A HIGH EFFICIENCY RESONANT CONVERTER FOR WIND POWER GENERATION UNDER RAPIDLY CHANGING ENVIRONMENTAL CONDITIONS

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ABSTRACT

This paper implements a new high efficiency single switch resonant converter for wind power generation under rapidly changing environmental conditions , with the various advantages that resonant power conversion has effectively implemented pulse –width modulation include a low switching losses ,low electromagnetic interference, less volume, low cost and less weight of components due to a high switching frequency, high effectiveness, and low reverse recovery losses in diodes due to a low di/dt rating at switching instant and zero voltage switching and zero current switching at the instant of switch on and switch off . This paper presents for a direct current dc-to-dc energy conversion applications with a loaded single switch-resonant converter. The suggested technique includes bridge rectifier and inductor-capacitor inductor (L-C-L) resonant converter. Output stage of the implemented loaded-resonant converter is regulated by a low-pass filter. A model dc-to-dc energy converter circuit with the novel loaded-resonant converter implemented for a load is established and tested to confirm its analytical problems. The measured energy conversion competence of the proposed novel loaded-resonant technology reaches up to 88.3%. Additionally, test results demonstrate a satisfactory performance of the proposed system by enhancing the pulse width modulation technique (PWM). Moreover, the proposed topology is highly favourable for applications of power electronic fabrications such as battery chargers, switching power supplies, renewable energy generation systems ,uninterruptible power systems, and telecom power Supplies.

Index Terms—Resonant converter, loaded-resonant converter, soft-switching converter, PWM technique

I. INTRODUCTION

Nowadays the generation of electricity is huge requirement , because the demand of electricity increases day by day the consumption of conventional energy sources like fossil fuels is also increases when there is increment in the power demand, since the fossil fuels are not renewable in the nature they can’t replenished again and it will take several years to produce this fossil fuels , so now the only source is renewable energy sources like pv , wind etc.Therefore, renewable energy has become attractive in recent years, following the implementation of a policy for sustainable development and reduction of environmental pollution. Renewable energy sources like solar and wind sources are the demanding sources because of their high efficiencies and reliability .now a days lot of researches are doing in this renewable energy sources. This paper presents the resonant converter wind power generation under rapidly changing environment conditions. All we know that wind speed is uncertain in the nature so the electricity obtained is not continuous and is fluctuated by sudden changes in environment conditions. If this wind system is connected to the grid or directly to the load grid may be effected and loads may be damaged. So in order to get high efficiency and reliability of the supply, the fluctuations should be reduced or controlled. And we can store this energy in batteries for future purpose for this energy conversion we introduced a resonant converter with increased efficiency .The Semiconductor power switches are utilized in power electronic equipment’s has led to rapid improvement of this machinery in recent years. The switching power converter plays vital role in the power energy conversion applications. In specified, direct current (dc)-to-dc converters is majorly selected in industrial, residential, commercial devices these converters are designed by power electronics circuits that produce a dc voltage into a different level, often providing a desired output. Power semiconductor switches are the main parameters of power energy conversion arrangements. Pulse-width modulation (PWM) is the easiest method to regulate power semiconductor devices.

The PWM technique regulates the power flow by interrupting and allowing current or voltage by using semiconductor switch action with the use of pulses from different duty cycles. In generally, a situation occurred in which the voltage across or series current through the switch is abruptly manipulated and referred to as a hard-switched PWM. Because of its low effortless and ease to regulate power, hard switched PWM techniques have been highly developed in present power energy conversion applications.

Consequently, a large switch voltage and a large switch current happening instantaneously require that the switch withstands high switching strains, with a safe operating and protecting area, is given by the dashed lines in Fig. 1.

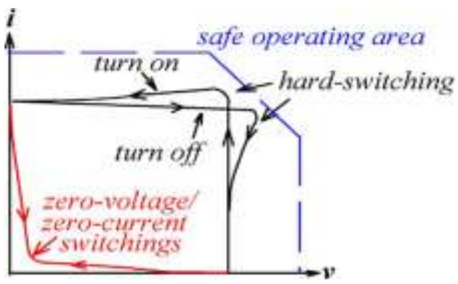

Fig.1.Typical switching trajectories of power switches.

