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200w Switched Mode Power Supply with Uninterrupted 110v Dc Power Supply

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ABSTRACT: Power electronics circuits comprising of power conversion topologies like AC-DC converters, DC-AC converters and DC-DC converters. DC power for electronic circuits is most conveniently obtained from commercial AC lines by using rectifier-filter system, called a DC power supply. This project presents an output of 110V uninterrupted DC power supply from the input of 230V AC. This project proposes isolated AC-DC converters for battery charging application with the concept of constant current charging with regulated power supply. Half bridge converter is used for battery charging application followed by step-down transformer. And a DC-Dc converter-Fly back converter is used to boost the voltage. It has the boost operation mode, which is used to boost 12V DC to 110V DC, which is either from the outcome of step-down transformer or from the battery. The converter is suitable for battery powering of main appliances with switched mode power supply. Because the switching supply is rectifying the input voltage at the very beginning, so there is no need to create AC voltage. Such an appliances is powered simply by DC voltage with amplitude corresponding to the main voltage.

KEYWORDS: AC-DC converter, Battery charger, Half bridge converter, Power supply, DC-DC converter, Fly back converter.

I. INTRODUCTION

Generally, inan electrical system, the voltage is fixed (e.g. 12 volts from a battery, 230V Ac from the mains) and the current is determined by the load. Power is voltage multiplied by current, therefore the increases in the load, increases the power. The major part of an electrical system is its batteries. So the charging circuit for batteries is an integral part in the development of an electrical system. So the proper development of an efficient battery charging circuit is highly important in the manufacturing of an electrical system.

Many papers in the area of power electronics and drives propose the use of different types of DC-DC converters especially isolated converters. The selection of these converters is strictly based on the area of application and power levels. The Half bridge converter can be proposed in different ways according to the area of application.

Single stage half bridge converter is proposed for DC voltage regulation and power factor correction. The performance of the converter is depends upon inductor operation mode, that is it depends on whether the inductor is operating on discontinuous conduction mode or continuous conduction mode. If the proposed converter is operating in discontinuous conduction mode it not only has high power factor but also avoids, use of bulk capacitor from high voltage stress at light loads. So compared to two stage half bridge converter, single stage converter has the advantage of having one controller instead of two separate controllers as in two stage converter. Thus it has the advantages like reduced cost and less complexity.

The use of switch mode power supplies is widely increased in the modern industry in order to provide stable regulated output voltages.To achieve high efficiency circuit configuration, soft switching methods like zero voltage switching and zero current switching can be employed. Half bridge converter with ZVS operation was proposed to

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reduce the switching losses and the circuit cost compared with full bridge converter in medium and high power applications.

Several power converter topologies are proposed in high power applications like fuel cells, solar cells etc. These converters have the advantages like high voltage conversion ratio, high power capability, isolation between input side and output, avoids flux imbalance. But these converter topologies have the problem of transformer leakage inductance in output capacitors which leads to high voltage stresses and switching losses etc. So it is better to use snubber circuit to avoid these problems, so the concept of half bridge converter with PWM control is employed in order to get regulated output voltage for battery charging applications.

The flyback-current-fed push-pull dc-dc converter has several advantages over the conventional voltage or current-fed push-pull ones. It has one single input and no output inductor, which makes it a good choice for a multiple output power supply.

III. AC-DC CONVERTERS

1. HALF BRIDGE CONVERTER

Half bridge converter topology is an isolated dc-dc converter which is widely used in power electronics and drives application. This topology can be used for an output power capability up to 500W. One of the main features of half bridge converter is it reduces the OFF-stage voltage requirement of the primary side switches to VI apart from maintaining the bi-directional flux swing in the core. Thus the voltage stress and cost of the power switches is significantly reduced as compared to the push-pull topology. The secondary side of the half bridge converter is exactly same as the push-pull converter. In addition to battery charging applicationhalf bridge converter can be used for many other applications like UPS etc. due to the reduced complexity of the converter.One of the main features of isolated converter is the output can be configured either positive or negative. Since it consists of a transformer it can produce an output of higher or lower voltage than the input by adjusting the turns ratio.One of the main features of half bridge converter is, it reduces the OFF-stage voltagerequirement of the primary side switches to Vi apart from maintaining the bi-directional flux swing in the core.

