Extremely Low Frequency Low Power Oscillator using Half Bridge Inverter

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***Abstract*—This paper basically deals with generation of Extremely low Frequency (ELF). Due to long wavelength, ELF waves are used for long distance communication through solid medium unaffected by hindrances. Here, High Voltage (HV), 50Hz transformer is used for obtaining low voltage low frequency oscillator. A new topology of Half Bridge inverter is proposed by maintaining v/f ratio of coupling transformer within acceptable limits. Whole control circuit, driver circuit and power circuit is printed on a single Printed Circuit Board(PCB). Based on resonance concept, minimum operating conditions are developed which reduces the power consumption of the circuit, thus resulting in generation of ELF. The software model is simulated in MATLAB simulink environment.**

***IndexTerms*—Extremely Low Frequency, Half Bridge Inverter, super-capacitor, resistance less inductor**

I. INTRODUCTION

LF devices finds its number of applications in radio clocks, military, submarines, meteorological information broadcast, radio navigation, electromagnetic therapy etc. For seismic data measurements of rock and reservoir LF devices are used . It is important to set to have a set bandwidth of LF which otherwise could result in inaccurate development decisions and drilling [1]. Due to LF , the wavelength of the device is very long which makes its use possible for long distance communication. Due to long wavelength, the communication signals easily pass through various hindrances, thus remaining unaffected or undisturbed . Hindrances can be in the form of mountains, rock, sea water, underground mines and even earth curvature. ELF oscillator is an electronic signal with frequency below 2 Hz. The introduction of the concept of LF oscillation was firstly in the modular synths of early 1960s and 70s. ELF is a subradio frequency.

The United states Navy, the soviet/Russian Navy and the Indian Navy avail ELF communication facility. Wireless underground sensor networks(WUSN) burry sensors in the substratum region of the soil for irrigation and environment monitoring issues. This again find a wide range of applications such as infrastructure monitoring, sport ground, navigation, border patrolling, and agriculture [2].

The traditional method used for generation of ELF is by using CMOS thyristor based inverter technology to design ring oscillator. Again the minimum value of frequency being generated until today is 8.9 Hz [3]. However producing a frequency range of below 1 Hertz is quit difficult task. The generation of low frequency has been therefore a topic of research since 1935 . Over a decade, Resonant Converters has offered many advantages over the conventional PWM power converters, such as high frequency, easy EMI filtering, low switching losses, reduced stress on components (due to low di/dt and dv/dt) etc [4].

In order to generate LF, LV power oscillator concept of half bridge inverter is used driven by a coupled center tap transformer. A high voltage (HV)(230/230V,50Hz) transformer is used to generate LF and low power as HV transformer is easily obtainable. However LF, LV transformer is challenging to obtain due to problem of its saturation at LF. The inductance also tend to saturate at LF.

II. OUTLINE OF THE METHOD

Generation of low frequency is a challenging task because in an LC circuit the inductance offers very low impedance path to current due to saturation and hence the inductance offered is reduced. To make inductance behave like unsaturated inductance it is necessary to prevent it from going into saturation. This thing is possible in either in air core inductor or iron core inductor. In the case of iron core inductor, the voltage applied, therefore, required to be reduced in the same proportion as that of reduction in frequency, keeping v/f ratio constant. The available transformer using iron core has v/f ratio equal to 230/50 i.e. 4.6. For obtaining a transformer with LV, LF transformation, it is proposed to use an HV transformer which is designed for 50 Hz frequency. For obtaining 10v at the secondary of the transformer, the frequency can be reduced up to 2 Hz keeping v/f ratio constant. The aim of this project is to generate 10 volts, 2 Hertz ac from a dc source of 12 volts. The below block diagram shown consist of control circuit, driver circuit and power circuit.

