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High Step-Up Converter with Voltage Multiplier Module for Renewable Energy System

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Abstract:-In this project, A novel high step-up converter, which is suitable for renewable energy system, is proposed.Through a voltage multiplier module composed of switched capacitors and coupled inductors, a conventional interleaved boost converter obtains high step-up gain without operating at extreme duty ratio.The configuration of the proposed converter not only reduces the current stress but also constrains the input current ripple, which decreases the conduction losses and lengthens the lifetime of the input source. In addition, due to the lossless passive clamp performance, leakage energy is recycled to the output terminal. Hence, large voltage spikes across the main switches are alleviated, and the efficiency is improved.

Keywords:-Interleaved boost converter,Matlab/Simulink ,Solar panel rectifier,Voltage multiplier module

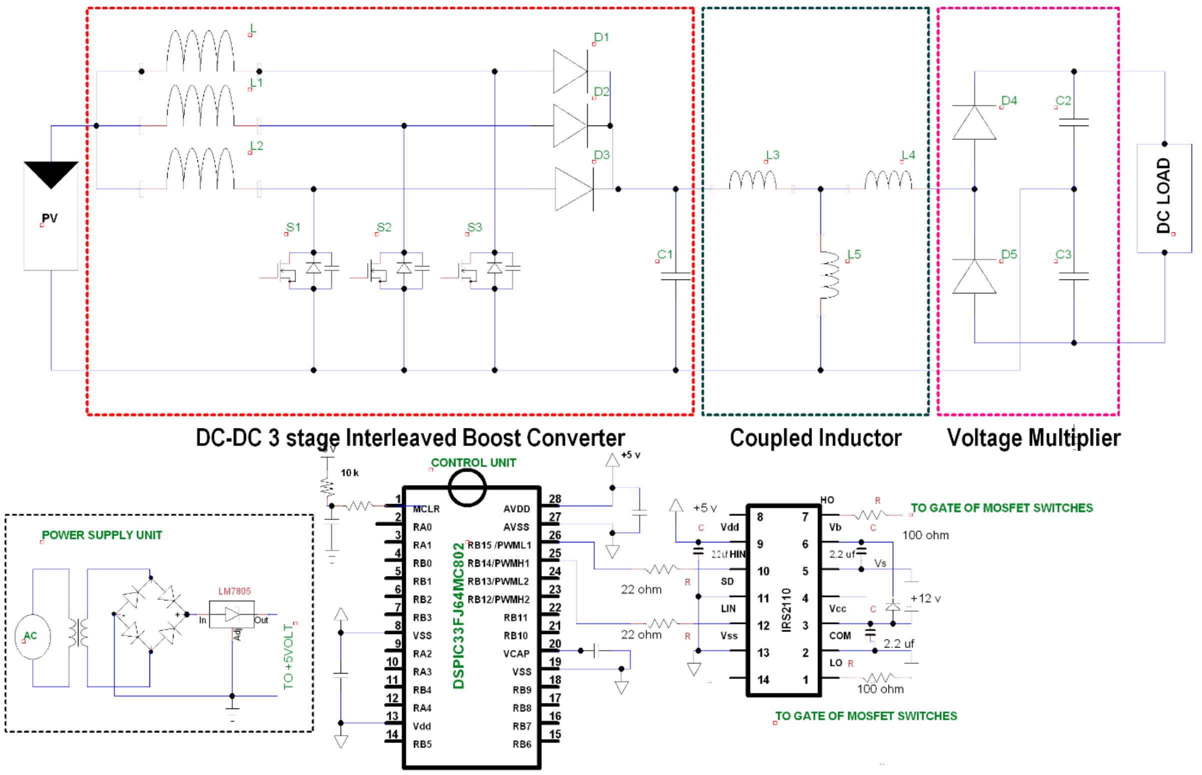


Fig.1.1

I. INTRODUCTION

Nowadays, renewable energy is increasingly valued and employed worldwide because of energy shortage and environmental contamination. Renewable energy systems generate low voltage output, and thus, high step-up dc/dc converters have been widely employed in many renewable energy applications such fuel cells, wind power generation, and photovoltaic (PV) systems. Such systems transform energy from renewable sources into electrical energy and convert low voltage into high voltage via a step-up converter.The high step-up conversion may require two-stage converters with cascade structure for enough step-up gain, which decreases the efficiency and increases the cost. Thus, a high step-up converter is seen as an important stage in the system because such a system requires a sufficiently high step-up conversion.

II. PROPOSED CONVERTER

The proposed converter is a conventional interleaved boost converter integrated with a voltage multiplier module, and the voltage multiplier module is composed of switched capacitors and coupled inductors. The coupled inductors can be designed to extend step-up gain, and the switched capacitors offer extra voltage conversion ratio. In addition, when one of the switches turns off, the energy stored in the magnetizing inductor will transfer via three respective paths; thus, the current distribution not only decreases the conduction losses by lower effective current but also makes currents through some diodes decrease to zero before they turn off, which alleviate diode reverse recovery losses.

The advantages of the proposed converter are as follows.
1) The proposed converter is characterized by low input current ripple and low conduction losses, which increases the lifetime of renewable energy sources and makes it suitable for high-power applications.
2) The converter achieves the high step-up gain that renewable energy systems require.
3) Due to the lossless passive clamp performance, leakage energy is recycled to the output terminal. Hence, large voltage spikes across the main switches are alleviated, and the efficiency is improved.
4) Low cost and high efficiency are achieved by employment of the low-voltage-rated power switch with low RDS (ON); also, the voltage stresses on main switches and diodes are substantially lower than output voltage.
5) The inherent configuration of the proposed converter makes some diodes decrease conduction losses and alleviate diode reverse recovery losses.

III. CIRCUIT DIAGRAM EXPLANATIONS

The proposed converter is a conventional interleaved boost converter integrated with a voltage multiplier module, and the voltage multiplier module is composed of switched capacitors and coupled inductors. The coupled inductors can be designed to extend step-up gain, and the switched capacitors offer extra voltage conversion ratio. In addition, when one of the switches turns off, the energy stored in the magnetizing inductor will transfer via three respective paths; thus, the current distribution not only decreases the conduction losses by lower effective current but also makes currents through some diodes decrease to zero before they turn off, which alleviate diode reverse recovery losses.

