A Simple Dual Band Filter Design with 0603 Case Size using IPD Technology for 1.8 GHz and 2.5 GHz DC-block Application

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Abstract: In this paper, a simple dual band filter chip is designed with 0603 case size using IPD technology. The dual-band filter achieves high frequency band at 2.5 GHz and low frequency band at 1.8 GHz. The insertion losses in high frequency band and low frequency band are -0.195 dB and -0.146 dB, respectively. The return losses in these bands are -22.7 dB and -22.8 dB, respectively. The simple dual-band filter based on SI-GaAs substrate is designed within die size of about 1.3 mm^2.

Keywords: Integrated Passive Device (IPD), GaAs, Dual-Band Filter, DC-block

1. Introduction

Integrated passive devices (IPDs) have attracted much attention in recent years, primarily due to the needs of handheld wireless devices to further decrease in cost and size and increase in functionality [1, 2]. Many function blocks in the RF modules, such as impedance matching circuits, harmonic filters, couplers, baluns, and power combiners/dividers, can be realized by using IPD technology.

Because IPDs are generally fabricated using standard wafer fab technologies such as thin film and photolithography processing, they can be manufactured with low cost and small size with excellent reproducibility.

With the rapid progress of wireless communication and strong requirement of miniaturization and multi-function design, dual-band filters have become important components for multi-band wireless communication products at microwave frequencies. For example, a global system for mobile communications (GSMs) operate at both 900 and 1800 MHz, Personal communication services (PCS) operate at 1800MHz, IEEE 802.11b and IEEE 802.11g wireless local area network (LAN) products operate in the unlicensed industrial-scientific-medical (ISM) 2.5 GHz band.

In this paper, we present a simple dual-band filter that covers PCS and ISM bands for 0603 chip DC-block application. The Agilent ADS2008 with IPD design kit developed by NanoENS Inc. is used to guarantee the proposed design.

2. GaAs IPD Process

In this paper, RF passive devices (such as MIM capacitors, thin film resistors, high Q inductors) and a dual-band filter are fabricated using SI-GaAs IPD process with 6 masks. Figure 1 presents a cross-sectional view of GaAs integrated passive devices. To achieve cost and size reductions, a low cost manufacturing technology for RF substrates and a high performance passive process technology are developed for RF-IPDs.

The substrate used for the fabrication is a 6 inch SI-GaAs wafer. which is advantageous to avoid the capacitive and inductive loading of a conductive substrate [3], with thickness of 0.625 mm, permittivity of 12.85, and a loss tangent of 0.006. The process features two levels of plated Cu/Au metal; for the first metal with thicknesses of Cu 4.5 μm and Au 0.5 μm, for the second metal with thicknesses of Cu 3.0 μm and Au 2.0 μm. PECVD Si_3N_4 of 1000 Å was used as the capacitor dielectric layer. Air-bridges were used for the metal layer crossover between inductor windings and the underpasses. After thinning the wafer to its final thickness, backside metallization was applied.

3. Dual-Band Filter Design

The design of simple dual-band filter circuit schematic is shown in Figure 2, which has parallel connection of two series resonance networks. This design used L_1 of 14.04 nH and C_1 of 0.51 pF for 1.8 GHz, used L_2 of 14.04 nH and C_2 of 0.26 pF for 2.5 GHz, which are selected through optimization with Agilent's ADS2008 for the

resonance networks. ADS2008 was used for the simulation of this circuit design.

4. Dual-Band Filter RF Characterization

The simple dual-band filter circuit as presented above is composed of two resonance circuits for 1.8 GHz and 2.5 GHz. Simulation results are superimposed in Figure 3 respectively. S_{11} (or S_{22}) represents the return loss, S_{21} represents the insertion loss. In those two pass bands, the insertion losses are less than 0.2 dB and return losses at input and output port are about -23 dB, respectively. The circuit is fabricated using the aforementioned IPD technology on a SI-GaAs wafer. Detailed circuit layout of the simple dual-band filter is shown in Figure 4 with a 0603 chip size of about 1.3 mm^2.

The simple design, good performance, and small chip size make it possible for the circuit to be used as a dual–band DC block as well as a simple dual-band filter.

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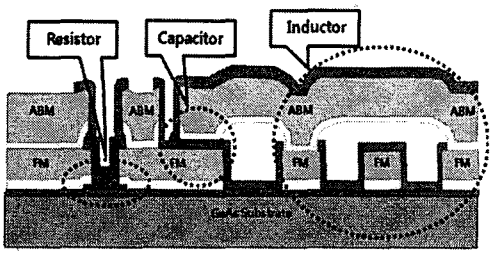

Figure 1. Cross-sectional view of GaAs IPDs

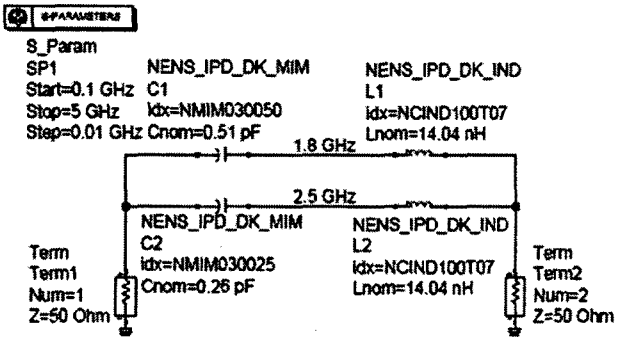

Figure 2. Schematic circuit of simple dual-band filter

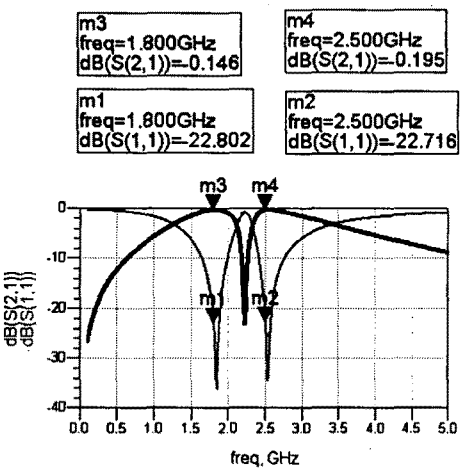

Figure 3. Simulation of S-parameters

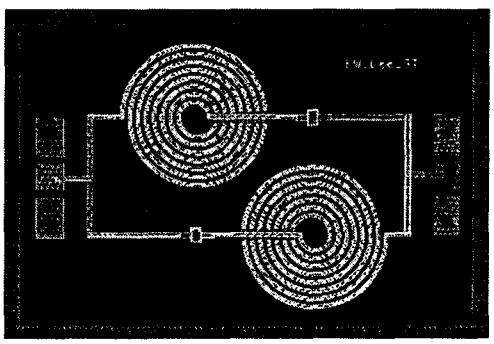

Figure 4. Layout of the designed simple dual-band filter