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Design and Implementation of High Step-up DC to DC Converter with Soft Switching Method

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Abstract: This project aims to increase efficiency of high step-up DC to DC converter it acts as a boost converter, it is used in the many battery powered applications. A right aligned modulation has been developed in order to minimize the conduction losses while maintaining soft switching method in MOSFET. In the conventional method, full wave rectifier is used in the secondary side due to that switching losses may occur, instead here, half wave rectifier with capacitors are used. Capacitor performs the filtering so that ripple voltage will be reduced. In addition to phase shift zero voltage switching technique, here zero current switching has been employed. As a result, the proposed converter has reduced switching losses and conduction losses than the conventional type. Also its voltage and current values have increased widely, therefore its power is also increased.

Key words: DC · Battery · soft switching · ZVS · ZCS

INTRODUCTION

DC to DC converters are used whenever DC electrical power is to be changed from one voltage level to another. It is important in portable electronic devices such as cellular phones which are supplied with power from batteries. DC to DC boost converters developed to maximize the energy harvest for photovoltaic systems and for wind turbines are called power optimizers. A several approaches to realize DC–DC isolated power conversion have been proposed based on full bridge, push–pull and current-fed topologies. A inverter based on a traditional push–pull DC-DC converter was presented featuring low cost and low component control, a modular architecture was presented to enhance scalability and reliability [1, 2], but it reduces transformer utilization, compromises magnetizing balance as the power rating increases, as well as limiting the possibilities for soft-switching operation. An innovative current-fed version of the push–pull topology has been reported as part of a grid connected inverter system.

A similar topology was employed in a step-up resonant converter, presenting a high voltage-conversion ratio [3, 4], current-fed full-bridge topologies were proposed featuring low-input ripple current and reduced stress in the input-side switches [5], but it need bulky input inductors (high current), present oscillations produced by the interaction between parasitic (leakage inductance, intra winding capacitance and the input inductor) and could present excessive degrading high-frequency ripple current in the output capacitors due to the absence of filter inductor. A full-bridge forward DC-DC converter with a full-bridge rectifier was presented [6] is a very robust topology when operated with zero-voltage switching (ZVS) technique and represents an industry standard in many applications, such as telecom power supplies(high input voltage).

A DC to DC converter with full bridge inverter topology using special modulation sequence is developed to minimize conduction losses. Also it reduces the reverse-recovery losses in the output side of rectifier, minimization of the transformer ringing and ensuring low stress in all the switches [7].

Proposed Converter

Block Diagram: A DC to DC boost converter is shown in Fig. 1. A DC supply is provided by the battery, initially it converts to AC then it is converts to DC with the help of rectifier, the output voltage will be higher than the input supply.

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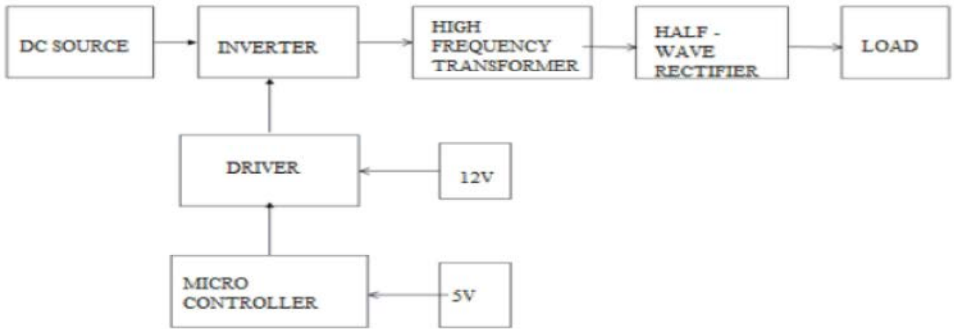

