Errata, "An Updated Universal QRP Transmitter"

QST, April, 2006. Last update 10Jan07.

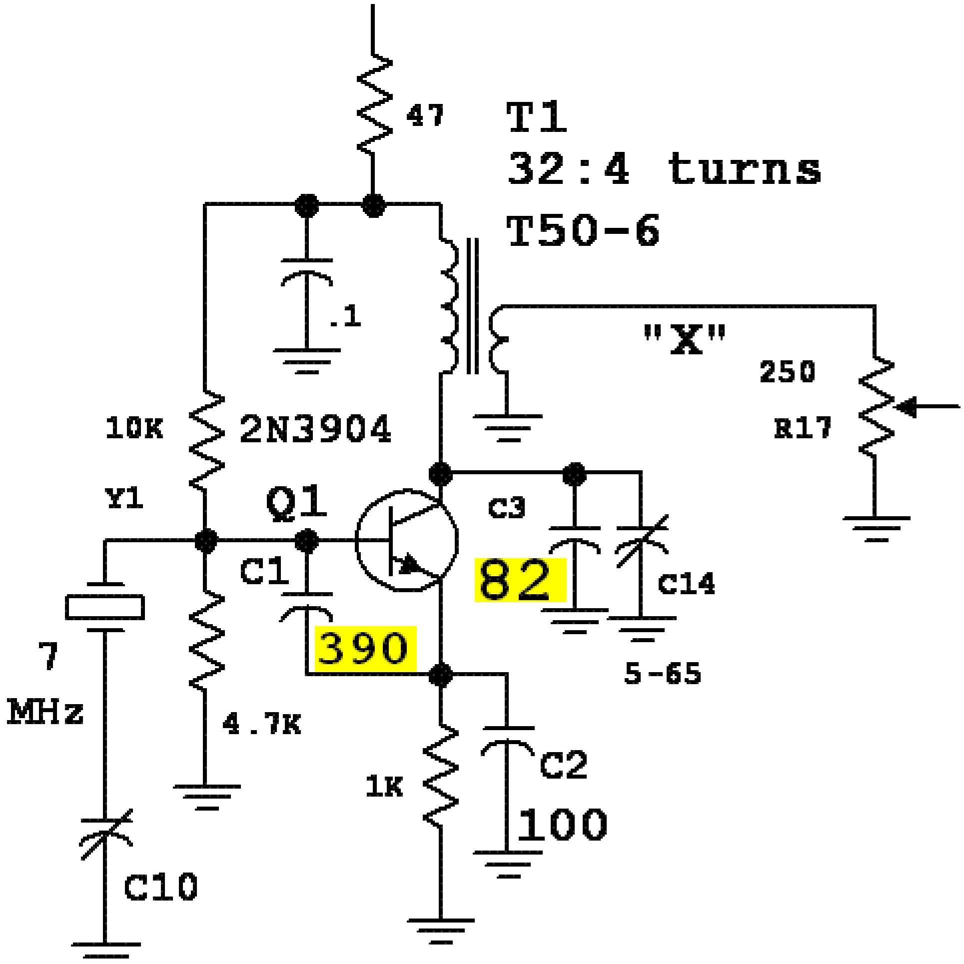
Also see "Crystal Oscillator Experiments," in *Technical Correspondence*, QST, July, 2006, pp 65-66. (19June06)

Page 28, middle text column, bottom paragraph. Reference is made twice to R2. That should be R20, the emitter bias resistor for Q2. (23March06)

Pages 28 and 29, a **Construction Note:** The VXO capacitor, C10 of Fig 1, is mounted on the front panel of the transmitter rather than the circuit board. Grounding of the capacitor has been reported to be critical. A lead, ideally a short one, should go from the variable capacitor to the ground foil near the oscillator stage, Q1. In one of the transmitters built, the builder had merely attached the variable capacitor to the panel and relied on the ground connection that held the board to the box. This was, unfortunately, close to the power amplifier. The result was that the crystal oscillator would not always come on when the spot button was pushed. Adding a cleaner grounding wire solved the problem. I checked my model and found that I had placed a ground lug on the chassis very close to variable capacitor C10 and had soldered it directly to the PC foil right next to Q1. (22 April 06)

Page 29, Fig 1 schematic. Reference is made in the text (p28, middle column, bottom paragraph) to a point Y. This is the output of the driver stage between C20 and T3. (23March06)

