Design of Compact DGS shaped Microstrip UWB-Bandpass Filter based on Circular Stub MMR for Mobile Communication

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Abstract: In this paper, An Ultra-wideband (UWB) - band pass filter (BPF) based on circular stub multi-mode resonator (MMR) is presented, which is formed by three stage circular stubs and cascading several open-circuited transmission line sections with a coupled-line section. We are also using the three arrowhead shaped defected ground structure (DGS) to enhance the performance of the filter. The performance analysis of proposed filter has been carried out using CST Microwave Studio on various radiuses of stubs. The best result is obtained for the pass band at the side stubs on radius 0.7 mm. The proposed filter exhibits pass band characteristics for the frequency range 3.6-10.45 GHz (Bandwidth-6.85 GHz) with minimum suppression of -62 dB. The constant group delay with maximum variation of 0.1 ns at the frequency of 3.7-10.6 GHz and good UWB performance makes it a selective candidate for various UWB wireless applications.

Keywords: ***BPF, circular stub, DGS, microstrip, multimode resonator (MMR), Ultra-wideband (UWB).***

I. INTRODUCTION

In the current scenario, Ultra-Wideband (UWB) communication system offers numerous wideband applications such as microwave medical imaging, Ground Penetrating Radar (GPR) and RFID tag for inventory control and asset management. Always compact and inexpensive UWB transceivers are required for such wireless applications. Therefore UWB transceivers should be compact and inexpensive [1] .An UWB transmitter with different blocks is depicted in Figure 1, where the input data are encoded, modulated, and multiplexed at the chip level, and then the multiplexed pulse is transmitted by a UWB antenna after reshaping and amplifying at the package level.

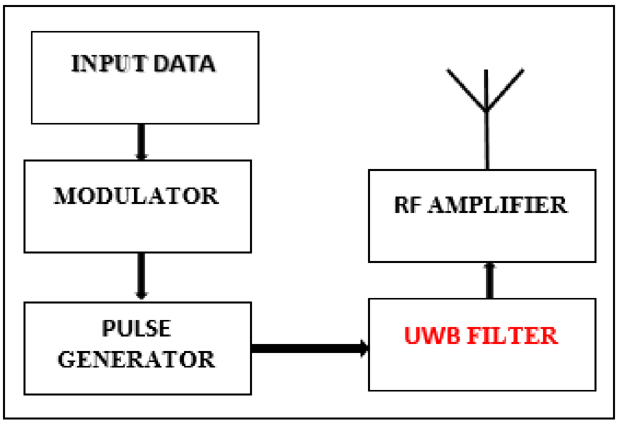


Fig 1: An UWB transmitter block diagram

In this paper extended version of MMR is used and proposed a novel microstrip line UWB band pass filter using Defected Ground Structure (DGS). Rest of the paper organized as follow: In the section- II, literature survey is presented and in the section-III, a detailed structural analysis of proposed design is carried out, the parametric study and result discussion is given in section-IV. Finally proposed design conclusion and future scope is given in section-V.

II. LITERATURE SURVEY

Researchers have managed to develop an UWB BPF with an excellent filtering performance with a very simple structure .The BPF using broadside coupled microstrip coplanar waveguide structure provided excellent UWB filtering performance in terms of its insertion loss, reflection loss and group delay compared to other works. Further research on this structure was done and a more functional bandpass filter was developed which not only operates over wideband but also has the capability to reject some frequency band. This work provided promising dualband ultra wideband filter which enabled the possibility of avoiding interference between UWB radio system and existing narrow band radio systems. In this paper, for UWB application, a low-cost knight's helm shaped double-sided printed PCB antenna is designed. The antenna gives a return loss of more than 10 dB, constant group delay and gain flatness over the frequency range set by the Federal Communications Commission (FCC) for UWB application.

 DOI : 10.18231/2454-9150.2018.0283

[2]. Ultra wide band (UWB) that is defined by the FCC for short-range high-performance wireless communication and sensor networks with useful features, such as extremely short time delay, immunity to multipath fading, being carrier free, and having low duty cycle, wide bandwidth, and low power spectral density, has been a subject of notice recently. Furthermore, UWB signals that are generated in the optical domain can be easily tailored to have a spectrum that meets the FCC specified spectral mask. In this paper, techniques to generate UWB signals in the optical domain will be discussed. The three categories are used to define this technique for generation of UWB signals based on the following: 1). phase-modulation-to intensity modulation conversion, 2). a photonic microwave delay-line filter, and

