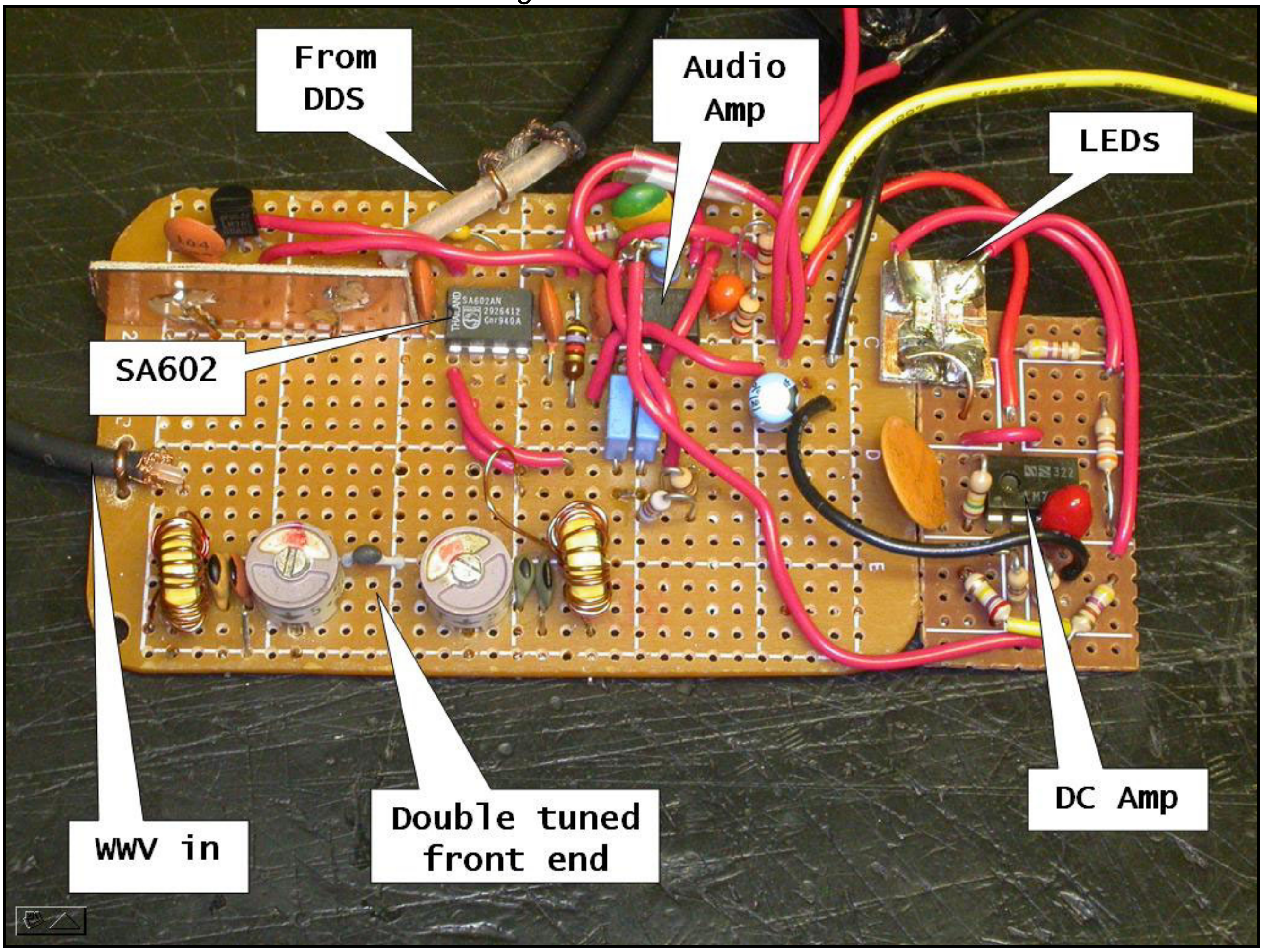


Figure 1. Schematic



Annotated WWV Rx Circuit

RF energy is coupled into and out of the front end filter by a second winding on each toroid. A 602 integrated circuit is used for RF amplification and mixing. The 602 normally generates its own local oscillator signal by connecting an external crystal or tuned circuit. However, in this receiver, there is NO LOCAL OSCILLATOR. The output of the DDS to be calibrated is used as the local oscillator. The 602 will mix the WWV carrier frequency with the DDS output and produce an output at the difference.

Operational amplifiers are then used to provide the large amount of audio gain needed. The 5532 op amp was selected for its low noise. The first audio stage has a gain of 50 as determined by the resistor ratio 240k / 4.7 k. The 0.001 capacitor connected across the feedback resistor makes the circuit into a low pass filter rolling off at 600 Hz. Notice this amplifier is DC coupled. It has high gain down to zero Hz.

A DC amplifier needs a reference level. This is conveniently supplied by using the complementary output of the 602. The other op amp input is connected to the differential output of the 602. This gives an additional gain of 2 but also nulls out any DC drift within the 602. The output from the first audio amplifier then is split into two signals. One generates an audio indication of zero beat and the other a visual indicator.

One signal path is a tuned audio stage typical of many CW receivers. This is a type of active filter known as "multiple-feedback bandpass" filter. The two 0.0068 mfd caps, together with the input and feed back resistor set the filter gain, center frequency and Q. The values selected result in a gain of 22 bandpass amplifier centered at 570 Hz. The audio output can drive earphones through the 10 mfd capacitor. The total audio gain is 1100. The circuit is somewhat microphonic. That is one of the disadvantages of a direct conversion receiver.

The other signal path is a DC coupled amplifier with a gain of 100 set by the resistor ratio 470k / 4.7k. The 0.1 mfd capacitor across the feedback resistor makes this into a low pass filter which begins rolling off above 20 Hz. Again a DC coupled amplifier needs a reference voltage of the other input. The "average" DC level is obtained by passing the signal through a 20k resistor and 10 mfd capacitor. The input voltage is then compared to this average value, and the difference amplified.

The output is connected to two LEDs. The intent was to have one LED on when the output was above 6 volts, and the other on when the output was below 6 volts. In practice, there was initially a 4 volt "dead zone" where neither LED is on. This is caused by the 2 volt turn-on voltage of the green LEDs. The dead zone was eliminated by including the 390 ohm resistor. The voltage across this resistor is close to 4 volts, biasing both LEDs very close to turn-on. With this resistor in the circuit, a small change in the amplifier output will turn one or the other LED on. The value of this resistor will be different if you use red LEDs with a different forward voltage turn-on.

CALIBRATING the DDS Circuit.

The output of the DDS circuit to be calibrated is connected to pin 6 of the 602 to provide a local oscillator signal. When the output of the DDS is within about 5 KHz of WWV, the AM carrier will produce a loud tone in the earphones. It is a simple matter to adjust the DDS to lower the pitch of this tone. As the frequency of the carrier beat gets less than about 200 Hz, it becomes difficult to hear. At this point, the audio from WWV should be heard. It will probably sound garbled. Tune for the clearest audio.

For the first 45 seconds of most minutes, WWV sends a 500 or 600 Hz tone on each second. (Now you understand why the bandpass filter at 570 Hz) Adjust the frequency of the DDS to give the purest sounding tone. If you listen carefully, the tone will appear to "waver" or "tremble" at the beat frequency. By careful adjustment, the frequency of the "waver" on the 600 Hz tone can be adjusted to less than 1 Hz.

There are a couple difficulties with this method. The "waver" on the 600 Hz tone is harder to hear when it is less than 5 Hz. But with some experience, it can be set to below 1 Hz. But also there are periods of time when WWV does not send the 500 or 600 Hz tone. Thus a second method of beat detection was included in the circuit.

As the frequency of the DDS is within about 20 Hz of the WWV AM carrier, the LEDs will begin alternately flashing. (The world's highest precision LED blinky ?) It is very easy to use the visual cue from the flashing LEDs to get the zero beat to under 1 Hz. If you both listen and watch the flashing LEDs, you will see they are in phase.

Two DDS circuits were built. One with the suggested 100 MHz DIP oscillator ($2) from Jameco. The other used a surface mount 100 MHz Citizen oscillator ($5) from Digikey. This was mounted "Manhattan" style in the space allowed for the DIP package. The zero beat detector allowed comparison of the two oscillators.

With the surface mount oscillator, a 15 MHz signal from the DDS drifted 10 Hz after a cold start. The DIP part drifted 39 Hz. The surface mount part stopped drifting in 5 minutes while the DIP oscillator drifted for about 10 minutes.

The accuracy of the signal transmitted by WWV is about 1 part in 100 billion (1×10^{-11}). However due to various propagation effects, the accuracy of the received signal is only about 1 part in 10 million (1×10^{-7}). How does this happen? Suppose the receiving station is 1000 miles from the transmitter. One part in 10 million is half a foot. That much change in the path length will affect the frequency as measured at the receiver. Remember that the signal is being reflected from the F2 layer which varies between 120 and 250 miles above the Earth's surface.

The output from an unamplified DDS is sufficient (200 mv p-p) to drive the LO input of the 602.

A 10 or 15 MHz crystal (series mode) in series with the antenna increases rejection of close in interference.

Photos by WB8RCR.

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Charlie Lofgren, W6JJZ

The Z-Match: An Update

The Z-Match antenna tuner is again proving popular. This note provides some background on the design, presents an improved "single-coil" version, and describes two tests for checking the performance of any tuner.

Classic Z-Match in an N2APB-enclosure, combined with the Rainbow Tuner SWR Bridge (LEDs on front panel)

The Z-Match is built around the multiband tank circuit that came into use around 1950 to reduce bandswitching chores in the tube rigs of the period. This circuit simultaneously tunes through two frequency ranges--for example, 3.5 to 10.5 MHz and 10 to 30 MHz--to cover the full HF spectrum. During the 1950s, both Harvey Wells and World Radio Laboratories incorporated the multiband tank in commercially produced versions of the Z-Match, and Allen King, W1CJL, an engineer for Harvey Wells, described the Z-Match in QST (May 1955, pp. 11-13, 116-118).

The year before King's article appeared, R. W. Johnson, W6MUR, had described another version of the multiband tank circuit (QST, July 1954, pp. 25-28, 122). The "standard" multiband tank uses two inductors. Johnson showed how to achieve similar results with a single inductor tapped at its midpoint. Although not incorporated in the Z-Match at the time (at least not in any published design that's come to my attention), Johnson's circuit provides the basis for the "single-coil" Z-Matches that have appeared in recent years. (The "single-coil" label is a slight misnomer, however, because the Z-Match also includes one or more output links.)

Drawing on articles from Australia and New Zealand, Bill Orr, W6SAI, reported on the single-coil circuit in CQ Magazine in August 1993, pp. 50-53, and gave other details in later columns. In its Winter 1994 issue, pp. 99-102, Communications Quarterly reprinted an article on the circuit by T.J. Seed, ZL3QQ, that had originally appeared in Break-In for March 1992. Meanwhile, in the ARRL Antenna Compendium, vol. 3, pp. 191-195, I reviewed King's Z-Match circuit from 1955 along with some ways to increase its matching range and described still another version of the single-coil circuit (not the one described in the present note).

Whether in its classic form as described by King or in the recent single-coil versions, the Z-Match essentially acts as an L-network. This can be seen by referring to Fig 1. The input capacitor, C1, functions as the series arm of the L-network. The tank circuit formed by C2 and L1 serves as the parallel or shunt arm of the network. In operation, the tank circuit is detuned on the high frequency side of resonance, thereby presenting an inductive reactance between the output side of C1 and ground. In a "normal" L-network having its shunt arm on the output side, the load would appear in parallel across the shunt element. Here output instead is taken through an output link. (For the full evolution of the circuit in this regard, see my Antenna Compendium article, referenced above.)

One problem with Z-Matches is limited matching range. In Fig 1, the option of switching in additional capacitance at C1 extends the range, particularly on the lower bands. Similarly, the two output links considerably broaden the impedance range.

Another problem in Z-Match design is that efficiency tends to fall off unless the output link or links are tightly coupled to the tank coil. In the circuit in Fig 1, the necessary tight coupling is achieved by interwinding the turns of the output links between the turns of L1. The toroid core helps, too. The availability of a separate high impedance output link, with more turns, serves the same purpose.

A third problem with the Z-Match is that the output balance may deteriorate under some load conditions, particularly high impedance loads--and this is more likely with the tight coupling necessary for best efficiency. Output balance can be improved in the single-coil Z-Match by changing the ground point on the tank coil. This too has been done in the circuit in Fig 1. The result may be thought of as a "semi-balanced" circuit. The links are symmetrical around the ground point on L1, but some imbalance remains in the tank circuit itself. Aside from improving output balance and altering the settings of C1 and C2 at which a match occurs, the change in the ground point on the coil does not affect the operation of the circuit. In most instances with "real life" antennas and open feed systems, the circuit in Fig 1 results in feedline currents that are balanced to within 1 dB (current on one side of the line versus current on the other side).

Other published single-coil designs tap the line from C1 into the tank coil L2 at various and differing points. The fact is that any tap point on L2 for the connection to C1 is a compromise, given the wide range of likely operating conditions and frequencies. Tests show that using the center tap on L1, where one section of C2 is also tapped into L1, is about as good a compromise as you will find.

The components in Fig 1 are as follows:

C1 and C2: 330 pf per section or greater.

L1: 24 turns enameled wire on a T-130-6 or T-200-6 core, tapped at 6 and 12 turns from the bottom; or 22 turns enameled wire on a T-157-6 core, tapped at 5 and 11 turns from the bottom.

L2: 10 turns enameled wire, interwound between the turns of L1, with 5 turns on each side of the ground tap on L1. (This is the high impedance link.)

L3: 4 turns enameled wire, also interwound between the turns of L1, with 2 turns on each side of the ground tap on L1. (This is the low impedance link.)

The dual section capacitor at C1 can be replaced with a single section capacitor and a switched padder capacitor (silver mica, 300 pf. or more, depending on the value of C1 itself). Both C1 and C2 float above ground. At QRO, this would require insulated shaft couplings, at least at C2. At QRP levels, insulated knobs suffice. Match the wire size for L1 to the core actually used--no. 18 for a T-200 core, no. 22 or 24 for the smaller cores. Select a wire size for the links that allows interwinding between the turns of L1. For QRP levels, any of the cores indicated above are more than adequate, as are small toggle switches at S1 and S2.

In adjusting the Z-Match, keep these two points in mind:

(1) In cases where you can get a match with both links, use the high impedance link. This loads the tank circuit more heavily, and may produce significantly better efficiency (up to a dB or so, depending on the composition of the load that the tuner sees).

(2) In cases where you can tune 30 meters and sometimes 20 meters at both the low capacitance end of C2 (the high end of the low frequency range) and the high capacitance end (the low end of the high frequency range), use the low capacitance setting. This gives a lower C/L ratio and again better efficiency.

No special instructions are necessary otherwise for adjustment, except to note that the tuning of C2 can be quite sharp. Initial peaking on receiver noise often simplifies adjustment.

For checking this or any other tuner, a couple of simple test devices are worthwhile. One is an "antenna simulator." This device is especially useful for making comparisons between various tuners (or tuner/balun combinations). The simulator consists of a pair of resistors of equal value whose total resistance approximates the expected feedpoint impedance at the tuner. (Several pair allow checking a range of impedances.) Connect the two resistors in series across the balanced output terminals on the tuner, and connect the junction of the two to the ground lug on the tuner. This *roughly* simulates an antenna system consisting of a balanced horizontal antenna over ground (such as a center-fed zepp or G5RV) and its feed line. To check the output balance of the tuner looking into the resulting feedpoint impedance, use an RF probe to measure the voltage drop across each resistor to ground while feeding a small amount of RF into the tuner (having adjusted it for a match). If the currents on each side are equal, the voltage drops across the resistors will be equal.

For this test, very little RF is necessary. If the RF probe is used in conjunction with a sensitive digital FET voltmeter, I find that the output from an MFJ Antenna SWR Analyzer is adequate. Using the SWR analyzer also allows easy checking over a wide frequency range.

The other test device is a current probe to use in checking performance with an actual antenna. It consists of 20 to 30 turns of enameled wire on an FT-50-61 or FT-84-61 core, with the two ends of the winding going to the voltage probe (again connected to a sensitive digital voltmeter). When RF current passes along a wire run through the middle of the core, RF voltage appears across the winding on the core. Simply slip the current probe over one side of the feedline and then the other side to check relative current on the two sides. For a "classier" current probe, permanently fix the core around one side of a short section of feedline that has clips on each of the section's four end wires (two at each end of the section). Inserting the section between the end of the actual feedline and the tuner is then a snap, as is reversing the probe from one side of the line to the other.

This arrangement will not give the absolute readings obtainable with a calibrated RF ammeter. It is quite adequate, however, for checking relative current and relative current balance on open-wire feed systems. But keep in mind that current at a particular point on a feedline will vary with frequency, as the length of the antenna and feedline varies in terms of wavelength. This means that readings taken at different frequencies are not comparable. Remember, too, to keep the power into the line LOW when you run the test. Again, the output of an MFJ Antenna SWR Analyzer is adequate when a sensitive voltmeter is used with the probe.

A final word about feedline (im)balance: It is true that current imbalance may produce some feedline radiation, but this is still radiation. What is more serious is that imbalance may be accompanied by other unwanted effects. (For example, it may be a symptom that part of the antenna system is functioning as an end-fed wire worked against ground, with RF current also flowing into a lossy ground system, where it warms the worms rather than radiating). So imbalance is worth minimizing. But at QRP levels, "RF in the shack" generally isn't a problem, and in most real-world situations there has to be substantial imbalance (perhaps several dB or more) before the station at the other end begins to tell the difference.

[For a better approach to testing for balance and efficiency than what's described above, see Frank Witt's article in QST for April 1995.--C.L., 7/15/96]

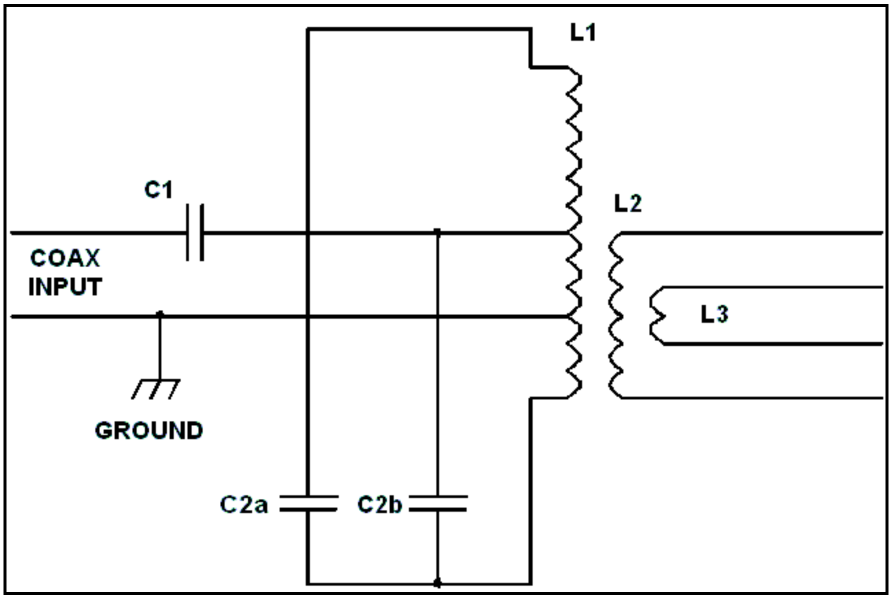

Figure 1: Schematic

Components are identified in the text of the article. To read the drawing the following comments may help:

C1 is shown here as a single section cap, but should be a *dual* section variable cap, with the second section switched in and out of the circuit in parallel with the section that is shown. (Use a s.p.s.t switch, S1, not shown.) Or switch a fixed padder in and out, as need be. Don't permanently wire the two sections in parallel, because sometimes you need a low minimum capacitance. If you use a three-section capacitor at C1, connect the second and third sections in parallel and wire S1 to switch in both of them as the high capacitance option.

C2a-C2b: dual section variable. The top of C2a goes to the top of L1. The top of C2b goes to the center tap on L1 (to which the line from C1 is also connected). The bottom (rotor/frame) of C2a-C2b goes to the bottom of L1.

The frames of both C1 and C2 need to be insulated from ground. L1 is the tank circuit inductor. See the text for winding instructions and the tap points.

The ground connection goes to the lower of the two taps on L1 (the 5 turn point with a T-157-6 core; the 6 turn point with a T-130-6 or T-200-6 core).

L2 is the high impedance output link (10 turns), which is centered on the ground tap of L1 (5 turns on each side of the ground tap), and is interwound between the turns of L1.

L3 is the low impedance output link (4 turns), which is similarly centered on the ground tap of L1 (2 turns on each side of the ground tap), and is interwound between the turns of L1 and L2.

Use a d.p.d.t. switch, S2 (not shown), to select the desired output link.

Rear of the Z-Match enclosure

Addendum

Here is an addendum to my Z-Match article in QRP Quarterly, July 1995. It includes modified toroid winding data to use when substituting small "plastic" capacitors for the higher-capacitance air-spaced units that I used in my published design. I also make recommendations on #2 vs. #6 toroid cores, and I suggest a couple of modifications for the version of the z-match found in the Autumn 1995 issue of SPRAT. (That's the date marked on the photocopy I'm using. I believe it is SPRAT #84.)

If anyone spots any glitches in this, I'd appreciate having them called to my attention.

I can provide the original article by email, if you want a copy.

The Z-Match design in my QRP Quarterly article (July 1995, pp 10-11) was based on the assumption that the tank circuit capacitor (C2) would be a dual section variable with at least 330 pf per section. If the capacitor instead is a small "plastic" variable of the kind marketed by Mouser and DC Electronics, then the inductance in the multiband tank circuit needs changing. The reason is that these small dual section capacitors have a lower maximum capacitance, of approximately 270 pf per section. Fortunately, their minimum capacitance is also lower, so the resulting maximum/minimum ratio allows full coverage of 80 through 10 meters, but only if the inductance in the tank circuit is properly altered.

You need to begin by selecting a toroid. I recommend a T-130-6 core, which gives better Q throughout the HF range than is attainable with a T-130-2 core. But either one is satisfactory. The important point is that the cores differ in permeability, so the number of turns will differ depending on which one is selected.

For a T-130-6 core (used with one of the small plastic variable capacitors at C2), substitute the following winding data for the data provided in my article.

L1 (the main tank coil): 32 turns of #24 enameled, tapped at 8 turns from the bottom (the ground tap) and at 16 turns (the center tap, running to C1, the series input capacitor, and also to one section of C2). The top of the winding (32 turns) goes to the other section of C2.

L2 (the high impedance link): 16 turns of #26 enameled, wound between the turns of L1, with 8 turns on each side of the 8-turn ground tap on L1.

L3 (the low impedance link): 4 turns of #26 enameled, wound between the turns of L1 and L2, with 2 turns on each side of the 8-turn ground tap on L2.

Using 4 turns for L3 permits considerable flexibility in matching very low impedances, without much degradation in the 50-200 ohm range. (Only careful tests disclose this degradation, and it is imperceptible in practice.) However, if you wish to optimize L3 for maximum efficiency in the 50-200 ohm range, use 6 turns instead of 4 (3 on each side of the ground tap on L1).

If a T-130-2 core is used, the number of turns must be reduced, owing to the higher permeability of the core. Based on the foregoing data, I calculate the proper number of turns for the #2 core as follows:

L1: 30 turns, tapped at 7 turns from the bottom (ground tap) and at 15 turns (to C1 and one section of C2).

L2: 14 turns, centered on the 7-turn ground tap on L1.

L3: 4 turns, centered on the 7-turn ground tap on L1.

Please note that I have derived the data for L1 when using a #2 core from the data for the #6 core, making the conversion on the basis of toroid winding formulas. If you do use a #2 core, you may wish to try reducing the total to 28 turns, tapped at 7 and 14 turns. (Because the #6 core gives higher Q, I have not actually experimented with a #2 core in my Z-Match circuit, when using the plastic capacitors.) The instructions and suggestions are otherwise the same as for the #6 core.

In my own "mini" Z-Match using the small plastic capacitors and a T-130-6 core, I have also changed the arrangement of C1/S1 (the series input capacitor and associated switch). I use a small d.p.d.t. toggle switch at S1, with a center-off position. It is wired so that in the center-off position, one 270 pf section of C1 is in the circuit. In the left hand position, both 270 pf sections of C1 are in the circuit. In the right hand position, both sections are in, plus an additional 500 pf padder (a silver mica capacitor). These options insure flexibility with unpredictable loads. In most instances, however, the arrangement in the original QRP Quarterly schematic should be adequate, even with the lower maximum capacitance of the plastic variables.

The resulting mini Z-Match has excellent matching range, efficiency, and balance. In fact, its efficiency is slightly superior to the efficiency of the units I've built using air-spaced

capacitors. (This probably is because of the lower C/L ratio in the tank circuit.) Regarding the tuner's power handling ability, information on the small plastic capacitors provided to me by Roy Gregson, W6EMT, indicates it should safely handle 15-20 watts of RF, although I've only run 5 watts through it. (Keep in mind, however, that load conditions will have some effect on power-handling capacity.)
I've also enhanced the versatility of my mini-tuner by building an absorptive SWR bridge into it. Resistance values were selected so that the highest SWR seen by the rig during tune-up is about 1.2:1.

Regarding the Z-Match design in SPRAT, Autumn 1995, p 9 (which Roy, W6EMT, has worked with), I would similarly recommend a T-130-6 core, in place of the T-130-2 core indicated in SPRAT. Here, too, the change requires an adjustment of the number of turns.

For the SPRAT design but with a T-130-6 core (and using small plastic variables), I calculate the modified turns count as follows:

> **Main tank coil:** 29 turns total (instead of the 27 turns specified in SPRAT for the #2 core). Tap at 12 and 17 turns from the bottom. The 12-turn tap goes to one section of the tank circuit capacitor, and the 17-turn tap goes to the series input capacitor. The top of the winding (29 turns) goes to the other section of the tank circuit capacitor.
>
> **Link:** 8 turns, interwound between the turns of the main tank coil at the tank coil's "cold" (grounded) end. SPRAT says to use p.v.c. covered wire for the link. I doubt that use of enameled wire would make a detectable difference, but conceivably it might have a small effect on the interwinding capacitance and thus on balance with high-impedance loads.

The SPRAT circuit shows a single-section series input capacitor, but I recommend using a two-section capacitor (the same kind that is used in the tuner's multiband tank circuit), and Roy tells me that he has incorporated this modification into his Z-Match that's based on the SPRAT design. Use a s.p.s.t. switch to put the second section of the input capacitor into the circuit. (See C1/S1 on the schematic in my article in QRP Quarterly.) This will increase the matching range, especially on 80 and 40 meters. However, do *not* wire the second section permanently in parallel with the first section, because it is sometimes necessary to have a *low* minimum capacitance, and paralleling the two sections defeats this objective.

For evaluating matching range, balance, and efficiency, I recommend the tests and "Geometric Resistance Box" (tm) described by Frank Witt, AI1H, in QST, April 1995. (The tests included in my QRP Quarterly article are useful, too, but Frank's are more easily done and allow considerable precision and accuracy. Be sure to watch for his forthcoming article in volume 5 of the ARRL Antenna Compendium, in which he refines the balance test presented in his QST article.) I've used Frank's tests to evaluate my design and the SPRAT design that Roy has drawn on.

The "bottom line": My tests, as posted on QRP-L, 7/19/96, indicate that my Z-match design handles *high* impedance loads somewhat better than does the SPRAT design, in terms of both balance and efficiency. This results from the placement of the ground point within the multiband tank circuit and the availability of a separate high impedance output link. My design gives more flexibility, too, at the *very* low end of the range of impedances likely to be encountered, because of the separate low impedance output link. (The tests I posted did not cover this aspect.) In my design, the two output links and the switchable input capacitor also add versatility in handling complex loads that include varying amounts of reactance, which may throw the tuning considerably off of the settings for largely resistive loads and out of the range of a tuner with fewer options. The "price" paid for this additional flexibility is two small switches. The choice otherwise is something of a toss-up, and either design (mine or the SPRAT/W6EMT design) yields a highly serviceable and easily built "antenna tuner." As a practical matter, choosing between one or the other turns pretty much on personal inclination.

I pick my own design (surprise!) because I like to maximize matching options, even though I may seldom need to use them. I also prefer the best feedline balance I can get, even though I know from computerized antenna/feedline modeling that--within limits--feedline imbalance generally has little effect within commonly-used wire antenna systems. So perhaps it's aesthetics. For the same reason, others may place a higher value on lean simplicity and thus choose the "competition."

QUESTION:
If I adapt my QRO components for 160 meters, what might be the best > approach? Add more capacitance with the same coil? Rescale the whole thing for 1.8-20 MHz or so, and not expect the highest HF bands?

I use a z-match to tune a 110' centerfed wire (with about 45' of 450 ohm ladder line) on 160 thru 12 meters. (As for whether this is a good antenna system on 160, see below.) The circuit is the same one described in my e-mailable packet of z-match material (same, too, as in the article in volume 5 of the ARRL Antenna Compendium (just out)), but with the inductance of the main tank coil increased about four times, and the links increased too. You could do the same thing by doubling both the inductance of the coil and the capacitance of the double section tuning capacitor, but a cap to accomplish the latter is hard to find. (And quadrupling rather than doubling the inductance theoretically gives a better L/C ratio in the tank circuit in terms of efficiency.)

In the unit I'm using, the inductor is 36 turns on a T-157-2 core, with the center tap at 18 turns (!) and the ground tap at 9 turns. The high impedance link is 16 turns, and the low impedance link 6 turns. The cap is about 365 pf per section. The low band tuning range covers 160-40, and the high band range 40-12. I won't vouch that the coverage would extend this high with all antenna systems. (The magnitude and composition of the complex impedance at the system's tuner feedpoint will make a difference.)

You could probably use the same approach on Roy Gregson's ZM-1, but as I recall the ZM-1 comes with a T-130 core, which would make for a tight fit
for the necessary turns.

Info Packet for the Asking

Anyone one who wants my z-match packet, just drop me an email note and I'll send it by reply email.

Incidentally, lest someone think I'm loonier than I really am, I don't mean to say that a 110' center-fed wire is a very good antenna on 160. It isn't. In fact, it's downright crummy. But it's what I currently have--and the station ground isn't good enough to feed it as a T on 160--and the z-match tunes the system.

Please note that the winding data for the toroid are for powdered iron cores of #6 material (usually colored yellow), which I recommend for the circuit. Cores of #2 material (red) are satisfactory, but are inferior in terms of Q. They are also higher in permeability. This means the number of turns on L1 will have to be reduced if you use a #2 core. A reduction of 2 turns--one off each end--should be adequate. Keep the ground tap on L1 midway between the bottom and the center tap, and keep the links (L2 and L3) centered around the ground tap and L1. (Use the same number of turns for the links as indicated for the #6 cores.)

Thanks to Fred Bonavita, W5QJM, and Pete Hoover, W6ZH, for continuing to send me copies of "tuner" articles they encounter in various publications; to Fred again for providing the "plastic" capacitors I used in my mini Z-Match; and to Roy Gregson, W6EMT, for several informative email notes on the SPRAT design and Roy's own experiments.

The author may be reached at …

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NOTE: *A compilation of Charlie Lofgren's articles on the Z-match tuner may also be found on the web at: http://www.pconline.com/~rohrwerk/k0jd/z-match.html*

The following article appeared in QRP Quarterly, July 1995, pp 10-11, and a revised and expanded version (including the same circuit but with some additional suggestions) is appearing in volume 5 of the ARRL Antenna Compendium (forthcoming). If you wish to use small "plastic" capacitors (approximately 5-270 pf, of the sort listed by Mouser and DC Electronics) rather than the larger ones indicated below in the article, see the modifications described in the "Addendum" that I have available by email.

include construction projects for beginners all the way up to the advanced digital and RF experimenters. Annual subscriptions are $15 (for US & Canada) and $20 (for foreign addresses). For information, contact editor/publisher George Heron, N2APB at n2apb@amqrp.org or visit HOMEBREWER Magazine home page at www.amqrp.org/homebrewer.

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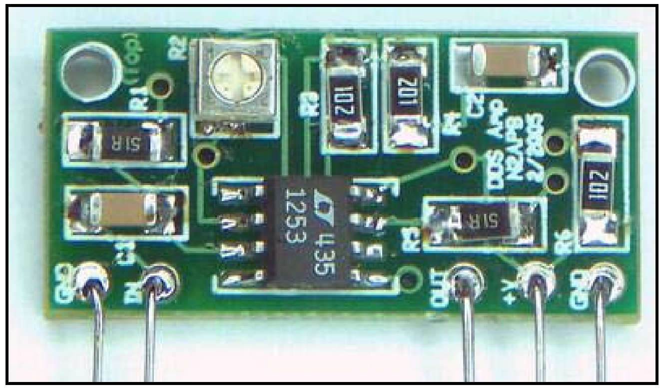
George Heron, N2APB
Joe Everhart, N2CX

~ DDS Amp ~

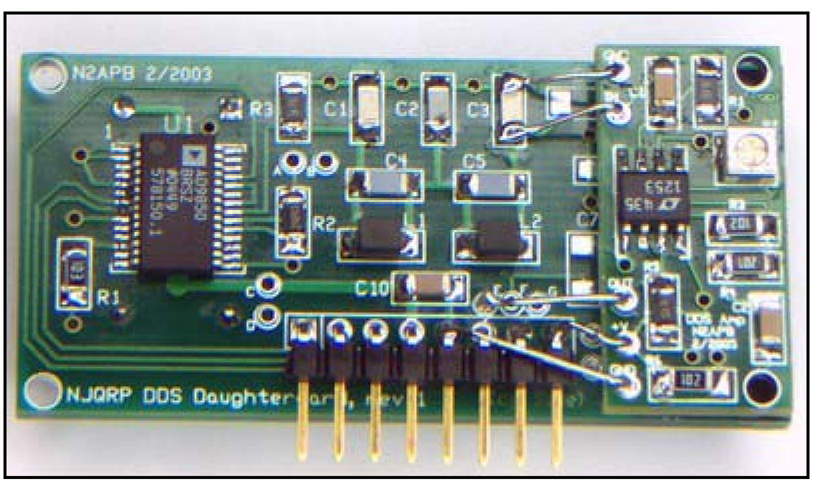
Upgrade your DDS Daughtercard with a good-quality RF Amp

Replace that stock MMIC amp that came with the original DDS Daughtercard to get a super-clean signal, adjustable output level and near-flat response from 1-30 MHz.



The DDS Amp also makes a great stand-alone RF amplifier for use in other projects.

The original DDS Daughtercard, designed and produced by the NJQRP/AmQRP clubs over the years, has been a very popular "modular signal generator kit" for those wishing to create rock-stable RF signals for use in test and local oscillator configurations around the shack. In the last year, however, the DDS card has been used in increasingly demanding applications calling for constant output levels across its frequency range and cleaner spectrum than could be consistently provided with the MMIC devices (MAR, MAV, ERA) used for the RF amp. Further, it was difficult at times to keep this high-gain device from oscillating. So the design team has come up with an ideal solution for a new RF amp that replaces the current RF output stage and fits on a small board that is positioned right on that same end of the DDS card.



The small DDS Amp "grand-daughtercard" sits right on the original DDS Daughtercard in place of the original MMIC (MAR-1, MAR-4, MAV-11 or ERA-3) used as the RF amplifier for the earlier designs.

The DDS Amp circuit is based around a dual video amplifier IC (LT1253) in an 8-lead SMT-package that we fit onto a small 1" x 1/2" pc board. The board sits on the end of the DDS Daughtercard when the output amplifier components are removed and conveniently connects into the circuit with short wire jumpers. The amplifier is unconditionally stable (k>1) and yields spectrally-clean signals with harmonic energy 35-40 dB down from the fundamental, yielding the ideal signal for impedance measurement. We've added a trimpot in the feedback path to allow precise setting of +10 dBm output levels being delivered to the reflectometer for best performance. This amplifier design provides an appropriate signal using supply voltages from 16V down to 8V, thus still allowing for convenient battery operation without the need for that extra 8V regulator on the DDS Daughtercard.

