

Recent Advances in Microwave Planar Filter Technology

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SUMMARY This invited paper aims to present an overview of our recent research and development (R&D) of advanced microwave planar filters, in particular with miniaturization and/or electronically tunable/reconfigurable functionalities, which are in demand for future communication/radar systems as well as emerging wireless applications.

Key words: microwave filters, planar filters, multilayer filters, tunable filters, reconfigurable filters

1. Introduction

Recently, there is an increasing demand for miniature and/or tunable/reconfigurable microwave planar filters. For the filter miniaturization, we have exploited multilayer liquid crystal polymer (LCP) technology [1]–[11]. LCP has been popular not only due to its superior electrical properties up to millimeter-wave frequencies [12], but also because itself is an excellent packaging material for system-on-package [13]. It has a stable low dielectric constant around 3 and low dielectric loss tangent 0.0025 over a wide frequency range. Compared to LTCC, LCP has much lower processing temperature around 280°C. Although LCP has lower dielectric constant than LTCC, which makes it more challenging for RF/Microwave circuit miniaturization, it makes LCP circuit design less sensitive to fabrication tolerances than LTCC, which is very important for multilayer laminated circuit. Although some cheaper PCB laminates can be used for miniature filter designs, LCP offers much higher flexibility on circuit thickness and a very strong coupling can be achieved with a separation as small as 25 μm . This is very important for the design of low frequency filters that requires large capacitances. Furthermore, in the LCP adhesive system [14], circuit layers (core films) and prepreg layers (bonding films) have almost the same characteristics, such as thermal expansion coefficient, dielectric constant and water absorption, which can be a great benefit for both filter designs and practical applications.

In addition to the filter miniaturization, electronically tunable or reconfigurable filters are also in increasing demand in current and emerging multifunctional communication and radar systems owing to their efficiency in use and flexibility in control of frequency spectrum. In general, to develop an electronically tunable or reconfigurable filter,

active switching or tuning elements such as semiconductor p-i-n and varactor diodes, RF microelectromechanical systems (MEMS) or other functional material-based components including ferroelectric capacitors need to be integrated within a passive filtering structure [15]. Planar filters can conveniently facilitate this kind of integration with a small size and to this end we have carried out R&D for tunable or reconfigurable planar filters are based on planar structures [16]–[33].

In the following parts, several typical advanced planar filters resulting from our R&D are highlighted.

2. Packaged LCP Filters

This section is to demonstrate the methods for integrating filters within a package as one of the stages in the manufacturing process, using LCP multilayer technology. Including the packaging in the manufacturing process will reduce the number of processes needed and thus, the final cost of the solution.

2.1 Hermetic Packaged UWB Filter

The concept for packaging with CPW input/output (I/O) ports is illustrated in Fig. 1, which consists of two layers of LCP substrate holding the packaged device in between. The bottom layer will interface between the host board and the packaged device through a CPW structure. Since the CPW structure has both signal and ground on the same plane, it will simplify the connection of the device to the host board. On the other side, the top layer is the ground plane for both the CPW structure and the packaged device. In this way, the CPW becomes grounded-CPW (G-CPW). However, to simplify, G-CPW will be referred as CPW in this paper. CPW and ground plane are connected through via-holes. On top



Fig. 1 Main concept for packaging with CPW input/output (I/O) ports.

Manuscript received April 2, 2015.

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DOI: 10.1587/transelec.E98.C.598

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Japanese Science and Technology, 1988

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