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Thesis submitted in fulfillment of the requirements for the degree of Master of Science

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Candidate's Declaration

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledged as referenced work. This topic has not been submitted to any other academic institution or non-academic institution for any other degree or qualification.

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ABSTRACT

This thesis reports a research carried out to design monolithic microwave integrated circuit (MMIC) low pass filters using circuit and electromagnetic simulations. The filters were designed to be constructed on both Si and GaAs semiconductor wafers. The principal objectives were to reduce both circuit size and spurious content.

Three types of designs are proposed here. The first is a Butterworth filter made of commensurate stubs, while the second filter is of the *m*-derived type. Both filters are realized using a single gold layer on the semiconductor substrate. The stub filter exhibited filtering action with a cut-off frequency of 10 GHz. In the *m*-derived filter design, the metal and substrate layers used were optimized with the aid of the electromagnetic simulator to improve the steepness at the transition region. The filter demonstrated a maximally flat passband with a cut-off frequency of 10 GHz and passband and stopband insertion losses of 0.2 dB and greater than 20 dB respectively. The overall size of the circuit was 1.296×1.6 mm^2, smaller than filters constructed from transmission lines designed by other workers. The filters used standard materials compatible with MMIC technology.

The third filter uses a novel metal/polyimide/metal multilayer structure consisting of buried coplanar waveguide and polyimide overlay. Two via holes were used to connect the coplanar waveguide to a transmission line at the top. The structure and the materials used are compatible with MMIC processing. Owing to the unique multilayer architecture, the filter operates well without spurious in the passband and stopband. The combination of several different materials in the structure also reduces the size. The proposed filter has a cut-off frequency of 3 GHz and an area of 1.0×0.7 mm^2 while the stopband insertion and return losses were 20 dB and 25 dB respectively. Optimum performance was obtained when the metal and polyimide thicknesses were 5 μm each. A theoretical model to explain the new structure and design methodology are discussed in detail.

To the author's knowledge this project constitutes the first local work on multilayer MMIC filter designed using electromagnetic simulation. Due to the fact that electromagnetic signals tend to radiate into space at microwave frequencies, more accurate designs were made possible using electromagnetic simulators in this work.

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