Improvement for Precisely Designing Quartz Resonators

Project Representative

Kazuhiro Hirota

Nihon Dempa Kogyo Co., Ltd.

Authors

Koji Toshikawa[*1], Takashi Yamaguchi[*1], Yoshiro Teshima[*1], Shigetaka Kaga[*1], Kazuhiro Hirota[*1]

＊1　Nihon Dempa Kogyo Co., Ltd.

Abstract

Quartz resonators are widely used for applications such as communication devices as key parts of frequency control and selection. Although main mode of quartz resonators which is thickness-vibration has remarkably stable frequency-temperature characteristics, in case couples with spurious mode at a given temperature, it shows large frequency fluctuation at the temperature.

So shape and size of quartz plate and electrodes have to be adjusted to avoid coupling with spurious modes. Because spurious problems are actualized so that downsizing demands increase, it becomes difficult to find out good design to meet them.

Then we are aimed at utilizing simulation in designing of quartz resonators effectively. However large-scale simulation environment is needed to improve calculation accuracy, it was a major hurdle. In 2014, we made calculation model from precise measuring of actual resonators and calculated it by UV 2000 which has large-scale memory system but only at one point of temperature due to limitations of calculation time. The result was compared to measured frequencies of main mode and spurious modes. As a result of resolving the calculation scale problem, we obtained adequate accuracy to predict coupling-temperature. In 2015, we calculated temperature characteristics over a wide range of temperatures. The calculated result compared with measured one shows accuracy of 5 ℃ about coupling-temperatures.

As above described, we demonstrated possibility of simulation to obtain accurate characteristics of quartz resonators, and lead the way to utilizing simulation in designing.

Keywords: large-scale simulation, finite element method, quartz resonator, frequency, coupling temperature