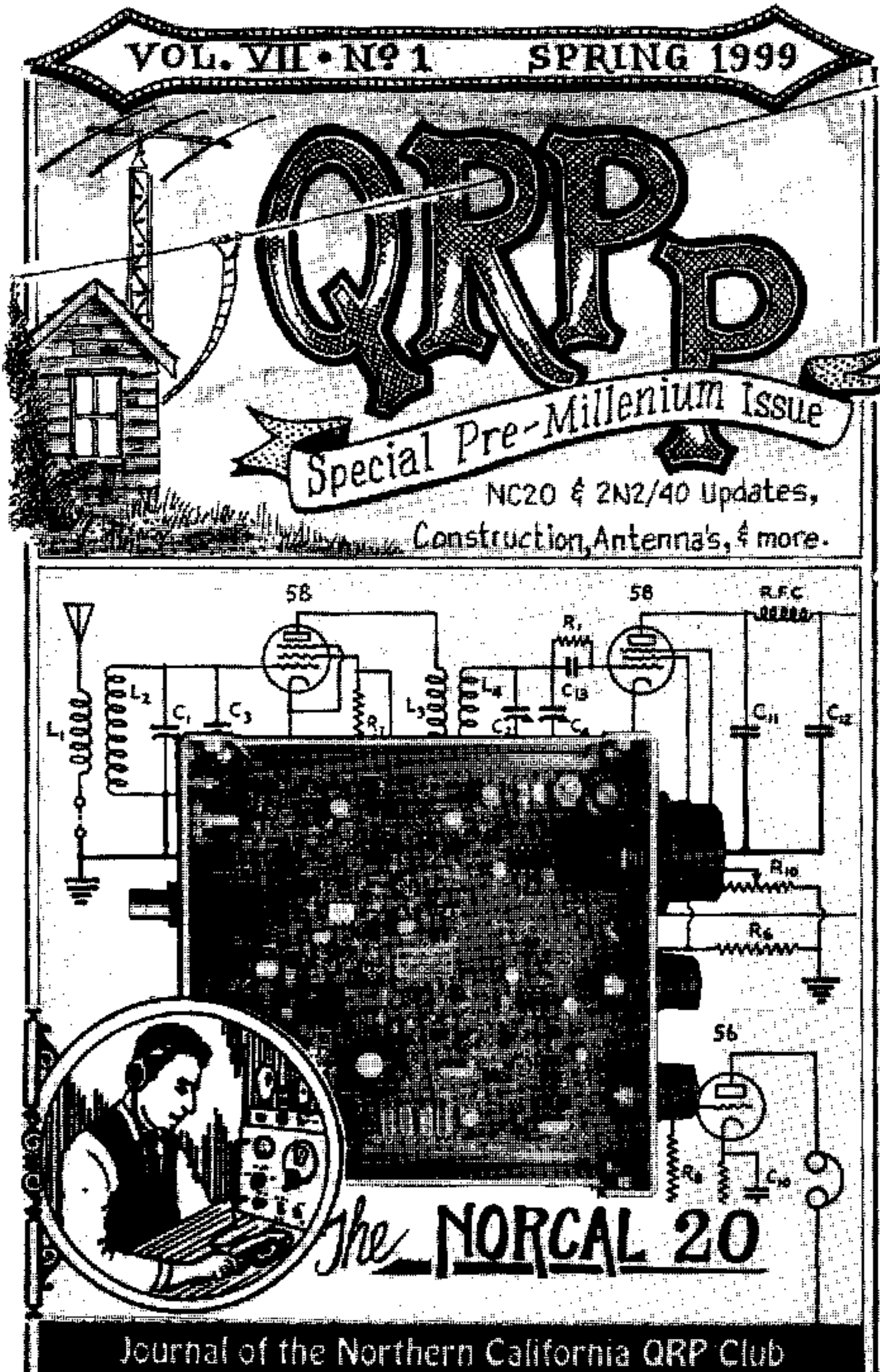
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Special Pre-Millenium Issue
NC20 & 2N2/40 Updates,
Construction, Antenna's, & more.
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From the Editor

by Doug Hendricks, KI6DS

Just a very short column this time, as there is so much to print and so little space available. We wanted to provide you with some projects to build using the Manhattan style of construction that was featured in the last issue, and believe that we have done it here. Note that the back issues for 1998, Volume 6 are now available, but the price has gone up to $20 for the book, $4 for P&H in the US, higher for DX. Please see the inside back cover for details.

We realize that the past two issues have been out later than we would prefer, but we are doing this as a hobby, we are a club publication, and we ask for your patience and understanding. We do make every effort to be on time, but sometimes we don't make it. Thank you for your support. Congratulations to Dave Benson, Paul Harden and L.B. Cebik on their election to the QRP Hall of Fame. Well deserved. 72, Doug, KI6DS

The Bushmaster Antenna

by Joseph Street, VE3UXE
102 Cornerbrook Creek
Waterloo, ON N2V1L2 Canada

In assembling a portable HF radio station there are a great many considerations to take into account. This is especially true in the case of a station to be used in wilderness backpacking. Not the least of these considerations is the choice of antenna. The antenna must be small and lightweight and have good efficiency, which is very important when operating QRP. Also of prime importance is the minimization of feedline losses which leaves one with the choice of an antenna which is fed near the ground, or the use of large quantities of low loss feedline which is normally bulky and/or heavy. When operating in the wilderness, trees are the obvious choice for antenna support, but can also be an obstacle to success when in dense forest. Vertical antennas are fairly easy to erect but their efficiency is low unless used with a near perfect ground, and their low radiation angle may be less than desirable for some. While a dipole is more tolerant of a poor ground, it needs to be raised to a decent height which can be a real challenge in dense forest, and there are the aforementioned problems with the feedline to contend with. What is really needed in this particular case is an antenna which can be erected close to the ground, have good efficiency, and radiate at high as well as low angles, while being small and light enough to stick in your pocket, and cost less than 20 bucks to boot. The question is, what kind of antenna can meet all of these requirements? The answer of course, as any Red Green fan would know, is to use duct tape!

Having had success with a commercially made small loop with QRP opera-

Photo 1: The complete antenna packed for travel.

tion from the home shack, I decided to try to build something portable along these lines. After reading about the small transmitting loop described in the ARRL Antenna Handbook, I was inspired to replace the copper tubing with aluminum foil. I also deviated from the design described in the handbook in the means of matching the loop to the feedline, but essentially the antenna is the same. The antenna is well known and well described in the handbook so only a brief overview of the theory of its operation will be given here.

The antenna takes the form of a single turn inductor with the ends connected by a series tuning capacitor. This is simply a tank circuit which has a high to very high Q, depending on the amount of loss resistance in the tank circuit components. Keeping loss resistances down is paramount to producing an efficient loop antenna. Forget about using wire for a small transmitting loop. Commercial units are constructed with large diameter tubing and split stator capacitors using all welded construction to reduce the loss resistance which must be in the milliohm range for decent efficiency. This design uses a continuous strip of wide flat aluminum foil to form both the loop conductor as well as the tuning capacitor. This approach ensures that losses are kept to a minimum. The antenna which has a very low radiation resistance, on the order of one ohm, may be matched to the transmission line by various means, but in this particular case, link coupling is used to reduce loss. If one examines the formulae for this type of antenna as given in the handbook it is interesting to note that as the area of the loop increases the radiation resistance increases which translates as an increase in efficiency , assuming loss resistance is kept low. Also when radiation resistance increases, Q is reduced yielding an increase in usable bandwidth. The text also notes that when the circumference of the loop reaches somewhere between a quarter to one third of a wavelength, the loop becomes self resonant and the tuning capacitor loses its ability to tune the loop. I speculated that if the loop were made long enough to be self resonant then the bandwidth might be large enough to cover the entire 50 Khz of the 30 meter band I was interested in.

In building several iterations of the design it became apparent that the circumference of the loop should be kept slightly smaller than the self resonant length. It is desirable that some tuning capacitance be needed to resonate the loop at the desired frequency. This is useful to compensate for the different loading effects of erecting the antenna in different locations, which affects its resonance. As long as the loop is not too small the Q will be low enough to afford plenty of bandwidth. One version of the loop which had a circumference of 16 feet showed a bandwidth of 200 Khz on the 20 meter band between the 2:1 SWR points.

Construction of the antenna is simple. I used a single piece of 2 inch wide aluminum foil duct tape to form both the loop inductor and tuning capacitor sections. 3 inch wide material is also available and should reduce loss especially for the lower frequency designs. Regardless of what size you use, it MUST be aluminum foil, not the fiber type duct tape which is more common. Begin by cutting the tape to a quarter wavelength or slightly less according to your needs, but remember the shorter it is the lower the useable bandwidth will be. I laminated the tape to a strip of 0.004" thick polyethylene plastic to add strength and support to the aluminum foil. The capacitor is created by making a hinged section out of a couple of 2 inch wide strips of Plexiglas 4 to 5 inches long. The dimensions are not critical. Stack the two plates and drill a 1/8" hole through both the plates opposite to where the hinge will be. Enlarge the hole in one of these plates to 7/32", and tap it with 1/4-28 threads. This is for the tuning screw which I made by threading a short section of hard plastic tubing with the matching male thread. The tuning capacitor is made by taping each end of the duct tape to one of the Plexiglas plates (check the orientation when you do this so the holes match up when the plates are overlapped to form the loop). I then added an extra layer of insulation made from polyester film to the capacitor section using carpet tape. The polyester was obtained from a transparency commonly used for overhead projection. The end without the holes can now be hinged. Make sure the duct tape is not twisted and then make a hinge with a couple of strips of packing tape to join the ends of the loop and form the hinge for the variable capacitor. The tuner is made by passing a piece of small shock cord through the tubing and through the holes in the capacitor plates.

Stretch the shock cord so that it is under tension with a knot on each end of the tuning mechanism. See Photo No. 2 for details. The capacitance can now be varied by screwing the tubing in and out which pushes the movable plate away from the stationary one. The shock cord pulls the plates together when the tubing is unscrewed and also allows the tuning screw to be removed for storing the antenna while holding everything together to avoid losing the screw. A note of caution here, even at low transmitted power there is very high voltage present on the capacitor when tuning so be sure to use plastic parts in the construction, and avoid contacting the metal surfaces of the loop when power is on. It is best if the duct tape is insulated on both sides which can be easily done by covering it with a long plastic sheath. A good source for such a thing is the material used for forming plastic bags with a heat sealer. It comes in rolls and in vari-

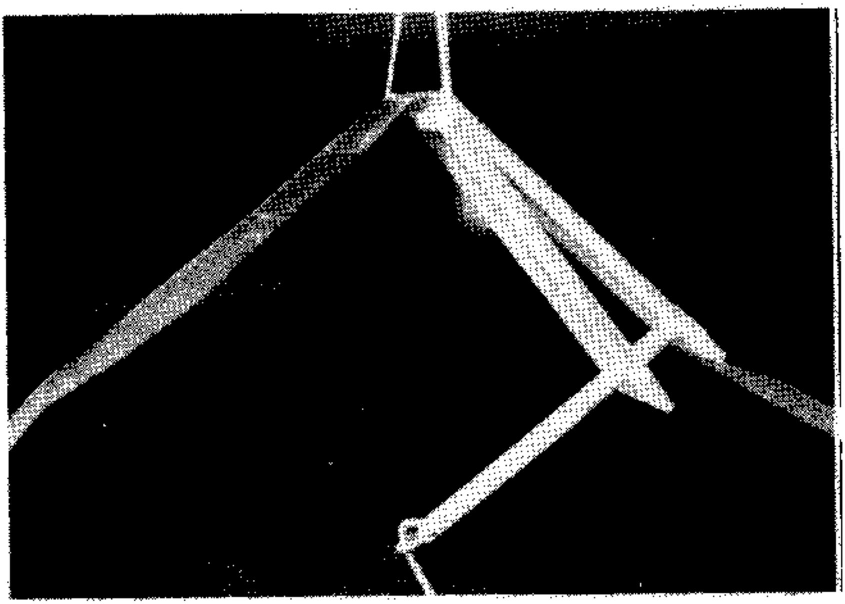


Photo 2. Tuning capacitor and top support detail.

ous widths. A width slightly wider than the duct tape is ideal and can even be sealed at both ends using a small home baggie sealer to waterproof the antenna. Alternatively a long strip of plastic can be cut from a roll of plastic sheet and folded around the duct tape and held on with strips of packing tape to achieve the same purpose.

The antenna is hung in a diamond shape which requires only one vertical support. It is important that the hinge of the capacitor be at the apex of the diamond otherwise it will not be possible to get a perfect 1:1 match to the feedline. I cut some plastic tubing slightly longer than the width of the duct tape and secured four of these to the inside surface of the loop with a strip of packing tape so that a string may be passed through the tubing for the purpose of supporting the antenna. The tubing ensures that the duct tape is not damaged by the string when the loop is put under tension. The matching section is made by cutting a piece of insulated solid wire, I used 20 gauge, to a length which is 1/5 the circumference of the loop. Solder one end of this wire to the braid of the coax and the other end to the center conductor. Ground radials are optional but increase efficiency because they double the effective area of the loop raising the radiation resistance and helping increase the bandwidth as well. I used four lengths of 24 gauge speaker wire cut to the same length as the antenna circumference and then pulled them apart to form 8 radials. Solder these to the braid as well and insulate these connections with heatshrink and electrical tape.

Erecting the antenna is a matter of finding a suitable support, trees are perfect for this. Keep away from large metallic objects as much as possible. Directly below the support point drive a tent peg to secure the bottom of the loop. An equal distance on either side of this peg drive another so that you have three pegs in line. Hook the string at the bottom of the loop to the middle peg and raise the loop by a string to the support point, then tension the

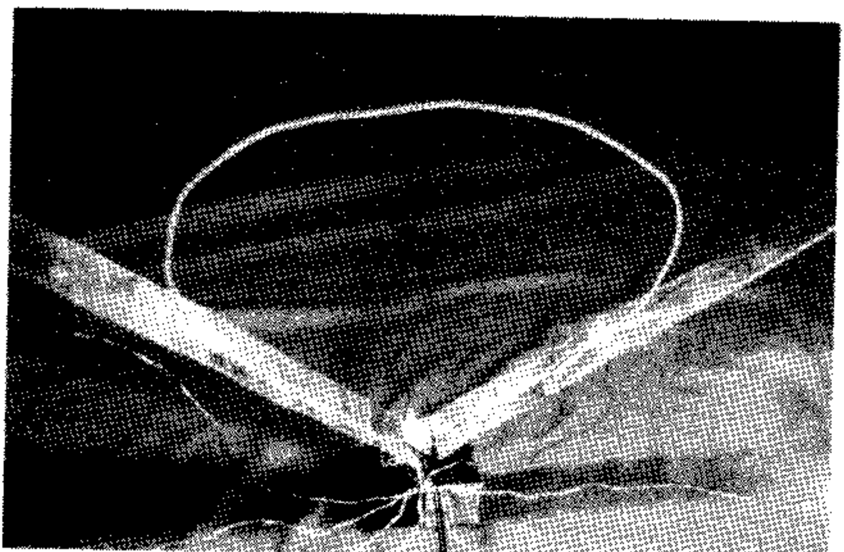


Photo 3: Feedpoint and Matching Point Detail

side lines so that you get a symmetrical diamond shape with the largest possible area. Now the matching section can be attached. Bend it into a small loop shape and secure it to the inside surface of the vee formed at the bottom of the loop as shown in Photo 3. This can be done with paper clips or hairpins or whatever works. I use some small pieces of the same insulated 20 gauge wire used in the matching section for this job, and they also double as twist ties for the ground radials which I roll up separately to keep them from getting tangled. Spread out the ground radials if any, and you are ready to tune the loop.

The antenna should be tuned at a low power. I use 1/4 watt and slowly adjust the plastic tuning screw until the reflected power drops to zero. The capacitance effect of your hand in proximity to the loop will affect its resonance. When you withdraw your hand the SWR will increase. To compensate for this find the null and then tweak the screw a little to increase the capacitance (back the threads out slightly to bring the plates slightly closer) and when you remove your hand the SWR will drop to a perfect match. Its really easy to get the hang of this after a few tries. Be sure not to touch any part of the loop while doing this since it will severely affect the tuning and could give you a shock if the loop is not fully insulated. If the reflected power cannot be brought to zero, check that the antenna is straight and symmetrical. It is important that it be erected perpendicular to the ground plane, so make sure it is not leaning on an angle. Also, you will have to experiment to see how much of the matching loop should be secured to the main loop to get a perfect match by trial and error but it can be found quite easily and is not super critical. I tune mine up for the center of the band and achieve less than 1.15:1 SWR over the entire 50 Khz tuning range. I have not tested the maximum power handling of this kind of antenna but have used up to 10 watts with no problem. When there is a wind the duct tape can sometimes flutter, which causes the SWR to flutter as well. To eliminate this problem simply lift the two pegs that guy the sides of the loop and swing the loop

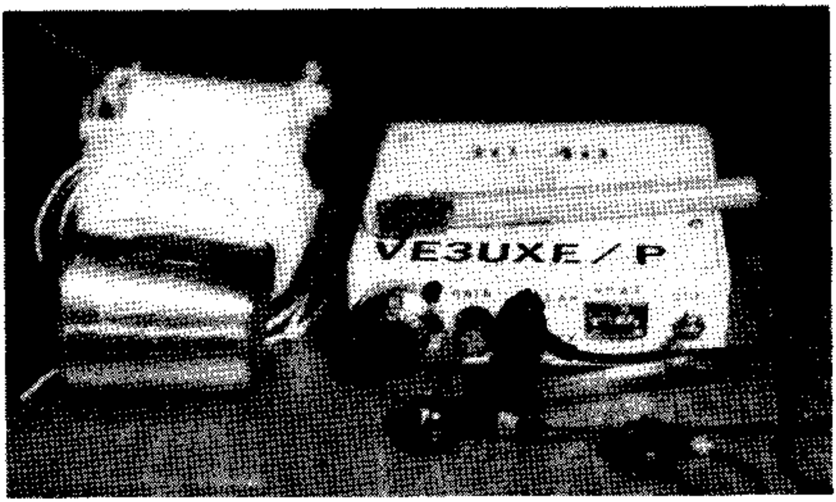


Photo 4: The complete VE3UXE Portable QRP Station.

around in the azimuth until it is lined up with the wind direction. I have also added four more support points to the loop to allow it to be spread out into an octagon shape. This is practical if there are two trees on either side of the antenna, and helps a lot to stabilize the loop against the wind.

With the materials on hand, and a little experience you can build one of these antennas in under an hour. Similarly it takes about ten minutes to set one of these up and tune it once you know what you're doing, and it works just great. I have had no trouble making many contacts throughout the continent with one watt on 30 meters. Much time and aggravation is saved in getting the station on the air with this antenna whether on the side of a clearing or in dense bush.

Build A "Jersey Fireball 40" QRP Transmitter & Amplifier

by George Heron, N2APB

The Jersey Fireball 40 isn't going to get you any trophies in the DX contests, any pelts in the Fox hunts, or any ooh's & aah's in the "bells and whistles" category of equipment in your shack ... but this little gem will go together quickly and provide all sorts of amazing contacts for you. See how many miles-per-watt you can get with just a 9V battery and antenna!

Okay, so just what is the "FB40"?

The "Jersey Fireball 40"[1] is a simple, easy-to-build low-power CW transmitter designed to operate in one of several amateur radio bands. Its name is derived from the fact that the project was designed and kitted[2] by the New Jersey QRP Club[3] members, and that the basic RF power output can be up to 40 milliwatts.

The FB40 uses a TTL crystal oscillator "can" as the heart of a milliwatt-level CW transmitter. The designer of our club project, Clark Fishman[4], WA2UNN, chose an oscillator frequency of 28.322 MHz as a starting point, added some simple circuits to divide this frequency down to hit 80m, 40m, 20m as well as 10m. We also put a low pass filter in the design to clean up all the ratty harmonics coming from the square waves of the ICs and to allow multi-band operation.

You get to select what band in which you want to operate! All you need to do is install a capacitor in the correct position on the printed circuit board to select one of the following frequencies: 28.322 MHz, 14.161 MHz, 7.080 MHz, or 3.540 MHz. The kit comes with filter components for 7.080 operation, but we supply a list of filter component values that can be used to put the transmitter on the other frequencies as well ... just substitute a couple of parts from your junk box and you'll be able to operate on 10m, 20m and 80m in addition to the 40m band supplied.

The design also includes a TiCK keyer chip! This is a small IC programmed as a fully-featured iambic keyer, including speed control and other options. All you need to do is drop this chip into the board, add a couple of components and you'll be paddling to your heart's content. (The TiCK chip is available from Embedded Research.[5])

If you add just a few more optional "T-R switch" components, you'll be able to allow an external receiver to be connected to the circuit board, thus providing transmit/receive switching using the same antenna connected to the FB40 transmitter.

And yet another option that should thrill many hams is that the FB40 design (and circuit board) includes an RF power amplifier! Once you get expert at making contacts at low milliwatt levels, you might want to add some parts from your junk box to boost the FB40's output power to around 1.5 watts.

The Jersey Fireball 40 is quite a feature-packed little project that should provide lots of fun and many contacts.

A Little History

The "fireball" transmitter concept has been around for a number of years and has been published by several individuals. Most of these designs, including our Jersey version, are based on the use of a prepackaged oscillator contained in a metal "can" which is able to be plugged into a standard 14-pin IC socket. These cans are typically used in computers, test equipment and other devices as a source of a stable and accurate master frequency.

Oscillator cans come at various factory-prepared frequencies like 4 MHz, 10 MHz, 40 MHz, etc. However, designers are able to order the cans at specific frequencies they might need for their projects. Our FB40 oscillator frequency was chosen because it was readily available and its 28.322 MHz base frequency divides down relatively nicely into the amateur bands.

Prior articles concerning the use of oscillator cans appeared in Nov 1990 of *73*, April 1993 of *QRP Quarterly*, and Nov 1998 of *73*. You could reference these articles for additional background and use.

Circuit Description

Refer to the schematic shown in Figure 1 of the center foldout. The heart of the Jersey Fireball 40 QRPp Transmitter is a pre-packaged TTL oscillator can in the form factor of a 14-pin IC. This oscillator operates at 28.322000 MHz and swings about 1.5 Vp-p.

The basic principle of operation is that the oscillator U1 provides a signal to a series of TTL flip-flop stages used to successively divide the frequency in half. These signals are then routed through a capacitor and on to a 5-element low pass filter. The LPF provides appropriate filtering and conditioning of the original square wave signal, thus turning it into a relatively clean transmitted signal.

The divider circuits are 74LS74N dual edge-triggered TTL flip-flops, selected for their low price and low power consumption.[6] They are configured as toggle flip-flops - meaning that the output changes state on the positive edge of each input clock signal. This is ideal for a divide-by-two function desired for the FB40, knocking the 10m frequency down by half each time we add another gate. The chips operate to well over 30 MHz, so there was little problem with response, delays or signal levels.

The first stage flip-flop (U2a) after the oscillator divides the 28.322 MHz signal in half to yield a 14.161 MHz signal. The second stage U2b divides the 14.161 MHz signal down to 7.080 MHz. And the third stage (U3a) divides the 7.080 MHz signal in half to 3.540 MHz. Admittedly, the specific frequencies are not necessarily hot beds of CW activity (except perhaps on 80m), but they are not too far off the beaten path. Additionally, other oscillators can easily be substituted to achieve better/different frequencies through the divider chain.

The outputs of the flip-flop stages, and the original 28.322 MHz signal itself, are all routed to some jumper pads where you can select which signal is presented onward to the next stage by proper placement of the capacitor Cx. The 40 meter version needs to have the capacitor in the third position, allowing the 40m signal to pass on to the low pass output filter.

The output filter is a 5-element Chebychev filter with components determined by using Wes Hayward's popular

RF Analysis software programs[7]. A table of values is shown below:

	C4	L1	C6	L2	C5
80m	1700 pF	2.17 uH	2400 pF	2.17uH	1700 pF
40m	820 pF	1.1 uH	1000 pF	1.1uH	820 pF
20m	450 pF	0.6 uH	630 pF	0.6 uH	450 pF
10m	230 pF	0.3 uH	330 pF	0.3uH	230 pF

Table 1: Output Filter Component Values

The filter inductors are constructed by winding toroids to achieve the desired values. The standard formula for the number of turns was obtained from Paul Harden's, NA5N "Data Book for Homebrewers and QRPers" (see reference at end of document[1]):

N = 100 * SQRT (Ldesired / AL)

So with 1.1 uH being the desired inductance, we need about 16 turns for 40m operation.[2] If you'd like to operate the FB40 on 80m, 20m or 10m (which would be really nice in the coming sunspot peak!), just substitute the appropriate caps and inductance (# turns) per Table 1 above.[3]

The output of the FB40 was measured using an HP spectrum analyzer. The second harmonic of the fundamental 40m signal was seen at 45 dB, and the third was seen at 52 dB ... not to shabby for a TTL oscillator can, some divider chips and a simple filter. And certainly good enough for safe operation at these power levels.

The FB40 is keyed by bringing the pin 7 of the TTL oscillator to ground at the KEY connector pad on the left side of the board.

The output of the FB40 was measured at 10 dBm, which corresponds to 10 milliwatts into a 50 ohm load. This varied from unit to unit and tended to be a function of how strong the TTL totem pole outputs were in the 74LS74 chips. (They aren't optimally made to be looking at 50 ohms, so the interface to the output filter isn't quite ideal.) But even so, with almost no insertion loss, the filter takes the signal and presents it effectively to a 50 ohm load, such as a tuned antenna feedline or an ATU.

The power source input to the FB40 board can be any voltage in the range of 9-14 volts. The LM78L05Z three terminal regulator can supply 5V at 100ma safely, and this circuit design operates well within that limit.

Optional Circuit: T-R Switch

When operating a separate transmitter and receiver, it is oftentimes convenient to automatically switch the single antenna from the receiver to the transmitter during "key down" times. This transmit-receive switchover can be done by several means; circuit traces are included on the FB40 pc board to provide a simple version of T-R switching.

The T-R switch function is provided by a series resonant circuit connected between the RF source and an associated receiver. Capacitor C16 and inductor L6 are series resonant at 7 MHz and provide very little signal attenuation during receive. However when the transmitter is putting out its 5-40 mW signal, diodes D1 and D2 alternately conduct, bringing the junction of L6/C16 to near ground potential during transmit. This action limits the power going to the receiver input to only about 1 mW, and makes C16 effectively part of the output filter network. Most receivers should be fine with this configuration, although its automatic gain control (agc) system needs to have fast recovery. (The agc can be adjusted on many receivers.)

Side note: The series-resonant circuit going to the receiver is a critical element, and requires some different component values when used on the various bands of the FB40. Table 2 shows the component values for the different bands of operation:

Band	C16	L6
80m	56 pF	36 uH, 9T #28 wire on T50-2
40m	47 pF	10.8 uH, 52T #26 wire on T37-2
20m	33 pF	3.9 uH, 31T #28 wire on T37-2
10m	22 pF	1.4 uH, 19T #28 wire on T37-2

Table 2: T-R Component Values

Optional Circuit: TiCK Iambic Keyer

The IC at U4 is a versatile little iambic keyer chip in an 8-pin package provided by Embedded Research (see reference at end.) This chip is not part of the components supplied in the FB40 kit, but the pc pads and traces have been provided on the board to allow you to easily add the keyer option to the basic kit. The TiCK enables you to connect a paddle to the DIT and DAH input pins, and key the transmitter through a 2N2222A driver transistor. The TiCK can be programmed by grounding the PGM connector pad at the bottom of the pc board, per the instructions provided by the vendor. Speed, memory, weighting are all controllable parameters for this chip.

Optional Circuit: RF Power Amplifier

A number of years ago, Wes Hayward, W7ZOI had published an inspirational transmitter project called the Ugly Weekender[1]. He provided some "boots" for a 4 mW flea power VFO and buffer amp such that he could bring the output power up to several watts.[2] With Wes' permission, the FB40 also provides this circuit design as an optional amplifier that the user can easily construct right on the pcb.

The amplifier is a fairly efficient Class C design consisting of driver transistor Q3 and power transistor Q4. Resistors R6 and R7 reduce the FB40's output by half so as not to overdrive the amplifier. (A 100 ohm potentiometer could be conveniently added here as a drive control.) In order to reduce the current drain of the Q3 driver transistor stage, transistor Q2 supplies +V only when the oscillator is keyed. D3 is a Zener diode used to protect power transistor Q4 in case the transmitter is keyed without an antenna connected; and C15 is used to create a total capacitance of 450 pF at the Q4 collector, including the capacitance of the transistor, the Zener. the receiver pick-off cap and the fixed cap itself. (A variable cap could be used for C15 in order to peak transmitter efficiency.) A 50-ohm input / 50-ohm output network is also used and is shown with component values are shown for 40 meter operation. (Components for operation on other bands may be determined by consulting the ARRL Handbook.) Similar to the T-R switching used with the stock version of the FB40, this amplifier uses a series-resonant L/C circuit to connect to the receiver's antenna terminal. [Note: Only one T-R switching circuit is needed – if the power amplifier and its T-R switch components are employed, components L6/C7/D1/D2 are not needed.]

Many thanks to W7ZOI and W7EL for providing a circuit to give us a signal with just a little more respect on the air!

Building the Kit

This section describes how to put

your kit together. As you progress through each step, be sure to put a checkmark in the boxes to help you keep track of things during the interruptions (phone calls, kids pulling at the sleeves, dog biting your slippers, rare DX coming from the rig's speaker, etc.)

Wind the Filter Inductors

Now comes the real fun part of the project ... the dreaded ***toroid winding exercise***! You need to create two inductors, L1 and L2, for the low pass filter. It's really not that tough. Uncoil the red magnet wire and cut in half - you should end up with two pieces each about 12" long.

Both inductors will be constructed exactly the same way by wrapping 16 turns of the magnet wire around a toroid core. Count one turn each time the wire is passed through the core.

The heat strippable magnetic wire being used requires no scraping to clear the red insulation off the leads being soldered to the PCB pads. Once the wires of each inductor are trimmed to the right length (determined by temporarily inserting them on-end into position L1 and L2 on the board), tin the ends of the wires by doing the following. Using a good hot soldering iron, place the tip under the end of the wire to be tinned and add a little solder so that there is a small pool of molten solder and flux on top of the iron with the wire in the pool. After several seconds, the insulation will melt away and the wire will be tinned where it is in contact with the iron. Continue moving the iron slowly toward the toroid core adding solder as you go, until the wire is tinned within 1/16 inch or so of the core. Repeat the procedure for the other leads and brush off any carbon residue from the ends of the wires before you insert L1 and L2 into position on the circuit board.

Tug the wires gently from the bottom of the board to ensure that the toroids are securely in place and then solder the wires to the pads.

Winding the Amplifier Filter Inductors

For the amplifier circuitry, you next need to create four toroid inductors: L3, L4, L5 and L6, and two transformers T1 and T2. Toroid inductors really not that tough to construct, and transformers are merely toroids with two windings on them!. Uncoil the supplied red magnet wire and use the specified lengths for each of the inductors as described below.

L4 & L5: Both of these inductors will be constructed exactly the same way by wrapping 20 turns of the magnet wire around a T37-6 toroid core (yellow). Measure off a 15 inch length of magnet wire and begin winding the toroid core. Count one turn each time the wire is passed through the core.

L3: Measure off a 12-inch length of magnet wire and wind 10 turns on an FT37-43 toroid core (<u>black</u>/unpainted), similarly to the way L4 and L5 were shown.

L6: You should next create inductor L6 in the same manner. Measure off 28" of red magnet wire and wind 52 turns around a T37-2 toroid core (<u>red</u>). That's a lot of turns for such a small toroid so you will need to keep the windings very closely spaced. In fact, there will be a need to overlap some of the winding at the end in order to get all turns on. That's okay.

T1 & T2: These transformers are each "bi-filar-wound" inductors on a toriod core, meaning that you'll be combining two magnet wires together and winding them at the same time. T1 and T2 are constructed identically. Measure off two 9-inch pieces of red magnet wire. These wires should be twisted tightly together as illustrated below.

(Suggestion: You can clamp the ends of the wires in a vise and use a twist drill to wind the length of the wires together.) You will then wind the combined, twisted wire pair around a FT37-43 toroid core (black/unpainted) in the same manner as previously. See the diagram below for proper connection of the four leads:

When two wires of the same color are twisted and wound together on a toroid, it's very hard to know which ends to connect together for the center tap of the transformer. You will need to use an ohmmeter to determine proper ends. On one of the wires, a is the start and a' is the end. On the other wire, b is the start and b' is the end. You should twist wires a' and b together to form the center tap.

Trim the leads to the correct length, prepare the ends with the soldering iron again, and install them onto the board. Prepare and install the second transformer in the same manner.

Power transistor Q4 should have a heatsink, as it will be getting fairly warm during normal operation.

Provisions have been made to have the KEY pad by the U1 oscillator can also key the first stage of the power amplifier. Because this KEY line floats at 5 volts when not keyed, a Zener diode (D5) is used to prevent the 2N2222A first stage of the amplifier from being turned on all the time. This is a nice feature when operating from the firls with limited battery supply.

You should ensure that this amplifier stage is indeed OFF when the key is up ... measure the collector of Q2 to ensure that it is near zero volts with the key up. (The collector is at the junction of C7, R12 and C11 on the board.) If Q2 is not turned off, you may need to lower the value of R4 slightly until Q2 does turn off when the oscillator is unkeyed. No harm is done if Q2 is always ON, and normal operation of the amplifier is permitted; but power consumption will be slightly higher.

An interesting feature of the FB40 design and circuit board layout is that this power amplifier can be quite independent from the FB40 transmitter. The components and ground plane are layed out such that the amplifier portion of the board may be cut off in order to form a general purpose amplifier for the bench or other projects. If this is desired, merely saw the board at the marks provided on the component side. Extra pads for input, +V and ground have been provided if you do take this "standalone" route.

Optional Installation of a TiCK Keyer

Installing the TiCK keyer chip from Embedded Research makes operating a CW transmitter so much more fun. Costing only about $5, this little 8-pin IC will enable you to use your Bencher, NorCal, or whatever kind of paddles you might happen to own.

The sidetone output of the board can be used to feed an audio amplifier or a small speaker, providing a tone whenever the DIT or DAH paddle input is grounded. Alternatively, a small piezo electric speaker[1] may be conveniently driven by U4 pin 3, connected in place of R1 and R2.

A pushbutton may be connected from the PGM connector pad to ground, allowing the TiCK to be programmed in the manner described in its data sheets. The paddle connections are made to the connector pads DIT, DAH and GND.

Putting the FB40 on the Air

Connect a 50-ohm 40 meter antenna to ANT and GND.

If the T-R switching components are installed, connect your receiver antenna terminals to RX and GND. Otherwise, do not connect the FB40 transmitter directly to the same antenna as is feeding the receiver (or transceiver in receive mode). You will likely damage the receiver. If you only have one antenna to use for both transmit and receive, and if you do not have the T-R switching components installed on the board, you could put a SPDT toggle switch in to alternately connect the antenna between the transmitter and receiver, thus providing a manual T-R switch.

If you have the amplifier side of the board populated, you'll be using the ANT and RX connections. Using the amplifier also includes the T-R switching components, so you can feel safe in connecting your receiver to RX.

Connect a hand key (or a temporary jumper) between KEY and GND. Or, if you are using the TiCK keyer, connect a paddle to Dit, Dah and Ground.

Apply power to the +V and GND and go through some preliminary checks to ensure that there are no shorts. Check for 5V to the ICs and ensure that the voltage regulator VR1 isn't getting too warm. If either condition is not right, go back and look for the solder bridges and proper placement of components. The total current being supplied should be less than 100ma.

With a receiver tuned close to 7.080 MHz, you should hear the Fireball 40 signal. The tone should be steady and free of any hash-like interference.

With a 4-to-40 mW FB40 QRPp signal driving the amplifier portion, you will have 1-3 watts going up to your antenna.

That's it! You can mount your Jersey Fireball 40 in a suitable enclosure, or just have it sitting out on the desk. Several of us in the NJ-QRP Club have put the FB40 into Altoids tins .... It's amazing how the size of the PCB worked out just right for that.

Go forth and communicate!

[1] For a short time, this piezo device is available free from Embedded Research with the purchase of a TiCK keyer chip.

NOTES:

1 The "Jersey Fireball 40 QRPp Transmitter" is copyright 1998/1999 by C. Fishman and G. Heron. All rights reserved

2 NJ-QRP Club is selling the basic 40m kit of parts and pc board for $10 postpaid. Write to NJ-QRP Club, George Heron, N2APB, 45 Fieldstone Trail, Sparta, NJ 07871.

Website: http://www.njqrp.org
E-mail n2apb@amsat.org

3 The New Jersey QRP Club is a group of amateurs located in-or-around New Jersey with a common interest of low power communications, efficient operating skills, and a love for homebrewing of electronic equipment. Membership is free. Monthly meetings are held near Princeton. Club members are in regular contact via an Internet mail listserver. To subscribe, put SUBSCRIBE NJQRP in the body of an e-mail and send to
LISTSERV@NJQRP.ORG.
A comprehensive and fun club website is regularly maintained at
http://www.njqrp.org.

4 Clark Fishman, WA2UNN, PO Box 150, Andover, NJ 07821. E-mail: wa2unn@nac.net

5 Embedded Research (supplier of the TiCK keyer chip), PO Box 92492, Rochester, NY 14692. E-mail: http://www.frontiernet.net/~embres/

6 By using "Advanced CMOS" TTL devices instead of the "Low-power Schottky" ones used for U2 and U3 (74LS74), one could get more effective power transfer from the chips. The AC devices provide an output impedance much closer to the 50-ohms that the output filter was designed

for, thus providing a better match and more power to the antenna work using the FB40 on 20m through 80m.

7 Some builders have questioned how we obtained the output filter component values for operation on the different bands. The computer program used is one called "L.exe - Low Pass / High Pass Filters, version 1.50", a Wes Hayward program supplied by the ARRL. This is a neat program that automates one of the standard filter calculations in the Handbook to provide all sorts of filters with varying parameters: Butterworth, Chebyshev, Elliptical, variable number of elements, cut-off frequencies, and maximum ripple values. In each case, we chose a 5-element Chebyshev low pass filter with 50-ohm input and output impedance, with 1 dB maximum ripple, and a cut-off frequency at the next higher megahertz value from where we were operating. [e.g., a cut-off frequency of 4 MHz was selected for the 80m filter, etc.]

8 Paul Harden's, NA5N, excellent reference book is called "Data Book for Homebrewers and QRPers", ISBN 0-913945-57-9, and costs about $20. You can contact Paul at na5n@rt66.com

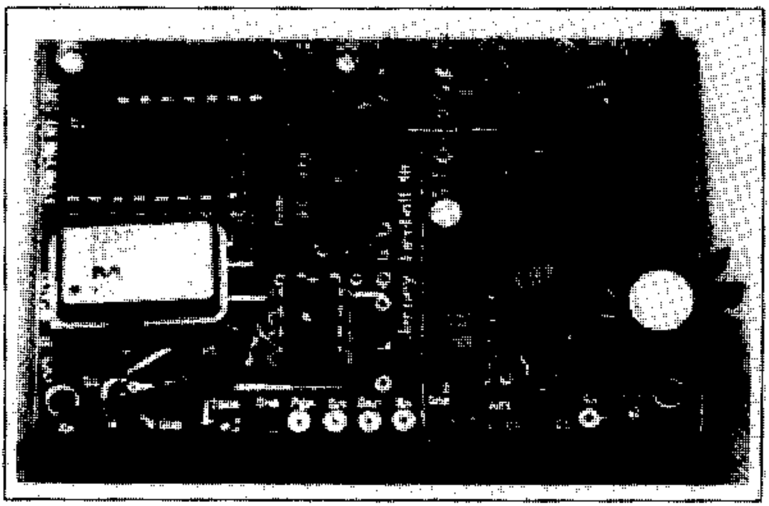
9 In order to accommodate the greatly varying core permeabilities at different frequencies of use, each core has an inductance index, or "AL". Thus looking up the T37-2 core used in the FB40, you'll find its AL = 40 uH per 100 turns. So if we wanted the 1.1uH value for our filter inductor, the equation computes to: N=100*SQRT(1.1/40)=16.58. Since we can't have fractional windings with toroidal inductors, we rounded this to 16 Turns. Close enough!

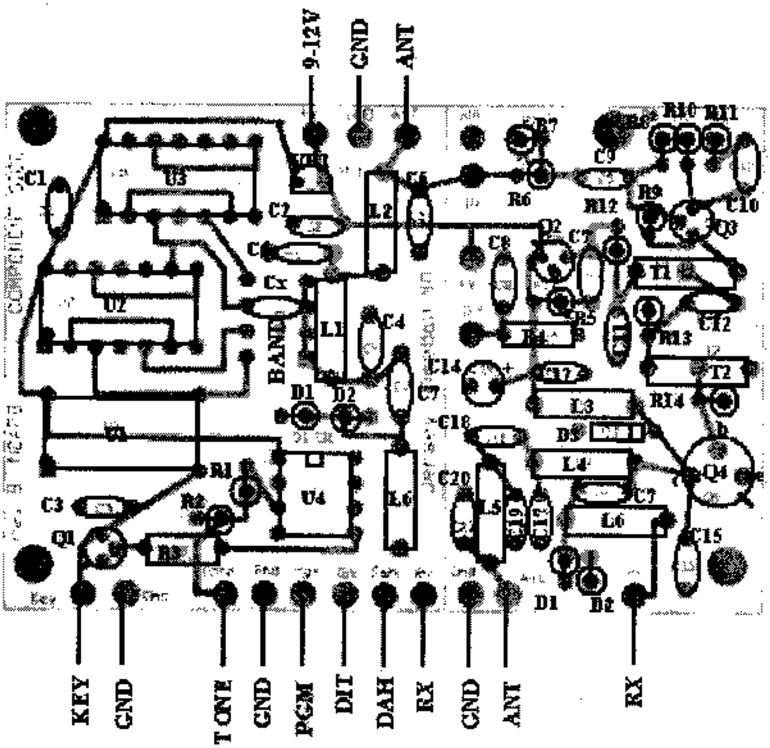
10 You might need better quality capacitors when attempting to build your output filters for the higher frequencies. At 14 MHz and 28 MHz, the el cheapo disc capacitors are quite lossy and results in a low Q filter. Try using some silver mica caps (or equivalent) and your output power at the higher frequencies might improve.

11 W7ZOI's Ugly Weekender was published in QST for August 1981

12 Wes had also based this amplifier directly on the work on Roy Lewallen, W7EL, in a project Roy did called "An Optimized QRP Transceiver" in QST for August 1980.)

13 For a short time, this piezo device is available free from Embedded Research with the purchase of a TiCK keyer chip.





Component layout for New Jersey Fireball 40 & Amp

The St. Louis Doublet

by Dave Gauding, NF0R
nf0r@slacc.com

The St. Louis Doublet is a lightweight 10-40M antenna for portable or fixed locations. The SLD uses a South Bend SD-20 collapsible fiberglass fishing pole as a single support. This design borrows gently from the classic G5RV antenna of Louis Varney. An SLD is usable with manual or automatic antenna tuners. With feedline shorted and worked against a good ground the doublet will also operate 80M. The popular 20' fiberglass pole is prone to bending along the slim 3' tip section. Keeping the overhead weight, sail area and feedpoint movement under control prompted this project.

Parts List

1 ea. #01 safety fishing swivel
6 ea. small nylon tie wraps
1 ea. 1/4" phone plug shell
1 ea. BNC bulkhead jack
18' flat computer cable, 2 conductors
51' #20 magnet wire
CA-type instant cement
Silicone sealant/adhesive

Assembly

1. Following the example thread the flat computer cable feedline through the lower eye of the swivel leaving two inches protruding. Fix in place by adding tie-wrap immediately above the lower eye.

2. Now thread two tie-wraps through the lower eye. Cinch-up to approximately the size shown in the example. These are the insulated points for the radiator elements.

3. Cut the magnet wire into two 26' sections. Strip the ends and attach to the tie-wraps. Leave a pigtail for connecting the radiator to the feedline.

4. Split the computer cable about one inch above the swivel. Strip the ends of both stranded conductors. Position the conductors along the radiators and wrap with the pigtails. Solder the connections.

5. Use a tapered reamer to open the end of the phone plug shell to take the threaded body of the BNC jack. Turn down flush several times to establish the threads in the plastic. This assembly provides the transition from flat cable to the coax.

6. Split and strip the lower end of the flat cable. Then slide on the phone plug shell. Solder one conductor to the BNC center-pin. Solder the other conductor to the anti-turn flat machined in the jack threads.

7. To achieve a good joint with minimum solder accumulation file the flat down to bright metal before soldering. If necessary file the joint flush after soldering to aid in fitting the plastic shell to the connector.

8. Add three tie-wraps along the flat cable feedline covered by the phone plug shell. The assembly will be potted. These tie-wraps serve as strain reliefs for the soldered connections.

9. Carefully thread the previously installed plastic shell past the wiring connections and then screw on to the BNC connector. Add a CA cement seal before mating the two parts permanently. Allow this joint to dry thoroughly before potting the assembly.

10. Fill the shell to the top with silicone sealant. Center the feedline in the shell and allow the assembly to dry for twenty-four hours.

Builder Notes

#20 magnet wire is the heaviest size recommended for this particular doublet when suspended from the SD-20 pole. #26 magnet wire is very serviceable and will survive all but the strongest winds. Any solid or stranded wire of equivalent weight including insulated wire may be substituted. Since magnet wire is usually soft drawn it makes sense to convert to hard drawn to avoid sagging and dimensional changes later. Attach the wire to a solid point. Pull steadily until it stops stretching and trim to size. 51' of magnet wire can lengthen several feet.

17-18' of tuned feedline seems to work well for this application. The RG-58 feedline continuation can be any reasonable length. Since the SLD is tuned remotely the feedline dimensions and impedance are not that critical. No follow-up work has been done to optimize performance such as adding a coaxial balun.

The unbalanced configuration makes the antenna usable with automatic as well as manual antenna tuners. A continuous flat cable feedline can be used if a balun is available. Precautions must be taken to protect the fragile stranded wire connections.

A smaller #03 swivel can be substituted for size #01. A little more dexterity is required during fabrication. Either swivel size slips through the convenient wire eye at the tip of the SD-20 pole. The element ends can be looped to create a low-profile attachment point or collar buttons are good lightweight end insulators. Inexpensive solid monofilament is the preferred support line.

The choice of potting material is not critical. Any high-quality silicone adhesive is acceptable. Epoxy glue is a suitable substitute.

Related Antenna Applications

Either size fishing swivel can be used for tuned doublets fed with 300 ohm twinlead. Cut a 1/4" long opening about 2" from the end of the line. Position the opening over the lower eye of the swivel. Attach each side of the feedline by passing a tie-wrap through the eye. Strip and trim the excess wire and solder to the radiators. Stronger radiator wire may be required for antennas with long unsupported runs of twinlead. The homebrew connector for transitioning from tuned flat cable to coax is usable with 300 ohm twinlead as specified for the original G5RV antenna. Punch several clean holes through the webbing so the potting material can get a good grip on the feedline. Epoxy glue is recommended for potting this modification.

On the Air

The prototype SLD was routinely tested at one watt output on 10, 15, 20, 30 and 40M for several weeks. The antenna was installed on a SD-20 at 20' and configured as a shallow inverted vee. On 80M it was fed against a cold water pipe ground. The SLD's overall performance justifies passing the design along to others.

Even with several sharp bends at the feedpoint the flat cable handles 50W output consistently without complaint. This was the maximum output available during testing.

The flat cable should be taped about 2' below the SD-20 tip during installation. This distributes overhead weight more effectively and helps the tip section resist bending in stronger winds. When installing an SLD balance the elements so there is no side pressure on the pole other than the basic weight of the antenna. Wrapping the feedline several times along the SD-20 support reduces sail area.

The simplest way to mount an SD-20 pole is to slip it over a 1.25" diameter hardwood dowel. Drill a 12" dowel to take a sturdy 10" steel gutter spike. Rest the pole butt right on the ground or on three pan-head screws installed equidistant near the bottom of the dowel. Longer dowels may be used to elevate the feedpoint several more feet.

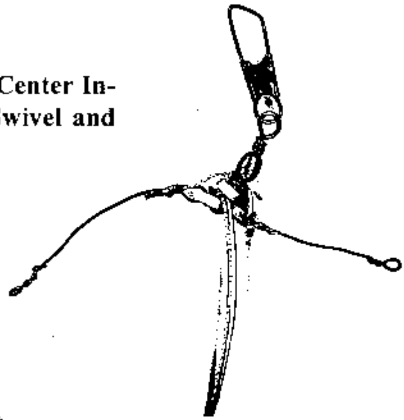
Reality Check

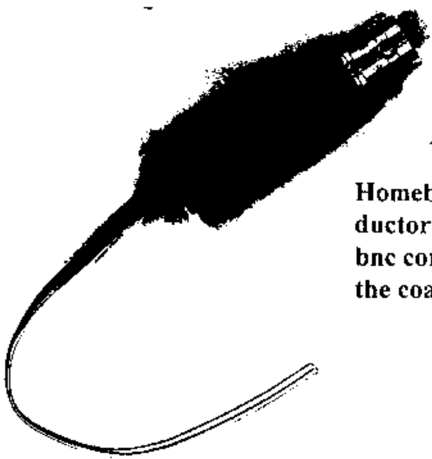
The flat computer cable feedline is undoubtedly lossier than traditional twinlead, 450 ohm and 600 ohm alternatives. However, other than #24 gauge speaker wire or RG-174 coax there are few truly lightweight feedline alternatives for horizontal antennas suspended from an SD-20 pole. With the forgoing in mind convenience gets the nod over maximum performance with an SLD. On the plus side the antenna installs quickly practically anywhere and does not require ground radials. This is a very serviceable doublet for the minimalist operator with emphasis on portable operations..

Comments

A follow-up to the St. Louis Doublet will describe a 10-80M version along with the companion St. Louis Shaft. The latter is a simple a low-cost pvc upright for elevating the feedpoint up to 40' high. Builders spending a pleasant hour at the bench and a $5.00 bill will not be disappointed with the performance of an SLD. As always, improvements and modifications are officially encouraged.

Dave Gauding, NF0R's Center Insulator made from #3 Swivel and nylon wire ties.





Homebrew connector for twin conductor cable and coax (note that a bnc connector is used to connect to the coax)

Number 3 Fishing Swivel as it comes out of the package.

Basic 40 Meter Popcorn Superhet Receiver

by Todd Gale, VE7BPO
1436 Cherry Cresc West
Kelowna BC V1V3X8 Canada

Discussion

The Basic 40 Meter Popcorn Superhet Receiver is a no-frills, relatively low-cost superhet receiver with a 4.00 MHz Intermediate frequency. With the exception of Q6, all transistors are the ultimate popcorn part, the 2N3904. This is the basic sister to the enhanced version on this web site. Much of the design of the various stages must be credited to Wes Hayward as I borrowed heavily from his previous work and through ideas obtained by discussion. If one were to homebrew the diode ring mixers, indeed this would be a very low cost receiver giving reasonable performance which outperforms any NE602 based superhet receivers that I have built or listened to.

Bandpass Filter and RF Preamp

From the 50 ohm receiver antenna jack, first off is a double-tuned bandpass filter which was designed by Rick Campbell, KK7B and works very well. The trimmer caps can be the 5 - 20 pF units sold by Digikey and Mouser. The fixed-value caps in my prototype were inexpensive monolithic ceramic capacitors purchased from DigiKey. Rick used an NP0 ceramic for the 10 pF coupling cap plus silver-mica type for the 100 pF caps in his original design.

The RF amp is a feedback amp pulled from Solid State Design for the Radio Amateur published by the American Radio Relay League. It has a 50 ohm input to properly terminate the bandpass filter. A -6 dB pad follows the amp to help provide a 50 ohm input for the following mixer and to reduce stage gain to help preserve the signal to noise ratio of the receiver. The transformer T1 is one of 3 broadband transmission line transformers in this receiver. It transforms the 200 ohm collector impedance to 50 ohms for the following stage.

Mixer and Diplexer

A 50 ohm diode ring mixer (7dBm) such as the MiniCircuits SBL-1 or TUF-1 or homebrew are all suitable. Following the mixer is a simple diplexer using the ~3 times the IF rule that I have seen in many textbooks and articles. The cutoff frequency chosen was 11.78 MHz as this allows the use of a standard value capacitor (270pF). To wind the .68 uH inductor use 13 turns on a T37-2 toroid or 12 turns on a T50-2 powdered iron torroid core. You can easily use 24 - 26 AWG wire for the inductor. Do not omit this diplexer!

IF Preamp and Crystal Filter

Some builders may object to the choice of a 2N3904 as the IF preamp since thie transistor used should ideally have an Ft of 500 or greater. This is done in the sister receiver and the sister's huskier IF preamp can be used instead of the stage shown. A 2N5179 or PN5179 could also be substuted for the IF Preamp or RF amp transistors, if you have them on hand. The resistive pad following the IF preamp is mandatory and provides the correct 200 ohm input impedance for the crystal filter that follows.

The IF filter crystals should be closely matched in frequency to prevent unwanted ripple in the passband. Generally, you have to buy 10 and then if you have a frequency counter, use the receiver BFO stage to test your crystals for matching. Pick the closest 4 crystals and use them in your filter. It does not matter if the crystals have series or 20 pF load capacitance, but it does matter that they are matched in frequency within 40 hertz of one another or better for this receiver.

For my prototype receiver, I purchased ten 20 pF load capacitance 4 MHz crystals and luckily found 4 that matched each other within 9 hertz! For those builders who do not have a frequency counter, some QRP parts retailers sell matched sets of crystals.

It is important to note that the BFO should be set on the high side of the IF frequency as simple crystal ladder filters have a steeper upper passband than lower passband. The crystal filter is terminated by the 4:1 transmission line transformer and then 50 ohm impedance of the IF amplifier. The -3dB pad following the IF feedback amplifier also helps to terminate the crystal filter by helping ensure a 50 ohm IF amp input impedance and should not be omitted.

Many may balk at just one stage of IF amplification, but since there is no AGC and this is a CW receiver, it works well. A feedback amp is once again used to provide correct input and output impedances for stages connected to the IF amp. A simple IF gain control is used, but could be easily omitted for the more frugal builder. To do so, remove the IN4007 diode from the .1 uF cap on Q3's emitter and connect a 4.7 ohm resistor from the .1 uF cap to ground. When the 1K IF gain pot is turned down to just above minimal IF gain, some noise is generated but is easily avoided by tweaking the IF gain control. An alternate scheme could be omitting the IF gain control as discussed and replacing it with a switchable -10 dB resistor pad in the circuit.

For the IF gain control, any junkbox rectifier-type diode could be used if you do not have a 1N4007. Following the IF amp is another attenuator set for -3dB and then a 50 ohm diode ring mixer. The mixer/detector can be SBL-1 or TUF-1 types or homebrew if you want to reduce costs further as the mixers are the single most expensive components in this receiver.

AF Stages

Following the detector, a grounded base amp connected to an active decoupler is used to provide a 50 ohm, hum-resistant active termination to the product detector. No low pass filtering is used in the AF stages however audio quality and gain are good. Two high pass caps to ground are used to remove circuit hiss. The 1 uF coupling cap connected to the 10K pot was picked to attenuate any remaining power supply hum. Keep all leads short as practical in the AF preamp to help insure stability. Use a simple 10K linear-taper pot for the volume control as the 4K7 resistor gives a faux log-taper response. Q7 is completely optional and is used to mute the receiver if it is used in conjunction with a transmitter.

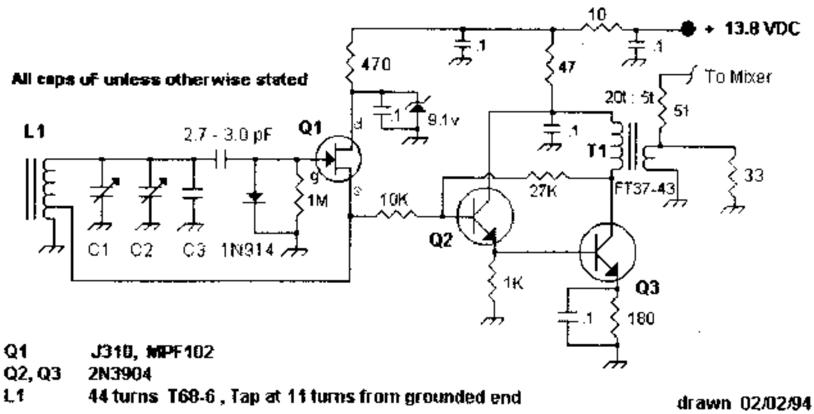
The AF amp is the perennial LM386N and is a low cost, easy to use AF amp. Turn it upside down and solder pins 2 and 4 right to your copper ground plane to anchor this part. There are a number of low-noise alternatives to the LM386 available which are generally more expensive but would be quite suitable. Discrete component AF amps can also be used, but a popcorn part such as the LM386N maybe cheaper and easier.

VFO and BFO

This VFO was first popularized by Roy Lewallen, W7EL and has been used in countless homebrew and commercially sold QRP rigs. For the 40 meter ugly superhets, you have a choice of a VFO frequency of 3 MHz or 11 MHz and I chose the former for this project.

For L1, you can use the T68-6 as shown or redesign your own inductor using a T50-6 core. The T68-6 core allows the builder to wind the coil using # 24

3 MHz VFO



AWG wire for enhanced Q and stability. The main tuning capacitor, C1 that was used had a built in reduction drive and went from 4 - 19 pF. If you use a tuning capacitor with a greater capacitance swing, you may have to connect it to the top of L1 via a small-value NP0 capacitor to reduce the tuning frequency range. This can be done using math or by just plain experimentation.

C2 is a small ceramic air-variable trimmer from my junk box used to set the lower band edge of the VFO. It can be omitted if the user wants to go frugal and experimentally set the lowest frequency of the VFO using small-value ceramic NP0 caps.

Air variable caps for C1 and C2 are mandatory for minimal drift VFO operation. C3 actually refers to 4 NP0 ceramic caps which were used to place the VFO on the correct frequency. Four caps were used to minimize heating and thus drift in the VFO.

For the prototype VFO which tunes something ~ 3.00 to 3.67 MHz, I used the mentioned air-variable, four NP0 ceramic caps (20pF, 100pF, 5pF, 100pF) and C2 the trimmer cap that went from 2 - 50 pF. These values should be used only as a guide for prospective builders as there are many variables at play.

Following a 10 minute warm up period, the VF0 frequency stability is excellent. Again, keep all component leads as short as possible. T1 is a broadband transformer wound by using 20 turns of # 26 AWG over a FT37-43 toroid core and then distributing 5 secondary turns spaced evenly over the primary windings. Do not omit the 33 ohm load resistor. The 2.7 to 3.0 pF coupling cap should also be of the NP0 ceramic type. Q1 can be the J310 (my favorite) , 2N4416 , MPF102 or other correct substitutes. This VFO should be in a seperate sealed, shielded box from the rest of the receiver.

VFO Stability Hints

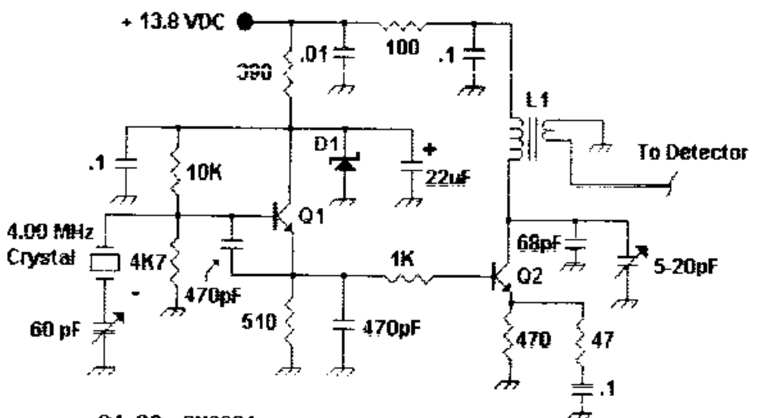
Numerous tips for enhancing VFO stability have been generated from Wes Hayward, W7ZOI, Roy Lewallen, W7EL, Doug DeMaw, W1FB and others. Here are a few summarized:

1. Use air wound or powdered-iron toroidal inductors made from number 6 material.

2. Use the heaviest guage of wire possible to wind your inductor.

3. Anneal the inductor by boiling it in water for around 5 minutes after winding.
4. Use ugly construction above a SINGLE-SIDED copper side up ground plane.
5. Capacitors in the L-C circuit should be NP0 ceramic type.
6. Use air variable capacitors for tuning that have double bearings and no backlash.
7. The VFO should be operated at a lower regulated voltage.
8. Do not use cheap low-Q trimmer caps.
9. Completely encase the VFO to prevent RF leakage and to minimize environmental temperature changes.

4 MHz BFO

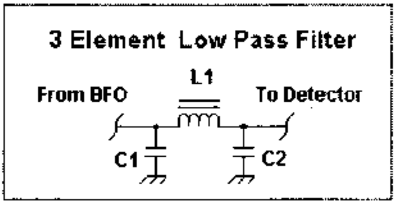


Q1, Q2 2N3904
D1 9.1 volt 400 mW Zener Diode
L1 19.8uH, XL = 498 ohms T68-2 Toroid 59t Primary 12t secondary

Shown is a 2 stage BFO for use with the ugly 40 meter superhets with a 4.00 MHz IF. This is a design by W7ZOI which I have used from 3.5 to 9 MHz by only changing the crystal and the Q2 output coil and capacitor values to suit the frequency of choice. The output coil is 59 primary and 12 secondary windings on a T68-2 toroid core. You will need in the order of 79 pF to resonate this coil, thus a 68 pF plus a 5-20 pF variable works well.

If you do not have a T68-2 core, a T50-2 could be used with 30 AWG wire which is a bit difficult so you could opt for an XL of 200 ohms which would be 40 primary and 8 secondary turns on a T50-2 core. You would need ~200 pF to resonate such a coil and the BFO would have reduced output power, but would still work okay. If you design your own tank, you probably should not use an XL/XC less than 190 ohms for the output stage at 4 MHz. Use a 5:1 turns ratio for primary to secondary windings.

It wouldn't hurt to follow the Popcorn Superhet BFO with a low pass filter. A simple pi-type 3 element filter is suitable. Since I had a couple of 470 pF caps left over, I made a low pass filter using a 6.8 MHz cutoff frequency with a 1.17 uH inductor. A 1.17 uH inductor using a T37-2 core requires 17 turns while on a T50-2 core requires 15 turns. Caps were inexpensive monolithic ceramics from DigiKey. The filter is shown below, L1 = 1.17uH, C1 and C2 = 470 pF. If you want, you may use other cutoff frequencies to suit any junkbox caps you have on hand and use an XL/XC of 50 ohms.



BFO Construction

Keep component leads as short as possible to promote stability. Do not omit the zener diode D1. I thought of using a small ferrite bead on the base of Q2 and will try it on the next version of this BFO that I make. The BFO, if unstable can break into all sorts of weird AF sound effects that are very annoying. The BFO should ideally be in a shielded box, but many amateurs have good results by just placing the BFO strategically in the receiver chassis.

When winding L1, make sure you wind the secondary coil so that the secondary's grounded end is on the cold side of the primary coil that connects to the 100 ohm resistor and positive voltage. I just pick one end of the primary coil and close wind the secondary coil from this point in the same direction for the correct number of windings. Then the starting point of the secondary can be grounded and the other end connected to the detector or a low pass filter.

After building the coil, temporarily place a 51 ohm resistor from the secondary output lead to ground. Then you can test and peak the tuning of the output tank into a load. Leave the resistor in place for all your testing work such as crystal matching or RF stage testing until you are ready to connect it to the product detector.

The 60 pF variable cap connected between the crystal and ground is used to set the beat frequency of the BFO. Adjust it to get a good sounding beat note when listening to a station. You will notice that the beat frequency can be tuned roughly by just listening to 40 meter band noise in the headphones and then tweaked on an active QSO.

Construction Ideas

When constructing any project, build in small modules and test each one seperately. For instance, the AF amp should be built first and then tested by injecting a very low-level audio frequency tone into that stage and listening for output in your headphones. Every QRP workbench should have a simple AF tone oscillator from a schematic similar to the ones used for keying sidetones in CW transmitters. The encased oscillator should have to a 100K or so potentiometer connected to the output to vary the output signal amplitude. Generally use maximum resistance on the 100K pot to start with and reduce this resistance slowly as the in-test amplified oscillator output could be very loud!.

After testing the AF amp, build the 3rd AF preamp stage including the 10K panel mounted pot so you can vary the gain going into the AF amp. Now inject the AF oscillator output into the input on the pot and vary the 10K pot to ensure that the stage you built is working. It should be a lot louder now and should go up and down in volume with the 10K pot.

Finally build the remaining preamp stage and once again test the circuit with your AF oscillator. The output into the phones should be painfully loud now when cranked up!

The next stage to build would be the BFO. If you do not have a scope, peak the tuned circuit by watching the S meter on a radio receiver located nearby. Ensure that you put a load on the output winding of the BFO such as 47 ohm resistor to ground. A small piece of wire can be used as an antenna if the BFO signal is too weak to activate the S meter on your receiver.

Once peaked, you can now use the BFO to match your IF crystals. To use the BFO to match your crystals, use a small wire to bypass or disconnect the 60 pF variable capacitor that is used to connect the crystal to ground. In other words, the bottom lead of the crystal is connected to ground with a short piece of wire. This makes testing your crystals a little more scientific as the variable capacitor cannot influence the crystal frequency during testing.

You can also use the BFO in conjunction with a scope or voltage probe to test the various RF amps in the receiver. I do this all the time with my scope. Proceed with this build a stage, test a stage method and you should be rewarded with a functional end product.

Uglier Sister 40 Meter Popcorn Superhet Receiver

by Todd Gale, VE7BPO
1436 Cherry Cresc West
Kelowna BC V1V3X8 Canada

[Note: Main schematic in center section]

Discussion

Above is the higher-performance big sister to the Ugly 40 Meter Popcorn Superhet. It resembles its little sister quite a bit and parts between the two designs maybe interchanged to suit the builder. Parts common to both rigs will not be discussed, please read the comments on the 40 Meter Popcorn Superhet Receiver webpage in addition to the comments on this page.

Filters and RF Amplifier

Following the bandpass filter is a Norton transformer-coupled negative feedback amplifier. This stage is designed for a gain of 12 dB, although the 9 dB gain design would also be very suitable. Please refer to the web section entitled A Low Noise Broadband RF Amp for winding instructions. Transistor choices for Q1 are any low-noise type such as the 2N3866, 2N5109, 2N5179 or PN5179.

The Norton Amplifier

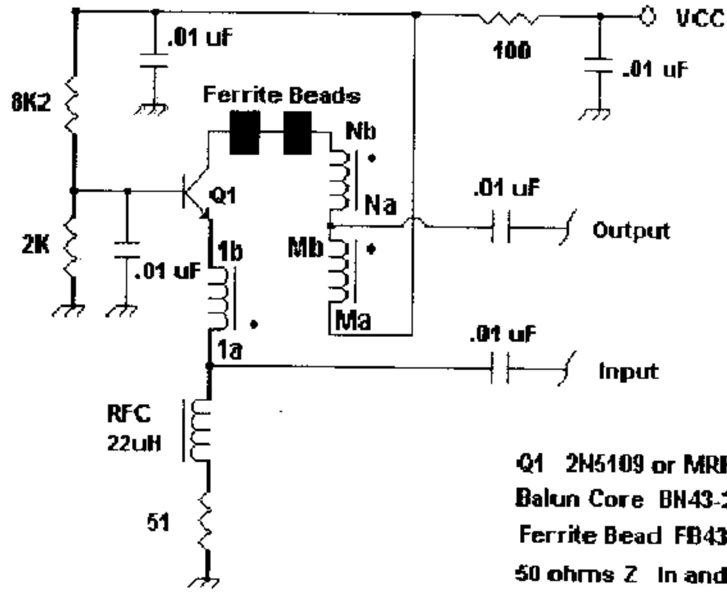
The above schematic is a version of a circuit developed and patented by David Norton and Allen Podell in June 1974. This variation was described by Joe Reisert, W1JR in the now defunct Ham Radio Magazine. The Norton design uses transformer coupling to achieve "noiseless negative feedback" and is really outstanding. A great article utilizing and augmenting on this technique receivers is by Jacob Makhinson, N6NWP in QST magazine for Feb 1993 with "A High Dynamic Range MF/HF Receiver Front End". Makhinson arranged 2 in push-pull to obtain excellent results. Obtain a back-issue of QST for closer study.

If you are building a contest-grade receiver and need a good RF preamp and/or post mixer amplifier, the Norton type is quite suitable. An amp built using a 2N5109 can have a noise figure in the 2.5 - 3dB range. I have also built them with 2N3866, MRF517, MRF581 and a 2N5179 although the last transistor would be a somewhat poorer choice. This schematic with a 2N5109 is good from 1.8 to 150 MHz with a 1.2:1 VSWR or less according to Joe Reisert. I have even put one in a friends CB radio and he was delighted.

Winding and Construction Hints

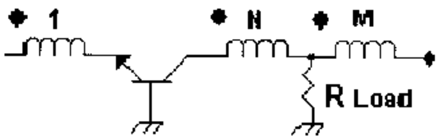
Making the Norton amps requires some planning to keep all component leads as short as possible. The transistor leads

High Dynamic Range RF Amp



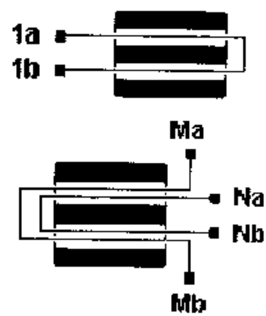
Q1 2N5109 or MRF581
Balun Core BN43-2402
Ferrite Bead FB43-101
50 ohms Z In and Out

Four Practical Transformer Ratios



N = 1 , M = 2 , GAIN = 6 dB
N = 5 , M = 3 , GAIN = 9.5 dB
N = 11 , M = 4 , GAIN = 12 dB
N = 19 , M = 5 , GAIN = 14 dB

Balun Core Winding Info



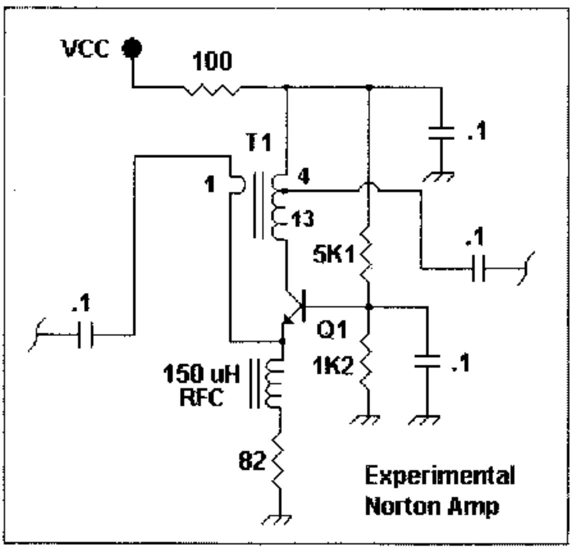
and any connecting components should be trimmed as short as practical to promote stability. Sketch the component layout on a piece of paper and modify it until you are satisfied you have designed a good layout. I usually use a terminal strip piece to support the transformer and to attached the positive voltage wire to. The ferrite beads on the transistor collector aid in stability and should be used to preserve the noise figure by squashing any oscillations should they develop. The 22 uH choke can be the little epoxy coated units that are color coded and look somewhat like resistors. Do not use a choke less than 22 uH.

Before winding, the builder must first decide how much gain is needed from the amp. For an RF preamp, the stage should have gain equal to or greater than the passive stages after it. Also there will be losses in the transformer, so the theoretical gain of the Norton amp maybe 1 dB off and will need to be factored in.

For the purposes of discussion, a 9.5 dB amp is desired , so N = 5 and M = 3. The first step is to mark one side of the core with a dab of liquid paper, paint or a small piece of tape. This will allow you to keep track of the transformer later. To mark, hold the core so that both channels are parallel to the floor. one on top of the other. Apply your dab of paint to the top of the core and use the marked top to denote the A windings. 1a, Ma and Na will all start from the top channel in the balun core.

Using 32 AWG wire for all three windings. start with winding 1 and wind the single turn from point 1a to 1b. Cut off the leads so thay are shorter than 2 inches. Next, wind Ma to Mb three complete turns through the binocular core and trim the leads if needed. Tie a small knot in the wire at both ends. This will clearly mark this M winding. Both windings should look like the diagram under the schematic. 1a to 1b are on the left of the balun core and winding Ma to Mb are on the right side of the core. Mb has a distingishing knot at the tip of both wire ends. Ma starts from the top of the core which you have marked with a dab of paint or something. Finally, wind Na to Nb five complete turns through the core in the same direction as the previous winding M. Strip wires Na and Mb (Mb has the knot) , twist together and solder.

Strip the leads VERY gently with sandpaper or your favorite other method. Insert the transformer in your circuit and cut the leads to their proper length and then solder away. It maybe preferable to prestrip the leads on winding 1 as it is hard to strip the cnamel off a fine wire that has only one turn and it may accidentally pull out of the core. If it does, just re-insert it into the balun core on the correct side. Once you have soldered Na and Mb you can always identify the windings later because you have marked the top of the balun core which denotes the A windings. Try and make your windings gently tight as if there is too much slack you may have difficulty getting the last few windings thru the core



channels. A 14 dB gain amp maybe impossible to wind with 32 AWG wire, it may best to use 34 AWG for that amplifier. I have never built one for greater than 12 dB. The transformers are a bit tedious to wind, however persevere and the results will be well worth it. For HF, you can substitute 0.1 uF caps for the 0.01 caps shown if you like.

The amp shown in the above schematic experimentally uses a ferrite toroid for the transformer and has ~10 dB gain. Incidently, it can also be wound on a balun core using 2 windings, a one turn loop and then a second wire with a tap as shown in the above schematic. A balun core would not be experimental and this amp is very stable with a balun core.

To wind the toroidal version of this amp, wind 13 turns of AWG #26 on a FT37-43 core. Next wind the 14th loop but leave a generous loop for tapping into. Then wind 3 more close turns on the coil to finish. You should have 17 turns of wire with a tap 4 from the end, thus creating the 13 - 4 inductor as shown in the schematic. To complete the coil, wind 1 turn of wire over the cold end as shown in the schematic. It is tricky, but try to keep the one turn link as short as possible. A ferrite bead over the transistor collector is also helpful, but not mandatory. You can try increasing the turns (1:21:5 etc) to experimentally obtain more gain from this amp. The toroid version of this amp is good for understanding how the Norton amp works and maybe an option for builders who do not have balun core ferrites in their junkbox.

Mixer and Diplexer

For the mixer, a 50 ohm diode ring mixer such as the SBL-1 from Minicircuits can be used. LO injection should be around 7dBm. The diplexer that follows is described elsewhere on this website and to get the necessary 800 pF for the capacitors, simply parallel a 470 with a 330 pF or a 120 pF with a 680 pf capacitor. The inductors at 1.99 uH are wound on powdered-iron toroids. You can use # 26 AWG wire and it requires 22 turns on a T37-2 core or 20 turns on a T50-2 core. In addition, you can use a #6 material toroid or substitute the lower order diplexer from the sister 40 Meter Popcorn Superhet.

IF Preamp, Crystal Filter and IF Amp

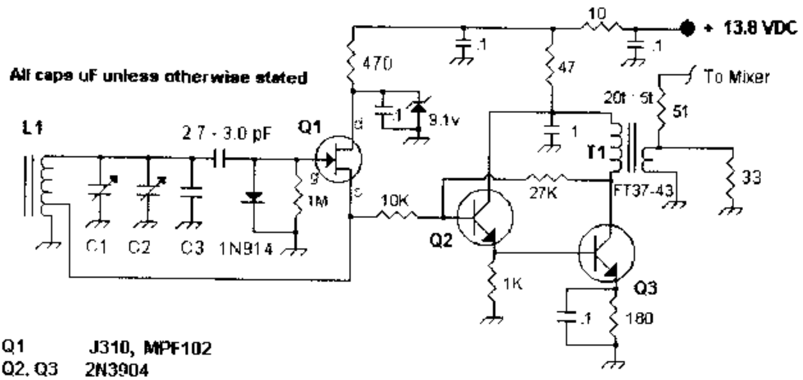
Except for the coil, the IF preamp and IF amp are identical and both warrant a small clip-on heat sink. These amps draw substantially more current than their counterparts in the sister receiver. The 200 ohm -6dB pad following the IF preamp should not be omitted as it helps prevents the stage from seeing reactances created ahead by the crystal filter. The four diodes form a 13dB limiter to protect the crystal filter should a catastrophically large signal be present in the receiver's front end. They maybe omitted. A -3dB 50 ohm resistive pad terminates the IF amp and helps establish a 50 ohm input impedance for the product detector ahead. No IF gain control is used. This receiver has good large signal handling capability and reducing the AF gain was found to be all that was needed when listening to the kilowatt crowd. An IF gain control similar to the sister receiver could be used if the IF amp emitter resistor section was redesigned. The input impedances of the two feedback RF amps is ~50 ohms. The crystal filter is unchanged from the sister receiver.

VFO and BFO

This receiver uses the same VFO/BFO as it's little sister. For improved performance, one could follow the VFO with a low pass filter to launder any harmonic energy present in the output. A low pass filter is also helpful following the BFO.

You can use the simple 3 element filter shown with the BFO schematic or design a half-wave filter if you are really keen.

3 MHz VFO



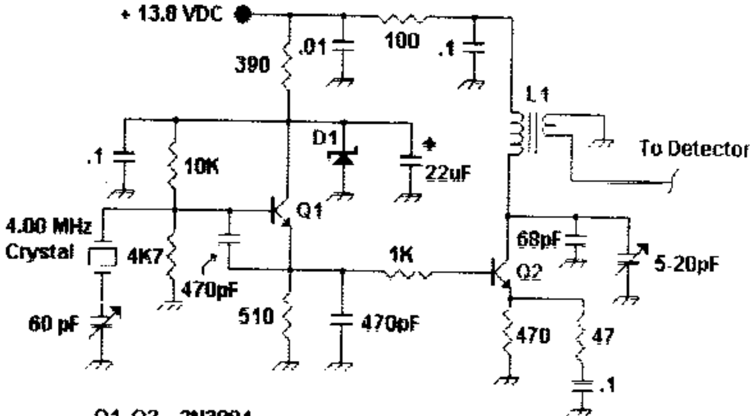
Q1	J310, MPF102
Q2, Q3	2N3904
L1	44 turns T68-6 , Tap at 11 turns from grounded end

drawn 02/02/94

This VFO was first popularized by Roy Lewallen, W7EL and has been used in countless homebrew and commercially sold QRP rigs. For the 40 meter ugly superhets, you have a choice of a VFO frequency of 3 MHz or 11 MHz and I chose the former for this website. For L1, you can use the T68-6 as shown or redesign your own inductor using a T50-6 core. The T68-6 core allows the builder to wind the coil using # 24 AWG wire for enhanced Q and stability. The main tuning capacitor, C1 that was used had a built in reduction drive and went from 4 - 19 pF. If you use a tuning capacitor with a greater capacitance swing, you may have to connect it to the top of L1 via a small-value NP0 capacitor to reduce the tuning frequency range. This can be done using math or by just plain experimentation. C2 is a small ceramic air-variable trimmer from my junk box used to set the lower band edge of the VFO. It can be omitted if the user wants to go frugal and experimentally set the lowest frequency of the VFO using small-value ceramic NP0 caps. Air variable caps for C1 and C2 are mandatory for minimal drift VFO operation. C3 actually refers to 4 NP0 ceramic caps which were used to place the VFO on the correct frequency. Four caps were used to minimize heating and thus drift in the VFO. For the prototype VFO which tunes something ~ 3.00 to 3.67 MHz , I used the mentioned air-variable, four NP0 ceramic caps (20pF, 100pF, 5pF, 100pF) and C2 the trimmer cap that went from 2 - 50 pF.

These values should be used only as a guide for prospective builders as there are many variables at play. Following a 10 minute warm up period, the VF0 frequency stability is excellent. Again, keeps all component leads as short as possible. T1 is a broadband transformer wound by using 20 turns of # 26 AWG over a FT37-43 toroid core and then distributing 5 secondary turns spaced evenly over the primary windings. Do not omit the 33 ohm load resistor. The 2.7 to 3.0 pF coupling cap should also be of the NP0 ceramic type. Q1 can be the J310 (my favorite) , 2N4416 , MPF102 or other correct substitutes. This VFO should be in a seperate sealed, shielded box from the rest of the receiver.

4 MHz BFO



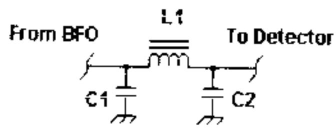
Q1, Q2 2N3904
D1 9.1 volt 400 mW Zener Diode
L1 19.8uH, XL = 498 ohms T68-2 Toroid 59t Primary 12t secondary

Shown is a 2 stage BFO for use with the ugly 40 meter superhets with a 4.00 MHz IF. This is a design by W7ZOI which I have used from 3.5 to 9 MHz by only changing the crystal and the Q2 output coil and capacitor values to suit the frequency of choice. The output coil is 59 primary and 12 secondary windings on a T68-2 toroid core. You will need in the order of 79 pF to resonate this coil, thus a 68 pF plus a 5-20 pF variable works well.

If you do not have a T68-2 core, a T50-2 could be used with 30 AWG wire which is a bit difficult so you could opt for an XL of 200 ohms which would be 40 primary and 8 secondary turns on a T50-2 core. You would need ~200 pF to resonate such a coil and the BFO would have reduced output power, but would still work okay. If you design your own tank, you probably should not use an XL/XC less than 190 ohms for the output stage at 4 MHz. Use a 5:1 turns ratio for primary to secondary windings.

It wouldn't hurt to follow the Popcorn Superhet BFO with a low pass filter. A simple pi-type 3 element filter is suitable. Since I had a couple of 470 pF caps left over, I made a low pass filter using a 6.8

3 Element Low Pass Filter



MHz cutoff frequency with a 1.17 uH inductor. A 1.17 uH inductor using a T37-2 core requires 17 turns while on a T50-2 core requires 15 turns. Caps were inexpensive monolithic ceramics from DigiKey.

The filter is shown on the previous page. L1 = 1.17uH , C1 and C2 = 470 pF. If you want, you may use other cutoff frequencies to suit any junkbox caps you have on hand and use an XL/XC of 50 ohms.

Construction

Keep component leads as short as possible to promote stability. Do not omit the zener diode D1. I thought of using a small ferrite bead on the base of Q2 and will try it on the next version of this BFO that I make. The BFO, if unstable can break into all sorts of weird AF sound effects that are very annoying. The BFO should ideally be in a shielded box, but many amateurs have good results by just placing the BFO strategically in the receiver chassis. When winding L1, make sure you wind the secondary coil so that the secondary's grounded end is on the cold side of the primary coil that connects to the 100 ohm resistor and positive voltage. I just pick one end of the primary coil and close wind the secondary coil from this point in the same direction for the correct number of windings. Then the starting point of the secondary can be grounded and the other end connected to the detector or a low pass filter. After building the coil, temporarily place a 51 ohm resistor from the secondary output lead to ground. Then you can test and peak the tuning of the output tank into a load. Leave the resistor in place for all your testing work such as crystal matching or RF stage testing until you are ready to connect it to the product detector. The 60 pF variable cap connected between the crystal and ground is used to set the beat frequency of the BFO. Adjust it to get a good sounding beat note when listening to a station. You will notice that the beat frequency can be tuned roughly by just listening to 40 meter band noise in the headphones and then tweaked on an active QSO.

Product Detector and Diplexer

A diode ring mixer is used for a product detector. Following the detector is a simple audio diplexer to help terminate the mixer products with a 50 ohm impedance. The diplexer is similar to the one used in the Ugly Direct Receiver on this website. The 2.7 millihenry inductor is hand wound on a FT37-43 toroid and the method for construction is located on the just-mentioned web page. If you choose not to use the 2.7 mH audio inductor, replace it with an inductor wound with 10 turns of #26 AWG on a FT37-43 ferrite core. Also replace the 1uF capacitor to the right of the 2.7 mH inductor in the schematic with a .01 uF unit. Capacitors in the diplexer must be non or bipolar.

AF Chain

The AF chain of this receiver pretty much follows the one used in the sister receiver except for a little more decoupling. The 22 ohm resistor on the emitter of Q6 can be decreased down as far as 10 ohms or increased to as high as 150 ohms to trim the maximum volume into a speaker or headphones. The lower the resistor value the more gain is realized. Transistor choices for Q5, Q6, and Q8 are numerous. Consult the Ugly Direct project for a list of NPN transistor choices. Q6 is a 2N3906 or 2N5087. Low-noise 2N5089s and a 2N5087 were used in the prototype receiver. Q7 is used for muting the receiver and can be omitted if a mute feature is unwanted. An LM380N is used as the final AF amp. A different audio amp can be used such as the LM386N or the new SSM2211 IC to suit the builder. If you remove the negative feedback from the LM380, place a 0.1 uF cap from pin 6 to ground. Remember to keep your leads short as possible in the AF chain or motor boat and/or train whistle noise may plague your receiver.

The DL-QRP-PA - A Home Made Project

by Peter Zenker, DL2FI
(Translation of an article in QRP-Report, the magazin of the DL-QRP-AG for QRPp)

QRP means 5 Watt carrier output or 10W PEP, at least this is the international definition. While it would seem to be easily done, this is assumed by many Hams to not be a technical issue. But this is not true as you will see very quickly if you have a closer look at the PA of many QRP Rigs.

