The study of frequency-temperature behavior of SAW resonator

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Abstract

Surface acoustic wave (SAW) devices are widely used in communication equipment because of the good quality. However, as operation frequency of the SAW growing higher and higher, the temperature variation on frequency shift has a significant impact on the performance of the resonator. Thus it is extremely important to predict the temperature-frequency behavior of SAW resonator.

The temperature variation is applied on the structure of the SAW resonator as a steady-state uniform field. The motion of the structure is described by incremental Lagrangian equations. The thermal deformation and the third-order elastic constants are introduced into the piezoelectric equations, which is quite Different from traditional piezoelectric equations. The equations are directly solved based on a periodic interdigital transducer (IDT) unit of SAW resonator. In order to research different temperature effects of different piezoelectric materials, we take Lithium niobate, aluminum nitride and quartz as examples. The temperature coefficient of frequency is usually regarded as the evaluation of temperature-frequency behavior. To get a small and even zero temperature coefficient, a SAW resonator with a double-layer IDT is built, and the optimal structural size is found. The results show that an excellent temperature coefficient of frequency of the SAW resonator is approximately equal to zero (0 ppm/℃) at 25℃ and the resonant frequency is 1214.9MHz with the wavelength being 4μm on the optimal situation.

Keywords: Surface acoustic wave; temperature-frequency behavior; incremental Lagrangian equation; temperature coefficient of frequency