Page 29, Fig 1. **40 Meter difficulty:** Some builders had reported difficulty with tuning C14, the variable capacitor that tunes the collector circuit of the oscillator. First, the variable capacitor was too close to minimum C. A well defined peak was not always found. But of even greater significance, tuning C14 to some values could allow the oscillator to loose crystal control of the frequency, producing oscillation in the 6.4 to 6.9 MHz region. (Not a good thing at all!) I did the experiments and found that I could duplicate the observations with my model of the 7 MHz transmitter, even though I had not encountered any of the difficulties in the initial construction. Fortunately, solutions to both problems are simple and shown in the figure below. First, we changed C3 from 100 to either 68 or 82 pF to remove the tuning ambiguity. Both N8ET and N4KH found that removing a turn or two from the high L winding on T1 will accomplish the same end. Second, adding C1=390 pF to the 40 meter circuit produces an oscillator that is always crystal controlled for any tuning of C14. The new component values are shown in yellow in the figure below. (22 April 06)



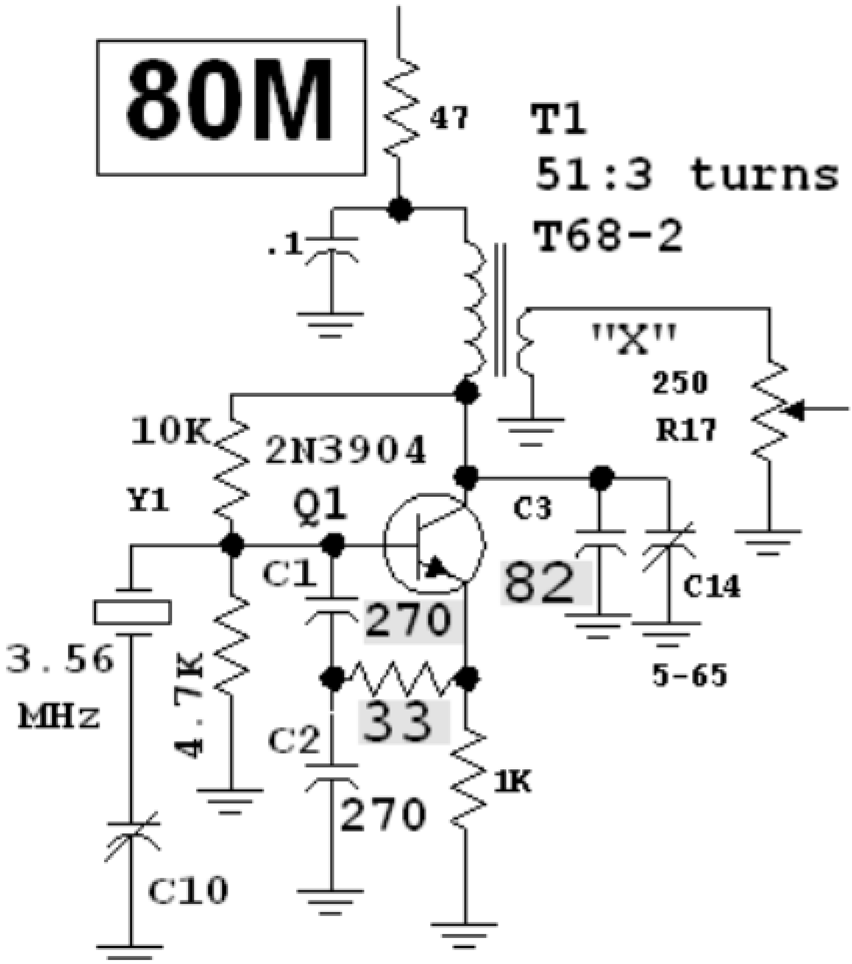
(22 April 06)

Page 29, Fig 1, **80 Meter Oscillator**. After the experience of April 22, it seemed prudent to examine the other bands. An oscillator and driver section was built up and used for the examinations. The output was observed with a 50 Ohm terminated oscilloscope. A frequency counter was also attached through a 10X scope probe. If the 40 meter experiment was "interesting," the 80 meter oscillator was "enlightening." First, I found that the tuning was slightly off, easily fixed by dropping C3 from 100 to 82 pF. I now found two different undesired C14 tuning modes. At some settings (high C14) there would be no crystal control. But with other settings (low C14 values) we could achieve crystal control near 3.8 MHz. This was probably operation on a spurious crystal response, a phenomenon consistent with the crystal physics.

The desired operating mode was still possible because the highest amplitude occurred at the desired frequency of, in my case, 3.560 MHz.

I tried the "fix" that worked for 40 meters, increasing C1 from 200 to 1000 pF. This helped a great deal, but did not completely eliminate either problem. It just made it easier to get close to the mark. In an attempt to understand the operation, including what looked like a "spurious oscillation," I removed the crystal and drove the crystal port with a signal generator. Sure enough, the "amplifier" was unstable, producing an output that jumped in amplitude as the generator was tuned. This was a good thing, for we have methods to tame a misguided amplifier. Two of these tools are loading and feedback. Loading helped in that setting the gain pot at maximum output produced more stable results. But this got in the way of being able to adjust output. The other tool, negative feedback, turned out to be the more interesting. One does not normally think of applying negative feedback to an oscillator circuit, but it certainly helped in this case.

