DESIGN AND IMPLEMENTATION OF T SHAPED RESONATOR MICROWAVE LOW PASS FILTER FOR COVID 19 TEMPERATURE MONITORING

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Abstract - This paper shows the design of microstrip low pass filter (LPF) using T-shaped resonator having wide stopband. The structure is composed of rectangular patches, substrate and ground plane. The T shaped resonator has FR4 Epoxy(relative permittivity of 4.4 and tangent loss of 0.02) dielectric substrate with 1.6mm thickness which is of miniature in size, low cost and to obtain best filter characteristics based on S-parameters. The physical size of ground plane and substrate are of same dimensions 20mm x 15.5mm.The implemented and simulated LPF using Ansys HFSS has a center frequency(f_0) 2.8 GHz, where the measured values of the insertion loss is above -3db and the return loss is below -10db.The measured results has good advantages of low insertion loss and high return loss. This shows the method of transforming conventional lumped elements into microstrip line is able to resolve complexity of circuit design. The designed LPF can be used in the temperature monitoring using wireless communication for biomedical applications.

***Key Words*:** microstrip lowpass filter, wireless biomedical sensor network, temperature monitoring**.**

1. INTRODUCTION

Microstrip LPFs are utilised in real-time monitoring in modern wireless communication. Wide stopband, low insertion loss, high return loss, compact size, and rapid response are all important properties for LPFs.

The basic objective of LPF in wireless communication is to have suppressed harmonics and compact size. Stepped impedance resonators (SIRs), open stubs, and semilumped element resonators are the most common solutions. These solutions, on the other hand, have limited stopband properties and are rather substantial in size. Higher order harmonics have been suppressed and the size of LPFs has been reduced after extensive investigation. Despite several compact techniques for rejecting harmonics, bandstop performance is still limited [1-2]. LPFs with a coupled-line hairpin resonator are designed in [3]. These LPFs have a good stopband and are small; however they have an unfavourable transition band. A compact LPF with a wide rejection band and a small size is reported in, although it has an undesirable transition band [4].A compact superconducting low pass filter (LPF) is proposed, but it has a high attenuation level and suffers from gradual response [5]. Low pass filters are not designed to provide a sharp response, and suppressing cells lack a wide rejection band. Complex structures, gradual roll-off, and wide stopband widths are all problems [6-8].Wide stop band, sharp response, and compact size are all features of the proposed filter. The designed LPF can be used in a biomedical application. The patient's body temperature is tracked in real time using the Wireless Biomedical Sensor Network [9-12]. A skin-attached temperature sensor has a high thermal sensitivity, making it easier to specify a small change in temperature of 0.5ºC can be detected for flexible wearable technology [12]. Section 2 describes the design of 2.8 GHz microstrip low pass filter and how it can be used in temperature monitoring. Section 3 represents the results and discussion of S-parameters. Section 4 presents the conclusion.

2. METHODOLOGY

A T-shaped resonator was used to design a 2.8 GHz microwave low pass filter with a sharp roll off and wide stopband for the biomedical application of continuous temperature live monitoring and updation for home quarantine covid-19 patients with flexible wearable technology using Wireless Biomedical Sensor Network.

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2.1 Block diagram

The below block diagram Fig-1 shows how each block works for the temperature monitoring using low pass filter.