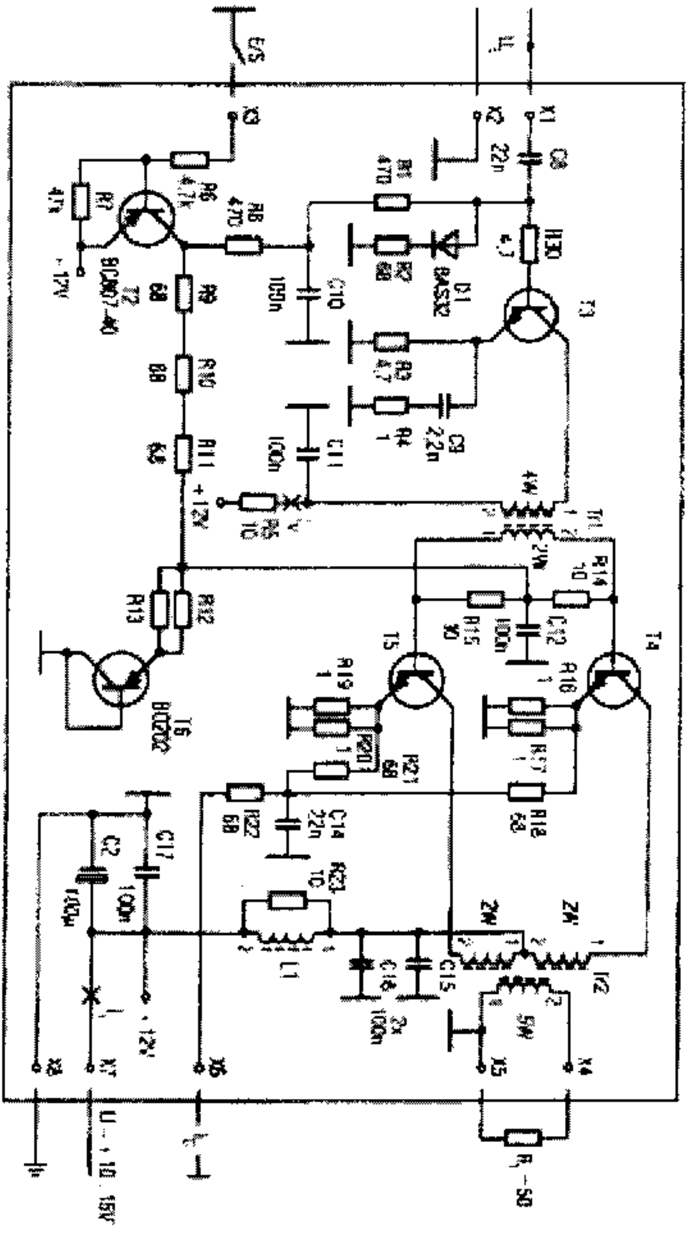
While homemade QRP-receivers are often highly sophisticated, the transmitter part of most QRP-rigs are usually quite simple. As a type of standard normally most constructors use a single step PA. Recently, very often cheap V-MOS switches are used instead of real bipolar RF-Power transistors. To meet FCC rules, the PA normaly is followed by a sumptuous lowpass filter which also very often does not help enough. Hams trying to build their own rigs based on such designs, even if they use kits, almost never reach the assumed power level especially on the higher frequencies. This results in dozen and dozen of tweaking procedures every time a new schematic or a new kit appears.

In the past I have tried several of the tweaking procedures myself. Following the instructions given by lots of people on the Internet QRP-L or in other Ham Radio publications I tried nearly all published modification for the NorCal40, the SIERRA and some 10 to 15 other rigs. Using simple measurement techniques some of the modifications seemed to work great, e.g the power of my SIERRA at 28 MHz was more then doubled. Using a high tech Analyzer which I borrowed from a friend I had to learn that power is not power. What I had seen on the DummyLoad plus wattmeter was shown at the Analyzer as a broadband noise. In other words, My modified SIERRA produced RF at severel frequencies up to the UHF range, but at the desired 28 MHz frequency I found the same output as before.

And old law in RF says: If a PA is well designed, every thing in it does what it is designed to do. If the Output transformer is designed to run at 2 Watt level, tweaking it to 5 Watt normaly results in increasing harmonics without changing the complete design.

The designer of the DL-QRP-PA Helmut, DL2AVH has worked on this problem for many years. Since the early 80's one result of his experiments is the knowledge that miniaturizing of semiconductor power amplifiers is a way to go that helps a lot. The reason for miniaturizing is the fact that even in 5W RF-Amplifiers currents are very high. Compared to a 5 Watt Valve PA he calculated that due to the high current the line length of all lines between any two points of a semiconductor PA have to be 600 times shorter then in a valve PA. This could only be realized by using SMD parts. The second result of his experiments was that he now only works on push-pull amplifier concepts. As he says, push pull amplifiers don't cost much more, but give you much better results in terms of harmonics then any other type of PA. Even with some overloading as is quite normal in Amateur Radio transmitters causes only very little more harmonics in a push pull amplifier but make a standard PA to be a type of big harmonic gun.

Using some of the QRP-PA's I've seen in my lab would give you at least some bad comments by angry friends. While



Schematic of DL-QRP-PA

testing such a PA at 3515 kHz my friend DL7ARY phoned in asking me why I not was responding to his call at 7030 kHz where he could hear me with an S7 signal.

Experiments with severel V-MOS PAs showed that due to the characteristic of V-MOS it is nearly impossible to get linearity and good harmonic suppression below 28 Volts. At 12 Volt range they can only be used as a switch. but not as a PA for RF.

As a result of his long time experimenting Helmut now presents his RF broadband amplifier devoted to the DL-QRP-AG. It is a push pull PA using a pair of 2SC1971, designed to give a harmonic level as small as possible, to work absolutely stable between 11V and 15V and to give an output level of 9.7 Watt to 7.5 Watt between 1.8MHz and 50MHz. The PA needs a driver level of about 200mV to 300 mVand has a gain figure of 37 dB +- 1dB over the entire frequency range of.

It is constructed on a double sided PC-board about 1 by 1 inch, using 36 SMD parts, two double hole torroids plus 3 RF Transistors and one constant current source. As a first batch we produced 100 of this PA. About 50 have been sent out in Kit form and the other 50 have been sent out as a kit to members of the DL-QRP club DL-QRP-AG. The response was overwhelming. Allthough some people had problems with the SMD parts (I personaly used an extra big magnifier), not one reported problems on the RF side. In the meantime the DL-QRP-PA has been adopted to nearly all known QRP-Rigs. It works absolute great in my SIERRA and in the QRP+ from Index as well. The harmonics of the SIERRA are at least -65 dBC (below carrier) I got response from German White Mountain users which are happy now and it also fits great into a NorCal40.

The PA is no longer availeable from the DL-QRP-AG, but it can be purchased as a SEMIKIT from the FUNKAMATEUR Reader Service. (Thats a big German Amateur Radio Magazine) They offer a kit with all SMD parts already soldered :-) for a very reasonable price. You can order the PA using the Internet shop at http://www.funkamateur.de. The shop is partialy english language, prices are in USD and you can use your credit card.

Rochdale QRP Convention 1998

by Tony Fishpool, G4WIF

Following shortly after Pacificon comes the premiere British QRP event - the annual convention at Rochdale in Lancashire. By the time G3MFJ & I had reached the motorway that takes you from the county of Yorkshire to Lancashire, the rain was more like sea with vertical slots in. Thus it was to continue for the whole day.

Not surprisingly, this didn't dampen the enthusiasm of the visitors who flocked to the hall at St. Aidens Church, where George G3RJV carries out his "day job". Within a half hour of opening, the place was packed, and it was with some relief when the lectures started in the adjoining church, and the crowd in the hall thinned out a little. John G0BXO our membership secretary, and Graham G3MFJ our database manager, were kept busy on the club stand enrolling new members and renewing subscriptions. Playing hooky from the Kanga stand, I attended a very entertaining talk by the club treasurer Peter G3PDL, who spoke about portable operation with a particular emphasis on using telescopic roach poles to hold up various vertical antenna. Other Rochdale regulars David Stockton and Practical Wireless editor Rob Mannion also spoke to a packed church.

Later, back in the hall, there was an auction from the estate of two silent key members. Ian G3ROO and Dick G0BPS took it in turns to squeeze a pound or two from the assembled crowd. Several choice items came under the hammer and Ian got into a bidding war over a Heathkit HW9, saying that he had sold his a good while ago and wanted one again. Ian finally got his wish, and as Dick handed it over he was seized with laughter - the manual had written on the cover "Property of G3ROO". The rig had gone through several owners and Ian had bought it back again - at £5 more than he sold it for!

After the convention had finished, the party mood continued back at the vicarage with about fifty or so people tucking into a huge Chinese "take out". A space was cleared on George's workbench and Steve G0XAR and Jan G0BBL produced a project upon which they had been working with Alan G7PUB.

It's a receiver based on the R2 by KK7B and was married up with not one, but two DDS's and all controlled with a PIC. The acid test was to put it on 40m, which in Europe in the evening, is a good test for any receiver. It received extremely complimentary remarks from many, including Ian G3ROO and Sheldon Hands GW8ELR who said he was "very impressed" with the performance. Obviously, this project is in the early stage right now, but we saw it first at Rochdale.

Another first was a demonstration of the G3MFJ Wobulator. This simple but canny piece of test equipment will make aligning receivers virtually child's play. Hopefully, we can twist Graham's arm to write it up soon for SPRAT.

Later I sat at George's PC, with a bucket full of floppy discs, copying a number of past SPRATs. By the time this report is published, the project will no longer be secret, so keep an eye out on the club website (www.btinternet.com/~g4wif/gqrp.htm)

Bill Hickox K5BDZ almost certainly travelled the furthest to attend the convention. Having come all the way from Texas, he said it was well worth the journey. We greatly enjoyed his company too and the QRP chattering went on until the wee hours. Finally, I discovered why the convention is always on a particular weekend each year. It's the night that the clocks go back an hour and George can at least get some sleep before getting up for work on Sunday morning!

Kitbuilding 101

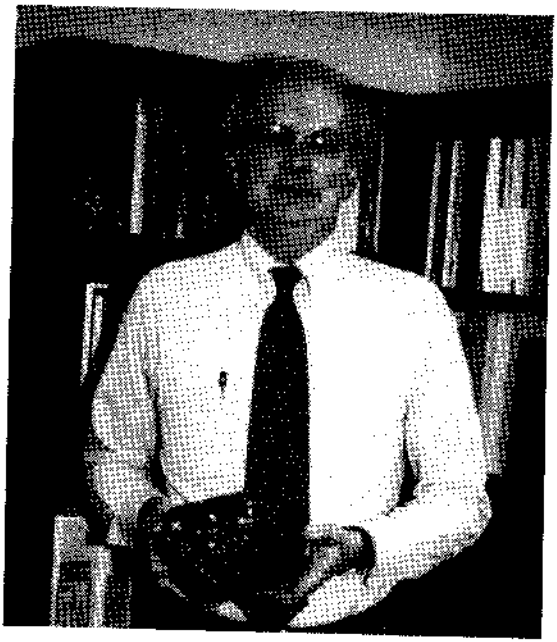
By Dave Sumner, K1ZZ
k1zz@arrl.org

"Dave, if I send you a NorCal 20 kit will you build it?" That's how Doug Hendricks, KI6DS, capped a description of NorCal's goodwill project during a visit to ARRL Headquarters last summer. "Sure!" I replied, not knowing quite what I was getting into but emboldened by his promise that the kit wouldn't be ready for a few months yet.

In February, a videotape-sized package from Doug showed up at home. Sure enough, it was the NC20 kit. If I'd thought Doug would forget his generous offer and let me slip off the hook, I was out of luck. A few weeks later I'd run out of excuses to postpone the project; after all, at that time of year in New England there's not a lot of yard work to do unless you're into mud sculpture. True to kitbuilders' tradition, I commandeered some space on the dining room table and opened the box.

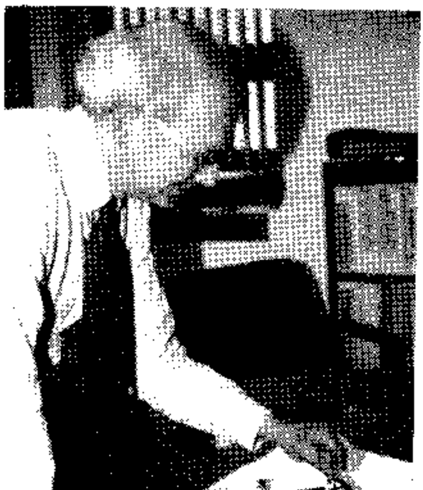
Lest anyone think I've been a pencil pusher all my life, I cut my teeth in electronics at age 14 by working afternoons and weekends in a radio/TV repair shop. My boss was a ham, W1GEA, who had spent his whole life in a wheelchair with cerebral palsy. Self-educated in electronics, he used kids like me as his hands. When the repair business was slow he'd have me build one-tube converters for local reporters so they could listen to police calls on their car radios, or put together an AM transmitter for him from a schematic he had in his head, or maybe replace the capacitors in his Hallicrafters TV set (yes, I said TV set) just for the exercise.

But that was 35 years ago. For the past couple of decades my main interest in home construction has been antennas, and



Dave Sumner, K1ZZ proudly displays his NorCal 20 Transceiver

my soldering mostly confined to coax connectors. Still, I figured, how much different could the NC20 be from the wiring of octal sockets that I remembered so fondly from my youth? Then I started pulling the tiny components out of the box. With the benefit of hindsight it is now obvious that I should have invested immediately in a magnifier, and perhaps in a better soldering iron than the one Santa had procured at Radio Shack for my Christmas stocking a couple of years ago. At the time it seemed a point of pride that I should be able to identify the components without artificial assistance, and to solder them in place with the sort of equipment that might be available in a developing country — after all, that was the real purpose of the project, wasn't it? Fortunately, luck was with me and as we shall see, neither of these self-imposed constraints seriously interfered with eventual success — testimony more to the competence of the designer than to my skill as a constructor.



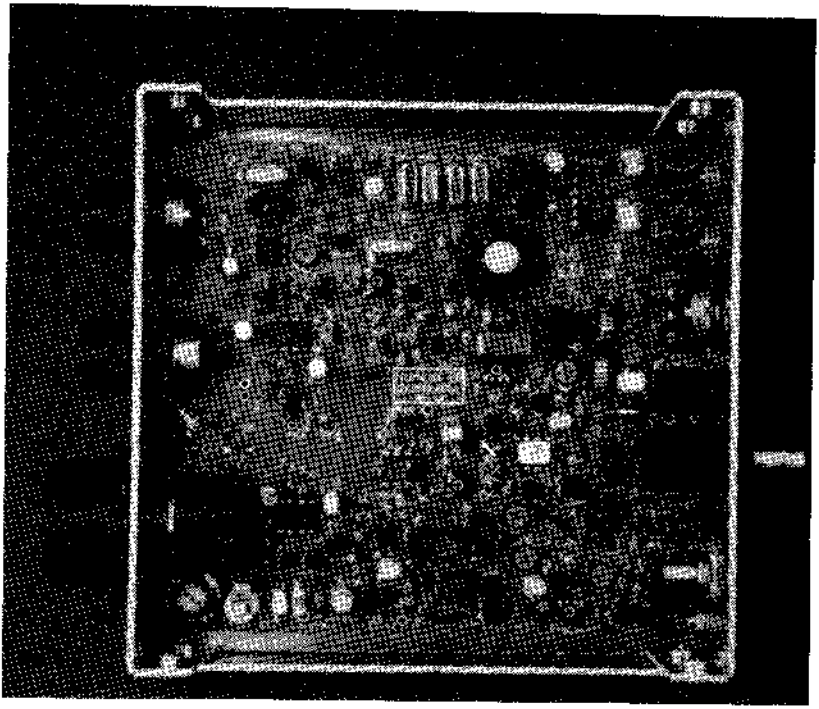
Dave gives his NC20 a final tweaking at the ARRL offices.

In my haste to begin populating the circuit board I skipped checking the parts actually supplied against the parts list. This wasn't a fatal mistake, but it did later cause me to think the 6.2K-ohm resistor was missing when in fact it was just a different color. In a couple of hours the first night I finished the first four of 16 sections in the construction manual, checked the voltages, and went to bed feeling quite smug. This was going to be a piece of cake. Obviously, the hard part had been simply getting started.

Well, maybe not. On my first attempt to wind L1 I used up too much wire in making the tap and had too little left over for 35 turns. When I got to Section 7 I couldn't find an instruction to install R1 and R100, but from the schematic it was obvious they had to be there for the circuit to work so I put them in anyway. (Later Doug told me this omission had been reported on the NorCal reflector, but I didn't discover this incredibly useful resource until after I was done.) Everything else through Section 9 went just fine.

Then I hit my first major obstacle: the Audible Frequency Annunciator wouldn't. Annunciate, that is. No matter how many times or how hard I pushed the button, nothing happened. I listened for the VFO in my FT1000MP; it was oscillating just fine, and I trimmed it onto frequency using the 'MP for calibration. I could also hear, weakly, the 100-kHz oscillator associated with the AFA. E-mail consultations with Doug and designer Dave Fifield, AD6A, revealed that the problem most likely was a rogue AFA chip, which Doug promised to replace immediately. In the meantime I decided I could do without the AFA for the moment, so I pressed on toward the finish line.

At Section 12, playing with the TiCK keyer was so much fun that it almost dis-



This photo shows the excellent job that K1ZZ did building his NC20

tracted me from completing construction. What an ingenious little device! Still, I was anxious to hear real signals so it was time to move on. Soldering wires to the crystal cases was a challenge. The instructions say. "you should be able to tin it fast enough that you can hold the crystal's metal case with one hand while you do the tinning, and not get burned." Right. If that's on the final exam for Kitbuilding 101, I flunk. Either all that sun you California guys are exposed to has toughened your skin, or metal doesn't conduct heat as well out there as it does here. Fortunately, the crystals were more forgiving than my fingers. You may have heard of the Stockholm Syndrome, in which hostages begin to sympathize with their captors. Something similar may happen to kitbuilders: by the time I had finished the receiver I was actually beginning to enjoy winding toroids.

Now, building a kit isn't quite the same as assembling your own creation from scratch — particularly when you're blessed with a board of the high quality that's used in the NC20. The real credit belongs to the designer, not to the builder. Even so, I confess to feeling quite a rush when I hooked up the power and the antenna and immediately heard signals. On to the transmitter!

In Section 15 I found I was one trimmer capacitor short, and spent all the time I'd saved by not checking the parts list on locating a suitable replacement in my junk box. Well, how suitable it was would be a matter of opinion. It was the right value, 8-50 pF, but about 30 years old and so oversized that it looked as out of place as a 1953 Buick at a Ferrari dealership. Still, I couldn't wait to get on the air and figured it ought to work — 20 meters isn't exactly UHF -- so I put it in and headed for the home stretch.

Plugging in the last toroid, I hooked up the antenna, headphones, keyer paddle, and power and prepared to conquer the world. Unfortunately, it quickly became obvious that the rig was more QRP than intended: there was no measurable output and the signal was weak in the 'MP receiver. Something was wrong. I unhooked the power, keyer paddle, headphones, and antenna and carefully examined the underside of the circuit board. Sure enough, there were not one but two solder bridges in the transmitter section. I heated up the iron, fixed those, hooked everything back up again, and my 10 hours of mostly enjoyable labor was finally rewarded.

Alignment was easy. I set the output at a smidge below 5 watts. Now, would anybody be able to hear this cute little toy? Tuning from the bottom of the band, the first CQ I heard was from ZA1D. Should I give him a call? Why not? Sure enough, he came back — as did RZ6ALP, LZ1OJ, UA9MHN, UN7BQ, UA9UY, 4K9W, UA9JMM, I6DVC, UN7CS, UA4PNL, and RV6HA that first night.

Compared to working the same sort of DX with the FT1000MP, which is a fine piece of equipment, I'd have to say the joy is inversely proportional to the price of the radio.

In the interests of full disclosure I'm compelled to reveal that my antennas are inconsistent with the QRP life style. On 20 I have stacked 4-element yagis at 104 and 52 feet. (The lower antenna is fixed on Europe, not that I expect any sympathy for this handicap.) Even when tickled with just 5 watts, the stack offers an edge over the guy running 100 watts to a trap vertical. I know I should string a dipole at 30 feet to fully savor the QRP experience. On the other hand, from previous QRP forays (I'm an honorary member of the G-QRP Club and a sometime participant in QRP events) I know that having a good antenna at my end gives someone with a simple antenna a chance for a QSO that might not otherwise be possible.

A couple of days later, another package arrived from Doug with a replacement AFA and trimmer capacitor and, unexpectedly, a 10-turn pot. Thanks, Doug! Desoldering was more difficult than soldering, but before long I was back in business with a fully functional AFA (another ingenious device) and coverage of the bottom 84 kHz of the band. My first subsequent visit to 14.060 yielded a two-way NC20 QSO with W0MS and a nice chat with guru Rick Campbell, KK7B. Since then I've installed Dave's AGC mod and while I'm not sure it's working the way it should, for now it's more fun to operate than to troubleshoot. I'll leave that for sometime when there's a solar flare.

I'm in awe of Dave, AD6A, for his design skills — not just for the circuit, but for executing it on a "wireless" board that an out-of-practice desk jockey like me could get to work on the first try (almost). The receiver is a joy to listen to. I'm equally in awe of Doug, KI6DS, for managing (and especially for kitting) the project. I know there are many others who have made essential contributions to the NC20 project; my hat's off to you all.

The next time someone whines at me that "hams don't build equipment any more," would you guys be kind enough to beat them up for me? 72, Dave, K1ZZ

QRP Fun
At
1999 Ft. Tuthill
QRP Symposium

SPONSORED BY THE ARIZONA ScQRPions QRP CLUB

The Third Annual Ft Tuthill QRP Symposium will be held at the Ft. Tuthill County Park, south of Flagstaff, Arizona, on Saturday, July 24, 1999. This Symposium will feature speakers noted in the QRP community, and will offer the opportunity to meet and mingle with some of the notables in the QRP world.

Co-located with the largest Ham-Fest in the Southwest, in it's 47th year, QRP-ers will have a chance to hear talks on topics of interest to all in the hobby, meet with some of the rig designers, see QRP equipment from various vendors and generally have a great time in the cool pines of Northern Arizona.

There is a group campground available, reserved for QRP-ers, for those wishing to stay on-site. There are numerous motels and hotels in Flagstaff for those not wishing to 'rough' it. See **http://www.extremezone.com/~ki7mn/tut99.htm** for more information.

This is one of the premier QRP Forums on the QRP circuit, and is a very pleasant place to spend a weekend in the dog days of summer. Bob Hightower, Brian Kassel, Roger Hightower, and the rest of the Arizona QRPers do an outstaning job of hosting this event that draws some of the biggest names in QRP. One of the special guests this year will be Dave Benson, NN1G from Newington, CT, designer of the NN1G Transceiver, NE40-40, NE40-30, Green Mountain series of CW Transceivers, White Mountain series of SSB Transceivers, the Frequency Mite, the SWL 40, 30, 20, & 80 series that was the basis of the popular Elmer 101 series in QRPp and on QRP-L, and his latest design, the DSW with built in Keyer, AFA and Digital VFO. Dave was inducted into the QRP Hall of Fame this year and is a popular speaker and designer well known in QRP Circles.

One of the nice features of Ft. Tuthill is that there is no charge for the QRP Forums and activities. Come and join us for all the fun in Flagstaff in July.

The NorCal 20 Design

by Dave Fifield, AD6A

****

Doug said "Design us a proper rig.
That's robust, like a Soviet MIG.
With a receiver that doesn't fold,
And a transmitter that does what it's told.
And make it, oh, about yay big"....

****

Preamble

Wow! We did it! The NorCal 20 kit completed and shipped. It was a marathon task but, with the help of the whole NorCal 20 team who did a marvelous job all round, all the little last minute tasks got done. Everything seemed to just come together right, in the end. Please excuse the long thanks list below, but it's the least I can do to bring all these wonderful people a little fame and attention for all the unstinting hard work they put into (and will continue to put into...) this huge project. Please join me in thanking them all.

Thanks to Doug, KI6DS, who procured all the parts for the kits and, with several NorCal members, spent hours and hours putting the kits together. Thanks to Jim, WA6GER, who did the manual photocopying, the final bundling of the kits and the shipping (everyone got theirs, right?). Thanks to Mike, K1MG, who conceived, designed and coded the AFA chip that is in every NorCal 20. Thanks to Doug, KE6RIE (got it right this time Doug, okay?!), for providing the superb cases for the kits. Thanks to Dave, W6EMD, and Gary, AB7MY, who spent many hours testing and fine tuning the prototypes as beta builders. Thanks to Gary, N2JGU, and Brad, WB8YGG, for re-working their TiCK design to suit my demanding design criteria. Thanks to Paul, NA5N, for his power-amp design experience, advice and RF measuring. Thanks to George, G3RJV, and his helpers in the G-QRP club for agreeing to provide the third-world distribution for the giveaway kits. Thanks to Jerry, WA6OWR, for providing WWW design and publicity. Thanks to Rich, KI6SN, for editing the manual (and for the great write-up in Worldradio! – Guys, if you don't already get Worldradio, you should – it's a great read with up-to-the-minute ham radio news/articles/commentary). Thanks to all our suppliers who gave us the breaks in the prices that we needed to make this project a success. Finally, thanks to my wife, Caroline, KF6MOV, who put up with so much during the development of the rig.

Phew, hope I didn't forget anyone! If I did, please forgive me, and accept my praise and thanks for a job well done. Now, on to the technical stuff that y'all are really reading this for!

Many of you will have seen my presentation of the design of the NorCal 20 at last year's Pacificon (or QRPacificon as we affectionately nickname it now!). Since then, the design of the rig changed a bit and the layout of the board quite a bit more! We held back until we had just about every little bug worked out of the design before we committed to shipping kits. Well, *nearly* every little bug – we had to ship the rig with non-optimal AGC, as many of your ears can attest! More on that later – if you didn't know, there is a nice easy-to-do modification that makes the AGC real smooth and much better all round.

The 5-page schematic (as the kit was shipped) is in the center foldout section of this edition of QRPp. I will refer to this in my missive as we go through the design description. The design philosophy was to make a single-band rig that would hold its own against the big boys in contests, DX pile-ups and in areas of the world where there is lots of short-wave broadcast QRM and crossmodulation in lesser receivers. Unlike many of my predecessors. I didn't try to minimize the quiescent current on receive. rather. I tried to maximize performance (within budget. of course!).

VFO

Right back in the very beginning of the project, Doug and I decided that the rig would have to have a VFO. We were not happy with the limited frequency coverage that you get with VXO designs. I decided the VFO would be a more-or-less standard Hartley oscillator using an FET. I have always had good luck with these oscillators stability-wise (the NorCal 20's VFO is pretty stable too. so my decision was a good one I think!). I also decided. in the interests of cost and component availability, that the VFO would be varicap diode tuned. Using a varicap diode to tune a VFO adds thermal stability. linearity and other design complications to think about. After many different versions and tweaks. the final design was deemed a) repeatable, b) stable (enough) and c) linear (enough) for use in the kit…phew!…it was a lot of hard work - the most difficult part of the whole design.

Check out the first sheet of the schematic. On this sheet you will see, from left to right, the tuning voltage generation circuit for the varicap diode, the Hartley oscillator and the buffer/amplifier. Let's take each of these in turn.

The tuning voltage needs to be such that we use the most linear region of the varicap diode's capacitance curve that we can. For the chosen varicap, the MV209, this means a tuning voltage that starts at +2V and goes up from there. Below +2V, the capacitance change per Volt is almost logarithmic – it gives a big swing in capacitance. but it is really non-linear. so I didn't want to use it. The op-amp. U1. provides an output swing that can go from approximately 2V above its negative rail voltage to approximately 2V below its positive rail. Since the negative rail (pin 4) is GND and the positive rail is about +12V. this gives us a useful swing of about 2 to 10V to play with. Isn't it convenient too that the minimum output voltage (2V) that we can use from the LF351 op-amp is also the minimum voltage that we want to use on the varicap diode? It was fate. guys, when I saw this. I knew it was right!

Ergonomics tests done with both 1 turn and 10 turn pots led me to provide a reduced range when a 1 turn pot is used. The maximum usable (easy to tune around/set the VFO) range for a 1 turn pot seems to be about 30 to 40 KHz. For a 10 turn pot, the maximum usable range seems to be about 70 to 100 KHz. Changing the feedback resistor in the op-amp circuit changes the gain of the circuit and allows us to easily set the output voltage swing range a bit lower when a 1 turn pot is to be used.

The TUNE pot's voltage range is set by resistors R1 and R100. R1 sets the 2V end of the tuning voltage to the varicap diode and R100 sets the 10V end. This doesn't seem right does it? Once you consider that the op-amp is INVERTING, then it does make sense (hopefully!). The fancy links that you see around the TUNE pot are there to allow us to turn the pot around (electrically). You see, I found that 1 turn and 10 turn pots tune the band in opposite directions! Having the links there allows the user to set the rig up so that the

20m band always tunes from low to high frequency-wise as you turn the TUNE pot clockwise (can I patent this idea?).

You'll notice that the voltage for the TUNE pot and for the mid-point reference voltage (on pin 3 of U1) are both derived from the VFO's clean +8V supply rail. The tuning voltage must be very stable and not vary when the rig is operated from any power supply from about 10V to 14V. The 8V regulator, U2, does this nicely – well, in most cases it does! – it seems there were a few "rogue" regulators that slipped out with some of the kits, meaning that some of you had to replace them in order to get a chirp-free transmit output (we're very sorry about that, but hope you all learnt something from it!)

The nice thing about the op-amp circuit I used to generate the tuning voltage is that it has what is known as a "summing node" at pin 2, the negative input terminal. This allowed me to add RIT fairly simply, by adding in another voltage that varied the VFO frequency up or down a little from the transmit frequency. The tricky part of this design was finding a way to remove the RIT voltage from the summing node during transmit. I tried all sorts of designs and experiments, none of which worked. Then, late one night as I was racking my brains for a solution, I was staring at a bunch of old British electronics magazines (called ETI, for the curious) and found a section called "101 useful circuits" – in there was an analog music synthesizer sample-and-hold circuit (for the key voltage) that used a simple FET switch and op-amp. That was the answer! A few minutes later, I'd designed the circuit values and was breadboarding the circuit that you see before you. Later on, I further realized that this is also the commonly used FET switch technique that is used to MUTE receivers. I limited the range of voltage that the FET had to deal with from source to drain (it's reversed one way round, if you think about it). Some FETs couldn't handle more than a couple of volts before reaching their pinchoff voltage. Later, after we shipped the kits, we found that some of the MPF102's shipped are no use at all in this configuration (they vary wildly apparently). The belated answer is to change this device to a 2N5457 or J309 FET (pin-for-pin compatible) – only bother doing this if you are having chirp problems on transmit though. To prove that this is what's causing your chirp (whoop), temporarily lift one end of R5 – if the chirp goes away, Q1 is your culprit, if it's still there, change out the 78L08 regulator (U2).

An 8V tuning voltage swing that results in about 70KHz tuning range gives us about 1.14E-4V/Hz. To get a 20Hz shift in the TX output frequency, this means a 2.28mV change in the tuning voltage. That's not a lot is it! Some people have speculated that this swing is coming from the 12V connection to U1 not being regulated. The math says otherwise – the LF351 chip has a 100dB power supply rejection ratio. This means that to create a 20Hz shift, the power rail would have to vary by around 228V. This, clearly, is not the source of the small shift some people are seeing.

The output of the VFO FET is fed to a standard shunt-feedback buffer amplifier that buffers and amplifies the VFO signal (shock!). The input impedance of the buffer-amp is approximately equal to the reactance of C8 at 5MHz (3.183K) in series with R12 (12K). This comes to just a little over 15K, not too high, but high enough. The gain of the buffer-amp is roughly equal to –R14/(C8||R12) = -47K/15K = -3.13. This is just enough to get the output signal at the emitter of Q4 to be large enough to drive +7dBm of signal into the local oscillator port of the double-balanced mixer U3. The output level at this point will vary a bit depending on the gain of the FET used for the VFO (Q2). The manual mentions this as being the prime suspect if you aren't getting enough TX output power.

The signal at Q4's emitter is distorted somewhat by the non-linear load presented to it by the local oscillator port of the RX mixer, so a clean version of the VFO signal is tapped off the collector of Q3 to feed the transmit mixer. This reduces output spurii in the transmit spectrum.

Receiver

We got a big break early on in the design cycle when Dave Gauding NF0R, Jim Smith N0OCT and Lee Johnson KE0MC of the St.Louis QRP Club found us some nice +7dBm high-level double-balanced mixers (Minicircuits TFM-2, very similar to the more usually seen TUF-1 mixers) at a vastly reduced price. This basically enabled us to add a bunch of features to the rig that made it what you see before you – a complete package with just about all the features you need to "go get 'em!". This mixer enabled me to design a pretty good receiver front-end – I hope you agree!

Turn to the second sheet of the schematic. This sheet contains the RF sections of the receiver. The signal from the antenna jack arrives at the top left of the schematic as the signal RXIN from sheet 4. If you turn briefly to sheet 4, you will see that the RXIN signal comes from the transmitter harmonic filter input. On receive, the harmonic filter is used in reverse (the filter characteristic is the same either way round), so it pre-filters a lot of garbage at frequencies higher than 14MHz and stops them from becoming a problem in the receiver front-end.

Back on sheet 2, TC2 and L2 form a series tuned resonant circuit on 14MHz (the series tuned circuit is a very low impedance at resonance, as you will recall) allowing receive signals to pass through to T1 without much attenuation. On transmit, the diodes at the junction of TC2/L2 (a high impedance point) conduct to limit the RF voltage going into the receiver so no damage is done. This circuit is commonly called a T-R switch. I claim no originality for its design.

Receive signals are then passed through a fairly narrow (my calculations showed about a 150KHz bandwidth here) double-tuned bandpass filter. This filter rejects out-of-band signals that may cause imaging or crossmodulation problems in the receiver. The filter is a fairly standard design. It has about 4dB of loss. A novel feature is the RF attenuator arrangement that I came up with. Instead of using a mismatched 500Ohm pot on the input side of the filter like most of my predecessors, I came up with a new approach that proved to be both matched (better matched anyway!) and cheaper. I noticed that the impedance in the center of the filter was about 10 to 12K and thought "why don't I just used a standard 10K pot at this point in the circuit?" I couldn't think of any reason why not, so I tried it – it turned out that it actually works very well indeed (another patent application here?).

To overcome the 4dB loss of the front-end filter and the –6dB loss of the double balanced mixer, I used a fairly standard FET front-end pre-amplifier (Q5). This pre-amp has about 8dB of gain and provides the receiver with a fairly low overall noise figure (about 8dB, but this has not been measured yet). Dave Meacham (elsewhere in this issue I think) suggests that the noise figure/match into the pre-amp can be improved by reducing the number of turns on T2's secondary to 3 turns (instead of 4). I haven't tried this, but it is worth considering this mod.

Without some form of VHF/UHF

damping, the pre-amp would simply become a VHF oscillator. The normal method of controlling this is to use a small ferrite bead on the drain lead of the FET. I found this method to be too expensive and somewhat microphonic as well. A simpler, cheaper solution to this problem is to add a small series resistance in the drain lead. This kills the VHF/UHF gain of the stage totally (thanks to Mr. Miller and his effect) and makes the pre-amp unconditionally stable. It does knock a tiny bit off the HF gain, but we have enough that we don't need to worry about it here.

The drain circuit of the pre-amp is broadly tuned to 14MHz and impedance matched to the RF port of the double balanced mixer using a capacitive tap. Again, I believe Dave Meacham has a useful mod that improves the match and Q of the tuned circuit here.

The double balanced mixer (U3) mixes the VFO signal with the band-limited receive signals to produce a whole spectrum of first, second, third (ad infinitum) order mixer products at its IF port. We are only interested in the first order product of the input frequency (20m band) minus the VFO frequency, that is, the IF frequency of 9MHz.

However, we have to do something with all those other mixer products to stop them from upsetting our receive mixer. We need to terminate them all in 50Ohms. So where's the 50Ohm termination resistor you ask? Well, the post-mixer amplifier takes care of terminating both the wanted signals at 9MHz and all the unwanted stuff up and down the spectrum. Q6 provides an approximate 50Ohm termination for all the frequencies that matter to us here. Since there can be quite a lot of energy at the unwanted mixer product frequencies, we have to be able to handle the total power of all these signals in the post-mixer amplifier without the amplifier itself producing its own intermodulation products from all the stuff we don't really want. This means that the post-mixer amp has to be a fairly beefy amplifier and use quite a bit of current. I used a 2N4427 device for this, rather than the more usually seen 2N5109 because it was a) cheaper and b) cheaper. The 2N4427 has very similar specs to the 2N5109 at the frequencies of interest in this design. The post-mixer amplifier has a gain of about 20dB and, with a quiescent current of about 35mA, provides an output third order intercept point (IP3) of about +25dBm. This is more than adequate to ensure good receiver performance (you can reduce the current consumption here, at the cost of receiver performance, if you like). It does mean, however, that the 2N4427 device needs a small heatsink to dissipate the power.

The output of the post-mixer amp (Q6) needs to see a fairly constant 50Ohms termination across the spectrum, since this type of post-mixer amplifier reflects its output termination impedance to its input. Therefore, we cannot simply feed the amplifier's output straight into a crystal filter. At resonance (9MHz) a crystal filter's impedance characteristic is all over the place. A simple 6dB attenuator (R30, R31, R32) provides 12dB of return loss for the signals from the post-mixer amplifier output to the crystal filter and back again. This provides the best compromise balance between signal loss and post-mixer amp termination impedance.

The 4 pole 9MHz crystal filter provides about a 300Hz CW filter bandwidth with a nice flat top response, sharp skirts (stopband attenuation is in the order of 70dB) and about 9dB of loss. "More loss?" I hear you ask, "When are we going to see some gain for a change?"

Right here – next comes the IF amplifier. Notice that this is the same type of shunt-feedback buffer-amp that was used for the VFO. The input impedance is about 50Ohms, it has about 27dB of gain and an output impedance of about 50Ohms too. Additionally, it has fairly low noise, so all in all, it's a nice clean IF amp design.

If you're still following me at this point, you may have noticed that I haven't said anything about the AGC PIN diode gain controls along the way. I was saving that for the section on AGC later, but I guess we have to mention D11 right here, since the amplified IF signals have to pass though it at this point. D11's circuit can be considered a variable RF resistor in series with the IF signals – more about the AGC later.

The IF amplifier, because of it's fairly high gain, adds some noise to all frequencies passing through it. This includes both our wanted sideband (the CW signal you are trying to listen to) AND the unwanted sideband. There is little or no signal at the unwanted sideband, but the product detector (next thing in the circuit) doesn't care. It simply mixes (demodulates) them both down to audio frequencies. If there is a lot of noise in the unwanted sideband, this will be mixed down to audio as unwanted noise along with the wanted signals from the wanted sideband (still with me?). Since the IF amp does add noise to the unwanted sideband, this is bad. Significant improvement in the noise performance of the product detector can be had by placing another simple crystal filter just ahead of it. In my design, the product detector (U4) has some internal gain that also adds noise, but we can't do anything about that without a major re-design using more amplifiers and a passive product detector. The unwanted sideband noise filter (X5) is matched so its frequency aligns with the main filter and is designed so that it doesn't upset the nice flat top of the main filter too much.

The output of the unwanted sideband noise filter is impedance matched to the input of the NE602 product detector with a broadband RF transformer. This steps the impedance up from around 50Ohms to the 1.5K of the NE602. The NE602 contains a Gilbert cell mixer and an oscillator circuit – for your reference, the conversion gain of the NE602 is about 17dB. I use the internal oscillator as the BFO – it is running at 9MHz, with a small offset (set by TC6) that allows you to hear signals as audio tones after they are demodulated.

The differential audio output from the product detector is fed to schematic sheet 3. Capacitor C43 removes much of the unwanted high frequency noise from the audio. On sheet 3, U5a provides some useful audio gain, about 11dB, and a low pass filter characteristic that rolls off at 1298Hz. Filter-amp U5a is configured as a simple differential amplifier with gain roll-off frequency set by 1/(2*pi*RC). R49 and R50 provide the mid-rail voltage for all the audio filtering sections. C48 and C49 provide AC noise decoupling to GND from this mid-rail point.

The single-ended output of U5a passes through the FET MUTE switch Q9. Again, there have been several constructors who have had problems with bad MPF102's here. If you are experiencing clicking/thumping on key down or key up, consider changing this FET to a 2N5457 or J309A part. The FET MUTE switch is switched by the MUTE signal from the transmit control section on sheet 5. The switch output is fed directly into a bandpass filter built around U5b. Since all the inputs and outputs of the audio circuits around and about the MUTE switch are all at the same basic mid-rail DC potential, there are no thumps or clicks introduced into the audio path. I have seen several other designs, in the past, where this detail was not considered, resulting in a design that has significant RX/TX changeover transition problems (audio coupling capacitors charging/discharging).

The bandpass filter has a center frequency of 700Hz, a mid-band gain of about 30dB and a Q of about 5. The center frequency can be altered to suit other frequencies if desired, but it was found to be adequate for most operators who like CW notes from about 600Hz to 800Hz. The bandpass filter op-amp is also pushed into service as a straight inverting op-amp to amplify the sidetones from sheet 5. The SIDETONE signal is fed straight into the inverting input of the op-amp where it bypasses the filtering effect of the bandpass filter arrangement.

The audio output from the bandpass filter is fed directly to the AGC circuits. A small attenuator formed by R56/VR4 cuts the audio signal down to a level where the main audio amplifier can handle it without distorting. The LM380N audio amplifier was chosen because it can easily drive 1W of clean audio into a small loudspeaker. The more ubiquitous LM386 just doesn't have enough poke to drive most loudspeakers that I have tried, and I invariably end up being disappointed with the result. The LM380 does have quite a lot of gain though, hence the need to attenuate the audio feed to it (we need the full audio level from the output of the bandpass filter for the AGC circuits however).

Capacitor C57 decouples a lot of high frequency audio noise to GND and keeps the LM380N from sounding too "hissy". R58 and C61 form a Zobel network at the output of the audio amp – this provides very high audio frequency roll-off and keeps the audio amp happy when driving inductive loads. Audio output is by means of a stereo jack – or there is room to put a small loudspeaker right in the case of the NorCal 20. Notice the output is from a STEREO jack – you wouldn't believe it, but I had a few cases where people complained of low output that I eventually diagnosed as them using MONO jacks plugged into the stereo output jack socket! Of course, the audio was shorted out!

AGC

The AGC system was added to the requirements about halfway through the project. Several hams, who had played with early prototypes, insisted that we add AGC! Looking back, I think they were right. Without AGC, the receiver is a pain to use – you have to keep one hand ready on the RF attenuation pot all the time as you tune the band – if you want to protect your hearing that is!

Adding AGC to the receiver was not an easy task. I experimented with several different arrangements of PIN diode attenuators (before the RF pre-amp, after the RF pre-amp, after the post-mixer amp, before the IF amp etc.). Some of theses arrangements were disastrous, for example, a PIN attenuator place between the RF preamp and the mixer resulted in the VFO frequency being pulled by strong signals which resulted in "whoop" on receive! In the end, I settled on one PIN attenuator after the IF amp (D11) and two more PIN diode variable gain amplifiers. The first of these (D9), added to the RF pre-amp, doesn't have much affect on the RF gain at all, and the second (D10), added to the emitter circuit of the post-mixer amplifier has a fairly big effect on the post-mixer amp gain. The third (D11) is an in-line attenuator that contributes quite a large amount to the AGC attenuation range (approx. 30dB if I recall correctly). These three stages of AGC were found to be inadequate in dealing with the range of gain variation required for "good" AGC function – the AGC needed far more range.

Back at the drawing board, I scratched my head for quite a while – I didn't want to have to start using MC1350 I.F. amplifier chips (noisy and expensive), but how else was I going to get the gain variation required? Then I recalled Wayne Burdick's SST design with the simple AGC that he'd come up with built around his product detector and AF amplifier. Wayne had discovered that, by applying a common-mode DC voltage to the input pins of the NE602 device, you could vary its conversion gain quite a bit. That was it – I was using an NE602 for my product detector, so I could do the same thing. Well, I refrained from using a low voltage red LED as per the SST (I found it very distracting) and went for a simple set of series diodes (D19-21) to get the right AGC voltage from the audio. It worked pretty well (or so I thought!). This was how the kit was shipped – with two AGC loops (independent of each other). However, as many of you will testify, the AGC action on strong signals was far from ergonomic – it absolutely clobbered the signals down to nothing, then slowly released a little audio – someone aptly coined the phrase that it "sounds like someone hitting it with a baseball bat".

Well after all the kits were shipped, Dave Meacham revisited the AGC design and came up with some mods that would ease the baseball bat action a bit, but still wasn't really what you'd expect from a nice smooth AGC response. I dug into the design a bit more and decided that part of the problem was that the two loops weren't progressive and were unconnected. The rig needed just one AGC loop or something far more complex in the way of controlling the two loops together. It wasn't long before I realized that I could very easily feed the NE602 with an attenuated version of AGC2 and things should work quite well. A quick bit of math found the attenuator resistor values 2.2K and 680Ohms would do the trick nicely. I tried it. WOW! What a difference! The AGC was now really smooth acting and had waaaaay more range than it ever did before. I was impressed. I found that by removing the first AGC PIN diode stage it made next to no difference in the AGC range and action, BUT it did make a big difference to the intermodulation performance of the RX front-end – I decided to take it out. The modification details are elsewhere in this magazine.

Guys, this modification is a "must do". The improvement is huge – my NorCal 20 prototype has over 110dB of AGC range now – signals up to +10dBm at the input do not bother it! You will find that you rarely need to use the RF attenuator control on the rear of the rig after you do this mod.

Transmitter

I spent a lot of time on the transmitter design. Many circuit ideas and canned designs were tried – all but the final design had flaws. I wanted a simple, cheap transmitter design that would be variable from 0 to over 5W output, very stable, very clean and easy to tune up. The first prototypes used and IRF510 MOSFET for the final. Driving that thing was a nightmare! In the end, I gave up on it because of its terrible efficiency at anything other than full power output.

After a bit of a search, I found a nice high gain CB type bipolar transistor designed specifically for this type of application, the 2SC1969 made by Mitsubishi. This was reasonably priced and was available – a rare thing these days!

The transmitter was sort of designed in reverse – the PA transistor's gain/input power requirements set the driver stage's design requirements. The design of the output side of the PA was trivial. The work had already been done for me and published in QEX sometime last year. A simple 4:1 impedance step-up transformer (T8) brings the transmit VSWR match somewhere close to 1.5:1. The harmonic filter from QEX was simply scaled to 14MHz. This type of elliptical filter adds notches in the transfer function at the second and third harmonics. It works very well indeed. A tiny amount of transmit RF is detected by D23 for use when setting up the VFO and transmitter.

Since the 2SC1969 has about 13dB of power gain, it really didn't need to have a hefty driver (and hence, expensive). A paralleled pair of PN2222A transistors were all that was required to do the job – guess where I got that idea from? The NorCal 2N2222 design contest of course! The two transistors share the collector current. Resistors R77 and R78 ensure even load distribution between the two transistors and also set the gain for the stage. I designed the output of the driver stage to be broadly tuned to 14MHz. This is achieved with the inductance of the primary of T7 with capacitor C76. I have not seen this technique used anywhere before, so unless I hear otherwise, I claim the bragging rights as its inventor. "So what?" you ask, "big deal!" – well, it is a big deal – making the intercoupling between the driver and the PA tuned like this VASTLY improves the output spectrum and tames the whole transmitter from taking off at frequencies other than the required 14MHz (another patent maybe?). This filtering effect plus the elliptical harmonic filter on the PA output add together to produce the cleanest output spectrum I have ever seen from a QRP kit. The harmonics are at least 70dB below the main carrier – better than most commercial rigs! The mixer generated spurious outputs aren't too bad either, being at least 54dB below the main carrier – these could be improved using a more sophisticated design (a more balanced mixer or maybe a DDS?).

The driver stage designed, I needed about 0 to 4V peak to peak to drive the driver. Our old friend the shunt feedback amplifier handles this nicely. Q14 and Q15 form the amplifier that has a gain of about 22dB at 14MHz. C105 was added to ensure stability at frequencies much higher than 14MHz (it kills the VHF/UHF gain of the circuit totally). The output of this amplifier takes the form of an emitter follower – simply tapping the emitter resistor provides drive from 0 to 4V p to p (VR6) which sets the output power anywhere from 0 to about 7W.

Prior to the shunt feedback amplifier is the transmit mixer and double tuned filter. U7, an NE602 provides the 9MHz needed to mix with the 5MHz VFO frequency. Transmit offset is handled in the same way as receive offset – TC7 adjusts the offset to match the receiver, so when you transmit you are on exactly the same frequency as the fellow you are calling. The VFO input level to the transmit mixer needs to be carefully controlled. Dave Meacham suggested using a capacitive divider to do this accurately and in a way that will allow the probing of this point with test equipment (e.g. an oscilloscope) without it having much effect on the signal level itself. A resistive divider with the same signal levels would be grossly affected by the adding of an oscilloscope probe on pin 1 of U7.

The differential output of U7 is tuned to 14MHz by the primary of T5 and C70/TC8. T5 is loop coupled to T6 – this method does two things for you, a) it converts the balanced signal to unbalanced in T6 and b) it reduces the level of unwanted lower frequency spurious signals that are generated in the mixer section of U7. T6's secondary is resonated with TC9/C71 to 14MHz.

The net result is a transmitter that meets all the design goals that I set out to achieve. Please feel free to plagiarize any or all of the transmitter design for your next project.

TiCK Keyer & TX/RX Timing Control

The TiCK keyer chip from Embedded Research was chosen because it has a nice set of features and Brad/Gary were willing to do a bit of alteration to the device to suit my design requirements for the NorCal 20. I wanted them to do some special things with the audio output drive so I could have a simple, thump-free sidetone in the rig. Sidetone from pin 3 is first filtered by R82/C89, then level adjusted by VR7 and then fed via a very small capacitor, C96, to the audio amplifier stages of the rig.

The TiCK keyer chip has all sorts of essential keyer features such as paddle swap, speed adjust, weighting adjust, iambic mode A or B, straight-key mode etc. An added bonus is that the TiCK III (sometimes called Super TiCK) chip, that contains even more features like memory and beacon mode, is a drop-in replacement for the TiCK I in the NorCal 20. This allows users to upgrade real easily. The TiCK's features are programmable using a front panel mounted push-button switch. All TiCK setup data is lost when the rigs power is removed.

The digital output of the TiCK keyer drives the base of Q19. Q19 is a simple NPN switch. When a paddle is pressed, TiCK pin 5 goes to logic 1, which turns transistor Q19 ON. This pulls the base voltage of transistor Q20 towards GND, which turns transistor Q20 ON. Q20 is normally held in the OFF state by R85. The voltage at the collector of Q20 does not immediately go straight up to 12V though, instead, because of C94 charging, the collector voltage ramps linearly up to 12V in about 1.5mS. This controlled edge turn-on causes the transmitter output envelope to also have a nicely controlled rise time, hence occupying the minimum necessary bandwith. At the end of transmission of a code element, the TiCK output (pin 5) returns to 0V switching transistor Q19 OFF again. This turns Q20 OFF again, but this time, because of the charge already held in C94, the collector voltage cannot immediately go to 0V – it ramps down linearly in about 2mS, controlling the falling edge of the transmitted RF envelope in a similar manner as the leading edge.

The receiver MUTE and RIT circuits need to be switched for the RX to TX and TX to RX transitions. Switching transistor Q21 turns ON pulling the MUTE line to 0V during transmission. This transistor ensures that the receiver is muted and the RIT is OFF before the +12VTX line is up and the transmitter active and, through R98/D26, that the receiver remains muted until the transmitter has stopped transmitting. There is another modification that can be made to the circuit here – to extend the time that the receiver is muted after transmission. This modification is also provided elsewhere in this edition of QRPp.

AFA

The Audible Frequency Annunciator (AFA) measures the VFO's frequency, does some clever math on it and converts the result to an audible Morse code annunciation of the last two KHz digits of the actual frequency the rig is tuned to on 14MHz. Thus, for 14.060MHz, the AFA will announce "60" in Morse code. The AFA has two modes of operation, Auto and Manual modes. Auto mode is where the AFA sends a very short "pip" every time you tune through a 1KHz point on the dial, and then, when you stop tuning, announces the frequency you stopped on after a few seconds. Manual mode is where you press a front panel mounted push-button switch every time you want to hear the AFA announce the current frequency. Mode selection is by board mounted links. A small slide switch can be mounted in the mode link holes and a corresponding hole cut in the bottom of the case to allow access to it – if you'd like to be able to change modes on the fly.

The audio output on pin 7 of the AFA is treated in the same way as the audio from the TiCK keyer – VR8 sets the audio level. The AFA needs a reference frequency to compare to, so requires a 100KHz crystal. It contains the circuitry needed to turn pins 2 and 3 into an oscillator. The output level of the VFO is too small to drive the digital input of the AFA directly, so our old friend the shunt feedback amplifier comes to the rescue once again! Q22 and Q23 form the amplifier that provides about 4V peak to peak signal for the AFA. D27 and R96 stop the VFO signal from being amplified during transmit. This was found to help reduce the incidence of spurious announcements by the AFA during transmissions, when the AFA was in Auto mode.

Conclusion

The astute will notice that the basic design of the NorCal 20 is fairly easily adaptable to other bands. Although the NorCal QRP Club won't be offering this design for other bands, the new "High Performance Ham Radio Kits" company called "Red Hot Radio" that I have formed to ensure a supply of these neat radios, will. You can check out the Red Hot Radio website at http://www.redhotradio.com for more information. The instructions for converting the NorCal 20 into a Red Hot 40 are on the web, as are all the modification details mentioned throughout this article. If you missed out on the original club kits, you can order a Red Hot kit from here too.

That's enough advertising. Folks, I must say it was a real pleasure and immense fun to do the design work on this radio. Please write to me if you have any questions on the design or troubleshooting it – my email address is below.

It sure was a lot of work, but when I read emails from people whose rigs work nicely (first time!) and hear people on the air actually using them, then all memory of those late nights fade away to nothing and I'm left feeling proud and very, very satisfied with a job well done. See you on 20m!

72, Dave Fifield, AD6A
support@redhotradio.com

NC20 Transmit Timing Mod to Cure "Real" Sidetone THUMP

by Dave Fifield, AD6A

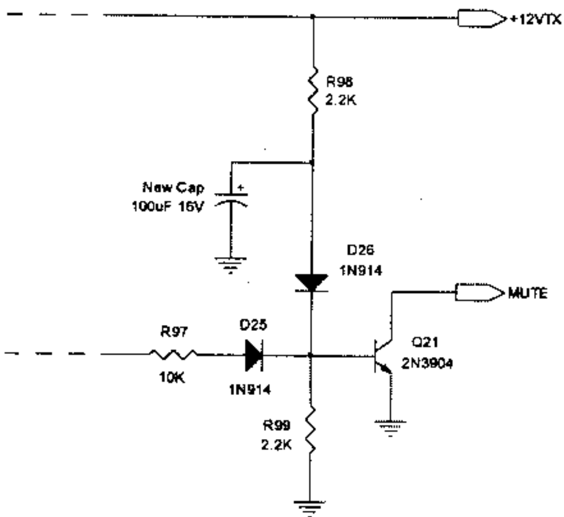
If you have tried to use the "real" sidetone from the NorCal 20's receiver, you will no doubt have been put off by the loud clicking (a.k.a. THUMP) that accompanies the end of each Morse code element. Some radios will be affected more than others depending on their exact transmit timing. If you do the AGC mod that I suggest then you won't be able to use "real" sidetone mode at all since the mod ties the product detector into the main AGC loop, which means on transmit, the product detector is completely shut down (by the MUTE line). I'm working on an alternative mod that will allow you to have both nice clean modified AGC and be still be able to use "real" sidetone mode, but I'm not there yet, so you'll have to wait a while longer. For now, whether you are doing the AGC mod or not, this timing mod is worth doing. In fact, on some rigs, after the AGC modification has been performed, there will be a slight amount of clicking even using TiCK sidetone until you do this mod.

The reason for the slight thump/click is that the MUTE switch, transistor Q21, is turning off too fast at the end of each transmit element (Morse code element). This is due to the current available from the falling

+12VTX line not being sufficient to keep Q21 turned on for very long, allowing a small amount of the tail end of each transmit element to get into the now unmuted receiver, leading to a rather nasty pulse throughout the whole receiver chain. A simple cure is effected by changing the value of R98 from 10K to 2.2K and adding a 100µF 16V "hold-up" capacitor to the junction of D26 and R98 as shown in the diagram below:

At the start of each transmission, the 100µF capacitor charges up fairly rapidly through R98. At the end of each transmit element, as +12VTX falls, the charge in the capacitor continues to supply current to the base of Q21, keeping it turned on for a few more milliseconds. This keeps the MUTE signal low long enough for the transmission to completely cease, allowing the receiver to completely recover without any THUMP. The upper limit of the rig's QSK speed is affected by this modification, but normal operation at up to 40+ wpm seems to still be fine. You may like to play with the values of R98 and the new capacitor to fine tune the mod for your rig – there will be some differences between rigs.

With this modification in place (though not the AGC mod) and with R52 = 5.6K, the "real" sidetone is a pleasure to use. Of course, this means you have to manually turn off the TiCK's default sidetone each time you turn on the rig, but you may consider this a small price to pay for being able to hear exactly what the transmit offset is. 72 es GL, Dave Fifield, AD6A



TWEAKING THE NORCAL 20

by Dave Meacham, W6EMD
206 Frances Lane
Redwood City, CA 94062
Internet: ddm@datatamers.com

Here are seven mods that I developed on my prototype rig after the NC20 design was firmed up and the manual printed:

1) Revised crystal filter:

This mod gives a narrower bandpass, much better match, and 2dB lower insertion loss. The only penalty is a rounded top on the response curve...you hardly hear it. Change the capacitor values to the sequence 1200pF, 680pF, 1200pF, 680pF, 1200pF (C30 through C34).
Return loss = 23dB
Insertion loss = 7dB
Bandwidth = 480Hz @ -6dB points

2) Revised roofing-filter:

This mod centers the response curve better on that of the main filter. Change C38 and C39 to 820pF. On the underside of the board cut the trace between C36 and the emitter of Q8. Scrape off the solder mask on each side of the cut, and solder a 120-Ohm resistor across the cut.

To avoid cutting any trace, Gary Surrency suggests lifting one end of C36 and soldering the 120-Ohm resistor in series with it (above the board). To save some money, Dave Fifield suggests using the two 680pF caps removed from the roofing filter for the revised main filter, and the two 820pF caps from the main filter for the new roofing filter. He also suggests simply adding three 390pF caps underneath the PCB in parallel with the remaining three 820pF caps of the main filter to bring them up to 1210pF, instead of having to replace the 820s with 1200s.

3) Hiss fix:

This mod kills the hiss from U6, but is useful only for headphones. Cut the trace (on the underside of the board) from C62 to J1 (close to C62). Jumper the cut (as above) with a 39-Ohm resistor. Add a 22uF tantalum capacitor from the hot terminal of J1 to ground (negative to ground). Change R56 to 10k Ohms. (This is a refinement of the mod mentioned in the manual.)

4) Preamp fix:

This simple mod improves the MDS (receiver sensitivity) by more than 1dB. Just add a 220pF capacitor (under the board) across C22. I used a C0G mono cap. Retune TC5 for maximum signal. If you run out of tuning range, spread the turns on L3, or, in an extreme case, remove one turn. This mod increases the load impedance seen by Q5 from 365 Ohms to 1200 Ohms, and increases the loaded Q of the tuned circuit from 2.3 to 8.8. You will notice the sharper tuning of TC5.

5) BPF match:

Remove one turn from the secondary of T2 so that it becomes 3 turns to give a better match. Change C17 to 3.9pF or 4pF, NP0 or C0G type.

6) Output low-pass filter:

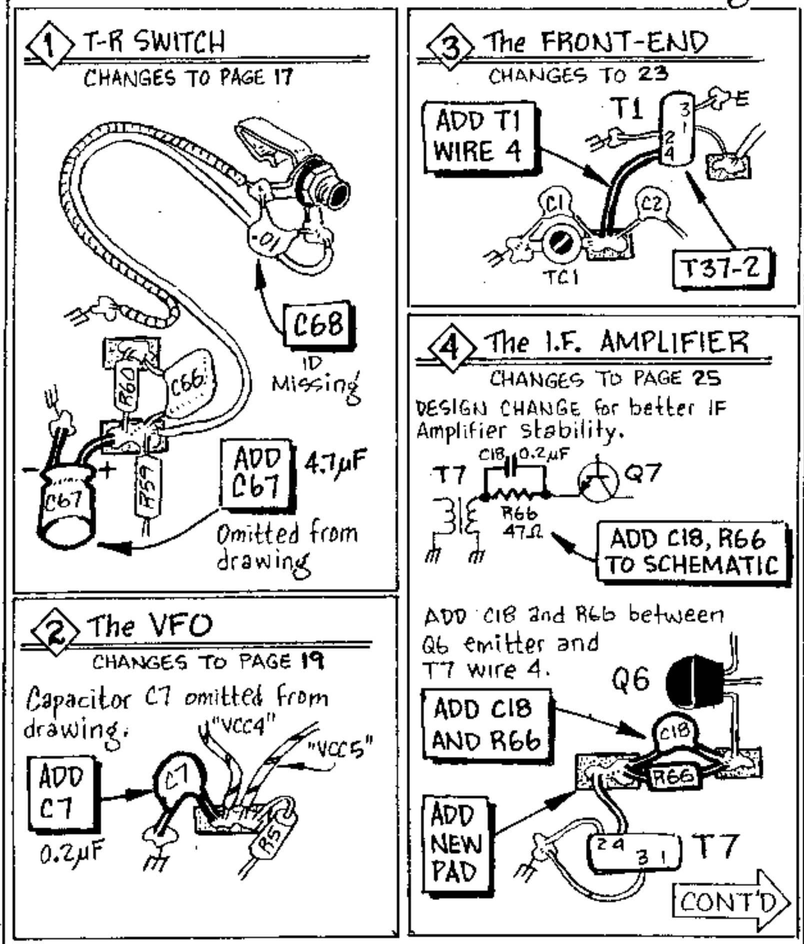
Change L6 to 8 turns, and L7 to 7 turns. Change C80 to 300pF (two 150pF caps in parallel). Be sure and use 100V NP0 or C0G caps. Remove C82. These changes improve the harmonic attenuation and the matching.

7) Reactive T4 fix:

The stock T4 suffers from a low inductive reactance of about 2.9k Ohms referred to the secondary. The load is 3k Ohms resistive in the NE602. Increasing the inductive reactance gives a more resistive termination for the roofing filter, resulting in better performance. Just change T4 to 4:22 turns of number 28 wire, or (better yet) to 6:33 turns of number 30 wire (harder to wind). I think you will like the improved performance. 72, Dave, W6FMD

The 2N2/40 ADDENDUM

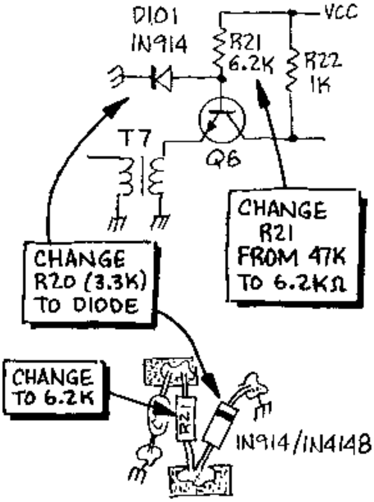
The errors and omissions discovered in the 2N2/40 construction article (WINTER 1998 QRPp) by various builders and the designer, Jim Kortge K8IQY, are detailed and illustrated below. In most cases, schematics are correct - with a few parts omitted from the drawings.



⟨4⟩ The I.F. (Cont'd)

CHANGES TO PAGE 25

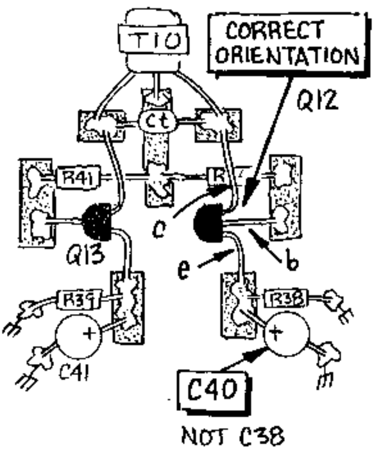
An alternative to adding R66 is to use a diode in place of R20 for proper biasing.



⟨6⟩ AUDIO AMPLIFIER

CHANGES TO PAGE 31

The orientation of Q12 is incorrectly drawn - proper placement shown here.



⟨7⟩ TX AMPLIFIER

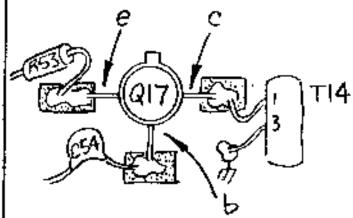
CHANGES TO PAGE 35

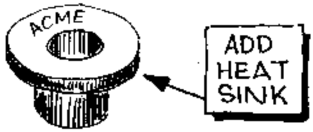
Toroidal transformers T12 and T13 are wound on T37-2 cores, not FT37-2

⟨8⟩ The PA Stage

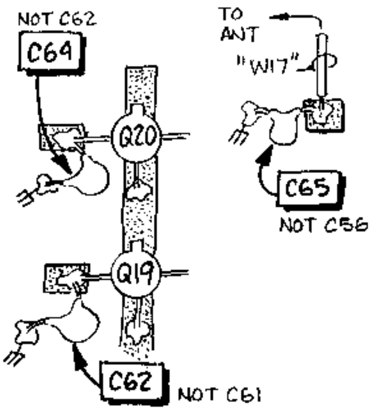
CHANGES TO PAGE 37

TX Driver transistor should be a TO-18 (metal can) 2N2222A with a heat sink.





Three Capacitors are mislabled:



SOME 2N2/40 GOODIES...

The ScQRPion Screened Board.

The AZ ScQRPions have made a copper clad board for the 2N2/40 with the location of all the pads & major components screened into place. This uses the illustration on page 13 of the Winter 1998 QRPp. The 2N2/40 winner at the Ft. Tuthill hamfest used this board for a neat, clean build. Extra copper clad provided for making the pads. Available for $5.00 from:

BOB HIGHTOWER, KI7MN
1905 N. Pennington Dr.
Chandler, AZ 85224

2N2/40 UPDATE INFO

Jim Kortge, K8IQY, maintains a website for the 2N2/40 listing noted errors, mods, etc. For latest info, see:

www.qsl.net/K8iqy

2N2/40 AM QRM?

From Elliott Lawrence, WA6TLA

Elliot lives very close to a 50KW AM station that was ever-present in the audio stage. He cured it by adding a 1000pF (.001µF) cap on the Q11 audio preamp, from Q11-base to ground. A 4700pF cap eliminated the QRM completely – experiment for good value without shunting audio gain.

2N2/40 CERTIFICATES

Have you built the 2N2/40? Preston Douglas, WJ2V, himself a 2N2/40 builder, has made a handsome certificate to award those who build the rig. They are also serialized. To get yours, send the following to Preston:

1. 9x12 envelope, addressed to you with two stamps.
2. Photo of your completed 2N2/40. Photo will be returned. Photo can also be sent electronically.
3. Name, call, date & time of your first 2N2/40 QSO.

Send to:

PRESTON DOUGLAS, WJ2V
216 Harborview North
Lawrence, NY 11559

2N2/40 OUTPUT FILTER

A couple of builders have reported a little difficulty attaining a low SWR with a tuned antenna which was corrected by adding 2 turns to L6 and L7 in the output filter (for 19 turns). This is likely due to small variations in the "mu"-factor between toroids, even though all T37-2's, affecting the impedance transformation slightly of the filter.

MORE HINTS and KINKS

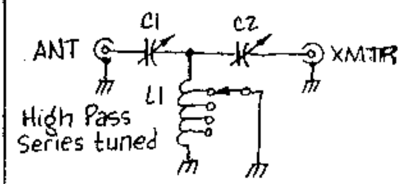
THE TRANSMATCH RECEIVER

SUBMITTED BY — WALTER DUFRAIN, AG5P
St. Louis QRP Society (SLQS)

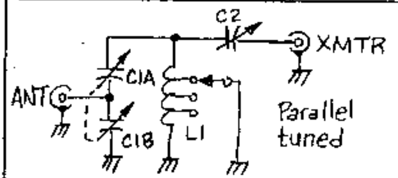
THIS PROJECT IS QRPp Y2K COMPLIANT

If you have an antenna tuner (and most QRP'ers should), you can make a nifty WWV receiver or station monitor. Antenna tuners are some form of tuned circuit and/or high pass filter. It will resonate at some HF frequency due to the L and C values selected on the tuner controls. By adding a simple diode detector, you have a crystal radio for receiving strong shortwave stations, WWV, or your own signal.

TYPICAL ANTENNA TUNERS

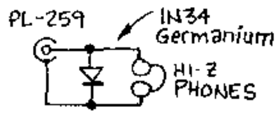


SIMILAR TO MFJ-971 TUNER

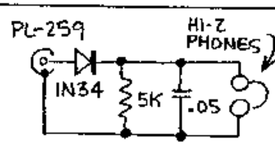


"ULTIMATCH" STYLE

DETECTOR CIRCUITS



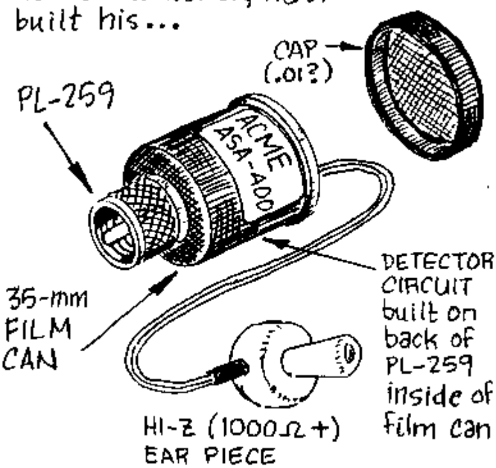
The simplest AM detector using Hi-Z of phones to form the audio



Standard half-wave AM detector

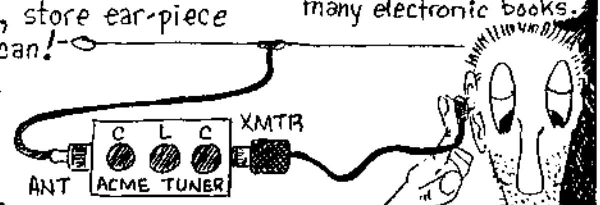
Additional AM detector circuits can be found in many electronic books.

Here's how Walter, AG5P built his...



When not in use, store ear-piece inside of film can!

Plug-in detector unit and tune in station. Record settings.

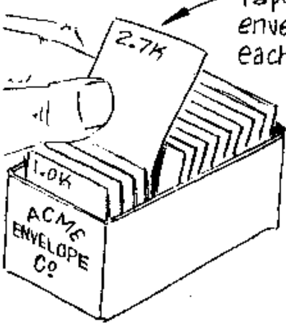


ORGANIZING THOSE PARTS...

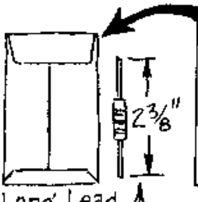
LIKE THE NORCAL RESISTOR/CAPACITOR KITS ®

USING COIN ENVELOPES

From Jim Osburn, WD9EYB



Paper Coin envelope for each value



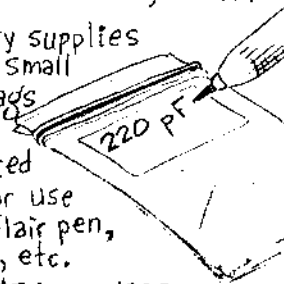
Long Lead Resistor

STANDARD COIN ENVELOPES	
No.	SIZE
A-1	2¼ × 3½
B-3	2½ × 4¼
C-4	3 × 4½

A box of 500 is about $10

USING POLY ENVELOPES

From Chris Trask, N7ZWY



Jewelry supplies carry small poly bags with a frosted box for use with Flair pen, pencil, etc.

About $7-10 per 1000

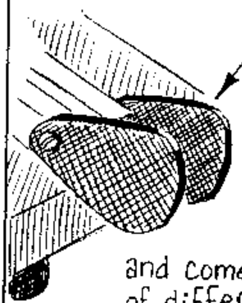
Size: 1½ x 2 and larger.

One Source is
RIO GRANDE JEWELRY
Albuquerque, NM
1-800-545-6566

Chris also reports Jewelry Supply business are also a good source for cheap small tools, pliers, boxes, etc

REPLACEMENT FINGER PIECES FOR PADDLES

From Bob Tellefson, N6WG



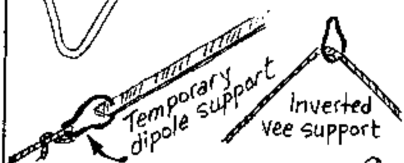
BASS GUITAR PICKS make great replacements for most paddles and come in a range of different colors.

Strong and thin - they also work great on the K8FF paddles with wide spacing.

QRP TO THE FIELD GADGET

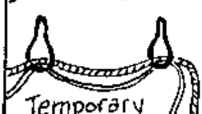
From Jan Medley, NØQT

Shower curtain holder - upper metal clip thingie



Temporary dipole support

Inverted vee support



Temporary cable organizer

Dead Mouse holder

All sorts of temporary uses.

NorCal's T-Shirts

NorCal offers two shirts:The NorCal T-Shirt and The NorCal Zombie T-Shirt (Limited Edition) The price is $15 each plus $3 shipping and handling in the US, $5 shipping for DX. The shirts are the recognizable NorCal "GOLD" and high quality and heavy duty. The NorCal shirt is imprinted with the NorCal logo and the NorCal Zombie shirt is imprinted with the NorCal Zombie Cartoon. The shirts are gold with the NorCal Logos in black and the Zombie Cartoon is multicolor. To order Send $15 + $3 postage ($5 DX) to:

Jerry Parker,
426 Tanglewood Ct.
Paso Robles, CA 93446

Don't forget to specify your size: M, L, XL, XXL (Note XXL shirts are $3 additional) Please make check or money order out to Jerry Parker, NOT NORCAL, US Funds Only.

QRPp Back Issues Pricing:

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Shipping: US

$4 for 1 - 3 issues, $5 for 4 - 6 issues.

Shipping: Canada

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Shipping: DX Pacific Rim, Australia & New Zealand

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QRP Frequency Crystals

NorCal has available the following crystals in HC49U cases for $3 each postage paid in th e following frequencies: 7.040 MHz, 7.122 MHz., 10.116 MHz. Send your order and payment in US Funds only to: Doug Hendricks , 862 Frank Ave. , Dos Palos, CA 93620, USA. Make check or money order to Doug Hendricks, NOT NorCal.

QRPp Subscriptions

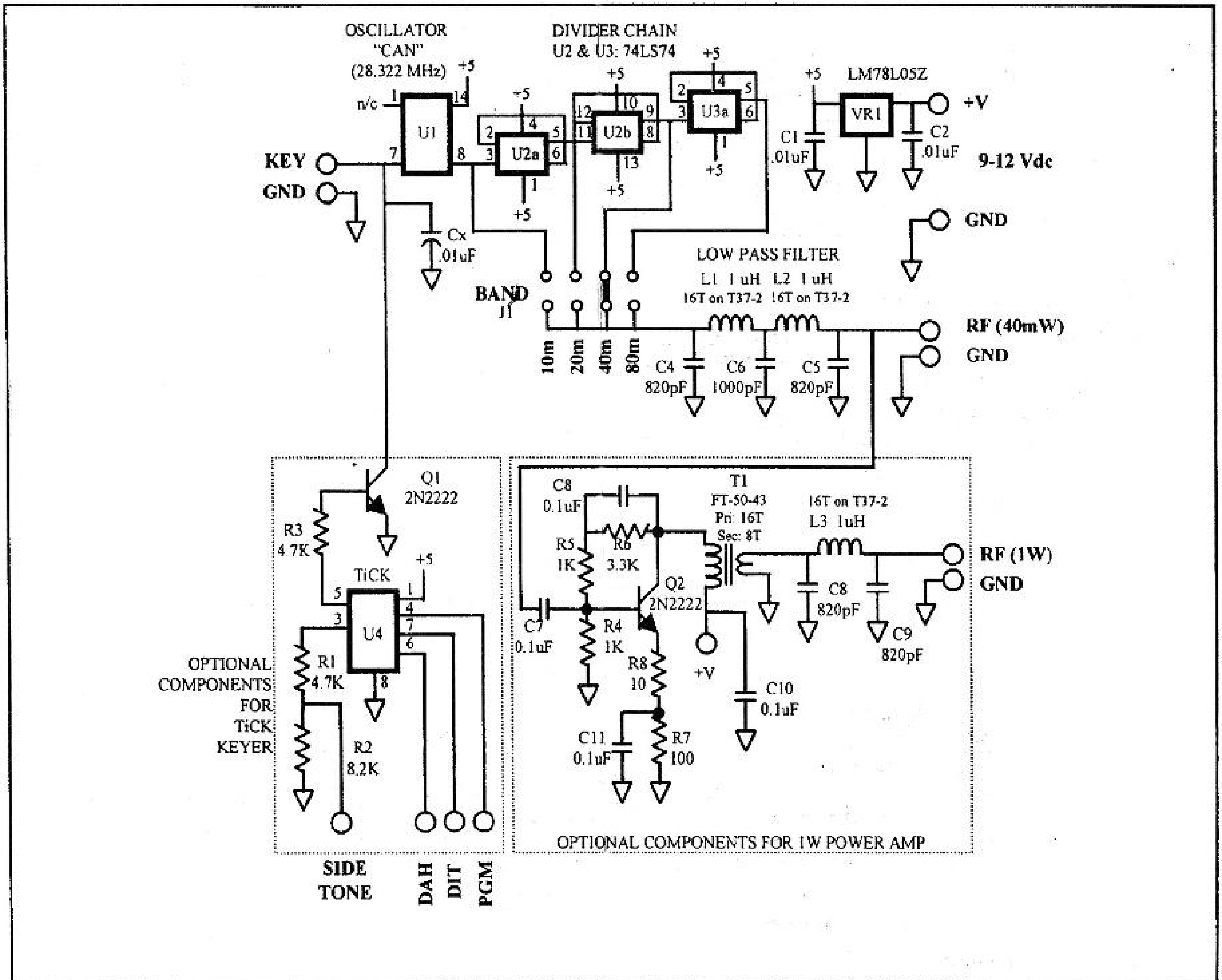
QRPp is printed 4 times per year with Spring, Summer, Fall and Winter issues. The cost of subscriptions is as follows: US and Canadian addresses: $15 per year, issues sent first class mail. All DX subscriptions are $20 per year, issues sent via air mail. To subscribe send your check or money order made out to Jim Cates, NOT NorCal to: Jim Cates, 3241 Eastwood Rd., Sacramento, CA 95821. US Funds only. Subscriptions will start with the first available issue and will not be taken for more than 2 years. Membership in NorCal is free. The subscription fee is only for the journal, QRPp. Note that all articles in QRPp are copyrighted and may not be reprinted in any form without permission of the author. Permission is granted for non-profit club publications of a a non-commercial nature to reprint articles as long as the author and QRPp are given proper credit. The articles have not been tested and no guarantee of success is implied. If you build circuits from QRPp, you should use safe practices and know that you assume all risks.