Circuit Description

The DDS Amp is a departure from the approach used previously to amplify the low-level DDS signal to something more usable by homebrewers and RF designers.

The original DDS Daughtercard design used various broadband amplifiers made by Mini-Circuits Labs. The monolithic amps are simple to use and require only a few added components to make a working amplifier. They do, however, have some shortcomings.

The first was the limited selection of amplifiers that could produce the several volt peak-to-peak signal required by the bridge circuit in the Micro908 Antenna Analyst and other instrumentation-based circuits. Those devices that could provide this high level into a 50-100 ohm load either had too much gain variation across the 1-30 MHz range or they required in excess of 70 ma for their power. This means a lot of heat must be dissipated in a small surface-mount package. One candidate, the ERA-3, performed well in beta tests of a half dozen units or so, but in a larger trial many of the amplifiers oscillated at several GHz producing excessive distortion of HF signals and unwanted spurious products. We assumed a confluence of conditions conspired to produce these ultimate problems in the field – the ground plane of the DDS Daughtercard was not optimally layed out for the MMIC, the latest device used (ERA-3) had tremendous gain-bandwidth making it more prone to oscillations, and the production run of devices had slightly different operational characteristics than those used in the beta trial. Nevertheless, an improvement was called for.

We decided instead to use a video amplifier integrated circuit – the LT1253 – that was designed to drive low impedance loads with the low distortion required for video applications. A schematic diagram of the two-stage amplifier is shown in Figure 1. Each amplifier section behaves like an operational amplifier. The voltage gain of the amplifier stages is set by the ratio of the feedback resistor pairs, R2/R8 for the first stage and R3/R4 for the second stage. R2 is variable to provide amplifier gain adjustment.

Voltage divider R6/R9 biases the first amplifier midway between the V+ supply and ground to allow maximum voltage swing. The bias is carried through to the second amplifier by direct output to input connection.

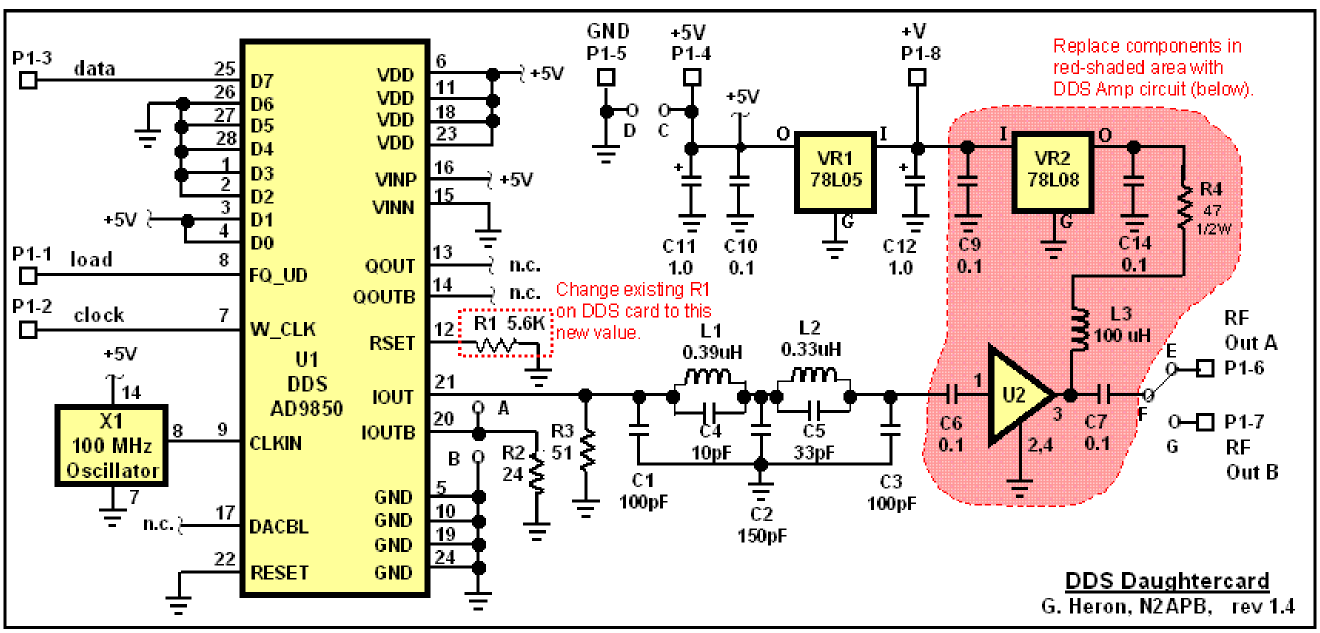
Capacitor C6 provide isolation and filtering on the V+ power supply line. Capacitor C3 bypasses the R6/R9 divider to minimize unwanted coupling to the power lines and filters out any noise or extraneous signals. Capacitor C1 provides input RF coupling without upsetting the amplifier DC bias. Capacitors C2, C4 and C5 provide RF ground to their associated feedback resistors while not affecting DC bias.

Resistor R5 sets the amplifier output impedance to about 50 ohms and is needed to prevent the potential for amplifier instability with unknown load impedances.

Jim Kortge, K8IQY performed some very useful Bode plot analysis for us in the early stages of the DDS Amp design. His findings are shown later in this article.

How the DDS Amp "fits into" the DDS Daughtercard

The original RF amplifier circuitry is shown below in the schematic of the DDS Daughtercard. The components in the red shaded area need to be removed from the circuit board and the small DDS Amp pc board will sit above that end of the board where the parts were removed. Additionally, the value of R1 on the DDS Daughtercard needs to be changed to 5.6K. Changing this "DDS current programming resistor" sets the DDS to generate a signal of the correct level into the low pass filter and then on into the DDS Amp, thus nicely balancing the gain of the amplification chain.



DDS AMP "grand-daughtercard" for the DDS Daughtercard
Original "MMIC" RF amplifier components (in red shade above) replaced by LT1253 video op amp (below)
Greater RF output – adjustable up to +10 dBm, or about 3V pp.
Output signal unaffected by varying +V supply voltage – great for battery operation.
Near-constant output level from 1-30 MHz, with superior signal purity: harmonics down > 40 dB (typ)

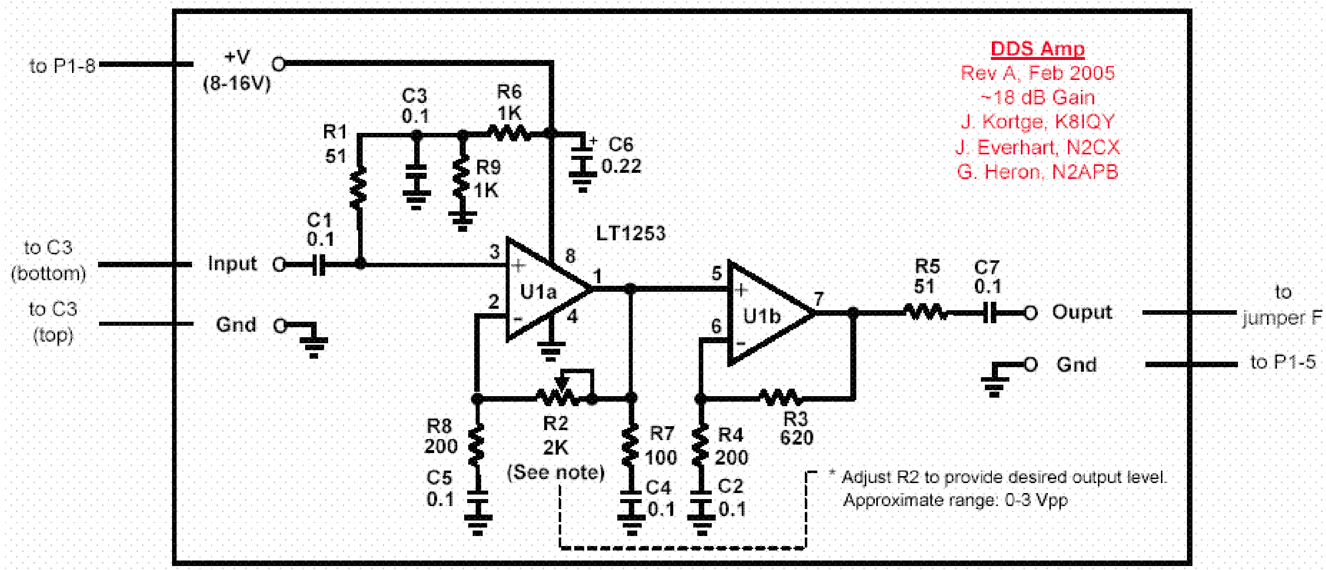


FIGURE 1: Schematic for the DDS Amp amplifier, used in place of the MMIC-based amps originally on the DDS Daughtercard. The 1K/1K voltage divider establishes a virtual ground that lets the DDS Amp deliver adequate signal right down to an 8V "low" battery voltage. The trimpot allows setting of the best level into the end application.

It's a Great Solution!

All in all, the DDS Amp is a great addition to the DDSDaughtercard. It provides for outstanding measurement results from the Micro908 and also works well in the QuickieLab, MS-DDS, and IQ-VFO projects. We have already delivered DDS Amp kits to all Micro908 owners for incorporation on all these instruments in the field, and results have been superb.

Thanks to Jim Kortge, K8IQY and Joe Everhart, N2CX for the design of this circuit. It is a great improvement to the DDS Daughtercard.

By the way, if you are currently experiencing good results with your DDS Daughtercard and are happy with its performance, especially when using the original MAR-1 or the MAV-11 devices, there is no compelling reason to change to use the DDS Amp Kit.

The authors may be contacted as shown below …

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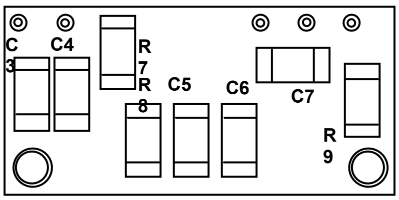
3 Easy Steps to Upgrading your DDS Daughtercard …

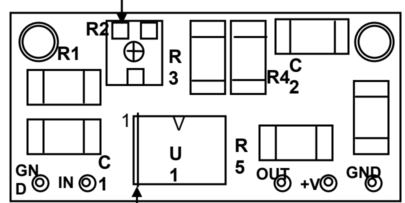
1) Assemble the DDS Amp "grand-daughtercard" …

Solder parts to bottom side after top side components are attached.

Add R2 trimpot first. Tin one pad first, then carefully hold the trim pot in place with tweezers, and re-heat the pad. Solder the other two pads. Measure about 1K ohm on traces to ensure successful connection.



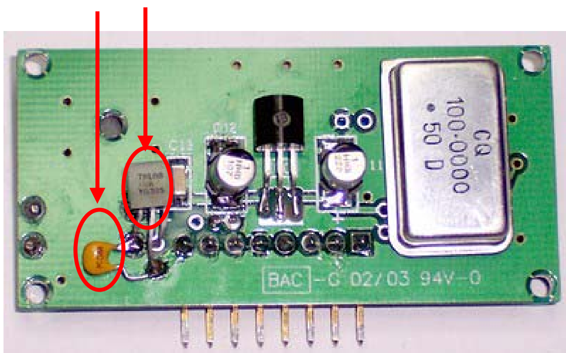
Bottom side

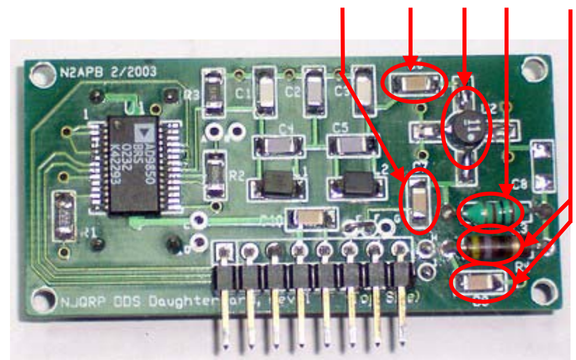


Top side

Small beveled edge on package
denotes side for pin 1.

2) Remove the current "RF amp components" from the DDS Daughtercard …

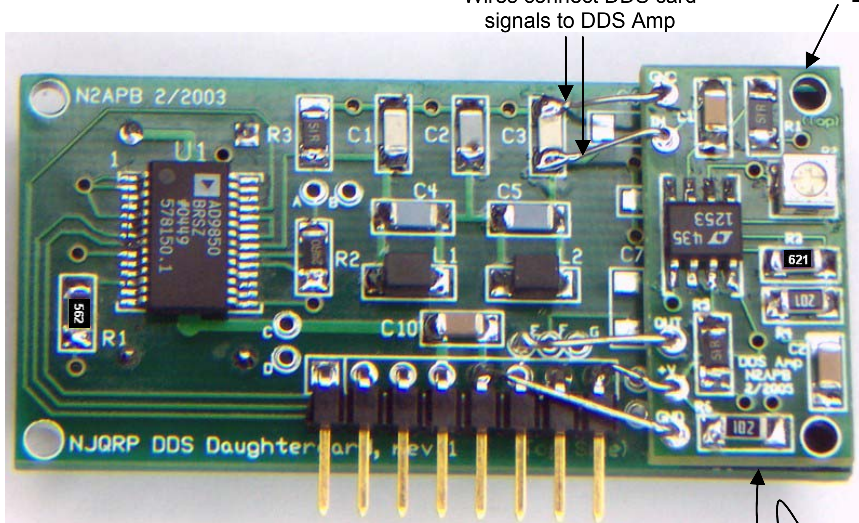




3) Add the DDS Amp board to the top of the DDS Daughtercard and wire it in …

Wires connect DDS card signals to DDS Amp

DDS Amp



DDS Daughtercard shown with DDS Amp attached

Add piece of electrical tape between the DDS card and the DDS Amp

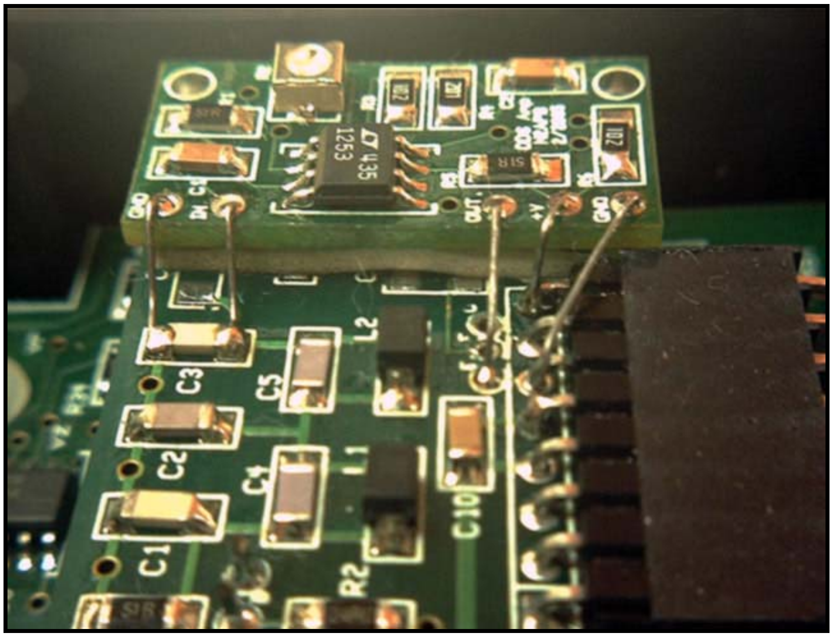
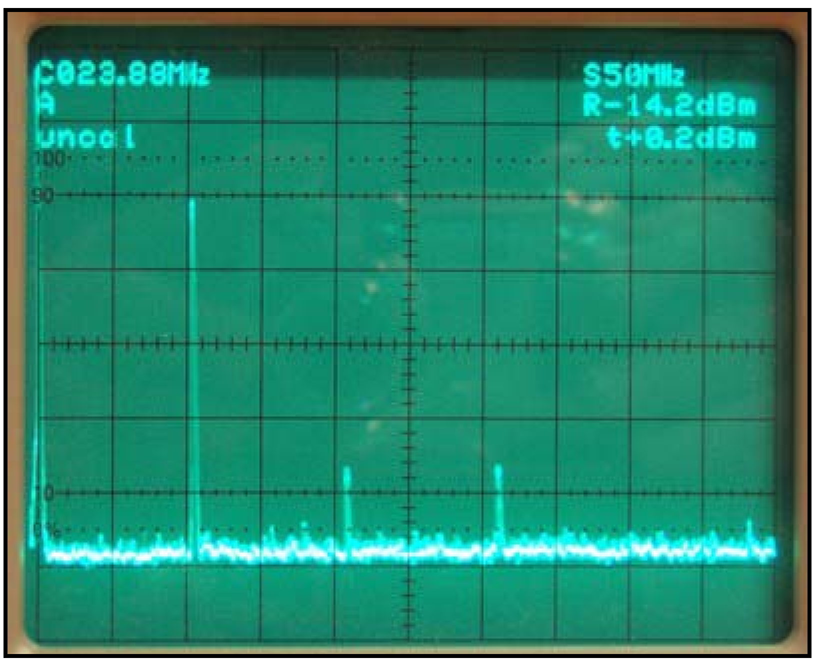


Photo of the DDS Amp in place on the DDS Daughtercard. The pcb is positioned atop the DDS Daughtercard in place of the MMIC circuitry. Electrical tape insulates the pcb from the DDS Daughtercard and wire jumpers conveniently connect and hold the Amp to the DDS card. Amplitude can be adjusted from about 0.5V p-p to almost 4.0V p-p using the onboard SMT trim pot, allowing it to be used in applications requiring different drive levels.



Spectrum analyzer display shows harmonic energy more than 35 dB below the 10 MHz fundamental. This is a characteristic essential for good and accurate readings to made by the Micro908 Antenna Analyst and other demanding applications.

LT1252 & LT1253 DDS Amplifier Bode Plot Information

An LT1252 amplifier used for DDS post-amplification service was evaluated using an Advantest R3361A spectrum analyzer. The LT1252 DDS amplifier was supplied by George Heron, N2APB of the AmQRP organization.

The amplifier was evaluated by driving it at a signal level of -10 dBm, using the tracking generator in the R3361A. Its output was fed to the spectrum analyzer and the frequency response was measured from 1 MHz to 100 MHz. A comparable data plot was produced using the identical setup, but with a LT1253 dual amplifier. The data differences between these two amplifiers are show below.

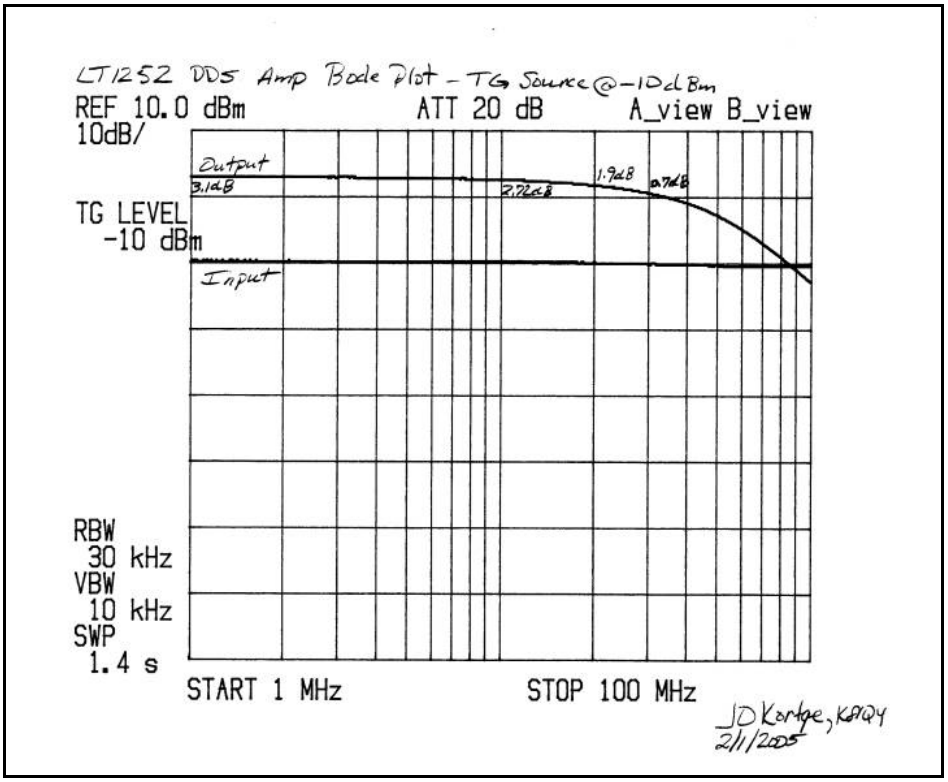
Data Comparison:

Frequency (Mhz)	LT1252 Output (dB)	LT1253 Output (dB)	Difference (dB)
1	3.1	8.7	5.6
10	2.7	8.6	5.9
20	1.9	8.4	6.5
30	0.7	8.2	7.5
Freq 1-100 MHz Diff:	2.4	0.5	

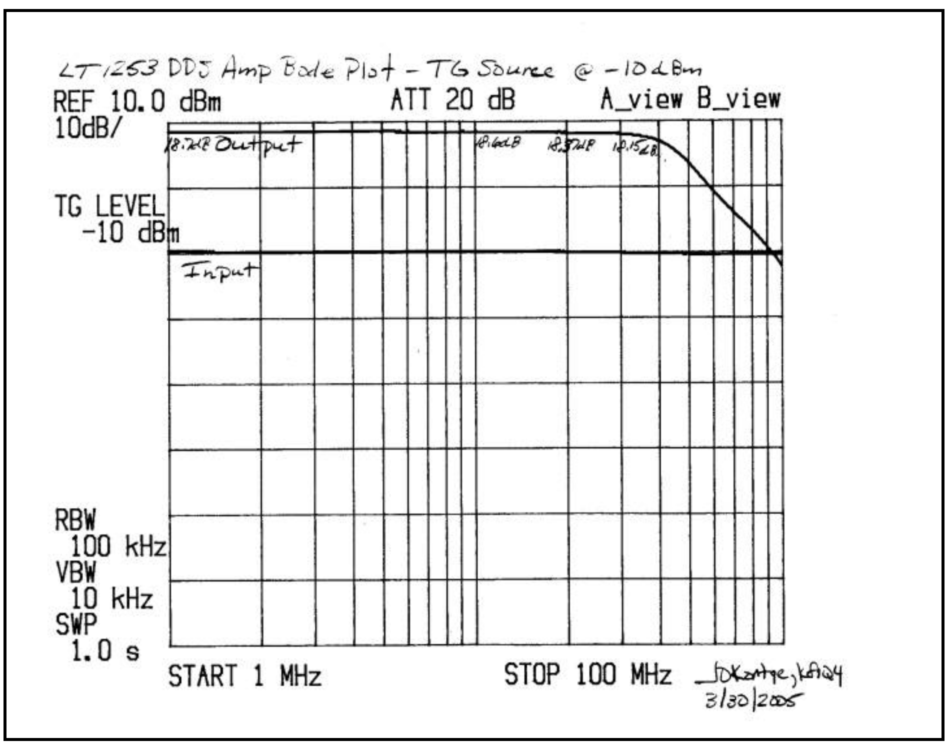
Note that the LT1253 amplifier was set up to provide approximately 19 dB of power gain at 1 MHz, whereas the LT1252 amplifier as evaluated was designed to provide approximately 13 dB of gain at the same frequency. The feedback resistor pair in the LT1253 can be adjusted to provide the same 13 dB gain level as the LT1252 amplifier, while improving the higher frequency response (less loss at 30 MHz). In fact, the feedback scheme used in the LT1253 amplifier was optimized for added gain with some slight degradation of 30 MHz performance.

The respective Bode plots of the LT1252 and LT1253 amplifiers are included on the next page.

Jim Kortge, K8IQY
February 1, 2005



LT1252 DDS Amp Bode Plot



LT1253 DDS Amp Bode Plot

DDS Amp Parts List

Qty	Designator	Description	Digi-Key P/N
2	R1, R5	Resistor, 51 ohms, SMD 1206	311-51ECT-ND
3	R3, R6, R9	Resistor, 1K ohms, SMD 1206	311-1.0KECT-ND
1	R2	Trimpot, 2K ohms, SMD	490-2248-1-ND
2	R4, R8	Resistor, 200 ohms, SMD 1206	311-200ECT-ND
1	R7	Resistor, 100 ohms, SMD 1206	311-100ECT-ND
6	C1, C2, C3, C4, C5, C7	Capacitor, 0.1 uF, SMD 1206	PCC1883CT-ND
1	C6	Capacitor, 0.22 uF, tantalum, SMD 1206	493-2338-2-ND
1	U1	Dual op amp, LT1253, SOIC	LT1253CS8-ND
1	PCB	PC board, approx 0.5" x 1"	

AmQRP.ORG HOMEBREWER

Wayne McFee, NB6M

TWO FOR THE ROAD

A Dual-band CW Transceiver for 40 and 20 Meters

The rig pictured above is fun and easy to operate, and incorporates "big-rig" features that make QSO "tail-ending", "hunt and pounce", and even "split" operation a snap.

Although there are a few multi-band QRP kits available today, their cost is somewhat prohibitive and that factor has many of us looking for other solutions. Two of the reasonably priced SW series board kits from Small Wonder Labs were used in this rig, as the basis from which a very nice dual-band CW rig was constructed, at a total cost much less than the cheapest dual-band kit available.

As can be seen in the photo, a keyer paddle is built right into the front panel of the rig. There are dual VFO controls, a fine-tuning pot, and, to the left of the paddle, two push-button switches that control the Tick Keyer chip and the FreqMite CW frequency annunciator built into the rig. All one needs to plug into this rig are DC power, a resonant antenna for the band of choice or a multi-band antenna and tuner, and earphones.

After experiencing how good a rig the SW40, and later SW40+ was, the schematic was examined with an eye to determining how much additional circuitry and switching would be needed in order to construct a multi-band rig from one of the Small Wonder Labs board kits.

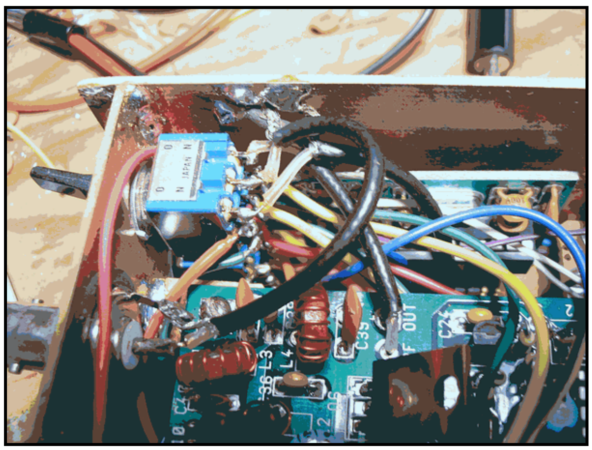
Since a primary goal of this construction was ease of duplication, it appeared that it would be simpler and easier to use a second board and add appropriate switching for the controls and connectors than it would be to add the circuitry and switching necessary to make one board function properly on two bands. Therefore, that route was taken.

After all possible additions and features were considered, including the extensive treatment on tweaking the 40 Meter version of the board that was featured in the ARRL publication, QRP Power, it was decided to include dual VFO controls, a fine-tuning control, a built-in Tick Keyer, a built-in Audio Frequency Annunciator, and a Keyer paddle built right into the front panel of the rig. The Dual VFO controls would provide a means of operating split, or even a manual type of RIT, as needed. Split operation is accomplished by manually switching from one VFO tune control to the other, setting the receiver frequency on one, and the transmitter frequency on the other.

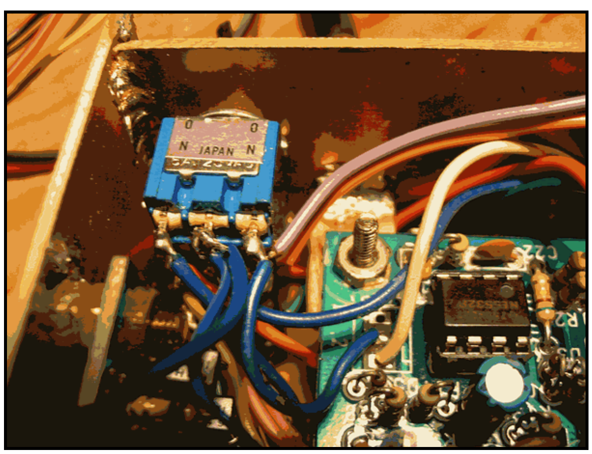
An SW series board was already on hand for the most popular HF band for QRPers, 40 Meters, and it seemed only natural that the second board should be for 20 Meters, giving the ability to make contacts night or day, year round, as well as some very nice DX contacts. An SW-20+ and a Freq-Mite frequency counter/audio annunciator were ordered from Small Wonder Labs, and a Tick Keyer Chip was ordered from Embedded Research.

While awaiting their arrival, the switching circuitry was designed. All controls and connectors were to be switched between the two boards, so that no extra controls or connectors were needed and one didn't have to unplug and re-connect any of the electrical connections to the rig. The Tick Keyer and the Frequency Annunciator would be connected so as to function, automatically, with whichever board was powered up.

Although electronic switching of some of the elements was considered, it was unnecessary. Two Triple-Pole Double-Throw toggle switches connect the antenna, audio output, RF Gain control and the dual VFO pots to the selected board.

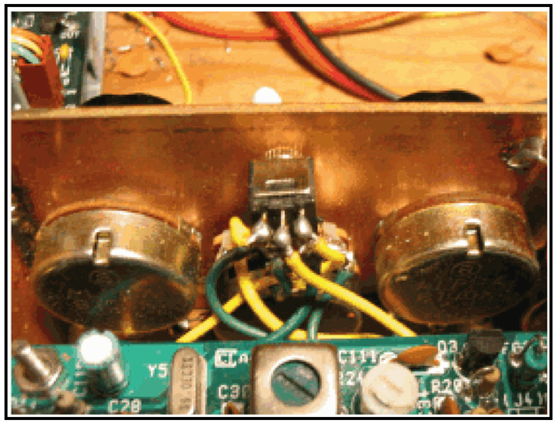


Band Switch S1



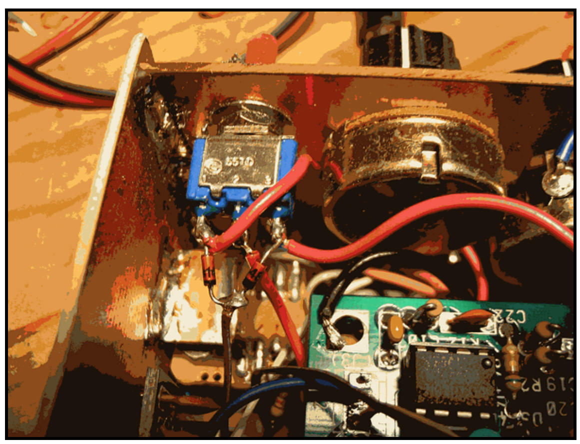
Band Switch S2

A Double-Pole, Double-Throw toggle switch selects the desired VFO tuning control. The fine-tuning control is a 5K pot wired in series between Vr and the appropriate center pole of the Dual VFO selector switch.



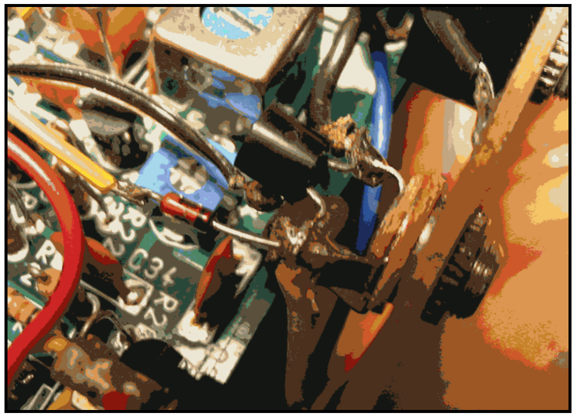
Dual VFO Pots, Fin-Tune Pot below, and VFO Selector Switch in upper center

DC Power is supplied to the selected board by a "center off", Single-Pole, Double-Throw toggle switch mounted on the front panel. So that the Freq Mite receives supply voltage no matter which board was powered up, the anodes of two 1N914 diodes were attached to the two "on" terminals of the center-off power switch, their cathodes were connected together, and the supply voltage for the Freq Mite was taken from that point.



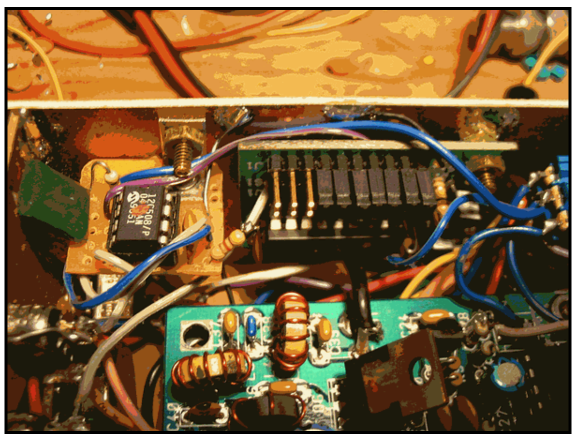
Power Switch, Center Off, with Diodes and Power Line to FreqMite Connected

The Tick Keyer is electronically connected to the key lines of both boards, by adding a 1N914 diode in series between each key line and the Key Jack and by connecting the keying transistor powered by the Tick Chip right across the Key Jack itself, with the keying line from the Tick Chip run to the base of that transistor.



Keying Transistor Connected Across Key Jack
Diode Isolates One Key Line From the Other

The 5 Volts regulated for powering the Tick Keyer is taken from the regulator circuit in the Freq-Mite, so that it has power no matter which board is activated. The small boards for these two items are bolted to the side of the case with 4-40 machine hardware.

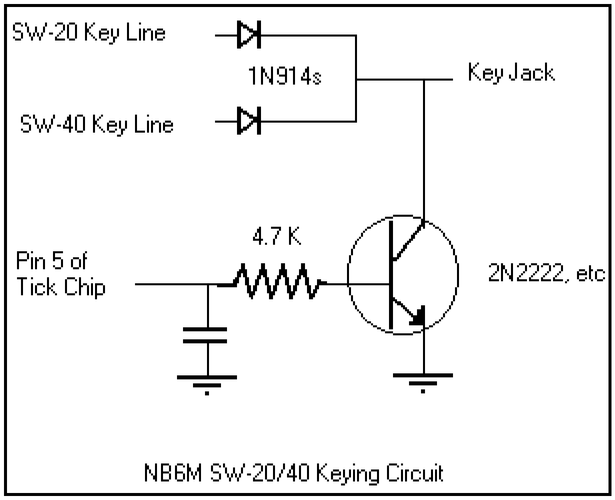


Keyer and FreqMite Boards Bolted to One Side of Case

The Freq-Mite samples the transmitted frequency of whichever board is powered up, at point "B" in the circuit, the wiper of the RF Gain pot. Because of the Diode T/R switching scheme, there is more than sufficient RF there on transmit for the Freq-Mite to sample.