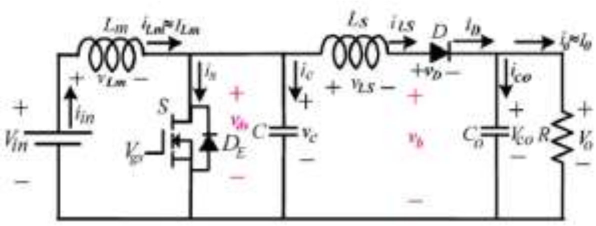

Fig. 2.Proposed loaded-resonant converter for a dc-to-dc energy conversion system

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Resonant converters are widely used in the application of sustainable power generation applications. The fundamental necessities of resonant converters are their little size and high efficiency. A high switching frequency is needed to accomplish little size. In any case, the switching losses are directly related with the switching frequency ,therefore decreasing efficiency of the resonant converters. To take care of this issue, some soft smooth switching approaches must be utilized at high switching frequencies. Zero voltage switching (ZVS) and zero-current switching (ZCS) systems are two normally utilized smooth switching techniques [14]–[19]. In these systems, either voltage or current is zero amid the switching time either on or off time, considerably diminishing the switching loss and expanding the reliability of resonant converters when used for renewable energy source application, zero current switching converters work with steady on-time control. They should work with an wide range of switching frequencies when the scopes of the input source and load are wide, making the filter circuit plan hard to optimize. Be that as it may, the customary ZVS plot decreases turn-on loss and declines the turn off switching loss by diminishing the rate of increment in voltage, reducing the overlap between the switch voltage and the switch current. This work develops a novel single-switch highly efficient converter with ZVS topology based on the traditional ZVS concept for renewable energy generation applications. essential elements incorporate a basic circuit structure, simplicity of control, soft switching for dynamic power devices or loads, low switching loss, and high vitality change effectiveness. This novel single-switch high-effectiveness converter with ZVS topology can be thought to be an expansion of the conventional ZVS control converter. It uses a capacitor over the dynamic power switch in the novel single-change power converter to create a freewheeling stage with a conventional ZVS control converter, empowering the novel converter to work with a consistent resonance frequency markedly much reduced circulating energy.

Additionally, for dc-to-dc energy conversion features , the parallel-loaded-resonant converter is generally suggested as the energy conversion stage owing to its simple circuitry and distinctive input characteristics. Conversely, a large filter inductor used to the bridge rectifier output side of in a conventional parallel-loaded-resonant converter then may be increase the cost, weight and volume. Depended on the parallel-loaded resonant converter, this effort develops a novel loaded-resonant converter. The implemented novel loaded-resonant converter is greater to the predictable parallel resonant converter in term so reduce size, simple topology ,light weight and simple control.

II. CIRCUIT DESCRIPTION AND OPERATING PRINCIPLES

2.1 Circuit Description:

Wind power:

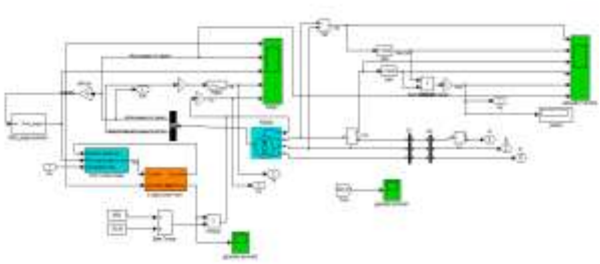

Fig .3.Simulation diagram of wind power generation

In this model we generate the electricity by using permanent magnet synchronous generator in this model there is a need of wind turbine model, pitch angle controller and two mass drive train and a permanent magnet synchronous generator

Pitch angle controller is used to control the angle made by the wind with the turbine blades to make constant speed operation.

2.2 Diode bridge rectifier

The power generated from the wind power station is Ac so to convert ac to dc we use diode bridge rectifier

2.3 Resonant converter

This circuit is mainly consist of inductor , capacitor, filter, power electronic switch MOSFET and a diode are connected in amanner as shown in the figure given below .

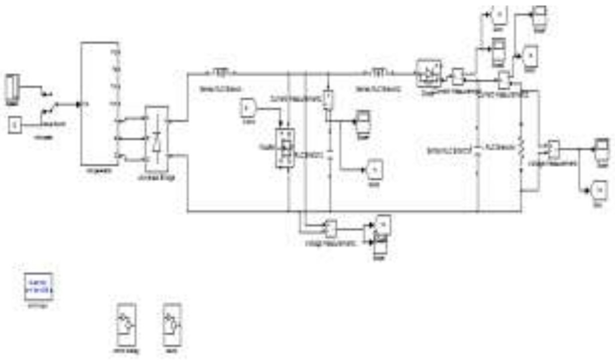

Fig. 4. Simulink model of the proposed resonant converter

The aim of this work is to construct a high-efficiency power electronic converter that can be implemented in the renewable

