

# Compact edge and end coupled wide band filter with notch at 5GHz

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**Abstract.** In this paper a compact Ultra Wide Band filter with notch at WLAN frequency is designed. The filter is a designed using coupled lines arranged in inter digital capacitor form. The filter is designed to allow microwave signals in the range of 2GHz to 7GHz with a notch at 5GHz. The measured results show the notch at 5GHz with transmission coefficient of -14dB. With uniform group delay in pass band and nonlinear group delay at notch frequency.

## 1 Introduction

Wireless systems have increased rapidly during the past generation, which has resulted in a fully covered frequency spectrum. In communication, the system can be termed as wideband when the message bandwidth considerably exceeds the coherence bandwidth of the channel. Ultra wide band (UWB) technology has great potential in the development of various modern transmission systems, for instance, through-wall imaging, medical imaging, vehicular radar, indoor, and hand-held systems, etc. Due to this UWB filter with band rejection capabilities are in great demand. Many designs of filters are proposed in recent years with size optimization and improved performance. The wideband bandwidth is forced to use for any communication link due to a high data rate. Aperture coupling integrates two bandpass filter designs for dual/tri band operation [1]. Filter with multiple-mode resonators is categorized as stepped impedance resonator and is application oriented with transmitting signals in whole UWB pass band of 3.1GHz – 10.6GHz [2]. In [3] a wide bandpass filter consisting of three parallel coupled lines with the centre one connected to a radial open stub. It operates at a centre frequency of 3GHz. In [4] a filter based on transversal signal interference principle was implemented. Two transmission line section and two shunt open stubs were utilised. UWB filter with quarter wavelength spaced shunt stub transmission lines can be used in UWB communications and localization systems [5][6]. In [7] a band stop filter is designed with dual U-shaped DMS (Defected microstrip structure). DMS circuits are more immune than DGS (Defected ground structure) from crosstalk and ground plane interference. A compact filter using zeroth-order resonance of third-order coupled CRLH resonators for WiMAX applications is discussed in [8]. In [9] different designs

combining a bandpass and a notch filter are developed in to operate in the receiving band from 350–470.

In this a paper a UWB filter is designed with notch at WLAN frequency of 5GHz.

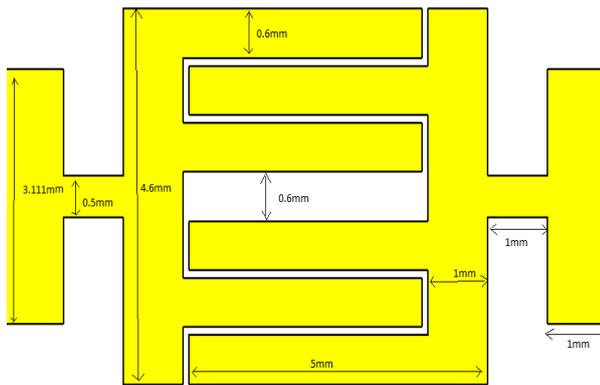
## 2 Design of UWB

The filter is designed on a FR4 substrate with permittivity of  $\epsilon=4.1$  and substrate height 1.6mm. In order to create a pass band behaviour, edge coupling and end coupling are employed. Lower the end coupling gap, higher the transmission. The surface currents at the end gap between the transmission lines affect the filter behaviour. These currents are proportional to the area and thus the increase in area near the change of the direction of surface currents (the reason for higher gap in the centre) improves the design performance. The 50 ohm lines length can be varied according to need. Here, to measure the hardware results and for the probe to touch the line for measuring results, the lines on either side have been extended. In all the graphs showing S parameter results, S11 or S22 characterize reflection coefficient and S12 or S21 characterize the transmission coefficient.

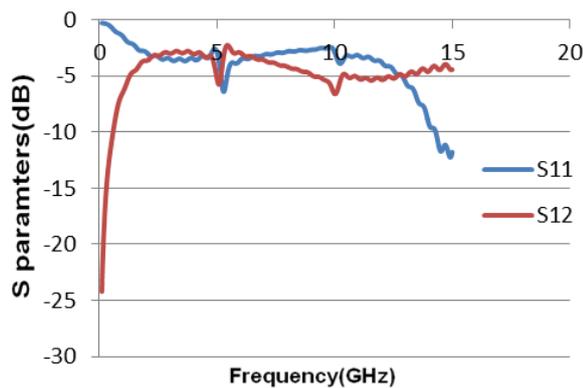
### 2.1. Design

The layout with dimensions of proposed design are shown in fig 1. All the coupling gaps are all 0.1mm. This design exhibits UWB behaviour between 2GHz – 7GHz, with a notch stop band at 5 GHz.

