A Homebrew 30 Meter Radio in a Weekend

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Most weekends my wife and I try to do something together. One dreary weekend in January, though, my wife had brought a lot of work home, and was going to be busy both days. I was on my own. While I was waiting for some parts I'd ordered for the big project radio I'd been working on, I had been browsing my little technical library. I had picked up some ideas, so I decided to see if I could build a radio from scratch in a weekend.

Fortunately, I have a reasonably deep junk box. I have been building radios, and scrounging parts for radios, since dinosaurs ruled the earth and antennas were made of wood and stone. (Trust me, aluminum and copper are a great improvement.)

I decided to try for a thirty meter radio, because I had a crystal at 10.111 MHz, scrounged from a defunct satellite receiver. I built the transmitter first, because I thought it would be easier, and thus would give me more nearly instant gratification.

The circuit I used for the transmitter came from my trusty copy of *Solid State Design for the Radio Amateur*. It is the circuit that, I think, has come to be called the Little Joe, an excellent two stage design by W7ZOI.

I made a few changes from the SSD version. The result is shown in Figure 1. I wanted to use the crystal in a variable crystal oscillator (VXO), so I modified the oscillator for that. C2 and C5 are both 100 pF, larger than I would otherwise have used in those positions. Larger feedback caps seem to allow more tuning range in a VXO. I added a 15 µH molded choke and a variable cap that I estimate had a maximum capacitance of about 100 pF in series with the crystal. Those gave me tuning from about 10.107 down just to the lower edge of the band. Not a huge range, true, but better than being stuck on a single frequency.

I used an untuned transformer between the oscillator and the final, though I kept the same 9:1 turns ratio. I figured if it did not work I could tune it, but it seems to work just fine. Finally, I changed the output low pass filter to a 5-element one for more harmonic suppression.

I also used transistors that I had available in the junk box. The oscillator is a PN2222, though any similar transistor ought to work. For the final I used an obsolete National NSD102, a supply of which I found at a hamfest a few years ago. In the original version W7ZOI used a 2N3553, also obsolete, but possibly more obtainable, since it was made by more than one vendor. And there are many transistors that are still easily available that will work.

Finally, I used a Japanese PNP for the keying transistor, but a 2N2907, 2N3906, 2N4403 or MPS-A56 will work just as well. Note that, as built, the final is keyed and the oscillator runs all the time, which may or may not be optimum. It will certainly make it easy for the receiver to spot, but might overload it.

The transmitter worked when I first powered it up, putting out a clean-looking 1.5 watt sine wave into a 50 ohm dummy load. Figure 2 shows the finished product. As is the usual case, I used "ugly construction" to make the little rig. Total building time was under two hours, which left a big chunk of the weekend for a receiver.

The receiver, a direct conversion type, started with an idea gleaned from a presentation by Rev. George Dobbs, G3RJV, at FDIM 2005, and documented in the Proceedings. One of the circuits he mentioned was the two-diode frequency-doubling mixer, which is a circuit in which the local oscillator (LO) is injected at half the working frequency. The mixer then doubles the injection frequency. The advantage is that the LO does not run at the signal frequency, and is thus immune to pulling. I had seen the circuit before, but had never tried it. This seemed like the opportunity. Figure 3 is the resulting receiver schematic.

I built the LO first, a Clapp variable frequency oscillator (VFO) that covered 5.05 to 5.075 MHz, which when doubled

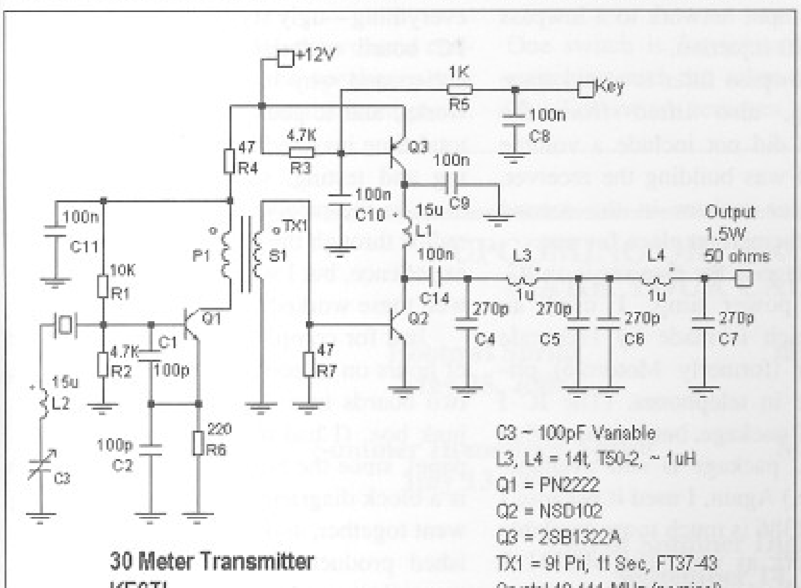

Figure 1—The weekend transmitter schematic.

