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FULL RANGE SOFT-SWITCHING ISOLATED BUCK-BOOST CONVERTERS WITH INTEGRATED INTERLEAVED BOOST CONVERTER AND PHASE-SHIFTED CONTROL

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ABSTRACT

A new method for deriving Isolated Buck-Boost (IBB) converter with single-stage power conversion , and novel IBB converters based on high-frequency bridgeless interleaved Boost rectifiers are presented. The semiconductors, conduction losses and switching losses are reduced significantly by integrating the interleaved boost converters into the full-bridge diode-rectifier. Various high-frequency bridgeless boost rectifiers are harvested based on different types of interleaved boost converters, including conventional boost converter and high step-up boost converters with voltage multiplier and coupled inductor. The full-bridge IBB converter with voltage multiplier.

INTRODUCTION

In electronics engineering, a DC to DC converter is a circuit which converts a source of direct current from one voltage to another. It is a class of power converter.DC to DC converters are important in portable electronic devices such as cellular phones and laptop computers, which are supplied with power from batteries. Such electronic devices often contain several sub-circuits with each sub-circuit requiring a unique voltage level different than that supplied by the battery. Additionally, the battery voltage declines as its stored power is drained. DC to DC converters offer a method of generating multiple controlled voltages from a single variable battery voltage, thereby saving space instead of using multiple batteries to supply different parts of the device.

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BLOCK DIAGRAM

The input supply is fed to the isolated buck-boost converter. Present day fast converters operate at much higher switching frequencies chiefly to reduce weight and size of the filter components. As a consequence, switching losses now tend to predominate, causing the junction temperatures to rise. Special techniques are employed to obtain clean turn-on and turn-off of the devices. And the converteroperates depends on load. The converter is control by driver circuit and operates by using PIC controller.

Power supply unit

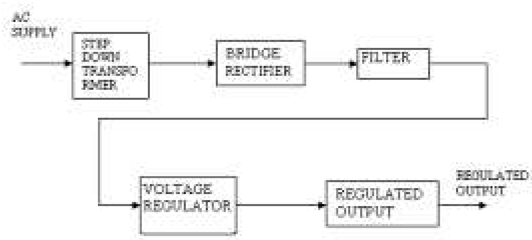

FIG.1 POWER SUPPLY UNIT

As we all know any invention of latest technology cannot be activated without the source of power. So it this fast moving world we deliberately need a proper power source which will be apt for a particular requirement. All the electronic components starting from diode to Intel IC's only work with a DC supply ranging from -+5v to 0-+12v. We are utilizing for the same, the cheapest and commonly available energy source of 230v-50Hz and stepping down, rectifying, filtering and regulating the voltage. This will be dealt briefly in the forth-coming sections.

Step down transformer

When AC is applied to the primary winding of the power transformer it can either be stepped down or up depending on the value of DC needed. In our circuit the transformer of 230v/0-12v is used to perform the step down operation where a 230V AC appears as 12V AC across the secondary winding. One alteration of input causes the top of the transformer to be positive and the bottom negative. The next alteration will temporarily cause the reverse. The current rating of the transformer used in our project is 1A. Apart from stepping down AC voltages, it gives isolation between the power source and power supply circuitries.

Diode bridge rectifiers

The ac input from the main supply is stepped down using a 230 /30V step down transformer. The stepped down AC voltage is converted into dc voltage using a diode bridge rectifier. The diode bridge rectifier consists of four diodes arranged in two legs. The diodes are connected to the stepped down AC voltage. For positive half cycle of the ac voltage, the diodes D1 and D4 are forward biased (ref fig). For negative half cycles diodes D2 and D3 are forward biased. Thus dc voltage is produced to provide input supply to the DC-DC Converter.

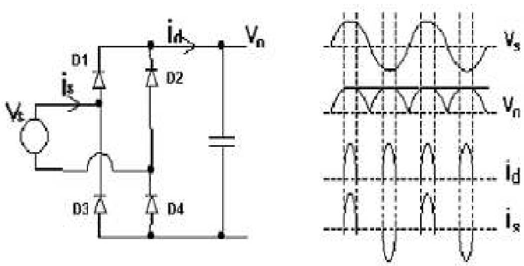

FIG 2 DIODE BRIDGE RECTIFIERS

When the positive half cycle is applied to the diode bridge rectifier, the diodes D1 and D4 are forward biased. The diodes start conducting and the load current flows through the positive of the supply, diodeD1, the load, the diode D4 and the negative of the supply. The diode D2 and D3 are reverse biased and do not conduct.