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**Fig. 1.** Optimized Design with dimensions

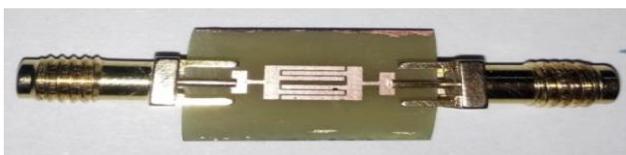


**Fig. 2.** S-parameters of the proposed design

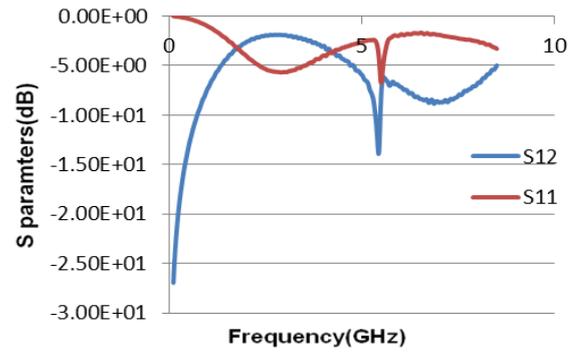
## 2.2. Parameters

Transmission is observed to be reduced with an increase in edge gap between the horizontal impedance lines. Change in end gap between 0.1mm to 0.3mm, decreases the transmission and increases the reflection whereas increasing coupling width decreases transmission and BW, increasing reflection. Also, by increasing coupling line length, the pass band starts at an even lower frequency.

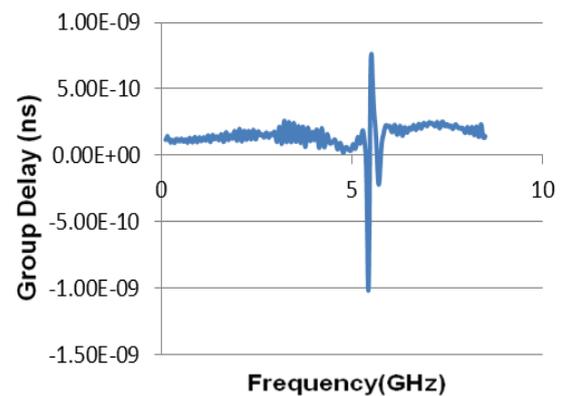
## 3 Results and Discussion



**Fig. 3.** Fabricated design with SAM connectors.



**Fig. 4.** Measured return loss and transmission coefficient of proposed design.



**Fig. 5.** Measured Group Delay of proposed design

**Table 1. Size Comparison**

Work	Material	Thickness	Size
Proposed work	$\epsilon = 4.3$ FR4	1.6mm	10mm x 4.6mm
[10]	$\epsilon = 2.2$	0.508mm	45mm x 5.8mm
[11]	$\epsilon = 10.8$	1.27mm	16mm x 1.7mm
[12]	$\epsilon = 3$ Rogers 3003	1.52mm	10mm x 5mm

The hardware results show the fabricated filter exhibits Ultra wide band between 2GHz to 7GHz. One notch is observed at 5GHz being the ranges of WLAN, BLE, Wi-Fi. From fig 5 it can be seen that the change in group delay is observed at notch frequency. From table I it can be seen that the designed filter is compact in size.

## 4 Conclusion

The proposed design is highly size optimized with its dimensions being 10.1mm x 3mm and exhibits good UWB behaviour with less reflection in the range between 2GHz – 7GHz and with a notch at 5GHz. The notch at 5GHz avoids the interference of other communication signals travelling in the same range as the filter supports. Thus prevents extra noise and transmission of corrupted signal in the intended range. The existing UWB filter size which is currently deployed in UWB systems is around 25mm x 28mm. Hence, this a highly compact and size optimized design which behaves as an ultra-wide band filter. The fabricated design as expected, showed one notch 5GHz.

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