A COMPACT UWB BANDPASS FILTER WITH IMPROVED SELECTIVITY USING MODIFIED COUPLING STRUCTURE

Surya Prakash. G.\textsuperscript{1} and Mrs. H. Umma Habiba.\textsuperscript{2}

\textsuperscript{1}Student, \textsuperscript{2}Assistant professor

Department of Electronics and Communication, Sri Venkateswara college of Engineering, Anna University, Sripurerumbudur, Chennai.

gsuryalss@gmail.com(+919487847297)

Abstract: This paper presents a compact ultra-wideband (UWB) band-pass filter (BPF) with improved selectivity. A dual-mode ring resonator is constituted to allocate its first two resonant frequencies in the UWB band, and the dual-line parallel-coupled structure is used in this compact UWB filter, which is expected to achieve much tighter coupling degree. The modified coupling structure is obtained by taper connecting open ended stubs with defected Ground Structure. The modified coupling structure provides better selectivity and improved out-of-band performance. Simulation result shows a filtering characteristic with pass-band from 3 to 7 GHz, 10 dB return loss bandwidth of about 6 GHz, minimum insertion loss of 0.50 dB at 8.5 GHz and sharp selectivity with more than 60 dB.

Keywords: Defected Ground Structure, Band Pass Filter, Ultra Wide Band, dual-line coupling, Selectivity

1. Introduction

In 2002, the Federal Communications Commission (FCC) of the United States released the frequency band 3.1-10.6 GHz for ultra-wideband (UWB) commercial communications. [1-3] So recently, more attention has been paid to applications of ultra-wideband (UWB) technology on wireless communication system. UWB technology is promising and attractive for local area networks, position location and tracking, and radar systems, because UWB has the characteristics of low cost, high data transmission rate and very low power consumption. [3] Many UWB devices and circuits have been proposed and investigated widely. It is important to reduce their size and weight in order to integrate them with other components as a compact system. [6] Compact and broadband bandpass filter (BPF) is a key passive component and highly demanded in a UWB system. [4]

A planar BPF, based on a microstrip structure, can provide the advantages of easy design, low cost, compact size, and is widely used in a variety of RF/microwave and millimeter-wave systems to transmit energy in pass-band and to attenuate energy in one or more stop-bands. So, compact UWB micro-strip BPF can be used in a UWB communication system. UWB filters must have a fractional bandwidth of more than 70%, and it is very difficult to achieve such a wide pass-band with a traditional parallel-coupled transmission line structure. Therefore, there is a requirement for UWB BPF with a strong coupling structure that can be easily fabricated. In this design, a dual-line coupling structure has been used to implement a strong coupling between the input/output port and the resonator, which is more compact than the inter-digital coupling structure.

In this paper, a UWB BPF with improved selectivity is presented. To suppress the spurious pass-band, the proposed coupling structure is constructed by taper-connecting two folded open stubs to the traditional parallel-coupled lines, which can weaken the coupling efficient at the higher order harmonics of the ring resonator and suppress the spurious pass-band with the desired pass-band response nearly unchanged. The defected ground structure improves the out of band performance and reduces the size of the micro-strip design. The proposed filter shows a wide pass-band from 3 to 7 GHz with good...
frequency characteristics and minimum insertion loss of 0.50 dB at 8.5 GHz, 10 dB return loss bandwidth of about 6 GHz.

II. STRUCTURE AND ANALYSIS OF THE COMPACT UWB MICROSTRIP BPF

The topology of the presented compact microstrip-line UWB BPF is shown in Fig. 1. The ring resonators have been used in this novel compact UWB filter. The dual-mode resonator (DMR) consists of one ring section in the center and four identical high-impedance line sections at the two sides. Similar to the conventional coupled line resonator, the proposed DMR may be viewed as a stepped impedance resonator (SIR). [4] The parallel-coupled dual-line structure has been used in this compact BPF, as shown in Fig. 1. This type of coupling structure used in the UWB filter is expected to achieve much tighter coupling between the input/output port and the dual-mode resonator than the conventional parallel coupled line, which can increase the S21-magnitude of the compact UWB filter and widen the passband of the filter. A dual mode ring resonator produces two resonant frequencies which act as start and stop band frequency for proposed UWB BPF filter.

