Single Stage Switching Power Supply With Half Bridge Toplogy Simulation for LED Lamp Driver

Prijith.M, M.S.P.Subathra, Senraj

Abstract- ***Single stage switching power supply with half bridge topology simulation for LED lamp Driver is presented in this paper.LED lamp driver needs only dc supply. In this paper dc supply is obtained as output while giving ac input voltage of 110V. It is formed by combination of ac/dc converter and dc/dc post regulator. Compared to other switching power supply this reduces cost ,size and simplifies circuit design. It increases efficiency and output voltage can be controlled. The simulation of single stage switching power supply using half bridge topology using Psim software is done and output voltage and power are verified .by using this get an output voltage of 48 V dc output and power range up to 120 W ,and efficiency is above .89 . It is used in LED lamp drivers and piezoelectric element drivers.***

Keywords:Single stage switching power supply, half bridge topology

I. INTRODUCTION

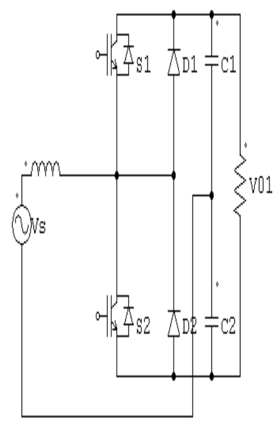
The proposed single-stage switching power supply is formed from integration of one half-bridge ac/dc converter and one half bridge dc/dc post regulator. Compared to the conventional two-stage power supply, this configuration reduces cost and size, simplifies the design, and increases efficiency with both pulse width- modulation (PWM) controller and switch integrations.

The dc output required for one dc load can be obtained from two-stage switching power supply, one ac/dc converter connected to one independently controlled dc/dc post regulator. The main advantages of two stage switching power supply are high power factor and low source current harmonic[1-8].

However, there are some disadvantages in these structures, including poor efficiency due to two-stage power processing and a larger circuit structure caused by the more active switch components and corresponding PWM controllers.

The advantages of the half-bridge topology are high power factor due to low distortion in the source current and isolation between input and output therefore the half-bridge power converter structure is one of the most popular two-stage switching power supply which both stages are shown in Fig1 and Fig 2 respectively. These two stages are in series to obtain the required dc output and four active switches and two corresponding controllers are included[12-13]. The two-stage structure will enlarge the circuit size and cost, and make the control design complicated. In addition, the efficiency is reduced because of the topology with two series power stages.

Proposed single stage switching power supply with half bridge topology is shown in Fig 3 it is formed by combination of one half-bridge ac/dc power factor corrector and one half bridge dc/dc post regulator. It consists of ac powersupply,inductor,diodes,switches(IGBT),capacitors,trans former,filter,load.



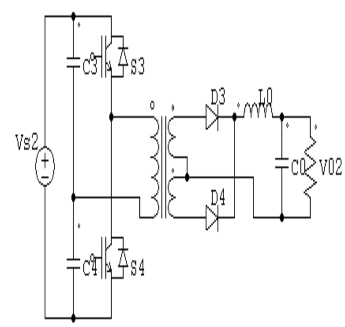


Fig1 Fig2

Fig1 Half bridge ac/dc converter &Fig 2 dc/dc power converter

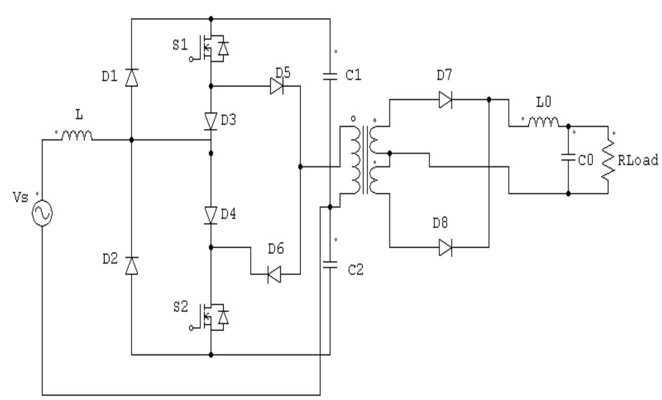


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Fig 3 Proposed single stage switching power supply with half bridge topology

II. WORKING PRINCIPLE

For analysis convenience, one traditional switching control method is used to make the low-side switch S_2 switching for the positive-half-cycle and the high-side switch S_1 switching for the negative-half-cycle of the source voltage. The positive-cycle and negative-cycle operations and corresponding waveforms are illustrated as follows. Noted that the bulk capacitorsC_1 and C_2 are assumed ideal and the voltages on both are equal, that is, $V_{CB1} = V_{CB2} = V_{CB.}$

Positive and negative half cycles are identical[5].

