KE7HR - Five Crystal VXO

Paul R. Jorgenson KE7HR
NSS 39382FE

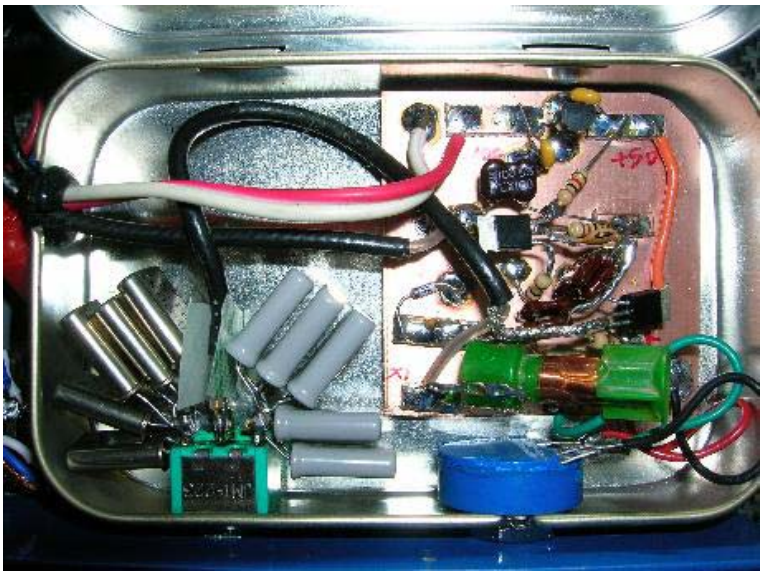
While building a couple of QRP rigs for 75 meters, I wanted a VFO that would work under demanding conditions. I tried several different circuits with varying amounts of success. Some worked well on the bench, others did not even work well there (a kit version) after a time. With my use of the radios in portable and varying temperature conditions (from outside to inside caves), I really needed stability that I was not getting from the VFO's. I tried straight crystal control. This was stable enough, but QRM just off of frequency made communications difficult.

I searched my personal library and the internet for VXO circuits that might work. The so called "Super VXO" by JA0AS (silent key) and JH1FCZ looked the most interesting. This circuit was also given a few words in "Experimental Methods in RF Design". It used two crystals in series with an inductor and variable capacitor. Further searching found a circuit by NB6M as used on the Rock Mite 40. This circuit used two crystals in series with switched (in essence, variable) inductors and a variacator diode. This became the basis for my experiments and eventual working VXO.

I bread boarded a version of the NB6M circuit with a variable inductor from my junk box and then proceeded to try various diodes in the variacator part of the circuit. G0UPL has published a couple of articles about using LED's and rectifier diodes as varicaps. I spent several nights with a small drawer full of diodes trying them out. Some worked wonderfully, others did not work at all. The joy of experimentation! The rectifier diode that worked the best as a varicap had house markings and I can find no data for it. The LED's that I tried also worked to some degree. What I settled on was a purpose built variacator that I had gotten from Dan's Small Parts. The part number is BB329A.

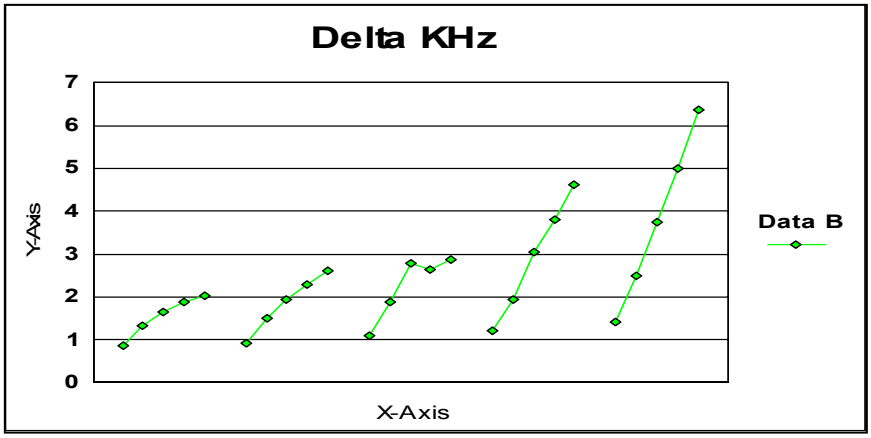
With the variacator worked out, I started wondering if since two crystals worked better than one in a VXO circuit, how many would be used effectively. The area where I was working is about 5 MHz so the crystals are less capable of moving off of their marked frequency than those around 7 MHz and higher. I tried more crystals and kept track of what the frequency shift was for the different conditions. The chart and graph on the next page shows the results. The anomaly in the 20uH series is probably due to the variable inductor core, but was certainly repeatable. It turns out that one crystal is capable of being shifted off of the marked frequency with this circuit, two was more, and so on. I stopped at five crystals since this was starting to take up as much area as I wanted to use for my VXO. Beyond 39uH, the VXO was unstable and was not really under crystal control.

