Microstrip Filter with Reconfigurable Frequency Responses Based on Capacitor Chips

Achmad Munir and Hardy Lukius
Radio Telecommunication and Microwave Laboratory
School of Electrical Engineering and Informatics, Institut Teknologi Bandung
Jalan Ganesha No. 10 Bandung, 40132, Indonesia

***Abstract* - The development of microstrip filter which has reconfigurable frequency responses for wireless communication systems is presented. By incorporating capacitor chips into the filter circuits, the frequency response of filter is reconfigured for uplink GSM-900, ultra wide band (UWB), and 2.4GHz wireless local area network (WLAN). The microstrip filter which is implemented on a 0.8mm thick FR4 Epoxy dielectric substrate consists of 3 different patches on the top side and 2 different pairs of capacitor chips. From the measurement, the realized filter shows good agreements with the simulated one with the bandpass response of 72MHz and 2.21GHz for uplink GSM-900 and UWB, respectively, and the bandstop response of 2.15GHz for 2.4GHz WLAN.**

***Index Terms* — Frequency response, microstrip filter, reconfigurable, wireless communication systems.**

1. Introduction

In recent years, due to the wide application of wireless communication system the demand of devices with ability to handle some features has increased remarkably. The use of wideband frequency spectrums has led to the need of devices with wideband responses to process different ranges of frequency spectrum. A tunable RF filter which is suitable for frequencies below 10GHz has been developed using varactor diodes [1]-[2]. Meanwhile, a reconfigurable and switchable filter for several frequency bands has been investigated numerically and experimentally to give frequency responses in a wide range of application [3]. However, those filters have been designed based on active components, i.e. semiconductor, in which it is almost dependent from the external power supply.

In this paper, instead of using active components, capacitor chips are proposed as the basis of reconfigurable filter to obtain different response in some frequency bands. The proposed microstrip filter which is implemented on a 0.8mm thick FR4 Epoxy dielectric substrate is designed to work for some frequency ranges including uplink GSM-900 bandpass, UWB bandpass, and 2.4GHz WLAN bandstop. Prior to the realization, parameters of microstrip filter are optimized to ensure the filter workable at desired frequency bands. A brief description related to the design of filter for each frequency band as well as its physical size will be presented. Then, the measurements are carried out to obtain the characteristics of realized reconfigurable microstrip filter to be compared with the design results.

2. Design of Reconfigurable Microstrip Filter

As illustrated in Fig. 1, the reconfigurable microstrip filter is designed on a 0.8mm thick FR4 dielectric substrate with the dielectric constant of 4.4. The final design has the size of 45mm x 45mm. The ports for input and output are made by microstrip lines extending from the center pin of 50Ω SMA connectors. The proposed microstrip filter consists of 3 different patches on the top side for 3 different frequency band applications and 2 different pairs of capacitor chips incorporated into the patches.

The layout for uplink GSM-900 bandpass response referred as patch-1 which takes the combination of meander line shape and straight one is connected to the patch-2 using capacitor chips of 10pF. When patch-2 is connected to the ground using 2 capacitor chips through the patch-3, the microstrip filter is reconfigured as UWB bandpass. The patch-3 which is shorted to the groundplane using via-holes in both end-sides is placed 2mm from the patch-2. Both capacitor chips have the value of 10pF where each capacitor chip is placed 3mm from the end-side of patch-3. To obtain 2.4GHz WLAN bandstop response, the patch-2 takes a microstrip line in shape of rectangular ring with the width of 1.5mm and the gap of 0.4mm. The ring is connected with microstrip lines with the width of 1.5mm act as input and output ports. The width of microstrip line is designed to have 50Ω of input/output impedance.

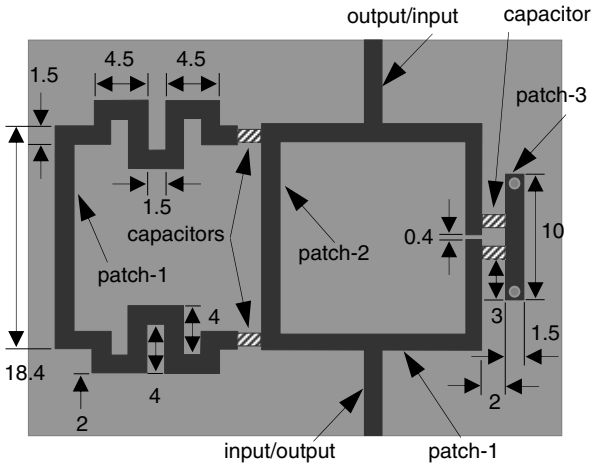

Fig. 1. Overall design of microstrip filter with reconfigurable frequency responses (unit in *mm*).

3. Hardware Realization and Characterization

Fig. 2 shows the realized reconfigurable microstrip filter deployed on a 0.8mm thick FR4-Epoxy dielectric substrate with 2 SMA type connectors are connected to the input and output ports for experimental characterization. Capacitor chips of 0805 type with each value of 10pF are soldered over the patch-1 and the patch-2 as well as between the patch-1 and the patch-3. The measured results are plotted in Figs. 3-5 for uplink GSM-900 bandpass filter (BPF), UWB BPF, and 2.4GHz WLAN bandstop filter (BSF), respectively. As comparison, the simulated results are depicted together for each frequency band.