3).optical spectral shaping and dispersion-induced frequency to- time mapping. The areas for future development and the challenge of implementation of these techniques for practical applications will also be discussed [3]. A novel ultra-wideband (UWB) band pass filter (BPF) is designed. Using the hybrid microstrip and coplanar waveguide (CPW) structure, CPW nonuniform resonator or Multiple-Mode Resonator (MMR) is constructed to generate its first three resonant modes occurring around the lower end, centre, and higher end of the UWB band. [4]. With narrow notched (rejection) band a compact ultra-wideband (UWB) bandpass filter (BPF) in the UWB passband realized on a microstrip line is implemented and presented in this paper for use in wireless communication applications within the unlicensed UWB range set by the Federal Communications Commission (FCC) [5]. Using stub-loaded multiple-mode resonator (MMR), a novel compact ultra-wideband (UWB) bandpass filter (BPF) is presented in this paper. The MMR is constructed by loading three open stubs in a uniform-impedance resonator, i.e., one stepped-impedance stub at the center and two uniform-impedance stubs at the symmetrical side locations [6]. In this paper by the US Federal Communication Commission (FCC), the power spectral density of UWB for indoor/outdoor communication devices is defined. This paper shows the design of microstrip BPF using coupled half-wave resonators using CST microwave studio EM simulation platform [7]. In this paper an ultra-wideband high-temperature superconducting bandpass filters is designed for Japan's low-band spectrum. First, they designed a low-band filter with a microstrip three-mode resonator loaded with two open stubs. The three-mode resonator is characterized by the ease of controlling the frequency response compared with other resonators. In addition, they loaded a low-pass filter consisting of a microstrip coupled-line hairpin unit to suppress all unwanted high-frequency harmonics. The simulated filtering characteristics of the low-band filter gave a wide passband. A 25 mm ×25 mm microstrip stub loaded three mode resonator band pass filter is designed which have pass band only 3.4 GHz -4.67 GHz only and has insertion loss of 0.06 dB. Although a good insertion loss achieved in this design, but ground plane material is gold, therefore fabricated prototype is very expensive [8]. Another novel microstrip line UWB band pass filter has been reported in [9] using multiple mode resonator (MMR) with insertion loss of 2 dB and group delay varies from 0.2 to 0.43 ns. In [10] a compact UWB band pass filter is designed using MMR with high insertion loss of 0.2 dB at center frequency of 6.8 GHz. A parallel-coupled microstrip line band pass filter for UWB applications has been developed in [11].

III. Filter Design Procedure

Proposed filter is designed on the FR4 substrate with the size of 20 mm × 20 mm with the dielectric constant of 4.3 and substrate height is 1 mm. The proposed filter have three arrow head defected ground structure (DGS) which enhance the pass band as well as roll off factor as depicted in figure 2.

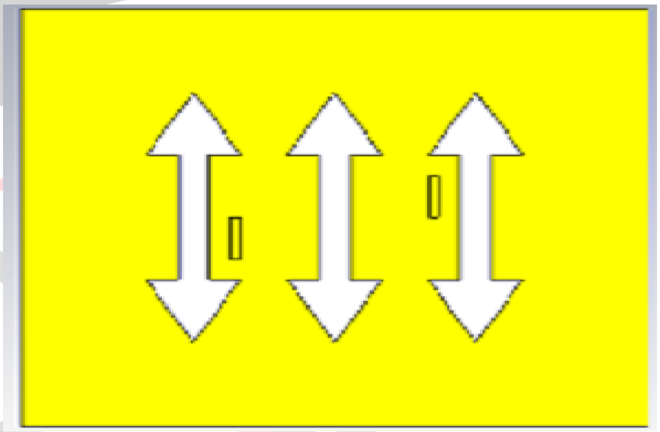
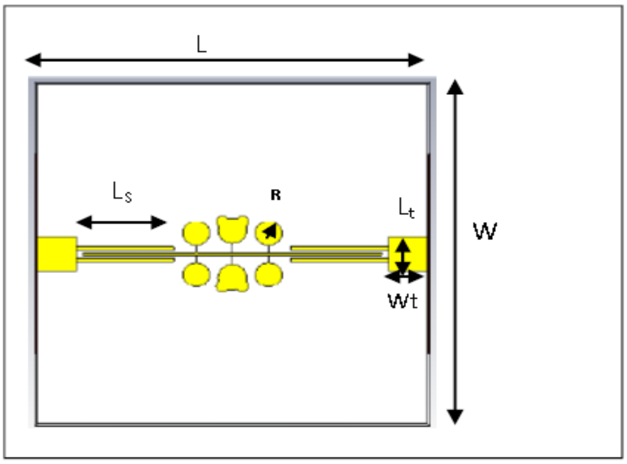


Fig 2: DGS structure with three arrowhead shape

There are three circular stubs on the top of the substrate with microstrip coupled line which is enhancing the other desired parameters like return loss, insertion loss, group delay etc. of the proposed filter. All dimensions of the proposed UWB BPF filter is also defined under the figure 3.