A. Mode 1 operation

Switch *S*1 is turned OFF and switch *S*2 is turned ON while diodes D_1 , D_2, D_3, and D_5 are turned OFF. There are three current conducting loops in this equivalent circuit. In the first loop, the PFC inductor current i_L passes through L, D_4 , S_2 , and C_2 sequentially from the ac source. In the second loop, one current conducts through D_6 and S_2 sequentially and goes out of the primary side of the transformer. In the third loop, the output inductor current i_{L0} travels through L_0 , the output load, the lower secondary side of the transformer and D_8 sequentially.

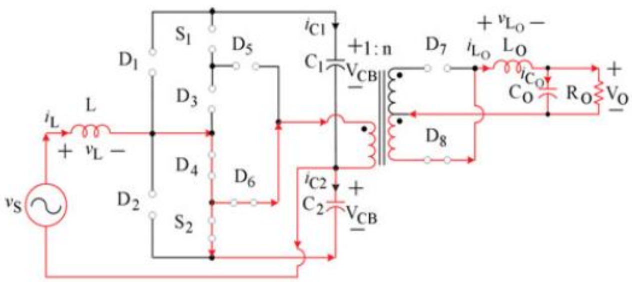

Fig 4 mode1 operation

B.Mode 2operation

Switches S_1 and S_2 both are turned OFF and diode D_1 is turned ON to conduct while diodes D_2, $D_{3,}$ D_4 ,D_5 and D_6 are turned OFF. There are two independently conducting loops in this equivalent circuit. One loop describes the PFC inductor current i_L passing through L, D_1, and C_1 sequentially from the ac source. The other describes the output inductor current i_{L0} , which is shared by both D_7 and D_8 as current travels through L_0 and the output load sequentially .

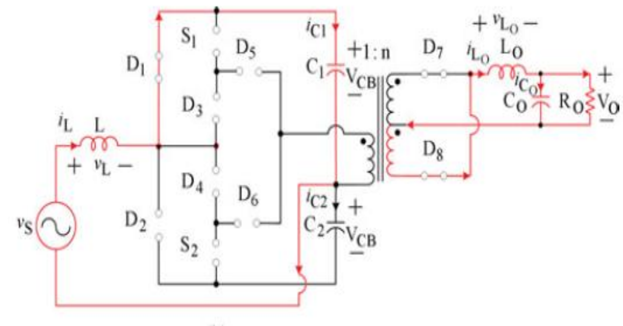

Fig 5 mode2 operation

C.Mode 3 operation

Switches S_1 and S_2 and diodes D_2 , D_3 , D_4 , D_5 and D_6 are still turned OFF. Because i_L has gone to zero at the end of the second duration. Diode D_1 is then turned OFF. There is only one conducting loop in this equivalent circuit, which is the output inductor current i_{L0} still traveling through L_0 and the output sequentially, of which the circuit state on the secondary side is the same in the last duration

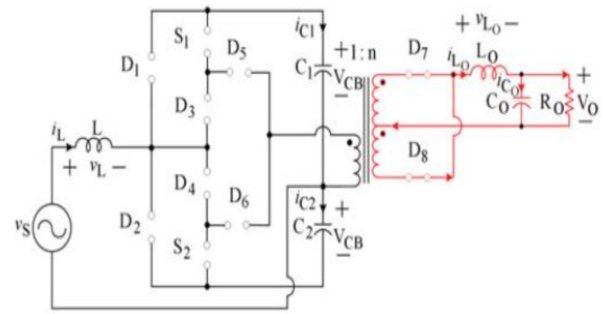

Fig 6 mode3 operation

D. Mode 4operation

Switches S_1 and S_2 and diodes D_1 , D_2 , D_3, D_4, D_5 and D_6 are still turned OFF. Diodes D_7 and D_8 are turned OFF because the output inductor current i_{L0} has gone to zero at the end of the third duration. Now, there is no current conducting loop in this equivalent circuit except for the output terminal

