3P3-1

Power Transmission Characteristics of EWC-SPUDT SAW Filter for Inverter Gate Drive Circuit

インバータ用ゲート駆動システムに適した一方向性 SAW フィルタの耐電力特性

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1. Introduction

Research into the design of future inverter circuits in the field of power electronic circuits has produced a number of reports on the use of multilevel inverters with multiple switching devices. The multilevel inverter outputs a high-quality waveform that is close to a sinusoidal wave, and the multiple output voltage levels and lower voltage applied to each switching device lead to an increase in the conversion efficiency. However, the larger number of switching devices requires more signal cables to transmit the gate control signals. To reduce the number of signal cables to a single coaxial cable, we proposed a multiplex transmission system that uses a surface acoustic wave (SAW) filter[1,2]. The proposed system uses frequency division multiple access (FDMA) to control the switching devices in the multilevel inverter. To increase the electrical withstand voltage between the input and output ports, a transversal type of SAW filter was selected. In this paper, we fabricated a uni-directional SAW filter that effectively transmitted electrical energy to the switching devices.

2. Design and Fabrication of the EWC-SPUDT

To transmit both the gate control signal and electrical power, we chose a unidirectional SAW filter with the electrode width controlled by a single-phase unidirectional transducer (EWC -SPUDT). As shown in **Fig. 1**, a Pt layer was deposited as a weight material on the 128° Y-X $LiNbO_3$ wafer for the interdigital transducer (IDT) to increase the reflectivity of the EWC-SPUDT cell. The Pt layer was then covered with Al and SiO_2 layers to reduce the ohmic resistance and increase the electrical insulation. **Figure 2** shows the fabricated EWC-SPUDT with the wavelength (λ) of 9.8 μm and the overlap length (W) of 343 μm. The horizontal gap of 100 μm in the center area increased the electrical withstand voltage between the input and output IDTs.

A simulator based on the finite element

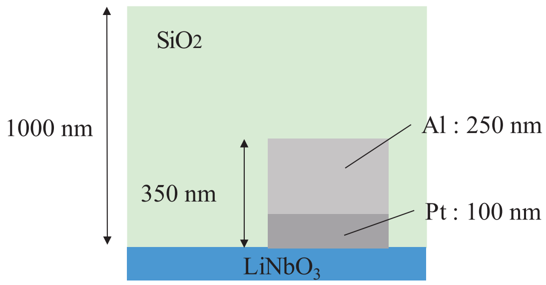

Fig. 1　Cross section of the fabricated IDT

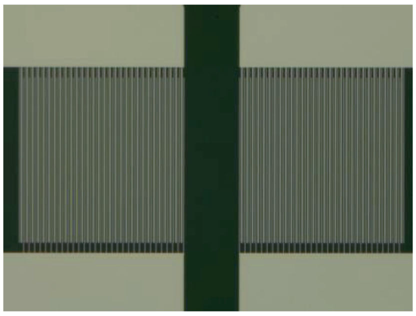

Fig. 2　Center area of the fabricated transversal EWC-SPUDT. Gold (white) indicates the Pt/Al layers.

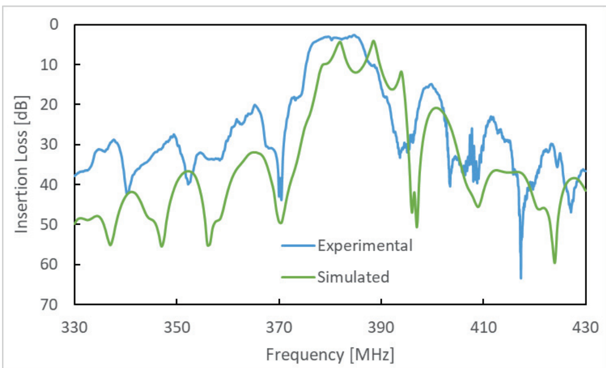

Fig. 3　Transmission characteristics of the simulated and fabricated EWC-SPUDTs.

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method (FEM) was use to optimize the IDT design for the lowest insertion loss conditions. **Figure 3** shows a comparison of the transmission characteristics between the simulated and experimental devices. The experimental results gave a minimum insertion loss of 2.59 dB and a center frequency of 384.7 MHz.

3. Power Durability Characteristics

Power durability tests were performed using the electrical power transmission system shown in **Fig. 4**. During measurement, the input signal frequency was adjusted to give a minimum insertion loss in the passband. Three EWC-SPUDT samples with the same IDT design were tested. **Figure 5** shows the measured power durability characteristics when the input power was varied in the range 20 to 30 dBm. All samples ceased to work when an input power of 30 dBm was applied. Figure 5(a) shows a linear relationship between the input and output power, from which the estimated internal power loss for an input power of 30 dBm is nearly 400 mW. When the input power was 28 dBm, the output power was over 350 mW, which is a large enough value for the latter part of the proposed system.

4. Conclusion

To increase the electric power transmitted through the SAW filter in the proposed system, we fabricated several unidirectional SAW filters (EWC-SPUDTs) and measured their power durability characteristics. Experimental results showed that the output power reached 350 mW, which is sufficiently enough value for the proposed system. The results demonstrated the validity of the Pt/Al/SiO_2 structure for the proposed EWC-SPUDT design.

Acknowledgments

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References

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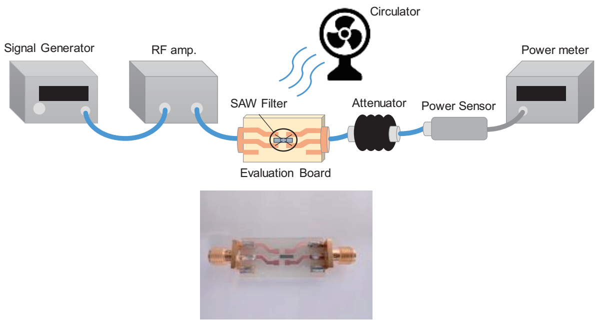
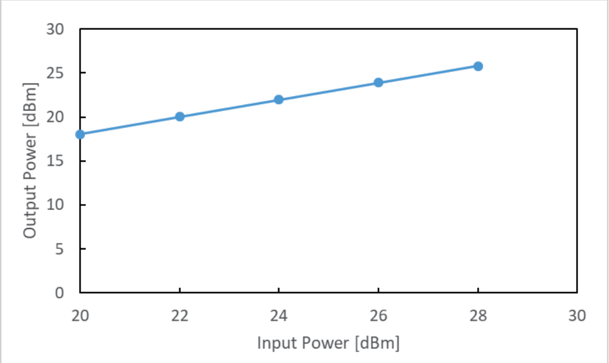
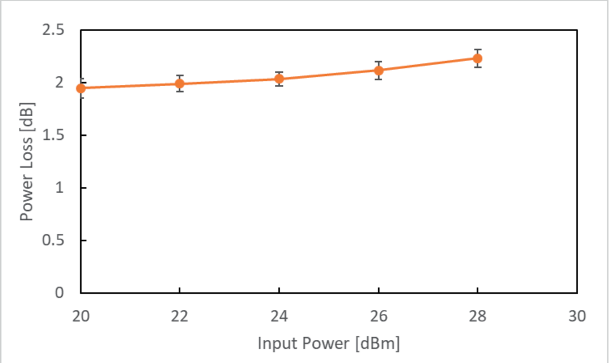


Fig. 4 Schematic of the electrical power transmission measurement system.



(a) Output power



(b) Power loss

Fig. 5 Power durability characteristics of the fabricated EWC-SPUDT.