International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 04 Issue: 04 | Apr -2017 www.irjet.net p-ISSN: 2395-0072

Generation of Extremely Low Frequency below 1Hz

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Abstract - *Generation of low frequency has been a topic of research since 1935. Due to long wavelength, ELF waves are used for long distance communication through solid medium unaffected by hindrances. Extremely Low Frequency (ELF) waves are basically used for communication through a solid medium. They can penetrate easily into the earth, through rock, and under sea water for communication with submarines. Ultra-capacitors, since its invention has achieved a significant progress due to its charge holding capability over the conventional capacitors. This makes its use possible for low current, low voltage, low power applications. However, it posses several challenges for producing Extremely Low Frequency (ELF). Simulations will be carried out in MATLAB/simulink environment thus generating frequency of about 0.5 Hz.*

Key Words: Extremely Low Frequency, low power, sub soil seismic communication, half bridge inverter

1.INTRODUCTION

Low frequency devices are used for seismic data measurements of rock and reservoir parameters. It is important to have a set bandwidth of low frequency which otherwise could result in inaccurate development decisions and drilling. The extremely low frequency of the order of 0-2Hz is obtained from seismic velocity data. Thus low frequency modeling has become crucial [1]. ELF waves find its extended applications for infrastructure monitoring, sport ground, navigation, border patrolling, and agriculture. Oscillator is best suited for such applications which produce periodic oscillating signal such as sine wave, triangular wave or square wave. The wave shape and amplitude are determined by the design of oscillator circuits. The output frequency may be kept fixed or variable depending upon the requirement. Communication system can operate on a frequency which is below 100Hz, as they are designed with unique properties. Because of these properties, the US Navy has dedicated its work for the last 10 years, so as to analyze all the parameters in this frequency range and get a better understanding on the design of the communication systems, which will be used on transmitters of submarines . This work has been pursued under the name of Project Sanguine and that too world wide.[2]. Low Frequency generated up till date is of the order of 8.94 Hz using RC phase shift Ring Oscillator designed by CMOS Thyristor technique. This method also had static power dissipation of 5.7 µW.[3]

2. Related Work

The work carried out by me is subdivided into two parts :-

A] ELF Generation using LC Tank Oscillator

There are several variations in oscillators namely, sine wave oscillators, RC or CR oscillators, crystal oscillators, relaxation oscillators, sweep oscillator and LC oscillators. There has been a consistent development in oscillation technologies ever since the LC oscillator has been built by Elihu Thomson in 1892. The LC oscillators use inductor and capacitor to determine the frequency at which it oscillates. The stored energy in the inductor is released to charge the capacitor which in turn discharges and stores energy in the magnetic field of the inductor. The process is cumulative and hence it is regarded as tank circuit. The LC oscillator offers approximately sinusoidal waveform and has greater frequency stability over the other oscillators.

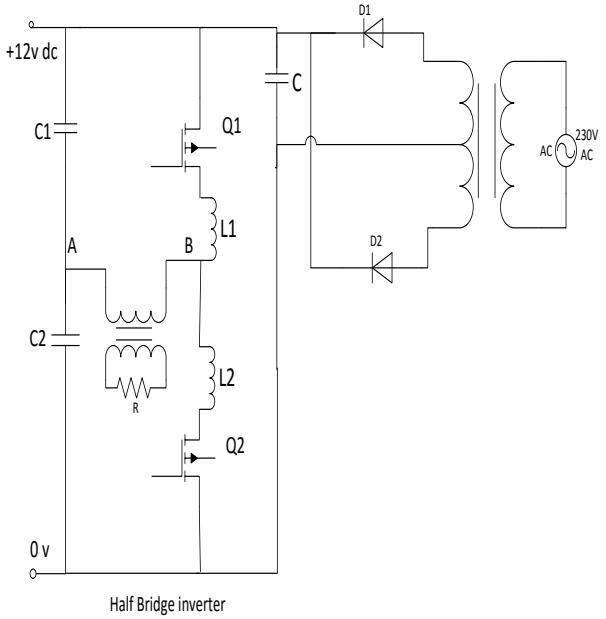


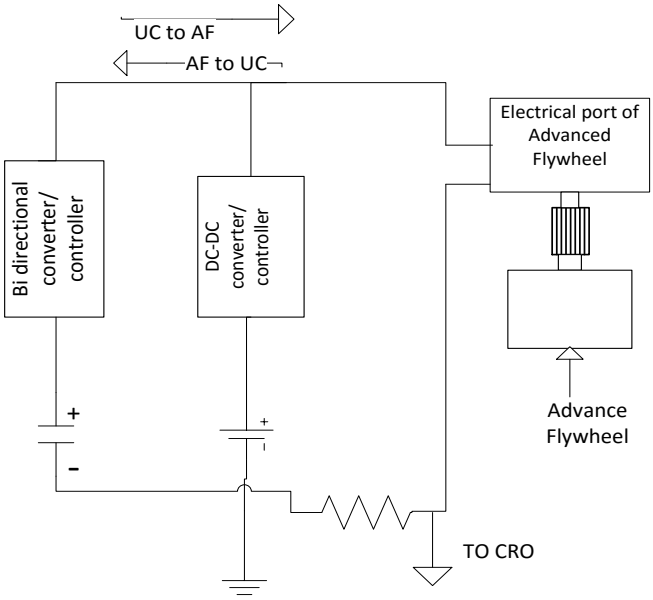
Fig-1: Proposed LF oscillator using Half Bridge Inverter

The above figure 1 is a new topology of Half Bridge inverter for generation of ELF. It comprises of two power MOSFET'S, two capacitors, and two inductors in series with power MOSFET'S. Power circuit diagram used for the

present invention consists of a half bridge basic square wave inverter whose input is 12 V dc, and output is 10 V square wave at about 1 Hz. The LF output will be picked up by the primary of 230/230 volt transformer connected between terminals A and B. The secondary of the transformer will be connected to resistive load. There is also provision to connect capacitor across the transformer winding on either side of the transformer.

B] ELF Generation using combination of Advanced Flywheel and Ultra-capacitor

In classical mechanics, when a system is dislocated from its equilibrium position, it experiences a restoring force . Such a restoring system oscillates about the equilibrium point with constant amplitude and frequency in absence of damping force. A small pendulum marks a good example for such system. The electrical analogous systems are LC circuits. The twin features of mechanical and electrical system can be combined together for generation of specific frequency. The result of oscillations may be periodic and sinusoidal. A flywheel is mechanical storage device having high moment of inertia due to which it opposes the speed changes. The flywheel stores energy when the torque is applied to it and releases energy when the torque is required by the mechanical load. It can be used in applications where the energy from source is intermittent. The proposed ELF oscillator below 1Hz is achievable with the use of an ultra-capacitor and an advanced flywheel. Figure 2 shows the basic scheme of proposed low frequency oscillator. It



consists of an ultra capacitor and an advanced flywheel. The low frequency output can be observed across a small resistor on CRO. The battery in the proposed scheme can act as standby or it can be completely omitted if there are no losses.

Fig -2: Proposed Scheme

3. CONCLUSIONS

An ultra-capacitor and an advanced flywheel can be paired to form an oscillatory system useful for generating extremely low frequency oscillations much lower than a fraction of a Hertz. The system has been simulated on MATLAB to confirm the concept introduced here also hardware needs to be designed in order prove the proposed claim. The proposed method introduces an innovative method of generating oscillations in mhz range, using recently popular components, viz. ultra-capacitor , LC tank oscillator and advanced flywheel. Proposed new scheme appears to be attractive since the focus is on large farad value easily obtainable in case of ultra-capacitors.

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