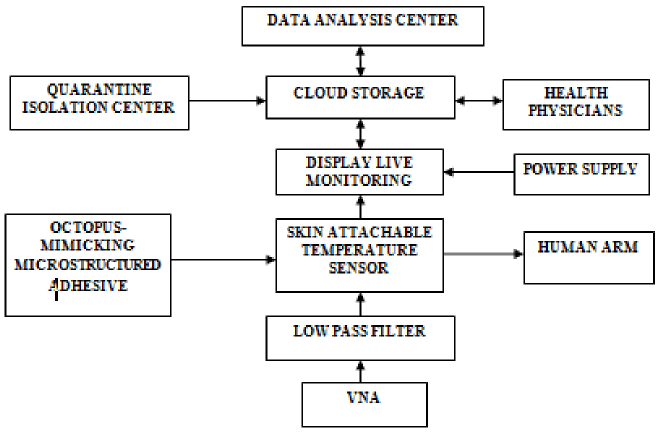

Fig-1: Block diagram

With the help of a low pass filter, the skin-attachable temperature sensor can be used to accurately monitor the temperature as shown in the block diagram above. The low pass filter has a bandwidth of 2.37 GHz to 2.80 GHz, which allows the temperature to be detected in the allowed frequencies. The VNA (Vector Network Analyzer) is a test instrument that measures a network's responses as vectors (real and imaginary parameters) in order to characterise its performance and see the output of a low pass filter. The skin-attachable temperature sensor is a resister-type temperature sensor with a wide temperature range of 25 to 40 degrees Celsius. The octopus-inspired micro structured adhesive is designed to have high performance and mechanical stability after repeated bending, as well as stable temperature sensing over long periods of skin attachment. The monitor is powered by a 12 volt DC power supply. The live updates of the patient's temperature using the WiFi module are stored in the cloud. The data will be gathered in the data analysis centre as a record of the patients in home quarantine. A quarantine isolation centre is an emergency section where patients can receive additional treatment.

2.2 Flow Chart

The below flow chart Fig -2, explains the flow of the working principle of covid 19 patient monitoring in non-contact way remotely with the help of designed microstrip low pass filter with the allowed frequencies makes the activation of temperature sensor and the flow continues with yes or no condition according of the work.

