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Editorial

Passive Planar Microwave Devices

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1. Introduction

Passive planar circuits play a key role in many RF/microwave applications, such as in wireless communications, medical instrumentation, and remote sensing. From their earliest developments during World War II to the present day, they have become indispensable for their low cost and low weight while maintaining high performance. As a result, they are still undergoing research and development. In recent years, multiple technologies have been proposed with the aim of combining the characteristics of traditional planar and nonplanar transmission lines, highlighting substrate integrated waveguide (SIW) technology as the most popular among them.

This Special Issue is focused on highlighting recent contributions to microwave device development in planar technologies. A total of twelve papers have been published in this volume, each addressing several important research problems and advancements in the field of filters, multiport circuits, dividers, combiners, couplers, multiplexers, microwave sensors, and antennas. These articles provide a significant contribution to the state of the art.

2. Contributions

Planar technologies allow for a wide number of possibilities when facing new designs and challenges. In this Special Issue, a compilation of twelve relevant papers on the topic of passive planar microwave devices has been published.

In [1], ElKhorassani et al. presented the design of a two-port electronically tunable phase shifter with progressive impedance transformation in the K band. The phase shifter consists of a 3 dB hybrid coupler loaded with reflective phase-controllable circuits. They measured the prototype at a frequency of 18 GHz, showing a dynamic range of 600 degrees. Zhu et al. [2] proposed a new method to monitor patients with Huntington's disease (HD) using wireless sensing technology. Experimental data were firstly collected by the self-developed microwave sensing platform (MSP) and subsequently preprocessed. Finally, support vector machine (SVM) and random forest (RF) algorithms were used to train the model. The MSP system continuously monitors patients in a noncontact manner, which offers more convenience and privacy. The experimental results show that the prediction accuracy of SVM can be as high as 98.0%, and that of RF can reach 96.7%. Camacho-Gomez et al. [3] proposed a design for a multiband textile antenna for LTE and 5G communication services, composed of a rectangular microstrip patch, two concentric annular slots, and a U-shaped slot. They showed that the coral reef optimization, with the substrate layer (CRO-SL) algorithm, can produce a robust multiband textile antenna, including the LTE and 5G frequency bands. For the optimization process, the CRO-SL is guided by means of a fitness function obtained after antenna simulation by a specific simulation software for electromagnetic analysis in the high-frequency range. In [4], Kumar et al. presented a planar, microstrip line-fed, quad-port, multiple-input multiple-output (MIMO) antenna with dual-band rejection features for ultra-wideband (UWB) applications. The proposed MIMO antenna design consists of four identical octagonal-shaped radiating elements that are placed orthogonally to each other. The dual-band

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rejection property (3.5 GHz and 5.5 GHz corresponding to Wi-MAX and WLAN bands) was obtained by introducing a hexagonal-shaped complementary split-ring resonator (HCSRR) in the radiators of the designed antenna. Isolation was observed to be higher than 18 dB, and the envelope correlation coefficient (ECC) was less than 0.07 for the MIMO/diversity antenna in the operating range of 3–16 GHz. Dai et al. [5] proposed an ultra-wideband and miniaturized spoof plasmonic antipodal Vivaldi antenna (AVA) for ultra-wideband antenna applications, such as in the 2G/3G/4G/5G base stations. They designed and measured an antenna operating from 1.8 GHz to 6 GHz, with an average gain of 7.24 dBi.

Muñoz-Enano et al's [6] review paper focuses on microwave sensors, particularly planar sensors based on resonant elements for material characterization, including solids and liquids. In addition, they reported the main advantages and limitations of microwave sensors based on electrically small planar resonant elements. Moreover, they presented several sensing strategies, with a special emphasis on differential-mode sensors. In [7], Medran del Rio et al. proposed a new dual-band balanced bandpass filter based on magnetically coupled open-loop resonators in multilayer technology. The lower differential passband, centered at the global positioning system (GPS) L1 frequency, 1.575 GHz, was created by means of two coupled resonators etched in the middle layer of the structure, while the upper differential passband, centered at a Wi-Fi frequency of 2.4 GHz, was generated by coupling two resonators on the top layer. Magnetic coupling was used to design both passbands, leading to an intrinsic common-mode rejection of 39 dB within the lower passband and 33 dB within the upper passband. Arnberg et al. [8] demonstrated the beneficial effects of introducing glide symmetry into a two-dimensional periodic structure. Specifically, they investigated dielectric parallel plate waveguides periodically loaded with Jerusalem cross slots in three configurations: conventional, mirror, and glide symmetry. Out of these three configurations, they demonstrated that the glide-symmetric structure is the least dispersive and has the most isotropic response. Furthermore, the glide-symmetric structure achieved the highest effective refractive index, which enables the realization of a broader range of electromagnetic devices. To illustrate the potential of this glide-symmetric unit cell, a Maxwell fish-eye lens was designed to operate at 5 GHz.

Trujillo-Flores et al. [9] developed a fully transparent multiband antenna for vehicle communications. The antenna is coplanar-waveguide-fed to facilitate its manufacture and increase its transmittance. An indium–tin–oxide film, a type of transparent conducting oxide, was selected as the conductive material for the radiation path and ground plane, with a sheet resistance of 8 ohms/square. The substrate is glass with a relative permittivity of 5.5. The proposed antenna meets the frequency requirements for vehicular communications according to the IEEE 802.11p standards. Additionally, it covers the frequency bands from 1.82 to 2.5 GHz for LTE communications applied to vehicular networks. Cui et al. [10] proposed a multilayer bandpass filter with high selectivity. To this aim, the discriminating coupling formed by slot-coupled quarter-wavelength and half-wavelength resonators introduced a zero at $3f_0$ (f_0 is the center frequency), while the second harmonic was also suppressed due to the quarter-wavelength resonators. As a result of the multilayer structure, source–load coupling was introduced to improve selectivity. Then, an extra coupled line path was added with the same amplitude as the discriminating coupling path while they were out of phase. Thus, signal cancelation produced three extra transmission zeros, with a further improvement in selectivity and suppression performance. The design was validated by a manufactured prototype bandpass filter centered at 2.49 GHz with a fractional 3 dB bandwidth of 8.1%. Kim et al. [11] designed a microwave planar cutoff probe to measure the cutoff frequency in a transmission (S21) spectrum. For real-time electron density measurement in plasma processing, three distinct types of probes were demonstrated: point-type, ring-type (RCP), and bar-type (BCP). Moreover, the work includes a computational characterization of an RCP and a BCP with various geometrical parameters, as well as a plasma parameter, through a commercial three-dimensional electromagnetic simulation. Among the investigated parameters, the antenna distance was found to be the most important parameter for improving the accuracy of both RCP and BCP. Finally, Herraiz et al. [12] proposed a new wideband transition from the microstrip line (MS) to ridge empty substrate integrated waveguide (RESIW), with a dielectric taper based on the equations of the superellipse. The new wideband transition presents simulated return losses in a back-to-back transition greater than 20 dB in an 87% fractional bandwidth, while in the previous transition, the fractional bandwidth was 82%, which supposes an increase of 5%. Furthermore, the transition presented simulated return losses greater than 26 dB in an 84% fractional bandwidth, while the measured return loss was above 14 dB with an insertion loss lower than 1 dB throughout the band.

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