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Microstrip Coupled Band Pass Filter for the Application in Communication System

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Abstract - *This paper proposes novel planar microstrip filters in employing coupled structures in the form of section of linear strips. Such filters are not only compact, but also can improve the RF performance in both the pass band and stop band. Performance analysis is done by plotting S-parameters. Impedance and VSWR plots show the perfect matching of the proposed filter. Further, effective medium parameters such as permittivity and permeability are retrieved. This filter may lead to various applications in communication system.*

Key Words: Microstrip, Filter, Cut off frequency, VSWR, Group Delay, Resonance etc.

1. INTRODUCTION

Filters are mainly frequency selective elements. A network that is designed to attenuate certain frequencies but pass others without loss is called a "filter". The filtering behavior results frequency dependent reactance providing by inductors and capacitors. Typically, frequency response includes band-pass, high pass, band pass and band reject characteristics. [1-6]

Electromagnetic waves at the frequency range of about 2 to 40 GHz are referred to as microwave. Microwave radio operates in unlicensed bands are 2.4 GHz and 5.7 GHz and are licensed band it could operate like 6GHz, 7 GHz, 8GHz, 10GHz, 11GHz and 13GHz, 15GHz, 18GHz and 23GHz, 38GHz frequency bands [7-9]. At these frequencies, highly directional beams are possible and microwave is quite suitable for point-to-point transmission. Concentrating all the energy into a small beam using a parabolic antenna (like the familiar satellite TV dish) gives a much higher signal to noise ratio, but the transmitting and receiving antennas must be accurately aligned with each other [10-14]. It's a type of unbounded network transmission medium. Microwave is mainly used for satellite communications.

A microwave system includes an antenna, radio, multiplexes, waveguide and feed cables. Based on capacity and radio equipment, antenna size, tower heights and terrain elevation will play a major role in how it will planned and construct the system [15-19].

These four factors also will dictate system reliability, multi-path fading, fade margin calculations, Fresnel zone clearance, interference analysis, system diversity and long-distance specifications. Figure 1 shows the Communication Frequency Spectrum [20-27].

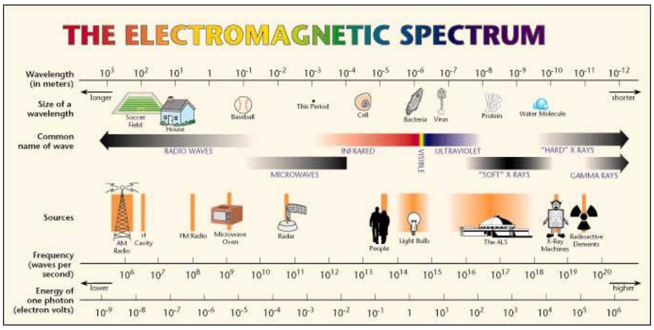

Fig 1:- Communication Frequency Spectrum

The novel compact size BPF is proposed in this paper. Several band pass filters are developed and EM simulated results are obtained using ANSYS HFSS 15v. The proposed filters find various applications ranging from IEEE 802.11a WLAN, HIPERLAN, JAPAN WLAN to Satellite Communications.

2. Literature Review

In 1999 Jia-Sheng Hong ; M.J. Lancaster ; D. Jedamzik ; R.B. Greed, They propose recent developments of an eight-pole planar high-temperature superconducting (HTS) bandpass filter with a quasi-elliptic function response. A novel planar filter configuration that allows a pair of transmission zeros to be placed at the band edges is described. The miniature HTS filter has a fraction bandwidth less than 1% and is designed for mobile communication base-station applications to increase sensitivity and selectivity. Design considerations including filter characteristics, design approach, sensitivity analysis and unloaded quality factor of resonators are addressed.

In 2017 Sen Chen ; Ling-Feng Shi ; Gong-Xu Liu ; Jian-Hui Xun, They propose demonstrates the dual transmission zeros (TZs) of band pass elliptic prototype filters that can be directly implemented with two resonators in microstrip. An experimental filter based on the proposed alternate circuits is designed and fabricated. In order to improve the rejection of stop band, two additional TZs are introduced to the proposed filter.

In 2017 Baoping Ren ; Zhewang Ma ; Haiwen Liu ; Masataka Ohira ; Pin Wen ; Xiaolong Wang ; Xuehui Guan, They propose a novel compact diplexer with hybrid resonant structure is proposed in this paper. The hybrid structure includes one microstrip stub-loaded dual-mode resonator and one slot line stub-loaded dual-mode resonator. These two dual-mode resonators both with two controllable resonant modes and one transmission zero are used to construct the desired passbands of the proposed diplexer. Meanwhile, the inherent transmission zeros are designed to locate in the stopbands and thereby improve the isolation between the two passbands.