During the negative half cycle, the diodes D1 and D4 are reverse biased and they stop conducting. The diodes D2 & D3 are forward biased and they start conducting. The load current flows in the same direction for both the half cycles. Thus the ac supply given to diode bridge rectifier is converted into pulsating dc.

Filtering unit

Filter circuits which are usually capacitors acting as a surge arrester always follow the rectifier unit. This capacitor is also called as a decoupling capacitor or a bypassing capacitor, is used not only to 'short' the ripple with frequency of 120Hz to ground but also to leave the frequency of the DC to appear at the output. A load resistor R1 is connected so that a reference to the ground is maintained. C1R1 is for bypassing ripples. C2R2 is used as a low pass filter, i.e. it passes only low frequency signals and bypasses high frequency signals. The load resistor should be 1% to 2.5% of the load.

1000∝f/25v : for the reduction of ripples from the pulsating.

10∝f/25v : for maintaining the stability of the voltage at the load side.

O, 1∝f : for bypassing the high frequency disturbances.

Voltage regulators

The voltage regulators play an important role in any power supply unit. The primary purpose of a regulator is to aid the rectifier and filter circuit in providing a constant DC voltage to the device. Power supplies without regulators have an inherent problem of changing DC voltage values due to variations in the load or due to fluctuations in the AC liner voltage. With a regulator connected to the DC output, the voltage can be maintained within a close tolerant region of the desired output IC7805 is used in this project for providing +12v and –12v DC supply.

Isolated interleaved boost converter

Isolated boost converter is desirable in the low-to-high dc/dc application where isolation is required or a large step up is in a need. The challenge of designing such a converter for high power applications is how to handle the high current at the input and high voltage at the output. An effective way is to parallel the inputs and series the outputs of the isolated boost converters. Based on this concept, a new interleaved and isolated boost converter is proposed in this paper that has two inductors in parallel at the input to share the current .

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Driver circuit

The driver circuit is supplied using a step down transformer 230V/12V AC .In this project the driver circuit is mainly used to amplify the pulse output coming from the microcontroller circuit.The output from pin 1 and 2 of PIC16F877A is passed to the buffer IC CD4050 .The buffer IC acts as a NOT gate .the output from the buffer IC is passed to the two optocoupler respectively. The optocoupler is used to isolate the voltages between the main circuit and microcontroller circuit. This signal is passed to the transistors CK100 and 2N2222 which is connected in a Darlington pair model. The driver circuit has two legs. First leg is connected to switch-1 Sm and the second leg is connected to switch-2 Sa. Thus the 5V pulse from the microcontroller circuit is amplified to 12V and sent to MOSFET switch.

DRIVER CIRCUIT COMPONENTS

The driver circuit is used to amplify the pulses. It consists of three main components they are:

- OPTOCOUPLER
- BUFFER IC
- TRANSISTOR

Optocoupler

There are many situations where signals and data need to be transferred from one subsystem to another within a piece of electronics equipment, or from one piece of equipment to another, without making a direct ohmic electrical connection. Often this is because the source and destination are (or may be at times) at very different voltage levels, like a microprocessor, which is operating from 5V DC but being used to control a MOSFET that is switching at a higher voltage. In such situations the link between the two must be an isolated one, to protect the microprocessor from over voltage damage.

Relays can of course provide this kind of isolation, but even small relays tend to be fairly bulky compared with ICs and many of today's other miniature circuit components. Because they're electro-mechanical, relays are also not as reliable and only capable of relatively low speed operation. Where small size, higher speed and greater reliability are important, a much better alternative is to use anoptocoupler. These use a beam of light to transmit the signals or data across an electrical barrier, and achieve excellent isolation.

Optocouplers typically come in a small 6-pin or 8-pin IC package, but are essentially a combination of two distinct devices: an optical transmitter, typically a gallium arsenide LED (light-emitting diode) and an optical receiver such as a phototransistor or light-triggered diac.

The two are separated by a transparent barrier which blocks any electrical current flow between the two, but does allow the passage of light. The basic idea is shown in Fig.1, along with the usual circuit symbol for an optocoupler. Usually the electrical connections to the LED section are brought out to the pins on one side of the package and those for the phototransistor or diac to the other side, to physically separate them as much as possible. This usually allows optocouplers to withstand voltages of anywhere between 500V and 7500V between input and output.Optocouplers are essentially, digital or switching devices, so they're best for transferring either on-off control signals or digital data. Analog signals can be transferred by frequency or pulse-width modulation.