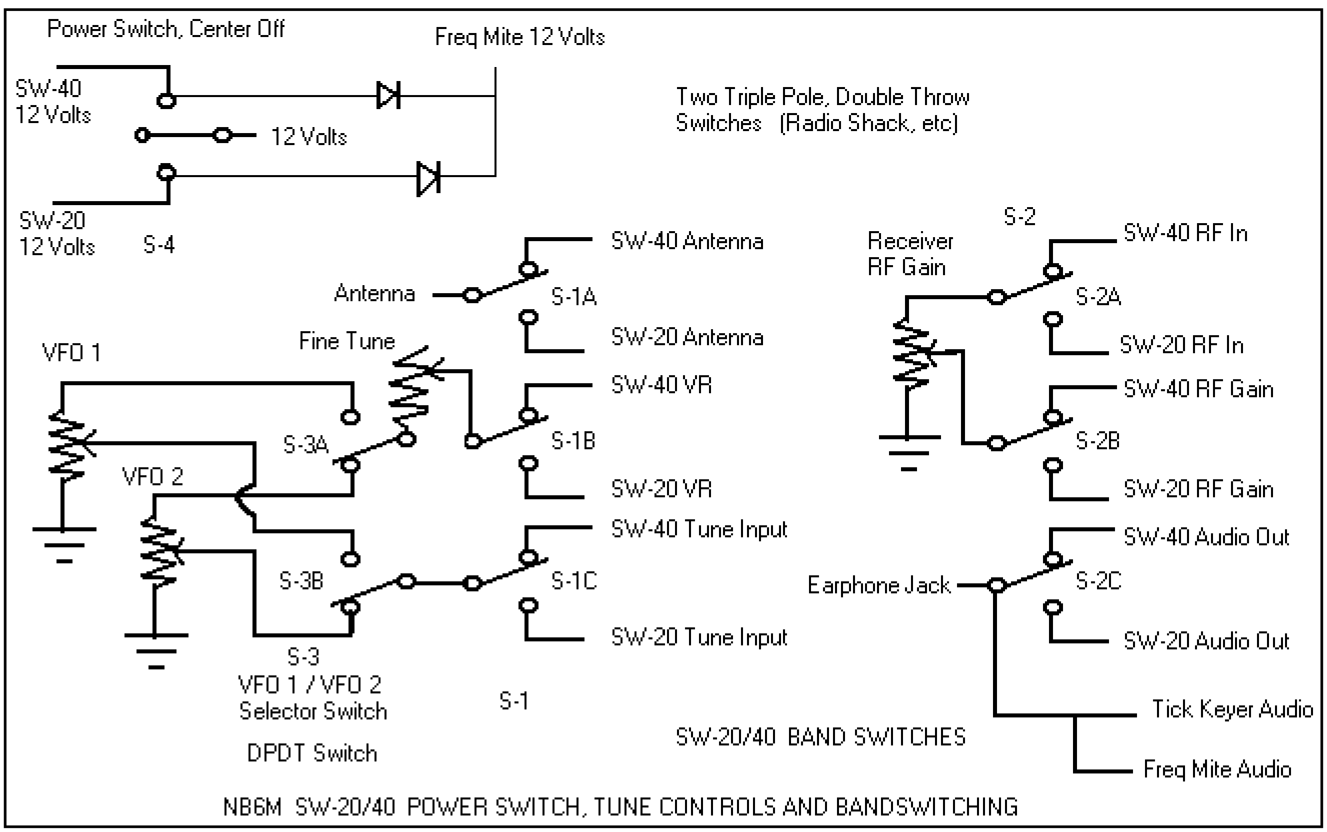
The Freq-Mite can be set up to announce just the last three digits of the sampled frequency, for those instances when it is sampling a heterodyne VFO. The transmitted frequency is being sampled here, and, by appropriate positioning of small jumpers on the Freq-Mite PCB, the Freq-Mite is set up to announce all the digits of the sampled RF. In practice, one needs only to key the rig momentarily, activate the Freq-Mite by pressing a push button on the front panel, and unkey the rig. The Freq-Mite then announces in CW the sampled frequency, at a user selected CW speed.

There is enough audio available from both the Freq-Mite (CW frequency announcement) and Tick Keyer (side tone and mode selection) so that the audio outputs from both those circuits are run through selected values of resistance directly to the earphone jack. A 330 Ohm resistor was placed in series with the audio output from the Freq Mite, and .1 uf Capacitor and a 1 KOhm resistor were placed in Series with the audio from Pin 3 of the Tick Keyer Chip.



Keying circuit schematic

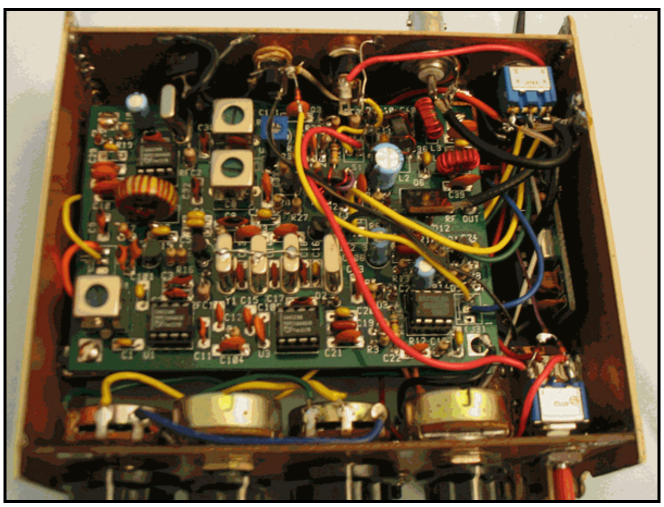
Schematic for the VFO controls and band-switching configuration:



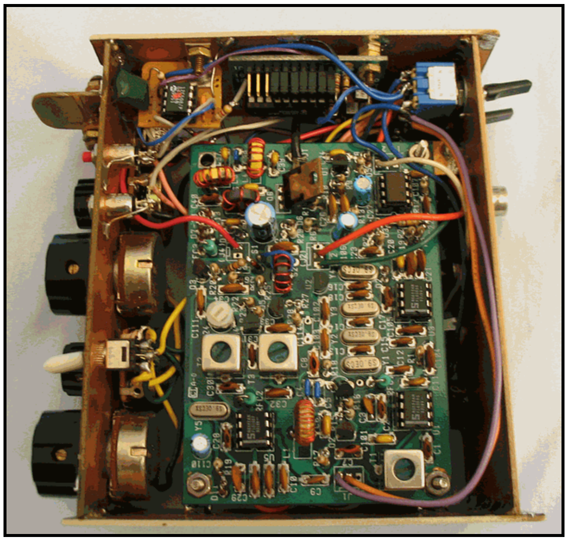
With the switching arrangement taken care of, the enclosure could be designed. At first, some thought was given to including a battery pack and a tuner in the rig. However, it was decided that having the battery pack outside the main enclosure would provide a very positive way of ensuring that the rig was off and preclude any chance for leakage or other corrosive problems from the battery pack. Since resonant antennas such as dipoles would be used in portable situations as often as non-resonant types, the tuner would be a separate item as well.

With those decisions made, work began on positioning the four circuit boards, all controls and connectors, and the built in Keyer paddle so as to end up with a small, QRP size enclosure. The material used for all the panels of the enclosure except the front panel is single sided PC board. It is very easy to cut, drill and shape, provides a built-in ground plane, and makes a good-looking enclosure as well. Double-sided PC Board was used for the front panel, as various items would be soldered directly to both sides of that panel.

Although there were some misgivings about what sort of interference and interaction problems might be created, the two main transceiver boards were placed back to back, spaced less than one quarter of an inch apart. They are mounted on three tabs made from double-sided PC Board, which are soldered to the left wall and rear panel of the PC Board enclosure. Operational tests performed upon completion of the rig proved that those misgivings were unfounded. No problems of any kind have been detected. Each board seems to act just like it would in a box all by itself.



Inside, top of rig, showing 40 Meter board, rear panel connectors and band switches, and front panel controls



**Inside bottom of rig, showing 20 Meter board,
tick keyer and FreqMite boards at top of picture,
Band Switches on the rear panel, and front panel controls**

The Keyer Paddle, Tick Keyer, Freq-Mite, Main Power switch and the two Band Switches are positioned to the right of the two main boards in the enclosure, with the power switch on the front panel, the paddle sticking out through the front panel, the two Band Switches on the rear panel, and the Tick Keyer and Freq-Mite boards attached to the inside of the right side panel of the enclosure.

The finished package, made from single sided PC Board material except for the front panel, looks quite nice and has no sharp edges or protruding screws. The front panel is made from double sided PC board because of the fact that various items are soldered directly to it, both front and rear. Both the front and rear panels are recessed 1/4" back from the front and rear edges of the top, bottom, and sides of the enclosure, which gives a pleasing look and also helps protect protruding switches, knobs and connectors. Although the paddle protrudes out about 3/4 of an inch from the front of the rig, about 1/4" further than the two largest knobs, there has been no damage from carrying the rig in either backpack or suitcase.

**Front panel of rig, with controls as follows: Top Row = VFO1, Fine Tune, VFO2, RF Gain, Power
Bottom Row = VFO Switch, FreqMite Button (black), Keyer Button (red), Keyer Paddle Control.
Labels are on front edge of top panel.**

Rear of rig, showing band switches to the left, and the connectors shared by the two boards

With the front and rear panels recessed 1/4", the top and bottom panels were simply tack-soldered in two spots to the front panel, and in two spots to the side panels at the rear. No screws or other hardware were needed, and if one has the tools with which to affect repairs, one has the tools necessary to remove the panels.

DUAL BAND RIG SPECIFICATIONS

Enclosure size: 5 1/8" Wide, 4 2" Deep, and 2 1/8" High

Inside dimensions (front and rear panels inset 1/4"): 5" W, 4" D, 2" H

Front Panel Controls: VFO 1 and VFO 2 Tuning
Fine Tuning
VFO Switch
Receiver RF Gain
Power On (20 Meters), Off, On (40 Meters)
Freq-Mite Activator Button
Tick Mode Control Button
Keyer Paddle (single or dual)

Rear Panel Controls: Band Switches (two) select either 20 Meters or 40 Meters

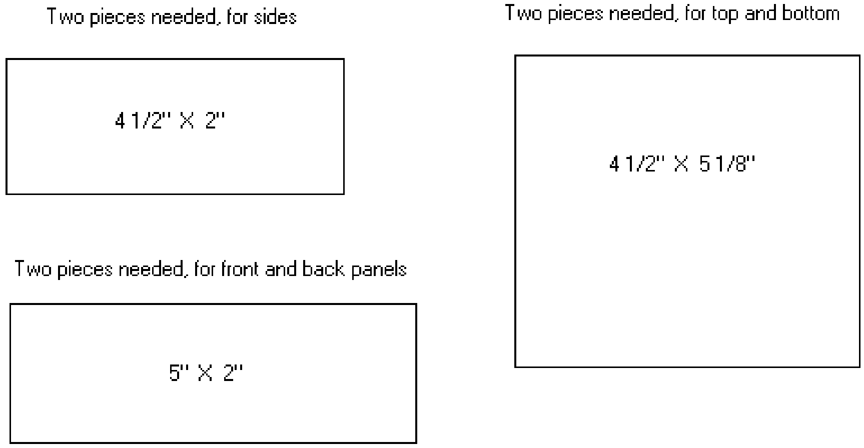
Rear Panel Connections: Antenna
DC Power
External Key (or External Keyer if desired)
Earphone (Low Impedance)

Transmitter Power Out, both bands 1.5 Watts

DUAL BAND RIG PARTS LIST

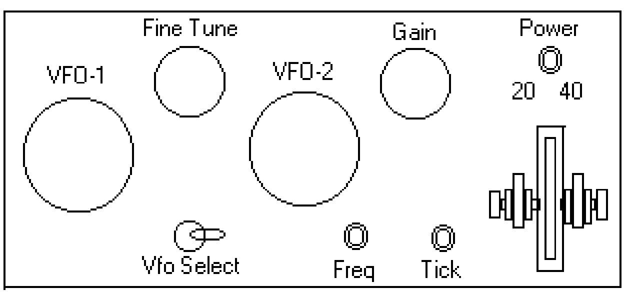
Two mono-band transceiver boards (SW series from Small Wonder Labs, or your choice)
Freq Mite (Small Wonder Labs, or your choice of annunciator)
Tick Keyer Chip (Embedded Research)
Supply of PC board material (see enclosure parts drawing)
Triple Pole, Double Throw Switches - Two
Center Off, Two Position toggle switch - One
Double Pole, Double Throw toggle switch - One
Push Button switches - Two, Normally Open
100 K Ohm Linear Taper Pots - Two
5 K Ohm Linear Pot - Two (One if no Fine Tune control desired)
Antenna Jack
12 Volt Power Jack
Key Jack
Earphone Jack

ENCLOSURE PARTS NEEDED



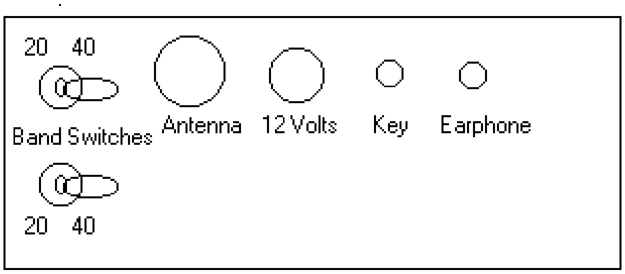
SW-20/40 Enclosure

All pieces are made from PC Board material. If available, make all but the front panel from single sided material, as that looks much nicer. The front panel must be made from double sided material, as various items are soldered directly to both sides. (Grounds for pots, Paddle adjustment screws, etc)



FRONT PANEL

NB6M SW-20/40 Front Panel Layout



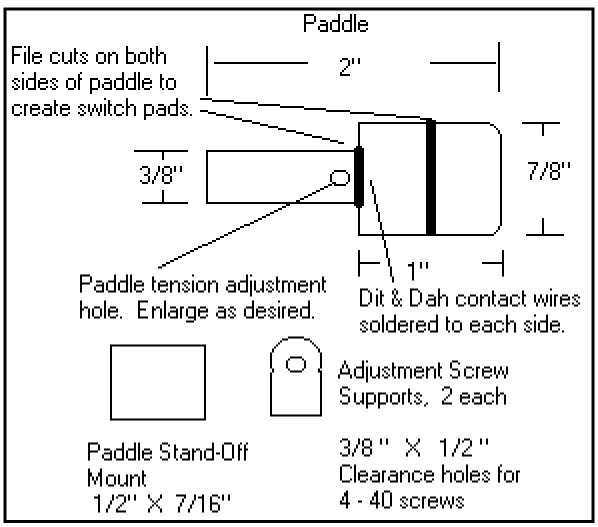
REAR PANEL

NB6M SW-20/40 Rear Panel Layout

KEYER PADDLE CONSTRUCTION

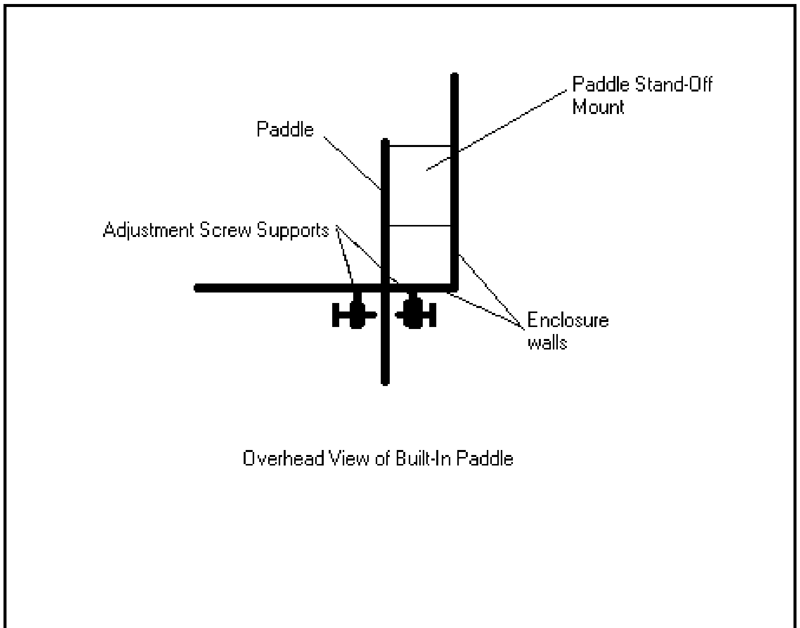
The Keyer Paddle is built right into the front panel of the rig. The details of construction of the paddle are very similar to the methods outlined in a previous article by the author, entitled "The NB6M Paddles", published originally on the NorCal QRP Club Website and in the March, 2000 QST magazine from the ARRL, and now available from the American QRP Club website. Instructions and drawings are included below so that either a single or dual paddle setup can be constructed. I suggest you read the original article first, before starting on this project. It can be read and downloaded from the American QRP club website.

The paddles are mounted on rectangular stand-offs, made from double sided PC Board, that are soldered to the inside of the right side of the PC Board enclosure for the rig. The adjustment screw supports for the single paddle are soldered to the front of the front panel of the rig's PC Board enclosure. In the dual paddle setup, the adjustment screws are attached directly to the paddles themselves.



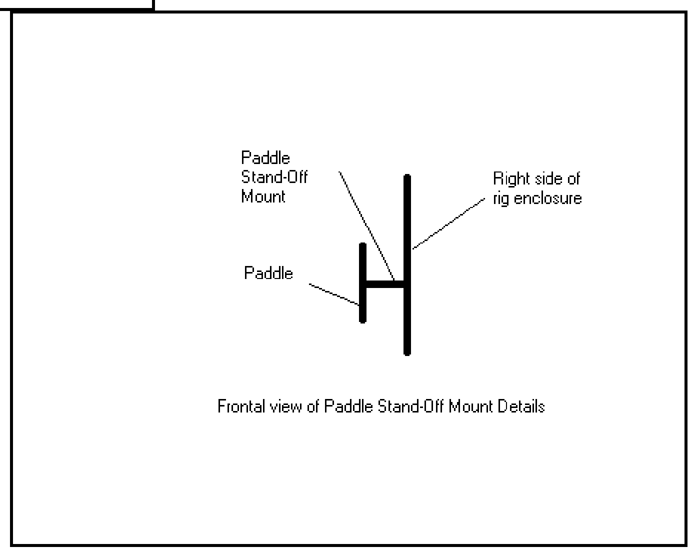
SINGLE PADDLE PARTS

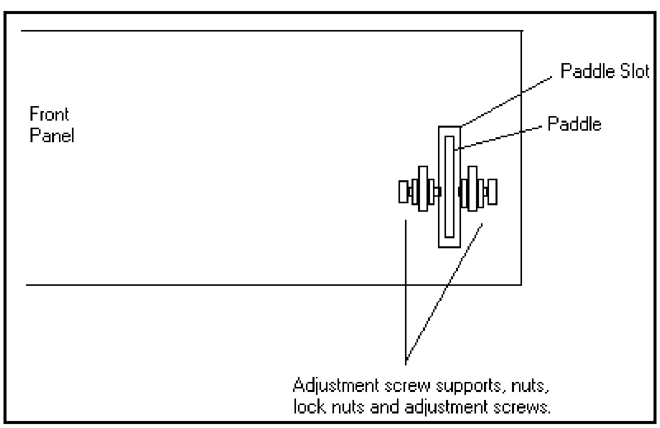
In addition to these PC Board parts, you will need two 4-40 X 1/2" Brass screws, four 4-40 Brass nuts, and one 4-40 X 1" Brass screw to help with the installation of the Adjustment Screw Supports



From overhead, the single paddle installation looks like this.

From the front, without the front panel, the single paddle installation looks like this.





With the front panel installation shown, the single paddle setup looks like this.

All of the parts for the keyer paddles, either single or double, are made from double-sided PC Board. First, draw the individual parts for the paddle setup you desire on a piece of PC Board.

Leave the Paddle Stand-off Mount or Mounts about a 1/16" wider than the indicated width so that you can file them to final dimension during the installation process. This will help ensure that each paddle ends up pretty well centered in the slot cut for it in the front panel of the PC Board enclosure. For my single paddle setup, I cut a vertical slot 1/8" wide and 1" tall, centered 1/2" from the right edge, and placed below center, vertically, because I installed the main power toggle switch directly above it. The exact slot placement depends on the layout of your particular rig.

Drill all the holes in the pieces before sawing the parts from the board. I ended up with a hole about a quarter of an inch in diameter for the paddle tension adjustment, but I suggest you start with a smaller size and use a tapered reamer (Radio Shack) for enlarging it after the paddle is cut from the board and shaped. You could place about a half-inch (the length of the stand-off support) of the narrow end of each paddle into a small bench vise and try the tension, then enlarge the tension adjustment hole a little at a time until you have the desired amount of tension.

Using a Hack Saw, cut the pieces from the board. Round the corners and smooth the edges of the pieces with a file.

For the single paddle setup, the copper foil is cut in two places on each side of the paddle. This can be done with either the edge of a small file or with a Hack Saw. Cut just enough to be sure you have separated the copper foil nicely. What you are doing is creating the switch contact pads for the Dit and Dah sides of the paddle. It is necessary to cut the foil in two places on each side of the paddle, as shown in the drawings, so that static electricity and other stray electrical currents from your skin won't cause erratic keying. For the double paddle setup, the cuts are made just on one side of each paddle.

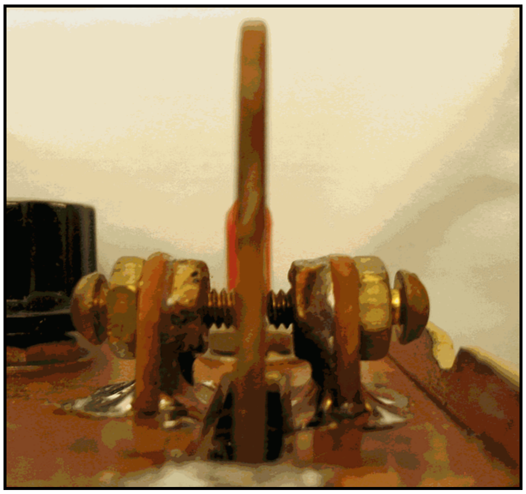
For the single paddle setup, solder one 4-40 brass nut to one side of each of the adjustment screw supports, in order to provide the threads for the screws to fit into. You could simply drill and tap (with a 4-40 tap available at any hardware store) the PC board material and use just the lock nuts. However, in the interest of strength and durability, I recommend soldering a nut to each support. For the double paddle setup, one 4-40 brass nut is soldered to the outside of each paddle for the adjustment screws to fit into.

The Single Paddle Assembly Procedure

First, cut the slot, in the appropriate location for your layout, in the front panel. I did it by drilling a series of 1/8" holes in a vertical line, and then using a small, flat file to shape the slot by removing the material left between the holes.

Then, solder a brass nut to one side of each of the two adjustment screw supports. A small, wooden board with a hole in it, laid on your work table, is useful here. Screw a brass screw into a nut and place the end of the screw through the hole in the support and into the hole in the board. This will place the nut against the support with the screw centered in the clearance hole. Solder the nut to the support, let it cool, and remove the screw from the nut. Repeat with the other support.

Position the rig so that the front panel is facing up, and is horizontal. Then, position the two adjustment screw supports on the front panel, and solder them into place. The trick to positioning them is to screw a one inch long 4-40 brass screw through both supports, leaving about 3/8" between the two soldered-on nuts, which should be on the inside of each support, facing each other. This can be visualized in the photo below.

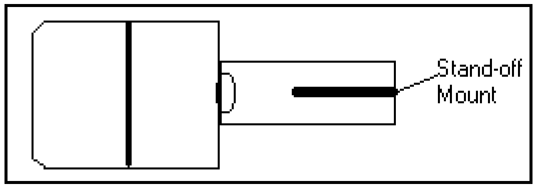


Use the slot as a guide for placing the adjustment screw supports, as the supports should be on opposite sides of the slot, each one an equal distance from the slot, and centered vertically in relation to the slot. The two supports should be far enough from the slot so that a good, strong bead of solder can be run along the inner joint of the support and the front panel. At this stage in the construction, the paddle itself will not be in place, not as depicted in the photo above, but will be added later.
First, tack-solder each side of the two supports. This will ensure that they don't move during the soldering process. Then run a good bead of solder along the lower edge of each support.

Once the pieces are tack soldered and you want to run a bead of solder between the two surfaces, which are at 90 degree angles, the trick is to prop the unit up so that the two surfaces form a V, with the apex at the bottom and the two sides about 45 degrees from the vertical. This way, the melted solder will run quite nicely along both sides of the joint, and form a very strong and nice looking connection.

Next, remove the one inch screw from the adjustment screw supports, install the two lock nuts, one on each adjustment screw, running the lock nuts right up to the screw heads, and screw the adjustment screws into their respective supports. Leave a space between the two screws equal to the width of the slot.

Then, lay the paddle flat on your work table and position the standoff mount so that its long side is centered in the narrow end of the paddle and the standoff is vertical in relation to the paddle, as pictured below.

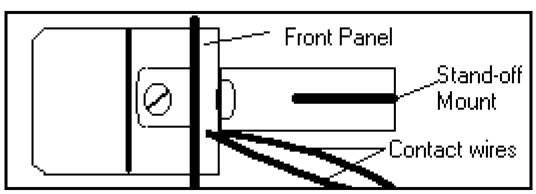


Tack-solder one side of the stand-off mount to the paddle, check to see if it is still vertical, 90 degrees to the paddle, tack-solder the other side, then run a good bead of solder along both sides.

Now slip the finger end of the paddle through the slot in the front panel, from the rear, with the standoff mount towards the near wall of the enclosure. Check to see how much material needs to be removed from the standoff support in order to center the paddle in the slot.

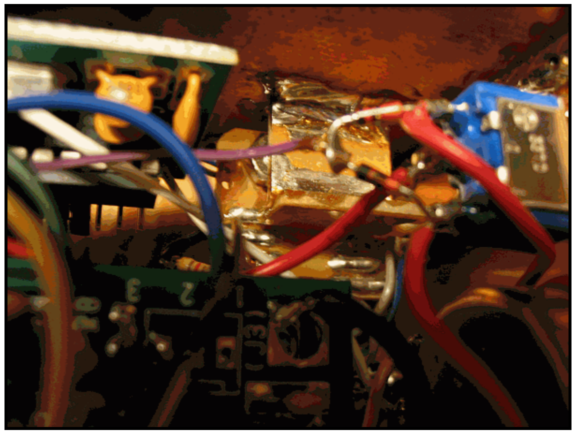
Remove the paddle and file material from the standoff support. File a little at a time and try the paddle, then remove a little more. It is pretty hard to put material back on once you have filed it off, so take your time.

Once you are satisfied with the amount of material removed from the standoff support, solder the two wires for the Dit and Dah switch contacts from your keyer to the back edge of each switch contact on the paddle, as shown in the drawing below. Most right-handers would want the Dit wire connected to the right side of the paddle and the Dah wire connected to the left side, as this would provide for sending Dits with the thumb, and Dahs with the fingers.



Then slide the paddle in through the slot from the rear until the solder joints attaching the contact wires to the paddle are just clear of the back of the front panel and the file cuts separating the switch pads from the touched portion of the paddle are just outside the adjustment screw supports, as shown in the drawing above.

Position the standoff mount against the side of the enclosure and hold the paddle assembly in place. Screw the adjustment screws in until they are both against the paddle and the paddle itself is centered in the slot. Check to see that the paddle is parallel to the slot, and is parallel to the bottom of the enclosure. Tack-solder one side of the standoff mount to the enclosure, re-check the positioning and alignment of the paddle and tack-solder the other side of the standoff mount. Then, run a good bead of solder along both sides of the standoff mount.



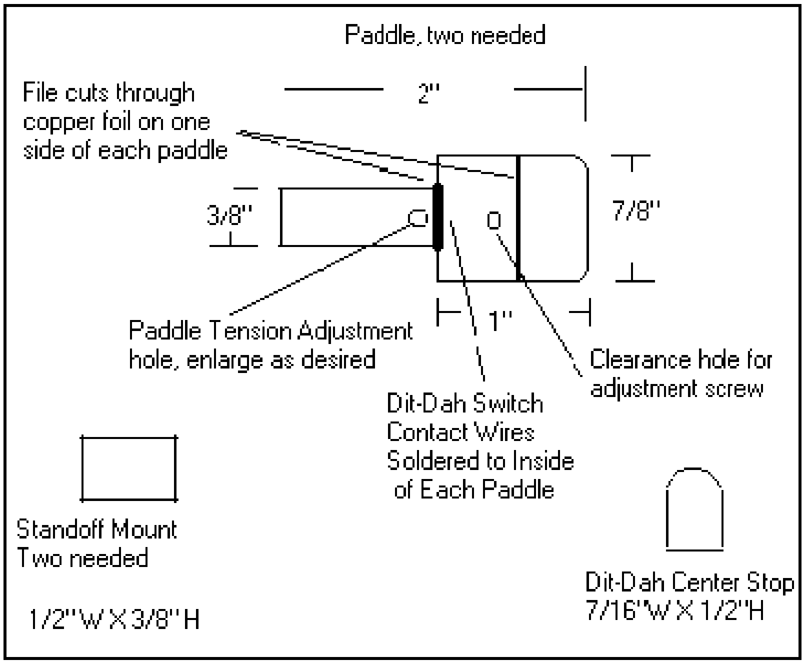
The Finished Paddle Standoff and Paddle Installation can be seen below the power switch here

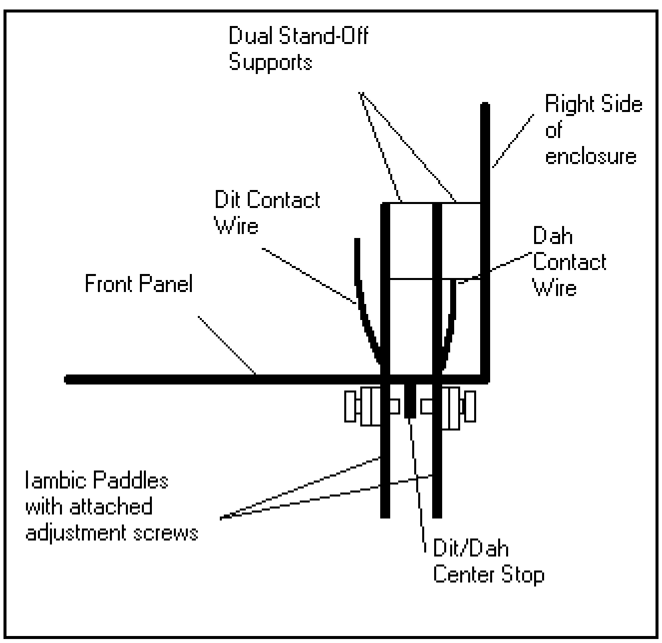
Now, loosen the two adjustment screws slightly and adjust them for whatever switch gap feels good to you. Tighten the lock nuts to maintain that gap. That's all there is to it for the single paddle setup.

Finished Single Paddle Installation

DOUBLE PADDLE CONSTRUCTION

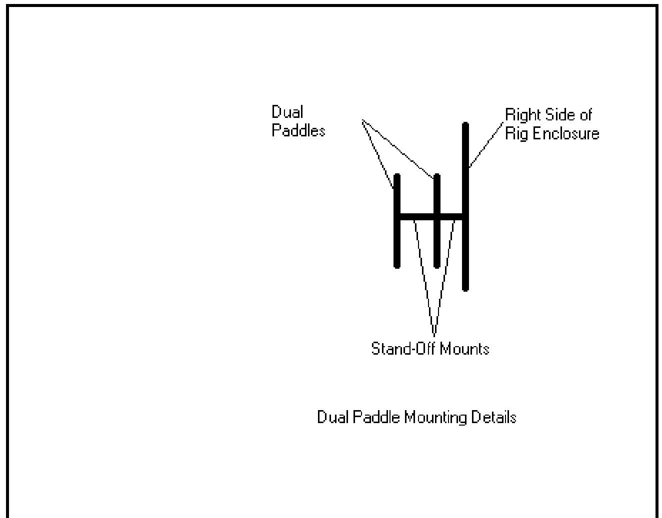
In addition to these PC Board parts, you will need two 4-40 X 1/2" Brass screws, and four 4-40 Brass nuts.

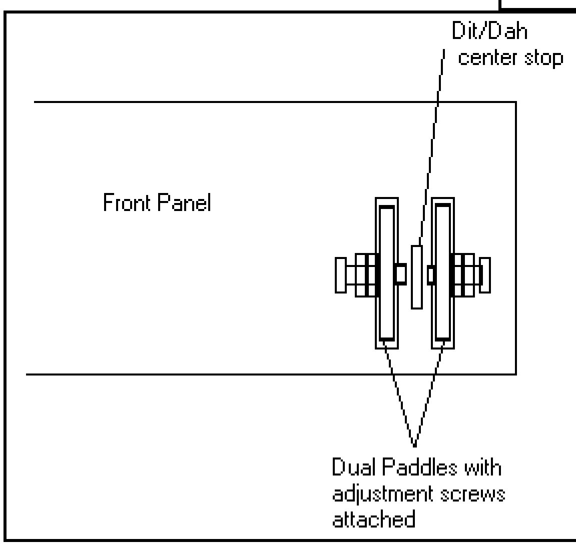




From overhead, the dual paddle installation looks like this.

Front view of dual paddle installation without front panel.





The dual paddle setup looks like this with the front panel installation complete.

Cut the two slots in the front panel of the enclosure in the locations you desire. The actual spacing of the paddles in terms of the distance from the near enclosure wall and the distance between paddles is up to you, depending on your layout and the paddle spacing you desire.

Then, draw the parts on the PC Board. Drill the holes before sawing out the parts, just as we did for the single paddle setup. Make the tension adjustment holes in the two paddles smaller to begin with, about 1/8", and enlarge them as desired after the parts are cut out. For the double paddle setup, you need adjustment screw clearance holes and tension adjustment holes in each paddle.

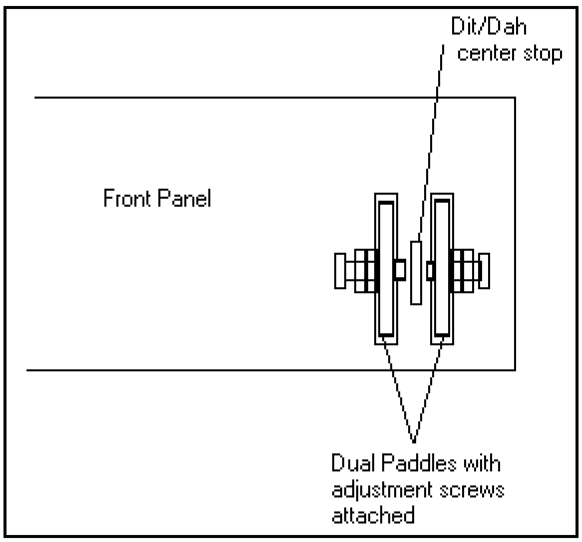
Make the two standoff Mounts wider than specified initially, so they can be filed to finished dimensions to match the spacing of your two slots in the front panel. The standoff mount which goes between the wall of the enclosure and the nearest paddle is made initially just wider than the distance from the wall to the center of the closest slot. The standoff mount that goes between the two paddles is made initially just wider than the distance between the centers of the two slots.

Although a dimension is specified in the drawing for double paddle parts, the actual distance between paddles and the distance between the paddles and the enclosure wall is up to you and the standoff mounts are made accordingly.

Saw out the parts with the Hack Saw, smooth the edges with the file, and make the two switch pad cuts on one side only of each paddle. This will now be the inside of each paddle. Make your adjustments to the size of the tension adjustment holes in the two paddles. Try to get the tension as close to the same in the two paddles as possible.

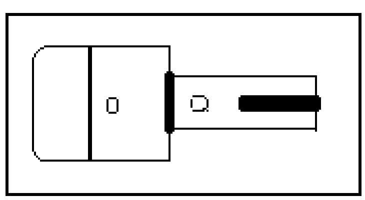
Position the rig so that the front panel of the enclosure is up, and is horizontal with your work table surface.

Position the Dit/Dah Center Stop between the two slots, parallel to the slots and centered between them, perpendicular to the surface of the front panel. See the drawing of the double paddle setup, below, for further clarification if needed.



Tack solder one side of the Center Stop, check its position, and tack solder the other side. Then, run a good bead of solder along both sides of the Center Stop, making a good, strong joint with the front panel.

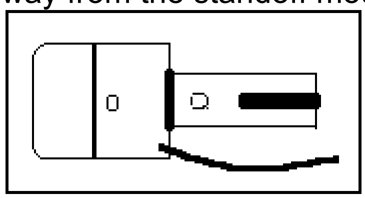
Now, lay one paddle flat on your work table, with the switch pad file cuts UP, and position one standoff mount centered in the narrow end of the paddle, perpendicular to its surface, as pictured below.



Tack-solder one side of the standoff mount to the paddle, check its position, and tack-solder the other side to the paddle. Then run a good bead of solder along both sides of the joint.

