Poster Abstract

Rapid SAW Sensor Development Tools

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Integrated Vehicle Health Monitoring (IVHM) of aerospace vehicles requires rugged sensors having reduced volume, mass, and power that can be used to measure a variety of phenomena. Wireless systems are preferred when retro-fitting sensors onto existing vehicles. Surface Acoustic Wave (SAW) devices are capable of sensing: temperature, pressure, strain, chemical species, mass loading, corrosion, acceleration, and shear stress. SAW technology is low cost, rugged, lightweight, and extremely low power. For these reasons new SAW sensors are being investigated for aerospace applications.

The lack of integrated design tools for SAW devices has led us to develop tools for design, analysis and automatic layout generation of Surface Acoustic Wave (SAW) devices. After considering currently available tools, we found it necessary to develop a parameterizable library for the layout of SAW devices. This library is much like the standard cell libraries found in digital design packages. The library is implemented in an existing layout editor to reduce software development time. The library allows the user to automatically generate detailed layouts of SAW components such as delay lines, resonators and sensors.

The Impulse Response method was used to implement the frequency domain model of a SAW delay line device. The model is mainly first order, but it includes the second order effects from triple transit echoes. The model calculates the frequency response, the loss of the system, the admittance, and the electrical parameters for circuit simulators. This model assumes a constant metallization ratio of 0.5 (equal spacing and finger widths). The model generates plots of the frequency response, radiation conductance, acoustic susceptance, and the insertion loss of the SAW design. In addition to the plots, several parameters are calculated and written into a summary report to aid in analyzing the design. The plots allow complete analysis of the SAW device. The parameters are written to a file for input for the automatic synthesizing of the layout for the device in a layout editor.

Instead of duplicating commercially available design tools, these tools are used with the Parameterizable library components to automatically generate layouts of SAW devices. To demonstrate the capability of the library components, the layout of a SAW delay line with the parameter values shown in Figure 1 was generated. Figure 2 is the output of the layout generator. This layout can be used to create 3D models of the device and netlists which can be used to create fabrication masks.

The fabrication masks can be used to construct the SAW device shown of Figure 3. The frequency response of the system is plotted in (Figure 4) along with the measured frequency response from the device in Figure 3. A comparison between the calculated frequency response and the measured frequency response demonstrates that the first order model captures the main characteristics of the central lobe and the first side lobes. The addition of the triple transit echo signal to the model improves the response accuracy and can be seen as the small ripple on the top of each lobe.

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Topic Area: No-power Sensor-Tags and RFID

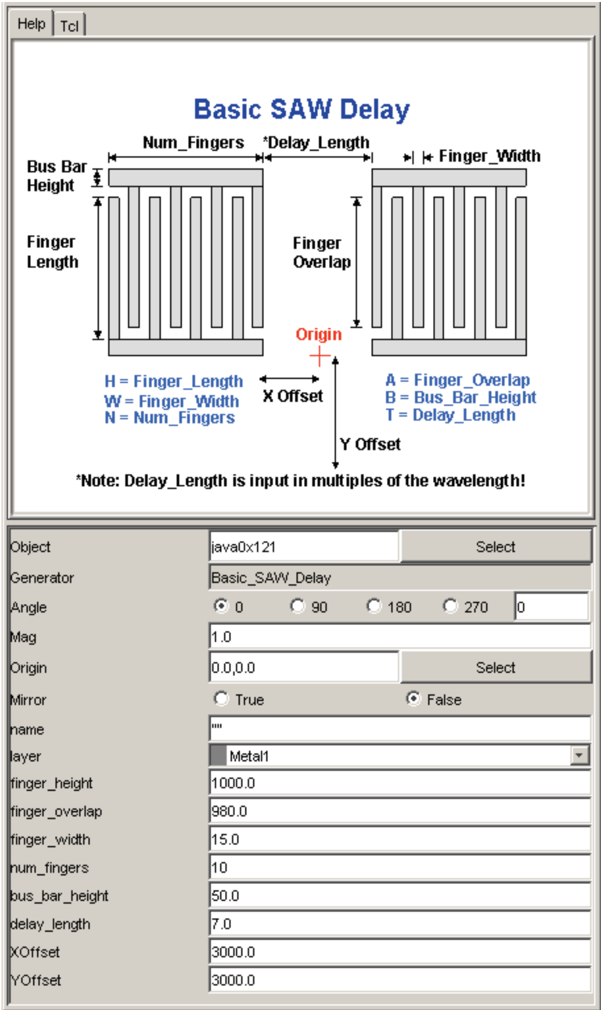

Fig. 1. Layout Generator dialogue box. This dialogue box is where the parameters for the basic SAW delay line are input.