In 2017 Mohammed Fadhel Hasan ; Ali Sadeq Abdulhadi Jalal ; Emad Shehab Ahmed, They propose a simple, compact design of dual-band bandpass filter is introduced in this paper. The proposed filter is based on stub loaded resonator (SLR). It is composed of two stub loaded half wavelength open ring resonators. The design is performed in two steps to obtain the required dual-band response. The first band is produced by using two half wave open ring resonators while the other band is obtained by loading a stub to the half wave open ring resonator.

In 2018 Hongliang Guo ; Jia Ni ; Jiasheng Hong ; Petronilo Martin Iglesias, They presents a recent investigation of dual-mode microstrip filter with non-resonating nodes and nonuniform Q lossy technique. By utilizing the dual-path and dual-mode property of dual-mode open-loop resonator, non-uniform Q distribution is deployed for passband flatness improvement. As there is no coupling between even-mode and odd-mode, the odd-mode Q-factor can be properly reduced by loading resistors over the symmetric plane of each resonators.

In 2018 Jian-Feng Li ; Zhi Ning Chen ; Duo-Long Wu ; Gary Zhang ; Yan-Jie Wu, A dual-beam filtering patch antenna consisting of a slotted patch, a metal strip underneath the patch, two pins, and a ground plane is proposed for wireless communication application. A wide operation band with stable symmetrical dual-beam far-held radiation pattern is obtained, and two radiation nulls at the lower and the upper band edges, respectively, are controlled to ensure a sharp rolloff rate at the band edges for both reflection coefficient and realize gain.

In 2018 Divya ; K. Muthumeenakshi ; S. Radha, Nowadays, RF Energy harvesting plays an important role in scavenging energy from the ambient sources. The RF energy harvester consist of antenna and filter to improve the performance of the output voltage. The RF circuit also receives the interference signal which reduces the overall performance of the circuit. To reduce the ripples and harmonics at the output voltage of the RF energy harvester a filter is needed.

3. Design of proposed structure

The proposed structure works as a microstrip band pass filter for communication applications and the structure is a three layer in which the middle layer is acting as a dielectric material made of FR4 substrate; this layer is covered from top and bottom by conducting metallic surface acting as a patch and ground respectively. The proposed three layer structure is shown in figure 2.

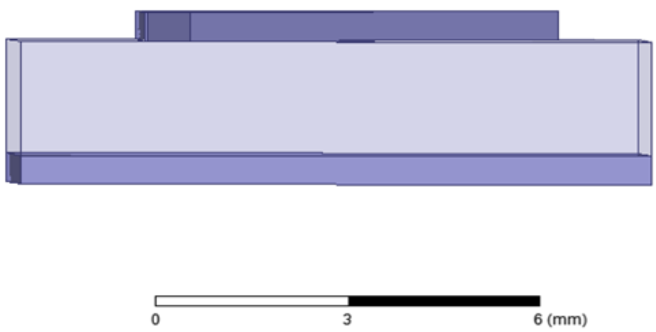

Fig 2:- Three Layer Structure

Figure 3 show the proposed design of the Band Pass filter operating at 8.1 GHz frequency, the substrate used as a dielectric material is FR4 with thickness of about 0.765 mm, the size of the filter is 120*120 mm2. This proposed band pass filter provides a good stop band of 2.27GHz (from 6.86GHz to 9.71GHz) with very high sharpness factor (0.94 and 0.96). It has miniaturized size (Area = 6mm*10mm). VSWR response shows that it has very good harmonic rejection property in stop band region. Group delay response shows its linear characteristic in out of stop band. With having extra width of microstrip line and. Resonators with small slit area, it is expected that it will have better power handling capacity.

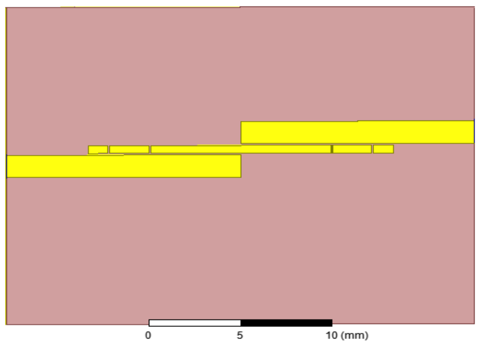

Fig 3:- Designed microstrip filter

4. Simulation and Results

S-parameters describe the input-output relationship between ports in an electric system. S11 represents how much power is reflected from the antenna and hence is known as the reflection coefficient.S12 represent the power transferred from port 2 to port 1. S21 represent the power transferred from port 1 to port 2.

