*IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE)*
*e-ISSN: 2278-1676,p-ISSN: 2320-3331, Volume 11, Issue 3 Ver. IV (May. – Jun. 2016), PP 108-111*
*www.iosrjournals.org*

# Development in Integrated Front end Design for RF Applications

Shilpam Saxena[1], Apurv Shrivastava[2], Madhur Deo Upadhayay[3]
[1]*Electronics & communication Engineerig, Amity University,Gwalior,India*
[2]*ArchitectureDepartment,School of planning & Architecture,Bhopal,India*
[3]*Electronics & communication Engineering,Shiv Nadar University,Noida, India*

***Abstract:*** *In this paper, various approaches of antenna and filter co-design are presented to reduce size, insertion loss and losses due to cable and connectors used for interconnecting both components. The new approach of interconnection gives larger Bandwidth and efficiency.*
***Keywords:*** *Antenna, Co-design, Filter, Integration, RF front end*

## I. Introduction

Miniaturization, integration and optimum cost are the three most basic demands in today's printed circuit board technology. For better user experience, the size reduction has been a trend in the wireless system design. The development of wireless communications includes several indispensable technologies like wireless local area networks, cellular communications and wireless personal area networks. The reason behind the innovation on better and advanced technologies to achieve the integration and miniaturization of multiple systems is consumer demand for using these radio technologies by means of hand-held mobile devices. Generally Antenna and filter are considered as the critical components in reducing the whole size of the RF Front design. In most of the communication systems receiving antenna is followed with a band-pass filter. In microwave band, filter is usually of distributed type, and implemented using a transmission line resonator. Direct connection between antenna and filter may induce additional mismatch losses and deteriorates the performance of the filter. Therefore the integration of the antenna and filter will be of great interest, which can provide both desired filtering and radiating functions [1]. So they are integrating in a single module.To match the input impedance of the antenna with the receiver, the radio frequency front end consists of an impedance matching circuit, which transfers maximum power from the antenna. There are many ways of miniaturization and one of them is to set in passive circuitries and inter connect them into a package, which is known as system-in package. Another way of miniaturization is to combine all the required various useful circuitries into a single device without restricting it to 50Ω (or 75Ω) constraints, and this is known as co-design [3].

## II. Various approaches of Co-design

In Co-design approach of integration of antenna and filter, a common ground plane is sandwiched between the two. Hairpin filter and micro-strip notch antenna are used for designing purposes. In traditional design approach both were cascaded with 50-ohm interface. They took large substrate size but in co-design approach both are connected vertically by a metallic via hole and arranged to have parallel currents so that electromagnetic interference is reduced. Figure 1 shows the Traditional and Co-design version of antenna and filter. In traditional design approach the input port of notch antenna is connected to the output port of hairpin filter. The complete module takes large substrate size and both the components are connected in cascade with 50 ohm interface. The traditional design approach was not beneficial from user point of view because of large size and cost, as the conductor material requirement increases due to cascade connection between the two. Figure 2 shows the simulated and measured $S_{11}$ parameters for both the co-designed and the traditional antenna-filters. For the co-design version, the measured pass-band is from 4.06 to 4.26 GHz and the impedance bandwidth is 4.7%. For traditional version pass band is 4.03 to 4.14 GHz.