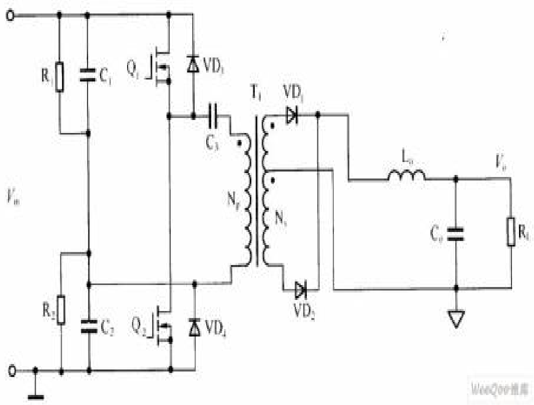

Fig.1. Circuit diagram of Half bridge converter.

1.1 MODES OF OPERATION

The operation of half bridge converter can be explained in two modes according to the switching ON of two switches Q1 and Q2.

1.1.1 MODE 1

Mode 1 starts when switch Q1 is ON. This occurs during first *DTs* period. The input source voltage Vin is connected to one end of the primary winding through switch Q1. The other end is at Vin/2. The voltage across the primary is Vin/2 with the dot end being positive with respect to the non dot end. The diode VD1 is ON and VD2 is OFF. The energy is supplied to charge up the inductor through the diode VD1.

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1.1.2 MODE 2

This mode starts when the switch Q2 is ON. This occurs during the second *DTs* period. Q1 and Q2 will be ON during alternate *DTs* periods with *D* and *Ts*being defined with respect to the inductor current ripple. During this time, Q2 is ON and the voltage across the primary winding is Vin/2., but the dot end is negative with respect to the non dot end. This will facilitate the core flux to swing in the negative direction. In secondary, VD2 is ON and VD1 is reverse biased. The inductor energy is flow through diode VD2. When both Q1 and Q2 are OFF, the inductor current freewheels through both VD1 and VD2. The current flowing in the center tapped secondary is in directions that will cancel the flux in the core due to each other. This will leads to the voltage across the entire transformer being zero.

IV. DC-DC CONVERTERS

1. FLYBACK CONVERTER

The Flyback converter is composed of a push-pull transformer and one two-winding flyback transformer. In addition, the circuit includes two switches and two output diodes. The converter's characteristics are as follows:

1) It has two operation modes, namely, buck and boost that depend exclusively on the duty ratio. For duty ratio less than 0.5, it operates in the buck mode (non overlapping mode), and for duty ratio larger than 0.5, it operates in the boost mode (overlapping mode).

2) Its switches are at the same reference point, which simplifies the driving circuitry.

3) When both transformers have the same turns ratio, the output characteristics in continuous conduction mode (CCM) are the same for both the overlapping and the non-overlapping operation modes.

4) It has only two output diodes.

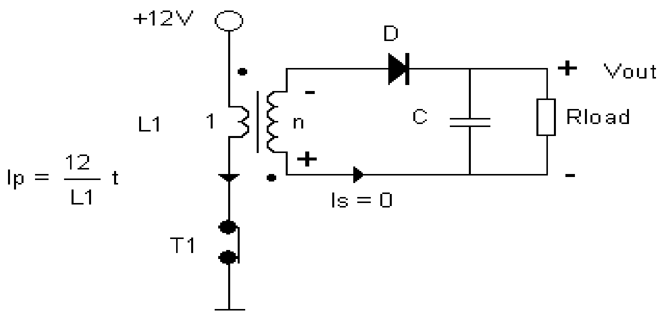

Fig.2. Circuit diagram of Flyback converter

1.1. MODES OF OPERATION

The circuits representing the stages of operation for a half cycle are shown in Fig. 3.

First of all, when the MOSFET turns on, given that the polarity of the transformer is reversed, a current flows to the primary winding of the transformer, when energy is stored. At this time, the diode is off. Next, when the MOSFET turns off, the stored energy is output through the diode from the secondary winding of the transformer, and after undergoing rectification and smoothing, it generates a DC voltage.

The figure.4.below illustrates this operation and the voltage and current waveforms at major nodes:

1) When the MOSFET turns on, a current flows to the primary winding of the transformer, where energy is stored. During this time, the diode remains off.