3.1. SOLAR PANEL:

A solarpanel is a packaged, connected assembly of solar cells, also known as photovoltaic cells. The solar panel can be used as a component of a larger photovoltaic system to generate and supply electricity in commercial and residential applications. Because a single solar panel can produce only a limited amount of power, many installations contain several panels. A photovoltaic system typically includes an array of solar panels, an inverter, and sometimes a battery and interconnection wiring.A solar panel or photovoltaic module, is composed of individual PV cells. This crystalline-silicon panel has an aluminium frame and glass on the front. Solar panels use light energy (photons) from the sun to generate electricity through the photovoltaic effect. The structural (load carrying) member of a module can either be the top layer or the back layer. The majority of modules use wafer-based crystalline silicon or thin film cells based on cadmium telluride or silicon. The conducting wires that take the current off the panels may contain silver, copper or other non-magnetic conductive .The cells must be connected electrically to one another and to the rest of the system. Cells must also be protected from mechanical damage and moisture. Most solar panels are rigid, but semi-flexible ones are available, based on thin-film cells. Electrical connections are made in series to achieve a desired output voltage and/or in parallel to provide a desired current capability.

3.2Interleaved Boost converter:

With the rapid evolving IT technologies, today, the power factor correction (PFC) design is facing many challenges, such as power scalability, high entire-load-range efficiency, and high power density. Power scalability is a very desirable and cost-effective approach in the PFC design in order to keep up with servers' growing power requirements. Higher power density can eventually reduce the converter cost and allows for accommodating more equipment in the existing infrastructures. Driven strongly by economic and environmental concerns, high entire-load-range efficiency is more and more required by various organizations and programs, such as the U.S. Energy Star, Climate Savers, and German Blue Angel. Today, the existing boost PFC is reaching its limitations to meet these challenges simultaneously. Using the cutting-edge semiconductor devices, further efficiency improvement at light load is still needed. There are limited approaches available for increasing the power density due to the large EMI filter and inductor size. Interleaved multi-channel boost PFC is a promising candidate to meet those challenges, but the interleaved boost converter is a less explored area. On the other hand, the multi-channel interleaved buck converter for the VR application has been intensively studied and thoroughly explored. One basic approach of this study is trying to extend the existing knowledge and techniques obtained from multiphase buck converters to the multichannel interleaved boost converters since there are similarities existed between the multiphase buck and the multi-channel boost converters. The existing studies about the interleaving impact on the EMI filter design are based on the time domain ripple cancellation effect. This approach is good enough for most of the filter designs. However, unlike the conventional filter designs, the EMI filter design is a specification related process.

3.2.1.Interleaving technique:

The concept of interleaving, or more generally that of increasing the effective pulse frequency of any periodic power source by synchronizing several smaller sources and operating them with relative phase shifts, is not new. Interleaving technique actually exists in different areas of modern technologies in different forms. Take a typical automobile engine as an example. In today's internal combustion engine, several cylinders are connected to a common crankshaft and that the power stroke portions of their cycles are non-simultaneous. By firing each cylinder in sequence, the effective pulse frequency of the engine is increased and the net torque ripple is reduced. Increasing the number of cylinders raises the pulse frequency and total output power of the engine without increasing the firing frequency of the individual cylinders. This could be considered as a very good example of interleaving technique being applied in the field of mechanical engineering.

In the field of power electronics, application of interleaving technique can be traced back to very early days, especially in high power applications. In high power applications, the voltage and current stress can easily go beyond the range that one power device can handle. Multiple power devices connected in parallel and/or series could be one solution. However, voltage sharing and/or current sharing are still the concerns. Instead of paralleling power devices, paralleling power converters is another solution which could be more beneficial. Furthermore, with the power converter paralleling architecture, interleaving technique comes naturally. Benefits like harmonic cancellation, better efficiency, better thermal performance, and high power density can be obtained. In earlier days, for high power applications, in order to meet certain system requirement, interleaving multi-channel converter could be a superior solution especially considering the available power devices with limited performance at that time. One of such example can be found in the application of Superconducting a Magnetic Energy Storage System (SMES). The current stress of such application is extremely high, yet certain system performance still need to be met. On the ac side, the total harmonic distortion (THD) in voltages and currents of the regulatory standards must be respected. A further constraint comes from the switching loss that is proportional to the valve switching frequency. The proposed solution in the referred paper consists of using multiple interleaved three-phase current-source converters. With this multi modular converter the current stress can be divided to a level that can be handled by gate turn-off thyristor (GTO), the static induction thyristor (SI), etc, and reduces the ohmic component of their conduction losses. The results shows interleaving technique was applied quite successful in this application. Such examples also can be found in many other applications, such as Static VAR Generator (SVG), high voltage direct current (HVDC) applications, etc.

Interleaving technique was also investigated in the early days for the smaller power spacecraft, satellite or avionic applications, and was introduced as unconventional SMPS power stage architecture. In such applications, one major concern is the input and output filters rely almost exclusively on tantalum capacitors due to the highest available energy-storage-to-volume ratio at that time. However, the ESR of this filter capacitor causes high level thermal stress from the high switching pulsed current. The input and output filter capacitance is usually determined by the required number of capacitors sufficient to handle the dissipation losses due to the ripple current. Interleaving multiple converters can significantly reduce the switching pulsed current go through the filter capacitor. By properly choosing the channel number with considering the duty cycle, the ripple current may be reduced to zero. Furthermore, interleaving increases the ripple Frequency to be n (n is the total channel number) times the individual switching frequency. The ESR of the tantalum capacitors is inversely proportional to the frequency.

