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Improvement of Phase-noise in Colpitts Oscillators using Partial Electrode SC-cut Resonators
部分電極SCカット振動子を用いたコルピッツ発振回路における位相雑音の改善

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1. Introduction

For many years, bipolar junction transistor (BJT) Colpitts crystal oscillators have been used as circuits that have low phase noise characteristics for communications. At the 1996 IEEE Frequency Control Symposium, Watanabe and coworkers greatly improved Colpitts oscillators. [1] The circuit was inserted into the quartz resonator in the emitter-base “returning branch” of the standard colpitts oscillators in order to restrict the narrow-band negative resistance zone and improve phase noise. We reported on low phase noise BJT Colpitts crystal oscillators that use the filter resonator Q value, i.e., AT-cut, of a filter element. [1]

In this paper, we thought about reducing phase noise by using the SC cut resonator on the partial electrodes using the same circuit experimentally.

From the analysis result, we evaluated the effectiveness of these oscillators by manufacturing a system and demonstrated the improvement in near-career or floor frequency phase noises.

2. Methods

2-1. Narrow Band Colpitts Oscillators

A narrow band Colpitts crystal oscillator is shown in Figure 1.

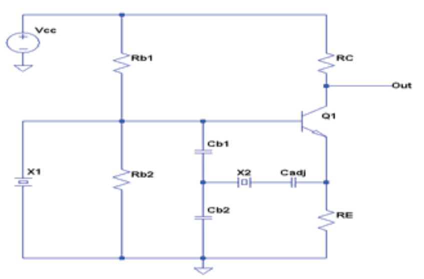

Fig. 1 Narrow band Colpitts oscillator. [1]

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Generally, a crystal resonator is connected between the base-GND and C_{B1}, C_{B2}, and the resonator form a loop to oscillate. In the circuit of Fig. 1, a crystal resonator filter was inserted into the feedback path between C_{B1} and C_{B2} and the capacitance between the emitter and base.

Figure 2 shows another kind of a quartz oscillator of the SC cut resonator on partial electrodes. Other circuits are the same as Fig. 1. The configurations of two is advantageous, i. e. does not pass other modes either, and it is the best to make a floor as a phase noise. By our circuit, SC and the AT cut resonator are 10MHz.

Table 1 shows the equivalence parameters presented by a circuit of Fig. 2.

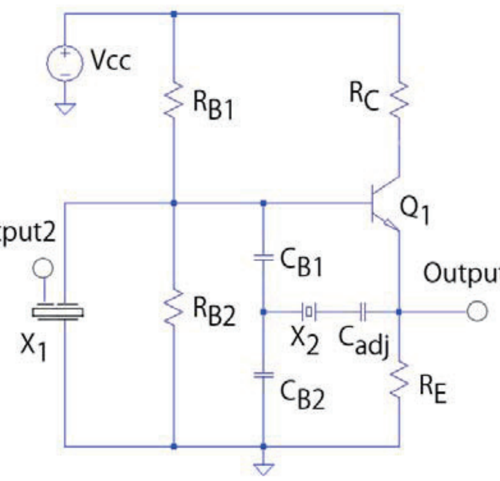

Fig. 2 New Narrow band Colpitts oscillator.

Table 1 Circuit parameters in Fig. 1 and 2.

R_{b1}	R_{b2}	RC	RE	C_{b1}	C_{b2}
100kΩ	200kΩ	100Ω	5.1kΩ	100pF	39pF

Figure 3 represented block diagram at the entire of the system using a circuit in Fig. 2. One of output1 and output2 is connected to the amplifier of 20dB as input. Furthermore, the output of an amplifier is input into a signal source analyzer, and phase noise is measured.

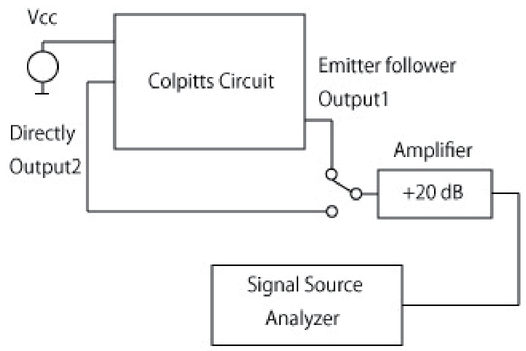

Fig 3 Block diagram

The Vcc was adjusted so that output2 fitted output1.

3. Results

Figure 4 is the case which the partial electrodes SC cut resonator was inserted in. A case is a radius of 15.6mm and 4.8mm in height.

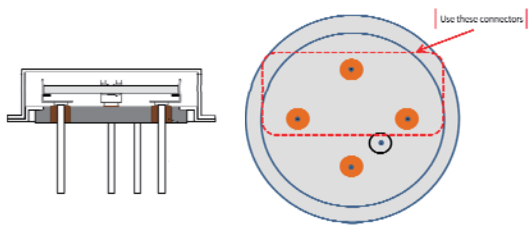

Fig. 4 Partial electrodes SC cut resonator

Figure 5 shows the results of the measured value. Measurements were performed at room temperature.

It has a phase noise of -70 dBc/Hz at an offset frequency of 1Hz, and has a phase noise of -135 dBc/Hz at an offset frequency of 1000Hz. This value is normal as crystal oscillators.

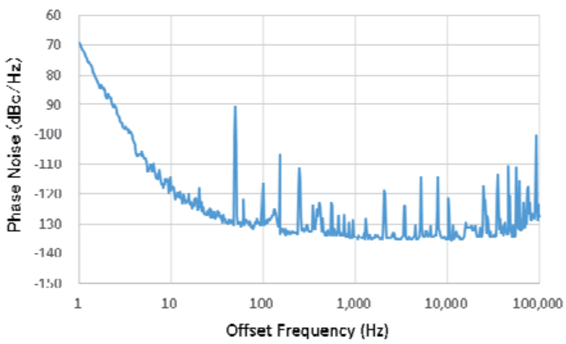

Fig. 5 Phase noise measurement result

In contrast, Fig. 6 is a result using the SC cut resonator with partial electrodes. The same as Fig. 5, we could assume that a phase noise of -70 dBc/Hz at an offset frequency of 1Hz. And we were able to obtain a phase noise of -144 dBc/Hz at an offset frequency of 1000Hz.

First of all Fig. 5 and Fig. 6 are the same as -70dB in offset 1Hz. The reason is influence to depend on room temperature.

Subsequently, the differential of the -9dB/1000Hz is a variation with the SC cut having partial electrodes.

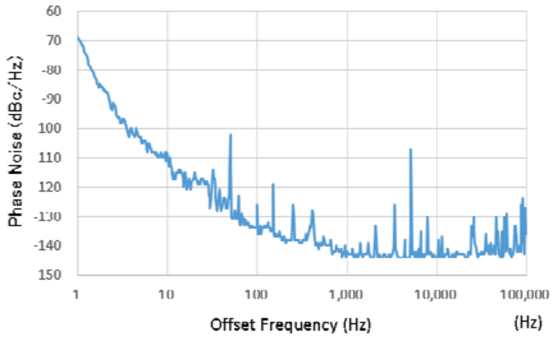

Fig. 6 New phase noise measurement result

4. Conclusion

By using partial electrodes and narrow band Colpitts crystal oscillators, we obtained a low phase noise of -144dBc/Hz at an offset frequency of 1000Hz. As future work, we will investigate how to keep the ambient temperature and further stabilize the temperature of the crystal oscillators.

Acknowledgments

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5. Reference

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