

THREE PHASE BUCK-BOOST DERIVED PFC CONVERTER FOR MORE ELECTRIC AIRCRAFT

Submitted in partial fulfillment of the requirements for the award of

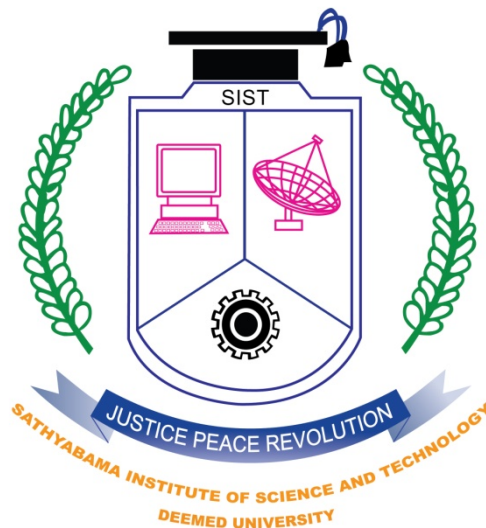
Bachelor of Engineering Degree in

Electrical and Electronics Engineering

by

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**DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
SCHOOL OF ELECTRICAL AND ELECTRONICS ENGINEERING**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

Accredited with Grade "A" by NAAC

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of
R. VELMURUGAN (Reg. No. 38140061) and **S. MUTHURAMAN** (Reg. No. 38140032) who carried out the project entitled "**THREE PHASE BUCK-BOOST DERIVED PFC CONVERTER FOR MORE ELECTRIC AIRCRAFT**" under our supervision from November 2021 to May 2022.

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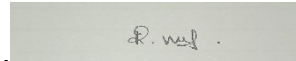
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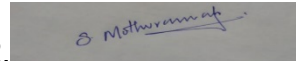
DECLARATION

We **VELMURUGAN.R**(Reg. No. 38140061) and **MUTHURAMAN.S**(Reg. No. 38140032) hereby declare that the Project Report entitled “**THREE PHASE BUCK-BOOST DERIVED PFC CONVERTER FOR MORE ELECTRIC AIRCRAFT**” done by us under the guidance **Dr. V. MEENAKSHI** is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Electrical and Electronics Engineering.

1.



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SIGNATURE OF THE CANDIDATES

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ABSTRACT

In more electric aircraft (MEA), three phase power factor correction (PFC) rectifiers of several kilowatts are required. In this paper, a three phase buck-boost derived PFC converter with three switches and with input inductors connected in delta configuration for use in MEA is presented. The proposed converter is operated in discontinuous conduction mode (DCM) to achieve PFC at ac input. This avoids the inner current control loop which further eliminates the current sensors. It requires only one output voltage sensor unlike five sensors in conventional PFC converter for its control implementation. This makes the system cost effective, more reliable and robust. A simple voltage control loop is used to generate the gate signals. The steady state operation of the converter and detailed design calculations are presented. For each power component, the analytical expressions for calculating the average and RMS current ratings are derived to facilitate the converter design. The small-signal model of the converter is presented to aid the controller design. The experimental results from a 2kW laboratory prototype are presented to confirm the operation of the proposed converter. An input power factor of 0.999, an input current total harmonic distortion of as low as 2.76% and a high conversion efficiency of 96% are achieved from the prototype.

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CHAPTER 1

INTRODUCTION

1.1 GENERAL INTRODUCTION

The main objectives of more electric aircraft (MEA) are to reduce aircraft idle weight, reduce engine emissions, reduce engine noise and reduce fuel consumption to make air travel more efficient and environmentally friendly. In MEA, hydraulic, mechanical and pneumatic subassemblies are replaced by electrical systems to accomplish these goals. In addition, a heavy mechanical gearbox called an integrated drive generator (IDG) was removed and the generator was connected directly to the main engine, resulting in frequencies varying from 400 to 800Hz. These variable frequency generating power electronic converters are used with a small number of components and sensors required to convert variable frequency AC into continuous DC with high power quality and reliability. In conventional commercial aircraft, passive diode-based auto transformer multi-pulse rectifiers are used for AC-DC conversion.

Such rectifiers are simple and reliable, but are heavy due to line frequency transformers and occupy a large space. Also, the output DC bus voltage depends on the load and the supply voltage. These shortcomings can be overcome by using an active energy conversion system. In 2012, a comparative evaluation was made between passive 12-pulse auto transformer rectifiers and active three-phase power factor correction (PFC) PWM converters. Active PFC converters are reported to show potential for future aircraft due to their high power density, excellent input power quality and tightly regulated DC bus voltage. Several three-phase PFC rectifier topologies have been reported in the literature to improve power quality, and their comprehensive review is provided. Popular topologies for AC-DC conversion are: buck, boost, buck-boost type rectifiers, with high power rating at input and output [10]. In MEA, boost or buck boost type rectifiers are suitable choices for AC-DC conversion because the DC connection voltage is higher than the peak input AC voltage. A simple voltage control ring is used to generate the gate signal. Detailed design calculations of standard position function and converter are provided. For each power component, the analytical

expressions for calculating the mean and rms current ratings are obtained to facilitate the converter design. A short-signal model of the converter is provided to facilitate the controller design. Test results of the 2kW laboratory prototype are provided to confirm the operation of the proposed converter. An input power factor of 0.999, a total harmonic deviation of 2.76% less input current and 96% higher switching efficiency is achieved from the prototype.

