

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.

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,1989 *Recent Advances in Mechanical Engineering* K.M. Pandey,R.D. Misra,P.K. 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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Adeli, Luís Paulo Reis, Sandra Costanzo, 2017-03-28 This book presents a selection of papers from the 2017 World Conference on Information Systems and Technologies WorldCIST 17 held between the 11st and 13th of April 2017 at Porto Santo Island Madeira Portugal WorldCIST is a global forum for researchers and practitioners to present and discuss recent results and innovations current trends professional experiences and challenges involved in modern Information Systems and Technologies research together with technological developments and applications The main topics covered are Information

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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 modern 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 of fundamental 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 influenced the thinking of all of those who have associated with him

Recent Advances in Edible Fats and Oils Technology Yee-Ying Lee, Teck-Kim Tang, Eng-Tong Phuah, Oi-Ming Lai, 2022-03-15 This book is written by international experts with both academic and industrial credentials It presents for the first time a collection of up to date scientific advances in the area of edible fats and oils technology over a span of 10 years from 2009 to the year 2019 The book covers the existing and recent advanced techniques adopted in the edible fats and oils research and touches on the processing and modification to the traceability and sustainability issues of fats and oils Some recent technologies like supercritical carbon dioxide microwave ultrasound and enzymatic assisted processes ionic liquid enzymatic processes biosensor and membrane technology are presented in the book The book aims to provide the technologists and researchers in research development and operations in the edible fats and oils industries with critical and readily accessible information on the recent advances in the field The book is divided into three broad sections Fats and Oils Chemistry and Processing Fats and Oils Modification and Health Implications and Fats and Oils Safety Social Environmental and Economic Impacts It is an extremely comprehensive and valuable resource which serves as an essential reference for students and lipid scientists from academia or industry

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Chen,2000-04-05 Proceedings of the Second International Symposium on Recent Advances in Microwave Technology.

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Embedded Systems Smain Femmam,Pascal Lorenz,2024-05-11 This book is devoted to enhanced version of selected papers presented at the 7th International Conference on Communication and Network Technology ICCNT 2023 The objective of the proceedings of ICCNT 2023 is to present the recent research results and technological advances in the fields of theoretical and experimental applications of embedded systems communications and signal processing decision as well as in emerging areas related to the tracks of the conference The specific topics of interest within the scope of this special issue include design tools for electronics and embedded systems embedded systems and software system on chip SoC multiprocessor system on chip MPSoC platforms and applications network on chip NoC design methodologies reconfigurable computing system design synthesis and optimization advanced communications circuits and systems for communications optical fibers applications optical communications sensors image laser applications in telemetry LiDAR system anemometry computer 3D visions range technique RF and wireless communications image and signal processing decision image and video processing technology compression coding and implementation cryptology and watermarking real time systems sensors and instrumentation data acquisition audio acoustic speech biomedical signal processing sensor microsystems and industrial sensors computer engineering and networks cloud computing technology internet technology computer security computing networks and data acquisition Proceedings of 3rd International Symposium on Recent Advances in Microwave

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aim of the 2nd international conference on recent advances in materials manufacturing and machine learning processes 2023 RAMMML 23 is to bring together all interested academic researchers scientists engineers and technocrats and provide a platform for continuous improvement of manufacturing machine learning design and materials engineering research RAMMML 2023 received an overwhelming response with more than 530 full paper submissions After due and careful scrutiny about 120 of them have been selected for presentation The papers submitted have been reviewed by experts from renowned institutions and subsequently the authors have revised the papers duly incorporating the suggestions of the reviewers This has led to significant improvement in the quality of the contributions Taylor Francis publications CRC Press have agreed to publish the selected proceedings of the conference in their book series of Advances in Mechanical Engineering and Interdisciplinary Sciences This enables fast dissemination of the papers worldwide and increases the scope of visibility for the research contributions of the authors Japanese Science and Technology ,1988

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