

The 2N2/30

A 30-Meter Discrete Component CW Transceiver built Manhattan-style

Designed by: Jim Kortge, K8IQY

Summary

This paper describes the design, construction, and performance of a 30-meter discrete component CW transceiver based on the authors' previous award-winning 2N2/40 design. New and revised circuits are employed in this latest offering, providing improved performance over the 2N2/40, while retaining the straightforward, Manhattan-style construction approach. Details on using SMT components with this construction method are provided. This new design carries forward the extensive use of PN2222 transistors, while also employing other discrete active devices to enhance performance and reduce construction effort.

Introduction

The 2N2/30 transceiver project actually got started a short time after the 2N2/40 was published in the winter 1998 issue of QRPP. Several persons inquired about the feasibility of adapting the design of the 2N2/40 to 30 meters. Over the course of about 2 years, many emails went back and forth with these individuals regarding the needed changes to create such a rig. Interestingly, only one individual in the group with whom email correspondence occurred, got to the point of actually starting the build of a rig.

The changes required in the frequency sensitive circuits were easily obtained by frequency scaling the 2N2/40 values.

Since the VFO circuitry of the 2N2/40 had been very stable, and reproducible, it made sense to keep that design intact, which meant moving the IF frequency to accommodate the 30 meter band at 10.1 MHz. The choice for the IF was primarily driven by the availability of inexpensive computer crystals. A quick check of the Mouser catalog revealed 7.3728 MHz series mode crystals available from manufacturers Vishay and Fox, both preferred sources from past experience. With a 7.3728 MHz IF, the VFO would operate at 2.7272 MHz. This was close enough to the 2.085 MHz frequency of the 2N2/40 VFO to reasonably assure stability and reproducibility.

Very little additional work took place on the evolution of the 2N2/30 until another significant event occurred.

In the summer of 2001, John Wagner, N1QO organized a group build of the 2N2/40 rig via a Yahoo-based Internet group. While the original design of that rig was a good first attempt at designing a CW transceiver from scratch, it did have areas where improvements could be made. Additionally, some of the parts in the original design had become unavailable. As the group was getting organized and parts sets were being procured, many of the circuits of the 2N2/40 were updated to achieve better performance, while keeping with the original goals of that design to use

discrete components, while retaining active devices from the PN2222 family. Specific changes include redesign of the receive RF amplifier, post-mixer amplifier, variable bandwidth filter, receive mute, and audio amplifier string. Those changes significantly improved the performance of the rig, and this configuration was called the 2N2/40+. As it turned out, most of the upgrades to the 2N2/40 were carried over to the 2N2/30 design.

One of the hundred-plus 2N2/40+ group builders was Jeff Hecht, K8GD. His 2N2/40+ was very well built, and worked well. It was one of many displayed by Yahoo group builders at FDIM, during the Dayton Hamvention in the spring of 2002. During the course of our many discussions, the subject of a 2N2/30 surfaced. Sensing Jeff's enthusiasm for Manhattan-style construction, it became clear that a formal 2N2/30 transceiver design should occur.

In September of 2002, an email arrived from Jeff that he was ready to build a 2N2/30. Since the design was not finalized, it was time to get busy! It seemed appropriate to design, build, and test the circuits before Jeff got too far along in his construction. To his credit, Jeff did much of the early work on scaling the VFO, and rechecked earlier scaling of the tuned circuits. We worked together as a team, especially at the beginning of the project, staying abreast of each other's progress via many digital images and emails.

Features

Receive

Double-tuned Input Filter: 200 KHz BW
"Noiseless" Norton RF Amplifier: 12 dB
Diode DBM
4 pole Crystal IF Filter: ~500 Hz BW
JFET Audio Mute
3 Audio Stages: Speaker capable
Varicap Tuned VFO: 50 KHz Coverage
Adjustable Span RIT

Transmit

Diode DBM
Double-tuned Amplifier
Variable Output Power
Exceeds FCC Purity Specs
QSK Operation: Solid State Switching

Measured Performance

Receive

Sensitivity (MDS): -132 dBm
Linear Dynamic Range: 100 dB
Opposite Sideband Rejection: 60 dB
IF Rejection: 94 dB

Transmit

Power Output: 12-Watts (13.8 vdc)
Spurious Output: -50 dBc

Design Overview

A set of schematic diagrams and a Bill of Material are included in this paper for use during the technical discussion and construction sections. Readers are encouraged to use these resources while reading to enhance their understanding of the presented material.

The 2N2/30 follows the general design of many QRP rigs. It consists of a superheterodyne conversion strip on the receive side and a complete RF generation strip on the transmit side. Both sections share a common VFO. Each of these subsystems contains a Local Oscillator (LO). The receive LO allows one to optimize receiver response by centering the receive pass band to the center of the crystal IF filter. On the transmit side, a separate LO provides offset adjustment, resulting in a side tone matching the received audio. Switching between receive and transmit is done with solid-state switches to provide QSK capability. When transmitting, the 2N2/30 is listening to its own signal.

Beginning with the receive side, incoming antenna signals are routed through the transmit LP filter to the receive T/R Switch. Diodes D1 and D2 in this switch conduct when transmitting, protecting the front-end of the receiver from damage. From there, received signals pass through the RF gain control, and on to a doubly tuned Input Band Pass Filter. This filter is lightly coupled, and has a 200 KHz pass band at the half-power or -3 dB points. Its response is shown in figure 1. Signals from this filter are then coupled to a Norton "Noiseless" RF Amplifier providing 12 dB of gain. Winding transformer T3 correctly is key to this stage working properly. This amplifier was chosen because of its low noise, wide dynamic range, and stability if built correctly. From this stage, signals are passed to the RF input port of an ADE-1, Level 7 diode double balanced mixer. The LO drive (at 2.7272 MHz) to the Rx Mixer comes from the VFO. This common subsystem will be discussed in another section.

The output of the receive mixer drives a -3 dB Attenuator. This attenuator, along with the input impedance of the Post-Mixer Amplifier provides a constant 50-ohm load to the mixer IF port. A common-base configuration is used for the Post-Mixer Amplifier, which provides high isolation from output to input, thus preventing the large impedance changes seen at the input to the crystal filter from appearing at the mixer IF port. The Post-Mixer Amplifier has 9 dB of gain. An impedance matching network (C22 & L6) transforms the 1.3 KOhm output of the Post-Mixer Amplifier down to the 125 ohm input impedance of the 4 Pole, 500 Hz Crystal Filter. The crystal filter uses 7.3728 MHz series mode crystals, and has an actual center frequency of 7.3731 MHz. The LO injection is above the center of the filter, so it is used as a lower sideband filter. It is designed with Butterworth response characteristics, suitable for CW reception. Figure 2 is a plot of its frequency response. Note that parallel inductors can be used to offset the holder capacitance of the crystal, thereby improving the symmetry of the response curve.

The 125-ohm output-impedance of the crystal filter is transformed down to the 3 ohm input impedance of the IF Amplifier using a 13-turn to 2-turn transformer, T5. Signals into the IF Amplifier drive a common base stage with resistor R25 providing the collector load. A common emitter second stage is directly coupled to the first stage by sharing R25, which also provides second stage base bias. The IF Amplifier overall provides some 40 dB of gain. Amplified signals are passed to the Product Detector through a 4:1 ratio bifilar wound transformer, T6, in the collector of the common emitter stage. Received IF signals are applied to the Product Detector stage, on the center tap of trifilar wound transformer T7. The Product Detector is a diode single balanced mixer, with LO drive at 7 dBm provided by the Rx Local Oscillator. Recovered audio is available from the output of the Product Detector stage at the junction of inductor L11 and capacitor C33.

Audio is then coupled into the Audio Pre-Amplifier, the first of three audio amplifier stages. This first stage has a gain of 20 dBv and includes audio shaping with a peak at 750 Hz. Following pre-amplification, the audio is then passed to the Rx Mute stage. This stage uses a P type JFET, allowing the drain and source leads to be at dc ground potential, and the “on” conduction to be controlled by applying a positive signal to the gate. Final amplification of the audio signal occurs in the dual stage, direct-coupled Main Audio Amplifier. This first stage of this 4-transistor amplifier provides gain and phase inversion using a differential pair, transistors Q13 and Q14. The collectors of these transistors then drive the push-pull output stage comprised of transistors Q15 and Q16. Audio is taken from the 8-ohm secondary winding of transformer T10, at a level suitable for driving either a speaker or headphones. Power gain of the Main Audio Amplifier is 80 dB when driving a 16-ohm load.

On the transmit side, signal generation begins with the Transmit Local Oscillator. Its signal feeds the LO port of the Transmit DBM, another ADE-1 commercial mixer, with a 7 dBm level signal. The mixer RF port is driven by an output of the VFO, and set at a level of -3 dBm using a voltage divider comprised of R43 and R44. At this drive level, the mixer is well under its maximum rating, thus minimizing spurious mixing products. Signal output from the mixer IF port is passed through a 3 dB attenuator to provide a constant load condition. The signal, at 10.1 MHz is then coupled to the first stage of the Transmit Cascode Amplifier pair via transformer T8. The secondary of T8 is tuned, and as such, provides attenuation of unwanted mixing products. Additional amplification occurs in the second stage. The primary of transformer T9, in the collector of Q12, is also tuned to further reduce spurious signals. This Cascode amplifier provides some 30 dB of gain, and delivers a clean 10.1 MHz signal to the downstream stages that are untuned. The secondary of transformer T9 drives trim potentiometer TR1, which controls RF power output.

Following the Cascode amplifier is the Transmit RF Driver, which provides another 13 dB of gain. This stage operates in class A, as does the previous Cascode amplifier, to minimize spurious outputs. RF output from the driver is taken from the 2-turn secondary winding of transformer T11. The Transmit Final Amplifier uses a single 2SC2166 device that is packaged in a TO-220 style case. This stage operates in class C, and provides another 16 dB of gain, and a maximum power output in excess of 10 watts when a sufficient heat sink is provided. RF energy is coupled to the Transmit Low Pass Filter via paralleled 0.1 μ F capacitors to minimize self-heating. The low pass filter circuitry transforms the output impedance of the final amplifier transistor from 25 ohms up to 50 ohms, and provides attenuation of harmonic and spurious energy. Figure 3 is an output spectrum plot that shows all spurious energy is at least 50 dB below the main carrier. This plot was generated with the 2N2/30 providing 3.5 watts of output power at 10.125 MHz into a dummy load.

The common VFO is very similar to that used in the 2N2/40. It is a varicap diode tuned Colpitts oscillator, followed by two stages of buffering on the signal output for frequency stability. The varicap diode was changed to a more readily available MV209. With the components selected, the frequency span is from 2.7272 MHz up to 2.7312, resulting in 50 KHz of band coverage. Frequency stability is achieved by using polyester (Mylar) capacitors (C14 and C15) in the feedback network, and NPO capacitors (C11, C12, C13, and C16) at all other critical locations. Frequency drift from a “cold start” to “operating temperature” is less than 500 Hz. The low impedance emitter output of the Colpitts oscillator drives the high input impedance of the first

buffer, Q4, which is configured as an emitter follower. A tuned collector, class-A driver stage follows. The primary of transformer T4 is tuned to resonance to enhance signal purity, while supplying required drive levels to receive and transmit double balanced mixers. Each mixer is driven by its own secondary, and the power level needed for each respective mixer is determined by the number of turns used. The receive output level is set at 13 dBm, allowing for 6 dB of attenuation ahead of the receive mixer LO port, to achieve 50 ohm impedance loading on this port. In like manner, the 1 dBm transmit output is passed through a resistive divider to lower the signal by 4 dB, and place a 50 ohm load on the RF port of the transmit mixer.

Construction Overview

As all of the 2N2/XX rigs have been, the 2N2/30 is built using Manhattan-style construction techniques. The reader is assumed to have knowledge of this building method. Each new design by the author attempts to create a learning environment, where new circuits or building methods are explored. In this design, the generous use of surface mount parts in a “Manhattan environment” met that objective. In addition, some new “packaging” ideas were successfully implemented. Those will be highlighted as we proceed.

Most of the construction documentation will be provided by means of images taken as construction proceeded. These images impart far more information than one can provide with words. Comments will be used to point out salient details, which might not be obvious.

Figure 4 shows the first part of the 2N2/30 that was built. This small subassembly contains the Receive T/R Switch, RF Gain control, and Rx Input Band Pass Filter. It is approximately 1.25 X 1.625 inches in size, and designed to be mounted to the front panel via the RF Gain control, POT1. It came out really well for a prototype, and this concept will be reused in other rigs. Transformers T1 and T2 are wound with #28 magnet wire, and mounted by their leads. This is the largest wire gauge that can be used and still get the required number of turns on the size 6 core. Surface mount capacitors are used for C2 and C3. Note that the mounting pads are 1/32-inch thick PC board material. Pads of this thickness were used through out the rig. Miniature coax with connectors handle the input and output signals.

The remaining 2N2/30 circuitry is built on a 5 X 7 inch substrate. This size was chosen for ease of construction by new builders. After the substrate was cut to size, it was marked off into areas sufficient in size to contain the components needed for each major section. Knowing how large each area should be comes with building experience. Power and signal wiring is routed in the “galley areas” between sections, as has been done on past designs.