![Fig. 1. Topology of the presented compact microstrip-line UWB BPF.](image)

Fig. 1. Topology of the presented compact microstrip-line UWB BPF.

An improvement is developed in this work by introducing the modified coupling structure for harmonic suppression. The proposed coupling structure is formed by taper-connecting two folded open stubs to the traditional aperture-back parallel-coupled lines.

The length of the coupled line for half wavelength parallel coupled band pass filter is given as [5]

\[
l_a = \frac{\frac{\pi}{2} \pm \delta_e - 2\Delta \theta_e}{\frac{\pi}{\lambda_e}}
\]

Where \( l_a \) is the length of coupled element, \( \theta_e \) is the even mode electrical length, \( \lambda_e \) is the even mode wavelength, \( \delta_i \) is the positive integer, \( \theta_o \) is the odd mode electrical length and \( \lambda_o \) is the odd mode wavelength. The above length equation is calculated using MATLAB simulation.

FR4 Substrate is assumed to design the filter with following details,

<table>
<thead>
<tr>
<th>Relative dielectric permittivity</th>
<th>( \varepsilon_r = 4.6 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness of the substrate</td>
<td>( h = 1.6 \text{ mm} )</td>
</tr>
</tbody>
</table>

**Table 1**

![Fig. 2. Simulated frequency-dependent transmission responses of the presented DMR.](image)

Fig. 2. Simulated frequency-dependent transmission responses of the presented DMR.
Following the above-mentioned considerations, the characteristic impedances of the high- and low-impedance lines are chosen as $Z_{0L} = 100$ ohms and $Z_{0C} = 50$ ohms. For very thin conductors (i.e., $t \to 0$), the closed-form expressions that provide accuracy better than one percent are given as follows. [6]

$$w/h = \frac{1}{8 \left[ 1 - \frac{1}{8 \pi^4} \right]}$$  \hspace{1cm} (5)

$$A = \frac{Z_{0L} \sqrt{2(\pi + 1)}}{119.9} + \frac{1}{2 \pi - 1} \left[ \frac{\ln \pi + \ln 4}{\pi} \right]$$  \hspace{1cm} (6)

Using the above equation $A$ is calculated as

$\begin{align*}
A &= (100 \cdot \sqrt{2(4.6 + 1)}) \cdot 119.9 + 0.7777 \cdot 0.4027 \\
A &= 3.8
\end{align*}$

Substitute $A$ value in equation

$w/h = 1/(5.5876 - 2.7963 \cdot 10^{-3})$

$w/h = 0.17$

From given specification $h = 1.6$ mm

Therefore $w = 0.2$ mm

**III. RESULTS**

The proposed UWB bandpass filter is designed, simulated, and optimized using electromagnetic simulation tool ADS (Advanced Designed System). The final dimensions of the UWB filter are $R=1.8$ mm, $R_o=0.7$ mm, $l_a=6.2$ mm, $W=1.2$ mm, $G_1=3.4$ mm, $G_2=2$ mm, $S_1=1.1$ mm, $S_2=1$ mm.

**Conclusion:**

A compact UWB microstrip BPF with improved selectivity using modified coupling structure is presented. The parallel-coupled dual-line structure used in this UWB filter is expected to achieve much tighter coupling between the input/output port and the dual-mode resonator than the conventional parallel coupled line. The simulated results show pass-band from 3 to 7 GHz, 10 dB return loss bandwidth of about 6 GHz, minimum insertion loss of 0.50 dB at 8.5 GHz. The modified coupling structure provides low coupling efficient and suppress the harmonics in the unwanted pass band.

**REFERENCES**