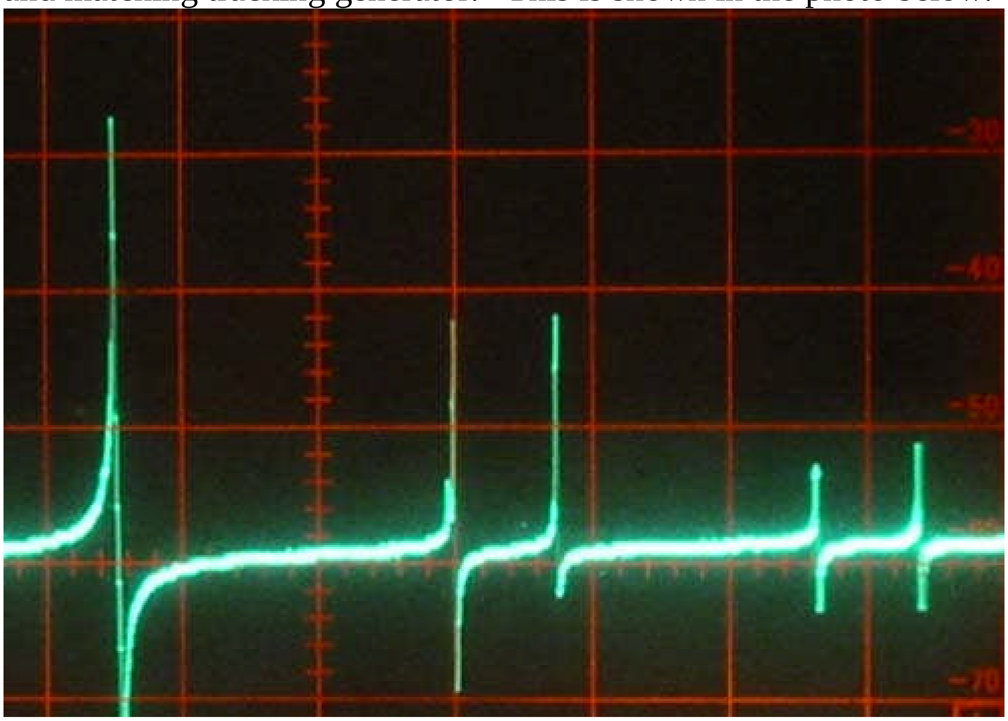
Our final circuit for the 80 meter oscillator is shown below. (25 April 06)



C1 and C2 are both 270 pF which produced good results. The negative feedback is realized by adding a 33 Ohm resistor in the emitter signal path and by moving the 10K bias resistor from the 0.1 uF bypass capacitor to the transistor collector. With this circuit, we were **NOT** able to tune C14 to a state that was not crystal controlled. Clean keying was confirmed by listening with a receiver.
(25 April 06)

Page 29, Fig 1. **The 80 Meter Crystal and a glimpse of the physics.** The observation of crystal controlled oscillation above the nominal "3560 kHz" crystal frequency led me to investigate the crystal in more detail. A quick test circuit was thrown together consisting of the crystal with transformers and BNC connectors on each side. The transformers were a bifilar 12 turn winding of #28 wire on FB73-2401 beads. The high permeability material was picked to obtain the high inductance needed for this relatively low frequency.

Once the fixture was built, it was terminated in a spectrum analyzer at one end and driven with 0 dBm from a HP-8640B signal generator at the other port. Peaks were observed at the nominal frequency plus four additional higher frequencies. The frequencies and the attenuation observed were: 3559.4 kHz, 7 dB; 3800.9 kHz, 21 dB; 3874.3 kHz, 22 dB; 4066.4 kHz, 32 dB; and 4141.2 kHz, 34 dB. After our initial home lab measurements, we took the fixture over to a neighbor's place (thanks to Marty, K7AYP) and did a sweep that showed the overall response using his Tektronix 496 spectrum analyzer and matching tracking generator. This is shown in the photo below.