Figure 5 shows the completed VFO section. Construction started at the output stage, Q4 with its components, progressed through Q3, and then Q2 with its components. Diodes D4 and D5 with their associated components were the last to be added. Transformer T4 and inductor L3 were wound with #26 magnet wire. Inductor L3 is mounted to the PC board substrate with #8 size nylon shouldered washers on either side, and held in place with a 4-40 nylon screw, threaded into the substrate. Note the liberal use of surface mount resistors and capacitors. These save space, and are actually easier to work with than leaded parts, once one is accustomed to handling them. The next piece of circuitry to be built was the Receive RF Amplifier. SMT parts were again used to advantage. Transformer T3 was wound with #26 magnet wire and mounted by its leads. With

this stage, keeping leads short enhances amplifier stability. A mating input connector for the Rx Input BP Filter assembly was added later so is not shown in this image.

The Rx Mixer, an ADE-1 surface mount part, was then soldered to a 6-pin header, and glued to the substrate. Both attenuators were then added, as well as connections to the VFO and Receive RF Amplifier. This construction is shown in Figure 7.

Figure 8 shows the next section to be built. This group of components is the Post-Mixer Amplifier and 4 Pole Crystal Filter. They were built in that order, with the amplifier first, and the crystal filter after that. Using SMT capacitors in the crystal filter made this section easier to build than when using larger, leaded parts. Note that optional inductors shown across each crystal in the schematic were not used, as they were not available at the time of construction. When available, they will be added.

The IF Amplifier stage was then built. It is shown as figure 9. Fewer SMT parts could be used here, due to the layout needed. Transformer T5 was wound with #26 magnet wire and mounted by its leads. Bifilar transformer T6 was wound with two parallel strands of #28 magnet wire, and lead mounted also. For stability, these two transformers should be separated as much as possible.

Figure 10 shows the configuration of the Product Detector. Transformer T7 was wound with #28 magnet wire and mounted by its leads. The trifilar winding was done with parallel leads, to assess if this winding method could be used. It works fine, but is not recommended for the beginner. Twisting the three wires together, at 6-8 turns per inch before winding, will make the winding task much simpler. Using a different color for each wire will simplify the final connection process. Except for diodes D9-D12, and inductor L11, all remaining parts are SMT.

The Receive Local Oscillator was built next. That is shown in figure 11. This section is another where SMT parts were used sparingly due to the circuitry layout. Note this section's proximity to the Product Detector, which it feeds.

Figure 12 shows the layout of the Audio Pre-Amplifier. It was also built with standard leaded parts due to layout considerations. A short length of shielded cable carries the audio signal to this circuitry from the Product Detector stage. Diodes D16-D17, which are actually part of the Rx Mute circuitry, are shown in this image. They were later moved to the Rx Mute circuitry to avoid confusion for other builders.

The Main Audio Amplifier section followed the Pre-Amplifier. They were built in that order so the receiver could be used and evaluated, which does not require the Rx Mute circuitry. Additionally, the circuit for doing the Rx muting had not been defined and modeled. This stage is shown as Figure 13. Construction started on the rear edge of the board with the mounting of transformer T10, and proceeded toward the input to this stage. Circuit layout again dictated the use of leaded components.

At this point, a complete receiver had been constructed, minus the Rx Mute circuitry. Figure 14 shows the 5 X 7 substrate now populated with an essentially complete, and operable receiver.

The first stages of the transmit section to be constructed were the Transmit Local Oscillator followed by the Transmit Mixer. With the circuitry of the transmit LO being identical to that of the Rx LO, building is uncomplicated, since the same general layout can be followed. The transmit mixer, another ADE-1, also used a 6-pin substrate for mounting. A piece of RG-174 coax carries the VFO signal to the voltage divider comprised of R43 and R44 on the RF input port of the mixer. Figure 15 shows this completed circuitry.

Figure 16 shows the layout of the Transmit Cascode Amplifier. This circuitry was built with leaded components except for the power and bias bypass capacitors. Both transformers, T8 and T9, were wound using #28 magnet wire and mounted by their leads. As was suggested with the receive high gain IF amplifier stage, separating T8 and T9 as much as possible will improve stability. Missing from this image is drive control trim potentiometer TR1, which was added before moving on to the driver stage.

The Driver Stage uses all leaded parts except for the power and emitter bypass capacitors. Note the transistor is a metal 2N2222A, which requires a heat sink during operation. Transformer T11 is wound with #26 enamel wire and mounted by its leads. Figure 17 shows the layout for this stage.

The next stage to be built was the Transmit Final Amplifier, using the 2SC2166 transistor. This stage is shown in Figure 18. Most important when building the final amplifier is to keep leads as short as practical, which improves stability. For this section, another small substrate was used, allowing a different final amplifier layout to be substituted. The smaller substrate was glued to the main substrate with 4 very small drops of superglue, one in each corner. It is grounded to the main substrate by a soldered brass strip along part of the left rear edge. Inductor L16 is wound with #24 enamel wire, and mounted by its leads. Inductors L17 and L18 are wound with #26 enamel wire, and lead mounted also. Numerous surface mount capacitors are employed, including a stacked pair of 0.1 μ F units for C75-C76, which are hidden behind L16. A small heat sink will suffice when running low power, under 3 watts, but a much larger heat sink is required at full output capability.

With the transmit section essentially complete, it was time to go back and add the missing Receive Mute circuitry. Figure 19 shows that stage. Here, a mixture of leaded and SMT parts could be used. Note that diodes D16-D17 are now where they belong. Volume control, POT3, connects from the output of this circuitry to the input of the Main Audio Amplifier.

Figure 20 shows the last stage to be built on the main substrate, the very simple Receive/Transmit Switch. A metal 2N2907 is used here, but a plastic PN2907 would work just as well.

A workable 2N2/30 rig was packaged and used for several weeks before the RIT circuitry was finally designed, constructed, and installed. Figure 21 shows the completed 2N2/30, except for the RIT subsystem, before it went into a case.

Adjustable Span RIT circuitry is contained on 2 small substrates. The first, Part A, contains the circuitry for the frequency offset control, constructed on a 1 X 1.125 inch substrate. All of the

components except for potentiometer POT4 and the 2N7000 are SMT. This board is mounted to the front panel using the potentiometer's threaded shaft. Figure 22 shows that assembly.

The remaining circuitry, Part B, containing the frequency-offset components is mounted on another small substrate measuring 0.5 X 0.75 inches. This small substrate is affixed to the main substrate, adjacent to the VFO circuitry as Figure 23. A circuit partitioning scheme was used that placed the frequency sensitive components in close proximity to the VFO, so that frequency shifts due to temperature and stray lead capacitance would be minimized. All of the components used were SMT except trimmer capacitor TC10.

Installing the completed 2N2/30 into a suitable case is dictated mostly by personal preference. TenTec makes a very complete line of aluminum cases, both in unfinished and finished. Their TP-47 model will easily handle the 5 X 7 inch main substrate, and has ample height for mounting the various controls, especially if the larger Bourns or equivalent multi-turn dial is used. This case is the same one used for the 2N2/40+, the rig built for the winter 1998 QRPp article.

The final two images, Figures 24-25, are of the completed 2N2/30 in a TenTec TP-47 case. No case painting has been done, as this is outside work, and the rig was completed in late November 2002. Worth noting in these images is the method used to heat sink the 2SC2166 output transistor. A "U" shaped bracket was bent out of 0.75-inch wide, 0.025-inch thick copper stock. It is bolted to the tab of the final transistor, and the inside rear of the case. Excellent heat transport results, moving the heat in the final transistor to the rear case. With this arrangement, no perceptible temperature rise occurs on the transistor or case during extended key down conditions.

Final Comments

Building a 2N2/30 isn't as complicated as it might appear on the surface, nor difficult to get running, especially if it is built correctly. However, a few suggestions might be in order. First and foremost, don't be intimidated by the number of schematic pages, nor the parts list. The schematic was broken into several pages to preserve clarity. As for the number of parts, if one only looks at those required for a stage, those numbers are quite manageable. When the rig is being built, use the image figures only as a guideline, not the way *it has to be done*. Manhattan-style construction allows great latitude in parts placement without affecting performance. Go slowly, building, then testing, a stage at a time. If test equipment is limited, don't give up. The rig can be completely aligned with signals off the air.

Finally, if you have never built a rig from scratch, do it! There is nothing that compares to starting out with a pile of lowly parts, some solder, a few hours here and there, and transforming those into a high performance thing of beauty that listens, talks, and reflects the builders unique personality and skills.

As always, kudos to my wife and best friend Kathy, KB8IMP, who puts up with all my hobbies, especially the ham radio related designing, building, digital imaging, and writing.