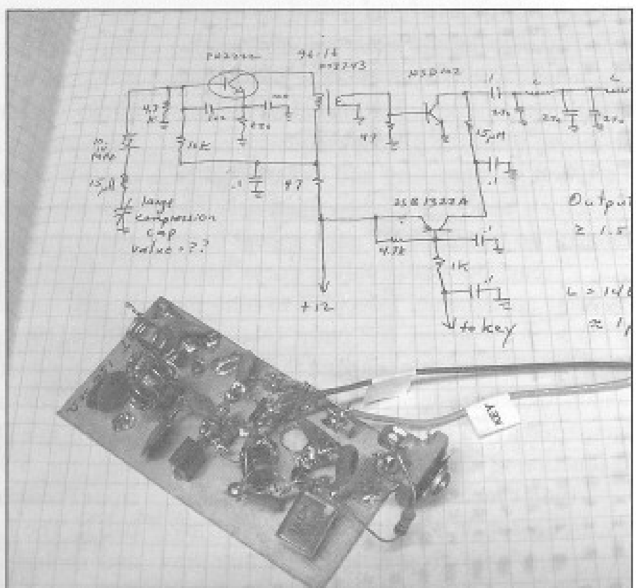

Figure 2—The transmitter board completed.

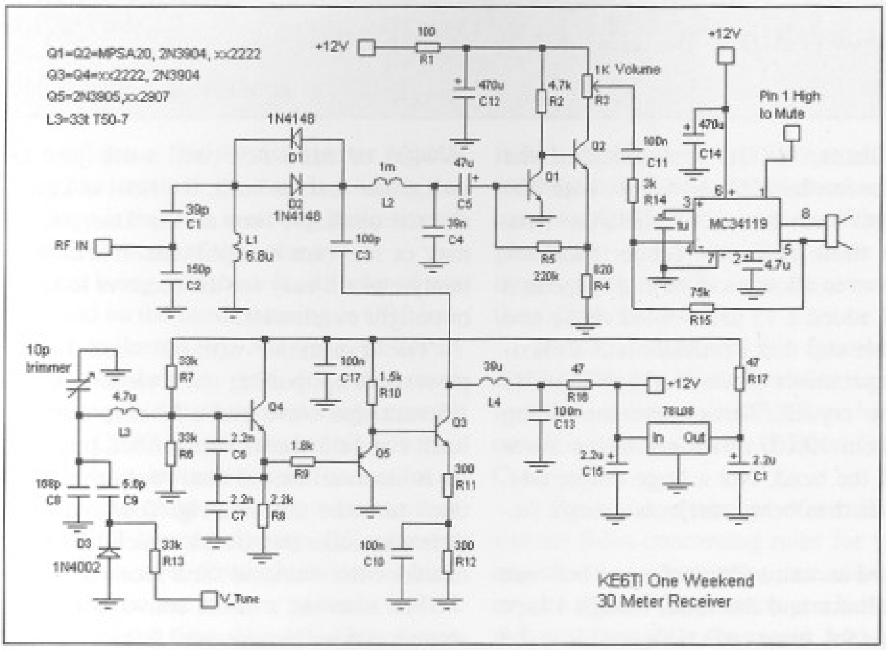

Figure 3—The weekend receiver schematic.

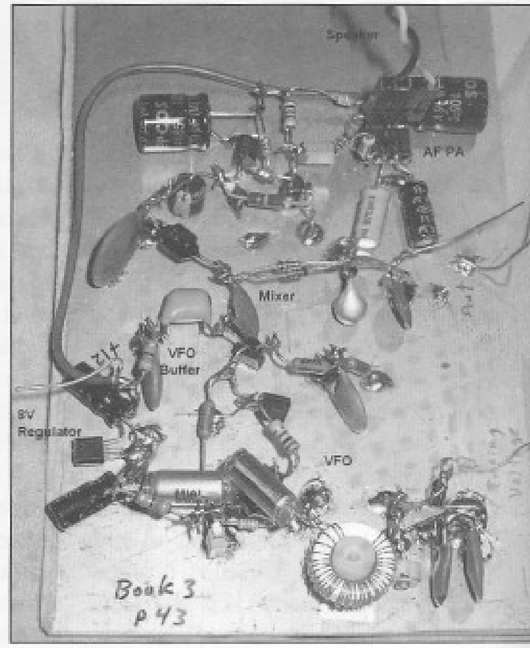

Figure 5—A view of the weekend receiver from another angle.

