



# Design and Optimazation of Active 9–11GHz Band Pass Filter for SAR Applications

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(Recieved 12 March. 2012 Accepted 5 April 2012)

**ABSTRACT :** Technologies have advanced rapidly in the design of filters to enhance effectiveness of mobile communications including SAR applications. In this research work 9 to 11 GHz active band pass filter for of 32 order Kaiser window with 0.5 Beta was designed using XILINX and MATLAB soft wares. This was optimized and analysed by passing the square wave pulse signals at 10 GHz,14 GHz and 18 GHz keeping the sampling frequency at 48 GHz. These results were presented and discussed.

**Keywords:** Active filter, MATLAB Filter Design and Analysis (FDA) Tool, XILINX Electronic Design Automation(EDA) Tool.

## I. INTRODUCTION

A filter is a device that passes electronic signals at certain frequency ranges while preventing the passage of others. An active filter is a type of analog filter distinguished by the use of one or more active components such as voltage amplifiers, buffer amplifiers. They are generally a solid state transistor or operational amplifier.

Active filters are preferred over passive filters especially at high frequency ranges where the response of the passive filters is very poor and they add their own noise due to LRC components. The inductors are avoided in active filters which otherwise add weight and hence they are resistible for airborne SAR applications.

There are basically 4 types of active filters for e.g.,

- Butter worth, Chebyshev, Bessel, and Elliptic filters.

Active filters using OP amps falsify the ideal frequency response. The most important influence is caused by the finite gain bandwidth product of the OP amps. Analog active filters suffer from deviation from nominal values of the passive components of course have influence on the frequency response of the filter. To avoid these deviations, the digital filters need to be designed and developed.

## II. PROPOSED DESIGN METHODOLOGY

In this paper the design of Butter worth type of digital active band pass filter for frequencies 9 to 11 GHz of 32 order Kaiser window with 0.5 Beta for a sampled frequency of 48 GHz is carried out. The design process involved in this work is described in the following steps which is also shown in the block diagram in Fig.1.

- MATLAB (Filter Design and Analysis Tool) FDA software tool is used to generate the coefficients required for the operation of the filter.

- Xilinx(Electronic Design Automation Tool) EDA software tool was used to design the filter.
- In this design methodology Finite Interval Response (FIR) and Kaiser window with 32 order TAP was used.
- Coding was done in VHDL-VHSIC (Very High Speed Integrated Chip) Hardware Descriptive Language.
- Filter response was derived for the sampling frequency of 48 GHz.
- To test the efficiency of the 9 to 11 GHz designed Band pass filter various at 10 GHz, 14 GHz and 18 GHz were passed and results were obtained.

The (FDA) Filter Design and Analysis tool in MATLAB provides the option to design the digital filter to offer the respective response and coefficients to be implemented within the design using VHDL. Filter design can be carried out often selecting various options available in FDA tool for generation of required coefficients for the respective filter from the target menu using the C header option of the FDA tool.

The generated coefficients in the C header files are then used in the VHDL file for the digital filter designing which is to be convoluted with the sampled data of SAR.

Simulated SAR signal accompanied with random noise is sampled at a frequency of 48 GHz.

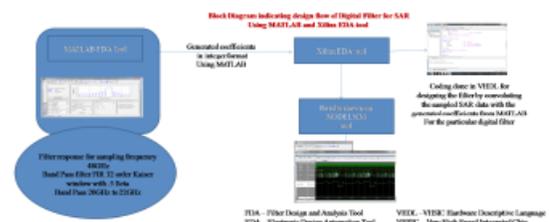


Fig. 1. Block diagram of the proposed Design flow methodology.

### III. RESULTS AND DISCUSSION

The designed filter response characteristics of the digital active band pass filter for 9 to 11 GHz for 32 order Kaiser window with 0.5 Beta for sampling frequency of 48 GHz is as shown in Fig. 2 clearly achieving the filter design.