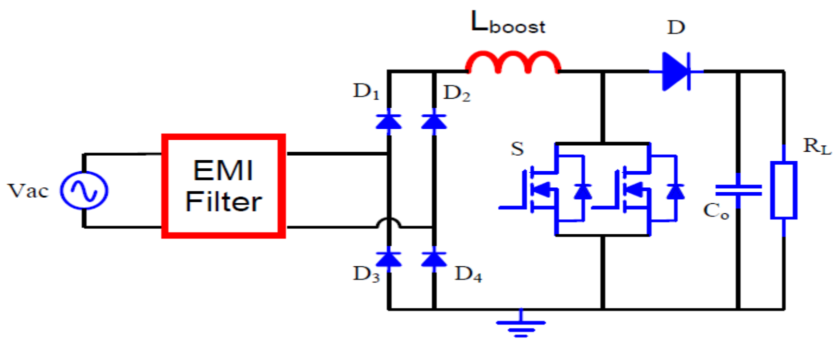


Fig: 3.1. Circuit diagram of IBC

IV. MICROPROCESSOR

This Versatile programmer is a dedicated PIC Micro controller Programmer. All the PIC series of IC's except the 17 series can be programmed with this Hardware through RS232 Port of PC. This programmer also supports ICSP programming for on board programming of supported flash PIC devices. MPLAB IDE, PIC CCS C compiler Demo software with MPLAB Plug-in, and programming instructions are provided in CD-ROM. The programmer software is compatible to Windows 98, Windows 2000, and Windows XP platforms. A Soft copy of the user manual is also included in the CD, in addition to the hard copy provided with the Kit. This Dedicated programmer is for programming a wide range of PIC Micro controllers including EEPROMS, PIC12 series, PIC16 series & PIC18 series of IC's.

4.1.SPECIFICATIONS

- Auto detection of programmer by software
- Regulated Power supply 5,13.5V
- Auto Flash upgrades through serial port
- 16 MHz crystal Oscillator
- Built in RS232 connector
- ZIF socket for easy programming
- External ICSP Interface for on board programming
- Programmable configuration and ID
- Selective Erase and programming for supported PIC Devices
- Manual / Auto Reset
- Configurable COM Port.
- Program, Read, Verify and Blank check Modes
- Hex Code Editor
- Program & Verify fly Window
- Switchable to MPLAB software
- Extensive Integrated Help
- Debug vector Read & write
- Oscal value read & program (for selected chips)

4.2. MPLAB

MPLAB Integrated Development Environment (IDE) is a free, integrated toolset for the development of embedded applications on Microchip's PIC and dsPIC microcontrollers.

HI-TECH Software is an Australian-based company that provides ANSI C compilers and development tools. Founded in 1984, the company is best known for its HI-TECH C PRO compilers with whole-program compilation technology, or Omniscient Code Generation (OCG). HI-TECH Software was bought by Microchip on 20 February 2009, whereupon it refocused its development effort exclusively on supporting Microchip products.

The HI-TECH C Compiler for PIC10/12/16 MCUs (Lite mode) is a freeware compiler. It supports all PIC10, PIC12 and PIC16 series devices. The features of HI-TECH C Compiler are listed as followings:

- Fully compatible with Microchip's MPLAB IDE
- Fully ANSI-compliant
- Includes Library source - for standard libraries and sample code for I/O drivers
- Includes macro assembler, linker, preprocessor, and one-step driver
- Runs on 32/64-bit Windows, Linux and Mac OS X

4.3. PROTEUS

This package splits into three parts very conveniently namely: -

ISIS : Intelligent Schematic Input System - for drawing circuit diagrams etc.
ARES : Advanced Routing and Editing Software - for producing pcb layout drawings.
LISA : Lab center Integrated Simulation Architecture - for simulation of circuit diagram. Separate handout.

4.3.1. PROTUES Virtual System Modelling (VSM)

PROTUES combines advanced schematic capture, mixed mode SPICE simulation, PCB layout and autorouting to make a complete electronic design system. The **PROTUES** product range also includes our revolutionary **VSM technology**, which allow you to simulate micro-controller based design, complete with all the surrounding electronic.

4.3.2.Intelligent Schematic Input System (ISIS)

ISIS lies right at the heart of the **PROTUES** system and is far more than just another schematic package. It has powerful environment to control most aspects of the drawing appearance. whether your requirement is the rapid entry of complex design for simulation & PCB layout, Or the creation of attractive Schematic for publication **ISIS** is the right tool for the job.

Product Features

1. Produces publication quality schematic style templates allow customization of supplied library
2. Mouse driven context sensitive user interface automatic wire routing and junction dot placement
3. Full support for buses including sub- circuit ports and bus pins large and growing component library of over 8000 parts