2) When the MOSFET turns off, the stored energy is output trough the diode from the secondary winding of the transformer.

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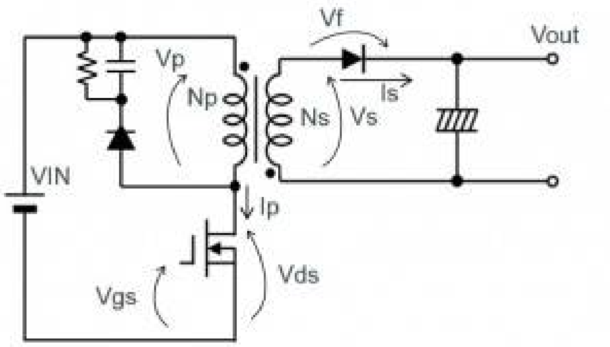

Fig.3. Stages of operation

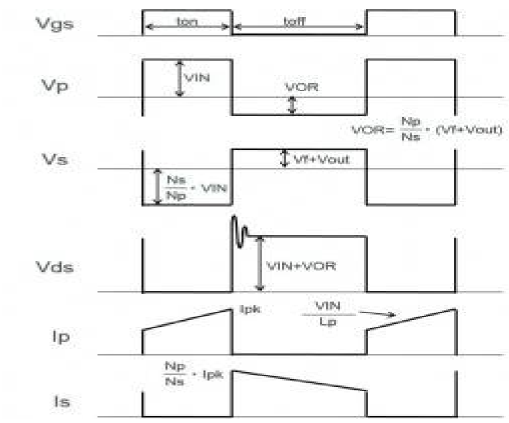

Fig.4. Current waveforms at major nodes

1.1.1. SNUBBER CIRCUIT

In flyback converters Snubber circuit is used. Because a gap is provided in the core of the transformer, the flyback method involves an increase in magnetic leakage flux, causing the generation of leakage inductance. Although a switching current also flows to the leakage inductance, resulting in build-up of energy, because the transformer is not coupled to the other windings, there is no transfer of power. This generates a surge voltage exceeding the voltage tolerance of the MOSFET can lead to the destruction of the MOSFET. To prevent this possibility, a snubber circuit is provided that suppresses the surge voltage. In the above circuit diagram, the circuit composed of a resistor, a diode, and a capacitor provided on the primary side represent a snubber circuit. Keep in mind that snubber circuits are basically necessary in flyback converters.

V. PWM PULSE GENERATION

1. PWM CONTROLLER IC

One of the most important processes in the hardware development of a DC-DC converter is pulse generation either by using analog method or digital method. In analog PWM pulse generation method analog IC's are mainly used for the development of PWM pulses. Here it is better to know the concept of PWM generation by both analog and digital method. One of the main advantages of PWM controller is we can control the pulse width of the switches so that we can regulate output voltage and current. This is the main reason for the large scale advancement in the area of PWM generators (both analog and digital generators). Because compared to fixed pulse generation topologies variable pulse generation topologies have its own advantage.

One well known PWM controller IC is introduced for the generation of gate pulses, that IC is TL 494. The TL494 is a fixed frequency, pulse width modulation control circuit designed primarily for switch mode power supply

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control. The TL494 consists of 5V reference voltage circuit, two error amplifiers, flip flop, an output control circuit, a PWM comparator, a dead time comparator and an oscillator. This device can be operated in the switching frequency of 1 KHz to 300 KHz.

The TL494 is a fixed-frequency pulse-width-modulation (PWM) control circuit. Modulation of output pulses is accomplished by comparing the saw tooth waveform created by the internal oscillator on the timing capacitor (CT) to either of two control signals. The output stage is enabled during the time when the saw tooth voltage is greater than the voltage control signals. As the control signal increases, the time during which the saw tooth input is greater decreases; therefore, the output pulse duration decreases. A pulse-steering flip-flop alternately directs the modulated pulse to each of the two output transistors.

Design values
fs = 25 KHz
Ct = 0.01 Uf
Rt= 1/ (2*fs*Ct) = 2 K =2.2 K as standard values.

