The Integration of Reconfigurable Filters for the Matching of Wideband Antennas

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***Abstract*—This paper presents a technique to reduce the cost and overcome the high processing power needed to analyze the signals received by wideband antennas. The idea is based on matching a wideband antenna to a reconfigurable filter. This will allow an easier processing for the received signal and the replacement of the bank of filters needed after the antenna by one reconfigurable filter element. Two prototypes are shown to prove the validity of the proposed technique.**

I. Introduction

Wideband antennas represent an essential part of the RF front-end in a cognitive radio communication system. They are needed to sense the channel user's activity over a wide spectrum. This monitoring is very essential in such environment since it improves the spectrum usage efficiency. Also, the channel sensing provides the cognitive radio processing block with the required information needed to adapt according to the channel varying conditions and most importantly to learn from previous channel usage in order to predict future outcomes [1].

In this paper, we present a technique to reduce the cost and minimize the processing power required to analyze the signals acquired by wideband antennas. The idea is based on integrating and matching a reconfigurable filter with the wideband antenna structure. This will divide the wideband performance of the antenna into a series of narrower sub-bands. In the next section, the proposed reconfigurable filter is discussed and the matching of the reconfigurable filter with two different wideband antenna structures is shown as well.

II. Reconfigurable Filter

In this paper, we present a reconfigurable filter that can be matched to a wideband antenna. The filter can be cascaded with the antenna or integrated within the wideband antenna feeding line. The filter structure and its dimensions are shown in Fig. 1. It is printed on Rogers Duroid 5880 substrate of dimension 30 mm x 30 mm. The filter consists of a full ground in the bottom layer and a stripline of width 5 mm at the top layer. A varactor is placed in the middle of the structure to allow the filter to tune its band-pass frequency. The varactor changes its capacitance from 2.67 pF to 0.68pF by varying the junction voltage from 0V to 30V. Two small gaps of width G_W=0.2 mm are etched to isolate the dc bias current from the two ports of the filter. These gaps act as bypass capacitors. Two bias lines of width B_W=0.4 mm and length B_L= 11.87 mm are incorporated to provide the dc voltage to the varactor. Two 1.2 nH SMD inductors are included between the filter structure and the bias lines to isolate the RF current from leaking to the power supply. The measured tuning in the filter band-pass frequency for different voltage levels is shown in Fig. 2.

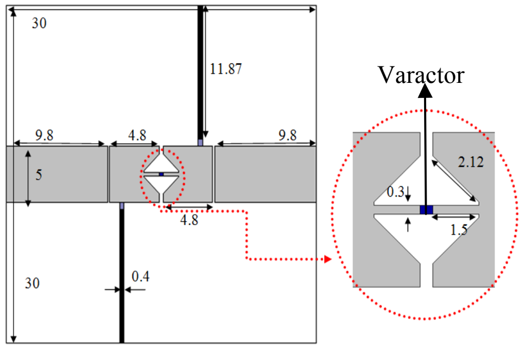

Figure 1. The structure of the reconfigurable filter

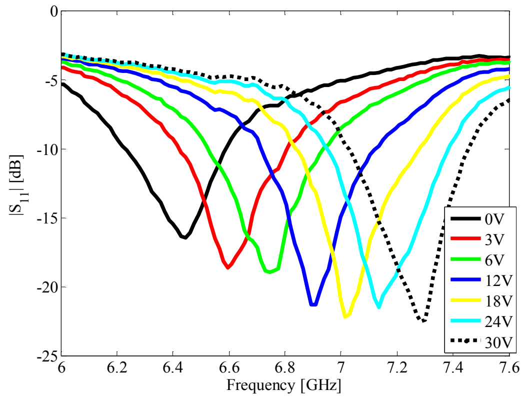

Figure 2. The measured $|S_{11}|$ of the filter

The matching of the reconfigurable filter with the wideband antenna can be done as follows:

A. Integrating the filter in the antenna feeding line:

In this case, the filter constitutes a major part of the antenna since it lies in its feeding network as shown in Fig. 3. The antenna under study is a dual sided printed Vivaldi antenna which is a wideband radiator. By integrating the reconfigurable filter, the antenna response depends on the operating band-pass frequency of the filter. A bias-tee is used to supply the appropriate voltage to the varactor incorporated within the filter structure. The use of the bias tee eliminates the need for any external DC wires attached to the filter structure [2].