4.4 CONTROLLER UNIT:

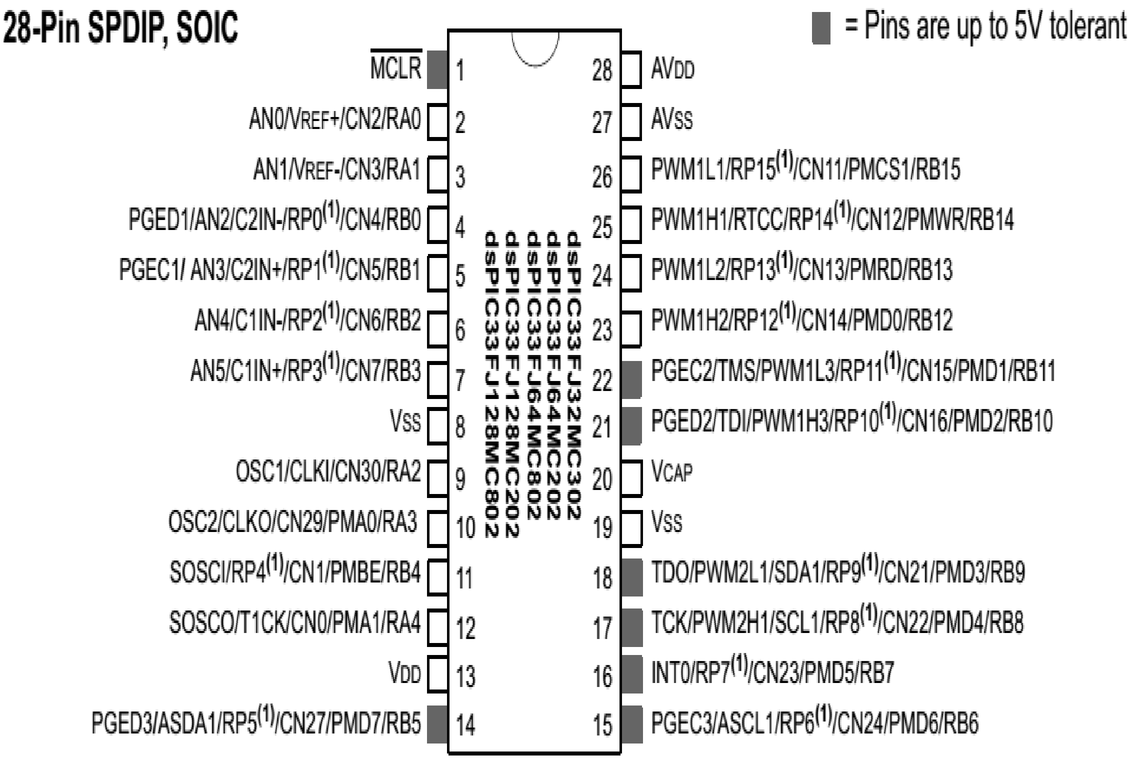
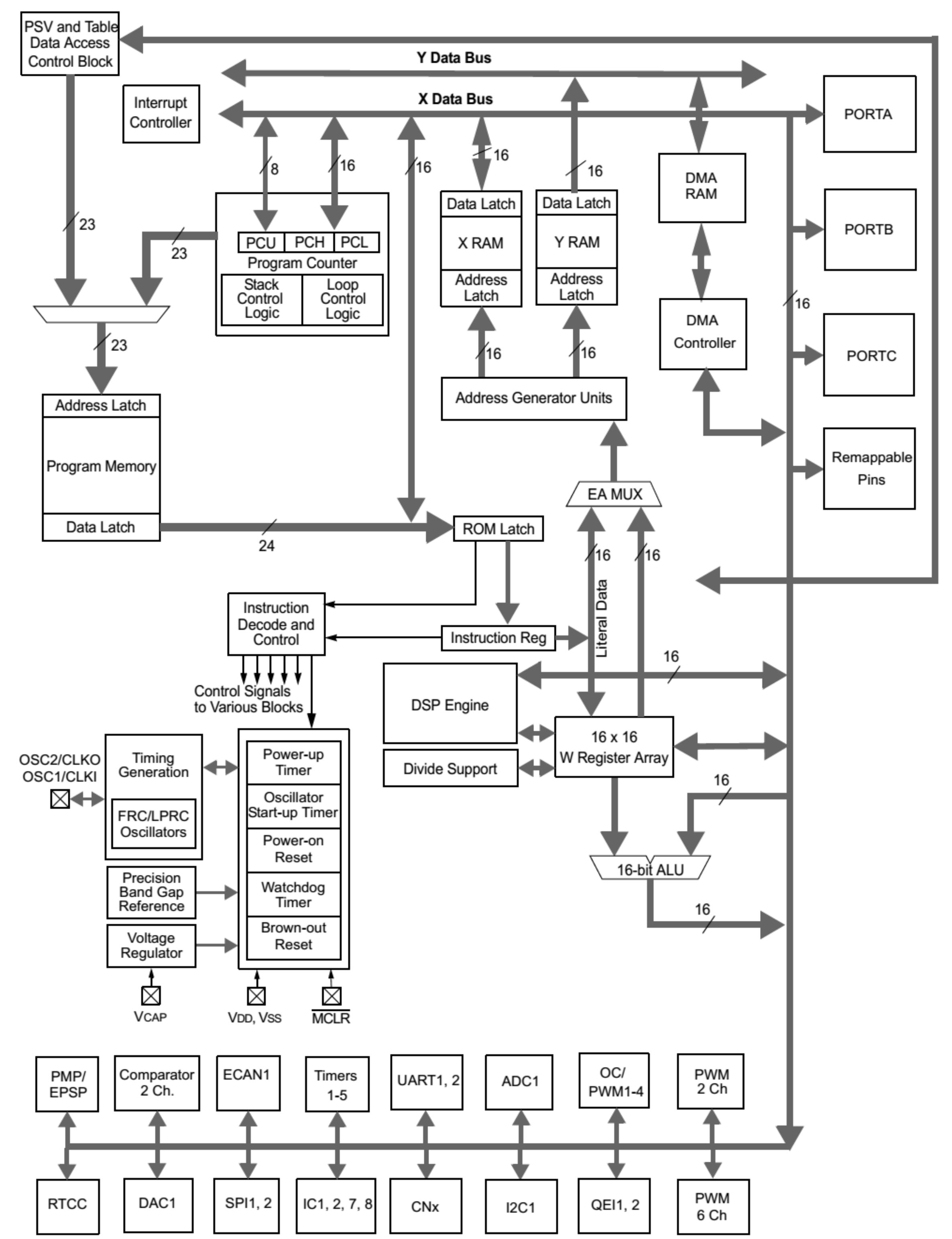


FIGURE 1-1: dsPIC33FJ32MC302/304, dsPIC33FJ64MCX02/X04 AND dsPIC33FJ128MCX02/X04 BLOCK DIAGRAM



Note: Not all pins or features are implemented on all device pinout configurations. See **"Pin Diagrams"** for the specific pins and features present on each device.

4.5.MOSFET:

A cross section through an n-MOSFET when the gate voltage VGS is below the threshold for making a conductive channel; there is little or no conduction between the terminals source and drain; the switch is off. When the gate is more positive, it attracts electrons, inducing an n-type conductive channel in the substrate below the oxide, which allows electrons to flow between the n-doped terminals; the switch is on.

The metal–oxide–semiconductor field-effect transistor (MOSFET, MOS-FET, or MOS FET) is a transistor used for amplifying or switching electronic signals. The basic principle of this kind of transistor was first patented by Julius Edgar Lilienfeld in 1925. Twenty five years later, when Bell Telephone attempted to patent the junction transistor, they found Lilienfeld already holding a patent which was worded in a way that would include all types of transistors. Bell Labs was able to work out an agreement with Lilienfeld, who was still alive at that time. (It is not known if they paid him money or not.) It was at that time the Bell Labs version was given the name bipolar junction transistor, or simply junction transistor, and Lilienfeld's design took the name field effect transistor.

In MOSFETs, a voltage on the oxide-insulated gate electrode can induce a conducting channel between the two other contacts called source and drain. The channel can be of n-type or p-type (see article on semiconductor devices), and is accordingly called an nMOSFET or a pMOSFET (also commonly nMOS, pMOS). It is by far the most common transistor in both digital and analog circuits, though the bipolar junction transistor was at one time much more common. The 'metal' in the name is now often a misnomer because the previously metal gate material is now often a layer of polysilicon (polycrystalline silicon). Aluminium had been the gate material until the mid 1970s, when polysilicon became dominant, due to its capability to form self-aligned gates. Metallic gates are regaining popularity, since it is difficult to increase the speed of operation of transistors without metal gates.