energy generation systems. This application of a power electronic converter depends on the effectiveness of its structure in minimizing switching losses in the energy transformation interval. Soft switching has potential to provide lossless switching and has become increasingly popular with researchers. This work develops a novel current-fed resonant converter with ZVS and ZCS operations of both the active power switch and the rectifying diode for energy conversion. Fig. 1 shows a basic circuit diagram of the proposed novel single-switch resonant converter for renewable energy generation applications. It comprises a choke inductor *Lm*, a metal–oxide–semiconductor field-effect

transistor (MOSFET) that operates as a power switch *S*, a shunt

capacitor *C*, a resonant inductor *Ls*, an energy-blocking diode *D*, and a filter capacitor *Co*. The capacitor *Co* and the load resistance *R* together form a first-order low-pass output filter, which reduces the ripple voltage below a specified level. The MOSFET is a favored device because its body diode can be used as an anti parallel diode *DE* for a bidirectional power switch. Notably, the shunt capacitance *C* includes the power switch parasitic capacitance and any other stray capacitances (such as the winding capacitance of the choke *Lm*). Careful design of the circuit parameters guarantees that the power switch *S* is switched by ZVS and the energy-blocking diode *D* is switched by ZCS, optimizing the op.

2.4 B.Circuit Operating Principles

The novel single-switch resonant power converter for sustainable power generation applications is examined utilizing the following assumptions.

1) The switching components of the converter are ideal, such that the drop in forward voltage over the

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resistance of the active switch in the ON state is irrelevant.

2) The proportionate arrangement resistance of the capacitance and stray capacitances is realizable.

3) The qualities of the inactive parts are direct, time invariant, and is not depend on the frequency.

4) The filter capacitance *Co* at the output terminal is typically very large; the output voltage across capacitor *Co* can therefore be treated as an ideal dc voltage in each switching cycle.

5) The choke inductance *Lm* at the input terminal of the novel single-switch resonant power converter is large. Therefore, the input current through the inductor *Lm* can be treated as an idealized dc current in each switching cycle.

Depending on the switching states we have six modes of operations like as shown in fig.4

Mode 1: this mode indicates at the time of switching instant before this state the mosfet is in off state at that tine the resonant inductor current i_{ls} is positive and greater than the input dc current i_{lm} .the zero voltage switching occurs only when the mosfet off at zero voltage otherwise the energy stored in the capacitor will be dissipated in the active switch like mosfet.To overcome this problem an anti parallel diode must be conduct before the mosfet is on.when the capacitor voltage is zero then a on signal is given to active switch s1.so that zcs and zvs conditions are takes place.

Mode 2: In this mode the active switch mosfet is still in on condition here the applied voltage present across the i_{lm} and the current in inductor is increases and I_{ls} is gradually reducing .when it reach zero value the operation enter to mode 3

Mode 3 :in this mode also the power switch is remains on state .the inductor current I_{lm} increases gradually this mode is finished when the active switch is off in this case I_{ls} is zero Is is constant.

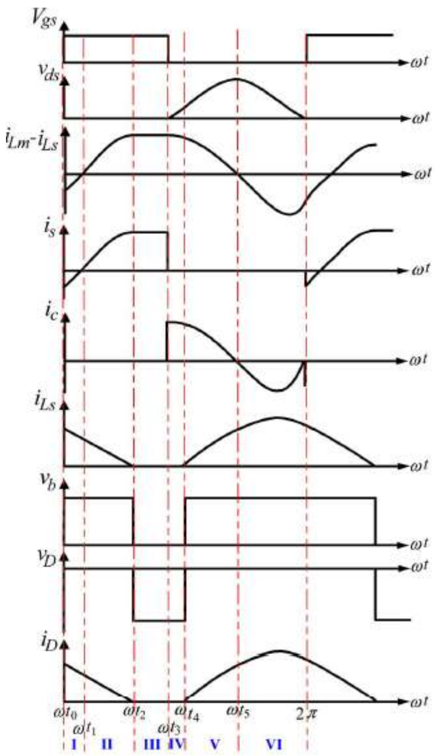

Fig. 5.Idealized voltage and current waveforms.

Mode 4: at the starting of this mode the active switch is off and the capacitor current equal to I_{lm} . and the voltage across the capacitor starts increasing from zero to a finite value . to obtain the ZVS condition the switch should off at zero voltage. during this mode the output power across the load is supplied by capacitor C_o..

Mode 5: in this mode the active switch remains in off mode. here also the capacitor voltage gradually rising to a finite value and capacitor current also decreases gradually and falls to zero.

Mode 6: this mode starts when the capacitor voltage starts decreasing from a finite value to zero . here the capacitor current I_c is negative. and the active switch is on at 2pi to minimize switching losses.