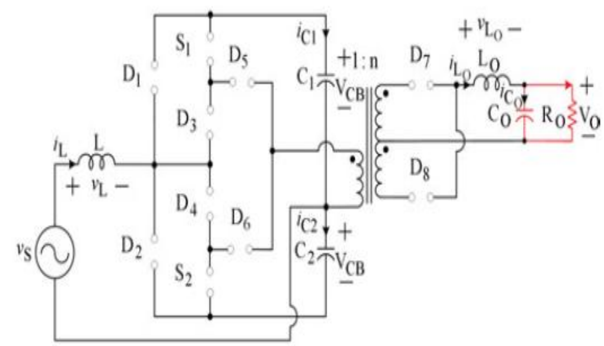

Fig 7 mode4 operation

III. DESIGN OF CIRCUIT COMPONENTS

a. Input inductor design

$$L = \frac{(2.5 \times V_{in} \times d(1-d))}{I_0 \times f_s},$$

Where d is the duty cycle =0.172, V_{in} is the ac supply voltage 110V, f_s is the switching frequency=45KHZ

b. Bulk capacitor design

$$C1=C2=\frac{P}{\eta \times d \times V_{cb} \times 2 \times \pi \times f_s \times V_{cb\ ripple}}=650\mu F$$

c. Output inductor design

$$L_0 = \frac{V_0 \times (V_{cb} - V_0)}{f_S \times \Delta I \times V_{cb}}$$

d. Output capacitor design

$$C_0 = \frac{V_0 \times (V_{cb} - V_0)}{8 \times L \times \Delta V \times f_s{}^2 \times V_{cb}}$$

Design parameters

Input voltage	110 V
Input inductance	470µH
Duty cycle	0.172
Bulk capacitance C1,C2	650µF
Output voltage	48 V
Output inductance	55µH
Turns ratio	4:1
Switching frequency	45 KHZ

e. Zero Crossing Detector Design

The used zero-crossing detector circuit shown in Fig 8 . The circuit is designed to ensure the low-side switch S_2 operate corresponding to positive-half-cycle and the high-side switch S_1 operate corresponding to negative-half-cycle respectively. The IC μA741_1 output signal is high and μA741_2 output signal is low while the source voltage Vs is positive, then the μA741_1 output signal is passed into CD4081_1 through the forward-biased diode and operated with the PWM signal by AND logic to control the low-side switch S_2 . On the other hand, μA741_2 output signal is high level and the μA741_1 output signal is low while the source voltage Vs, negative, then the μA741_2 output signal is passed into CD4081_2 through the forward-biased diode and operated with the PWM signal by AND logic to control the high-side switch S_1.

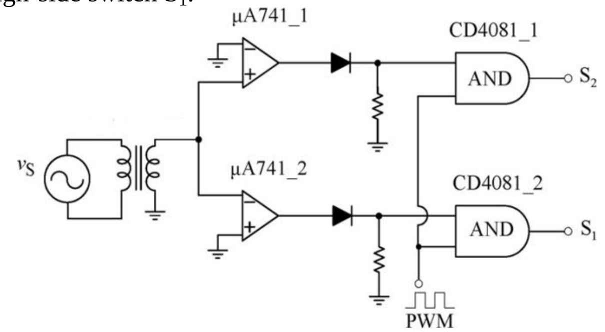

Fig8 Zero crossing detector

IV. SIMULATION MODEL USING PSIM

The closed loop simulation model using psim software is shown in Fig 9 input supply from the source 110 V ac is given to the inductor from inductor the signal passes through the switching control it includes two switches and diodes one of the switch is turns on at a time and the output from that is given to the capacitor and this output voltage is given to the transformer and it step down the voltage and given to the load through diodes and inductor capacitor filter. By varying the output load we can vary output current and output power. An error amplifier and zero crossing detectors are used as control circuit for making the circuit closed loop .