An insulated-gate field-effect transistor or IGFET is a related term almost synonymous with MOSFET. The term may be more inclusive, since many "MOSFETs" use a gate that is not metal, and a gate insulator that is not oxide. Another synonym is MISFET for metal–insulator–semiconductor FET. Usually the semiconductor of choice is silicon, but some chip manufacturers, most notably IBM and Intel, recently started using a chemical compound of silicon and germanium (SiGe) in MOSFET channels. Unfortunately, many semiconductors with better electrical properties than silicon, such as gallium arsenide, do not form good semiconductor-to-insulator interfaces, thus are not suitable for MOSFETs. Research continues on creating insulators with acceptable electrical characteristics on other semiconductor material.

In order to overcome the increase in power consumption due to gate current leakage, a high dielectric is used instead of silicon dioxide for the gate insulator, while polysilicon is replaced by metal gates. The gate is separated from the channel by a thin insulating layer, traditionally of silicon dioxide and later of silicon oxynitride. Some companies have started to introduce a high-κ dielectric + metal gate combination in the 45 nanometer node. When a voltage is applied between the gate and body terminals, the electric field generated penetrates through the oxide and creates an "inversion layer" or "channel" at the semiconductor-insulator interface. The inversion channel is of the same type, p-type or n-type, as the source and drain, thus it provides a channel through which current can pass. Varying the voltage between the gate and body modulates the conductivity of this layer and thereby controls the current flow between drain and source.

The Power MOSFET switch IRF840 is used. A Power MOSFET is a specific type of metal oxide semiconductor field-effect transistor (MOSFET) designed to handle significant power levels. Compared to the other power semiconductor devices (IGBT, Thyristor...), its main advantages are high commutation speed and good efficiency at low voltages. It shares with the IGBT an isolated gate that makes it easy to drive. It was made possible by the evolution of CMOS technology, developed for manufacturing Integrated circuits in the late 1970s. The power MOSFET shares its operating principle with its low-power counterpart, the lateral MOSFET. The power MOSFET is the most widely used low-voltage (i.e. less than 200 V) switch. It can be found in most power supplies, DC to DC converters, and low voltage motor controllers. Because of their unipolar nature, the power MOSFET can switch at very high speed. Indeed, there is no need to remove minority carriers as with bipolar devices. The only intrinsic limitation in commutation speed is due to the internal capacitances of the MOSFET (see figure 4). These capacitances must be charged or discharged when the transistor switches. This can be a relatively slow process because the current that flows through the gate capacitances is limited by the external driver circuit. This circuit will actually dictate the commutation speed of the transistor (assuming the power circuit has sufficiently low inductance).

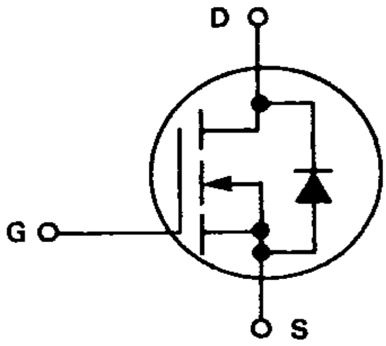


Fig 4.5.1. MOSFET

4.5.1ADVANTAGES

- Silicon gate for fast switching speeds.
- Low R_{ds}(on) to minimize On-losses, specified at elevated temperature.
- Rugged---SOA is power dissipation limited.
- Source to drain diode characterized for use with inductive loads.
- Dynamic dv/dt rating
- Repetitive avalanche rated
- Fast switching
- Ease of paralleling
- Simple drive requirements

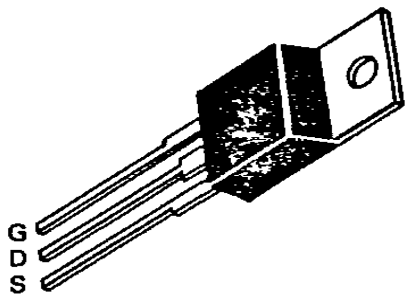


Fig.4.5.2. IRF840

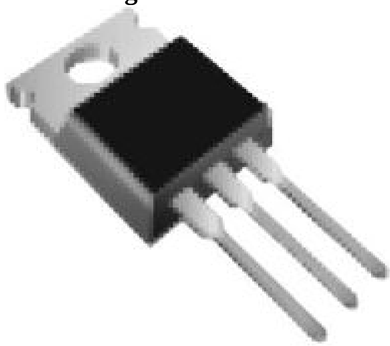


Fig.4.5.2. IRF840

PRODUCT SUMMARY		
V_{DS} (V)	500	
$R_{DS(on)}$ (Ω)	V_{GS} = 10 V	0.85
Q_g (Max.) (nC)	63	
Q_{gs} (nC)	9.3	
Q_{gd} (nC)	32	
Configuration	Single	

TABLE 4.5: PRODUCT SUMMARY OF MOSFET

Third generation Power MOSFETs from Vishay provide the designer with the best combination of fast switching, ruggedized device design, low on-resistance and cost-effectiveness. The TO-220AB package is universally preferred for all commercial-industrial applications at power dissipation levels to approximately 50 W. The low thermal resistance and low package cost of the TO-220AB contribute to its wide acceptance throughout the industry.

This N-Channel enhancement mode silicon gate power field effect transistor is an advanced power MOSFET designed, tested, and guaranteed to withstand a specified level of energy in the breakdown avalanche mode of operation. All of these power MOSFETs are designed for applications such as switching regulators, switching converters, motor drivers, relay drivers, and drivers for high power bipolar switching transistors requiring high speed and low gate drive power. These types can be operated directly from integrated circuits.