Fig. 1: Block diagram of DC to DC converter

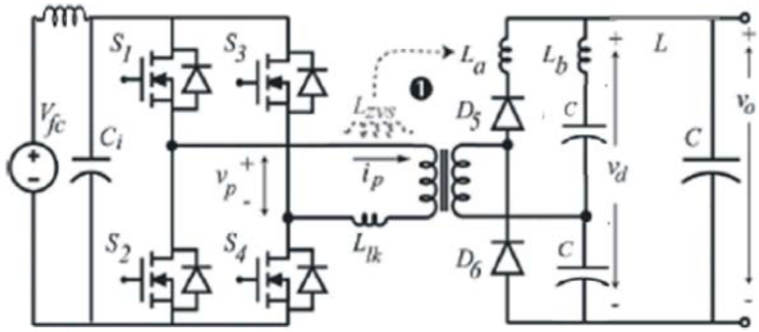

Fig. 2: Circuit diagram of DC to DC converter

A DC voltage of 15v or 24v is given as a input supply its provided by the battery source in direct or an AC power supply can be converted as DC by the rectifier and given as the input supply. A MOSFET switches performing the inverting function which converts DC to AC, with the soft switching characteristics in order to avoid the switching and conduction losses. A Micro controller is used for providing trigger pulse for the MOSFETs. Driver it acts as a power amplifier is used to amplify the pulse output from micro controller. It is working with the prinicple of opto coupler. It isolated the microcontroller and the power circuits. High frequency transformer is used for step-up purpose and also used for isolation purpose. Due to high frequency the transformer size is small. Filtering is done with the help of capacitors it filters the ripple voltages and helps to provide higher voltage. Load will be resistive load or DC motor.

Circuit Diagram and its Operation: A Battery is used for providing the DC voltage it is given to the MOSFET, where the DC voltage is converted to AC, it is a very low voltage it is increased by the step up transformer so that secondary voltage will be more than the primary.

Then it is converted again as DC by the half wave rectifier, the DC voltage would be having more ripples, its filtered by the capacitors in the secondary side. The output DC voltage will be more than the input DC voltage and in the output side either resistive load or DC motor is used. When the switch s1 is ON state, the s4 switch also will be ON state in that time switches s3 and s2 will be in OFF state, when the s3 conducts the switch s2 will be conducting, accordingly the rectifier in the secondary side will be conducting and gives the DC voltage.

RESULTS AND DISCUSSION

Simulation Results of Existing Converter: In the primary side it has no inductance for providing] zero current switching and in the secondary side full wave rectifier it would have switching losses and ripples, ripples will be more here, due to all reasons the output voltage and current is very less due to this efficiency is less. It is follows with the output voltage and power.

Simulation Results for Proposed Converter: The proposed converter in the primary side has an added advantage of zero current switching by connecting the inductor in series with the MOSFET switch with the zero voltage switching and soft switching technique used in the mosfet switches in order to reduce the conduction and switching losses. In the secondary side instead of full

