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Smart Media KOREAN INSTITUTE OF SMART MEDIA 한국스마트미디어학회

논문 발표순서 (Oral Session 1~4)

Oral Session 4 : 정보처리 및 인식
4월 28일 (토) 09:30-11:00
발표장 : 중앙대학교 100주년 기념관 619호 / 좌장 : 이귀상(전남대)

09:30-09:45	제목 :	Object Tracking via Spatial-temporal Learning combined Correlation Filter
	저자 :	YUJIA ZHANG(전북대학교), SOOK YOON(목포대학교), DONG SUN PARK(전북대학교)
09:45-10:00	제목 :	Gesture-based Emotion Recognition: Deep Learning Approach
	저자 :	Son Thai Ly, Guee-Sang Lee, Soo-Hyung Kim, Hyung-Jeong Yang(전남대학교)
10:00-10:15	제목 :	Fingertip Detection Using Deep Neural Networks
	저자 :	Hai-Duong Nguyen, In-Seop Na, Hyung-Jeong Yang, Guee-Sang Lee, Soo-Hyung Kim(전남대학교)
10:15-10:30	제목 :	Hand Gesture Recognition Using 3D_CNN With Keyframe Extraction
	저자 :	Nguyen Ngoc Hoang, Guee-Sang Lee, Soo-Hyung Kim, Hyung-Jeong Yang(전남대학교)
10:30-10:45	제목 :	Depth-based Hand Interaction System using Convolution Neural Network
	저자 :	Nhu-Tai Do, Hai-Duong Nguyen, Young Chul Kim, Guee-Sang Lee, Hyung Jeong Yang, Soo-Hyung Kim(전남대학교)
10:45-11:00	제목 :	Ultra-Wideband Bandpass Filter with Adjustable Notch band and High Return Loss Characteristics
	저자 :	Phanam Pech, Qi Wang Phirun Kim, 정용채(전북대학교)

Ultra-Wideband Bandpass Filter with Adjustable Notch band and High Return Loss Characteristics

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Abstract

In this paper, an ultra-wideband (UWB) bandpass filter (BPF) with a high return loss and a notch band is proposed. High return loss and notch band characteristics can be obtained by controlling characteristics impedance of coupled line and length of the open-circuit stubs, respectively. For the validation, the UWB BPF was designed to obtain 25 dB return loss with a notch band at 8.2 GHz. The results shows that the 25 dB return loss is extended from 3.35-6.9 GHz and 8.84-10.33 GHz. The maximum attenuation at the notch band of 8.2 GHz is better than 50 dB.

1. Introduction

Ultra-wideband (UWB) systems have been researched and developed in many applications. Since UWB band is covered the other narrow band communication system, such as world interoperability for mobile access (WiMAX, 3.5 GHz) and a wireless local-area network (WLAN) bands (5.2 and 5.8 GHz). Therefore, the notch bands are required to suppress the interference band. Recently, the UWB bandpass filter (BPF) without and with single- and multiple-notched bands were recently investigated [1]-[7]. In [1], a high return loss UWB BPF was proposed without a notch band. Similarly, a multi-mode resonator (MMR) with input/output couplings was proposed in [2] with relatively poor stopped band suppression and no notch band characteristics. In order to overcome this, single-notch band UWB BPFs were designed using dual stepped-impedance stub-loaded resonators [3], interdigital coupling structure [4], and short-circuited stub transmission lines (TLs) [5]. Similarly, an asymmetric coupling strip to produce dual-notch bands by adjusting the physical length of the resonator was mentioned in [6]. Moreover, triple- and quad-notched bands UWB BPFs using interdigital coupled with multiple-mode resonator and broadside-coupled microstip/coplanar waveguide were introduced in [7] and [8], respectively. The previous UWB BPF works were focused on harmonics suppression, notch bands, and the circuit size. However, the UWB BPF with a high return loss and adjustable notch band within the passband is not considered due to realization difficulty and limitations of resonator coupling. High return loss and harmonic suppression of UWB BPF can improve the stability of the system and enhance maximum output power compared to the lower return loss BPF.