Features

- Ids= 8A; Vds=500V ;Rds(on)= 0.850Ω
- Single Pulse Avalanche Energy Rated
- SOA is Power Dissipation Limited
- Nanosecond Switching Speeds
- Linear Transfer Characteristics
- High Input Impedance

4.6 PHERIPHERAL INTERFACE

4.6.1 MOSFET GATE DRIVER

The High And Low Side Driver (IR2110) is a high voltage, high speed power MOSFET and IGBT driver with independent high and low side referenced output channels. Proprietary HVIC and latch immune CMOS technologies enable ruggedized monolithic construction. Logic inputs are compatible with standard CMOS or LSTTL outputs, down to 3.3V logic. The output drivers feature a high pulse current buffer stage designed for minimum driver cross conduction. Propagation delays are matched to simplify use in high frequency applications. The floating channel can be used to drive an N-channel power MOSFET or IGBT in the high side configuration which operates up to 600 volts.

The driver circuit is used to drive the bi-directional converter switches where in this project the converter acts as a shunt active filter (2-quadrant) for unity power factor operation and the dc voltage regulation. Here two BJT's (n-type and p-type) are used for amplification.

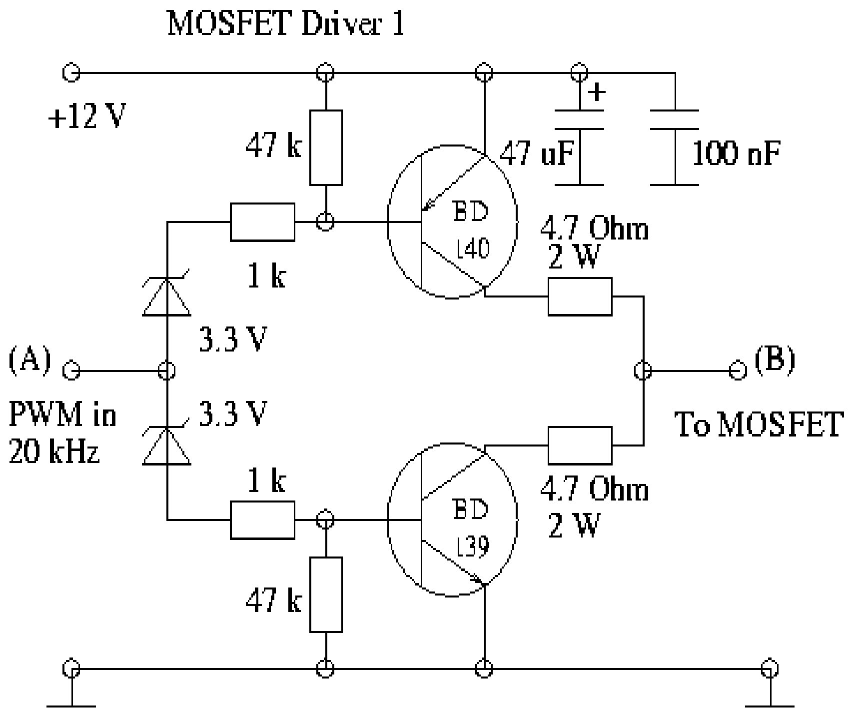


Fig.4.6.1DRIVER CKT IR2110

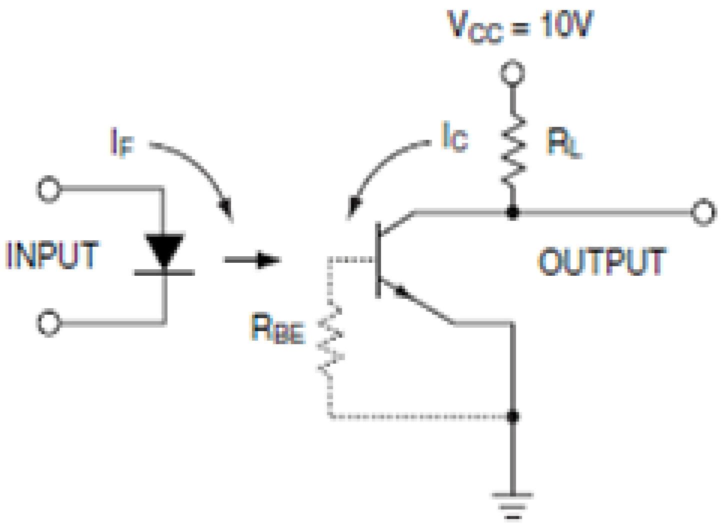


Fig.4.6.2 Operation of the MOSFET gate driver

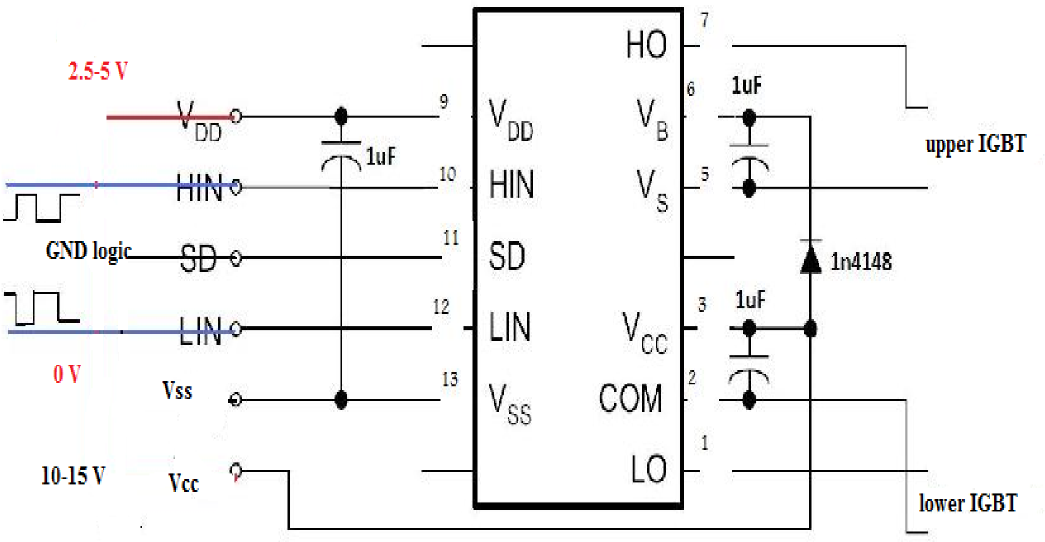


Fig.4.6.3. Driver Circuit operation

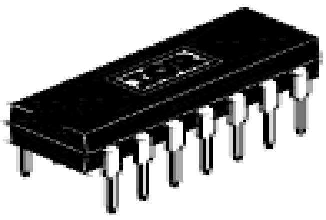


Fig.4.6. IR2110 Driver

4.7 POWER SUPPLY UNIT

Power Supply for PIC 16F877A Microcontroller

This section describes how to generate +5V DC power supply and +12V DC power supply.