Now slip the finger end of the paddle through the slot in the front panel closest to the side wall of the enclosure, from the rear, with the standoff mount towards the near wall of the enclosure. Check to see how much material needs to be removed from the standoff support in order to center the paddle in the slot. Remove the paddle and file material from the standoff support. File a little at a time and try the paddle, then remove a little more. Since you cannot put material back on, once you have filed it off, take your time.

Once you are satisfied with the spacing of the paddle in the slot, solder either the Dit or Dah contact wire from your keyer to the back edge of the switch pad, just in front of the tension adjustment hole in the paddle. The selection of Dit or Dah wire will depend on how you want the paddles set up. For most right-handers, this would be the Dah contact. Remember, the switch pad is on the paddle side away from the standoff mount.

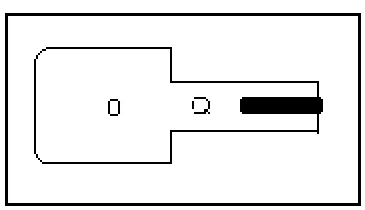


Contact wire connected to switch pad on same side of paddle as standoff

Then slide the paddle in through the slot from the rear until the solder joint attaching the contact wire to the paddle is just clear of the back of the front panel, and the file cut separating the switch pad from the portion of the paddle that is touched by your fingers is just even with the outermost edge of the Dit/Dah Center Stop. There needs to be enough space between the clearance hole for the adjustment screw and the front panel so that when you solder a 4-40 nut in that location it will clear the front panel.

Position the standoff mount against the side of the enclosure and hold the paddle assembly in place. Check to see that the paddle is centered in the slot, that the paddle is parallel to the slot, and is parallel to the bottom of the enclosure. Tack-solder one side of the standoff mount to the enclosure, re-check the positioning and alignment of the paddle, and tack-solder the other side of the standoff mount. Then, run a good bead of solder along both sides of the standoff mount.

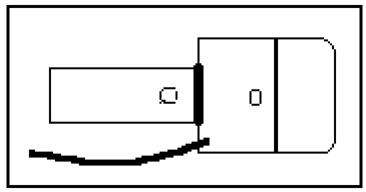
Now, lay the other paddle flat on your work surface, with the switch pad file cuts DOWN and position the other standoff mount as you did with the first paddle, and as pictured below.



Tack-solder one side of the standoff mount to the paddle, check its position, and tack-solder the other side to the paddle. Then run a good bead of solder along both sides of the joint.

Slip the finger end of the second paddle through its slot in the front panel, from the rear, with the standoff mount towards the first paddle. Hold the second paddle's standoff mount against the first paddle and check to see how much material needs to be removed from the standoff support in order to center the second paddle in the slot. Remove the paddle and file material from the standoff support. File a little at a time and try the paddle, then remove a little more. Pretty hard to put material back on once you have filed it off, so take your time.

Once you are satisfied with the spacing of the paddle in the slot, solder the other contact wire from your keyer to the back edge of the switch pad, just in front of the tension adjustment hole in the paddle. If you are right handed, this will be the Dit contact.

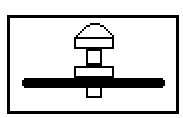


Contact wire connected to opposite side of paddle from standoff

Then slide the paddle in through the slot from the rear until the solder joint attaching the contact wire to the paddle is just clear of the back of the front panel, and the file cut separating the switch pad from the touched portion of the paddle are just even with the outermost edge of the Dit/Dah Center Stop. As with the first paddle, there should be enough distance between the clearance hole for the adjustment screw and the front panel so that when you solder a 4-40 nut in that location it will clear the front panel. Also, the outer end of the second paddle should be even with the outer edge of the first paddle.

Position the standoff mount against the first paddle and hold the paddle assembly in place. Check to see that the paddle is centered in the slot, that the paddle is parallel to the slot, and is parallel to the bottom of the enclosure. Tack-solder one side of the stand-off mount to the first paddle, re-check the positioning and alignment of the paddle, and tack-solder the other side of the stand-off mount. Then, run a good bead of solder along both sides of the standoff mount to form a good, strong joint between it and the first paddle.
Now screw two brass nuts onto an adjustment screw, running one of the two right up against the head of the screw and positioning the other nut about 3/16" from the end of the screw. Install two nuts on the other adjustment screw in the same fashion.

Turn the rig onto one side, so that the paddles are horizontal, parallel to your work surface. Place one adjustment screw assembly into the clearance hole in the upper paddle as pictured below, and solder the lower nut to the paddle.



Turn the rig over so that the other paddle is up and horizontal, parallel with your work surface. Place the other adjustment screw assembly in position, and solder its lower nut into place on the paddle. Once both adjustment screw assemblies have cooled, adjust the spacing for the

Dit and Dah contacts with the adjustment screws, and, when you are happy with the spacing for each, tighten the lock nuts.

Whether you like the single or double paddle version, you can build a very nice keyer paddle right into your rig. Best of all, it can be modified to fit into whatever rig you want, and can be built to suit you, in either style. Of course, there is a bit of work involved, so there is certainly nothing wrong with leaving the built-in paddle construction off the project, and using another type of paddle.

OPERATIONAL CONSIDERATIONS

Before powering the rig up, for whichever band is desired, set the two band switches to the appropriate band. As long as you don't transmit, it hurts nothing to power up one board when the band switches are set for the other. Even if the rig is inadvertently keyed, nothing bad should happen, as the power amplifier transistors on both boards are protected by the Zener diode connected from their Collectors to ground. However, the best procedure is to select the desired band with the two band switches first, then power up the appropriate board with the main power switch.

When the rig comes on, you will hear the beeps from the Tick keyer indicating that it is on, and a CW "A" from the Freq Mite. If you press the Freq switch right after that, the Freq Mite will send its announcements in the faster of its two CW announcement speeds. If you don't press the Freq switch within two seconds, it sends the announcements in its slower speed. Depending on whether you have used the Tick keyer chip that has mode and speed memory built in, you will need to program it for your desired sending speed.

Use a good quality pot as a fine-tuning control. A poor quality pot used in that location will cause erratic movement of the frequency when the fine-tuning knob is adjusted. If you choose not to modify the SW boards so as to provide expanded frequency coverage, as outlined by Dennis Monticelli, AE6C, and Mitchell Lee, KB6FPW, in their treatise in QRP Power on tweaking the SW series boards, you really don't need a fine-tune control. With the normal 40 Khz of coverage with the SW series boards the rate of tuning is fairly slow and it is easy to fine-tune a signal with the main tuning knob.

However, in this case, the tuning range was extended to 63 KHz in the SW-40+ board, by changing C-8 to 150 pf, and to 98 KHz in the SW-20+ board, by changing C-8 to 56 pf, and the fine-tuning control is a nice addition. After the C-8 changes, the value of C-7 on both boards was adjusted so as to set the lower edge of the tuning range just above the bottom of the band.

In practice, the dual VFO tune controls are wonderful for tail-ending QSOs, parking one "VFO" on that frequency, switching to the other and doing a band search for other QSOs as desired, while switching back to the first one from time to time so as to know when that QSO is ending and you can make your call.

CONCLUSIONS

Today, there are a few multiband QRP rigs on the market that cover as many as four, or even five bands. However, their prices may well make the choice of building a two-band rig, such as this one, from a pair of reasonably priced board kits, very attractive.

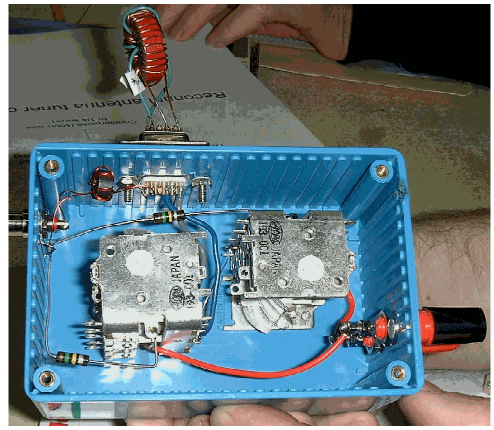
Obviously, the choice of bands is up to the builder, and this switching and control scheme can be used with any pair of board kits that use pots and varicaps for VFO tuning. The result, in this case, was very much worth the effort, and well worth duplicating, at a total price much less than those of the presently available multi-band rigs. Give this approach a try.

Wayne McFee, NB6M may be reached by mail at 2379 Saint George Drive, Concord, California 94520, or by email at NB6M@aol.com

Phil DeCaire, WB7AEI

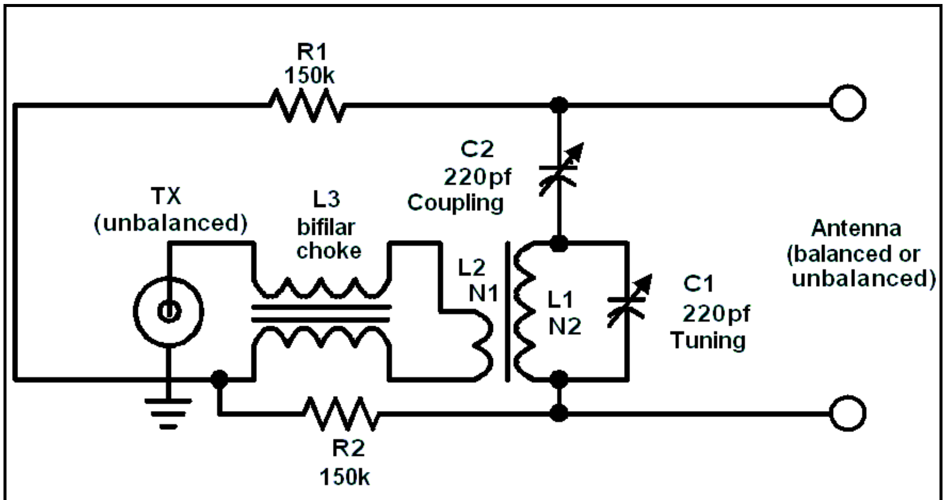
A Versatile QRP Antenna Tuner

Need a tuner? How about one that will handle a wide range of impedances including EFHWAs (end-fed half-wave antennas)? How about one that will handle balanced lines?



I first stumbled onto this tuner in the pages of "QRP Classics", in an article written by Doug DeMaw and originally published in September 1988 QST. I needed a tuner, tossed this circuit on a breadboard, and used it on the air in that form for a year, finally building one in permanent form. It doesn't seem to be a commonly used circuit, but there are several unique characteristics that make it very flexible. I've used it in my shack as a general purpose tuner for at least half a dozen years, and it has always tuned everything I needed it to, including balanced lines. Just recently I got interested in EFHWAs, which require a specialized tuner, and once again this tuner filled the bill.

This is a simple project that could be built in an afternoon. For QRP use you can make it light and small. For high power use, large coils and wide-spaced capacitors would be required. Here's the schematic of the "deluxe" version.



Resonant antenna tuner circuit

Description:

You can see that it is pretty simple - really just a tuned circuit with a coupling link to the transmitter. L1 and C1 resonate at the operating frequency, which provides some additional system selectivity on both transmit and receive. The transmitter is coupled to the tuned circuit by the L2 link winding. The 50-ohm impedance at the rig is jumped up by the square of the turns ratio (N2/N1) to appear as hundreds or thousands of ohms across the tuned circuit. The real magic comes from the variable coupling capacitor C2 in series with the load, which allows matching a load impedance lower than or equal to the transformed 50 ohms. We can make the tuned circuit impedance anything we want so that it works with our particular antennas and bands.

With the link coupling, the tuned circuit is floating, and balanced line can be connected and tuned. All my antennas, most of them balanced, have been fed with 300-ohm twinlead, and this tuner has worked well. A feedline resonance problem on 15M was fixed by adding a current balun (common mode choke L3) to the unit after the fact. The choke is in the 50-ohm side where it can function best. The final improvement was the addition of "static drain" resistors R1 and R2 from both sides of the tank to the low side of the link to prevent static buildup and possible equipment damage.

I needed a multi-band tuner, but I didn't have such good luck with DeMaw's method of bandswitching by putting a second inductor in parallel with the main inductor. So instead, I mounted a DB-9 female connector on the box to accept plug-in coils. I built a series of plug-in coils for different bands using powdered iron toroid cores. The plug-in coils (with both L1 and L2 wound on them) are soldered to DB-9 male connectors. The coils can be optimized for a particular frequency/ impedance range, and recently I've built some more for EFHWA use.

Both variable capacitors have to be floating for balanced line use, so the unit is built in a small plastic box. Of course, you need to use well insulated knobs on the tuning capacitor shafts! Hand capacitance effects have not been a problem. The air variables are some 5 section AM/FM units, tuning 5 to 220 pF on the biggest section. I've run this tuner on 40-10 meters at QRP power levels and have had no problems with heating, arcing, etc. Binding posts/ banana jacks were used for the antenna connection, and an RCA connector was used for the rig. See the photo at the end of the article.

Design constraints:

Lets look at some of the design constraints and operation. One thing we don't want to do is run an excessively-high Q, since that will burn more power in the tuner and make adjustment really touchy. As an upper bound, we probably don't want to exceed a loaded Q of about 20. The loss of a single tuned circuit is given by the ratio of the loaded to unloaded Q's.

Assuming an unloaded Q of 100 (limited primarily by the inductor) and a loaded Q of 20, the insertion loss is nearly 2 dB. A loaded Q of 10 gives a loss of slightly less than 1 dB. Its worth noting that any tuner more complicated than an L network, which by definition is a minimum

Q matching network, can have this same problem of excessive operating Q and losses. That's one reason why tuners don't have unlimited matching range, and it's a good reason to customize your tuner for your particular antenna (or conversely optimize your antenna system for your tuner!).

The tuner will tune out some amount of reactance on the line. A capacitive impedance will require less tuner capacitance, while an inductive impedance will require more tuner capacitance to reach resonance. If the reactance is beyond the limits of the variable tuning capacitor to compensate, then the inductor value will have to be adjusted. That can be done later in the process.

To design this tuner, you need to pick the frequency, midrange capacitance value, and a maximum impedance value for matching. You can guess if you do not know, and then modify the coil as necessary after building it to make it work. Say you decide on 1250 ohms, which is about a 4:1 VSWR on a 300-ohm line. That gives an impedance ratio of 25:1 (1250/50) and a turns ratio N2/N1 of 5:1 (the square root of 25). Lets say the capacitor midrange value is about 100 pF, and that we're building it for 40 meters.

We do not want the loaded Q to be greater than 20. This means XL and XC can't be less than 1250/20 or 63 ohms, and the minimum inductance is about 1.9 uh. The capacitor reactance (100 pF at 7 MHz) is 227 ohms, so the loaded Q will be around 5.5, giving a loss of only ½ dB. The inductance required to resonate at 7 MHz is 5.2 µH.

Now comes the hard part – finding compromise inductor values that will work. Lets say we have some T50-2 cores and want to use those. The core AL is 49. 32 turns gives us 5.02 uH but requires a 6.4 turn link which we can't do (whole numbers only!). We could go with 32 turns and a 6 turn link, which gives us an impedance ratio of 28.4 instead of 25. Or we could drop the turns to 30, which gives 4.41 uH, still comfortably larger than the minimum required 1.9 µH, and use 6 link turns. Either way should work in most cases. So we wind the coil and hook it all together.

Operation and coil optimization:

In most cases the tuner should work fine as built. You should be able to adjust the two variable capacitors to get a 1:1 VSWR. Start by adjusting the tuning (C1) for minimum reflected power, and then adjust the coupling (C2) for minimum reflected power. You can also peak the tuner on received signals and noise before transmitting. You'll have to go back and forth and adjust both C1 and C2 several times for minimum reflected power, like most tuners.

Once you've figured out the settings, you can mark them on a label or make up a chart with settings for different bands.

If you can't reach a 1:1 or just barely get there, adjustments are needed to optimize the tuner for your particular situation. Here are the guidelines for adjustments to the basic values.

1. Minimum VSWR with tuning capacitor set at maximum: More inductance is needed, rewind toroid L1 with more turns.
2. Minimum VSWR with tuning capacitor set at minimum: Less inductance is needed, remove some turns from L1.
3. Minimum VSWR with coupling capacitor set at maximum value: Higher resonant impedance needed, reduce L2 link turns.
4. Minimum VSWR with coupling capacitor set near minimum value: Lower resonant impedance needed, increase L2 link turns.

My general purpose inductors all use T68-10 cores (that's what I had at the time) with inductance values between 5.2 uH (41 turns, 40M) and 0.9 uH (17 turns, 10 & 15M). Turns ratios are in the 4:1 to 7:1 range, giving tank impedances in the 900- to 2330-ohm range.

For EFHWA use the impedances and inductances are higher. A 10:1 turns ratio gives 5000 ohms resonant circuit impedance. My 20 meter coil is 20 turns on a T94-2 (3.4 uH) with a 2 turn link. This gives a loaded Q of about 17 and tunes with 38 pF nominal capacitance. My 40M EFHWA coil has 30 turns on a T94-2 with a 3 turn link. Both tune EFHWAs very well and allow adjustment down to 1:1 without changing link windings or coil taps, as must be done with some EFHWA tuners. Make sure the EFHWA is connected to the variable coupling capacitor, and connect a counterpoise wire to the "low" side of the tuner. The counterpoise usually needs not be more than 5-to-10 feet of wire, although a ¼ wave wire is theoretically best.

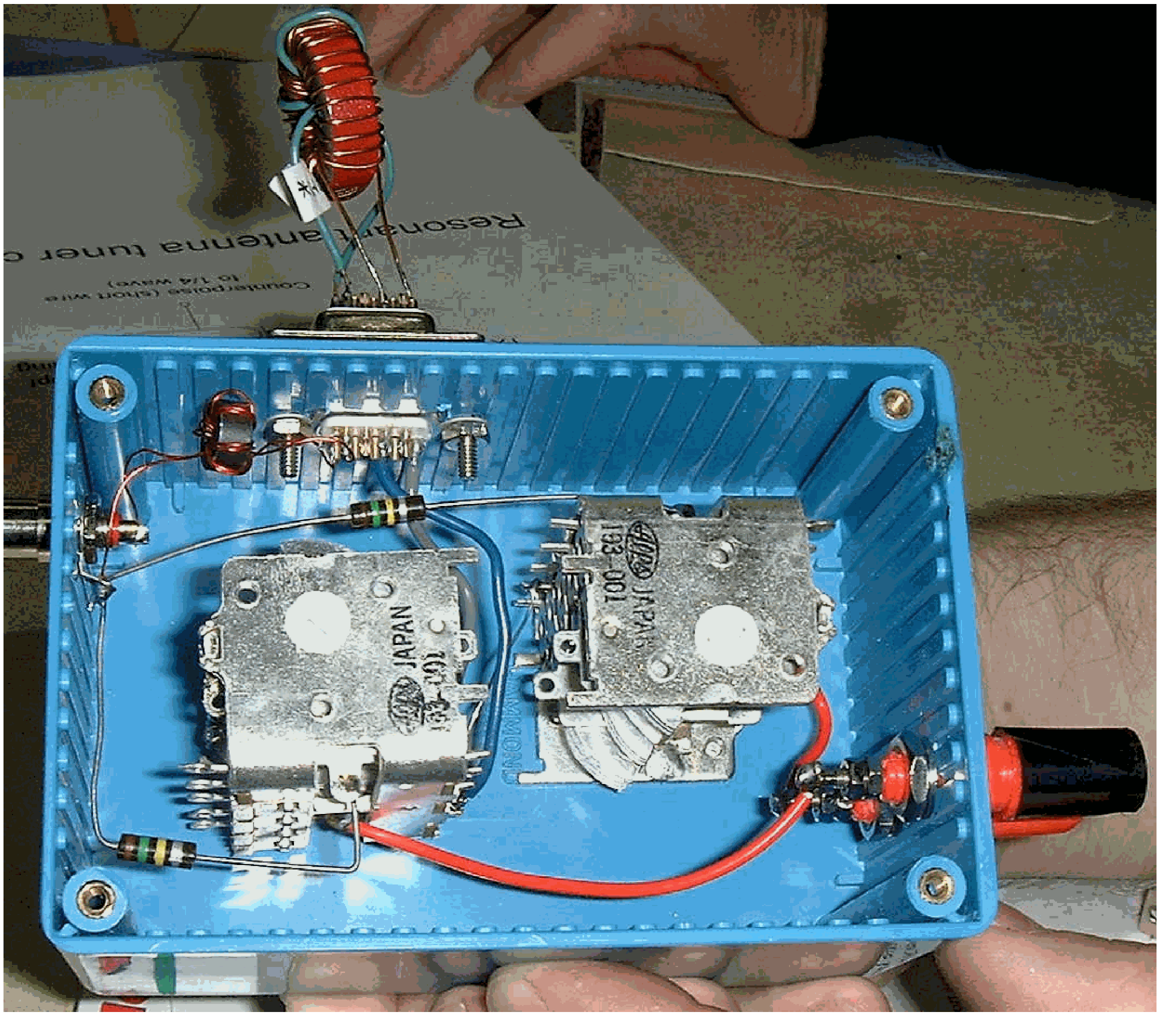
Of course, you want to maximize inductor Q. Use the largest wire size that allows you to get the right number of turns on the core. My coils all use #22 enameled wire except for the 40M coil where #26 is used so the turns will fit. I use plastic insulated solid hookup wire to wind the links, and I spread the link coils out across the middle of the winding rather than bunching them up at an end in order to improve balance.

The current balun (L3) is just a bifilar winding of 7 turns on an FB43-2401 ferrite core – about the same as an FT37-43 core. That gives about 25 uH inductance for any unbalanced currents. I have seen conditions where that choke got warm with higher power, but the main inductor should never get warm at QRP power levels.

The R1 and R2 static drain resistors were added to drain off storm induced static on the antenna. I've seen thousands of volts develop on my low wire antennas! I used 150K resistors because I had a bunch of old parts with nice long leads. Anything from 100K up should work fine.

Tune away!

Phil DeCaire, WB7AEI can be reached by email at pedecaire@email.msn.com.



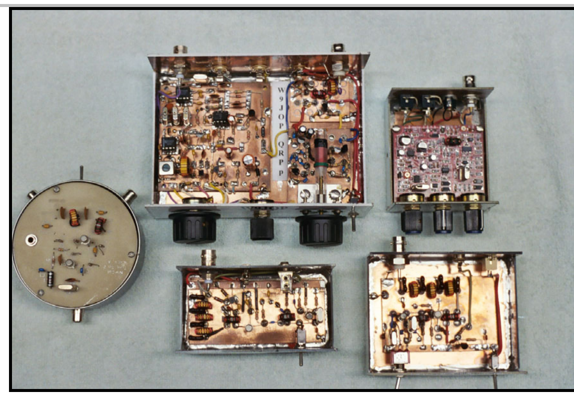
Resonant Antenna Tuner used at WB7AEI. The plug-in coil is visible on top with its DB9 connectors. Antenna connections are the binding posts on the right. The rig connection is the RCA jack on the left. The current balun is the small toroid to the left of the DB9 connector. As you can see, there really isn't very much here!

AmQRP.ORG HOMEBREWER

Robert H. Chapman, W9JOP

Worked All States … on Tuna Tins!

W.A.S. awards received from ARRL and QRP ARCI using only the little Tuna Tin II QRP transmitters … what an achievement!



In September of 1995, we sold our home in Indiana, including the ham station. We moved to Virginia, thus putting us off-the-air for quite a while. After SWL'ing got the best of me, decided to build a Tuna Tin II, just as a "fun project", and the story starts from there.

I ordered the "can" from George N2APB in March of 2000. I assembled the rig, and it worked right from the start. 350 mW is the word that I was spreading, which turned out to be a little high. I built a G5RV antenna, strung it up between a couple of trees, with the center being at 50ft and ends a bit higher, and added a MFJ coupler "to keep the little rig happy".

My first contact was with Glen, N8WE, who was also running a Tuna Tin. Of course, my Tin is crystal-controlled on 7043 kHz.

February 28, 2001:

Being stuck on 7043 kHz was a drag. So next came the SMK-1, a surface mount kit from Norcal QRP Club. This was an introduction to SMT technology. The rig is on 7039 kHz +/- 500 Hz, running 220 mW. Now we have TWO frequenciess, plus a bit of 'wiggle room' of 500 Hz, or so. Then I began to receive those little chuckles, "what are you doing on this frequency? You're supposed to be on 7043".

March 22, 2002

There must be QRPp on another band. Again, the Tuna came to mind, so I changed the circuit and filter to put one on 20 meters. So now I'm running 250 mW and rock-bound on 14060 kHz. This rig worked so well that I added another one – this time for 20/30 meters: 14062 and 10114 kHz, using the same power, thus doubling our capability on 20. The 14060 rig was used to snag KH6U and WL7WH. Working KH6 land was exciting and now have four of them in the log.

June 1, 2003

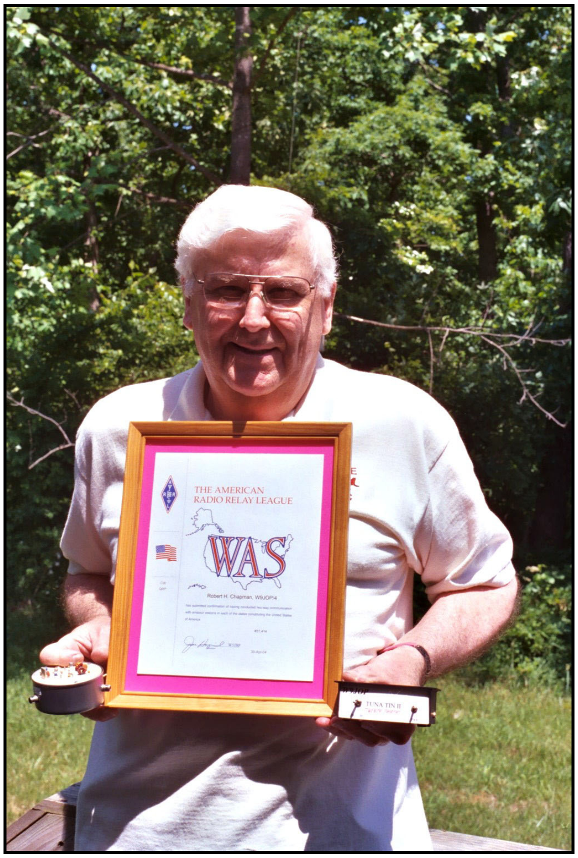
Crystals, crystals – gotta get away from them! Why not try a Tuna Tin with VFO? Well, we purchased the Sidekick receiver kit and VFO/PTO kit; scrounged up enough parts to build "half-a-Tuna", and incorporated all of this into a pc board enclosure. I named it the "SIDEKICK-N-TUNA", which we are now using on 40 meters. I have sort of become known as the "terror of 40"! The SideKick-n-Tuna runs150 mW, thus the half-tuna. The receiver covers 40 kHz (you pick the coverage), while the VFO covers the entire band, +/- a little.

I earned the W.A.S. QRP ARCI Award, # 518, (250mw, CW, mixed band), Dated April 19, 2004.

Next I received the ARRL, W.A.S., Certificate, # 51,414, CW - QRP. This one was accomplished with "TUNA TINS only": 48 States with the 40m "Can", and the remaining KH6U and WL7WH with the 20m Tin @ 250 mW into a G5RV @ 50ft.

Yes, the Tuna Tins will chase DX … 32 countries, and 48 VE's !

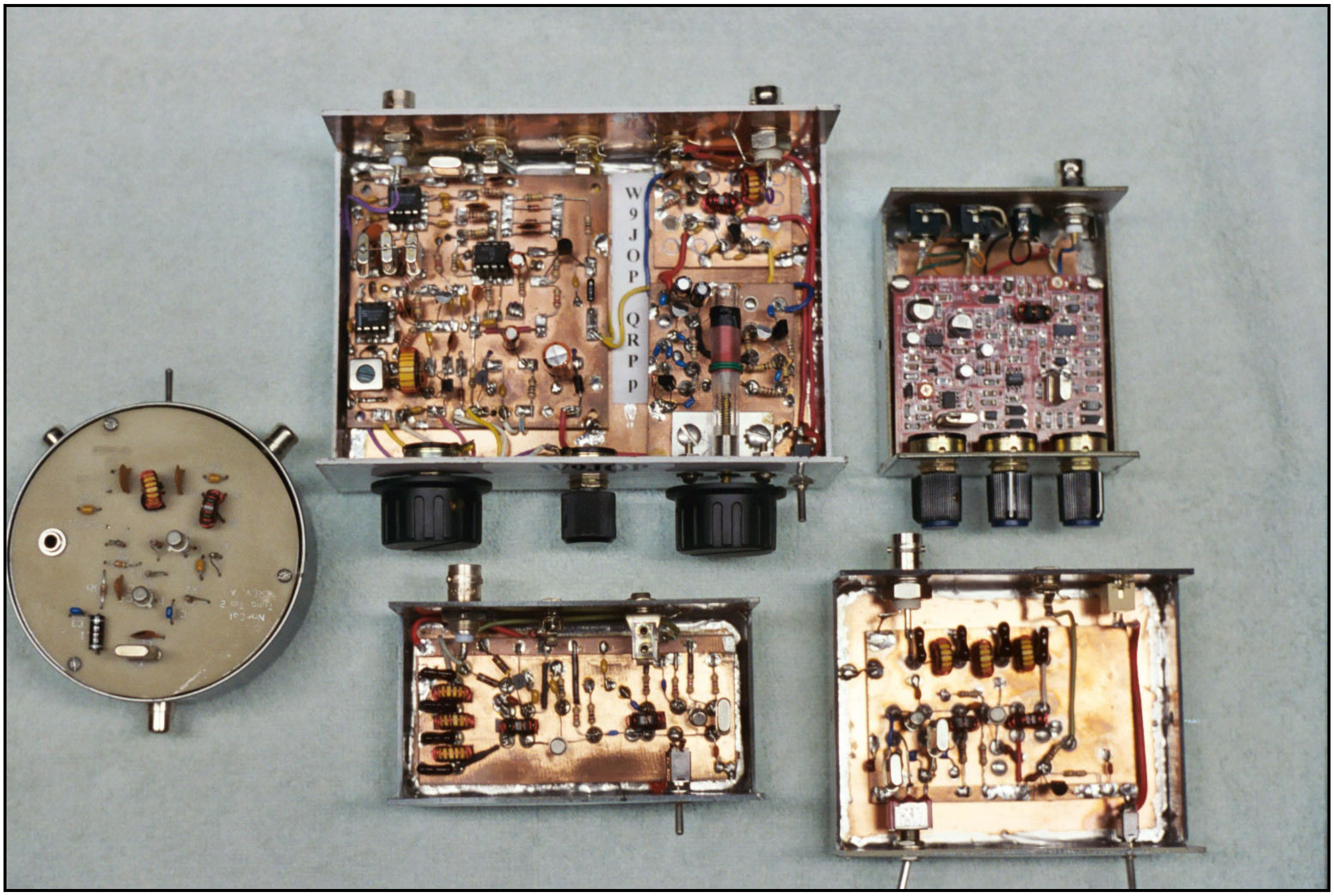
Before venturing into QRPp, we were active on the RS-12 satellite, earning a W.A.S. on that bird. Also played around with DX and came away with a DXCC HONOR ROLL, with power ranging from 30 to 100 Watts using assorted wire ants, TA33, verticals, etc.



At age 71, been hamming for 50 years. Don't know, perhaps "milli-watts next"!

72, and thanks to the fellows with the "keen ears" for answering my calls.

Bob W9JOP/4 QRPp   *rhchap@hotmail.com*



Rigs in photo …

- RIGS WITH TOPS REMOVED
- LEFT SIDE: CANNED TUNA TIN II, XTAL 7043 @ 250 MW.
- UPPER LEFT: "SIDEKICK-N-TUNA" (MY NAME FOR IT). RCVR IS ON THE LEFT.
- TUNA TIN XMTR IS IN UPPER RIGHT CORNER, WITH THE VFO/PTO IN LOWER RIGHT.
- CORNER. RCVR COVERS 40 KCS, AND XMTR COVERS ENTIRE 40MTR BAND, @ 150 MW.
- UPPER RIGHT: SMK-1 40 MTR XCVR. XTAL 7039 +/- 500 CYCLES @ 220 MW.
- LOWER LEFT: 20 MTR TUNA TIN, XTAL ON 14062, @ 250 MW.
- LOWER RIGHT: 20/30 MTR TUNA TIN, XTALS ON 14060 AND 10114, @ 250 MW.
- RIGS IN H/B PC BOARD ENCLOSURES.

AmQRP.ORG HOMEBREWER

David Ottenberg, WA2DJN

Surface Mount Diode Check

I came up with the idea of measuring a larger/axial-packaged diode with a digital multi-meter to determine which end was the cathode. Then, by applying the same technique to one of those very small SMT-packaged diodes in the Micro908 kit, I was able to determine proper orientation of the diode on the pc board.

I recently ordered the AmQRP Micro908 antenna analyzer kit. When I received it, I checked the manual and found that there were resistors, capacitors and diodes which were in tiny surface mount packages.

I easily installed the resistors and capacitors but found I could not determine the anode side of the diodes which was indicated with a feint bar marking on one end. So I came up with the idea of using the standard reading that a multi-meter would give for a diode by checking a larger axial diode with my DMM. This technique showed that when the positive probe was on the anode and the negative probe on the cathode, I would get a high-resistance reading. When the probes were reversed I would get no reading at all. Therefore I surmised that my particular DMM supplied a positive voltage on the red/positive lead with respect to the black/negative lead, and this forward-bias condition actually produced a bit of leakage current through the diode-under-test. In this way, when I applied the probes to the small SMT diodes in the kit, I was able to empirically determine their polarity and mount them properly on the Micro908 pc board.

Note 1: In order to more easily probe the tiny diode, I took the DMM's test leads and ground them to a fine point. This allowed them to make good and precise contact with the ends of the diodes.

Note 2: Not all multi-meters provide a positive voltage on the red/positive probe during resistance measurements. You should check your DMM to determine the voltage polarity on the probes and check out a known-polarity diode as I did in order to determine your specific diode polarity-determining technique.

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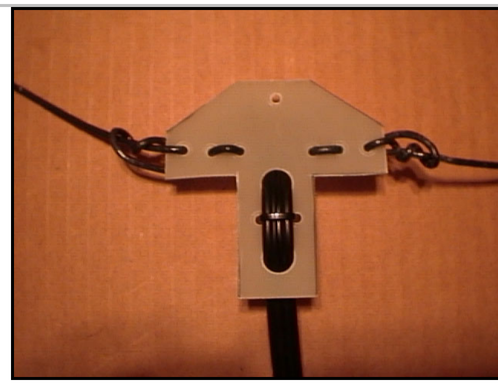
AmQRP.ORG HOMEBREWER

Joe Everhart, N2CX

80m "Squirt Plus" Antenna

This article describes the upgraded design of the Squirt antenna. Emphasis will be made mainly on differences in Squirt Plus construction.



I introduced the Squirt, a reduced size 80-meter antenna, in issue #4 of the NJQRP QRP Homebrewer Magazine in order to get lots of Warblers on the air.

[Note, QHB Magazine is no longer produced, but photos and diagrams of his article "80 Meter Alchemy" may be found in the online QHB Extra! web page at the NJQRP site: http://www.njqrp.org/qhbextra/4/4d.html .]

Made from readily available material, it was a cheap and easy way to get rolling on 80. And, opportunist that we are, NJQRP was able to locate enough material to make a limited number of them available for sale. But all good things end eventually. The original Squirt used light gauge wire for its elements and light-duty 300-ohm feedline for its feedline. The result was fine for a "starter" antenna and relatively inexpensive.

But a number of users expressed a desire for something more durable and with better performance. As it turns out a limited source of higher-grade wire and feedline was uncovered, although at a somewhat higher cost. This article describes the upgraded design, the Squirt Plus. Since Squirt construction was detailed in the earlier article, most common construction information will not be repeated. Emphasis will be made mainly on differences in Squirt Plus construction.

