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LF AND VLF SINE WAVE GENERATOR USING SIMULATED INDUCTOR

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ABSTRACT

In today's world of technical innovation, "compactness in everything" is the motto and this leverages reduction in the size of elements to be used in the design of any electronic product. Ultimately, the use of inductor is ruled out as it requires large number of turns of coil for any design at very low frequencies. However, there are certain circuits where inductor cannot be dispensed with. One such case is the audio frequency oscillator and a better choice is to go for designing oscillators using a simulated inductor. In this paper, oscillators implemented using a newly proposed tunable filter with simulated inductor is presented and the results are validated.

Keywords: oscillator, cut-off frequency, inductor, filter, op-amp, simulated inductor, synthetic inductor.

1. INTRODUCTION

There are various oscillators that can be used at audio and radio frequencies and each have their one pros and cons. But when it comes to audio frequency range, the widely used oscillators are the RC phase shift and Wien bridge oscillators. LC oscillators are not used due to certain drawbacks. The main drawbacks are the requirement of large value of inductor which in turn results in more number of turns of wire, costly, heavy and occupies more space. The physical inductor itself cannot be fabricated in integrated circuits which doesn't suite the present technology [1-8]. These short comings are removed by designing a simulated inductor. The newly proposed simulated inductor replaces the physical inductor. This proposed inductor does not suffer from electromagnetic interference and can be used at any frequencies. It also eliminates the need for using large number of turns of wire. It can be easily fabricated in Integrated Circuits technology and the quality factor is high. The electrical characteristics of the proposed simulated inductor very well match with the physical inductor.

2. PROPOSED OSCILLATOR

The proposed oscillator shown as block diagram in Figure-1 has two functions, one is the generation of square wave using free running oscillator and the other is the extraction of the fundamental frequency sine wave using LC tuned filter circuit. The proposed oscillator which employs the proposed simulated inductor is shown in Figure-2 which will work with very low and low frequencies which is not possible with the already available audio oscillator. The proposed simulated inductor has high quality factor also. Figure-3 below shows a graph plotted between the theoretical and practical value of the proposed simulated inductor.

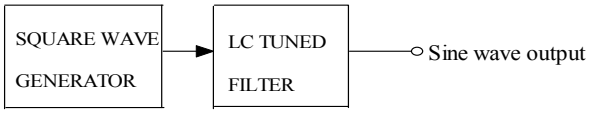

Figure-1. Block diagram of oscillator circuit.

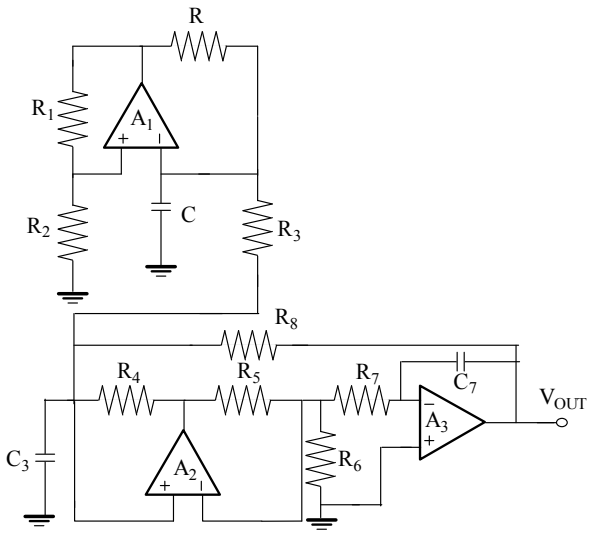

Figure-2. Newly proposed oscillator using the proposed simulated inductor.