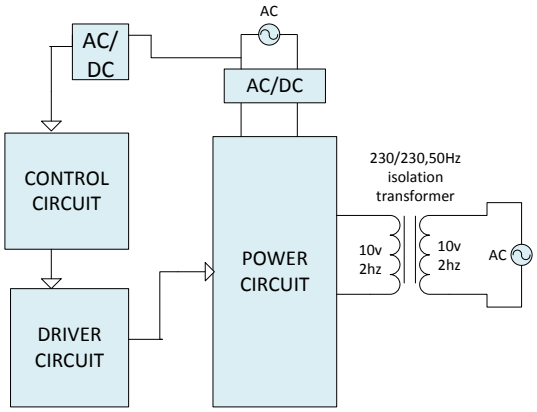

Fig. 1. Block Diagram of System Hardware

III. SOFTWARE ANALYSIS

The proposed topology intends to have an output frequency as low as below 2 Hz. Although generation of ELF is quite difficult task due to saturation problem of the inductor, still due to new proposed technology of Half-Bridge inverter it was possible to come out with such a low frequency at the output terminals. The proposed scheme has been simulated in MATLAB 13 simulink environment and the results have been shown in figure 2. It shows voltage and current waveform successfully simulated for frequency of 0.5 Hz. However getting 0.5 Hz frequency experimentally is quiet challenging task due to saturation of inductor core. The simulation time has been taken as 10 seconds. The material used for designing of inductor decides its inherent resistance. In order to have sustained oscillations, the inductor resistance has to be negligible.

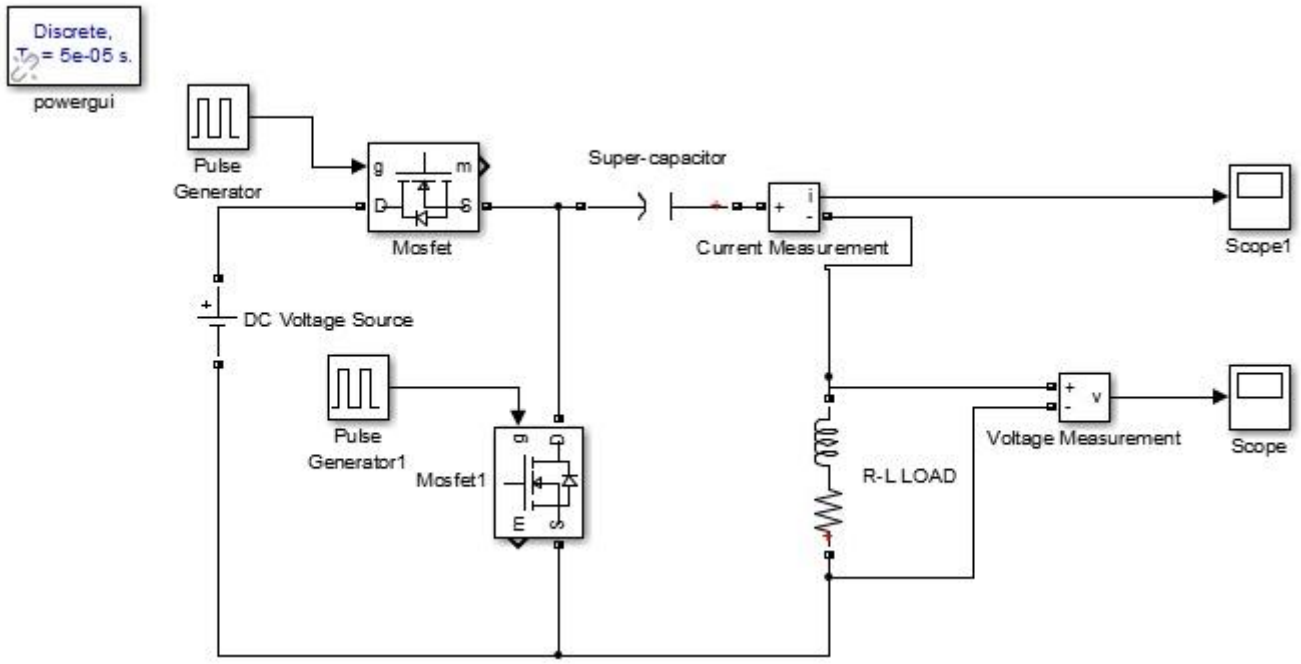

Fig. 2 Simulink model for ELF Oscillator

The value of inductor and Super-capacitor chosen after few calculations is 0.1F, 7.5volt for capacitor and inductance of about 1Henry with a negligible resistance of 0.1 Ohm. The figure below shows the simulated results from the simulink environment . Figure 3 is the current waveform whereas figure 4 is the sinusoidal voltage waveform. The attenuation in the waveform is obtained due to the R-L load. In order to eliminate this attenuation there is a need of inductor to be designed which will be resistance less. However, to design such an inductor is quite complex process due to saturation of inductor at low frequency.