QRPp, Journal of the NorCal QRP Club
862 Frank Ave
Dos Palos, CA 93620

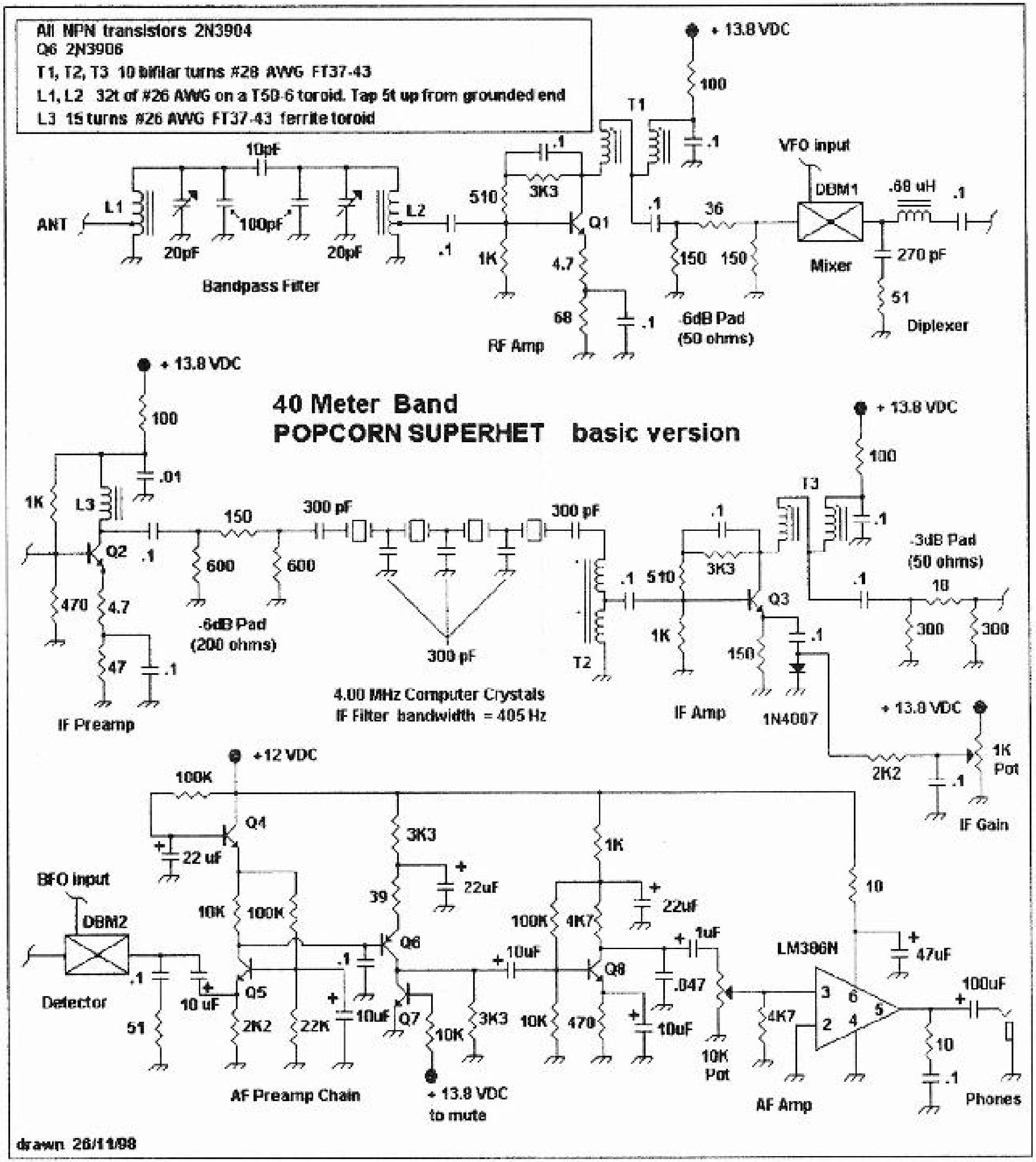
PRESORT
FIRST-CLASS
Permit #72
Socorro, NM
87801

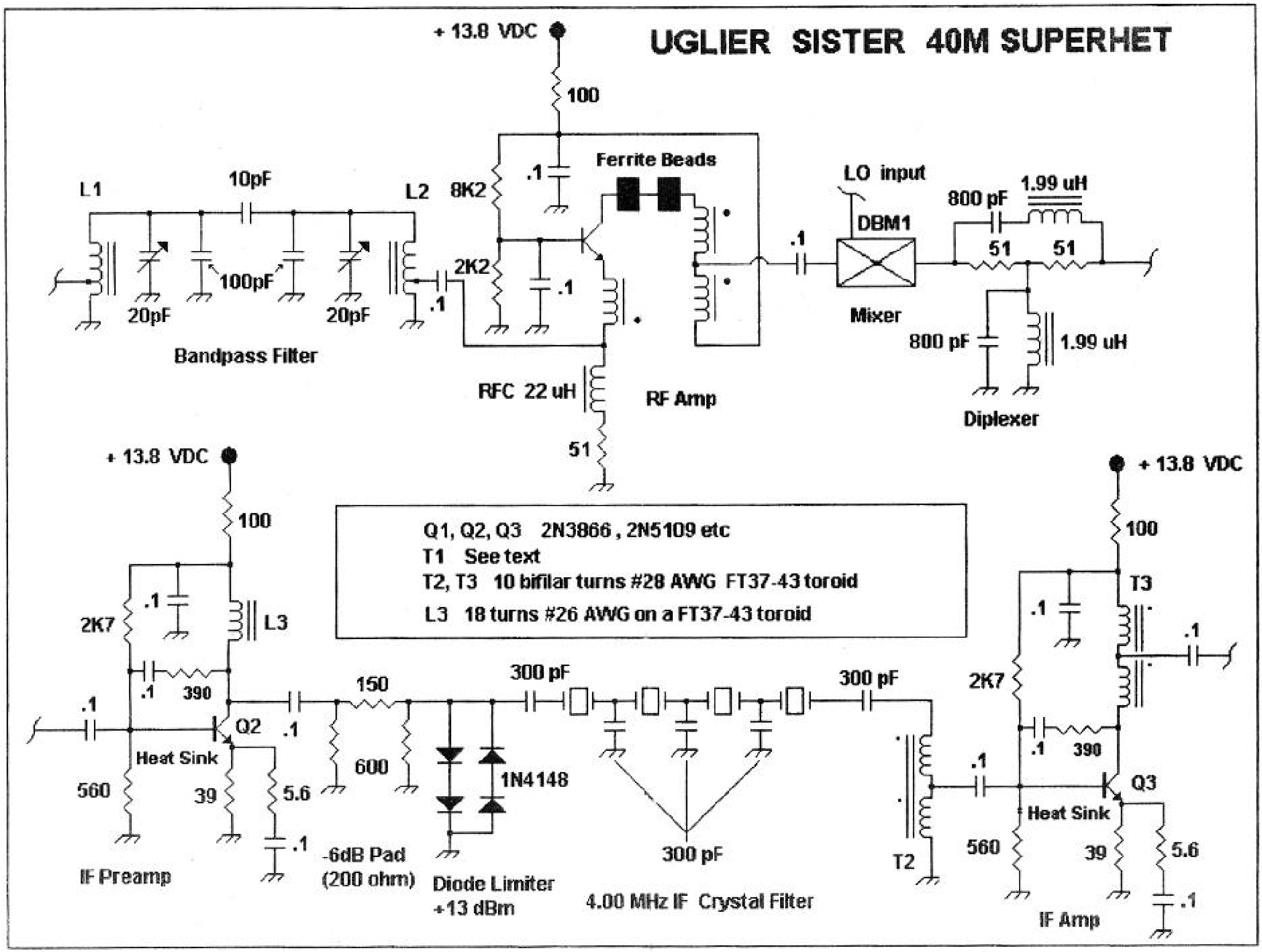
Special
Pre-Millenium
Issue
'Cuz it took 1000
years to finish :(
-The Print Shop

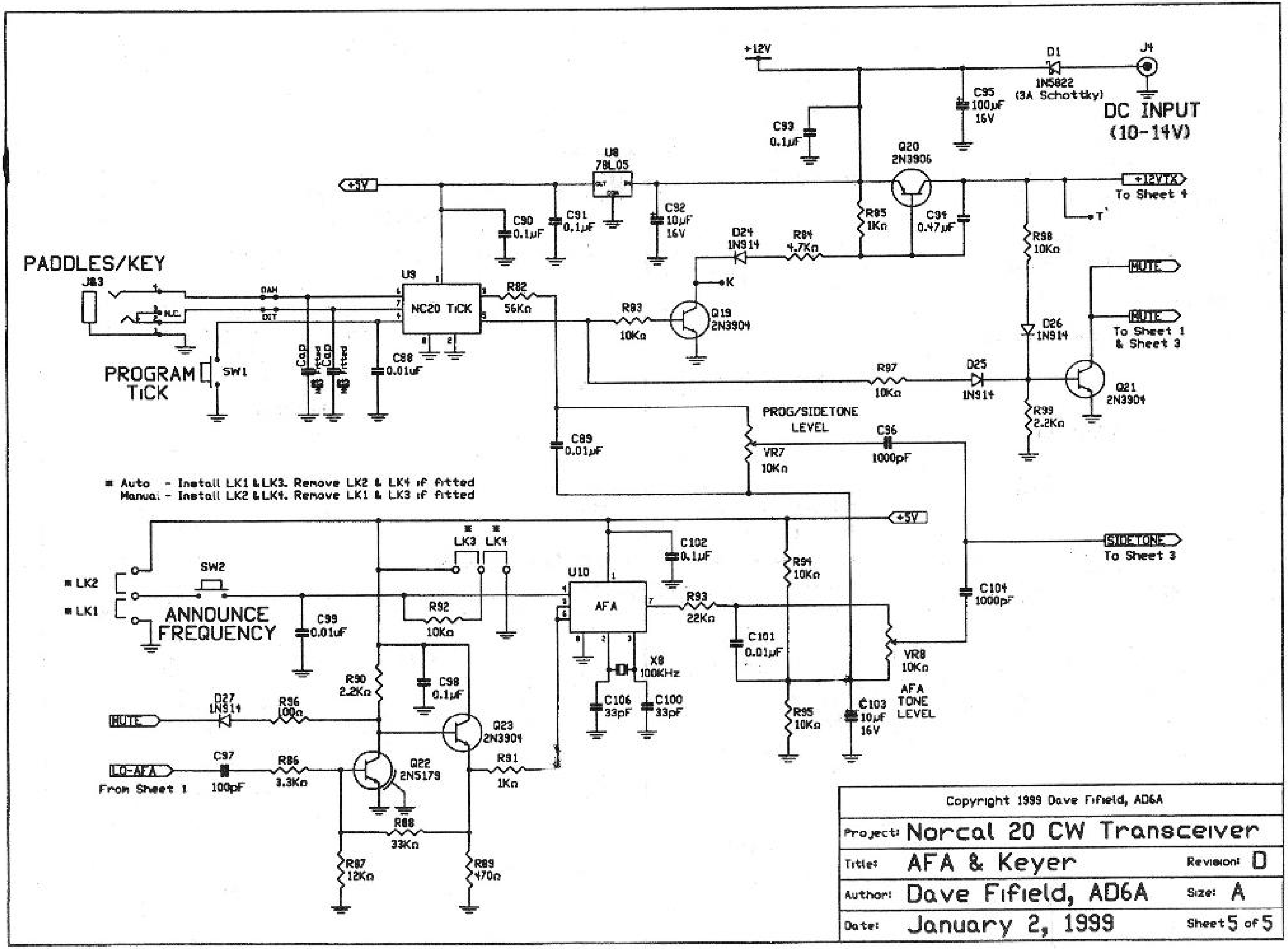
Pre-sort
FIRST CLASS

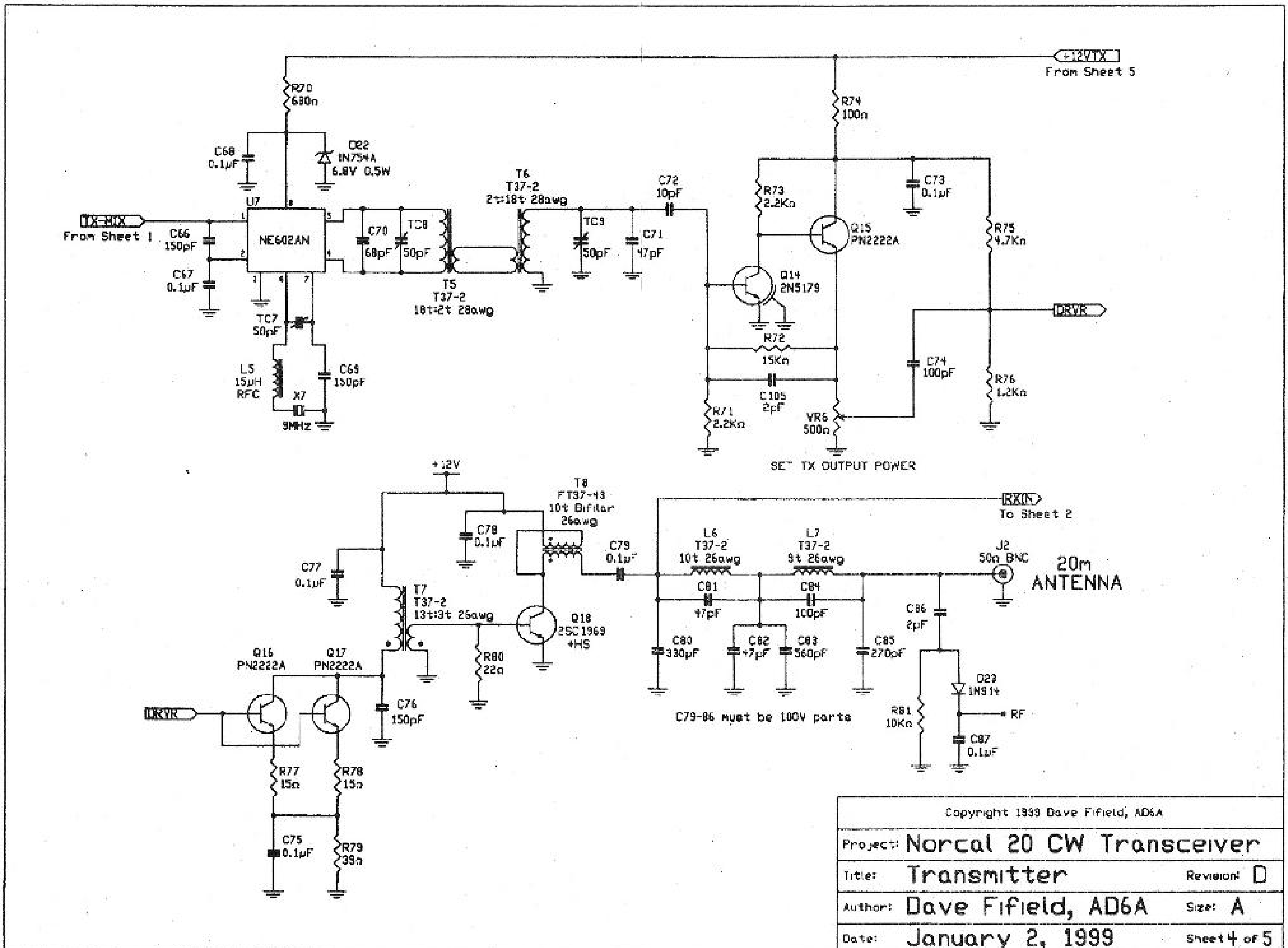


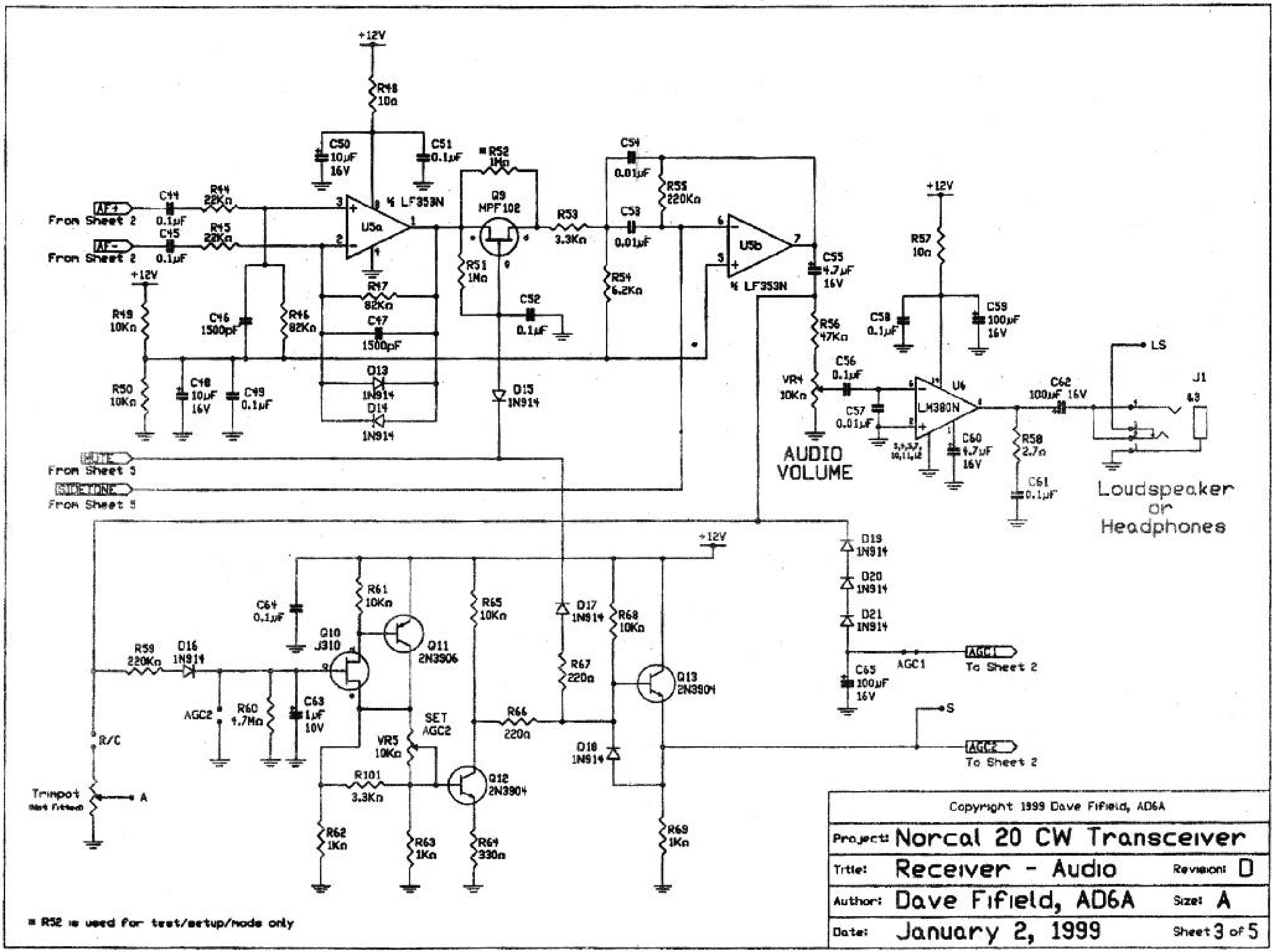
Schematic for the JERSEY FIREBALL 40


All NPN transistors 2N3904
Q6 2N3906
T1, T2, T3 10 bifilar turns #28 AWG FT37-43
L1, L2 32t of #26 AWG on a T50-6 toroid. Tap 5t up from grounded end
L3 15 turns #26 AWG FT37-43 ferrite toroid
40 Meter Band
POPCORN SUPERHET basic version
ANT
Bandpass Filter
RF Amp
-6dB Pad
(50 ohms)
VFO input
DBM1
Mixer
Diplexer
+ 13.8 VDC
IF Preamp
-6dB Pad
(200 ohms)
4.00 MHz Computer Crystals
IF Filter bandwidth = 405 Hz
IF Amp
1N4007
-3dB Pad
(50 ohms)
IF Gain
1K
Pot
BFO input
DBM2
Detector
AF Preamp Chain
+12 VDC
+ 13.8 VDC
to mute
LM386N
10K
Pot
AF Amp
Phones
drawn 26/11/98

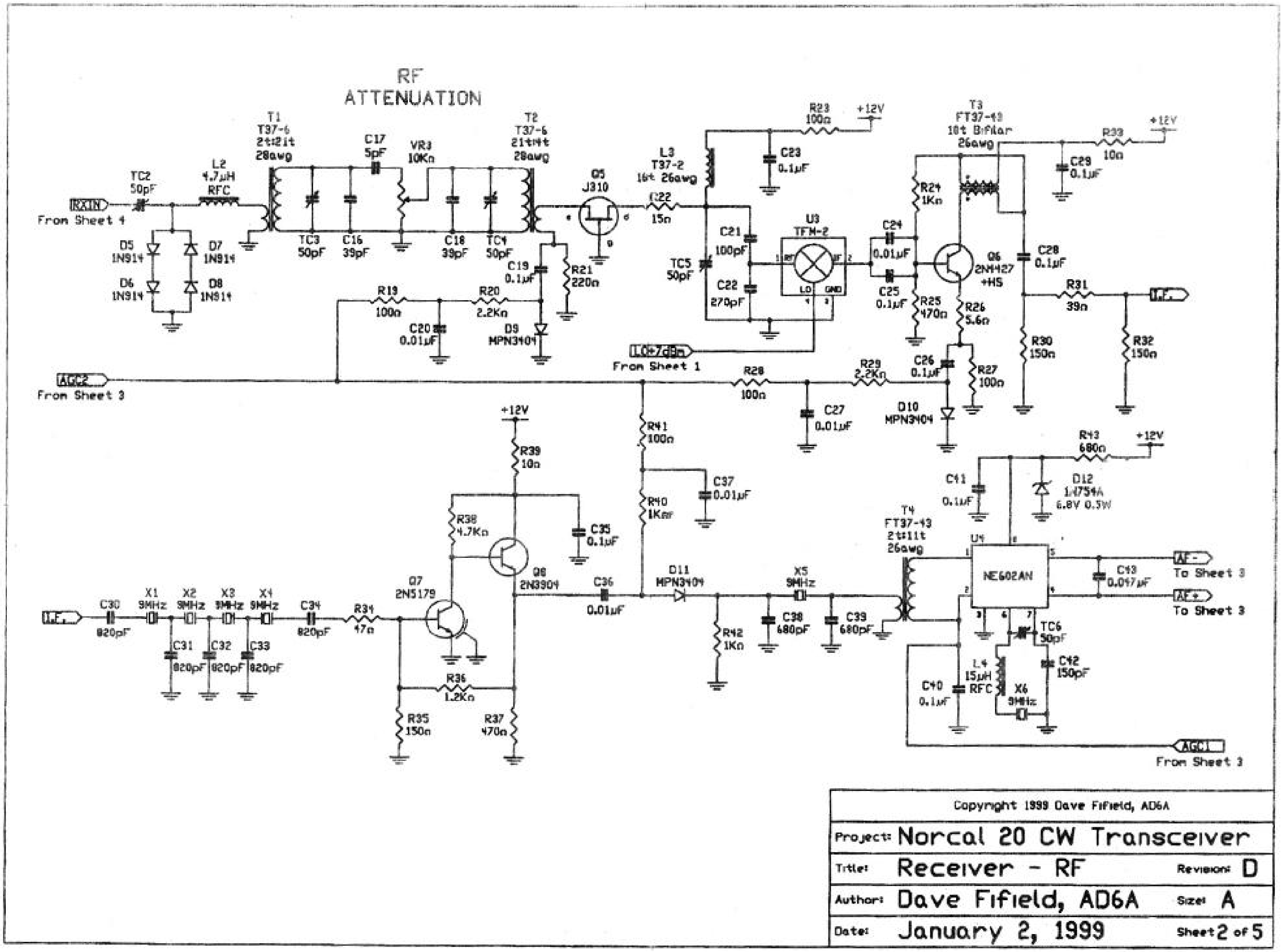

UGLIER SISTER 40M SUPERHET
+ 13.8 VDC
100
Ferrite Beads
L1
10pF
L2
8K2
.1
LO input
DBM1
800 pF
1.99 uH
51
51
100pF
2K2
20pF
20pF
Mixer
Bandpass Filter
RFC 22 uH
RF Amp
Diplexer
Q1, Q2, Q3 2N3866 , 2N5109 etc
T1 See text
T2, T3 10 bifilar turns #28 AWG FT37-43 toroid
L3 18 turns #26 AWG on a FT37-43 toroid
2K7
L3
390
150
300 pF
Q2
Heat Sink
600
1N4148
560
39
5.6
-6dB Pad
(200 ohm)
Diode Limiter
+13 dBm
4.00 MHz IF Crystal Filter
T2
T3
Q3
IF Preamp
IF Amp

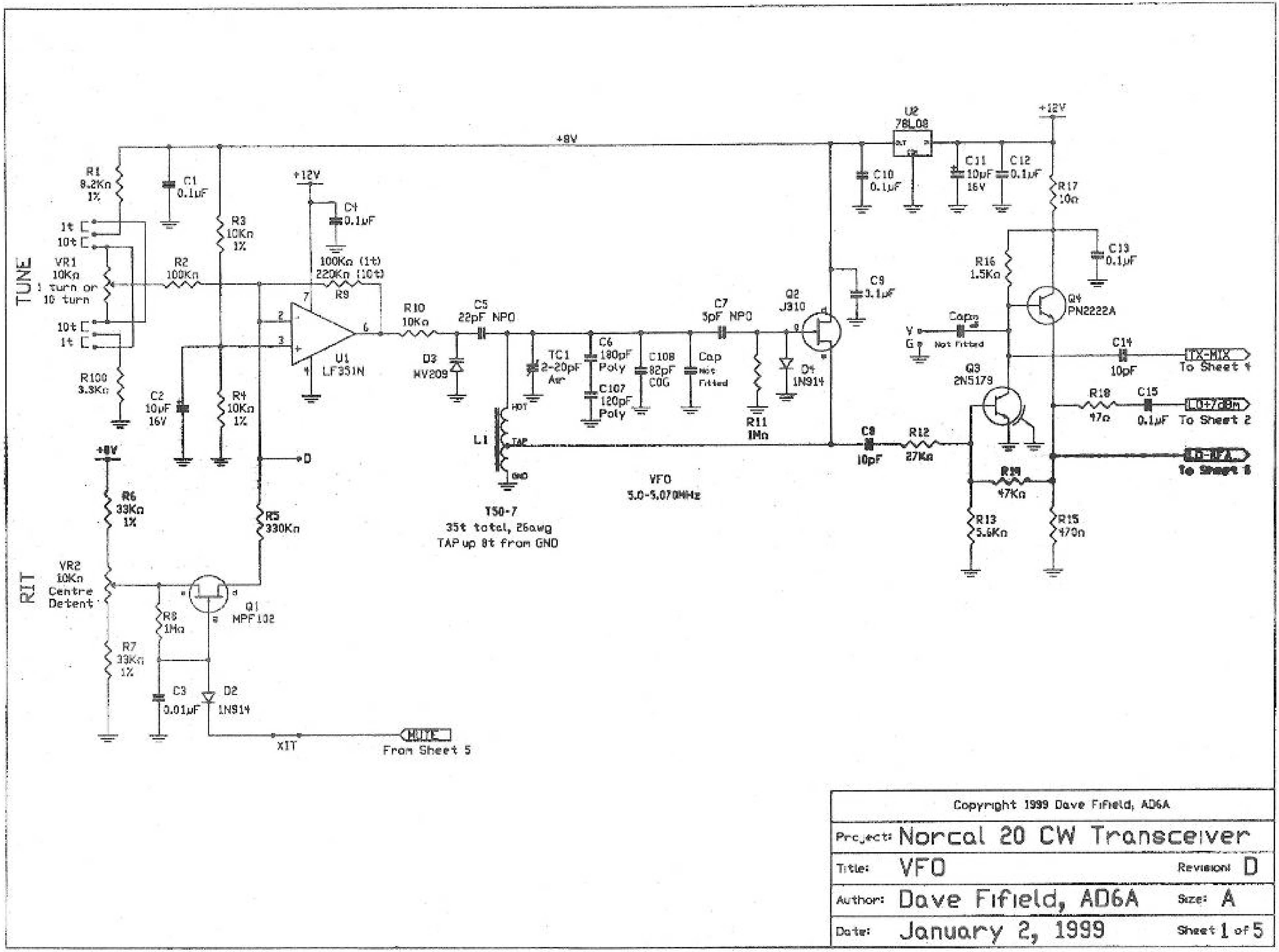

+12V
D1
1N5822
(3A Schottky)
J4
DC INPUT
(10-14V)
C95
100µF
16V
C93
0.1µF
Q20
2N3906
U8
78L05
+5V
C90
0.1µF
C91
0.1µF
C92
10µF
16V
R85
1Kα
C94
0.47µF
+12VTX
To Sheet 4
T
D24
1N914
R84
4.7Kα
R98
10Kα
MUTE
MUTE
To Sheet 1
& Sheet 3
PADDLES/KEY
J&3
U9
NC20 TiCK
R82
56Kα
R83
10Kα
Q19
2N3904
K
D26
1N914
PROGRAM
TiCK
SW1
C88
0.01uF
R97
10Kα
D25
1N914
Q21
2N3904
R99
2.2Kα
PROG/SIDETONE
LEVEL
C96
1000pF
C89
0.01µF
VR7
10Kα
* Auto - Install LK1 & LK3. Remove LK2 & LK4 if fitted
Manual - Install LK2 & LK4. Remove LK1 & LK3 if fitted
+5V
LK3
LK4
C102
0.1µF
SIDETONE
To Sheet 3
SW2
U10
AFA
R94
10Kα
C104
1000pF
* LK2
* LK1
ANNOUNCE
FREQUENCY
C99
0.01uF
R92
10Kα
R93
22Kα
C101
0.01µF
VR8
10Kα
AFA
TONE
LEVEL
X8
100KHz
R90
2.2Kα
C98
0.1µF
C106
33pF
C100
33pF
C103
10µF
16V
R95
10Kα
MUTE
D27
1N914
R96
100α
Q23
2N3904
LO-AFA
From Sheet 1
C97
100pF
R86
3.3Kα
Q22
2N5179
R91
1Kα
R88
33Kα
R87
12Kα
R89
470α
Copyright 1999 Dave Fifield, AD6A
Project: Norcal 20 CW Transceiver
Title: AFA & Keyer
Revision: D
Author: Dave Fifield, AD6A
Size: A
Date: January 2, 1999
Sheet 5 of 5


+12VTX
From Sheet 5
TX-MIX
From Sheet 1
NE602AN
U7
R70 680Ω
C68 0.1µF
D22 1N754A 6.8V 0.5W
C66 150pF
C67 0.1µF
TC7 50pF
L5 15µH RFC
X7 9MHz
C69 150pF
C70 68pF
TC8 50pF
T5 T37-2 18t:2t 28awg
T6 T37-2 2t:18t 28awg
TC9 50pF
C71 47pF
C72 10pF
R74 100Ω
R73 2.2KΩ
Q15 PN2222A
Q14 2N5179
C73 0.1µF
R75 4.7KΩ
DRVR
R72 15KΩ
C105 2pF
C74 100pF
R76 1.2KΩ
R71 2.2KΩ
VR6 500Ω
SET TX OUTPUT POWER
+12V
T8 FT37-43 10t Bifilar 26awg
C78 0.1µF
C77 0.1µF
T7 T37-2 13t:3t 26awg
Q18 2SC1969 +HS
R80 22Ω
Q16 PN2222A
Q17 PN2222A
C76 150pF
DRVR
R77 15Ω
R78 15Ω
C75 0.1µF
R79 39Ω
RXIN
To Sheet 2
C79 0.1µF
L6 T37-2 10t 26awg
L7 T37-2 9t 26awg
C81 47pF
C84 100pF
C80 330pF
C82 47pF
C83 560pF
C85 270pF
J2 50Ω BNC
20m ANTENNA
C86 2pF
D23 1N914
R81 10KΩ
RF
C87 0.1µF
C79-86 must be 100V parts
Copyright 1999 Dave Fifield, AD6A
Project: Norcal 20 CW Transceiver
Title: Transmitter
Revision: D
Author: Dave Fifield, AD6A
Size: A
Date: January 2, 1999
Sheet 4 of 5



+12V
R48
10Ω
C50
10µF
16V
C51
0.1µF
R52
1MΩ
C54
0.01µF
R55
220KΩ
C44
0.1µF
R44
22KΩ
AF+
From Sheet 2
C45
0.1µF
R45
22KΩ
AF-
From Sheet 2
U5a
½ LF353N
Q9
MPF102
R53
3.3KΩ
C53
0.01µF
U5b
½ LF353N
C55
4.7µF
16V
R49
10KΩ
C46
1500pF
R46
82KΩ
R47
82KΩ
C47
1500pF
R51
1MΩ
C52
0.1µF
R54
6.2KΩ
R56
47KΩ
R57
10Ω
C58
0.1µF
C59
100µF
16V
LS
J1
R50
10KΩ
C48
10µF
16V
C49
0.1µF
D13
1N914
D14
1N914
D15
1N914
VR4
10KΩ
C56
0.1µF
C57
0.01µF
U6
LM380N
C60
4.7µF
16V
C62
100µF 16V
R58
2.7Ω
C61
0.1µF
AUDIO
VOLUME
MUTE
From Sheet 5
SIDETONE
From Sheet 5
Loudspeaker
or
Headphones
D19
1N914
D20
1N914
D21
1N914
C64
0.1µF
R61
10KΩ
R65
10KΩ
D17
1N914
R68
10KΩ
Q10
J310
Q11
2N3906
R67
220Ω
Q13
2N3904
AGC1
To Sheet 2
C65
100µF
16V
R59
220KΩ
D16
1N914
AGC2
R60
4.7MΩ
C63
1µF
10V
SET
AGC2
VR5
10KΩ
R66
220Ω
D18
1N914
S
AGC2
To Sheet 2
R/C
Trimpot
(Not Fitted)
A
R101
3.3KΩ
Q12
2N3904
R62
1KΩ
R63
1KΩ
R64
330Ω
R69
1KΩ
* R52 is used for test/setup/mode only
Copyright 1999 Dave Fifield, AD6A
Project: Norcal 20 CW Transceiver
Title: Receiver - Audio
Revision: D
Author: Dave Fifield, AD6A
Size: A
Date: January 2, 1999
Sheet 3 of 5


RF ATTENUATION
RXIN From Sheet 4
TC2 50pF
L2 4.7µH RFC
T1 T37-6 2t:21t 28awg
C17 5pF
VR3 10KΩ
T2 T37-6 21t:4t 28awg
Q5 J310
L3 T37-2 16t 26awg
R22 15Ω
R23 100Ω
+12V
C23 0.1µF
U3 TFM-2
T3 FT37-43 10t Bifilar 26awg
R33 10Ω
C29 0.1µF
R24 1KΩ
C24 0.01µF
Q6 2N4427 +HS
C28 0.1µF
D5 1N914
D6 1N914
D7 1N914
D8 1N914
TC3 50pF
C16 39pF
C18 39pF
TC4 50pF
C19 0.1µF
R21 220Ω
C21 100pF
TC5 50pF
C22 270pF
C25 0.1µF
R25 470Ω
R26 5.6Ω
R31 39Ω
I.F.
R19 100Ω
R20 2.2KΩ
C20 0.01µF
D9 MPN3404
LO+7dBm From Sheet 1
R30 150Ω
R32 150Ω
AGC2 From Sheet 3
R28 100Ω
R29 2.2KΩ
C26 0.1µF
R27 100Ω
C27 0.01µF
D10 MPN3404
R41 100Ω
R39 10Ω
C37 0.01µF
R43 680Ω
C41 0.1µF
D12 1N754A 6.8V 0.5W
R38 4.7KΩ
R40 1KΩ
C35 0.1µF
T4 FT37-43 2t:11t 26awg
U4 NE602AN
AF- To Sheet 3
AF+ To Sheet 3
C43 0.047µF
Q8 2N3904
C36 0.01µF
D11 MPN3404
X5 9MHz
Q7 2N5179
X1 9MHz
X2 9MHz
X3 9MHz
X4 9MHz
C30 820pF
C34 820pF
R34 47Ω
C31 820pF
C32 820pF
C33 820pF
C38 680pF
C39 680pF
R42 1KΩ
TC6 50pF
C42 150pF
L4 15µH RFC
X6 9MHz
C40 0.1µF
R36 1.2KΩ
R35 150Ω
R37 470Ω
AGC1 From Sheet 3
Copyright 1999 Dave Fifield, AD6A
Project: Norcal 20 CW Transceiver
Title: Receiver - RF
Revision: D
Author: Dave Fifield, AD6A
Size: A
Date: January 2, 1999
Sheet 2 of 5


TUNE
RIT
+8V
+12V
R1 8.2KΩ 1%
C1 0.1µF
R3 10KΩ 1%
C4 0.1µF
VR1 10KΩ 1 turn or 10 turn
1t
10t
R2 100KΩ
100KΩ (1t) 220KΩ (10t) R9
U1 LF351N
R100 3.3KΩ
C2 10µF 16V
R4 10KΩ 1%
R10 10KΩ
D3 MV209
C5 22pF NPO
TC1 2-20pF Air
C6 180pF Poly
C107 120pF Poly
C108 82pF C0G
Cap Not Fitted
C7 5pF NPO
R11 1MΩ
D4 1N914
Q2 J310
C9 0.1µF
U2 78L08
C10 0.1µF
C11 10µF 16V
C12 0.1µF
R17 10Ω
C13 0.1µF
R16 1.5KΩ
Q4 PN2222A
Cap Not Fitted
C14 10pF
TX-MIX To Sheet 4
Q3 2N5179
R18 47Ω
C15 0.1µF
LO+7dBm To Sheet 2
C8 10pF
R12 27KΩ
LO-RFA To Sheet 5
R19 47KΩ
R13 5.6KΩ
R15 470Ω
L1
HOT
TAP
GND
T50-7
35t total, 26awg
TAP up 8t from GND
VFO
5.0-5.070MHz
D
R6 33KΩ 1%
R5 330KΩ
VR2 10KΩ Centre Detent
Q1 MPF102
R8 1MΩ
R7 33KΩ 1%
C3 0.01µF
D2 1N914
XIT
MUTE
From Sheet 5
Copyright 1999 Dave Fifield, AD6A
Project: Norcal 20 CW Transceiver
Title: VFO
Revision: D
Author: Dave Fifield, AD6A
Size: A
Date: January 2, 1999
Sheet 1 of 5

Volume VII No. 2 SUMMER 1999

QRPp

Special
Regen Receiver Issue

Featuring 14 Regen Circuits

Articles by:

Charles Kitchin, N1TEV
Tony Fishpool, G4WIF
Paul Harden, NA5N
Graham Firth, G3MFJ
Doug Hendricks, KI6DS
Bruce Kizerian, KK7ZZ
Dennis Baker, W9OCP
Chuck Schwark, Antique Radio Club of Illinois (A.R.C.I.)

Journal of the Northern California QRP Club

Table of Contents

From the Editor
by Doug Hendricks, KI6DS
ki6ds@dospalos.org

I am excited about this issue. It is another "Theme" one, and the theme as you can tell, is Regens. I love regens, and when I saw the response to the NorCal Regen Building Contest at HamCom this summer, I knew that we had to have more information available to the builders out there. Regens are perfect first time projects because they are so easy to build, cheap, and they work so well. But the best part is that they are fun to operate once you have finished building.

Please build one or more of these circuits if you have not built a regen in your ham career. You have missed one of the pleasures of being a ham if you have not operated a regen. And,if you have never built anything, this is the place to start. Take a look at the articles, there are plans and circuits for 14 different Regens in this issue, including 3 commercially available kits. I want to take a moment and say a special thank you to Martin Jue of MFJ and Scott Robbins of TenTec for their permission to reprint large sections of their regen kit manuals, and for their permission to print the schematics of their kits. When I asked, they never hesitated, in fact they were pleased to offer the help.

This summer has been very exciting for me. JoAnne and I took a 7 week trip all the way back to the New England area, and I was fortunate enough to visit QRPers all along the way. We visited HamCom in Dallas, Wayne Smith, K8FF in Cleveland, Dave Benson, NN1G in Newington, Ed Hare and Mike Tracy at the ARRL Headquarters, Steve "Melt Solder" Weber in New Hampshire, all of the New Jersey QRP Club guys at a meeting in Princeton, NJ, Richard Stamile on Long Island, Gary Diana and Brad Mitchell in Rochester, NY, the Ft. Smith, Arkansas group, including Jay Bromley & Kelsey Mikel and finally we ended our trip at Ft. Tuthill. Thanks to all for the hospitality.

I was away from NorCal stuff for an extended period, and it refreshed me and I am eager for the next projects, Pacificon, and all of the other things that go on with NorCal. Please read the announcements on the next page, as they are important.

I also look forward to seeing all of you at Pacificon. 72, Doug.

All Subscribers Please Read

We are well aware of the lateness of the past 3 issues of QRPp. Things beyond our control have caused serious delays in getting the journal printed. Some things just happen, but there comes a time when something has to be done to get back on track, and that is why you have received the Spring and Summer issues so close together. We have sent a copy of this summer issue to everyone who was current with the spring issue, but had their subscription expire due to the fact that there was not enough time to send in renewals. We trust that you will renew now, and ask that you look at your mailing label on the back cover. If it is highlighted in color, your subs have expired, and you need to renew right away.

I am the editor, and I am in charge. I also get to accept the blame when things don't go right. I accept that blame and apologize for the problems that we have had and the inconvenience that it has caused.. We are going to do everything possible to keep the issues more timely, but we do appreciate your patience and understanding. 72, Doug, KI6DS, Editor, QRPp.

Pacificon 99

NorCal is pleased to announce that once again we will be sponsoring the QRP Forums at Pacificon. It will be on Oct. 15, 16, and 17th in Concord, CA at the Sheraton Hotel. Our speaker lineup this year is outstanding, and includes: Paul Harden, Dick Pascoe, Mike Gipe, Joe Everhart, Jim Kortge and Jim Duffey. They will all be speaking on Saturday, but you will want to come early on Friday as we are planning on having a Tuna Tin 2/MRX Receiver building event. NorCal will be giving away 50 Transmitter/Receiver kits starting at noon on Friday. First come- first served as long as they last. But you do have to agree to build it at Pacificon, because we will be using the rigs to have an operating event on Friday night. Bring a couple of 9V batteries, headphones with an 1/8" plug, a key and some building tools. Plus don't forget the QRP open house on both Friday and Saturday evenings starting at 7:00 PM. Saturday night's open house will feature our building contests, with two divisions this year, the 2N2/40 and the Regen Building Contest. Also, we will be providing compendiums again this year for the first 300 attendees. Jim and I look forward to seeing you there.

NorCal Toroid Kits

NorCal is offering the following Toroid kit for sale:
25 T37-2, 25 T37-6, 25 FT37-43, 25 FT37-61, 10 T50-7, 1 T130-2 and 25 Ferrite beads. This is a $70 value, the price is only $25 – $4 shipping US, $8 shipping DX. Send your order with check made out to Jim Cates to: Jim Cates, 3241 Eastwood Rd., Sacramento, CA 95821. Kits should ship Oct. 1st.

$10 Receiver Has Microvolt Sensitivity

by Charles Kitchin, N1TEV
26 Crystal St.
Billerica, MA 01866

[Originally Published in Electronic Design News, Aug. 18, 1994. This article started the current craze in regen receivers and was the inspiration for Paul Harden, NA5N to design his famous Desert Ratt Transceiver.]

The three-transistor circuit in Fig 1 costs less than $10 to build, uses commonly available components, and consumes less than 10 mA from a single 9V battery. If you wind coil L_1, as the figure shows, the circuit receives signals in the 5- to 15-MHz short-wave band. You can add turns to or subtract turns from L(or change C_2) to receive other frequencies. Q_1, a 10¢ bipolar transistor, acts as a high-gain regenerative stage and amplifies microvolt-level signals at the antenna up to hundreds of millivolts to drive diode-detector D_1. In addition to providing high gain, regeneration also greatly increases the Q (selectivity) of the circuit, producing a high-Q circuit, which can use low-cost coils (or free hand-wound coils).

Using a high-transconductance bipolar transistor for Q_1 rather than a vacuum tube or JFET provides much more gain per microamp of current. However, in previous bipolar circuits of this type, the regeneration level has been difficult to control. In this circuit, R_1 and R_2 provide a large amount of negative bias at the emitter of Q_1 to achieve smooth control. R2 allows for user control of the regeneration. You should adjust the pot so that Q_1 is just at the threshold of oscillation where both gain and selectivity are maximum. $Q_2$and Q_3, a two-transistor amplifier, which has sufficient output level to directly drive headphones or a small speaker, amplify the detected audio signal output from D_1. R3 can become a volume con-

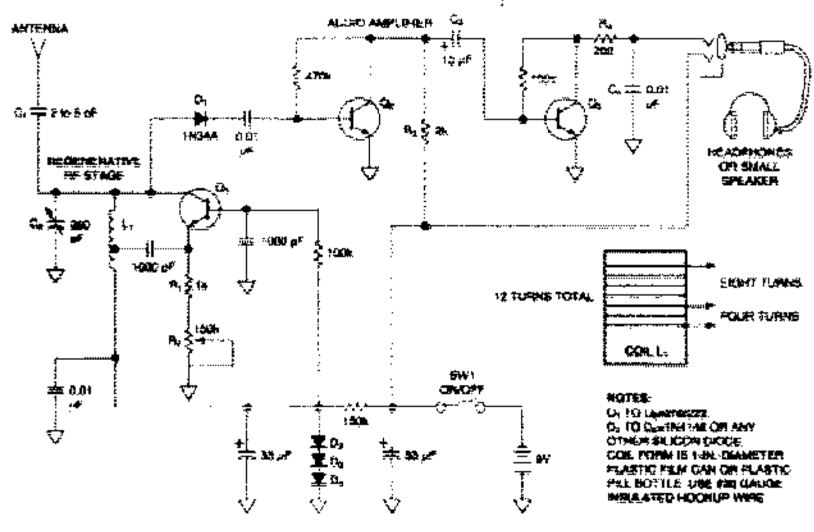


Fig. 1

trol if you replace it with a 2-kOhms potentiometer and connect C3 to its wiper. R_4 and C_4 form a lowpass filter that maintains circuit stability and improves the receiver's sound quality. D_2, D_3, and D_4 implement a low-cost voltage regulator to keep the voltage supplying Q1 fairly constant, which minimizes drift.

This receiver works with a short whip antenna, which you can connect directly to the top of tuning-capacitor C_2, or you can use an outside antenna for better reception. When you use an external antenna, C2 must decouple the antenna's capacitance from L_1. The regenerative stage of Q1 operates at less than 30 µW (50 µA at 0.6V). This low power, combined with the use of a small capacitor for C_1, prevents the detector (if it oscillates) from interfering with other receivers in the area. This problem was common in the 1920s and 1930s when tube-type regenerative receivers of this type, dissipating several watts of power, caused interference.

Commercially Available Regen Receiver Kits, a Review

by Doug Hendricks, KI6DS
862 Frank Ave.
Dos Palos, CA 93620

Ever since Charles Kitchin, N1TEV published his regen receiver article in Electronic Design News, I have been curious about regen receivers. Dave Gauding, NF0R, was the first to tell me about them, and he mentioned the Kitchin circuit as being one that worked well. We have seen a strong resurgence of regens lately, and I can't really explain why, other than they are just neat to build, fun to use, and work surprisingly well. Also, they tend to give you a sense of history as you "drive" your simple regen, you can close your eyes and imagine yourself as a "resistance fighter" in WW2, tuning the band listening for the latest instructions from Bletchley Park.

Currently there are 4 commercial regen kits available that I know of; The World Band Receiver by MFJ, TenTec's 4 Band Shortwave Receiver, TenTec's 9 Band Shortwave Receiver and the Ramsey Regen Receiver. I have built all of them, and can only recommend the first 3. The Ramsey kit is just two much money for what you get. And the quality of the Ramsey kit is not up there with the other three. Therefore, I am only going to discuss the MFJ and the two TenTec kits.

The first kit will be the TenTec 4 Band Shortwave Receiver.

The manual is very well done. It has a sample short wave log page, information about the 4 bands it tunes, a circuit description, schematic diagram, parts list, glossary of terms, circuit board xray view, and step by step circuit board assembly steps. After you finish building it, there are sections on controls and connections, understanding regeneration, testing and adjustments, setting up a shortwave antenna, tuning SSB voice signals, a trouble-shooting guide, and how to finish and customize your receiver.

Finally, there is an appendix for ham club leaders and teachers. I would rate this manual as first class.

Here are the bands that the T1054 regen covers:

"Band 1: 5.90 to 6.4 MHz. The main purpose of this tuning range is to give you lots of strong shortwave broadcasts in late afternoon through early morning on the 49 meter band, 5.95 to 6.20 MHz.

Band 2: 6.9 to 7.4 MHz. This gives you the 40 meter ham band from 7.0 to 7.3 MHz, with many evening broadcasts among the ham CW and SSB signals.

Band 3: 8.5 to 10.2 MHz. This band lets you tune all of the popular 31 meter broadcast band, 9.5 to 9.9 MHz. You can also find the WWV time signal at 10.0 MHz. (or on Band 4 at 15.0 MHz.) The 30 meter ham band (CW and RTTY only in the USA) is at 10.1 to 10.15 MHz. This tuning range is generally busy 24 hours per day.

Band 4: 11.5 to 16.5 MHz. On the 20 Meter ham band (14.0 to 14.35 MHz), you can hear strong CW and SSB voice signals from around the world throughout the day and well into the evening. This is the most active and crowded of the international ham radio bands. You also are able to tune the 21 Meter shortwave broadcast band (13.6 to 13.8 MHz.), and all of the 19 Meter band (15.1 to 15.6MHz.) Station WWV at 15.0 MHz. provides precision time and frequency information."

(Page 3 TenTec 1054 Manual).

Then TenTec does something that fits in well with their scheme of education of the kit builder. The tell us the story of the Regen Receiver. Here is that story from the TenTec 1054 Manual, pp. 4-5.

The "regenerative receiver" moved the world of radio reception and broadcasting beyond the limits of crystal sets useful only for hearing a strong local signal. For over a decade, these magical, whistling, squawking, glowing boxes were the norm for home listening as well as for the first generation of radio hams.

Receiver design evolved swiftly. The "superheterodyne" became the norm during the 1930's. Regenerative receivers, often called "Gennies," were left to tinkerers and beginners. Even though those receivers were simple and quite sensitive, they had a number of shortcomings: instability, touchiness, difficulty in separating strong stations, a tendency to generate interference to other receivers, and a general reputation for making odd sounds that resembled everything from birds to motorboats.

However, the sheer simpleness of the regenerative circuit remained attractive to experimenters and beginners. In fact, as recently as the 1960's, one company marketed a $14 kit for building a complete transceiver using only one vacuum tube: half of tube served as a regenerative receiver, and the other half was a low-power crystal-controlled transmitter. In addition, many thousands of engineering careers as well as ham radio licenses were launched with the building of "my first shortwave radio" from do-it-yourself regenerative receiver kits offered by the major radio companies of several years ago. (The fondest daydream back then of most of these radio builders was to be able to afford to move up to a "superhet communications receiver." Their fondest memory today is that very first receiver kit!)

From the late 1970's through the '80's, as consumer electronics and new ham radio equipment became more sophisticated so very rapidly, interest declined not only in regenerative receivers, but also in kit building and even in shortwave radio listening. One or two generations of Americans simply missed out on the thrill and satisfaction of building and understanding a simple radio set which could receive signals from anywhere in the world.

Next TenTec gives not one but two circuit descriptions of the 4 band regen. Here are both of them. I found both of them informative and interesting. First the simple.

To say it simply, a detector converts radio energy from an antenna into audio energy, i.e., a sound which you can hear. A detector can be as simple as a crystal diode, which is the hear of the simple *"crystal radio". If you've ever heard unwanted radio signals on a stereo, telephone, PA system or intercom, you can assume that some part of those devices has acted as a detector to convert a nearby CB, taxi or broadcast signal into intelligible sound. (This process of detection is also referred to as demodulation.)*

This receiver consists of an RF amplifier (Q1), a "regenerative" detector oscillator (Q2, Q3), an audio preamplifier (Q4), and an integrated circuit audio amplifier (U1). Transistor Q5 provides voltage regulation for the varactor tuning circuit controlled by D1 and for the detector/oscillator circuit.

In the following explanation, the words regeneration, feedback and oscillation all mean approximately the same thing.

By itself, a detector can interpret or demodulate only very strong signals such as a nearby AM radio station. However, the process of regeneration can make a simple detector much more sensitive by turning the detector into an "oscillating amplifier." The regeneration circuit repeatedly feeds the detected signal back to the input which boosts its strength many hundreds of times. This feedback process must be carefully adjusted, which is the function of the regeneration control.

The frequency of oscillation is determined by the choice of capacitors (bandswitch), the inductance value of L1 and the setting of the tuning control. If the oscillator is tuned to 7 MHz, for example, any radio signal on that frequency will be boosted and detected in the regeneration process. The resulting output from transistor Q3 is a low level audio signal which is boosted by Q4 and further amplified to speaker level by the LM386 IC ("integrated circuit") amplifier

The RF amplifier (Q1) serves two purposes. It boosts the RF signals from the antenna to the detector, and it minimizes the amount of oscillator RF going back out to the antenna.

Now for the more complex explanation that is found in the appendix for ham club leaders and teachers.

In brief, the circuit uses RF regeneration and high levels of DC feedback. Notice that the antenna is coupled directly to the drain of RF amplifier FET Q1 rather than through the LC tuning network. Direct coupling of the drains of Q2 and Q3 isolates the LC circuit from the antenna input, enhancing stability and greatly minimizing RF oscillator output to the antenna. Such RFI was a significant problem in traditional regenerative circuits which permitted the oscillating detector to behave as an unstable but potent QRP transmitter.

The S2 and S3 bandswitches select a combination of capacitors across with L1. With no capacitors switching, frequency coverage is determined solely by the varactor circuit in series with C2.

Trimmer pot R8 provides for smooth regeneration over all tuning ranges, compensating for individual FET characteristics. Trimmer R1 attenuates antenna RF, serving as RF gain control. Its function is easily duplicated by an external pot.

Simple regenerative detectors have very low-level audio output suitable only for high impedance earphones. Boosting such audio must be done with care - the job of the Q4 preamp circuit. This 1054 design buffers the highly sensitive oscillator/detector section and uses the full audio output capabilities of U1, LM386. C18 sets U1's voltage gain figure at 200. Removing C18 results in a voltage gain of 20.

While a single DC supply is certainly possible, we determined that there would be less chance of problems for beginners by providing independent DC supplies for *the RF and audio sections of the receiver.*

It should be obvious that lower frequencies may be tuned by adding capacitance (or inductance) to the simple LC tuning, and that higher frequencies might be tuned by reducing C2. While you certainly are free to experiment, please bear in mind that we designed this circuit to provide an interesting sampling of 6-15 MHz. activity with good audio at a bargain price and deliberately chose not to press its possibilities to their outer limits. The extra pads for "C5" permit trying additional capacitance for tuning lower frequencies.

Page 26 {of the TenTec Manual, not this issue of QRPp} *mentions the option of adding a "bandspread" control: an alternative is to use a higher value for R3 (10K), which will reduce the voltage swing applied to the MV209 varactor. The effect will be finer tuning but reduced frequency coverage. This may be desirable if there is special interest in a particular band segment such as the 40 meter Novice band. Remember that any change to optimize one band will affect tuning on all the bands.*

TenTec also has a very good section on using and understanding the regeneration control. I was quite impressed with it, and am printing it here as I am sure that many of you have never used a regen before, and don't quite understand how to operate it. This applies to any regen, not just the TenTec's.

Using and Understanding the Regeneration Control

In theory, your receiver's Regeneration Control adjusts the level of feedback or self-oscillation of the FET detector section (Q2). In practice, this control is like a "joystick" for optimizing receiver performance. Your ability to handle this "joystick" saves you many dollars over today's cost of receivers which perform similar functions automatically. You might even get more control over receiver performance in varying situations than may be possible with more expensive receivers. Once you know how to use it, it's a fun control.

With the control turned fully to the left (counter clockwise), the receiver is virtually silent. "Regeneration" begins at a certain point as you turn the control clockwise. The exact point varies not only from band to band but even as you tune within a given band. Regeneration begins as an audible increase in background noise followed by a soft hiss. The hiss, or any signals that may be on frequency, increases as you continue to turn clockwise. If you go too far, the signal becomes distorted, or the receiver begins to squeal (oscillate).

Always use the least amount of regeneration necessary for good reception of a given signal. The best reception of AM shortwave broadcast signal occurs just before regeneration begins. If you hear a whistle (carrier) along with an AM signal, turn the control back slightly until the carrier disappears.

When there are many very strong shortwave AM Broadcasts in a given band, such as is common in the early evening, you will find it possible to tune them in one after the other with the regeneration control set "way back" and requiring virtually no adjustment. In other words, you would tune from station to station just as if using any other type of shortwave set.

When the receiver is adjusted for good AM reception, CW signals will sound like hisses. Advancing the regeneration control slightly will bring in the familiar beeping associated with CW, RTTY or similar signals.

The regeneration control can also

serve as a fine tuning control, permitting slight adjustments of CW pitch for the most pleasing sound; or best clarity in a SSB voice signal. After you've had some practice with using the regeneration control, it will become second nature, giving you a sense of real control over the performance of your receiver.

Tuning SSB Signals

SSB signals are those voice signals which sound like Donald Duck unless they are tuned in properly. They have no background carrier as do AM Broadcast signals. On modern ham radio transceivers, tuning SSB is made so easy by internal filters that many licensed ham operators are not aware of the basic technique for tuning in SSB signals on receivers without such filters.

The first fact to know about any given group of SSB signals is whether they are Upper (USB) or Lower (LSB) Sideband. In ham communication, LSB is used on 1.8 through 7.3 MHz and USB is used for higher frequency bands (14, 18, 21, 28 MHz.)

Think to yourself: for lower sideband, tune down. For upper sideband tune up.

This means you would "approach" the LSB signal by tuning from higher frequency (right) to lower (left), from higher voice pitch to lower. Here's how, step by step:

1. Pick out a strong, high pitched Donald Duck voice.

2. Turn the tuning knob ever so slightly to the left.

3. If the pitch of the voice went down slightly, you're heading in the right direction.

4. Slowly tune left slightly more until the voice is clear.

Reverse this process to tune up (to the right) to USB signals on the bands above 40 Meters. The Regeneration Control often can be used to do the last touch of fine tuning to bring the voice in clearly. If signals are exceptionally strong, it may be necessary to reduce RF Gain.

Here is the parts list for the TenTec 1054 Regen Receiver

C1 100 pF Disc
C2 220 pF Disc
C3 120 pF Disc
C4 47 pF Disc
C5 Pads supplied Not used
C6 .01uF Disc or Mono
C7 .01uF Disc or Mono
C8 1uF Elec.
C9 .01uF Disc or Mono
C10 33 pF Disc
C11 .1uF Disc or Mono
C12 .01 uF Disc or Mono
C13 .1uF Disc or Mono
C14 100uF Elect.
C15 .01uF Disc or Mono
C16 1uF Elect.
C17 100 uF Elect.
C18 10 uF Elect.
C19 .1 uF Disc or Mono
C20 .1 uF Disc or Mono
C21 100 uF Elect.
C22 10 uF Elect.
D1 MV209
J1 1/8" Stereo Jack
L1 2.8uH adjustable shielded coil
Q1 J310
Q2 J310
Q3 J310
Q4 2N4124
Q5 2N4124
R1 10K trimpot
R2 10K
R3 10K
R4 1K
R5 10K
R6 10K Pot
R7 1M
R8 100K Trimpot
R9 10K
R10 1K

R11 4.7K
R12 470 ohm
R13 47K
R14 10K
R15 270 ohm
R16 10K Pot
R17 27 ohm
R18 10 ohm
R19 22K
R20 10 ohm
R21 10K Pot
S1 DPDT
S2 DPDT
S3 DPDT

In summary, I recommend this kit, especially for the beginner. It is an excellent introduction to shortwave listening, and it is cheap. The kit is only $20, and includes all parts, nice circuit board, and a front panel. To order contact:

TenTec
1185 Dolly Parton Parkway
Sevierville, TN 37862
Phone: 1-423-453-7172
Orders: 1-800-833-7373

MFJ-8100
World Band Receiver

Next we are going to go up both in price and quality. The World Band Receiver by MFJ sells for $59.95 and is the model 8100K. The manual, less the schematics are available on the MFJ web site at WWW.mfjenterprises.com. But Martin Jue, W5FLU, who is the owner of MFJ, has kindly granted permission for us to publish the schematics in QRPp. Martin is also member #222 of NorCal and a long time friend of QRP.

The MFJ8100 Receiver Features:

1. 5 separate tuning ranges between 3.5 and 22 MHz.
2. Smooth 6:1 vernier-reduction tuning.
3. Sensitive FET RF amp and detector stages.
4. Dual headphones for sharing the fun
5. Use economical "personal stereo" headphones or speakers
6. Smooth, well engineered regeneration circuit
7. True choice of AM-CW-SSB reception
8. Excellent reception even with a few feet of wire antenna

The MFJ is a complete kit, it comes with everything that you need to build it, including a very nice case. The thing that I really like about the MFJ is the tuning. It uses a real air variable cap with a 6 - 1 reduction drive and tunes the best of all of the commercial kits that I have used. The board is very spacious and spread out, the instructions are excellent and almost everyone can build this kit. In fact, if you are a beginner and want a better kit, although it is more expensive (you get what you pay for), this one is the one to build.

Circuit Description

In brief, the circuit uses RF regeneration and high levels of DC feedback. Notice that the antenna is coupled directly to the source of RF amplifier Q3 rather than through the L-C tuning network. Direct coupling of the drains of Q1 and Q3 isolates the L-C circuit from the antenna input, enhancing stability and greatly minimizing RF oscillator output to the antenna. Such RFI has been a serious problem in traditional regenerative circuits which permitted the oscillating detector to behave as an unstable but potent QRP transmitter.

R4 reduces the Q of L1 (10uH) for smoother regeneration. The SW1 bandswitch selects a combination of simple inductors. For example, the total inductance for Band A is L1 + L2 + L3 + L4 + L5. The inductance for Band E is only L5. And so forth.

Air variable C1 uses a 50 pF range

and mechanical vernier reduction to provide smooth "bandspread" in parallel with C3 and trimmer C5 which perform the traditional "bandset" function.

Trimmer pot R20 ensures adjustability for smooth regeneration over all tuning ranges, regardless of individual FET characteristics.

C17, C9, C10 and R9 form a low pass filter to block RF from the audio amplifier and provide basic audio filtering.

Volume Control R2 varies OUTPUT rather than low level input to the LM386 audio amplifier. This approach further isolates the RF stages from variations in the audio section.

The LM386 (IC1) circuitry employs all recommended options for maximum gain and protection from self-oscillation.

To prolong useful battery life, R13 limits current draw by the LED (CR1) to minimum reasonable visibility as an'on/off indicator.

Did the above sound familiar to you? Well it should have, because both the MFJ and the TenTec 1054 manuals were written by the same person. Dan Onley, K4ZRA. My first thoughts were. oh, the MFJ is the same circuit as the TenTec, but in a case, with an air variable for tuning instead of a varactor. But if you look at the two circuits, (you will see several more differences. The MFJ changes bands by switching inductors in and out, the TenTec does it by switching in capacitors. The audio amplifier volume control is on the output of the MFJ, and on the input of the TenTec. The circuits have similarities, but they also have obvious differences.

I like the MFJ better because it seems to be more complete. The case is rock solid, the air variable capacitor is high quality, and the receiver just seems to hear better than the TenTec. Plus it is not near as finicky to operate.

The MFJ circuit is a 5 band receiver, with the following frequency coverage:
Band A: 3.5 to 4.3 MHz.
Band B: 5.85 to 7.40 MHz.
Band C: 9.5 to 12.0 MHz.
Band D: 13.2 to 16.4 MHz.
Band E: 17.5 to 22 MHz.

I found that the MFJ receiver is the easiest to tune and use, and it is very stable. The Frequency coverage seems to be about right, and it does not tune too sharply.

MFJ 8100K Parts List

C1 8-50 pF air variable w/red. drive
C2 .1uF
C3 47pF
C4 .1uF
C5 5-30 pF trimmer
C6 33pF
C7 .01uF
C8 .01uF
C9 .0033 polystyrene
C10 .1uF
C11 .1uF
C12 22uF elect.
C13 100uF elect.
C14 10uF elect.
C15 .1uF
C16 75pF
C17 .0033 polystyrene
C18 1uF elect.
C19 470uF elect.
C21 .01uF
C28 .01uF
CR1 Red LED
IC1 LM386
L1 10uH
L2 3.3uH
L3 1uH
L4 .47uH
L5 T50-2 Toroid, 8T
Q1 J310
Q2 J310
Q3 J310
R1 10K Pot, Regeneration
R2 250 ohm Pot, Volume

R3 10K
R4 10K
R5 10K
R6 1K
R7 1M
R8 10K
R9 1K
R11 22 ohms
R12 15 ohms
R13 2.2K
R17 10 ohms
R19 10K trimmer. RF Gain
R20 100K trimmer, regeneration
J1 Antenna connector
J2 Stereo 1/8" Jack
J3 Stereo 1/8" Jack
SW1 5 position rotary switch
SW2 DC on-off pushbutton switch.

The manual is very complete and gives easy to follow step by step instructions and includes a trouble shooting section. And, if you still can't get your receiver to work, you can give MFJ a call and one of their technical reps will help you. A nice touch.

The TenTec 9 Band Shortwave Receiver

The final entry in my review is the 9 band shortwave regen receiver from TenTec, the 1253. This is the most complex of the kits, and the only one that I would not recommend to a beginner. This kit comes in a great case that is as rugged as can be, but it is not easy to build and put together. Gary Diana, N2JGU of Embedded Research fame built one with his son, Gary Jr., and he told me that Gary had no trouble with the soldering but he did not think that he would have been able to complete the kit, i.e. putting it in the case without a tremendous amount of frustration. I agree.

The 1253 covers 9 bands in the following segments:

Band 1: 1.760 to 1.990 MHz.
Band 2: 3.3 to 4.150 MHz.
Band 3: 5.5 to 6.9 MHz.
Band 4: 6.8 to 8.6 MHz.
Band 5: 8.5 to 11 MHz.
Band 6: 10.1 to 13.2 MHz.
Band 7: 12.5 to 16 MHz.
Band 8: 14.7 to 18.5 MHz.
Band 9: 18.5 to 21.5 MHz.

As you can see several of the bands overlap, so you get almost continuous coverage from this kit.

Here is TenTec's description of the 1253.

This receiver consists of an RF amplifier (Q1), a "regenerative" detector/oscillator (Q2/Q3), an audio preamplifier (Q4), and an integrated circuit audio amplifier (U1). Integrated circuit U2 is a voltage regulator supplying a stable 8.0 volts to all circuits except Q4 and U1. Transistor Q5 provides additional voltage regulation for the varactor tuning circuit controlled by D10 and for the detector/oscillator circuit.

Band switching is accomplished by the CD74HC4017 IC, a TTL "decade counter" used in numerous digital logic circuits. It is wired so that pressing the pushbutton provides the "clock pulse" needed to advance or "count" to the next output. The voltage from a given output pin lights the corresponding LED and powers the Q1/Q2 circuitry through the inductor selected. Diodes D1-D9 are "PIN" diodes which pass DC voltage through the band selection inductors (L1-L9) while also stopping the RF energy of Q1/Q2 from interfering with our being absorbed by the switching circuit and power supply circuitry.

The frequency of oscillation is determined by the choice of inductors (bandswitch), any capacitors used for C34-42, and the setting of the tuning controls. If the oscillator is tuned to 7 MHz. for example, any radio signal on that fre-

quency will be boosted and detected in the regeneration process. The resulting output from transistor Q3 is a low level audio signal which is boosted by Q4 and further amplified to speaker level by the TDA2611A IC amplifier.

The RF amplifier Q1 serves two purposes. It boosts the RF signals from the antenna to the detector, and it minimizes the amount of oscillator RF going back out to the antenna.

Diodes D11 and D12 permit the use of an external DC power supply with no need to remove the batteries.

As you can see, this receiver is just a little more complicated than the first two, and it is mostly due to the switching arrangements of the electronic band switch, but it is basically the same receiver circuit. When you look at the parts list, you also note many more parts in this kit.

TenTec 1253 Parts List

R18, 23	3.3 ohm
R3	10 ohm
R28, 29	100 ohm
R14	270 ohm
R16	470 ohm
R26	560 ohm
R7, 10	1K
R25	1.5K
R15	3.3K
R8, 11, 27	4.7K
R2	6.8K
R9, 13, 19	10K
R24	22K
R12	47K
R4, 22	1M
R1, 5, 17, 20, 21	10K Pot
R6	100K Trimmer
C2	33pF
C34	56pF
C1, 13	100pF
C18	220pF
C3, 4, 6, 7, 9, 19	.01uF disc
C20-28	.01uF mylar
C8, 15	.1 disc
C12	.1 mylar
C5, 11, 31	1uF elec.
C29	10uF elec.
C14, 33	33uF elec.
C30, 32	100uF elec.
C17	220uF elec.
C10, 16	470uF elec.
L9	1.2uH
L8	1.5uH
L7	2.2uH
L6	3.3uH
L5	4.7uH
L4	8.2uH
L3	12uH
L2	33uH
L1	68uH
Q4,5	MPS6514
Q1, 2, 3	J310
U2	MC7805CT
U1	TDA2611A
D1-9	ISS 135 or BA482
D10	MV209
D11, 12	1N4002
LED1	Red LED
J1	1/4" speaker jack
S1	Toggle switch

Electronic Switch Board Components

R1	470 ohm
R3	1.8K
R2	3.3K
C1	.01uF mylar
U1	CD74HC4017
D1	5.1V Zener
LED1-9	LED's Green
SW1	Mom. Switch

The schematics for all three radios are located in the center fold out section. I would like to thank Scott Robbins at Ten Tec and Martin Jue at MFJ for permission to print the schematics and parts lists. Obviously if you build from scratch, you can build any one of these kits by scrounging the parts. But if you want to do it the easy way, contact the two companies and buy the kits, it is a lot more fun to build that way as you won't be frustrated trying to find parts. Here are the addresses:

MFJ8100K. $59.95
MFJ Enterprises, Inc.
300 Industrial Park Rd.
Starkville, MS 39759

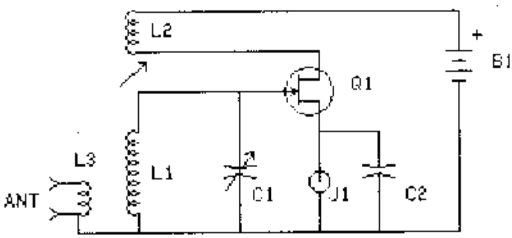
Phone: 1-800-647-1800
TenTec 1054. $24
TenTec 1253. $59

Ten Tec Inc.
1185 Dolly Parton Parkway
Sevierville, TN 37862
Phone: 1-800-833-7373 (Order Line)
Info: 1-423-453-7172

Look, No Resistors!

by Anthony Felino, WN6Q
P.O. Box 2702
Santa Barbara, CA 93120

This receiver is an entry in the "Simplest Schematic" category. The idea was to build a radio that could actually be used on the air with the bare minimum of parts. The receiver will actually work without C2, but shows "hand capacity" effects. I have made several contact using this receiver and it works pretty well, as long as you are in a quiet room. It will not hear everything that a receiver with more stages will, but it is usable.



C1 50-130pF Variable from WW2 Command Rec.
C2 .01 Mono
L1 5uh (WW2 Com. trans. tank coil.
L2 Rotating link inside L1, 4 T.
L3 1T Link around L1
Q1 MPF102
J1 1/4" phone jack
B1 9V Battery

Features:

* Hardly any parts
* Frequency coverage 5.7-7.8MHz.
* Phone jack acts as on-off switch
* Radiation is only about -40dBm (0.1W)

Operation:

Plug a pair of 2000 ohm headphones into the 1/4" phone jack on the front panel. This turns the receiver on. Plug a 50 ohm antenna into the BNC jack on the front panel. Turn the large tuning knob to reach the approcximate frequency of interest. Begin with the small regeneration knob all the way counter clockwise. Turn it gently to p:revent stripping the 60 year old phenolic gear. Rotate the regeneration control clockwise and find the first noise peak. Leave the control clockwise of the peak for CW reception, and counter clockwise of the peak for AM reception. The receiver will overload easily on CW in this condition. Increase regeneration to reduce the sensitivity. If you go too far, the receiver will begin to "squeal". Signals will seem louder, but will appear in many places on the dial. Do not use the receiver in this condition.

A SHORT WAVE REGENERATIVE RECEIVER PROJECT

By

Charles Kitchin, N1TEV

Introduction

The following project is recommended for Ham radio clubs that are interested in introducing their membership to receiver "homebrewing".

The Chelmsford Charter school (Chelmsford, MA) graciously provided us access to their facilities.

We set-up a radio "production Line" with a small drill press at one end. Here the wooden cabinets were drilled, glued, and the tuning capacitors and some of the other front panel controls were installed. We had several "coil winders" further down the line, followed by the rest of the group, who worked on wiring their printed circuit boards.

The BARS Ham Radio club was fortunate to have several experienced "Elmers" including club president Ken Caruso-WO1N, club treasurer Bruce Anderson-W1LUS, New England Vice ARRL Director Mike Raisbeck-K1TWF, and regenerative radio/homebrewing fanatic Chuck Kitchin-N1TEV. Many other members of the club helped out by donating parts or their time to this project.

Danny Raisbeck-KB1DFJ, Trying-Out His Radio.

The majority of the kit builders were graduates of the Chelmsford Charter School summer Ham radio class and their dads. However, the enthusiasm was widespread and several BARS members just had to build one too! Clubs planning to tackle a project like this should plan on a minimum of two sessions to complete the kits. You need to plan time to teach soldering techniques, component identification and schematic reading.

The radio described here is a two band short wave receiver which is both very sensitive and very portable. It receives AM, single sideband (SSB), and CW (code) signals over a frequency range of approximately 3.5 to 12MHz. This includes the 80, 40, and 30 meter Ham bands plus several international short wave bands. The basic cost of this project is approx. $35 per receiver including the cost of the PC board.

This receiver is ideal for code practice and for general short wave listening although a certain amount of practice (and patience) is needed while the user learns how to tune and adjust the controls. This should be considered a medium skill level project. It was designed to be built by the average Ham under the mentorship of experienced "elmers" who can provide guidance on soldering, coil winding, troubleshooting, and operating the receiver. It is also a good "family" project. In the BARS club class, several parents built radios with their kids

This project is designed to be built using the FAR Circuits printed circuit board (the name of the PC board is the same as this project's title). The use of this board is HIGHLY recommended as it greatly reduces the time spent soldering the circuit and avoids the many wiring errors that always occur during construction. It also helps prevent crossed connections and provides better performance than a hand wired board (because proper component location and shielding are designed into the PC board). The PC boards are available from FAR Circuits for $5.00 each plus $1.50 shipping for up to 3 boards. There is a group discount rate of 10% for 10 boards or more. You can contact FAR Circuits at 18N640 Field CT. Dundee, IL. 60118-9269. Tel: 847-836-9148 (voice and FAX) EMAIL: Farcir@ais.net

Circuit Description (Simplified)

As shown in the schematic in the center foldout section, this receiver consists of three sections: a radio frequency (RF) stage, a detector stage, and an audio amplifier stage. A bipolar transistor is used in the radio frequency stage, a JFET in the detector and the audio amplifier uses a low-cost IC. The RF stage (Q1) amplifies the antenna signals and provides isolation to prevent the radio's oscillations from causing interference to other receivers in the area. JFET Q2 is a "regenerative" detector, which, by the use of positive feedback, greatly increases the receiver's sensitivity. It also supplies a local oscillation for the reception of CW and SSB signals. The audio stage (IC1) amplifies the audio signal and provides enough output to drive headphones or a small speaker.

Circuit Description (Detailed)

Q1 operates as an untuned, grounded-base RF amplifier, providing gain and isolating the detector's oscillations from the antenna. This RF stage provides ample gain and its high output impedance does not load L2 excessively. This helps provide very high selectivity.

C1 ac couples the antenna signal from Q1's emitter, which prevents shorting R1 should the antenna become grounded. L1 inductively couples the output signal from the JFET drain to the detector.

JFET Q2 operates as a tickler feedback or "Armstrong" regenerative detector circuit. Secondary winding, L2, and capacitors C3a (and C3b) select the received signal while tickler winding, L3, provides regenerative (in-phase) feedback. The circuit is basically a user-controlled oscillator to which an RF signal is coupled. The detector multiplies the gain of the JFET and the selectivity of the coil by 1000 times or more. When operating below the threshold of oscillation, the detector serves as a high gain amplifier and AM detector. When oscillating, the detector heterodynes (mixes) its local oscillation with those of the signal to provide an audio "beat note".

Diode D3 functions quite well as a "poor man's varactor". The voltage from the battery is divided down by R8 and applied to D3 through series resistor R9. C11 removes any RF pick-up and also filters-out any noise as R8 is adjusted. Diode D3 is reversed biased by the voltage selected by R8. When this reverse bias is zero, D3 has about 50pF of capacitance; as R8 is turned-up this capacitance decreases, eventually to zero. Capacitor C3c reduces and linearizes the effect of R8. It also divides-down the signal voltage so that D3 does not become forward biased on strong RF signals.

R2/C4 are a "grid leak" arrangement that (together with R3) set a very high level of operating bias for the JFET, making regeneration control much smoother. C5 is a "throttle-capacitor" REGENERATION control, while RF choke, L4, isolates the RF signal appearing at the regen capacitor from the power supply. Zener diode D2 regulates the drain voltage of the detector, to make the receiver very stable in the oscillating mode.

The audio output is extracted from the JFET source and travels through resistor R4 to the audio filters. R4 isolates C10 and C12 from R3 and C8 in the detector's source; otherwise, the detector may break into super regeneration. This can occur with high levels of RF feedback when a long RC time constant is used in the detector circuit. A large increase in either R2 or C4 would produce the same effect.

The audio signal travels to the VOLUME control, R6. SW2, a single-pole, double-throw (center-off) toggle, can switch-in an additional capacitor (C12) to reduce the audio bandwidth for CW or SSB reception. An LM386 audio-amplifier IC provides adequate volume to drive headphones or a small speaker.

Diode D1 is a safety feature, which protects the receiver if the battery is connected backwards.

Collecting the Parts

Most of the components for this project can be purchased at your local Radio Shack or by mail order from Digi-key or other supply houses. A complete parts list is shown below.

Parts List For Short wave Receiver

C1 0.1mF Ceramic disc Capacitor, 16V or higher
C2. C7. C11, C12, C15, C16, 0.01 mF Ceramic disc Capacitor, 16V or higher
C3a, C3b Receiving type variable capacitor with one or more gangs. Minimum capacitance should be approx. 10pF or less and maximum capacitance 200 to 300pF. FRS, AES, OSE.
C3c 5pF Mica or NPO ceramic capacitor, 16V or higher
C4 100pF Mica or NPO ceramic capacitor, 16V or higher
C5 Receiving type variable capacitor with a minimum capacitance of approx. 10pF or less and a maximum capacitance of 100 to 200pF. FRS, AES, OSE.
C6 47mF electrolytic Capacitor. 16V or higher
C8 1000pF Mica or NPO ceramic Capacitor, 16V or higher
C9 4.7mF electrolytic Capacitor, 16V or higher
C10 0.022mF ceramic capacitor, 16V or higher
C13 10mF electrolytic Capacitor, 16V or higher
C14 220mF electrolytic Capacitor, 16V or higher
D1 Any silicon rectifier diode (1N4001, 1N4004, etc)
D2 1N4736A 6.8V Zener diode (DK)
All resistors below are 5%, 1/8W carbon composition or carbon film types
R1 2.2k
R2, R9 1M
R3 2.7k
R4 5.6k
R5 1.0k
R7 10
R6 10k potentiometer, audio taper preferred with on/off switch (RS, FRS)
R8 Any 50k to 150k potentiometer, audio taper preferred (RS, FRS)
L1-L3 Pill bottle coil form using RS#22 gauge hookup wire (see text)
Q1 2N2222 bipolar transistor (DK, RS)
Q2 MPF102 JFET Motorola transistor (DK, RS)

IC1 National Semiconductor LM386 amplifier (DK, RS)
SW1 Power on/off (part of R6) (RS, FRS)
SW2 Audio Filter switch: any small SPDT Toggle (DK, RS)
SW3 Band switch: any small SPDT Toggle or rotary switch (DK, RS)
RFC1 3.3mH RF Choke (Digi-key part # M7332-ND $1.80)
Stereo headphone jack (1/8 inch) for Walkman type headphones (RS)
Binding Posts for Antenna and ground connections (DK, RS, FRS)
8 pin DIP Socket for IC1 (optional)
9V Battery Holder
9V Battery (or use +12V source, see text)
Knobs: 1 large (3-4 inch) (FRS, AES) , 4 "communications type" knobs(RS)
FAR CIRCUITS PC Board (see text)
One wooden base, 8.5 inches long by 5.5 inches wide (or wider).
Two wooden sides, 7 inches high by 5.5 inches wide (or wider)
One front panel, 10" wide by 7" high. Use three eighth inch Luan plywood.
One back panel, 10" long by 3" wide. Use one eighth inch masonite
Fifty feet of hookup wire for the antenna, a short length for a ground connection.
6X32 machine screws 1" long (to mount variable caps)
Small brass screws (for mounting coil and PC board)
Speaker wire, nails, glue, Qdope, solder.
Walkman type headphones

Available Options

Vernier Dial for Main or fine tuning control. Jackson Drive or use lower cost Japanese verniers from OSE or from You-Do-It Electronics (Needham, Ma)
Plug in Coil Forms to make a very wide range receiver (Long wave all the way up to 10M operation is possible) (AES part number PC-211)
5 Pin tube Socket for above (AES)
3 Banana jacks for external battery or power supply, red,blk,blue. (DK, RS, FRS,AES)
RCA audio jack for connecting the receiver's output to an external amplifier or tape recorder.(RS)
RS: Your Local Radio Shack store.
DK: Digi-Key corporation, 701 Brooks Avenue South, Thief River Falls, MN 56701-0677. Phone: 218-681-6674, EMAIL: www.digikey.com.
FSR: Fair Radio Sales, P.O Box 1105, 1016 E. Eureka st., Lima, Ohio 45802.
Phone:419-223-2196, EMAIL: fairadio@alpha.wcoil.com
AES: Antique Electronics Supply, 6221 South Maple Avenue, Temple Arizona 85283.
Phone: 602-820-5411, EMAIL: www.tubesandmore.com
OSE: Ocean State Electronics, 6 Industrial Drive, PO Box 1458, Westerly, RI 0289.
Phone: 1-800-866-6626 EMAIL: www.oselectronics.com

Substituting Parts

Standard one, two, or three gang AM radio type variables, with different capacitances than those shown in the schematic, can be used for C3. Almost all will work fine, except that the receiver's frequency range will be somewhat different from the circuit shown here. Multi-band operation requires a multi-ganged capacitor (or plug-in coils) but a very decent single band receiver can be built using any single gang variable capacitor with a maximum capacitance of 200 to 400pF. If an air variable with a maximum capacitance over 200pF is used, the receiver will have more critical tuning, as more frequency range is packed into a single band. The addition of a vernier reduction drive or the use of a fine tuning control with a bit more range will solve this problem.

With the coil wired as shown in the schematic, 80 meter reception requires about 180pF total capacitance, 40 meters about 50pF. To change the received frequency range, simply add or subtract one or two turns from winding L2 (more turns will lower the frequencies received, fewer turns will tune higher frequencies). Alternatively, you can just solder (or switch-in) a MICA capacitor in parallel with C3 (using the shortest leads possible) to lower the frequency range or in series with C3 to raise it.

The amount of regeneration control will also vary with the type of variable capacitor used. Many air variables may be substituted as long as the minimum capacitance is somewhere around 10-20pF and the maximum capacitance (with all gangs are tied together) is 100pF or more. With multi-ganged capacitors, simply connect-up more gangs if more regeneration is needed, or disconnect gangs for less. You can also add or subtract a turn or two from the tickler winding.

Some General Tips for Group Construction

It is strongly recommended that, before group construction begins, the most experienced Ham should build the first receiver. This prototype receiver will then be available for everyone to look at while they are building their radio and it also will help discover any potential "bugs" before group construction begins. It is also essential that, once the prototype receiver is finished (and working properly), that the group copy it exactly, being especially careful to ground the frames of the air variable capacitors in exactly the same way.

Once the prototype is finished, all the parts can then be collected. They should be placed in individual boxes or bags and labeled with their part number (i.e.: all resistor R1's are in one box, R2's in another etc.) Individuals can then come up and take their parts a few at a time, as they wire their PC boards.

As with any RF circuit, keep all wires as short as possible and be sure that all components are grounded directly to the PC board ground, using separate, very short, ground wires. Avoid "daisy-chain" grounds, where a ground wire connects to one component then it runs on to the next. This can introduce some very strange effects. With a "daisy-chain" the components are all grounded at different points along the wire, which may have strong RF signal levels across it. This is especially true in a regenerative circuit where RF levels are high

Building the Cabinet

This receiver is designed to use a wooden cabinet for several very good reasons. First, standard pine board and plywood are cheap and easy to find. They are also easy to fabricate using basic hand tools. Another important reason is that the main tuning coil of a regenerative receiver needs to be kept well away from any metal, otherwise both the sensitivity and the selectivity of the receiver will suffer.

But a metal cabinet CAN be made to work (and work well), as long as the coil form is kept at least three inches away from any metal on all sides. And a metal cabinet does have some advantages. It will provide good grounding and shielding, with generally better stability than a wooden enclosure. A metal cabinet also helps prevent any "hand capacitance" effects, although these should be minimal with this design.

If the wooden base is located at the bottom of the side boards and the air variable capacitors are directly attached to the base, spacers will be needed to lift the capacitors up high enough (above the base) to allow the use of large knobs on the front panel. You can eliminate this problem by simply attaching the wooden base a few inches above the bottom of the side boards. The variable caps can then be screwed down directly onto the base.

Parts Layout

Note that the coil form containing windings L1, L2, and L3 should be located as close as possible to the PC board using the shortest leads possible. If long wires are used, they tend to radiate energy into other areas of the circuit and can cause some very strange effects in a regenerative set.

When mounting the two variable capacitors, solder a short wire to the body of each or attach the wire using one of the capacitor's mounting screws. The use of two very short connecting wires, one between each capacitor's frame and the PC board ground, is essential.

Try to arrange the receiver's layout so that all wires are kept as short as possible with the audio wiring physically separated from the RF (radio frequency) wiring. The volume and fine tuning controls should be mounted onto the front panel and then connected to the PC board using shielded wire. Be sure to run a separate ground wire between the ground terminal on the volume control and the PC board ground. This will prevent any "ground loop" effects.

The toggle switch, SW2 for the low pass filter should be mount right next to the volume control. Capacitor C10 can be wired between this switch and the volume control using short leads. If C10 is wired into the PC board, be sure to use shielded wire between this connection and the volume control.

Wiring the Circuit

Using the schematic and parts list as a guide, install and solder all the components into the PC Board. Be careful that diodes and capacitors are installed correctly: the striped end of the diodes is the cathode end and matches the stripe marked on the PC Board. Some of the capacitors are also polarized and are labeled + and − so refer to the schematic and the PC board labeling to install these correctly. Also, be sure that the JFET (Q2) and bipolar transistor (Q1) are installed correctly. The flat side of Q2 is marked on the PC board; the emitter of Q1 is the lead next to the tab (this is also indicated on the PC board). The base of Q1 is the center lead and the collector is the lead on the end opposite the emitter. You can substitute a PN2222 here, and it will work fine but be aware that the pinout for this transistor is different from that of the 2N2222. Most builders will want to leave out C12 and C17 from the PC board and simply wire these two capacitors right across the volume and fine tuning controls.

Winding the Coil

The receiver has one main coil with three windings: a primary (L1), a secondary (L2), and a tickler winding (L3). Carefully make these three windings on each coil form, being sure to check the schematic diagram as you do so. Use Radio Shack #22 insulated hook-up wire for the windings. Be sure that the tickler winding (L3) is located on the ground side of the secondary winding (L2…see Figure 1 schematic).

It greatly simplifies construction if you use different color wires (of the same size) for each winding: for example, black for L1, red for L2, green for L3, etc. The coil form used is a 1.25 inch diameter plastic pill bottle 2.5 inches to 3 inches long. You can also use many other common items such as 1.25 inch diameter thin walled PVC sink drain pipe, and other plastic bottles of the same length and diameter. The exact frequency range (and the amount of regeneration) will vary with the diameter of the coil form used. It's best to stick with the size recommended, but it is possible to use many other types of coil forms.

When winding the coil, first drill two small holes in the coil form at the beginning of each winding. Then feed the wire through the first hole and out through the second. Before you start the winding, simply tie a knot at the point in the wire where it enters the form — this will keep the wire from loosening-up later on. Then wind the coil tightly onto the form counting the turns as you go. Keep the turns close together and try not to let the wire loosen up as you wind (this takes a little practice). When the winding is finished, drill two more holes at the point on the form right where the winding ends (hold the end of the wire with the thumb of one hand while holding the drill in your other hand). Now, feed the wire through and tie a knot at the end to hold the coil in place. A second set of hands helps here.

Solder the wires from the coil form to the PC Board using the shortest possible lead lengths. When the receiver is finished (and working correctly) you can use Q dope to cement the windings firmly to the form. Avoid using standard glue as this will destroy the Q of the coil and the selectivity of the receiver (it's much better to have nothing here than to use standard glue).

Coil Winding Tips for Group Construction

For group construction, have a seasoned "Elmer" supervise the coil winding. Try to wind all the coils exactly the same as the prototype. All the coils should use the same diameter form, the same wire size, the same number of turns and the same spacing between turns. If all the coils are wound differently, the receivers can all be made to work properly but, an experienced Ham will be needed to fix them all up at the end of the project, (by adding or subtracting turns, etc)...and this takes-up a lot of time.

So, a little bit more work in the beginning of the project will save a great deal of work at the end. Before soldering the three coil windings to the PC board, use an Ohm meter to check that there is continuity in each coil and have an "Elmer" check that all the windings have been made correctly.

Testing and "Debugging" the Receiver

Once all the components and the three coil windings have been soldered to the board, temporarily connect a 9 volt battery to the anode of D1 and use a voltmeter to do a quick test. First, measure the voltage at the cathode of D1. It should be approx. 0.7V less than the battery voltage or about 8.3V. Next, measure the voltage at the cathode of D2. This should be approx. 6.8V (more or less). This same voltage should be present on the regen capacitor and on the drain ("D") of Q2. Measure the voltage at the JFET source. This can vary a lot with individual devices but it should be approx. 1.5 to 2V. Then measure the voltage at the emitter of Q1. This should be approx. 0.7V less than the voltage on the base of Q1 or about 7.6V (8.3V-0.7V = 7.6V). Finally, measure the voltage on pin 5 of IC1. This should be at mid supply or around 4.2V.

If all the voltages are correct. wire the two variable capacitors (C3 and C5) to the PC board using the shortest leads possible. Then wire the output jack J1 (using a RS stereo jack. the 2 "hot" leads go to C14, common to ground). Then wire the volume control to the board.

Test the audio stage first. Plug-in a set of headphones or connect a speaker to J1, and turn-up the volume control half way. You can just place your finger on the top of the volume control and listen for a buzz in the headphones

Now test the detector. Use a clip lead to connect a short piece of wire (a foot or two but not more) to the primary winding (L1) right at the collector of Q1. Slowly turn-up the regeneration control until the detector oscillates, producing a "live" sound (a large increase in background noise). If the detector refuses to oscillate, carefully check the wiring. If the wiring seems OK, try swapping the wires to the tickler winding.

Once the detector is oscillating, test the radio frequency (RF) amplifier stage. by connecting an antenna to C1 and a good ground to the PC board ground. You should be able to receive some stations. even during the daytime. If the circuit is working correctly. screw-down the PC board onto the wooden base. Drill a hole in the center of the pill bottle coil form and use a small brass screw to attach the coil to the wooden base right next to the PC board.

Next, mount the volume and fine tuning controls on the front panel. Drill three holes in the back panel about 1.5 inches apart and mount the antenna. and ground binding posts and headphone jack. J1. Connect a short ground wire between the ground post and the ground of the PC board. Connect the free end of C1 to the antenna post.

Final Receiver Check-out

This receiver should be very sensitive and it should also be stable, with freedom from any "strange effects".

When the receiver is finished, do the following tests to insure that everything is working properly. Connect an antenna wire and a ground wire to the receiver. Carefully check the receiver over its entire frequency range. There should be NO oscillation anywhere with the regen control set to minimum capacitance. Then check that oscillation occurs as the regeneration is turned up (again. check this over the entire frequency range). And VERY IMPORTANT. the set should go into, and out of, oscillation at exactly the same point on the regeneration control.

If the set oscillates all the time, even when the regen control is set to minimum capacitance, then 1 or 2 turns will need to be removed from the tickler winding (L3). This assumes that the coil has been connected to the PC board using the shortest wires possible...if not, then fix this before going on.

On some sets, you can just shove the tickler winding further down – so it's farther away from the main winding. Using the FAR circuits PC board and the coil dimensions given on the schematic, three turns on the tickler winding should be correct using a wide variety of capacitors for C5. If a multi gang capacitor is being used, you can try correcting fewer (or more) gangs to get the best regeneration control range.

If a hand-wired board (with a poor layout) is used or if the coil or ground wiring is too long, a hysterisis effect may occur on some sets. This usually shows-up at the lower frequencies around 80M. Hysterisis is an effect where the circuit "snaps into" oscillation suddenly after turning the regen control way up and then the oscillation fails to go off until the control is turned way down. If this occurs, try connecting a second ground wire between the receiver's ground post and the frame of the regeneration capacitor (C5). On some receivers, two additional ground wires may be needed. The use of a protype receiver will help avoid any of these problems. One the prototype is built, and working correctly, all the others receivers should closely follow its grounding and interconnection wiring.

The volume control should be able to be turned all the way up with out any "motor boating" effects. "Motor boating" should never occur if the set has been built using shielded wires for the volume and fine tuning controls. If it still "motorboats", the addition of a second 0.01mF capacitor, right across capacitor C12 (on the volume control) should cure this problem.

Receiver Set-up

Be sure to use a good ground connection with this receiver. This increases sensitivity and also makes the receiver more stable and easier to tune and operate. You can get a fairly decent ground by (very carefully) loosening the screw holding on the plate of the nearest AC outlet. Just connect a short wire between this screw and the receiver's ground post. For a better (less noisy) ground, connect the receiver's ground wire to a cold water pipe or radiator.

The antenna can be almost any length of standard hook-up wire run out to a tree or even just dropped out of an upstairs window. A twenty to fifty foot length of wire will be entirely adequate for excellent short wave reception.