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Figures

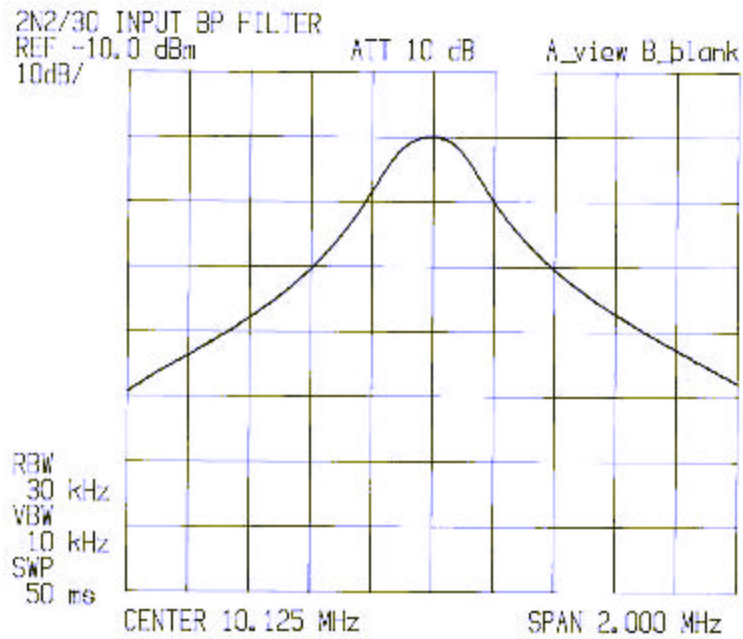


Figure 1
Receive Input Band Pass Filter

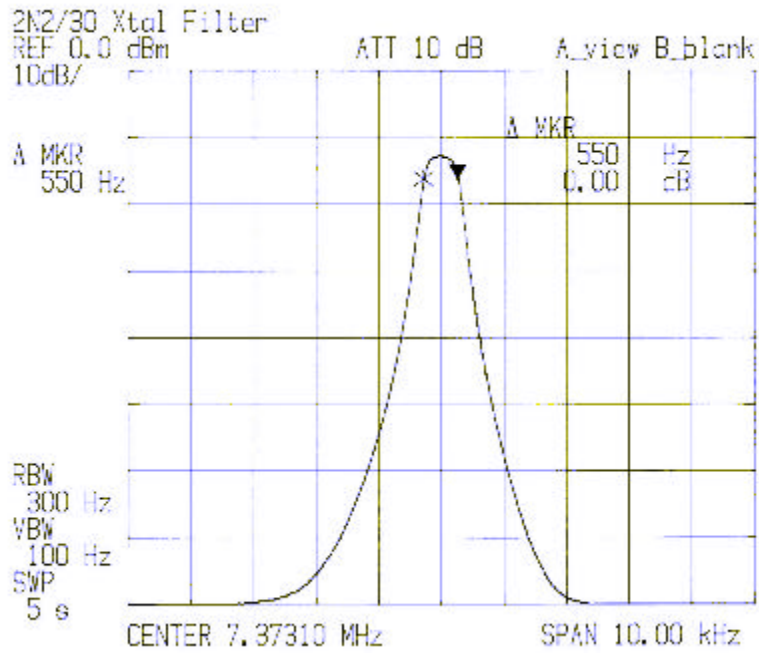


Figure 2
Receive Crystal Filter

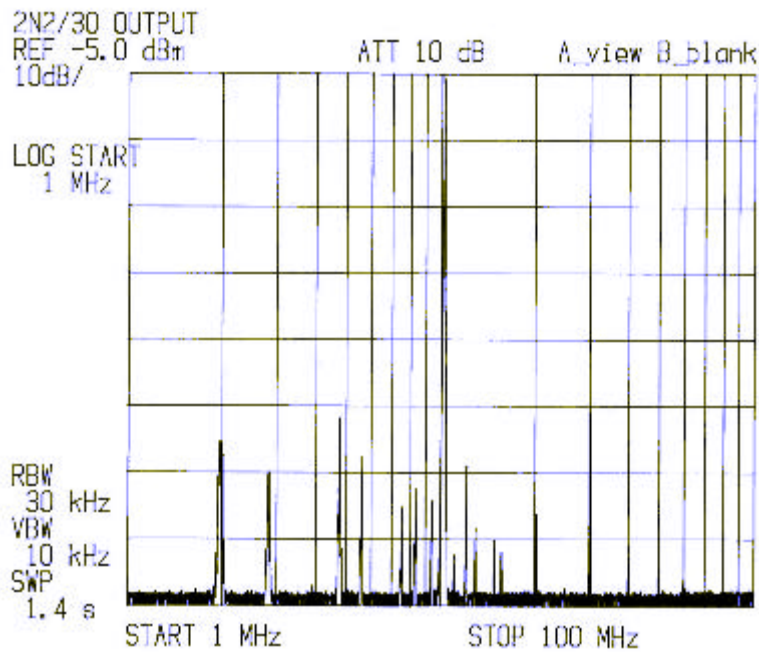


Figure 3
Transmit Output Spectrum

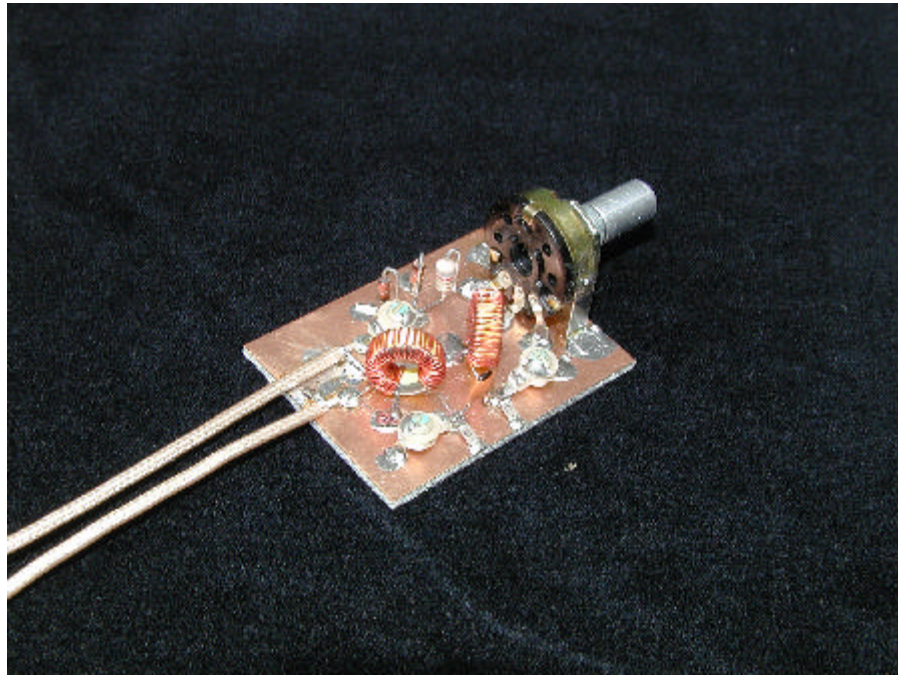


Figure 4
Receive T/R Switch, RF Gain, & Input BP Filter

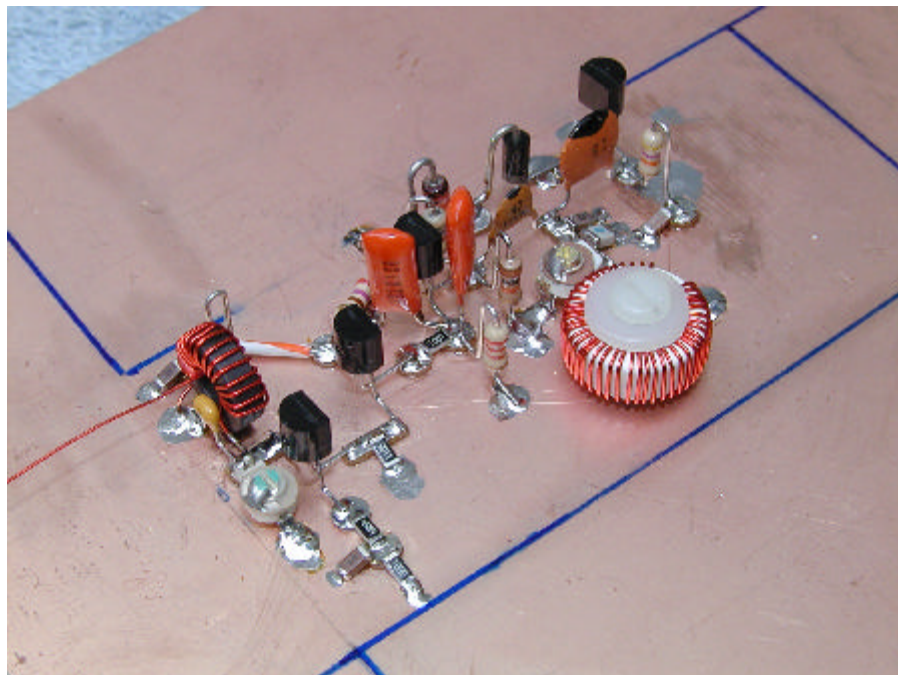


Figure 5
Varicap Tuned, Buffered VFO

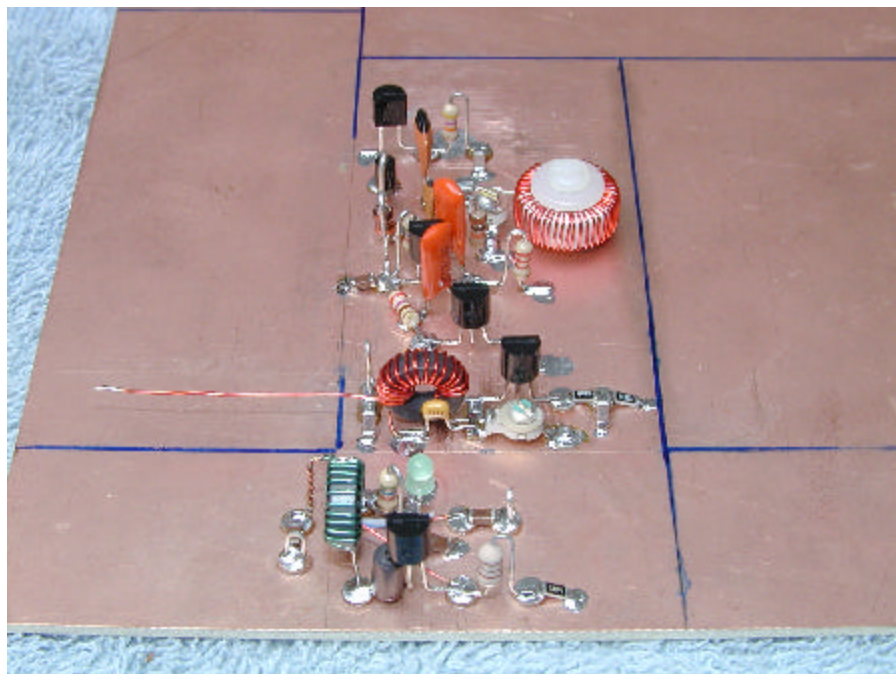


Figure 6
Receive RF Amplifier

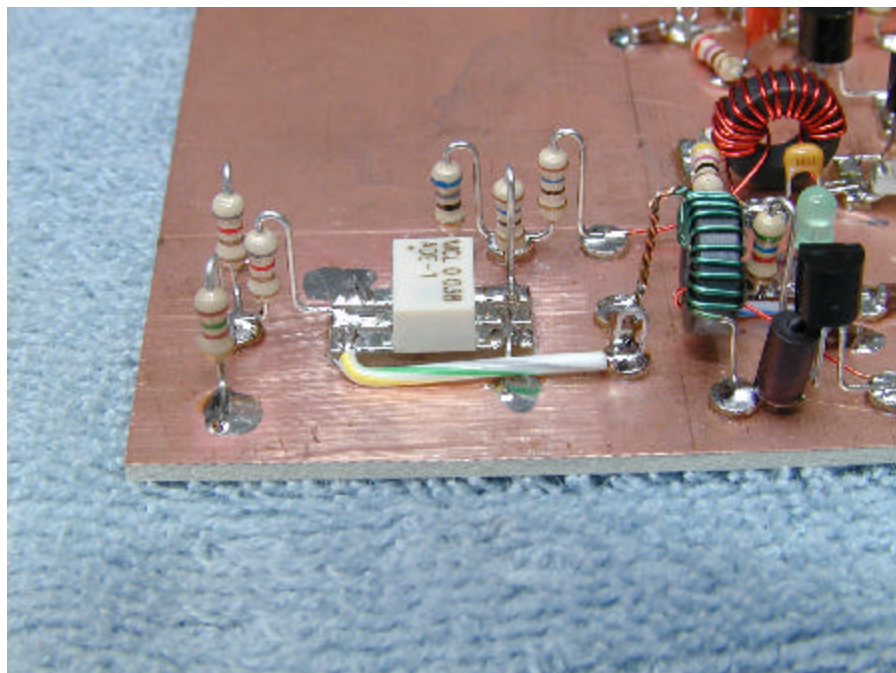


Figure 7
Receive Mixer

