# A New Novel BPFs Design for UWB Application

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**Abstract**— This Paper presents a low insertion loss, sharp-rejection, and wideband band pass filter for Ultra Wide-band (UWB) communication. The Federal Communication (FCC) authorized the commercial use of the UWB technology in February 2002. Where, the frequency range of the spectrum mask in an indoor environment is from 3.1GHz to 10.6GHz. But band pass filter must have good sharp-rejection above 5GHz, because of using 5GHz wireless LAN. To transmit digital information on maximum of 1Gbps using this range (3.1~5GHz), the band pass filter with the same pass band is indispensable. These 5- pole and 9-pole inter digital BPF with 2 stub has low insertion loss and good skirt characteristic especially above 5GHz. The measurement results are very similar to simulation ones

## 1. INTRODUCTION

In February 2002, FCC authorized the commercial use of Ultra Wideband (UWB) technology [1]. The spectrum mask in indoor environment, which FCC defined, is shown in Fig. 1[2]. The frequency range of pass band is from 3.1GHz to 10.6GHz, but interference of wireless LAN systems makes some problems if using bandwidth from 5GHz to 6GHz. So this paper focuses on frequency range from 3.1GHz to 5GHz. In order to transmit the digital information exceeding 1Gbps using this frequency range, the Ultra Wide-Band Pass Filter (UWBPF) with same pass band is indispensable. Design techniques for single mode micro strip filters such as broad side edge coupled filters have already been established. The high performance requirements for communication satellite frequency multiplexes typically are satisfied by use of dual mode cavity or dielectric resonator filters. Cavity and dielectric resonator filters have the drawbacks of relatively large size and high cost [3-4]. Use of dual mode resonators allows the realization of a compact high-quality microwave BPF whose attenuation poles play a role in improving the skirt characteristics [5-9].

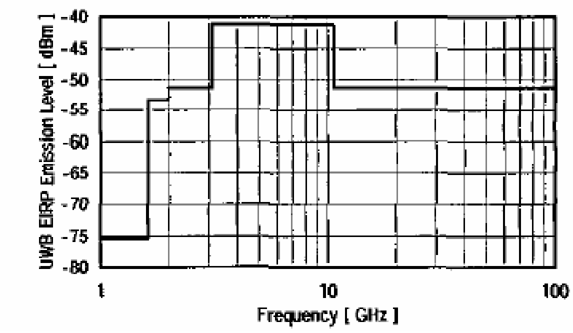


Fig.1 spectrum mask in indoor FCC[2]

In this paper we focus on two specifications of UWBPF. One is low insertion and the other is high rejection at 5GHz. So the fundamental transmission characteristics of developed UWBPF will be reported and successful result of measurement and very similar simulation result will be displayed.

## 2. SIMULATION OF UWBPF

There are several methods to design but this paper used simulation method. Table 1 shows the specification of UWBPF. Fig. 2 is pattern shape of 5-pole and 9-pole for simulation. For simulation we used Serenade 8.0. Basically 5-pole inter-digital BPF with 2 stubs is designed for low insertion loss and 9-pole is for high rejection at 6GHz. But both case we need wide band characteristics, so group delay and linearity for wide band are very important characteristics. 9-pole BPF is designed for high rejection at 5GHz so good rejection specification but higher insertion loss and summarized as table 2.

For 5-pole inter-digital BPF, S21 in pass band is less than 1dB so good simulation result but S11and S22 are a little more than -20dB but they will not make problem. Fig. 4 presents Group delay whose value is from 0.59ns to 9.5ns.

9-pole UWBPF has good rejection about –48dB at 6GHz but high insertion loss maximum 1.7dB. Group delay is from 1.2ns to 2.2ns.

## 3. RESULT OF MEASUREMENT

For measurement UWBPF is made with Fr-4 PCB whose $\varepsilon_r$ is 4.6 and wrapped by Aluminium case. It has is 2.1mm X 2.5mm size, 0.8mm thickness, and two SMA connectors for connecting

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Fig. 7 and 8 present appearance of UWBPF. Anritsu's network analyser 37352A is used for measuring characteristics of UWBPF.