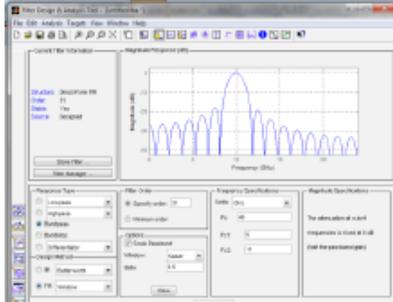


Fig. 2. Band pass filter response characteristics for sampling of 48 GHz of 9 GHz to 11 GHz.

The responses of the same designed filter was tested by passing a simulated SAR square wave pulse signal of 10 GHz, 14 GHz and 18 GHz whose results are as shown in Fig. 3 and 4 and 5 respectively. These results clearly bring out the signal plus noise and output of the filter in these figures.

The output response of the filter for 9 to 11 GHz in figure 3 shows with out any noise and the object of designed filter for the stated band pass of 9-11 GHz is achieved. 14 GHz out put signal is suppressed substantially and 18 GHz signal is completely suppressed as brought in Fig. 4 and 5 respectively.

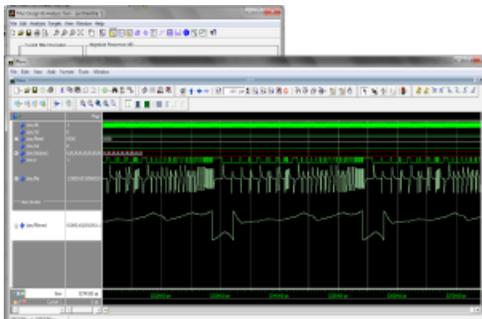


Fig. 3. Output Response of filter for 9 GHz to 11 GHz signal.

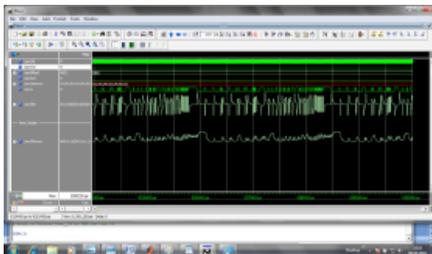


Fig. 4. Output Response of filter for 13 GHz to 15 GHz signal.

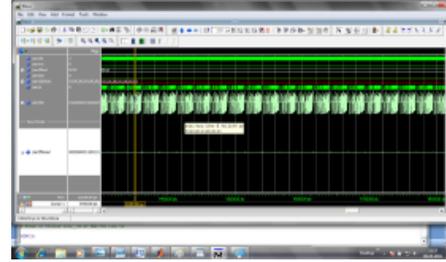


Fig. 5. Output Response of filter for 17 GHz to 19 GHz signal.

It is seen from the Fig. 3, 4 and 5 that the band pass filter design is clearly achieved using the methodology proposed in this paper. It is seen from the figure 3 that the simulated SAR signal clearly passing through the 9 to 11 GHz window, by suppressing the noise levels, presenting the reflected echo of the SAR signal.

It is observed from the figure 4 that the filter response for the band pass frequency of 13-15 GHz the noise level has become predominant for the same SAR signal. Further it is observed that from the figure 5 that the filter output for 17-19 GHz signal completely suppresses the signal.

### IV. CONCLUSION

The results obtained from this design clearly demonstrate that a band pass Butterworth digital active filter was designed successfully by using MATLAB FDA and XILINX EDA software tools. The response was successfully obtained for the designed frequency of 9–11 GHz for 32 order Keiser window with 0.5 Beta for a sampling frequency of 48 GHz by passing a simulated square wave pulsed SAR sample signal as brought in figures 3, 4 and 5 respectively. These filters are suitable for SAR applications to mitigate random noise levels with improved SNR and give the desired target response so that resolution and identification of desired objects are achieved.

### V. FUTURE SCOPE

This experiment on simulation design of SAR filters by MATLAB and XILINX software tools show the way to formulate practical design of filters for SAR applications for Remote Sensing for Disaster management, Agriculture, rural development and military applications. These filters will play a crucial role in practical implementation in future SAR signal noise reduction.

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