The Plus uses the same design as the original effort in that it is a reduced-size 80-meter dipole using printed circuit board material for its insulators, a so-called "tuned" feeder and the same simple tuner to match the feedline to 50 ohm coaxial cable. Differences are:

1. It uses 14 ga. insulated wire for the dipole elements. This makes it more durable in withstanding exposure to weather and allows it to be installed as a horizontal dipole if desired or as an inverted vee as with the original Squirt.
2. The Plus uses heavy-duty 300-ohm feedline. This feeder with a partial foam dielectric material
   is physically stronger and should offer lower loss than the original feeder.

These changes in material require some differences in design and construction of the center insulator and feedline connector. The remainder of this article will provide a description of Squirt Plus construction differences accompanied by photos and diagrams of the new antenna.

The first difference in the Squirt material is that the center insulator needs larger holes for both the dipole wire elements and the feedline. In summary, the wire element holes are increased in size from 1/16" to 1/8," they are spaced farther apart, the feedline holes increase in size from 3/8" to 7/16" and the spacing of the feedline holes increases to 1 inch.

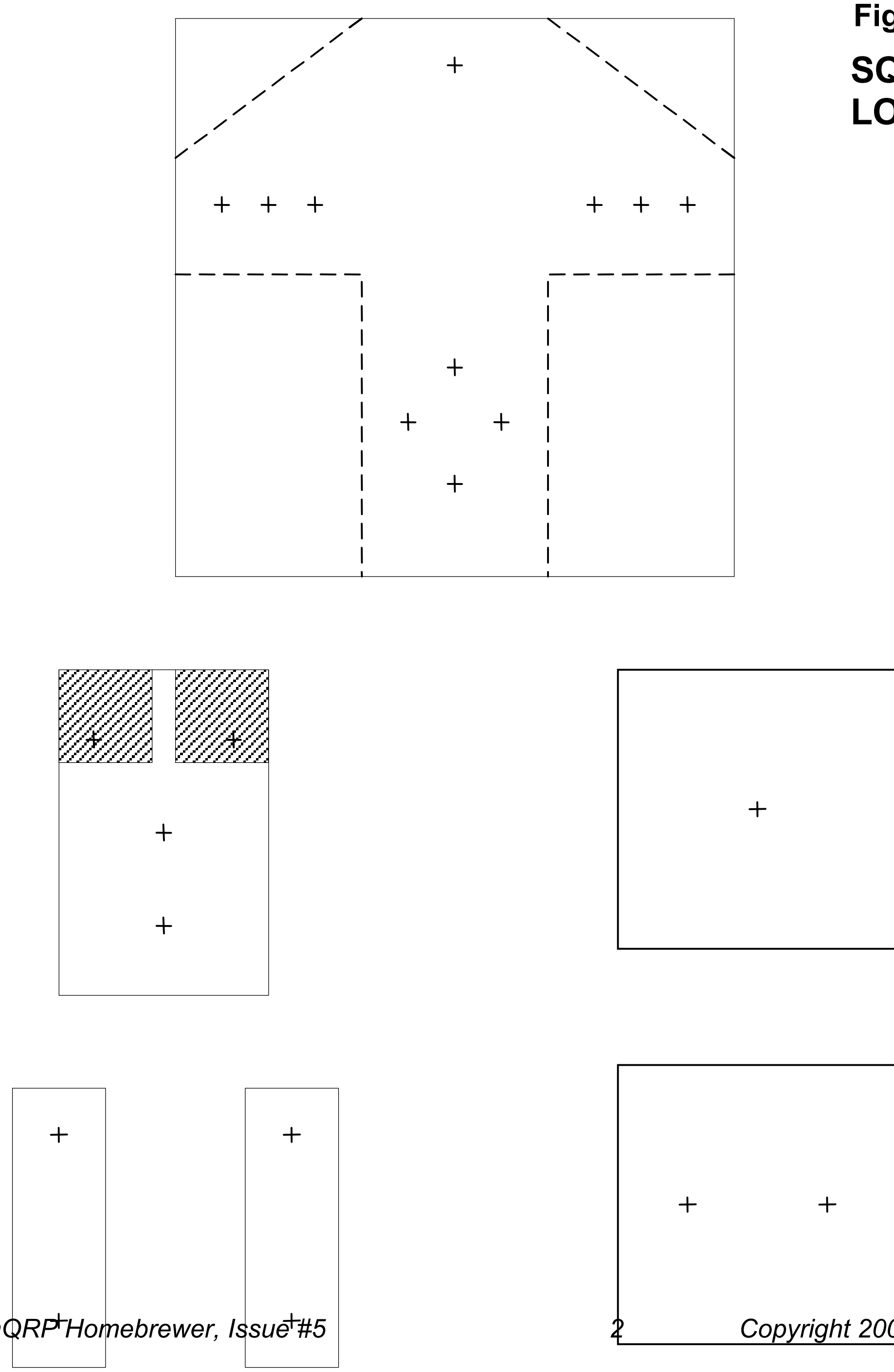
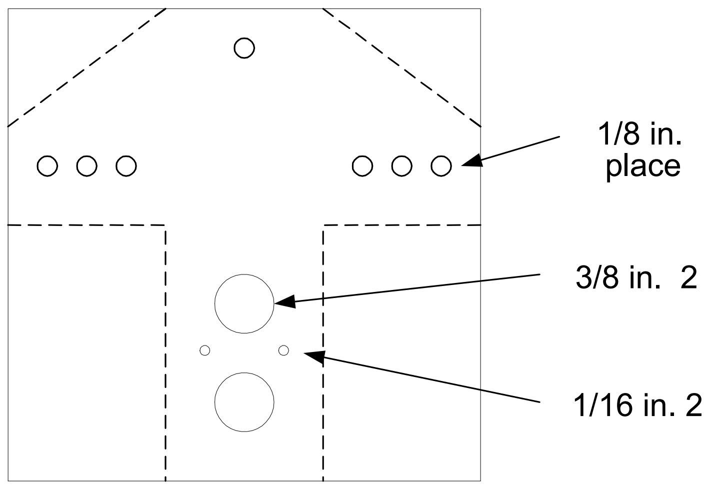


Figure 1a

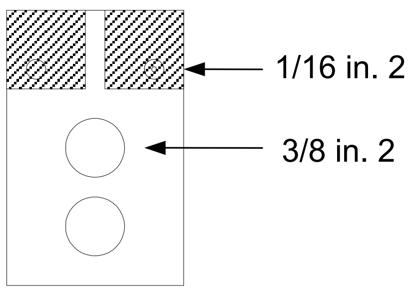
SQUIRT HOLE LOCATION TEMPLATE

Figure 1b

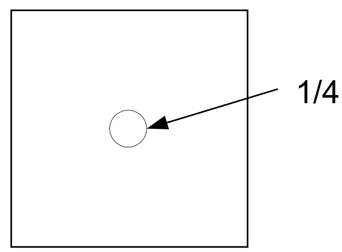
SQUIRT HOLE SIZES



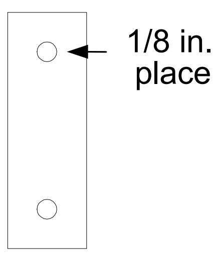
Center



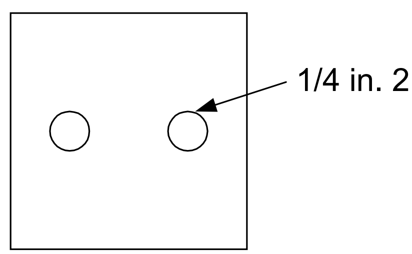
Feedline



Tuner BNC End



End



Tuner Binding post End

The second difference is that the feedline connector needs to have its feedline hole sizes and spacing increased as with the center insulator. And because of the hole changes, the connector size has to be increased to 2-3/4 inches.

These changes are reflected in the template presented in Figure 1, which is reproduced actual size.

The remaining figures in this article document Squirt Plus construction. Figure 2 shows the 3x3 inch piece of pc board material that will be used for the center insulator along with the partially cut-out center insulator template. In Figure 3, the template is shown fully cut out and attached to the pc board material.

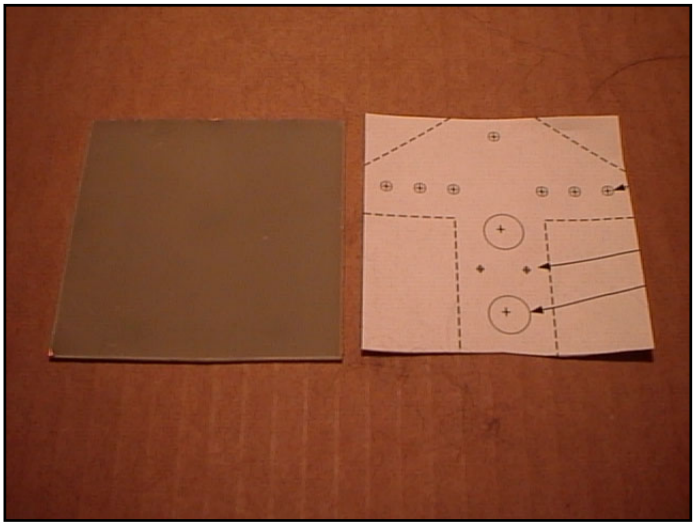


Figure 2

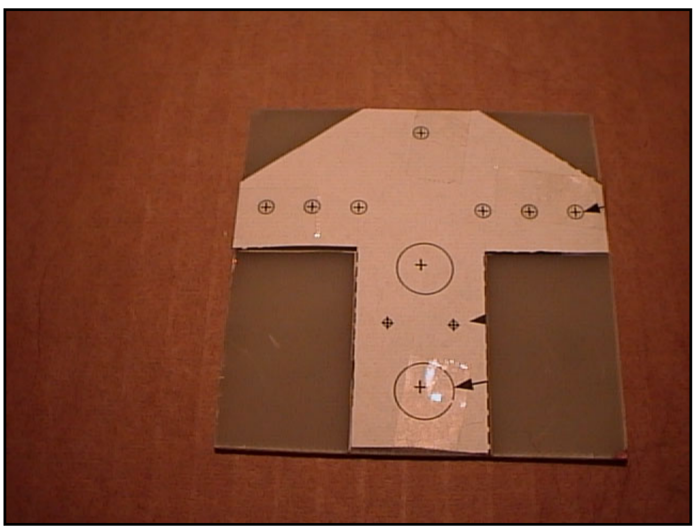


Figure 3

Figure 4 next shows the insulator along with a hammer and center punch used to punch the insulator hole locations. Figure 5 next shows the insulator after the hole location marking. The center-punched hole locations have been highlighted for this photograph with a marking pen. Note also that lines have been marked on the insulator to indicate where material is to be cut away to make the final shape. This cutting is most easily done with a good pair of tin snips. Figure 6 is a view of the final center insulator.

Figure 4

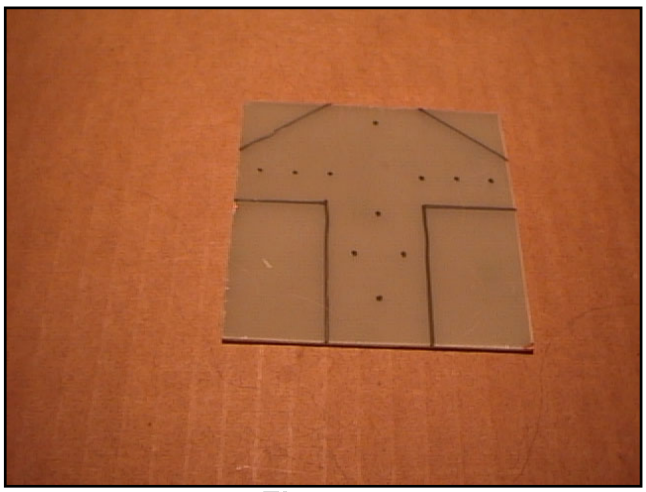


Figure 5

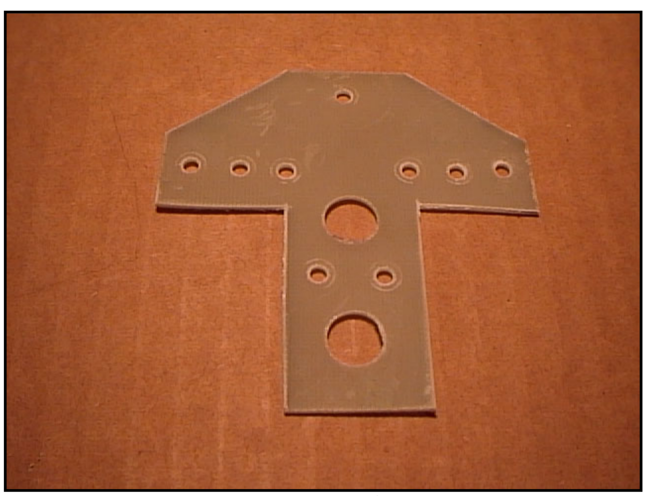


Figure 6

A similar process is followed with the feedline insulator. The major difference with it is that two copper pads are left behind as described in the original article. The finished center insulator and feedline connector can be viewed in Figure 7.

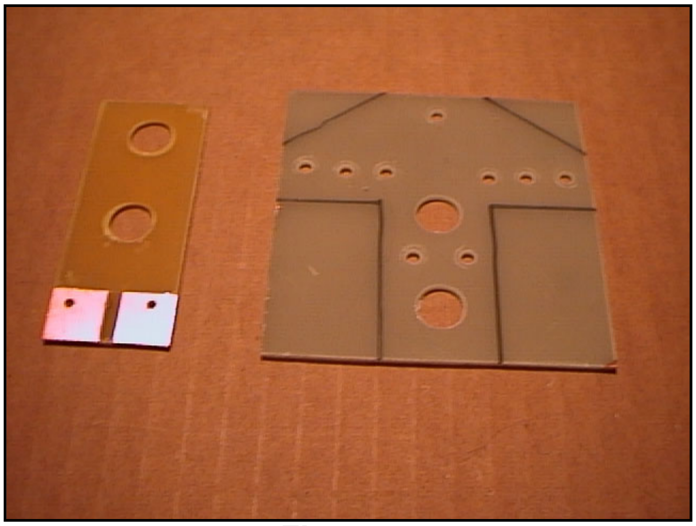


Figure 7

Figures 8 and 9 illustrate the front and back of completed Squirt Plus center insulator. Note that the feedline is looped thorough the two vertical holes and secured by a nylon tie. The wire dipole elements are also looped thorough the horizontal series of holes and several wraps are made outside the insulator to Hold them in place. The feedline leads are stripped, twisted with the stripped ends of the dipole legs and soldered. Not shown is a protective coating of RTV that should be made over the soldered connection for long-term weather protection.

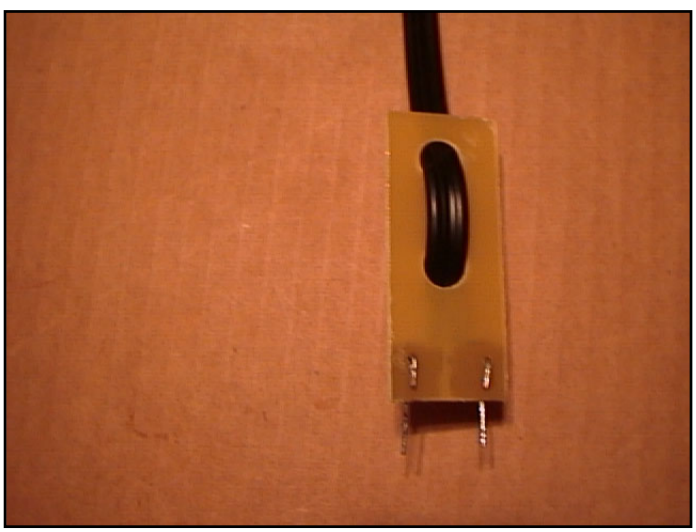


Figure 8

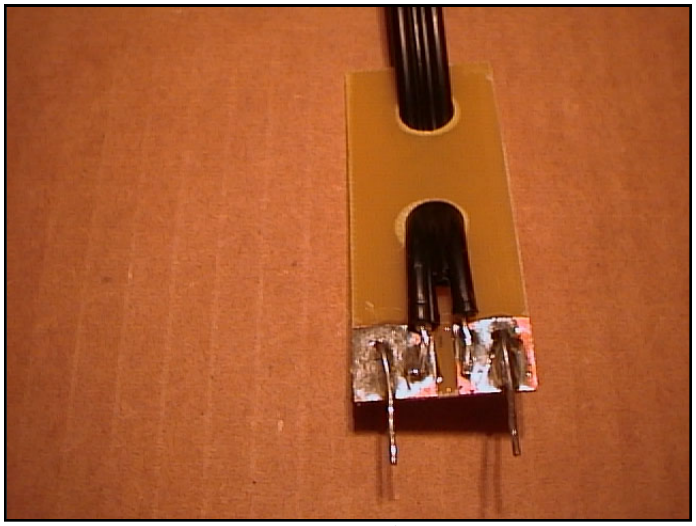


Figure 9

Finally, feedline connector construction is provided in Figures 10 and 11. The feedline is looped through the two large holes as in the center insulator to hold it in place. However since there is less strain at the connector end of the feedline no nylon tie is needed.

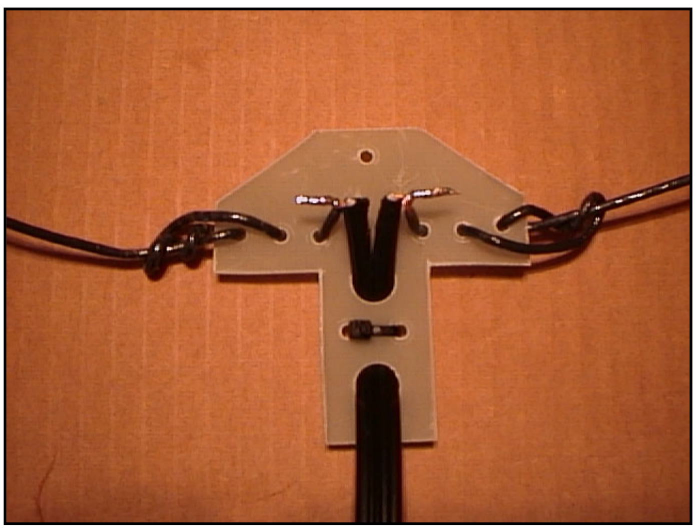


Figure 10

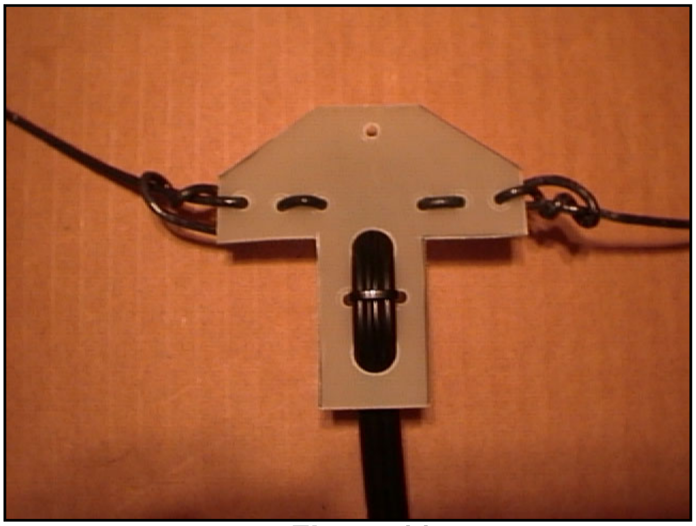


Figure 11

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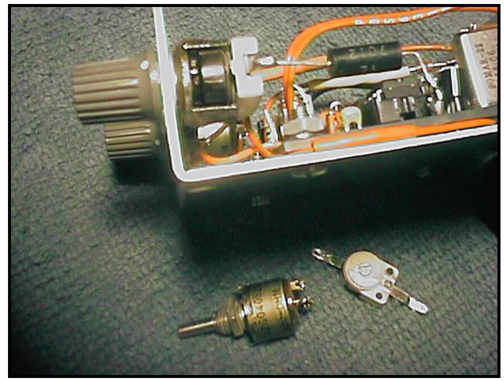
AmQRP.ORG HOMEBREWER

Ron Hege, K3PF

Simple VXO – Rock Mite 20 Meters

I decided to try to VXO my Rock Mite so it would have the ability to tune a little above and a little below the 14.060 MHz crystal frequency.



I first tried a 5 – 60 pF variable NPO capacitor. I lifted the crystal lead from the junction of R10 and soldered the variable cap in series with the crystal and R10. The oscillator would not tune below about 14.061 MHz which was unsatisfactory since the QRP calling frequency is 14.060.

I then tried placing a 4.7 uH molded choke in series with the variable cap and R10. The oscillator tuned from about 14.057 to about 14.065 MHz. The 8 kHz tuning range was more than I expected, and it was now both above and below 14.060. However, the low end frequency reading was roughly 2.5 kHz below the crystal's fundamental frequency and the high end was roughly 5 kHz above the crystal's fundamental.

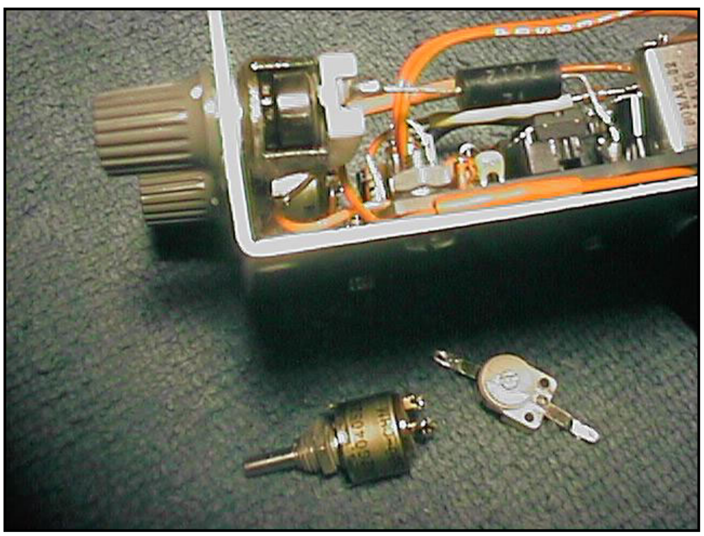
Since adding the 4.7 uH inductor in series with the variable cap shifted the frequency down below 14.060, it seemed reasonable that additional inductance might shift it down more. So, I tried a 6.8 uH inductor, just to see what would happen. The low frequency went down to about 14.054 MHz and the high end went to about 14.064 MHz. Not only did the low frequency shift down but the total tuning range increased. It was now about 10 MHz. The distance away from 14.060 was now about 6 kHz on the low side of 14.060 MHz and about 4 kHz on the high side.

My curiosity was aroused. Would adding more inductor produce an even wider tuning range? I wired an additional 2.2 uH choke in series with the existing 6.8uH for a total of 9uH. The tuning range ended up much broader than I expected. The lowest frequency was now about 14.048 MHz and the highest frequency was about 14.063, which is about 15 kHz of tuning range. 15 kHz seems like a lot of tuning range for a single crystal VXO. I wonder if I have an exceptionally active crystal? Anyway, I gave up experimenting at this point. I decided to use the 60 pF trimmer and the 6.8 uH choke for my VXO. Once the installation was finalized, I listened for stations on the air and found I could hear signals throughout the trimmer cap tuning range. There is a noticeable peak in the center of the receiver crystal filter. However, signals on either side of center come though plenty loud enough to work off center stations. This suggests that an audio filter might be in order to give this excellent radio more selectivity.

I Initially had difficulty tuning my Rock Mite to a received signal in order to be at the proper offset audio frequency when I transmitted. I got the answers I needed from the article Rock Mite VXO Mods, by Wayne McFee NB6M. Wayne explained that he first zero beats the received station using his VXO. The Rock Mite function switch, the same one that adjusts the keyer speed, is then pressed "one" time switching the Rock Mite to its other receive frequency. This operation sets the Rock Mite for proper audio offset while the transmitted signal is dead on the other station's frequency. I strongly suggest you read Wayne's excellent article. You might be more interested in his wide range VXO. It can be found at the Rock Mite files web site http://www.qsl.net/n0rc/rm/

I checked my transmitter's steady state RF output into a dummy load as I varied the VXO's trimmer cap from one extreme to the other. I still had full RF output and the slight changes I saw, as I varied the trimmer, were insignificant.

If you decide to try this mod for your Rock Mite, remember that the trimmer cap must be isolated from ground. I was able to isolate my trimmer by gluing it with epoxy to the plastic rotor inside an old potentiometer housing.



This is how I attached the VXO trimmer cap to a modified potentiometer. I removed the pot's resistance element and glued the capacitor's rotor with quick set epoxy to the pot's plastic rotor. The pot's plastic rotor insulates the cap from ground. The capacitor's stator was glued to the pot's housing to keep it from turning. I don't have a source for parts because mine came from my junk box. You will have to use some ingenuity to fit your capacitor to your pot.

Ron – K3PF

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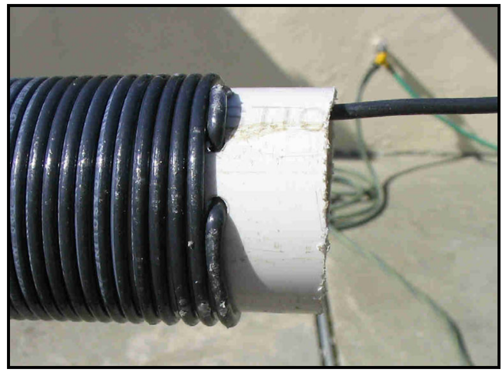
Wayne McFee, NB6M

A Short 40 Meter Dipole

I made up a shortened 40 Meter dipole for use with the TinEar. It is resonant at 7.042 KHz, so it would be good for transmitting purposes too, and can be configured as a Vee, or as a vertical with counterpoise as well.

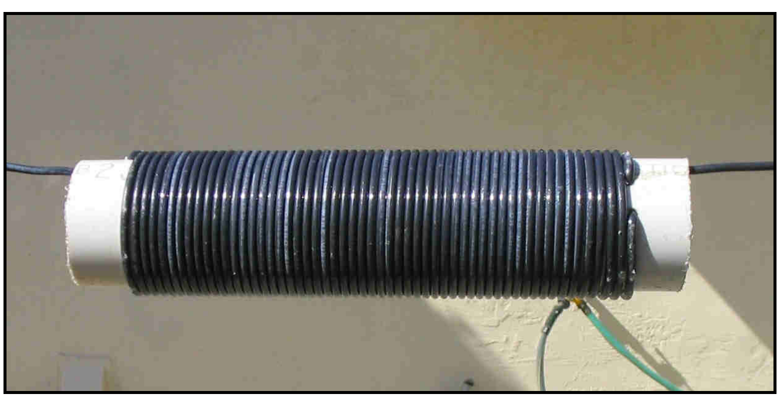


I've wanted to build and test a shortened 40 Meter dipole that could be used in reduced space conditions, with TinEar receiver, or with any other 40 Meter receiver, Transmitter, or Transceiver, for some time.

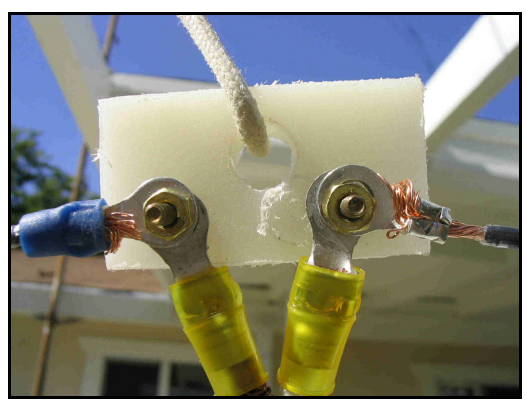
At the local "Yardbirds" home supply center, I bought a 500' roll of #14 stranded wire with black insulation, and a small package of crimp-on ring terminals. I already had a length of 1 1/4" inside diameter PVC pipe, which has an outside diameter of 1 3/4".

These materials, a homemade center insulator, a length of RG-8X coax, and a BNC connector, were used to make up a 40 Meter, shortened dipole that is resonant at 7.042 KHz. It has a bandwidth of about 100 KHz with less than 2 to 1 SWR, so it could certainly be used for transmitting purposes on the lower 100 KHz of the band, without a tuner.

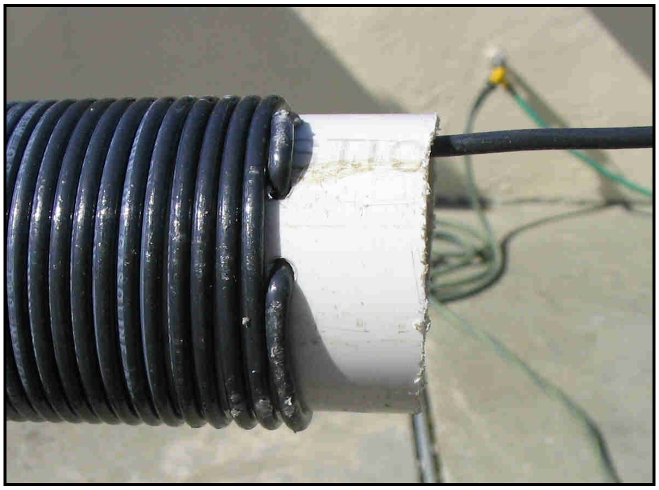
Have a look at the pictures.



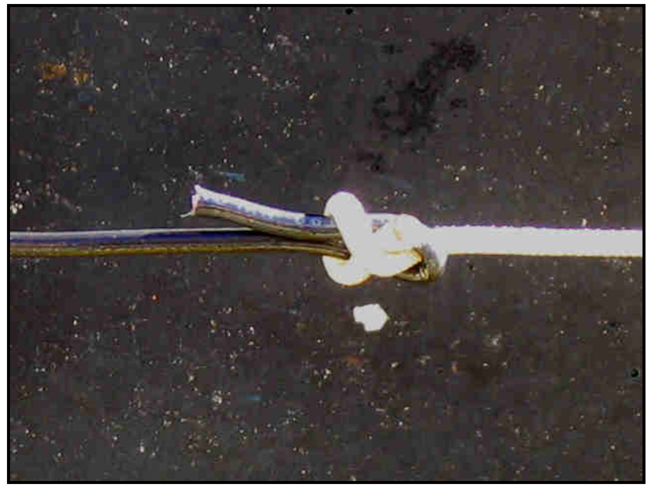
55 Turns on PVC



Center Insulator



End Detail



Sheet Bend

The two loading coils are wound on 8" sections of the above mentioned PVC pipe. Three, 3/16" holes are drilled near one end of each 8" piece, with the line of holes parallel to the cut-off end of the pipe and about a half inch apart – see the picture labeled "Loading Coil End Detail".

One continuous length of wire is used for each whole leg of the antenna, which makes building the antenna very easy, and there are no connections to make, or worry about corroding, between the wire sections of antenna and the loading coils. Once put together, the connections on the center insulator are sealed with caulking compound.

The distance from the center insulator to the loading coil is exactly 10.0 feet. 11 feet of wire is run in through the end hole of the line of three holes at one end of the 8" PVC pipe section. Then out through the adjacent hole, and then in through the last of the three holes, so that the 11 feet of wire for the antenna leg comes out from the inside of the pipe (again, see the picture labeled "Loading Coil End Detail").

A convenient piece of iron rod, wood, or whatever is handy, is placed in a bench vice, to act as an axle upon which the 500' spool of wire turned, and the PVC pipe section is turned by hand in order to wind on 55 turns, close-wound.

After re-counting the 55 turns, an additional 6 feet of wire is pulled from the spool, so that there will be enough length for the 5 feet or so needed on that side of the loading coil, and the wire is cut.

A matching set of three holes is drilled next to the 54th turn, and the 6 feet of wire is fed through the holes, just as on the other end of the loading coil. In one hole, out the next, and in the third, so that the 6 foot pigtail of wire comes out the from the inside of the PVC pipe.

Exactly 10.0 feet of wire is measured on the longer (11 foot) length, starting from the corresponding end of the loading coil, the excess cut off, the insulation stripped back for a half inch, and a ring terminal crimped on. (See Center Insulator picture)

The other leg of the antenna is made in exactly the same way as the first, and both legs are connected to a home-made center insulator, using #4 brass screws and nuts. The center conductor of the RG-8X coax connects, with a ring terminal, to one leg of the antenna, and the braid, with its ring terminal, connects to the other antenna leg. A BNC connector is installed on the end of the coax.

An antenna analyzer, "Tenna Dipper", or low transmitter power and an SWR meter is used to determine the resonant frequency. Since both legs were made deliberately long, the resonant frequency is low at the beginning, and equal amounts are trimmed, a little at a time, off the 6 foot ends of the antenna legs, until the antenna is resonant at the desired frequency.
In this case, 54 1/4" of end wire, with one inch folded over and a sheet bend used to attach the supporting line, the antenna resonated at 7.042 KHz. The resulting overall length of the dipole is 30 feet, two and a half inches.

A TinEar receiver was connected to the shortened dipole for testing purposes. The antenna was strung up in the back yard, about 6 feet off the ground. It being daytime, there weren't as many signals present as there would be at night, but they were there, both in the CW and SSB segments, and the antenna gave a good accounting of itself.

While a shortened dipole cannot be expected to perform exactly as well as a full sized version, it comes close, especially if it is installed well above the ground and away from large metal objects. The one area where it is somewhat lacking is in bandwidth, as its low SWR bandwidth is less than that of a full sized dipole. However, for someone with reduced space available for antennas, the compromise is well worth it.

The leg of the antenna that is connected to the center conductor of the coax can be run vertically, suspended from a line run through a pulley up in a tree or whatever, and the other leg run horizontally, a few feet above the ground, making an L shape, to save even more space.

A very nice, shortened vertical can be made by using a ten foot section of stiff PVC Conduit pipe, winding the loading coil just in from one end, and running the wire along the 10 foot length in order to make the longer section of the vertical. A 6 foot collapsible antenna from Radio Shack, bolted to the top of the 10 foot section, above the loading coil and attached to the wire, could form the "stinger", as its length could be adjusted for resonance in any part of the band.

One, two, or more wire legs, with loading coils, would form both guy wires and ground plane, supporting the vertical atop another, stiff section of PVC Conduit, perhaps 8 feet or more high.

I have used a multi-band version of just exactly that as a portable antenna when I am traveling.

If you are using similar wire, and are using the antenna just for receiving, the finished dimension of 54 1/4" for the shorter wire section of the antenna legs should work just fine. If you plan to use the antenna with a transmitter as well, start with a longer length in that section, as was described, and use either an antenna analyzer, "Tenna Dipper", or low power and an SWR meter to determine the resonant frequency and adjust the length to resonance.

If your antenna space is limited, give this one a try.

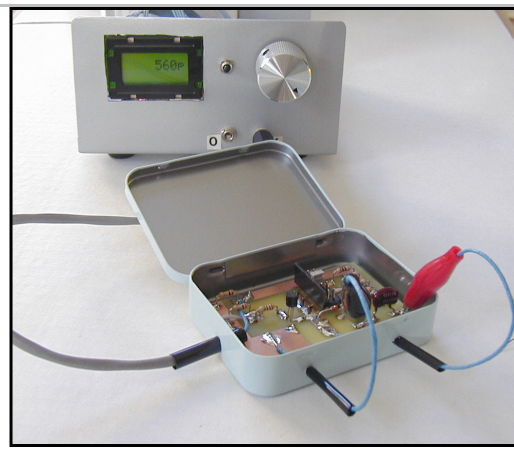
Wayne McFee, NB6M may be reached by mail at 2379 Saint George Drive, Concord, California 94520, or by email at NB6M@aol.com

AmQRP.ORG HOMEBREWER

Ron Carr, WA1VGB

Measuring Capacitance Values with a PIC-EL

With a handful of external components and a PIC-EL, capacitors can be measured with good accuracy and repeatability. Values up to 10 uF can be measured.