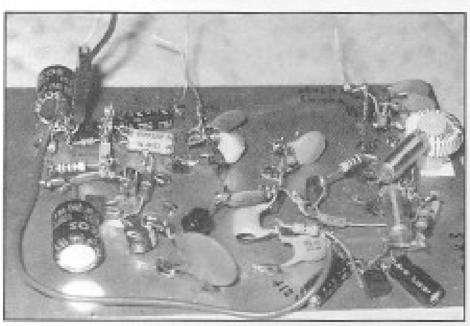

Figure 4—The weekend receiver completed.

just covered the 30 meter band. I used a pre-wound toroid from the junk box for the VFO's tank inductor, and tweaked the surrounding values to get the frequency range I wanted, compressing and expanding the inductor's windings a bit to fine tweak the range. The two 2200 pF caps appear to be polystyrene, but that's only a guess based on their appearance. I decided to tune the VFO with a voltage, and put a 1N4002 to work as a variable capacitance diode, which worked fine. (Had it not, I would have tried a real varactor, or perhaps the C-B junction of a bipolar transistor.)

I didn't measure the oscillator's stability, but it sat on a signal from one of my generators with no great pitch change for several minutes.

Theoretically, the mixer would not have pulled the VFO, but I am constitutionally incapable of building an unbuffered VFO. I added a simple, direct-connected two stage buffer, taking the output from the second stage's collector. I also added a small three terminal regulator to keep the VFO's supply voltage constant.

I used a single tuned circuit between the antenna input and the mixer, arranged for a bit of impedance step up. I didn't design that network; instead I simply scaled it to 30 meters from the one shown in the FDIM *Proceedings* article. The pair of diodes that comprise the mixer run from the top of the input network to a lowpass filter and the LO injection.

After the lowpass filter is a two stage audio preamp, also lifted from the *Proceedings*. I did not include a volume control when I was building the receiver, but the collector resistor in the second audio stage is the perfect place for one.

The final stage in the receiver is an IC-based audio power amp. I used an MC34119, which is made by Freescale Semiconductor (formerly Motorola) primarily for use in telephones. (The IC I used is in a DIP package, but it appears that only the SOIC package is still available from Freescale.) Again, I used it because I had it. The LM386 is much more available and should work as well. The MC34119 drives a small speaker lifted from a junked computer. The MC34119 has provision for muting by bringing pin 1 to the supply voltage, but I decided not to make use of that feature.

I did not really expect much from such a simple receiver, built so quickly and with so little analytical work on my part. But bench tests showed it could easily hear a 1 mV signal from my URM-25, and it had no trouble copying several 30 meter signals with no more antenna than a three-foot clip lead in my basement. I have not yet put it on my big outdoor antenna.

I built these two, transmitter and receiver, the way I build pretty much everything—ugly style, on a piece of scrap PC board material. See the pictures to understand why it is called 'ugly,' but it works, and it goes together quickly. The total time invested in these two, for building and testing, was about eight hours, most in the receiver. I have built a lot of radios through the years, so I have a bit of experience, but I was still surprised at how well these worked.

Just for completeness, I took a couple of hours on a second weekend and put the two boards into a cabinet I found in my junk box. (I had to come up with a back panel, since the box lacked one.) Figure 6 is a block diagram of how the whole thing went together, and Figure 7 shows the finished product. I added reverse polarity protection to the incoming power lead, and swapped out the mica trimmer in the transmitter for a small plastic variable. I