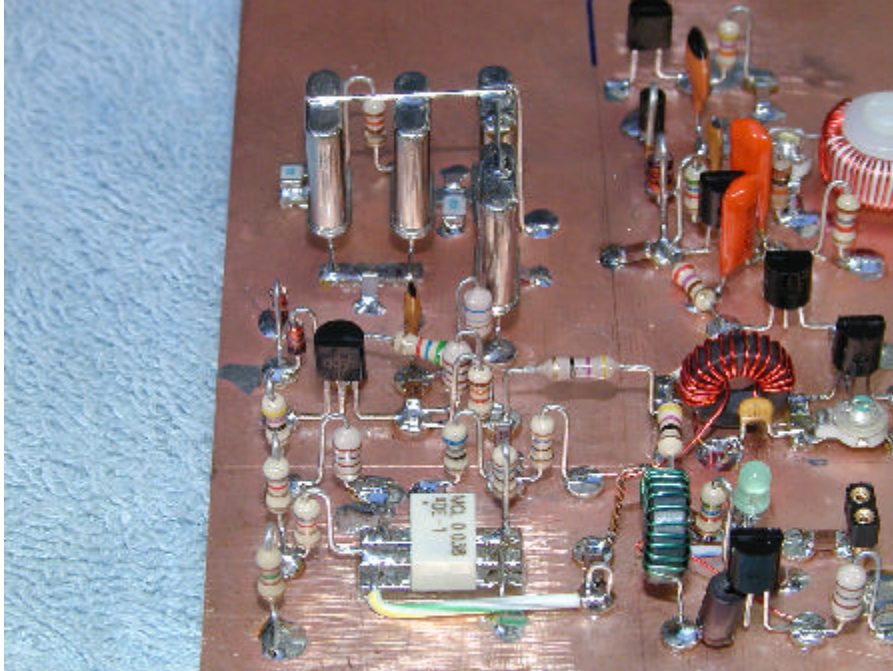


Figure 8
Receive Post-Mixer Amplifier & 4 Pole Crystal Filter

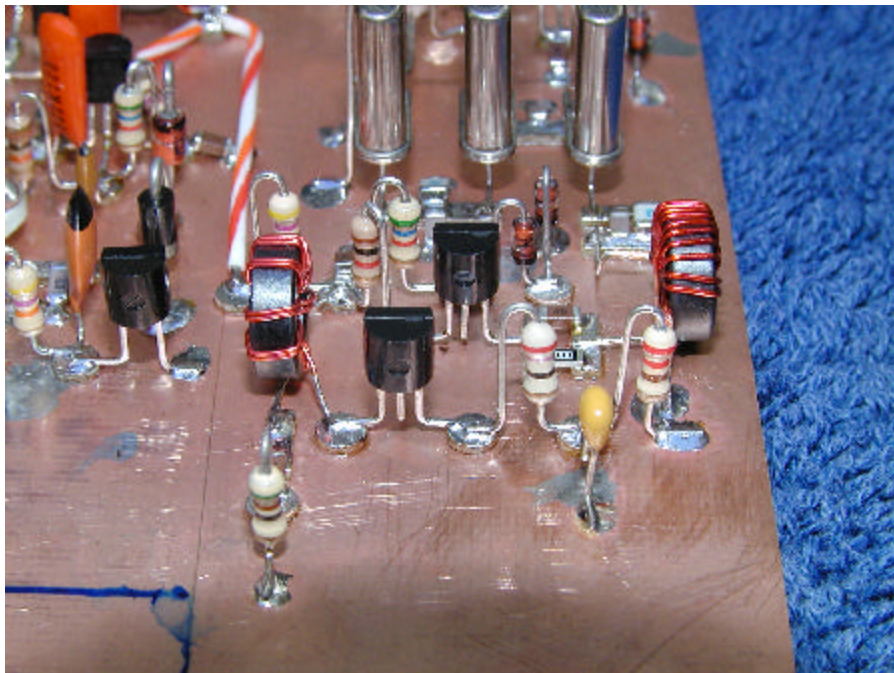


Figure 9
Receive IF Amplifier

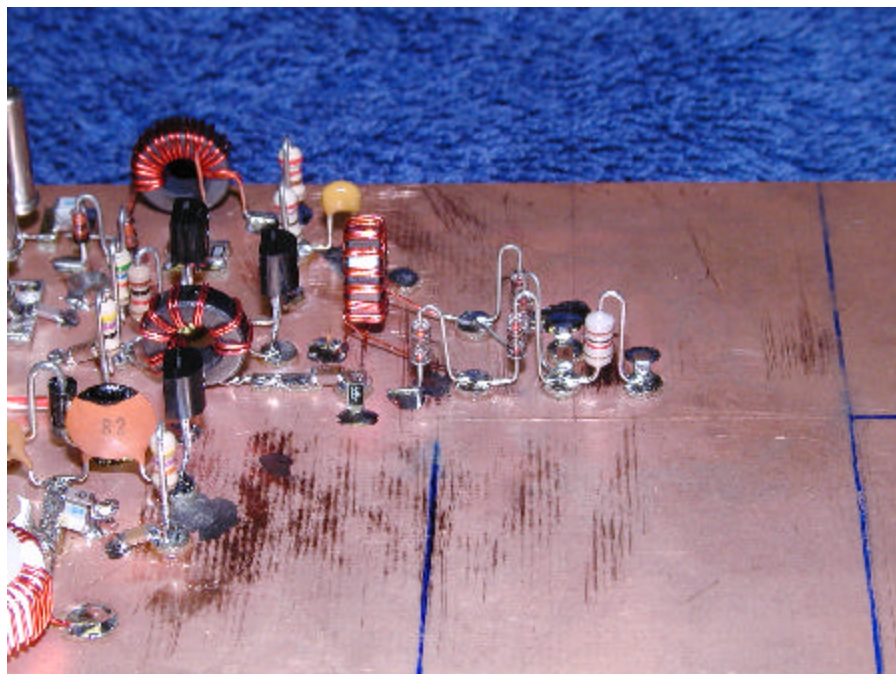


Figure 10
Receive Product Detector

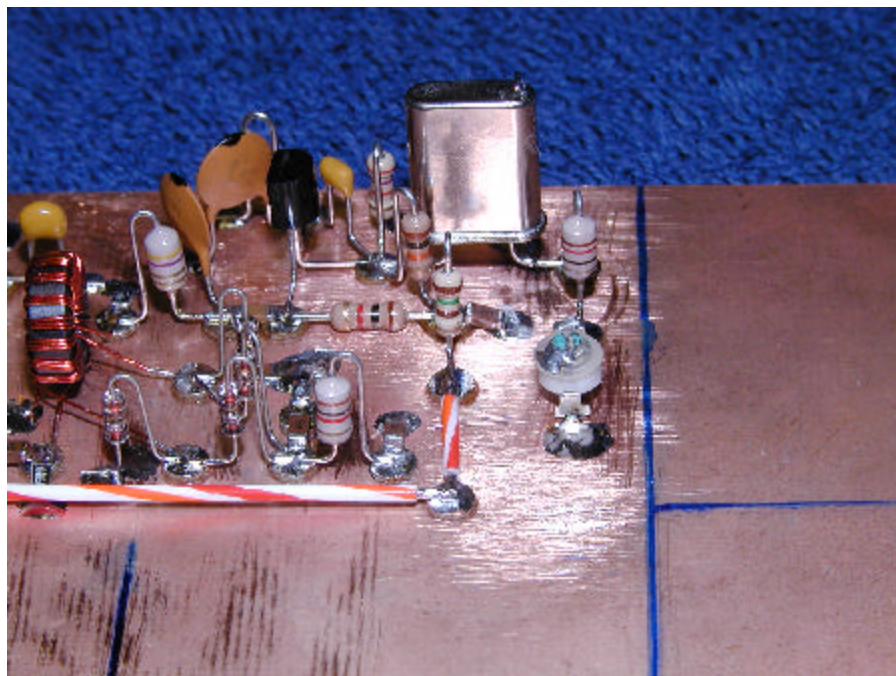


Figure 11
Receive Local Oscillator

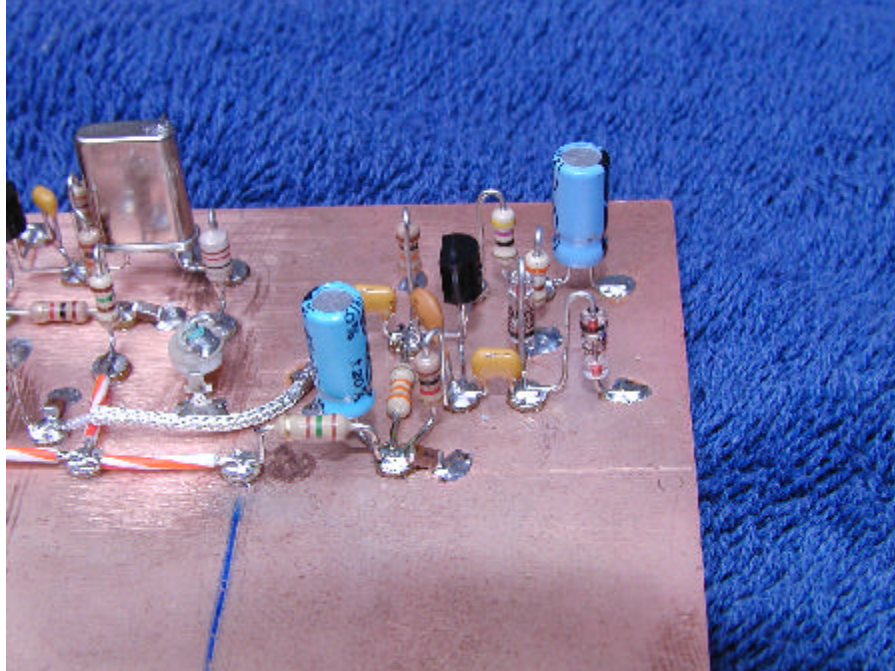


Figure 12
Receive Audio Pre-Amplifier

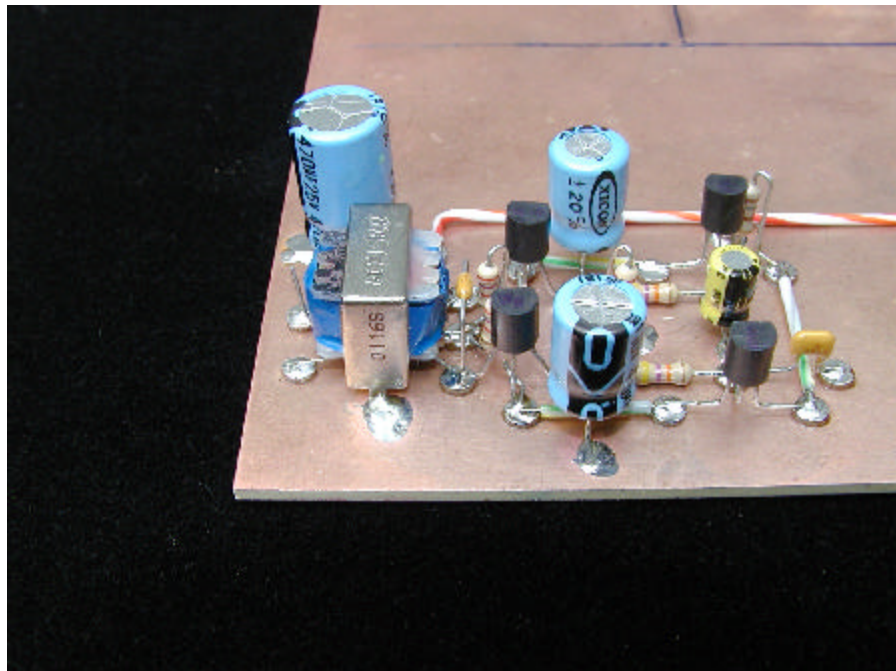


Figure 13
Receive Main Audio amplifier

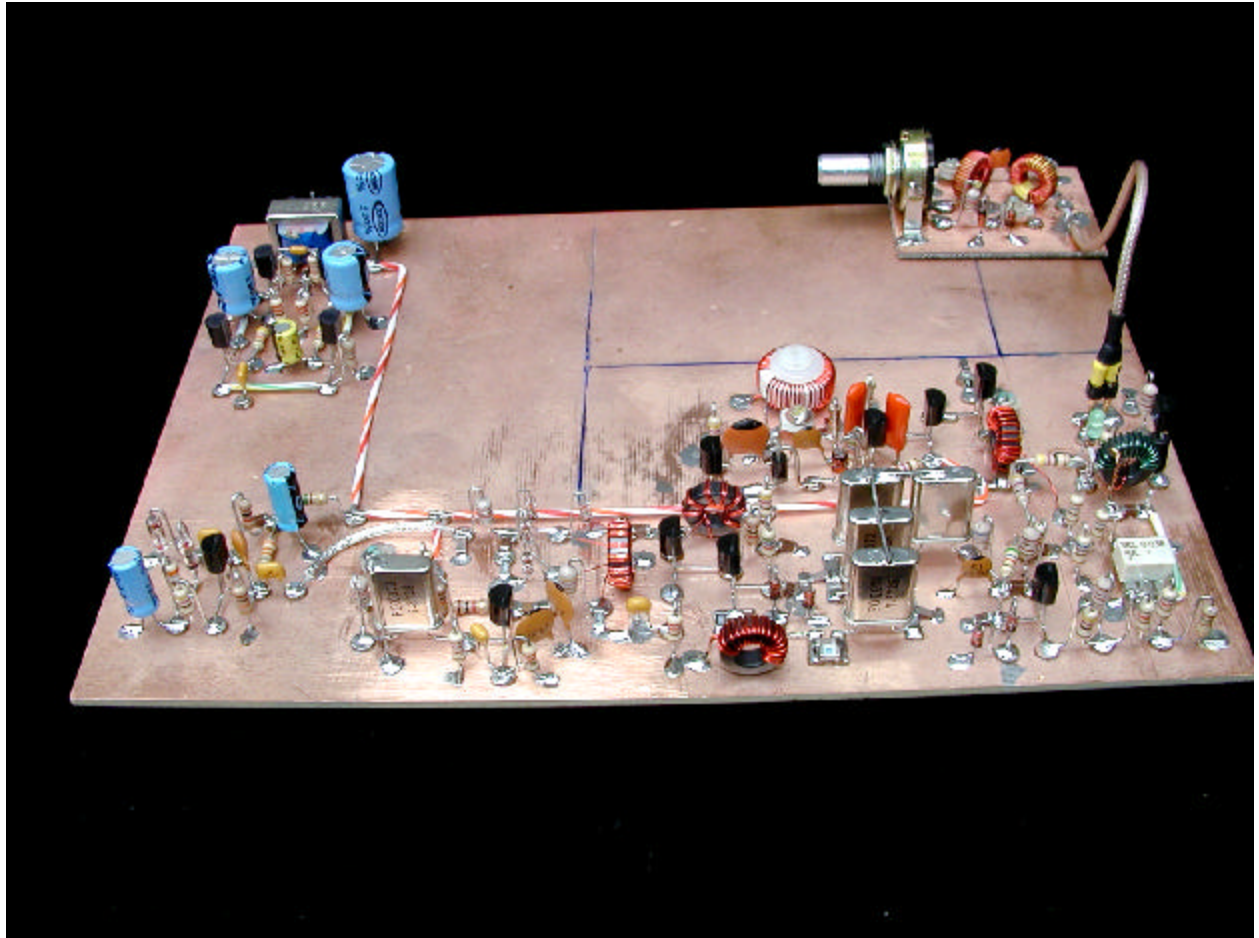


Figure 14
Receiver Overall

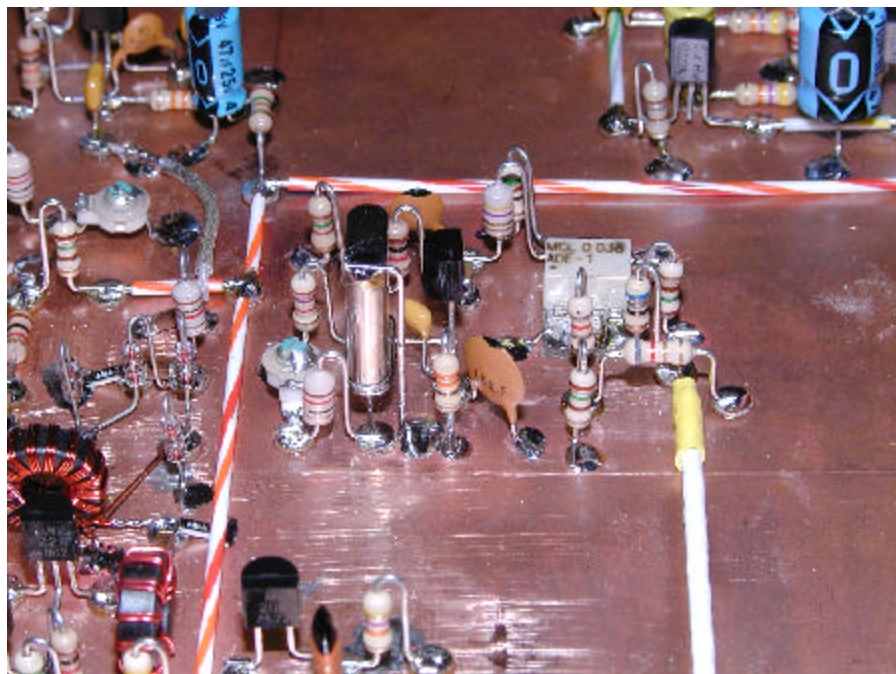


Figure 15
