

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