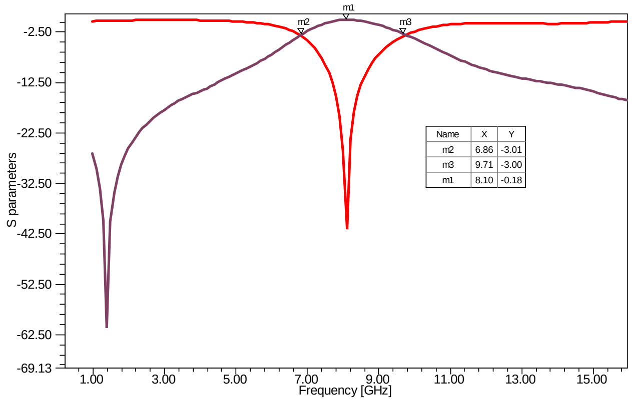

Fig 4:- S11 plot for the proposed Band Pass Filter

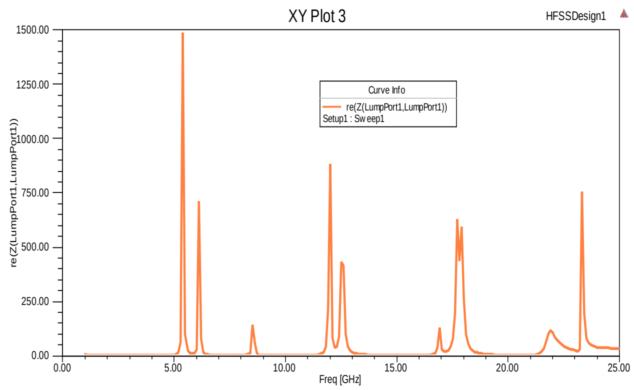

Fig 5:- Real part of port 1

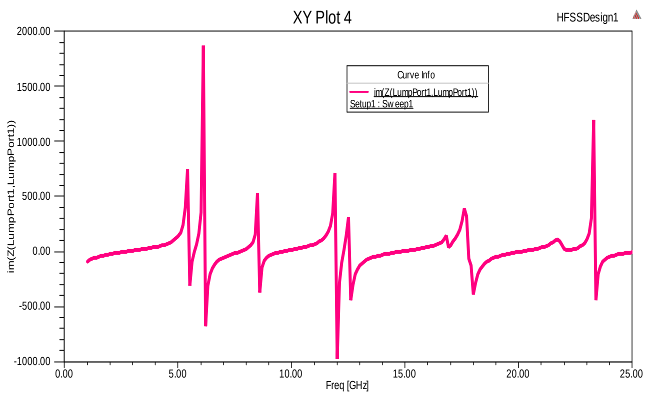

Fig 6:- Imaginary part of port 1

Voltage Standing Wave Ratio (VSWR) is an indication of the quality of the impedance match. VSWR is often abbreviated as SWR. A high VSWR is an indication the signal is reflected prior to being radiated by the antenna. VSWR and reflected power are different ways of measuring and expressing the same thing.

