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Design of a Micro strip Quad-Band Band pass Filter for LTE Using Stub Loaded Resonators

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ABSTRACT - A Quad-band bandpass filter for wireless RF devices is presented. The circuit is capable of serving multiple FDD and TDD bands of the 4G LTE standard. A microstrip transmission line is used to feed stepped impedance resonators for providing four bands in LTE spectrum. The proposed filter is simulated using IE3D simulator. The centre frequency and bandwidth of each passband can be controlled by physical dimensions of resonators. The bands are centered at 1.2, 2.4, 3.2, 3.4 GHz. It has a return loss of -35dB and 0dB of insertion loss. The size of the circuit is 16x16 mm^2 . The above filter can be used for wireless applications such as WiFi, WLAN, WiMAX, WCDMA applications.

KEYWORDS – LTE- Long Term Evolution, BPF- BandPass Filter, RL- Return Loss, IL- Insertion Loss, SIR- Stepped Impedance Resonator.

I. INTRODUCTION

To meet the requirements in the recent development of wireless broadband communication, switch over to the 4G LTE becomes a necessity. LTE, Long Term Evolution, marketed as 4G LTE, is a standard for wireless broadband communication of high-speed data for mobile phones and data terminals. It provides more security [1]. It is based on the GSM/EDGE and UMTS/HSPA network technologies, increasing the capacity and speed using a different radio interference[2] together with core network improvements. The standard is developed by the 3GPP. It provides high selectivity [3].

LTE network can achieve download rates up to 299.6 Mbps and upload rates up to 75.4 Mbps depending on the user equipment. Lower latencies for handover and connection setup time than with previous radio access technologies. It can support for terminals moving at up to 350 km/h (220 mph) or 500 km/h (310 mph) depending on the frequency bands. It uses OFDMA scheme for downlink and SC-FDMA for uplink data transfer. High performance multiband bandpass filters (BPF)[4],[5],[6] have become indispensable in the RF front ends of communication systems. In [4], stub loaded resonators are used to design multiband filter. To address this need, a variety of multiband bandpass filters designs have been recently proposed. Stepped impedance resonators are utilized to build the quad-band bandpass filters. A four section SIR can able to achieve quad-band response by tuning its electrical length. It is difficult, however to control the passbands independently, and these structures are relatively complicated. Stub loaded resonators are used in the analysis of odd and even mode methods are widely used structures in the design of multi-band filters. Thus the bandwidths of the passbands mainly depend on the coupling coefficients, which can only be adjusted over a relatively narrow range.

In this article, the odd and even-modes of the SSLR are used to generate only one passband as long as the fundamental even-mode resonant frequency is close to the fundamental odd-mode resonant frequency. Thus the bandwidth is determined primarily by the distance between the fundamental even-mode resonant frequency and the fundamental odd-mode resonant frequency.

II. QUAD-BAND BPF

Quad-band supports four different radio frequency bands. Different mobile phone networks around the world use different bands. A phone can only be used on a network if it supports the correct band(s).

All devices which have more than one channel use multiple frequencies; a band however is a group of frequencies containing many channels. The designed filter in figure (1) consists of four resonators, each of different widths. Each can be independently variable without affecting other three. The widths of the resonators are 0.8mm, 0.7mm, 0.5mm, 0.6mm respectively. Stubs are short circuited lengths of transmission line intended to produce a pure reactance at the attachment point, for the line frequency of interest. The shorted stub input impedance is given in equation

$$Z_{SC} = jZ_0 \tan(\beta l) \qquad (1)$$

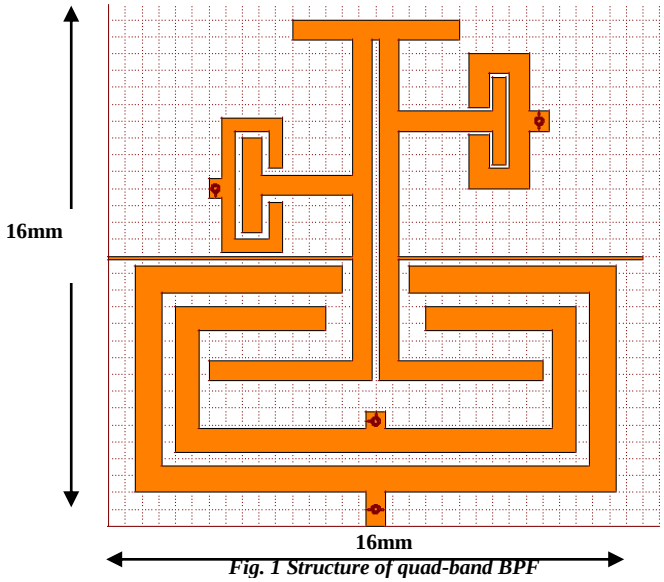

Fig. 1 Structure of quad-band BPF

Any value of reactance can be made, as stub length is varied from zero to half a wavelength. Four shorted stubs are attached with each of the resonator. The stubs are shorted for the frequency selective operations over the LTE frequency bands. The size of the circuit is 16×16mm. FR4 is used as the substrate with 4.4 as dielectric constant (Ɛr). The distance between the resonator and the feed line is 0.2mm.

III. Results And Discussions

The designed filter is simulated by using IE3D simulator. The obtained results are mentioned below.

The center frequency and bandwidth are adjusted by varying electrical length of the resonators and stubs attached with it. The group delay, being an important filter parameter is found by using equation(2)

$$\tau_d = -(d\beta/d\omega) \qquad (2)$$

The stepped impedance resonator is used as it posses different lengths and widths properties on four resonators. The output bands obtained here are centered at 1.2, 2.4, 3.2 and 3.4 GHz. The overall bandwidth is from 1GHz to 3.5GHz.

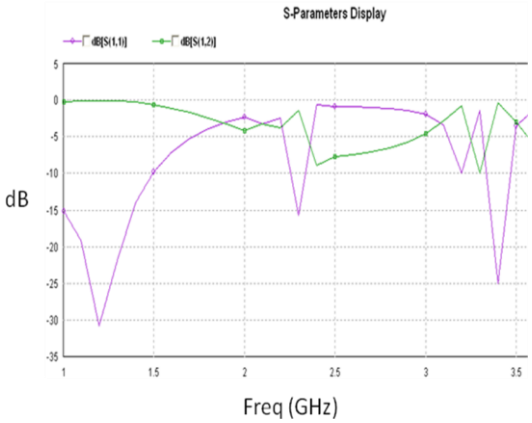

Fig. 2 Stimulated result

The resultant bands can be used for many wireless applications. This provides huge advantage for this design. The insertion loss obtained is at 0dB and return loss has maximum dip at -32dB.

IV. Conclusion

This paper proposes quad-band bandpass filter for LTE bands. In this project, by using quad-band (four) design, can able to support four bands in a device. To be used in LTE devices, it should be able to provide higher rejection over interference and to provide wide bandwidth. The filter size is 16x16mm. The center frequencies are at 1.2, 2.4, 3.2, 3.4 GHz. The proposed design is used for wireless applications such as WiFi, WLAN, WiMAX, WCDMA applications. It is used for many wireless applications. The reduced size and interference of the filter has achieved a wider advantage than the last works.

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