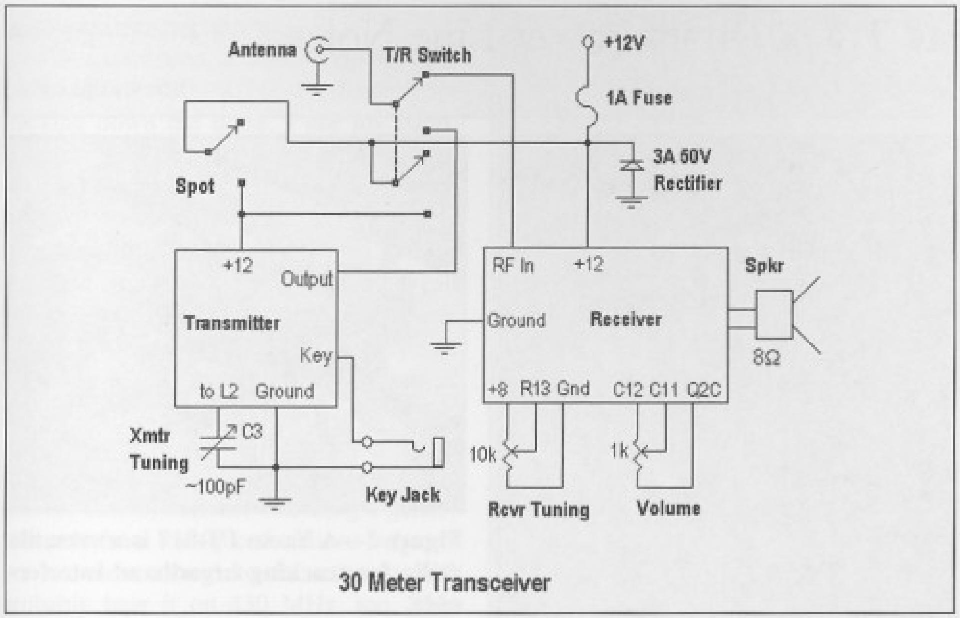

Figure 6—Transceiver interconnections.

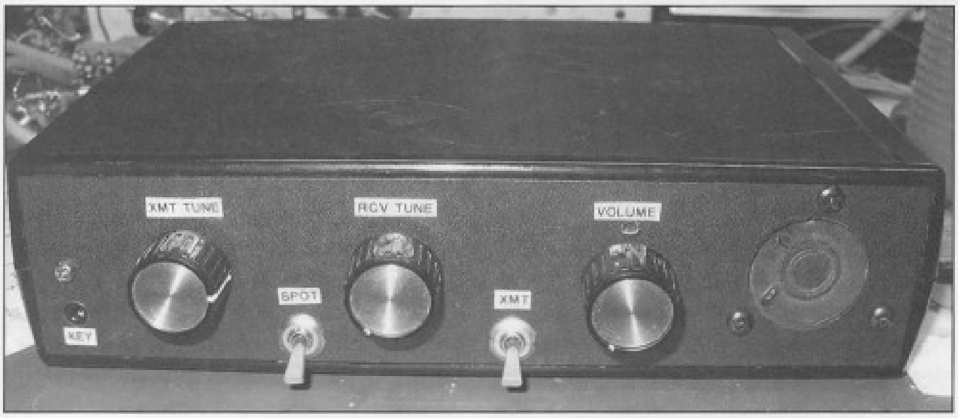

Figure 7—The completed transceiver, installed in a "not so ugly" enclosure.

mounted tuning controls, the volume control (in place of R3), the speaker, a key jack and two switches on the front panel. One switch is for transmit/receive (T/R) switching and the other is for spotting. The T/R switch removes power from the transmitter when in receive, as well as switching the antenna from one board to the other. There is no provision for sidetone, which, in my station, comes from an outboard electronic keyer.

This is not really a construction article. I do not expect anyone to try to duplicate what I have done, but I wanted to show that building a radio is not necessarily a long, difficult project.

References:

1. http://www.qrp4u.de/index_en.html This is an interesting site generally. But see the "Some Useful Tables" section for the source of the transmitter's low pass filter.

2. FDIM 2005 *Proceedings*: 4. "Amateur Radio In Reduced Circumstances", Rev. George Dobbs, G3RJV

3. http://www.gqrp.com/ "A Short Guide to Harmonic Filters for QRP Transmitter Output." Rev. George Dobbs G3RJV. This is another table of low pass filters for QRP transmitters.

4. http://www.arrl.org/tis/info/pdf/9902044.pdf. Still more low pass filters.

5. http://www.aoc.nrao.edu/~pharden/hobby/_lpf_pa.pdf. This is an excellent tutorial on transmitter output filters.

6. http://www.agder.net/la8ak/c21.htm. LA8AK has loads of information in these pages. The link here goes to a page that includes information about the frequency doubling mixer I used in the receiver. (You'll find almost exactly the circuit I used labeled "Bad Construction." According to this site, I need to terminate the mixer better, but that is for later experimentation. For now, it seems to work well enough, at least on small signals.)