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A Compact Dual Bandnotch Filter for ISM Applications.

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Abstract: *A novel circuit structure of dual-band notch Fil-ters is proposed in this paper. This structure comprises two shunt-connected stepped impedance resonators with J Inverter,a transmission line in between. Theoretical analysis and design procedures are described. Insertion loss method is used to find the discrete filter design. The derived synthesis equations have two degrees of freedom which provide more design flexibility in filter synthesis. In this paper, A wide bandwidth micro-strip band-stop filter (BSF) is presented. For efficiently reduce the size of the filter. the filter operate in two ISM Bands.*
Index Terms: *Bandstop filter(BSF), dual-band(DB) filter, filter synthesis, stepped-impedance resonator (SIR).*

I. Introduction

Microwave bandstop filters are highly desired for their effec-tive suppression of spurious signals in wireless communication applications. The dual-band or multi-band RF/Microwave sys-tem has become quite popular in recent years because of the need for wireless mobile communications. Dual-band bandstop filters (DBBSFs) are attractive due to their ability to treat the unwanted double-sideband spectrum of high power amplifiers and mixers using one single filter to decrease the size and cost of the circuit. In a microwave communication system, the band stop Filter is an important component typically adopted in both receivers and transmitters.

The industrial, scientific and medical (ISM) radio bands are radio bands (portions of the radio spectrum) reserved internationally for the use of radio frequency (RF) energy for industrial, scientific and medical purposes other than telecommunications. Examples of applications in these bands include radio-frequency process heating, microwave ovens, and medical diathermy machines. The powerful emissions of these devices can create electromagnetic interference and disrupt radio communication using the same frequency, so these devices were limited to certain bands of frequencies. In general, communications equipment operating in these bands must tolerate any interference generated by ISM applications, and users have no regulatory protection from ISM device operation. Rejection of such band is necessary for amplifiers and mixers out of band rejections and harmonics.

Dual band stop filters (DBBSFs) are commonly employed in high-power amplifiers and mixers to suppress the double-sideband spectrum to reduce circuit size and cost. Numerous structures and methods have been proposed for realizing dual-band Filters. The dual-stop band response can be determined by applying a two-step frequency-variable transformation to the low-pass prototype Other benefits of DBBSFs are their low passband insertion loss and group delay, since their resonators resonate in the stopband rather than in the passband.

II. Related Work

The robust receiver solution is proposed for unlicensed bands and Interfering signals of increased power level expected in these bands get acceptable as they are reduced by a tunable band reject filter controlled by the digital receiver unit with tunability achieved by using varactor diodes[1]. A Filter-Antenna with reconfigurability is acheived by using a PIN diode attached within the U slot of the ground plane is presented for both the cases of cognitive radio[2].

A Tunable BRF with high interference elimination and low pass band insertion loss is designed by Zhengzheng Wu, Yonghyun Shim and et.a in which rejection band switch-ing is done by usingohmic switches with MEMS capacitors and is Fabricated using silicon based Integrated passive de-vice(IPD) technology provide miniaturized structures[3]. The filter designed by using MEMS technology on Coplanar Wave Guide (CPW) transmission line with Complimentary Split Ring Resonator(CSRR).The CSRR etched on both the patch l line and ground plane of coplanar wave guide.Tunability in the rejection band is achieved through RF-MEMS switched capacitor[4].

Kuo-Sheng Chin and et. al designed a filter using Stepped Impedance Resonators (SIRs) with two stop band at desired frequencies. DBBSF have low insertion loss since the stop band resonation is more than that of the pass band.It eliminate the unwanted double side band spectrum of RF components[5].

A compact wide bandwidth filter using dendritic structure is designed by Yun-hong He and et.al with low cost are widely used in communication systems sucha as oscillators, equalizers etc. The cascading dendritic structures are used to form First Order and 2nd order cell structures.[6]. The ultra wide band (UWB) with ISM band interference is removed by using a notch filter with high Q.Due to the power handling capacity and high rejection perfomance cavity band reject filters are used in the base station of RF front end [7].