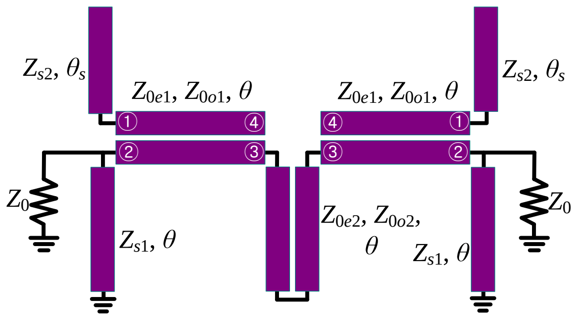

Fig. 1. Proposed UWB BPF structure.

This paper investigates a new UWB BPF design method for a high return loss with an adjustable notch band within the passband. The proposed filter can provide multi-transmission poles in the passband.

2. Design Equations

Fig. 1 shows the proposed structure of microstrip UWB BPF. The proposed circuit consists of two short-circuit $\lambda/4$ TLs and three $\lambda/4$ coupled lines with two open-circuit stub TLs. The open-circuit stub TLs are used to produce transmission zero (TZ) in the specific frequency without seriously degrading the passband response. The proposed UWB BPF is a symmetrical structure so even- and odd-mode analysis can be applicable for understanding of the proposed UWB BPF operation. The equivalent circuits for even- and odd-mode excitations are shown in Fig. 2(a) and (b), respectively. For analysis, the input impedances of equivalent even- and odd-mode circuit are derived as (1a) and (1b), respectively.

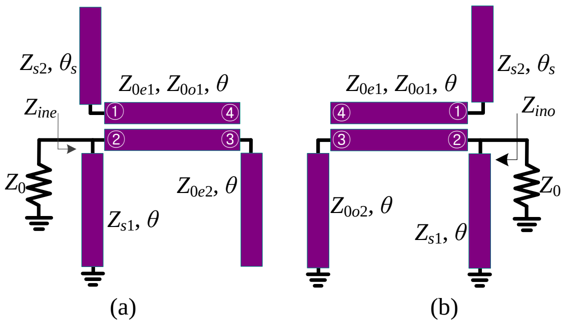

Fig. 2. Equivalent circuits: (a) even-mode and (b) odd-mode.

$$Z_{ine} = j\frac{Z_{s1}P_e}{M_e + Z_{s1}N_e} \tag{1a}$$

$$Z_{ino} = j\frac{Z_{s1}P_o}{M_o + Z_{s1}N_o}, \tag{1b}$$

where

$$M_e = \left(2Z_{0e1}Z_{0o1}\cot\theta + Z_{s2}Z_p\cot\theta_S\right)\left(Z_p - 2Z_{0e}\cot^2\theta\right) \tag{2a}$$

$$N_e = \left(Z_p + 2Z_{0e}\right)\left(Z_p\cot\theta + 2Z_{s2}\cot\theta_S\right) - Z_m^2\csc^2\theta\tan\theta \tag{2b}$$

$$P_e = 2Z_{0e1}Z_{0o1}\left(Z_p - 2Z_{0e}\cot^2\theta\right) + Z_{s2}Z_p\cot\theta_S\left(Z_p\tan\theta - 2Z_{0e}\cot\theta\right) \tag{2c}$$

$$M_o = \left(2Z_{0e1}Z_{0o1}\cot\theta + Z_{s2}Z_p\cot\theta_S\right)\left(Z_p + 2Z_{0o2}\right) \tag{2d}$$

$$N_o = Z_p^2\cot\theta - \tan\theta\left(Z_m^2\csc^2\theta + 2Z_pZ_{0o}\right) + 2Z_{s2}\cot\theta_S\left(Z_p - 2Z_{0o}\tan^2\theta\right) \tag{2e}$$

$$P_o = \left(2Z_{0e1}Z_{0o1} + Z_{s2}Z_p\cot\theta_S\tan\theta\right)\left(2Z_{0o} + Z_p\right) \tag{2f}$$

$$Z_P = Z_{0e1} + Z_{0o1} \tag{2g}$$

$$Z_m = Z_{0e1} - Z_{0o1} \tag{2h}$$

From (1), two-port *S*-parameters of symmetrical network can be obtained as (3).