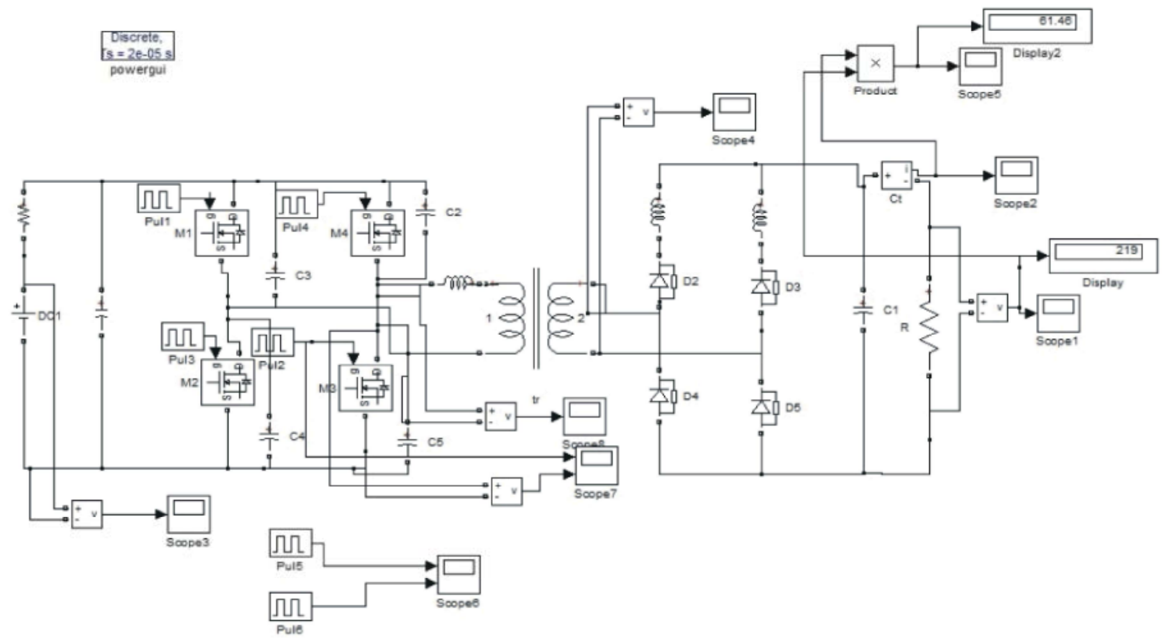

Fig. 3: Simulation diagram of existing converter

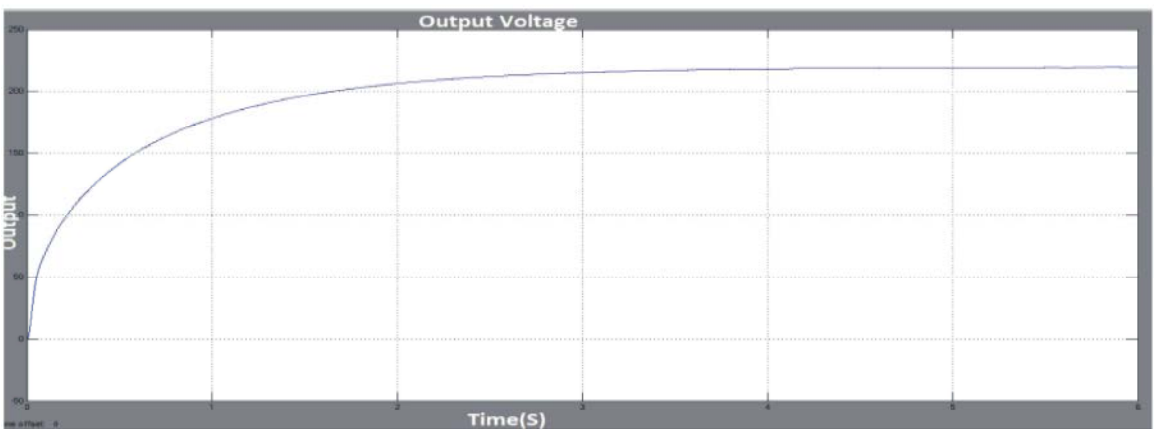

Fig. 4: Output voltage

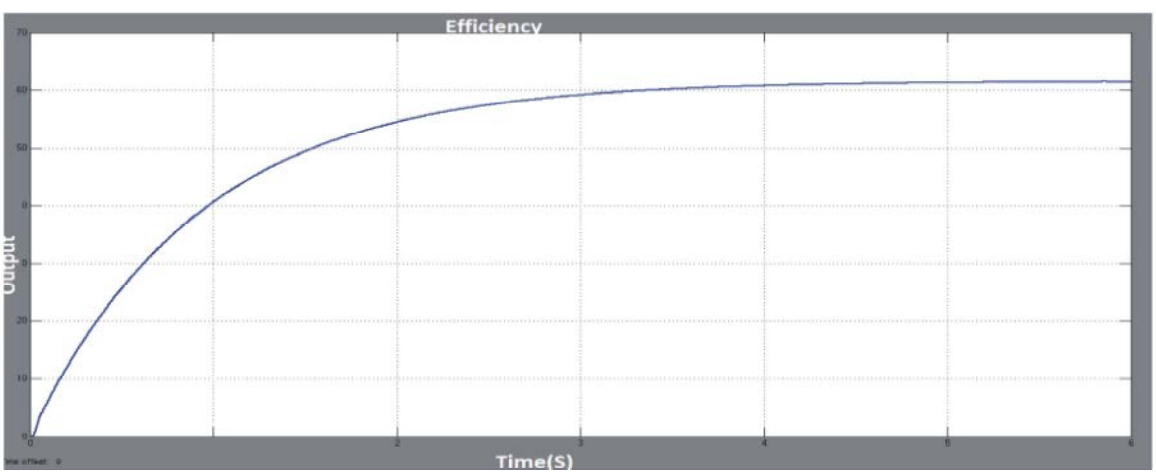

Fig. 5: Power

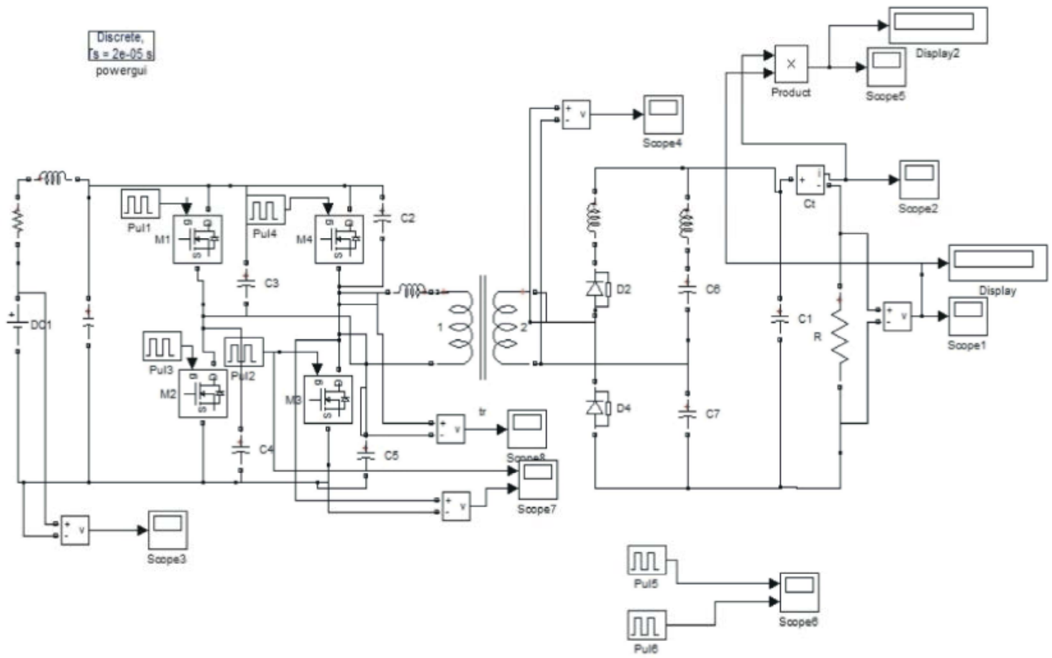

Fig. 6: Simulation of proposed method

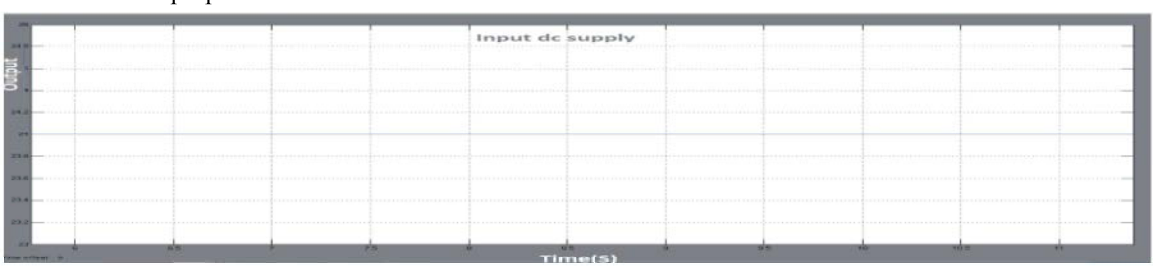

Fig. 7: Input DC supply

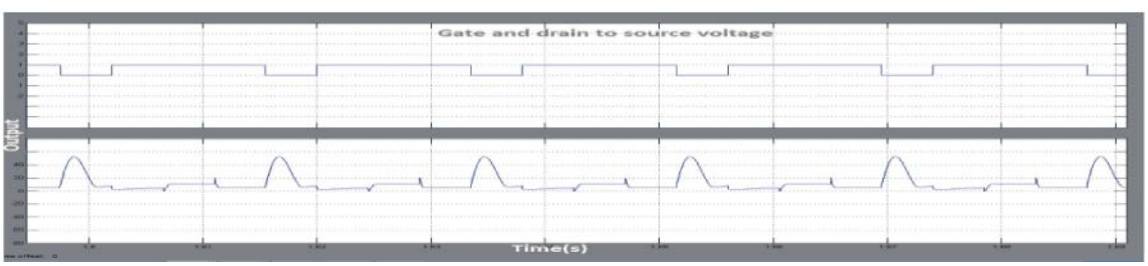

Fig. 8: Gate trigger pulse with drain to source

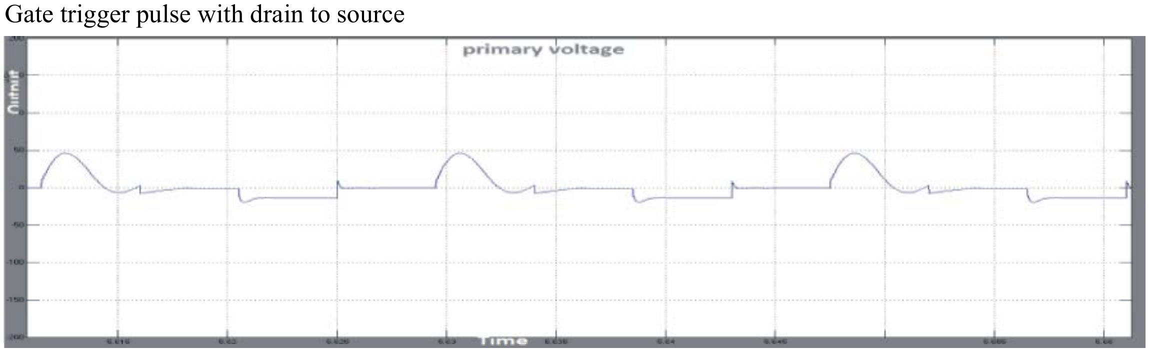