SIMULATION RESULTS

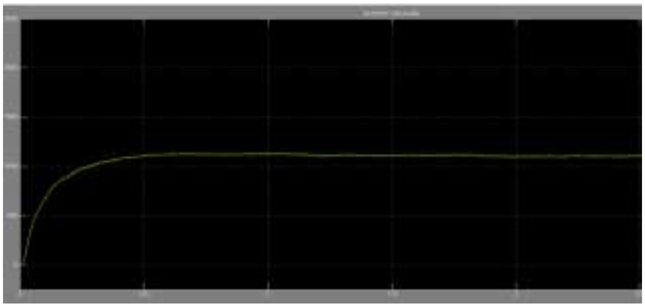

Fig.6. Output voltage across the load resistance

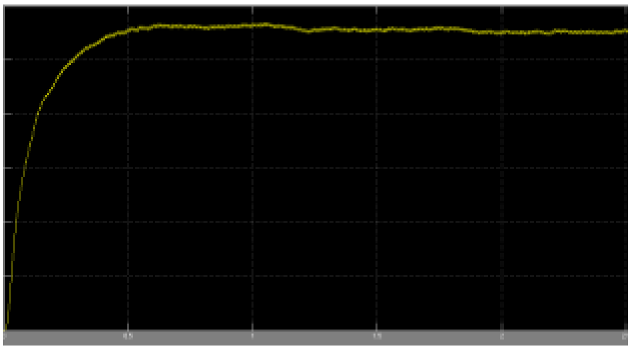

Fig.7. output current

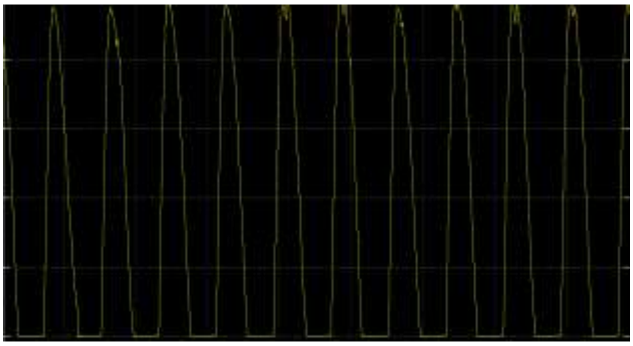

Fig.8. voltage across the switch V_{ds}

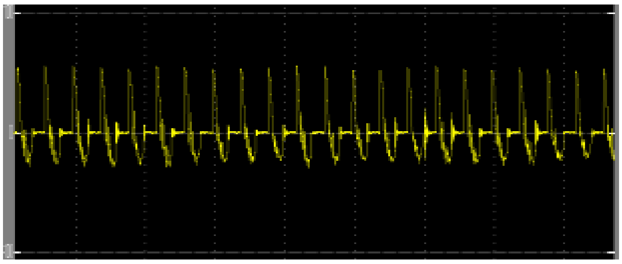

Fig.9. current flowing through the capacitor Ic

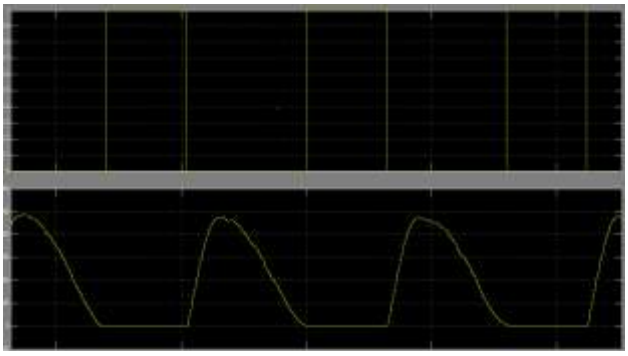

Fig.10. switching pulses vs voltage across the capacitor V_c

III. CONCLUSION

In this paper, a novel single-switch resonant power converter
with an energy-blocking diode has been designed for use in a wind powerx generat.ion system under rapidly changing environmental conditions .the proposed resonant converter is easy to understand simpler low cost and with less number of components , the resonant converter is simulated tested .and the performance of the converter is verified.

The proposed single switch resonant converter having the advantage of soft switching like zero voltage and zero current switching minimized the switching losses and increase the efficiency of the energy transformation. The output power can be determined from the characteristic impedance of the resonant tank by adjusting the switching frequency of the converter.

The novel single switch resonant converter is supplied by wind power generation system to get the required output voltage.

The simulated results shows that the performance of resonant converter under rapidly changing environmental conditions .when this proposed resonant converter applied to a resistive load the satisfactory energy transformation efficiency 97.3%.The novel single-switch resonant power converter topology yields a higher energy conversion efficiency than conventional class-D resonant converters. Favorable performance is obtained at lower cost with fewer circuit components.

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