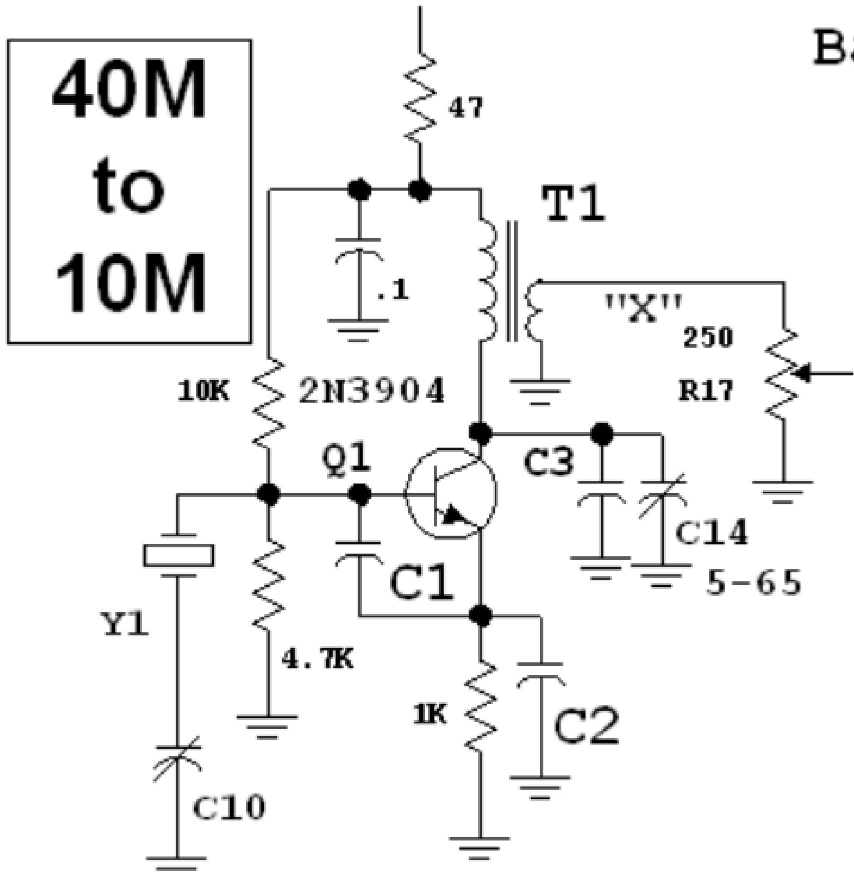


The sweep rate was extremely low for this measurement, about 1 second per division. This was required because of the narrow bandwidth of the peaks from this fairly high Q crystal. The amplitudes are not accurate because the peak widths are less than one pixel in the digital storage display of the spectrum analyzer. One can span in on a specific peak to obtain more accurate amplitude data, but the "big picture" would then be lost.

I want to emphasize that these spurious responses are NOT problems with the crystal supplied by Kanga US. Almost all crystals will have spurious responses, usually above the nominal frequency. The attenuation of the spurs with respect to the desired resonance will vary and will be greater with high quality crystals. The crystals we see these days are usually round discs of quartz. The quartz thickness determines the resonant frequency. The center part of the disc is plated with a metal film where electrodes are attached. The electric field required for crystal operation is then established between the electrodes. The plating loads that part of the crystal between the electrodes, causing a lower frequency than that of the rest of the disc, but that region has the highest excitation. So, the dominant oscillation occurs in the quartz under the plated electrodes. There is some excitation of the outer parts of the disc and it is this response that leads to the spurs. The amplitude of the spurious oscillation is sometimes attenuated by beveling the edges so that the quartz thickness decreases as the edge is approached. But this is an expensive processing step and is not present in low cost crystals.

It is exciting to encounter these subtleties of physics in something as simple as a homebrew low power amateur radio transmitter. One of the themes of the April 2006 QST paper that I tried to inject was that a project like this can present all sorts of interesting details of this sort. These comments were aimed at the prospective builder who might want to examine a circuit with greater depth than encountered with a kit. They were also included as a subtle "dig" for the FCC which seems bent on elimination of CW in our licensing structure. My message was that even simple CW gear can offer exciting avenues of education. An underlying idea that is also part of my comment was that education is a central part of this game we play with amateur radio. This is my central purpose, which is, I believe, all too often overlooked when the emergency communications assets of amateur radio are featured in discussions. OK, so much for my daily "blog." I'll step down from this particular soap box. (26 April 06)

Page 29, Fig 1, **Oscillator for 40 through 10 Meters.** After the experiments with 40 and 80 meters presented above, I studied and modified the circuit for the other bands. Although the other oscillators were generally well behaved, undesired modes could be found with extreme tuning of C14. Adding C1 to the circuit when it was initially absent always fixed this problem. The modified circuit and new values are shown in the figure below: (25 April 06)



Band	C1	C2	C3
40	390	100	82
30	390	100	0
20	390	100	0
17	100	33	0
15	100	33	0
12	33	18	0
10	33	18	0

(25 April 06)

Page 32, Reference 7. The url is given as www.kangaus.com. It should be http://www.kangaus.com. (10Jan07)