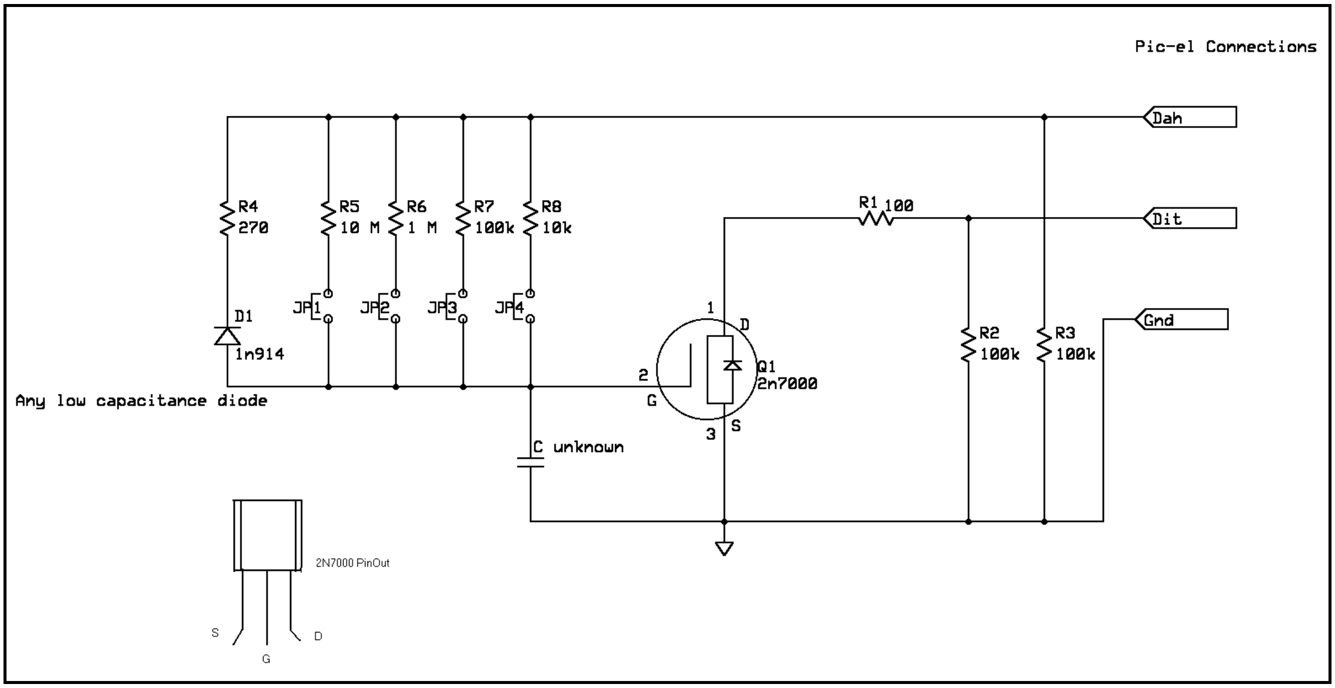
Did you get in on the PIC-EL Kit craze over the last couple of years? If you did, my project here is an easy measurement circuit that works with software that I programmed for my PIC-EL that allows me to measure capacitors and display their values value in the LCD of the PIC-EL board.

To partially quote from the American QRP Club web page on this project (http://www.amqrp.org/elmer160/board/index.html) … "The AmQRP 'PIC-EL Kit' is a multi-function PIC16F84A-based project board that serves as the basis for the experiments still being conducted by John McDonough, WB8RCR in the online PIC Elmer 160 course. The course material is geared around use of common I/O components -- pushbuttons, LEDs, LCD display, rotary encoder and speaker -- and the experiments are designed to take the student through a step-by-step creation of software programs that beep, display and otherwise interact with the user in an instructional manner. The PIC-EL project board also contains a built-in serial programmer that allows the user to download new programs directly from the PC and "burn" them into the PIC microcontroller ... without requiring any other specialized programming hardware. Thus whenever you make a change in the software source code on your PC, by following the course material or if making your own original program, all that's needed to program the PIC device is to connect the board to the PC with a serial cable."

So by designing a simple circuit that connects the standard PIC-EL project board to the component-under-test, we have the

Circuit Diagram

I like simple circuits and this one is pretty simple.

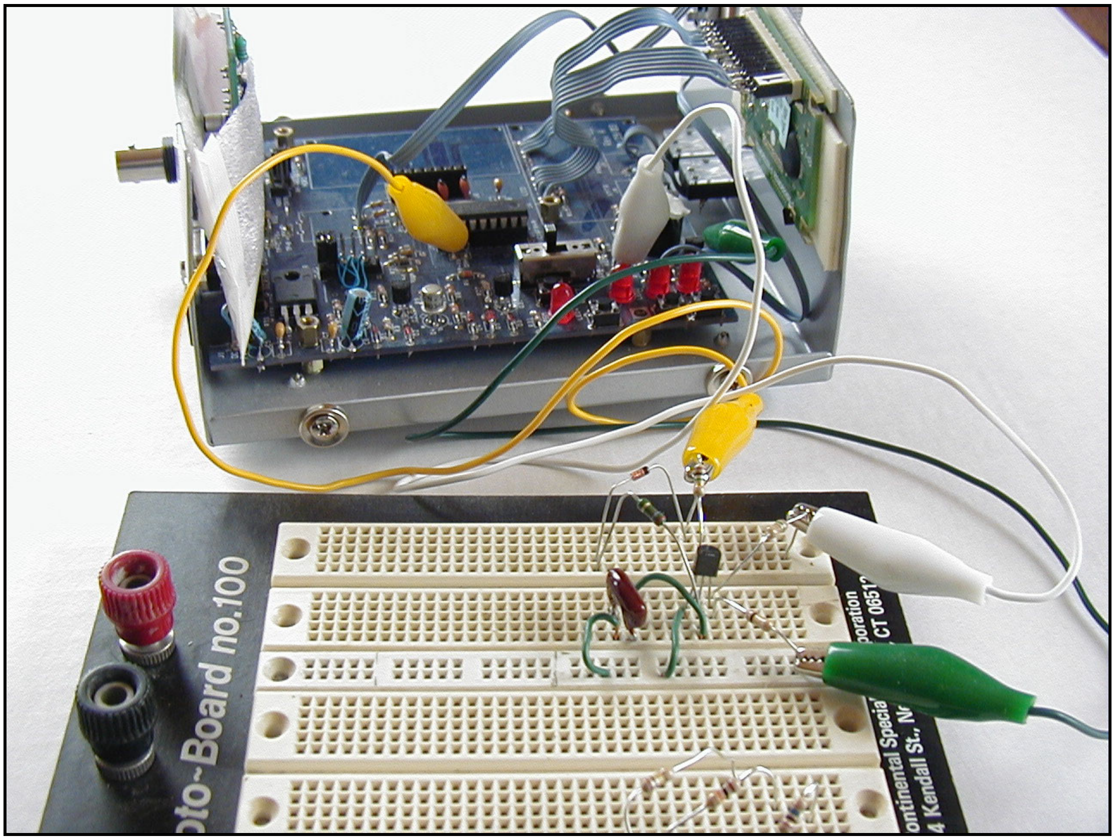


Measurement circuit diagram

Connected to the Dah pin of the PIC-EL is a selection of resistors that are used to charge the unknown capacitor. A jumper is positioned to select only one of R5, R6, R7, or R8 to be in the circuit. You could also use a flying lead with an alligator clip to select the resister instead of the jumper that I used. When the Dah pin is driven high, the capacitor will charge through this resistor. Also connected to the Dah pin is the series connected D1 and R4. When the Dah pin is driven low, the capacitor will discharge via D1 and R4. The capacitor being measured is connected to the gate of Q1. When the voltage on the gate of Q1 reaches the gate threshold (1 – 2 volts), the output will switch low. The output state of Q1 is read via the Dit pin on the PIC-EL. A couple of 100 k resistors are included in the circuit for static protection.

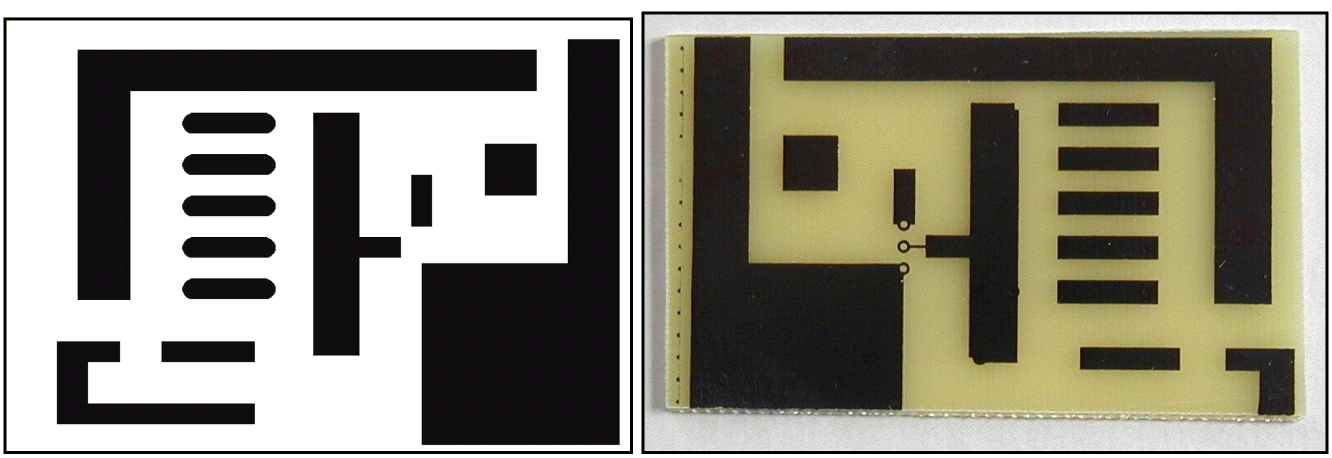
Construction

There are a lot of options here. I made a circuit board. You could build up the circuit Manhattan style. Or you could simply gather together the parts and bread board the circuit each time you wish to measure some caps. I have included a suggested layout, but I didn't follow that exactly. The scrap of PC board I used was slightly smaller than the layout and the etching process I used resulted in a mirror image of the layout.

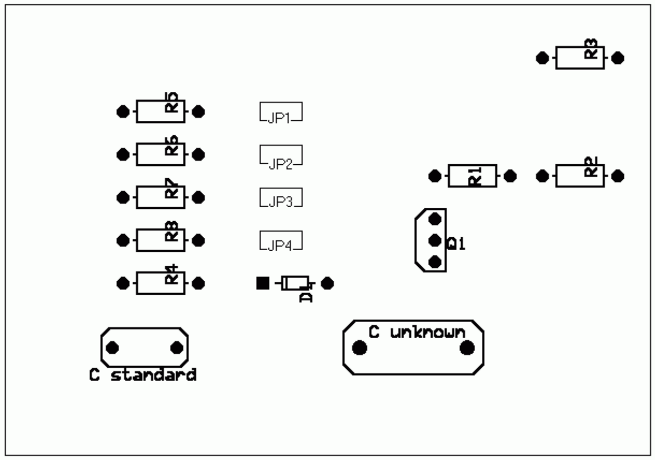


Prototype of the measurement circuit (foreground) with the PIC-EL (enclosure in background)

Keep in mind that the layout is not critical. My breadboard version worked just as well as the final version. I drew the schematic and layout using ExpressPCB. The circuit board was made using a laser printer method as outlined on the web at http://www.fullnet.com/u/tomg/gooteepc.htm. I used Multi Project Paper and did not use any chemicals for cleaning the board or stripping the toner – I used a dish washing scrubby and some soap.



Homebrew pc board was constructed using a laser printing method.



Component layout of the measurement circuit

Operation

First load the program into the PIC-EL. The program will display its startup banner and then will enter measuring mode. Start without any capacitor connected to the measuring leads. A capacitance value will be displayed that will probably be incorrect; don't worry yet. Select the resistor you wish to use by positioning the jumper. You can expect the following range and characteristics from each resistor:

- 10 Meg - Range 1 pF to 0.01 uF. Readings may bounce around and be slightly unstable depending upon where the unit is positioned. I think the high impedance is susceptible to 60 Hz interference from house wiring.
- 1 Meg – Range … 100 pF to 0.1 uF, and will give a good indication of the correct value down to 10pF. This is the range that I have used the most.
- 100 K – Range … 1000 pf to 1.0 uF.
- 10 K – Range … 01 uF to 10 uF.

Now the program must be made aware of the resistor in use in order to display the correct values.

Press PB3 one time and the display will read RES 1 M. Turn the encoder to select the value of resistor that was physically selected with the jumper. Press PB3 again. The display will now read Zero N. Since the capacitor under test isn't connected yet, this is a good time to set the zero point. Turn the encoder so the display reads Zero Y. Press PB3 again. This will return the program to measure mode and the display should read zero or very close. (It may even toggle between zero and a very high value.) Whenever you want to change the range by changing the resister, you will need to repeat these steps.

To get accurate measurements, you will need to now calibrate the reading. I soldered a 560 pF, 2% capacitor on my circuit board for this purpose. Hook up the test leads to your standard known capacitor and turn the encoder until the correct value is displayed. You are now ready to measure unknown values.

Program Overview

The capacitance is measured by timing how long it takes to charge the capacitor through the selected resistor. The timing period is stopped when the voltage on the gate of Q1 reaches the gate threshold voltage and the drain switches low. What are we measuring here? Is this the time constant? Not exactly. The gate threshold on the 2N7000 can vary a lot from part to part and also varies with temperature. The gate threshold is a bit lower than 63% of 5 volts. But the value measured will be proportional to the time constant and that is all that really matters. I determined experimentally that the capacitance per PIC instruction cycle is 1.7 pf when using the 1 Meg resistor. The calibration step will tune out any variance caused by different parts or different temperature or different layouts.

In calculating the capacitance to display, recall the formula for the time constant

$$T = RC$$

But we are measuring a value proportional to the time constant so add a fudge factor to the equation,

$$F * T = RC$$

solve for C

$$C = F * T / R$$

This indicates a division is needed, but I based the calculation on the 1 Meg resistor and adjusted the decimal place of the result for when the other resistor values are used. Then, since R is known to be 1 Meg, we can combine it with the fudge factor and come up with a new fudge factor , F2. (F2 = F / 1 Meg _)

And the equation is now

$$C = F2 * T.$$

F2 was found to be 1.7 pF as stated above and a multiplication is needed to display the correct result.

Program details

The heart of the program is the timing loop. There are two jobs that need to be done, increment a timer/counter and detect when the Dit pin goes low so the counting can be stopped. A hardware feature of the 16F84 is used to divide this work up so the loop can be as short as possible. Timer0 is set to count each instruction cycle. The timer interrupt is used to increment a high counter each time Timer0 overflows from 255 to 0. This frees up the program such that it only needs to detect when the Dit pin goes low.

So the main loop looks like:


```
mloop:  btfsc  PORTA,4    ; check if dit is low
        goto  mloop       ; 3 clock loop
```

The code comment says this is a 3 clock loop. This means the counter values returned by this code will not be a series like 1,2,3,4,5,6…. ,but will be 3,6,9,12,15… With the 4 meg crystal on the 16F84, each instruction will take 1 us. A rough calculation of the accuracy to be expected goes as follows (when using the 1 Meg resistor):

- The displayed values will step in increments of 5.1 pF (3 us counts x 1.7 pf per us)
- The zero count could be off +/- 1
- The count when measuring the unknown can toggle +/- 1
- Adding worse case (1 off for the zero and 1 off for the count) gives 2 counts, or 10 pF

So expect +/- 10 pF when using the 1M resistor, +/-1 pF when using the 10M resistor, plus +/- 100 pF when using the 100K resistor and +/- 1000 pF when using the 10K resistor.

1 us accuracy

Could the accuracy be better? I spent considerable time investigating 1 clock accuracy. This can be realized by swapping the jobs that were split up. We can use the hardware to detect when the Dit pin goes low. To do this, the Timer can be set to use the external pin (Dit). If the Timer is preset to 255 and the clock edge is set to negative going, there will be an interrupt when the Dit pin goes low. The interrupt routine can save the counter value. This leaves the software to implement the counter. We can't loop for 1 us accuracy, so the counter is straight line code

```
Incf    counter,F
Incf    counter,F
Incf    counter,F
Incf    counter,F
```

And so on. This is good for counting up to 255. The downside is that 255 `incf` instructions in a row use up one fourth of the available instruction memory. After subtracting the zero offset, the resulting range of values that can be measured with the 1M resistor is about 1pF to 300 pF. I decided that this range was too limited for what I wanted. (The 1st method presented has a range of 10 pF to 0.1 uF with the 1M resistor) .

Fixed Point Fractions

To display the capacitance value, the count has to be multiplied by 1.7. To do this on an 8 bit micro, we use a trick. (The trick is to fool the programmer not the micro) . We pretend that our 8 bits consists of 2 bits that represents whole numbers and the other 6 bits are a fractional part. (This is an unsigned Q6 number . The 6 means that we have 6 bits representing the fractional part) With this scheme we can represent numbers from 0 to 3.99 with an accuracy of 1/64 or .0156 How this all works is best understood by considering a special case. Any number multiplied by 1 is the same number. In our case we are using 64 to represent the value 1. As an example, multiply 9 times 1.

In binary using 64 to represent 1 in the multiplier only

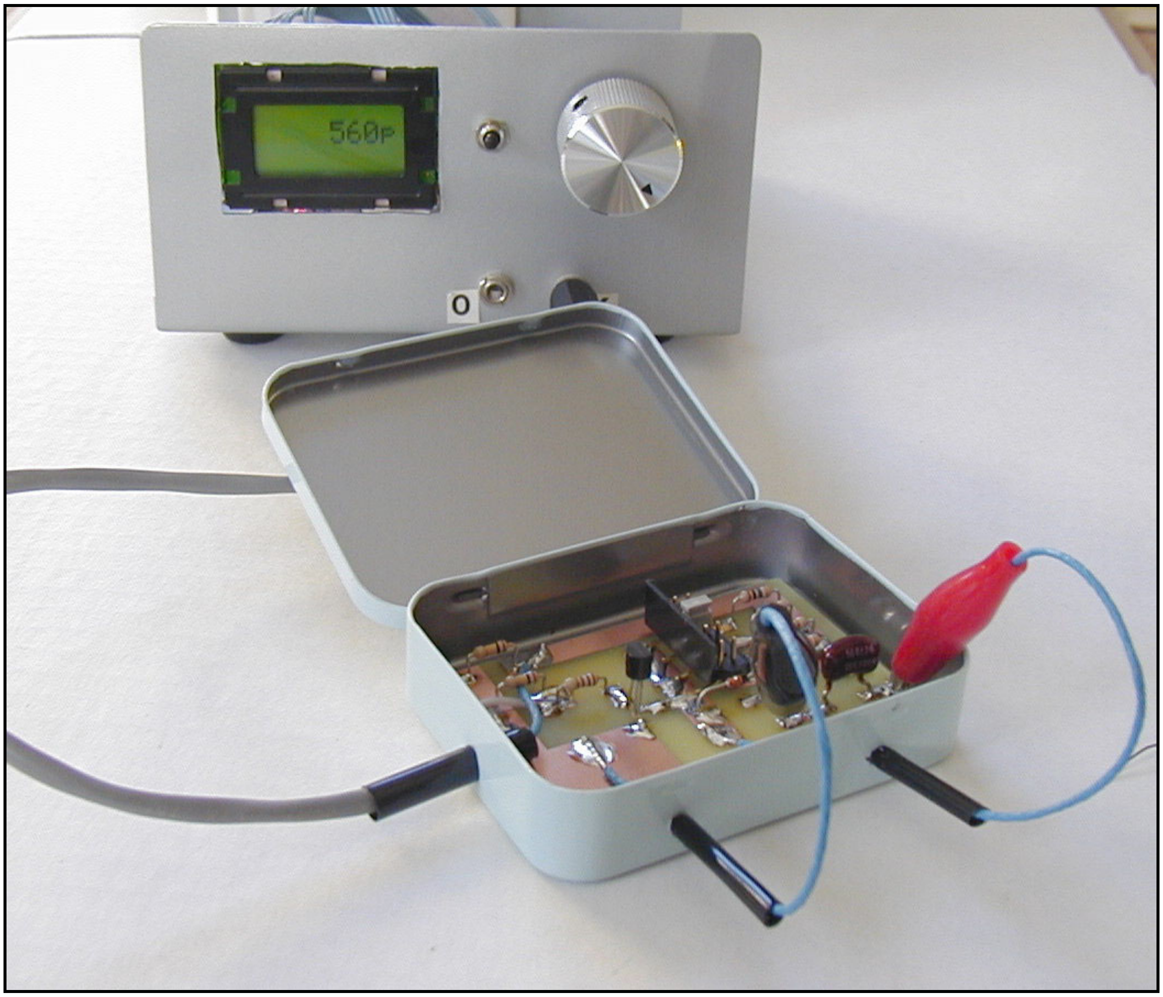
```
      00001001    9
    x 01000000    1E6
    -----------------
      00000000
     00000000
    00000000
   00000000
  00000000
 00000000
00001001
00000000
----------------------
000001001000000
```

What we should see from this exercise is that the bit pattern expected (1001 or 9) is found in the answer, but it is shifted up by 6 bits. When we multiply by 1.7, we will get the correct bits in the answer, but they will also be shifted up by 6 bits. The code that follows the multiplication has to take this shifted position of the answer into account by shifting the answer back or by some other means. If you look at the program code, you will see that I used the result in place when calculating the 100,000 digit and the 10,000 digit; and then shifted it left two places to align it in the high bytes of the product. (acc1 acc2).

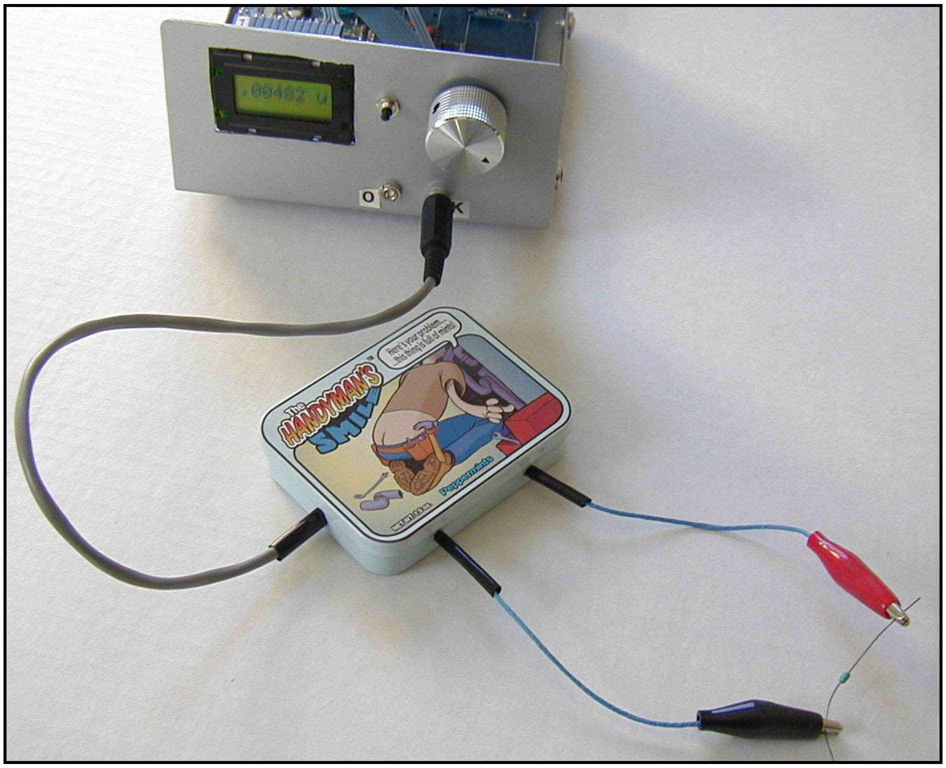
Options

I developed the circuit and program to work the best when measuring values in the 100 pF to 2000 pF range with the idea I would use it when building transmitting filters. You can change the program to suit your needs. For small value capacitors, you may wish to explore the 1 us accuracy method outlined. If you wish to measure values above 10 uF, you could investigate using the prescaler with the counter to extend the range. The circuit would probably work fine if a 1 k resistor was used; and that would be an easy way to extend the range up to 100 uF.

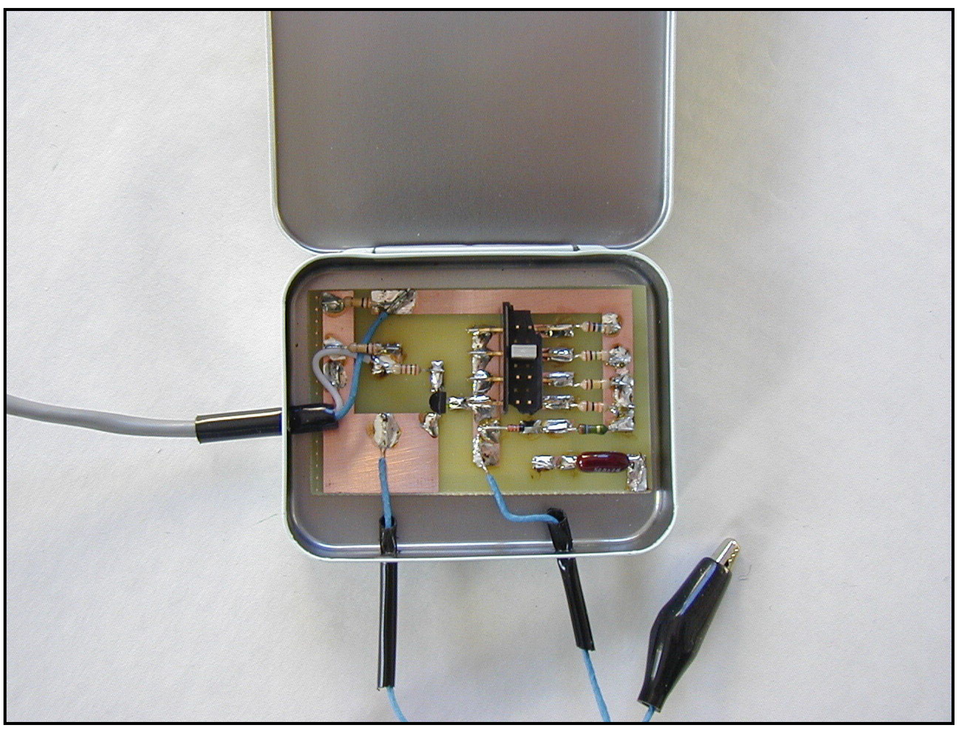
Download the software here



Calibration



Completed project



Close-up on the measurement circuit

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AmQRP.ORG HOMEBREWER

Joe Everhart, N2CX

TEST TOPICS
… and More!

Hysteresis and Temperature Compensation

Test Topics and More

This installation of Coming To Terms discusses a term that often comes up in electronics called hysteresis. No, it’s not a medical term but an effect that is often unwanted though it’s often necessary.

Designed For Test this time around deals with a topic that applies not only the electronic circuits used in test equipment but to all kinds of electronics – temperature compensation. While our equipment is often used in a more or less controlled environment inside our shacks, there are times when it must be used in places where temperature is not controlled. Slight temperature variations usually have only a small effect on performance but gear exposed to wide extremes need special care to preserve acceptable operation.

Coming To Terms

According to the on-line dictionary at www.webster.com “hysteresis” is defined as “retardation of an effect when the forces acting upon a body are changed”. Well that’s accurate but about as satisfying as drinking a thimble of water you’re parched. The effect is similar to what you experience when you have a tuning dial with backlash. Let’s say you are tuning a receiver to zerobeat a signal. You tune upward and *juuust* overshoot it. Then you tune back down and again overshoot it in the opposite direction.

Another example sometimes happens when you are trying to carefully measure a VFO’s frequency change with temperature. You may observe that say, it reads exactly 7040 kHz at 70 deg. F then increases 1 kHz for every 10 degree rise. At 80 deg. it reads 7041, at 90 it’s 7042, and going up as high as 130 deg you measure 7046. Now that you have seen how it changes with increases in temp you want to measure it below 70 deg. For argument’s sake, assume you first simply return the circuit to the starting point, 70 deg., let it stabilize and red the frequency. “What the…?” you say, it now reads 7039.5 instead of the original 7040. In other words the frequency does not retrace linearly. Now that’s hysteresis!

It is not as unusual as you may think. Quite often with VFOs it's caused by some component that suffers a slight change in characteristics with a change in temperature and never returns to its original value at the original temperature. The author once had a Heath VF1 VFO with exactly that phenomenon. Replacing the silver mica capacitors in the LC circuit fixed the problem. It can also be caused by mechanical shifts in inductor windings that are not secured by Q-dope or by slug tuned inductors without some sort of lock on the threads of the slug's tuning screw.

The previous examples show where hysteresis is unwanted. There are a number of uses for this characteristic that are very useful. Many homebrewers are familiar the Schmitt trigger circuit. It is a switching circuit whose input is an analog voltage and the output is either of two voltage levels. So far this seems innocuous and a high gain amplifier, a digital buffer or an inverter can do the same job. As you will see, though the Schmitt trigger has something extra.

Figure 1 shows how a simple comparator's output varies with input. With the input at ground the output is at ground. As the input voltage rises, the output remains at ground until an input of 2.5V is reached. Then the output abruptly jumps to 5V and stays there as long as the input is above 5V. As the input decreases to 2.5V, the output switches to ground and remains there.

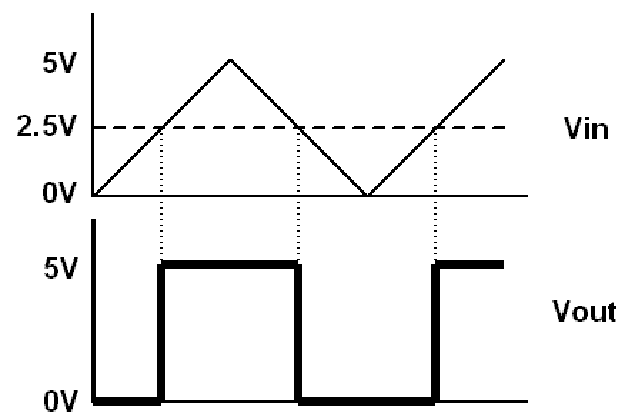

Figure 1 – Comparator switches at set voltage

Figure 2 demonstrates how differently a Schmitt trigger works. At low inputs, the output behaves the same, remaining at ground. However it doesn't go high until the input reaches 2.6V, a tenth of a volt above the comparator's switching point. As with the comparator, the output stays high for increasing input levels. Now as the input level is decreased the output doesn't drop until an input of 2.4V is reached and stays low down to 0 volts input. The difference in input needed to switch in the plus and minus directions is two tenths of a volt and is called the hysteresis of the circuit.

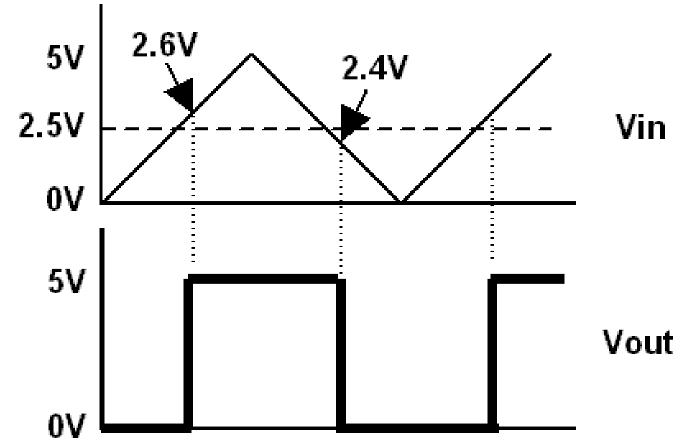

Figure 2 – Schmitt trigger adds hysteresis

What the hysteresis does in the real world is to clean up the output signal. You can imagine that if the input were 2.5V and there was as 50 mV of noise superimposed on it, the Schmitt trigger would switch cleanly to the high state as soon as the sum was 2.6V and cleanly back low when it dropped to 2.4V. The comparator, on the other hand would bounce back and forth between its high and low states in response to the noise, causing a noisy output signal. Hysteresis allows the Schmitt trigger to effectively produce a sharp output in the presence of noise, while a simple comparator will not. In fact practical circuits using comparators often add some hysteresis via positive feedback to achieve this improved operation.

A familiar application of exactly the same principle is used on the thermostats of home heating and cooling systems. When you home heater thermostat is set for a temperature of 70 deg., it is set by design so that the heat doesn't come on until it senses an air temperature several degrees below 70 and doesn't shut off until the air is a couple of degrees above 70. If it didn't work that way, the heater would wear itself out very quickly because it would be constantly cycling! The net result is that the thermostat setting is the average of the high and low swings, in this case 70 degrees

Designed For Test

As promised DFT looks at discuss temperature compensation of electronic circuits. It's a rather open-ended topic so this column will look at it in terms of providing improved performance of quartz crystal oscillator circuits as a prime example. For brevity we will simply call them crystal oscillators. Nitty-gritty details will not be considered in this high-level overview.

Crystal oscillators are used in electronic circuits since they are a simple means of providing accurate and stable frequency sources. They are what make possible electronic communications since they allow us to accurately tune transmitters and receivers. They also are the heard of digital clock circuits used in computers and digital electronics and, of course, in clocks used for timekeeping.

Briefly there are two main important frequency characteristics that need to be taken into account in making a usable crystal oscillator. The first is that the oscillator must be able to be accurately set to the desired operating frequency. This is called initial frequency calibration.

The setting accuracy for initial calibration is usually described in terms of either a percentage of the desired frequency or in the related term PPM accuracy. Common inexpensive crystals used when a precise frequency is not needed are often specified at 0.1 to 0.05 percent accuracy. At one Megahertz this means that they might be as much as 500 to 1000 Hz high or low from the nominal frequency. PPM accuracy is more common for timekeeping and communications applications. 1 ppm is 1 Hz maximum error at 1 MHz or 7.04 Hz at the common 40 meter QRP cw frequency. (For reference 1 ppm represents a time error of about 2.5 seconds per month).

An adjustment is usually provided on crystal oscillators to allow initial frequency setting and to let a user check periodically and reset the frequency to calibrate out the error due to aging. A representative crystal oscillator circuit is shown in Figure 3. It looks very much like a Colpitts oscillator with a crystal in place of the usual inductor. Capacitor Cv is in series with the crystal to provide for initial adjustment to within 1/10 ppm or so of the desired frequency.

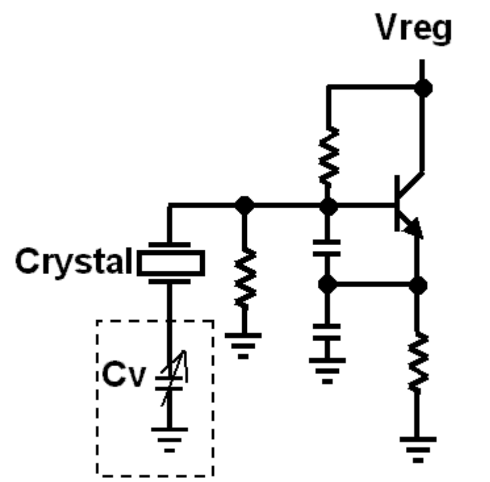

Figure 3 – Basic quartz crystal oscillator

The second important frequency characteristic is how well the oscillator will stay on frequency. A number of things can cause it to drift but two major contributors are crystal aging and temperature stability. Aging is a natural effect of manufacturing that causes the frequency to change over time. It tends to settle out over time to a small drift though it never really stops. Very expensive crystals are carefully mounted to minimize stress and are housed in hermetic cases with inert gases to lessen the effect. Most inexpensive crystals will age less than 10 ppm per year.

Temperature stability is a much larger concern. Under normal room temperature conditions it is not unusual for a reasonable crystal oscillator to be stable to within more than 1 ppm. This is about 7 Hz on 40 meters or about 30 Hz on the 10 meter band. At HF this is not too bad at all for a radio. At VHF it starts to be a concern and at microwave frequencies it is too much to allow for narrowband communications such as CW or SSB. Further, it is marginally acceptable for test equipment such as frequency counters used to set radios on their proper frequency.