Tuning and Regeneration Adjustment

Some practice will be needed in learning to adjust the receiver for best performance. For AM reception (International short wave stations), increase the regeneration level until the detector is just barely oscillating. Then use the main tuning capacitor (C3a) to get close to the desired signal. Reduce the regeneration level to just below oscillation and use the fine tuning control to finish tuning-in the station. It's often a good idea to use two hands, one for tuning and the other for regeneration control. If the station is very weak, set the regen level slightly above oscillation and "zero beat" to the center of the carrier. This will provide you with VERY high sensitivity, typically better than 0.5 microvolt.

For CW (Morse code) reception, set the regeneration level just into oscillation. This will give you the highest sensitivity and selectivity. Tune the receiver to either side of the carrier to get the desired beat note. The CW beat note should be very stable, if it varies at all, simply increase the regeneration level.

SSB operation is similar to CW except keep the regen level fairly high at all times to avoid "blocking". This can occur when strong stations lock the detector onto the center of the carrier. Simply reducing the input signal level or increasing regeneration will prevent this. Strong SSB signals may need full regeneration to unblock. High regeneration levels should also eliminate any frequency drift.

Home Brew Doerle 2-Tube Radio

by Chuck Schwark A.R.C.I.

(This article first appeared in Antique Radio Classified, October, 1994 Vol. 11, No.10)

As a member of the Antique Radio Club of Illinois. I became interested in the historical aspects of the early days of commercial and shortwave broadcasting. After reading articles in many of the 1930's radio books and magazines of the era. I decided to try my hand at building a "home-brew" radio. Vintage parts and junker sets are still available at hamfests, swap meets and flea markets. Using original parts and hardware for this project would be fun and give me a sense of what it was like to build a regenerative tube radio from scratch.

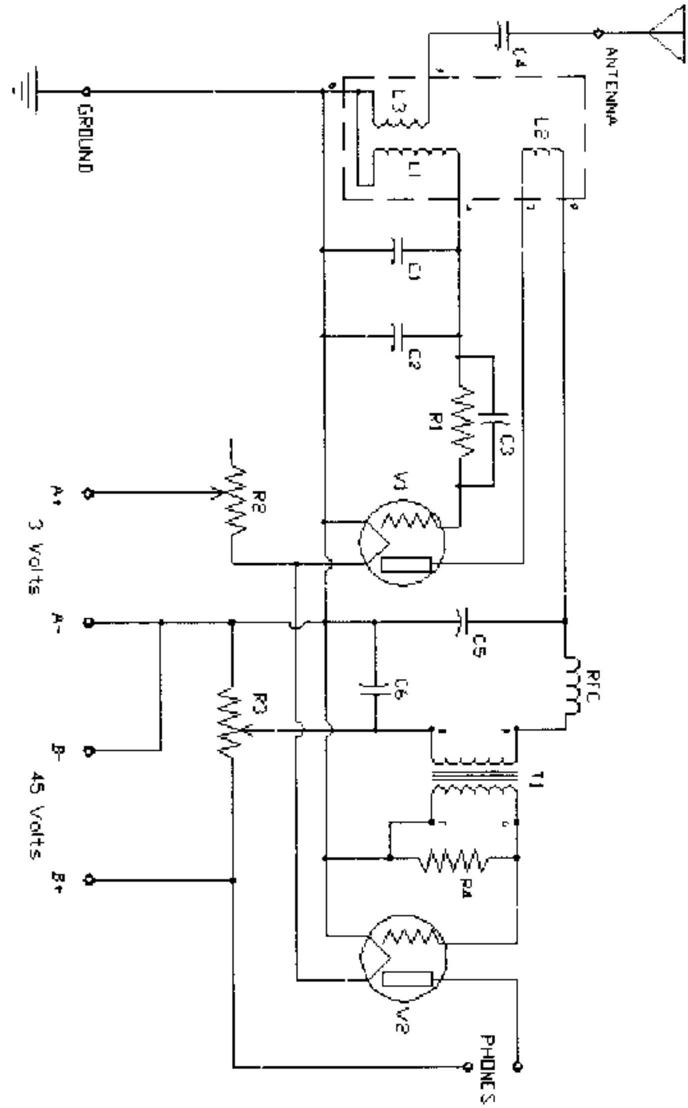
Considering the age of the parts needed was fifty to sixty years, finding all the right parts was going to take time. It took over a year and a dozen swap meets, auctions, hamfests to track down the parts. Radio parts manufacturers like I.R.C., Cornell-Dublier, Carter, Kurz-Kasch, Eby, Hammarlund, Pilot, National and Yaxley show the variety of parts available sixty years ago. Some of the parts needed restoring themselves in order to make the radio look "new". Any corrosion or scratches would detract from the overall look and feel of the set. I wanted to preserve the sense of artistry and design that early builders used.

After looking through many reprints, I picked a 2-tube regenerative circuit popularized by Walter C. Doerle in the early 1930's (see fig. 1). A combination of two of the designs in The Hammarlund 1937 Short Wave Manual, and additional information from two other sources was used in the construction. Hints and tips on design from the Short Wave Beginner's Book and coil designs from the Short Wave Coil Data Book were also used. To simulate a vintage radio buffs' search for parts where he could find them. I selected many different parts' manufacturers (see parts list).

The two triode tubes are used as a regenerative detector and an audio amplifier. I wound a set of five plug-in coils covering the standard broadcast band and the most popular international shortwave bands. Except for some screws, the oak base and phenolic front panel, all the parts are either used originals or new old-stock parts. The hook-up wire was even recycled from a vintage tube tester chassis. During construction, I received valuable information and tips from club members and friends.

After construction, I attached the antenna, ground and battery wires to the set hoping it would not melt down on the first try. Unfortunately, there was only one small plume of smoke that rose from the regeneration potentiometer. There was no damage to the set, however. After correcting my error, I heard local AM stations coming through loud and clear. Tuning was sharp and the sensitivity was much better than I expected.

In the evening, distant AM stations like KMOX in St. Louis and KOA in Denver were not hard to pick up. The shortwave performance was surprisingly good as well. Catching a dozen or more stations from around the world wasn't more difficult than using a commercially built radio. Without any dial calibrations to go by, searching for stations in the shortwave bands gave me a feel for how it was done by early radio experimenters. This radio has heightened my appreciation and enjoyment of the hobby and I would encourage others to give it a try.


ANTENNA
C4
L3
L2
L1
GROUND
C1
C2
R1
C3
V1
R2
A+
3 Volts
A-
C5
RFC
C6
R3
B-
45 Volts
B+
T1
R4
V2
PHONES

Doerle 2-Tube Regenerative
Parts List

- C1 140 pF. variable, BANDSET, **Hammarlund MC-140-M**
- C2 35 pF. variable, BANDSPREAD, **Hammarlund MC-35-S**
- C3 100 pF. / 400 v. mica. **Sangamo**
- C4 35 pF. variable. ANT. COMP., **Hammarlund HF-35**
- C5 250 pF. / 400 v. mica. **Cornell-Dublier**
- C6 0.1 uF. / 600 v. paper, **Aerovox**
- R1 3 Meg ohms. 1/2 w. carbon. **Lynch**
- R2 10 ohm rheostat, FIL ADJ. **Amsco**
- R3 50 K ohms. var.. REGEN. **IRC**
- R4 200 K ohms, 1/2 w. carbon. **IRC**
- RFC 2.5 uH. choke. **National**
- T1 10:1 audio transformer. **Rauland R-13, "All-American"**
- V1 #30 triode, DETECTOR, **Raytheon**
- V2 #30 triode, AUDIO AMPLIFIER, **Raytheon**
- PHONES High impedance 3K ohms. **Brandes "Superior Matched Tone"**
- L1 |
- L2 | **See Coil Chart below**
- L3 |

Coil	Freq. Coverage	L1 turns	L2 turns	L3 turns
1	650 kHz - 1450 kHz	100	20	10
2	1200 kHz - 2.5 mHz	50	20	10
3	2.0 mHz - 4.2 mHz	20	10	7
4	3.8 mHz - 8.0 mHz	11	5	7
5	8.0 mHz - 15.5 mH	4-1/2	5	5

All coils are wound in the same direction using #30 AWG enameled wire, close-wound. There is 1/16" spacing between coils. For each coil, L1 (grid) is the top winding, L2 (tickler) the middle and L3 (antenna) is the bottom. Hammarlund XP-53, 5-pin type forms are used which are ribbed, but have an effective diameter of 1-1/2".

The "Two Dollar Regen"

by Tony Fishpool, G4WIF
38 James Road
Dartford, Kent DA1 3NF
U.K.

This radio would never have been born but for the enthusiasm of Doug Hendricks KI6DS. Doug decided that it would be a good wheeze if there were a construction contest at Hamcom 1999. There followed a blaze of e-mails from Doug to QRP-L and like a later day P.T. Barnum, he hustled a lot of people (including me) into building. I will confess straight off that I have plagiarized shamelessly from articles of others, mostly from the late Doug DeMaw[1] W1FB. Doug's regen circuit used a variable capacitor. I decided that the difference with my radio, was that it would be really cheap to build, so I adapted it for varicap tuning.

Ten turn pots are expensive,[2] so I pinched an idea from Graham G3MFJ and soldered some shafts onto a couple of miniature preset (multi-turn) potentiometers. This made tuning and regeneration control very smooth.

J-Fet Q1 does all the hard work and the 741 op-amp delivers enough audio to power a pair of walkman phones. There was plenty of gain when connected to my doublet, but on a yard or so of wire, it needed some help from a 2N2222 RF stage (this time stolen from the NA5N Desert Ratt).

The inductor L2 is formed by placing 46 turns of 28 SWG enameled copper wire on a T50-6 toroid. At 11 turns from the grounded end, take a tap which will go to the regeneration control. L1 is 5 turns of 28 SWG wires wound on top of the grounded end of L2. The nearest AWG gauge is 27, so I suggest using the next smallest available wire. The BB204 is a "double" varicap, and I grounded the two anodes so as to place both vaicaps in parallel.

With the components chosen, the regen covers the 49 metre shortwave band. Alter the turns on L2 and the values of C8 and C10 for other bands.

The method of construction I use is similar to the "Manhattan" style - made popular by my good friend Jim Kortge K8IQY. I prefer to avoid contact with superglue as it always does a better job of sticking me. So I make my pads by using a modified wood drill that cuts a circular "island" in the PCB material. Layout isn't too critical, but I advise not letting L1/L2 "see" the audio stage. In Fig 1, you can see I placed an off cut of PCB material in-between the stages. If some components appear to be missing in Fig. 1, it will be-cause I located them underneath the board.

As an extra refinement (and therefore not included in the "Two Dollar" rough cost), I adapted the G3RJV voltage monitor[2] to indicate approximate frequency. The idea to use the LM3914 in this way came from Bill Jones, KD7S[3]. This circuit uses an LM3914 Dot/Bar display driver which measures the voltage at the slider of the tuning potentiometer. The higher the voltage, the more reversed biased the varicap becomes, and therefore the higher the tuned frequency. Transistor Q3 is in common collector mode and therefore presents a high impedance to the varicap tuning circuit so as not to load it unduly.

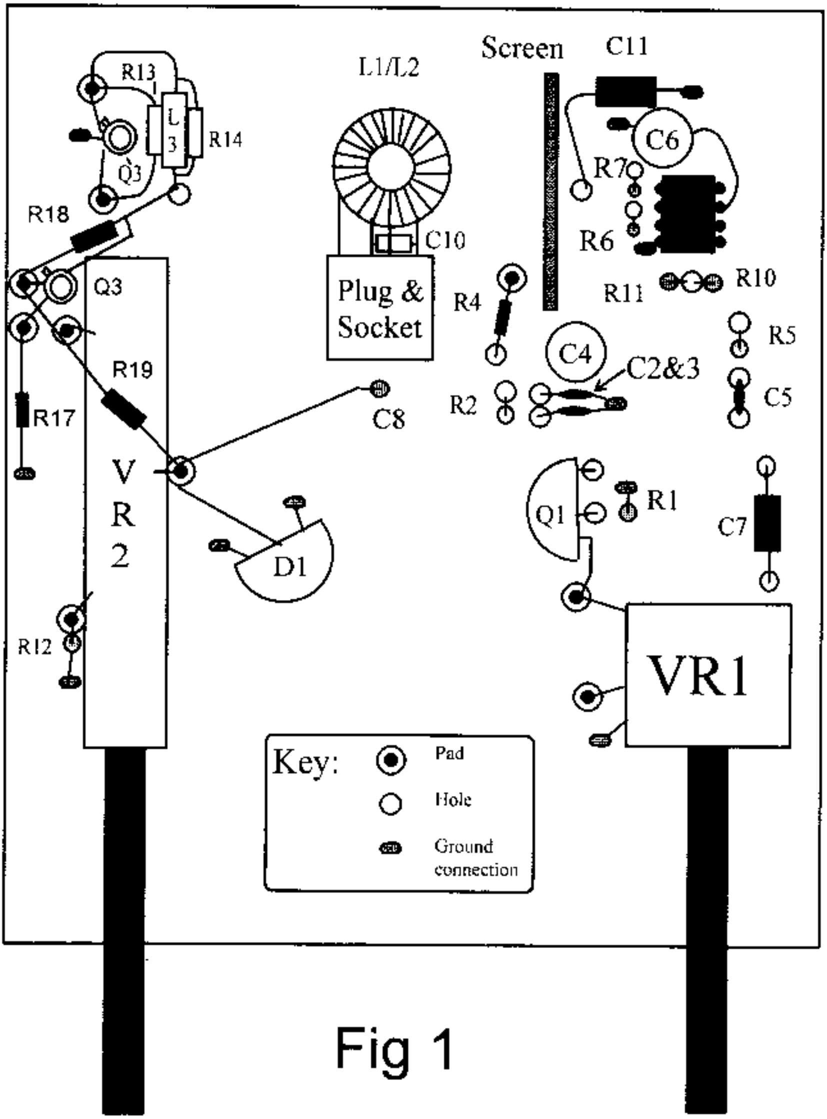
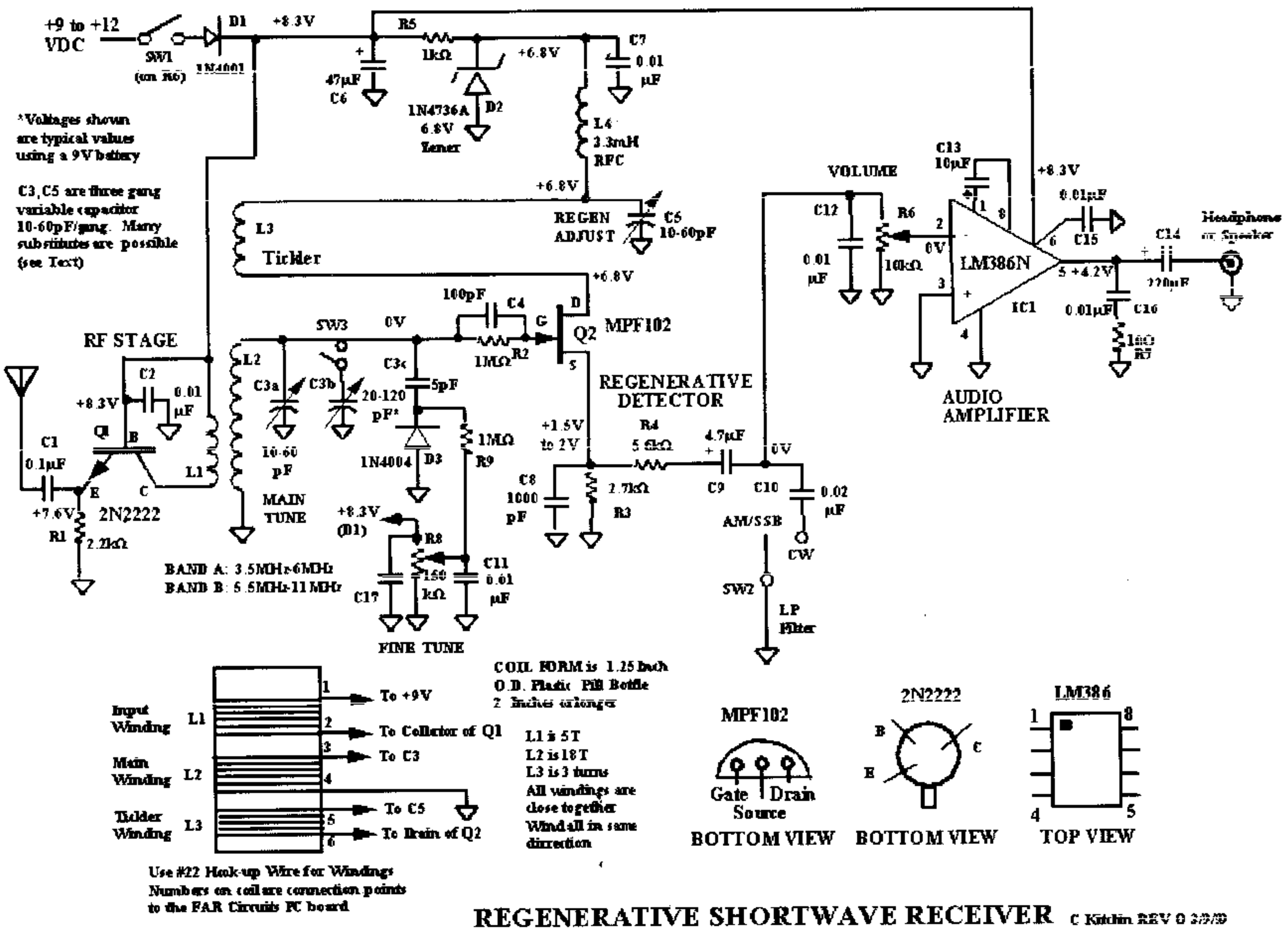
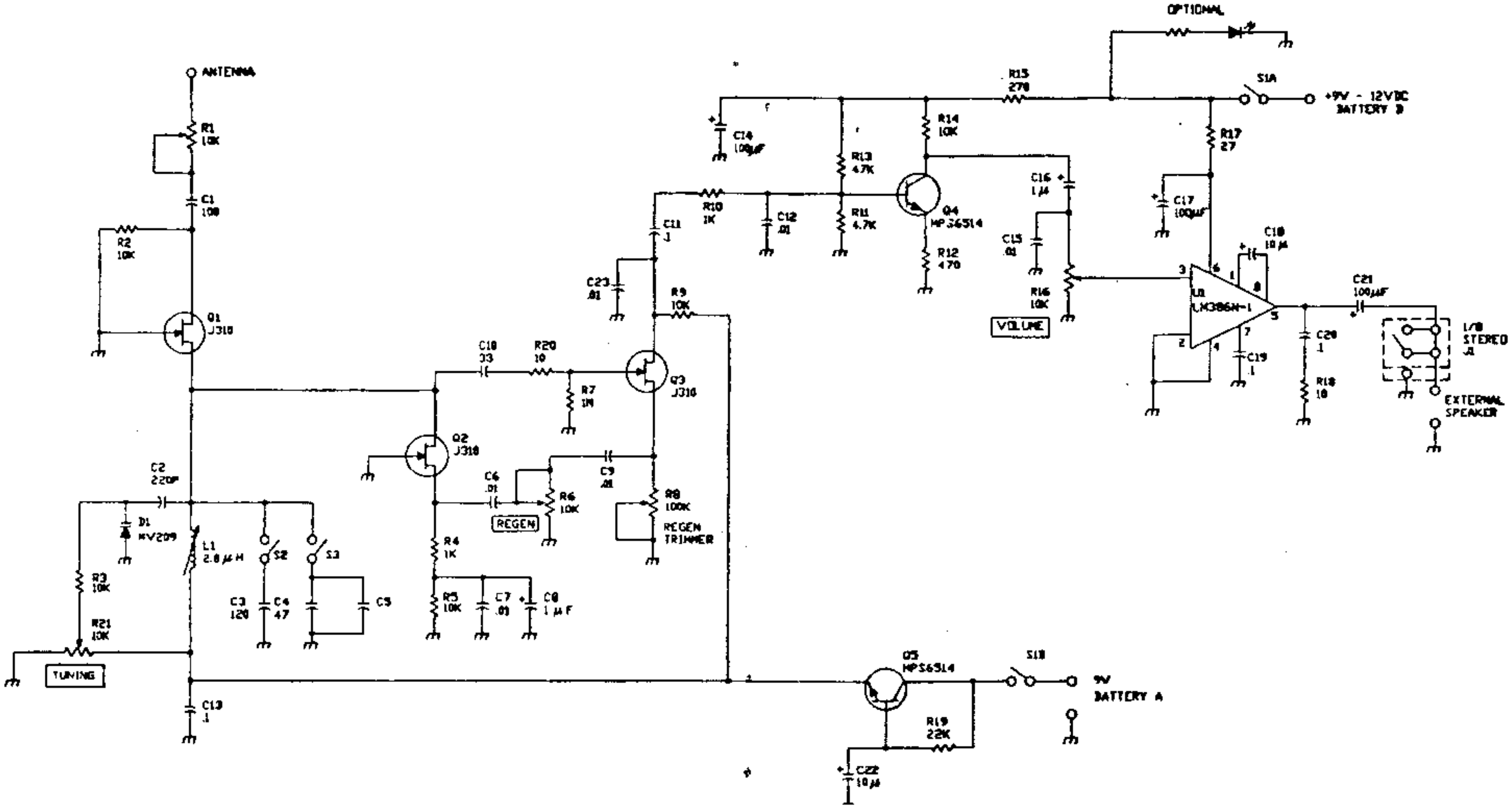

R13
L3
R14
Q3
R18
Q3
R19
R17
VR2
R12
L1/L2
C10
Plug & Socket
C8
D1
Screen
C11
C6
R7
R6
R4
R11
R10
C4
C2&3
R5
R2
C5
Q1
R1
C7
VR1
Key:
Pad
Hole
Ground connection

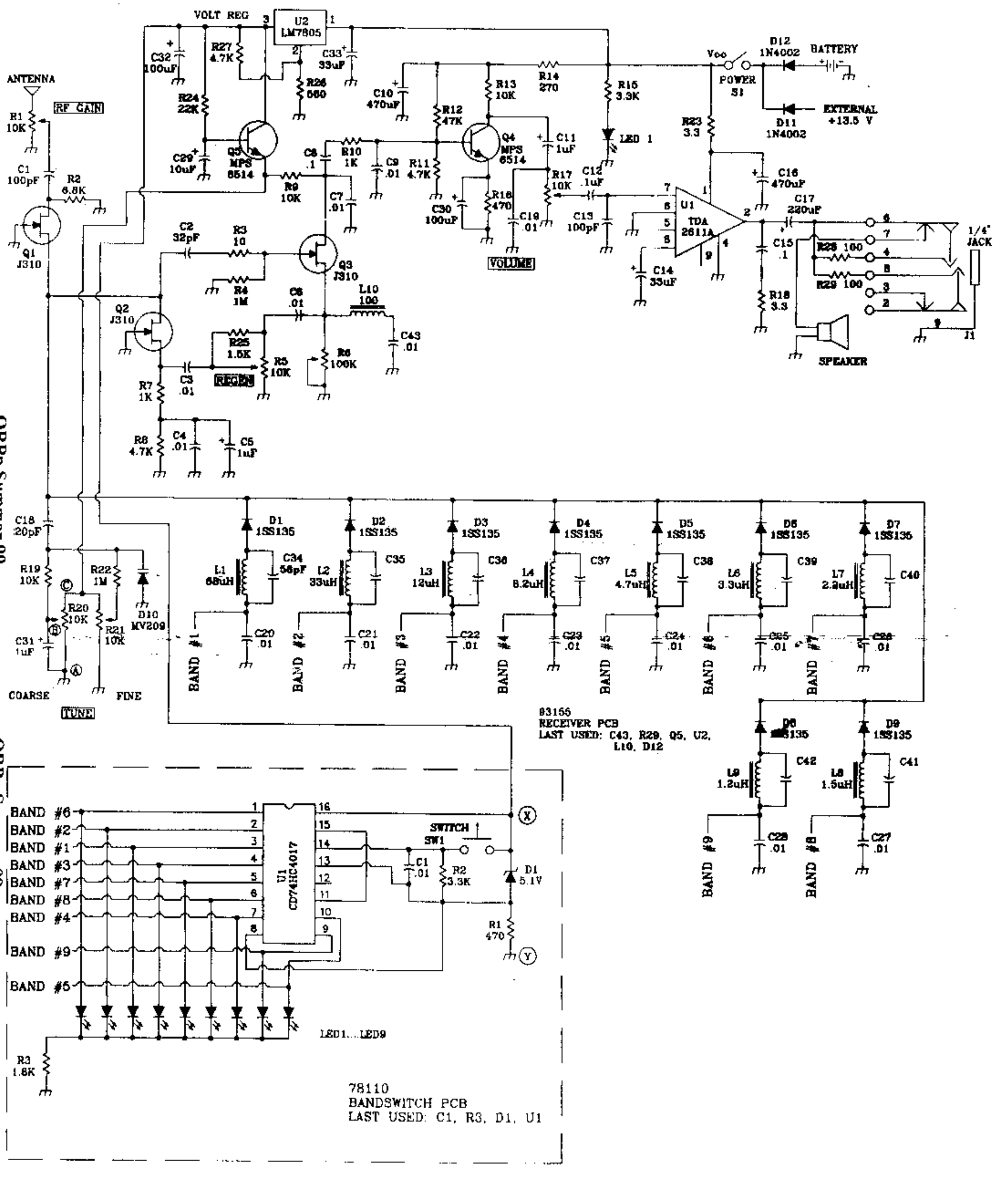
Fig 1


+9 to +12 VDC
SW1 (on R6)
D1 1N4001
+8.3V
R5 1kΩ
47μF C6
1N4736A 6.8V Zener D2
+6.8V
C7 0.01 μF
L4 3.3mH RFC
*Voltages shown are typical values using a 9V battery
C3, C5 are three gang variable capacitor 10-60pF/gang. Many substitutes are possible (see Text)
L3 Tickler
REGEN ADJUST C5 10-60pF
RF STAGE
C2 0.01 μF
C1 0.1μF
Q1 2N2222
+7.6V R1 2.2kΩ
L1 L2
SW3 0V
C3a C3b 10-60 pF
C3c 5pF 20-120 pF*
MAIN TUNE
1N4004 D3
1MΩ R9
C4 100pF
1MΩ R2
Q2 MPF102
REGENERATIVE DETECTOR
+1.5V to 2V
C8 1000 pF
R4 5.6kΩ
R3 2.7kΩ
C9 4.7μF
C10 0.02 μF
AM/SSB CW SW2
LP Filter
+8.3V (D1) R8 150 kΩ
C11 0.01 μF
C17
FINE TUNE
BAND A: 3.5MHz-6MHz
BAND B: 5.5MHz-11MHz
VOLUME
C12 0.01 μF
R6 10kΩ
C13 10μF
LM386N IC1
AUDIO AMPLIFIER
C15 0.01μF
5 +4.2V
C16 0.01μF
R7 10Ω
C14 220μF
Headphones or Speaker
Input Winding L1
Main Winding L2
Tickler Winding L3
To +9V
To Collector of Q1
To C3
To C5
To Drain of Q2
COIL FORM is 1.25 Inch O.D. Plastic Pill Bottle 2 Inches or longer
L1 is 5T
L2 is 18T
L3 is 3 turns
All windings are close together
Wind all in same direction
Use #22 Hook-up Wire for Windings
Numbers on coil are connection points to the FAR Circuits PC board
MPF102
Gate Drain Source
BOTTOM VIEW
2N2222
BOTTOM VIEW
LM386
TOP VIEW
REGENERATIVE SHORTWAVE RECEIVER
C Kitchin REV 0 2/2/99

TenTec 1054 4 Band Regen Receiver

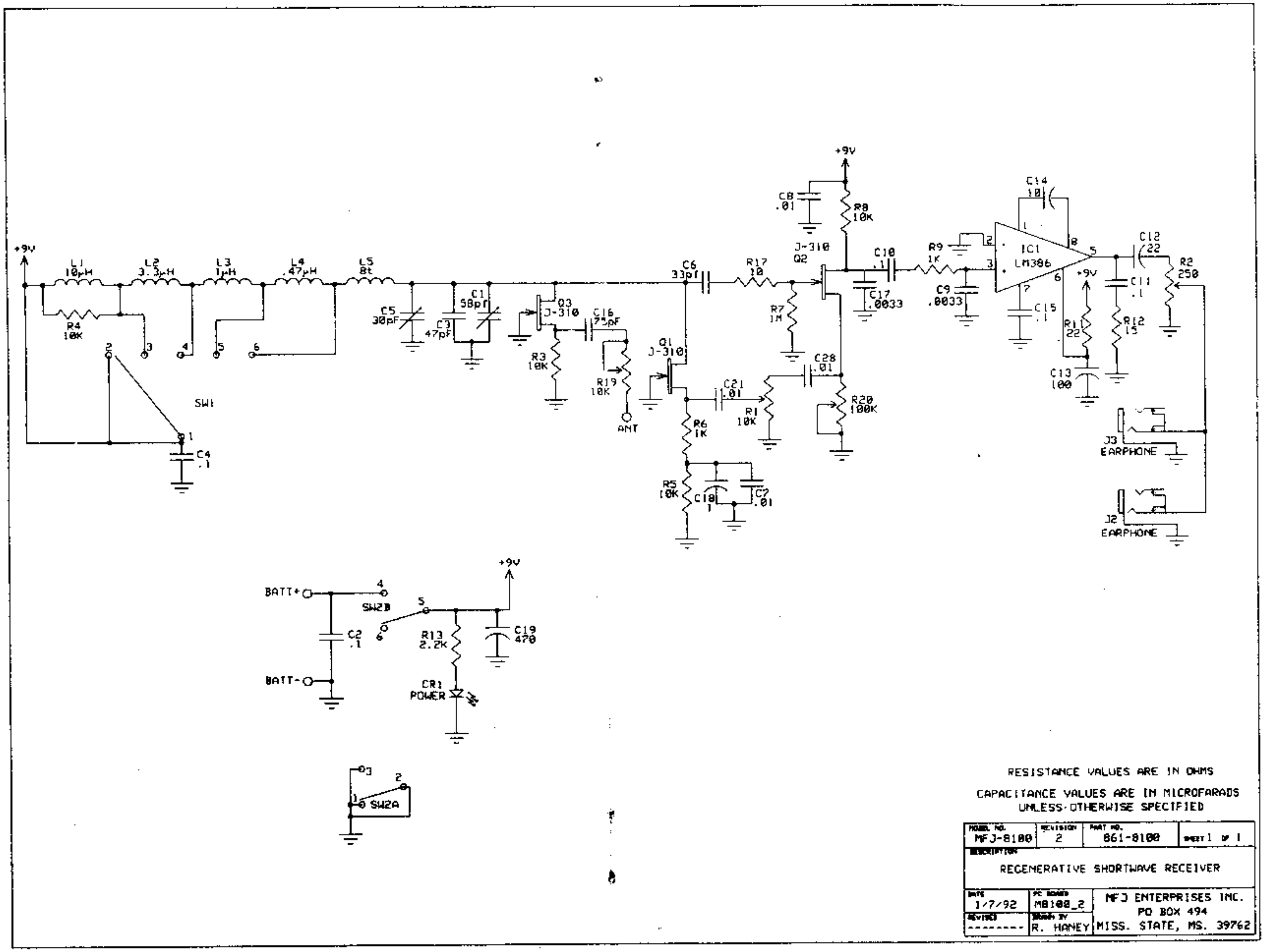


Q4, Q5 = type 2N4124, previously MPS6514



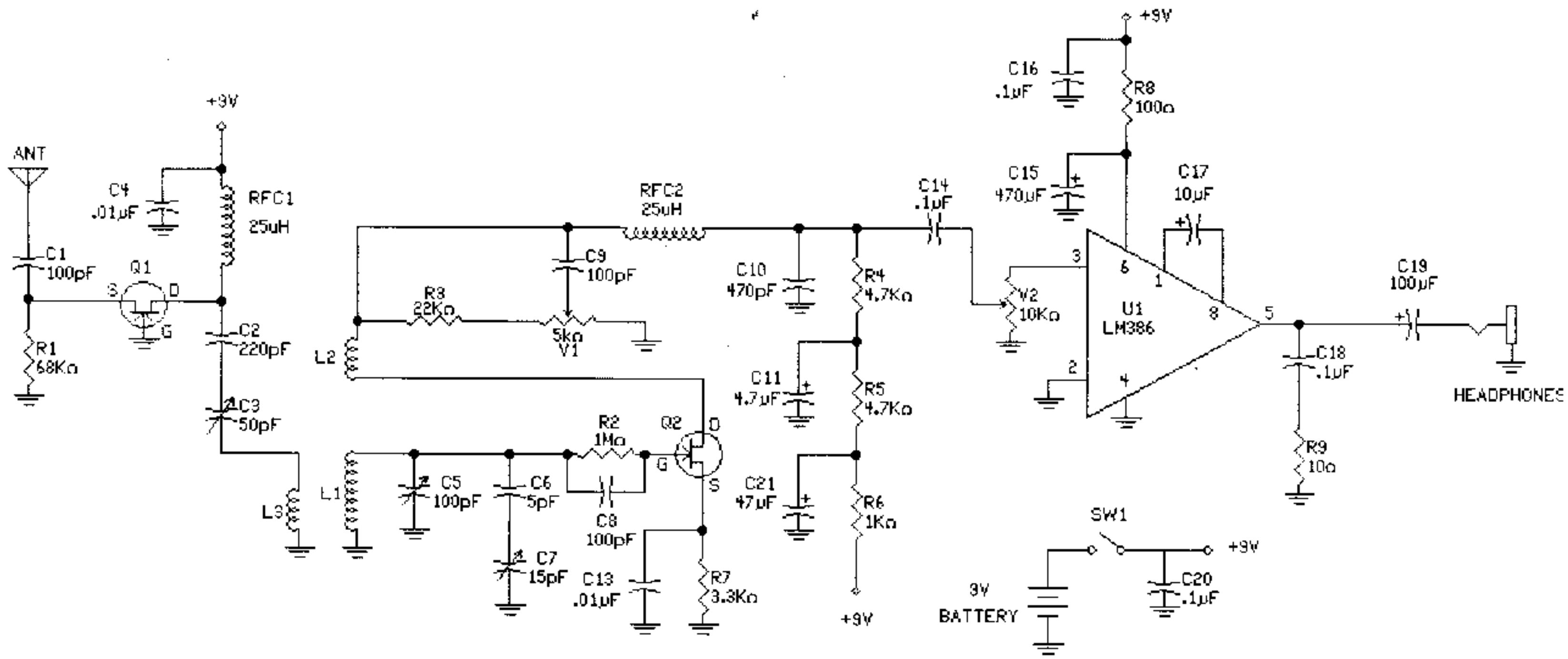
T-KIT Model 1253 Receiver
Schematic Diagram

QRPp Summer 99



+9V
L1 10μH
L2 3.3μH
L3 1μH
L4 .47μH
L5 8t
R4 10K
SW1
C4 .1
C5 30pF
C3 47pF
C1 58pF
Q3 J-310
C16 75pF
R3 10K
R19 10K
ANT
C6 33pF
Q1 J-310
R6 1K
R5 10K
C18 1
C7 .01
C21 .01
R1 10K
R17 10
R7 1M
C28 .01
R20 100K
J-310 Q2
C8 .01
R8 10K
C10 .1
C17 .0033
R9 1K
C9 .0033
IC1 LM386
C14 10
C15 .1
R11 22
C13 100
C12 22
C11 .1
R12 15
R2 250
J3 EARPHONE
J2 EARPHONE
BATT+
BATT-
C2 .1
SW2B
R13 2.2K
CR1 POWER
C19 470
SW2A
RESISTANCE VALUES ARE IN OHMS
CAPACITANCE VALUES ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED
MFJ-8100
2
861-8100
SHEET 1 OF 1
REGENERATIVE SHORTWAVE RECEIVER
1/7/92
MB100_2
R. HANEY
MFJ ENTERPRISES INC.
PO BOX 494
MISS. STATE, MS. 39762

W9OCP REGEN RECEIVER



Q1, Q2 = MPF102, 2N5484, etc.

C5 = 100 pF VARIABLE

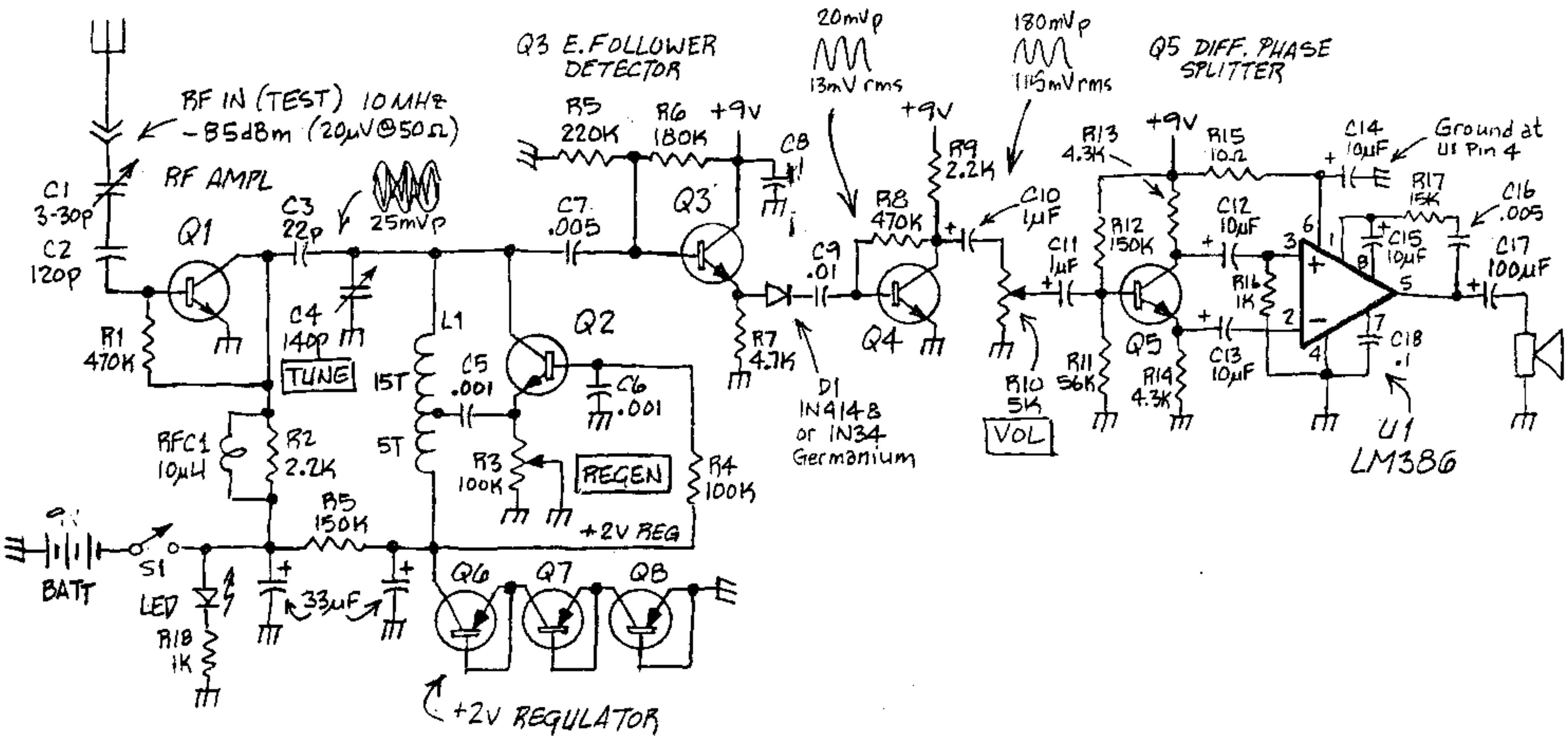
C6 = 5pF NPO

C7 = 15pF VARIABLE

L1 = 15 TURNS

L2 = 4 TURNS

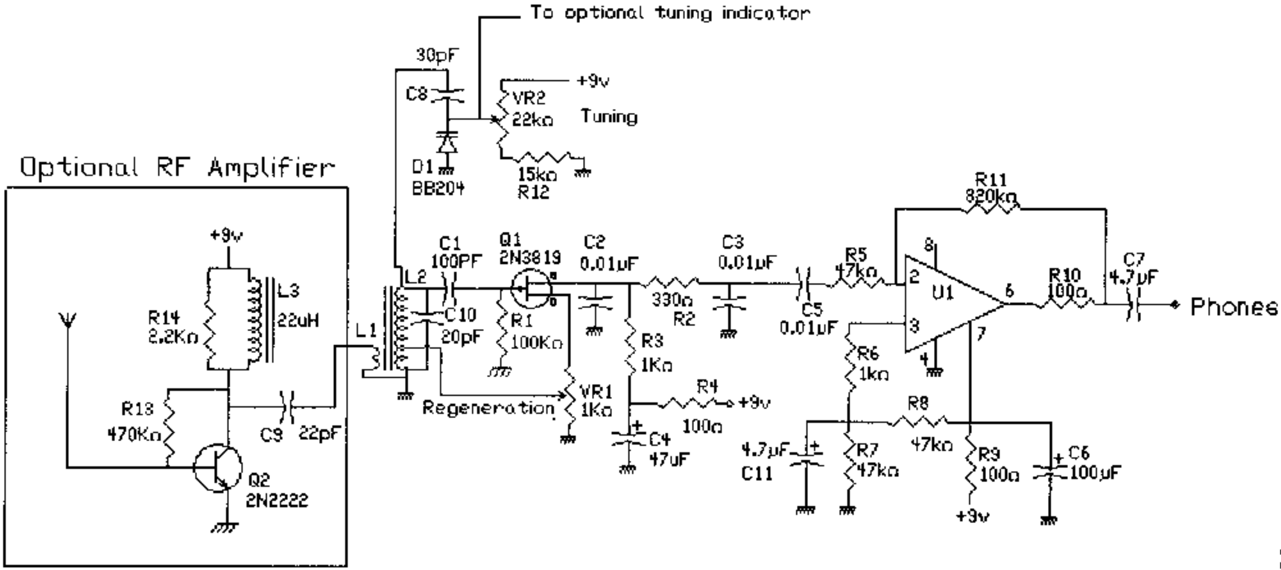
L3 = 5 TURNS



This is an enhanced version of the original DESERT RATT. Minimum detectable signal (MDS) ≈ -105dBm (~1µV) CW and -93dBm (5µV) AM. Emitter follower detector (Q3, D1) added to reduce loading on Q2 which increased sensitivity. Q5 phase splitter to drive U1 differentially, which does seem to lower overall noise level and provides slightly better fidelity. This was an experimental circuit to try techniques I wish to employ in the next generation of regens --- the HOWLIE CRAFTERS!

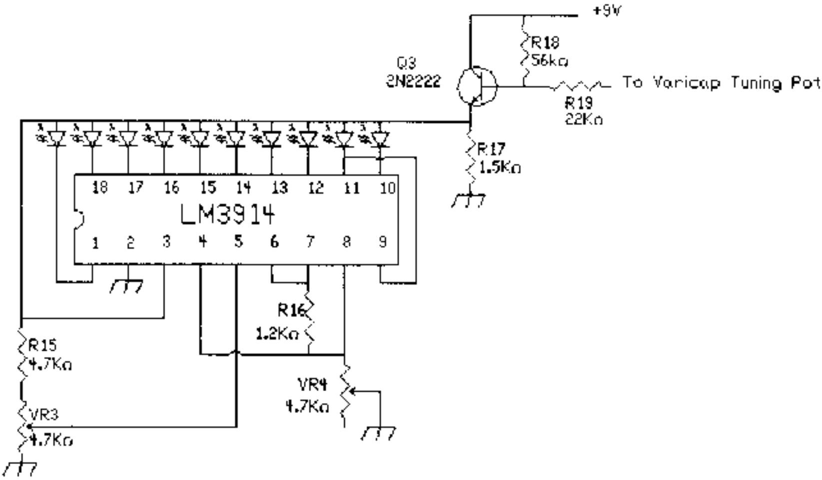
DESERT RATT 3 6-96
Paul Harden NA5N
PO Box 757 • Socorro, NM 87801

Two Dollar Regen ▪ G4WIF



L2 46 turns of 28 SWG wire on a T50-6 toroid. Place tap at 11 turns above the grounded end.

L1 5 turns of 28 SWG wire wound over the grounded end of L2



Two Dollar Regen Optional Tuning Indicator

Component List
The "Two Dollar Regen"

C1	100pF Silver Mica
C2, 3, 5	.01uF Disc
C4	47uF Elect.
C6	100uF Elect.
C7	4.7uF Elect.
C8	30pF Silver Mica
C9	22pF Silver Mica
C10	20pF Silver Mica
C11	4.7uF Elect.
D1	BB104 Varicap Diode
L1/L2	T50-6 (see text)
L3	22uH
Q1	2N3819
Q2, 3	2N2222
U1	LM741
VR1	1K trimmer
VR2	22K Trimmer
VR3, 4	4.7K Trimmer

R1	100K
R2	330 ohm
R3, 6	1K
R4, 9, 10	100 ohm
R5, 7, 8	47K
R11	820K
R12	15K
R13	470K
R14	2.2K
R15	4.7K
R16	1.2K
R17	1.5K
R18	56K
R19	22K

References:

[1] W1FB's Design Notebook pages 60 & 109.
[2] SPRAT 96 page 9

Confessions of a Regen Junkie!

by Dennis Baker, W9OCP
1413 E. Oaks Trl
Houlton, WI 54082

This article is being written not only to describe how to build a simple regenerative receiver, but also how to apply some prototyping techniques to building any electronic circuits. The ideas have particularly useful in learning to build regenerative receivers.

My introduction to regens began a long time ago when Earl Sande traded me something for a breadboarded one or two tube broadcast band regen. It used a "D" size cell for the filaments and a 22 1/2 volt cell for the B+. What a thrill!! Late at night, in Upper Michigan, I could hear everything!! I was hooked. The Knight Kit Ocean Hopper, Space Spanner, and Spanmasters followed. What a great time to be a kid! Later, a Radio Shack kit-solid state kit was tried with dismal results. Bummer. For many years, I was certain that you couldn't build a solid state regenerative receiver that worked as well as a vacuum tube receiver. With appropriate apologies to the "Valve Guys", boy, was I wrong!

Along came Charles Kitchin with his "10 Dollar Regen" that has 2 transistors in the output, and I just had to give it another try. The little sucker really worked! Even better with the 2N2222 of the audio output world, the LM386. Since that time, I've prototyped almost every regen circuit that I could find. Boy, they're all over the house. Some torn apart, a lot in various stages of being tested, but all of them work, to one extent or another.

I've learned a lot about regens from the experimenter/hacker/junkie standpoint and won't pretend to know why much of what I have found out, really works. I just know they do. A Doug DeMaw, I ain't. We really lost a great teacher when he passed away. The circuit here probably has a few parts you don't need and probably some that are missing. Mods are always great to "personalize" a circuit and make us feel like we have actually added something that makes the project work better. I've built multiple detector modules for the Kitchin Hartley and Armstrong circuits, Harden's Pipsqueak and Ratts, the Colpitts, the MFJ/TenTec, Rocky W9SCH, the Lindsay "TwinPlex", ARRL Handbook, Sprat & G-QRP, etc., etc.. So far, the Armstrong has become my favorite because it is very simple and lends itself to easy control. None of my regens are complex because if the control is there, they just doesn't seem to need a lot of stages. Mine typically use one FET or transistor for an RF amplifier, mostly to minimize the antenna effects more than stopping oscillator radiation. One FET serves as the regenerative detector, usually a 2N5484 because a local surplus house didn't know what they were worth. Yes, I do feel guilty. And finally, an LM 386 audio output amplifier with the 10 mfd electrolytic across pins 1 and 8 provides plenty of audio. A 9 volt battery powers all of the regens and usually draw between 3 and 8 milliamperes. Cheap headphones, usually 32 ohms, or so, with the Radio Shack adapter to convert from stereo to mono at 16 ohms, provide adequate audio to middle age ears.

If a detector is going to be running a gain of 100,000 or a million, maybe we had better take special pains to control it. To me, this means that control will needed at every stage possible. It has been reported that you can't control the regeneration using a pot and get the same results as with a throttle capacitor. Maybe you can if you fool the circuit into thinking the pot is really a variable capacitor. Maybe you can if you get the tickler winding "just right". Maybe you can if you get the antenna winding "just right". Or maybe the battery is dead and I'm just hearing voices. Nah. I don't think so. Here's how this stuff works in Western Wisconsin.

Look at any article and we find the "how to wind the coil" instructions. They usually show a main, frequency winding, a tickler winding and, for the Armstrong oscillators, an antenna coupling winding. And they show a 1/8", 3/16" or 1/4" spacing. What if 5/32" is the best? Why not make the tickler and antenna windings adjustable? It's easy, and here's how you do it. All of my coils are wound on standard, discount building supply, PVC water pipe that is about 1" ID and about 1 5/16" OD. It only costs a couple of bucks for a 10 foot piece. Buy a nice clean one so you don't have to clean it later. Soap and water works but try to have the glaze in good shape.

Figure out what frequency you want to build for and test wind the turns to determine the spacing between the little holes you are going to drill in the pipe to anchor the winding. I like the frequency between 4.8 MHz and 13 MHz because there is a lot of "stuff" to listen to. WWV at 5 and 10 MHz make good markers. 40 meters and 30 meters are neat, and all sorts of interesting things appear on the 60, 49, 41, 31, and 25 meter bands. The wire I use is from a telephone system removed from where I work and was available from one of my other passions in life, "dumpster diving"! It seems to be solid, about # 24, with vinyl covering; about 15 turns seems to give the right tuning range. Like it a little higher? Use less. A little lower? Use more. This circuit works great in the broadcast band, too. The 15 turns, with the wire described, needs about 5/8" spacing on the PVC coil form. A coil form about 2 1/2" to 3" is a nice length. Drill 2 holes, about 1/8" apart in side of the form and another 2 holes spaced about 5/8" away. They should be perpendicular to the length of the tube and located so the finished coil will be about in the center of the coil form. Do you notice a lot of "abouts"? That's one of the thrills of building. Learning, customizing, modifying..."abouting". There is a reason for the extra length of the coil form and "abouting". Put one end of the wire down into the hole where the actual winding will start and fish it out of the one along side, to anchor it. The longnose pliers work well here. Keep a rubber band on the handles and you have an always available "third hand". Wind the coil by holding the wire in your hand and holding it on the form with your thumb while turning the form with your other hand. By applying tension as the wire slides through your hand and positioning it with your thumb, you get a very nice coil...unless you go "Oops" and have to start over. You can reposition the winding where it belongs by turning the form and moving it with your thumb. Anyway, it doesn't have to be a work of art. Picasso never got the hang of it either. Now anchor the other end of the completed coil by passing the wire through the other 2 holes; leave about 3" of wire at each end. Now, coat the entire coil with clear nail polish and stand the form on end to dry.

When the coil is dry, at least a couple of hours, with normal humidity, it's time to wind the tickler and antenna coils. Here is where your regen is going to get some of it's sparkle. Get a plain old sandwich bag from the kitchen and cut it so you have a strip about 3/4" wide and long enough to wrap the coil form with about 1 1/2 turns. It has to be one of the polyethylene film bags; Glad or Saran Wrap won't work. Wrap the bag film on one end of the coil form and hold it in place. Now that you have a trained thumb from the first coil, wind 7 or 8 turns of wire in the same direction as the first coil, in about the center of the film, while holding the wire in place, the film not wrinkled. Now, clip the wire and while still holding the winds in place, unwind turns from each end until you have 5 turns of wire, in about the center of the film wrap. This should result in a nicely wound coil, if you have held it well. Now, twist the ends of the wire together, about 3 or 4 twists, while preventing the wire from overlapping adjacent turns where possible. The 5 turn winding should now be held by the twist at the ends of the winding. Again, apply the clear nail polish and let it dry for a couple of hours. When it is dry, repeat the procedure at the other end of the coil form, but this time, use only 4 turns. Taking care to smooth out the film will make life easier at the next step. Again, leave about 3" of wire from each end of each winding.

What you have just done is to make a coil where the two small tickler and antenna coils are easily adjustable. Now, depending on the circuit parameters, both can be set to the position that is "just right". For the more adventuresome builders, you can use another piece of PVC pipe, after all, you still have 9 feet, 9 inches left (!), and simply slide the coil off when dry and put it on the frequency coil form. That's why you want the glaze on the PVC pipe; so you can easily slide the windings. You can trim the polyethylene film here also but don't be tempted to remove it because clear nail polish doesn't slide like the poly film. OK, go ahead and try it because you can put it back after it doesn't slide.

I have access to a machine shop and like to make a Delrin "L" with mounting holes and a 6-32 tapped plug turned to the ID of the PVC pipe. This holds the coil in position and up above the base about 3/4". You can also cut a couple of 1/2" long rings from the pipe and mount the coil form on them. Use brass screws so the coil can be changed when you want to change the frequency of the receiver. Trust me, you will.

Now, to the circuit. Don't send me letters saying it's all wrong. Mine works and yours should also. The only thing different about the Armstrong circuit here is that it uses a 5 K pot to control regeneration instead of a throttle capacitor, and it is located through a capacitor, at the tickler coil. I know, you are <u>NOT</u> supposed to put a pot across the tickler coil because it's noisy. This idea kinda came from a very old article that used a pot, as a rheostat, in series with a 500 pf capacitor. That's way too much capacitance. The 5 K pot is down near ground so there isn't much noise. A 4.7 K resistor across the pot will even make it less and doesn't change the pot curve much at the low end where the control is usually set. It seems to be so quiet that many times I have to "swish" the regeneration control because I can't tell when it goes into and out of regeneration. That ain't bad!! It's like a throttle capacitor, but using a pot. This may because you can set the tickler winding to where it is "just right". If you have too much tickler feedback, I've seen it cause the hysterisis that you will see if you fool around with enough circuits. Also the "click" of going into and out of regeneration. Smooth is nice...

The 100 or 150 pf capacitor to the choke side of the tickler winding seems about right and I'm not sure that the 27 K ohm resistor might not be improved. Try it. The power to the detector is also a little strange in that it uses a lot of resistance and capacitance. Maybe it could be changed but this seems to work. This is a "here is how I did it article". If you want state of the art EE, you need to read Doug's books or the Kitchin articles. I don't do EE. My first college whole heartedly agreed with me.

The schematic shows the component values that seem to work well in this little circuit. They probably are not critical, but these work and have been used in similar other articles. The audio amp has not been modified to reduce hiss because middle age ears have "built in filters". The RF amplifier has been "lifted" from the Kitchin article because it is very simple and works. The design doesn't seem to be critical because the main function is to provide antenna isolation and not added gain. I've built up six, or so, RF amps and they all pretty much work the same. Another plus of using an RF amplifier is that coupling to the antenna is much less critical. Instead of a variable capacitor between the antenna and the RF amp, a couple of fixed capacitors and an alligator clip work almost as well. As mentioned earlier, the gain of the detector stage alone is adequate if well "tamed" by the type of available control.

Follow the schematic and try to keep the power and audio sections away from the FET and coil connections. All of my prototypes are first made on the little Radio Shack plug in strips and, later, if they work, are committed to a circuit board. I always build another circuit rather than remove the parts because no two circuits seem to work exactly the same and, having one working, helps trouble shoot the dead one; every regen seems to have its own characteristics. This is probably a result of such extremely high gains and normal component part variations. Again, Radio Shack comes to the rescue. Their two section, break apart circuit board (276-159) really saves time, effort, and improves the appearance of the project. Usually, I use one side or 1/2 of the "as purchased" board for the LM 386 amp, and the other 1/2 for the FET detector. The RF amp usually is only 1/4 of the purchased board, unless you build Kitchin's cascode RF amp. When building, if a trace needs to be broken, simply cut it with a knife. Like wiggling the blade back and forth while applying pressure. If you need a hole, drill one with a small bit like a number 59 or 63; a Fiskars handdrill works great. Connections to the module can be made using a clipped resistor lead, bent to a small "L", and soldered to the trace on the bottom side of the board. Tack solder to the lead on top of the board. Be sure to include multiple grounds to minimize ground loop "fun". For really neat project boards, you can't beat the ones from FAR, but to prototype something quick, the RS boards work well.

I try to mount the modules on a wood base and use an aluminum front panel. If sheet aluminum is not available, aluminum flashing and masonite are available at building supply houses. This helps minimize hand capacity effects. The modules can be attached with #4, 1/2" or 5/8" wood or sheetmetal screws. While at building supply or hardware store, buy a foot of 1/4" Polyflow polyethylene tubing. You can cut these to 1/4" long pieces, using a razor blade, and they make great standoffs for very little money. If you don't cut them square, your modules can end up at some very interesting angles.

For tuning the frequency, use whatever variable capacitors you can find. If small, the tuning range is reduced so you may have adjust turns to find your favorite frequency. Then, start hitting the hamfests or garage sales to look for variables. When the regen is up and running, you may want to add a capacitor, size depending on the frequency, like 75 pf if you are using a 100 pf variable, for "another band". Typically, I will tack a silver mica at the hot side of the tuning variable and bring up a ground from the board so it is about 1/8" away from the silver mica lead. A small alligator clip holding both leads is the switch to put it into the circuit. When not in the circuit, clip it on the ground lead so you know where it is for the next time. A silver mica is used because they typically have sturdier leads than some of the others. A bandspread capacitor variable is not absolutely required but helps tune in higher frequency stations. Almost any capacitor can be used if a series fixed cap sets the maximum.

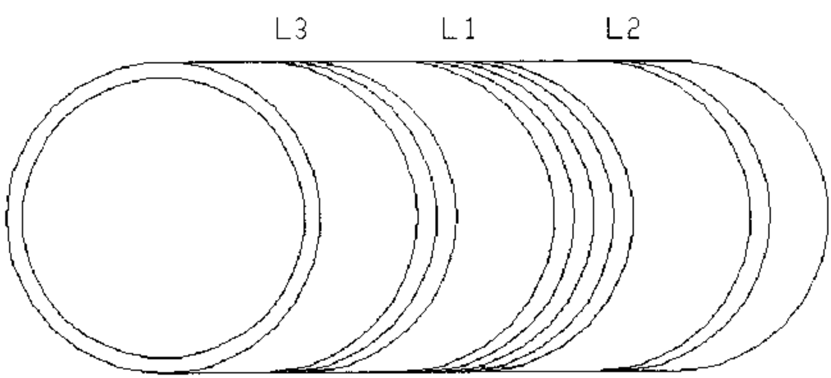
Orientation of the 4 turn tickler winding cannot be "about"; it has to be phased properly to provide feedback. If the oscillations won't start, reverse the leads or simply slide the winding off the coil form, flip it 180 degrees, and replace it. When building the broadcast version of the regen, I over wound the coils, and the frequency winding was1.345 Mh when measured! You could almost listen to DC, if so inclined! I simply removed turns until the right frequency was heard on the monitor receiver, about 1700 KHz at minimum tuning capacitance. Also, an MFJ 207 SWR Analyzer has been handy in providing a signal for reference. You will know if the turns are "just right" for the tickler because if there are too many turns, the regeneration won't quit; not enough and it won't start regardless of the wnding position on the coil form. With the BC receiver, I actually had to remove the winding and rotate it like the old variometers, to stop the regeneration, until enough turns were removed. Being able to move the coils provides a nice way to get the coils "just right". The 5 turn winding is the antenna input coil and is slid along the coil form until the signals are received with adequate strength. Don't position it too close to the frequency winding and, if the signals are low, add turns or rewind the coil. My antenna is a 20 foot wire around the drape rods of a room, inside an aluminum sided house. The ground is the one "in the shack".

Calibrating the regen is helpful to know where you are. Usually I tape a piece of 3"x5" card under the tuning knob and may draw a tuning arc before attaching it. A calibrated receiver is usually available so, set the regen like it is going to receive, antenna cap and winding in position, regen and tickler in position, and tune the oscillating regen to the calibrated receiver. Make a mark corresponding to the regen tuning knob on the cardstock and move the next spot, keeping the regeneration peaked. This way, the regen dial will be, hopefully, as close to the calibration as is possible. Another way is to use known stations, like WWV, CHU, WWCR, etc. and log the cardstock. The procedure should include trimming the regeneration control so the calibration will be accurate. If you use the alligator clip "second band" you can put the calibration numbers on the opposite side of the arc or use another color. Try to keep the dial simple so it looks neat and doesn't get confusing.

This same circuit has been used up to 22 MHz and down to the broadcast band; I have a lot more work to do to improve the operation at high frequencies. It was while I was listening to the 31 and 49 meter bands "the other night" that prompted me to write this article. When set up, using the identical circuit described, it was impossible to tell the difference between this regenerative receiver and a superhet. Without even touching the regeneration control, moving from 9.5 MHz to 6 MHz was impressive. The receiver modified to the broadcast band produces a signal every 10 KHz of the dial. any spot without a "clear channel" station. various programming and calls can be heard plus and minus QSB. Using the available controls, especially the regeneration, the bandwidth can be narrowed to where ringing is evident. Fibber McGee and Molly never sounded better coming out of a station in Cincinnatti!

These little. very simple receivers are outstanding in terms of what they can do and I am constantly amazed at how well they work. They are simple, but there is a deceptive side to them when so few parts can cause so much frustration. There is also something uniquely different and ultimately satisfying about building one of these gizmos from scratch. and having it exceed your expectations. There is. no longer. "nothing to do". There is always something to try to further customize your own personal regenerative receiver and make it work even better. If nothing else. it has to be some of the best therapy available to a "Regen Junkie"!

Finally. thanks has to be given to many people over the years that have provided stimulation. knowledge. and interesting learning tools. Some of them are C.F. Rocky-W9SCH, T.A. Blanchard. Art Trauffer, Doug DeMaw, Charles Kitchin, Paul Harden, Lindsay, and a lot of others that never knew the spark they helped keep alive. 72, Denny Baker, W9OCP

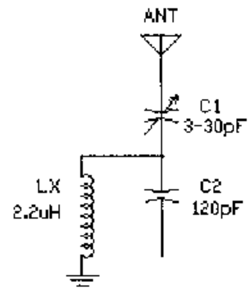


Coil Winding Detail For W9OCP Regen

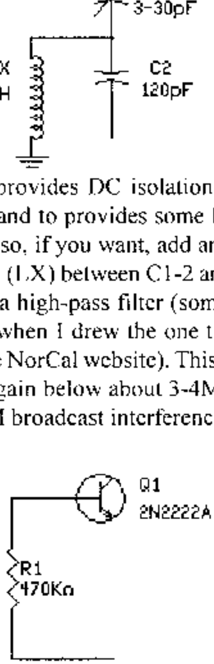
How a Regen Receiver Works, A Tutorial on the Desert Ratt 3

by Paul Harden, NA5N
PO Box 757
Socorro. NM 87801
na5n@rt66.com

Antenna Coupling - Parts: C1, C2



C1, C2 provides DC isolation from the antenna and to provides some Hi-Z coupling. Also, if you want, add an inductor of 1-2uH (LX) between C1-2 and ground to make a high-pass filter (somehow got omitted when I drew the one that ended up on the NorCal website). This will "roll off" the gain below about 3-4MHz to reduce AM broadcast interference.

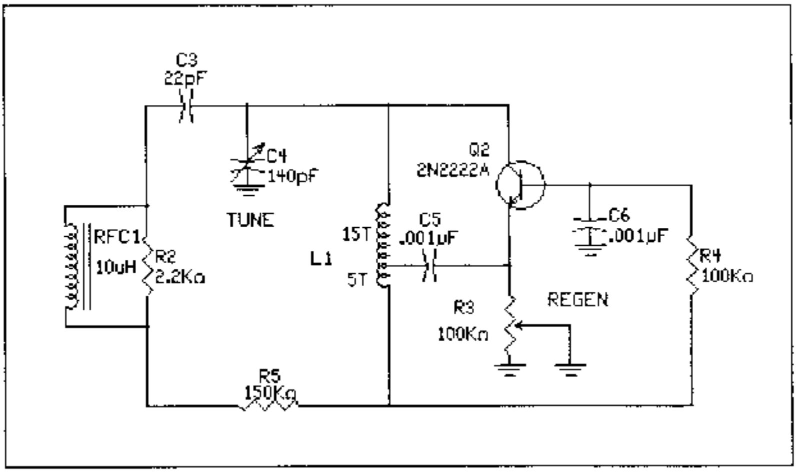


RF Amp. - Parts: Q1, R1

Q1 is an untuned amplifier, meaning it will amplify everything on it's base, from about 3-4MHz (if high pass filter installed) to over 100MHz. R1 is what forward biases the base to about 0.8V (just above cutoff) to give it as large a dynamic range as possible. Gain will be 8-12dB, depending on the gain (hfe) of Q1. This is not a good amplifier design - just a real cheap and easy one.

Regen Stage - Parts: C3, C4, RFC1, R2, L1, C5, Q2, C6, R3, R4

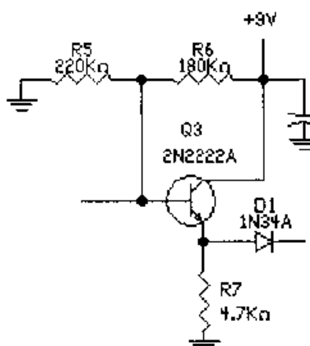
Q2 - the regen stage - operates off this tiny 2V. This is what gives this particular regen circuit a very smooth regenerative action. This scheme was designed by Charles Kitchin, N1TEV, and it quite clever. C3 couples the energy from the RF amplifier into the regen stage. It should be a fairly small value so the impedance of the regen stage doesn't "load" it down. C4 is the tuning capacitor. It is across the full windings of L1 to make a parallel L-C tuned circuit. To find the frequency of the tuning, using the Fr=1/(2pi * SQRT(LC)) equation, calculating it for the minimum and maximum capacitance values of C4. Of course you need to have an idea what the value of L1 is too! R2 is the collector load resistor for the Q1 RF amplifier. The value is what determines the gain, along with the hfe of Q1. L1 is the main tuning inductor. See above C5 is where the feedback occurs. R3 (the regen control) determines the amount of current going through Q2. The higher the value, the more resistance in the emitter, and the larger the signal that will be developed across R3 ... which is then squirted directly back into the tuning coil L1 via C5. This is feedback, and the more feedback, the higher the gain that will result. Of course a point is reached where the feedback will through Q2 into self-oscillation, converting it immediately from an amplifier into an oscillator. The trick is to increase the amount of feedback for the highest possible gain. JUST PRIOR to it going into oscillation. Q2 is the regen stage. C6 is part of the feedback network. R3 is the regeneration control (see above) R4 applies the 2V to forward bias the gate. The high values of R4 and R5 bias Q1 at a very low current value to conserve battery power. C5 is where the feedback occurs. R3 (the regen control) determines the amount of current going through Q2. The higher the value. the more resistance in the emitter. and the larger the signal that load on it. like a detector diode, will load down the Q2 stage. reducing it's gain potential and lowering the Q (selectivity) of the circuit. Therefore, I added an emitter follower Q3 to act as a Hi-Z to Lo-Z buffer between the regen stage and the detector. R5 and R6 bias Q4 for class A (it's conducting all the time). The signal comes from the emitter. not the collector. The same level of RF voltage (ac) on the Q3 gate will also be across R7. No amplification. but it does present very little load to



will be developed across R3 ... which is then squirted directly back into the tuning coil L1 via C5. This is feedback, and the more feedback. the higher the gain that will result. Of course a point is reached where the feedback will through Q2 into self-oscillation. converting it immediately from an amplifier into an oscillator. The trick is to increase the amount of feedback for the highest possible gain. JUST PRIOR to it going into oscillation.

Emitter Follower and Detector - Parts: R5, R6, C8, Q3, R7, D1

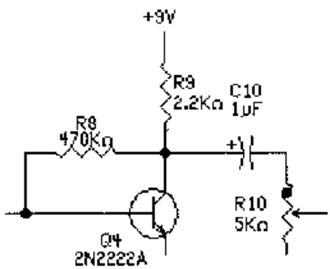
When regen stage Q2 and L1 is at it's high gain point. it is a high impedance amplifier. which gives it it's high Q. To put any Q2, and R7 becomes the source impedance for the D1 detector diode. If you don't use a germanium diode, that is say



you use a 1N914/1N4148 silicon diode, you might want to drop the value of R7 to 1.5-2K to drive D1 with a lower source impedance. If you want to be a real AM detector efficiency neophyte, make R7 a 5K trim pot and adjust for maximum gain ... which occurs when R7 is the characteristic impedance of D1 and the C9/Q4 load. D1/C9 is the simplest of AM detectors to save parts. Between D1 and C9, you can also add a low pass filter (usually a resistor and a cap to ground to remove things >5-6KHz or so) and RF filtering to make it a more efficient filter. These types of enhanced AM detectors can be found in the ARRL handbook, etc.

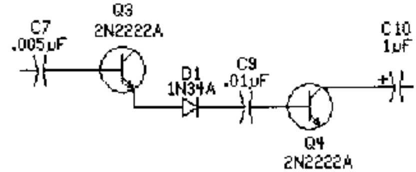
Audio Amp. - Parts: R8, R9, R10, Q4

Again, not the best amplifier design, just a very simple, cheap one by the self-biasing of R8 and no emitter resistor. You can build a "proper" audio amplifier here, with bypassed emitter for higher gain and better fidelity. Remember, this is a minimum parts radio, that makes some real "engineering" shortcuts you would have flunked the test in college over. But it works! R10 is the volume control. It can be any value from 2K to say 50K.



Coupling - Parts: C7, C9, C10

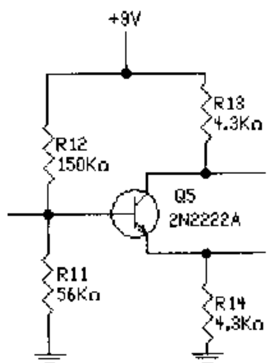
C7 couples the high gain RF signal into Q3, an emitter follower (More on this in a minute) C9 couples the detected audio from D1 into the Q4 audio amplifier, and keeps the dc voltage on Q4 base off the diode so it doesn't become reversed bi-



ased and not detect weak signals. C10 couples the audio to the Q5 audio splitter, and keeps the +9v on the top of R9 from going to ground through the volume control R10 instead of transistor Q4 (where it's kinda needed to make it work!)

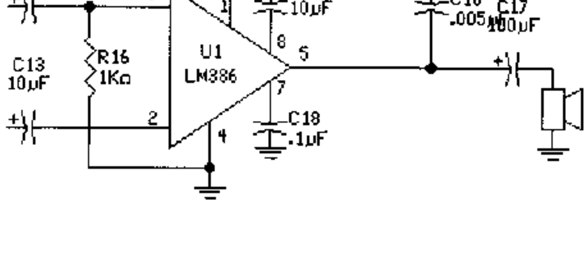
Signal Splitter - Parts: R12, R11, R13, R14, Q5

This was an experimental circuit I designed in for someone once, and not really intended to be published. But it does work. It splits the signal between the emitter and collector, which is why R13 and R14 are at the same value. The signals at the emitter and collector will be 180 degrees out of phase, and thus drives the LM386 in the differential mode. This will effectively produce about 6dB of additional gain. Although, Q5 itself offers little gain. You could run the output of R10 volume control, through C11, to pin 3 of the LM386 (and ground pin 2) to omit this stage. If you find the BBC to be a bit anemic, then add the Q5 stage or another audio amplifier circuit. The values of R13-R14 aren't real critical, just as long as they are the same (down to 2K would probably work OK, except draw more current).



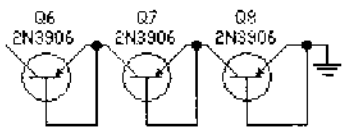
Second Audio Amp. - Parts: R15, R16, C14, U1, C15, C18, R17

R16 places a 1K load on the LM386 input to help keep it from "motor- boating" as the difference signals from Q5 goes through zero. This is optional and may not be needed in all cases. The current going through U1 will vary with the audio. On strong signals, the current can cause an internal voltage drop to U1 to toss it into a low frequency oscillation, often called "motor-boating", as it sounds like an idling motor boat. R15 and C14 forms a filter to attempt to keep the internal voltage drop from being too severe. If it still motor boats, increase the value of C14 up to 100uF to keep the dc voltage on pin 6 relatively constant. U1 is he famous LM386, available at Radio Shacks for a buck or so. An LM380 can also be used. These two devices are used because they are designed for driving a low-Z load (like an 8 ohm speaker) while a regular op amp or transistor amplifier is not. C15 sets the gain on the LM386 (the LM380 does not have this feature). Inside the LM386, there is a resistor that biases a differential amplifier. The lower the value of this resistor, the higher the gain. So this C15 is a bypass capacitor across this internal resistor that lowers its value at ac (audio) frequencies and increases the gain. The effective value of C15 is 2.2uF (for a little extra gain) to a maximum of 10uF for the full potential gain of 46 dB. R17-C16 is a low pass filter that reduces some of the "hiss." It is optional, and sometimes takes some piddling with R17 to get it right. The output of the LM386 on pin 5 is biased at 1/2Vcc, or in this case, will be 4.5V with no signal. C17 isolates this dc voltage from the speaker. Otherwise, you'd have an 8 ohm resistor (the speaker) from 1/2Vcc directly to ground. This will shutdown the internal LM386 amplifiers and kill your battery in a few tens of seconds! So it keeps this 1/2Vcc bias to the LM386. C17 can be any value around 10uF or higher. The higher the value, the more ac voltage coupled to the speaker, and the lower the frequency that will be passed. Thus, the 100uF cap shown will pass quite a bit of the "bass" components of the audio. Might help offset the squeal! The effective value of C15 is 2.2uF (for a little extra gain) to a maximum of 10uF for the full potential gain of 46 dB.



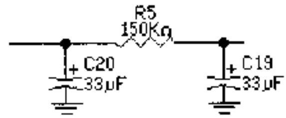
2 Volt Regulator - Parts: Q6, Q7, Q8

This particular Desert Ratt was designed for someone who had a whole bunch of PNP's he wanted to use, so this is where I used them! You can use three diodes to ground also. Each diode (or transistor junction) drops about 0.7V. Therefore, 3 in series will drop about 2V ... so it's a very cheap "poor man's" 2 volt regulator, or 2V zener diode. The current through the diodes is set by R5 150K. You could also replace the diodes/transistor with a resistor, to make a 2 resistor voltage divider, with the first resistor, R15 (150K) dropping 7V (from the 9V supply), leaving the desired 2V. WHAT VALUE OF RESISTOR WOULD YOU NEED TO DO THIS? The only problem with this scheme, is the 2V would get lower and lower in voltage as your battery weakened. It wouldn't take much before Q2 failed to work.



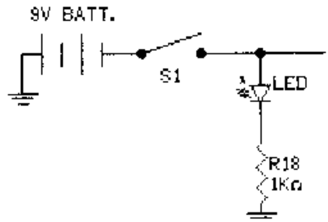
Power Supply Filtering - Parts: R5, 2 33uF caps.

R5 sets the very low current for making the 2V and the current for Q1. The 33uF caps are power supply filtering, the first to keep the 9V constant with current changes due to the changes in the audio detected, and the second 33uF filters the 2V bias. They can be any electrolytic of 4.7-10uF or larger.



Power - Parts: S1, LED, R18

S1 is the power switch. LED and R18 serves no purpose except to make it glow in the dark :-) If your LED is too bright, increase the value of R18. If too dim, decrease the value.



Two Curious Regens and a Curious Amplifier

by Graham Firth, G3MFJ
13 Wynmore Drive
Bramhope, Leeds LS16 9DQ
U.K.

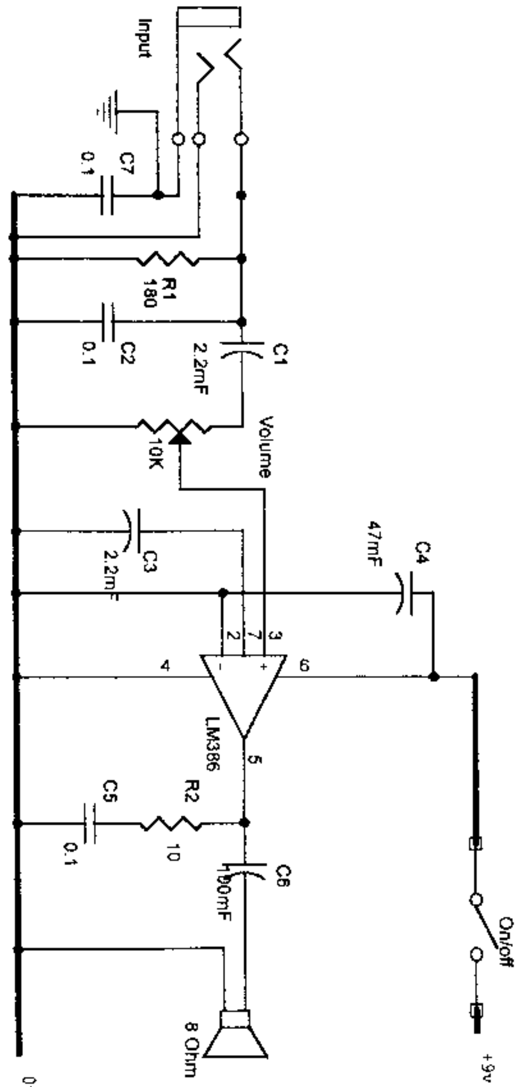
These three projects: the Curious Regen Mark I, the Curious Regen Mark II and the Curious Amplifier were constructed for the Regen building contest that NorCal QRP Club sponsored at Hamcom. The name comes from the fact that all three projects were built in mint tins, thus the Curious name.

No circuit board layout is provided as they were built using veroboard and point to point wiring. It would be quite simple to build all of these using the "Manhattan" style of construction popularized by Jim Kortge, K8IQY in his now famous 2N2/40 transceiver.

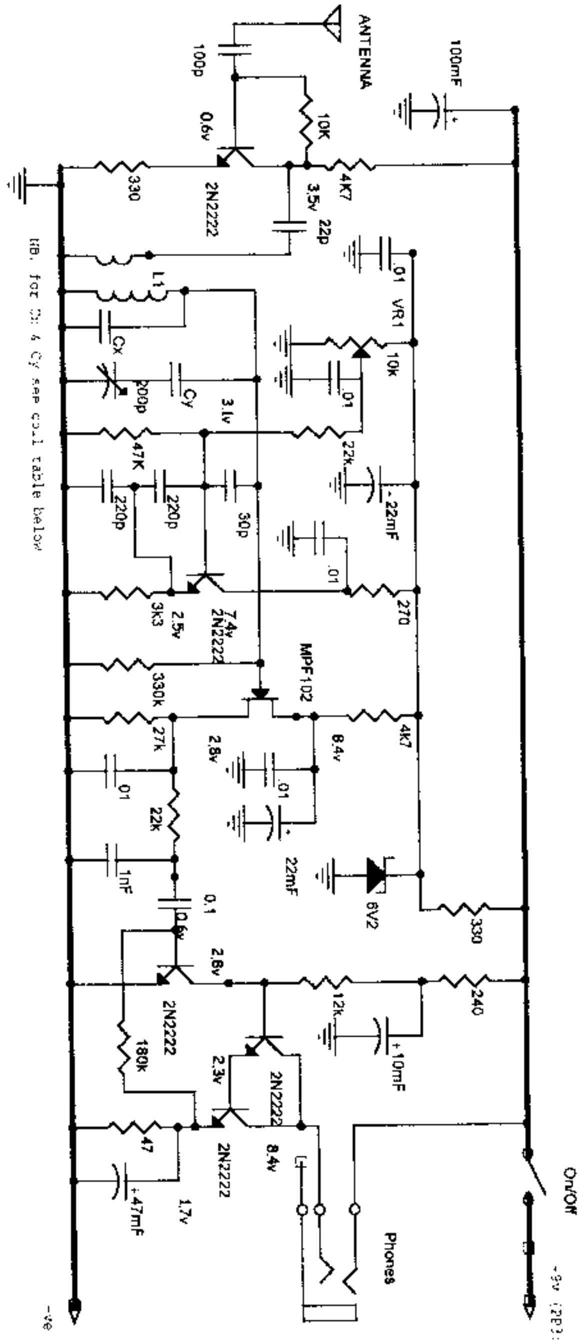
Enjoy and have fun building. 72, Graham, G3MFJ

[Ed. Note: Graham, Tony Fishpool, G4WIF and I had a separate contest at Hamcom to see who could build the best regen. I lost to both of them. They are excellent builders. 72, Doug, KI6DS]

A Curious Amplifier ■ G3MFJ



A "Curious" Regen Mark I ▪ G3MFJ



Parts List for Mark I	
R1	10K
R2, 9	4.7K
R3, 12	330 ohm
R4, 11	22K
R5	47K
R6	270 ohm
R7	3.3K
R8	330K
R10	27K
R13	240 ohm
R14	12K
R15	180K
R16	470 ohm
VR1	10K
C1	100pF
C2	22pF
C3, 4, 9, 10, 11	.01uF
C5	22uF
C6	30pF
C7, 8	220pF
C12	22uF
C13	1nF
C14	0.1uF
C15	10uF
C16	47uF
C17	100uF
Cx	See Coil Table
Cy	See Coil Table
VC1	200pF
TR1, 2, 4, 5, 6	2N2222
TR3	MPF102
L1	See Coil Table

Parts List for Mark II	
R1, 17	180K
R2	6.8K
R3, 4	1.5K
R5	560 ohm
R6, 11	4.7K
R7, 14	22K
R8	47K
R9	270 ohm
R10	3.3K
R11	470K
R13	27K
R15	220 ohm
R16	12K
R18	470 ohm
VR1, VR2	50K
C1	47pF
C2	100uF
C3, 5, 7, 11, 13, 14	.01uF
C4	22pF
C6	330pF
C8	30pF
C9, 10	295pF
C12, 15, 18	22uF
C16	1nF
C17	1uF
TR1, 2, 4, 5, 6	2N2222
TR3	MPF102
ZD1	7.5V
VD1	SMV166
L1	See Coil Table

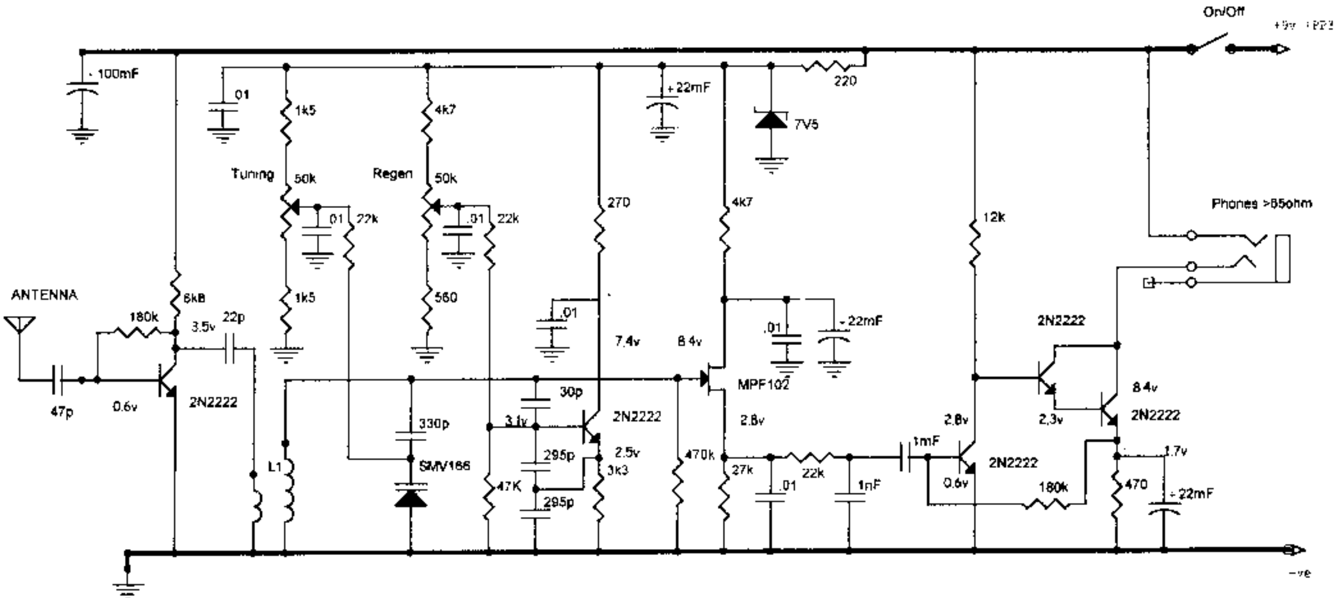
Coil Table for Curious Mark I

Band	Core	Primary	Secondary	Cx	Cy
20M	T37-6	3T	24T	25pF	10pF
40M	T37-6	7T	45T	56//6.8pF	33pF
41M BC	T37-2	5T	38T	56pF	30pF

Coil Table for Curious Mark II

Band	Core	Primary	Secondary
1.55-3.1MHz	T37-2	12T	110T
4.1-8.1MHz	T37-2	6T	36T
9.1-17.5MHz	T37-2	4T	16T

A Curious Regen Mark II – G3MFJ



The ElmeRadio Project

by Bruce W. Kizerian, KK7ZZ
678 W. Jennings Lane
Centerville, UT 84014

The ElmeRadio is more of an idea than a piece of hardware, an idea about helping young people build a radio (or any other electronic device.) and learning how it works in the process. It is a way of building and learning. It is not just a cute little yellow and blue box with knobs on it, but an introduction to a learning process.

An individual cannot build an ElmeRadio without a companion. Participants in this project fall into two categories. Beginners who learn, and experienced individuals who teach. For each it is an enjoyable experience. Try to remember how excited and fascinated you were when you were introduced to radio as a kit. Do you remember how you felt? Want to recapture that excitement and fascination? Participate in an ElmeRadio project with a youngster or inexperienced older person. Your reward will be knowing that you started someone down the path to a rewarding career or hobby.

The radio you will build is a simple regenerative AM broadcast band receiver, based on designs by Charles Kitchin and Charles Wenzel. It has been optimized for simplicity and low cost. Your student will be dazzled by its flashy Elmer Yellow front panel and Elmer Blue enclosure. This is a remarkably high performance receiver, capable of receiving many local AM stations without an external antenna.

A manual which will be provided with the radio will teach basic electronic theory, component recognition, and soldering and building techniques.

The ElmeRadio was designed to quickly give builders a successful experience. The AM broadcast band was chosen for this reason. Strong and plentiful signals along with a wide variety of music, news and talk will insure that students of every age and inclination will find something familiar and interesting on their radios immediately after construction is completed.