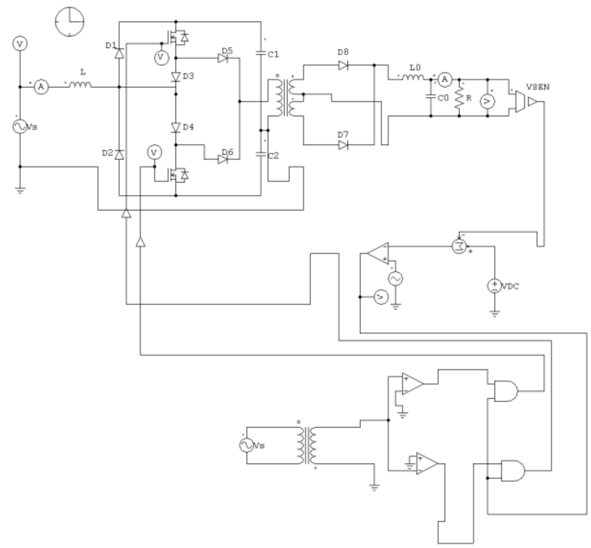

Fig 9 Psim model

V .SIMULATION OUTPUTS

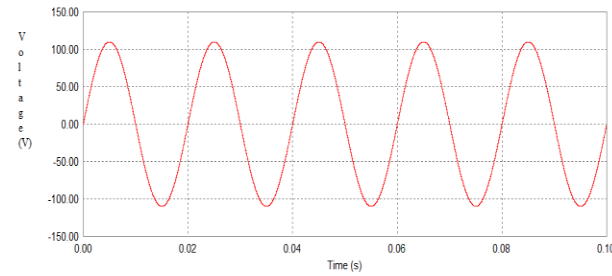

Fig .10 Input voltage waveform

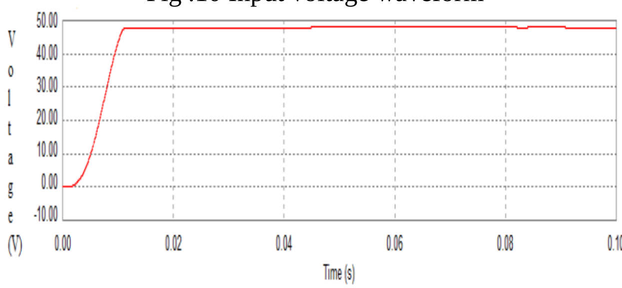

Fig11 Output voltage wave form

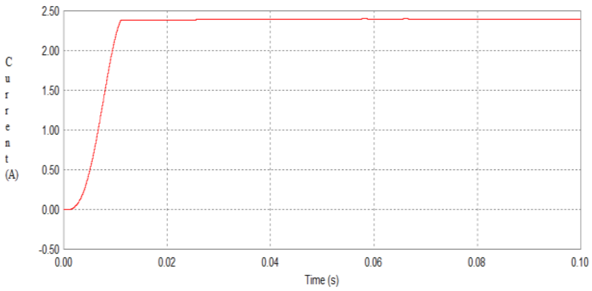

Fig12 Output current waveform

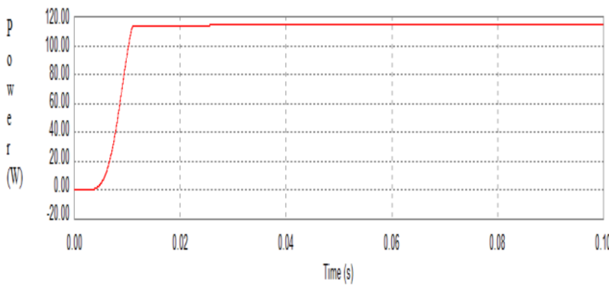

Fig13 Output power waveform

From simulation results it can be seen that as by taking load resistance R=20 ohm the output voltage is 48V dc and output current is 2.4 A .The output power is nearly 120 W

VI.EFFICIENCY CALCULATION

Variables	Values
inputvoltage	110 V
Input current	1.2 A
Input power	128.04 W
Output voltage	48 V
Output current	2.4 A
Output power	115 W
efficiency	89.97%

By simulation we can know the input voltage ,input current, output voltage and current thus we can calculate efficiency using equation and it can be seen that its around 89.9%.

VII.CONCLUSION

In this paper discussing about single stage switching power supply with half bridge topology simulation for LED lamp driver. Here only single stage switching power supply is used for giving supply to the circuit, Compared to the conventional two-stage power supply, this configuration reduces cost and size, simplifies the design, and increases efficiency. Disadvantages of two stage switching power supply are poor efficiency due to two-stage power processing and a larger circuit structure. The single stage switching power supply simulation is done using Psim software and results are obtained. The output dc voltage is 48 V and output power is 115 W when the input is 110V AC supply ,so it is used for LED applications and by calculation the efficiency is above 89.9%.

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