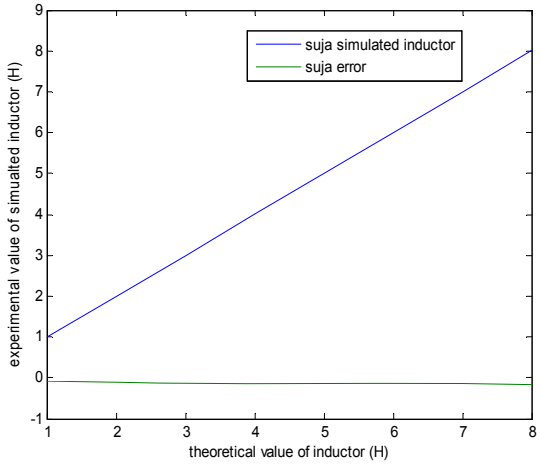

Figure-3. Comparison between the theoretical and simulated value of the newly proposed simulated inductor.

In the tuned circuit the L is replaced by the proposed simulated inductor. The required frequency of the sine wave can be extracted from the square wave by varying the frequency determining components namely the capacitor and the proposed simulated inductor of the tuned circuit. The circuit is designed for extracting the fundamental sine wave of frequency 100Hz.

3. DESIGN OF PROPOSED OSCILLATOR

Circuit design for the proposed oscillator:

Cut off frequency: fo= 100Hz, hence

$$L = 2.536H \quad C = 1\mu F$$

$$R_1 = R_2 = 1K\Omega \quad C = 1\mu F \quad R = 4.55k\Omega$$

Design of proposed Simulated L:

Value of L to be designed: 2.536H

Assume C=1µF, C3=1µF, then if

$$R_4 = R_6 = R_7 = R_8 = R = 1.59k\Omega, R_5 = 795\Omega,$$

$$R_3 = 4.78k\Omega$$

4. SIMULATION RESULTS OF THE PROPOSED OSCILLATOR

The circuit is designed for 100Hz and the output of the oscillator obtained using the simulation software PSPICE is shown in Figure-4. From the analysis the total harmonic distortion (THD) is found to be around 5.95% as shown in Figure-5. The proposed oscillator produces sustained oscillation at the required frequency and the total harmonic distortion is well within the standard limit.

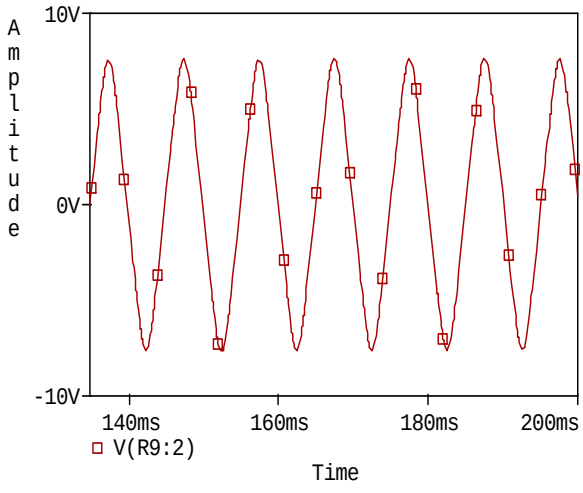

Figure-4. Output waveform of the proposed oscillator.

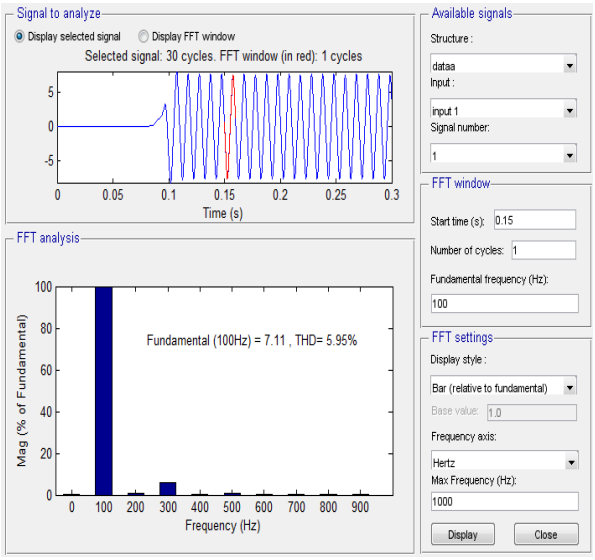

Figure-5. Frequency spectrum and THD for sine wave of the proposed oscillator at 100Hz.