For those who wish to continue building and learning, other ElmeRadios are planned. A shortwave version will soon be ready, as will an FM broadcast band superregenerative receiver. The future may also bring a 2 Meter monitor receiver. And don't forget the ElmerKey, a simple code practice oscillator with a built in key. In fact, any circuit can be an ElmerCircuit. Remember, we are learning a way to build. We are not just building kits. Anything that will fit into the blue box can be made into an Elmer Project. Educators and other interested persons are encouraged to copy improve, kit up, and distribute any ElmerCircuit. 72, Bruce Kizerian, KK7ZZ

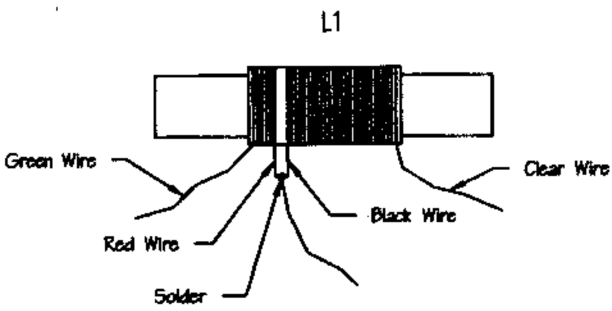
ElmeRadio Parts List

C1	4.7pF disc	Mouser
C2	200pF Variable	Electronic Goldmine #G8538
C3	100pF Polystyrene	Mouser
C4	.001uF Polystyrene	Mouser
C5	0.1 Polyester Film	Mouser
C6, 8, 9, 10	47uF/16V Elect.	Mouser

C7	.01uF Polyester	Mouser
L1	AM Loopstick Ant. Coil	Electronic Goldmine #G8537
R1	1M Audio Taper Pot/Switch	
R2	100K	
R3	2.2M	
R4	200 ohm	
R5	150K	
Q1	2N3904	
D1, 2, 3	1N4148	
U1	TL431 Shunt Regulator	Mouser
J1	1/8" Stereo Jack	
Case	Carlon B108R Electrical Box	
Front Panel	Double sided PCB Material 2.38" x 4.25"	
9 Volt Battery Clip		
9 Volt Battery Holder		

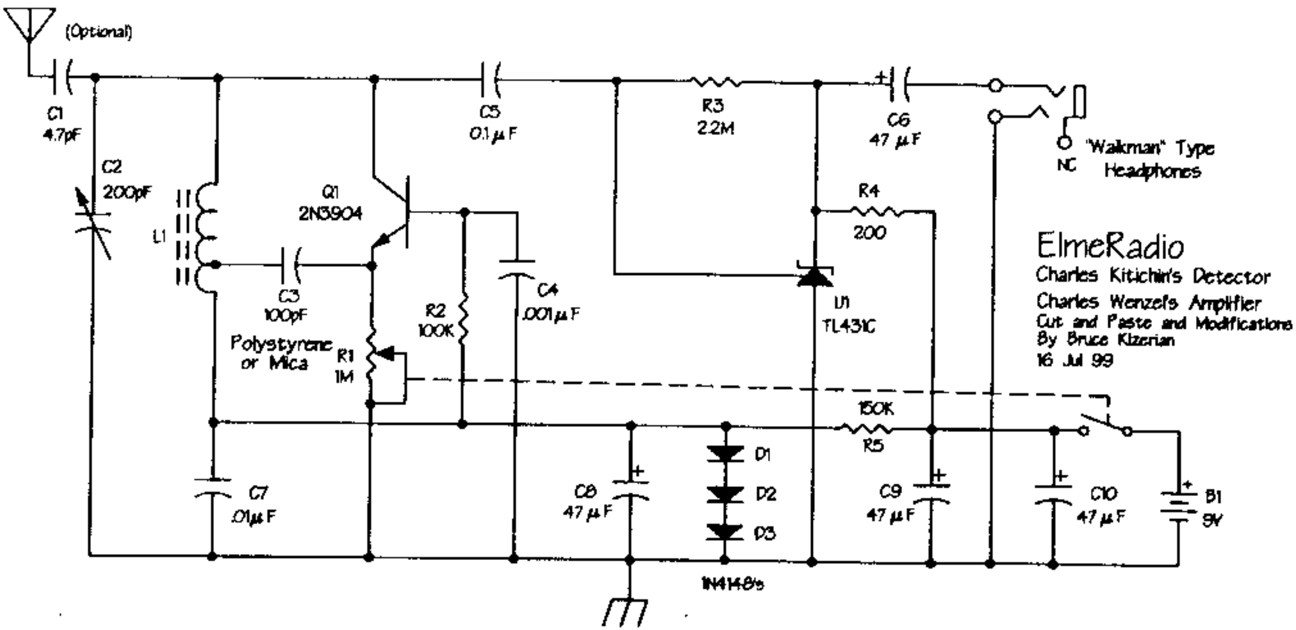
Additonal Parts Needed for More Complex ElmeRadio

Q2	2SK241
R4	2.2K
R5	10K Audio Taper with switch
R3	1K
C7	.01uF Polyester
C5, 9	.1uF Polyester
D1	1N34A

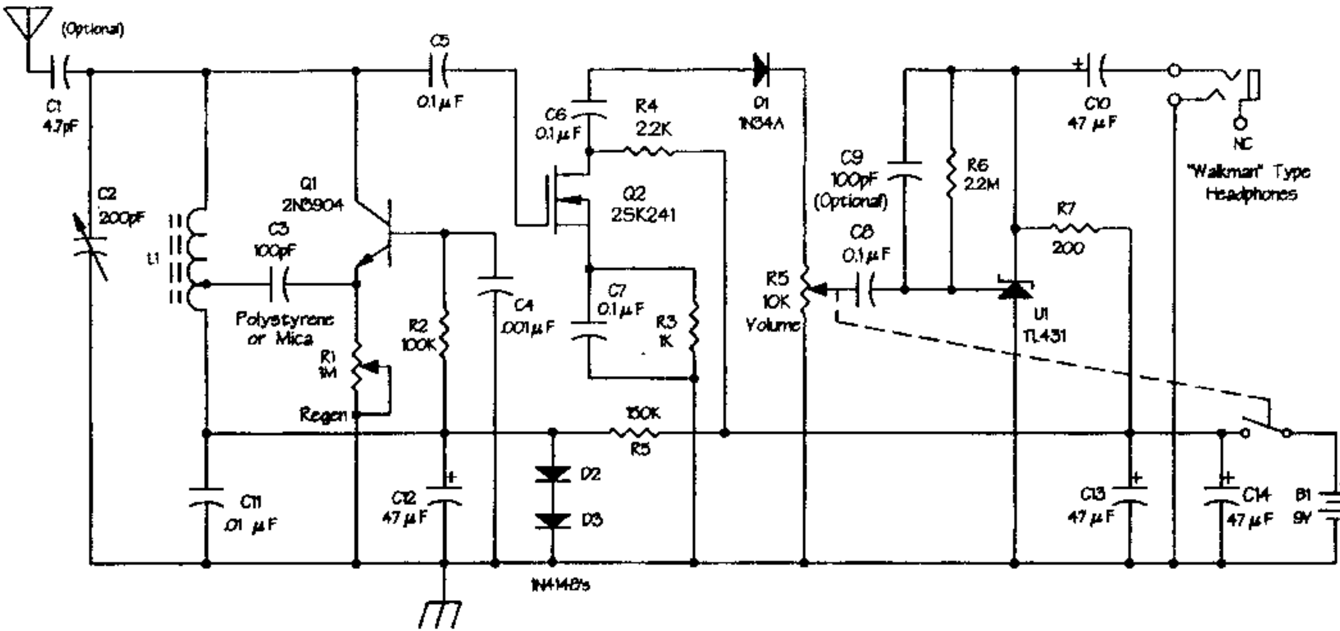


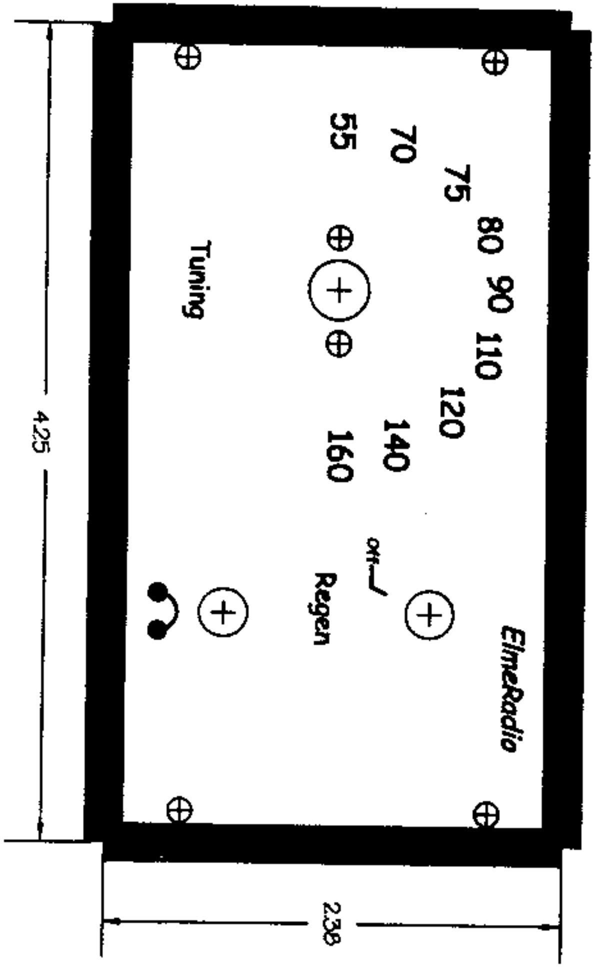
L1 Wiring Details

Simple ElmeRadio ▪ KK7ZZ



More Complex ElmeRadio ▪ KK7ZZ





Front Panel Layout for Both ElmeRadios. Copy on Bright Yellow Paper

Simple ElmeRadio Notes:
C1 Dual variable polycap. Use both sections in parallel.
R1 Audio Taper Pot with switch. Must be larger than 250K
U1 NTE999 may be subbed.
C10 Locate as close as possible to R4 & U1.
C9 Locate as close as possible to switch.

Label Instructions:

1. Copy Label to astrobright yellow paper.
2. Cut out label.
3. Fold top and sides around edges of panel.
4. Laminate with clear packing tape.
5. Punch or drill holes to size.
6. Box Carlong B108R Electrical Box

A Regenerative Receiver, the Pipsqueak

by Paul Harden, NA5N
P.O. Box 757
Socorro, NM 87801
na5n@rt66.com

[Note: This article was originally printed in the St. Louis Qrp Society Peanut Whistle in November 1995, and was printed in Mar. 1996 QRPp. The artwork was done by Brad Mitchell, WB8YGG, KI6DS]

I have been fascinated by regenerative receivers since the first one I built in the early 1960's - the receiver that opened the world of short wave to me at a young age, and probably what launched me on a career in electronics and a ham ever since. Even with 1R5 vacuum tubes now long gone, I still find myself building a regen now and again, experimenting with different bipolar and FET transistor circuits. Last year in *Electronic Design News* (EDN), there was a simple regen receiver that caught my eye... a simple circuit, but implemented slightly different than circuits I've seen before. So, I built one, and it worked as well as the fancier FET versions I've built. Making a few of my own modifications, such as using an LM386IC for better audio gain, I called it the "Pipsqueak". So impressed with the circuit, I called the author at Analog Devices, Charles Kitchin, who turns out to be a ham and an avid low power builder, N1TEV.

I then built another "Kitchin" detector with a front end preamp for more RF gain and other embellishments. I called this one the "Desert Ratt". This one works so well, I listen to it several times a week... the BBC World News primarily... from the speaker, while doing other things in the shack. But it's always been a kinda private endeavor - building regens just isn't the sort of thing you want to brag about to fellow QRPers.

Then one day on the QRP-L internet group, Dave, NF0R asked about the article and I could not resist responding. It was time to come out of the closet and admit, I too, build regens. This started an enjoyable relationship with the SLQS and Dave, mostly through email and regular mail. Dave has since sent me a few goodies from the SLQS parts bin and I offered to build a regen receiver for the St. Louis Club, based on these parts. This includes the famous St. Louis variable caps of the tuner fame, and LM380 audio amplifier board and an S-meter. That project has begun and when completed will Part II of this series. Prototyping has begun and I'm excited about finishing the "rig". It will be a general coverage shortwave receiver with a switch for the 40 meter band and coil data for the other popular QRP bands. It will have sufficient audio to drive a speaker and will even have an "S" meter! All this with 4 transistors and the LM380 audio board. Dave and I have decided to call this SLQS regen receiver the "Howlie Crafters". (If you don't get it ask an old timer.)

In the meantime, warm up your soldering irons and try building the "Pipsqueak". It is a very simple circuit, easy to build, using virtually any construction method from "Ugly" to "Really Ugly", like mine.

Why Build a Regen?

Regenerative receivers were the first generation of radio receivers used by hams, back to the days of Armstrong. Even though built today with semiconductors, they still have the original "sound" and romance of their turn-of-the-century cousins. They are much different from the ease of a superhet: they take some practice and skill to operate. but once a station is properly tuned in, you'll be amazed at the gain and how well it sounds for a single transistor stage. It will send you back tot he old days of radio.... is that the SOS from the Titanic?? Regens have a charm of their own and can entertain you for hours.

From a project point of view, they are an ideal project. First, they're almost a fail save circuit, guaranteed to work almost no matter what. All parts (except the variable capacitor) can be bought at Radio Shack for about $10; if you have a junk box of parts, you probably have everything you need. Due to its low parts count, you can build it about any way you choose. Fancy perf board, copper clad board, pretty or ugly. If you've never built anything from scratch before, try a regen circuit. Just figuring out how to solder everything together and build the thing mechanically is fun in itself.

On the practical side, just think of the electronics you'll learn. Even though it's a very simple circuit, over half of the basic circuits used in electronics are there... tuned circuits, RF amplifiers, oscillators, audio amplifiers, biasing transistors, diode rectification, interstage coupling, dc bypassing, etc. Build one, poke around the circuit with a DVM, change a component to a different value and see what happens. You'll be ready to upgrade in no time, or your money back! You can learn how this stuff really works and you'll never forget it.

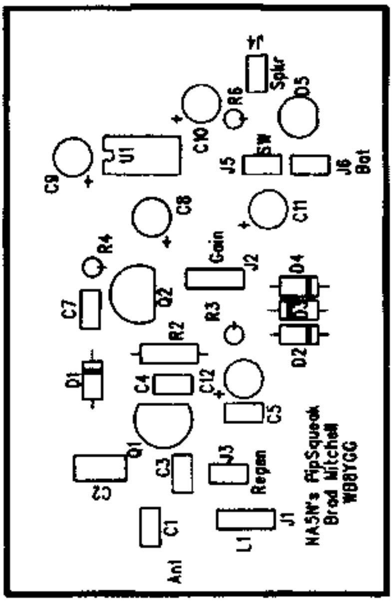
How the Circuit Works

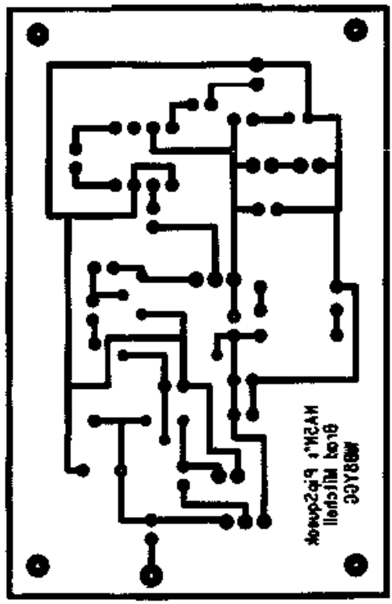
Q1 is basically a Hartley oscillator circuit, the kind with the tapped coil. The current through Q1 is controlled by Pot R1. With sufficient current through Q1, enough energy will flow through C3 to sustain oscillation. The objective is to increase R1, the regeneration control, just to the point of oscillation. At this point Q1 becomes a very high gain, hi-Q amplifier, with gains of more than 100,000 not unusual. Any signal on the antenna at the resonant frequency determined by L1 and C2 will be amplified by Q1. However, when Q1 breaks into oscillation, it will mask the RF signal. Setting R1 for maximum RF gain without inducing oscillation is critical, but once achieved, tremendous gain occurs. The amplified RF signal is detected by D1 to recover the audio. It is capacitively coupled to Q2, an audio amplifier. Q2 will conduct with a base voltage of > 0.6V. R4 biases the base at about 1V to ensure constant conduction (the definition of a class A amplifier). Thus the small voltage variations on the base from D1 will be amplified. R5 is the collector load, where the amplified signal is developed. It is tapped off by R5, the volume control and capacitively coupled to the LM386. C8 can be any value greater than 1uF; the larger the value, the lower the frequency response. The gain of U1 is determined by C9. With no C9, the gain is 26dB, sufficient to drive earphones: 10uF will produce the maximum gain of 46dB, sufficient to drive a speaker. A value less than 10uF will produce an intermediate gain. The output audio is applied to the speaker (or phones) through C10. Like C8, it can be any value greater than 1uF.

Charles Kitchin uses D2-D4 to establish a very stable voltage for the Q1 regen stage, which makes this circuit very stable compared to others I have built. A 0.6V drop occurs across a diode junction, such that D2-D4, with limiter R3 forms a 1.8V voltage regulators. C6 stores this voltage while C5 keeps the RF out of this DC bias. It provides for a very smooth regeneration action.

Winding Coil L1

Another beauty of building a regen is winding your own coil and I don't mean





a toroid!! Good old fashioned coil. Kitchin recommends a 35 mm plastic film case, which works quite well; I use IC shipping tubes with equal success. Here's where you can be real creative. Just don't use anything that's metallic. L1 consists of 15 windings for the RF part and 5 windings for the "tickler" part. With a 200 pF variable cap for C2, this produces a frequency range of about 6-16MHz. Your mileage will vary. Experiment with different number of windings. The rule of thumb is for the tickler winding to be about 1/3 of the RF winding.

Some Construction Hints

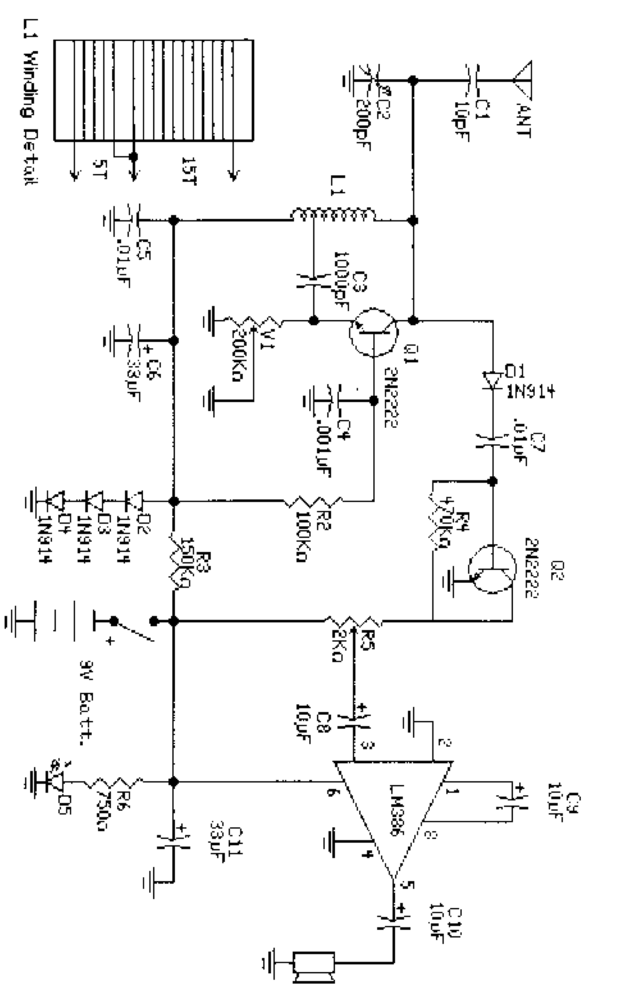
The circuit can be built almost any conceivable way. Keep the RF components as close to each other as you can, however. It is best to build the circuit on a piece of wood, as a metal chassis causes lots of hand capacity effects. Do not put a metal case over your finished radio... it can keep L1-C2 from oscillating. The LM386 is carried by Radio Shack for $1. I recommend that you also get an 8 pin IC socket. It makes soldering things together much nicer without the chance of overheating the IC.

You will find this circuit to be very tolerant of circuit values. If you are using junk box components, just come as close as you can, it will probably work. R1 can be 100K or greater; R5 can be 2K to 10K; C1 any small value. C3 and C4 must be the same value, but can be 700pF to 1500pF. Q1 and Q2 can be any NPN transistor, although a high Hfe and high FT works best.

If you're a new builder, I recommend you build the audio portion first. Power it up. R5 to maximum and you should hear a slight hiss. A touch of the finger to the base of Q2 should produce a hum. Then build the regen stage. When completed, power it up again and advance R1. Towards maximum, you should hear it start to "squeal". It's working. Attach to a wire antenna, (not 50 ohm coax). A 12 foot wire or more is ideal.

Operation

Turn on the receiver and advance the regen control until you hear a squeal. Back off to just before it squeals, or oscillates. As you tune C2, you will hear occasional squeals. These are usually stations. Stop and adjust R1 for proper regeneration. For the international broadcasters such as the BBC, their powerful signals gives good starting practice on proper tuning. This is aggravated by an effect called "pulling". This is where you advance the regen control for proper amplification and the received frequency will pull down a bit. It's a two handed operation jiggling both the tune and regen controls. GL and 72, Paul, NA5N



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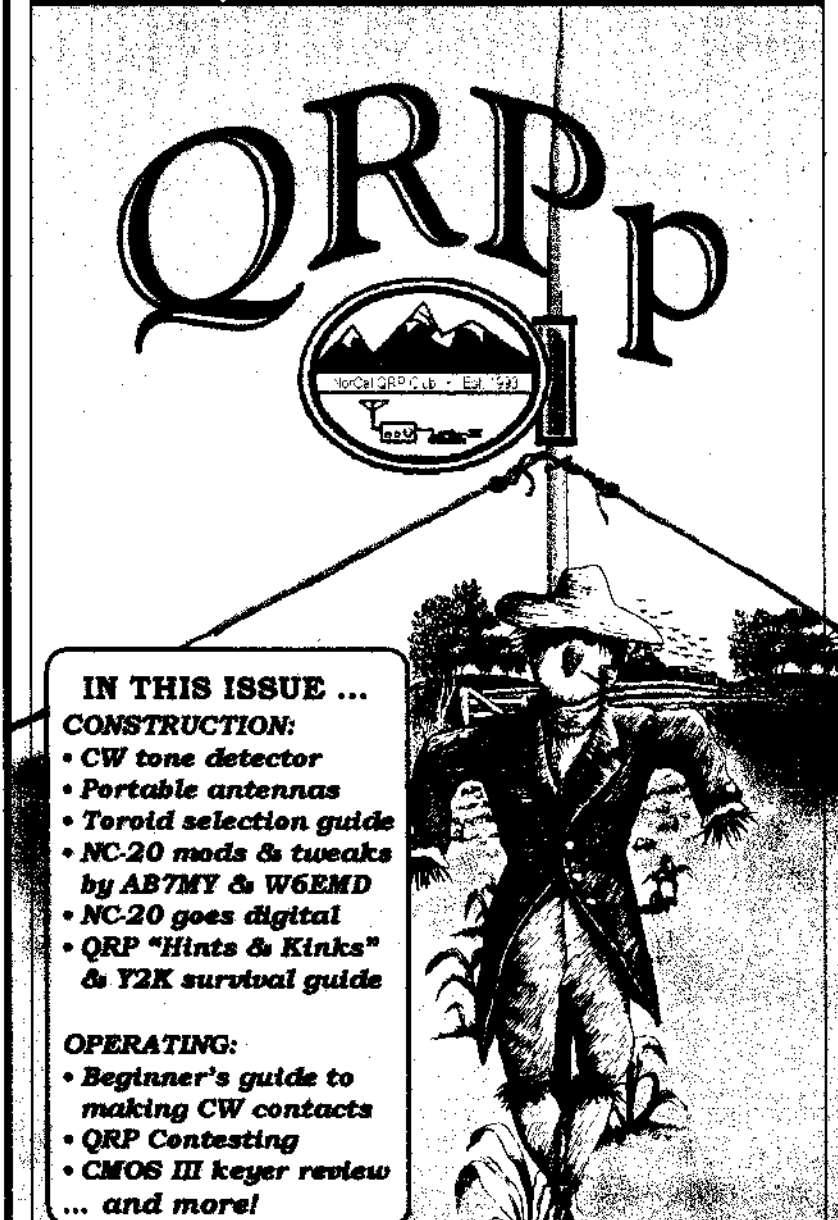

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- ***NC-20 goes digital***
- ***QRP "Hints & Kinks" & Y2K survival guide***

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Journal of the Northern California QRP Club

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From the Editor

by Doug Hendricks, KI6DS

This issue has some excellent articles, including a long one on "How to make a CW contact" by Jack Waggoner, WB8FSV. You might wonder why I would devote so much space to an article like this. The answer is that it is very valuable information and is especially valuable to the beginners out there. We must always keep in mind that we are always attracting new people to QRP. That is the life blood of our hobby.

Also, we have another in the series of Blue Printing QRP rig articles by Gary Surrency, AB7MY. Gary is the best that I know for writing articles on tweaking rigs. If you have a NorCal 20, be sure to read this one plus the one on page 57 by Dave Meacham, W6EMD. They will make a great rig even better.

Check out a couple of timely articles by a new author to QRPp, Jay Bromley, W5JAY.

And finally, I am most pleased that we have Paul Harden's QRP Hints and Kinks back again. He has a couple of extra pages this issue. Those begin on page 61 and are wonderful as always. Have a good fall and get on the air and make contacts. 72, Doug, KI6DS

CW Offset Tone Decoder

by Jerry Henshaw, KR5L
Address Needed
City, State, Zip
jhenshaw@bellsouth.net

This circuit was designed for those of us who are tonally challenged when it comes to zero beating with another CW station. My K2 has a built in "Spot" feature that allows you to zero beat with a station of interest. Although the Spot feature works well, I am almost tone deaf so it is of little help to me. I have posted this little circuit on the Elecraft reflector and there has been a very good response. Peter Zenker has asked to publish the circuit in the German QRP newsletter. Additionally, it has been pointed out that FISTS has published a similar circuit in their newsletter. The circuit presented here is my own original design — heck, there are probably better circuits but mine works great for me.

Tom Hammond, N0SS, took it upon himself to layout a PC board for the circuit and has kindly given me his permission to publish it here. Thanks Tom, your generosity is greatly appreciated.

The design is based upon a PLL Tone Decoder IC. I used a NTE832 substitute for the more popular NE567. I was unable to purchase a real NE567 locally so I used the NE832. I haven't had the opportunity to verify that a NE567 will work in my circuit.

The component values in this circuit will allow you to set the center frequency (CW side tone note) from about 350 Hz up to over 1 Khz, which should be adequate for most users. The LED "lock" indicator has a 1 K resistor in series with +VCC thus setting the current at 8ma (at 8 volts). The spec sheet says VCC can be anywhere from 5 to 9 volts. You can increase the value of the 1K resistor to lower the LED current if you so desire.

I plan to mount a subminiature LED or SMD LED in the "Rate/Lock" button on my K2 to indicate a "Lock" condition.... Kinda appropriate don't you think? This mounting scheme doesn't require drilling any holes in the K2's front panel (horror of horrors). If I want to return the K2 back to its "factory original condition", all I have to do is replace the key cap.

The center frequency of circuit is determined by the 5K trim pot (at least 10 turn pot), 2.2K resistor, and the .47 uFcapacitor. Be careful in selecting the .47 uFtiming capacitor. The stability of timing capacitor determines the stability of the free running center frequency oscillator. In my case I used a Mouser # 581-470NK63 metallized polyester film capacitor. The oscillator has remained stable at 650 Hz (my CW offset frequency) within 1 cycle over the course of several days.

I used a 100 uFelectrolytic to couple the audio from my rig to the circuit. A 10 uFwould probably work just as well. I used 10 uF and a 22 uFelectrolytic capacitors (from my NORCAL capacitor kit) for the filter capacitors. Tom Hammond laid out the PC board for two tantalum caps. If you use electrolytics, please make sure the negative leads go to ground and the positive leads go to the IC pins 1 and 2.

The lock range on the circuit is plus or minus 20 Hz of the center frequency. It is very easy to "rock" the tuning knob a few degrees and watch the LED go on and off then simply stop in the center of the on/off range. This is very easy to do in practice. You can tighten up the bandpass filter by increasing the 10 uFand 22 uFcapacitors. The ratio of the value of the two capacitors should be at least 2:1 , 3:1 may be even better. I used the values of capacitors that were available in the NORCAL capacitor kit.

What is amazing, at least to me, is the circuit's ability to dig tones out of the noise. The little circuit is listening for a very narrow audio spectrum and is very good at differentiating the tone from QRN... very impressive. Not my circuit, the tone decoder chip.

I used a frequency counter attached to pin 5 (Timing Resistor) to measure the center frequency. You really need a good quality 10/15 turn trim pot to accurately adjust this frequency setting. An alternative method is to key your transmitter into a dummy load feed the audio (I used the headphone jack) to the circuit and adjust the trim pot until the LED lights up. Use this method if you don't have a frequency counter. You must adjust the trim pot very slowly to allow the PLL to lock on your side tone with each slight rotation.

The circuit will indicate a lock after 2-3 dits at 25 WPM. I had my prototype set up on the bench with a long test lead attached to my bench power supply. In this set up, my circuit would pick up RF from the transmitter and NOT indicate a lock during transmission. So keep your leads short or use a 9 volt battery if you use the circuit in an external fashion. By the way, the built in hysteresis of the circuit will NOT let you copy CW by watching the blinking LED!!!

I built my prototype on a R/S universal PC board. I used simple point to point wiring. The entire circuit fits within a 1 inch square. I used a R/S "Y" connector at my headphone jack to couple the audio into the tone decoder. The circuit requires a "normal" audio level for detection – the general rule is if I can copy the signal by ear, the circuit can detect it as well.

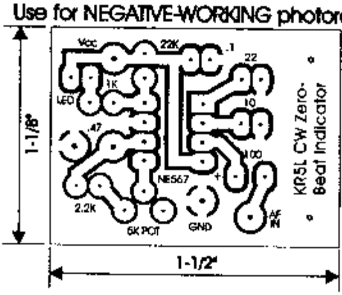
I plan to mount this circuit (yes my prototype board) inside my K2 as soon as my order for replacement key caps come in. Right now I use it on the bench and it works great. I am amazed how badly I can recognize tones by ear. I have thought on several occasions that the circuit wasn't working properly because I tuned in a station using my "ears" and the LED was doing nothing, zip, zero, nada. But lo and behold, I turned the tuning knob a few degrees and suddenly the LED was merrily blinking away indicating a lock. I tested the circuit by switching between CW N and CW R. There was little or no tone difference between these settings indicating I was zeroed in on the station. I would have been way off if I had relied solely on my ears for a zero beat!

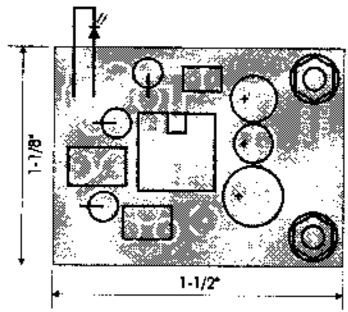
The present circuit draws about 25ma with the LED turned on (with a 1K current limiting resistor). It draws about 17 ma while in "listening only" mode. I have ordered a CMOS version of the NE567, which uses 1/10 of the current of the original chip. The frequency determining components are one half the value of the original circuit (.47uFbecomes .22uf) and the bandpass caps are considerably smaller as well. Tom Hammond's PC board should still be okay as the physical size of the parts should remain the same. Homework assignment — build a CMOS version of this circuit and let us all know how well it works. I plan to build one as soon as my CMOS chips arrive.

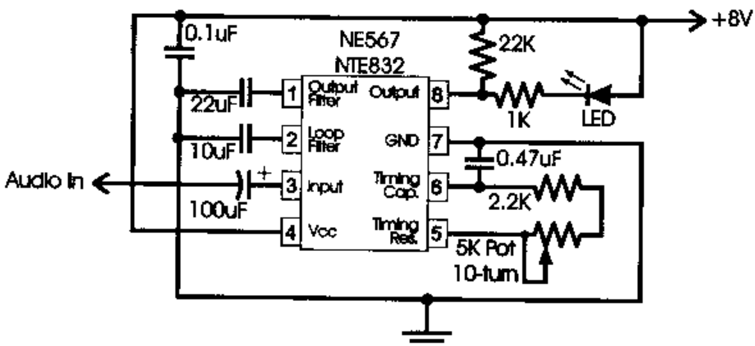
So if you are tonally challenged and need a little help in zero beating a CW station, give this circuit a try. If you build one, please let me know if your results compare with mine.

72's, Jerry Henshaw, KR5L

Use for NEGATIVE-WORKING photoresist







Specialized Parts available from Mouser (www.mouser.com)
0.47 Metallized Polyester Film, 581-470NK63 ($0.67)
0.1uF Monolythic Ceramic 581-UDZ104K1 ($0.31)
10 uF 16V Tantalum, 581-10K16V ($0.50)
22 uF 16V Tantalum, 581-22K16V ($0.73)
100 uF 16V Electrolytic, 208-16V100 ($0.39)
5K 12-Turn Top Adjust Pot, 594-74W-5K ($2.25)
NE567 DIP-8 tone Decoder/PLL 513-NJM567D ($0.38)

Note: The diode orientation is correct in the schematic, the parts over lay has it reversed. Please be careful if you build the circuit.

A Beginner's Guide to Making CW Contacts

by Jack Wagoner WB8FSV

Finding Someone To Talk With
Answer a CQ

How the heck do you begin a CW conversation? How do you find another ham to talk with? My favorite method is to **answer a CQ**. Sending several CQs followed by your callsign indicates you want to start a contact with someone. Simply tune up and down the band searching for that familiar "CQ", zero beat your transmit frequency with that of the CQer(or as close as you can get), and call them when they finish their CQ. Normally a one by two call on your part is all that is needed, "N1XYZ de WB8FSV WB8FSV K". If band conditions are poor, or there is a lot of QRM(interference), perhaps a two by three or a one by four call is in order. One by two initial calls in response to a CQ are common these days, sending your call letters too many times marks you as a beginner.

Please do not reply to a CQ if the CQer is transmitting too close(within one kHz or so) to an ongoing QSO. Doing so will likely cause unnecessary QRM to the ongoing QSO, you may even drive them off the air. Not cool. Common ham courtesy says do your best not to cause unnecessary QRM. Occasionally I will hear a CQing station that I would really like to answer, but the CQer is too close to an ongoing QSO, as I mentioned above. The best thing would be to not answer the CQer, but I have been know to answer the CQer at least one or two kHz away from the CQers frequency. My hope is that they will hear me and move their transmitting frequency to mine. Then I can have my contact and not cause QRM to the ongoing QSO. Sometimes this works, but likely the CQer will not even hear you, or will not change their transmit frequency when they answer you.

Sometimes when you answer another ham's CQ, they may not hear you well enough to get all of your callsign. Or they may not hear you at all if the band conditions are bad. There is such a thing as one way skip: you may hear West Coast stations fine, but none of them hear you. Not uncommonly more than one station besides you will reply to the same CQ that you did. You may even hear the other station(s) answering the same CQer that you are, at the same time. The CQing station may hear a mixed jumble of several stations answering him or her at the same time. The CQing station may then send "QRZ?" or "QRZ de N1XYZ?" Meaning, who the heck is calling me, please call again. Or the CQer may send nothing at all, perhaps they are just overwhelmed by more than one answer at a time, or by all the QRM. Many times I have found that if a CQer does not respond to my first reply and I hear only silence, if I call him(or her) again, they may well return to me.

Not uncommonly, when you begin to reply to another ham's CQ, you will hear other stations besides yourself calling the CQer at the same time that you are. I usually continue transmitting and then see if the CQer answers me or one of the other stations. If the CQer chooses you over the other stations, you can assume your signal was likely stronger or more interesting. If you do not have a competitive nature, then stop transmitting as soon as you hear other hams answering the CQer. Let them have the contact. Should you really want to make the contact yourself, continue calling and then drag out your call by sending your callsign once or twice after you hear the other answering station(s) finish their call. This trick, often used by DXers, sometimes works. Also, if while answering a CQer, you hear the CQer return to another different station, stop transmitting. You lost. Continue your search for another CQer. If you **really** want to contact this CQing station you could simply wait for them to finish their current contact and then tailend them.

Occasionally as I scan the band looking for a CQ to answer, I may come across a ham sending their callsign two or more times, before they sign, "N1XYZ N1XYZ K". I believe it is safe to assume this ham has just finished sending a CQ, and often, if I like their callsign, I will listen a second, then go ahead and call them. Since I heard only their callsign and not the actual CQ, it is possible that this is **not** a CQ(maybe they were calling another ham instead). Listen a few seconds to ensure you are not interrupting a QSO, then assume that it was a CQ. I have found that sometimes if I wait for this suspected CQer to send another separate CQ, by that time they will have attracted a few more replies to their CQ, and I may lose out on what could have been a good contact. In the same regard, you may be in contact with another ham and end one of your transmissions by sending your own callsign two or more times(perhaps you repeat your call a few times because the other ham has copied it wrong). Then as a result, in the middle of your contact, you may be called by a third ham, who incorrectly assumes you have called CQ. Simply ignore the interrupting third ham.

When answering a CQer you should zero beat the other ham's frequency, or set your transmit frequency as close to theirs as possible. Many hams today, in order to deal with the increasing QRM, make use of very narrow receive filters. The CQer may have their narrow filter turned on and not hear you answer if you are more than a few hundred cycles away from their transmit frequency. This is a quite common occurance on the CW ham bands, and points to the importance of correctly zero beating with your ham rig. By the same token, should you be calling CQ, do so with your narrow CW filter turned off, or you may well not hear several answering hams. Many hams are uncertain how to correctly zero beat their rigs on CW.

If you are fortunate to have a newer transceiver that has dual VFOs, it can simplify your search for a CQ to answer. While scanning for a CQ, if you come across something interesting, such as someone tuning up(a potential CQer), a clear frequency(that you may wish to use later to call your own CQ), or an interesting QSO(that you might want to tailend when it finishes), then leave one of your VFOs on that spot. As you then continue scanning for a CQ, you can periodically, at the press of one button, switch to your second inactive VFO and see what's happening on your other interesting frequency. Having two VFOs built into your radio can greatly enhance the ease and convenience of your CW operation. Sometimes I wish my rig had three or four VFOs. HI. If your ham rig does not have dual VFOs, you can simply remember, or write down, any interesting frequencies you come across while scanning.

Call Your Own CQ

Tuning around searching for CQs can tend to be frustrating. At times there just don't seem to be many folks calling CQ, and the ones I do hear are jumped on by a much stronger or faster station than me. Never fear, there are other productive ways to find a CW contact. Obviously another method would be to find a nice quiet unused frequency and call CQ yourself. Before you fire up your transmitter and send a CQ, listen a few minutes to the frequency to ensure that you are not going to stomp on another conversation. It is very possible that another ham is transmitting on the same frequency but their signal is skipping over you. It is highly recommended that you send a "QRL?", or better yet send a "QRL de WB8FSV?" to see if the frequency is clear. Technically the FCC requires you identify each transmission, and an unidentified "QRL?" is frowned upon. Although everybody does it. Or, if you have the patience, an even better method is to simply listen to the frequency in question for at least 5 minutes. Even then I would still send a "QRL?" before I cut loose with my CQ.

An old fashioned and rarely heard equivalent of "QRL?" is "dit-dit dit", or the CW letters, "I E". It would be sent before a CQ to see if the frequency was clear. Just like "QRL?". The correct response is the same as that to "QRL?" If you happen to be listening and hear someone send an "I E", if the frequency is not busy the correct response is to say nothing or to perhaps send an "N" for "no". If the frequency is busy, like you are having a QSO on the frequency, the correct response would be to send a "C" or "yes". "C" is often used as a CW abbreviation for the word "yes".

If your CQ is answered by more than one station, usually the best practice is to reply to the strongest station. The strongest station is more likely to copy you stronger also, and you will be better able to copy each other should you both be attacked by QRM, QRN, or QSB. If you are able to copy the callsigns of both hams who answer your CQ, and the weaker station has a more interesting callsign, certainly you could answer the weaker/more interesting ham. Since the weaker station is answering your CQ, obviously they can hear you as well. Should two stations respond to your CQ, you can answer them both and try a three-way contact. Three-way contacts on CW are difficult to do.

Send your CQ at the speed you would like to be answered. A three or four by two call repeated twice should be sufficient, "CQ CQ CQ de WB8FSV WB8FSV CQ CQ CQ de WB8FSV WB8FSV K". There are many variations. You will hear some beginners sending 15 or 20 CQs before their callsign, not a good idea. If you scan the band and find it active and full of ham signals, a shorter CQ should work. At times when I know another ham is listening on the frequency(perhaps I just heard them tune up), I may get them to answer with a simple one by one, "CQ de WB8FSV K".

After sending your CQ you may get an instant response, or you may get no response at all. It may also take some hams a moment to respond to your CQ. They may need to tune up their rigs, zero beat your frequency, or take a few seconds to run to their desk from across the shack. These folks may answer you five or ten seconds after your CQ. Be patient. After sending a CQ myself, I may tune around my transmit frequency a bit using my receiver's RIT(receiver incremental tuning). Because some hams may have trouble zero beating my transmit frequency correctly. Perhaps they are still using crystal control - not uncommon with homebrew QRP radios.

If I get no response after a couple 3 by 2 CQ calls, or I can tell there is very little activity on the band, I may then send a 6 by 2 CQ. The more CQs you transmit, the greater the chance that another ham scanning by will hear and answer you. I believe a pair of 6 by 2 calls is more than enough CQs. Should you still get no response to your own CQs, maybe the band conditions are just plain lousy, maybe you are transmitting too close to another QSO that you can't hear, maybe no one wants to talk to you. Try another frequency, try another band, listen for someone else calling CQ, or turn off the radio and go feed the cat.

Tailend Another QSO

A third major way to find someone to talk with on the ham bands is tailending. To tailend a conversation is to wait until another contact is completed, and then call the participant you want to talk with. This may work about half the time. Not uncommonly you will get no answer. The station you call is probably not expecting a call, they may have already turned off their radio, or may simply have something else to do. But sometimes tailending works. As you scan across the band looking for CQs or for a clear frequency on which to call your own CQ, you may hear an interesting conversation that you wish to contribute to, or you may hear a ham friend you want to say hello to.

The polite way to tailend another QSO is wait until the other stations are completely finished. This is easy to determine if you are able to hear both of the stations talking. But sometimes due to radio conditions you will hear just one of the stations. For example, you hear the end of a QSO between KH6XYZ and WB8FSV. You would like to work KH6XYZ and are unable to hear WB8FSV. When you hear the first station send something like, "HOPE TO CUAGN 73 WB8FSV de KH6XYZ TU K", wait. Wait a minute or two until the first station KH6XYZ acknowledges WB8FSV's last transmission, perhaps by sending a final "73" or a "dit-dit". If instead you call KH6XYZ as soon as you heard them sign, "de KH6XYZ TU K", you may well be transmitting at the same time and on the same frequency as WB8FSV, who KH6XYZ is trying to listen to. This is a good way to make KH6XYZ dislike you and decide not to answer you. This polite advice does not generally apply to tailending a rare DX station. Calling and working rare DX stations is usually a mean and cut throat procedure. Another reason I much prefer friendly domestic CW QSOs over fighting for rare DX.

At times you may be waiting to tailend a ham QSO, when the station you would like to talk to ends their last transmission with a "CL" for "closing" or "clear". This indicates that person is signing off and leaving the air, turning off their rig, and will accept no other calls. If you call the CLing station anyway, they may still reply out of politeness, but they are probably anxious to leave. If you just have to talk with them, don't keep them too long.

Breaking In

Breaking into an ongoing conversation is also possible, although rarely successful. Breaking into a QSO on CW is much more difficult than on phone. It is rarely done on CW. Some folks will think you impolite and ignore you, many newer hams will have no idea what's going on and consider you to be QRM. If you want to try, the standard method on CW is to wait between transmissions and then send "BK" for break, or better yet send, "BK de WB8FSV" if you have enough time. Allowing a third person to break into your contact can be confusing, especially for new hams. These "roundtable" QSOs are easier to manage on phone, or in the controlled environment of an organized net, like an NTS traffic net. But don't worry, breaking in is rarely encontered on CW. For those new hams who later move from CW to phone, be careful about using the word "break" on phone or SSB. On phone many hams use "break" to interrupt a net or a conversation when they have an emergency to report.

"Break in" has another meaning in CW. It refers to the time it takes your receiver to recover after you stop transmitting. Most modern transceivers have what is called full break in, meaning that you can receive instantly after transmitting on CW. You can even receive in between the dits and dahs of individual letters. Full break in CW even has its own Q signal, QSK. Years ago radio receivers had a several second delay before you could receive after transmitting, in order that your sensitive receiver was not overloaded by your nearby transmitter. Full break in CW is taken for granted today, but it is one of many technological innovations that today make ham radio so much easier. Such as dual VFOs, digital readout, automatic tuning, or one of my favorites: direct frequency keypad entry.

What Do You Talk About? The Art of Rag Chewing

Now that you have established contact with another ham via CW, what the heck do you talk about? Every ham contact, CW or phone, consisits of at least three basic items: your name, your location or QTH, and a signal report(RST) for the other station. What order you send these three items is unimportant, although commonly today you will hear signal report/location/ name. When I started in ham radio 29 years ago, the order was almost always signal report/name/location.

The Standard name/location/RST/ 73 QSO

These three items are the essential minimum required for a QSO. While it is true that in working a DX station in a pileup you may only exchange callsigns and a signal report, in a "real" contact the name/location/RST are standard, and you continue from there. The next most commonly discussed subjects in CW QSOs are usually the weather(WX), the radio equipment people are using, the hams' ages and how long they have been hams. For many CW contacts that will be the extent of the contact. The other ham will sign off and end the contact. Most likely because the other ham is new to CW conversation making, and simply doesn't know what else to say. Or perhaps the short-winded ham isn't into making conversation. Personally I enjoy longer CW contacts, called "rag chews".

QSO Template for Beginners

When first starting out on CW, many new hams will often use a template or model, to make sure they send all the essential information. For example:

"______ de WB8FSV TNX FER CALL BT MY NAME IS JACK JACK BT QTH IS HILLIARD, OH HILLIARD, OH BT UR RST IS ___ BT HW COPY?"

And perhaps on your second transmission:

"______ de WB8FSV TNX ______(name) FOR NICE REPORT BT MY RIG IS A KNWD TS 450 ANT IS A DIPOLE BT WX IS ________ TEMP IS ___ BT HW COPY?"

Just fill in the blanks to fit the QSO, inserting your own callsign, name, QTH, and rig. And go on from there as a starting point if you choose. By the way, that strange BT is used in CW as a spacer, a device to separate your thoughts. Some folks will use a period instead. BT is sent in CW as (dah dit dit dit dah). The CW letters B and T sent together.

I feel that a more professional CW technique is to limit the amount of punctuation used during a QSO. Some new hams may send four or five BTs in a row while they think about what they will send next. One or two BTs in a row should be enough. Here is what I mean by limiting punctuation, "TNX DAVE UR RST IS 579 579 MY NAME IS JACK JACK ES MY QTH IS HILLIARD, OH HILLIARD, OH BT HW? N1XYZ de WB8FSV K". There, I got away with using just one BT.

Other Stuff to Talk About

For some beginning hams, and for some experienced hams too, that is all the information they will willingly send to you. You may have to draw out more conversation from them. Kinda like pulling teeth. HI . When I work a new ham on CW I often end each of my transmissions with a question to give the other guy(or girl) something to talk about, to draw them into a conversation. For example, "How many states have you worked? Any DX?" or "Is it raining at your QTH also?" If the other ham mentions something such as their age and how long they have been a ham, you can take that as a hint they would like you to send them back the same information about yourself.

If you live in a small town, describe where it is in relation to a much larger city. Does the area where you live have any unusual characteristics that other hams might find interesting? I often tell other hams that I live on the edge of town - two blocks from cornfields. Or that central Ohio is a flat as a pancake due to glaciers scraping it level 15,000 years ago. Or that Hilliard is Ohio's fastest growing city. What is your town's population? Any famous or semi-famous people born there(besides yourself)? How large is your yard? Where is your radio shack located in your house?

Over the years I have developed a number of topics that I may bring into a CW contact in order to keep the conversation going. Even for me sometimes I just run into a wall, my mind goes blank, and I can't think of what to send next, so these commonly used topics of mine can come to the rescue at times. For example, I'll describe how my cat Rasta often naps on top of my TS 450 rig and I believe that after all these years I suspect my cat understands CW. Or I'll describe what I see at that moment out my basement window. Or talk about how I enjoy collecting stuff(stamps, baseball cards, radios, QSL cards). Or ask the other ham if they have access to the Internet to see if we share a common interest about computers.

I try to send the name of the other ham I am in contact with at least once during each of my transmissions. This frequent use of the other person's name makes for a friendlier QSO and tells them you care who they are. Don't get carried away with this personalizing your comments. Using the other ham's name once per transmission is enough.

When you first start out, any CW contact is fun. It's cool to see how far your equipment will reach, how many states you are able to work. After you have made a number of CW contacts you may discover that the best contacts are those that are different. Not the standard name/location/RST/rig/WX/age/73 type of contact. You may meet another ham who just loves to gab(like me) or who is involved in a different ham activity(such as satellite or packet) and would love to tell you about it, or another ham who may have a lot in common with you such as age, work, or other hobbies. One of the fascinating things for me about making ham radio contacts is you don't know what the other ham is like or how the conversation will develop until you begin.

Standard Operating Techniques
Correctly Reporting RST

Here I am including a few useful topics that didn't fit in elsewhere. For example, what is this **RST** thing? It is a method of giving another ham a signal report and stands for readability, signal strength, and tone. R is on a scale of 1 to 5, and both S and T on a scale of 1 to 9. An RST of 599 would be the strongest cleanest report possible. For really incredibly strong signals some hams will refer to a 20 or 30 over S9, reflecting an S-meter reading. Readability is self-explanatory. R5 is normal, R4 to me means you copy more than half of what is sent, and R3 to me means you only hear a word or two. I have **never** given another ham an R of 2 or 1. Signal strength is pretty subjective, just use your ears to judge. Some new hams use their rig's S-meter to determine the S they report. I don't think this is a good idea. Tone is the most misunderstood and misused report. Only rarely will I give a report less than T9, and then never lower than T8. For example, if someone has a bad AC hum on their signal, key clicks, chirp, or is drifting badly in frequency, I may give them a T8. Giving a tone report of less than T9 may really get the other ham worried about the quality of their transmitted signal, so be prepared to explain what you mean.

The RST report that one ham gives to another often influences the RST report that is received in return. If, at the beginning of a QSO, the other ham first gives me a good 599 report, I find myself more likely to send them back a good report also. I believe we do this subconsciously, it is human nature. As an optimist, my RST reports generally tend towards the positive. Even if it is a contact during which I send the first RST, I may well add an S point or two to the other ham's RST. An S point or so above what I might give if I were brutally honest. I want to begin the QSO on the right foot and make the other ham feel good about continuing the contact.

Not uncommonly when you hear a ham send an RST report, for example 599, they will send the letter "N" in place of the number "9". Or 5NN in this case. This number code is another time saving device used on CW. Or you may hear the letter "T" sent in place of the number zero, "MY POWER IS 2TT WATTS". Each "T" is usually sent several times in length longer than the actual letter T to distinguish it from a T. There is a number code for almost every number, even though the N and T codes are virtually the only ones you will ever hear. Although during the 1998 CQ WW DX Contest I heard many European CW stations report their zones as "a4" or "a5" instead of sending "14" or "15". It saved them several milliseconds of time I suppose. Here is the entire number code, for the interest of those old timers reading this. Its use probably dates back half a century in CW.

1 = a	6 = 6
2 = u	7 = b
3 = v	8 = d
4 = 4	9 = n
5 = e	0 = t

How to Zero Beat Another Station

CW stations should always try to zero beat each other. That means to adjust your rig's transmit frequency to exactly match the transmit frequency of the other ham you would like to talk to. Hearing two CW stations conduct a conversation a few hundred cycles apart is a waste of frequency space, and is inviting QRM. How does one zero beat another station? Easy to do on phone or SSB, just tune so that the other fellow's voice sounds normal. But trickier on CW because when you put your receiver exactly on a CW station's transmit frequency, you hear nothing, zero. In modern transceivers, in the CW mode, the receiver's BFO is offset from the displayed, transmit frequency in order to produce an audible tone. In other words, the transmit and receive frequencies are far enough apart for you to hear a pleasantly pitched tone when your transmitter frequency is tuned to exactly that of the ham you are listening to. This frequency offset is frequently about 600 Hz or Hertz.

Here is how I zero beat another CW station with my own rig, a Kenwood TS 450. I tune into, or sweep through, the other CW signal, the pitch going from high to low, until the other ham's CW signal disappears. Now my receiver is zero beat with the other ham's transmit frequency. But I want my transmit frequency to be zero beat with the other ham's transmit frequency. So then I tune again, with the other ham's pitch going from low to high, until I am 600 Hz away. For example, if the other ham's transmit frequency is 7137.90 kHz, I would tune my transceiver to 7137.30 (7137.90 minus .60 equals 7137.30.) to transmit exactly on his transmit frequency. The direction you tune or sweep, the pitch going either from high to low or going from low to high, is rig dependent. On Kenwood ham radios you would tune the pitch from high to low as you tune higher in frequency, to reach the 600 Hz offset and be zero beat with the others ham's transmit frequency.

This zero beat frequency stuff is pretty weird, it confuses me at times, and I hope I explained it correctly. The frequency offset for CW in most transceivers explains why when you are listening to a CW signal in the tranceiver's "CW" mode, and you switch to phone, to "LSB" or "USB," you loose the CW signal and have to go search a bit for it again.

Using CW Abbreviations and Q Signals

Abbreviations are very commonly used in CW. They save time and are, I think, one reason why CW is so cool. Once you have learned many of the abbreviations as well as CW operating techniques, you are "in", you're a member of the CW using fraternity. Knowing and using CW correctly is kinda like belonging to an exclusive club. Anbody can pick up a microphone and talk on the ham bands; doing CW requires skill and finesse.

Lists of abbreviations and Q signals used on CW are available many places, I will just mention a few of the most commonly used.

ADR	address
GN	good night
RIG	station equipment
AGN	again
GND	ground
RPT	repeat
BK	break
GUD	good
SK	end of transmission
BN	been
HI	the telegraphic laugh
SRI	sorry
C	yes
HR	here
SSB	single side band
CL	closing
HV	have
TMW	tomorrow
CUL	see you later
HW	how
TNX-TKS	thanks
DE	from (French)
N	no
TU	thank you
DX	distance
NR	number
UR	your
ES	and (French)
NW	now
VY	very
FB	fine business
OM	old man
WX	weather
GA	go ahead
PSE	please
XYL	wife
GB	good bye
PWR	power
YL	young lady
GE	good evening
R	received as transmitted
73	best regards
GM	good morning
RCVR	receiver
88	love and kisses

And the International "Q" signals, recognizable in any language:

QRL	Is the frequency busy?
QRT	stop sending
QRM	interference
QRX	wait, standby
QRN	noise, static
QSB	fading
QRO	increase power
QSL	acknowledge receipt
QRP	decrease power
QSY	change frequency
QRS	send slower
QTH	location

Don't get worried about using abbreviations when you are starting out with CW. It is perfectly OK to spell out every word during a QSO. It's just easier using abbreviations. There are many more CW abbreviations and Q signals, but those should keep you busy. There are also a whole series of QN_ signals for use on CW traffic nets. Also used commonly on CW are punctuation marks; the period, comma, question mark and BT being the most common. To separate thoughts or topics during a CW contact a period or a BT (dah dit dit dit dah) are commonly used. You'll hear the slash symbol sometimes (dah dit dit dah dit) to note portable or QRP operation for example. Like WB8FSV/9 or WB8FSV/QRP.

The "K" letter used at the end of each CW transmission indicates, "end of transmission - go ahead". When two hams engaged in a CW conversation do not wish to be disturbed by anyone else breaking in, they may send "KN" instead of "K" at the end of each transmission. Or if a ham wants to limit the extent of his CQ, he may also use KN. For example, "CQ VT CQ VT de N1XYZ KN" says this ham would like to be answered only by hams in the state of Vermont.

Here are a few other commonly heard CW expressions that are actually combinations of letters sent as a single character. You will encounter these CW symbols on the air.

Wait, stand by (AS)
dit dah dit dit dit
Slash (DN)
dah dit dit dah dit
End of message (AR)
dit dah dit dah dit
End of contact (SK)
dit dit dit dah dit dah
and of course, Break (BT)
dah dit dit dit dah

At the very end of a CW contact you may hear the two stations sending dits at each other, this derives from the old expression, "shave and a haircut, two bits". It sounds like dit dit-dit dit dit, dit-dit. The first station will send the dit dit-dit dit dit and wait for the second station to send dit-dit in return. This was more popular on CW years ago, but you will still hear it today. Today it may be shortened to sending just the final dit-dit, as in "73 N1XYZ de WB8FSV GN dit-dit". New hams more frequently use the full dit dit-dit dit dit, dit dit expression than more experienced hams. Not uncommonly when I end a QSO on the novice bands and trade dit dits with the other ham, I may hear a third, or even a fourth station add their own dit dit. They were listening along in silence to our QSO, and decided to add their two bits as well. This is an unprofessional operating habit. If the eavesdropping station wants to make their presence known with a few dits, I believe they should go ahead and tailend one of us, and start a legitimate QSO. Just goes to show that as you transmit on the ham bands, there are likely more than just a few folks listening.

Obscure, Rarely Used CW Characters

To be honest, I have never heard any of these CW characters in 29 years on CW, but it is still fun to know they exist. Do not use them on the air, other hams will not have any idea what you are sending.

Colon [:] dah dah dah dit dit dit

Underline [_] dit dit dah dah dit dah

Semicolon [;] dah dit dah dit dah dit

Paragraph [ ] dit dah dit dah dit dit

Hyphen [-] dah dit dit dit dit dah

Dollar sign [$] dit dit dit dah dit dit dah

Double hyphen [=] dah dit dit dit dah

Multiplication sign [x] dah dit dit dah

Quotation ["] dit dah dit dit dah dit

Addition sign [+] dit dah dit dah dit

Apostrophe [*'*] dit dah dah dah dah dit

Understood [ ] dit dit dit dah dit

Left bracket [(] dah dit dah dah dit

Attention [ ] dah dit dah dit dah

Right bracket [)] dah dit dah dah dit dah

Underline [_] dit dit dah dah dit dah

To transmit a fractional number in CW, send a slash[/](dah dit dit dah dit) between the numbers in the fraction. One half is transmitted as 1/2. To send a number that includes a fraction, transmit a hyphen between the whole number and the fraction itself. 5 2/3 is sent as 5-2/3. To indicate the percentage sign, transmit the figure zero followed by the slash and the figure zero again. Similar to the fraction, a hyphen is used to transmit a whole number. or a fraction, followed by a percentage sign. For example 2 % is transmitted as 2-0/0. To send the minute sign['] or the second sign["] used in latitude and longitude coordinates, use the apostrophe once or twice as appropriate. There are also 12 or more Morse Code characters for letters used in certain European languages which use the Latin alphabet. Thanks again to L. Peter Carron, JR., and his book, *Morse Code:The Essential Language*. The American Radio Relay League, 1991, for these obscure CW characters.

Here are a few of the auxiliary CW characters used with some European languages, thanks to Chuck, KB2E, in his letter to the FISTS Keynote newsletter. "...the German A with two dots over it, Ä, (dit dah dit dah): the Spanish-Scandinavian A with an accent mark, or a dot, over it, Å, (dit dah dah dit dah); the German-Spanish CH (dah dah dah dah); the French E with an accent over it, É, (dit dit dah dit dit); the Spanish N with that wavy line over it that we all know now because of the infamous El Nino, ñ, (dah dah dit dah dah); the German O with two dots over it, Ö, (dah dah dah dit); and the German U with two dots over it. Ü, (dit dit dah dah)." I am uncertain of the precise linguistic terms attached to each of these diacritical marks. whether they be grave, umlaut. or circumflex, but you get the idea. I have never heard them used in CW. but then again I don't work very many Europeans on 40 and 80 meters.

Taking Notes During a QSO, Logging, Using GMT/UTC Time

While I am in contact with another station CW station, I take notes. In fact I write down every word sent by the other ham. Mainly this is because I have a memory like a screendoor in a submarine! But I recommend at least noting the main points made by the other station, so that you will remember what to comment on during your next transmission. I circle with my pen those items I want to remember to bring up next go around.

I am kind of strange in that I save all these notes I've taken during my QSOs, going back 29 years. Really. It is absolutely fascinating to go back through my notes and read, word for word, what I talked about when I was a novice 28 years ago. Kinda like a ham diary. By FCC regulations we are no longer required to keep a log of the radio contacts we make, but I **highly** recommend it. Not only for QSLing purposes, but so that you can look up when in the past you worked a familiar callsign. And looking through your old logbooks will bring back lots of pleasant memories of QSOs gone by. I keep copious notes in my logbook, beyond the standard date, time, frequency, callsign, RST, name, location, to help me remember what was special about each contact.

I fill out as much information as I can in my logbook at the very beginning of each QSO. This saves me time and, if I accidently bump the VFO dial during the QSO and change frequency, I can use my logbook to look up my original frequency. Or you can use your frequency lock control if your rig is so equipped. My cat Rasta has been known to jump up on my desk while I am QSOing and rub against my VFO before I can stop him. Perhaps my cat did not like the other ham's fist. HI.

After you have been on the air a while, another ham will someday surprise you during a QSO by using your name before you give to them, or asking if your old Heath DX 60B transmitter is still running. How did they know your name or about your rig? Turns out you have worked this ham before but forgotten, and they either have a very good memory, or they keep their log on a computer. I would love to put all 29 years of my ham contacts in a computer database, but whew! The data entry would take months. If you are just beginning your ham career and have a computer, then get some logging software.

Hams should always use GMT or UTC time when logging and keeping records. Try to keep a schedule set up for 8 pm with another ham who lives in a different time zone. Do you meet at 8 pm your local time or 8 pm their time? No problem if you both use UTC time. Always fill out QSL cards using UTC time. Do not use 24 hour military time. Confusion often arises when you make a ham contact close to 0000 hours UTC. Because in UTC the date changes at 0000 or midnight UTC. What date do you put on your QSL card? Use the UTC date. I frequently receive QSL cards from new hams with the correct UTC time but the wrong date. They have grown up accustomed to the date changing at midnight their own local time.

Keeping track of the current time in UTC takes practice. You could tune your receiver to a time standard station like WWV or CHU to determine the current UTC. Clocks are available that tell time in UTC format. Or you could, like me, just memorize your local/UTC equivalents. You can make a little chart with your local/UTC equivalents. You will need to make two such charts since local/UTC equivalents change twice a year, with the switch between daylight time and daylight savings time. This twice yearly switch pretty much takes place all over the world, not just in the United States.

Identifying as per FCC Regulations

Speaking of FCC regulations, amateur radio operators are required to identify themselves on the air by transmitting their callsigns. At least every ten minutes. I believe it is also a good idea to identify at the beginning and end of each of your transmissions as well, even if less than ten minutes has passed. You will hear some experienced CW operators taking turns transmitting during a QSO without IDing. For example:

- first station "WHATS UR WX LIKE? BK"

- second station "SUNNY ES COOL. HW ABT U? BK"
- first station "MONSOON HR, RAIN ES 70 DEGS..."

No problem as long as they ID every ten minutes. If band conditions are poor or there is lots of QRM, IDing at the beginning and end of each transmission is wise, or the other station may not realize you turned it over to them. Easy way to completely loose one another. To save time I will sometimes end my transmissions with only my own callsign, like "HW COPY? de WB8FSV K". Cool, as long as every ten minutes I start or end one of my transmissions with something like, "WHAT SAY FRED? N1XYZ de WB8FSV K"

Dealing With QRM and QRN

Characteristically, when listening to shortwave radio frequencies, which include the most popular ham radio bands, you will hear noise, static, interference, and fading. They sometimes make reception of ham radio signals difficult, sometimes downright impossible. I view them as a challenge. I call them the three dreaded Qs: QRM(interference), QRN(noise and static), and QSB(fading). With experience and practice you can learn to deal with the three dreaded Qs and enhance your enjoyment of amateur radio.

First let me discuss QRM, probably the most frequently encountered and most disturbing of the three Qs. And the only one you yourself can help reduce by your own radio operating habits. QRM is a fact of life on the ham bands, get used to it. Try to plan your operating methods so that you cause as little QRM to other hams as possible, and everybody will be happier. There are technical means to help alleviate QRM: passband filters, audio filters, DSP and RIT. For example your RIT(receiver incremental tuning) can be used to "tune out" QRM. You can move your RIT away from the interfering signal until it is nearly out of your receiver's passband tuning range, leaving just the signal you want to hear. I have found that even when there is no QRM, moving my RIT a little bit changes the tone of the signal I want, often improving reception.

With practice you will be able to eventually, with your ears alone, "tune out" many of the interfering stations and concentrate on the signal you want. Most QRM from other hams is unintentional. If you find someone intentionally QRMing you, playing games with you, the best advice is to ignore them. Do not acknowledge their presence in any way or you may encourage them to continue. Ask for a repeat, change frequency, sign off if you have to. I would not mention anything about "QRM" or "SOME LID".

Sometimes when I answer a CQing station and that station is unable to copy me, perhaps due to QRM near our frequency, I will then call them a second time after changing my transmit frequency a few hundred Hertz. That small change may allow the other ham to now hear me through the QRM. The same thing is true if some QRM suddenly appears during your QSO. Although don't QSY too far, or the station you are talking with may lose you.

You and the other station may both agree to QSY(change frequency) to escape some QRM. Be careful. Successful QSYing on CW is quite difficult. For me it works about fifty percent of the time. Quite often you will lose each other. QSY during a CW QSO with caution. Be careful to state exactly where you would like to QSY, say up 2 kHz, or to 3715 kHz, rather than simply stating, "let's QSY up" somewhere.

Another practical use to having dual VFOs in your ham rig is that you may be able to use them to chase off QRM. Sometimes during a QSO I will put both of my transceiver's VFOs on my same operating frequency. Then tune the inactive VFO a few hundred cycles(or Hertz) up or down in frequency. Whether you tune up or tune down a few hundred cycles depends on the direction that your rig's receiver "sweeps" as you tune. My Kenwood sweeps or changes pitch from high to low as I tune higher in frequency. During my QSO if I hear another ham call "QRL?" to see if the frequency is clear, I will interrupt my own QSO for a few seconds, switch to my second inactive VFO, and transmit a quick "C", meaning, "yes this frequency is in use." I could have remained on my original frequency and sent my "C" in answer to his "QRL?" But it is likely the QRLing ham would not have heard my answer due to the narrow passband of his receiver(in other words he is too far away from my transmit frequency) or due to the direction of the sweep of his own receiver. By leaving my second inactive VFO a bit off of my own transmit frequency, I can protect a larger area of frequency space around myself from potential QRM. Again, please do not answer a CQ if the CQer is too close(within a kHz or less) to an ongoing QSO in order to avoid QRMing the other QSO.

One very annoying, for US hams, form of QRM is the shortwave broadcast stations found most evenings throughout the 40 meter novice band. We have to share the band with them, I like to view it as a challenge. There will be times during a QSO when one of these broadcasting stations will sign/on and begin transmitting on or very close to the frequency you are talking on. First you will hear their unmodulated carrier as they tune up, followed by their interval signal. Then usually at the top or bottom of the hour, the broadcast station will begin their official broadcast with their national anthem. Then the news. Quite often you will lose all trace of the other ham you were in QSO with as soon as the broadcaster opens up with their carrier. Sometimes you can still hear each other through the unmodulated carrier, but you had better quickly say your 73s before the music starts. A few times I have been able to continue a contact as long as the broadcast station does not transmit music. If the broadcast QRM on 40 meters is just too much for you, there is always 80 meters. Or switch your ham receiver to the AM mode and delve into the fascinating world of shortwave broadcasting.

QRN refers to noise heard on shortwave radio. There are basically two types of QRN, natural and manmade. Natural QRN is the static generated, for the most part, by thunderstorms. The radio static, or QRN, generated by thunderstorms travels great distances via skip, just like radio signals on shortwave. At any given moment you may be able to hear the static from dozens of storms, hundreds and thousands of miles away. At a given distance from a radio station on shortwave there is a dead zone, which the radio signal skips over. Same thing is true for thunderstorm static. I have been on 40 meters CW while I knew there was a thunderstorm nearby, and heard no static. I was in the thunderstorm's dead zone, its static was skipping over me. Other hams I then contacted were barely able to copy me through the static, although I heard them fine. Pretty weird. There are many more thunderstorms during the warm summer months, meaning that winter provides the best reception on the 40 and 80 meter ham bands. Both thunderstorms and static decrease in number and intensity with nightfall. Rarely, during a particularly intense solar disturnbance, the shortwave radio frequencies will go dead. All you may hear is a continuous rushing noise or QRN caused by the solar disturbance.

Man-made QRN comes from many sources, including automobile engines, electric motors, fluorescent lights, electric fences, loose wires on electric power lines, and lawnmowers. Other QRN is purposely broadcast on shortwave radio frequencies, such as over-the-horizon radar and high speed RTTY. It becomes what we call QRN when it is broadcast by nonhams on ham frequencies. A good noise blanker or a ham radio equipped with DSP may help reduce this noise. Before I purchased my current home, I walked the property with a portable SW radio receiver tuned to 80 meters, to determine if there was any man-made QRN inherent to the site. I heard no local QRN, so I bought the house.

HAARP QRN?

I have been hearing an interesting form of QRN on the 40 and 80 meter bands for the past several months (Oct, Nov, Dec 98, and Jan 99). A very regular and periodic QRN that builds up gradually, holds at a peak for about 30 seconds, then abruptly disappears. Followed by no QRN for about a minute and then again the gradual buildup, etc. This cycle repeats for hours at a time. It is not heard every single evening, but more often than not. In my CW converstaions I have discovered that this periodic QRN is being heard all over the East Coast and Midwest of the US, although not as well on the US West Coast. Have you heard this mysterious noise? My guess is that perhaps the source of this QRN is that gigantic government HAARP transmitter up in Alaska. The government is beaming megawatts of radio energy straight up into the atmosphere to research the ionosphere. I wish they would stop.

Oh yes, and then there is QSB, or fading. This is a natural phenomenon, one of the mysteries of radio propagation. How QSB works is not difficult to understand. Why it occurs is the mystery. There seems to be at least a little fading present on most shortwave frequencies, particularly at night. The duration and depth of the fades can vary widely. Just another challenge to make your ham radio operating and shortwave radio listening more interesting.

Repeating Info Due to QRM

It is important to ensure that the ham you are in contact with is able to copy at least the three essential items of the QSO: your name/location/RST. So normally in any CW contact these items are repeated twice, "UR RST IS 579 579 BT MY NAME IS JACK JACK" etc. If the band conditions are stinko, three repeats might be in order, of at least the name and RST. For the rest of the contact, in bad QRM, QRN, or QSB, hams have been known to employ one of two other repeating techniques. One would be, "MY MY WX

WX IS IS CLOUDY CLOUDY" and the other technique is, MY WX IS CLOUDY MY WX IS CLOUDY". I normally use the latter.

You can tell that the other ham you are in contact with is experiencing QRM if they tell you, if they ask for lots of repeats, if they get your name or callsign wrong, or if they hesitate long seconds before returning to you after you complete a transmission. If the ham you are talking with sends many more repeats than normal, you can assume they are hearing QRM on your signal, and they probably would like you to use many repeats as well. If I believe my signal is being stepped on, I will send the other ham's name more frequently than I normally would, to assure them that at least I can copy them. For example, "TNX DAVE BT MY WX IS LOUSY BT DAVE HW IS UR WX? HW COPY DAVE? N1XYZ de WB8FSV K". Even in very heavy QRM folks are more likely to pick out their own name or callsign out of the muck. Occasionally you will work another ham on CW who refuses to copy your callsign correctly. Usually you can correct them by repeating your callsign frequently at the beginning and end of your transmission. Or if that doesn't work, try, "MY CALL IS WB8FSV WB8FSV NOT WD8FSU". Amazingly a few hams on CW will continue to use your incorrect callsign regardless of what you tell them.

Correcting Mistakes in CW

Everyone occasionally makes a mistake while sending their Morse Code. Sometimes your key or keyer seems to have a mind of its own. The most common method to correct a mistake is for the sending station to send a rapid series of dits, like the number five with a few extra dits added. Eight dits is the recommended number of dits, although no one is counting. And to then send the correct CW character or word. This is fine. Personally when I send a mistake **in the middle of a word**, I don't see the need to emphasize it with the rapid dits. I simply pause and then send the correction. The station you are talking with is copying along with you, letter by letter, and they probably realize as soon as you that you have made a mistake. I feel it is more professional to use a pause rather than the rapid fire dits.

But, if I make a mistake at the beginning of a word, the other ham copying along with me has no idea I have made a mistake. So in this case a device is needed to signal that a mistake has been made. I prefer to use a question mark rather than the rapid fire dits. Another CW device you may hear less often to indicate a mistake is "dit-dit", like the CW letter I, sent once or twice after the mistake and before the correction.

You will hear some hams use a question mark to signify that they are going to repeat a word, even if they have not made a mistake. For example, "MY NAME IS JACK? JACK". This use of a question mark is frequently employed to indicate the repetition of a difficult or unusual word in a CW radiotelegram by CW traffic handlers.

How Long Should the Contact Last?

Talk as long or as short as you like. Most CW contacts on the novice bands seem to last about half an hour or so, which mean that they rarely get beyond the standard name/location/RST/rig/WX/73 stage. That is perfectly OK. I myself like to talk a bit longer. For me, a good CW rag chew generally lasts around an hour, sending and receiving at about 13 wpm. My longest CW contact ever was a 3 1/2 hour marathon, but after the second hour we began trying to stretch it out to see how long we could go! At about 10 wpm(words per minute), a common speed on the novice bands, it can easily take half an hour just to send the name/location/RST/rig/WX/age/73 info. Normal human verbal conversation is around 120 wpm; so a SSB or phone QSO of half an hour would cover a lot more ground than a CW QSO of half an hour at 10 wpm.

How Fast/Slow Should You Send CW?

Normally, adjust your code speed to match that of the other ham you are talking to. This is especially true if you answer another ham's CQ or tailend a conversation. People commonly send a CQ at the speed they would like to be answered. If you answer a person CQing at say, 15 wpm, and you send at 10 wpm, the CQer generally will be polite and slow down to your speed. This does not always happen, so be careful about answering a CQ sent by a CW speed demon. Normally a "PLEASE QRS" (please send slower) sent to the other station will elicit the correct response from them, and they will slow down.

It is easy, especially with an electronic keyer, to send faster than you are able to comfortably receive. Try to match your send speed to that of your receive speed. With practice your speed will improve. Making CW contacts is a great and fun way to increase you code speed. Another tip is to occasionally stretch yourself, try to copy CW at a slightly higher speed than you are comfortable. Do not do this during a QSO you are having when you are under pressure to copy everything correctly. But just listening around the band. Participating in slow speed CW traffic nets is another neat way to help you increase your code speed, and perform a public service at the same time.

You'll discover a wide variety of CW speeds on the novice bands. Most folks go slow, less than 15 wpm, but you will hear hams going over 30 wpm also. They may go fast to show off, or perhaps there are no more clear frequencies available in the general bands. Some speedy novices and techs may be experienced CW operators, perhaps they were hams years ago and were recently relicensed, or learned CW in the military or merchant marine and just now got into ham radio. Also the 80 meter novice band was moved a few years ago and now includes frequencies used by higher speed CW traffic nets. You will frequently hear them in the early evening between 3675 and 3700 kHz. Many of the hams you encounter on the novice bands will be novices and technician-pluses, but there are a number of general, advanced and extra class hams to be found also. They may feel more comfortable doing CW at slower speeds or they may, like me, simply enjoy working new hams. I have been lucky in my 29 years as a ham to have been the very first contact for over 80 hams now.

How Do You Gracefully End a QSO?

It's no big deal, many hams will just send, "TNX FOR QSO 73" or "GOTTA GO TNX 73" and sign off. That is fine. Myself, I like to leave a bit more politely, such as, "DINNER HR 73", "I GOT A PHONE CALL, CUL", "TIME HR TO QSY TO BED", "MY

XYL IS YELLING, TURN OFF THAT RADIO AND DO SOMETHING USEFUL", or "SRI ED MCMAHN IS AT MY DOOR WITH 10 MILLION DOLLARS 73".

There will be times when, after several exchanges, you realize that you just don't want to talk to this person anymore. You could, as I have heard some hams do, just disappear. But I think having a few tactful excuses for leaving to choose from is a good idea.

It is not uncommon that QRM will grow to the point that it is impossible to copy the other station you are in QSO with. Some hams in this case will just give up and stop transmitting. I would recommend instead that you at least send a 73 and sign off properly. Don't leave the other ham wondering what happened to you. On your end you may not hear anything except QRM, but perhaps the other ham you were talking with still copies you fine. Maybe the QRM is one way, skipping over his location. If the QRM or QRN or QSB just destroys a QSO I am involved in, I will send something like, "SRI DAVE NO COPY NO COPY QRM QRM 73 73 N1XYZ de WB8FSV."

Occasionally during a QSO, the station I am talking to simply disappears. Maybe they have rig problems, an important phone call, or the irresistable call of nature. Try not to simply disappear. If another ham vanishes during a contact with me, first I will send a friendly, "DAVE?", and if no answer, then send, "N1XYZ de WB8FSV K" once or twice before I give up. Even then I leave my VFO on the same frequency a few minutes while I fill out my logbook and the QSL card, in case the ham reappears.

A Typical Evening for Me on 40 meters CW

Choosing My Band

After turning on my rig, getting comfortable in my chair, opening my logbook, and pulling out my scratchpad, I choose my band. I personally enjoy 80 and 40 meter CW, particularily 40 meters, so I will search between 7100 and 7150 kHz. 80 and 40 meters are noted as good rag chewing bands, as are 160 and 30 meters. Starting at 7100 I slowly turn the dial of my transceiver, stopping at each CW signal I hear. I will listen a few seconds, long enough to determine if the station is sending a CQ, or is already engaged in a conversation. I am looking for a CQ to answer, the way in which I usually begin a CW contact. Since I am not a novice or technician, I almost feel like an intruder in the novice bands, and would much rather answer than send a CQ here. Although if I am unable to locate an interesting CQ after searching for 15 or 20 minutes, I may go ahead and call my own CQ. Or perhaps search the general CW frequencies, or switch bands, or go watch TV. HI.

Scanning for CQs

A full scan from 7100 to 7150 kHz for CQs might take only a couple minutes, particularily at night when the 40 meter band will be filled with powerful SW broadcast stations, rendering big chunks of the novice band unusable. Activity on 40 meters at night is usually limited to a few small relatively clear areas in between the broadcast stations. For example, now the regions around 7108 and 7137 kHz are often clear most evenings. Several years ago 7125 kHz was always available at night, not now- this is because the SW broadcast stations periodically change their operating frequencies and schedules. A scan of the 40 meter novice band in the daytime may take longer with the absence of the broadcast stations and with more hams. Weekends on 40 meters can get quite busy.

In most of the world the 40 meter ham band stretches from 7000 to 7100 kHz, and 7100 to about 7500 kHz is used as a shortwave broadcast band. Only hams in North and South America are able to use the full 7000 to 7300 kHz. And only in the United States is 40 meters divided into different phone and CW segements. Hams in Canada and in South America can use CW or phone anywhere within 7000 to 7300 kHz. This explains why you can hear Spanish speaking SSB phone stations some evenings in the 40 meter novice band. This is a good indication of band conditions, how 40 is often open deep into South America in the evenings. When the band conditions are good, you may even hear European or Asian SSB stations just below 7100 kHz.

Once I discover a CQing station, I first determine if that ham will be able to hear or copy me. If the CQer is relatively weak, chances are they will be unable to copy me. Generally the stronger the station you hear, the greater the chance they will hear you in return. Radio propagation is usually two way. Not always. Sometimes it is fun to call a weak station just to see if your rig can reach them. Perhaps the other ham's signal is weak because they have a less than optimal antenna system, such as a dipole in their attic. Or maybe they are using QRP(low power). After scanning the band for a while and perhaps making a few calls, you will be able to judge the condition of the band. Is the skip long or short? Is the band open to the West Coast, south to Florida, or not at all. Occasionally I will turn on my rig, listen a bit, try to answer a few CQs to no avail, make a few fruitless CQs myself, then give up and go play on the Internet. Particularily true during the last few years with the bottom of the sunspot cycle upon us. The next sunspot cycle, Cycle 23, is just now beginning and radio propagation conditions are slowly improving.

Do I Want to Answer this CQ?

But, let's say I hear a strong CQ. Next I determine if I want to answer this CQ. Since I enjoy working new hams, a ham with a new callsign gets first priority by me. After you are on the air a while, you can pretty well guess how long a ham has been licensed by just their callsign. Usually, I am attracted by certain types of callsigns. For example a one by two call, like W8TZ, is usually an old timer. They often enjoy rag chewing and are full of fascinating ham stories and experiences. Callsigns that form words intrigue me, such as KA4TON or N3HAM, or callsigns that are similar to mine, like KB9FSW. In 27 years on the ham bands I have worked only five other FSV callsigns: W3FSV, KA1FSV, VE3FSV, WB4FSV, and WA0FSV. I treasure those QSL cards. My wife and I love New England and my ears always perk up when I hear a 1 district callsign. From Ohio I seem to have a pipeline into New England, meaning I find it quite easy to work New England hams.

Often when I hear a CQ, I will quickly look it up in the Callbook, to discover what city the ham is calling from. Perhaps it is a city or state I have visited or vacationed in, have friends or family in, have a favorite sports team in, in other words have some connection to that we can talk about in our potential QSO. My computer is upstairs and my radio room is downstairs, so I cannot access a CD callsign database. Therefore I use a printed Callbook. Even a Callbook a couple years old helps I believe. It enhances my ham radio operation by allowing me to discover a little more information about a ham before I decide to answer their CQ. Unfortunately 1997 is the last year that printed Callbooks will be available. Too bad, it is the end of an era. Of course after I have completed the contact, and am filling out the QSL(I try to QSL **every** contact), I use a callsign server on the Internet to get the ham's current mailing address.

Not having a printed Callbook or access to a callsign server is perfectly OK. It just means you will wait a few moments longer to discover to whom you are talking. The suspense can be exciting. You can still QSL the other ham by asking them to send you their mailing address over the air, or to send you their card first.

Making a Contact

So now I've decided to answer the CQer and establish a contact. A one by two call should be sufficient on my part. Although if band conditions are lousy, something like a one by three or a two by four might be more appropriate. I have already made sure my rig is tuned up and ready to transmit. Your ham transmitter must be tuned so that there is an impedence match between the transmitter and the antenna, ensuring the best possible transmitted signal. Many modern transceivers include an automatic antenna tuner which makes tuning a breeze. When tuning up your rig do it as quickly as possible so you don't cause unecessary QRM to others. Even if you use an automatic antenna tuner you are transmitting a weak but audible CW signal over the air. Tuning up without an automatic antenna tuner usually means you are transmitting a very strong carrier over the air. Make it short please. Actually you should be using a dummy load to tune into, so that you are not heard over the air. If you must tune up on the air, try to do so on a clear frequency, or perhaps on top of one of those 40 meter shortwave broadcasting stations.

And the CQing station comes back to me. Hooray! It's a KF4 station in North Carolina, a ham I worked about a month ago. The callsigns in this story have been changed to protect the innocent. HI. He doesn't remember me, but his callsign and QTH seem familiar, so I look in my logbook and find him. On the average I make about 20 CW contacts a week, mostly on 40 and 80 meter CW, so I commonly hear and work the same stations more than once. After we exchange the standard name/location/RST, I ask him if he has received my QSL card yet and how many states he has worked so far. He remembers our previous contact. During our first QSO the KF4 had only been on the air for a couple weeks, and at about 10 wpm and with lots of mistakes, the minimal name/location/RST was enough to deal with. Now on our second contact we are able to find out more about each other. Hey neat, he is into computers also. We swap e-mail addresses and I tell him about my homepage. I will e-mail him tomorrow and send him the address of my homepage. Sending http addresses on CW is not easy. I am forever having to explain what a tilde is. My KF4 friend in North Carolina says thanks for the FB QSO but it is almost his bedtime. I send him some of my famous personalized QSO ending lines, and we both sign.

Some hams on CW soon develop several of their own personal phrases or expressions to liven up and personalize their QSOs. There are the standard CW phrases that everyone uses such as, "HOPE TO CUAGN. NICE TO MEET U, BEST 73 TO U ES URS". These are perfectly OK, but I like to use some of my own unique CW expressions. "RAIN HR, GREAT STAY INSIDE ES HAM WX or ENJOYED QSOING WID U or HELP QRM ATTACK!". To hear my best ones you will have to work me on the air. QCWA magazine(Quarter Century Wireless Association) regularly prints many of the humorous CW expressions that its members have heard on the air.

It is almost my bedtime also, but I would like to squeeze in one more CW contact. So after logging my KF4 contact I begin another band scan for CQs. 40 meters tonight is pretty noisy and filled with three very loud SW broadcast stations, normal. I've been looking now for fifteen minutes after my contact with the KF4 station, and found no CQs. Each time I have scanned across the novice band I noticed the area around 7145 kHz is clear. Perhaps I will call CQ here myself if I can't find any other CQs. But then I do hear a weak CQ from a new ham, a KC2. He is pretty weak, meaning I may well be weak to him as well, but I answer his CQ anyway. There isn't much else going on. Low and behold, he comes back to me.

He does not have a very good fist, his CW spacing is way off, he makes a lot of mistakes, and his CW operating technique needs work. But I am still able to copy about 75 percent of what he sends, and make a good guess at the rest. I copy, "THIS S TY FERST QSO". I am his first contact. Infinitely cool. My favorite kind of contact. I live to make first contacts. My new KC2 friend only sends his QTH once, half of which I loose in the QRM, and he forgets to send his name and my RST. Still I believe it was a fairly successful first QSO. The contact took about 45 minutes, mainly since we were working at less than 5 wpm and I sent many repeats of my information.

I have a great deal of patience with new hams. After all we were all new hams at one time. Most hams well remember their first contact. My own first contact was at 5:30 pm on Feb 6, 1970 on 15 meter CW with a WB8 station. It was a local ham across town. I had to telephone her to ask her to listen for me on the air. I had been calling CQ for two days with no answers. Later I discovered that a vertical antenna mounted on the roof needs to be grounded. This was news to me. After I put some radials on my vertical I began to get lots of answers to my CQs.

It is getting late and the KC2 and I both sign off. I fill out my logbook and a QSL card for the KC2, including a short letter congradulating him on his first contact. Time now to QSY to bed. I turn off my Kenwood TS 450, and **disconnect the antenna.** The end of a most successful ham radio day. In two evening hours I have renewed acquaintances with an old ham friend and made a new ham friend. What a neat hobby!

Straight Key, Electronic Key, Bug, or Computer Keyboard?