L=20 mm, W= 20 mm, Ls =5mm, Lt = 2mm, R =0.7 mm, Wt=2mm

Fig 3: Proposed MMR Based UWB Filter structure

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IV. RESULTS AND DISCUSSION

The parametric analysis of proposed filter has been carried out using CST Microwave Studio Tool. All the parameters of the filter are analysed at three different radiuses of side stubs which is denoted by R.

The parametric study of simulated results of return loss of the proposed filter is shown in figure 4.On the variation of R with0.5 mm; the minimum suppression is -42 dB have been noticed with the frequency range of 3.59 – 10.97 GHz. Further increases the radius to a value of 0.6 mm value of minimum suppression is further decreases to a value of -51 dB with frequency range of 3.59- 10.7 GHz. At the value of radius 0.7 and 0.8 mm minimum suppression and frequency range are -61 dB, -42 dB, 3.6-10.45 GHz and 3.6- 10 GHz respectively. From above these we can analyse the low as low value of minimum suppression is achieved at radius of 0.7 mm whereas somehow compromise in terms of frequency range. Return loss in pass band is -61 dB so this mean only about 0.001% power is reflected back in pass band which is very less . Return loss in stop band is about -0.25 dB so this means about 90% power is reflected back in stop band from port -1 to port-2.

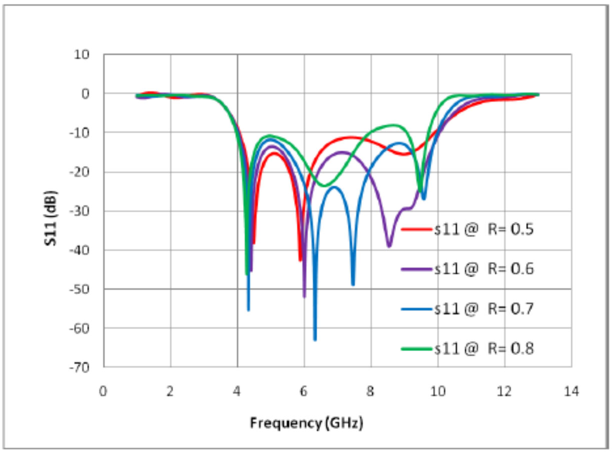

Fig 4: Return loss analysis in Pass band

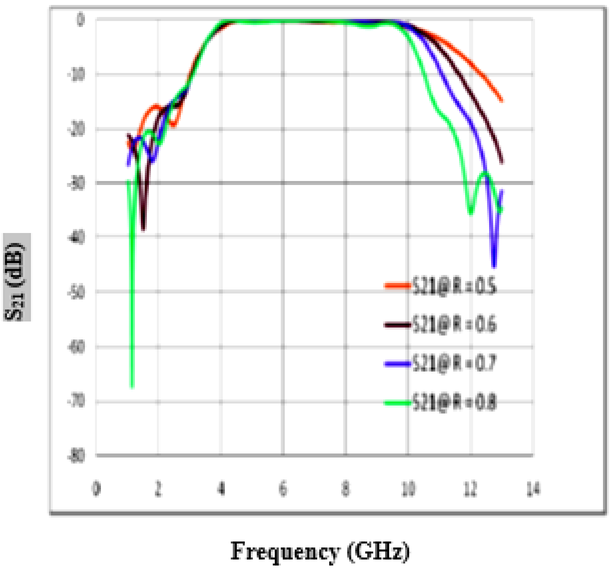

Fig 5: Pass band results of proposed UWB filter

All these radiuses of side stubs. The insertion loss is about -0.2 dB and same for these entire changes in the radius with fractional bandwidth 111% as shown in figure 5. Insertion Loss in pass band is about -0.2 dB so this means about 90% power is transmitted in port 1 to port 2. Insertion loss in stop band is about -45 dB so this means about 0.01% power is transmitted in port 1 to port 2. The filter is featured by good performance in stop band. The defected ground structure (DGS) with three arrowhead is improve the pass band response of the proposed filter and also use to size miniaturization and reconfigurability.

The group delay of the proposed filter is more constant with a variation less than 0.1 ns at the interested frequency range as shown in figure 6, so that's mean this filter has good stability.