Even the internally generated heat of a radio or ambient temperature changes will worsen frequency drift. Common uncompensated crystal oscillators can change frequency as much as plus or minus 100 ppm over the range of 0 to 70 deg. C (32 to 158 deg F). At 10 meters this represents a change of plus and minus 3 kHz! This is marginal even for HF and totally unacceptable on the higher bands. Obviously oscillators need some sort of temperature compensation to overcome temperature effects for use over this kind of temperature range.

Let's look at a number of techniques to achieve temperature compensation. This will be a very general discussion with only a very high-level description of compensation methods. A wealth of material is available in amateur and commercial publications and on the Internet for those interested in digging deeper into the subject.

There are two important features to nearly all temperature compensated circuits.

The first is the use of a voltage regulator. This is imperative to remove yet another possible source of frequency variation. Simple three terminal regulators such as the 78LXX series are a good inexpensive solution that is almost a "no-brainer".

The second feature is that the oscillator circuitry should be mounted in some sort of enclosure that provides electromagnetic shielding (yet one more thing that you won't have to worry about) and some degree of isolation from sudden ambient temperature changes. An enclosure and possibly some internal thermal insulation average out temperature changes making them easier to handle.

The first compensation technique is to keep the oscillator at a constant temperature. Practically this usually means heating the oscillator circuitry to a temperature higher than the highest anticipated environmental limit and maintaining this temperature at a stable value. This might range from a more-or-less familiar "crystal oven" to a small enclosure that keeps only the most important frequency determining elements of the oscillator at a constant temperature. Commercial ovenized oscillators have been manufactured that are the same size as a common DIP IC package for special applications.

Figure 4 shows the basic ovenized oscillator elements. The crystal and oscillator components are mounted on a printed circuit board mounted in an insulated can or enclosure. A heating element such as a power resistor provides the heat source to heat the circuitry above the ambient temperature. A temperature sensor and possibly some control circuitry to maintain it at a constant level. A common internal temperature is usually in the range of 65 to 70 deg. C (149 to 158 deg. F).

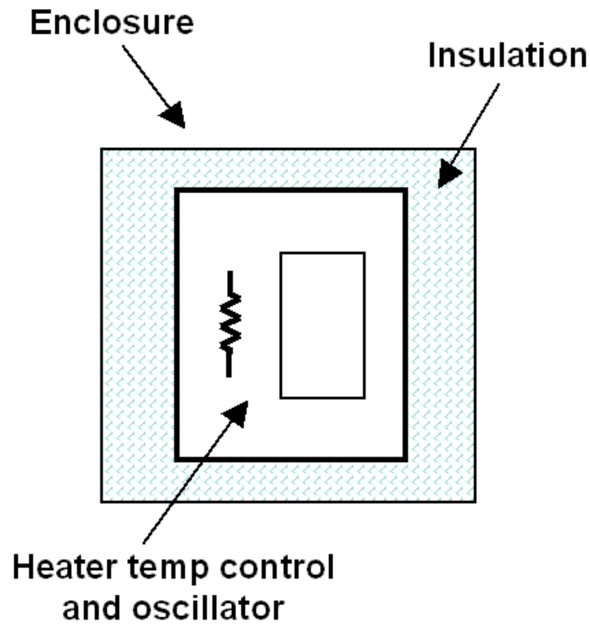

Figure 4 – Ovenized oscillator elements

The simplest controller uses a mechanical thermostat that operates like a household thermostat and keeps the internal temperature to within several degrees of the desired setting. Alternatively a thermistor and a comparator with hysteresis can be used to drive the heating element.

A more sophisticated system might use a temperature sensing IC and a pulse width modulated voltage drive to the heating element. Proportional control of the heater drive in a design like this controls the amount of heat supplied, with more heat during startup when the temperature is far from the end value and decreasing hear as the final temp is approached. Control to within a fraction of a degree is possible for superb frequency stability.

Temperature ovens are simple but have several disadvantages:

- They are not power conserving since the heater may need as much as 5 watts of power.
- They have a long heat up time. The internal temperature may take five or 10 minutes to stabilize from room temperature or more under colder conditions. Frequency will be inaccurate until warm up has completed.
- The elevated temperature accelerates crystal aging requiring more frequency recalibration of the operating frequency.

Some amateurs have taken another tack in temperature stabilization. In the early days of moonbounce some hams buried their reference oscillators in the ground below the frost line (as much as 10 feet or so down!). Temperature below ground remains constant in the range of 50 to 60 degrees F underground providing a "free" temperature control source.

Oscillators operating in controlled temperature environments as described above can easily achieve frequency accuracy and stability that are a fraction of one ppm. Commercial units using proportional temperature control are available with 0.01 ppm specs.

The second compensation method is to build a true temperature compensated crystal oscillator or TCXO. This type of device measures its internal oscillator temperature and retunes the oscillator to counteract the temperature-induced frequency change. This means that each oscillator needs to be individually calibrated across its operating temperature range.

Temperature monitoring circuits range from very simple to extremely complex. The simplest methods provide approximate compensation over a limited operating range but improved performance and extended operating ambients require added sophistication. Two large benefits of TCXOs is that they do not require the excessive power needed to operate a heater and not needing a heater means that they stabilize to their final frequency in a matter of seconds rather than minutes as with the ovenized oscillators.

It is tempting to consider using only temperature compensating capacitors to do the job. This is commonly done with VFOs mainly to counteract the frequency drift of the VFO inductor. However doing real-world compensation requires a painstaking selection process to find the exact right capacitance value and compensating characteristics. There are no small inexpensive temp-compensating caps with adjustable capacitance and temperature characteristics. What's more frequency variation is not linear with temperature but has a shape that can be approximated as a cubic function (fancy math term – don't worry over it too much. Some representative curves are shown in Figure 5.

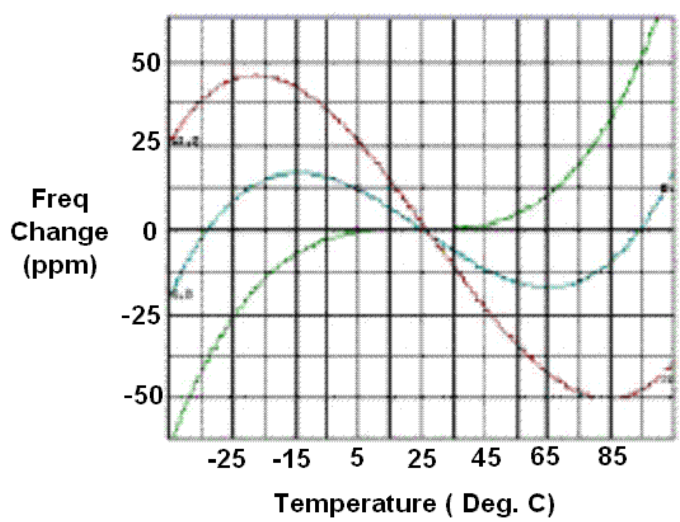

Figure 5 – Crystal oscillator Freq. change vs. temp.

More commonly the temperature sensing and tuning elements are separate and have some amount of adjustability to handle the variability of the oscillator drift curve and unit-to-unit variability.

The simplest method replaces the crystal adjustment capacitor with a thermistor and a fixed capacitor as shown in Figure 6. The thermistor has a resistance that varies with temperature and the net effect of the two components in series is like a temperature varying tuning capacitance. Proper selection of the thermistor and fixed cap can result in frequency stability on the order of a couple ppm over a plus or minus 20 degree F variation. It truly is a brute force method and requires quite a bit of experimentation to find exactly the right component values.

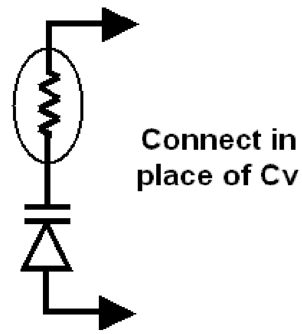

Figure 6 – Simplest compensation circuit

The most common TCXO designs use a more sophisticated approach. The next increment of complexity is to use a network of two thermistors and two potentiometers to provide a tuning voltage to a voltage variable capacitance diode. This is shown schematically in Figure 7. The compensation is optimized by first setting the pots to their center position and plotting the frequency variation with temperature. Next the pots are adjusted slightly and a new temperature run made and the results are again plotted. This continues until the frequency variation is minimized to the desired amount.

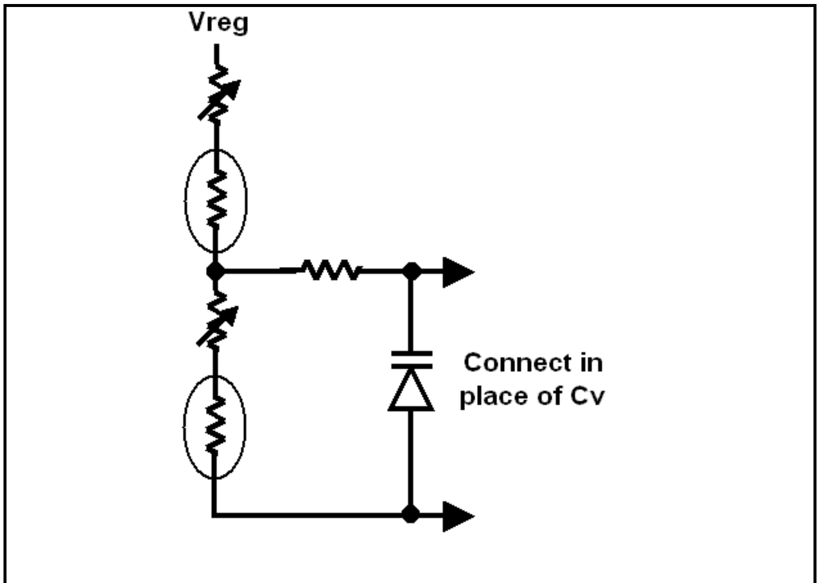

Figure 7 – Two thermistor compensation circuit

The author has observed this method in a production environment for land-mobile two-way radios where tens of oscillators were compensated at one test position per day. After the operator learns how the adjustments work out, he can do testing at only three temperatures and compensate the frequency variation to less than 5 ppm total over a the land mobile range of -40 to +85 deg C in only two or three temperature sweeps.

The thermistor/resistor network can be extended to three elements as illustrated in Figure 8. This circuit is typical of high quality commercial TCXOs. Repeated temperature runs and adjustment can yield stability better than one ppm over the military electronics temperature range of -55 to +125 deg. C.

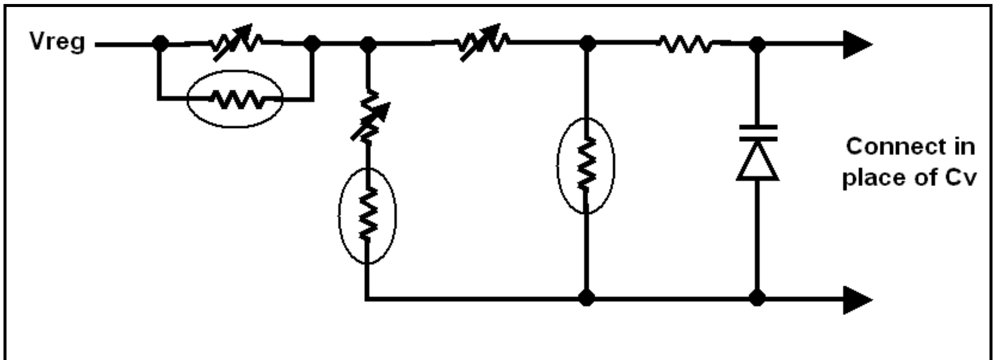

Figure 8 – Three thermistor compensation circuit

The final type of TCXO method adds a microprocessor between the temperature-measuring device and the oscillator tuning components. A rudimentary block diagram is shown in Figure 9. The idea is that the microprocessor can derive a tuning voltage versus temperature that will very closely match the characteristics of the oscillator. The thermistor/potentiometer methods can be tweaked to only approximate the desired compensation. However using a microprocessor, calibration can be used to calculate degree by degree the amount of compensation needed. This data is stored in the memory and is recalled based on the measured temperature. Further the computer chip can calculate a compensation curve based on the measurements at each temperature and use this to refine the compensation. Not only that, but the whole process can be automated so that the drudgery and potential human error inherent in making a large number of repetitive reading is overcome. The accuracy of the microprocessor controlled TCXO can be on the order of several tenths or less ppm over extended temperature ranges.

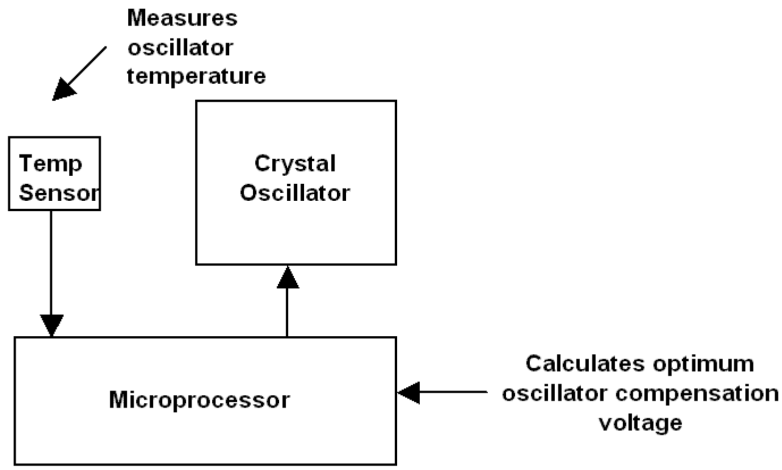

Figure 9 – Microprocessor controlled temperature compensated oscillator

Stimulus and Response

Sorry but there's no room for the Stimulus and Response section of TTAM. The next column will present a number of printed and Internet references that the author has found handy for coming up with test equipment and general electronic circuit ideas and explanations. Shucks, a whole article could easily be devoted to that topic alone.

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Richard Fisher, KI6SN

QRP Operating

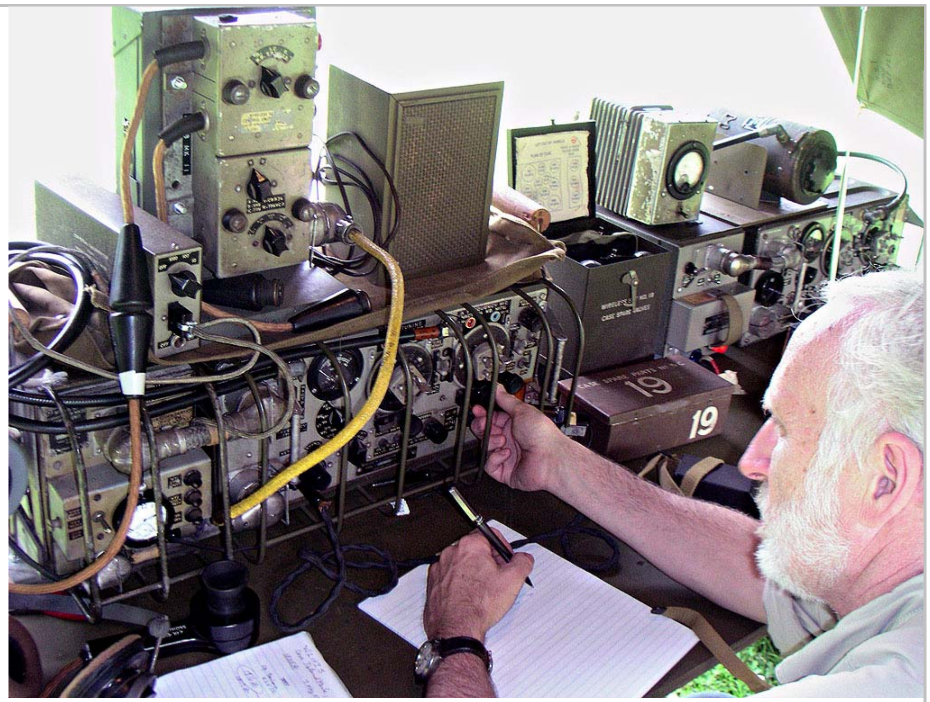

Photo (right): Small Wonder Labs' Dave Benson, K1SWL, at the controls of no small wonder during Field Day 2004 with "a WWII re-enactment outfit, the 1st Canadian Paratroop battalion."

QRP FIELD DAY '04: HAVING A BLAST FROM THE PAST

Dave Benson, K1SWL, writes from Colchester, CT: "Field Day 2004 was decidedly different! I was invited to participate with a WWII re-enactment outfit, the 1st Canadian Paratroop battalion.

"This was a small outfit – a half-dozen uniformed personnel, several tents and jeeps and some crowd-pleasing military 'hardware.' We were set up in a busy public park along the waterfront in Stamford, CT, and literally hundreds of folks of all ages stopped by to check us out.

"If there was ever a year for operating challenges, this was it! Our rig was a Model 19 Mk III transceiver, dating from the early 1940s. This equipment was intended for use in tanks and armored vehicles and featured a cage across the front panel – intended to keep both transceiver and personnel safe in the harsh armored environment.

"Dial markings were in English and Cyrillic. The beast weighed nearly 100 pounds, not counting various control boxes. A single tuning dial covers 2.5 to 8 MHz, so you can imagine that tuning was a bit touchy! Fine-tuning a station was an art – the dial backlash was about a KHz. It gets better – the receiver passband width seemed to be at least 15 KHz, so there was no lack of signals to listen to. Keying was strictly by straight key – an insulated affair with about 1/8" of travel.

“T/R switching involved plugging the key jack in and out with each transmission. The sound of the dynamotor added a certain ‘charm’ to the experience as well.

“This beast was powered by a bank of 4 deep-cycle batteries under the operating table – this being the sole concession to modern technology.

“Results?

“We operated under the callsign of **Chuck Counselman, W1HIS,** and worked about 50-60 stations on 80 and 40 meters. Our third operator, Barbara Lombardi, K1EIR, is a sightless amateur and put us to shame – an artist with the straight key!

“The antenna was an OCF Zepp up about 25 feet and tuned with a variometer. This is a low QSO total, but considering the gear, this felt like a very satisfying result. In past Field Days, I've worked drifting, chirpy signals with QLF keying. I'd assumed they were ‘shade-tree operators’ running on low

batteries. I know better now, and have a better appreciation for what the old timers went through. We've sure got it good these days!

“Memorable experiences?

“Meeting people! My ‘standout’ was a Russian émigré who’d gotten his Reserve training in the early 80s. We had a good laugh over the mutual fear and paranoia of the Cold War years. Veterans from nearly everywhere checked in with us to share their experiences – one old gent had crossed the Rhine at Remagen under fire – a participant in the capture of that beachhead.

“The radio shack attracted *a lot* of interest. Everyone knew what Morse code was, but had largely never heard it before. Lots of questions about using the code, and it was especially gratifying to have young folks stick around for up to a half hour, enthralled by the whole thing!”

MORE ACTS OF QRP KINDNESS

Frank Shears, K7RMJ, of Murfreesboro, TN, writes: “I read (“QRP Operating”) in AmQRP Homebrewer No. 4 with much interest. Especially the story from Joe Trombolino, W2KJ, who talked about acts of kindness.

“Something similar happened to me recently.

“I was reading the new QRP Forum web site made available by Jeff Davis, KE9V, at http://ke9v.net/qrpbb/index.php and read about a gentleman (Larry Mergen of Raymore, MO) **KØLWV** who mentioned he had an MFJ 9020 QRP rig that *"I used it once and put it back into the closet. It turned me off of QRP rigs."*

“This piqued my curiosity so I asked Larry what was wrong with it and why did he put it back in the closet. He said he sent it back to MFJ and it checked out clean but it still put out a "beep" every few minutes and he was through with it. So, being the kind soul I am, I offered to purchase it or trade for it. He said he would send it to me after the weather thawed out in his area.

“Well, I thought he meant in the spring, but a few days later he said it had thawed out and I should watch for it in the mail. Well, one good deed deserves another so I promised him that when I was through tweaking, snooping, etc., I would pass it along to someone else who had the same interest and at the same price.”

‘RMJ said he’d like this philosophy to be encouraged “in our QRP ranks.”

“When I was 11 years old,” he continued, “someone donated an old Viking Adventurer – thanks Grandpa – to me because I was too poor to buy a rig and didn't have the technical expertise to build one.

“I have had a wonderful life and fulfilling career in electronics thanks to this hobby and think it would be great to help along someone else the same way I was helped.

“Lets give something back to this great hobby after all it has given us.”

QRP DX: WHEN QRP TENACITY PAYS OFF

Mike Byrd, AC4UR, writes from Seffner, FL that he recently “added **3B9C** to the log for 40 meters. Using a K1 at 5 watts to a vertical. I spent several days calling for several hours with no luck. I didn't think it was possible but it couldn't hurt to try.

“Finally on April 1, I heard him call AC4??, and I sent my call several times. He sent AC4AR??? Oh no, I sent my call several more times and the reply was “NIL.” I turned off the radio and did some computer stuff for a while. I kept telling myself it isn't the end of the world, as I didn't think it was possible anyway.

“After an hour I turned the radio on again and found **3B9C** still plugging away. I joined in again calling every time. After a few minutes he sent AC4UR?? Yeow! I sent my call several times and he gave me a signal report. I sent a return several times and TU several times.

“I got a ‘TU’ back. Wow, a happy moment in QRP history. Still I was not sure I would be in their log. It has happened to me several times with getting my card returned and stamped “NIL.”

“I checked their online log the next day and found my call listed with a contact on 40 meters.

“Today I dropped a card in the mail. I can't believe the ops at **3B9C** – to be able to pull a 5-watt signal out like that. I truly appreciate them making such an effort to give me a report after several attempts.

“That now makes 107 for me on 40 meters. Some other greats recently: **VK5XE, HK0GU, T30ZF, ZL2AGY, CX1SI, ZD8Z** and **8R1K**. VK and ZL are common but I was never able to work them before.

“The K1 is a pretty good radio with some shortcomings. The AGC is a nightmare during a contest and will leave you with ear damage if you are not careful. I added the noise blanker to solve some local issues. It stopped working after a month or so and I haven't fixed it yet. I will probably just buy a new one rather than fool with it.

“I added the LogiKit SCAF-1 filter. That is a great help with selectivity and helps keep the audio under control since the K1 AGC is a little slow to react. I always got a huge first *dit* or two before the audio settled down. The built-in keyer is good but the memory is too clumsy to be practical.

“I have been reviewing all the information I can find on four-square arrays and sloper arrays. In the information on verticals and radials I did find some great ideas.

“The feeding and phase control seems to be left to commercial units as most articles state they are too complicated to homebrew.

“I don't believe that as the truth. They can be complicated and verifying results can be questionable. There are many parameters to take into account, but I wouldn't say *too complicated*. All that said, I am planning a sloper array for 40 meters. Not as much gain as a four square, but good directivity and easy to feed.

“I hope to start a transmitter project this year. I have a few parts and still need a vernier dial. I have been on Ebay trying to get one. They end up way too costly for me. Does anyone know where I can buy Simpson meters? I was saving an old one my father gave me but it has been lost during one of my moves.”

Richard Fisher, KI6SN may be reached by email at ki6sn@aol.com or by postal mail at 1940 Wetherly Way, Riverside, California 92506

Richard Arland, K7SZ

"TUNING UP"
… The Argonaut from Hell

A demonically-possessed Argonaut 509 captures K7SZ's attention for longer than he expected!

If I have a weakness for QRP equipment it has to be the Ten-Tec Argonaut series of analog QRP transceivers dating from the early 1970s up through the mid 1980s. There is something almost magic about owning one of these little beauties. Ten-Tec recognized that they had a winning product when they brought out the original analog Argonaut, Model 505, in 1972. This little radio offered both CW and SSB modes at about 2.5 to 3 watts output (5 watts input power) on the five major HF bands: 80, 40, 20, 15, & 10 Meters. Housed in a very pleasing beige case with wood grain top and end panels, the Model 505 was an instant success among radio amateurs who wanted a low powered HF rig for portable operation or to experiment with QRP.

The Model 505 included a single conversion superhet receiver based around a 9 MHz four-pole crystal filter, which was a very big step in the right direction, since most QRP rigs of that era featured a direct conversion (DC) receiver of dubious lineage. All too often these DC receivers utilized one dual-gate MOSFET as the first RF mixer which could easily be driven into non-linearity due to large input signals on the band. The resultant mess usually trashed out the receiver leaving the operator listening to a mish-mash of garbage. The Argo's superhet provided the lucky operator with true single signal reception, as long as the bands were not overcrowded. The superhet design led to the inclusion of an audio derived AGC, which made operating on a cluttered, noisy band much easier on the ears.

After a couple of years, the engineers at Sevierville unveiled an improved QRP transceiver, the Argonaut Model 509, in 1975. The "509" was the most prolific of all the analog Argonauts and can be found relatively easily on the internet and at ham radio swap fests. The Ten-Tec engineers had done their homework and the resultant transceiver was a much improved version of the original. For one, the receiver RF deck had been redesigned to improve the sensitivity. The Model 509 still suffered from the four-pole 2.8 kHz IF filter, but there were mods out to rectify that situation (more on this later). Both the Model 505 and 509 had the 10 meter band as one continuously tunable band that had a tuning rate four times that of the lower HF bands. To say that tuning in a signal on the 10 meter band became a critical chore is an understatement. Dial calibration also suffered on 10 meters. One complete revolution of the main tuning knob on 10 meters resulted in moving the receiver 100 kHz, whereas the same one turn revolution on the four lower bands only moved the receiver coverage 25 kHz. As you can see, it would be extremely easy to tune right across a weak signal on 10 meters with this increased 4X tuning rate.

Both of these analog Argos exhibited outstanding CW keying which has since become the benchmark for all QRP CW rigs irrespective of who makes them. The full break-in (QSK) found on the Models 505 and 509 was an absolute joy to use for an active CW operator. Keying on these two QRP rigs is utterly flawless; switching between transmit and receive seamlessly, giving the operator a taste of true full break-in keying found only on much more expensive and higher powered radios. Once you use an analog Argonaut on CW you won't want to go back to semi-break-in, ever.

As mentioned previously the one area that both of these models can stand improvement is in the IF strip. Obviously, the engineers at Sevierville wanted to keep costs within budget and a low cost 9 MHz four-pole 2.8 kHz crystal filter would yield the best trade off between performance and price. I seriously doubt that anyone at Ten-Tec ever envisioned any of these analog Argonauts being used to do some serious DXing or contesting. Don't tell the QRP crowd that. Many QRPers desired to improve the selectivity of these rigs for that very reason and implemented some rather unique solutions to the IF selectivity problem. The Ten-Tec engineers came to the rescue and provided one of their eight-pole 2.4 kHz SSB filters, normally used as an option for the Argosy Model 525, as a drop-in replacement for the stock four-pole filter in the Argonauts. This was not a true "plug and play" mod, but required the owner to unsolder the stock filter and install the new filter and do some additional rewiring to make things work. After a quick realignment of the IF the Argonaut receiver now performed admirably, even under extreme RF stress like one would encounter on a contest weekend. I have personally done this mod to several of the 509s and 515s that I've owned and I'm here to tell you that this mod is definitely worth time and expense of doing. It makes a dramatic improvement in receiver selectivity and dynamic range. International Radio offers one of their eight-pole 2.1 kHz SSB filters in a much smaller package than the Ten-Tec filter and I have it on excellent authority that the improvement in performance is startling using this much narrower InRad SSB filter.

Five years after the introduction of the Model 509, Ten-Tec debuted the last of the analog Argonauts, the Model 515. The engineers at Sevierville made some significant improvements on this radio, which included splitting the 10 meter band into four 500 Hz segments that had the same tuning rate as the lower bands. The receiver front end was hotted up and, most noticeable of all, the color scheme of the radio was radically changed. Gone was the familiar beige and wood-grain case. It was replaced with a gold-on-black color scheme that was striking, to say the least. All the associated accessories for the Model 515 were also redesigned with the new gold-on-black color scheme. In short, this newest analog Argo was sleek and sexy. Unfortunately only about 800 of these rigs were ever produced which makes them semi-rare and they tend to be expensive on the used gear market.

One accessory for the Model 515 that was an absolute "must have" was the split-band speech processor (OK, the crystal calibrator was nice, too). This optional outboard speech processor, when properly adjusted, made the Argonaut 515 a real contender on the HF bands during contests and when trying to bust DX pileups. Unfortunately, these processors are rarer than the Model 515, so if you happen to find one, grab it, hang on to it and use it on your rig (or sell it to me!)! They are a very potent weapon in making any of the analog Argonauts into a lean, mean DXing machine.

Lacking the split-band speech processor, you can accomplish much the same end result by buying one of the Ten-Tec **T-Kits ™**, Model 1551, speech processor (about $15 less s/h at last look) and wiring it directly into the mic input circuitry of the Argonaut. Word of warning: ***Follow the instructions on adjustment to the letter.*** Failure to do so will result in your transmitted audio sounding really, ***really*** bad. There is nothing quite so ugly sounding as a mal-adjusted speech processor on a SSB rig. The object of this game is to increase your ***average*** RF output power to an acceptable level. Of course, your PA transistor will have to be robust enough to handle the added power increase. Thankfully, the finals used in the analog Argonauts (while no longer available) are underrated for their assigned task. Once properly adjusted the **T-Kits ™**, Model 1551 will increase your average RF output significantly and result in a much more competitive signal on the bands. This is a good thing. As the "Big Gun" DXers are fond of saying: "Loud is good!"

As long as we are discussing transmitted audio for SSB purposes, it wouldn't be a bad idea to procure a small three band microphone equalizer/preamp for use between the microphone and the Argonaut. In one of my ***QRP Power*** columns in QST I outlined some steps the innovative QRPer can take to modify and shape the audio input to the radio in order to accentuate the mid-range (1500-2500 Hz) frequencies to further enhance the readability of the SSB signals. It really doesn't take much of an equalizer to realize some noticeable increase in readability at the receiving end. A Berringer 602-A mic preamp/equalizer costing less than $50 will do the trick nicely.

All three of the analog Argonauts are pleasant radios to use. Their controls are intuitive, and extremely well laid out (ergonomics). While many will argue that 2.5-3 watts of RF output is hardly enough to pursue ham radio with, I, along with many Argonaut owners, will totally disagree. Over the years I have worked over 300 countries using a multitude of gear, but by far my favorite QRP rigs are the analog Argonauts. They work well, they are fun, easy to operate radios and their performance, especially on CW, is fantastic.

Introducing……"The Argonaut 509 from Hell"!

Of course, you all know what's coming next. After making all these gloriously wonderful statements about the analog Argonauts, I'm going to recount my battles with a demonically-possessed Argonaut 509, or as I call her, "The Argonaut 509 from Hell"!

Sometimes I don't know what possesses me. I have an extraordinary array of QRP gear: a FT-817, a NorCal NC-40A, an OHR 100, several SSTs, a Rockmite, a fantastic KX-1, etc. Why, then, would I want to regress and pick up a used Argonaut 509? In a word: Nostalgia. That's right. I wanna relive my yout.

After prowling around on e-bay (eech!) and e-ham, I finally located a Model 509 in Florida. The owner had two, actually, and offered me the cosmetically better looking one of the pair for $190, which was a good price for a "near-mint" condition Model 509. I jumped at the chance and sent off my money. What arrived was somewhat less than "near-mint", to say the least.

While the cosmetic condition of this 30 year old rig was indeed "near-mint", electrically this poor old Argonaut need ***intensive*** care as opposed to tender loving care!

Upon initial power up, I found several problems ranging in complexity from ultra-simple to extremely technically heavy. The easiest remedy involved the receiver pre-selector which would not hold position and tended to rotate counter-clockwise after being peaked on band noise. The “fix” was merely an adjustment of the movable RF amplifier deck plate. A couple of minutes work with a small screwdriver, repositioning the plastic guides in the front and back of the pre-selector box, and things worked as advertised.

Next, I had a general “tune around” the bands and noted that the dial calibration was off by up to 100 kHz on the lower four bands and the 10 meter band was totally dead. Not a good sign. The analog Argonauts were not designed like some rigs where the band calibration was a simple matter of adjusting the local oscillator (LO) coil/capacitor arrangement to “move” the band edges to their proper places.

The 505 and 509s used a couple of coils per band (residing on the **Oscillator** board, sub assembly 80233) that are selected by a ganged wafer switch. Each band has a dual coil assembly that, when selected by the bandswitch, is placed in series with L11, the main PTO coil, in the VFO circuit (called a Permeability Tuned Oscillator or PTO). Each band’s calibration and linearity are obtained by adjusting these top and bottom coil slugs. The primary frequency you are working with during this alignment process is around 5-6 MHz on each band. Q_4, a bipolar transistor multiplier stage, is placed behind the two isolation stages (Q_2 & Q_3) that succeed the PTO. This doubler/tripler stage takes the primary frequencies produced by VFO (Q_1) and multiplies them up to either twice or three times their original frequency where they are mixed (via the **TX/RX Mixer** board, sub-assembly 80261) with the input from the **RF Front End** board (sub assembly 80262) to produce the required 9 MHz IF frequency on each band. Both of these primary frequency adjustments on the **Oscillator** board are extremely interactive and just when you get the lower end of each band adjusted properly, you find out that you are out on the top end of that band by 25 to 50 kHz. Can you say “frustrating”? Sure you can!

In addition, I noticed that the bandswitch control (a double ganged switch arrangement that uses a physical linkage behind the front panel) was not locking up in place properly. When changing bands, I found that I had to wiggle the bandswitch several times to insure that all of the switch wafers would seat properly. Once I had the 509 disassembled and the front panel completely removed, it was a simple matter of straightening out the linkage rods between the two switches and tightening down the small Allen screws on the linkages to achieve positive bandswitching each time the switch was rotated.

Of course, the elastic “bungee” cord that is part of the dial pointer/indicator was stretched all out of whack on my “near-mint” Argonaut Model 509. This is the most common problem found on any of the analog Argonauts (as well as the Argosy and most of the early Ten-Tec analog radios). The folks at Sevierville still support all theses older radios very well and it only costs a couple of dollars for them to send you a new florescent orange plastic dial pointer, Dacron line and “bungee” cord to completely restring the dial.

Now the PTO rebuild kit for these early rigs is a different matter. That costs about $25 (at last purchase) and takes between four to six hours to accomplish. This is the second most common problem found on the analog rigs made by Ten-Tec. Word to the wise: if you purchase an analog Argonaut, plan on buying a PTO rebuild kit and at least one (preferably two) dial cord kits, because I will bet you dollars to donuts that you will end up rebuilding the PTO sooner rather than later. You might as well get it over with!

My “near-mint” 509 did not need a PTO rebuild when I received it. No, I caused that little problem all by my lonesome! In trying to linearize the tuning on 80-15 meters (remember 10 meters was still not working) and spinning the main tuning control from end-to-end on the rig, I managed to create a need for a PTO rebuild. It seems that 30+ year old grease that was used to lube the PTO coil and the reduction drive, hardened up like cement after multiple trips up and down the band. What the heck, I called Ten-Tec, spoke with Garland Jenkins (whom, by the way, is ***the*** premier source of information on the Ten-Tec analog rigs) and he had a PTO rebuild kit and a couple of dial cord kits in the mail to me, pronto. I also discussed the lack of 10 meter operation with him and received some insight as to what to look for. More on Garland later.

After a wonderful six-plus hour session, I had the PTO back together and completely rebuilt. It now tuned very smoothly, so I went back to trying to linearize the bands on the 509.

The manual is a bit fuzzy regarding exactly the proper procedure on how to accomplish the alignment. As mentioned previously, the five bands are controlled by five dual slug coils on the **Oscillator** board. This is the PC board that sits above the PTO and bandswitch, on the top side of the Argonaut chassis. There is an aluminum plate labeled with the various band coils that must be firmly secured in place using four countersunk screws prior to doing any alignment. Without the plate in place the each band’s oscillator coil will be incorrectly aligned and when the plate is replaced and secured, the oscillators will be pulled significantly off frequency. So, a word to the wise, be sure that this plate is in the proper position and adequately secured prior to accomplishing the alignment.

Each coil has a top and bottom slug and the coils must be aligned in proper sequence starting with the 10M band. Since I didn’t have the 10M band working, I started with 15 meters and worked downward to 80M. The interaction between slugs on each coil is amazing. Just when you think that you have correctly aligned that band, a trip to the top and bottom end of the band will reveal that the alignment has shifted and must be reaccomplished! Talk about an exercise in frustration! In the end I was finally able to align the 80, 40, 20, & 15 meter bands fairly well (now I know why the Ten-Tec technicians get $45/hour to do this work!). Each band, except for 10M, was tracking almost perfectly. It took a while, but in the end I triumphed!

