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Design And Simulation of CFOA Based Active Band Pass Filter For High Frequency RFID (Radio Frequency Identification) Technology

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Abstract- In today's world RFID plays a vital role in the field of communication. RFID stands for Radio Frequency Identification. It works on Low frequency (LF, 30 - 500kHz), High frequency (HF, 10 - 15MHz) Ultra high frequency (UHF, 850 - 950MHz, 2.4 - 2.5GHz, 5.8GHz).In this paper, the author(s) proposed a design of active band pass filter on high frequency (HF,10-15 MHz) because an active band-pass filter is needed for the RFID to reject all signal outside the band. The design of an active band pass filters is based on CFOA. For this purpose we use AD844 IC because these ICs having capability of realizing amplifiers exhibiting gain-bandwidth decoupling and these are work on very higher Slew rate up to 2,000 V/μ s. The simulation result of the circuit using MULTISIM software, their ultiboard design and 3D view of the proposed circuit are also included.

Keywords: RFID, Band-pass filter, CFOA based AD844 IC, Multisim, Ultiboard design and 3-D view

I. INTRODUCTION

Radio Frequency Identification is a technology which uses electromagnetic fields to identify and track tags and it can be attached to any object. It basically has two components RFID reader and tags. High frequency RFID can track tags within a distance of 1 to 12 inches. The RFID Reader is used to transmit and receives the signal and the tag which is attached to an object. An RFID tag has microchip which contains an integrated circuit and antenna. RFID Reader requires an active band-pass filter which is used to reject the frequency outside the 10-15 MHz frequency range.

In earlier research many types of designed were proposed based on filter design for RFID [1-4]. In 2009 [1], Active band-Pass Filter for Low Frequency RFID was proposed for (10-20 KHz) frequency. In 2012 [2], Integrate Band-pass Filter was designed for 13.56 MHz RFID Reader. In 2014 [3], An Active RC Band-Pass Filter was designed. The filter is designed from given specifications of the filter, center frequency of 15 kHz and roll-off rate of -20dB/decade. In 2009 [4], Active Band-Pass Filter for Low Frequency RFID was proposed for (10-20 KHz) frequency. In 2014 [4], the 4th order active band- pass filter using multiple feedback and Sallenkey topologies was designed and fabricated for RFID system reader to reject all signals outside the band (10-20) kHz . In this paper, the author(s) are designing CFOA based active band pass filter on high frequency (10-15 MHz) using AD844 IC. CFOA has gain- bandwidth independence, higher slew rate and consequently higher frequency range of operation. Instead of other op-amp IC, in this paper we have used AD844 as it provides: better ac performance, high linearity, and an exceptionally clean pulse response. It has a very fast large signal response and very high slew rate (2,000 V/μ s).

II.RADIO FREQUENCY IDENTIFICATION (RFID)

RFID uses radio waves for its working. RFID tag send data to RFID reader and then data is transferred to computers where it can store for further use.

RFID tags operate in three frequency ranges: (LF, 30 - 500 kHz) High frequency (HF, 10 – 15 MHz) Ultra high frequency (UHF, 850 - 950MHz, 2.4 - 2.5 GHz, 5.8GHz) [5].

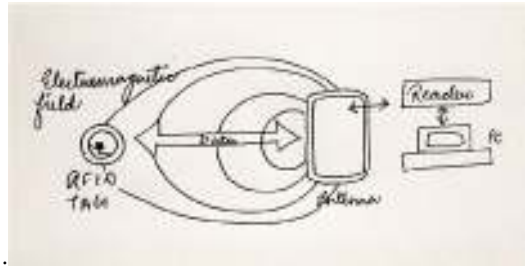

Fig. 1: RFID System

III. ACTIVE BAND PASS FILTER

Active Band pass filter has a pass band between two cutoff frequency (F_L and F_H). It passes only particular band of frequencies and attenuates frequency outside this band. In this paper, we choose lower frequency (F_L) =10MHz and higher frequency (F_H) =15MHz.

Active band pass filter is of two types: Wide band pass filter and Narrow band pass filter. Wide band pass filter has Q<10 whereas Q>10 for narrow band pass filter. Here, Q is the quality factor and is used to measure the selectivity. When

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we design the first order filter then the roll off will be ± 20 dB/decade and when we increases the order then the roll off will also increases.

Active Band Pass Filter can be formed by cascading low pass filter with a high pass filter as shown in figure.