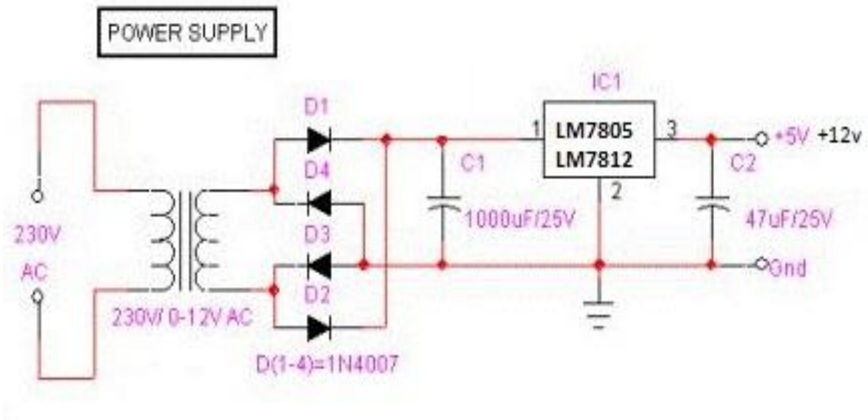


Fig4.7. Power Supply Unit

The power supply section is the important one. It should deliver constant output regulated power supply for successful working of the project. A 0-12V/1mA transformer is used for this purpose. The primary of this transformer is connected in to main supply through on/off switch& fuse for protecting from overload and short circuit protection. The secondary is connected to the diodes to convert 12V AC to 12V DC voltage. And filtered by the capacitors, which is further regulated to +5v, by using IC 7805 and +12v by using IC7812.

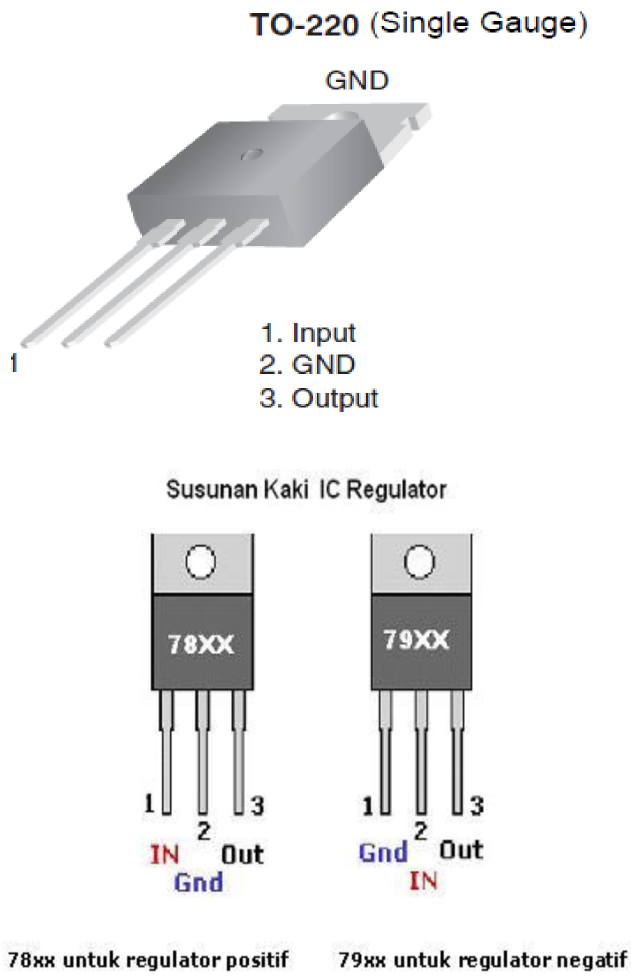


Fig: 4.7.1Regulator IC's

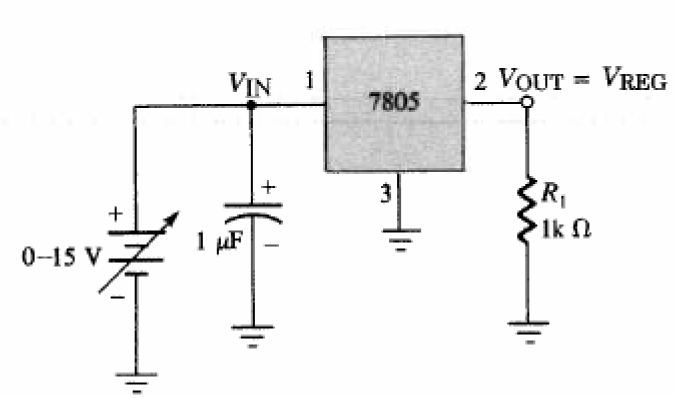


Fig.4.7.2. Regulators Unit

In electronics, a linear regulator is a component used to maintain a steady voltage. The resistance of the regulator varies in accordance with the load resulting in a constant output voltage. In contrast, the switching regulator is nothing more than just a simple switch. This switch goes on and off at a fixed rate usually between 50 kHz to 100 kHz as set by the circuit. The regulating device is made to act like a variable resistor, continuously adjusting a voltage divider network to maintain a constant output voltage. The primary advantage of a switching regulator over linear regulator is very high efficiency, a lot less heat and smaller size.

The transistor (or other device) is used as one half of a potential divider to establish the regulated output voltage. The output voltage is compared to a reference voltage to produce a control signal to the transistor which will drive its gate or base. With negative feedback and good choice of compensation, the output voltage is kept reasonably constant. Linear regulators are often inefficient: since the transistor is acting like a resistor, it will waste electrical energy by converting it to heat. In fact, the power loss due to heating in the transistor is the current times the voltage dropped across the transistor. The same function can often be performed much more efficiently by a switched-mode power supply, but a linear regulator may be preferred for light loads or where the desired output voltage approaches the source voltage. In these cases, the linear regulator may dissipate less power than a switcher. The linear regulator also has the advantage of not requiring magnetic devices (inductors or transformers) which can be relatively expensive or bulky, being often of simpler design, and being quieter. Linear regulators exist in two basic forms: series regulators and shunt regulators.

