DESIGN AND IMPLEMENTATION OF SINGLE SWITCH SEPIC CONVERTER FOR SUPPLYING LED DRIVER CIRCUIT WITH PFC CORRECTION AND THE AUTOMATION SYSTEM

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Abstract - *The single switch led driver based on boost PFC converter and SEPIC converter for power factor correction and automation system is proposed. In this proposed system , to obtain high power factor the step up converter should operate in discontinuous mode and SEPIC converter can be used to increase the life time of LED driver. Snubber circuit was designed to convert from peak voltage into low voltage and leakage inductor energy can be reclaimed . DC bus capacitor is used as low voltage capacitor where input should be directly propotional to output power. During power failure ,the emergency lamp can be designed for automation system. Thus the proposed LED system can be helpful to provide high efficiency and high power factor. The experimental working prototype can be verified by output of 48V and 2A .*

***Keywords: SEPIC* converter *,LED* driver, Snubber circuit, Boost power factor converter and automation system.**

1. INTRODUCTION

Recently now a days, LED(light emitting-diode) plays a vital role in Lighting applications.LED have many advantages compared to conventional lamps.LED have many advantages such as power consumption is low life time may be longer(50000 hours),high efficiency and provide environment safety.

For operation of LED , SEPIC converters can be used to obtain high productivity, cheaper and weightless. A high power factor can be achieved with the help of power factor correction circuit (PFC circuit) for an AC input voltage .By using a snubber circuit, the current harmonics can be reduced and limits the voltage required for the circuit.

In each stage LED drivers have double switches and double control circuits which are larger size and expensive. To avoid this problem, a single stage led driver is used, which has single switch for both the stages .A high pf can be obtained by using a boost PFC circuit.

In this paper , a single stage DC-DC LED driver based on boost-SEPIC PFC converter with lossless snubber is proposed The boost PFC can be operated in Discontinuous conduction mode(DCM) for getting high power factor. For light load conditions DCM is preferred. A snubber circuit is used for clamping the peak voltage into low voltage required for SEPIC converter.

The SEPIC converter is used for continuous supply of current without any interruption. Thus proposed LED driver can get more productivity and high pf.

Thus, the life time of the LED driver depends upon the hours of usage of power. If we utilize 12 hours a day, the life time can be 11 years and using 8 hours a day, the life time can be 17 years .Thus, the block diagram can be explained below.

2. BLOCK DIAGRAM OF PROPOSED AREA

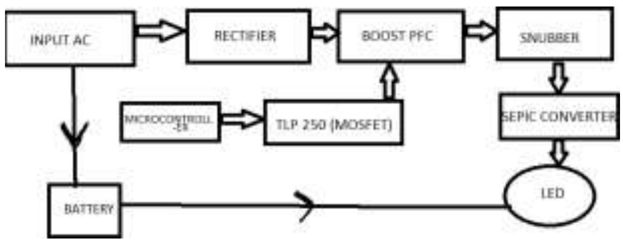

Figure.1 Block Diagram

The AC input is passed to rectifier. The rectifier modifies AC into DC. Input voltage contains active and reactive power. The reactive power should be less than or equal to 0.9.The power factor is corrected by using the boost PFC circuit. The PWM signals are controlled by using the microcontroller. The output is fed to TLP 250 MOSFET driver circuit to maintain 12 V, which is given to snubber circuit .In snubber circuit the harmonics are eliminated for continuous supply of current required for SEPIC converter .The output of SEPIC converter is finally fed to LED driver circuit.

3.WORKING OF SEPIC CONVERTER

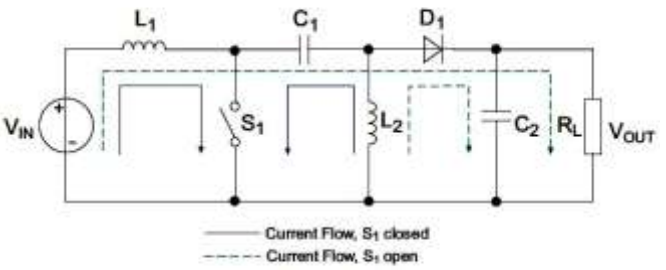

Figure.2 Working of Sepic Converter

To increase the overall efficiency of the light emitting diode (LED) we employ a DC-DC converter. The DC- DC converter is used for the continuous supply of current and the voltage can be high or low ,it will modify the required voltage for the driver circuit. This DC-DC converter can be of any type as buck or boost or buck boost type. If the output voltage has to be increased, we use a boost converter else we require buck converter.