Fig. 9: Transformer primary voltage

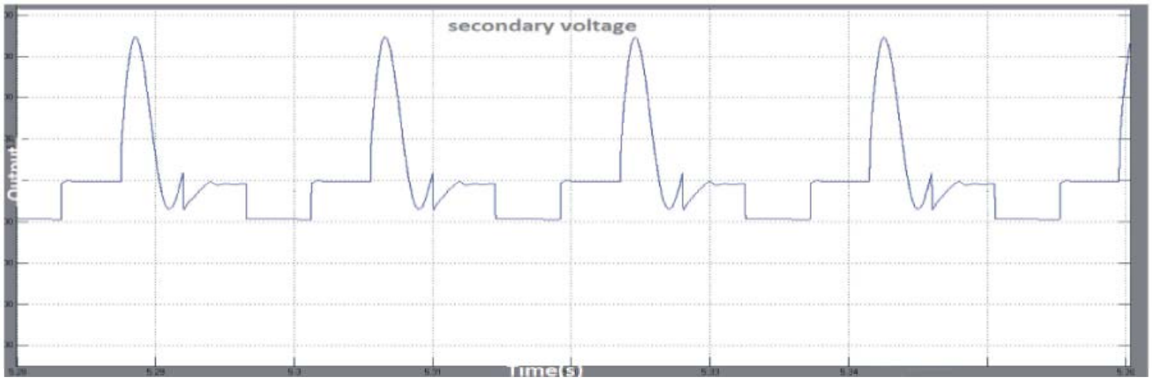

Fig. 10: Transformer secondary voltage

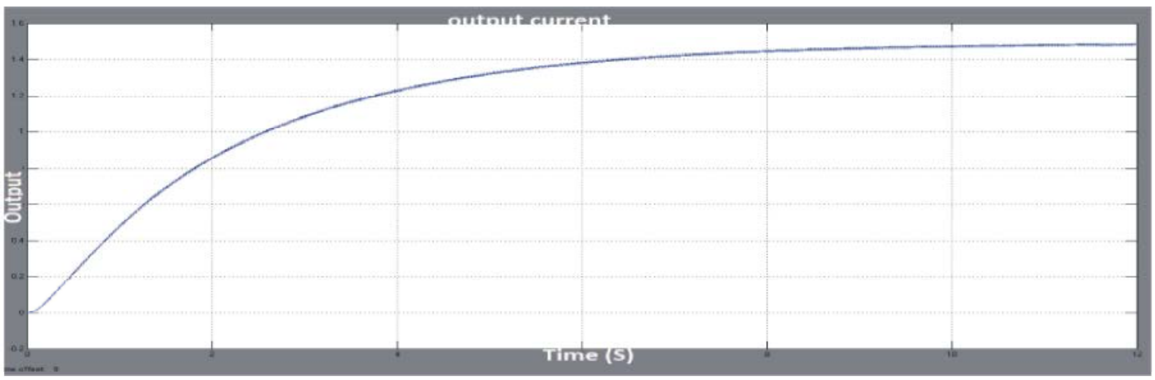

Fig. 11: Output current

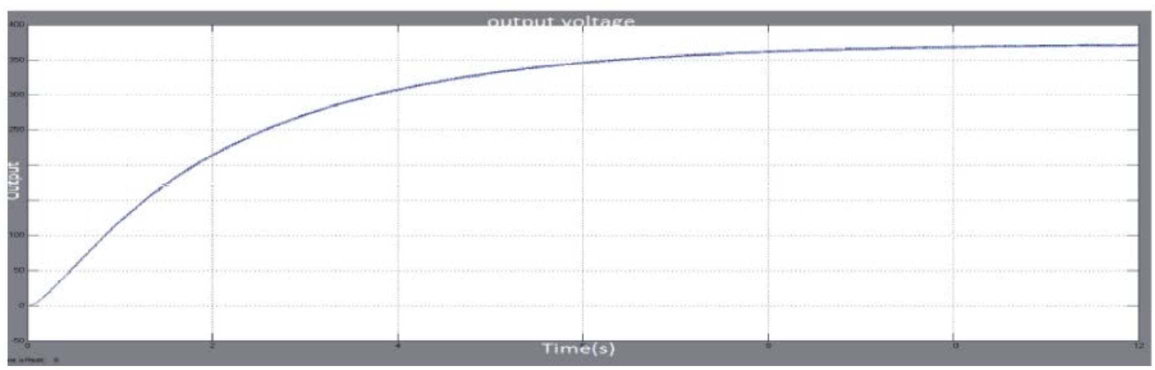

Fig. 12: Output voltage

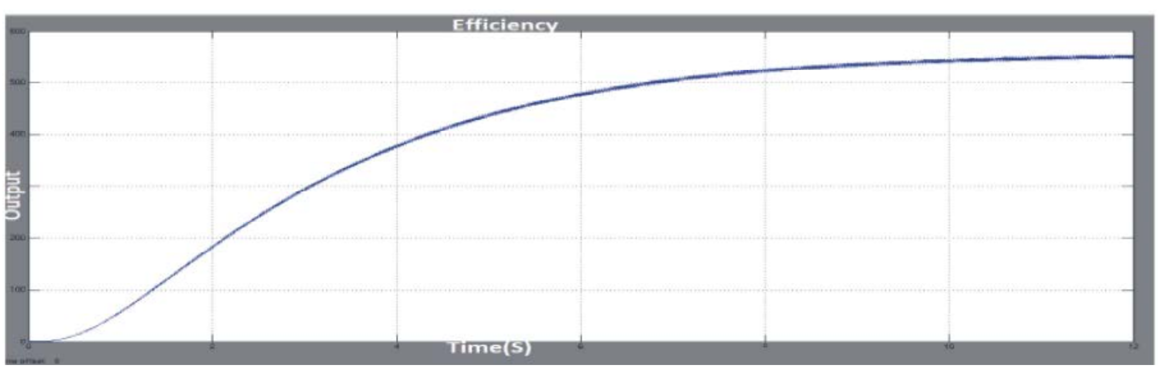

Fig. 13: Power

Hardware Diagram

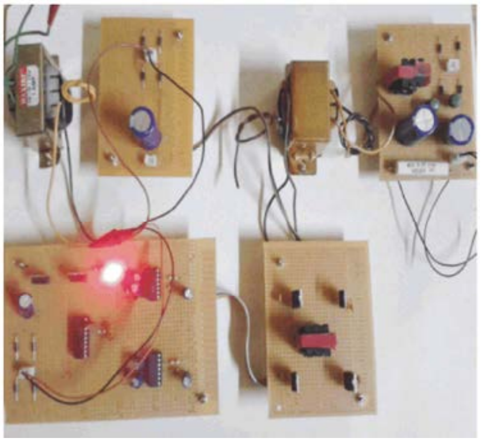

Fig. 14: Hardware kit diagram

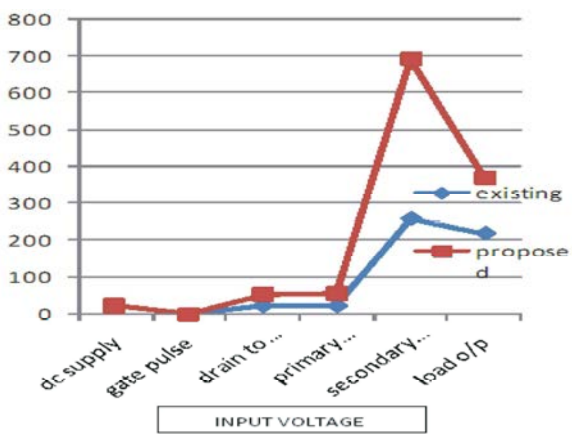

Fig. 15: Characteristics of input and output voltages

Table 1: Simulation Results