Transmit Local Oscillator & Transmit Mixer

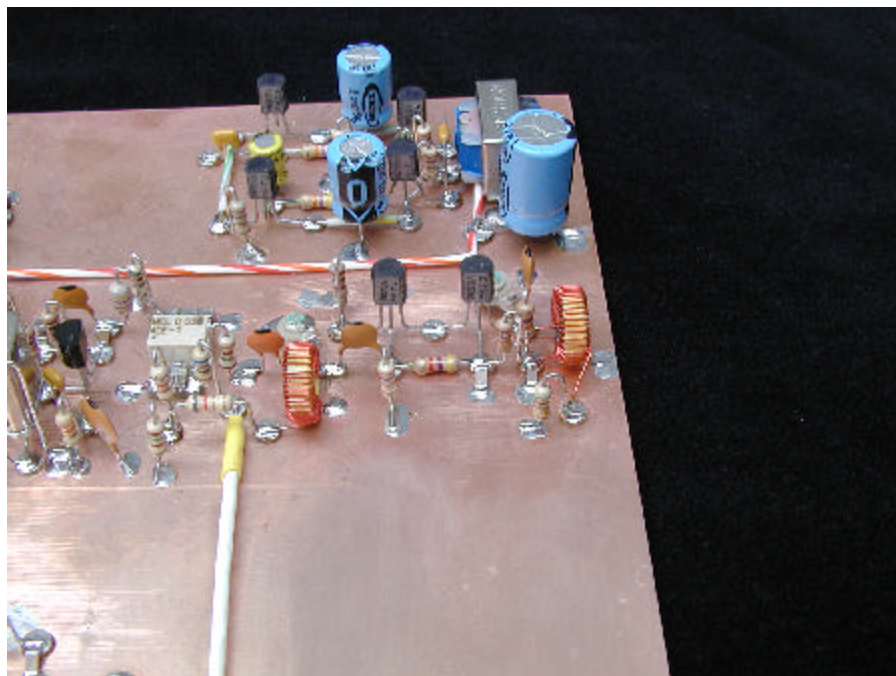


Figure 16
Transmit Cascode Amplifier

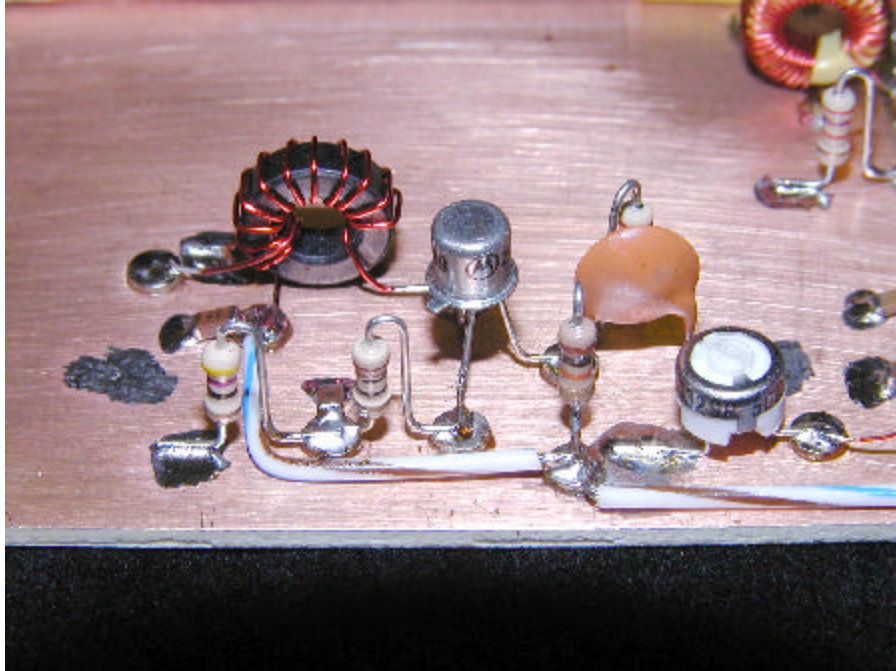


Figure 17
Transmit Driver

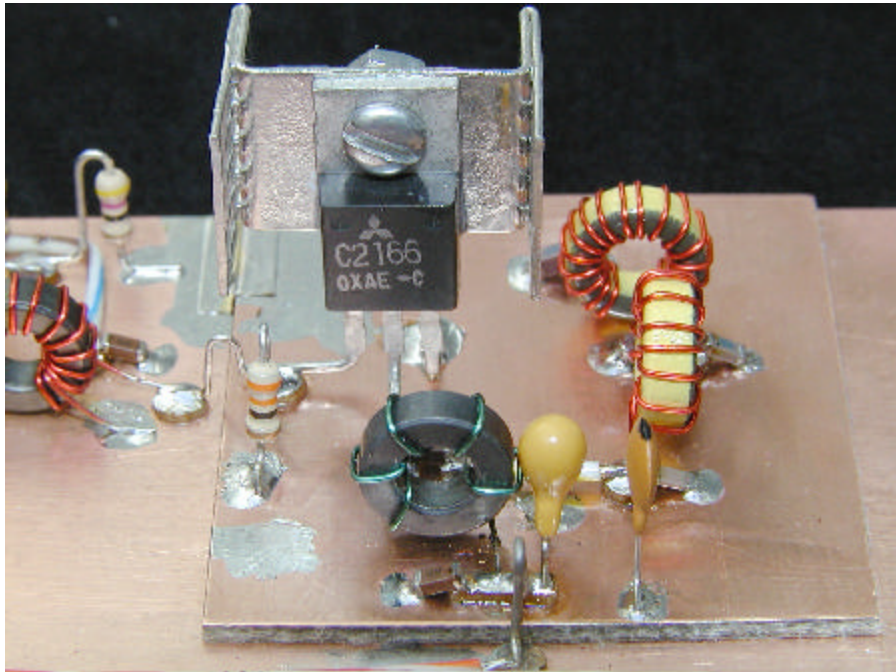


Figure 18
Transmit Final Amplifier

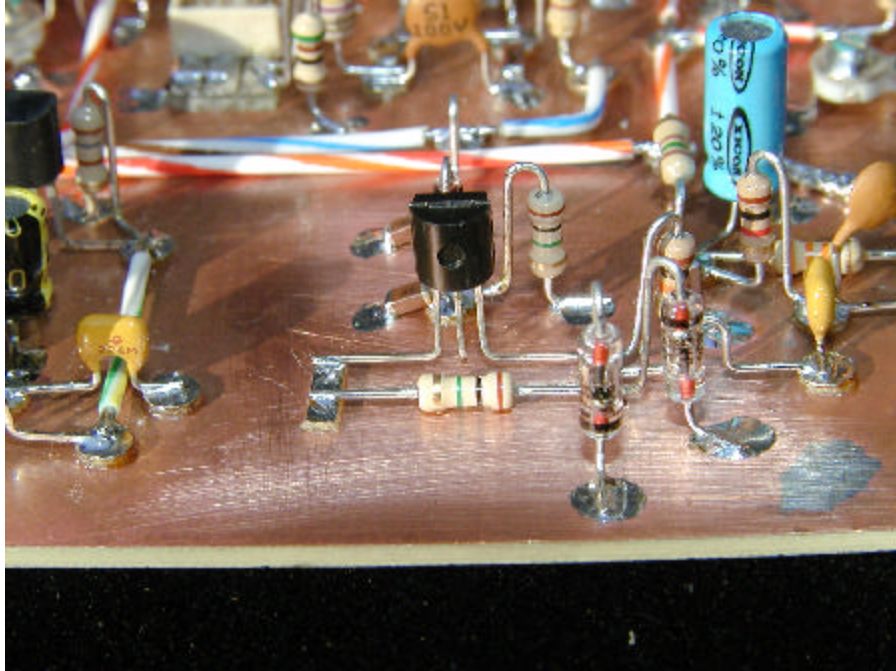


Figure 19
Receive Mute

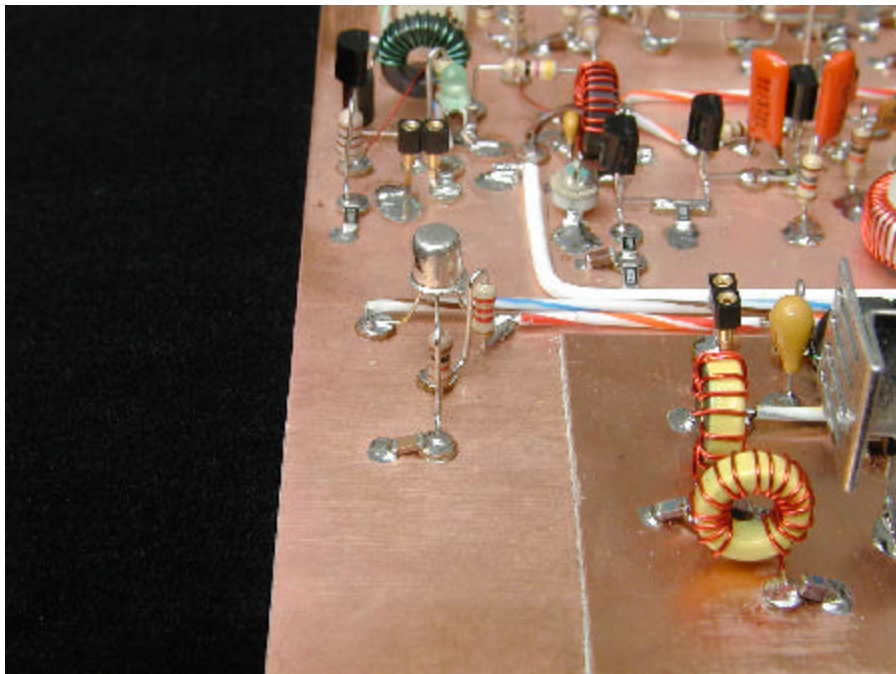


Figure 20
Receive/Transmit Switch

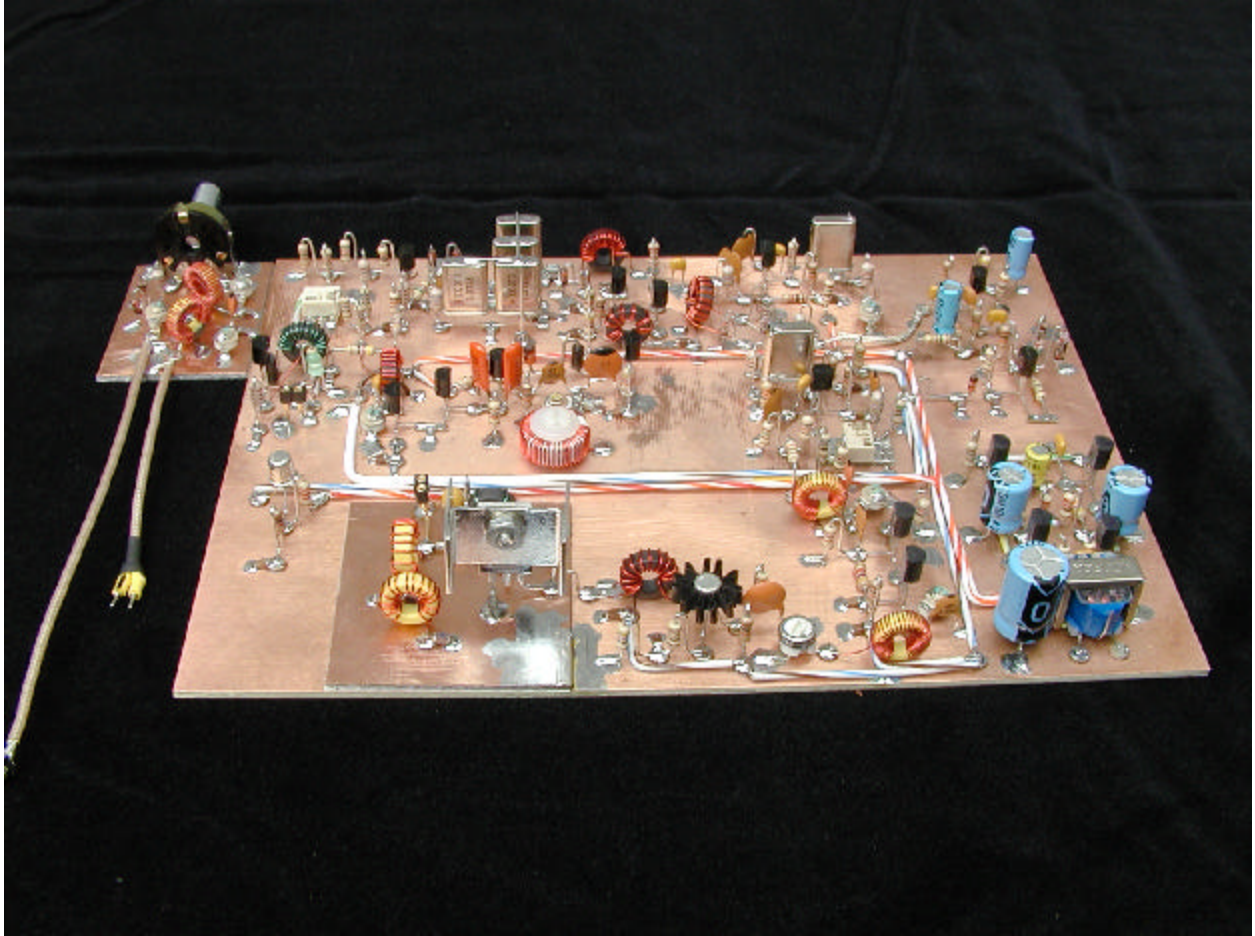


Figure 21
Completed 2N2/30 except RIT

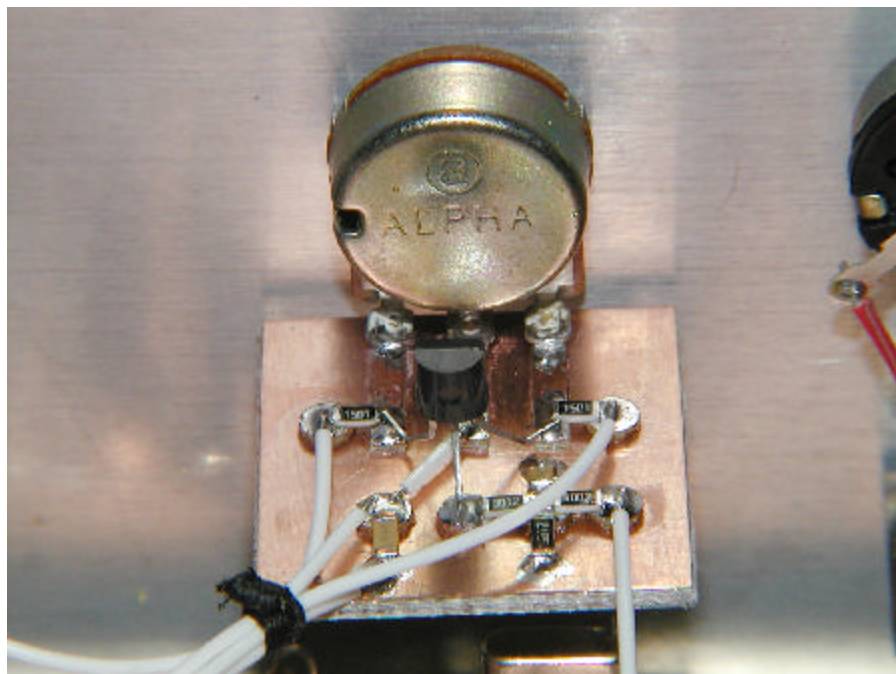


Figure 22
RIT - Part A

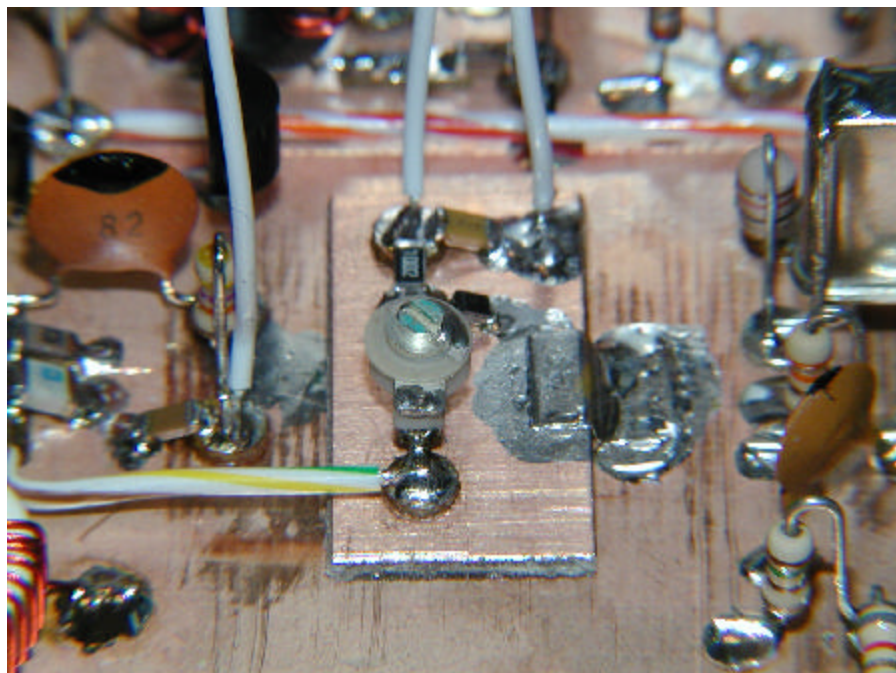


Figure 23
RIT - Part B