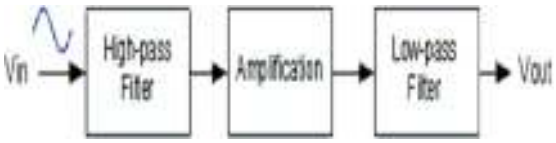

Fig.2: Active Band Pass Filter

IV. CFOA (CURRENT FEEDBACK OP-AMP) AND AD844 IC

Current feedback operational amplifier (CFOA) has a variable-gain and constant bandwidth. It has higher slew rate and operate on a higher frequency range. They do not have a gain bandwidth product conflict. When signal amplitudes increases, it shows a very small loss in bandwidth. Since large signals can be accommodated with minimal distortion therefore, these amplifiers have good linearity at very high frequencies.

The AD844 IC is a CFOA based IC. It is a high speed monolithic IC. It is a current feedback operational amplifier IC. It has high bandwidth around 60 MHz at gain of 1 and around 33 MHz at gain of 10 and provides very fast large signal response with excellent DC performance. It has very high slew rate, typically, 2,000 V/μ s [6].

V. CALCULATIONS

Here, we have design a wide band pass filter for low cutoff frequency F_L=10MHz and high cutoff frequency F_H=15MHz.

1. Low pass filter components

Value of capacitor C=0.01μF
Value of variable Resistor $R_8=1/ (2\pi F_H C_2)^{1/2} =1/ (2\times3.14\times15\times 10^6\times0.01\times10^{-6})^{1/2} =1.06\ \Omega$
Value of Resistor R_4=RF=200×R8=200×1.06=212 Ω
2. High pass filter components

Value of capacitor C_1=0.05μF
Value of variable Resistor $R_5=1/ (2\pi F_L C1)^{1/2}=1/ (2\times3.14\times10\times10^6\times0.05\times10^{-6})^{1/2} = 0.318\ \Omega$
Value of resistor R1=RF=200×R5=200×.318=63.60 Ω
Theoretically, values are:

CENTER FREQUENCY (F_c) = $(F_H\times F_L)^{1/2} = (15\times10)^{1/2}$=12.24 MHz
BANDWIDTH (BW) = F_H-F_L= 15-10 = 5 MHz
QUALITY FACTOR (Q) = F_C /BW=F_C/ (F_H-F_L) =12.24/ (15-10) =2.44
Practically, values are:

CENTER FREQUENCY (F_c) = 14.279 MHz

QUALITY FACTOR (Q) =14.279/ (15-10) =2.88

VI. DESIGN AND SIMULATION RESULT

We have design wide band-pass filter at high frequency for RFID using IC-AD844 on Multisim. The circuit diagram is shown in given figure.

1. Designing of active wide band-pass filter on Multisim using AD844 IC.

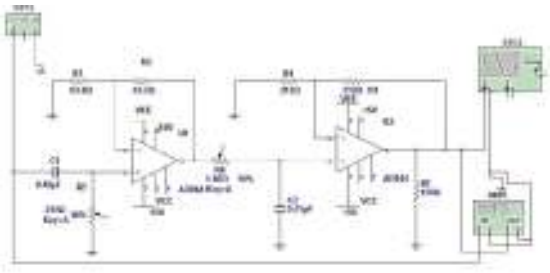

Fig. 3: Schematic circuit diagram of 1st order band pass filter

Output results of proposed CFOA based wide band-pass filter are shown in fig. 4 and 5. The frequency response curve is shown in fig. 6 using bode plotter. The results shows that the center frequency is approx. 14.279 that is closely to the theoretical value and the roll off is 21.931 dB. This first order wide band-pass filter passes the band of frequencies from 10 MHz-15 MHz and stop the frequencies outside this band.