Series regulators are the more common form. The series regulator works by providing a path from the supply voltage to the load through a variable resistance (the main transistor is in the "top half" of the voltage divider). The power dissipated by the regulating device is equal to the power supply output current times the voltage drop in the regulating device.

The shunt regulator works by providing a path from the supply voltage to ground through a variable resistance (the main transistor is in the "bottom half" of the voltage divider). The current through the shunt regulator is diverted away from the load and flows uselessly to ground, making this form even less efficient than the series regulator. It is, however, simpler, sometimes consisting of just a voltage-reference diode, and is used in very low-powered circuits where the wasted current is too small to be of concern. This form is very common for voltage reference circuits.

All linear regulators require an input voltage at least some minimum amount higher than the desired output voltage. That minimum amount is called the dropout voltage. For example, a common regulator such as the 7805 has an output voltage of 5V, but can only maintain this if the input voltage remains above about 7V, before the output voltage begins sagging below the rated output. Its dropout voltage is therefore 7V - 5V = 2V. When the supply voltage is less than about 2V above the desired output voltage, as is the case in low-voltage microprocessor power supplies, so-called low dropout regulators (LDOs) must be used. When one wants an output voltage higher than the available input voltage, no linear regulator will work (not even an LDO). In this situation, a switching regulatorextension of the said two circuits. You will observe that you can infinitely multiply the input voltage by following the pattern of repeatedly adding a series-connected rectifier-capacitor combination. It's up to you to experiment on adding more diodes and capacitor to achieve the desiredoutputvoltage.

The above voltage quadrupler circuit uses minimum components to approximately multiply (quadrupler) the AC voltage (Vin) across the input terminals. The resulting output voltage is DC (Direct Current). Capacitors, C2 and C3, charges to double the value of Vin. The series combination of C2 and C3 produces a DC voltage equivalent to two batteries connected in series. The result is an output DC voltage that is four times the value of Vin. The voltage rating of the diodes and capacitors used should be within safe level, preferably, double the value of the input voltage. You may use capacitance values of 1000mF or higher. The higher the value of the capacitance, the smoother (non-fluctuating) the resulting output DC voltage.

IV. SIMULATION

MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. Typical uses include

- Math and computation.
- Algorithm development.
- Data acquisition.
- Modeling, simulation, and prototyping.
- Data analysis, exploration, and visualization.
- Scientific and engineering graphics.
- Application development, including graphical user interface building.

MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. This allows you to solve many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar non interactive language such as C or FORTRAN.

The name MATLAB stands for matrix laboratory. MATLAB was originally written to provide easy access to matrix software developed by the LINPACK and EISPACK projects. Today, MATLAB engines incorporate the LAPACK and BLAS libraries, embedding the state of the art in software for matrix computation

MATLAB has evolved over a period of years with input from many users. In university environments, it is the standard instructional tool for introductory and advanced courses in mathematics, engineering, and science. In industry, MATLAB is the tool of choice for high-productivity research, development, and analysis.

MATLAB features a family of add-on application-specific solutions called toolboxes .Very important to most users of MATLAB, toolboxes allow you to learn and apply specialized technology. Toolboxes are comprehensive collections of MATLAB functions (M-files) that extend the MATLAB environment to solve particular classes of problems. Areas in which toolboxes are available include signal processing, control Systems, neural networks, fuzzy logic, wavelets, simulation, and many others.

Output Voltage & Current

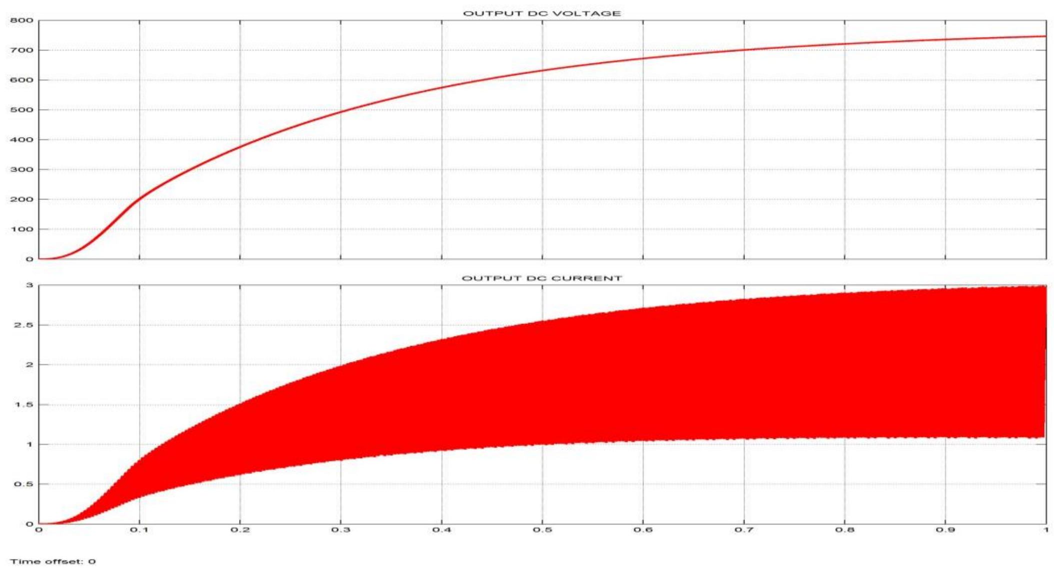


Fig: 4.1.Output and load voltage of matlab simulation

V. CONCLUSIONS

This paper has presented the theoretical analysis of steady state, related consideration, simulation results, and experimental results for the proposed converter. The proposed converter has successfully implemented an efficient high step-up conversion through the voltage multiplier module. The interleaved structure reduces the input current ripple and distributes the current through each component. In addition, the lossless passive clamp function recycles the leakage energy and constrains a large voltage spike across the power switch. Meanwhile, the voltage stress on the power switch is restricted and much lower than the output voltage (380 V). Furthermore, the full-load efficiency is 96.4% at Po = 1000 W, and the highest efficiency is 97.1% at Po = 400 W. Thus, the proposed converter is suitable for high-power or renewable energy applications that need high step-up conversion.

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