S.no	Attributes	Existing	Proposed
1	DC SUPPLY	24V	24V
2	GATE VOLTAGE	1V	1V
3	DRAIN TO SOURCE VOLTAGE	23V	54V
4	PRIMARY TRANSFORMER	24V	57V
5	SECONDARY TRANSFORMER	258V	693V
6	RESISTIVE LOAD O/P	219V	370V
7	CURRENT O/P	0.281A	1.5A
8	POWER	61.46W	548.5W

wave it has half wave rectifier with the capacitor, the capacitors acts here for the filtering purpose in order to reduce the ripples and reduces switching losses, as a result its current and voltage value is higher than the conventional so that its power efficiency is more in the proposed converter. Its followed with its waveforms of i/p DC, gate pulse vs drain to source voltage, primary transformer, secondary transformer, resistive load output, current output, efficiency.

CONCLUSION

In the proposed method soft switching for both the zero voltage and current is used, because of this the current value will be more and losses will be reduced. In the secondary instead of full wave rectifier, here half rectifier is used, due to this switching losses would be reduced. Capacitors on the secondary side helps to reduce the o/p ripple voltage. Due to the soft switching method switching losses are reduced and it leads to reduce the size of transformer core. As a result of soft switching with both ZCS and ZVS, losses have been reduced more than the existing and the voltage range has increased lot by this, capacitors in the secondary side reduces the ripple voltage, because of this the power is highly increased.

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