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A Brief Review on Ultra Wideband Microstrip Filters

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A B S T R A C T

This paper presents a review of the techniques, challenges faced and potential research trend in ultra wideband microstrip bandpass filters. Microstrip filters continue to draw a lot of research attention due to its importance in modern communication systems. Issues such as flat passband response, wide stopband, compactness, size and weight are discussed in this article. Designing an ultra wideband filter has its own challenges also. Various techniques are being used to design ultra wideband bandpass filters in order to achieve wide passband.

Keywords: Microstrip, band pass, filters, ultra wideband

1. Introduction

A microwave filter is a two-port network used to control the frequency response at a certain point in a microwave system by providing transmission at frequencies within the passband of the filter and attenuation in the stopband of the filter. Filters play an important role in many RF/microwave applications.

They can also be used to split or blend frequencies. Emerging applications like wireless communications continue to place greater demands on RF/microwave filters, such as better performance, smaller size, lighter weight, and lower cost.RF/microwave filters can be designed as lumped element or distributed element circuits, depending on the requirements and specifications. They can be achieved in waveguide, coaxial line, and microstrip transmission lines, among others.

Pioneers such as Mason, Sykes, Darlington, Fano, Lawson, and Rechards pioneered microwave filter theory and technique in the years leading up to World War II. In the late 1930s, several approaches of filter design were developed under the guidance of these pioneers. G. Matthaei, L. Young, E. Jones, S. Cohn, and others from Stanford Research Institute became particularly active in filter and coupler work in the early 1950s. Since then, filter research and development has been extremely popular and in-demand [1].

2. Microstrip Filters

Because microstrips can function at a wide range of frequencies, their usage in the design of microwave components and integrated circuits has exploded in popularity over the last decade. Microstrip is also lightweight, simple to produce, and cost-effective to integrate. Numerous formulae for the analysis and synthesis of microstrips have been presented by a number of scholars. The rapid development of new microstrip and other filters has been accelerated by the recent advancement of novel materials and fabrication processes, such as Monolithic Microwave Integrated Circuit (MMIC) and Micro Electro Mechanical Systems (MEMS).

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3. Types of Microstrip Filters

Several compact and high performance microstrip filters have been reported such as by using cross-coupled microstrip hairpin-resonators [2], aperture-coupled microstrip open-loop resonators [3], cross-slotted patch resonator [4], HTS microstrip quasi-elliptic function [5], defected ground structure (DGS) [6], photonic band gap (PBG) excited split-mode resonators [7], complementary split ring resonators [8], fractal-shaped microstrip coupled-lines [9], ring or stepped- hybrid microstrip/CPW structure [10], parallel coupled HTS [11], folded open-loop ring resonators (OLRRs) [12], coupled metamaterial resonators [13], electromagnetic band gap (EBG) embedded multiple-mode resonator [14], multilayer dual-mode dual-bandpass filter [15], parallel-coupled microstrip lines [16], capacitance loaded square loop resonator [17], asymmetric capacitive/inductive coupling [18], etc.

4. Ultra Wideband Bandpass Filters

In 2002, the U. S. Federal Communications Commission (FCC) approved the unlicensed use of ultra-wideband (UWB) from 3.1 GHz to 10.6 GHz for commercial communication purposes [19]. Since then, academic and industrial research into various UWB devices has developed significantly. BPF is one of the essential components in the UWB communication system, and various structures have been studied to achieve wideband filters. However, radio signals such as the WiMAX (i.e., 3.5-GHz band), wireless local-area network (WLAN) (i.e., 5.2- and 5.8-GHz bands), 6.8-GHz RF identification (RFID) communication, and some 8.0-GHz satellite-communication system signals may interfere with the UWB radio system within the range defined by the FCC. To avoid interference by the undesired radio signals, UWB BPFs with a notch band in order to avoid being interfered by the undesired radio signals are essential in the UWB communication systems. Numerous different techniques are being explored day in and day out to achieve this purpose.

5. Use of DGS, PBG, CPW and CBCPW structures in Ultra wideband filters

One of the most exciting areas of research these days is defective ground structures (DGS) for microstrip lines, such as diverse microstrip photonic bandgap (PBG) structures with periodic etched defects on the backside metallic ground plane. The PBG study was originally done in the optical fields, but the PBG structures can be applied to a wide frequency range, including the microwave frequency band, if the dimensions are properly scaled. PBG circuits have recently sparked increased interest in microwave and millimeter-wave applications. The only PBG structures with a periodic structure have been known to provide frequency band rejection, i.e. bandgap efficiency.

The electromagnetic band-gap (EBG) or photonic band-gap (PBG) structure exhibits a bandstop behavior over a certain frequency range, in which the propagation of electromagnetic waves is prohibited. Due to the band-gap that can suppress the unwanted signals, the PBG structures have a wide range of applications in antennas, filters, couplers, high-speed circuits, etc. Therefore, the investigation of PBG structures has attracted much attention through different methods [20].

A unit DGS is a novel etched lattice shape for the microstrip. The shield current distribution in the ground plane is disrupted by an etched defect in the ground plane. This disturbance can change transmission line parameters such as line capacitance and inductance. The DGS is a backside metallic ground plane with narrow and wide etched portions that increase the effective capacitance and inductance of a transmission line, respectively. The shape, size, and orientation of a slot can have an impact on the filter's and neighbouring circuits' performance. The sharpness of transition and stopband rejection is influenced by the shape of the DGS slots. The position of the DGS slots is also a critical parameter for the design of the compact and better filters.

Several topologies useful for the realization of coplanar waveguide bandpass filters have been reported in recent years. As with microstrip, coplanar waveguide (CPW) filters may be comprised of coupled lines, stubs and/or lumped elements and are often based on multilayer configurations. Coplanar waveguides (CPWs) have several advantages over conventional microstrip lines, including no need of via-holes, easy connection of both series and shunt components, low dispersion and radiation loss, and so on. Furthermore, due to an additional backside metallic ground plane, the conductor backed coplanar waveguides (CBCPWs) could improve both the power-handling capability and the mechanical strength of the integrated circuit [21, 22].

In the equivalent circuit of the defected ground structure (DGS), there are a series inductor and a shunt capacitor, so the DGS exhibits a bandstop response. Although the open or short stub also exhibits a bandstop response, it can’t reduce the circuit size. Recently, the DGSs have been extensively studied to further reduce the circuit size and improve the stopband characteristics of the filters. Along with that the slow-wave CBCPW SIR and the CBCPW with DGS are also being studied widely to design microwave circuits.

6. Conclusion

From the above literature survey we find that there is still ample scope for the design and development of advanced miniaturized microstrip bandpass filters in the form of multilayer, multimode, parallel coupled ultra wideband bandpass filters for modern communication systems.

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