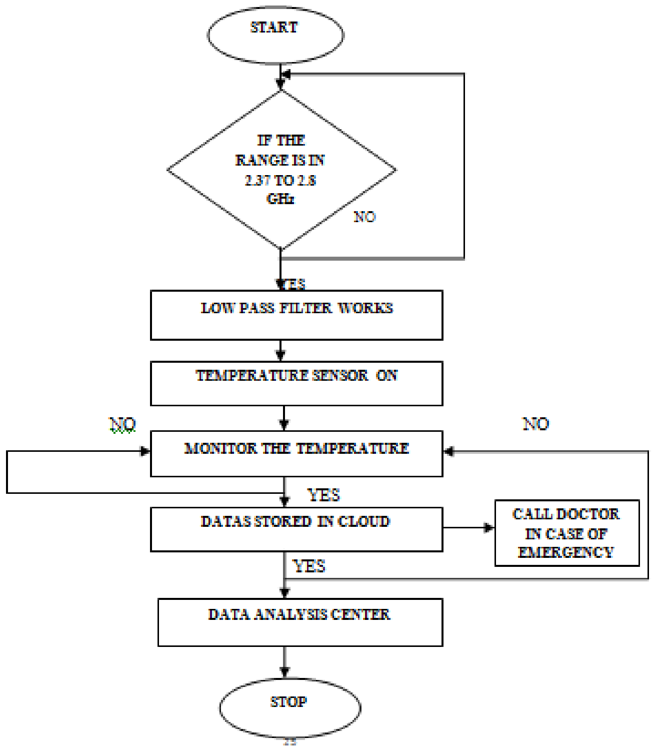

Fig-2: Flow chart

2.3 Design Methodology

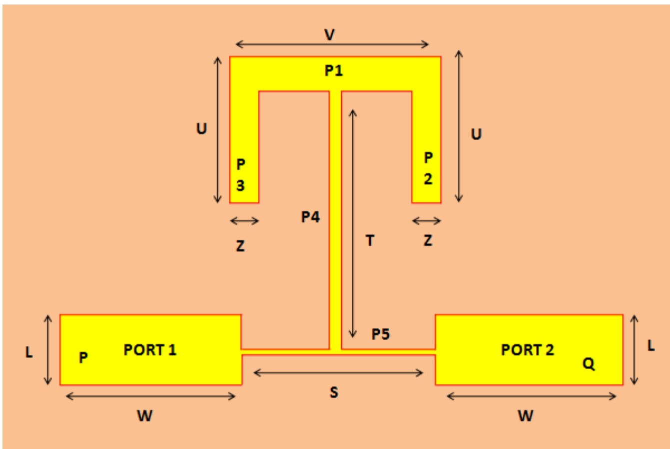

Fig-3: Design of 2.8 GHz Microstrip Low Pass Filter

A T-shaped resonator is designed, as shown in Fig-3. The values of L and C are first considered. The second step is to acquire similar lumped element values. Finally, Ansys HFSS software is used to calculate the values of LC equivalent circuit elements. The center frequency (fo) of this resonator is 2.8 GHz, and it has a high attenuation level of 3db. To understand control of the transmission zero and performance of filter, layout of the filter is represented by equivalent circuit and transfer function is equated to zero.

$$\frac{v_o}{v_i} = \frac{R + C_1(2L_2 + L_3)Rs^2}{R + C_1(2L_1 + 2L_2 + L_3)Rs^2 + 2L_1 s(1 + C_1(L_1 + 2L_2 + L_3)s^2)}$$

The LC equivalent circuit elements(Fig -4) can be expressed as,

$$L = \frac{l_L . Z_L}{v_p}$$

$$C = \frac{\beta}{2\omega Z_c} tang(\beta . l_C)$$

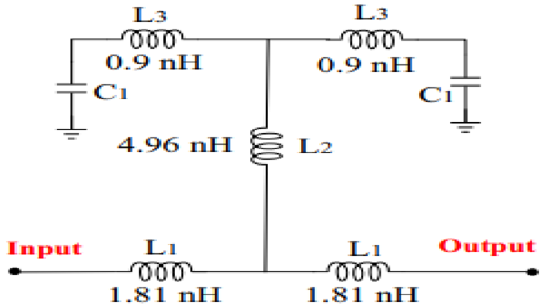

Fig-4 Equivalent circuit

DESIGN ELEMENTS	DIMENSIONS
Substrate, Dielectric constant	Fr4 Epoxy . 4.4
Substrate Length (A)	15.5 mm
Substrate Width (B)	20 mm
Substrate Height (H)	1.6 mm
Patch Total Length(S,T,U,V,Z)	10.8 mm
Patch Total Width (S,T,U,V,Z)	13.6 mm
Ground Length(X)	15.5 mm
Ground Width(Y)	20 mm
Port slot 1 P (L,W)	5 mm, 3 mm
Port slot 2 Q (L,W)	5 mm, 3 mm

Table-1: Design elements and Dimensions

The microstrip low pass filter's design and dimensions are shown in the diagram above Fig-4 and Table-1. The ground plane and substrate have the identical dimensions of 20mm x 15.5mm. FR-4 is most typically utilised as an electrical insulator because of its low water absorption and high mechanical strength. In both dry and humid circumstances, the material is known to keep its outstanding mechanical and electrical insulating properties. The patch's dimensions are listed above, and they are S,T,U,V,Z for a rectangular patch (P1,P2,P3,P4,P5). The overall length of the patch is 10.8mm, and the total width is 13.6mm.P stands for port 1, which is a reflection port with dimensions of 5mm x 3mm. The second port, Q, is a transmission port with dimensions of 5mm x 3mm. Tangent loss is 0.02 and relative permittivity is 4.4.

2.4 Covid-19 Patient Monitoring

With the increasing number of cases, it is becoming difficult to keep track of the health conditions of many quarantined patients.