For 5-pole UWBPF, Pass Band Insertion loss is 1.1~2.7dB and considering of insertion loss of two SMA connectors, maximum insertion loss is less than 2dB. Stop band insertion loss is more than 20dB at 2GHz and 6GHz. There is 1dB difference from simulation result but this is made by FR-4 characteristics. S11 of UWBPF is same to S22, because it has symmetric structure and value of S11 and S22 is less than –10dB. Group delay varies from 0.51ns to 1.17ns, so maximum variation is 0.61ns. Comparing to simulation result, measuring results is very similar to ones of simulation. Phase of this paper is very good linearity and it doesn't distort signal which we want to transmit

9-pole UWBPF has maximum 2.3dB insertion loss at 5GHz but embedding of SMA effect, real insertion loss is maximum 1.8dB. at 6GHz rejection ration is more than 40dB and S11 is less than 14dB. It also has good phase and linearity characteristics like fig. 15 and 16

Table 1 Specifications of 5-pole UWBPF

| Property | Value |
|---|---|
| $\varepsilon_r$ | 4.6 |
| Pass Band | 3~6GHz |
| S21 in pass band | <-1dB |
| S11/S22 in pass band | >-25dB |
| S21 @2GHz | >-20dB |
| S22@ 6GHz | >-20dB |

Table 2 Specifications of 9-pole UWBPF

| Property | Value |
|---|---|
| $\varepsilon_r$ | 4.6 |
| Pass Band | 3~6GHz |
| S21 in pass band | <-1.5dB |
| S11/S22 in pass band | >-20dB |
| S21 @2GHz | >-40dB |
| S22@ 6GHz | >-40dB |

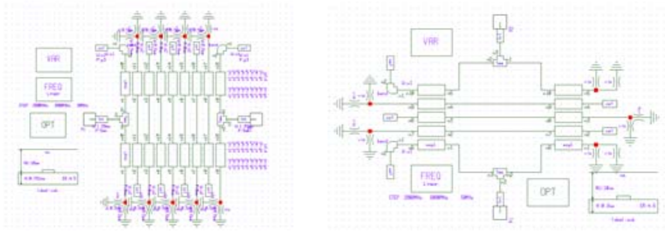


Fig. 2 Pattern shape of UWBPF for simulation (left is 9-pole and right is 5-pole)