$$S_{11} = S_{22} = \frac{Z_{ine}Z_{ino} - Z_0^2}{\left(Z_{ine} + Z_0\right)\left(Z_{ino} + Z_0\right)} \tag{3a}$$

$$S_{21} = S_{12} = \frac{\left(Z_{ine} - Z_{ino}\right)Z_0}{\left(Z_{ine} + Z_0\right)\left(Z_{ino} + Z_0\right)} \tag{3b}$$

The locations of the transmission poles (TPs) can be determined according to characteristic impedances of the TLs and coupled lines by giving $S_{11} = 0$. There are six TPs

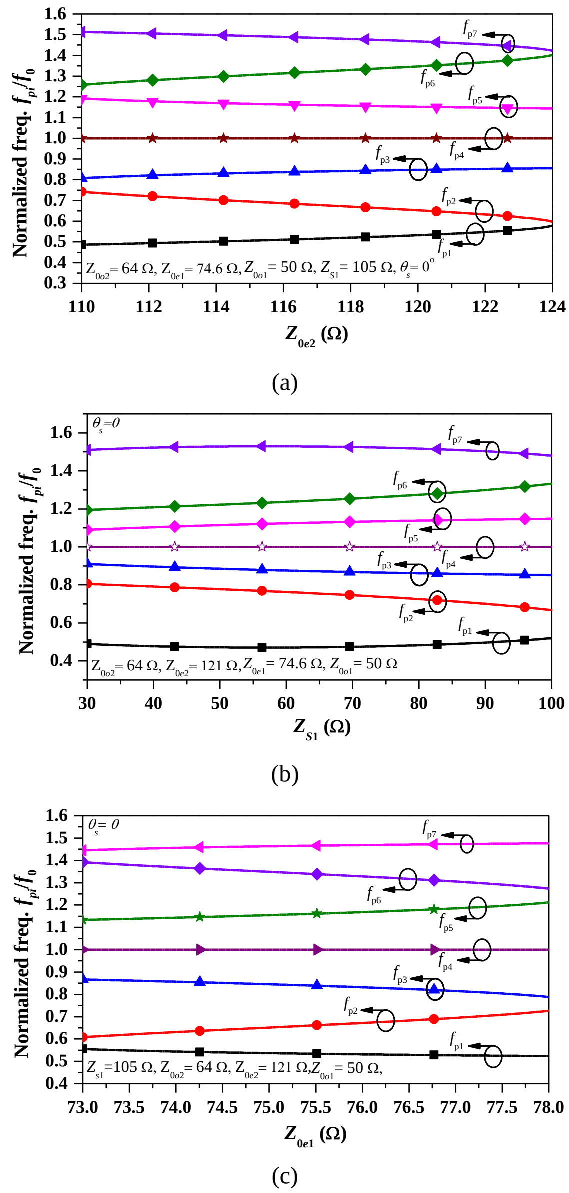

Fig. 3. Variation of transmission pols according to (a) Z_{0e2}, (b) Z_{S1}, and (c) Z_{0e1}.

