INVITED PAPER Special Section on Microwave and Millimeter-Wave Technology

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.

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

I. 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-onpackage [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 25µm. 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 owning 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

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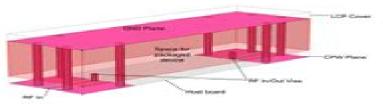


Fig. 1 Main concept for packaging with CPW input/output (I/O) ports.

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Manish Kumar, Anjani Kumar Singh, Subhash Sharma, Devendra Kumar

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Recent Advances in Microwave Technology Bharathi Bhat,1993 Microwave Technologies - Recent Advances and New Trends and Applications Hüseyin Şerif Savci, 2024-06-05 This book is intended to serve as a technology reference for graduate students researchers and engineers on various microwave engineering subjects The chapters encompass a wide range of topics in microwave engineering from its core science for developers to state of the art applications for its users Besides the fundamental technology related chapters such as advanced analysis techniques of microstrip structures using the finite difference time domain in Julia and tunable microwave filter designs there are chapters covering implementations of microwave technology in different applications such as medical imaging medical heating food drying and remote sensing for radio astronomy. The chapters are written based on a collection of theses research papers and case analyses by field experts and academicians The title of the book reflects that each chapter elaborates on a recent advancement or a brand new application of microwave engineering International Symposium on Recent Advances in **Recent Advances in Mechanical Engineering** K.M. Pandey, R.D. Misra, P.K. Microwave Technology, 1989 Patowari, U.S. Dixit, 2021-01-10 This book presents the select proceedings of the International Conference on Recent Advancements in Mechanical Engineering ICRAME 2020 It provides a comprehensive overview of the various technical challenges faced their systematic investigation contemporary developments and future perspectives in the domain of mechanical engineering The book covers a wide array of topics including fluid flow techniques compressible flows waste management and waste disposal bio fuels renewable energy cryogenic applications computing in applied mechanics product design dynamics and control of structures fracture and failure mechanics solid mechanics finite element analysis tribology nano mechanics and MEMS robotics supply chain management and logistics intelligent manufacturing system rapid prototyping and reverse engineering quality control and reliability conventional and non conventional machining and ergonomics This book can be useful for students and researchers interested in mechanical engineering and its allied fields

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Conference on Systems Control and Information Technologies 2016 It includes research findings from leading experts in the fields connected with INDUSTRY 4 0 and its implementation especially intelligent systems advanced control information technologies industrial automation robotics intelligent sensors metrology and new materials Each chapter offers an analysis of a specific technical problem followed by a numerical analysis and simulation as well as the implementation for the solution of a real world problem Recent Advances in Electromagnetic Theory H.N. Kritikos, Dwight L. Jaggard, 2012-12-06 The contributions of this book represent only a small sample of the work of the many researcher electromagneticians who have had the pleasure of being associated with Professor Papas either as students or as colleagues Many of us continue to work in the many and diverse areas that modem electro magnetism encompasses There is however a common thread that was derived from our association with Professor Papas that has greatly influenced our thinking and technical style of expression Professor Papas from his studies at Harvard brought with him to Pasadena a very fundamental and classical point of view that was instilled in all those who were associated with him He saw research problems as a combination offundamental physical and mathematical principles and the electromagnetic reality He searched and demanded clarity and often in the rather involved and engaging discussions which took place in his office he demanded that the baby picture be clearly drawn on the blackboard This requirement certainly for some of us who were working in widely varied subjects ranging from relativistic plasmas to almost periodic media has forced us to reexamine the fundamentals. The clear and lucid marriage of fundamental concepts to applications has been the trademark of Professor Papas s intellectual tradition and has greatly in fluenced the thinking of all of those who have associated with him **Recent Advances in Materials Technologies** K. Rajkumar, Elammaran Jayamani, P. Ramkumar, 2022-09-19 This book presents the select proceedings of the first International Conference on Energy and Materials Technologies ICEMT 2021 organized by the Department of Mechanical Engineering Sri Sivasubramaniya Nadar College of Engineering Kalavakkam India It covers the recent technologies in two broad thematic areas energy and materials Various topics covered in this book include advanced materials and characterization mechanical behavior of materials nanomaterials and nanotechnology biomaterials composite materials environmental friendly materials structural materials advances in aerospace technology and advanced materials and manufacturing The book is useful for students researchers and professionals in the area of mechanical engineering especially various domains of materials

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