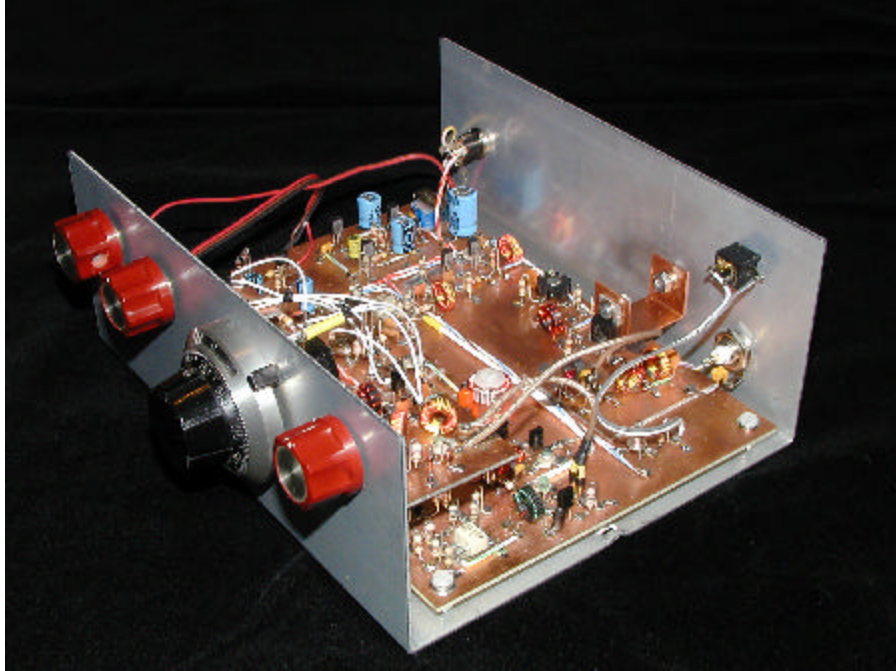


Figure 24
Completed 2N2/30 In Case-1

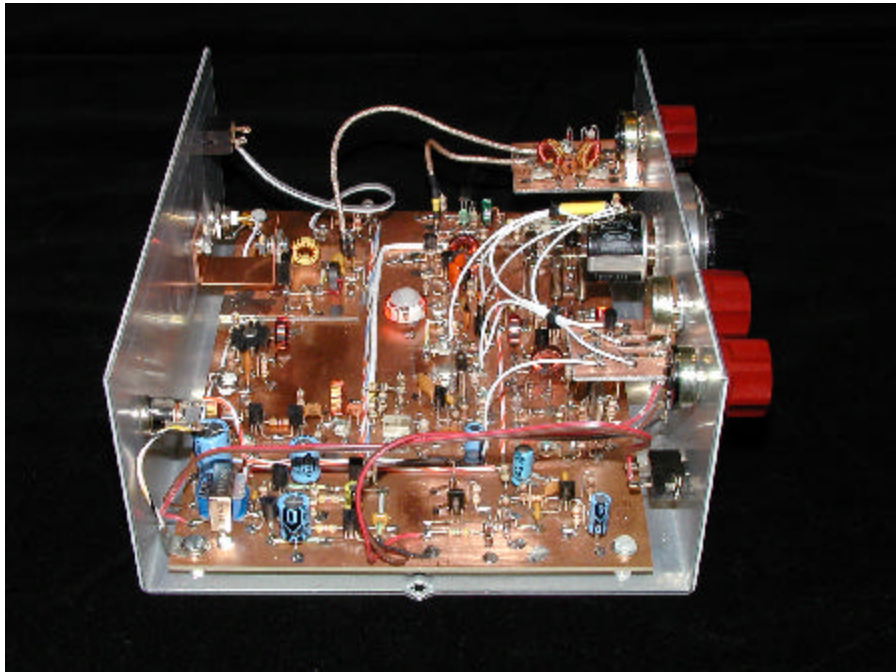


Figure 25
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Figure 25 – Completed 2N2/30 In Case-2, PB250007.JPG

2N2/30, A 30 Meter CW Transceiver

Designed by: Jim Kortge, K8IQY

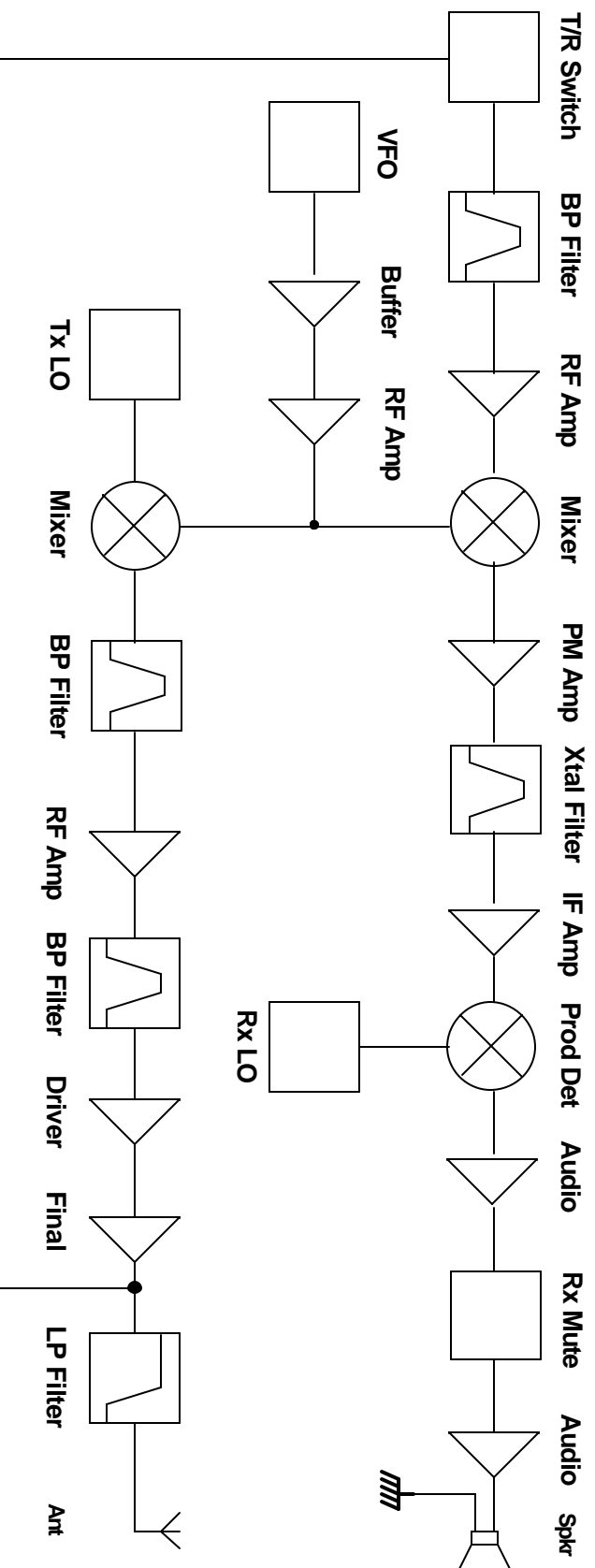
	1.5	1.5	1.5	1.5	1.0	
Rx Main Audio Amp	Rx Audio Mute	Tx Cascade Amp	Tx Driver	Tx Final	Rx/Tx Switch	2.0
		Tx Mixer	VFO	Rx RF Amp	Rx RF Amp	1.5
	Tx LO					
Rx Audio Pre-amp	Rx Audio Pre-amp	Prod Det	Rx IF Amp, Xial Filter, & Post-mixer Amp	Rx Mixer	Rx Mixer	1.5
						Rx LO