There are basically four types of devices used by most hams to send Morse Code. The straight key, also called the hand key, as well as the electronic keyer, the bug, and the computer keyboard. My favorite is the straight key, which I use 90 percent of the time. The straight key is more natural, more organic, and so is the resulting code. Learning to use a straight key well is not easy, it takes a great deal of practice. Pounding brass well with a straight key is an art. I am far more impressed when I hear an excellent "fist" on a straight key than I am with near perfect code sent with an electronic keyer.

I own two electronic keyers which I use mainly when I want to send faster speed CW. 15 wpm is about the top speed you can send intelligible code with a straight key. Although I have heard hams send good CW at 20 to 25 wpm with a straight key- it amazes me they can send that fast. Learning to use an electronic keyer, while it takes practice too, is easier than learning to use a straight key well. Once you have mastered the electronic keyer, using it can be a real pleasure. To effortlessly and gently squeeze those two paddles and produce near perfect code is one of the great joys of CW. I still prefer the organic/natural sound of a straight key fist to the mechanical sound of an electronic keyer. Hams using a straight key have a fist with personality. On an electronic keyer your fist sounds like everyone else's. Usually. Some new hams have difficulty sending with a keyer. I believe learning to send CW first on a straight key before switching to an electronic keyer is a wise method.

Speaking of personality, that to me is the biggest advantage to using a bug. Although a bug also produces code mechanically, the operator has complete control of the length of their dahs. This gives the ham the ability to send with their own distinctive fist, or "swing". Unfortunately, learning to send well with a bug takes years of practice, and a bug is notoriously difficult to adjust. Using a bug well is a challenge, almost like playing a musical instrument. After practicing on my own bug for five years, I developed a passable fist, until last year when my cat knocked my bug off my desk onto the floor. It hasn't sounded right since then. I hope my cat Rasta is not a no-code cat. After listening to CW stations for a few years, identifying the distinctive "swing" of a bug user is easy. When you hear someone sending good code with a bug, you are listening to a CW Master, a highly trained expert who has honed their CW skills through years of patient determined experience. In the hands of such a CW Master, a bug is capable of producing beautiful enchanting Morse Code.

A quick word about sending CW with a computer keyboard. Some Morse Code challenged hams use this method to generate and send CW. But for the most part I don't like computer generated and decoded CW. For me, using a keyboard is not "real" CW. Even worse is to use a Morse Code reader that decodes and prints out the code for you. A traditional amateur radio operator sends and receives CW using their own senses and faculties. I find computer generated and decoded CW too mechanical and impersonal. But at least it is CW.

FISTS - A Cool Club for CW Operators

There is an international organization dedicated to promotion of the use of CW in the ham bands. This group or club of hams is called **FISTS**, and is also known as the International Morse Preservation Society. I have had great fun since I recently joined FISTS. At times it is difficult to find another ham to talk with on CW. The FISTS club promotes several ham radio frequencies, those for example ending in 58: 14058, 7058, or 3558 kHz, as places to find other FISTS members to rag chew with. Another aim of FISTS is to encourage friendship within the club membership, which they do in part with these CW calling frequencies. I love to rag chew on CW and it is great knowing where to find others with the same interests. They also offer several awards for working 100 members and for working at least one member in each of the 50 United States. There are over 6000 FISTS members now, but finding one in each of the 50 US states is quite an undertaking. Only 4 hams have achieved this award so far.

Not long ago I worked my 100th FISTS member and qualified for my Century Award. Cool. Took me seven months. As much fun as working new FISTS members and adding to your total, is running into folks you have already worked and deepening friendships. After a couple QSOs you learn each others' names without having to look them up in your log. Of course you do not need to be a FISTS member to do this, but FISTS folks seem to me to be friendlier and more likely to rag chew.

Neat FISTS Story -

I was lucky to have been able to attend the 1998 Dayton Hamvention, May 15-17. Actually since I only live 72 miles from Hara Arena in Dayton where the Hamvention is held, I have attended every year for nearly 24 years now. I know how fortunate I am. This year I made it a point to attend the FISTS party Friday evening, hoping to put faces to some familiar calls. There I met Geo, G3ZQS, the founder of the FISTS organization, FISTS number 01. He came all the way from England to the Dayton Hamvention and to meet FISTS members. Neato. I drove home later that evening, and, still full of radio enthusiasm, I got on the 7058 FISTS frequency about 10 pm. After one FISTS QSO I heard a weak CQ FISTS and discovered it was Geo, operating as W8/G3ZQS. Using a friend's rig Geo was operating from his hotel room with a whip antenna on a truck bumper. It was quite a thrill to finally work Geo on the air, particularly since I had just had an eyeball QSO with him. A mini FISTS pileup on Geo thereby ensued.

How to Get Zillions of QSLs

My second favorite ham activity, after rag chewing, is collecting QSL cards. Guess it's because I love to collect stuff. I average one or two QSLs in my mailbox every day. One important secret to successful QSLing, at least among US hams(not DX), is to send your QSL card out first. If you wait for the other folks you work to send you their cards first, you can expect to receive at best one QSL for every ten contacts you make. One out of 20 is more likely. I try to QSL every single contact I make. I realize that can get expensive postagewise, but to me it is worth it.

Another important secret to QSLing is, I believe, to personalize your QSL card. Be sure to put a note from you on the QSL, with as much personal information as space permits, about what you discussed in your contact. My own QSL card contains all the required information just on the front of the card. leaving the back free for me to fill up with my personal notes to the other ham. My own QSL cards are homemade. I drew the picture on the front, and I print them on the copier at my workplace(don't tell my boss). This further personalizes my cards. I always mail my QSL inside of an envelope, thus ensuring my card arrives relatively unfolded, smudged or otherwise mutilated. I think folks appreciate a QSL in undamaged condition, and I seem to get more returns that way. Again the postage costs more for an envelope, but that is the reason I go to work every day. To make money to pay the electric bill so that I can ham, and so that I can pay all that postage. HI.

Finally, if there is a ham station from which you really need or want a QSL card, such as in Vermont or Hawaii, I would include a first class postage stamp with the QSL inside the envelope. Thus the other ham has one less reason not to return his or her QSL to you. An SASE(self-addressed stamped envelope) sent to the other ham is also a good idea, saving them the trouble of writing out your address. I myself do not usually send an SASE, because hams occasionally have oversized QSL cards that may not fit inside the SASE envelope you send them. Hams who live in rare states like Wyoming I'm sure are overwhelmed by QSL requests, and sending them return postage or an SASE increases your chances for their card. A connection to the Internet and a callsign server is an asset. An up to date address to which to send your QSL is a must.

Some hams who live in a small town regularly give the name of their QTH as that of a nearby larger city so that other hams will know where they are located. Not a good idea. Be proud of your own small town. If the QTH you give over the air does not match your mailing address(the address in the Callbook or callsign server), you may confuse hams when they later try to mail you their QSL card. They may decide not to send you their card.

Keeping accurate records of to whom you have sent, and from whom you have received QSL cards is important. Your logbook is a convenient place to do this. Sometimes I receive two QSLs from a ham for the same contact. They first mailed their card to me. But when they later received my QSL they could not remember, or had poor records, of whether they had sent me their card. So they mailed me a second card to be sure. I suggest filling out the QSL card that you intend to mail very soon after you make the contact. The QSO will still be fresh in your mind so that you are better able to write personal comments on the card, and so that you are more inclined to fill out and mail the QSL. Don't wait until you have a large stack of cards to send. QSLing then becomes more of a chore than a pleasure, and less likely to get done.

When you first begin to receive QSL cards, it is fun to display them up on your wall, in those clear plastic containers commonly available. After you have received a large number of QSLs, it becomes necessary to store them in a convenient place. Convenient because you well may wish to look up an old QSL card months later if you work the station again. Finding an old friend's QSL while you are QSOing them can enhance the contact. I keep my QSL cards in shoeboxes. I have filled six shoeboxes now. For quick easy access I keep the cards organized by US call districts 1, 2, 3, etc., and then by callsign type, KA1s, KB1s, N1s, WA1s, WB1s, K1s, W1s, etc. This is the next best method for keeping your cards organized and findable, short of keeping a computer log.

I feel my QSLing methods are fairly successful. I get about a 75 percent return rate on the QSL cards that I send out. New hams generally QSL better than more experienced hams. CW operators generally QSL better than phone operators. Jack Wagoner WB8FSV

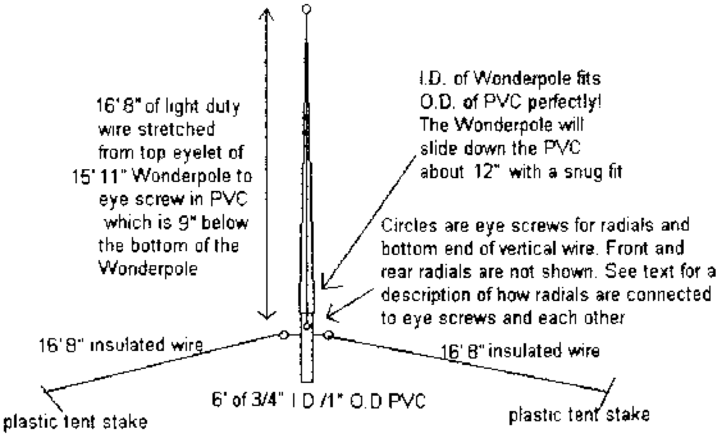
The 20-Meter Wonderpole

by Joel Kluender, NF9K
870 Prairie St. S.
Shakopee, MN 55379

In preparation for a backpacking trip to Montana which I'm planning for next summer, I wanted to come up with a 20-meter antenna for use in the field. I had four main objectives: (1) It had to be cheap, because I can hardly afford the trip in the first place. (2) It had to be lightweight (to be carried while backpacking at 9000 feet+ elevation!); (3) It could not rely on any trees or other natural structures for support; (4) It should be easy and quick to erect (< 15 minutes) What I came up with is a way to construct our old friend the quarter-wave ground-plane vertical in a way which meets all of the above objectives. Below are instructions on how to construct it.

Go to your local hunting/fishing store and buy a Shakespeare 16' Wonderpole crappie rod. This is a hollow telescoping fiberglass rod which weighs a hair under 1 lb. and extends to nearly 16 feet long (mine measures at 15'11"), and collapses to 3' 10". This is the most expensive part of the antenna - mine cost $15.99. Buy 4' and 2' sections of ¾" I.D./1" OD rigid PVC which can be joined at one end (if you are not concerned about length for backpacking, you can use a single 6' piece). Extend the Wonderpole to its full length, and remove its bottom screw cap. Slide the Wonderpole over the PVC until there is a snug fit, around 1' of overlap. You now have PVC + Wonderpole which when joined together are around 21' in length. Take a 17' 2" piece of light duty wire and twist-tie it to the top eyelet of the Wonderpole with 2" of the wire. I used a non-insulated stranded copper wire which is very light so that it does not weigh down the floppy tip of the Wonderpole. From the top of the pole, measure 16' 8" down and mark the spot, which should be around 9" below the bottom of the Wonderpole. Pre-drill a hole in the PVC and install a small eye screw. Twist tie the bottom end of the vertical wire to the eye screw with 2" of the wire. You should now have a 16' 8" vertical radiator which is just right for the 20-meter CW band. Predrill 4 more holes and install four more eye screws evenly spaced around the perimeter of the PVC ¾" below the eye screw of the vertical element. Using a short stretch of non-insulated wire, short the four radial eyescrews together with few winds around each screw (solder if you like - I didn't). Cut four 17' 4" lengths of lightweight

THE 20-METER WONDERPOLE



insulated wire (radials) and solder a small alligator clip on one end of each wire, while leaving the other end insulated. Purchase four plastic tent stakes. You are now ready to erect the antenna.

Insert the unprepared end of one of the radials through one of the eye screws and thread the wire through until the alligator clip is near the eye hole. Using 4" of the radial, twist the wire back on itself a number of turns and run the alligator clip back to the eye hole. Pull the radial slightly to tighten and to verify that the strain is on the main wire, not the alligator clip. Repeat this procedure with the other three radials. Twist-tie the insulated end of each radial to a plastic tent stake using 4" of radial. This should leave you with four, 16' 8" radials. With the antenna still on the ground, extend three of the four radials out to their approximate final position (eyeball it) and lightly hammer the stakes in the ground. Raise the antenna to an approximately vertical position and hammer in the fourth tent stake. Unless you are really lucky you will need to readjust the position of the Wonderpole and radials several times to achieve a vertical antenna with radials that are not too slack. With a bit of practice, one person can do this procedure easily and since this antenna is light it can fall without hurting itself or you! Feed the antenna with a short stretch of RG-58 (or your favorite 50 ohm coax) which is terminated on one end with alligator clips. Clip the braid to one of the radial eye screws and clip the center conductor to the eye screw of the vertical radiator. Attach the other end of the coax to your rig, and you're on the air with a nearly perfect SWR, no tuner required!

No vertical antenna with only a few radials is particularly efficient. But I have had some fun QRP QSO's with it and have received/given good reports. It clearly outperforms the shortened 20-meter Hamstick on my car with no radials. If you want more gain and are willing to use more feedline, then a inverted vee on a 33' DK9SQ mast (weighs about the same as the Wonderpole and PVC combined) is a better option. But if you are satisfied with the performance of a full-length ¼ wave vertical and want a cheap easy solution, then this antenna is for you. The whole system - including the rod, tent stakes, wire, hooks/clips and coax - can be built for $30 or less, depending on your junk box. It can be installed in less than 15 minutes in the field with practice, and collapses to 4 foot (or less) sections for transport. Enjoy!

N6IZ Portable/QRP Vertical Antenna

by Brian Boschma, N6IZ
5291 Country Ln.
San Jose, CA 95129

The concept for this antenna came about with the frustration of traveling and trying to run QRP operations from Hotels. I found it necessary to carry the transceiver, antenna system and a tuner. The tuner was just too much and could be eliminated. With the advent of low cost fishing pools that can extend from 45" to 20' a light weight structure became available. But the missing component was the ability to be able to match shortened antennas for 40 meters and 80 meters with out the need for a tuner or having to carry heavy loading coils. In addition, the loading coil solution has the disadvantage of resulting in impedance's below 50 ohms at the antenna base which then require a matching transformer or yet again the addition of a tuner.

What I hit upon as a solution was a scheme that uses folded transmission lines, sometimes referred to as a linear loads. The key was to make the transmission line adjustable in length so that the reactance can be adjusted for a perfect match. To facilitate this I used a technique that I also employ on my sail boat to adjust the position of fair leads for optimum sail tuning while racing. A bungi chord is used to separate two blocks that are joined by the adjusting line. In the sail boat this is a means to achieve mechanical advantage. in the case of the antenna the adjusting line is replaced with wire and the distance between the two blocks determines the reactance added to the antenna circuit.

Other goals included the ability to achieve a true 1:1 SWR, keep losses low by using large diameter conductors in the matching section and below it where currents tend to be high, keep the components light and easily stowed in a carry on bag, and allow a match to occur in high rise buildings where the abundance of steel in the structure can cause unusual matching challenges.

I opted for an adjustable transmission line that uses a pair of pulleys, a bungi chord, and RG174 used as a large diameter conductor. This matching section is stretched along the length of the vertical. The bungi chord, attached near the top of the vertical, keeps the transmission line pulled taught maintaining a line spacing equal to the diameter of the pulleys. A 4:1 mechanical ratio was used in the pulley system to allow a folded transmission line with two loops of RG174. The RG174 is only used for its large diameter and flexibility so that it can easily move through the pulleys. Other wires can be used but I would emphasize that smaller diameters are likely to lead to higher IR losses.

construct this device.

Theory of operation:

Refer to the diagrams for clarity. A shorted transmission line open at one end is resonant at frequenices in multiples of a ¼ wavelength. Between these frequencies it exhibits capacitance or

Parts List

Bungi chord length: Approx 6 ft of ¼", Suggest Marine Grade
RG 174 for transmission line matching section: 50 ft (for 80 mtr, 40 ft is ok for 40 mtr)
Fishing pole mast: Black Widow, order from Cabellas
Gnd Plane: 2 35' lengths, for 80 2 66' lengths
Pulley 2 two shieves: West Marine – Harken model #
Pulley 1 one shieve: West Marine – Harken model #
Driven element: 16 ft RG 174, clip lead at both ends. shorted braid to center
Folded transmission line matching section:

The transmission line is constructed of a continuous length of RG174 that is used for its outer conductor diameter. The Center of the coax should be left open or shorted to the braid at both ends. The length of this should be about 50 ft. The 174 passes through a pulley that in effect sets the spacing of the transmission line. What has been created is a transmission line that is shorted at one end (where it passes through a pulley) and open at the other where it is driven by the feed line and drives the vertical whip section of the antenna. Two additional pulleys, or rather a double block (two shieves mounted in the same housing) forms a fold in the transmission line so that the effective length is reduced from 25' to 12.5'. It is important that the matching section not be wound as a large coil but rather as a transmission line folded back upon itself. If you create a coil, all wound in one direction, you will be unable to achieve reliable and efficient match's. Refer to the included diagram for a picture of how to

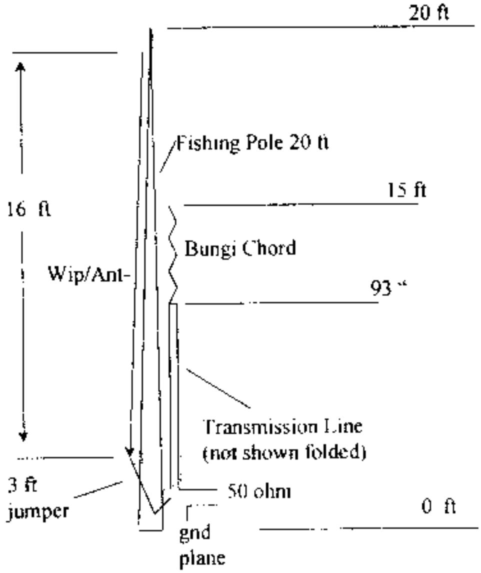
inductance reactance. If a vertical whip is too short then it is necessary to add inductance to reach resonance, if a whip is too long capacitance needs to be added to effectively shorten it. These lumped inductances on shortened antennas are usually implemented using loading coils. Loading coils work but in order to make them adjustable require a means of tapping at any point. This usually results in a heavy mechanism to form an adjustable coil.

The reactance exhibited by shorted transmission lines is used widely in antenna design. Examples are a gamma matching section on a yagi, the impedance transformation ¼ wave section at the bottom of a J Pole (the J part of the J pole is a open line driven at or near the shorted end then connected to a ½ wave whip), and the traps used in KLM yagis and GAP verticals, to name a few.

What has been arrived at in this case is a means to allow adjustment of the length of the transmission line and thus adjust the reactance to achieve a match at various frequencies of interest

N6IZ Portable Vertical Antenna Construction

Shown is general setup for 40 mtr operations.



Bungi attached with tie wrap loop.
WIP attached with clip leads
Pulley at base connected with tie wraps
Dual pulley at top tied to bungi
Transmission line is stripped back at tap points as needed.

to the amateur. In the case of 40 meter operation, that is described here, the whip section is at most 20 feet long and thus needs additional inductive reactance to achieve resonance. This is done by adding a transmission line approximately 20 ft long folded back against itself so that the matching section only constitutes 10 ft of antenna mast height. The folded transmission line runs up and down the mast as does the driven whip . Thus the 20 ft mast supports both the 20 ft whip and the 10 ft of transmission line.

The characteristic impedance of the transmission line is controlled by the spacing of the conductors and their diameter. In this case the diameter is that of RG174 and the spacing is somewhat uncontrolled since there are no spacers as in ladder line. I have found in operation that as long as the spacing is not varying too much over the length of the section the match is very stable. However, the abililty to alter the characteristic impedance leads to another means of fine tuning the match of the antenna. One can add a spacer that opens the line up and increases the Zo of the line. The resulting reactance is proportional to Zo and increasing the spacing increases Zo. The net result is that widening the spacing and forming a diamond appearance with the folded transmission line can dramatically lower the resonant point. I have used 12 inch to 30 inch spacers located 8 ft up the mast of the antenna. In doing this I can lower the point of resonance by as much as 1 Mhz when operating at or near 80 meters (< 4 Mhz.). You will find that this is a reasonable approach to tuning the antenna for a perfect match.

Another phenomenon that must

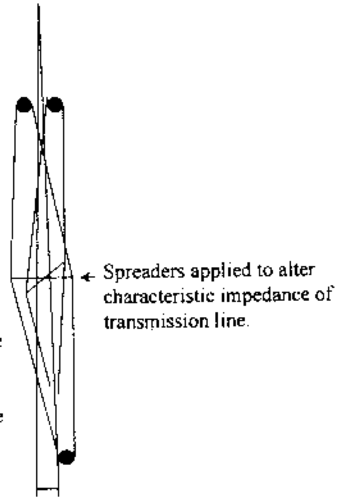
Transmission Line Adjustments To Accomplish Matching

Za= jZo*tan (Theta)

This equation shows the reactance that results when using a transmission line as a lumped element to match non resonant verticals.
Theta = angle of electrical length, 1/4 wave = 90 deg.

Zo = characteristic impdance of transmission line

From the above one can see that there are two ways to adjust Za, the reactance. Lengthening the transmission line increases Theta and increases Za. Altering Zo also has a similar effect.

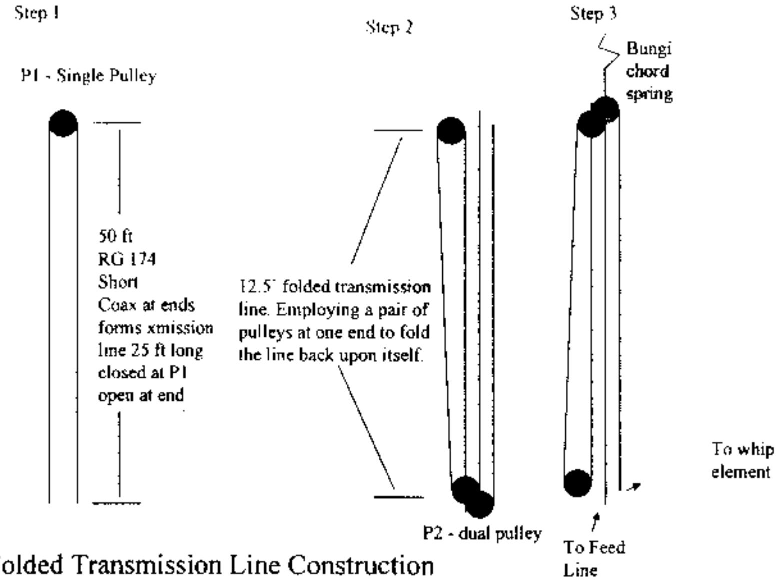


Spreaders alter Zo, distance between pulleys alters transmission line length. Both techniques are used to accomplish matching on multiple bands in this antenna.

be accounted for is the greatly reduced real portion of the impedance (much less that 50 ohms, simulation shows 6 ohms for this case) that is remaining after cancellation of the imaginary capacitive reactance for a shortened antenna. The folded transmission line in proximity to the driven element accounts for this. The transmission line a distance away from the driven element would only be able to cancel the antenna's capacitive reactance. Since the driven element is close to the folded transmission line the conductors of both contribute to the total field that comprises the electromagnetic field in the botton half of the vertical. This really means that the sum of the currents in all wires make up the current that creates this field (field is proportional total current, B =n*I, I = i1+i2+i3+i4+i5 for 5 conductors). One can see that while a single conductor would have a very low impedance with 5 conductors the total current is shared thus reduced in any one. Since only one conductor is driven at the end of the folded structure the current is reduced from the case of driving the driven element alone and thus the real resistance is raised well above 6 ohms (from simulation). The amount of sharing is greatly dependent upon the spacing between the transmission line wires and the driven element. So one can add yet another axis of adjustment to experiment with by tilting the transmission line away from the driven element.

In Operation:

The mast is erected with a 16' whip at the top, the bungi chord attached



Folded Transmission Line Construction

about 3 ft below the top, the matching section attached 12" from bottom on the fishing poles clip and tied to the bungi chord at the other end, and the feed line driving one end of the transmission line. The transmission line is then tuned by pulling the end that attaches to the feed line to the desired length and then the outer braid of coax stripped back to expose an area just large enough to make good contact with the clip leads on the feed line. In the case of 40 meter CW I have good results with 93" seperating the pulleys or about 31 ft wire (15.5 ft of transmission line, 7.5 ft of folded transmission line). In this case I achieve a match of 1.05 to 1 when connected to two 33' ground plane wires.

For 80 meters operation I have found that the length of the folded transmission section needs to be near 12 ft. Then with application of spacers as mentioned above one can readily tune the design to 80 mtrs. I have used two spacers 18 inches long each seperating the opposing leads of the folded transmission line. This results in a pair of diamonds on orthogonal places in place of parallel transmission lines.

In two recent events with other operators joining me in the field I have seen really good results when compared to other antennas based around the 20' fishing pole. At field day and the recent Bubba QRP contest there were Saint Louis veritcals present, some with matching coils. On 40, 20 and 15 I was able to achieve a match typically below 1.6 : 1. With the best on 40 meters at 1.01:1. QSO results also demonstrate the strength of the antenna as I had no problem working anything worked by the other stations and was able in some cases to work those that others missed. When compared to antennas using large loading coils on 40 meters I achieved excellent match without a tuner. The loaded antenna's were unable to get a good match on 40 without using a tuner (the loading coil only compensates for the capacitive reactance, not the lowerd resistance at the feed point; in addition the high currents that flow in the coil and possibly the mismatch of 50 ohm coax to the tuner result in I R losses). Another interesting aspect is the ability to change bands without lowering the antenna. For 40 the matching section is in use as an inductor and transmission line transformer, for 20 the driven element at 16 feet is driven without the matching section in place, on 15 the matching section is now used as a capacitive reactance and a match is achieved again.

Hope you enjoy this ariticle and the antenna. Once the thing is mastered you will find it works quite well.

Characteristics:
Bandwidth on 40 mtrs: 1:1 swr at 7.050. 1.5:1 at 7.339 MHz.

Blueprinting / Modifying the Norcal NC20

By: Gary Surrency AB7MY
Email: gsurrency@juno.com

Presented at the Ft. Tuthill QRP Symposium, 1999.

Since the initial introduction of the NC20, there have been a number of changes and improvements to the original circuit. As one of the beta testers, I have had the opportunity to try some ideas on the prototype and then compare it to the unmodified final kit for evaluation. I am quite pleased with these modifications. The intent here is to put the mods in a single document that can be used by all owners of the NC20.

I've organized the mods in a fairly logical order, starting with the receiver and proceeding from the antenna jack through the radio to the speaker output. Similarly, mods to the transmitter begin with the VFO stage, and end with the RF output at the PA stage. Some observations are noted at the end that really are general in nature and don't fit into any specific stage, per se'.

Receiver Mods:

· David Meacham, W6EMD, originally documented these mods. I have included them here for completeness, and with permission from Dave.

Begin W6EMD Mods:

1. The secondary of T2 should be changed to have 3 turns, instead of 4 turns as specified in the original circuit. This improves the impedance match to Q5, permitting a better transfer of signal to Q5.
2. A 220pf monolithic or disc capacitor should be added in parallel to C22. A better match to the input of the TFM-2 diode dbm is thus accomplished, and a sharper peak of trimmer TC5 will be noted. It is perhaps easiest to add this cap on the PCB bottom, using as short of lead length as possible. Re-align TC3, TC4, and TC5 after performing this mod and the one above.

3. The crystal filter as designed is pretty good. But if you crave a sharper bandpass, then the following changes, (also from W6EMD) can be made.

a) **Revised crystal filter:** This mod gives a narrower bandpass, much better match, and 2dB lower insertion loss. The only penalty is a rounded top on the response curve...you hardly hear it. Change the capacitor values to the sequence 1200pF, 680pF, 1200pF, 680pF, 1200pF (C30 through C34).

Return loss = 23dB
Insertion loss = 7dB
Bandwidth = 480Hz @ -6dB points

b) **Revised roofing-filter:** This mod centers the response curve better on that of the main filter. Change C38 and C39 to 820pF. On the underside of the board cut the trace between C36 and the emitter of Q8. Scrape off the solder mask on each side of the cut, and solder a 120 ohm resistor across the cut.

[To avoid cutting any trace, I suggested lifting one end of C36 and soldering the 120 ohm resistor in series with it (above the board).] – AB7MY

To save some money, Dave Fifield suggested using the two 680pF caps removed from the roofing filter for the revised main filter, and the two 820pF caps from the main filter for the new roofing filter. He also suggested simply adding three 390pF caps underneath the PCB in parallel with the remaining three 820pF caps of the main filter to bring them up to 1210pF instead of having to replace the 820pf's with 1200pf's.

c) **Hiss fix:** This mod kills the hiss from U6, but is useful only for headphones. Cut the trace (on the underside of the board) from C62 to J1 (close to C62). Jumper the cut (as above) with a 39 ohm resistor. Add a 22uF tantalum capacitor from the hot terminal of J1 to ground (negative to ground). Change R56 to 10k ohms. (This is a refinement of the mod mentioned in the manual.)

End W6EMD Mods

4. The 2N5179 transistor used for the post crystal filter amp at Q7can be replaced with a MRF904 from Tech America. This part has a very low noise figure, and it helped to improve the S+N / N ratio. Buy several of them while you're at it so you can have some for future projects. Pick the quietest one by trial-installing it before soldering it in. Q8 is not as critical to the NF, so it may be left alone.

5. Dave Fifield, AD6A, designed a mod to vastly improve the AGC action, over the rather abrupt behavior of the original setup. I have repeated it here for you convenience:

Begin AD6A Mods

a) Remove and discard the following components:

R19, R20, C20, D9, D19, D20, D21 and C65. *see note below

(Put them in your junk box for future experiments)

b) Put a wire link where D9 was fitted.

c) Change R29 to 3.9K (was 2.2K).

d) Change R60 to 2.2M (was 4.7M).

e) Change C63 to 0.47uF (was 1uF).

f) Fit a new 2.2K resistor under the

PCB from the junction of T4 and U4 pin2 to the AGC2 signal at R41. If you solder the resistor at the point where the wire for T4 comes through the PCB to the point where R41 comes through the PCB, you should be able to fit the resistor horizontally with almost no excess wire at either end (nice short leads).

g) Fit a new 680 ohm resistor in C65's position on the PCB.

h) With your digital multimeter, measure the voltage at pin 2 of U4. With no signal input to the RX, adjust VR5 for exactly 1.4V at U4, pin 2.

<<<<End AD6A mod>>>>

If after performing this mod you have a loud "whoop" in the RX audio on key-up, you'll need to do what I did to solve that annoying problem. Re-install the PIN diode at D9 along with its associated bias components. This will allow the AGC to reduce RF gain sufficiently during TX mode, so that the NE602 at U4 does not get clobbered by the strong TX leakage into the RX front-end and IF stages. One of my rigs was more affected by this problem than the other one, but I still left D9 in to avoid future problems with TX leakage into U4. This problem is worse at TX levels of 4-5 watts, as you would expect. Lower TX output levels may not produce such disturbing T/R pops. There is very little signal loss with the PIN diode installed instead of the wire jumper Dave mentions, so perhaps it is best to just leave D9, and its biasing resistors installed.

6. The AGC threshold voltage tends to drift considerably in the original design. Larry East, W1HUE/7, posted a cure for this on the QRP-L. Basically, a 1N914 or 1N4148 diode is inserted between the base lead of Q12, and resistor R63. The easiest way to wire this into the radio is to clip the folded-over lead of R63 to about 1/8". Solder the diode's anode to this short lead, and insert the cathode into the hole that goes to ground. I changed R63 from 1k to 1.5k to allow VR5 to end up near the middle of its range when the AGC setpoint was correct. On the other NC20 I have, it was necessary to use a 1.8k resistor. The slightly higher resistance also allows for a bit more AGC action, since Q12 effectively "sees" more of AGC voltage developed across R62. The proper setting of this threshold is when the voltage at U4's pin 2 is at exactly 1.40 v. This is the correct bias on this pin without any AGC control applied. With the AGC mods by Dave Fifield just presented, about 6.0 volts will be seen at the top of R41 (a convenient test point for your DMM). AGC voltage drift was reduced from several 10ths of a volt at the 6.0 volt AGC line, to only 70-90 mV over an hour period of warm-up. There is even less change measured at U4's pin 2 bias setting of 1.40 v, due to the 2.2k / 680 ohm resistive divider.

7. Some of the MPF102's used in the kit, have excessive leakage when biased off. This may cause the FET mute switch at Q9 to misbehave, causing an annoying pop during the T/R transition. I used a J309A in my kits to correct this. This FET had a much higher Rds_OFF resistance when measured, plus it also had a desirably low Rds_ON value when conduction. Some folks have used a 2N5457 at Q9 and also at Q1 in

the VFO for the RIT switch. But I prefer the J309A myself.

8. If you prefer a lower CW note than the approx. 700 Hz in the original design, then you may want to change a few resistors in the active audio filter. After some email exchanges with Dave Fifield on this topic, here's the scoop:

f=500Hz: R53 = 4.7K (was 3.3K), R54 = 8.2K (was 6.2K), R55 = 330K (was 220K)
f=600Hz: R53 = 3.9K or 4.12K 1%, R54 = 7.5K or 7.32K 1%, R55 = 270K or 267K 1%
F=650Hz: R53 = 3.9K or 3.83K 1%, R54 = 6.8K, R55 = 240K or 243K 1%

I chose the values for 600Hz. This is a convenient frequency, since the TiCK sidetone is very close to 600 Hz. I used 5% carbon film resistors, but first checked them with a DMM for value. Be sure to re-adjust the BFO trimmer at TC6 to put the IF signal in center of the new AF passband. It is best to disable the AGC at the pads provided, and connect an AF analog voltmeter (VOM) to the speaker output. Tune in a signal from another source, such as your big rig operating into a dummy load at low power. You may need to make small tuning adjustments to get this signal in the center of the IF crystal filter. The RIT control on the NC20 is handy for this. Tweak the trimmer and tuning on the NC20 for maximum AF voltage on the VOM.

If your big rig's sidetone and offset track each other, set it to match the new frequency of the NC20 AF filter, i.e., 600 Hz in my case. My TS-570D does this, as do most modern transceivers. Key the big rig, tune in the signal on the NC20, and adjust the trimmer at TC6 for maximum audio output at the new audio filter frequency. An audio frequency counter can be attached to the top of R58 to help set the BFO for the same sidetone as the big rig's setting. Once you have the RX BFO set, you need to adjust the TX BFO to keep the offset correct. Without touching either the big rig or the NC20's tuning knob, key the NC20 and adjust TC7 until the beat note between the NC20's TiCK sidetone and the received signal pitch on the big rig match. Unkey the NC20, and key the big rig again to check if the sidetone from the big rig and the audio tone on the NC20 are matched. Adjust the volume levels if needed. Repeat this procedure until you are satisfied. End of Receiver Mods

Transmitter Mods

8. The VFO on many NC20's chirps a little. Mostly this is due to the type of 78L08 3-terminal regulator used at U2. Replacing this device with a brand new L78L08ACZ from SGS Thompson usually cures the chirp. Dave Fifield will replace the faulty ones if you send him return postage. Note however, that excessive voltage drop in the power cord and DC connector can also cause voltage droop (as opposed to just voltage drop) during keying, so use at least an 18 gauge power cord and be sure the DC connector fits tight and is clean. Let's not have any chirpy NC20'S!

9. Because the RIT control has a detent at the center, it sometimes is difficult to tune in an off-frequency signal that is close to the detent. Reducing the RIT range helps, since the knob must rotate further from the detent to produce sufficient frequency change. Merely plac

ing a 3.3k to 10k ¼ w resistor right across the outer terminals of the RIT control is an easy way to accomplish this. Everyone has their own preference for how much RIT range is best for their operating style. So experiment with several values and pick the one that's right for you.

· I decided that a 4.7k value produces the range I like, but I did something else. I also changed R5 from 330k to 820k. Along with the J309A FET for Q1, these changes game me the RIT behavior I prefer.

10. If the VFO output is low, both the TX and RX performance will suffer. If a new J310 for the VFO oscillator does not help, then look at Q3 and / or Q4. I found I had to replace the 2N5179 at Q3 to get good VFO output. It's best to cut it out to prevent damage to the PCB, since it has four leads. If you have the 2N5179 still intact from replacing it at Q7 with a MRF904, you can try that one at Q3. Do not substitute a MRF904 for Q3, however. I found it performed poorly compared to the 2N5179 in this circuit. Check the VFO output at Q3's collector for improvements in RF output, since the diode dbm clips the RF level at the point labeled on the schematic as "LO+7dBm" to around 0.280vrms. You won't see a change in RF level at that point, unless it is below that level. At Q3's collector, you should have >1 vrms of RF if using an RF probe. I have about 1.50 vrms on my rigs.

11. I reduced the VFO's tuning range to about 72-73 kHz by placing two 100k resistors in series at R9. Insert each resistor straight into the PCB pads, and then bend the top leads together and tack solder them. This gives the desired 200k, which is not a common value.

12. Low TX output can be a result of a lot of things. First be sure that the TX bandpass filter at T5-T6 is tuned properly. There has to be two peaks on trimmer TC8 and TC9. If not, then check the number of turns on the toroids, or C70 and C71. Some trimmers have been noted to be bad, so they are also suspect. But if their maximum capacitance is merely low, then add a turn or two to the toroids to compensate. Tune the BPF trimmers with the TX output reduced to 1-2 watts for the best resonance reading. The bandwidth of this BPF does vary a bit over the rig's tuning range, so tweak the trimmers near your favorite frequency if you like. Low output from the TX BFO and BPF may be corrected by adjusting the size of C14, but keep it in the 8 to 15 pf range. Excessive VFO drive into the NE602 at U7 will cause it to produce more spurious output than the TX BPF can filter out. If the 8-15pf capacitance at C14 doesn't help low TX output, then the problem is elsewhere.

13. Assuming the TX BFO, BPF, and pre-driver / driver stages are functioning well, then low TX output may be the result of a PA stage fault. Do not increase the value of the 22 ohm resistor at R80, since extensive tests during the prototype stage indicated this low value is critical to good PA stability. Instead, look for a problem in the PA's lowpass (LPF) or associated components. Occasionally, a defective 2SC1969 is the cause. But more likely, low TX output is due to a bad component or error in the LPF.

· You can use an antenna analyzer to examine the PA output stage and its

LPF. Attach the analyzer to the antenna jack, and disconnect the DC power. Temporarily place a test resistor of 15-19 ohms across the PA Collector and Emitter leads. The value to use is approximated by the equation:

R_collector= (Vcc x Vcc) / (2 x P_out)

- For 13.8v and 5 watts, this works out to ~19 ohms. Use a 18 ohm ¼ w resistor, or two 39 ohm resistors in parallel. For 12v and 5 watts, it is 14.4 ohms. A 15 ohm resistor is fine.
- Set the analyzer to read RF resistance and reactance. Sweep the frequency on the analyzer around the 20m band to see if you can get near to a 50 ohm match, with low reactance. With the analyzer set to 14.060 MHz or thereabouts, carefully adjust the windings on L6 and L7 to achieve the best match. On my rigs, the best match occurred with the windings on L7 spaced around the upper half of the core. L6's windings are evenly distributed around the entire core.
- If your LPF just won't allow a good 50-ohm, low-reactance match – then you might try the alternate LPF values Dave Meacham determined. He used 8 turns on L6 and 7 turns on L7.Changing C80 to 300pF (two 150pF caps in parallel). and omitting C82 increased the output by 0.1W. Evidently, there are considerable variations in type-2 core material, but the analyzer will help you determine and correct this if it is true.
- Don't forget to remove the test resistor before applying power to the rig! Remove the antenna analyzer, too. Do not transmit into the analyzer!

14. I altered a few components around the keying transistor Q20 to change the keying characteristics. I had noted a difference between the rise / times of the RF envelope, and I also wanted to shorten the rise / fall times slightly to improve the keying at higher speeds. These changes consist of replacing R85 (1k) with a 510 or 560 ohm resistor. R84 (4.7k) is changed to 3.3k There is often too much voltage drop across the 2N3906 at Q20. More than 90-100 mV is reason to change it to a 2N2907A, MPS2907A, 2N4403, NTE159, etc. If Q19 and Q21 do not go into deep saturation during TX, or have much more than 60-100 mV from its collector to ground, replace them with another transistor of the same type. Or use a MPS2222a, 2N4401, NTE123A, etc. This insures good keying, fast muting, and silent, rapid, T/R switching. End of Transmitter mods.

Notes, comments, etc.

I have noted that the small, epoxy RF chokes should not be mounted tightly against the PCB, as this will cause adverse affects in the associated RF circuit. I found this behavior when I was adjusting the RX and TX BFO's, and also the T/R circuit at L2. I recommend leaving about 3/32" to 1/8" spacing between the bottom of the RFC's and the top surface of the PCB.

The Main Tuning knob does not go all the way on the shaft of the ten-turn tuning pot. Instead of cutting some off of the pot's shaft, check the bore of the knob for flashing that interferes with sliding the knob all the way on. A little help from a ¼" drill bit cured this problem on my rigs, but don't drill too deep and out the front of the knob!

If your rig performs as well on receive as mine, you may want to increase the value of R56 from 33k to 47k or 56k. This makes the audio gain control require more rotation so that the volume isn't too loud right off the CCW stop, or when using headphones.

When using Doug Hauff's anodized custom enclosure, it is difficult to get a good ground contact to the solder lug under the RIT control. I finally removed the front panel from the rig and masked the hole with a large flat washer using some tape. I then sandblasted the anodized coating away. The anodizing is extremely hard, and scraping it or using a toothed lockwasher does not work well. Perhaps someone has another way to remove this coating that I have not thought of. The front panel needs to be well grounded to prevent hand capacitance effects on the VFO, and also to insure good RF shielding.

Try these mods on your Norcal 20. Your feedback is welcome, and I hope your rig performs as well as mine do. 72, Gary, AB7MY

How to Contest, QRP Style with QRO Results

by Jay Bromley, W5JAY
1915 Bryn Mawr C
Ft. Smith, AR

Doug Hendricks asked me to do a piece on contesting. I don't know how he does it, but Doug has that ability to get people to write articles. I don't profess to be a writer, but I will try to do my best on a difficult subject. To write about contesting can be an endless subject, so I am going to focus on my favorite contest, The ARRL SSB Sweepstakes! First, let me describe myself as a QRPer that likes to dabble in contests instead of a contester who likes to enter QRP categories. I also contest in the CW mode, but I feel I am not good enough to run stations, yet! So, I rarely turn in a log in the CW Sweepstakes contest.

My start in the Sweeps using sideband was purely accidental. I was at the local Saturday breakfast back in 1997, talking up the latest QRP craze, when someone announced to the group "that all this QRP stuff is only good for the CW mode and not for SSB". Two of my good friends and heavy duty contesting freaks, Jerry AB5SE and Steve K5OY were there. Jerry and Steve had already asked earlier if I was going to work the Sweeps that weekend. I told them I might spend a few hours working the Sweeps. Up until this point I had only worked a few 160 meter contests, but never a full all out effort. The individual that proclaimed that QRP was useless to anything but CW had thrown down the gauntlet. I changed my mind as to how I would work the contest mainly to make him eat his words later. I just wanted to see how many states I could work and maybe win my state. I made a half-hearted effort and worked the contest 8 hours. I scored a whopping 32K and sent my log in to be checked. I forgot about the contest and the individual who prompted all this.

While coming back from Dayton/ARCI 4 days in May, I called Steve, K5OY, to tell him about the great time I had in Dayton and also how neat it was to see some of the well known QRPers receive awards at the awards banquet. Then Steve said, "You're going to receive an award yourself. You won the ARRL Sweepstakes in Delta Divi sion!!" I didn't realize it at the time how hard these plaques were to get. A few weeks later, while Steve and I were chatting about contests, Steve said there was some scuttlebut on the web about my score being low and it wouldn't happen again. Several contesters saw the low score and now had their sites set on getting their own plaque. My response was "I will put in a full effort to see if I could get another of these neat plaques to keep my other one company." Deep down, I admit that I use this for an incentive to do better than my last outing. While I didn't win another plaque this last year, I almost doubled my score and finished third in Delta Division.

OK, so now you know one of my secrets. You need an incentive to push yourself to do your best. The next thing you need to do is to evaluate your station, its weaknesses and strengths. As an example my station does well on the following bands —15m, 20m, 160m. It is OK on 75m, but weak on 10m and 40m.

You also need to look at the competition's station, if you can. How in the world do you do that when your competition is states away? Well, I use the Internet and word of mouth. I do searches on the contester's call. Most of the biggies love to show off and why not? They're the best, just daring you to take a shot at them. I mention word of mouth There is no better place than the QRP forums and hamfests. This summer at HamCom when the gang went out for dinner I ended up at the same table as Jim Duffey, Wes Spence and Chuck Adams. Later that night I was picking the brains of some of the Houston Big guns like Bill Steitenroth, K5ZTY.

OK, now you know where your station is compared to your competition, what's next? Go to forums like the one at Fort Tuthill with Ron Stark and Chuck Adams. Every time I listen to these guys I learn something new. Subscribe to magazines like the National Contest Journal. This contest stuff is like most sports, it is more mental than physical. Learn, learn, and learn.

Now on to some of the basics before we go on to some of my unorthodox stuff. Most of these have been repeated a hundred times in magazines like NCJ. Get your computer up and running a week before the contest. Make a trial run if you can before the contest to make sure all your equipment is in working order. If you can, take the day off before the contest to relax and to fine tune your station. Start on time on a band that is strong for your station. If you are using a wire and can't get a run going, then it is time to hunt and pounce. Don't stop and don't get discouraged, keep going. One thing I learned from Ron Stark is that winners keep going even though it seems hopeless. Remember you have a couple of handicaps with QRP and SSB.

Before the contest check out your audio with a friend on 10m. Hums and distortion are a no-no. If your rig is capable of running QRO, run it before the contest and get the nasties out with high power so you won't have any problems at the QRP level. I set my power up to 5 watts on a calibrated watt meter and then set my scope up so that the signal is just below the top and bottom lines. This is my reference. Even though I have several peak reading watt meters they just aren't accurate enough for SSB. All I have to do is glance at the scope to know I am QRP legal and ready for any ARRL official to verify my sta tion, grin.

I run 5 to 10 dB of compression and I also change the set up in my TS-950SDX from Hi-Fi to War mode. This is a DSP adjustment where I roll off the low end frequency response from 100hz to 3100hz. I leave the high end alone at 3100. My main goal here is to sound like I am not QRP. After you think you have your audio set right, go back to 10m and have your friend attenuate your signal as low as possible. If the results are loud, clear, and you are easy to understand, you are ready to go. I learned from my friend, Fran Slavinski, KA3WTF, mentally you are not QRP, but think and act like you are a 100,000 watt short wave station. In other words no wimpy sounding HC-4 element here. Restricted microphones like the HC-5 are OK but don't go running narrower than this. I am presently using a boom mic with Sennheiser HD545 headphones. The Heils started to hurt my head during the first contest I used them and that's why I am using the Sennheisers now.

You have to be comfortable all the way though the contest to do well. Don't forget a good chair, monitor at eye level, and controls easy to reach. Also, I would recommend a good voice keyer because when you get tired, you make mistakes and you don't want to have broken calls and have points taken away from someone else's logs because of your screw ups. Last year, after hearing one of the station's calls phonetically, I started using his call instead of mine. I don't know if it was the fatigue or what, but I finally had to stick a post-it-note on the computer monitor with my phonetics, so I wouldn't mess up. My error rate was just under 3%. It seems that most of the low power stations were around 2% and the high power category were under 1%. You should strive to be as good as the higher power categories. Accuracy is as important today as making contacts. It is better to slow down and not make mistakes than to run a high rate with errors you will be penalized for.

Most serious contesters recommend to not be too chatty and do away with "PLEASE COPY" along with the report. In other words, no wasted motion, as it separates winners from losers. This is one of the areas where I break the rules. You will have to decide for yourself if these tactics will work for you or not. For example: Last year, I wasn't able to get any runs going the first day. My second day, early in the afternoon, I had a score that didn't match the previous years' plaque winning eight hour effort. That is when I went to 15m, found a hole, and started calling CQ contest. I got a little mad and kept banging away and soon, I had a pile up going. Now I had the rate climbing and quite a few cheerleaders, when they found out I was QRP. Every time there was a comment on my signal was good for QRP, I would beg them to send other operators, even the ones not in the contest for a contact. It wasn't long before I made up for lost ground and started passing some of the other QRP stations. I then swung the beam up to the northeast and begged again. Obviously if you're a big gun and your rate is over 200 you would not be doing this. But when the chips are down you look for other ways to score points. When calling CQ contest and the rate is on the down side, I sometimes throw in QRP in the end to attract operators that might think I am too weak to be worked or that I might be back scatter. It is tough living in the Midwest and using the beam because you are leaving out half of the country and you have to use tricks like these to attract contacts. unless you have a switched antenna array instead of a rotator.

Another favorite tactic I like to use and did after my 15m run. I went to 20m and found the loudest signal I could at the low end of the band. I got as close as I could to him and still be able to copy stations. I like to call this the mosquito effect, because he doesn't know you are there and you're getting his over flow. Stations on his side of the country don't hear him, but will hear you. If he is a rare state and is spotted up on the cluster, again it is to your windfall. To do this type of operating takes serious receiver and lots of practice. I also recommend using high quality headphones with the volume turned down, to lessen the fatigue. I use all the crystal filtering and DSP that I can stand and still hear stations through the other station's monkey chatter. This is where all those nights chasing those 40m foxes, pay off. Listening on sideband is just as much an art form as it is for a high speed CW operator. I've had great CW Ops guest my station and work a little sideband DX. It is funny how I can hear the DX stations call my guest though the pileup before the pileup has died down. I tell them to go ahead and make their call when they never heard it. They usually freeze until the DX station makes another call for them after the pileup has died down a little. What it boils down to again is to learn, listen, and improve. Don't be afraid to experiment because every station has its own limits so you have to adjust accordingly.

So, now that I have done all this blabbing, what am I going to do to improve my station in this year's contest? The most important thing for me would be to get rid of the sloper on 40 meters and get some sort of directional array on that band. This is going to be hard to do considering I live on a city lot, and I am limited to what I can do. I use my tower as a shunt fed for 75m and 160m even though these bands haven't contributed much to my score, I am pretty effective here even at the QRP level. One thing I can do is add a voice keyer and play like I am K7RAT with monobanders at the start of the contest. See if I can get some runs going early. That way I can chase the last sections like Yukon in later hours. I missed Yukon last year and I was hearing Jay stand by for QRP stations, late Sunday afternoon. I guess this is the mark of a true contest QRPer. The power control looked tempting, but it stayed put and I missed Yukon. The other thing I wish I could do is to have a switched array so I could go two directions at once. This is something that is not practical at the QTH. The stations on the corners of the US have it made because they can pretty much point the beam in one direction and get most of the sections without wearing out their rotor. The beam I use is a highly directional log periodic which is great to minimize interference off the side and back, but sometimes you wish you could work off the back or side with the flip of a switch. When I first bought this antenna, I was interested in getting a little gain 20 through 10 meters and providing a lot of top loading on the lower bands for the slopers and shunt feeding. I wish now, I could go to some sort of monoband set up on all bands. But again this is not practical being in the city.

So there you have it. How to analyze your station to be affective against the big guns. I am convinced that no matter what station you have, you can be competitive if you look at the limits of your station and not necessarily follow conventional wisdom as to what is possible without the hardware. I am not sure I will ever be successful again, but, you can be sure, I will be in there giving it my best shot.

Hope to cu in this years Sweeps!!

73 de W5JAY..

THE NORCAL 20 GOES DIGITAL

by Bill Jones - KD7S

kd7s@psnw.com

When Dave Fifield (AD6A) designed the NorCal 20 he had the foresight to make it digital compatible. He placed pads on the PC board to pick off audio, key the transceiver, and even add frequency shift keying. The addition of a simple, homebrew interface and a shareware computer program transforms this venerable little CW transceiver into a lean, mean RTTY machine. Dave's engineering is only half the equation. Credit for the other half goes to W. F. Schroeder (DL5YEC) who created the software, HamComm. Besides RTTY, HamComm sends and receives AMTOR and keyboard CW. The registered version even copies Pactor transmissions. HamComm can be downloaded from any number of sources on the Internet. By far the best is Terry Mayhan's AUnofficial HamComm home page@ at http://home.att.net/~k7szl/.

The interface consists of a handful of common parts, most of which are available from Radio Shack. I built the prototype on a small piece of perfboard and mounted it inside my NorCal 20 cabinet. The transceiver requires no modifications beyond mounting the DB-9 connector on the back panel and connecting four wires from the interface to the main NC20 PC board. Normal (paddle generated) CW operation is not affected.

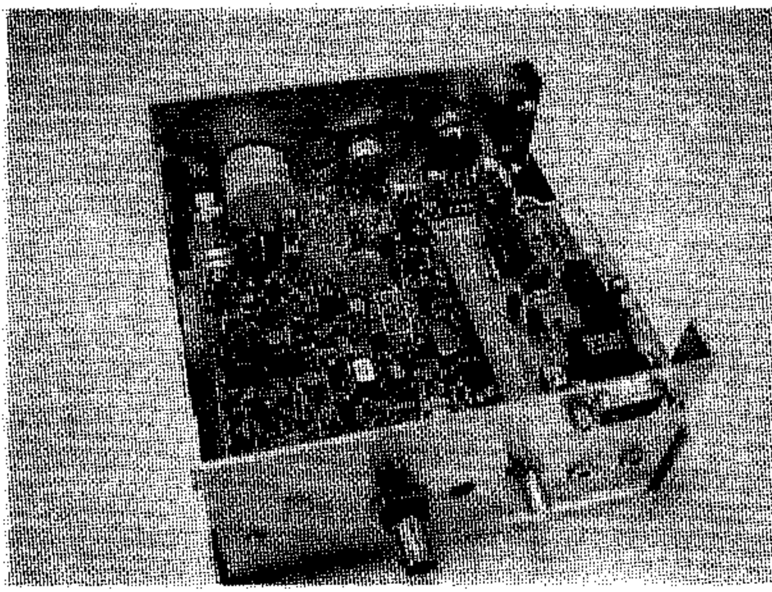
RTTY BASICS

Radio Teletype (RTTY) uses two different tones for data transmission. These tones are spaced 170 Hz apart. One tone is the Amark@ and the other is the Aspace.@ Characters are created by manipulating the mark and space tones in predefined patterns using a 5-bit (Baudot) code.

A common way to generate the RTTY characters is to feed audio tones to the microphone input of a SSB transmitter. This is known as AFSK or Audio Frequency Shift Keying. In the case of the NorCal 20, the transmit frequency is rapidly switched up and down by 170 Hz to achieve Frequency Shift Keying, or FSK for short.

A CLOSER LOOK AT THE INTERFACE

Decoding incoming FSK signals begins by feeding audio from the NorCal 20 to the non-inverting input of IC1, a TL071P Op-Amp. The audio is taken from the junction of R59, D19, C55 and R56 on the NC20 main board. There is a pair of pads marked AR/C@ situ



NorCal 20 back panel showing location of DB25 Connector

ated between the a.f. Gain (VR4) and RIT (VR2) controls which were designed just for this purpose. Use the right hand holeCthe one closest to VR2.

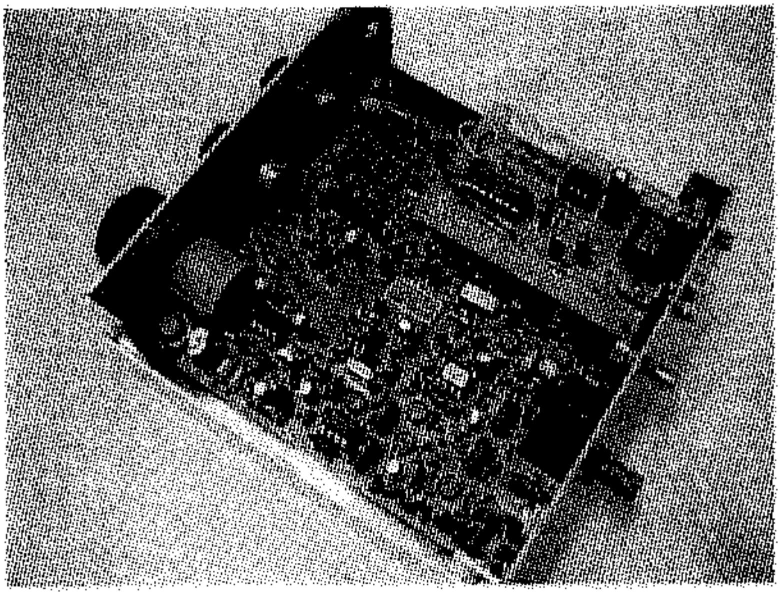
The receiver is tuned so that the incoming RTTY mark and space tones are equally spaced above and below a user selected center frequency. I chose 725 Hz to take advantage of the narrow CW filters in the NC20. Pin 6 of the TL071P outputs either a positive or negative going voltage depending upon whether the incoming tone is a mark or a space. The HamComm software then translates these changing voltage levels into the appropriate ASCII characters and prints them to the screen.

Switching to transmit uses a different part of the interface. The first thing that happens is that the software drives the base of Q1 positive which keys the NorCal 20. The collector of Q1 is connected to the pad marked AK@ on the NC20 PC board.

As characters are typed onto the computer's keyboard the software generated positive and negative voltage levels alternately turn Q2 on and off. Q2 drives IC2, a quad, bilateral CMOS switch. When Q2 is on, the FSK voltage on pins 2 and 4 of U2 comes from the variable voltage divider connected to pin 3. Conversely, when Q2 is off, the FSK voltage comes from the fixed voltage divider connected to pin 1. These voltages are fed to pad AD@ on the NC20 board. This causes the NorCal 20's frequency to shift in unison with the coded, 5-bit characters. The result is Frequency Shift Keyed RTTY.

INSTALL THE SOFTWARE

Install the HamComm software on your favorite computer and print out the document file, Hc.doc. **Read the**



NorCal 20 with RTTY installed

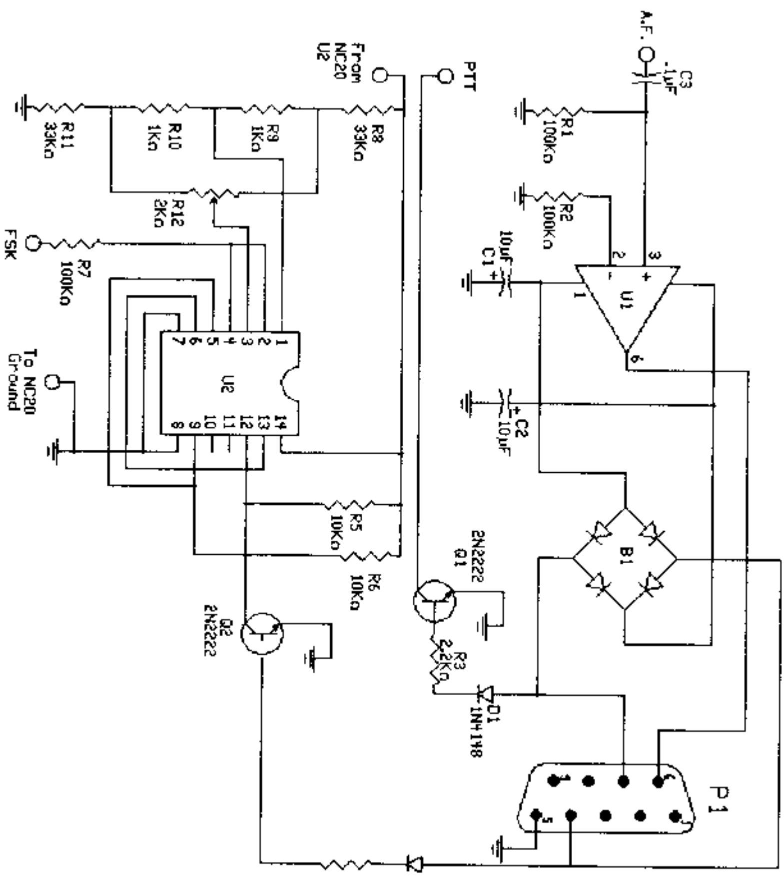
manual from beginning to end. If you're in a hurry, you can safely skip over the parts that talk about AMTOR and NAVTEX, but pay close attention to everything else. After you have gained a fair understanding of what the program does and how it works, modify the configuration file, Hc31.cfg accordingly. Set the center frequency to 725 Hz.

BUILDING THE INTERFACE

I suggest you construct the interface one stage at a time, just as you did with the NorCal 20 itself. Begin with the receive circuit with parts C3, R1, R2, U1, C1, C2, B1 and the DB-9 connector. This part of the circuit is powered by the computer and requires no external batteries or other power supply. Do not install U1, the TL017P just yet.

Test the interface by connecting it to your computer via a suitable serial cable to the Com port you specified in the hc31.cfg file. Run the HamComm software. Measure the voltage between pin 7 of the U1 socket and ground. You should see a positive voltage in the vicinity of 7-12 volts. Next, measure the voltage at pin 4 of the U1 socket. It should be negative and about the same level as on pin 7. Now switch to transmit (CTRL-T) and make sure the polarity does not change at pins seven and four. If everything is okay, shut the computer down and install U1 in its socket.

Connect a wire between the A.F. input on the interface and the rightmost hole of pads AR/C@ on the NorCal 20 main board. Connect a second wire from the interface ground (pin 5 on the DB-9 connector) to a ground pad on the NC20



NorCal 20 RTTY Interface

board. Turn your computer on and run HamComm. Power up your NorCal 20 and search for a strong RTTY signal. Your best bet is to listen between 14.080 and 14.090 MHz. Press the F7 function key on your computer and line up the mark and space tones with the vertical tuning lines on the screen. Press the spacebar to return to the main screen. You should see the decoded text marching across the screen. If all you see is garbage, go to HamComm's KEYING menu and make sure you have selected Normal instead of Reverse.

Once you are printing RTTY signals you can wire up the PTT circuitry. Install D1, R3 and Q1. Connect a wire between the PTT point on the interface to pad K on the NorCal 20 board. Run the program and confirm that pressing CTRL-T keys the transmitter. Pressing CTRL-T again should un-key the transmitter.

The last section of the interface is the FSK generator. Wire it up according to the schematic diagram. Notice that U2, the CD4066, draws power from the NorCal 20, not the computer like U1. Connect a wire from the +8 pad on the interface to the output pin of voltage regulator U2, the 78L08, on the NorCal 20 PC board. There is no auxiliary pad for this so you will have to solder it to the underneath side of the board. Make sure you select the +8 volt pin, not the +13.8 volt pin. The correct pin is the one closest to capacitor C4. Solder another wire from the FSK output on the interface board to pad D on the NC20 board.

FSK ALIGNMENT

If there is a tricky part to this whole thing, this is it. Alignment consists of, (1) adjusting the NC20's VFO frequency shift to 170 Hz. and (2) adjusting the NC20's transmit offset so that the mark (high) tone is well inside the crystal filter's upper bandwidth limitations. Let's take it one step at a time, beginning with 170 Hz frequency shift adjustment.

If you have a frequency counter capable of measuring audio frequencies you can set the shift by listening to the NorCal 20's transmitter in another receiver. Here's how.

1. Disconnect the serial cable from the computer to the interface.
2. Use a clip lead to connect the junction of D2 and R4 on the interface to ground.
3. Put the transceiver in transmit (into a dummy load) by cycling the TiCK command switch to the "tune" mode.
4. Tune the main station receiver so that the pitch of the NC20's signal is in the neighborhood of 600 Hz.
5. Remove the clip lead from ground and connect it to the +8 volt supply line.
6. Adjust R12 so that the pitch in the station receiver is 170 Hz higher than before.
7. Repeat steps 2 through 6 several times as there is some interaction.

If you don't have an audio frequency counter you can download a software based counter from the Internet at http://www.muenster.de/~welp/sb.htm#analyzer. This software is free but you have to have a sound card in your PC.

Another PC based approach uses a program called Hamview which is available at http://www.freeyellow.com/members/padan/. It also requires a sound card and allows you to see a graphical representation of all the (audio) signals from zero up to 2,048 Hz. The final step is to set the BFO trimmer and transmitter offset in the NorCal 20. You will use HamComm to help you.

Double check the HamComm Hc31.cfg file to confirm that you set the center frequency to 725 Hz. Start the program and press the F7 function key to view the spectrum display. Tune the NC20 to a clear frequency and notice where the noise peaks. Adjust trimmer TC6 so that the upper limit of the noise begins to diminish just beyond about 850 Hz.

Open your NorCal 20 manual to page 15 and follow the procedures to set the transmit frequency offset. The directions suggest you set the offset to about 700 Hz. It would be better to set it closer to 800 Hz to accommodate the 810 Hz mark frequency during RTTY transmit. If you would prefer, you can reset your HamComm center frequency to 625 Hz instead of 725 Hz (in the Hc31.cfg file) in which case you can set the NC20 offset to 710 Hz. If you do this, don't forget to reset TC6.

THAT'S A WRAP

If you've never operated RTTY before, the ARRL has some good books designed to get you started. Likewise, there are some excellent resources available on the Internet. Back issues of QST can also help.

While the NorCal 20 and HamComm combination doesn't exactly constitute a world class RTTY setup, it is nonetheless a very capable performer. I have worked coast to coast with it and enjoyed many solid ragchews. A quick call to DX stations often results in another country in the log book.

Finally, if you're hesitant to get your feet wet with RTTY you will be pleasantly surprised with the friendly attitude of those who frequent that mode. Like QRPers, they are gentlemen (and ladies). I have never found an RTTYer who wasn't patient and eager to help the neophyte.

Add a new dimension to your QRP operation and go digital. You'll be glad you did.

INTERFACE PARTS LIST

B1	bridge rectifier (Radio Shack 276- xxxx)
C1, C2	10 uFd, 25 volt tantalum
C3	0.1 uf disc ceramic
D1,D2	1N4148 or 1N914
P1	D-Sub, right angle PC mount connector (male)
Q1,Q2	2N2222 TO-92
R1, R2	100k, 1/8 watt carbon
R3,R4	2.2k, 1/8 watt carbon
R5,R6	10k, 1/8 watt carbon
R7	100k, 1/8 watt carbon
R8,R11	33k, 1/8 watt carbon
R9,R10	1k, 1/8 watt carbon
R12	2k, 10-turn PC mount trimpot
U1	TL071P
U2	CD4066

The CMOS III Keyer, A Review

by Jay Bromley, W5JAY
w5jay@alltel.net

Keyers are like keys, they have different levels of price and performance. One class of keyers is one that I like to refer to as the "most bang for the buck". In this class I have would put the Tick Keyers from Embedded Research. I also like the way Brad and Gary show up and support the various hamfest with QRP Vendor booths, and if they can't be there, they always donate prizes. In the ultimate class though, there is one keyer that I love more than the rest. It is the Super Cmos III, from Idiom Press, and that is what this article is about.

The neat thing about using the Super Cmos III is that it is not only feature packed, but it is also very user friendly. Basically there are six push buttons for the various features and one knob to control the speed. The push buttons operate the memories, the command modes and the inquiry modes. One of the things I like most is how easy the memories are to use and setup. Let's say you want to put your call in memory location one (push button 1). You push and hold down the first push button till you hear a tone and then release, you will hear the keyer send C back to you, which confirms you are in the character mode. In other words, the keyer is now waiting for you to send something to be put in that location. Then you send your call. Afterwards you will hear the keyer sends back to you the letter "I", this is a word space, if you want to keep going.

But in this case we just want our call in that location 1 so after you hear "I" you touch the push button again and now your call is in location 1. If you want to play the message, all you have to do is tap that particular push button. If you push the button 5 times, it will send your call 5 times. You don't have to wait on the keyer to be at a certain point before firing off the next message. It chains its self automatically by how you push the keys. Another example: I have W5JAY in memory location one, 599 in memory location two and AR in memory location 3, I push the first button once, the second button twice and the third button twice. This is what the keyer will play: W5JAY 599 599 AR AR. All this without waiting or using a second function key.

Let's go back to where we sent our call and it added a word space by sending back to us an "I" and was waiting for more input. You could send 599, wait for the "I", then send "AR", wait for the "I", then send "TU". If you make a mistake while sending, it's no problem, send a bunch dits like you would if you were on the air and it will erase the mistake and send the last character before the mistake. Then push the first push button again to close the memory mode. Now if you push the first memory push button it would send W5JAY 599 AR TU. You set it up the way that you want and after playing with it a little you can do it on the fly without any hassle.

There is a real time message mode also, though I rarely use this mode. This is what is so neat about this keyer, its flexibility. It will do most anything you want it to do with minimal fuss. I use my Cmos III in the V0 mode which emulates Super Keyer III timing with dot and dash memory. I also use the autospace function most of the time. However if you like Iambic timing with no dot or dash memory or Curtis A mode timing, all you have to do is push buttons one and two, which puts you in the function mode and sends the character "F". Then send V9 and your keyer is now set up for Iambic timing with no dot or dash memory. If you are wondering what would happen if you send something not in the Cmos III language (i.e. make a mistake on a command), it will send you what they call a "raucous raspberry". This is best described as a buzzing sound to let you know you did the wrong thing and to resend again.

Lets look at another feature, lets say you wanted to reverse from right hand paddle to left hand paddle. You would push buttons two and five simultaneously and the keyer sends back "R" for reverse. No more reversing leads in the middle of field day! Or if another op wants to use your paddles and they are set up backwards for him.

You can put the keyer in tune mode by pushing buttons four and five at the same time. The keyer acknowledges with an "X" and sends a continuous tone. This may also be done by going into the command mode and sending "X" with your paddles. This allows you to use both hands to adjust your tuner. To get out of the "tune" mode, just hit eithe paddle.

I like to go into the inquiry mode

to see what speed the keyer is presently set for. I use this a lot in setting up different paddles. I personally know what my top speed is, and if I can get it close to my bench mark without making mistakes, I know I'm close on key adjustment. To check keyer speed push buttons five and six simultaneously, and it will send a "?" back to you. You then send "S" for speed and it will send back to you at what wpm the keyer is at. You can check the status of all the command modes with the inquiry mode, without changing your present set up.

If you want to check the status of your keyer emulation, press five and six again, (puts you in the inquiry mode) and send "V" after the "?". It will send back to you the emulation your keyer is set at presently, but to change you will need to go into the command mode. You can set the inquiry mode speed range to anything. In other words your keyer could be set at 30 wpm but you may want your keyer in the inquiry mode to send back to you at a slower value like 15 wpm or you could have it follow the keyers speed control. When Chuck comes to town, I make sure all the CMOS III's in the shack track the keyer speed while in the inquiry mode. For some reason, Chuck doesn't like the keyer spitting back something slower than he has set the knob to. In other words if Chuck set the keyer at 35 wpm and asks it a question he wants it coming back to him at 35 wpm.

The CMOS III keyer can be set up as a beacon, and also does contest serial number increments. It has a built in adjustable side tone monitor in which the frequency can be varied, turned on, or off. Speed can go from 5-60 wpm, however default is 5-40 wpm. The ultra speed mode goes up to 990 wpm. Let's see Chuck top that one!! I set my range between 5-35 wpm. When the keyer is set up like this all I have to do is move the knob to the 12:00 position and I know I am around 18-20 wpm. I usually hang here unless I am chasing DX.

The features I mentioned above are about 1/4 of what the keyer is capable of doing. I guess in a way if you consider the features, the Super Cmos III also falls under the "most bang for the buck" keyer.

Even though they manufacturer a ready made unit, I prefer the kit. Mainly because I like to use batteries instead of using a power cord. To me this is an extra lead to get tangled in my already cluttered ham shack. The commercial version that I had, generated a small signal into my 20m receiver that was on USB. This wasn't a problem because it only happened on one frequency and I don't normally run CW while listening in the USB mode. I think the problem is in the non-bypassed three terminal regulator. In one of my Super Cmos III kits, I did the same thing and ran it off a DC supply with a regulator. I had the three terminal regulator bypassed for high and low frequency oscillations and I also had the input and output jacks by passed. There were no ghost signals on 20 meters when I built my kit this way. Also on the commercial version, the push button switches are surface mounted to the circuit board and poke through the cabinet, which always made me wonder how well they would hold up. I also didn't care much for their spongy feel.

Even though I prefer to build my own Cmos III as a kit I would recommend the commercial version. But be warned that you won't get to "custom ize your keyer, and put in the buttons and arrangements that you like. You will however, get the same keyer.

Here is how I built my kit. I used a Ten-Tec TG-24 case that is the same size as the commercial case. When I received the commercial version and set it next to my kit, I was shocked to learn the case was the same size (cool). I use the Radio Shack Soft Touch Momentary, part No. 275-1566A, for the switches. These are the nicest feeling switches I have come across so far, are easy to use with with my big fat fingers, and I don't make so many mistakes. I also use the mini speaker from Radio Shack part No. 273-092. For the input and output jacks, I use 1/8 inch stereo jacks. I try to minimize having different size plugs on my equipment. I use a battery holder for three AA cells for power. You could probably use lithium or a computer battery, but I prefer the AA's in case I'm in the middle of nowhere and they go bad, replacement is easier. Here is another hint if you roll your own, be sure to put a small tag to record the date when you install your batteries. I try to change mine out once a year because the batteries will start to leak before the keyer quits.

In the past if you wanted one of these keyers you had to mail order it. The service was not good. No person to talk to if there was a problem over a phone. Now all that has changed with Marshall Em at Morse Express handling these fine keyers. Marshall is set up for credit card orders over the Internet or the phone. No more waiting for weeks to find out if your order made it or not. The kit is $55 and he even has a hardware kit for $12 which includes push buttons, pot, RCA jacks, and a three terminal regulator. This is the best $55 bucks you can spend to help you not sound like a novice operator on 160m chasing DX in front of all your peers.

Marshall has built several of these into QRP command consoles. Maybe this is one of Marshall's secrets on being one of the Super Foxes last year. For those that missed hearing Marshall as a fox, you missed a rare treat. He was going three deep at a time, what a show. A lot of operators moved their frequency to the last station worked thinking they would beat the rest out when Marshall had them next up to bat. It sure was fun to see some of the super ops scrambling to remember where they were last. This really wasn't much of a problem though and I think he was one of the top finishers within the allotted time. Was it the CMOS III or Marshall? My bet is on both.

To show how sold I am on the CMOS III, I am using one on my TS-950SDX and my K2. The TS-870S already has one built in, Kenwood calls it a K1 Logic keyer!! It is the same thing with 4 memories instead of six. Both the K2 and the TS-950SDX have built in keyers. Why in the world am I using one of these keyers with a $4000 radio and the ultimate QRP rig, the K2. Bear in mind that I am mainly a headphone operator and any annoyances like pops, clicks, etc. will wear on you during a long contest. By the way none of these rigs are for sale, as each one has it's strengths and weaknesses. I love all these rigs and each rig has a very specific use. I am just trying to show how good the CMOS III keyer is.

Starting with the TS-950. The internal keyer has a reed relay in addition to the amplifier relay. You can turn off the amplifier relay and that helps the break-in some. There is a menu setting called chatter that I played with some that turned on the chatter suppression circuit, yuck!! Nothing helped much till I went to an outboard CMOS III. Now the TS-950SDX has break-in that rivals any rig (including the TenTecs), even while using the headphones. I can't believe I put up with the internal TS-950 keyer so long.

The K2 is a different story, the break-in is super and the internal keyer is very well behaved. You can go Iambic A or B and left paddle or right paddle just like the Cmos III. When you get to the memory portion of the K2 that is where all comparison ends. The K2 has a function button that must be used in addition to the memory location push buttons. You have to adjust your sending timing when setting up to what you want to playback. Say you have the keyer set to 20 wpm and you load a message in one of the memory locations of the K2. When you playback that message it will be at a different speed that you are sending. You can adjust your sending by trial and error to get the timing right, but I just can't see doing this in the heat of a contest. When you load a message in the CMOS III, it will playback at the same speed and force your timing to be right. I need all the help I can get to sound like I am a better operator.

To be fair to the K2, Wayne Burdick has improved the memory keyer a lot since the Beta test version and now the K2 keyer will allow you to do message chaining. In the Beta Test version you had to use the function button every time to fire a message off and there was no message chaining allowed. What makes it hard to fix is the memory buttons in the K2 do other things in addition to keyer functions. So the K2 for the most part is a two button affair for the memory keyer. To load a message you need to push the function button and then the memory location button. Now to send the message you still have to use function key once and then the memory location of the message you want to fire off. Once the message is going you can push the next memory push button, but not more than one at a time or it will quit.

Wayne says he is at the limits of what he can do software and memory wise. Eric Swartz (Wayne's counterpart at Elecraft) says they may offer an external key pad later to make the keyer easier to use like the CMOS III. If I am going to use something external I think I will stay with something I know, the CMOS III. I am even thinking of putting a CMOS III inside the K2 and use the I/O port for my own key pad. The bottom line is that the K2 built in keyer works fine for casual operating, but does not cut it for a contest situation. I'll use the keyer for ragchews, but when I operate contests, I will opt for the CMOSIII.

I know many of you out there are saying "who uses an outboard keyer these days?"when there are contest programs like NA that do all this and more. Well you are right for the big stay at home contests. But for the field events where you try to cut down on weight and all accessories as possible, a key pad or keyer is another box to carry around. I don't carry my laptop to field events. With the K2 sporting a built in battery, soon to be tuner, SSB, the rig is still a winner at being the ultimate QRP rig even though I may have to carry another box.

Also unless you are pretty experi

enced at chasing DX you are probably very nervous in a pileup and it is easy to make a mistake with no second chances. This is how I was a few years ago on 160 meters. The CMOS III really helped me get in those once in a life time DX expedition logs. It's funny how a person progresses, now I use the memory feature half the time and bang it out the old fashion way the other half. You have to get your confidence up and the CMOS III can help.

I used the TS-870 in the QRP Afield contest and without having to use a function push button I could push the memory keyer buttons without thinking about it. I would fire off sequence of six pushes and while the rig/keyer was doing its thing it left my hands free to do other things. This was my first contest with the 870 and my first contest in a year. There was a learning curve, but it didn't take long because of my past experience with the Cmos III. To me when things are really rolling good during a contest you need to keep everything simple and with the least wasted motion as possible.

The CMOS III makes you a better CW operator on the air whether you are chasing DX or contesting. It can also improve the break-in of a rig like the TS-950. When you have guest ops like over visiting it is very easy to sit them down and let them rip the airwaves up because they have there own CMOS keyer set up just the way that they want it. Just be sure it is in the right mode and the inquiry mode tracks with the keyer. grin.

Try the kit from Morse Express you will be glad you did!! 73 de W5JAY

1. Milestone Technologies, Inc. 2460 S. Moline Way, Aurora, CO 80014-1833 URL: , http://www.MorseX.com email address: n1fn@MorseX.com.

SOME MORE NC20 TWEAKS

by Dave Meacham, W6EMD
206 Frances Lane
Redwood City, CA 94062

These mods are "low key"...no higher TX power, or RX gain, although you may notice the smoother AGC. You WILL be able to take pleasure in the knowledge that your rig is more stable.

1) Change R20 to 4.7k and R29 to 3.9k to make the PIN diodes shut off in a progressive manner.

2) The stock bifilar collector transformer for the PA (Q18) has an open-circuit inductance of 168uH referred to the filter side. This is far more than necessary for that 50-Ohm circuit impedance. It invites self resonance, and PA instability due to the tendency to oscillate at low frequencies. 5 turns bifilar wound on an FT37-61 core gives 5.5uH, or nearly 500 Ohms inductive reactance (ten times the 50-Ohm impedance level). The stability-margin improvement is significant.

3) T3, the collector transformer for Q6, has the same problem in its stock form. Simply rewinding with 5T bifilar spread out over the same core gives 2400 Ohms of inductive reactance referred to the collector side (twelve times the 200-Ohm circuit-impedance level). The result is less chance of core saturation due to DC collector current, less chance of self resonance, and improved stability. 72, Dave, W6EMD
ddm@datatamers.com.

VE3DNL Explains Some Toroid Selection Guides

by Glen Leinweber, VE3DNL
leinwebe@mcmail.cis.McMaster.CA

What prompted Doug to select the cores from the myriad types offered by Amidon? Or why do you see these cores again and again in the circuits we build? First, we should separate the cores into two broad groups, because of two general applications where you'll find them: resonant circuits and broadband transformers. The iron powder cores are best for RF resonant circuits where a coil is resonated with a small capacitor. Iron powdered cores are good here for two major reasons-high Q and low temperature drift.

Broadband transformers require good coupling between windings. That means all the magnetic flux should stay in the core. And "broadband" often means that inherent winding impedance be high, even at low frequencies. So you'll want to have high impedance without too many turns. This requires high permeability that iron powdered cores don't have. High permeability comes at a price: higer losses and lousy temperature stability. Ferrite cores are less useful in resonant circuits because of low Q and temperature drift. And conversely, iron powdered cores are less useful as broadband transformers because not all the flux stays in the core, and you need many, many turns to get reasonably high impedance.

Here's a summary of Doug's choices:

Core	Al(nH/t^2)	Perm	Freq	Tempco
T37-2	5	10	2-30	95ppm
T37-6	3	8	10-50	35ppm
T50-7	4.3	9	3-35	30ppm
T130-2	11	10	2-30	95ppm
FT37-43	420	850	1-50	10000ppm
FT37-61	55.3	125	10-200	1500ppm

"Core" is Amidon's numbering system where "T" denotes toroid, "37" denotes outside diameter, and "2" is the iron powder recipe. "Al" is the winding factor that relates inductance to number of turns. In this case, one turn would give 5 nH. Inductance is proportional to turns-squared, so ten turns would give 100 times as much inductance (0.5uH) and one hundred turns would result in 50 uH. Note that the "Al" values in this table are different than usual - Amidon specs winding factors for iron powdered toroids as "microhenrys-per-100-turns" and ferrites as "millihenrys-per-1000-turns" :-/ In the table above, its "nanohenry-per-turn-squared". "Perm" is relative permeability, which tells how much more the flux lines would prefer going through the core than air. Entirely dependent on the core mix recipe. "Freq." is Amidon's recommendations of useful frequency range for this recipe. Top end is influenced by core losses, bottom end by huge number of turns required.

"Tempco" is the temperature coefficient in parts-per-million per degree ©. I'm guessing that it'd tell how much inductance would change for a one degree (Celcius) change in temperature. Note that tempco actually changes with temperature - these are likely numbers for the region around room temperature.

You want low tempco for a VFO coil. The "7" mix has the best, so Doug has chosen to include a T50-7 for use in VFO coils for low drift.

The big T130-2 gives a lot of inductance (Al=11) for use in a tuner. The two T37-2 and T37-6 types are good for general RF tuned circuit use. The two ferrite toroids "FT37" have high permeability which means flux lines stay confined inside the material. This ensures that coupling is very tight between windings - great for broadband transformer use. But losses are quite high resulting in low Q (which gets worse as frequency goes up). If you think "hey, with those nice high Al values, I can get BIG inductance with very few turns - losses should be low", then think again. Core losses are much higher than winding resistance losses and it shows up as low Q.

Look at the tempco - its terrible! These make lousy inductors for critical tuned circuit use, but OK inductors for chokes.

One other thing you have to worry about with ferrite cores is saturation losses. These losses depend on ampere-turns - the product of # turns x current thru those turns. Unlike powdered iron (which are VERY hard to saturate) ferrite cores can only take so much current (AC as well as DC) before getting really non-linear and lossy. Using a FT37-43 core as the collector choke in a 40-meter 5W final amp pushes it close to the limit. Losses show up as heat, so if your core gets hot, you're wasting RF power heating ferrite rather than the ionosphere. You need a bigger core, or one with a higher frequency spec (that'll require more turns).

These ferrites lose their magnetic properties at high temperature. Above the "Curie" temperature of 130 degrees ©, a FTxx-43 core might as well be made of glass - permeability drops to about one. For the FTxx-61 core, Curie temperature is 350 C. For more info, visit Bytemark's AWESOME website: http://www.bytemark.com/amidon or have a look in the HANDBOOK chapter 25.

-Glen VE3DNL

Later, on QRP-L, David Hinerman wrote: *For example, I want to couple a 50-ohm antenna lead to a 2-30 MHz amplifier stage whose input is 200 ohms. If I remember correctly, this requires a 2:1 turns ratio. (Impedance ratio is equal to turns ratio squared, right?) The 200 ohm load is transformed to 50 ohms by the transformer, but the transformer has inductance which appears as a reactance in parallel with the transformed load impedance. (Did I get that part right?) It seems to me I'd want a high reactance. How high is high enough?*

Glen's reply: Dave, OK, in your example, the critical info for # of turns is the 2MHz lower frequency limit, and the 200 ohm load impedance. You want the 200 ohms of load impedance to dominate over the winding impedance. For your parallel model of transformer reactance (in parallel with the 200 ohms) you'd like the transformer reactance to be something like (at least) five times the 200 ohm load. So how many turns is required to give 200*5 ohms at 2MHz?

Inductive reactance = 2 * PI * F * L
We want to find inductance L that gives 200*5 ohms:
L = 200*5/(2 * PI * 2000000)
L = 79.6 microhenries, or 79600 nanohenries

The Al winding factor for the FT37-43 core is 420 nanohenries per turn-squared. So you need SQRT(79600/420) turns: that's 13.76 turns. No such thing as a fraction of a turn with ferrites, so round up to 14 turns. You could build your 200 ohm to 50 ohm transformer a couple of different ways: One winding of 14 turns for the 200 ohm side, another winding overlaid of 7 turns for the 50 ohm side.

Another way: A bifilar winding of seven turns, which is two separate wires, wound together. Connect the end of one wire to the start of the other. The 200 ohm load goes across the series connected ends, while the 50 ohm source goes between one end and the "center-tap" where the two windings join. This would be OK for unbalanced source and load because one winding connection is common to source and load - that's ground.

This example should be checked up at the 30MHz. End of the range for losses. Up there, the capacitance between wires starts to become an important part of the winding impedance. If your desired frequency range were smaller, you might want to scale up a few turns more than 14:7 so that the 200 ohm load dominates winding reactance even more.

QRP HINTS & KINKS

A NorCal Exclusive

Illustrated by Paul Harden, NA5N

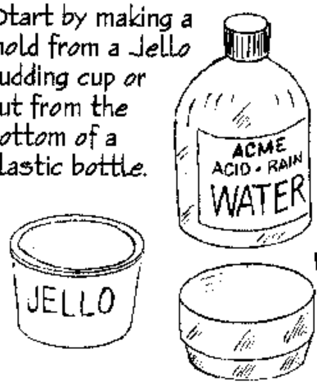
#10 More Neat Antenna Projects

A Bullet-proof Dipole Center Insulator

From Wes Spence, AC5K

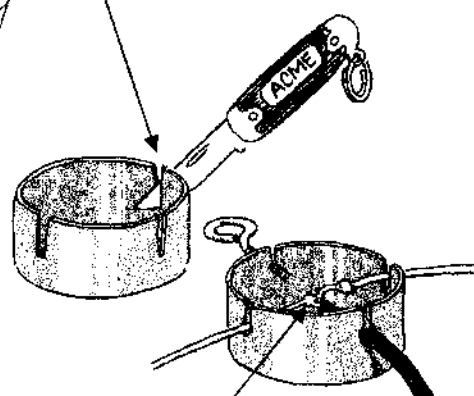
I saw this very rugged center insulator at the HamCom building contest in Dallas, and was struck at how virtually indestructable it was, and how it was suitable for "big and heavy" dipoles as well as the light "to the field" QRP dipoles. Wes' antennas, using this technique, has been in the air for years with no sign of breakdown.