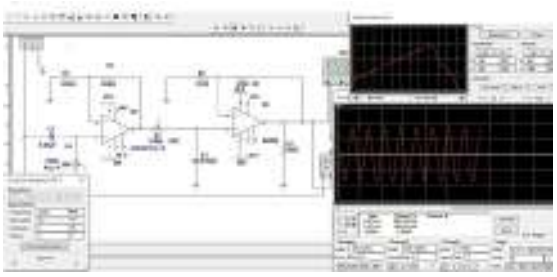

Fig. 4. Shows the circuit diagram with its output result

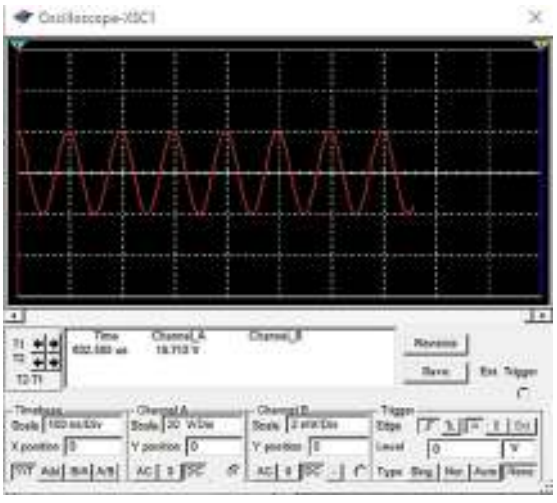

Fig. 5. Shows the output result

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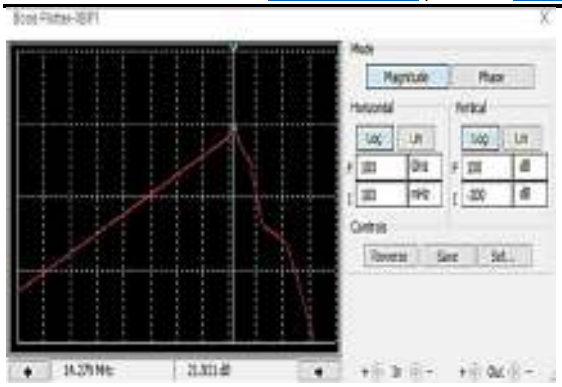

Fig 6. Shows the frequency response curve using Bode plotter

VII. RESULTS SHOWN IN TABULAR FORM

Values	Practically	Theoretical
Q-factor	2.88	2.44
Centre Frequency	14.279 MHz	12.24 MHz
Roll off	21.931 dB/decade	20 dB/decade

Table 1: shows the theoretical and practical values

VIII. ULTIBOARD DESIGN AND 3-D VIEW

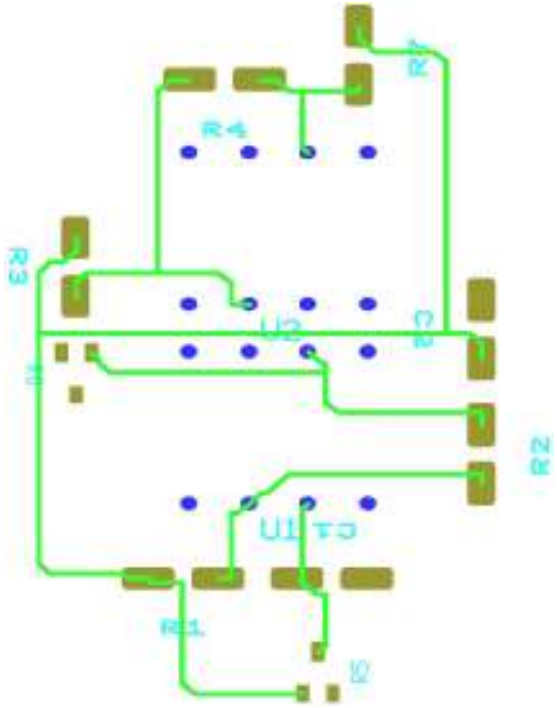

Fig. 7: shows the Ultiboard design of the active wide band pass filter

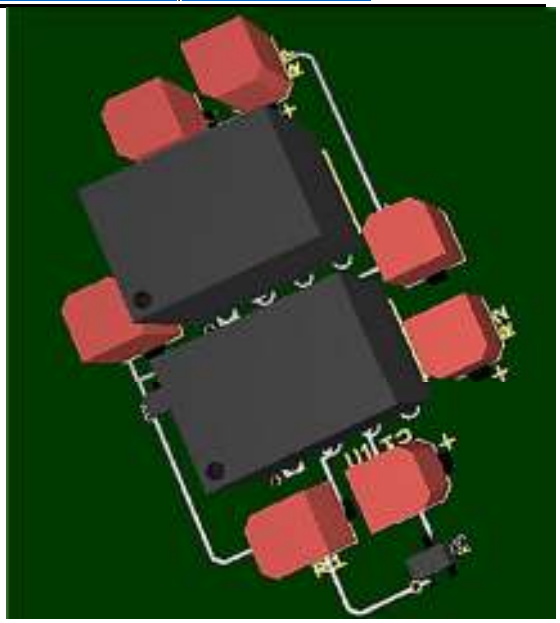

Fig 8. Shows the 3-D view of the active band pass filter

IX.CONCLUSION

In this paper, we concluded that the proposed design of an active band pass filter work on high frequency (HF,10-15 MHz) are used for RFID system because an active band-pass filter is needed for the RFID technology to reject all signal outside the band. The design was proposed of an active band-pass filter is based on CFOA. For this purpose we used AD844 IC. We concluded that these ICs having capability of realizing amplifiers exhibiting gain-bandwidth decoupling and these are work on very higher Slew rate up to 2,000 V/μ s. Therefore design of active band pass filter with the help of these ICs will be suitable for RFID technology. We have also presented the ultiboard design and 3D view also. These designs can be helpful for other researchers, students, for industry purpose etc. for to do their research work and for PCB designing work.

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