General description

In our project the optocoupler is used in the driver circuit. They are used to isolate the voltage between the main circuit and microcontroller circuit. The pulse is provided to the MOSFET switch using a microcontroller circuit; this circuit produces a waveform of 5V DC. This pulse is supplied to MOSFET switch which is supplied by 12V AC as the source and destination voltage is different they have to be isolated, which is done using optocoupler.

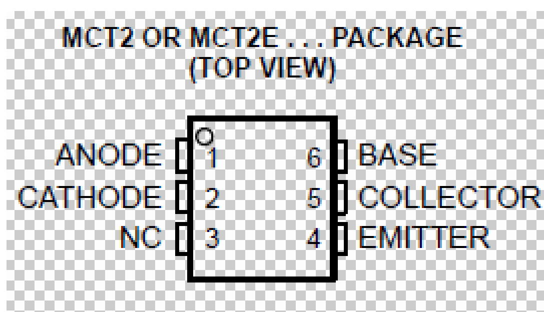

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FIG 3 MCT2 OR MCT2E OPTOCOUPLER

Specifications

- Gallium Arsenide Diode Infrared Source Optically Coupled to a Silicon npn Phototransistor
- High Direct-Current Transfer Ratio
- Base Lead Provided for Conventional Transistor Biasing
- High-Voltage Electrical Isolation . . .
- 1.5-kV or 3.55-kV Rating
- Plastic Dual-In-Line Package
- High-Speed Switching:
  t_r = 5 µs, t_f= 5 µs Typical
- Designed to be Interchangeable with General Instruments MCT2 and MCT2E

Buffer IC –CD4050

The CD4050BC hex buffers are monolithic complementary MOS (CMOS) integrated circuits constructed with N- and P-channel enhancement modetransistors. These devices feature logic level conversion using only one supply voltage (VDD). The input signal high level (VIH) can exceed the VDD supply voltage when these devices are used for logic level conversions. These devices are intended for use as hex buffers, CMOS to DTL/ TTL converters, or as CMOS current drivers, and at VDD = 5.0V, they can drive directly two DTL/TTL loads over the full operating temperature range.

3.3.3.1.2.2 Pin assignments for DIP

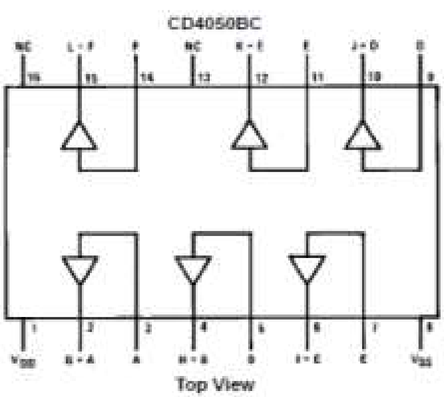

FIG 4 PIN ASSIGNMENTS FOR DIP

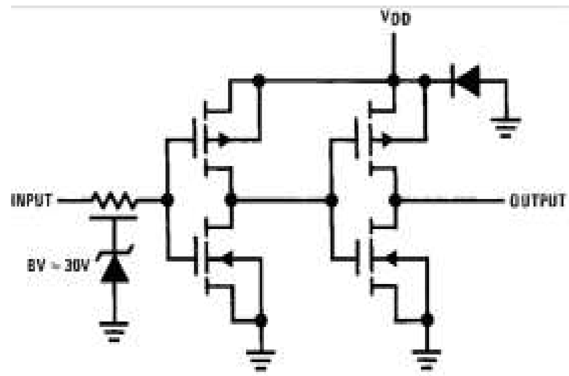

FIG 5 SCHEMATIC DIAGRAM

devices should be operated at these limits. The table of "Recommended Operating Conditions" and "Electrical Characteristics" provides conditions for actual device operation.

Note 2: VSS = 0V unless otherwise specified.

