

DESIGN OF HIGH VOLTAGE HIGH FREQUENCY HYBRID GENERATOR USING IGBT & RESONANT TRANSFORMER FOR WIRELESS ENERGY TRANSFER

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Abstract -

Design of High Voltage Generator using hybrid system also called solid state tesla coil containing old tesla coil design resonant transformer with more efficient HV fast switching IGBT to generate required output voltage at high frequency. System is equipped with feedback antenna to self-calibrate and tune itself to resonance frequency of both primary and secondary (Dual Resonance Phenomenon). Proper dedicated gate driver circuit and interrupter circuits are implemented with HV Capacitor bank to maximize output efficiency. The system act as a variable high voltage generator as well as capable of wireless energy transmission. A large amount energy is radiated out by the secondary coil end also called generating transmitter circuit. The radiated fluxes in the atmosphere can be captured by another inductive coil that can produce an induced current between the receiver coils that coupled to the primary coil. Since this technique use a magnetic & electromagnetic field to transfer the electrical energy, the flux that produces in the primary coil must be in high density with high frequency. Thus, the tesla coil is built as a transmitter to produces high voltage, high frequency and low alternating current in conjunction to produce high density flux.

Key Words: High Voltage, High Frequency, Resonant Transformer, Tesla Coil, IGBT, Wireless Energy Transmission, Electrostatic Energy, Magnetic Flux Coupling.

1.INTRODUCTION

In this project we are going to design a hybrid system based on old traditional Tesla Coil design but using new IGBT based driver circuit i.e. instead of using huge capacitor banks and slayer circuit with spark gap the primary of the resonant transformer is supplied by H-Bridge formation of IGBT which is rated for 80 Amp and 600 V each. This design is more cost effective and efficient with less losses and can achieve switching frequency of up to 1 GHz, hence the output electrostatic flux emitted from secondary of Tesla Resonant transformer is highly dense which can be use for wireless energy transfer purpose also. The design of resonant

transformer is adopted from traditional design of original Tesla Coil proposed by Nikola Tesla. The resonant transformer will have up to 6 Turns of high quality copper tubing with water cooled and the secondary of transformer will be up to 4 Feet tall winding having highly permeable acrylic tube of up to 6 Inches diameter and up to 10,000 Turns made up of highly coated magnet winding wire the complete set up will be coated in several coats of PU based resin for providing enough insulation and di-electric strength to withstand the output voltage.

The driver circuit contains 6 different sub- division of circuits which are interrupter, IGBT H bridge, protection circuit, gate driver circuits, resonance circuit. The H Bridge will be driven by dedicated high switching interrupt capable IC with dv/dt and di/dt protection and filters for smooth and lossless operation of designed H – Bridge. The Gate driver IC's will be controlled by feedback loop from resonance tuning circuits which will automatically tune the switching frequency of IGBT to the resonance frequency of both primary and secondary of resonant transformer {Tesla Coil}. The IGBT will be placed on water cooled forced air copper slab for optimum cooling. The secondary of transformer is fitted with top load toroid which helps in increasing the capacitance of the secondary and reduced resonant frequency also helps in reducing corona loss. There is also a protection circuit to limit the current going through primary of transformer for protection purpose of precious IGBT's. the protection circuit is also provided for system failure condition to isolate complete system from supply.

The system is also capable of wireless transmission of energy from point to point by the method of electromagnetic and electrostatic flux discharge from a transmitter point into the atmosphere. The transmitted high-density flux will travel to the receiver point and will induced current in it which will be coupled to a primary coil dedicated to convert received power to the commercial level for utilization.

2. Design & Hardware

2.1 Hardware used

1. Resonant Transformer(Tesla design)-6 Turns primary & upto 10,000Turns secondary 1KW with PU Resin poly-coat insulation
2. IGBT
3. Gate Drives IC
4. Ferrite Core Transformer
5. Interrupter Circuit
6. Copper Slab Heat Exchanger
7. HV Polarized Capacitors
8. Aluminum Torpid
9. High Voltage Diodes & Zener Diodes
10. Ferrite Core CT
11. Acrylic Body
12. Dimmerstat 1phase 240V 6Amp
13. Ground Mat