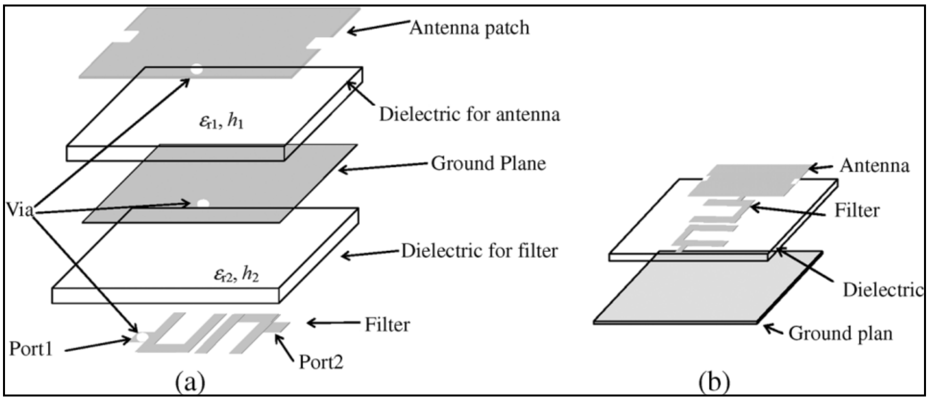



**Figure 1** Antenna-Filter (a) Co-design version, (b) Traditional version. [3]

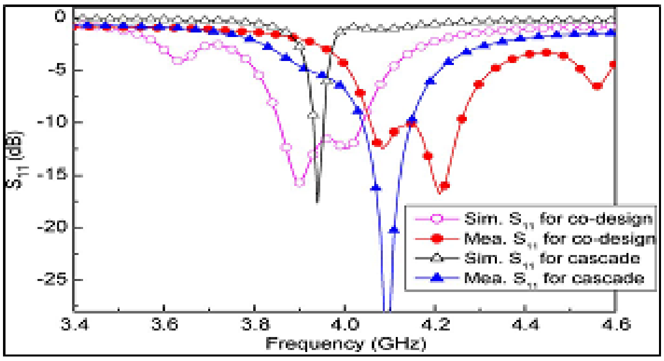



**Figure 2** Simulated and Measured $S_{11}$ Parameters for Co-designed and Traditional Version. [3]

With this configuration size reduction is achieved with improved gain and bandwidth. This co-design allows optimizing the size, performance and the narrow band characteristics. Instead of using notch antenna, antenna with four sharp cuts will provide larger bandwidth so that large number of users can use the channel. Figure 3 show the frequency response of Co-design approach of antenna and filter where rectangular patch is used. The four corners of the patch are provided with sharp cut and the benefit of this design is that it increases the whole bandwidth of the system and ultra wide band is achieved. The reason behind ultra wide band availability is good coupling between antenna and filter and also between via hole and ground plane and this is the reason of getting two resonant frequencies. The design approach is similar as used earlier but the only difference is bandwidth improvement and it is a big achievement because user requirement is our prime concern and this arrangement can be used for ultra wide band applications.

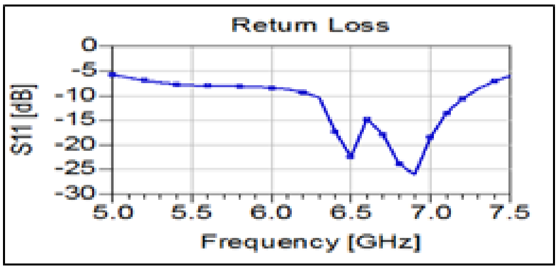
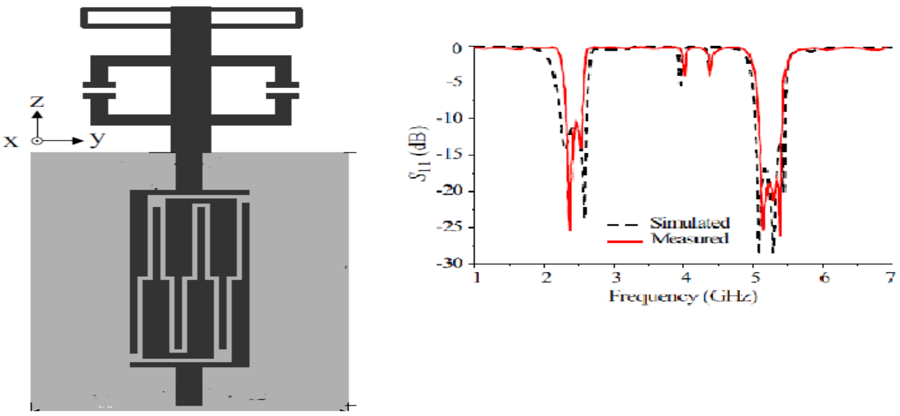



**Figure 3** Antenna-Filter Simulated $S_{11}$ for Co-design version [2]

Another co-design approach is used for WLAN application in which antenna covers the WLAN 2.4 to 2.48 GHz and 5.15 to 5.35 GHz bands easily. A loop loaded dual band monopole radiator and a micro-strip dual-band pseudo-inter digital band pass filter are integrated on a common ground plane. A loop loaded dual band monopole antenna is designed on a substrate and then a dual band pseudo interdigital band pass filter is designed separately on the same substrate. Both are designed for same frequency i.e. 2.45GHz and 5.2GHz. The antenna-Filter and the circuit board of an Access Point share the same substrate and the ground plane shown in Figure4. The design is carefully integrated and the proposed antenna-filter gives good selectivity and rejection in out of band regions and Omni-directional radiation patterns within the two desired bands [4].




(a) (b)

**Figure 4** (a) Co-design of compact Dual Band Filter-Antenna for WLAN application. (b)Simulated and measured $S_{11}$ of Antenna-Filter. [4]

A compact dual-band filtering antenna incorporating a PIN diode for 2.45/5.2GHz wireless local area network is designed. A monopole radiator and a micro-strip dual band pass filter are designed on a common substrate and ground plane with PIN diode shown in Figure 5. To increase the bandwidth of the design and for size reduction, reconfigurable technology is applied. The system reconfigures itself from one frequency band to another using a PIN Diode as shown in Figure 6. The performance of the filtering antenna is notably promoted by optimizing the impedance between the antenna and the band-pass filter, with good selectivity and out-of-band rejection.