The main problems are list out here:

1. Doctors need to monitor the patient's health regularly.

2. The Doctors are at risk of infection just for monitoring purposes

3. There are increasing numbers of patients for the doctors to monitor.

We are here to develop a 2.8 GHz microstrip low pass filter with sharp roll off and wide stopband of a T-shaped resonator for a wireless biomedical sensor network that enables for remote monitoring of several covid patients in order to address these problems. A skin-attachable temperature sensor is used to monitor the patient's temperature. The system then connects to a WiFi internet connection and broadcasts the data over the internet utilising WiFi transmission. If any aberrant condition in the patient's health is discovered, an alert is transmitted to a neighboring hospital's quarantine isolation centre, where doctors can be informed.

3. RESULTS AND DISCUSSION

3.1 Insertion Loss

The S11 parameter curve defines the insertion loss, with a measured value of greater than -3 dB. The reflection port is port 1.

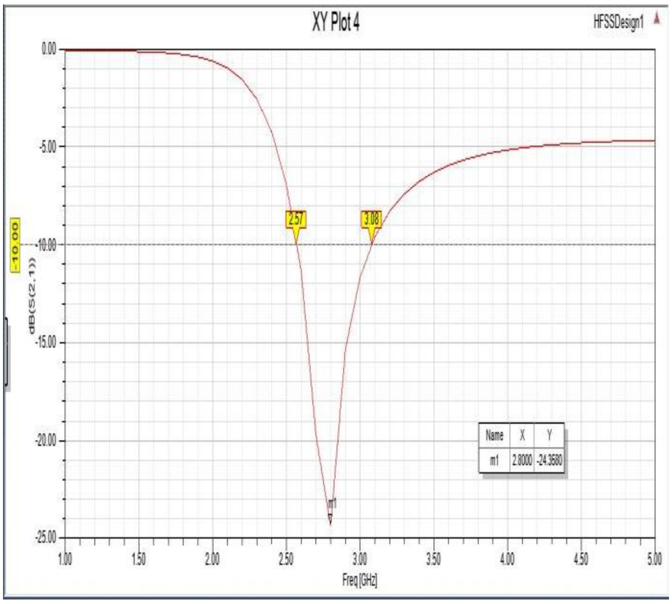

Fig-5 S_{11} parameter

3.2 Return Loss

The S21 parameter curve defines the return loss, with a measured value of less than -10 dB. The transmission port is port 2.