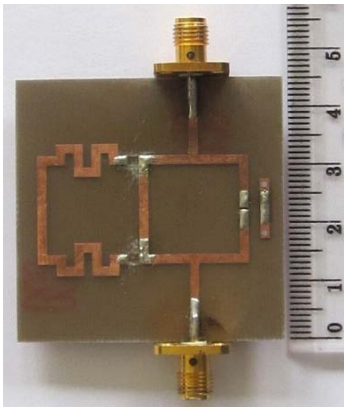

Fig. 2. Realized microstrip filter with reconfigurable frequency responses based on capacitor chips.

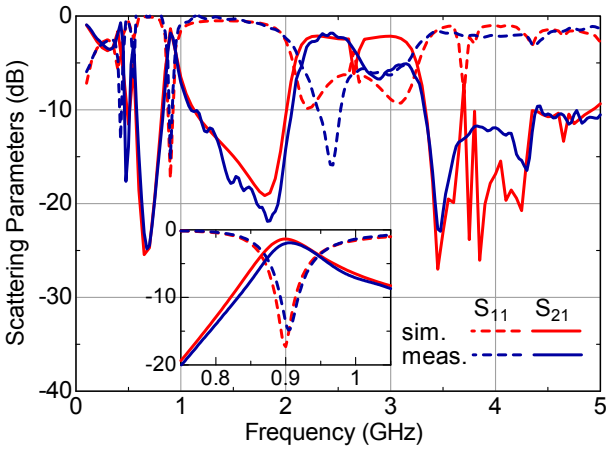

Fig. 3. Measured and simulated uplink GSM-900 BPF

From Fig. 3, the measured result of uplink GSM-900 BPF has the insertion loss of 2.00dB with the return loss of 13.71dB and the bandwidth response of 72MHz from 874MHz to 946MHz. While from the measured UWB BPF shown in Fig. 4, the average insertion loss and return loss at the passband area are 0.98dB and 19.15dB, respectively. It seems that the measured bandwidth response of 2.21GHz is slightly wider than the design one. Furthermore, the center frequency of realized 2.4GHz WLAN BSF plotted in Fig. 5 is slightly higher than the design result about 45MHz with the rejection rate of 38.95dB and the bandwidth response of 2.15GHz which is wider than the design one.

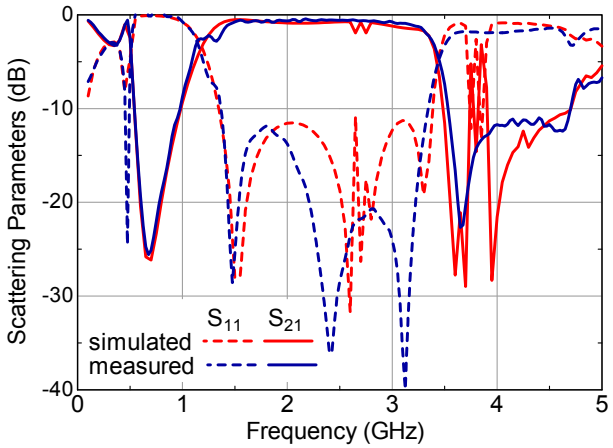

Fig. 4. Measured and simulated UWB BPF

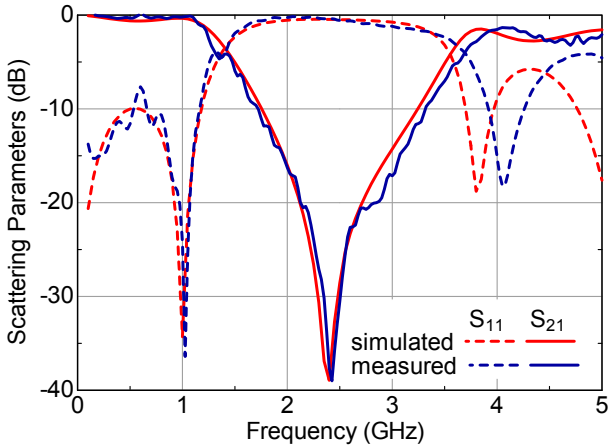

Fig. 5. Measured and simulated 2.4GHz WLAN BSF

4. Conclusion

The development of microstrip filter with reconfigurable frequency responses for uplink GSM-900 bandpass, UWB bandpass, and 2.4GHz WLAN bandstop has been demonstrated. The microstrip filter which has been deployed on a 0.8mm thick FR4 dielectric substrate has employed capacitor chips to obtain reconfigurability for each frequency band. It has been shown that the measured results show good agreement very well with the simulated ones for all frequency bands.

References

[1] A. R. Brown and G. M. Rebeiz, "A varactor tuned RF filter," *IEEE Trans. Microw. Theory Tech.*, vol. 48, no. 7, pp. 1157–1160, 2000.

[2] S. Saeedi, T. Heidari, M. H. Hafezi, and J. M. Baabuei, "Design, simulation and fabrication of a varactor tunable combline microwave filter," in *Proceeding of APMC*, Suzhou, China, pp. 1-4, 2005.

[3] M. F. Karim, Y. X. Guo, Z. N. Chen, and L. C. Ong, "Miniaturized reconfigurable and switchable filter from UWB to 2.4 GHz WLAN using PIN diodes," in *Proceeding of IEEE MTT-S IMS Digest,*, Boston, USA, pp. 509-512, 2009.