2.2 DESIGN

The given below is the block diagram of our project, now let us start from the supply end that is from dimmerstat. Which is used to supply main voltage to our system in variable range for smooth start. Then we can see the two thick line i.e. one is neutral and other one is phase feed to the circuit breaker which is then controlled by a protection circuit taking feedback of current information from two different circuits, first circuit is normal circuit in line with main supply i.e. phase wire and second circuit is the line with primary of resonant transformation now as we see it is a special circuit of a ferrite core circuit which we can use for high frequency. Now the protection system is providing OC protection based on two feedback. Then further we can see that there is supply and interrupter circuit block the function of this block is to provide various supplies at various required level to the other components and interrupter circuit is to ensure ON/OFF of IGBT to avoid commutation failure with this it has capacitor and inductor circuit for dv/dt and di/dt protection of IGBT. The interrupter is having feedback from two blocks "Primary and Secondary" resonance circuit which gives feedback of resonance frequency to make system tune to resonance frequency automatically.

The next block which we have is our "gate driver circuit with proper filters" for smooth operation and dedicated gate driver IC to supply commutation i.e. ON/OFF signal to the gate of IGBT. The lower voltage block of GDT and filters is electrically isolated from higher voltage operation IGBT H-bridge and capacitor bank using a ferrite core get driver transformer with 1 : 1 ratio i.e. isolation transformer after that the main block is IGBT block where all magic often. The IGBT switches according to resonance frequency of tesla coil and converts our main to 0-600v at frequency ranging from 400Khz to 1Ghz and at current of maximum 80 Amp burst.

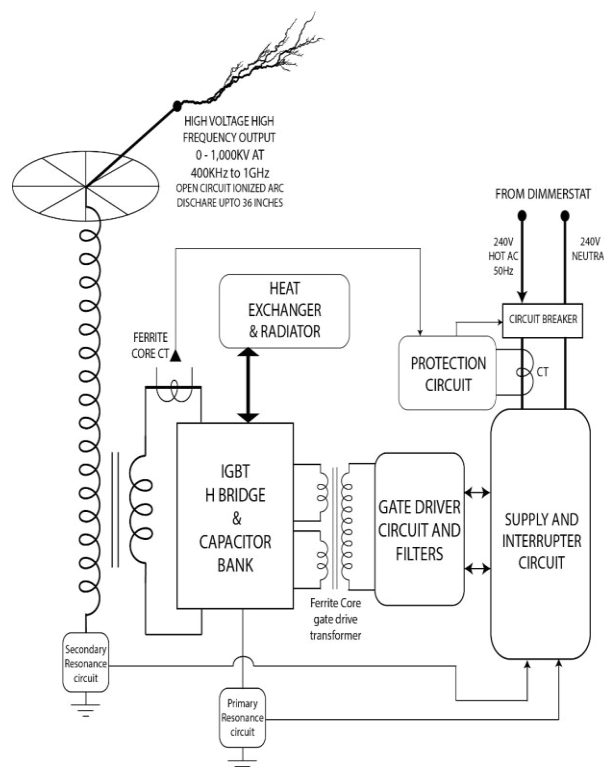


Fig : Block Daigram

The converted power is stored in capacitor bank and supplied to tesla coil as the IGBT are subjected to heating then we are placing them on thick copper slab and providing cooling based on jet cooling by BLDC high speed motor all this system is in heat exchanger the last part is our resonant transformer as shown in figure at top we can see toroid top load and a rod coming out for discharge of generated energy at 0-1000Kv at frequency of 400Khz to 1Ghz, current is in few mili-ampere 0-50mA.

3. METHODOLOGY

1. Studying Design of Resonant Transformer (Tesla Coil).
2. Studying the existing slayer spark gap driver circuit.
3. Designing of Solid State IGBT based driver circuit.
4. Fabrication of Secondary of Resonant Transformer or Tesla Coil.
5. Design and Fabrication of Dual Resonant Solid-State Tesla Coil Circuit.
6. Design of Top Load Torpid using Smooth Aluminum with Corona loss Reduction.
7. Assembly of Resonant Transformer and Driver Circuit.
8. Testing and analysis of complete system and tuning oscillation frequency to final resonant frequency.
9. Rectifying errors any finding areas of improvement.

4.CONCLUSION

The aim of our project is design of high voltage high frequency hybrid generator using IGBT and resonant transformer for wireless energy transfer is to design this system in such manner that it can run for longer time and supply energy for continuous time period as well as this all will help in complete our final aim i.e. to transfer energy wirelessly.

5.REFERENCES

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