Resonant Frequency Analysis of Quartz Shear Oscillator

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Abstract

Quartz crystals are widely used in frequency control applications because of their high Q factor, stability, small size and low cost. Quartz crystal also exhibits strong mechanical properties and good stability with respect to temperature variation. Depending on the shape and orientation of the crystal blank, many different modes of vibration can be used and it is possible to control the frequency-temperature characteristics of the quartz crystal. The most commonly used type of resonator is the AT-cut, where the quartz blank is in the form of thin plate cut at an angle of about 35°15' to the optic axis of the crystal.

The present paper reports the modeling of quartz oscillator for resonant frequency analysis based on piezoelectric effects. The proposed oscillator consists of a single quartz disc of radius 0.835 mm and thickness 334 um. There are two electrodes on the top and bottom surfaces of the geometry; one of them is grounded. Resonant frequency was determined in two different steps. In the first step, an AC voltage is applied to the top electrode. In the second step, the crystal is still driven by an AC voltage, but a capacitor of 1 pF is introduced between the voltage source and the top electrode of the crystal. Further, computation of frequency response of proposed device was done by adding different capacitors in series. From the simulation results, it is observed that the mechanical resonant frequency was increased with series capacitance. Adding a series capacitance is a familiar technique used frequently to tune crystal oscillators. To carry out this work, COMSOL Multiphysics® was used. AT cut quartz crystals are widely employed in a range of applications, from oscillators to microbalances. One of the important properties of the AT cut is that the resonant frequency of the crystal is temperature independent to first order. This is desirable in both mass sensing and timing applications.

Reference

1. IEEE Standard on Piezoelectricity, ANSI/IEEE Standard 176-1987, 1987.
2. B. A. Auld, Acoustic Fields and Waves in Solids, Krieger Publishing Company, 1990.