Fig 7:- VSWR of proposed Band Pass Filter

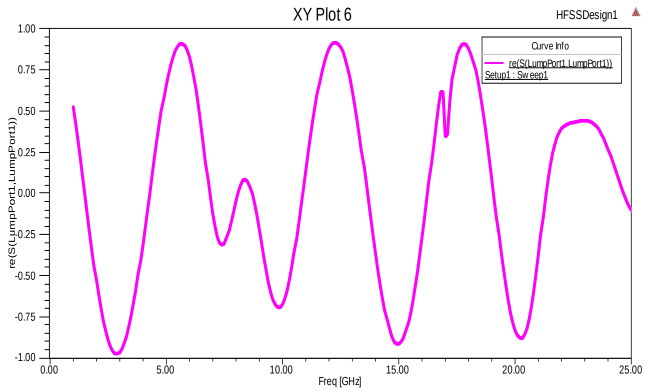

Fig 8:- Real part of port 1with Impedance

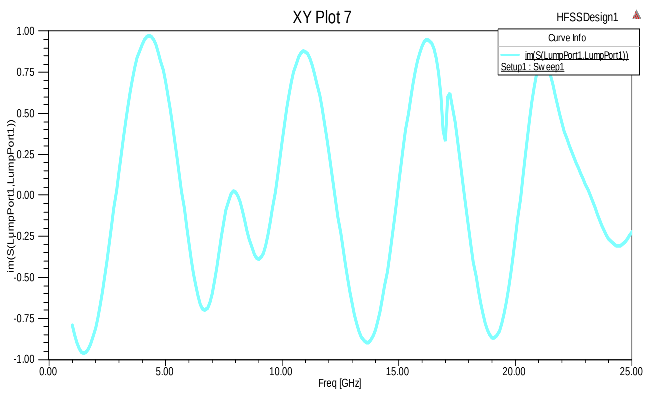

Fig 9:- Imaginary part of port 1with Impedance

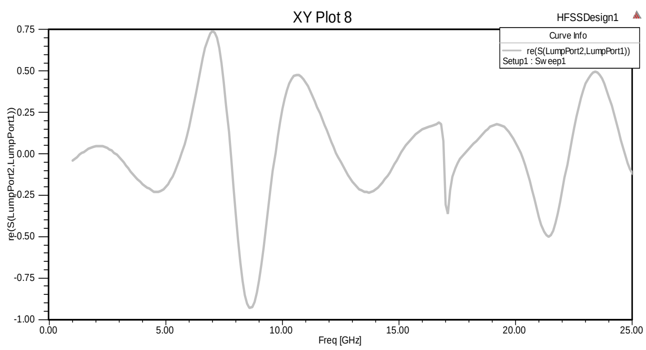

Fig 10:- Real part of port 2 with Impedance

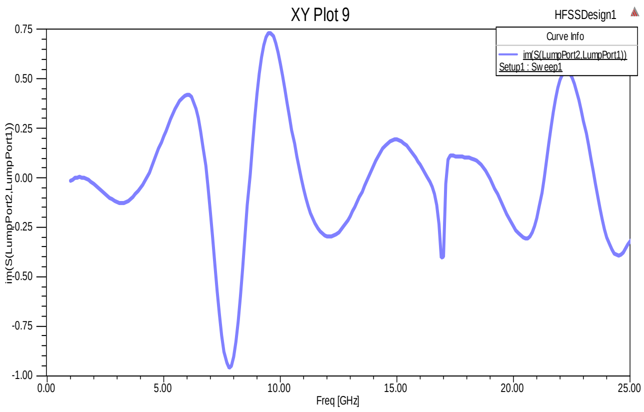

Fig 11:- Imaginary part of port 2 with Impedance

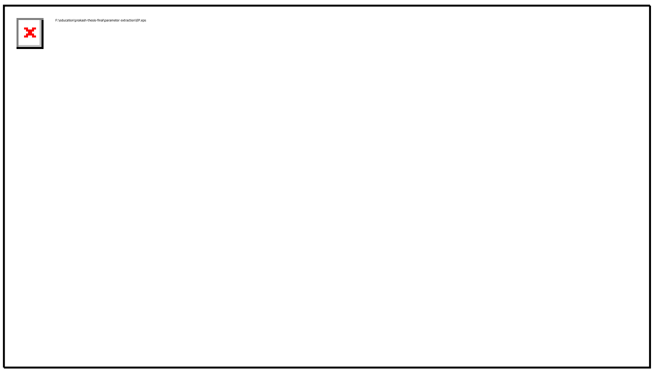

Fig 12:- Real and imaginary part of epsilon

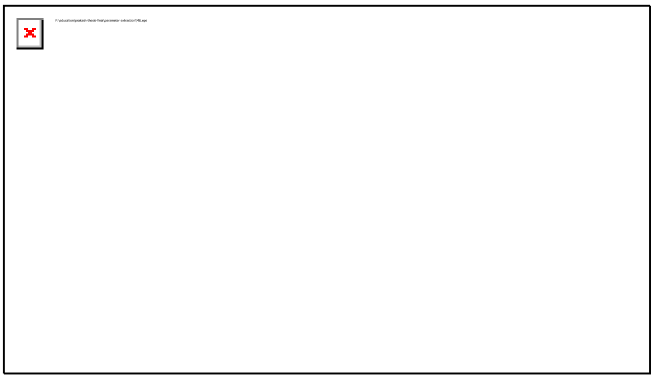

Fig 13:- mu vs frequency graph

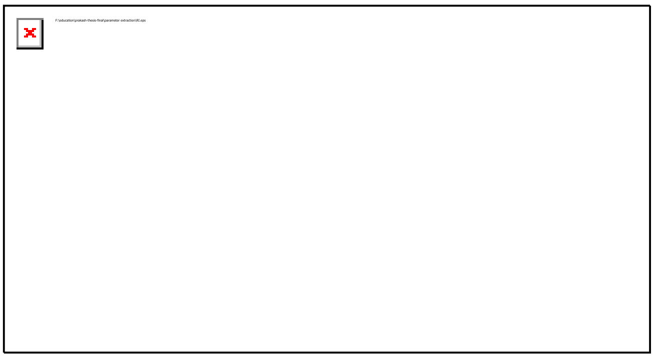

Fig 14:- Refractive Index vs. Frequency

5. Conclusion

The novel compact size BPF is proposed in this paper. Several band pass filters are developed and EM simulated results are obtained using ANSYS HFSS 15v. The proposed filters find various applications ranging from IEEE 802.11a WLAN, HIPERLAN, JAPAN WLAN to Satellite Communications. The proposed structure works as a microstrip band pass filter for communication applications and the structure is a three layer in which the middle layer is acting as a dielectric material made of FR4 substrate; this layer is covered from top and bottom by conducting metallic surface acting as a patch and ground respectively.

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