2N2/30 Substrate Layout

2N230HA.SCH; 04/05/2003

2N2/30, A 30 Meter CW Transceiver

Designed by: Jim Kortge, K8IQY

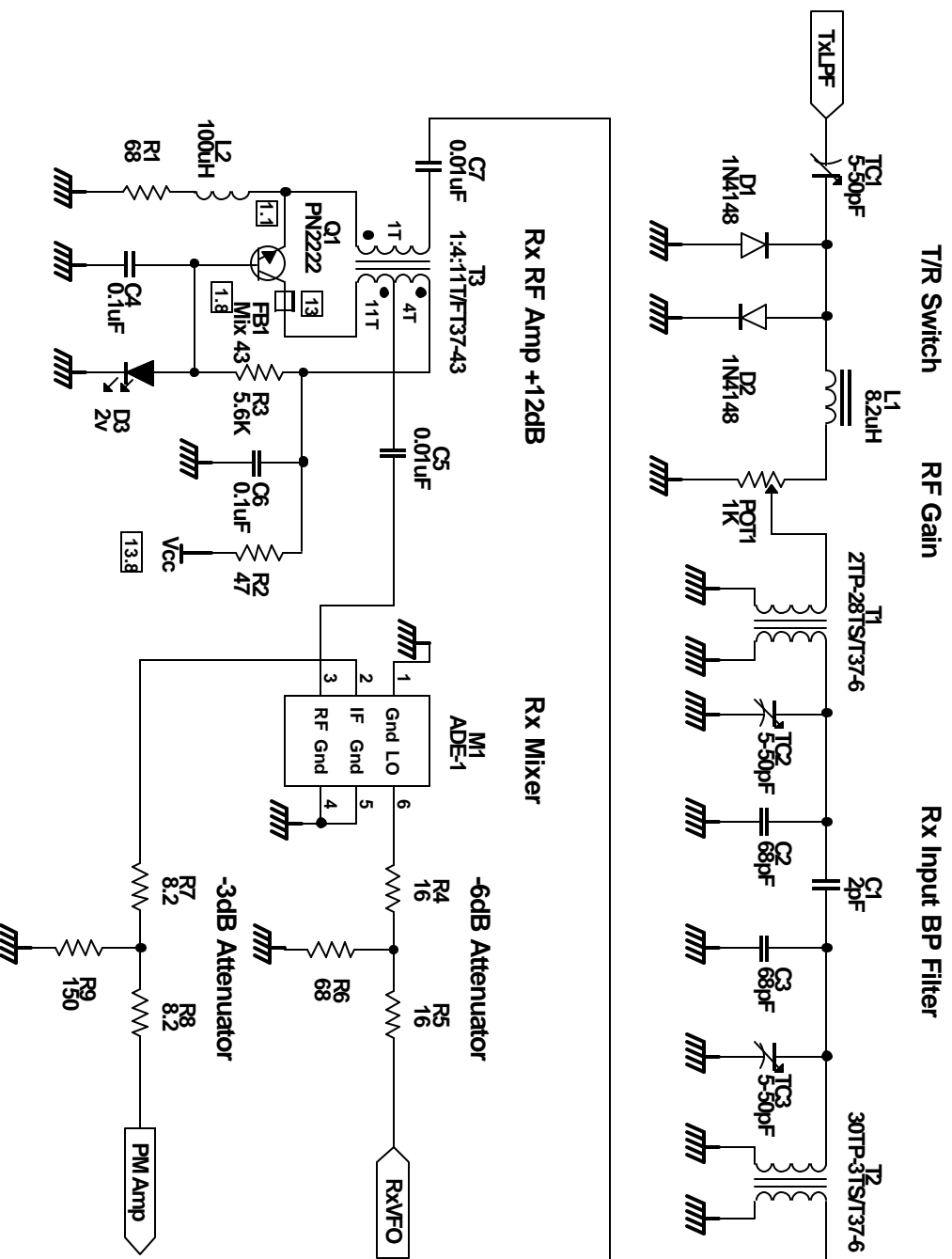


2N2/30 System Block Diagram

2N230GA.SCH; 04/05/2003

2N2/30, A 30 Meter CW Transceiver

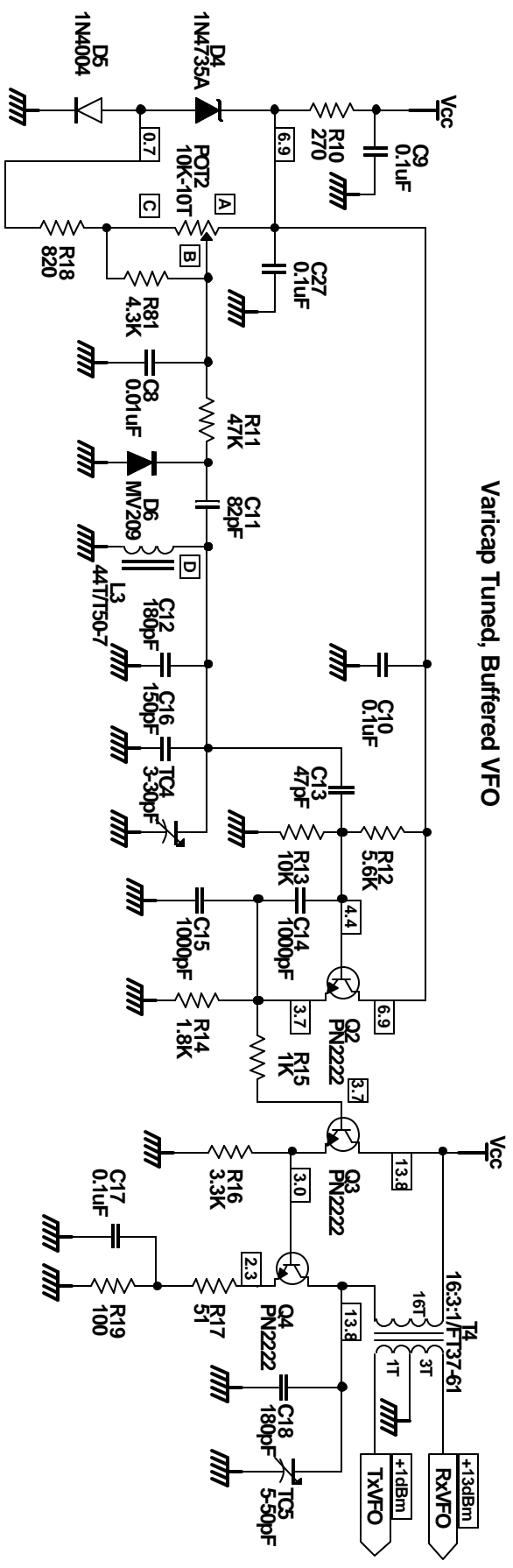
Designed by: Jim Kortge, K8IQY



2N2/30, A 30 Meter CW Transceiver

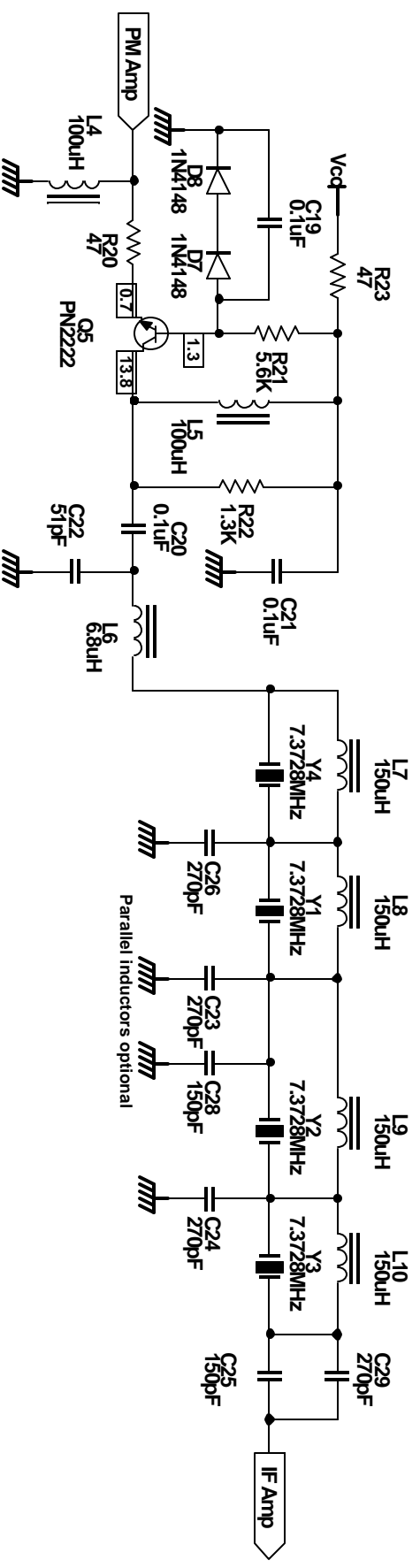
Designed by: Jim Kortge, K8IQY

Varicap Tuned, Buffered VFO



Post-Mixer Amp +9dB

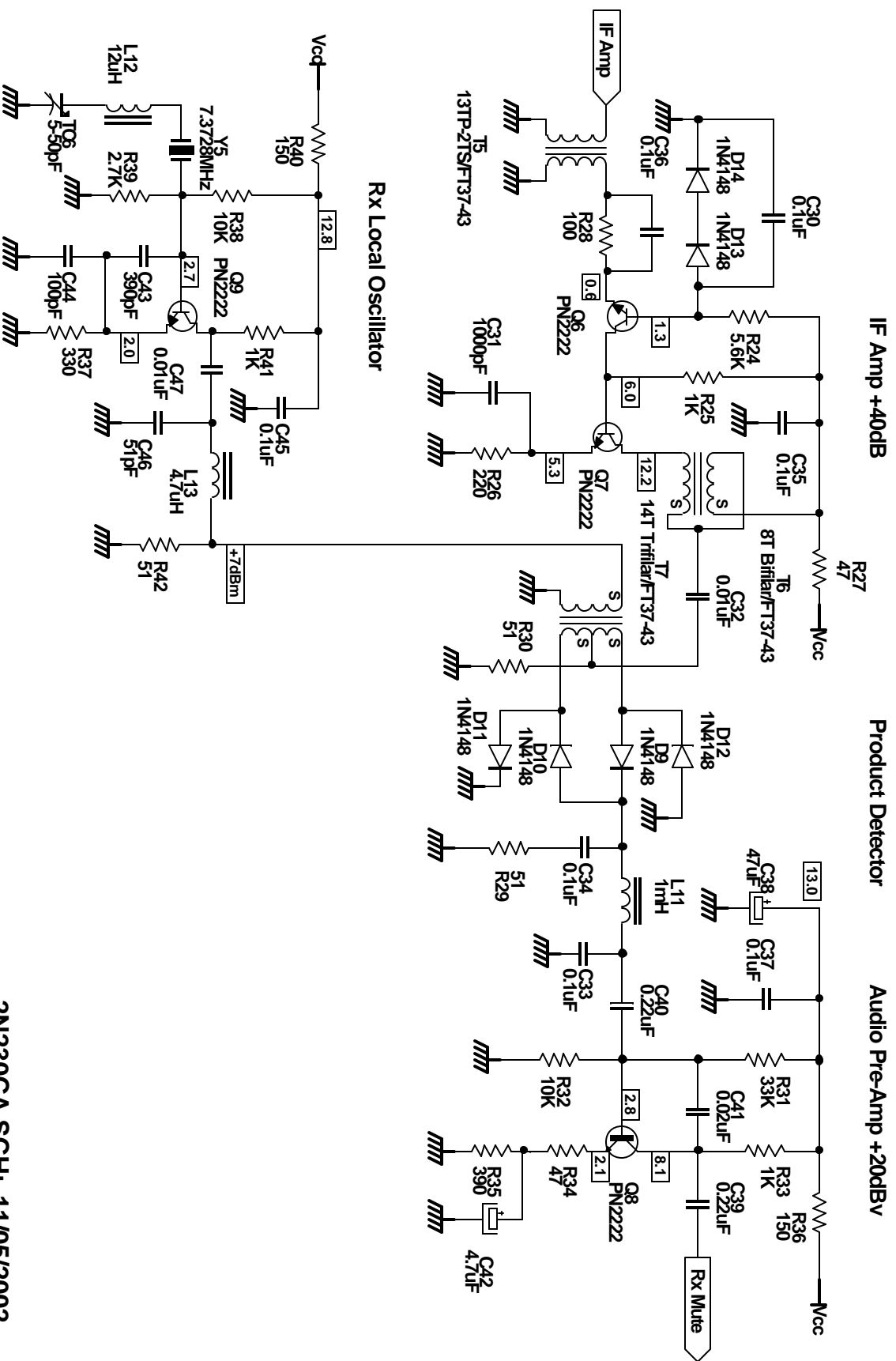
4 Pole, 500Hz Xtal Filter



2N230BA.SCH; 12/18/2002

2N2/30, A 30 Meter CW Transceiver

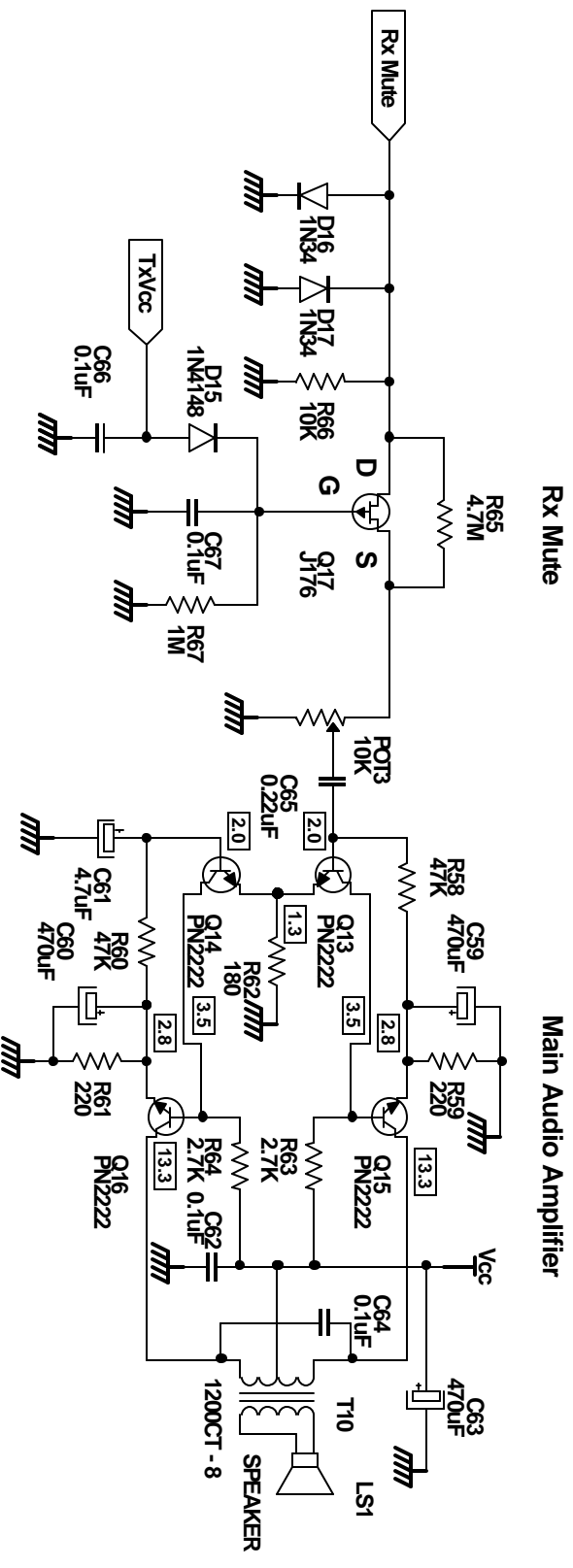
Designed by: Jim Kortge, K8IQY



2N230CA.SCH; 11/05/2002

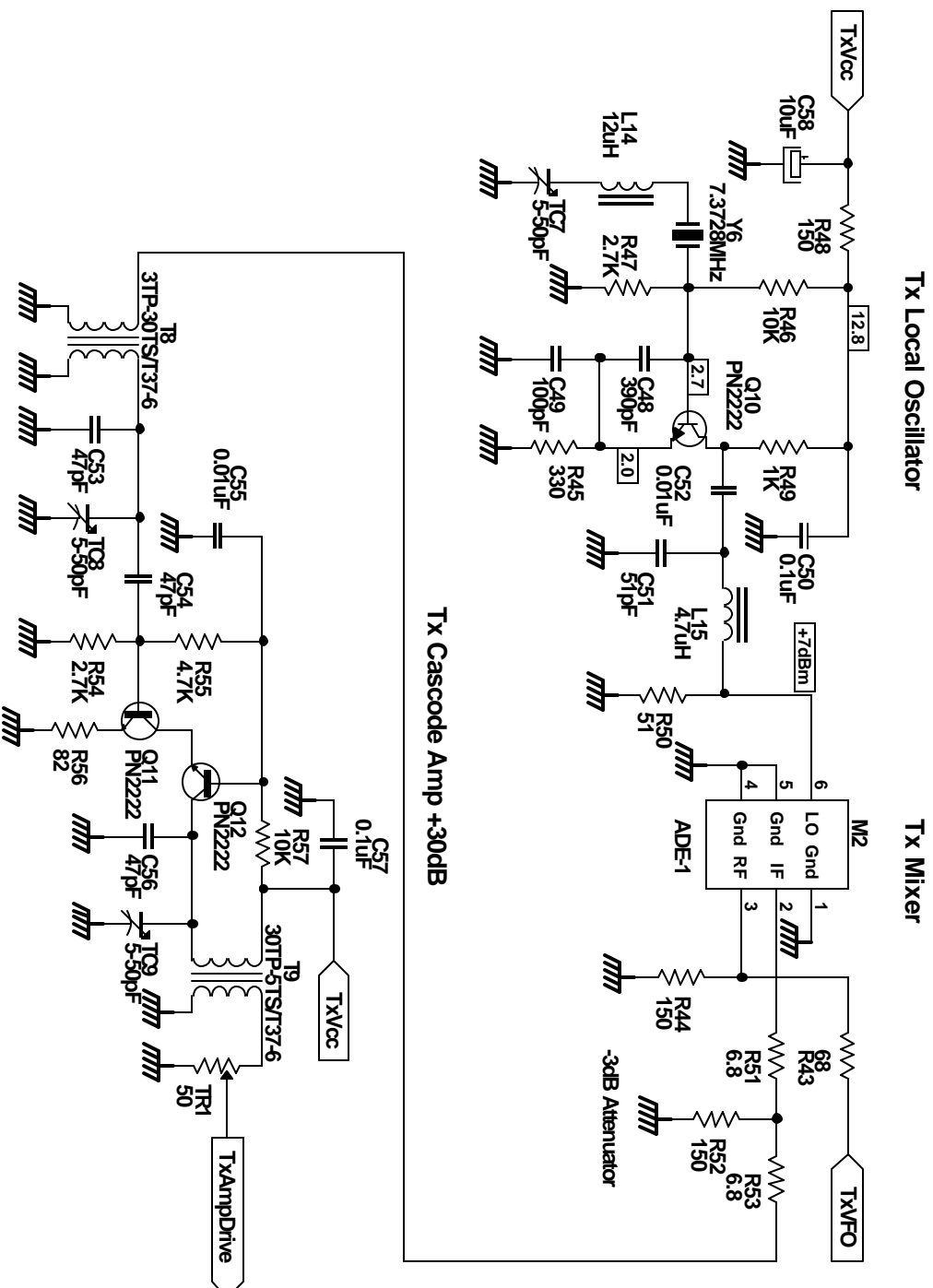
2N2/30, A 30 Meter CW Transceiver

Designed by: Jim Kortge, K8IQY



2N2/30, A 30 Meter CW Transceiver

Designed by: Jim Kortge, K8IQY



2N230EA.SCH; 12/18/2002

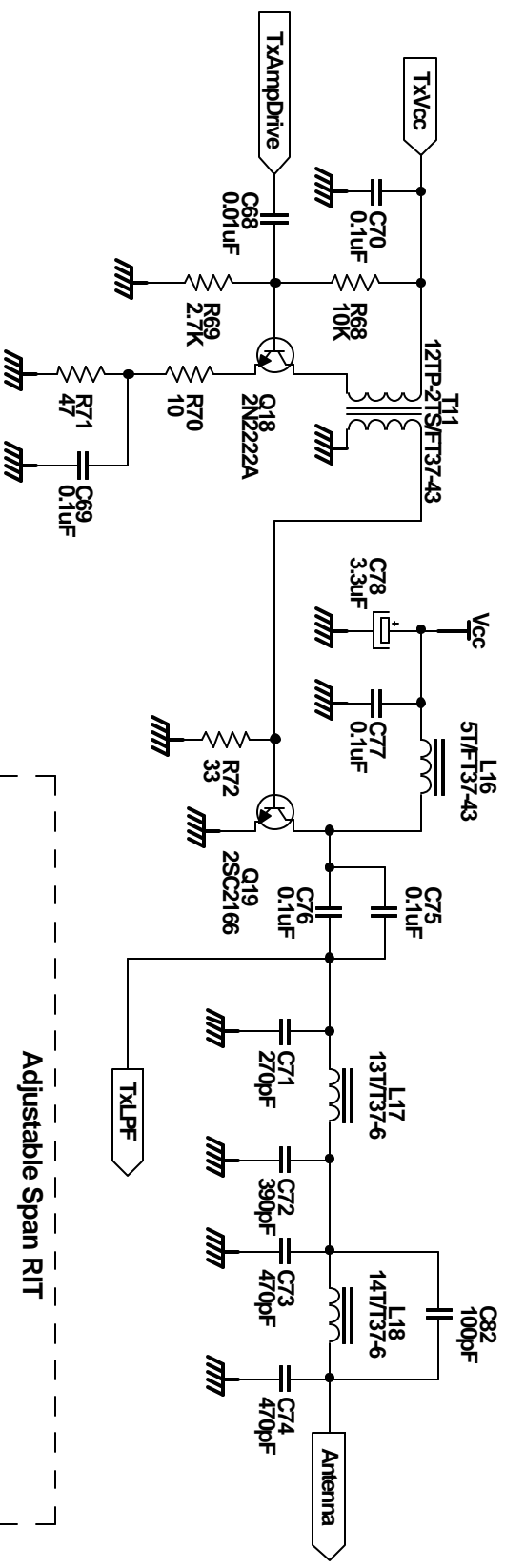
2N2/30, A 30 Meter CW Transceiver

Designed by: Jim Kortge, K8IQY

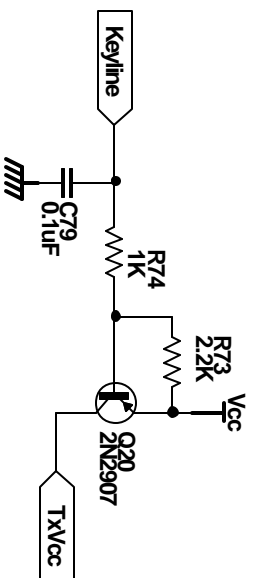
Tx RF Driver +13dB

Tx RF Final +16dB

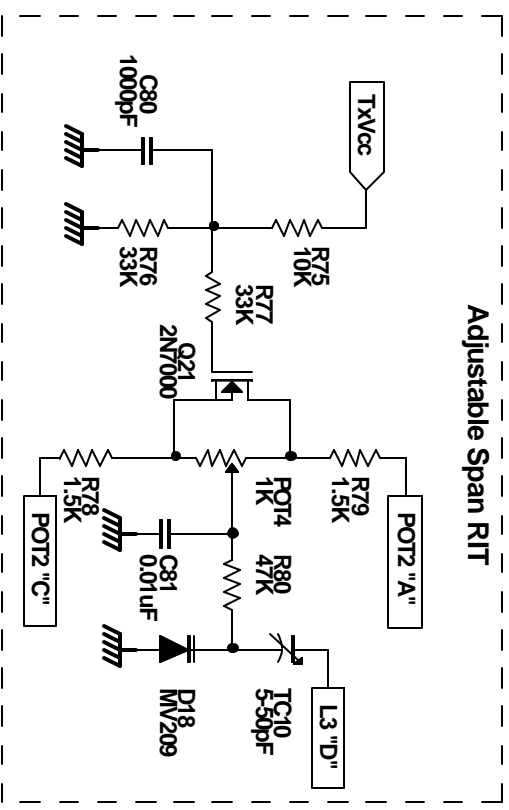
Tx LP Filter



Rx/Tx Switch



Adjustable Span RIT



Optional Circuitry

2N230FA.SCH; 11/05/2002

2N2/30 "Version A" Bill of Material

<u>Item</u>	<u>Qty</u>	<u>References</u>	<u>Value</u>
1	1	C1	1pF
2	1	C53	27pF
3	3	C13,C54,C56	47pF
4	3	C22,C46,C51	51pF
5	2	C2,C3	68pF
6	1	C11	82pF
7	3	C44,C49,C82	100pF
8	3	C16,C25,C28	150pF
9	2	C12,C18	180pF
10	5	C23,C24,C26,C29,C71	270pF
11	3	C43,C48,C72	390pF
12	2	C73,C74	470pF
13	4	C14,C15,C31,C80	1000pF
14	9	C5,C7,C8,C32,C47,C52,C55,C68,C81	0.01uF
15	1	C41	0.02uF
16	28	C4,C6,C9,C10,C17,C19,C20,C21,C27,C30,C33,C34,C35,C36,C37,C45, C50,C57,C62,C64,C66,C67,C69,C70,C75,C76,C77,C79	0.1uF