Only a few surprises left

That is a wrap for this time, gang. Rest assured that The Argonaut from Hell has a few surprises left up her sleeve-less dress! Suffice it to say that I learned far more about these analog Argos than I ever wanted to know while troubleshooting the problems encountered on this rig. On the bright side….at least I can laugh about it!

Vy 72/73 Rich K7SZ

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AmQRP.ORG HOMEBREWER

Ken Newman, N2CQ

QRP Contesting Calendar

June - July - August 2005

Wake-Up! QRP Sprint (CW) ... QRP Contest!
Jun 4, 0400z to 0600z
Rules: http://ruqrp.narod.ru/index_e.html

VK/trans-Tasman Contests (80M CW) ... QRP Category
Jun 4, 0800z to 1400z
Rules: http://home.iprimus.com.au/vktasman/RULES.HTM

IARU Region 1 Fieldday (CW) ... QRP Category
Jun 4, 1500z to Jun 5, 1459z
Rules: http://www.sk3bg.se/contest/iarur1fd.htm

QRP TACtical Contest (CW/SSB/PSK) ... QRP Contest!
Jun 4, 1800z to 2359z
Rules: http://www.n3epa.org/Pages/TAC-Contest.htm

Adventure Radio Spartan Sprint (CW) ... QRP Contest!
Jun 7 , 0100z to 0300z (First Monday 9 PM EDT)
Rules: http://www.arsqrp.com/

GACW WWSA CW DX Contest (CW) ... QRP Category
Jun 11, 1500z to Jun 12, 1500z
Rules: http://gacw.no-ip.org/contest.html

ARRL June VHF QSO Party QRP Portable Category
Jun 11, 1800z to Jun 13, 0300z
Rules: http://www.arrl.org/contests/calendar.html?year=2005

NAQCC WEEKNIGHT 40/80-METER SLOW SPEED SPRINT (CW) ... QRP Contest!
Jun 15, 0030z to 0230z
Rules: http://www.arm-tek.net/~yoel/sprint_0506.html

West Virginia QSO Party (SSB/CW)... QRP Category
Jun 18, 1600z to Jun 19, 0200z
Rules: http://www.qsl.net/wvarrl/wvqp.html

Quebec QSO Party (All) ... QRP Category
Jun 18, 1700z to Jun 19, 0300z
Rules: http://www.raqi.ca/qqp/regs.html

Run For The Bacon (CW) ... QRP Contest!
Jun 20, 0100z to 0300z
Rules: http://fpqrp.com

SP QRP Contest (CW) ... QRP Contest!
Jun 25, 1200z to Jun 26, 1200z
Rules: http://www.sk3bg.se/contest/spqrp.htm

Marconi Memorial Contest (CW) ... QRP Category
Jun 25, 1400z to Jun 26, 1400z
Rules: http://www.qsl.net/ik6ptj/

ARRL Field Day (CW/SSB/RTTY)... QRP Category
Jun 25, 1800z to Jun 26, 2100z
Rules: http://www.arrl.org/contests/calendar.html?year=2005

QRP ARCI Milliwatt Field Day (ALL)... QRP Contest!
Jun 25, 1800z to Jun 26, 2100z
Rules: http://www.qrparci.org/contest.htm

QRP BARBERSHOP QUARTET CONTEST (CW QRP)... QRP Contest!
Jun 29, 9PM to 11PM EDT
Rules: http://www.io.com/~n5fc/barbershop_contest.htm

RAC Canada Day Contest (CW/SSB) ... QRP Category
Jul 1, 0000z to 2359z
Rules: http://www.rac.ca/service/infocont.htm

"RUN WITH RAC" for more awards from QRP-Canada
See http://www.qrp-canada.com/

Original QRP Contest (CW) ... QRP Contest!
Jul 3, 1500z to Jul 4, 1500z
Rules: http://www.qrpcc.de/contestrules/oqrpr.html

MI QRP Fourth of July Sprint (CW) ... QRP Contest!
Jul 4, 2300z to Jul 5, 0300z
Rules: http://www.qsl.net/miqrpclub/contest.html

Adventure Radio Spartan Sprint (CW) ... QRP Contest!
Jul 6, 0100z to 0300z (US/Canada Monday evening)
Rules: http://www.arsqrp.com/

***IARU HF World Championship (CW/SSB) ... QRP Category**
Jul 9, 1200z to Jul 10, 1200z
Rules: http://www.arrl.org/contests/calendar.html?year=2005

UK DX Contest (RTTY) ... QRP Category
Jul 10, 1200z to Jul 11, 1200z
Rules: http://www.srars.org/ukdxcruleseng.pdf

FISTS Summer Sprint (CW) ... QRP Category
Jul 10, 1700z to 2100z
Rules: http://www.fists.org/sprints.html

QRP ARCI Summer Homebrew Sprint (CW) ... QRP Contest!
Jul 11, 2000z to 2400z
Rules: http://2hams.net/ARCI/index.htm

VK/trans-Tasman Contests (160m) ... QRP Category
Jul 17, 0800z to 1400z
Rules: http://home.primus.com.au/vktasman/

AGCW-DL QRP Summer Contest (CW) ... QRP Contest!
Jul 17, 1500z to Jul 18, 1500z
Rules: http://home.online.no/~janalme/rules/agcwdl.txt

North American QSO Party (RTTY) /QRP Entries Noted
Jul 17, 1800Z to Jul 18, 0600Z
Rules: http://www.ncjweb.com/naqprules.php

CQ WW VHF Contest (All, 6 & 2 Meters) ... QRP (10W) Category
Jul 17, 1800z to Jul 18, 2100z
Rules: http://www.cq-amateur-radio.com/infoc.html

RSGB Low Power Field Day (CW) ...QRP Contest!
Jul 18, 0900z to 1200z
Jul 18, 1300z to 1600z
Rules: http://www.contesting.co.uk/hfcc/rules/rqrp.shtml

Colorado Gold Rush (20 mtr CW QRP) ... QRP Contest
July 18, 2000z to 2200z
Rules: http://www.cqc.org/contests/

Run For The Bacon (CW) ... QRP Contest!
Jul 19, 0100z to 0300z
(Sunday 9PM to 11PM EST)
Rules: http://fpqrp.com
[Third Sunday 9:00 PM to 11:00 PM]

Islands On The Air Contest (CW/SSB) ... QRP Category
Jul 24, 1200z to Jul 25, 1200z
Rules: http://www.contesting.co.uk/hfcc/rules/riota.shtml

Flight of the Bumblebees (CW) ... QRP Contest!
Jul 25, 1700z to 2100z
Rules: http://www.arsqrp.com/

Adventure Radio Spartan Sprint (CW) * QRP CONTEST! *****
Aug 2, 0100z to 0300z (First Monday 9 PM EDT)
Rules: http://www.arsqrp.com/

Ten-Ten QSO Party (PH) ... QRP Category
Aug 6, 0001z to Aug 7, 2359z
Rules: http://www.ten-ten.org/calendar.html

TARA "Grid Dip" Contest (PSK/RTTY) ... QRP Category
Aug 6, 0000z to 2400z
Rules: http://www.n2ty.org/seasons/tara_grid_rules.html

North American QSO Party (CW) ... 100W Max. (/QRP noted on entry)
Aug 6, 1800z to Aug 7, 0600z
Rules: http://www.ncjweb.com/naqprules.php

Maryland/DC QSO Party (SSB/CW) ... QRP Category
Aug 13, 1600z to Aug 14, 0400z
Aug 14, 1600z to Aug 14, 2359z
Rules: http://www.w3cwc.org

North American QSO Party (SSB) ... 100W Max. (/QRP noted on entry)
Aug 20, 1800z to Aug 21, 0600z
Rules: http://www.ncjweb.com/naqprules.php

RUN FOR THE BACON (CW) * QRP CONTEST! *****
Aug 22, 0100z to 0300z
Rules: http://fpqrp.com

Ohio QSO Party (CW/SSB) ... QRP Category
Aug 27, 1600z to Aug 28, 0400z
Rules: http://www.oqp.us/

QRP BARBERSHOP QUARTET CONTEST (CW QRP)... QRP Contest!
Aug 31, 2100 EDT to 0300 EDT
Rules: http://www.io.com/~n5fc/barbershop_contest.htm

Thanks to SM3CER, WA7BNM, N0AX(ARRL), WB3AAL and others for assistance in compiling this calendar.

Please foreward the contest info you sponsor to N2CQ@ARRL.NET and we will post it and give it more publicity.

Anyone may use this "N2CQ QRP Contest Calendar" for your website, newsletter, e-mail list or other media as you choose. (Include a credit to the source of this material of course.)

QRP Contesting "Tips & Techniques"

I may not have anything new in contesting but it wouldn't hurt to review on these points. Anyone with more to add, PLEASE DO, and we'll add your input to the review.

ANTENNAS, ANTENNAS and ANTENNAS. Many would agree that antennas are the first three things to improve our results in contesting for any kind, whether Sprint or Contest.

Sample of the above:

QRP Afield '96 was won easily by AC5AM, Bob Stolzle. Having been in the contest, we wondered how it could be that this guy was S9 the whole contest, and always there sending 950 MW power. Now we know. The complete story was published in the "72" of Jan. '97. Again, antennas. He found the highest point in the area which just happened to have an old, unused broadcast radio tower. He raised two full wave delta loops (20 and 40 meters) and inverted vee's (20/40 mtrs) at the 100' level. A coax switch is used to choose the best antenna for the incoming signals.

The 100' level probably made the difference, being a strong signal from a QRPp station. His point too is that resonant antennas do much better than those with tuners. The idea was to call CQ on the loop. If no answer, call CQ on the Vee, and so on. If answered on a weak signal, switch to the other one if received better.

Now on to the rest of the real QRP World. Not many are going to find an unused 100+ foot tower to raise these types of antennas. Given that for the Contest type of event, the next thing would be the Op.

For the Op, the biggest thing would be the amount of operation time he is having fun with. Very few put in the 24 hours for the QRP ARCI Spring and Fall contests. The ones in the "TOP TEN" list reached that level according to the hours spent, assuming they are more than average stations. How do they do that? First one have to have the desire. It becomes less desirable at the 15 hour level unless you had plenty of sleep before the contest. To stay there, you have to have the necessary operator comforts. You know what they are for you. Things like a comfortable chair and headphones will take you further.

The first thing that took me to longer operating duration was the memory keyer. With this you can be relaxed much longer and your fist won't give out.

In recent years, computer logging will go even further. I use "NA" for the QRCI contests. When calling CQ, you can set a repeat every few seconds. All you need do is listen. If a station is answering, press the "ESC" key to stop the repeats, and enter his callsign. Press the "INSERT" key, and the station is answered and your info is sent. (You can input an RST if you wish). Enter his info and press the "=" key and you have sent an OK and a QRZ. That is it. (Except the log that is printed at the end.) Given that, you could be there a much longer time.
What else for the operator? **Practice, practice, and practice!** The more you do the better you get.

There are some excellent links to more contest tips. I would recommend the K3WWP link first. If you have been in contesting, chances are you worked John. He is using a homebrew QRP tube transmitter with an indoor antenna. If you don't have the antenna like AC5AM had, you can relate to K3WWP. Look for his tips at:
http://home.alltel.net/johnshan/contest_ss_tips.html

After that, you may want to check the tips from the top contesters. Check them out at: http://www.contesting.com. This is not QRP but many of the suggestions will help us all in contesting. This covers the pre-contesting, equipment, operating, and post-contesting. Most tips assume that you are running a KW, beams and contest software.

Anyone have more QRP contesting tips? I'm sure all would like to hear about them and we'll add any that can help us along.

CU in the next 'test!

72/73,
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http://www.amqrp.org/contesting/contesting.html

http://www.n3epa.org/Pages/Contest/contest.htm

Randy Foltz, K7TQ

Contesting: Look Around In The Field (LAITF)

Look Around In The Field (LAITF) was held May 22, 2004. This operating event added the dimension of having to do more than simply operate your radio.

We gave points for seeing then sending the name of wildlife you observed. You could also get points for each different wildlife that you copied from other participants. Finally we included the first letter of the name of the other operators you contacted. To score high you had to do more than just operate the radio.

There were categories for both home-based and field-going operators. Each of these were divided into single op and multi-op classes. No one reported having operated from home. N5IB, KD5UDB, and WA5TCZ operated Field-MultiOp from Louisiana State University using the call K5LSU. Everyone else who reported was single op from the field.

Just out of interest, I divided the animals seen into amphibians, birds, insects, mammals, and reptiles. Birds lead the way with 38%, followed by insects and mammals with 25%. The most noteworthy in the insects was a cicada who must have known we were looking for wildlife! Armadillo and black bear caught my eye from the mammals list. A gecko made the reptile list. He must have been seen at home since I think they are not native to the US!

As in any contest those who make the most contacts finish close to the top. The multi-op team of N5IB, KD5UDB, and WA5TCZ made 27 QSOs and claimed top score honors with 28,728 points. The best showing by a single op was WA8REI/P who made 14 QSOs and scored 5,400 points.

Category	Rank	Callsign	State	Category	QSOs	1st letters	SPC	WNSent	WNRcvd	Score
Field-Multi Op	1	K5LS	LA	F-M	27	15	19	14	22	28728
Field-Single Op	1	WA8REI/P	MI	F-S	14	11	8	13	14	5400
Field-Single Op	2	AD6GI	CA	F-S	13	7	7	2	12	1960
Field-Single Op	3	AA7EQ	AZ	F-S	10	8	7	5	9	1764
Field-Single Op	4	K7TQ	KY	F-S	7	6	6	7	7	1092
Field-Single Op	5	W2AGN	NJ	F-S	6	4	5	6	6	600
Field-Single Op	6	N6IZ	NV	F-S	5	5	5	1	5	300
Field-Single Op	7	N0EVH	MO	F-S	2	2	2	1	2	24
Field-Single Op	8	AK1P	CA	F-S	2	2	2	1	2	24
Field-Single Op	9	K2EKM	VA	F-S	1	1	1	1	1	4

LAITF Soapbox

N6IZ - Operated from Boundary Peak, NV @ 11000 ft. Too windy on top to put up antenna. Moved below ridge and used bristlecone pines as cover. Very quiet perch, but not too many on the air. 40 m seemed void of contesters, 20 was the only active band. Stunning views of desert and Sierra's in spring.

K2/2lb vert-all band. Only saw a lizard and lichen.

AD6GI -Wow! Fun contest; however, should have read the rules earlier and in more detail. Dah!

K5LSU - K2 & K1 with 44' doublet and BuddiPole. Ops were Jim (N5IB), Chris (KD5UDB), and Darron (WA5TCZ). Operations from the grounds of the BREC/LSU/BRAS Highland Road Park Observatory.

K2EKM - Listened for activity several times. Heard only 2 and worked 1. Bands seemed poor.

W8REI/P - QTH: Whiting Overlook, Midland, MI about 80 ft. above tabletop-flat terrain...manmade hill made from excavation of power plant cooling ponds; op'd out of my Winnebago Rialta motor home. RIG: FT-817, 5 watts, ANTS: 20 m. inv. vee 30/15 ft; Hustler 4BTV Vertical gnd mtd on MFJ-1904 plate in wet soil no radials. Bad QRN from t-storms; 15 m. dead; one 40 m. QSO; all others on 20m. Still, fun! I liked the exchange! Wx: 55-70 F./scattered T-storms/overcast/SE wind 8 mph. Picked a tick out of my hair (side of balding head) for one animal sent. Hi Hi.. Saw 11 BIG wild turkeys!

AA7EQ - Equipment was a K1, PAC 12 short vertical, Palm paddle, 4ah gel cell with a 5w solar panel. The PAC 12 worked well getting contacts on both coasts. I operated from Rucker Canyon campground, in the Chiricauhua Mountains of SE Arizona. The solar panel kept the battery fully charged through a 4 hour period.

N0EVH - Operated mobile from graduation ceremonies with FT-817 at 5 watts to hustler on the truck. Sri cud not play more. Thanks for contest.

K7TQ - I operated for an hour during a break from work while at Land Between the Lakes, KY. I had more wildlife names to send than I had contacts to send them to. The K5LSU gang sure was going strong.

Ken Newman, N2CQ

2004 Fall NJQRP Homebrewer Sprint

Hi All,

Here are the results for the 2004 Fall NJQRP Homebrewer Sprint. Look for the next Homebrewer Sprint on USA Sunday evening on March 28, 2005 0000 UTC. Additional info is planned on the NJQRP website and/or future Homebrewer CD.

I hope all enjoyed the sprint!

72 de Ken N2CQ@ARRL.NET

2004 Fall NJQRP Homebrewer Sprint Results						
Call	Mode	QSOs	Points x	SPCs x	PWR =	Score
N9NE	CW	97	388	52	7	141,232
N4BP	CW	78	312	41	7	89,544
K3ESE	CW	68	272	36	7	68,544
K4BAI	CW	85	112	49	7	58,310
K7TQ	CW	44	168	29	7	34,104
KØZK	CW	42	168	28	7	32,928
W5KDJ	CW	24	96	22	15	31,680
AD6GI	CW	36	144	31	7	31,248
WØUFO	CW	41	164	26	7	29,848
K8DDB	CW	34	136	29	7	27,608
WA8REI	CW	48	96	32	7	21,504
KB2FEL	CW	30	120	19	7	15,960
WA3FAE	CW	27	108	18	7	13,608
NJØE	CW	22	88	20	7	12,320
KD5UDB	CW	18	74	16	10	11,520
N9LTV	MIX	22	88	18	7	11,088
N7CEE	CW	16	64	14	7	6,272
KH6B	CW	14	56	14	7	5,488
VE7NI	CW	12	48	11	7	3,696

K4AQ	CW	18	36	14	7	3,528
KE2WB	CW	11	44	11	7	3,388
WB7AEI	CW	10	40	8	10	3,200
WØOOW	CW	9	36	8	10	2,880
WB9JTK	CW	11	44	9	7	2,772
N2CX	CW	6	24	5	7	840
W1PID	CW	5	20	5	7	700
NI8W	CW	5	20	5	7	700
Check Log:						
WQ2RP	CW	56	198	35	7	48,610
OP N2CQ						

-----------------------OPERATOR COMMENTS---------------

N9NE:
I had quite a day. Up at 2:30 am to drive to neighboring city for 6 am running of 26.2 mile marathon. Dragged across finish line at 11:16 am. (no 2:04 ET for this 61 year-old!). Home to nap and partially recuperate. Up at 5:30 pm to eat and get rig and computer set up for the sprint. Four hours of fun, and finally to bed at midnight.Rig is K2 @ 5 watts to quad-band beam and 176' doublet. High points: working John, K4BAI, on three bands, and Dean, KH6B on 40 meters.
Nice to work some new calls/faces as well as the regular QRP crowd!
de Todd, Oshkosh, WI

N4BP:
Rig : Elecraft K2
Antennas : 40M Dipole @ 35ft
All antennas taken down for Charley, Frances, Ivan, Jeanne, etc. Put back up my 40M dipole for the Sprint. 20M usually my best band, but dipole performance not very good there.
de Bob, Plantation, FL

K3ESE:
Setup: multiPIG+ at 5W into an 88' EDZ up 45', on 20M, and a 302' horizontal loop on all three bands, up about 50', both fed with balanced line and tuned with
a ZM-2. Very fun event, but...long! Very tired at the end, about to doze. I've seen better conditions, and also worse, so it was not too bad, skip-wise. Nice to
work Ken, at the Mothership!
72 es oo, Lloyd, Reisterstown, Maryland

K4BAI:
Rig: Yaesu FT1000MP, 4W. Ant: TH6DXX Beam & Inverted V dipole.
I enjoyed it even though I don't have any homebrew gear. QRN built toward the end and activity dropped, so I didn't stay for the last 45 minutes, hi.
73 de John, Columbus, GA

K7TQ:
de Randy, Moscow, ID

KØZK:
I operated from home QTH using indoor 20 metre dipole on 20 and 40 metres. Elecraft K2 s/n 692.
Condx poor until last hour, but did work KH6B on 20 which was nice.
72 de Arn, Lebanon, ME

W5KDJ:
K1-4 at 249MW, ANTENNA(S): Mosley 7 element.
Bands open to the west, worked KH6B. Had good time but I was to tired to complete entire contest.
de Wayne, Spring, TX

AD6GI:
Rig: Elecraft K2, 5 watts
Antennas: 15M, 40M and 80M - 40M short dipole up 40 feet
20M - Dipole up 25 feet
Nice cndx for test. Gud openings to east coast. Tnx to all for great ears and ur patience with me.
Looking forward to the next one.
73, Chuck, Sunnyvale, CA

WØUFO:
Used K-1 at 5W to 20M dipole and 40M tuner to 180ft wire. from cabin at Pine County MN.
Thanks for another good Sprint.
de Mert, Pine County MN

K8DDB:
Rig: Sierra, POWER OUTPUT 5 watts
ANTENNA(S): G5RV at 37 feet
I had a good time in the contest and worked a new state for 80 meters W.A.S. as a bonus. I'd forgotten how much fun my Sierra is!
de Mike, Vulcan, MI

WA8REI:
Operated out in the wilderness on a hilltop using battery power, but inside my 21 ft motor home. Lots of fun but not many stations heard in call districts 1, 3, 6 and 7. W5KDJ's 250MW was FB!
73,72 and oink-oink to all!
Ken, Ogemaw County, MI

KB2FEL:
HW-9 (20-40-80M) 4 Watts. 4BTV vertical and G5RV
de Bob, Valley Stream, NY

WA3FAE:
My rig is an Elecraft KX1 using a 88 foot EDZ at 35 feet with an LDG RT-11 tuner. I forgot this was Contest night! It's very enjoyable to work fellow QRPers. Everybody works hard to dig weak stations out of the mud, seeings how we are all in the same mud pit! Can't wait for next year.
de Forrest, Woodbine, MD

NJØE:
Rig: ten-tec t-kit 1320 (3W)for 20m, and a small wonder labs sw40+ (2W)for 40m.
The antenna was an 80m horizontal loop. I was still pooped from my QRP entry in the Texas QSO Party. Many thanks for sponsoring a fun event!
73, Scott, Dripping Springs, Texas

KD5UDB:
Hello all,
Had a great time as usual. I decided to try this Sprint at 1 watt and found that although I had to repeat a few exchanges, everyone I heard, I worked!. Lloyd - K3ESE and Bob - N4BP were "blowing my headphones off" loud into S. Louisiana as usual, and worked them both on 20 and 40 meters. Thanks to everyone who made this possible. My rig was a K1 on internal batteries and turned down to 1 watt.
The antenna was my usual 20 and 40 meter fan dipole installed about
20 feet high over the roof of the house.
de Chris, Baton Rouge, LA

N9LTV:
Rig: K-1, PSK20 & Dipoles
Worked only 20 and 40. A fun contest! Wish I would have worked the entire time. Worked 2 PSK stations on 20 but they weren't in the contest. Wish there were more.
de Rod, Carterville, IL

N7CEE:
Rig: Elecraft K-2 @ 5W.
Antennas: 170 foot 80 foot end fed wires with 66' counterpoise.
I operated from the Pine Forest Range in NW Nevada during a photo shoot for a book project.
72 de Bruce

KH6B:
Rig: K-2, internal battery, NORCAL paddles, RS PRO-35 headphones.
Antenna: 284' sloping Diamond Loop.
Nice sprint. Worked 'ME' to 'CA' and 'WA' to 'GA'. I even have 'HI' in my log!
72, Aloha de Dean, Hilo, HI

VE7NI:
Rig is Ten Tec 1340 QRP kit with 5 watts output power.
Antenna is a 40M inverted vee 40' at the apex.
Great fun with QRP as usual and lots of good operators!
de John, Kamloops, BC

K4AQ:
Yaesu FT-897 transceiver operated at 5 watts into an OCF 28-gauge insulated wire stealth antenna up 40 feet in heavy foliage trees next to I-75 in downtown Atlanta industrial area. SGC SG-237 Smartuner. WriteLog 10.48f.
de Matt, Atlanta, GA

KE2WB:
Rig: K2
Operating Time = 1.2 hours
Also used a homebrewed logging program
de John, Augusta, GA

WB7AEI:
Same equipment as usual (HB superhet RX, 1W VFO TX, and all HB accessories) less the 5 watt power amp. Must say I was pleased at how the 1 watt got out, especially with the EFHWA antenna up 17 feet at the highest. The band seemed good actually, although signals weren't strong. Worked more than ever before, although some like N4BP just weren't possible.Highlight was hooking up with WQ2RP, although it must have taken 5 minutes and 50 repeats of my call to get thru.
Thanks for the fun!
72's, Phil, Kent, WA

WØOOW:
Rig: SWL20 POWER OUTPUT 1W.
ANTENNA(S): 3/2 WAVE
Stuck on 20 gggrrrrrrrrr
de Steve, Johnson NE

WB9JTK:
Elecraft KX1, kit.... 3 watt output. Second hurricane went by Saturday. Antenna was a dipole 13 feet in the air in the middle and 5 feet on the ends. Ran rig from a car battery. Glad it had a "logging light" in it! I ordered it right after hurricane Frances. When electricty came back on I built it and had some fun. Then the next hurricane came by. No damage to the house, but no electricity so I was sure glad I had this rig since there was nothing else to do for many days.
73 de Alan, Delray Beach, FL

W1PID:
Rig: DSW 40 2W. Antenna: Windom OCF Dipole
Thanks!
de Jim, Sanbornton, NH

WQ2RP: (N2CQ opr)
Many thanks for your interest and activity in the Homebrewer Sprint. The rig here is the K1-4 at 5 watts on 20m and 40m and a Kenwood TS-850sat for 80m. The antenna is a random end fed wire (40m-80m) and TA33jr tribander (20m). Hope to see you again in the next NJ QRP Homebrewer Sprint on Mar 28, 2005 0000z
72 de Ken, Woodbury, NJ

2005 Spring NJQRP Homebrewer Sprint

Ken Newman, N2CQ

Hi All,

Here are the results for the 2005 Spring NJQRP Homebrewer Sprint. Look for the next Homebrewer Sprint on USA Sunday evening on September 26, 2005 - 0000 UTC. Additional info is planned on the NJQRP website and/or future Homebrewer CD.

I hope all enjoyed the sprint!

72 de Ken N2CQ@ARRL.NET

2005 Spring NJQRP Homebrewer Sprint Results

Call	Mode	Points	X SPCs	QSOs	X PWR	= Score	
WN1GIV	CW	93	372	60	7	156,240	(Op:N4BP)
K0ZK	CW	69	276	45	7	86,940	
W0UFO	CW	64	256	38	7	68,096	
N0NTA	CW	60	240	37	7	62,160	
W5TVW	CW	43	157	36	7	39,564	
N8XI	CW	44	176	26	7	32,032	
W5ESE	CW	31	124	26	7	22,568	
N0TK	CW	30	120	23	7	19,320	
NR7F	CW	29	116	20	7	16,240	
VE3XT	CW	26	104	20	7	14,560	
K7RMJ	CW	26	104	20	7	14,560	
W7GB	CW	26	104	19	7	13,832	
N9LTV	CW	24	96	20	7	13,440	
W2LJ	CW	25	100	19	7	13,300	
NG7Z	CW	17	68	16	7	7,616	
K4GT	CW	13	52	13	7	4,732	
W1PID	CW	9	36	8	7	2,016	
W3DP	CW	7	28	7	7	1,372	

K6IMZ	CW	11	22	8	7	1,232	
KW4JS	CW	7	28	6	7	1,176	
KD5CMN	CW	7	14	7	7	686	
N8RN	CW	4	16	4	10	640	
N5SPE	CW	4	16	4	7	448	
VE3NXB	CW	1	4	1	10	40	

Check Log:

WQ2RP NJQRP Club Station	CW	51	192	35	7	47,040	(Op:N2CQ)

----------------------OPERATOR COMMENTS---------------

WN1GIV:
Club Florida Contest Group
Software: N1MM Logger V5.0.52
Rig : Elecraft K2
Antennas : TH7-DX, 40M Dipole, 80M Dipole
de Bob, (N4BP), Plantation, FL

K0ZK:
Rig: Elecraft K2 s/n 692, 5 Watts.
Activity was pretty good while conditions were generally lousy. There was a lot of static crashes and signals were mostly weak although the west coast seemed to come in alright and I was able to snag Montana, WA, CA, OR, SD AB, AZ and 8P6 on 40 metres. The antenna was a military 30 foot mast made of 33 inch aluminum sections. The antenna is a few feet above ground sitting on a wine bottle insulator with 5 radials. A homebrew antenna coupler tunes this vertical well on 40, 30, 20, 15 and 10 meteres. It does fine on DX but just does not work for close-in states. I can't hear anyone in New England, NJ or nearby NY with it. I should put up a low dipole for those nearby states. I used a new key: a Bengali which I love. I never thought anything could better my Schurr. The Bengali is not better, butit is just as nice to send CW on it as the German paddle.
72 de Arn, Lebanon, ME

W0UFO:
I was using a K2 at 5W to a TA-33 stuck S.E. on 20M and a 120 ft zepp on 40M.
de Mert, St. Paul, MN

W0NTA:
Enjoyable contest even after eating too much at the Easter table with family. I used my trusty K2 and Force 12 Sigma-40XKR vertical antenna. Band conditions seemed very good, especially on 40 meters. I worked approximately 3 of the 4 hour contest. Thanks for a great

contest.
73, Dick, Greeley, CO

W5TVW:
Elecraft K1 POWER OUTPUT 5
ANTENNA(S): 135' Zepp at 50' fed with 450 ohm line.
Enjoyed contest. 20 wasn't good, but made a few there. 40 very noisy with QRN but did OK considering. Called and called on 80 and made more multipliers in spite of the heavy QRN. Hope to see everyone next time.
72 to all! Sandy, Hammond, LA

N8XI:
Elecraft K2 XCVR, 5W
40 Meters was in great shape, except for a little QRN (rain from the south)
72 de Rick, Taylor, MI

W5ESE:
This was my first time to participate with my new call (W5ESE). I was previously 'NJ0E'. I added 80 meters to my collection of kit gear with a Ten-Tec TKIT 1380 (4 watts). Continued using my Ten-Tec TKIT 1320 for 20 meters (3 watts) and my Small Wonder Labs SW+ for 40 meters (2 watts). My antenna is a 300' Horizontal Loop.
72, Scott, Dripping Springs, TX

N0TK:
Rig: K2 #3652 set at 5w Ant: Attic Dipole Heard WQ2RP, W5TVW and W0UFO on 80m but no antenna up to try to work them. Best signal heard was K0EVZ in the first hour of the sprint. All contacts were on 40m CW.
72 Dan, Highlands Ranch, CO

NR7F:
Station: Elecraft K2 at 5W. Antennas: single-band dipoles.
In mid-March I completed my second QRP rig, a K2. Having this radio has generated a lot more interest in QRP events, so when I stumbled upon the QRP Homebrewer Sprint, I could not pass it up. This was the first contest I made a serious effort at. I was not even sure if I would put more than about an hour into it , but at about 6:30 pm the activity on 40 meters was sufficient enough that I decided to make a go of it.
de Michael, Bothell WA

VE3XT:
The rig was a K1 to a homebrew vertical running 3W. Conditions were good for the entire contest and it was long enough to enjoy the benefits of shifting propagation to various areas in the south. Had a great time, thanks.
de Bill, Thunder Bay, ON

K7RMJ:
The receiver I used is a home brew 160 meter receiver with CA3028A mixer, a single

MC1350P IF amp and has a 455KHz IF. The receiver is used as a "tunable IF" with an outboard home brew 40 meter converter installed in an Altoids tin. My workbench power supply smoked on Saturday afternoon, so I had to resort to a 12V gel-cell for the contest. Transmitter is homebrew VXO controlled from the pages of QRP Classics. Antenna is an inverted el up 25 ft. An electrical storm rolled through the area about 19:00z so had to stop for a half hour in the middle of the sprint, but had a ball anyway. Let's do it again!!
Regards & 72's, Frank, MURFREESBORO TN

W7GB:
Equipment: Elecraft K1, A3 Tribander, R7 Vertical Nice contest. Keep up the good work.
73, Don, Moses Lake, WA

N9LTV:
Rig: K-1 & Dipoles 20 & 40m
I always have a lot of fun on these Homebrewer Sprints. One of these days I'll be able to participate for the entire 4 hours!
de Rod, Carterville, IL

W2LJ:
Equipment used: K2 @ 5 Watts to a G5RVI got a late start due to Easter company staying on into the evening; but once on the air, I found plenty of stations to work. 20 Meters was dead and 80 Meters had a high QRN noise level, which was a disappointment. It was good to hear a lot of stations on the air on a holiday evening. I'm looking forward to the next one!
Thanks, Ken!
73 de Larry, SOUTH PLAINFIELD, NJ

NG7Z:
Rig Elecraft K1 @ 5W
I was only able to fit in one hour due to other commitments. Fun contest. Will look forward to the next one.
73 de Paul, BOTHELL WA

K4GT:
Rig: Elecraft K2 @ 5W
de Jim, Atlanta, GA

W1PID:
Rig: Rig DSW-20 and DSW-40 2 watts ea. Ant. Windom OCF dipole
Thanks!
de Jim, Sanbornton, NH

W3DP:
Station: K1 at 5W output to G5RV at 25 Feet inverted Vee. NJQRP member #427. I was looking forward to this event, but gave up early due to the heavy QRN crashes. Thought I would turn in a log to show I at least participated. Hope conditions are better next time.
73, Dick, Camp Hill, PA

K6IMZ:

Operating using a Kenwood TS2000 at 5W into a High Sierra Screwdriver at 15 feet up. First time in a QRP/CW contest, what a kick! Not a serious effort, just wanted to get my confidence back on CW. Condx and local noise not great but was surprised by reports. I think I am in my own class: LPCA, (Low Power Crummy Antenna)! I hope to have my homebrew 6AG7 osc. and S-38B going by the September contest. How about a class for homebrew xmtr and pre-1960 rcvr? A lot of us are re-living our novice days with similar rigs. Thanks for the opportunity to have so much fun!
de Paul, Surprise, AZ

KW4JS:

Rig: Elecraft K2 running 5 watts into a R7000 vertical. Big thunderstorms at this QTH which resulted in not vy much sprint.
de John, KINGSTON TN

KD5CMN:

I used a commercial transceiver (FT-817) and ran 5 watts to an 88 foot dipole, so 2 points per QSO. I wasn't aware of which contest it was, I was just cruising around the bands waiting for supper. I could have used my Norcal 20 and doubled my point count. It's great to hear lots of QRP signals on the air.
Thanks and 73 de Mike, LAKE JACKSON TX

N8RN:

Rig: Sierra operated off a small solar charged battery
Pwr Out: 800 milliwatts
Ant: Inv. Vee up 24 feet I had to entertain relatives over Easter weekend so I was only able to get late into the contest for around 20 minutes. It was fun while it lasted. QRP operators are the best. I especially appreciate NR7F way out in Washington state picking up my weak signal. Good ears.
de Roy, Englewood, OH

N5SPE:

Rig: Elecraft K1 @ 5w
Thanks!
de Jim, Brandon MS

VE3NXB:

First time entry in this sprint. I had only limited time to have fun with my 40 meter unmodified Rock Mite. I only worked one CW fairly strong signal station, WQ2RP. May work 5w multi band next time. Thanks for the opportunity to enjoy the CW sprints.
de Greg, Kitchener, ON.

WQ2RP: (NJ QRP Club Station, N2CQ opr)

Many thanks for your interest and activity in the Homebrewer Sprint. The rig here is the K1-4 at 5 watts on 20m and 40m and a Kenwood TS-850sat for 80m. The antenna is a random

end fed wire (40m-80m) and TA33jr tribander (20m). Hope to see you again in the next NJ QRP Homebrewer Sprint on Mar 28, 2005 0000z
72 de Ken, Woodbury, NJ

Ken Newman
Woodbury, NJ
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