

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 400 kHz oscillator. The first crystal is a 400 kHz oscillator. The second crystal is a 400 kHz oscillator. The third crystal is a 400 kHz oscillator. The fourth crystal is a 400 kHz oscillator. The fifth crystal is a 400 kHz oscillator. The sixth crystal is a 400 kHz oscillator. The seventh crystal is a 400 kHz oscillator. The eighth crystal is a 400 kHz oscillator. The ninth crystal is a 400 kHz oscillator. The tenth crystal is a 400 kHz oscillator. The eleventh crystal is a 400 kHz oscillator. The twelfth crystal is a 400 kHz oscillator. The thirteenth crystal is a 400 kHz oscillator. The fourteenth crystal is a 400 kHz oscillator. The fifteenth crystal is a 400 kHz oscillator. The sixteenth crystal is a 400 kHz oscillator. The seventeenth crystal is a 400 kHz oscillator. The eighteenth crystal is a 400 kHz oscillator. The nineteenth crystal is a 400 kHz oscillator. The twentieth crystal is a 400 kHz oscillator. The twenty-first crystal is a 400 kHz oscillator. The twenty-second crystal is a 400 kHz oscillator. The twenty-third crystal is a 400 kHz oscillator. The twenty-fourth crystal is a 400 kHz oscillator. The twenty-fifth crystal is a 400 kHz oscillator. The twenty-sixth crystal is a 400 kHz oscillator. The twenty-seventh crystal is a 400 kHz oscillator. The twenty-eighth crystal is a 400 kHz oscillator. The twenty-ninth crystal is a 400 kHz oscillator. The thirtieth crystal is a 400 kHz oscillator. The thirty-first crystal is a 400 kHz oscillator. The thirty-second crystal is a 400 kHz oscillator. The thirty-third crystal is a 400 kHz oscillator. The thirty-fourth crystal is a 400 kHz oscillator. The thirty-fifth crystal is a 400 kHz oscillator. The thirty-sixth crystal is a 400 kHz oscillator. The thirty-seventh crystal is a 400 kHz oscillator. The thirty-eighth crystal is a 400 kHz oscillator. The thirty-ninth crystal is a 400 kHz oscillator. The fortieth crystal is a 400 kHz oscillator. The forty-first crystal is a 400 kHz oscillator. The forty-second crystal is a 400 kHz oscillator. The forty-third crystal is a 400 kHz oscillator. The forty-fourth crystal is a 400 kHz oscillator. The forty-fifth crystal is a 400 kHz oscillator. The forty-sixth crystal is a 400 kHz oscillator. The forty-seventh crystal is a 400 kHz oscillator. The forty-eighth crystal is a 400 kHz oscillator. The forty-ninth crystal is a 400 kHz oscillator. The fiftieth crystal is a 400 kHz oscillator. The fifty-first crystal is a 400 kHz oscillator. The fifty-second crystal is a 400 kHz oscillator. The fifty-third crystal is a 400 kHz oscillator. The fifty-fourth crystal is a 400 kHz oscillator. The fifty-fifth crystal is a 400 kHz oscillator. The fifty-sixth crystal is a 400 kHz oscillator. The fifty-seventh crystal is a 400 kHz oscillator. The fifty-eighth crystal is a 400 kHz oscillator. The fifty-ninth crystal is a 400 kHz oscillator. The sixtieth crystal is a 400 kHz oscillator. The sixty-first crystal is a 400 kHz oscillator. The sixty-second crystal is a 400 kHz oscillator. The sixty-third crystal is a 400 kHz oscillator. The sixty-fourth crystal is a 400 kHz oscillator. The sixty-fifth crystal is a 400 kHz oscillator. The sixty-sixth crystal is a 400 kHz oscillator. The sixty-seventh crystal is a 400 kHz oscillator. The sixty-eighth crystal is a 400 kHz oscillator. The sixty-ninth crystal is a 400 kHz oscillator. The seventieth crystal is a 400 kHz oscillator. The seventy-first crystal is a 400 kHz oscillator. The seventy-second crystal is a 400 kHz oscillator. The seventy-third crystal is a 400 kHz oscillator. The seventy-fourth crystal is a 400 kHz oscillator. The seventy-fifth crystal is a 400 kHz oscillator. The seventy-sixth crystal is a 400 kHz oscillator. The seventy-seventh crystal is a 400 kHz oscillator. The seventy-eighth crystal is a 400 kHz oscillator. The seventy-ninth crystal is a 400 kHz oscillator. The eightieth crystal is a 400 kHz oscillator. The eighty-first crystal is a 400 kHz oscillator. The eighty-second crystal is a 400 kHz oscillator. The eighty-third crystal is a 400 kHz oscillator. The eighty-fourth crystal is a 400 kHz oscillator. The eighty-fifth crystal is a 400 kHz oscillator. The eighty-sixth crystal is a 400 kHz oscillator. The eighty-seventh crystal is a 400 kHz oscillator. The eighty-eighth crystal is a 400 kHz oscillator. The eighty-ninth crystal is a 400 kHz oscillator. The ninetieth crystal is a 400 kHz oscillator. The ninety-first crystal is a 400 kHz oscillator. The ninety-second crystal is a 400 kHz oscillator. The ninety-third crystal is a 400 kHz oscillator. The ninety-fourth crystal is a 400 kHz oscillator. The ninety-fifth crystal is a 400 kHz oscillator. The ninety-sixth crystal is a 400 kHz oscillator. The ninety-seventh crystal is a 400 kHz oscillator. The ninety-eighth crystal is a 400 kHz oscillator. The ninety-ninth crystal is a 400 kHz oscillator. The hundredth crystal is a 400 kHz oscillator.

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Dual crystal oscillator output vs source resist



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Dual crystal oscillator output vs source resist



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