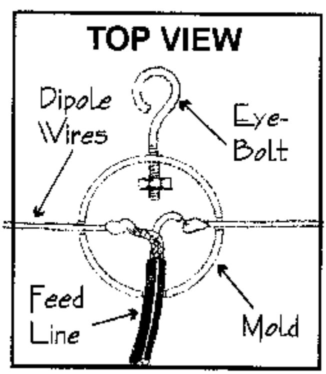
Start by making a mold from a Jello pudding cup or cut from the bottom of a plastic bottle.



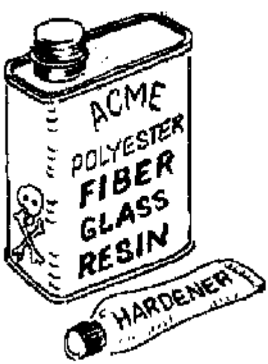
This becomes the form for holding the dipole wires, coax or ladder feed line, center support, and the mold for holding the resin until it dries.

Cut slits in the plastic sides for Holding the dipole wires and coax



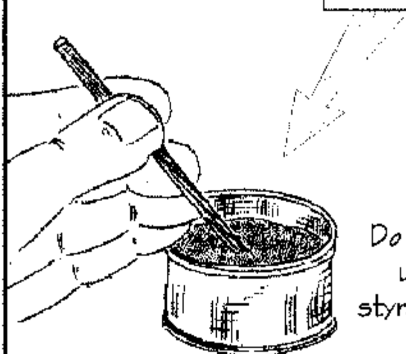


Solder coax/Ladder line to the dipole wires and set inside the mold – Suspending above bottom.

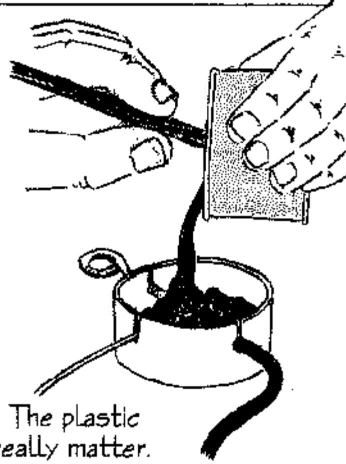


The "magic ingredient" is a polyester resin – such as "Condo" brand of polyester Fiberglass Resin for performing auto and boat repair. It comes in pint or quart sized cans, with a tube of hardener in the lid (much like 2-part epoxy).

It is recommended to mix the resin in a separate container – not the antenna mold directly. The resin will get hot as You mix the 2-parts together, so use an Appropriate container.

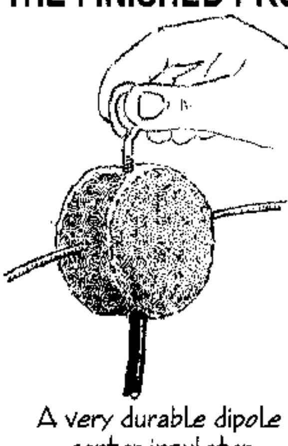


Do NOT use styrofoam!



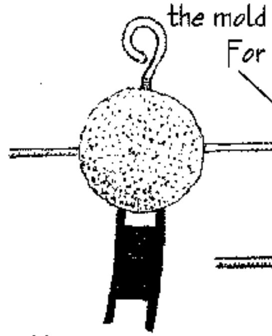
When resin is ready, pour into the mold. Resin should Set hard in about an hour. The plastic form may or may not come off. Doesn't really matter.

THE FINISHED PRODUCT

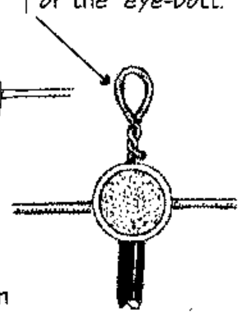


A very durable dipole center insulator

For a smaller QRP "to the field" dipole, use a plastic bottle cap for the mold and solid wire For the "eye-bolt."



Ladder-line version

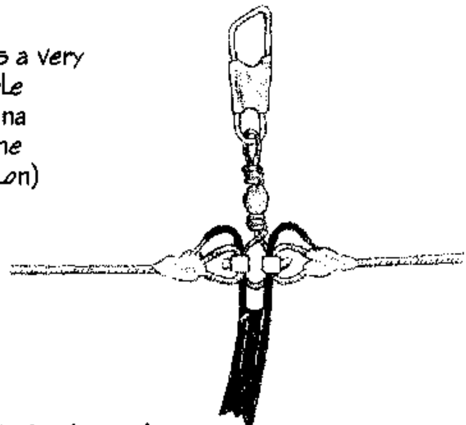


The "St. Louis Doublet" Portable Antenna

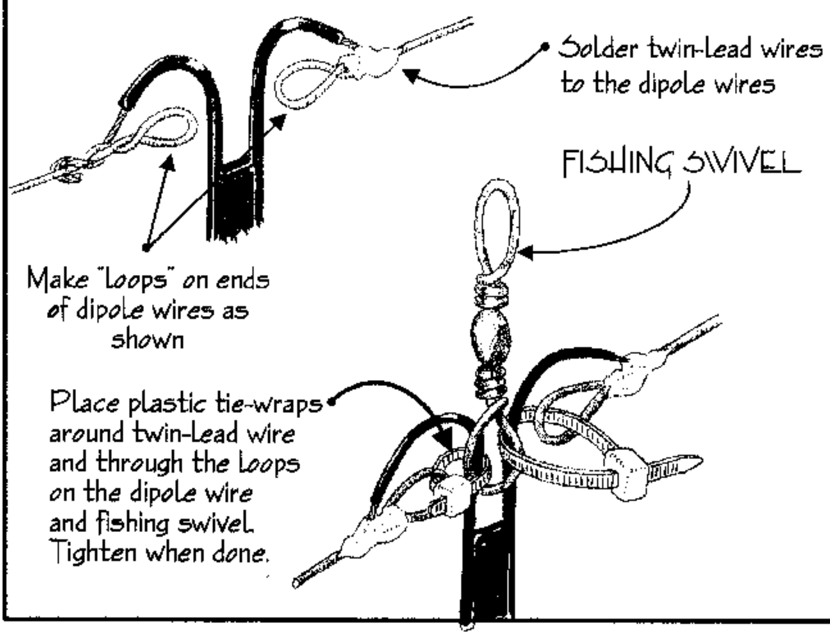
From Dave Gauding, NFØR

Dave Gauding's lightweight portable "St. Louis Doublet" was an article in the Spring 1999 issue of *QRPp*. However, the photo's of the center-fed swivel portion were not detailed enough, prompting many questions as to it's actual construction. The antenna is detailed here by illustrations, which will hopefully make this simple, clever little antenna a cinch to build and use.

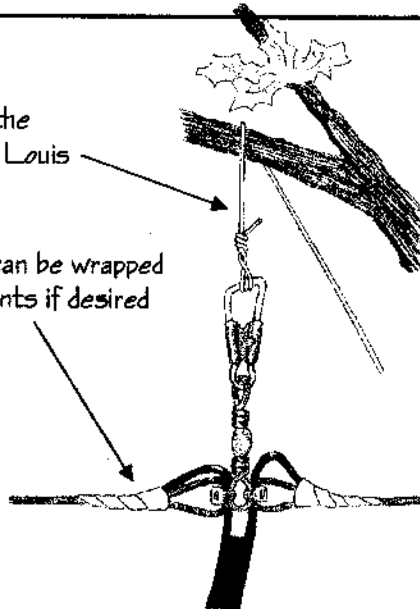
The St. Louis Doublet is a very lightweight portable dipole constructed of the antenna wire, feedline, a fishing line swivel and plastic (or nylon) tie-wraps.



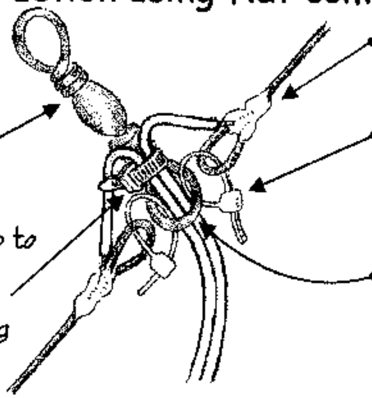
Construction using Twin Lead . . .



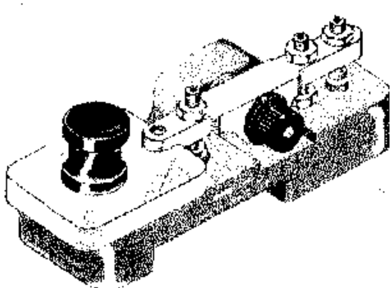
Using "in the field"



Construction using flat computer ribbon cable



Nifty New Straight Key



Doug Hauff's latest creation is a neat, very small straight key that does not need to be held down due to the pivot being perfectly balanced. It is milled out of aluminum and brass, magnetic "spring" and assembled for $44.95 + 5.00 P/H. Available from:

San Luis Machine Shop
200 Suburban Road, #F2
San Luis Obispo, CA 93401

See also the NorCal website

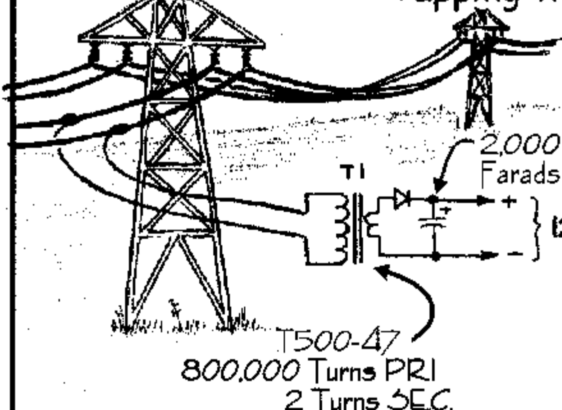
THE QRP Y2K SURVIVAL GUIDE

Illustrated by Paul Harden, NA5N

Emergency Y2K Power Sources

With the electrical power problems expected for Y2K, here's some ideas on keeping your QRP rig powered.

Tapping the "Power Grid"

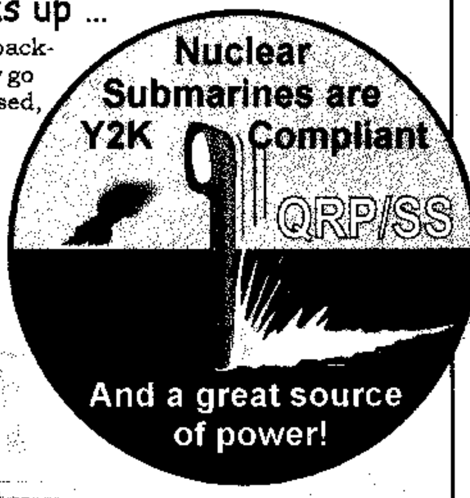


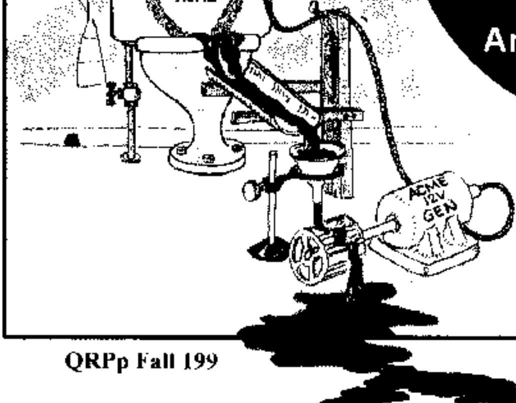
Your local power may be down while it is being rerouted to LA, NYC or someplace.

A simple tap on the high tension lines can provide plenty of power for your QRP rig.

When the sewer backs up ...

When Y2K causes your sewer to back-up, don't let that source of energy go to waste. It can be simply harnessed, as shown here, to drive a squirrel cage 12VDC generator.

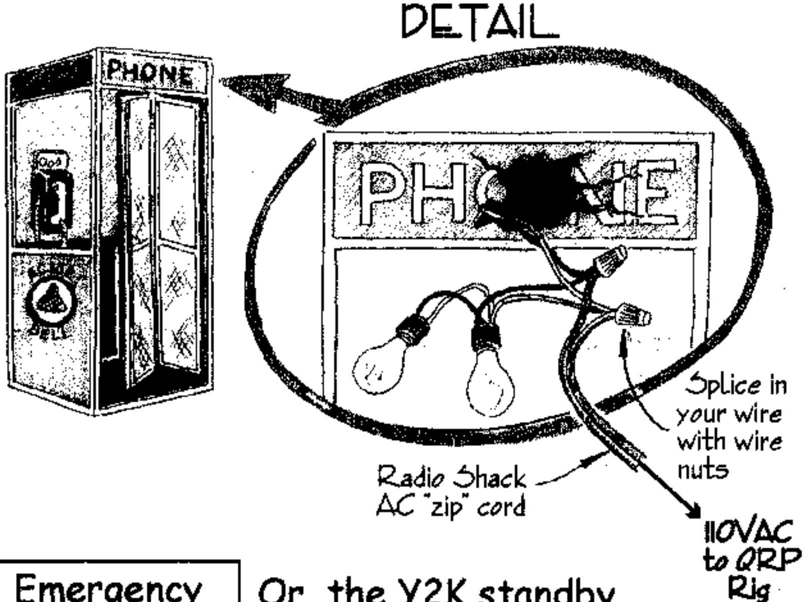




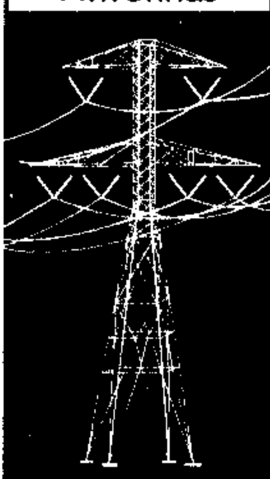
NOTES:
1. Fur-lined toilet seat optional.
2. Recommend you lower the toilet seat when QRP rig is not in use.

More Y2K Emergency Power

Here's another source of emergency power for your QRP rig that is often overlooked . . .



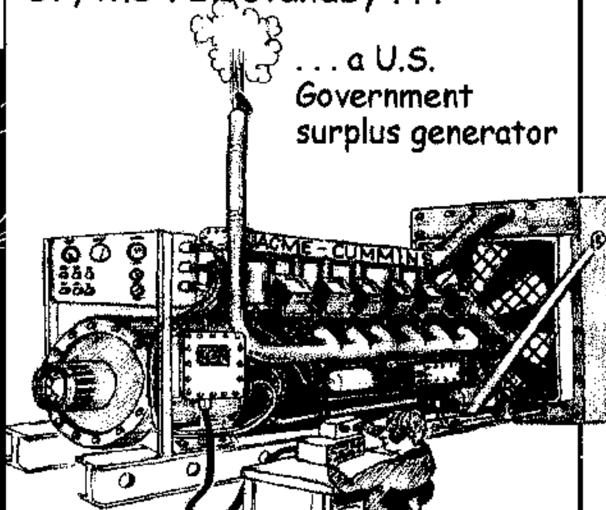
Emergency Antennas



And if your power is out ... you might as well load-up the dead power grid or a radio or cell phone tower.

Or, the Y2K standby . . .

. . . a U.S. Government surplus generator



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Jim Cates WA6GER, Doug Hendricks KI6DS and Paul Harden NA5N.

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3241 Eastwood Rd.
Sacramento, CA 95821

Please include a self addressed mailing label with all orders. Make checks or money orders to Jim Cates, NOT NorCal.

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NorCal has available the following crystals in HC49U cases for $3 each postage paid in the following frequencies: 7.040 MHz, 7.122 MHz. Send your order and payment in US Funds only to: Doug Hendricks , 862 Frank Ave. , Dos Palos, CA 93620, USA. Make check or money order to Doug Hendricks, NOT NorCal.

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QRPp, Journal of the NorCal QRP Club
862 Frank Avenue
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Y2K
Compliant

Vol. VII, Number 4 Winter 1999

QRPp

Special 6 Meter Issue

Plus the 2N2/6!

In this Issue ...

Journal of the Northern California QRP Club

This issue of QRPp *is devoted largely to the 6-meter ham band. Many QRPers have learned to enjoy 6M, while others seem to know little about this unique band. For those of you, like me, who are fairly ignorant about 6M, the following article, by Dave Finley, offers an excellent introduction to "the magic band."*

Dave Finley, N1IRZ, is author of "Morse Code: Breaking the Barrier," *published by MFJ Enterprises. He is a past president of the Socorro (NM) Amateur Radio Association and a frequent lecturer on radio topics.*

--NA5N

Six Meters: An Introduction

By Dave Finley, N1IRZ
Socorro, New Mexico

Six Meters (50-54 MHz) is known as "The Magic Band" to many of its fans, but the best description I ever heard came from a ham I worked during a frantic summer Sporadic-E opening: "This is a great band if you like having Mother Nature pull your chain."

On six meters, you can do almost anything that can be done on an HF band. Hams have earned WAS, WAC and DXCC on six. Six meters can sound like a contest weekend on 20, filled with signals and pileups galore. What makes it so different from the HF bands is that you never know when this excitement will come. That ear-blasting cacophony of signals can change into a completely dead band in only a few minutes. Or when this excitement will come. That ear-blasting cacophony of signals can change into a completely dead band in only a few minutes. Or vice-versa!

Six meters offers nearly every kind of propagation known. At the peak of a sunspot cycle, when the solar flux rises to between 150 and 200, the F-layer skip familiar to HF operators can provide worldwide contacts on six. If the flux goes significantly above 200, DX work on six can even get fairly reliable. Propagation modes more familiar to VHF operators, such as sporadic-E, auroral, meteor-scatter, transequatorial and moonbounce, all have been used on six meters.

Sporadic-E is the most common workhorse for six-meter operators. Peaking around the solstices (June and December), this mode of propagation can provide contacts over a few hundred miles or a couple of thousand miles or more with a "double-hop." It comes back every season, even during the sunspot minimum. Sporadic-E was essentially discovered by hams during the 1930s, when the old 5-meter band (56 MHz) produced contacts covering "impossible" distances. The "E-skip, season" runs from May to July, with another, shorter, peak in December and early January, but this propagation mode can appear at any time. A sproadic-E opening typically lasts for a few hours. For a thorough discussion of Sporadic-E, see the article by Emil Pocock, W3EP, in the April 1988 issue of QST.

Stations for Six

Today, it's easier than ever to get on six meters. Many of the newer HF rigs come with six-meter capability built in. There also are *transverters*, such as the ones from Ten-Tec and the 2N2/6 construction project later in this issue, that will put your HF rig on six, and single-band rigs such as MFJ's "Adventure Radio." If you're interested in DX, avoid the FM-only six-meter rigs and get one capable of CW and SSB operation. You don't need a lot of power. When six is open, it's open!

Antennas for this band are readily available commercially, but also easy to homebrew. A dipole for six meters is only a bit over nine feet long, and even a wire dipole, in a good location, will perform well. At this length, it also is easy to make a rotatable dipole from aluminum tubing. A three-element Yagi will perform admirably, and makes a nice weekend construction project. Ground-plane and J-Pole antennas also work fine for six meters.

While antenna polarization makes little difference for DX work, it is important if you also want to work other six-meter operators within ground-wave range. Most operators with Yagis or rotatable dipoles use horizontal polarization, so if you rely on a vertical ground-plane or J-Pole, you may miss out on local and regional six-meter nets, which can provide a nice way of keeping up with weak-signal VHF happenings. One way to get both polarizations in one antenna would be to build an "L" antenna for six, adapting the 10-meter design of W4RNL presented in the December 1999 QST, page 52.

Again, you don't need an elaborate station to get good results on six meters. During one opening, I exchanged honest S-9-plus signal reports with a station several hundred miles away, then he asked about my station. When I said, "ten watts and a ground-plane antenna," he laughed. His station: 1,500 watts and an array of four, 11-element Yagis. And the same signal report on both ends! (This guy uses his top-of-the-line station for six-meter moonbounce work.)

Getting on the air

Six-meter operators do a lot of waiting, because of the unpredictable nature of the band. To help show when the band is open, six-meter fans around the world have put a fairly extensive suite of ***6M beacons*** on the air. In the U.S., beacons occupy the region between 50.060 and 50.080 MHz. In other countries, beacons are spread more widely throughout the band. For lists of beacons, their frequencies, locations and other details, look at the following Web sites, which are updated regularly:

http://www.keele.ac.uk/depts/por/50.htm

Http://user.super.net.uk/~equinox/50.html

http://www.qsl.net/oz6om/bcn1099.html

It's a good idea to pick a few beacons in different directions from your QTH and check their frequencies regularly. During an opening, go through the beacon subband and note which ones you're receiving, then watch for them later.

Unlike the HF bands, six meters is much more rigidly structured in terms of what frequencies are used for what purposes. Ironically, six meters, available to all no-code Techs, is one of only two ham bands (2 meters is the other) with a CW-only subband which excludes all data transmissions. That CW-only subband runs from 50.0 to 50.1 MHz. Almost all weak-signal activity on six occurs between 50.1 and 50.4 MHz.

Calling frequencies are used extensively. From 50.100 to 50.125 is a "DX Window," in which domestic QSOs are discouraged. The DX calling frequency is 50.110. The traditional domestic calling frequency is 50.125. However, there has been a movement recently to extend the DX window to 50.130 and make 50.200 the new domestic calling frequency. This movement has been precipitated by the extension of six-meter privileges to hams in new countries around the world, and the associated increase in the number of DX stations on the air. Such band plans are, of course, voluntary, but are observed widely by the six-meter community.

The recommended CW calling frequency is 50.090, but you will often hear CW CQs on 50.125, too. Under the old band plan, you would hear many stations on 50.125 as the band opened up, then, as more stations discovered the opening, activity would spread upward in frequency, reaching 50.3 or 50.4 during a good opening. It seems likely that, while the new, expanded DX window probably will catch on, many operators will take some time to "let go" of the old, familiar 50.125. I would recommend monitoring both 50.125 and 50.200, as well as 50.090, during an opening. If the opening seems real good, start checking 50.110 for DX stations, too.

Most domestic weak-signal contacts on six are SSB, but in recent years, there has been an increase in CW activity. As mentioned above, the CW activity often is intermingled freely among the SSB signals. It would be nice to see more CW activity down around 50.090, and use the CW-exclusive subband to better advantage.

Grid Squares

The first thing you will be asked when you make a contact on six is, "what's your grid square?" While still little known among HF operators, the Maidenhead grid-square system, formalized at a VHF meeting in Britain in 1980 and adopted world-wide by the International Amateur Radio Union in 1985, is almost universally used as a locator system by VHF, UHF and microwave operators. The Maidenhead system divides the world into 32,400 squares, each 2 degrees of longitude by 1 degree of latitude. There are larger "fields" of 100 locator squares each, and each square is divided into smaller "subsquares." For most purposes, knowing your 2 degree by 1 degree square is sufficient.

VHF operators collect grid squares like HF operators collect countries. Many are working toward the ARRL's VHF-UHF Century Club (VUCC) award, which requires confirmed contacts with 100 grid squares. During VHF contests, some enthusiasts go on "Grid expeditions," to put rare grid squares on the air, while others become "rovers" to operate from several grids during the contest. Just as states or countries serve as multipliers for HF-contest scores, grid squares are the typical multipliers for VHF-contest scores.

You can find a ***grid-square map of the U.S.*** at:

www.amt.org/Multimedia/images/grid-na.gif

or plug your latitude and longitude into AMSAT's grid-square calculator at:

www.amsat.org/amsat/toys/gridconv.html

If you work much on six meters at all, you'll probably want to add your grid square to the information on your QSL card.

More information on the Web

Many hams have become rather fanatical about six meters, and there is a wealth of information about this band on the Web. To learn more, you can start at the site of the ***Six Meter International Radio Klub (SMIRK)***, at:

Http://www.smirk.org

You can earn a lifetime membership in SMIRK by working six members on six meters and collecting their SMIRK membership numbers. SMIRK sponsors contests, publishes a newsletter and meets annually.

Another good Web site is provided by the ***UK Six Metre Group***, at:

http://www.uksmg.org/

Six meters can provide you with a lot of excitement and new operating challenges. In addition to offering new awards and contests, this band can expand your experience with different propagation modes.

Finally, in my opinion, six meters serves a valuable function for the health of Amateur Radio. All licensed hams, except for Novices, can use six meters. In recent years, no-code Technicians have discovered this band in increasing numbers. When someone whose only experience with Amateur Radio has been local operation on 2-meter repeaters makes a six-meter contact with another ham more than 1,000 miles away, that can be a dramatic revelation that opens up a whole new world to them.

In many cases, such a revelation spurs that ham to upgrade their license and join us on the HF bands. When that happens, we have, in all likelihood, gained a lifelong radio devotee who otherwise might have dropped from our ranks from boredom. By showing such hams the wider world of our hobby, six meters earns its appellation of "The Magic Band."

Special Construction Feature:
Step-by-Step "Build it from scratch" 6M QRP Transverter

NorCal is pleased to present another excellent construction project -- the 2N2/6, a 6M-to-40M transverter, designed by Jim Kortge, K8IQY. Jim, who also designed the 2N2/40, again demonstrates good engineering and excellent performance can be achieved with commonly available parts. Jim's excellent article presentation, with the assembly drawings by Paul Harden, NA5N, offers another "step-by-step, build-it-from-scratch" project just about anyone can build.

A 40-Meter to 6-Meter, 2N2222 Based, CW Transverter

By Jim Kortge, K8IQY
P.O. Box 108
Fenton, Michigan 48430

The objectives of this project were to illustrate how transverters can be used to extend operation of a monoband transceiver to another band, to provide a low cost way of extending most 40-meter CW QRP rigs to 6-meters, and to test the practical operating limits of the common 2N2222 transistor. Most of the circuitry presented was modeled before being built using Electronic Workbench, a SPICE based commercial modeling system. Construction is based on the "Manhattan style", a method popularized by the author's previous work. An alignment generator's design and construction are also included. This transverter is a follow-on to the author's previously published design for a 2N2222 based 40-meter transceiver.

2N2/6 Transverter Specifications

Receive

Input: 50 Mhz
Output: 7 MHz
Front End: ~500 KHz bandwidth
Sensitivity: -120 dBm (0.25uv)
R. F. Amplifier: +10 dB
Diode single balanced mixer

Transmit

Input: 7 MHz
Input Power: ~2 watts
Output: 50 MHz
Output Power: 2 watts (3-2N2222A)
Spurious Outputs: <-50dBc
Good r.f. stability
Solid state T/R switching

Overall

10-2N2222 transistors; 1-2N2907 transistor
Circuits modeled with Electronics Workbench
Manhattan style construction; 4X5 inch footprint

Background

Transverters are a practical means of extending the operation of an existing, monoband transceiver to another frequency band. They work by linearly transforming the input signal of the exciter or driving transceiver to a higher, or lower band. Most of the input power is absorbed in an input attenuator, as the transformation is done at low power levels. Following the transformation, filtering, amplification and more filtering are applied to provide an output signal on the new frequency band.

On the receiving side, an equivalent process is used. An incoming signal is usually amplified, linearly transformed to the input frequency of the transceiver, filtered, and passed on for further processing. The transceiver is used to provide intermediate frequency amplification, detection, and audio amplification.

Since the driving transceiver often only has a single antenna connector, used for both receiving and transmitting, some means must be incorporated into the design to direct the incoming high level r.f. to the transmit section of the transverter, and send the low level signals from the antenna during receive, back to the transceiver. This is usually done with a system of relays, or solid-state switches.

While this transverter design provides 6-meter operation for a 40-meter transceiver, other band possibilities are possible. As an example, the design could be scaled to provide 12 or 17-meter operation from 40-meters, or possibly from 20-meters. Many other combinations are viable as long as the band of interest is not related to low order harmonics of the input.

2N2/6 Overview

Figure 1 shows a block diagram of the 2N2/6 transverter. It has three major sections, a receive strip, a transmit strip, and a common local oscillator. We'll look at each section in detail a bit later.

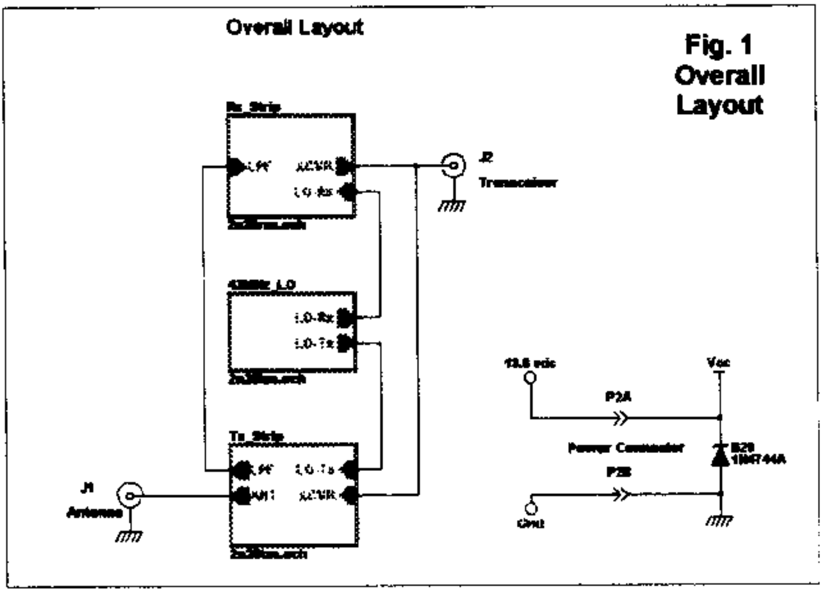


Fig. 1 Overall Layout

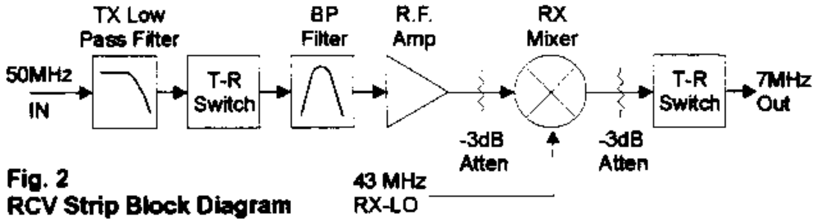


Fig. 2
RCV Strip Block Diagram

The receive strip takes incoming 50 MHz signals arriving from the antenna (connector J1), mixes them with the 43 MHz local oscillator signal, filters them, and makes them available on the transceiver connector, J2. These signals have been translated to 7 MHz, so they can be received by the 40-meter transceiver. As an example, an incoming signal at 50.100 MHz is translated to a frequency of 7.100 MHz.

On the transmit side, 7 MHz output from a 40 meter transceiver is sent to connector J2, significantly reduced in power by an attenuator, mixed with the 43 MHz local oscillator, filtered, amplified, filtered again, and sent to antenna connector J1. The output signals are at 50 MHz, and linearly track the tuning of the 40-meter transceiver providing the driving power. As an example, a 40-meter signal on 7.040 MHz becomes a signal at 50.040 MHz.

The local oscillator is common to the receive and transmit strips, and provides the approximate +10 dBm power level needed by the respective single balanced mixers. A common 14.318 MHz computer crystal is used in a frequency tripler circuit to generate the needed 43 MHz mixer drive.

Receive Strip Details

Figure 2 is a more detailed block diagram of the receive strip, showing all of the important elements.I ncoming 50 MHz signals are first routed through the transmit low pass filter. This attenuates all signals that are above the 6-meter band, which might mix with a harmonic of the 43 MHz local oscillator to produce a signal in the received 40-meter band. The signal then passes through the first of three transmit/receive (T/R) switches. This T/R switch isolates the receive strip from the transmit signal, on the antenna or input side. Next, the signal is passed through a lightly coupled, two resonator band pass filter, which attenuates out-of-band signals, both above and below 6 meters. Its frequency response is shown in **figure 3.**

The primary purpose of this filter is to restrict the band of signals passed to the r.f. amplifier. It also minimizes the signals that could mix with the fundamental or harmonics of the local oscillator and produce a signal in the received 40-meter band. Signals are then amplified by a common base r.f.

Fig. 3

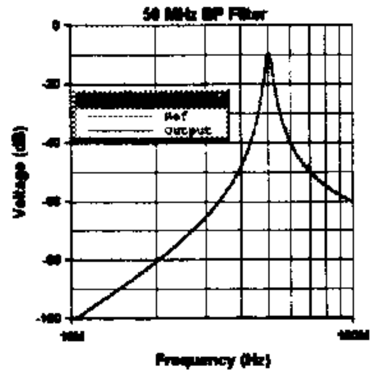
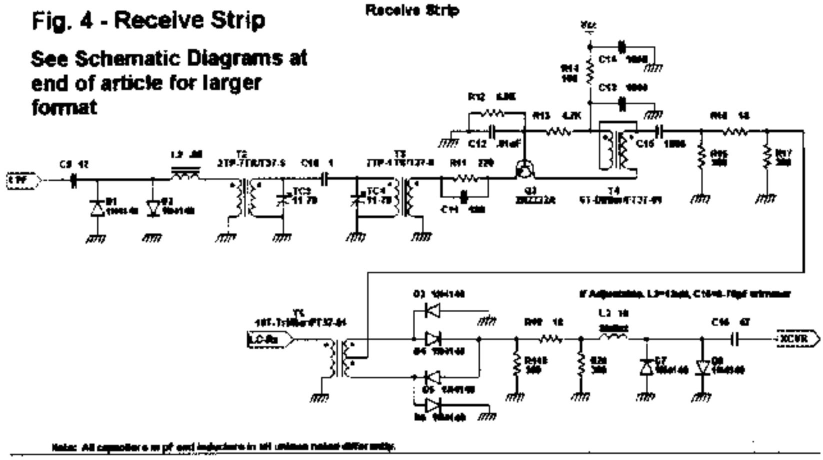


Fig. 4 - Receive Strip

See Schematic Diagrams at end of article for larger format



amplifier, with an untuned output. Gain of this amplifier is approximately +10 dB. An amplifier with a tuned output was attempted, but could not be made stable using the 2N2222 transistor. Considering the 2N2222A has a published Ft of 300 MHz, it is somewhat remarkable that +10dB of gain can be achieved at 50 MHz. From the r.f. amplifier, signals pass through a 50 ohm, 3 dB attenuator, and on to the diode, single balanced mixer. This mixer uses common 1N4148 diodes that are matched for forward resistance. Local oscillator drive to the mixer is at approximately +10 dBm. Mixer output signal is then taken through another 50 ohm, 3 dB attenuator, to keep the load on the mixer somewhat constant. The signal then passes through the second T/R switch. This switch serves two purposes. First, it is a series tuned circuit, so it attenuates non-7 MHz signals, and second, it protects the receive mixer from incoming, higher power r.f. from the driving transceiver during transmit. The series tuned components can be either fixed values, or adjustable, with the adjustable version being preferred for optimal performance.

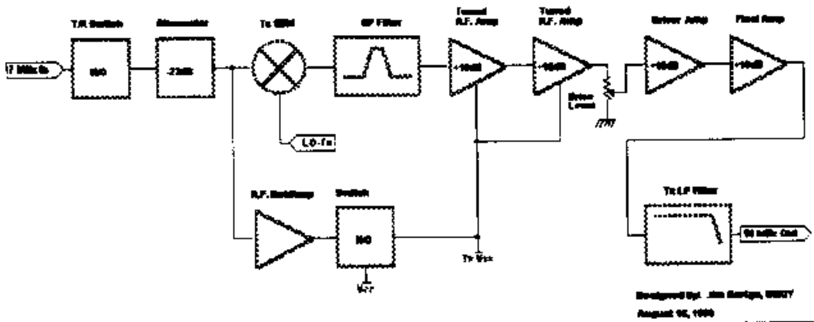
The receive strip schematic is shown above as **figure 4.**

Transmit Strip

Figure 5 (see page 11) is a detailed block diagram of the transmit strip.

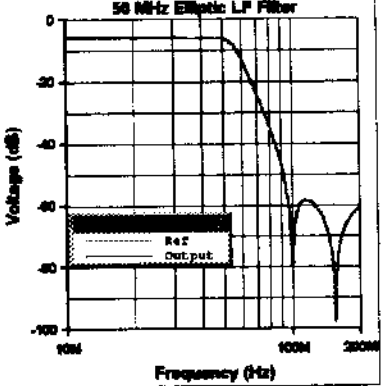
Incoming r.f. from the driving transceiver is passed through the third of the T/R switches. This switch is comprised of a pair of back-to-back 1N4007 rectifiers. It acts as an isolator at low r.f. levels so the transmit input attenuator does not load down the transceiver port on receive. The signal is then attenuated by -23dB by the input attenuator, and drives the RF port of the transmit single balanced diode mixer at about +10dBm. This mixer is a duplicate of that used in the receive strip. Also coming in to the mixer on the LO port is the 43 MHz local oscillator. Coming out of the mixer, the signals are routed through a narrow band pass filter, a duplicate of the input filter on the receive side that is ahead of the r.f. amplifier. This filter greatly attenuates the non-50 MHz signal components, including the 43 MHz local oscillator component. At this point, the 40-meter input signal is now converted to 6-meters, and reasonably well filtered. Two class A amplifiers with tuned outputs are next used to amplify the 6-meter signal up to about +13 dBm, or 20 milliwatts.

FIG. 5 Transmit Strip Block Diagram



The next amplifier in the chain is run at class B, for higher efficiency, and has an untuned output. It can provide up to about +23 dBm of output, or 200 milliwatts. This stage is the driver for the finals. The final amplifier uses 3-2N2222A transistors in parallel, just like the 2N2/40 rig. Using 3 transistors, one can achieve a safe output power of 2 watts. Following the final amplifier is an elliptic low pass output filter, with notches set for 100 and 150 MHz, the 2nd and 3rd harmonics of the 6-meter signal. This type of filter is required to meet the stringent requirements imposed by the FCC for emissions above 30 MHz. For a transmitter at 50 MHz, with a power output of 2 watts, all spurious components must be at least -50 dB below the reference carrier. **Figure 6** shows the frequency response of this filter. The notches just described are clearly visible.

FIG. 6
50 MHz Elliptic LP Filter



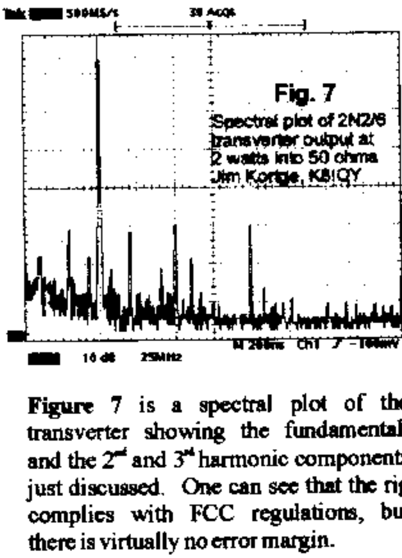
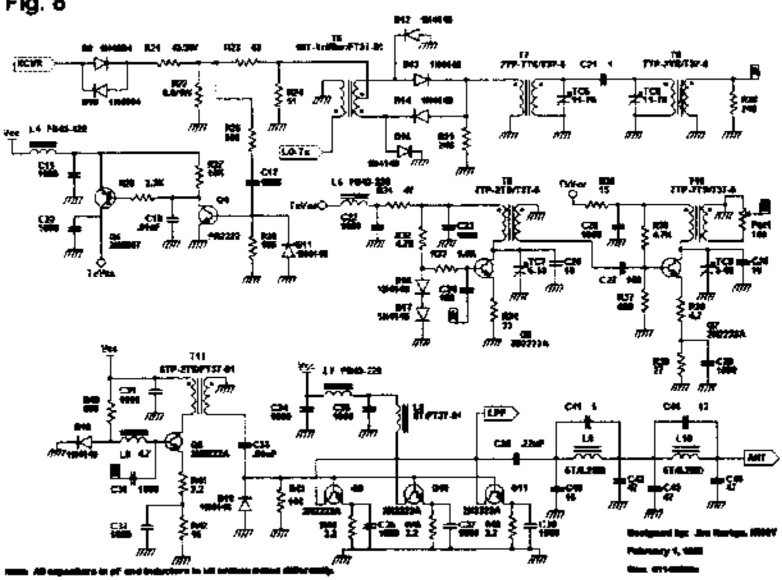


Figure 7 is a spectral plot of the transverter showing the fundamental, and the 2nd and 3rd harmonic components just discussed. One can see that the rig complies with FCC regulations, but there is virtually no error margin.

One of the unique features of the transmit strip is the use of r.f. sensed switching of the class A amplifiers during transmit. This was done for two reasons. The most obvious is to save power when not transmitting, as the two class A amplifier stages draw collectively over 40 milliamps of current. The less obvious is to eliminate internally generated VHF noise from these two stages when they

Fig. 8

Transmit Strip



are not being used for transmitting purposes. If these two stages are running during receive, incoming low level signals (those below about 25 microvolts) are completely masked by internally generated noise by the amplifier pair. **Figure 8** is the schematic diagram of the transmit strip. One can plainly see it is much more complicated than the receive strip, which is typical of most transverters.

Local Oscillator

A block diagram of the local oscillator is shown in **Figure 9**. The local oscillator section consists of a crystal controlled Colpitts oscillator with the output tuned to the 3rd harmonic of the 14.318 MHz, computer grade crystal. Series capacitance is employed to raise the fundamental of the crystal to 14.333 MHz, which triples to 43 MHz, the local oscillator frequency used in the transverter. The tuned output uses a capacitive divider arrangement to lower the output impedance driving the buffer amplifier. This approach helps decouple the oscillator stage from the buffer so that oscillator frequency pulling is minimized. It is also lightly coupled to the buffer stage to further improve

Fig. 9

43MHz Local Oscillator

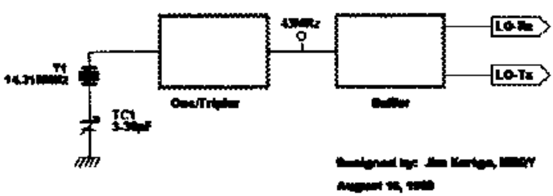
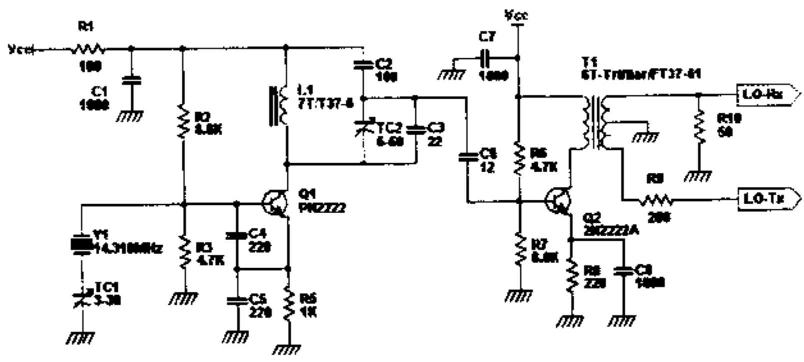


Fig. 10 43MHz Local Oscillator



Note: All capacitors in pF and inductors in uH unless noted differently.

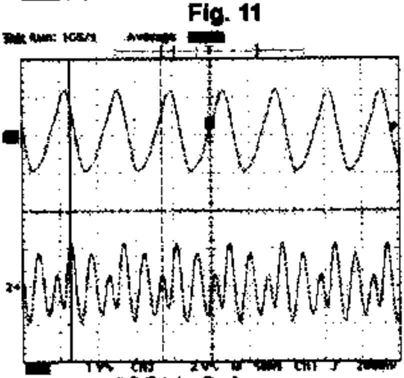
isolation. Output drive for receive and transmit single balanced mixers is taken from opposite phases of the untuned output transformer. The drive level on each side is about +10 dBm

Figure 10 shows the schematic diagram of the Local Oscillator section. A few variants in both oscillator design and layout were tried, but the current configuration seems to work the best overall. As an aside, it does have an interesting anomaly, not completely understood by the author. As shown in the output waveform, **figure 11**, there is a decrease in harmonic energy as the harmonics increase.

The waveform is not uniform at the 43 MHz output frequency. Interestingly, the EWB model of the same circuit shows the same anomaly. This is shown in **figure 12**. I suspect it has to do with circuit losses that become larger with increasing frequency. However, it may simply be loss in the oscillator output inductor itself, since the circuit is only getting a new "packet" of energy every third cycle of the output. This phenomenon may be quite typical of an oscillator with a third harmonic tuned output, and only represents my lack of experience with this type of circuit.

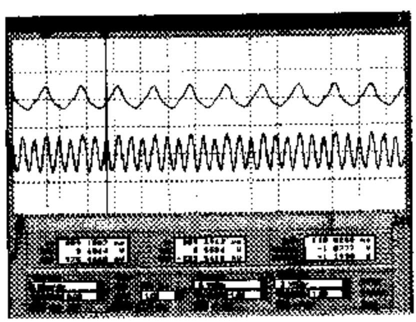
This completes the technical description of the system. We'll now turn our attention to the construction aspects of

Fig. 11



LO Tripler Performance

Fig. 12



Manhattan Style Construction Overview

Manhattan style construction gets its name from the fact that Manhattan is an island, and the technique makes use of small circular or rectangular pads (islands) affixed to the PC board substrate with an adhesive, as the connection points for components. In addition to the pad "islands", the name also suggests the "look of a city", with various sized and oriented components appearing as a city in miniature when viewed from a few feet away. **Figure 13** is a photograph of the transceiver board to illustrate this effect.

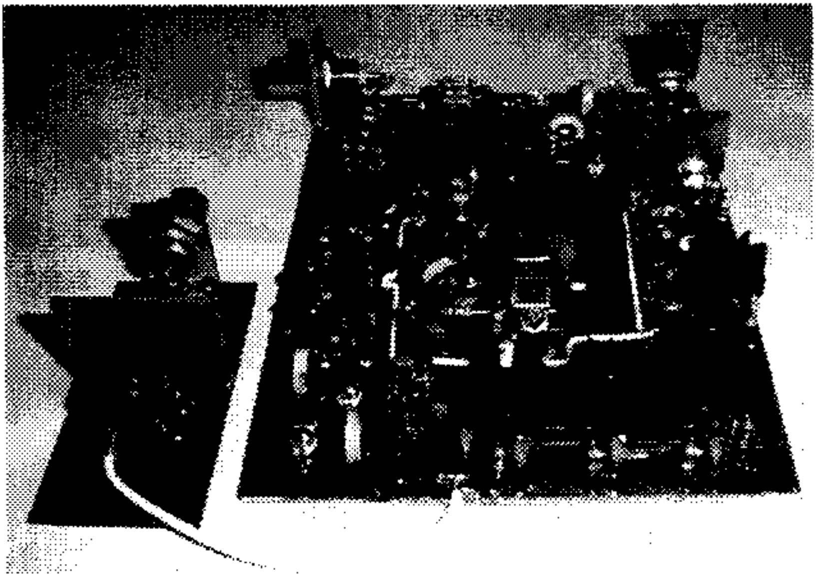


Fig. 13 - Photograph of the 2N2/6, built "Manhattan Style" by K8IQY

Manhattan Style Construction Overview

There are at least three very significant advantages to building with this technique. The first, and probably most important, is that building r.f. circuits over a solid ground promotes very quiet receive conditions as circulating r.f. currents are virtually non-existent. This effect also promotes stability in both receiving and transmitting circuits.

The second advantage is that the small pads act as a tiny bypass capacitor at each circuit node, helping to reduce or eliminate VHF and UHF parasitic oscillations. A 3/32 X 1/4 inch pad produced by an ADEL nibbling tool has a pad capacitance of nominally 0.5 pF, when bonded to a piece of PC board material. In like manner, a 5/32 inch diameter round pad has a capacitance of about 0.4 pF. Neither pad's reactance is significant (25-50K ohms) at HF or low VHF frequencies, but provides significant reactance (500 ohms) at 500 MHz, and above.

Advantage three relates to the ease of changing what has been built if it doesn't work. The parts can be easily removed and reused, as can the pads, to rebuild a different piece of circuitry. In addition, more circuitry can be added without having to completely redo a board.

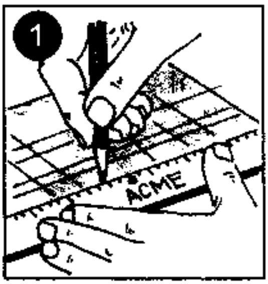
One can use the method to build a circuit on a substrate by generally following the layout show in the schematic. As a result, building is quite fast, and with practice, part orientation and location become very intuitive.

When using the method on a new circuit, trying to estimate the size of the finished board, and adding at least 25% to each dimension is a worthwhile endeavor. Any unused substrate can be removed later, when all of the circuitry is built. In addition, marking off sections of the substrate where various portions of the circuit will be built can be a great help in overall organization and layout.

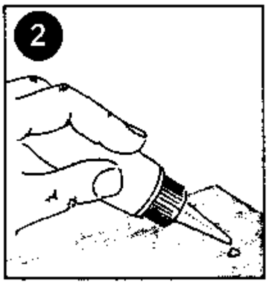
The basic steps for building with the "Manhattan" technique are illustrated below.

The "Pad" or "Manhattan" Technique

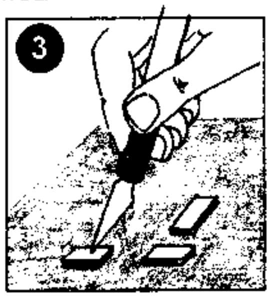
Pads are made from small pieces of copper clad. They can be made by cutting out of a piece of copper clad (single sided OK) with a nibbling tool, round punch (such as from Harbor Freight) or other means. The "main board substrate" is a solid piece of copper clad board, double sided is preferred.



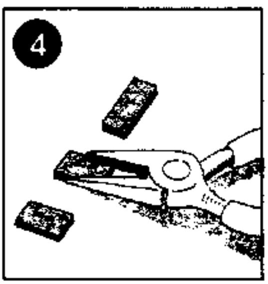
Draw guidelines and the footprints of each section with pencil on the copper clad board. Planning ahead is important!



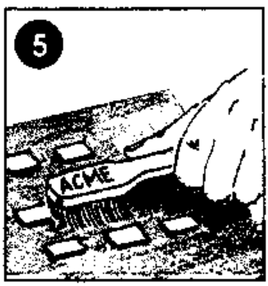
Apply a drop of *Super Glue* or other adhesive to the main board where pad is to be placed.
(Glue 1 or 2 at a time!)



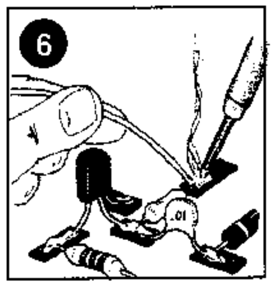
Drop pads in place over the glue drops and position with exacto knife or other sharp object.



Super glue affixes the pads quite well! To remove or reposition a pad, snap-off by a twist with needle-nose pliers.



Boards and pads can be cleaned with a brush and alcohol, mild solvent or water. Excess glue may have to be scrapped off.



Solder the components to the proper pads by following the detailed assembly drawings that follow.

CONSTRUCTION SECTION

The 2N2/6, as illustrated herein, was built in a "clam-shell" type metal enclosure about 4.5x5.5 in. square. The main substrate board was mounted using threaded standoffs in the main portion of the enclosure. The smaller output lowpass filter board was mounted on the inside of the rear panel. Also on the rear panel are the two BNC's, DC power connector and fuse holder. There are no controls on the front panel.

Jim's 2N2/6 is illustrated below. Of course you can follow this construction exactly, or modify to suit your own tastes.

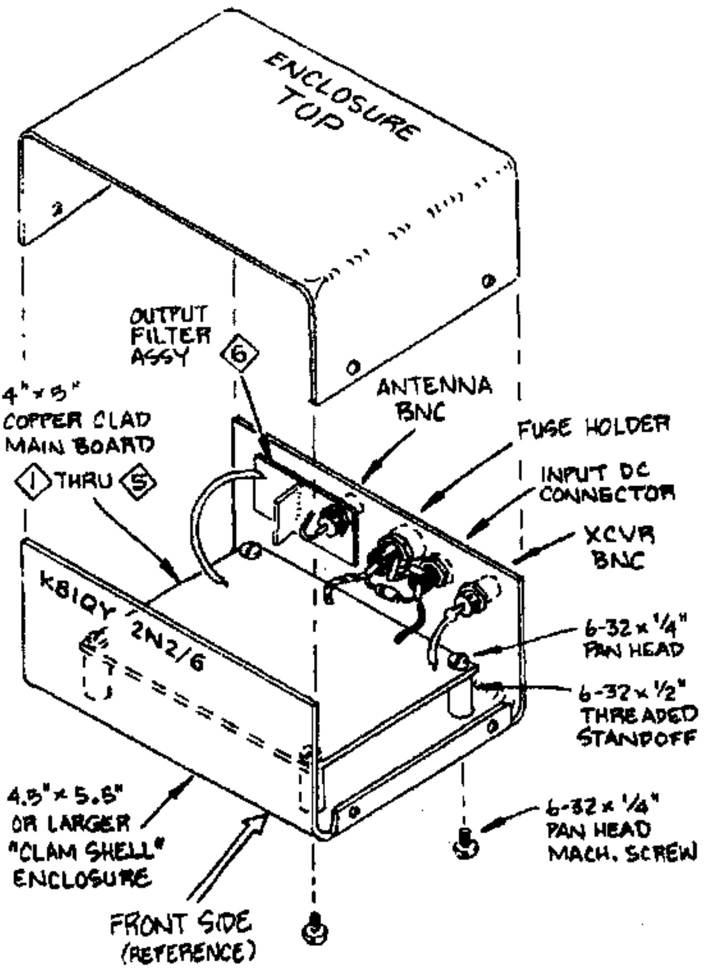


FIG. A - Exploded view, general parts layout and identification of the 2N2/6 Transverter.

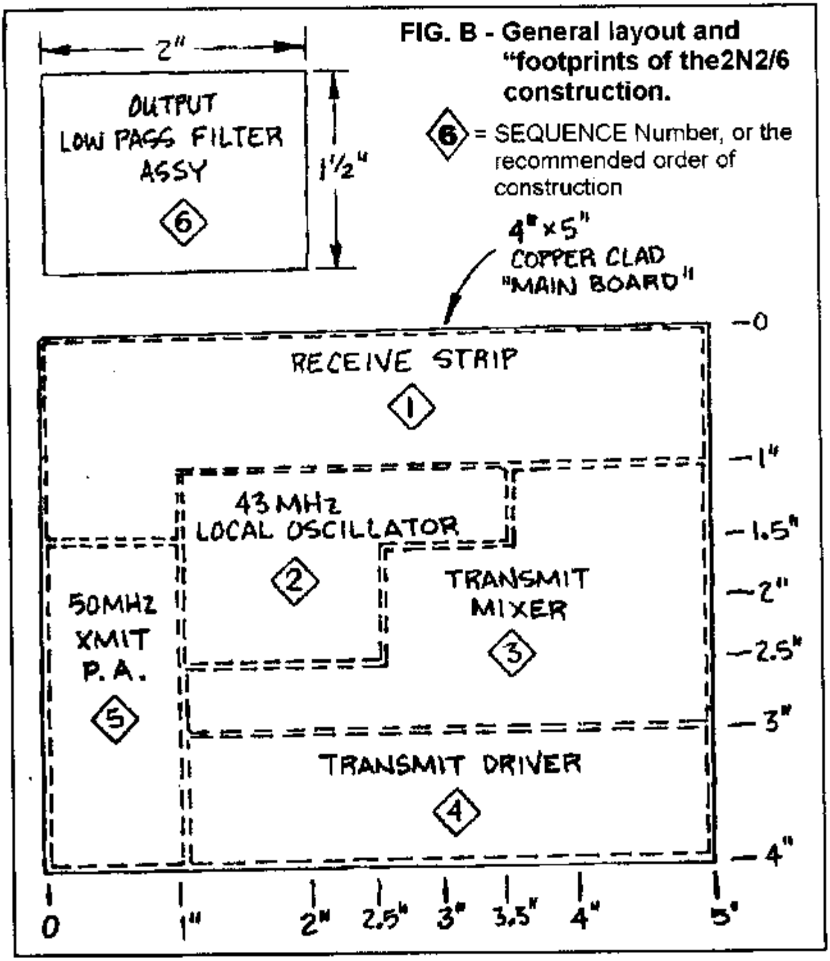


FIG. B - General layout and "footprints of the2N2/6 construction.

❶ RECEIVER STRIP CONSTRUCTION

Schematic	Assembly Dwg.
SHT. 1	**SEQ. #1**

For this project, construction begins across the long dimension of the substrate with the receive strip. The area utilized on the prototype was 1 X 5 inches, and is shown as SEQ. #1 in **figure A** above, the assembly illustrated in drawing **SEQ. #1**, and a photograph of the receive strip in **figure 14.** Moving from right to left (when viewed from the back-panel end of the board), one can see the double tuned front-end filter, then a tuned output r.f. amplifier (this was an early version using a plastic PN2222), attenuator, the single balanced mixer transformer and diodes, another attenuator, and the output T/R switch. The receive input T/R switch wasn't added until the transmit section was finished. As a point of reference, this assembly step is the only one which will show the substrate in this "inverted" orientation. All other figures will show the substrate rotated 180 degrees, that is, as viewed from the front panel.

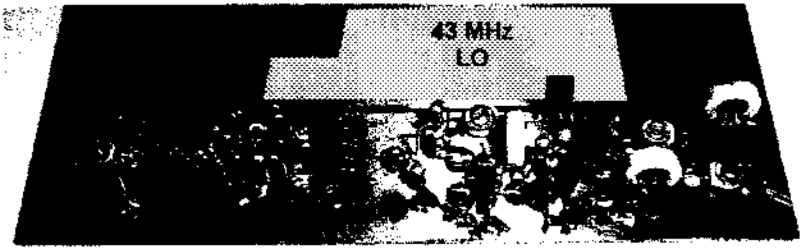


Fig. 14 - Photograph of the finished Receiver Strip construction
(Shaded area shows where 43MHz LO will be built)

The windings on transformers T1 and T2 are close wound as can be seen. This isn't the usual approach for winding toroids, as it adds a small amount of winding capacitance relative to winding over approximately 300 degrees, which is more common. However, this method provides greater consistency in the final inductance achieved, and is preferred if one does not have a means of measuring the wound toroids inductance.

It was during a preliminary test of the circuitry at this point in the construction that it became obvious the r.f. amplifier had to be redesigned, as it was most unstable! The tuned output version was replaced with the untuned circuit shown in the schematic, and good stability was achieved. The untuned version also saved one trimmer capacitor.

When this part of the transverter was done, it was tested by injecting a 43 MHz signal into the LO port of the receive SBM, while using a Yaesu FT-990 as the downstream transceiver. While no signals were heard on 6-meters, 49 MHz cordless telephone signals could be heard, especially those from a neighbor approximately ½ mile away. Of course, you can do this easier once you build the on-board 43MHz LO next. The **receiver alignment** procedures follows the 43 MHz LO construction.

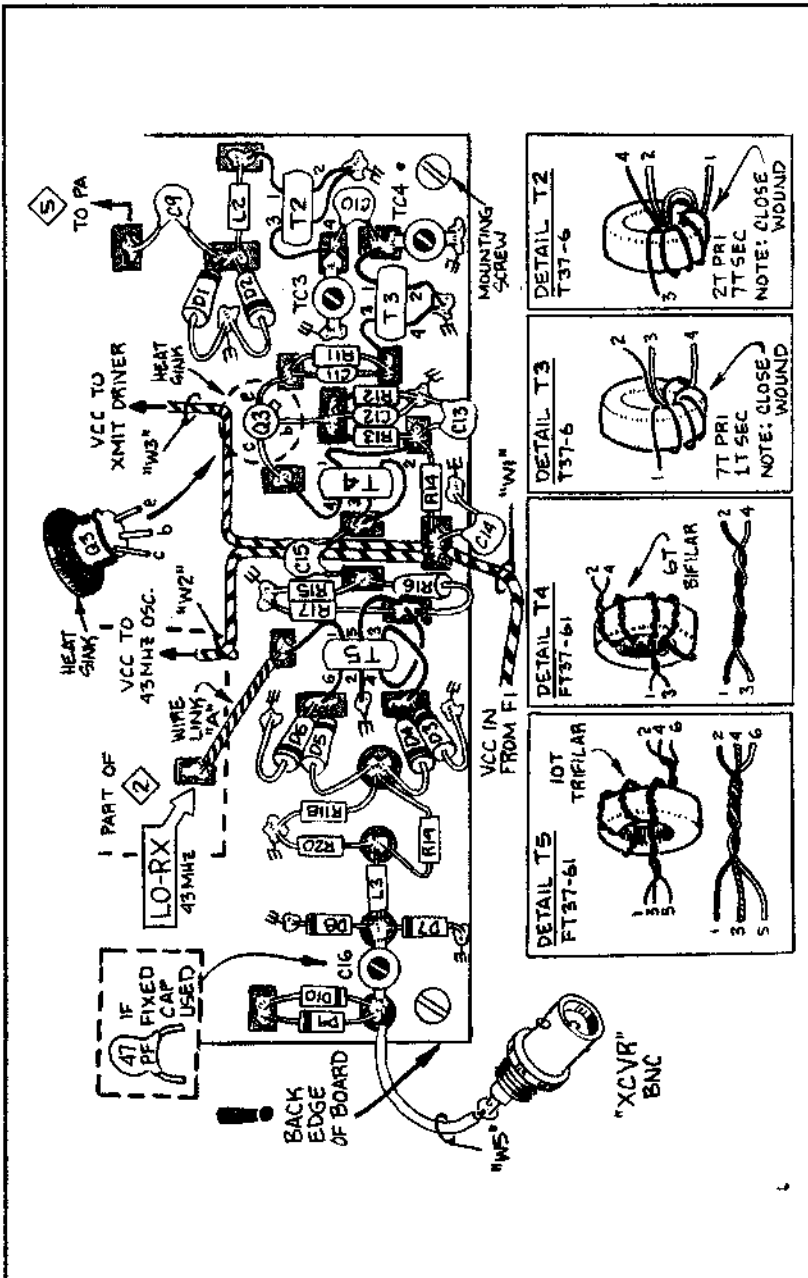
2 43 MHz LOCAL OSCILLATOR (LO)

Schematic	Assembly Dwg.
SHT. 2	**SEQ. #2**

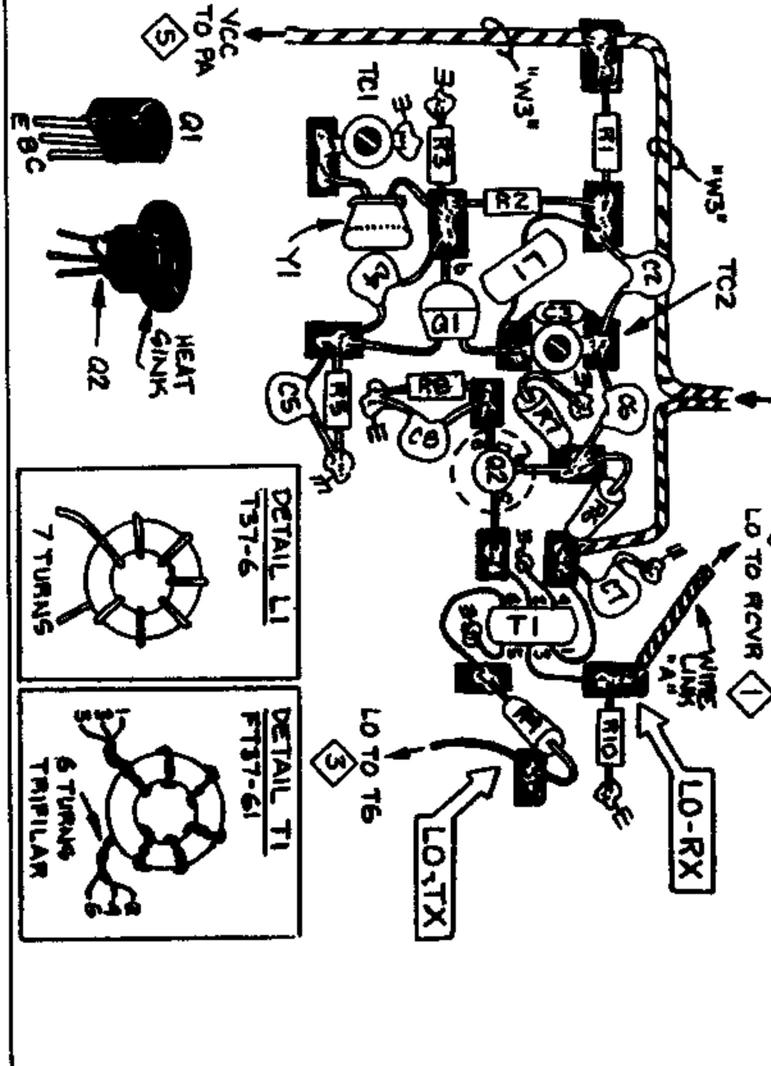
The 43 MHz local oscillator (LO) circuitry was then added below the receive strip. (Here is where the board reorientation takes place.) **Figure B** and the shaded area in **figure 14** shows the 43 MHz LO "footprint."

The layout of this stage was planned so that its output would be close to the LO port of the receive SBM. The oscillator itself was built to the left and the buffer to the right, with the untuned output transformer of the buffer (T1) below the receive single balanced mixer transformer (T5). The *wire link* shown in both SEQ #1 and SEQ #2 drawings is the LO link (signal LO-RX) between T1 and T5.

The footprint for the 43 MHz LO is slightly irregular in shape. Pencil out the area on the main substrate using the dimensions from **figure B** (pg. 17) for the oscillator, and the rest of the 2N2/6 will fall right into place..



SECTION **RECEIVE STRIP** | SEQ 1 | **2N2/6 TRANSVERTER** Designed by Jim Kortge, K8IQY Drawn by Paul Harden, NA5N



SECTION **45 MHz L.O.**	SEQ 2	**2N2/6 TRANSVERTER** Designed by Jim Kortge, K8IQY Drawn by Paul Harden, NA5N

Upon completion of the 43 MHz oscillator, you can now align the 2N2/6 receiver portion.

Receive Strip Alignment

At this point, a working receive converter exists, and can be tested by applying power and adjusting trimmer TC1 for 43 MHz output from the oscillator. Adjusting TC2 for maximum signal out of the buffer, measured on either of the transformer T1 outputs completes the local oscillator setup. The next step is to inject a 50.000 MHz signal into the antenna input (J1), and adjust receive strip trimmers TC3 and TC4 for maximum output, while listening on a transceiver attached to the transceiver output (J2), and tuned to 7.000 MHz. There is some interaction between these two trimmers, so adjustments will need to be repeated a few times to get everything peaked properly. If the transverter is built using a trimmer for C16, this trimmer should now also be peaked. Assuming everything adjusts and peaks as described, the receive strip should be capable of hearing 6 meter signals above about 0.25 microvolts, which is an MDS of about -119 dBm.

If a suitable signal generator is not available for doing the tune-up, this would be a good point in the project build to construct the alignment generator shown in the appendix. This generator can be used for the receive strip alignment, as well as the transmit strip alignment.

If this is your first project using Manhattan style construction, you might prefer to build the alignment generator first, to see how the method works and gain some confidence before starting the transverter itself. The alignment generator is at the end of the article. Or, build the Output Filter first, SEQ #6.

TRANSMIT STRIP CONSTRUCTION ❸❹❺❻

Construction continues with the transmit strip. It was build along the remaining edges of the substrate, beginning on the right side adjacent to the transceiver port and continuing in a "U" pattern, with the finals being adjacent to the receive strip input. This part of the circuitry is shown in **figure 15.**

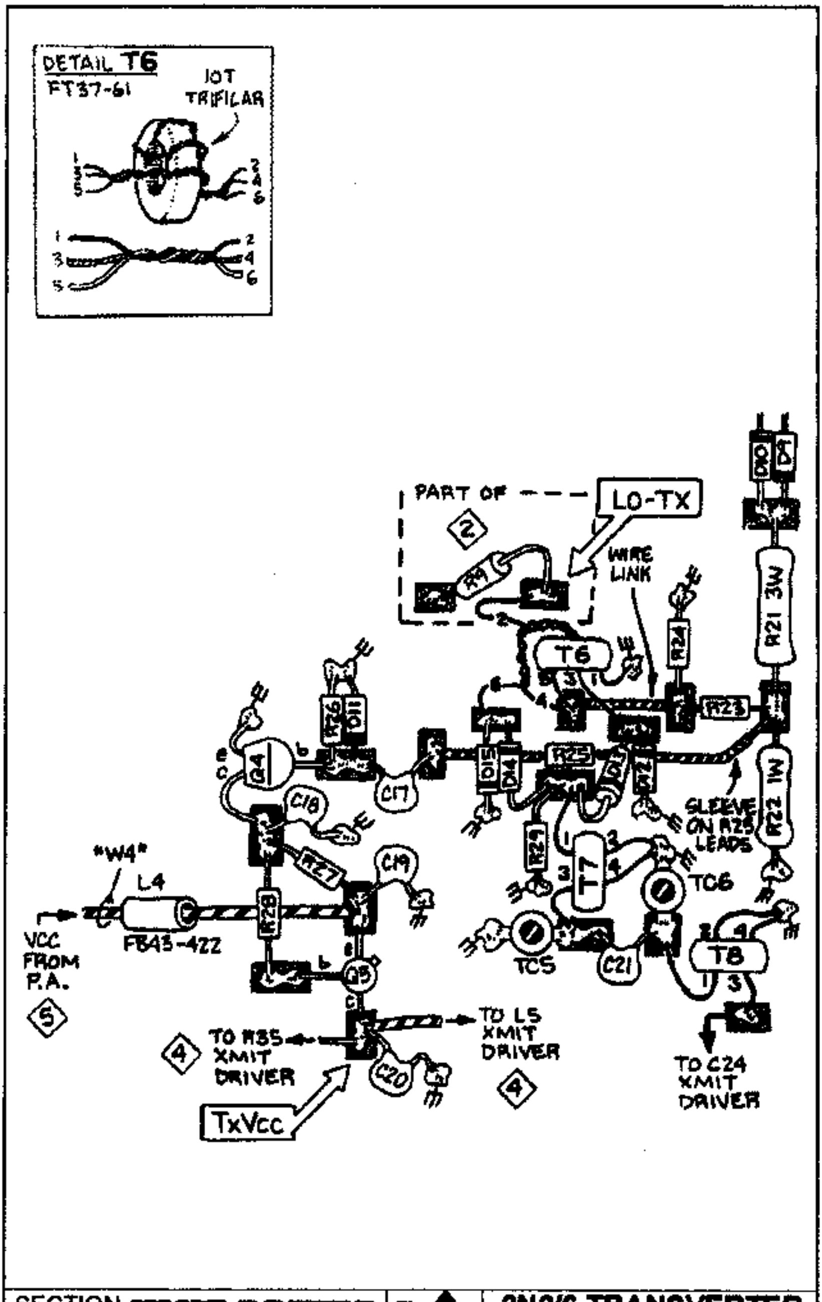
For construction purposes, and to keep the assembly drawings from getting too congested, the transmitter was divided into four parts:

SEQ #3 - Transmit Mixer & T-R Switch
SEQ #4 - Transmit Driver
SEQ #5 - Power Amplifier (PA)
SEQ #6 - Output Filter/BNC assembly.

❸ TRANSMIT MIXER CONSTRUCTION

Schematic	Assembly Dwg.
SHT. 5	**SEQ. #3**

The transmit strip input T/R switch is aligned with the coax connector, and feeds the input attenuator. This figure shows attenuator resistors R21 and R22 assembled from multiple ¼ watt resistors to achieve the required power dissipation. These units were replaced with single resistors of the proper value and wattage rating in the finished transverter. The transmit single balanced mixer was then added, inboard of the input attenuator. This was followed by the transmit band pass filter, which is shown below the transmit SBM in this figure. The two transformers in this filter (T7 and T8) were oriented 90 degrees to each other to minimize magnetic coupling between them, and to place the output of T8 close to the input of the yet-to-be built amplifier chain.



SECTION **XMIT DRIVER & T-R SWITCH** SEQ 3

2N2/6 TRANSVERTER
Designed by Jim Kortge, K8IQY
Drawn by Paul Harden, NA5N

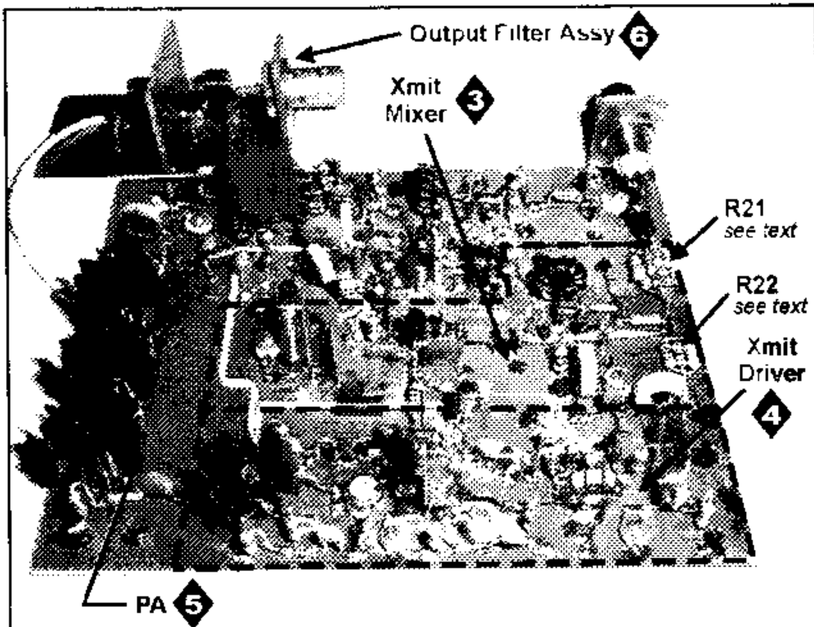


FIG. 15 - TRANSMITTER STRIP COMPONENTS

4 TRANSMIT DRIVER CONSTRUCTION

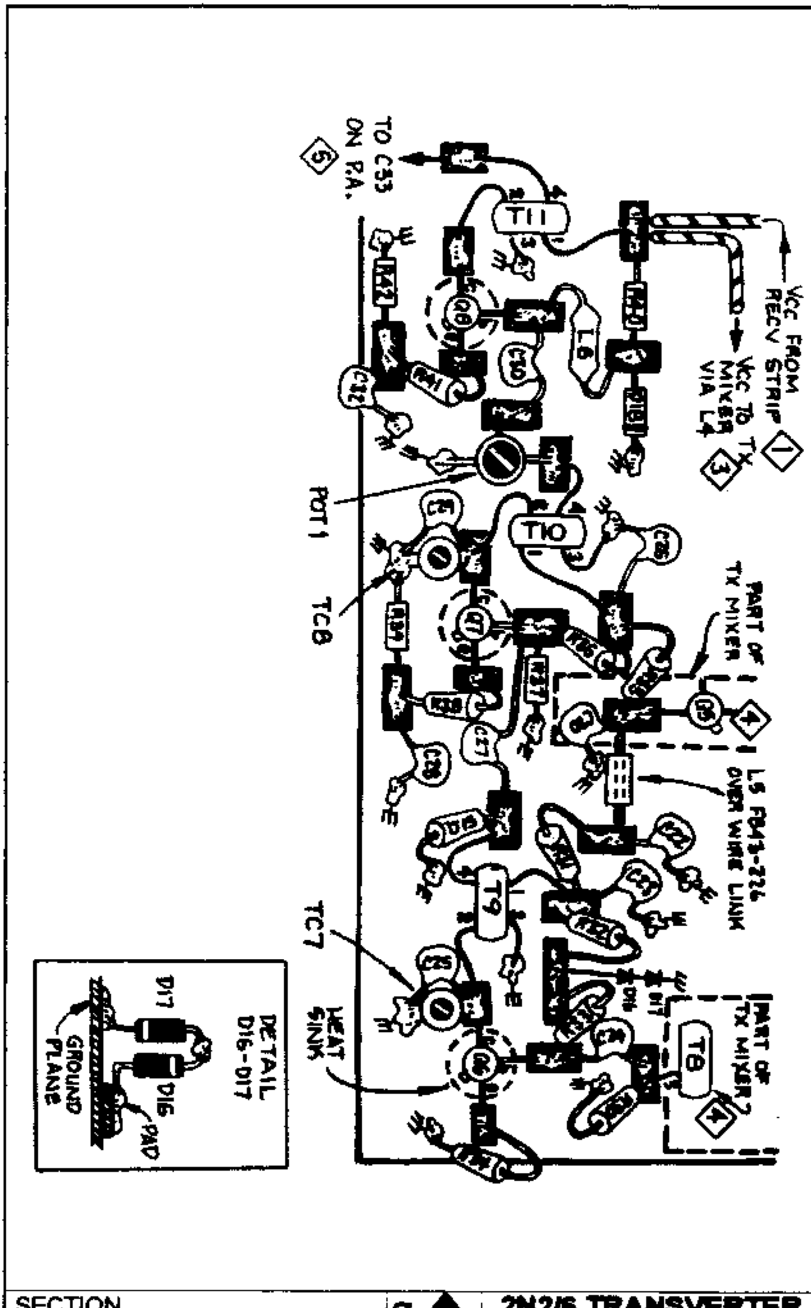
Schematic	Assembly Dwg.
SHT. 3	**SEQ. #4**

The transmit amplifier (driver) chain was then built along the front edge of the board, starting with the Q6 stage at the right , and proceeding left along the front edge, to the Q8 driver. Transformers T9 through T11 are wound using approximately 300 degrees of the toroid perimeter. This was done to reduce the inter-turn capacitance, which made the tuning sharper, and also improved the stability of the amplifier chain. Reason(s) for the improved stability brought about by the winding method are not yet understood! The heat sinks employed on Q6 and Q7 were originally constructed from 0.010 inch thick sheet brass. These worked well, but were eventually replaced for cosmetic reasons with commercially produced units.

5 POWER AMPLIFIER CONSTRUCTION

Schematic	Assembly Dwg.
SHT. 3	**SEQ. #5**

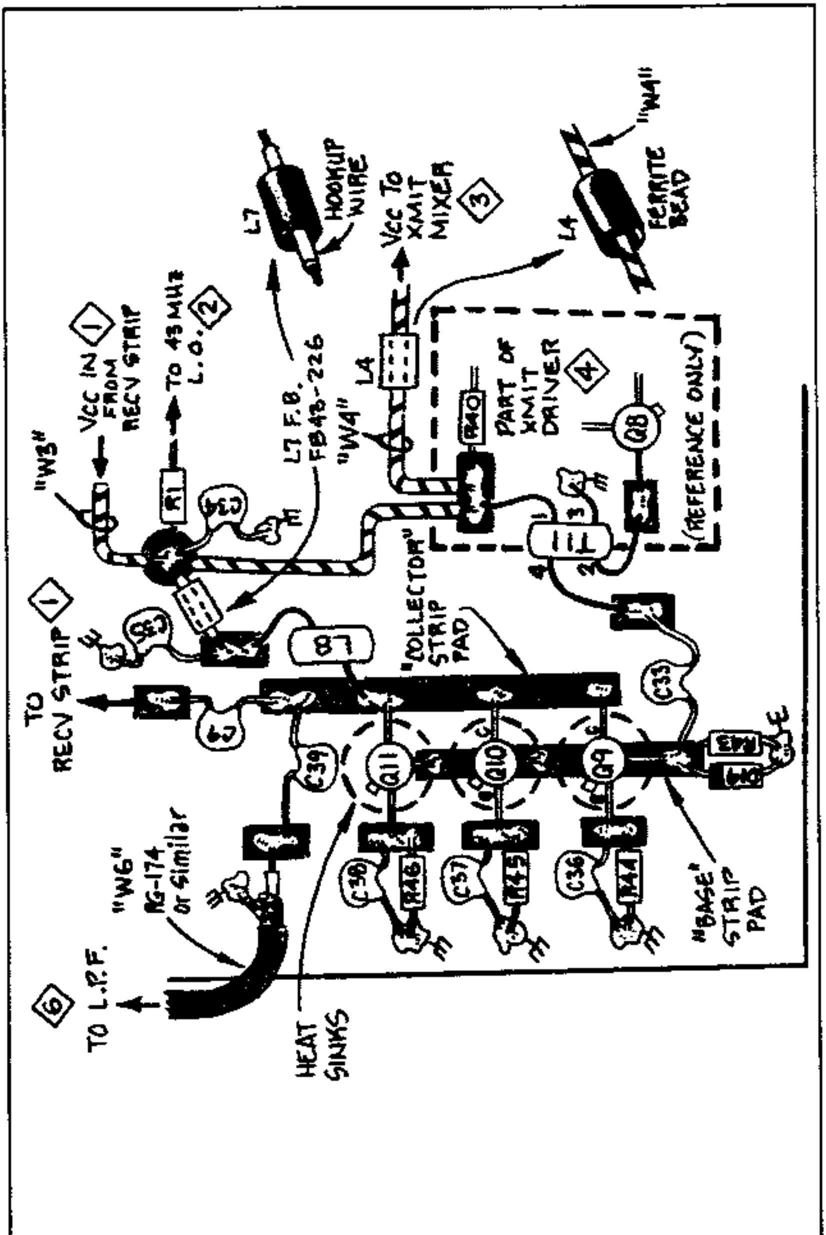
Completing the r.f. portion of the transmit strip entails building the final amplifier, or PA section, which is located along the remaining left edge of the substrate. This final uses approximately 3/32 inch wide by 1 ½ inch long strips of PC board material for the common base and collector busses. These busses, or "strips," are shown more clearly in figure 13 and the SEQ #5 assembly drawing. At the top end of this section are the components (C9, D1, D2, and L2) of the receive input T/R switch which were actually built along with the SEQ #1 receive strip construction.. Those components are also more visible in figure 13. Only C9 is shown on the SEQ #5 drawing for reference. It is important that Q9-Q11 have heat sinks.



SECTION
TRANSMIT DRIVER

SEQ 4

2N2/6 TRANSVERTER
Designed by Jim Kortge, K8IQY
Drawn by Paul Harden, NA5N



SECTION
POWER AMPL (PA)

SEQ 5

2N2/6 TRANSVERTER
Designed by Jim Kortge, K8IQY
Drawn by Paul Harden, NA5N

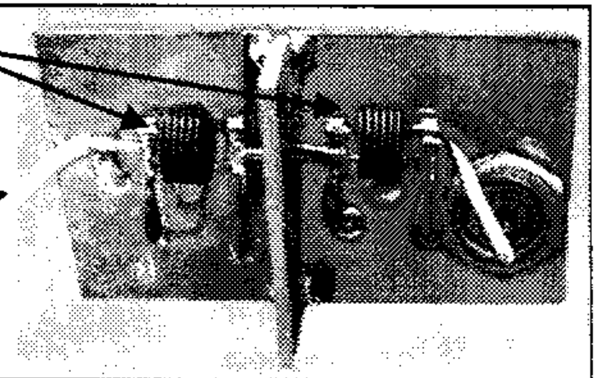


FIG. 16
PHOTO OF THE TRANSMITTER OUTPUT FILTER

6 OUTPUT FILTER CONSTRUCTION

Schematic	Assembly Dwg.
SHT. 3	**SEQ. #6**

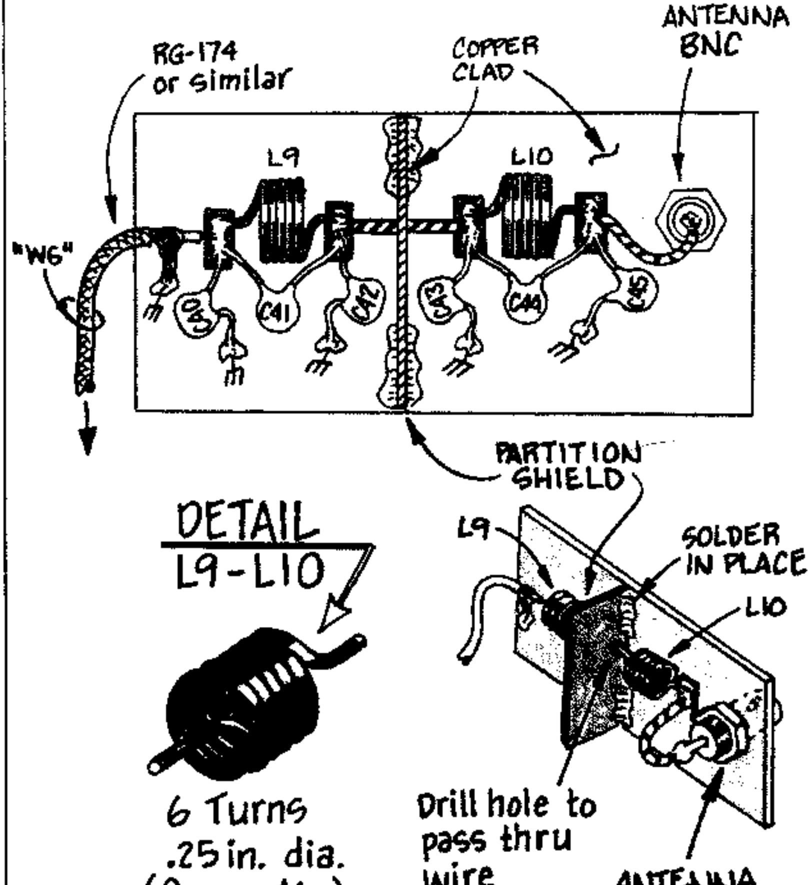
My original plan was to also have the output filter on this substrate also, but like the original 2N2 40, the output filter had to be placed on another board due to space problems. However, this really turned out to be somewhat of a good thing. It allowed experimenting with several output filter designs on a small substrate, and when the final configuration was decided upon, it was easy to mount it right at the antenna connector. Having the filter separate also expedited testing this section without having the main transverter board in the way. **Figure 16** shows the details of the output filter.

The 6 turn coils shown in figure 16 have been replaced with 5 turn units which improved the filters effectiveness in suppressing 2^{nd} and 3^{rd} harmonic energy.

Transmit Strip Alignment

Tuning up the transmit strip requires connecting a dummy load to the antenna connector. Then, the local oscillator is stopped by placing a short from the base of Q1 to ground. The reason for stopping the 43 MHz LO signal is that it is very easy to inadvertently peak the transmit strip on the LO signal, instead of the desired 50 MHz mixer component. After this step, a signal generator set to 50.0 MHz, and output level at –180 dBm, is connected between the LO port of the transmit signal balanced mixer and ground (across R29). Using a signal generator provides a cleaner signal for aligning the transmit strip and does not require keeping a driving QRP rig on the air for long periods while adjustments are made.