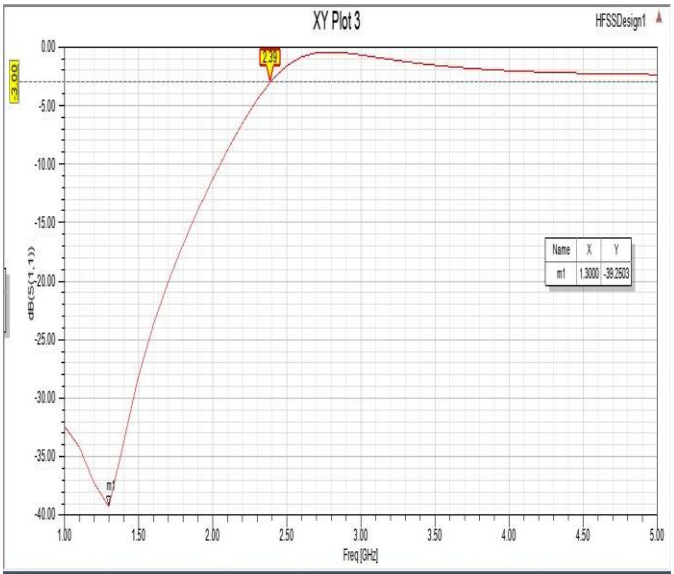

Fig-6 S_{21} parameter

3.3 Combination of both Insertion Loss and Return Loss

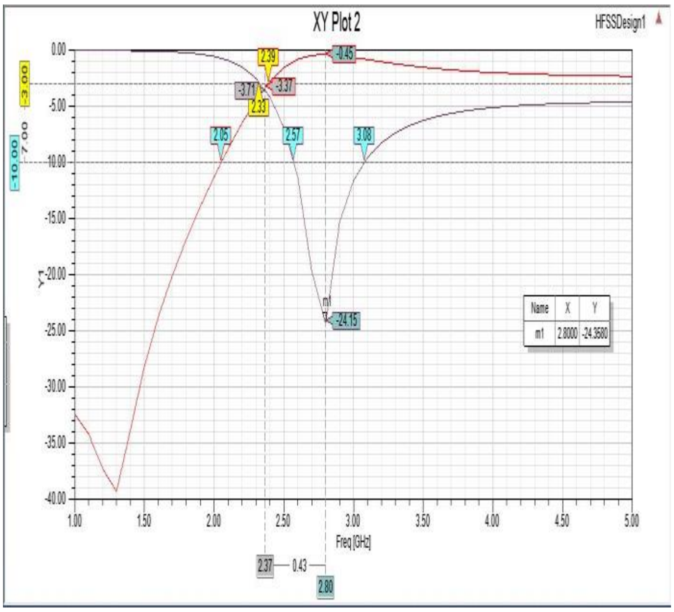

Fig-7 S_{11} and S_{21} parameter

The microstrip low pass filter with the center frequency value (f_o) of 2.8 GHz is illustrated in Fig-7, which combines both S11 and S21 parameter curves. Between 2.37 GHz and 2.8 GHz is the desired bandwidth. This microstrip low pass filter has a pass band of 0.43 GHz. When the S11 frequency and S21 frequency meet at 2.37GHz the sensor will get activated and the pass band of 0.40dB gives the full output in the sensor monitor at 2.8 GHz.

3.4 Design of 2.8 GHz Microstrip Low Pass filter

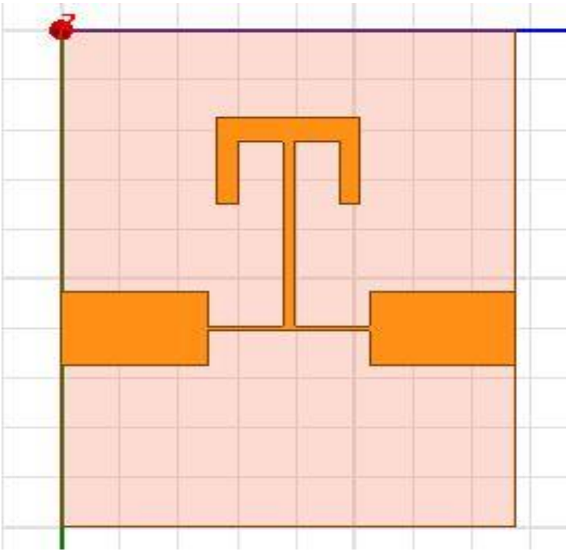

Fig-8 Design of LPF filter in Ansys HFSS software

The designed low pass filter produces a modeled and measured output value of 2.8 GHz, which is the centre frequency of the system. As a result, the design must account for open ports and the dissipation effect of microstrip lines, as well as extra adjustments and optimal accuracy in the HFSS following the final design in the software.

The designed 2.8 GHz center frequency f_o can be used for the biomedical application of continuous temperature live monitoring and updation for home quarantine covid-19 patients with flexible wearable technology using Wireless Biomedical Sensor Network .The measured S- parameters plotted in fig-7, along with the Ansys HFSS for comparison. The simulated output and the measured value gives a desired and valid agreement.

3. CONCLUSION

This paper proposed a mechanism for home quarantine covid-19 patients to have real-time temperature monitoring 24 hours a day, seven days a week, without the need for hospital supervision. This system provides a practical way to monitor a patient's temperature in real time. Designing a 2.8 GHz microstrip T-shaped resonator for a wireless biomedical sensor network that enables for remote monitoring of numerous covid patients has a great potential.

This solution provides flexibility and expandability for the doctors to avoid stressful situation and can treat the patient in accurate time. It is a user- friendly way for the patient to know their temperature in real-time.

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