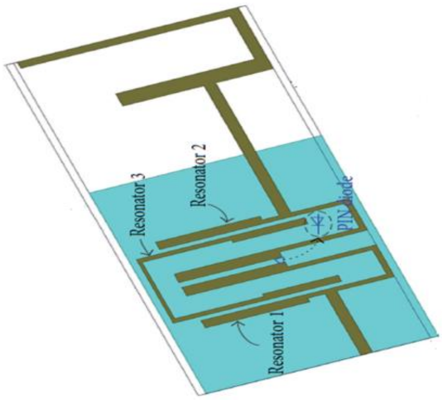
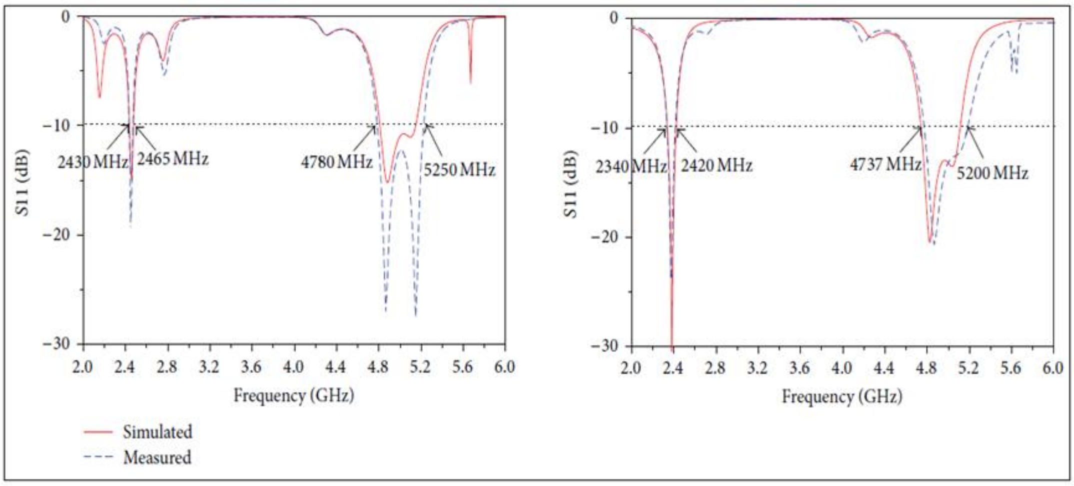



**Figure 5** Compact Dual Band Integrated Antenna Filter with PIN diode [1]

A new design of printed band pass filtering antenna for simple fabrication and integration is also introduced. Inverted L antenna and parallel coupled line is used for design purpose. Inverted L antenna not only work as a radiator but also as a last resonator of filter and the design gives good skirt selectivity and accuracy [5].One more antenna-filter module is designed. In this module, the last resonator of filter is replaced by element of resonant antenna and this antenna is connected to other resonators by two inter cavity slots. The whole design is manufactured using Substrate Integrated Waveguide technique [6]. A technique of matching wideband antenna with a reconfigurable filter is also introduced to overcome the high processing power required to analyze the signals and to reduce the cost, it will also replace the bank of filters required after the antenna by single reconfigurable filter element [7].




**(a)** **(b)**

**Figure 6** Simulated and Measured Reflection Coefficient against Frequency for the Proposed Filtering Antenna: (a) for state1 and (b) for state2. [1]

## III. Conclusion

In this paper, various approaches of antenna-filter co-design for miniaturization of RF front end is proposed. Wide band availability by Sandwiching ground plane between antenna and filter and dual band availability for WLAN using loop loaded monopole integrated with band select filter is achieved. The impedance matching between antenna and filter is optimized to improve the performance without restricting it to 50 ohm .It provides good selectivity and rejection in out of band regions.

## References


**Journal Papers:**

[1]. Chen, S., Zhao, Y., Peng, M., & Wang, Y. "A Codesigned compact dual band filtering antenna with PIN loaded for WLAN applications", International Journal of Antennas and Propagation , Artical ID 826171,6 pages,2014.

[2]. Ramprasad, J., & Jeyaprabha, T. " Design and Implementation of an integrated RF antenna filter co-design for UWB applications". International Journal of Modern Engineering Research , 2693-2694. 2012.

**Proceedings Papers:**

[3]. Zuo, J., Chen, X., Han, G., Li, L., & Zhang, W. "An Integrated Approach to RF Antenna Filter Co-Design".IEEE Antennas And Wireless Propagation Letters,Vol. 8,pp.141-144, 2009.

[4]. Wu, W.-J., Liu, Q.-f., Zhang, Q., & Deng, J.-Y. "Co-design of a compact dual band filter antenna for WLAN application". Progress in electromagnetics research letters Vol. 40, pp.129-139,2013

[5]. Chao-Tang Chuang, Shyh-Jong Chung "Synthesis and Design of a New Printed Filtering Antenna" IEEE Transaction On Antenna And Propagation, Vol.59, No.3,pp 1036-1042,March 2011.

[6]. Omar A.Nova, Juan C.Bohorquez, Nestor M. Pena "An approach to filter-antenna integration in SIW technology" 978-1-4244-9485-9, IEEE, 2011.

[7]. Y.Tawk, C.G. Christodoulou, M.Zamudio, E.Nassar "The Integration of Reconfigurable Filters for the Matching of Wideband Antennas"978-1-4673-5317-5, IEEE, 2013.