Once these steps are performed, a shorting jumper is placed on the collector end of R27, which switches the transmit strip on. Each of the stages is peaked, starting with transformer T7, and ending with T10. A few times through these four adjustments will have the transmit strip properly aligned. At this point, POT1 can be advanced to activate the driver stage, and T9 and T10 re-peaked, as there is interaction as power is supplied to the driver. POT1 can be advanced until 2 watts of power are indicated on a wattmeter. That's the maximum available from three 2N2222As running at 50 MHz. The final transistors should have heat sinks on them for this alignment, as should all of the upstream amplifiers and drivers stages.



SECTION

OUTPUT FILTER

SEQ 6

2N2/6 TRANSVERTER

Designed by Jim Kortge, K8IQY

Drawn by Paul Harden, NA5N

Output Power Transistors

How much power output can be obtained is *very* dependent upon the quality (gain) of the transistors used in the transverter. Using 2N2222A transistors from surplus sources is discouraged, as these will probably not be the best units available. That's probably why they were available on the surplus market..

DC Distribution and Interconnecting Wiring

Figure C shows the interconnecting wiring necessary for the 2N2/6. It's quite simple. Most of it is the DC distribution, from the DC input connector, via the fuse and fuse holder, to the board, and a few Vcc wire runs to the assembly sections. The only other wiring is connecting the two BNC connectors. All wiring can be done with standard #22 stranded hookup wire. The RG-174 mini-coax run from the transmitter to the Output LPF Filter can be #22 hookup wire as well, though a short piece of coax is recommended.

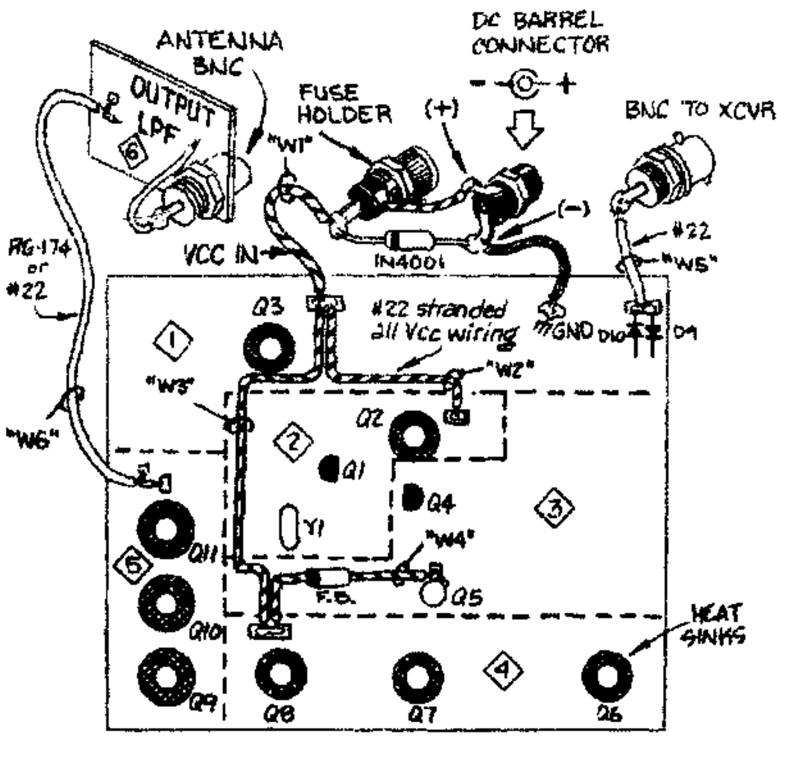


FIGURE C
DC AND INTERCONNECTING WIRING DIAGRAM

Current Status

Another 2N2/6 transverter has been constructed by Jay Chamness, W6JAZ to test the viability, and stability of the design before it was released to a broader audience via QRPp magazine. He built it from provided schematics and a color photo showing the layout. That unit was shipped to the authors in non-working condition. A quick check revealed the local oscillator was not functioning due to a building mistake. After minor changes, the local oscillator functioned properly, the transverter was functioning, and an alignment was attempted. Low power output was observed, eventually traced to another minor building error. After this error was removed, lower than normal output was still observed. Transistor Q7 was changed, and the output increased for that stage, but overall output was still low. Output transistors Q9 and Q10 were not getting warm during transmit, and were suspected to be failed. Both of these unit were replaced, and the output power increased dramatically. The rig was retuned, and was found to produce a solid 1 watt of output when driven by my 2N2/40, set for 2 watts of drive. This transverter is very stable, but does not produce as much power output as does the prototype unit. The difference most likely is due to the 2N2222 transistors used. I believe those used in this transverter are not as "hot" as those used in the original rig.

There are differences in the W6JAZ built transverter from the author's prototype. They were implemented based on feedback gained at Pacificon, most notably by Dave Meacham, W6EMD. Principally, the change was to reduce the standard bypass capacitor from a value of 0.22uF to 1000 pF, to help assure the bypass capacitors were not self resonant at 50 MHz. I suspect this change contributes to the better stability observed in this transverter over the prototype unit. The schematics have been updated with that change.

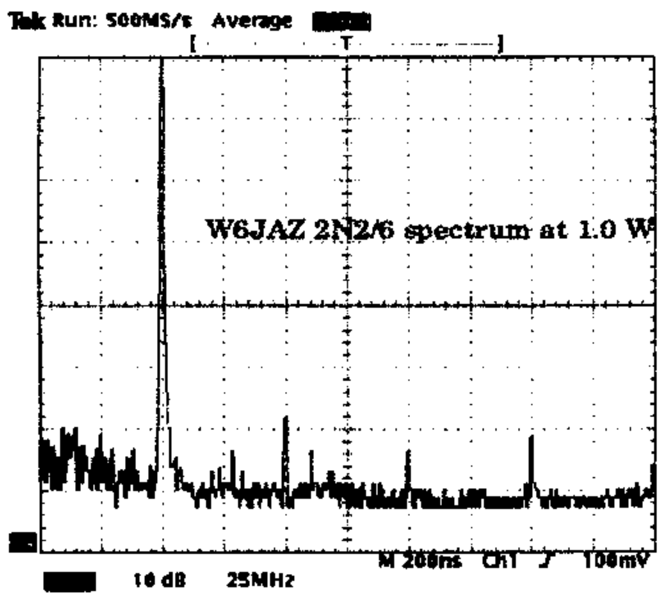


FIG. 17 - 2N2/6 OUTPUT SPECTRUM

Another change made in the W6JAZ transverter was in the elliptic low pass output filter. The physical size of L9 and L10 were too large, i.e. not ¼ inch inside diameter, as specified. These were rewound, and found to still have more inductance than required by the design, so a second set was wound with 5 turns instead of 6. These worked much better, and the power output increased a bit more with these new inductors. Also, the output spectrum was cleaner, so the design now specifies 5 turns for L9 and L10. **Figure 17** shows the output spectrum for this transverter while being driven by a signal generator connected to the 2 turn input link on transformer T7. The power output from the transverter was set at 1 watt.

It is gratifying to know that the design is such that at least a second unit could be built which functions reasonably close to the original prototype.

Summary

This was an interesting project from the beginning. It started out as an exercise to push the performance envelope of 2N2222 transistors, and experimentally determine if they could be used at 50 MHz. Once again the "cockroach of the transistor world" has shown its mettle in being useable well beyond its published operating range. In this experimental process , a very useable transverter design evolved, which will work with virtually all 40-meter QRP CW transceivers. Along the way, lessons were learned about building low-end VHF equipment using Manhattan Style construction techniques.

2N2222 vs. other transistors

Much room exists to "hot rod" this design by using transistors designed to operated in the low VHF region. It would be interesting and very educational to see how the performance and stability change when devices that are more appropriate are employed. I hope that someone will take the time to build part, if not all of the circuitry using better devices, so thatcomparative data are available.

APPENDIX: A 2N2/6 ALIGNMENT GENERATOR

As an aid in aligning the 2N2/6, a small signal generator was designed and constructed. The basis of the generator is a 50 MHz, ½ size can, crystal oscillator. With the addition of some common components, an approximate +18 dBm, 50-ohm signal source was constructed. It can be used to tune up both the receive, and the transmit strips.

Figure 1A shows how it was constructed, and **figure 2A** shows the schematic diagram for this alignment source.

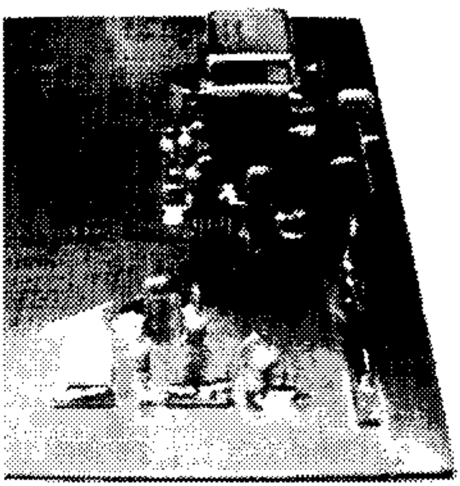


FIG. 1A
ALIGNMENT GENERATOR

Components D1,R1,C1 and D2 comprise a simple 5.3 volt power supply, to power the canned oscillator. The square wave output of the oscillator is coupled to C2, R2, and R3 to set its output impedance to 50 ohms. Output then passes through a 50 ohm low pass filter, comprised of components C3, L1, and C4. This filter attenuates harmonics of 50 MHz, leaving a reasonably clean, 50 MHz sine wave signal. The signal then passes through a 3 dB attenuator to provide a small amount of isolation, and to provide the desired −18 dBm signal level needed to tune up the transmit strip.

This alignment oscillator was built on an approximate 1 ½ by 2 ½ inch piece of PC board material. The power supply components are along the right edge. The canned oscillator is plugged into an 8 pin IC socket, mounted on ADEL nibbling tool produced rectangular pads. All remaining components were then built parallel to the power supply, so that the output is on the lower edge. The inductor shown has 6 turns, but was subsequently replaced with a 5 turn coil..

Figure 3A shows an oscilloscope trace of the alignment generator in operation.

THE 2N2/6 SCHEMATICS

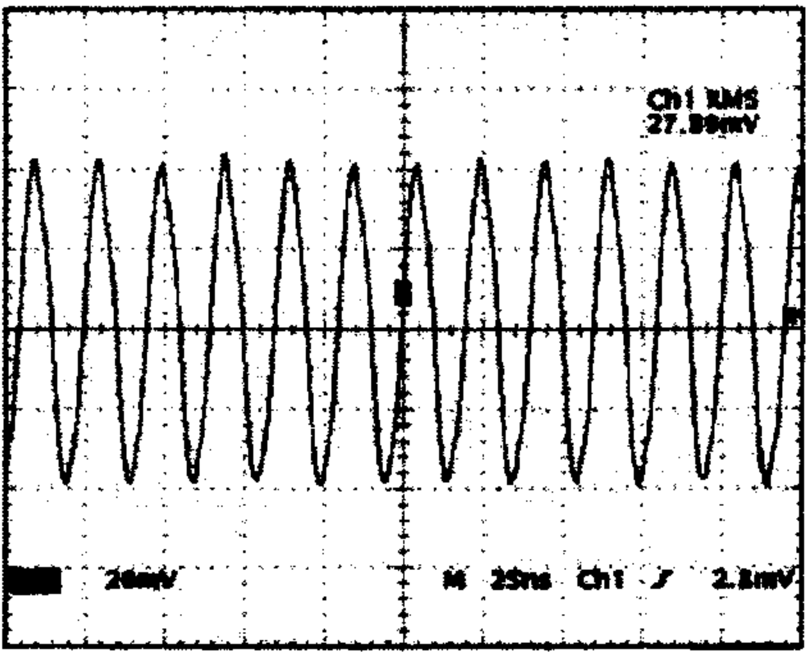
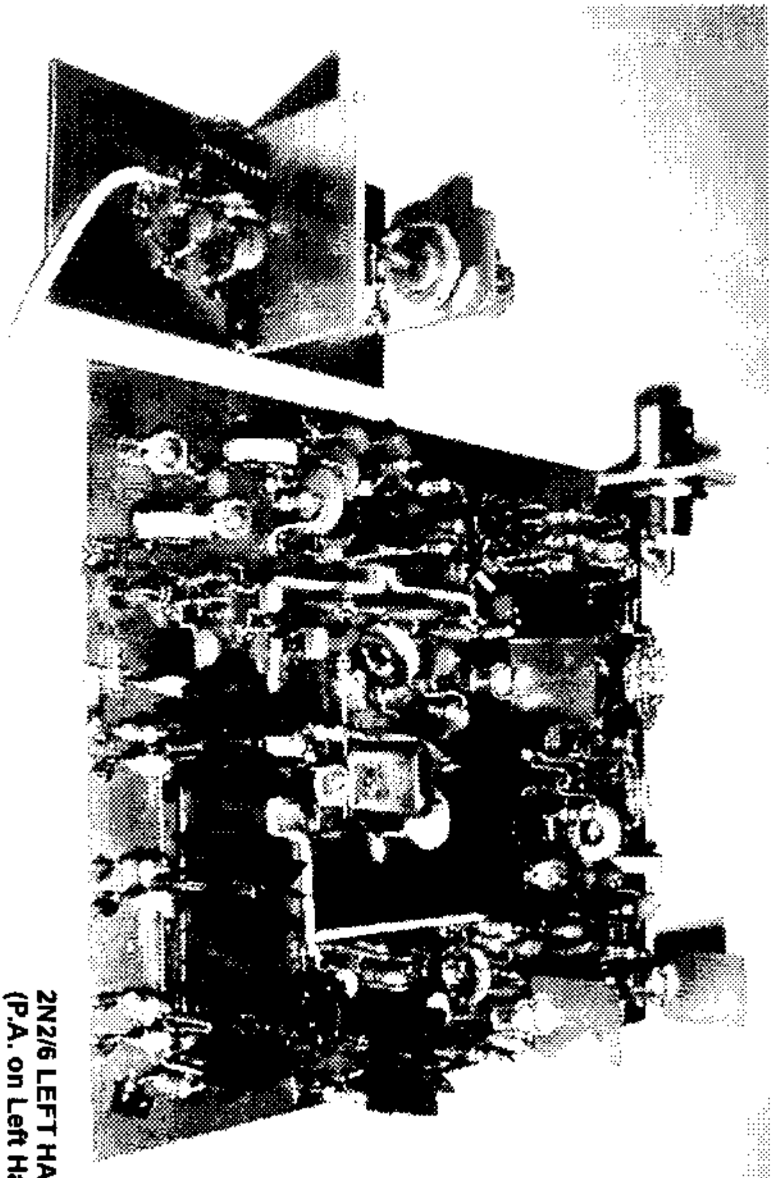
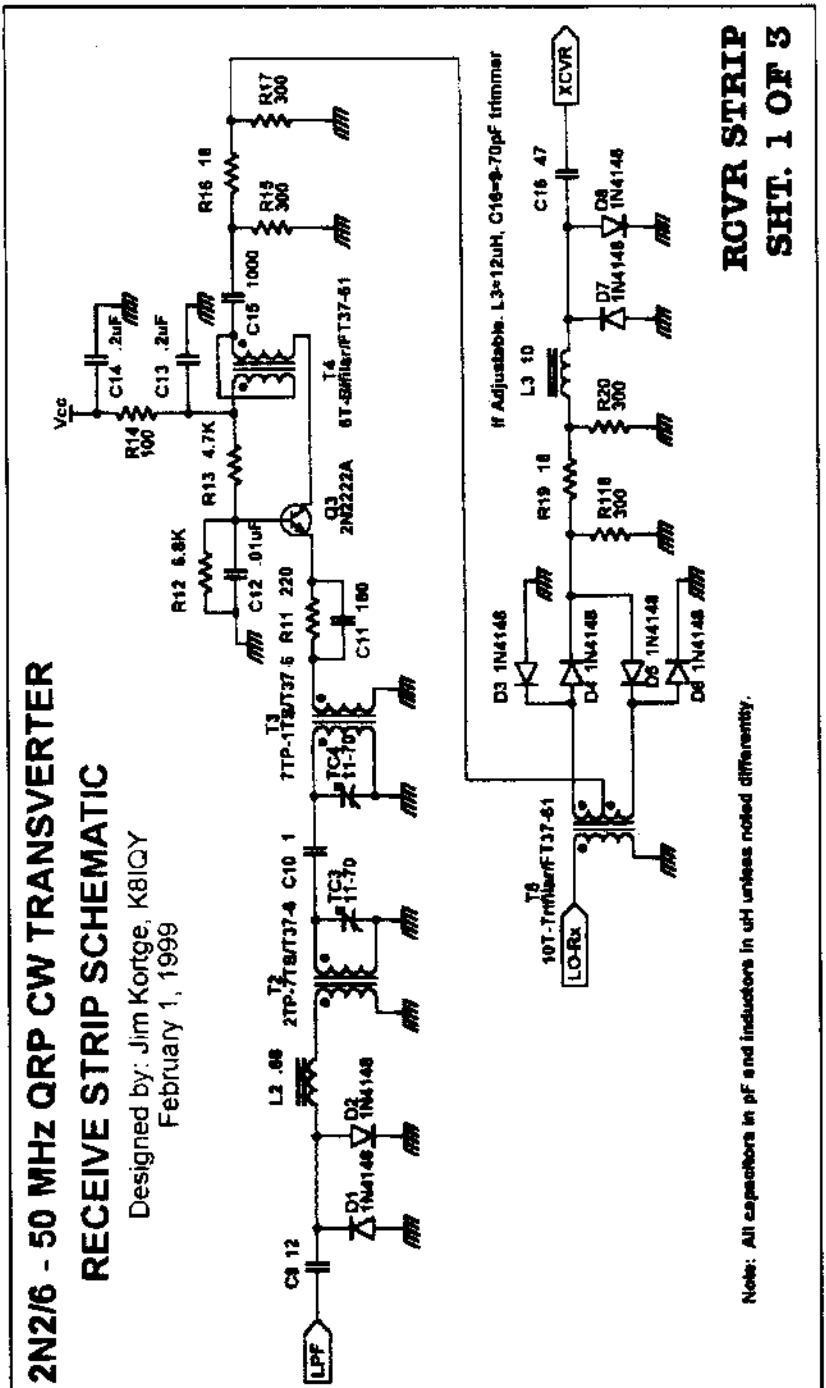


FIG. 3A - ALIGNMENT GENERATOR OUTPUT WAVEFORM



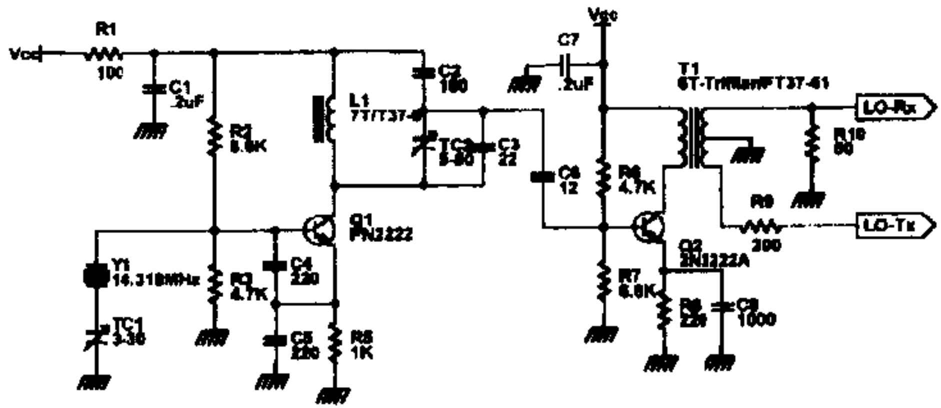
2N2/6 LEFT HAND VIEW
(P.A. on Left Hand Side)
See page 38 for Front View


2N2/6 - 50 MHz QRP CW TRANSVERTER
RECEIVE STRIP SCHEMATIC
Designed by: Jim Kortge, K8IQY
February 1, 1999
RCVR STRIP
SHT. 1 OF 3
LPF
C8 12
D1 1N4148
D2 1N4148
L2 .68
T2 2TP-7TS/T37-6
TC3 11-70
C10 1
TC4 11-70
T3 7TP-1TS/T37-6
R11 220
C11 100
R12 6.8K
C12 .01uF
R13 4.7K
Q3 2N2222A
R14 100
Vcc
C13 .2uF
C14 .2uF
T4 6T-Bifilar/FT37-61
C15 1000
R15 300
R16 18
R17 300
D3 1N4148
D4 1N4148
D5 1N4148
D6 1N4148
T5 10T-Trifilar/FT37-61
LO-Rx
R118 300
R19 18
R20 300
L3 10
D7 1N4148
D8 1N4148
C16 47
XCVR
If Adjustable. L3=12uH, C16=9-70pF trimmer
Note: All capacitors in pF and inductors in uH unless noted differently.

2N2/6 - 50 MHz QRP CW TRANSVERTER

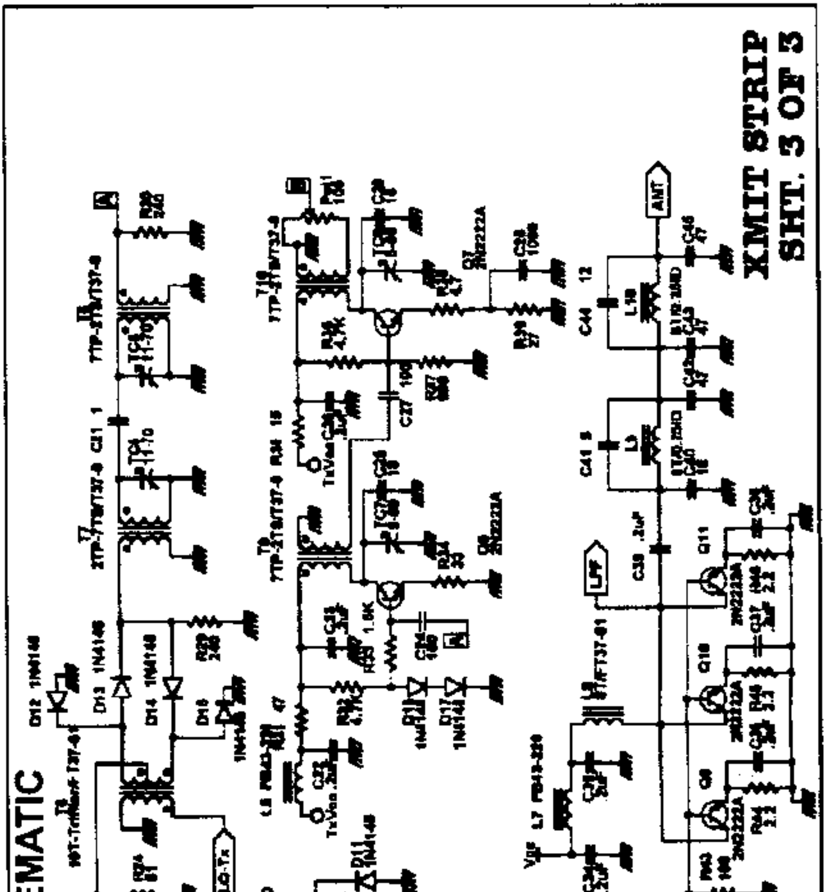
43 MHZ LOCAL OSCILLATOR SCHEMATIC

Designed by: Jim Kortge, K8IQY
February 1 1999



Note: All capacitors in pF and inductors in uH unless noted differently.

43 MHz L.O.
SHT. 2 OF 3


2N2/6 RECEIVE STRIP SCHEMATIC
XMIT STRIP
SHT. 3 OF 3
Designed by
Jim Kortge, K8IQY
February 1 1999

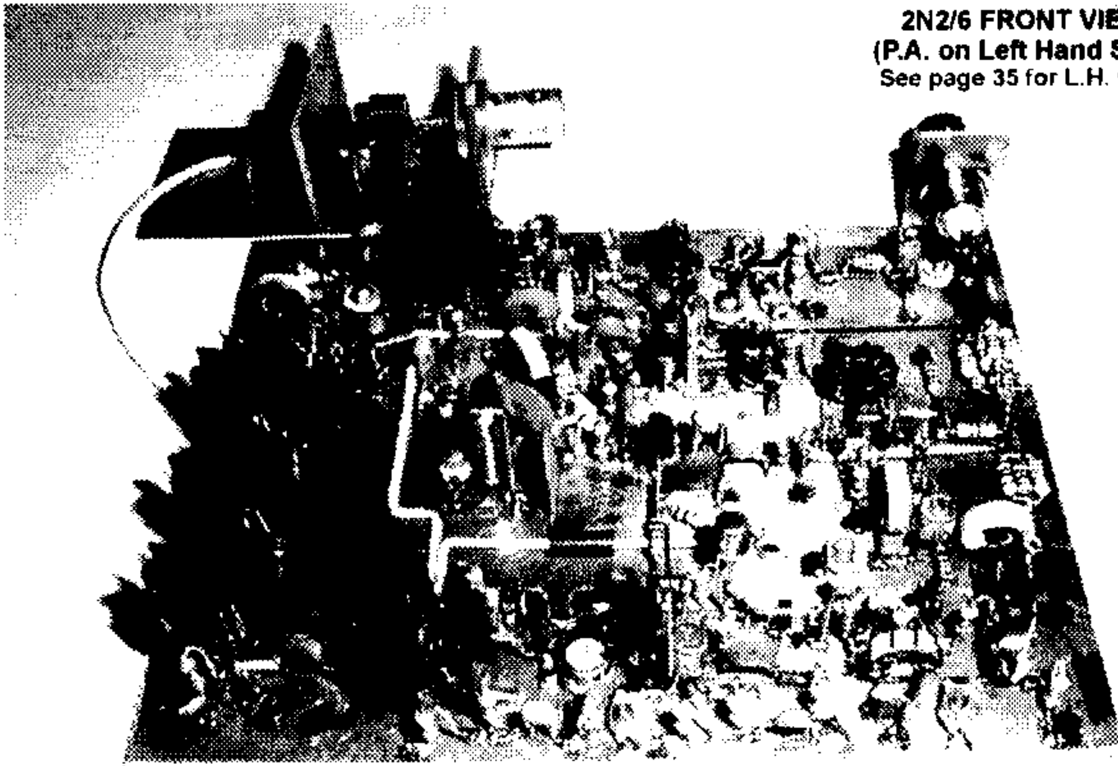
2N2/6 BILL OF MATERIALS

	ITEM	QTY	REF. DESIGNATION	VALUE	Order Part No.	
>	1	3	C12,C18,C33	.01uF		
>	2	1	C39	.22uF		
>	3	1	L2	.68uH		
>	4	2	C10,C21	1		
>	5	1	R33	1.5K		
>	6	1	L3	10uH		
>	7	6	R1,C24,C27,R14,	100		
>			R43,Pot1			
>	8	21	C1,C7,C8,C13,C14,	1000pF		
>			C15,C17,C19,C20,	(.001uF)		
>			C22,C23,C26,C28,			
>			C30,C31,C32,C34,			
>			C35,C36,C37,C38			
>	9	2	R26,R27	10K		
>	10	2	T5,T6	10T-Trifilar		
				FT37-61		
>	11	4	TC3,TC4,TC5,TC6	11-70pF		
>	12	3	C6,C9,C44	12pF		
>	13	1	Y1	14.318MHz		
>	14	3	C40,R35,R42	15pF		
>	15	4	C25,C29,R16,R19	18pF		
>	16	2	C2,C11	180pF		
>	17	1	R5	1K		
>	18	2	D9,D10	1N4004		
>	19	17	D1,D2,D3,D4,D5,	1N4148		
>			D6,D7,D8,D11,D12,			
>			D13,D14,D15,D16,			
>			D17,D18,D19			
>	20	1	D20	1N4744A		
>	21	4	R41,R44,R45,R46	2.2		
>	22	1	R28	2.2K		
>	23	1	R9	200		
>	24	1	C3	22pF		
>	25	4	C4,C5,R8,R11	220pF		
>	26	2	R29,R30	240		
>	27	1	R39	27		
>	28	8	Q2,Q3,Q6,Q7,Q8,	2N2222A		
>			Q9,Q10,Q11			
>	29	1	Q5	2N2907		
>	30	2	T2,T7	2TP-7TS		
				T37-6		

2N2/6 BILL OF MATERIALS

	ITEM	QTY	REF. DESIGNATION	VALUE	Order Part No.
>	31	1	TC1	3-30pF	
>	32	4	R15,R17,R20,R118	300	
>	33	1	R34	33	
>	34	2	L6,R38	4.7	
>	35	5	R3,R6,R13,R32,	4.7K	
>			R36		
>	36	1	R23	43	
>	37	1	R21	43/3W	
>	38	5	C16,C42,C43,C45,	47pF	
>	39	1	C41	5pF	
>	40	3	TC2,TC7,TC8	5-50pF	
>	41	1	R10	50	
>	42	1	R24	51	
>	43	1	R25	560	
>	44	2	L9,L10	5T/0.25ID	
>	45	1	R22	6.8/1W	
>	46	2	R7,R12	6.8K	
>	47	2	R37,R40	680	
>	48	1	T4	6T-Bifilar FT37-61	
>	49	1	L1	7T/T37-6	
>	51	1	T3	7TP-1TS T37-6	
>	52	3	T8,T9,T10	7TP-2TS T37-6	
>	53	1	R2	8.6K	
>	54	1	L8	8T FT37-61	
>	55	1	T11	8TP-2TS FT37-61	
>	56	1	J1	Antenna Connector	
>	57	2	L5,L7	FB43-226	
>	58	1	L4	FB43-422	
>	59	2	Q1,Q4	PN2222	
>	60	2	P2A,P2B	Power Connector	
>	61	1	J2	Transceiver Connector	

Order Part number - Use to record exact part number/order number from Mouser, Digi-Key, Radio Shack, etc.



2N2/6 FRONT VIEW
(P.A. on Left Hand Side)
See page 35 for L.H. view

So Happy to Be Here

By Richard Fisher, KI6SN
1940 Wetherly Way
Riverside, CA 92506
(909) 369-8302
KI6SN@yahoo.com

When **Doug Hendricks, KI6DS,** approached me about joining the staff of "QRPp." frankly I thought he'd gone nuts.

Here's a quarterly magazine that has been hugely successful because of its innovative approach to reporting primarily on the technical side of QRP.

So, why risk messing it up with a column about low power operations and QRP characters?

I never got around to asking Doug that question. When opportunity such as this knocks, it's best to open the door.

Knowing Doug as I do, I suspect he sees the need - and joy - of providing "QRPp" readers with more stories about themselves. Stories that originate away from the workbench.

Stories about adventures on the air. Stories about passionate QRPers converging on fast food joints to savor the friendship and bond a passion for low power operation instills in so many of us.

Doug genuinely loves this niche of the hobby.

And there's a lot more to amateur radio than plated-through PC boards and solder fumes.

He recognizes that, and wants to provide an anchored forum for it in "QRPp."

So, here I am.

THE WRITE STUFF

While I am a newcomer to "QRPp," amateur radio and journalism have been my bag for a lot of years in a lot of venues.

As a 14-year-old, my novice ticket arrived in February 1965: **WN1DWL.**

By summer I had my general: **WA1DWL,** and in October '65 I joined a relatively new organization called QRP Amateur Radio Club International, being issued membership No. 2419.

I'd go on to hold the calls **WA4KTN, N2EVH, N6MKA,** and finally **KI6SN.**

For a year of commemoration of pioneering QRPers of the 1920s, I held the call **nu6SN,** before reverting to KI6SN again for the long term.

But back in October '65, little did I know that more than 25 years later - in April of 1992, to be exact - I'd be joining the staff of QRP ARCI's quarterly journal "QRP Quarterly."

Under the editorship of **Paula Franke, WB9TBU,** I became its Members' News editor in 1992.

To the end of last year, it was a fine association with the magazine under the guidance of Paula, and her talented successors **Monte Starke, KU7Y; George Heron, N2APB;** and **Mary Cherry, NA6E.**

It's not uncommon in this business, however, to make changes for change's sake - and that was the case recently for me in deciding to leave the magazine.

Along the way, I was given the opportunity to write for **Worldradio,** a monthly magazine published by **Armond Noble, N6WR.**

In many ways, the QRP community owes Noble a huge debt of gratitude, because he is one of the few radio magazine publishers willing to dedicate space each month to coverage of QRP.

In late 1992, veteran QRPer **Rich Arland, K7SZ,** telephoned me from out of the blue to ask if I'd be interested in taking the reigns of Worldradio's QRP coverage - a duty he had assumed for the previous seven years.

Obligating yourself to turn out good stuff about low power operations is a pretty serious commitment, for sure.

But I opted to take the chance. My first WR QRP column appeared in April 1993. And since then I haven't looked back. Under the editorship of **Rick McCusker, WF6O,** Worldradio continues to support QRP and QRPers, not only by dedicating significant space each month to my QRP column, but in devoting other editorial space frequently to stories about low power operators from other writers, too.

So, between writing for "QRPp" quarterly, and Worldradio monthly, what do I do in my spare time?

I was intrigued in 1996 by an e-mail from **Russ Carpenter, AA7QU.** As it turns out, he had been given my name by **Wayne Burdick, N6KR.**

The two of them had come up with an idea to form an organization - principally for QRPers - that would focus on outdoor radio operations from beautiful and remarkable locations that operators reached under their own power: hiking, rowing, bicycling.

They were calling it the Adventure Radio Society.

Russ and Wayne were looking for a "word person" to help draft a constitution, perhaps do some kind of newsletter, and get the word out that ARS existed.

Who can resist a good adventure? Not me. I signed on.

ARS is approaching its fourth birthday, and since 1998 I've been privileged to serve as the executive editor of the organization's monthly web magazine "The ARS Sojourner" *(www.natworld.com/ars)* as well as membership chairman.

AS I SEE IT...

As you might imagine, all of these journalistic duties have put me in contact with lots and lots of wonderful and interesting QRPers over the years.

In my association with the Northern California (NorCal) QRP Club as a card-carrying member, I'd have to admit this organization has its share of QRP characters. I'd like to get to know them better; bring their stories to you in these pages.

When you think about it, Doug makes a lot of sense in formally adding this dimension to "QRPp." After all, once all of the wonderful circuits have been finished and smoke tested, where do we go from there?

We go to the airwaves, to the field, to the swap meets and the conventions.

That's what I'm so looking forward to doing in these pages - bringing to life the people who so enrich this organization, with its roots of course, in founders Doug Hendricks, and **Jim Cates, WA6GER,** his trusted and valued colleague.

NOW IT'S YOUR TURN

That's my story - as it has unfolded to this point, anyway.

Now, how about telling yours?

Here are some things to think about:

+ **Milliwatting:** There are some fascinating tales to be told on QRPers' accomplishments in *really* low power communications. Have you given milliwatting a try? How'd it work out?

+ **QRP contesting:** It can certainly be addicting. How about sharing your contesting story? Your successes and failures. It's all part of the mosaic we call low power operations.

+ **QRP ragchewing:** Is this a lost art? Lots of people seem to think so. Some believe fewer and fewer QRPers are getting on the air for casual operating anymore. Is that the case? If you're a QRPer who doesn't need a contest to fire up your rig, let us know. We'd love to tell your story.

+ **QRP characters:** Our niche of the hobby is blessed with some of the most interesting characters in amateur radio. If you know of someone who'd make an interesting profile, please let me know. I'll do my best to bring them into the pages of "QRPp." And remember: We're *all* characters.

+ **QRP swap meets and conventions:** OK, not all the excitement is on the air. Tell us about your eye-ball QSOs at the QRP-related outings you've been on.

Have something you'd like share with "QRPp" readers? Please contact me at the addresses at the head of this column. Hope to hear from you soon. Let the fun begin!

MILLIWATTING ALONG THE GREY LINE - PART DEUX ...

Randy Foltz, K7TQ, of Moscow, ID, writes that "in the July-98 QRP Quarterly, as AB7TK, I reported a milliwatt QSO with **Bruce Hopkins, then KL7JAF,** that took place on March 5, 1998. We played QRP limbo down to 100 mW where Bruce reported a 339. There was good gray line propagation on 14.060 MHz with a solar elevation in Moscow of -5 degrees and in Fairbanks of –7 degrees. The solar flux was 100.

"On Nov. 17, 1999, now with the new call **K7TQ,** I found Bruce Hopkins, whose new call is **KL7H,** calling CQ on 28.061 MHz and repeated the limbo.

"I went down to 100 mW where Bruce gave me a 519. This time the gray line numbers were a solar elevation in Moscow of -11 degrees and in Fairbanks of -4 degrees. Solar flux had improved to 230.

"Both of these contacts were good for 16,960 miles per watt.

"Look for great propagation along the gray line just before the sun sets to around the end of twilight.

"Favored directions are north and south, although the seasons modify that a bit. It works!"

QRP: A LA MODES

Bill Jones, KD7S, writes from Sanger, CA that recently he decided to see if he could make "at least one contact using as many different modes as possible. I started out with a 2-way QRP CW contact followed by a quickie QRP SSB QSO.

"Then I switched over to Pactor followed by PSK31. Ten meters was open so I made my first contact ever using FM via an HF repeater.

"That was so much fun that I called an AM station (25 watts with that one) which reminded me how great AM sounds. I went back to 20 meters and got on RTTY for a little bit but had to go to 20 watts. I looked for an AMTOR contact but no takers.

"Finally I downloaded the MT63 software and made two low power contacts on 15 meters.

"To wrap things up I went to 14.230 and shared a couple pictures using SSTV at 25 watts. So, in a single day I worked nine different modes - CW, SSB, Pactor, PSK31, AM, FM, RTTY, SSTV and MT63. Kind of goofy I guess, but lots of fun."

A K2 ADVENTURE

Rod Cerkoney, N0RC, writes from Fort Collins, CO that despite what the Weather Channel said, a Friday in December "was not partly sunny, or at least it didn't start out that way. It was mostly cloudy here - the dark 'bunchy' kind of clouds that suggest precipitation.

He was on a one-man "operating event" heading out into the field that also had the criteria of being in "interesting or historical places."

"I'd been planning these 'Kopkopelli' adventures for some time, just waiting for a good opportunity."

His sojourn from Colorado to Wyoming was, in part, to help QRPers get Wyoming for their WAS award.

"As I traveled north to Wyoming, things didn't change much, it just got windy (about 30+ miles per hour from the west and south).

the west and south).

"As I transitioned from northbound I-25 to westbound I-80 there were light snow showers in the air. And it was still windy, the blow-your-car-around kind of windy. I arrived at my general location about 9:30 a.m. This was good. I wanted to have enough time to scout out a good operating location.

"At the exit for Vedauwoo was another sign. It was for Ames Monument. I had plenty of time so I took a little side trip. Turns out Ames Monument is the marker for the high point along the Union Pacific Railroad of the mid to late 1800s! It was built by UPRR in 1882. To mark the spot, it sits at 8,200+ feet in elevation.

"A sign at the monument informs that the town of Sherman once was nearby. But it has long since disappeared.

"I stayed there for a while and let my imagination run, wondering what this place was like in the1800s. I considered Ames for an operation location. It's wide open, with horizons many miles away in all directions.

"I rejected the notion because of the wind. It was 30+ gusting higher maybe to 40-50 mph.

"Folks who have never been to Wyoming don't know what I'm talking about when I mention the wind. It is always windy there.

"On to Veedauwoo, light snow is falling again as I enter the park. As the day wore on the skies cleared but the wind remained.

"Temperatures were in the upper 30's. In the distance I could see Poland Hill, Turtle Rock, and Devil's Playground - rock formations carved over the millennia by the forces of nature.

"Not as grand in scale as Utah's Canyon Lands but against the juxtaposition of the high rolling plains of Wyoming, interesting.

"In the air, above a broad flat plain, a hawk is soaring, nearly motionless. For those who want a better idea of where I was at: trace out I-80 east bound from Laramie, WY.

"About 10 miles east of Laramie is the highest point on I-80 (8,640 feet), it should be marked on most maps. The next exit from there, a few more miles along I-80, is the exit for Veedauwoo and the Ames Monument.

"By 11a.m., I'm set up in a little depression near one of the rock formations with low pine trees scattered around, sheltered from the wind. It's not an ideal antenna location, but not bad either.

"I spent about an hour tuning the bands and listening to the NCDXF beacons to get an idea where to start.

"Ten meters was 'iffy,' but I gave it a try for a while, then dropped to 15 meters. That seemed to be the bread and butter band. The California beacon was loud, and so was the Hawaii beacon.

"Transposing those distances to the east I figured 15 got me coverage from the U.S. east coast and New England, on into the eastern fringe of the Midwest.

"Oddly, 20 meters did not produce many contacts . . . Some stations' first call was loud and clear but they dropped into the mud for the exchange. Perhaps it was the physics of propagation mashing our signals around. Or, maybe it was the ancient Indian spirits, toying with us. I prefer to think it was a little of both.

"The setup on my end was my G5RV inverted-V style. I used a DK9SO collapsible mast to hold up the center at about 30 feet The ends suspended about 6-8 feet up. The mast was lashed to a nearby fence.

"Coax trailed off the mast into the cab of my pickup. On the passenger side I had a large wide board resting on the seat, cantilevered outward onto a support in the foot well. It was a nice work surface, but a little cramped. I used my K2, Serial No. 286, the whole time. An MFJ 949 did the antenna matching, and my Shurr Profi's did the talking.

"Folks, the K2 is a great radio for this kind of operation. I set up the keyer to call

CQ every 15 seconds. I kept the filters wide and tuned the RIT (in wide mode) to find people. When things got quiet I was able to keep the CQs going while I tidied up the log or grabbed a snack.

"I had a blast, and will be doing this again. In fact I may just schedule a day trip to Wyoming 3 or 4 times a year. It's a great way to play hooky from work! This was something I've been wanting to do for a long time, since getting into QRP. Many thanks to **Bruce Muscolino, W6TOY,** for providing the catalyst to get me to act. Thanks to all who took time to seek me out. To those I missed, my apologies. There will be another time."

1999 QRP "To the Field" Results

by Jan Medley, N0QT
P.O. Box 1768
Socorro, NM 87801
jmedley@ix.netcom.com

Finally, and at last, the 1999 *QRP TTF* results are done! It seemed almost destined not to be. I was asked by Doug Hendricks if I could be the new NorCal Contest Manager after Joe Gervais, AB7TT, was forced to resign due to strenuous work commitments. I agreed, figuring "how hard could this be?" Famous last words, I soon learned. Joe forwarded me the logs after PacifiCon and I began going through them, only to discover many inconsistencies in the way each log was scored. So finally, I went through them all, log-by-log, and rescored them all. Most of this stemmed from some obvious confusion on how to score the *border stations* and the *Taco Bell stations*. It was intended to earn the bonus points for *each* Taco Bell worked, and likewise, if you worked a border station, the 2, 3 or 4 states involved counted as that many QSO points on that contact, as well as that many SPC's. The rules for the 2000 QRPTTF follow this article, and hopefully the scoring will be easier to follow. None-the-less, I felt it necessary to check and rescore each log so the scores shown below are more or less on the "same playing field" ... QRP *to the field* field, that is.

Unfortunately, there just isn't the room in this issue to print the *soap box* comments, except to report it sounds like everyone had a great time, plenty of adventures finding "that border" and the trials and tribulations getting to the site or returning. Nobody lost an oil pan or anything in 1999, but a few close calls with bugs, snakes and curious police. Some of the *soap box* comments will be posted on the NorCal webpage.

Thanks to all who participated, and we all look forward to working you in 2000!

1999 QRP To The Field 1999 Results

STN Call	Claimed QSO's	Total Pts	Chk'd QSO's	FINAL SCORE	LOC	Ops	Borders	Band
DX Stations								
VE7SL	109	201160	110	230020	FD	SO	1	All
VE6QRP	98	218240	86	199520	FD	MO	1	All
VE3QDR	44	26320	54	114240	FD	MO	1	All
HP1AC	67	131320	67	131320	HM	SO	1	All
VE6AAN	24	9360	21	12300	HM	SO	1	All
JR0BAQ	4	800	4	560	HM	SO	1	20m
Field Stations								
N2CQ	69	34680	69	51800	FD	SO	1	All
WD7Y	69	47520	70	49640	FD	SO	1	All
K7GT	56	27600	58	29760	FD	SO	1	All
W0YSE	47	28420	47	28000	FD	SO	1	All
AF5Z	34	18720	34	18720	FD	SO	1	All
KI7MN	16	6720	19	6720	FD	SO	1	All
WO3B	21	5720	21	5280	FD	SO	1	All
W3BTN	162	238740	189	278760	FD	MO	1	All
N7KE	152	123872	145	159000	FD	MO	1	All
N6WG	102	84240	102	86400	FD	MO	1	All
W2IV	89	83720	83	83660	FD	MO	1	All
K4AVX	47	27540	47	31620	FD	MO	1	All
K5RAC	20	8400	29	13020	FD	MO	1	All
KK4R	23	6440	23	6720	FD	MO	1	All
AK7Y	122	252000	143	308040	FD	SO	2	All
AE4GX	81	139440	80	139440	FD	SO	2	All
AE2T	72	131040	72	132720	FD	SO	2	All
WU0L	110	152320	67	89760	FD	SO	2	All
K4JSI	48	66560	48	69960	FD	SO	2	All
KO4WX	56	68400	56	68400	FD	SO	2	All
K1CL	54	64800	54	64800	FD	SO	2	All
W1FMR	35	51000	47	44160	FD	SO	2	All
WB1HBE	28	32760	38	35880	FD	SO	2	All

1999 QRP To The Field 1999 Results

STN Call	Claimed QSO's	Total Pts	Chk'd QSO's	FINAL SCORE	LOC	Ops	Borders	Band
Field Stations (con't)								
NA5N	29	9280	29	11600	FD	SO	2	All
KV2X	21	21840	21	10560	FD	SO	2	All
N1EI	9	4680	16	8840	FD	SO	2	All
KB0VCC	12	5760	16	7680	FD	SO	2	All
AB5UA	94	206000	94	214240	FD	MO	2	All
W0UFO	67	126000	87	162000	FD	MO	2	All
N0UR	214	742560	213	989880	FD	SO	3	All
N4DD	153	639600	151	618240	FD	SO	3	All
W0CQC	100	222480	100	234840	FD	SO	3	All
N0EA	130	509580	131	540000	FD	MO	3	All
Field -Single Band								
N6KM	9	1980	9	1540	FD	SO	1	20m
K4AGT	75	106080	75	122400	FD	SO	2	20m
WE6W	53	11660	53	12720	FD	SO	1	40m
KF4KSM	22	12320	28	8400	FD	SO	1	40m
W9WAC	41	8200	36	5040	FD	MO	1	40m
W4IM	45	43680	45	47840	FD	SO	2	40m
Taco Bell Stations								
AB8DF	66	86800	63	93840	FD	SO	TB	All
K0SU	25	28000	32	35000	FD	SO	TB	All
KB2JE	33	28120	33	28120	FD	SO	TB	20m
N6GA	18	8640	18	9120	FD	SO	TB	20m
N7FF	42	37800	42	37800	FD	MO	TB	All
Home Stations								
W4ED		65880	105	70150	HM	SO	1	All
K8CV	101	1270	124	61920	HM	SO	1	All
W5TB	87	41800	87	44650	HM	SO	1	All
K1QM	79	33970	78	35640	HM	SO	1	All
KQ0I	33	13690	58	22940	HM	SO	1	All

STN Call	Claimed QSO's	Total Pts	Chk'd QSO's	FINAL SCORE	LOC	Ops	Borders	Band

Home Stations (con't)

N7GS	42	7210	44	13340	HM	SO	1	All
N0IBT	19	4680	26	4860	HM	SO	1	All
K2UD	27	4350	25	4760	HM	SO	1	All
AB6SO	18	3040	22	3680	HM	SO	1	All
K8DD	12	1820	14	1650	HM	SO	1	All
WD8MNV	10	880	10	880	HM	SO	1	All
WA8GHZ	19	3230	19	3400	HM	SO	1	20m
K4JPN	14	1680	16	2040	HM	SO	1	20m
K4KJP	6	600	8	720	HM	SO	1	20m
AA1OF	6	490	9	700	HM	SO	1	20m
W8TIM	30	5440	32	6600	HM	SO	1	40m
WA8RXI	28	5510	28	5220	HM	SO	1	40m
KA8LLE	25	3900	24	4000	HM	SO	1	40m
N8CQA	17	1800	17	1800	HM	SO	1	40m
W7TAO	82	33200	99	49350	HM	MO	1	All

1999 QRPTTF PHOTO GALLERY

Everbody's favorite QRP DX station ...

HP1AC

"Cam" Castillo at his shack in Panama

It just never seems like a real QRP contest if you don't work our friend. HP1AC. Cam sported 131,320 points in this year's QRPTTF with his TS430S and TA33 Jr. beam. splitting his 49 QSO's evenly between 15M and 20M.

"Run to the Borders" - *Taco Bell* Style

In 1998, I received an email from an AZ ScQRPion (I regret I can't remember whom) who said the closest border to him was Taco Bell. That spurred the idea for 1999 to give a station working within "field of view" of a Taco Bell, border status. To our surprise, we had 7 stations that signed "/TB" of which 5 submitted their photographic proof. It added a most interesting element to QRPTTF, and a hearty thanks to those stations who gave up all human dignity and actually worked the contest from a Taco Bell parking lot! A few of the guilty are presented here.

--Paul, NA5N

Taco Bell #16259
Rt. 23S, Wayne, New Jersey
Walter Windish, KB2JE/TB

"Photo shows my actual operating position. QRP+ on passenger seat, Bencher paddles on console, 2 kids in the back and mom was out of town!"

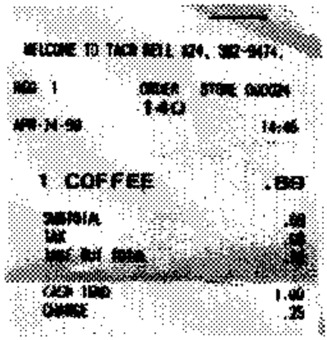
Taco Bell #19615
Morgan Hill, California
Frank N7FF and W6JZE

Pounding away on their NC40 and DK3 screwdriver antenna."

Taco Bell #24
Claremont, California
Cam Hartford, N6GA

"I never guessed how much ignition noise would be generated by people idling in the Taco Bell drive-thru lane! Fun contest when I could hear it."

Cam even submitted his Taco Bell coffee receipt!



Taco Bell #3431
Colorado Springs, CO
Rick Brown, KØSU

"Lots of fun - operating from the car was different. Heard lots of stations I could not work, except EA5OM! What happened to spring, anyway"
Note the snow at Rick's Taco Bell!

Taco Bell #9467
Brainerd, Minnesota
Tom Jones, WØQF

Tom worked 120 stations with his Sierra, 20M Bobtail antenna and an SWR higher than the price of a TB taco.

Strapping a beam to a "John Deere" tractor at the farm of Ed, VE6EDP put **VE6QRP** on the air for QRPTTF. Ops were Duncan VE6QRP, Russ VE6CGO, Niels VE6NJK, Dave VE6DV, John VE6ZAA, Harold VE6HFW and Heinz VE6AQW. This excellent station netted 218,240 pts. Canadian ingenuity at its best!

The view from the MO/OK/AK border station of Wayne NØEA. Red K5ALU, Dan NØDT and Gary KØBC. They used an inverted V and TA-33Jr beam to work 540,000 points.

1999 Zombie Shuffle Results

Ninety-one QRPers participated in the **1999 Zombie Shuffle** and awarded their official *Zombie Death Certificates.* In fact, the "causes of death" were so interesting, we decided to include them here with the results.

We'd like to thank Doug Hendricks and NorCal for donating the world-class *Zombie Lapel Pins*, that will no doubt be highly sought collector's items. But most of all, to thank the 91 Zombies who participated, had fun, and yet still have no clue as to what the point of the Zombie Shuffle was!

Jan did a great job lining up a host of guest *Elvis'* for the evening ... lot's of fun finding those Elvis's behind all those famous QRP calls. And of course the added bonus of working Ed Hare W1RFI and gang at W1AW on the original TT2.

72,

Paul NA5N
Zombie #004
Grand Zombie

Jan NØQT
Zombie #015
Contest Coroner

Call	QSO	W1AW	TOTAL	Cause Of Death
N9AW	77		40755	Crushed by QRM
N4ROA/Elvis	64	1000	33243	Too much shuffling and static zapped me
K7FD	55	1000	31314	None
KU7Y/Elvis	58	1000	30584	QRP-L
WE6W/Elvis	43		24899	Was up 1-4am nite before!
AL7FS	44	1000	22577	20m died and 40 had too much broadcast and noise
KA1AXY	15	1000	22260	RF burns
W5VBO	49		22189	Way too much fun & premature baldness
K5ZTY	41		21181	QRN
W6ZH	36		20890	Overdose of non-obtainium
WO3B	27		19202	Attended QRO Field Day
K1QM	30		18132	Brain dead
KB6HE	34		17003	Viagara
NW7DX/JR	31		16225	Runaway lawnmower
WØCH	23	1000	15011	Inhaling toxic rancid core solder fumes
W9SUL/Elvis	29		14246	XYL
W8SFF	25	1000	14222	She, who wasn't obeyed!
VE3VAW/Elvis	19		14044	
HP1AC	24		13342	RF
NØRC/Elvis	19	1000	12931	Fat Free food consumed on odd numbered days within 5 days of a full-moon
WB3AAL	21	1000	12819	My time expired. Worked all 4 hours.
W5USJ	24		12592	QRN, QRM, es etc on 40
WA9PWP	21	1000	12234	Thunderstorm --lightning stricken
AK1P	19		11890	Terminal tintinitus

Call	QSO	W1AW	TOTAL	Cause Of Death
NQ7X	21		11764	unknown?
AC6KW	23		11665	
VE6BPR	22		11346	Combination of QRM on 40m and de-alcoholized beer
NK9G	16	1000	11161	Broadcast out
W4NJK	7		11155	QRP comatose, previous QRO RF shock
WA3WSJ	18		11065	
K1MG	15	1000	10879	Too much fun
WD3P	13	1000	10832	Life
N2CQ	14	1000	10619	Marriage
NØQT	18		10565	Terminal writer's cramp
WBØYPO	20		10560	Grabbed a B+ line & ground at same time. Now need to touch B+ to operate
KGØEW	18		10528	Last words were: "Hey dudes--wanna see something cool? Watch this!"
W7ILW	15		10510	Ate too much pumpkin pie
WB4JJJ	16	1000	10274	
WA6OWR	19		10255	Of course
K5OI	15		10249	Boredom--waiting for SSB stations to leave 7.040
W6SU	14		10004	Undetermined
WA5WHN	19		9757	
NM8Y	13	1000	9729	XYL hit me over the head with K-2 for doing "happy dance"
K6RPN	16		9411	Heart failure from fright
K4NK	16	1000	9344	Fell off tower
N9MZP	14	1000	9296	Major transistor failure
KI7MN	17		9057	QRM'd
W3BBO	17		9054	No Body (knows)
K7TQ	15		8642	Overworked and Underpaid
WD8KQY	15		8201	Too much fun during Zombie Shuffle
KX7L	13		8111	SSB QRM from contesters on 40M!
AB8DF	11	1000	8033	Teenagers drove me over the edge
N7KT	14		7940	No more signals -adrenalin drained out
W2EB	16		7706	Not yet, thank you!!
N5WU	15		7690	Over work and not enough time for radio play

Call	QSO	W1AW	TOTAL	Cause Of Death
KIØKY	14		7587	Hyperexcitement acerbated by TT2 failure prior to the corpse's chorus
K1VP	15		7401	Don't know, I couldn't say, being dead and all
NUØV	13		7119	Too much fun
KQ5U	20		6870	Birthday on 10/31/41
N2VPK	13		6768	
N8IE	13		6719	Wife, 3 kids, mortgage, car payment...
W3CD	7	1000	6449	Not so fast! :)
N9WR	14		6434	Drowning (N9-Water Rat)
N2EI	10	1000	6417	
K8CV	11		6396	
WØQK	14		6335	40/80m Static
N3XRV/M	11		5940	CW at 70 mph
N4UY	14		5891	
N3AT	14		5750	QRM
K6MW	10		5521	Ringing in ears after listening to 40m
WA8RXI	10	1000	5474	
N5NW/Elvis	5	1000	4994	The King will never die...
WA5BDU	7	1000	4627	QRP fever complicated by 40m noise & QRM
N4EUK	7		4414	Bad pizza
KC2CLL (T+)	7		4277	Terminal vitamin D deficiency due to shack in dungeon (cellar)
N5YAK	9		4105	Electrocution from QRO amp
K2REB	3	1000	4068	Electrocuted while adjusting antenna
AI4CW/JR	5		3909	Bad meatloaf; compounded by QRM
W5TB	8		3787	Operating from banks of the "Skull Crusher" River in Arkansas
KIØG/TT2	5		3690	
K7SZ	7		3529	
KA5T	6		3307	
W4IM	5		2840	
KK5NA	5		2563	QRN
AA2VK	4		2270	Cells drained
KC7EAY	5		2260	Electrical mishap
WW4MC	9		2733	pneumonotramicroscopic-silliacovacaniosis
KE5TC	1	1000	1666	W1AW/TT2
N7TAU	3		1527	Fright!!!

Call	QSO	W1AW	TOTAL	Cause Of Death
KE5TC	1	1000	1666	W1AW/TT2
N7TAU	3		1527	Fright!!!
KCØBDW	2		968	RF Burns
W3AA/KB3BYT	1		941	Mob demonstration
N6CHV	1		815	
WD6BOR	1		685	Anxiety trying to work CW for the 1st time in a year during a 40m SSB contest.
VE5QRP/ VE5RC/Elvis	7		666	
K6JS/KF6PJM	1		502	K6JS=Insanity, KF6PJM=Ham Fever
W8ERV	1		402	QRM
AE4IC Elvis	27	not	rept'd	SSB contest on 40m
KØYO	5			Rusty nails

Everyone who participated in the Zombie Shuffle, and who sent in an envelope, received the above official **ZOMBIE DEATH CERTIFICATE** and ***Zombie Lapel Pin*** - hereby becoming official Zombies. If you didn't get one for the '99 Shuffle, we'll be sending them out the Death Certificates again for the 2000 Zombie Shuffle. It will *probably* be held on the Friday evening before Halloween, October 27, 2000. Rules to be announced on QRP-L.

QRP To The Field 2000 - *Water World*

Saturday, April 29, 2000

• OFFICIAL CONTEST RULES •

Date: Saturday, April 29, 2000
Time: 1500 to 2400 UTC (pick any 6 hours)
Bands: 40-20-15-10 meters, in the vicinity of the QRP calling frequencies: please be courteous to others
Mode: CW only
Power out (QRP only): 5 watts or less

The theme for this year is to get outside and get as close as possible to a water location! Sorry...bathtubs, toilets, sinks, leaky plumbing, water bottles and the like don't count. Just about everyone has a nearby location that involves some kind of lake, pond, river, canal, ditch, whatever! If you can't get away to be near the water, then set up out in your back yard or on the back porch and be a field station. *The whole idea of **QRP to the Field** is to get outside and operate!* So pack a lunch and get out there. Let's have some fun! A note of seriousness here. **Please keep your personal safety in mind**, especially Marine Mobile stations. Don't attempt to go out on the water before the fog has cleared, and please don't stay out on the water after dark. We want to have everybody around for next year too. So use a little common sense and please obey the laws governing your location. Select any 6-hour operating period. If you need to split it up into two or three hour intervals to accomodate other plans, then do so. Jump in there when you can, but only work a total of 6 hours.

Categories:

- **Marine Mobile (MM)** ... ***must submit photograph of operating position!*** Whether you're on a ship, canoe, kayak, raft, innertube or what have you....if you are afloat, then you're marine mobile. DO NOT sign /MM after your callsign, it will be part of the exchange.
- **Ocean (OC)** .... ***must submit photograph of operating position!*** This category also includes the Great Lakes and the gulf, cuz those babies are huge!
- **Other water (WT)** .... inland lakes, rivers, streams, park ponds, ditches, canals, etc.
- **Field station (FD)** .... any station that is outdoors and not using commercial power or fixed antennas.
- **Home station (HO)** ...... any station that is operating from an indoor or home location.

Exchange: RST + SPC + Category identifier (two letters)
Example: 559 NM WT -or- 55N CA OC

Scoring: **25 pts** - for each **MM** station worked per band
20 pts - for each **OC** station worked per band
15 pts - for each **WT** station worked per band
10 pts - for each **FD** station worked per band
5 pts - for each **HO** station worked per band

SPCs: (State/Province/Country) count once per band

Location Multipliers: MM = x5
OC = x4
WT = x3
FD = x2
HO = x1

Final Score: Total pts x Total SPC x Location = Final score

A summary sheet is available at the Norcal web site:
http://www.fix.net/~jparker/norcal.htm

Deadline: ***Send complete logs and summary sheets by June 1, 2000.*** Summary sheets must include a description of location and equipment used; also include photographs where indicated above. Pictures must show your station location and the water in the same field of view. Your log should include a minimum of time (in UTC), callsign of station worked, complete exchange received, RST sent (if not a static exchange). Incomplete submissions will be used as check logs.

Email submission (except MM & OC stations): send complete logs and summary sheets in ASCII text format only to:

nØqt@arrl.net

Please send ***text format only***, all other forms will be rejected, so no html, word processor documents or attachments please.

Snail mail (including MM & OC stations): send complete logs and summary sheets and photos to:

Jan Medley NØQT
QRPTTF 2000
P.O. Box 1768
Socorro NM 87801

QRPTTF Y2K

Paul Harden, NA5N
P.O. Box 757
Socorro, New Mexico 87801
NA5N@Rt66.com

The official contest rules for this year's **QRP To The Field (QRPTTF)** are on pages 55 and 56. There are a few major rule changes to note, as well as the new NorCal Contest Manager for which to address your questions and submit your logs.

Discussion.
For the past several years, NorCal has applied a *theme* to QRPTTF to encourage participation and foster some fun. And many QRPers have participated in QRPTTF together, combining it with camping trips and the like, doubling their fun by associating with other QRPers off-the-air as well as on-the-air.

For the past two years, the theme has been "Run to the Border" to encourage operating from a state line, and rewarding those who make this heroic effort with a larger multiplier. We believe this has been a successful theme, and from the soapbox comments received with last year's logs (and on QRP-L), most want to see this theme continue. However, others have pointed out the difficulty of the long distances in many cases in reaching the state line. Believe it or not, Californian's have complained about this the most, and rightfully so. It is a deceivingly big state, combined with the Sierra Mountain range running down the middle, for which few roads actually pass through them, making it a many-hundred mile line reaching the Nevada or Arizona border. Likewise, many QRPers on the east coast have found it difficult to operate near the state line due to private property ownership, in the middle of an interstate, etc. making such an operation hazzardous. Nor do I need mention the opinion of the state borders theme from our friends in Alaska and Hawaii -hi.

So in order to be fair and try to ensure as many people as possible can participate, we have decided to use bodies of water as this year's theme, and this year's field multipliers. This has several advantages. First, according to the 1990 Census, nearly 80% of the U.S. population lives within 100 miles of theocean, including the Gulf of Mexico and the Great Lakes. Granted, the 2000 Census might shift this number a bit! But evidently, most American's live near a major body of water. This should make it more convenient for many. Secondly, even for those land-locked QRPers, there is certainly a body water nearer to you than a state border. Remember, it's all in fun, and operating near a body of water is merely a means to reward those who make the effort to truly "go to the field."

One goal of QRPTTF is the added serendipitous effect of the contest. That is, scoring is often based more on luck than on skill. When you work a station in this year's QRPTTF, until you copy his exchange, you don't know whether that contact will be worth 5 points or 25. We feel this gives QRPers a more even playing field to compete with eachother inspite of what the other stations code speed or equipment may be. This means if your code speed is marginal at best and you're going to the field with your NC20 and the perverbial "wet noodle," you have the same change of earning a fairly large score as the guy working 35 wpm with his K-2 and portable TA-33 beam.

We want all to have fun, and QRPTTF has evolved over the years to try to offer most QRPers that opportunity to have that fun and compete with "the big boys."

We see QRPTTF as an "event" more than a contest, but regardless of your definition or plan of attack, we want you to enjoy it.

Ocean Stations (OC) will be those that operate from very near the ocean, such as from a beach, cove or overlook. How close must you be to the ocean, you ask? Just like for the state lines, as close as feasible without risking safety or ending up in the middle of a freeway or in someone's private property. We ask that you submit a photo of your operation when submitting a log. The photo must show your operation, along with the ocean, in the same field of view. And please identify the QRPers in the photo by name and call, in the event we use the photo in QRPp. For this you are rewarded with multiplying your final score by 4, plus the joy of handing out 20 points to everyone who works you. You can identify the ocean or beach you are operating from, if you wish, but strictly at your option. Please keep safety in mind at all times, and realize the ocean produces that nasty salt spray, so operate far enough way and take the precautions necessary to protect your equipment.

Maritime Mobile (MM) stations is the top-scoring bonus for QRPTTF. Keep in mind, this is intended for the seasoned seafarer's - those QRPers who have access to a boat or craft and have done this sort of thing before. I have received email in the past from several who like to operate from their crafts on the Great Lakes, Puget Sound, etc. Well, here's your chance to do it, and earn the maximum field location multiplier of 5, plus hand out 25 QSO points per contact. This category also requires a photo showing your operation with the ocean and/or your boat in the same field of view.

Again, safety is of the utmost concern. If you've never operated maritime mobile before, don't go out and rent a deep sea fishing vessel and tackle the Straits of Juan de Fuca to "get your feet wet." Bad idea fellas.

The WT or Water category is for about everyone else who operates from an inland body of water, such as a lake, reservoir, dam, river, canal, etc. You do NOT need to submit a photo, but the guidelines would be the same ... operate close enough that your station and the body of water are in the same field of view. How large must the lake or river be, you ask? As a general guide, if it has a name, it's probably big enough. This category will probably be the majority of stations worked during QRPTTF.

Field Stations (FD) are those who go to the field and for whatever reason, just can't seem to find a nearby body of water.

Home Stations (HO) are those who operate from an established station in their home. In the past, the home stations have felt discriminated against. We realize not everyone has the means to participate in QRPTTF from the field. So this year, all home stations will be listed separately in the results, so they can compete in score with others in the same home category. We really want you to enjoy the fun, too!

Whether you operate from a lake, river, the Atlantic Ocean or Maritime Mobile, we hope you take along a couple of QRP friends and make a nice weekend of it and enjoy the fraternity unique to our hobby. Have fun in all respects. If you have any questions about your intended operation or what category it qualifies as, please feel free to contact me at NA5N@Rt66.com, or the Contest Manager at *jmedley@ix.netcom.com*

The Next NorCal Kit ... or Two

Doug Hendricks, KI6DS
ki6ds@hotmail.com

NorCal has been rather quiet lately since our last kit, the NorCal 20. This doesn't mean that new kit projects are not in development! Like all NorCal projects, the NC-20 was filled with success, from the continued reports of the fun they were to build to how they operated on the air (many calling it "a real radio"), to launching Red Hot Radio in order to meet the continuing demand, to seeing the NC-20's being delivered to hams overseas, mostly through the efforts of G-QRP. It was indeed a rewarding project.

I have always been proud of the NorCal team over the years. They have designed great projects and developed many innovations in kit building. Many of these innovations have been adopted by commercial kit vendors and other club kits. Board mounted controls, easy-access and attractive enclosures, built-in TiCK keyers, audio annunciators, easy-to-follow instruction manuals and minimal alignment steps, to name a few.

Now it's time to introduce the next step in design and innovation for QRP kits by our design team: **surface mount technology (SMT).**

Why Surface Mount?
SMT is taking over the electronics industry. Already certain types of thru-hole components are getting hard to get, especially in quantity for a kit build. It's not a crisis situation yet, but it soon will be, particularly with some of the IC's we have learned to depend on. Since QRPers are in the forefront of kit building, it is to our benefit to learn how to use surface mounted components now at our leisure, before we're forced into it.

NorCal has two SMT kits in development (described below). We are offering these kits for the following reasons:

1. To keep up with the industry trends towards SMT. It's here to stay.
2. Gain the experience *now* in designing and building surface mount kits.
3. Develop the innovations necessary to make SMT construction by hobbyists easy and successful. This includes developing new ways to package a kit with many, tiny SMT components.
4. Many QRPers work in electronics for a living. And while many may not *yet* be using SMT, they will be required to in their jobs before long. An SMT kit will provide the experience necessary for both hobby and employment.
5. It is too costly for a commercial kit vendor to take the financial risk to develop an SMT kit. What we learn can be used by kit providers and clubs to develop their own SMT kits.

All in all, we think learning to work with SMT now, while we have the leisure of time, and not out of neccessity, will do nothing but help the hobby. If we do nothing now, then chronic shortages of parts will creep upon us, making homebrew projects and kits difficult to complete. This is learning experience we all need do overcome now. And we think once you build your first SMT kit, you will overcome the lack of confidence in working with SMT you may have now.

The TWO NorCal SMT Kits.

NorCal will be offering *two* SMT kits this year, which for now we'll call SMK-1 and SMK-2. SMK-1 will be ready to ship about the time you read this; SMK-2 is targetted for before PacifiCon in October.

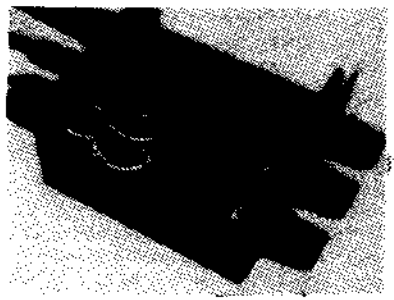
The main kit offering will be the SMK-2. This will be a full-ledged transceiver. However, before tackling this kit, we felt it would be beneficial to offer an easier kit first, so we can all gain some experience.

NorCal Announces Surface Mount Kit The SMK-1

The SMK-1 is the "training or beginner rig" before tackling the new full featured kit becomes available this fall.

The SMK-1 is basically the Tune Tin 2 and the MRX receiver with the mods shown on Dave Fifield's web page (www. redhotradio.com). Of course, we had to make some changes. First of all, the LM380 is not available in surface mount, so Dave switched it for an LM386. What Dave ended up with is a neat little surface mount project. It is a transceiver, with separate VXO tuning for transmit and receive. That means you have instant RIT and XIT! Plus, it uses diode switching and has a real side tone. The TT2 transmitter tunes about 1.5KHz and the receiver about 4-5 KHz. They do overlap so true transceiver operation is possible. No thump, no microphonics, just a slight chirp. We used the MRX receiver with a couple of mods and it works pretty good. Prototypes had an MDS of -117dBm, which is fine for 40M.

The exciting thing is the rig is all surface mount parts except for the 2 crystals (7.040 MHz), 2 trim caps and the 3 control pots. We use **1206 parts,** the "big ones." 1206 means they are .12 x .06 inches in size for the resistors and capacitors. There are 85 parts in the kit, a professional quality, double sided, solder masked, silkscreened board, and we supply all board mounted parts including the 3 control pots. You will need to come up with the audio jack, key jack, power jack and antenna jack of your choice. The 3 control pots are mounted across the front of the board, and are used to connect it to the front panel. The pads for the audio, key, power and antenna connectors are on 0.1" centers so you can use molex connectors if you wish (not supplied). We are not supplying a case, but out good friends at the NJQRP Club are offering a specially designed enclosure kit that comes with the connectors, knobs and feet. The information on the NJQRP case is on the next page. A photo of the prototype is shown below.



I've saved the best for last. The size of the board is 2.5" wide by 2.25" deep!

The cost? $30 + $4 shipping and handling. NorCal is taking orders now. Mail your check, made out to Jim Cates for $34 and requesting the SMK-2, and send to:

Jim Cates, WA6GER
3241 Eastwood Road
Sacramento, CA 95821

This is a very usable transceiver. It is not the NC-40 or NC-20, but better than the 49'er. The prototype puts out 360mW.

The SMK-1 is designed to introduce you to working with surface mount parts. It has over 70 SMT parts. We think the average builder will not have a problem with it. We did this to start training QRP homebrewer's in SM construction. We also wanted to do a simpler kit that would be very easy to build, provide training, easy to trouble-shot, and also give me experience in kitting before the full featured rig comes out. I have some unique ideas on how to package the parts so that they are easily identifiable yet reasonable to kit. This should be fun for all of us, learning together.

SMK-1 Enclosure Kit from the NJQRP

by George Heron, N2APB

SMK-1 in the NJQRP Enclosure Kit

The NJQRP club is pleased to offer another "first" for the QRP community: a homebrew enclosure kit made entirely from double-sided copper clad PCB material. Working closely with NorCal in the introduction of their SMK-1 transceiver, we designed an enclosure tailored to the small-sized SMK-1 and created a kit of all parts needed to finish off this surface mount transceiver.

Included in the SMK-1 Enclosure Kit:

- 8 precision-cut, pre-drilled copper clad boards which, when soldered together as instructed, form the enclosure shown above.
- 3 knobs (for the SMK-1 pots)
- 2 1/8" audio jacks (back panel)
- 2.1mm DC coaxial jack (back panel)
- Antenna BNC (back panel)
- 2 small screws to hold the top half of the case to the bottom
- 4 small screws and 2 nylon spacers for mounting SMK-1 in place
- 4 rubber feet
- Preprinted front and rear panel labels on clear acetate, suitable for gluing to enclosure for a professional, finished appearance.
- 10-page detailed instruction manual for finishing the SMK-1 with enclosure.

Availability: Will be ready to ship with the SMK-1 kits from NorCal early April.

Price and Ordering: The SMK-1 enclosure kit is $10 from the NJQRP Club. Send cash, check or money order payable to "George Heron, N2APB" to:

George Heron, N2APB
2419 Feather Mae Court
Forest Hill, Maryland 21050

Additional information and photos can be seen on the NJQRP website at:

www.njqrp.org/smk-1/

As of this writing, there has been seven prototype/beta-testers for both the NorCal SMK-1 kit, and the NJQRP enclosure kit.s. Everyone built them successfully, and all found getting the "knack" of working with surface mounted components was easier than they thought. Those first 2-3 resistors are a bear, but a snap after that!

The NorCal Surface Mount Transceiver
The "SMK-2"

by Doug Hendricks, KI6DS
ki6ds@hotmail.com

NorCal has been developing the next step in QRP kits -- a full fledged transceiver using surface mount parts. This kit, like the SMK-1, will use the larger 1206 sized components and use IC's that are the same size as the ones that Embedded Research uses for their surface mount TiCK Keyer.

What we are talking about is a full featured transceiver, very small in footprint, has a built in keyer, DDS VFO, and it will be offered on **10 meters** to begin with, with other bands added later. We will of course have some thru-hole parts that are necessary, but SMT will be used wherever possible.

The kit will be board and parts only, with you doing your own case. Who is the designer? Well, if we reveal that right now, the poor guy would be deluged with questions and wouldn't have time to finish the design. But rest assured that it is a very well known QRPer and an outstanding designer, professionally as well as for the hobby.

Target Date.
Our goal is to have the full-featured kit ready to release this fall, before PacifiCon. Hopefully in August or September. This will give us plenty of time to get the prototype boards done and built, parts in and packaged over the summer. Progress will be reported in QRPp and on QRP-L.

Target Price.
The SMK-2 kit is targetted for **$50.** This is for the full featured QRP transceiver with RIT, XIT, built-in keyer, DDS VFO, AFA and a commercial quality board. Can we do it? Yes, I think so. The DDS VFO chip will be premounted, as it does come in a package not feasible for the average guy to mount. But the rest of the chips, caps, inductors, trimcaps, trimpots, resistors, transistors, diodes, all will be surface mount where possible.

Rig Name.
We are calling it the "SMK-2" for the purposes of this article and initial announcement only. We'll no doubt come up with a far better name in the future! Maybe a good name will evolve out of those building the SMK-1 first.

Some challenges ahead.
We have several new problems to solve that are very unique to kitting a surface mount kit. They include how to package the kit, how to identify the parts, how to do the manual (remember, this will be the first time for many of the builders working with surface mount). We have some unique ideas, things that have never been done before with a kit. I am excited about trying these new ideas, and some of the concepts that the NorCal Surface Mount Team is working on now.

Why are we doing this?
Because, thru-hole parts are going away. For us to be on the cutting edge, to do new things, we will have to bite the bullet and use surface mount components in the near future. So why not do it now and be ahead of the game before shortages in thru-hole parts bite us? Look at it as a new skill to learn, not as something that you "can't do."

Orders ONLY for the SMK-1 are being accepted at this time;NOT for the SMK-2 full featured kit. When ready, it will be announced on QRP-L and in QRPp.

Surface Mount Kit(s) Summary

The SMK-2 is the full featured QRP transceiver. It will be released in the Autumn before PacifiCon. Orders for this SMT kit *are not being accepted at this time.*

The NorCal SMK-1 Kit is the TT2/MRX "training" kit. It will be ready to ship about the time you receive this issue of QRPp. *Orders are being accepted at this time.*

Send $34 ($30 + $4 shipping/handling) to:

Jim Cates, WA6GER
3241 Eastwood Road
Sacramento, CA 95821

Make check/MOs payable to Jim Cates.

The NJQRP Enclosure Kit is for the enclosure, knobs, etc. for the NorCal SMK-1. Order the enclosure kit from the **NJQRP Club,** *Not NorCal.*

Send $10 (shipping included) to:

George Heron, N2APB
2419 Feather Mae Court
Forest Hill, Maryland 21050

Make check/MO payable to George Heron.

NorCal Worked All States (WAS) Record

STATE	CODE	STATION	QSL	NOTES
Alabama	AL			
Alaska	AK			
Arizona	AZ			
Arkansas	AR			
California	CA			
Colorado	CO			
Connecticut	CT			
Delaware	DE			
Florida	FL			
Georgia	GA			
Hawaii	HI			
Idaho	ID			
Illinois	IL			
Indiana	IN			
Iowa	IA			
Kansas	KS			
Kentucky	KY			
Louisiana	LA			
Maryland	MD			
Maine	ME			
Massacheusetts	MA			
Michigan	MI			
Minnesota	MN			
Mississippi	MS			
Missouri	MO			
Montana	MT			
Nebraska	NE			

STATE	CODE	STATION	QSL	NOTES
Nevada	NV			
New Hampshire	NH			
New Jersey	NJ			
New Mexico	NM			
New York	NY			
North Carolina	NC			
North Dakota	ND			
Ohio	OH			
Oklahoma	OK			
Oregon	OR			
Pennsylvania	PA			
Rhode Island	RI			
South Carolina	SC			
South Dakota	SD			
Tennessee	TN			
Texas	TX			
Utah	UT			
Vermont	VT			
Virginia	VA			
Washington	WA			
West Virginia	WV			
Wisconsin	WI			

Q-Signals are an amendment to the International Radiotelegraph Convention (IRC) adopted during WW-I, intended for commercial telegraphy stations. Today's Q-signals are about a third of the original list, and still used by the military, maritime stations, and of course the radio amateur. Q-signals can be a question, an answer or a statement.

Example: **QRL?** .... "Are you busy?" or "Is this frequency in use?"
QRL .... "I am busy" or "This frequency is in use."

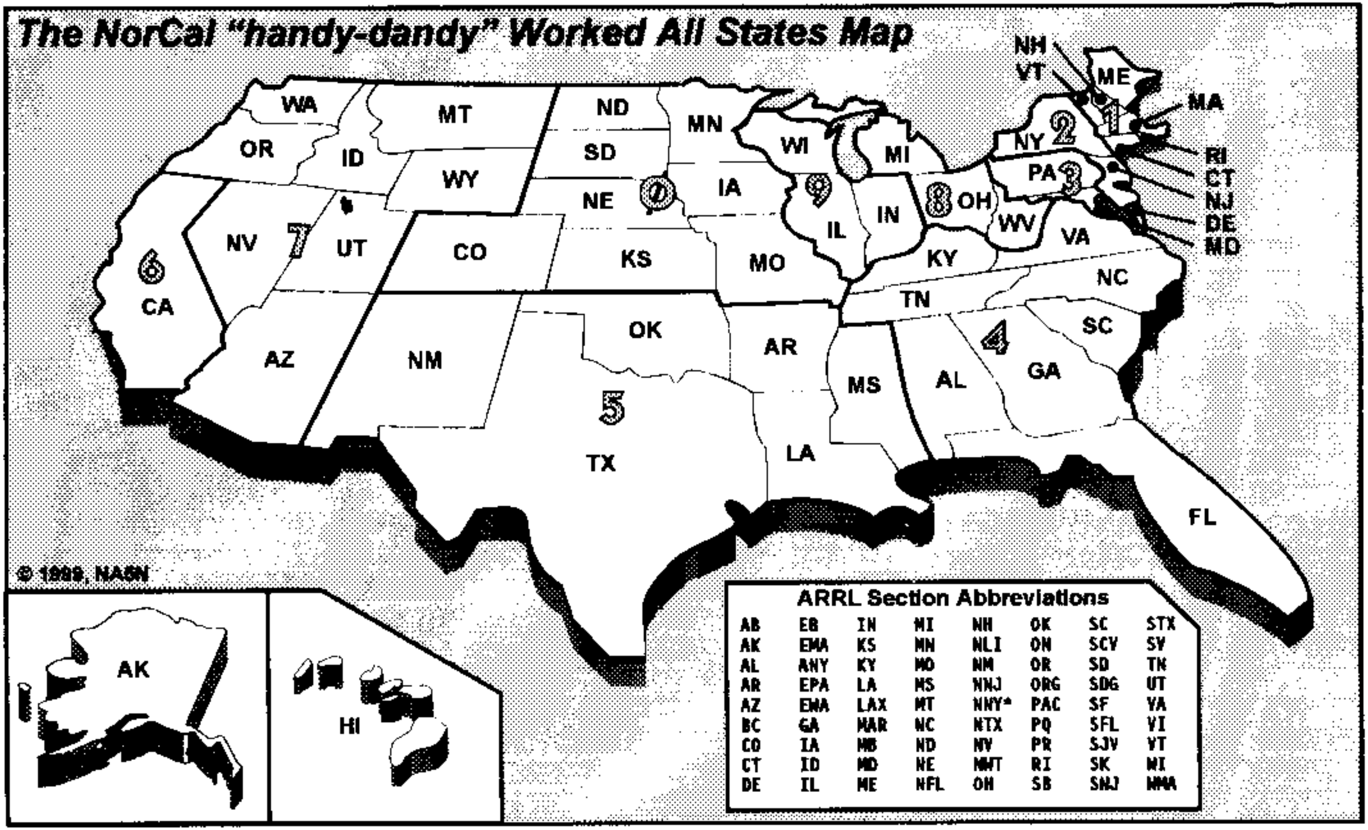
Q-Signals

†**QRA**	What is the name of your station?
†**QRG**	What is my exact frequency?
QRK	What is my signal intelligibility?
†**QRL**	Are you busy?
†**QRM**	Am I being interfered with? (**M**an-made interference)
†**QRN**	Am I being interfered with? (**N**atural interference)
†**QRO**	Shall I increase transmitter power?
†**QRP**	Shall I decrease transmitter power?
†**QRQ**	Shall I send faster?
†**QRS**	Shall I send slower?
†**QRT**	Shall I stop sending?
†**QRU**	Have you anything for me? (more to say, traffic, etc.)
†**QRV**	Are you ready?
QRX	When will you call again?
†**QRZ**	What station is calling me?
†**QSA**	What is my signal strength? (S1 to S5)
†**QSB**	Are my signals fading?
†**QSK**	Can you operate break-in?
†**QSL**	Can you acknowledge receipt?
†**QSO**	Can you communicate with ___ direct?
QSP	Can you relay to ___?
QST	ARRL special Q-signal, "Calling all radio amateurs."
QSV	Shall I send a series of V's?
QSW	Will you transmit on ___? (Frequency or time)
QSX	Will you listen for (station) on ___ KHz?
†**QSY**	Shall I change my frequency?
†**QTH**	What is your location?
QTR	What is your local time?
QTV	Shall I stand guard for you? (or assume net control?)
QTX	Will you keep your station open for further QSO's?

† Q-signals most commonly used on the ham bands.

Some "generic" meanings of Q-Signals (and/or in contest work)

QRP A category of hams using low-power equipment. Legally, QRP is 5W or less. QRP often implies small, homebuilt and/or battery powered transceivers.
QRZ In a contest or pile-up, used to mean "who is next to work me?"
QSL A card sent between stations to verify 2-way contact. Also used to ask if your last communications was received. **Ex.** *UR RST 57N NR138 QSL?*
QRX Sometimes used to mean "Please standby." **Ex.** *HV PHONE CALL PSE QRX*
QRT Going off the air; closing my station. **Ex.** *NEED TO QRT NW 73 OM*


The NorCal "handy-dandy" Worked All States Map
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ARRL Section Abbreviations
AB EB IN MI NH OK SC STX
AK EMA KS MN NLI ON SCV SV
AL ANY KY MO NM OR SD TN
AR EPA LA MS NNJ ORG SDG UT
AZ EWA LAX MT NNY* PAC SF VA
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CO IA MB ND NV PR SJV VT
CT ID MD NE NWT RI SK WI
DE IL ME NFL OH SB SNJ WMA

QRPp Subscriptions

QRPp is printed 4 times per year with Spring, Summer, Fall and Winter issues. The cost of subscriptions is as follows:
U.S. and Canada addresses:$15 per year, issues sent first class.
All DX addresses: $20 per year, issues sent via air mail.
To Subscribe: send your check or money order made out to Jim Cates (not NorCal) and mail to:

Jim Cates, WA6GER
3241 Eastwood Road
Sacramento, CA 95821.

U.S. funds only. Subscriptions will start with the first available issue and will not be taken for more than 2 years. Membership in NorCal is free. The subscription fee is only for the journal, QRPp.

QRPp Back Issues Pricing

1993 - $10, 1994 - $15, 1996 - $15, 1997 - $15, 1998 - $20, 1999 - $20.
Full year sets only available (no individual issues available).
Shipping: U.S.
$4 for 1-3 issues; $5 for 4-6 issues
Shipping: Canada
$4 for 1 issue; $5 for 2-3 issues; $7 for 4-6 issues
Shipping: DX Europe & South America
$5 for 1 issue, $7 for 2-3 issues, $10 for 4-6 issues
Shipping: DX PacifiC Rim, Australia & New Zealand
$5 per issue ordered.
All funds U.S. funds only. Make check or money order to Doug Hendricks (not NorCal) and mail to:

Doug Hendricks, KI6DS
862 Frank Ave.
Dos Palos, CA 93620

QRP Frequency Crystals

NorCal has available the following crystals in HC49U cases for $3 each, postage paid, in the following frequencies: 7.040 MHz, 7.122 MHz. Send your order and payment in U.S. funds only to Doug Hendricks (not NorCal) and mail to:

Doug Hendricks, KI6DS
862 Frank Ave.
Dos Palos, CA 93620

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