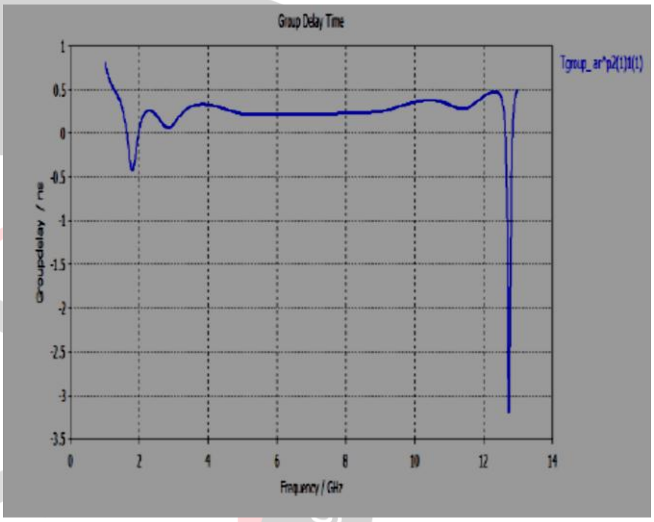

Fig 6: Group delay of proposed UWB Filter

V. CONCLUSTION AND FUTURE SCOPE

In this paper, a UWB filter with wideband characteristics has been designed and analyzed using CST microwave studio tool. The MMR techniques is not only offer low insertion loss as well as better matching with transmission line. This filter is composed of three circular stubs. The performance of the filter is best at radius 0.7mm out of other radiuses. It shows the frequency range 3.6-10.45 GHz (Bandwidth-6.85 GHz) with minimum suppression of -62 dB, which is comes under the UWB range defined by FCC. By adding the short- and open-circuited stubs at input/output ports for impedance matching, the performance of the filter can be improved further. The three arrowhead defected ground structure (DGS) is also enhancing the performance of the filter. The DGS is used to miniaturize the size of filter. Therefore good pass band behavior and compact structure of proposed filter is best suitable for recent mobile communication technologies.

ACKNOWLEDGMENT

The authors would like to thank Editors and Reviewers for their work and help.

 DOI : 10.18231/2454-9150.2018.0283

REFERENCES

[1] Wentzloff, David D., and Anantha P. Chandrakasan. "A 47pJ/pulse 3.1-to-5GHz All-Digital UWB Transmitter in 90nm CMOS." In *Solid-State Circuits Conference, 2007. ISSCC 2007. Digest of Technical Papers. IEEE International*, pp. 118-591. IEEE, 2007.

[2] Low, Z. N., J. H. Cheong, and C. L. Law. "Low-cost PCB antenna for UWB applications." *IEEE antennas and wireless propagation letters* 4, no. 1 (2005): 237-239.

[3] Yao, Jianping, Fei Zeng, and Qing Wang. "Photonic generation of ultrawideband signals." *Journal of Lightwave Technology* 25, no. 11 (2007): 3219-3235.

[4] Wang, Hang, Lei Zhu, and Wolfgang Menzel. "Ultra-wideband bandpass filter with hybrid microstrip/CPW structure." *IEEE Microwave and Wireless Components Letters* 15, no. 12 (2005): 844-846.

[5] Shaman, Hussein, and Jia-Sheng Hong. "Ultra-wideband (UWB) bandpass filter with embedded band notch structures." *IEEE Microwave and Wireless Components Letters* 17, no. 3 (2007): 193-195.

[6] Li, Rui, and Lei Zhu. "Compact UWB bandpass filter using stub-loaded multiple-mode resonator." *IEEE Microwave and Wireless Components Letters* 17, no. 1 (2007): 40-42.

[7] Ru-qi Xiao, Guo Yang,Wen Wu "Compact and High Performance UWB Band-Pass Filter based on parallel-coupled line." Conference on IEEE International Symposium on Microwave, Antenna, Propagation and EMC Technologies, pp. 300-302, 2017.

[8] Ishii, Hiroyuki, Toru Kimura, Naotaka Kobayashi, Atsushi Saito, Zhewang Ma, and Shigetoshi Ohshima. "Development of UWB HTS bandpass filters with microstrip stubs-loaded three-mode resonator." *IEEE Transactions on Applied Superconductivity* 23, no. 3 (2013): 1500204-1500204.

[9] Zhu, Lei, Sheng Sun, and Wolfgang Menzel. "Ultra-wideband (UWB) bandpass filters using multiple-mode resonator." *IEEE Microwave and Wireless components letters* 15, no. 11 (2005): 796-798.

[10] Sharma, Vinay Kumar, and Mithilesh Kumar. "Design of Microstrip UWB bandpass Filter using Multiple Mode Resonator." *American Journal of Engineering Research (AJER)* 3, no. 10 (2014): 169-177.

[11] Azaga, Mohamed, and Masuri Othman. "Design of parallel-coupled microstrip line band pass filter (BPF) for ultra-wide band (UWB) applications." In *Computer and Communication Engineering, 2008. ICCCE 2008. International Conference on*, pp. 280-283. IEEE, 2008.

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