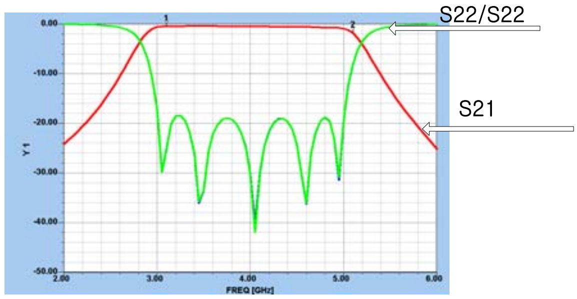



Fig. 3 S21, S11, S22 (Simulation result of BPF) of 5-pole

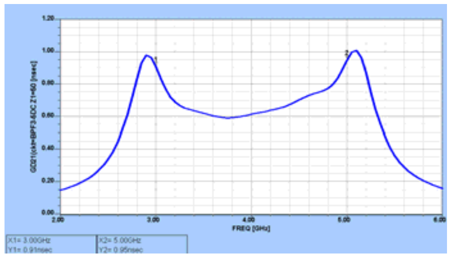



Fig. 4 Group Delay (Simulation result of BPF) 5-pole

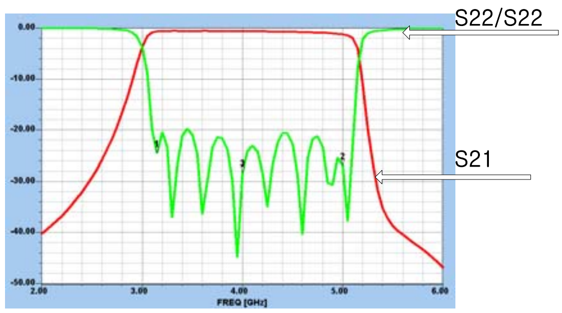



Fig. 5 S21, S11, S22 (Simulation result of BPF) of 9-pole

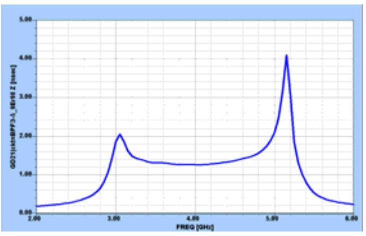
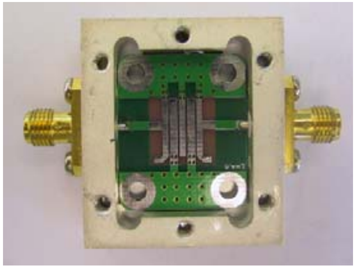


Fig. 6 Group Delay (Simulation result of BPF) 9-pole



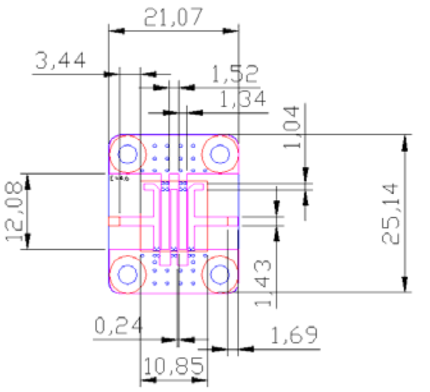
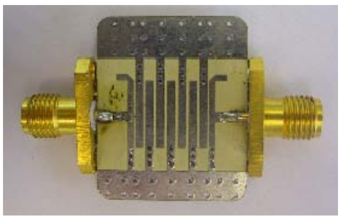