17	3	C39,C40,C65	0.22uF
18	1	C78	3.3uF
19	2	C42,C61	4.7uF
20	1	C58	10uF
21	1	C38	47uF
22	3	C59,C60,C63	470uF
23	1	TC4	3-30pF
24	9	TC1,TC2,TC3,TC5,TC6,TC7,TC8,TC9,TC10	5-50pF
25	2	R51,R53	6.8
26	2	R7,R8	8.2
27	1	R70	10
28	2	R4,R5	16
29	1	R72	33
30	6	R2,R20,R23,R27,R34,R71	47
31	5	R17,R29,R30,R42,R50	51
32	3	R1,R6,R43	68
33	1	R56	82
34	2	R19,R28	100
35	6	R9,R36,R40,R44,R48,R52	150
36	1	R62	180
37	3	R26,R59,R61	220
38	1	R10	270
39	2	R37,R45	330
40	1	R35	390
41	1	R18	820
42	8	R15,R25,R33,R41,R49,R74	1K
43	1	R22	1.3K

44	2	R78,R79	1.5K
45	1	R14	1.8K
46	1	R73	2.2K
47	6	R39,R47,R54,R63,R64,R69	2.7K
48	1	R16	3.3K
49	1	R81	4.3K
50	1	R55	4.7K
51	4	R3,R12,R21,R24	5.6K
52	9	R13,R32,R38,R46,R57,R66,R68,R75	10K
53	3	R31,R76,R77	33K
54	4	R11,R58,R60,R80	47K
55	1	R67	1M
56	1	R65	4.7M
57	2	POT1,POT4	1K
58	1	POT2	10K-10T
59	1	POT3	10K
60	1	TR1	50
61	2	D16,D17	1N34
62	1	D5	1N4004
63	11	D1,D2,D7,D8,D9,D10,D11,D12,D13,D14,D15	1N4148
64	1	D4	1N4735A
65	1	D3	2v, 10 ma LED
66	2	D6,D18	MV209
67	2	L13,L15	4.7uH
68	1	L6	6.8uH
69	1	L1	8.2uH
70	2	L12,L14	12uH
71	3	L2,L4,L5	100uH
72	4	L7,L8,L9,L10	150uH
73	1	L11	1mH
74	1	L16	5T/FT37-43
75	1	L17	13T/T37-6
76	1	L18	14T/T37-6
77	1	L3	44T/T50-7
78	1	FB1	Mix 43 Bead
79	1	T3	1:4:11T/FT37-43
80	1	T6	8T Bifilar/FT37-43
81	1	T11	12TP-2TS/FT37-43
82	1	T5	13TP-2TS/FT37-43
83	1	T7	14T Trifilar/FT37-43
84	1	T4	16:3:1/FT37-61
85	1	T1	2TP-28TS/T37-6
86	1	T8	3TP-30TS/T37-6
87	1	T2	30TP-3TS/T37-6
88	1	T9	30TP-5TS/T37-6
89	1	T10	1200CT - 8

90	1	Q18	2N2222A
91	1	Q20	2N2907
92	1	Q21	2N7000
93	1	Q19	2SC2166
94	1	Q17	J176
95	16	Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9,Q10,Q11,Q12,Q13,Q14,Q15,Q16	PN2222
96	6	Y1,Y2,Y3,Y4,Y5,Y6	7.3728MHz
97	2	M1,M2	ADE-1
98	1	LS1	SPEAKER