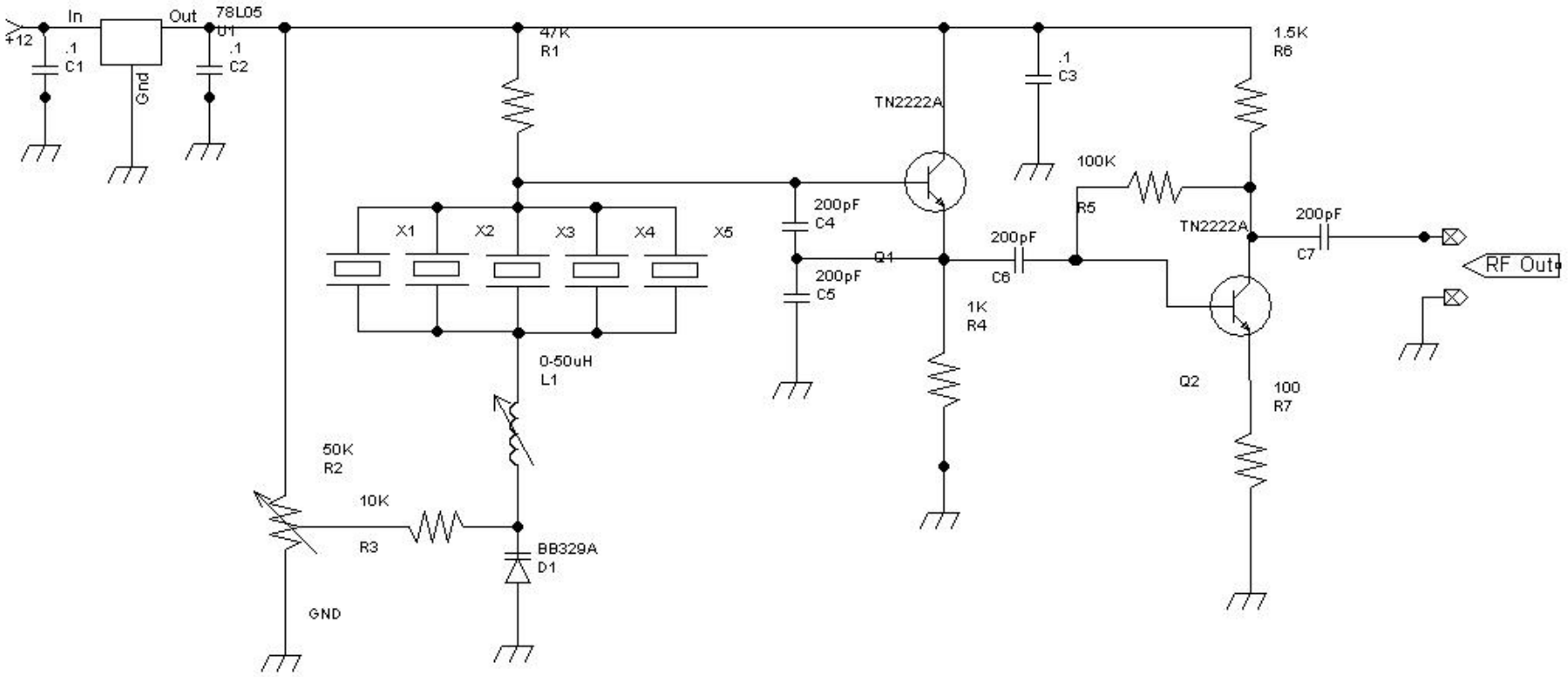
I settled on using 30uH for my final circuit. This gave me a predictable and repeatable shift with the components I was using as well as being slightly under the value which became unstable. One more modification (which did not make the circuit diagram) was to use a switch to use two different frequencies. Five crystals stacked on each side of the switch made for an impressive package. The oscillator and buffer were built on a piece of circuit board "dead bug" or "Manhattan" style. The output goes to the SSB rig which uses a NE612 chip. If other radios were to be used a second buffer would probably be a good idea.



How many crystals can be used effectively? I stopped at five...

uH	Num Xtals	Delta	F min	F max
0	1	0.86	5.06934	5.07020
0	2	1.34	5.06993	5.07127
0	3	1.65	5.07043	5.07208
0	4	1.87	5.07090	5.07277
0	5	2.04	5.07134	5.07338
10	1	0.93	5.06908	5.07001
10	2	1.51	5.06947	5.07098
10	3	1.95	5.06980	5.07175
10	4	2.30	5.07010	5.07240
10	5	2.60	5.07038	5.07298
20	1	1.08	5.06867	5.06975
20	2	1.87	5.06870	5.07057
20	3	2.78	5.06843	5.07121
20	4	2.63	5.06914	5.07177
20	5	2.87	5.06918	5.07205
30	1	1.22	5.06832	5.06954
30	2	1.93	5.06825	5.07018
30	3	3.04	5.06790	5.07094
30	4	3.81	5.06762	5.07143
30	5	4.62	5.06730	5.07192
39	1	1.42	5.06790	5.06932
39	2	2.49	5.06741	5.06990
39	3	3.76	5.06666	5.07042
39	4	4.99	5.06588	5.07087
39	5	6.36	5.06495	5.07131





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