Inspite of a LED driver we sometimes need to increase or reduce output voltage, hence buck boost converter can be used. But buck boost converter has certain disadvantages such as poor transient response, need of a filter in the input side, high peak current etc. Thus we use a SEPIC converter which can increase or reduce the output voltage of the LED system.

The block diagram of a SEPIC converter shows that it employs two inductors L1 and L2, three capacitors Cin, C1 and C2, a switch S1, a diode D and a resistive load R which are connected in series and parallel. Thecapacitor Cin is used as a filter capacitor, C1 as coupling capacitor and C2 as decoupling capacitor.

CASE 1 : WHEN THE SWITCH S1 IS OPEN

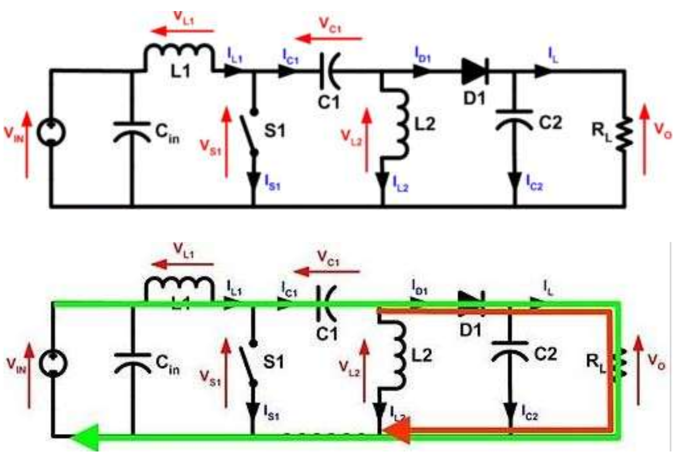

Figure.3 Circuit diagram when switchs1 open

When the switch S1 is open, input voltage flows through inductors L1 and L2, capacitances Cin, C1 and C2, Diode D1 and load R. The capacitances and inductances charges at this case. Voltage flows through inductor L1, capacitor C1, inductor L2, diode D1, capacitor C2 and load RL. This is the voltage path when the switch S1 is open. This switch can be of any switching device, but in this case we use a MOSFET (Metal oxide Semiconducting Field Effect Transistor). The main aim of using this SEPIC converter is to increase or reduce the output voltage to achieve the desired output.

This is done by adjusting the PWM signals which is fed to the switching device that is MOSFET. The output voltage of the SEPIC converter is boosted by increasing ON time of the PWM signals fed to the converter. And the output voltage of this converter can be reduced by reducing the ON time and increasing the OFF time.

CASE : 2 WHEN THE SWTICH S1 CLOSED

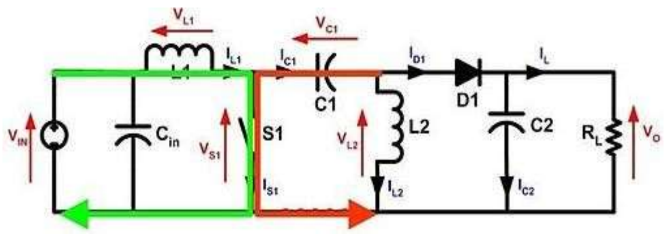

Figure.4 Circuit when switch S1 is closed

In this case, when the switch S1 is closed there exists two loops of operation, because the current flows through the low impedance path and hence it passes through loop1 which is indicated in green lines in the figure. Only the leakage current flows through the loop2 that is through capacitor C1, inductor L2, capacitor C2, diode D1 and load RL which is indicated in red lines. Only very less voltage passes through the load which is lesser than the input voltage of the converter. Thus the operation of a SEPIC converter is being discussed.

4. AUTOMATION SYSTEM

During the power failure, the energy stored in the battery is automatically delivers the power into the load. This acts as emergency lamp circuit.

PNP Transistor is a switch, As long as the mains power is ON, the positive from the supply is maintained at the base of the transistor, keeping it switched OFF. This prevents the voltage reaching from battery to LEDs.When the ac mains power is lost, the positive voltage at the transistor goes off, which makes the transistor biased though R1.This makes the voltage to pass from transistor reaching LED.