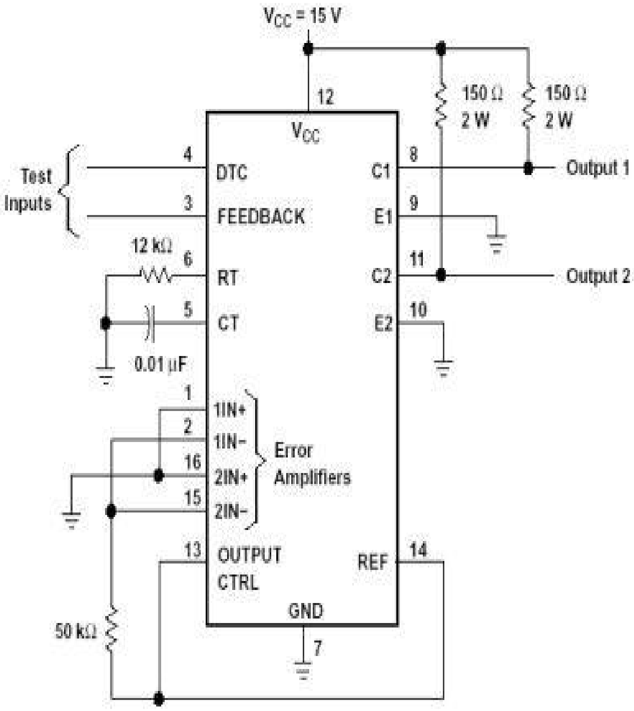

Fig. 5. Schematic of TL 494

2.DRIVER CIRCUIT

The circuit which generates the duty-ratio or frequency signals to control the switches of a converter do not have the capability to drive the switches directly. Therefore, a driver stage is added after the duty-ratio/frequency stage. The driver stage is capable of supplying the voltages and currents needed to switch the devices of the converter. The driver circuit can also be designed to provide the isolation required between the high-and-low voltage sides of the converter.

In this paper IC TLP250 which has an inbuilt opto-coupler is used for driving. The TOSHIBA TLP250 consists of a GaAlAs light emitting diode and an integrated photo detector.

This unit is 8-lead DIP package. TLP250 is suitable for gate driving circuit of IGBT or power MOSFET. Its features are input threshold current.

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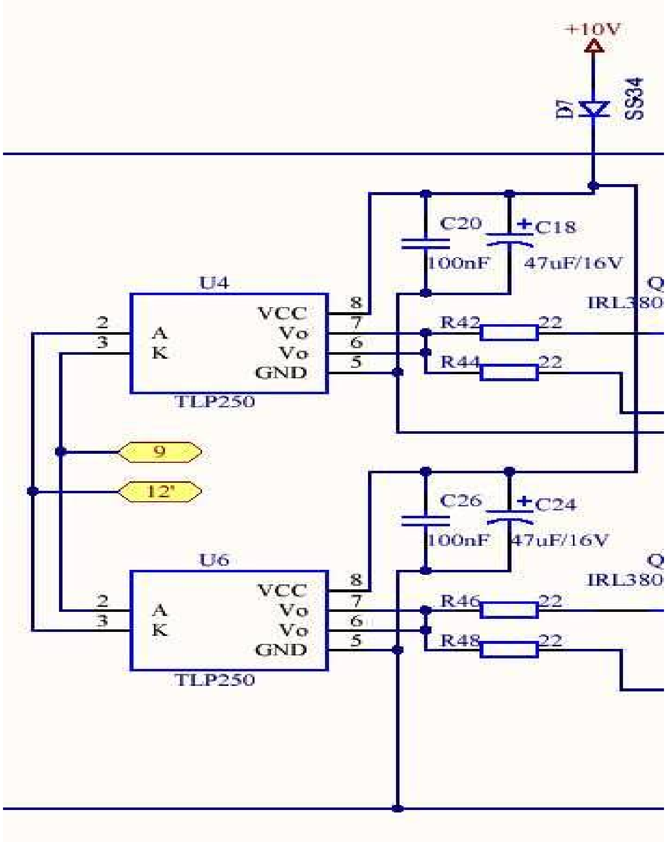

Fig.6. schematic of TLP 250

The typical driver IC's that used in general PWM generation methods are only intended for driving purposes. Because it carry out only the amplifying of the gate pulses that generates from the PWM controllers. But it is very important to provide the isolation for between the input side and output side of the PWM generators. So we have to use any of the isolation methods to provide the proper isolation. Generally we are using opto coupler IC's like MCT2E for such applications. Most of the driver IC's do not have optoisolation properties. For example if we are using IR 2110 driver IC for the driving circuit we have to include an opto coupler IC like MCT2E or any other type for isolation between input side and output side. But the main advantage of TLP 250 IC is it can be used for both driving and isolation purposes simultaneously.

