

Multi-crystal oscillator

Written by Hans Summers

Monday, 03 April 2017 15:05 - Last Updated Monday, 03 April 2017 19:24

Kostas SV3ORA informed me of his oscillator circuit which has a single J108 Field Effect Transistor and three crystals, oscillating all at the same time on their three different frequencies. His article on this oscillator met with some scepticism. People thought that one crystal should dominate, ignoring the others. You can read the forum discussion that Kostas copy and pasted and has on his web page article.

Kostas SV3ORA's triple crystal oscillator: <http://grp.gr/multiosc/index.htm>

Personally I can't think of any practical uses for this right now in any of my current or future projects. But I was interested to try out the circuit and see for myself, what happens... and it shouldn't take too long, there aren't very many components to connect together, are there.

WRONG! Yes it's a simple circuit... but it is deceptive! It's a circuit that I feel I could spend days and days studying, or weeks, even. But I don't have days. So this is a simple write-up of what I did, with some points for further investigation another time (or by another person).

The first problem was that I didn't have a J108 FET. I do have some J310 FETs though. As Kostas pointed out, the J108 has a significant amount of gate-source capacitance. Therefore he didn't need to add any external capacitance, he could rely on the internal capacitance of the J108. He said a much lower capacitance device like the J310 should have maybe 150pF added across the gate to source leads. Actually in my case I found the J310 worked (2 crystals oscillating at the same time) even without the additional gate-source capacitance. My construction is rather messy. Nevertheless I don't think there would be a relatively significant amount of stray capacitance to make up the difference in gate-source capacitance.

Refer to the following circuit diagram:

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Each crystal in the 800 kHz low gain oscillator is a 4 MHz crystal. The first crystal is a 4 MHz crystal and the second is a 4 MHz crystal. The third is a 4 MHz crystal and the fourth is a 4 MHz crystal. The fifth is a 4 MHz crystal and the sixth is a 4 MHz crystal. The seventh is a 4 MHz crystal and the eighth is a 4 MHz crystal. The ninth is a 4 MHz crystal and the tenth is a 4 MHz crystal. The eleventh is a 4 MHz crystal and the twelfth is a 4 MHz crystal. The thirteenth is a 4 MHz crystal and the fourteenth is a 4 MHz crystal. The fifteenth is a 4 MHz crystal and the sixteenth is a 4 MHz crystal. The seventeenth is a 4 MHz crystal and the eighteenth is a 4 MHz crystal. The nineteenth is a 4 MHz crystal and the twentieth is a 4 MHz crystal. The twenty-first is a 4 MHz crystal and the twenty-second is a 4 MHz crystal. The twenty-third is a 4 MHz crystal and the twenty-fourth is a 4 MHz crystal. The twenty-fifth is a 4 MHz crystal and the twenty-sixth is a 4 MHz crystal. The twenty-seventh is a 4 MHz crystal and the twenty-eighth is a 4 MHz crystal. The twenty-ninth is a 4 MHz crystal and the thirtieth is a 4 MHz crystal. The thirty-first is a 4 MHz crystal and the thirty-second is a 4 MHz crystal. The thirty-third is a 4 MHz crystal and the thirty-fourth is a 4 MHz crystal. The thirty-fifth is a 4 MHz crystal and the thirty-sixth is a 4 MHz crystal. The thirty-seventh is a 4 MHz crystal and the thirty-eighth is a 4 MHz crystal. The thirty-ninth is a 4 MHz crystal and the fortieth is a 4 MHz crystal. The forty-first is a 4 MHz crystal and the forty-second is a 4 MHz crystal. The forty-third is a 4 MHz crystal and the forty-fourth is a 4 MHz crystal. The forty-fifth is a 4 MHz crystal and the forty-sixth is a 4 MHz crystal. The forty-seventh is a 4 MHz crystal and the forty-eighth is a 4 MHz crystal. The forty-ninth is a 4 MHz crystal and the fiftieth is a 4 MHz crystal. The fifty-first is a 4 MHz crystal and the fifty-second is a 4 MHz crystal. The fifty-third is a 4 MHz crystal and the fifty-fourth is a 4 MHz crystal. The fifty-fifth is a 4 MHz crystal and the fifty-sixth is a 4 MHz crystal. The fifty-seventh is a 4 MHz crystal and the fifty-eighth is a 4 MHz crystal. The fifty-ninth is a 4 MHz crystal and the sixtieth is a 4 MHz crystal. The sixty-first is a 4 MHz crystal and the sixty-second is a 4 MHz crystal. The sixty-third is a 4 MHz crystal and the sixty-fourth is a 4 MHz crystal. The sixty-fifth is a 4 MHz crystal and the sixty-sixth is a 4 MHz crystal. The sixty-seventh is a 4 MHz crystal and the sixty-eighth is a 4 MHz crystal. The sixty-ninth is a 4 MHz crystal and the seventieth is a 4 MHz crystal. The seventy-first is a 4 MHz crystal and the seventy-second is a 4 MHz crystal. The seventy-third is a 4 MHz crystal and the seventy-fourth is a 4 MHz crystal. The seventy-fifth is a 4 MHz crystal and the seventy-sixth is a 4 MHz crystal. The seventy-seventh is a 4 MHz crystal and the seventy-eighth is a 4 MHz crystal. The seventy-ninth is a 4 MHz crystal and the eightieth is a 4 MHz crystal. The eighty-first is a 4 MHz crystal and the eighty-second is a 4 MHz crystal. The eighty-third is a 4 MHz crystal and the eighty-fourth is a 4 MHz crystal. The eighty-fifth is a 4 MHz crystal and the eighty-sixth is a 4 MHz crystal. The eighty-seventh is a 4 MHz crystal and the eighty-eighth is a 4 MHz crystal. The eighty-ninth is a 4 MHz crystal and the ninetieth is a 4 MHz crystal. The ninety-first is a 4 MHz crystal and the ninety-second is a 4 MHz crystal. The ninety-third is a 4 MHz crystal and the ninety-fourth is a 4 MHz crystal. The ninety-fifth is a 4 MHz crystal and the ninety-sixth is a 4 MHz crystal. The ninety-seventh is a 4 MHz crystal and the ninety-eighth is a 4 MHz crystal. The ninety-ninth is a 4 MHz crystal and the one hundredth is a 4 MHz crystal.

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Dual crystal oscillator output vs source resist



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Dual crystal oscillator output vs source resi



What didn't work...

I couldn't get three crystals to oscillate simultaneously the way Kostas did. I could observe at highest gain the highest frequency oscillating, then handing over to the next lower, then the lowest frequency crystal as I reduced the gain. But I could not find a point where all three oscillated at the same time.

Furthermore I could not succeed in getting EVERY pair of random crystals from my junkbox to oscillate simultaneously.

Further investigation...

So clearly this oscillator really does operate on multiple crystal frequencies simultaneously. I feel that a lot more study could be done, to completely understand how it works and why; and what are the necessary conditions for it to work. As I said, I really don't have time now... but

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here is what I would like to investigate, if I did have time:

1. Effect of adding different amounts of gate-source capacitance to the J310
2. Effect of different amounts of capacitance to ground, or loading, at the other end of the crystal (where I put 10pF)
3. How to make three crystals oscillate together, as Kostas did?
4. Investigate a variable amount of series resistance (some 10's of ohms) in series with each crystal to try to equalise the activity of the crystals - which might make it easier to get them to oscillate together at the same time
5. What is the effect on the actual oscillation frequency of the crystal? Is it pulled some amount?
6. Use of a more linear buffer, to investigate the spectral purity of the oscillations