Fig. 7 Appearance of 5-pole UWBPS



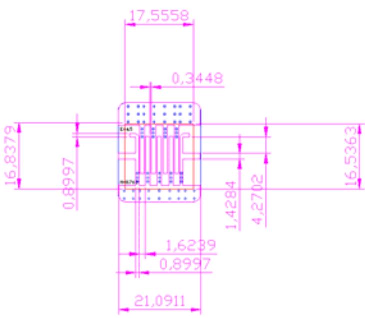



Fig. 8 Appearance of 9-pole UWBPS

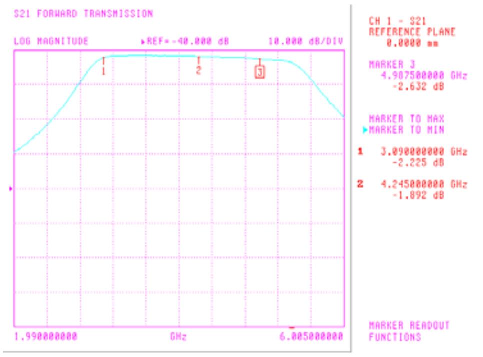



Fig. 9 S21 of 5-pole UWBPF

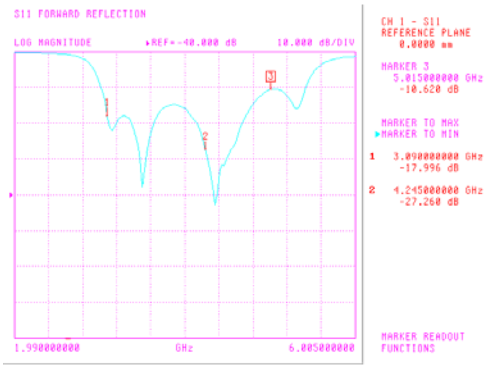



Fig. 10 S11 of 5-pole UWBPF

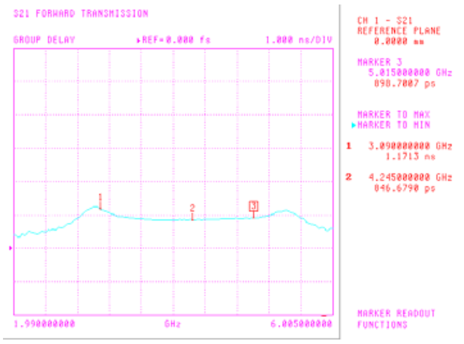



Fig. 11 Group Delay of 5-pole UWBPF

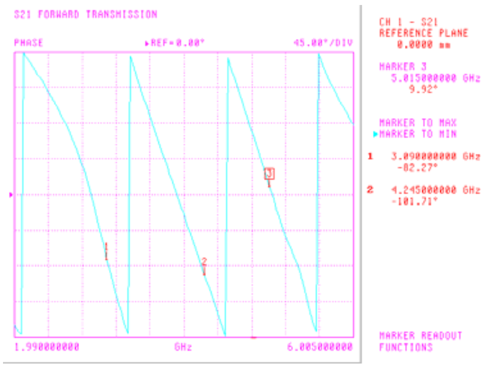



Fig. 12 Phase of 5-pole UWBPF

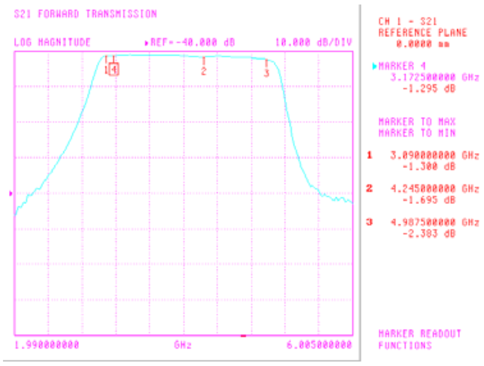



Fig. 13 S21 of 9-pole UWBPF

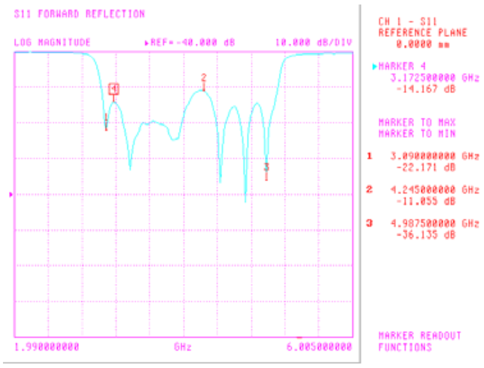



Fig. 14 S11 of 9-pole UWBPF

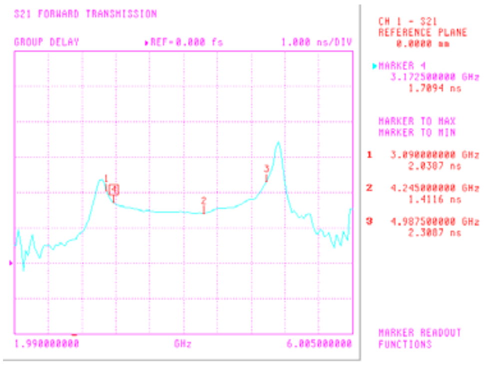



Fig. 15 Group Delay of 9-pole UWBPF

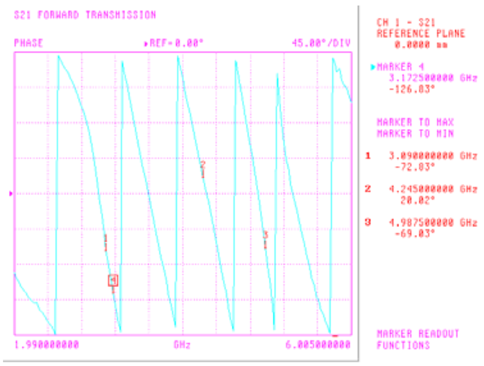



Fig. 16 Phase of 9-pole UWBPF

## 4. CONCLUSION

A new UWBPF, whose size is 2.1mm X 2.5mm, is proposed and it has good group delay and linearity characteristics. It is made of FR-4 and Anritsu's network analyser 37352A is used for measuring UWBPF.

Pass band insertion loss is less than 2dB, and stop band insertion loss is more than 20dB at 2GHz and 6GHz. S11 and S22 is more than 10dB.

Especially it has good linearity characteristics and 0.5ns group delay flatness.

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