Typical applications

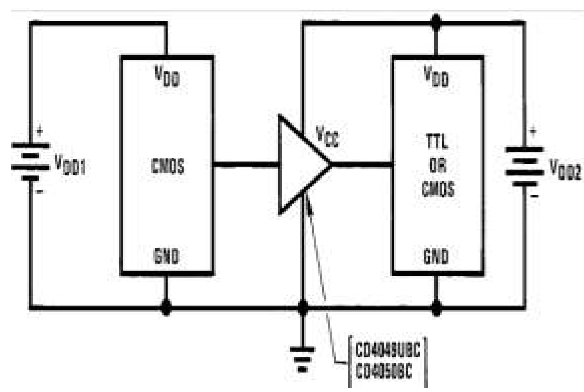

FIG 6 CMOS TO TLL OR CMOS AT A LOWER VDD

SIMULATION DIAGRAM

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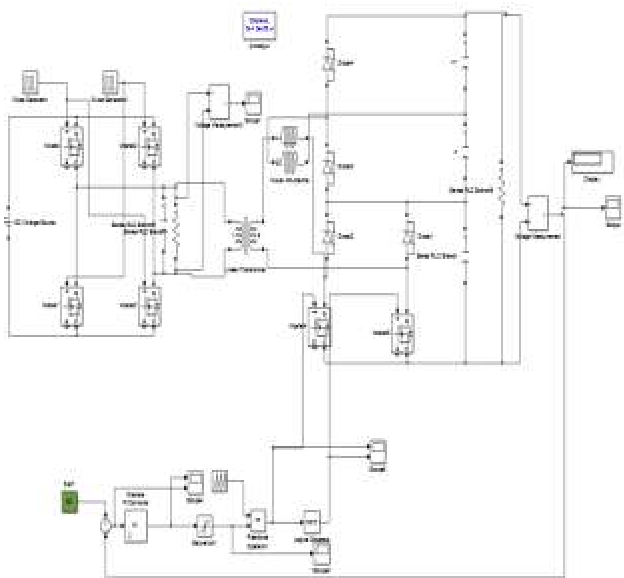

FIG 7 SIMULATION DIAGRAM

A buck-boost converter provides an output voltage can be either higher or lower than input voltage. Here the output voltage polarity is opposite to that supply voltage. It is also called as inverting regulator.

The buck converter circuit consist of pulse generator, MOSFET, switches, series RLC branch, voltage measurement and linear transformer. The dc input is given to the inverter and it inverts dc to ac and the voltage is reduced depends on its given pulses to the MOSFET switches. The capacitor is act as the filter and it connected at the end of the inverter. The inverter output is fed to the transformer input. The inverter output voltage is measured by using voltage measurement. And this output voltage waveform is show by using scope.

The transformer boosting the voltage without changing the frequency and is connected to the inductor, is boosting the voltage depends on its value of inductor. In the boosting circuit there are two switches is to be used because of the controlling the switching operation is controlled by the peripheral integrate controller for the boosting the voltage to the maximum value of the voltage of interleaved boost converter.

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BUCK OUTPUT

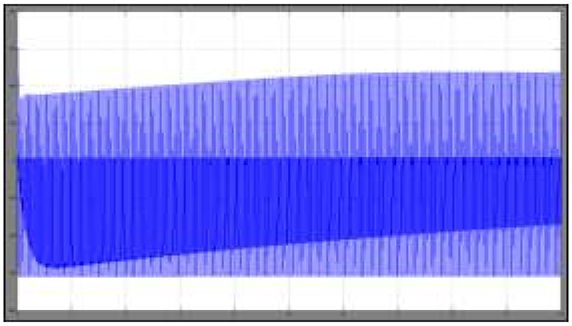

FIG 8 BUCK OUTPUT

The buck voltage is measured by using voltage measurement and this voltage value is displayed by using display. And this output voltage waveform is showed by using scope.

BOOST OUTPUT

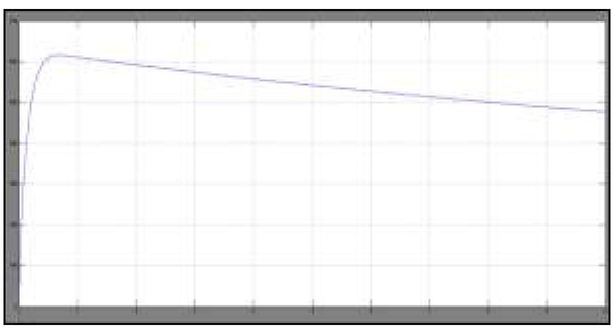

FIG9 BOOST OUTPUT

The boosted voltage is measured by using voltage measurement and this voltage value is displayed by using display. And this output voltage waveform is showed by using scope.

CONCLUSION

A full-bridge isolated Buck-Boost converter with voltage-multiplier on the secondary-side bridgeless Boost rectifier has been investigated. The voltage stresses of the semiconductors in the Boost-rectifier are reduced significantly due to the voltage multiplier, hence low-voltage rated devices with better conduction and switchingperformance can be used to improve efficiency. In other words, this converter is more attractive for high output voltage applications.Both buck and boost is been done here in a same circuit with the values shown in the scope and display of the simulation.A two converters are used in a circuit with two way outputs that is buck and boost which can be used depending on the application where we need to use.

HARDWARE RESULT

FIG10 SNAPSHOT OF THE HARDWARE

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