V. DESIGN

1. HALF BRIDGE CONVERTER

The design of half bridge converter mainly includes the design of center tapped transformer, inductor, capacitor and power switches. Based on these designs only we can implement the half bridge converter in a proper manner. So among these process transformer design is important one. The proposed half bridge converter specification is given below.

f=30 KHZ

T=1/30 KHZ

Ton=16.6μs

Primary turns

$N_{Mpp}= (V_P \times t_{on})/ (\Delta B \times A_{cp})$

$=28T$

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Secondary turns

111v/28 T=3.96V

=15V/3.96

=4T

2. FLYBACK CONVERTER

12V to 110V DC

f=40 KHZ

t=0.025=25µs

Primary turns

Nmin=(V×t)/(ΔB.Ac), Np=4T

Secondary turns

Vcc/Np=10.5/4=2.623 v/n

Ns=Vs/(v/n)

=111.25/2.625

Ns=43 T

3.CALUCULATE AIR GAP

Air gap,

lg=(µr×Np^2×Ac)/Lp

lg-airgap

µr- 4π×10^-7

Np- Primary turns

Ac- area of core

Lp- Primary inductance Gt

lg=(4π×10^-7×4^2×181)/(0.0036)

lg=1.0mm

VI. HARDWARE RESULT

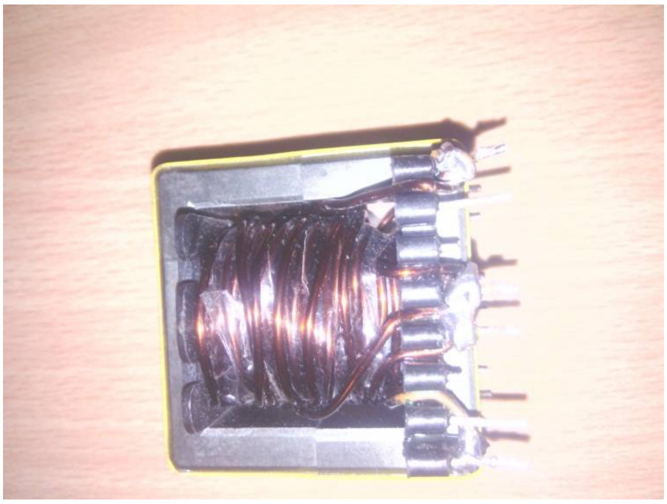

Fig.5. Winding of the transformer

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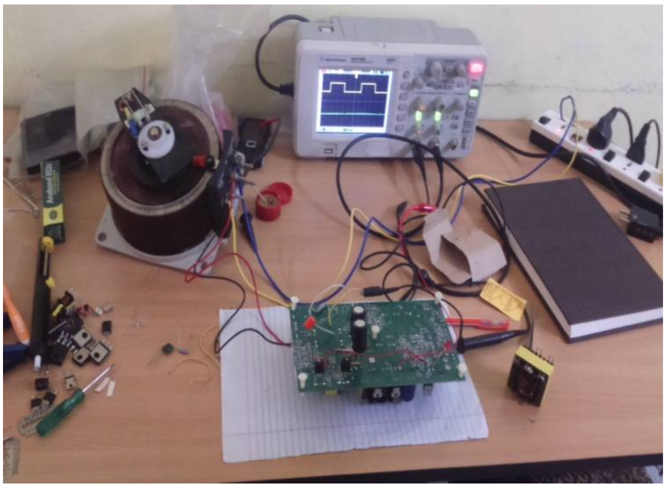

Fig.6. Hardware implementation setup of DC power supply

VII. CONCLUSION

The closed loop hardware implementation of the proposed half bridge converter with the proposed rating is done with respective design values, including the design of transformer and inductor. Thus the implementation of the battery charger by the concept of half bridge converter with high voltage rating is done. Next the flyback converter preserves all the basic properties of the conventional flyback current-fed-push-pullconverter with fewer components. Its operation is to boost the voltage level up to 110V DC from 12V DC.

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