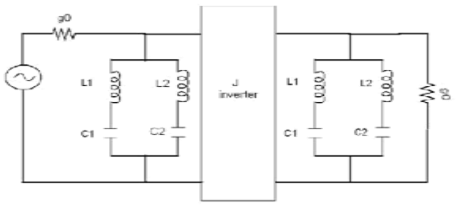

Fig. 1. Equivalent Circuit

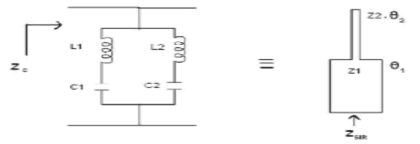

Fig. 2. Transformation circuit

Somdotta Roy Choudary designed a stop band filter con-sisting of a rectangular split ring resonator (SRR) with double tuned rejection frequencies at 2.45GHz and 5.8GHz (ISM bands).The intentional Defected ground structrure(DGS) is implemented with rejection property with back radiation prob-lems.Stop bands are at 2.4GHz and 5.6 GHz[8]. Chao-Hsiung Tseng and et.al proposes a microwave voltage-controlled oscil-lator (VCO) with stepped-impedance resonator (SIR) filter for elimination of out of band signals and used in radar and other wireless communication systems. The output wave signal's phase noise is measured using the VCO and is designed at 2.4GHz which is implemented by parallel transmission line SIRs hence reduces the sizes of the circuit[9].

M J. Chappel and et.al proposed a new filter bank system for the operation of multiple nodes in the software defined radio(SDR).The traditional system is upgraded with a recon-figurable front end filter. By LNA filtering the unlicensed band is protected from harmonics generated by the nonlineariteies or noise interference in the system[10].

III. Design And Implementation

All kind of filter can be designed with capacitor and inductance, the Schematic of Band-stop Filter is given below. DBBSF's have two parallel connected different length open stubs which are quarter wavelength long at the respective mid band frequencies. A topology that replaces these parallel connected stubs with SIR's is shown here in Fig 1. Fig 2 shows the equivalent circuit of Fig 1 in which the composite shunt resonator structure is used to get the two anti resonance fre-quencies. At the first resonant frequency when series resonator formed by L1 and C1 resonate , series resonator formed by L2 and C2 behaves as an open circuit as their impedance is much larger than that offered by the former. At the second stop band frequency series resonator formed by L2 and C2 will resonate, and the series resonator formed by L1 and C1 will behave as open circuit. Thus this represents a DBBSF. The transformation of LC circuit to microstrip equivalent is given by

IV. Simulation And Result

A second order DBBSF was simulated, fabricated and tested on an FR-4 substrate with r=4.4 and tan=0.02. The thickness of the substrate was 1.58mm and conductor thickness is 16um. The simulate result S parameter is shown in Fig . from the picture, we can see the first stop band is at 2.4 GHz, the second

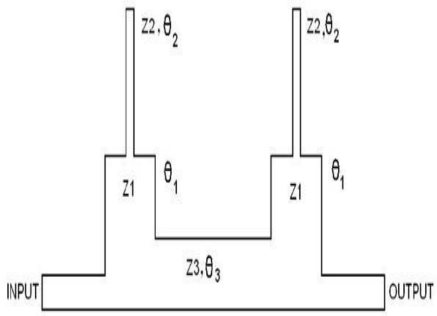

Fig. 3. Microstrip equivalent Circuit

stop band is at about 5.75 GHz, the stop-band rejection is more than 45 dB, the S 11 in both stop band is less than -10 dB, the result meet the required index. The hfss simulation result are given below. A miniaturized matched band-stop lter has been proposed, based on a stepped impedance resonator. In contrast to a dual-mode ring resonator that has an electrical length of 360, this filter yields a circuit size reduction of 50achieve a dual-band matched band-stop filter. The proposed dual-band shows high stop-band attenuation. Note that such results cannot be obtained using a conventional band-stop filter. The new prototypes were designed to suppress the interference among communication systems due to coexisting narrowband applications, especially in an aircraft system.

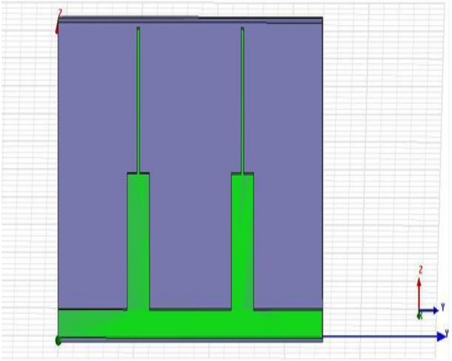

Fig. 4. Microstrip equivalent Circuit

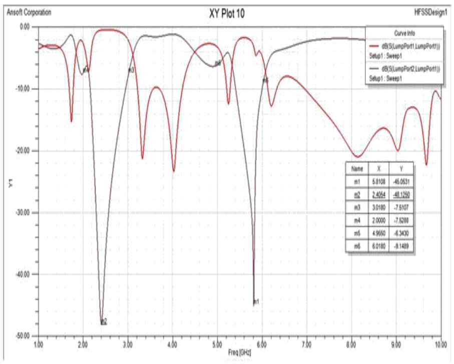

Fig. 5. return loss and insertion loss

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