can be obtained and their locations can be symmetric to the center frequency (f_0). Therefore, the proposed UWB BPF characteristics can be determined by arranging the locations of the TPs. Fig. 3 shows the location variations of TPs according to Z_{0e2}, Z_{s1}, and Z_{0e1}, respectively. As Z_{0e2} increases from 110 Ω to 124 Ω, the first, second, fifth, and sixth TPs (f_{p1}, f_{p2}, f_{p6}, and f_{p7}) are changed within the passband while f_{p4} is constant. However, the third and fourth TPs (f_{p3} and f_{p5}) are slightly affected at a low Z_{0e2}. Also, as Z_{s1} increases from 30 Ω to 100 Ω, the f_{p1}, f_{p2}, f_{p3}, f_{p5}, f_{p6}, and f_{p7} are changed in different manners. Meanwhile, the f_{p4} is constant. Moreover, as Z_{0e1} increases from 73 Ω to 78 Ω, the f_{p1}, f_{p2}, f_{p3}, f_{p5}, f_{p6}, and f_{p7} substantially are changed within the passband. However, the f_{p1} and f_{p7} are slightly affected. The mechanism for the location variations of the TPs according to Z_{0e2}, Z_{st1}, and Z_{0e1} can help the designer to optimize the characteristics of the proposed UWB BPF. Fig.

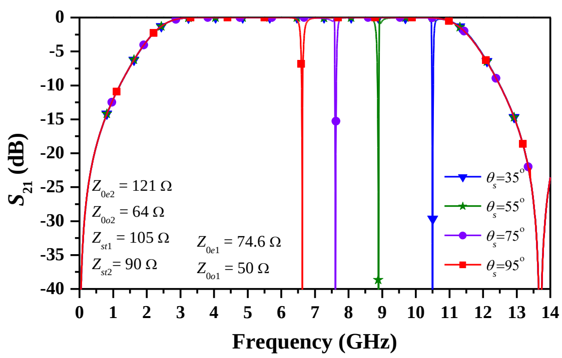

Fig. 4. Variation of notch band according to θ_S.

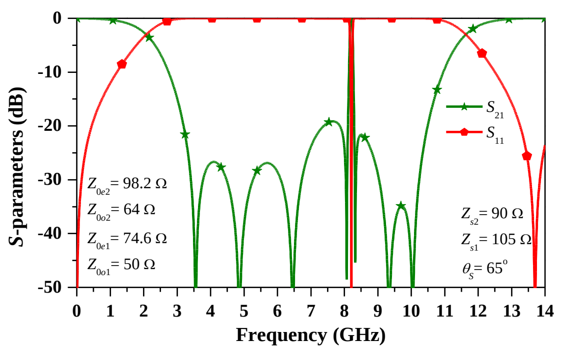

Fig. 5. *S*-parameter of proposed UWB BPF.

4 shows the S_{21} of UWB BPF with a variation of notch band. The notch band can be moved to high frequency as θ_S decreases. Meanwhile, the bandwidth of the passband is maintained with a variation of a notch band.

The design procedure of proposed UWB BPF is summarized as follow. Firstly determine the f_0, maximum return loss, and the notch band locations of the UWB BPF. Secondly, optimize the TPs location from Fig. 3. Thirdly, determine θ_S to allocate the notch band at the specific frequency from Fig. 4. Finally, calculated the physical dimension of the coupled lines and the TLs according to the PCB substrate using ADS.

3. Design Example

To validate the proposed circuit, a UWB BPF was designed at f_0 = 6.85 GHz with 25 dB return loss of the passband and a notch band at 8.2 GHz. From Fig. 3, the characteristic impedances of Z_{st1} = 100 Ω, Z_{0e1} = 65.4 Ω, Z_{0o1} = 48 Ω, Z_{0e2} = 98.2 Ω, and Z_{0o2} = 60 Ω were chosen to obtain 25 dB return loss of the passband. According to Fig. 4, the electrical length of θ_s = 65° was selected to allocate the notch band at 8.2 GHz. Fig. 5 shows the *S*-parameter characteristics of the UWB BPF with a notch. The fractional bandwidth (FBW) of 25 dB return loss is 101.81% extending over 3.35 - 6.9 GHz and 8.84 - 10.33 GHz. However, the return loss near to a notch band was slightly degraded.

4. Conclusion

In this paper, a new UWB bandpass filter with high return loss and a notch band was proposed. The notch band located within the UWB passband can be controlled by adjusting the length of the open-circuit stub TLs and does not affect the passband performance. High return loss of the proposed UWB bandpass filter can improve the overall system performance and stability.

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