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Design And Simulation of CFOA Based Bubba Oscillator And Its Application

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Abstract- Bubba oscillator has the ability to generate the stable sine wave with low distortion using op-amp. The processing power of Bubba oscillator is quite small, therefore they often transmit in the frequency range from VHF to HF band. It is used in various application like mobile devices, power invertors, communication etc. In this paper we proposed a design of bubba oscillator using current feedback operational amplifiers (CFOA) at 12 MHz frequency. For this purpose we will use the AD844 IC and the simulation results are also shown along with ultiboard design and 3D-view of the proposed circuit.

Keywords- CFOA, VFOA, bubba oscillator, IC, NI Multisim

I. INTRODUCTION

Bubba Oscillator is used in various applications because this circuit provides two waveforms in form of sine and cosine. These oscillators produced the stable output at low distortion. Normally bubba oscillators were designed only for low frequencies. In fact maximum oscillators are designed for low frequency only. At high frequencies the oscillators do not give a stable output. Thus the motive of using AD844 IC is to make the bubba oscillator work even at high frequency and give the output as stable as possible.

Many types of bubba oscillators based on operational amplifier were proposed for different applications on different frequency ranges [1-3]. A bubba oscillator was designed for pure sine wave inverter to produce a stable 60 Hz sine wave with little distortion [1]. A bubba oscillator was designed at 1.76 KHz frequency [2-3].

In this paper we proposed a design of bubba oscillator using current feedback operational amplifiers (CFOA) at 12 MHz frequency. For this purpose we will use the AD844 IC and the simulation results are also shown along with ultiboard design and 3D-view of the proposed circuit.

I.I. Bubba Oscillator

Oscillators are basically used to generate oscillations or in other way we can say to convert DC voltage into AC voltage. This oscillator also works in the similar way giving sine and cosine output. This type of oscillator belongs to the category of phase shift oscillators. In the bubba oscillator there are four R-C combination circuits, each providing a phase shift of 45 degrees. This results in output of very low frequency drift. The bubba oscillator gives two outputs: - one is a sine waveform and other is a cosine waveform. Its frequency is given by: $f = 1/2\pi RC$.

I.II. AD844 IC: - To design the oscillator with a current feedback operational amplifier the IC AD844 is used. This IC itself is a current feedback IC. The main advantage of using this is, including this IC in the circuit we can design the oscillator even for high frequency signals (up to MHz). In a CFOA configuration the feedback given to main amplifier is of current instead of voltage. This results in high slew rate. The feedback gain as well as the amplifier gain remains the same.

II. DESIGN AND SIMULATION

Designing of a bubba oscillator using IC AD844 requires the following equations and calculations:-According to the loop equation,

$$A\beta = A\,(1/(RC+1))^4$$

$$|\beta| = |1/(j+1)|^4 = |1/4|$$

Or we can say: $R_f = 4R_1$, where R_f is the feedback resistance. Thus we concluded that the gain of an ideal bubba oscillator is 4. The main gain to the oscillator is given by the U1. All the RC combinations are filtering circuits. The op-amps U2, U3 and U4 act as voltage follower circuits. The variable resistance R1 which is equivalent to R_f is 550Ω.The resistance R6 is equivalent to R_1 i.e. 130Ω. Diode D1 and D2 are virtual zener diodes (1N751). They are used to get the output for particular amplitude. The DC voltage is given to the oscillator at the non-inverting terminal of the IC. The DC voltage of about 0.5V is given to generate oscillations at about 2V.

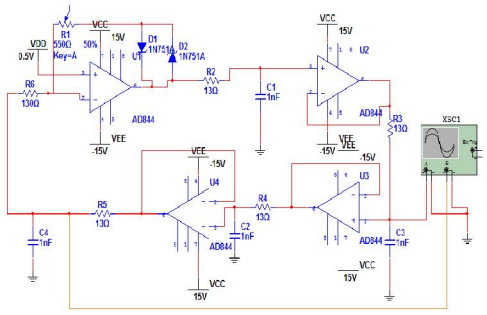

Fig.1: circuit diagram of Bubba Oscillator using AD844 IC

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III. EXPERIMENTAL RESULTS

The bubba oscillator using AD844 IC is designed using circuit values: R_1 = 130Ω,R_f=520Ω,C=C_1=C_2=C_3=1nf and R=R_2=R_3=R_4=R_5=13Ω. and the power supply is ±15V. Thus using above values, we get f = 12 MHz . This is the maximum theoretical frequency range of bubba oscillator. At this frequency range we found the output results in form of sine and cosine wave with very low distortion. The gain as calculated at high frequency is :- R_f/R_1 = 550/130 = 4.23. Thus due to high slew rate and increased bandwidth of AD844 high frequency operation of bubba oscillator is made possible.