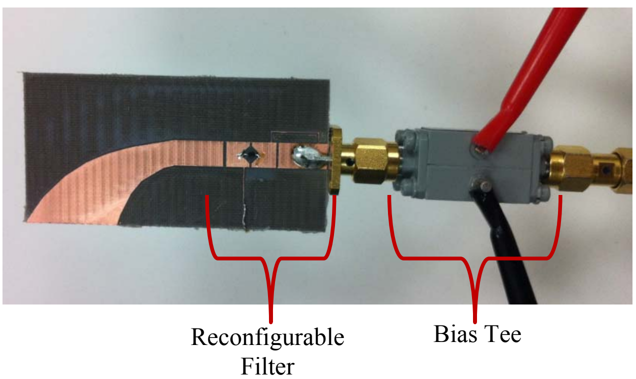

Figure 3. The integration of a reconfigurable filter within the feeding line of a Vivaldi antenna

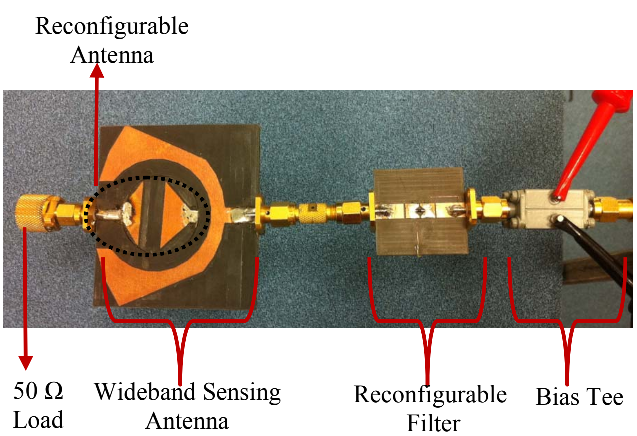

Figure 4. The cascade of the reconfigurable filter with the wideband antenna port of a cognitive RF front-end

B. Cascading the filter with the antenna:

If the antenna feeding line cannot accommodate the reconfigurable filter structure, one possible solution is to cascade the filter with the wideband antenna as shown in Fig. 4. The antenna structure is designed for cognitive radio applications. It consists of two ports where port 1 is a reconfigurable structure and port 2 is a wideband modified printed monopole. The reconfigurabilty in port 1 is achieved by feeding at different instances a triangular shaped patch via a rotation of 180^0 [3].

In this case, the reconfigurable filter is cascaded with the wideband antenna port and the reconfigurable antenna port is terminated via a load of 50 Ω. Similarly to the first case, a bias tee is now connected to the input port of the reconfigurable filter in order to activate the varactor. The wideband antenna covers the band from 3 GHz till 11 GHz. However by cascading the filter, the wideband antenna reflection coefficient depends on the filter operation. The measured reflection coefficient of the combination of the wideband antenna and the reconfigurable filter is shown in Fig. 5.

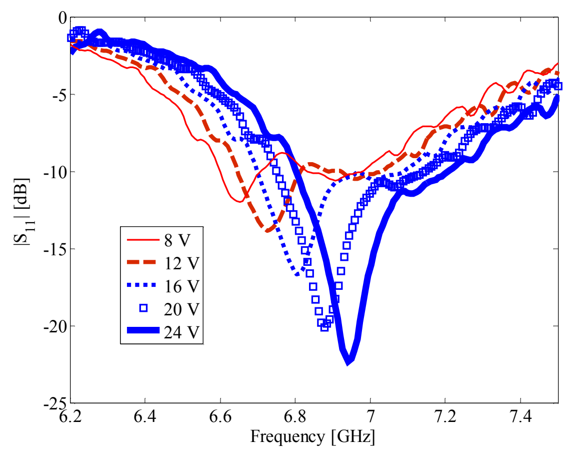

Figure 5. The measured reflection coefficient of the wideband sensing antenna and the reconfigurable filter

III. CONCLUSION

In this paper, we discuss the idea of matching a wideband antenna to a reconfigurable filter. This concept eliminates the need for high speed analog to digital converters (ADCs) which are costly and lack accuracy. Two prototypes are discussed to prove the validity of the proposed technique.

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