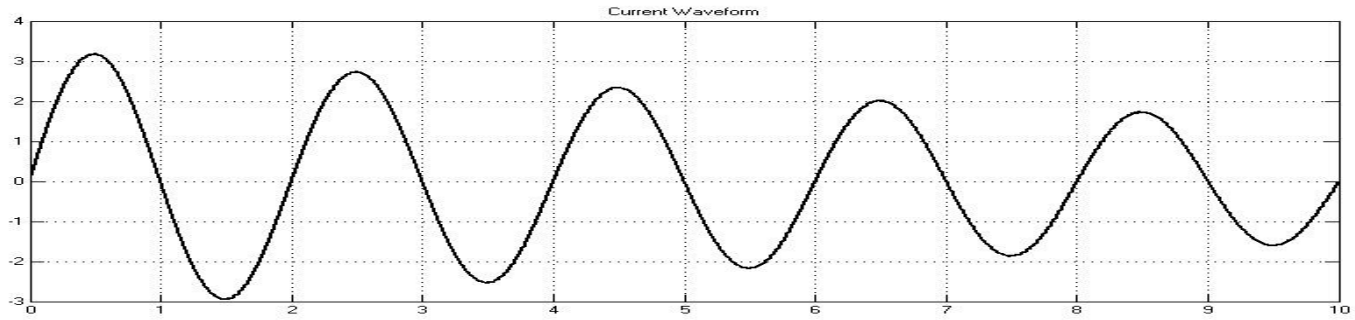

Fig.3 Current waveform for 0.5 Hz

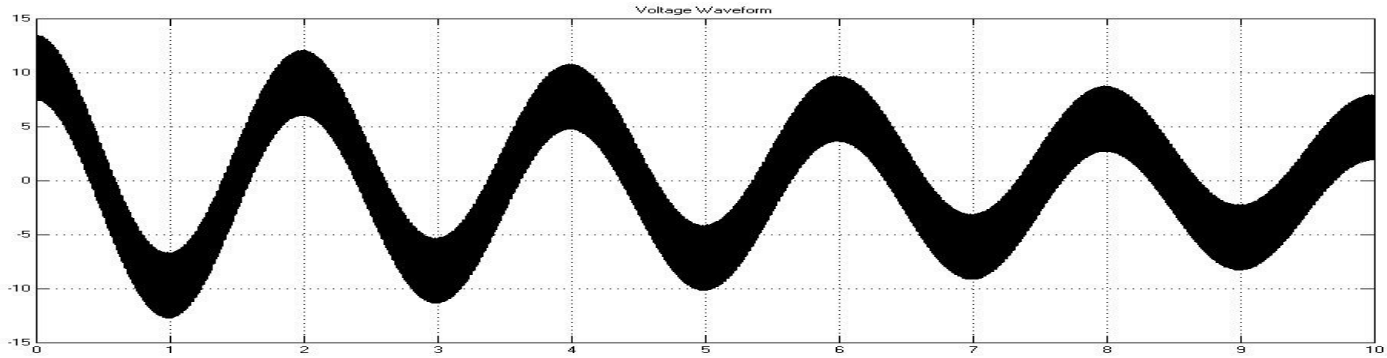

Fig.4 Voltage Waveform for 0.5 Hz

The above simulations are carried out and ultimately the wave-forms so obtained is with Extremely Low Frequency of 0.5 Hz. The frequency of oscillation has been found to be 0.5 Hz. Thus the time period of the oscillations is 1/0.5 = 2 seconds. The scheme is best suited for low voltage low power low frequency applications.

IV. CONCLUSION

The experimental results show that the oscillations are stable since they purely depend upon the value of circuit elements.The proposed method introduces an innovative method of generating oscillations in mhz range, using recently popular components, viz. ultra-capacitor and LC tank oscillator.

V. ACKNOWLEDGMENT

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REFERENCES

[1] M. Can Varun, Agnela R. Silva, "Communication Through Soil in Wireless Underground Sensor Networks – Theory and Practice".

[2] MWZQQ ATTORMEYS United States Patent M 3,302,745 Generation and Reception of Low Frequency Seismic Waves Kurt Ikrath, Elberon, N.I., Assignor to the United States of America as represented by the Secretary of the Army filed Feb. 6, 1964, ser. no. 343,161 4 claims. (cl. 181.5)

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[4] Young-Goo Kang ,Anand K. Upadhyay,Analysis and Design of a Half Bridge Parallel Resonant Inverter, SMPS Engineering , Department Zenith Electronics Corporation, 1000 Milwaukee Avenue, Glenview, IL 6002S, 0275-9306187;0000-0231 $1.00 @ 1987 IEEE.