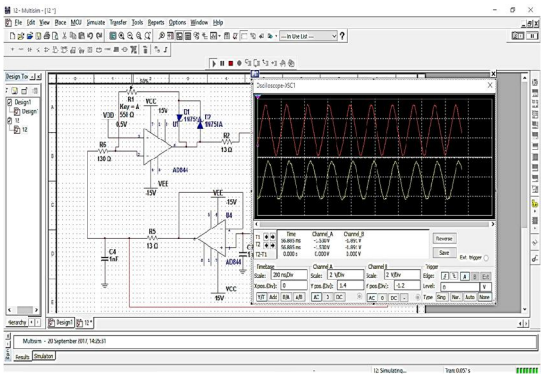

Fig.2: simulation results using AD844 IC

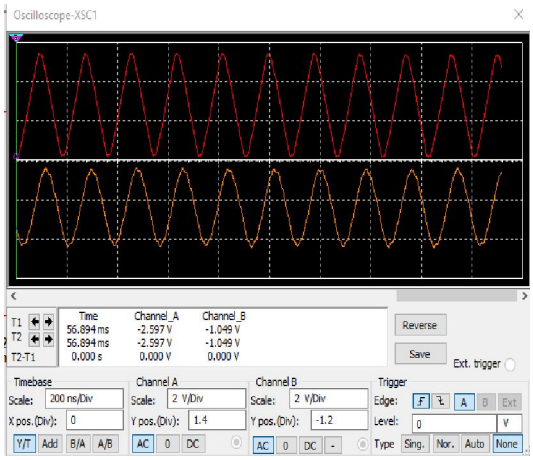

Fig.3: output waveform of Bubba Oscillator

IV. ULTIBOARD DESIGN

Ultiboard is an electronic Printed Circuit Board Layout program which is part of a suite of circuit design programs, along with NI Multisim [4]. Here we design the ultiboard layout of Bubba oscillator using AD844 IC.

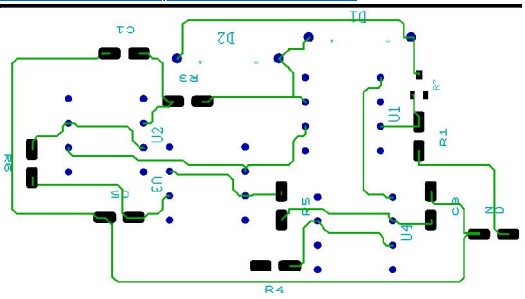

Fig. 4: ultiboard design of fig.1

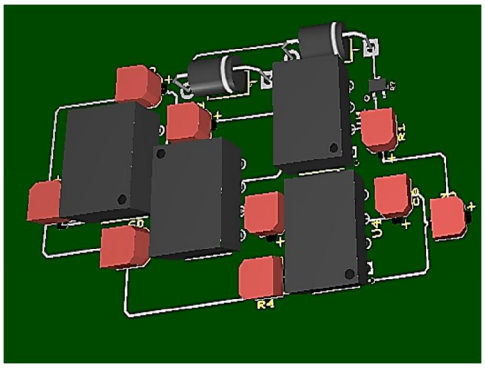

Fig.5: 3D layout of fig.1

IV. APPLICATIONS

The main application of oscillators is in converting a DC signal into an AC signal. Thus, oscillators find their use in power inverters. Bubba oscillator is frequently used in power inverters at low frequencies, as output at low frequency input is demanded. It gives output after passing through the transformer. As a sine wave generator they can also be used in servo, test equipment and telecommunication systems. Since bubba oscillator is able to generate stable oscillations from a DC source, this makes it eligible for use in areas where cost is considered important. The bubba oscillator is thus able to replace crystals and resonators which are quite costly. Also the crystal and resonators do not usually operate for frequency below 30KHz but a bubba oscillator can easily do so. Bubba oscillator has also the property of adjustability.

V. CONCLUSION

In this paper, an analysis and simulation about the high frequency (at 12 MHz), operation of bubba oscillator using AD844 is presented. CFA's have faster slew rate and the bandwidth stays high longer in CFA's. We also presented the ultiboard layout and 3D view of the bubba oscillator using AD844 IC. This design layout would be beneficial for researcher, students and industries. We concluded that when bubba oscillator circuit is designed with AD844 IC the circuit's maximum frequency range is increased which exhibits to new results obtained in simulation. This opens doors for many new areas of application of a bubba oscillator.

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