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Design Optimization of SAW Pressure Sensor with Equivalent Circuit Model

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In this paper, we present a novel surface acoustic wave (SAW)-based pressure sensor, which is composed of a broadband reflective delay line and a bonding substrate with a ~250 μm deep cavity. Using the equivalent circuit model, the SAW device was simulated, and the effects of interdigital transducer (IDT) structure, acoustic aperture size, and the number of IDT finger pairs on the device performance were studied. The finite element method (FEM) was used to calculate the diaphragm bending and the resultant stress/strain distribution along the diaphragm. From the simulated results, the optimal design parameters were determined. A new 440 MHz SAW pressure sensor on a 41°YX $LiNbO_3$ substrate was developed. The measured reflection coefficient S_{11} showed a high S/N ratio, a sharp reflected peak, and a large dynamic separation between the reflected peaks. The measured results matched well with the simulated results. When a mechanical compression force was applied to the diaphragm, the diaphragm was bent, resulting in time and phase angle shifts of the reflected peaks. The phase shifts were modulated depending on the amount of applied pressure. The sensitivity obtained was 2.6°/kPa.

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