

Review of NorCal's 2N2/40 Transceiver

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In the fall of 1997, Wayne Burdick N6KR, one of the co-founders of *Elecraft*, proposed a design contest for the 1998 Dayton convention. The premise of the contest was to build a transceiver using no more than 22 transistors, all of them the venerable 2N2222. No integrated circuits, PNP transistors, or voltage regulators were permitted. The winner of the contest was Jim Kortge K8IQY who devised a 40 meter CW transceiver he named the "2N2/40". A novel aspect of Jim's design was the use of a solid copper pc board ground plane serving as the mounting surface for small pieces of pc board that are glued down. Components are soldered to these pads, which became known as "Manhattan" pads. The solid plane permits a very low impedance path for all ground currents, contributing to a low noise receiver. No etched pc board is required, and the board layout can closely resemble the schematic diagram. Jim's design was published in the winter 1998 issue of *QRPP*, and many copies of the 2N2/40 were built. A lively Yahoo group, <http://groups.yahoo.com/group/2n2-40/>, is still a source of information for builders of the transceiver.

Once the limitations of the Dayton contest were no longer an issue, Jim began improving the design. The latest versions of the 2N2/40 show the result of 10 years of upgrades to a transceiver that performed well in the original design. The transmitter now uses a PNP keying transistor, and the final amplifier produces 5W of output with one device, instead of the three parallel 2N2222's used in the original. The mute circuit has a JFET for much better T/R switching, and the receiver includes a MOSFET RIT circuit. Jim has also developed versions of his original design for 30m and 20m.

Perhaps the greatest obstacle to this transceiver achieving wider popularity is the need to collect the parts and then figure out how to build it using the Manhattan method. At Pacificon in 2007, Jim presented his plans for the future of this classic design. In conjunction with NorCal, and with assistance from Dan Tayloe N7VE, the 2N2/XX will be available as a complete kit using a pc board. Versions for 40, 30, and 20m will be offered. But what about the solid ground plane to maintain that low noise receiver? Jim and his team have developed a multi-layer pc board that keeps the backside of the board a nearly continuous copper ground plane. The best of both worlds! This review describes my impressions with a prototype of the 40m version of this exciting new kit.

The original transceiver was typically built on a 5" X 7" piece of copper clad board. The new design is significantly smaller, on a 3.5" X 5.5", multi-layer board. The first thing you notice when you examine the kit is the high parts density on the board. Quite an increase when compared to the old design. By my count, there are nearly 300 components mounted on the board. All are thru-hole parts, except for the three packaged ADE-1 surface-mount double-balanced mixers. There are 15 plastic 2N2222 transistors (equivalent to the 2N2222), eight other transistors, and zero integrated circuits. The kit includes all the controls, including a 10-turn pot for the VFO, all required connectors and a custom case. It has RIT and both audio and RF gain controls. Transmitter output power is adjustable via a trimpot on the pc board up to about 4 or 5 Watts. There are 15 toroids to wind, down from 17 in the original design. The 40m version does not use a receiver

RF amplifier included in the 30m and 20m versions. This results in one fewer toroid to wind and one fewer PN2222.

Building the kit was really enjoyable. There was almost no need to adjust the lead spacing on the parts, as things just fit the way they should. Thanks NorCal for that! Jim has written an assembly manual that makes building this kit both easy and a good learning experience. The manual breaks up the job into 26 sections, each corresponding to a block in the transceiver. Some sections are completed in less than 30 minutes, others take an hour or so. At the end of each section, the builder is instructed to test the circuit up to that point. Jim wisely suggests that each section must work properly before continuing the build as it will not fix itself if you get something wrong. He is, of course, correct. I made two mistakes during my build, but since the error was confined to a small portion of the pc board, it was fairly easy to figure out my problem. (Both times it involved a toroid.) I estimate that it took somewhere around 20 to 25 hours to complete the transceiver assembly. Testing requires a voltmeter and a simple RF probe or an oscilloscope.

The new 2N2/XX rigs have the same quiet K8IQY receiver that makes it such a joy to use. The IF has a 500 Hz passband, and with its 4-pole crystal filter and 2-pole crystal roofing filter, signals seem to pop right out of the noise floor as you tune across the band. The VFO covers 100 kHz on 40 and 20 meters, and the entire 50 kHz band on 30m. I noticed a small drift in the VFO frequency for the first few minutes, but it quickly settled down after that. If you add a turns counter to the 10-turn VFO pot, you can approximate a digital dial. Jim's prototype case at Pacificon hinted at adding a digital display such as the Steve Weber KD1JV design, now available from QRPKits. The audio amp stages provide plenty of clean audio.

My receiver measured 135 mA from a 12V supply. This is more than an NE602-based receiver, but that's the price you pay for the improved dynamic range afforded by the passive double-balanced mixer design. I could not detect any thump in the smooth T/R circuitry. The manual claims more than 80 dB of opposite sideband rejection. I can't verify that claim with test equipment, but my ears tell me that I was not able to hear any unwanted sideband. The transmitter is a straight-forward design and with the output set for 4W, I measured 750 mA of current. A small heat sink is included on the 2SC5739, but it barely gets warm. A series Schottky diode provides reverse protection on the input dc supply line.

A couple of minor considerations. The sidetone is generated from sampling the transmitted RF, so the sidetone level is dependant on the transmit output power setting. I don't expect operators will be adjusting the output level very often, but the resistor that sets the sidetone level is mounted on standoffs so it can be easily changed. The RF gain pot is somewhat non-linear as it controls a transistor in the front end of the receiver to shunt the received signal. There is no AGC in the receiver, and tuning across a strong signal can make you reach for the gain control in a hurry. This may be an issue for some, but I normally keep the AGC on my K1 off all the time, so I guess I'm used to it.

Building the 2N2/XX will be somewhat challenging for those who have not dealt with toroids. There are nine transformers to wind, and they need to be done right. (I know from first hand experience.) The rest of the more than 260 parts are easy to install. Everything just fits. This is not a kit you should build by "installing all the capacitors, and then all the resistors, then the diodes" etc. Follow the manual and it will turn out well.

Having an oscilloscope makes test and alignment easy, and a signal source like the new NorCal S9 Signal Generator will help with receiver tune up.

All in all, a really enjoyable building experience, resulting in a great rig when you're done. If you have ever considered building one of Jim Kortge's 2N2 transceivers, but were not sure about assembling all the parts, or the Manhattan-style construction method, this is the opportunity you have been waiting for.

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