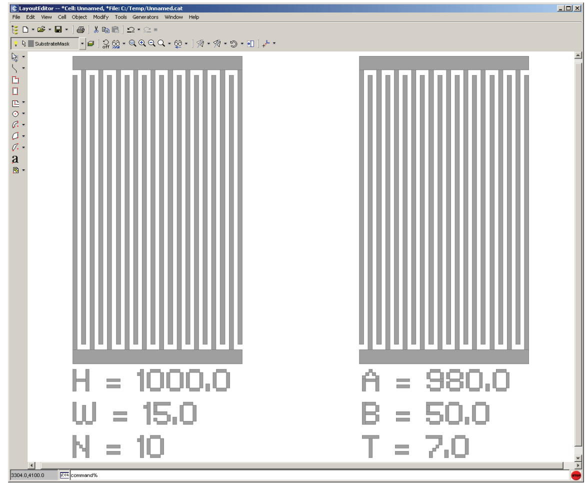

Fig. 2. Layout of a basic SAW delay line. The device consists of two IDTs with finger heights of 1000 µm, finger widths of 15 µm, 10 finger pairs each with an aperture of 980 µm. The bus bar heights are 50 µm, and the delay between the two IDTs is 7 wave-lengths.

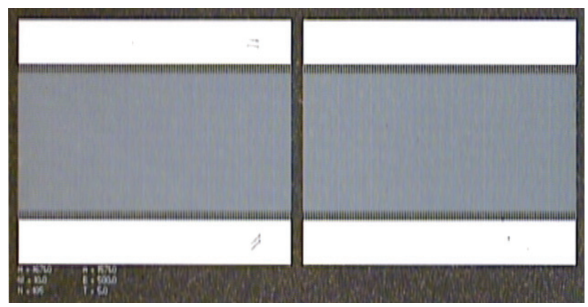

Figure 3. Prototype device with 105 aluminum finger pairs per IDT on a ST-cut Quartz wafer.

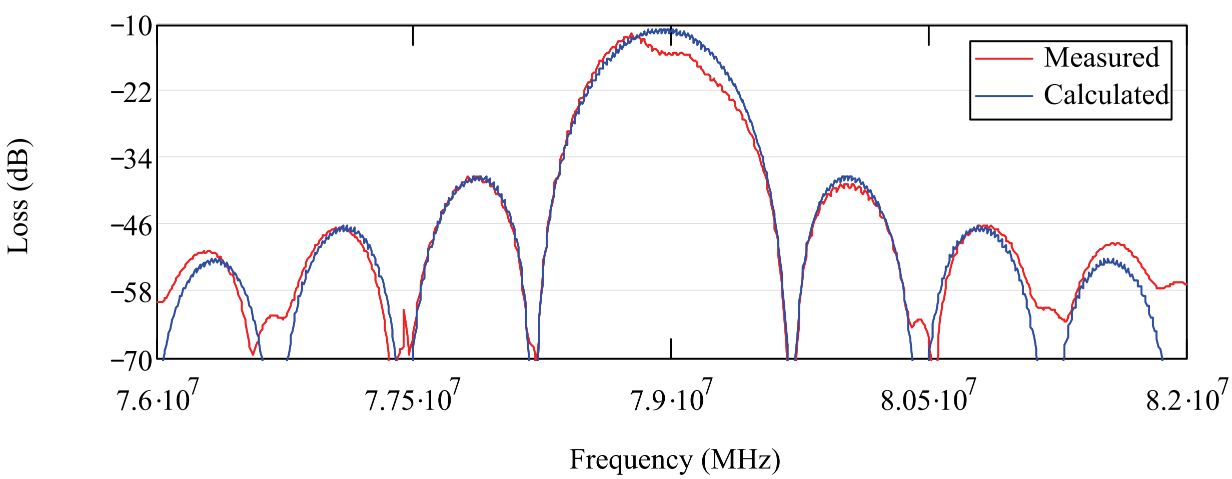

Fig. 4. Frequency Response of the SAW Delay line (shown in Fig. 3) on a Quartz ST cut substrate.

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