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Application of taguchi signal to noise ratio design method to ZnO thin film CMOS SAW resonators (Article)

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Abstract

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A systematic approach using Taguchi method is proposed for optimization of complementary metal oxide semiconductor microelectromechanical system surface acoustic wave (SAW) resonators . The aim of the present method is to enhance the performance of SAW devices in terms of electromechanical coupling coefficient while reducing the design and development cost. Controllable factors such as a number of transducers, N_t , the distance between input and output transducers, L_c , and the thickness of the piezoelectric materials, T_c have been optimized. $L_{27}(3^{13})$ orthogonal array was chosen to conduct 27 simulations with three level parameters. Time and cost efficient 2D finite element simulations were done using COMSOL Multiphysics ™ for two-step analysis Eigen frequency and frequency domain analysis. The orthogonal array, signal to noise ratio , and analysis of variance (ANOVA) were calculated to determine the best settings of the design parameters. The maximum electromechanical coupling coefficient is achieved at the optimal condition of $N_t = 6$; L_c =1.6 μm; T_c =2.5 μ m with increased performance by 4.68% for κ^2 and 9.62% for $G_{12}(f)$ compared to the initial conditions. The interaction between pairs of factors has also been investigated. The Taguchi method reveals that both N_t and L_c , and the interaction of $N_t \times L_c$ plays crucial roles in optimizing the electroacoustic conversion of the SAW devices. Hence, the experiment shows that the performance of the SAW device has been successfully optimized. © 2019 IEEE.

Author keywords

Electromechanical coupling coefficient | piezoelectric thin film | surface acoustic wave resonator | Taguchi signal to noise ratio | ZnO

Indexed keywords

Engineering controlled terms: Acoustic noise | Acoustic resonators | Acoustic surface wave devices | Analysis of variance (ANOVA) | CMOS integrated circuits | Cost benefit analysis | Electromechanical coupling | Electromechanical devices | Frequency domain analysis | II-VI semiconductors | Integrated circuit design | MEMS | Metals | MOS devices | Oxide semiconductors | Piezoelectricity | Taguchi methods | Thin films | Transducers | Wide band gap semiconductors | Zinc oxide

Engineering uncontrolled terms: 2D finite element simulation | Complementary metal oxide semiconductors | Comsol multiphysics | Design and Development | Electromechanical coupling coefficients | Optimal conditions | Piezoelectric thin films | Surface acoustic wave resonators

Engineering main heading: Signal to noise ratio

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