5.CIRCUIT DESCRIPTION

The filter circuit consists of Lf and Cf. The boost PFC circuit is composed of the boost inductor Lb, the main switch S1, and the reverse-blocking diode Db(which blocks reverse current through the boost inductor for DCM operation). The DC-bus capacitor Cdc , output capacitor Co , output diode Do and a snubber circuit consists of C1,D1 and L1 is included in DC-DC SEPIC circuit.

To describe the parasitic component of circuit parts for theoretical analysis, during switching period Vin can be considered as constant value. The output for S1 is fed by capacitor CS1.The magnetizing inductor Lm is within the coupled inductor T1 and the turn ratio of leakage inductor Lk is n:1(n=Np/Ns).Hence, Lm is greater than Lk.

Volt-second balance law states that , at the steady state the average inductor should be zero. The voltage across the C1 and Cdc should be equal to Vdc.The voltage through capacitances of C1, Cdc and C0 are considered to be constant.

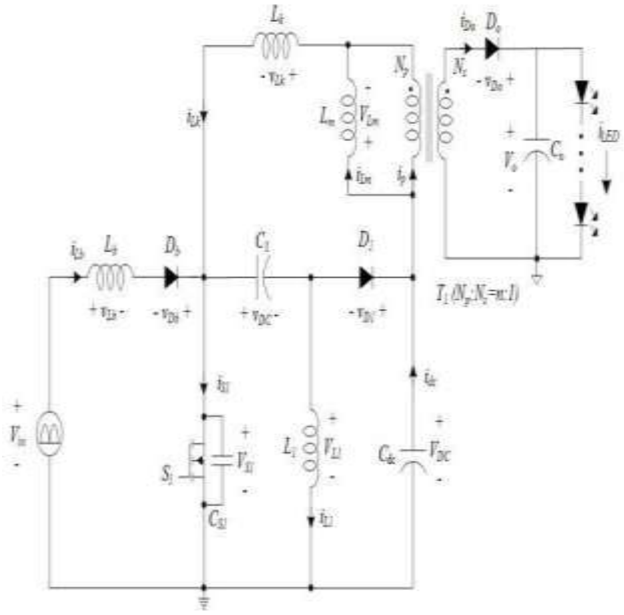

Figure.5 Circuit Diagram

6. RESULT

Thus the experiment was verified for 48V and 2A. The power factor is corrected for continuous operation of LED Driver circuit and high efficiency is achieved.

7. CONCLUSION

A single-switch DC-DC LED driver based on a boost-SEPIC converter with a lossless snubber has been proposed. The boost PFC circuit can be operated in DCM mode to achieve high power factor.

In DC-DC SEPIC circuit, the snubber circuit is used to clamp the peak voltage strikes and recycle the inductor leakage energy. A low voltage capacitor is added additionally because the input power is directly connected from boost inductor to the output. Thus the total productivity is improved. The experiment is evaluated for an output current of 2A and output voltage of 48V.

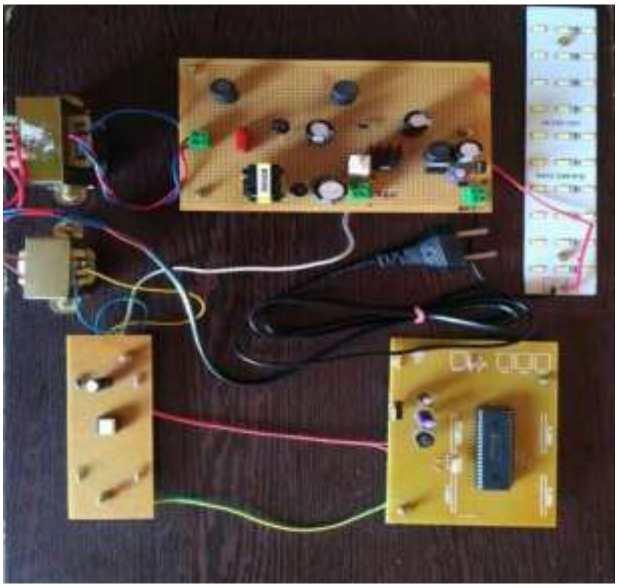

Figure.6 Prototype model

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