5. EXPEIMENTAL VALIDATION OF PROPOSED OSCILLATOR

The experimental set up shown in Figure-6 gives a sine wave output at 100Hz. This validates the generation of sine wave at low and very low frequency. It is one form of RC oscillator which employs resistors and capacitors. The proposed simulated inductor used in the proposed oscillator can be used for any applications. One such application is the filter [9-10].

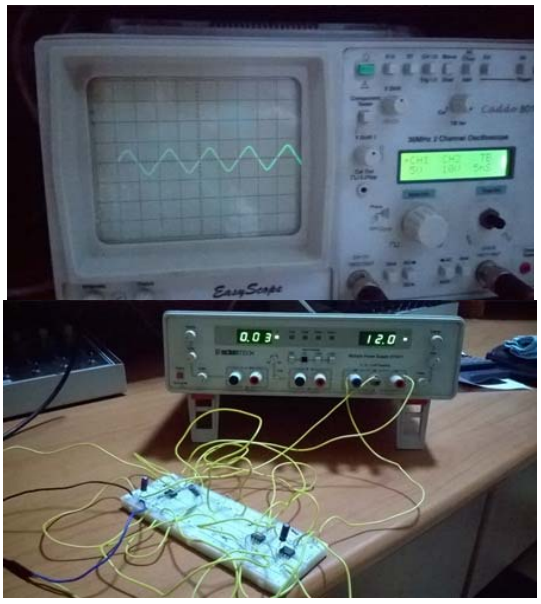

Figure-6. Experimental set for the proposed oscillator.

6. CONCLUSIONS

Oscillators used in the audio frequency range make use of coil of inductors of commercially available values. This paper is focussed on design of oscillators

even at low frequencies by using simulated inductor thus avoiding the huge sized large value of coil inductor. Thus the proposed oscillator works for all frequencies using simulated inductor of proper value. The experimental validation tallies with the simulation results thus emphasizing its use for any applications.

REFERENCES

[1] R.H.S. Riordan. 1967. Simulated inductors using differential amplifier. Electronics Letter. 3:50-51.

[2] D. Leach and S.P. Chan. 1971. A generalized method of active RC network synthesis. IEEE Transactions on Circuit Theory. 18(6): 643-650.

[3] L.T. Bruton. 1978. Multiple-Amplifier RC-Active filter design with emphasis on GIC realizations. IEEE Transactions on Circuits and Systems. 25(10): 830-845.

[4] R. Cuppens, H.J. De Man and W.M.C. Sansen. 1979. Simulation of large on-chip capacitors and inductors. IEEE Journal of Solid- State Circuits. 14(3): 543-547.

[5] Umesh Kumar and Sushil Kumar Shukla. 1989. Analytical study of inductor simulation circuit. Active and Passive Electronic Components. 13: 211-227.

[6] Wu Yue, Ismail Mohammedm and K. Olsson Haakan. 2000. A novel CMOS fully differential inductorless RF bandpass filter. IEEE International Symposium on Circuits and Systems. 4: 149-152.

[7] D. Susan and S. Jayalalitha. 2010. Analog filters using Simulated Inductors. IEEE International Conference on Mechanical & Electrical Technology, ICMET: 659-662.

[8] D. Susan and S. Jayalalitha. 2012. Low frequency amplifier and oscillator using simulated inductor. IEEE International Conference on communication technology and system design. Procedia Engineering. 30: 730-736.

[9] D. Susan and S. Jayalalitha. 2015. Amalgamation of continuous time filters by simulated inductor. ARPN Journal of Engineering and Applied Sciences. 10(20): 9429-9433

[10] D. Susan and S.Jayalalitha.2016.Simulated inductor-its relevance in analog track. ARPN Journal of Engineering and Applied Sciences. 11(19): 11271-11275.