1.2 AIM OF THE PROJECT

Three-phase power factor correctors of several kilowatts are essential for high power aircraft to achieve optimal energy conversion efficiency. To reduce switching loss, perception and control requirements, a three-phase buck boost derived pfc converter is provided with inductors integrated into the delta configuration. The proposed configuration requires only three switches and only one output voltage sensor instead of one output voltage sensor five. The output voltage of conventional pfc converters is controlled by a simple voltage control loop.

The generated prototype achieves high efficiency with 2.76% of the total harmonic deviation of the low input current and 96%. The output filter should be sufficient to keep the output voltage constant. The purpose of the project is therefore to minimize the transition and sensitivity components from the existing system

1.3 LITERATURE SURVEY

P. R. K Chetty, et. al.,(2012) proposes a Current injected equivalent circuit approach to modeling of switching DC-DC Converters in Discontinuous Inductor Conduction Mode, IEEE transaction on industrial electronics have proposed a new current injected equivalent circuit approach (CIECA) to modeling switching dc-dc converter power stages is developed, which starts with current injected approach, and results in a set of equations which describe completely input and output properties and an equivalent linear circuit model valid at small signal low frequency levels

G. Sivanagaraju. et. al., (2018) proposes a Discontinuous conduction mode three phase buck-boost derived PFC converter for more electric aircraft with reduced switching, sensing and control requirements, IEEE applied electronics conference and exposition. In more electric aircraft (MEA), three phase power factor correction (PFC) rectifiers of several kilowatts are required. In this paper, a three phase buck-boost derived PFC converter with inductors connected in delta configuration for aircraft application is presented. The proposed converter is operated in discontinuous conduction mode (DCM) to achieve PFC at ac input. This avoids the inner current control loop which further eliminates the current sensors. It requires only one output voltage sensor unlike five sensors in conventional PFC converter and uses a simple voltage control loop to regulate the output voltage. This makes the system cost effective, more reliable and robust. The steady state operation, design calculations and simulation results are presented. The experimental results from a 2kW laboratory prototype are also presented to confirm the operation of the proposed converter.

S. Gangavarapu and A. K. Rathore, et. al., (2017) proposes a Analysis and design of three phase single stage isolated Cuk based PFC converter,IEEE Industry application society annual meeting.In this paper, analysis and design of a three phase isolated Cuk based power factor corrected converter is presented. The proposed converter uses the voltage follower approach i.e it is operated in Discontinuous Conduction Mode (DCM). This avoids the inner current control loop which further eliminates the sensing of current. This makes the system more reliable and robust. The proposed control uses only one voltage loop for output voltage regulation and all the power switches are driven by the same gate signal. The operation, design calculations and simulation results from PSIM are presented to confirm the operation of the proposed converter.

G. Tibola and Barbi, et. al., (2013) proposes a Isolated Three-Phase High Power Factor Rectifier Based on the SEPIC Converter Operating in Discontinuous Conduction Mode, IEEE trnsactions on power electronics. This paper presents the analysis and design of a three-phase high power factor rectifier, based on the dc-dc single-ended primary-inductance converter (SEPIC) operating in discontinuous conduction mode, with output voltage regulation and high frequency isolation. The input high power factor is naturally attained through the operational mode without the use of current sensors and a current control loop. To validate the theoretical analysis, a design example and experimental results for a 4-kW, 380-V line-to-line input voltage, 400-V output voltage, 0.998 power factor, 40-kHz switching frequency, and 4% input current total harmonic distortion laboratory prototype are presented, considering two distinct modulators. In addition, experimental results for the output voltage closed-loop control are presented.

B. Tamyurek and D. A. Torrey, et. al., (2015) proposes A high power-quality, three-phase utility interface, APEC seventeenth annual IEEE applied power electronics conference and exposition. This paper presents a new three-phase AC/DC power converter topology that provides a high-power-factor interface to the utility. The circuit topology of the converter is based on the discontinuous mode flyback converter. The objective of this work is to develop the technology for the proposed converter to meet the high-power factor requirements and to serve the demand for an advanced high-power, inexpensive, efficient and small size AC/DC rectifier in the telecommunications market. A laboratory proof-of-concept converter intended for 12.5 kW output was built to investigate the performance of the proposed converter in a practical application. The experimental results verify that the proposed converter achieves a near-unity power factor at the input and a constant voltage at the load side of the interface. However, the efficiency of the converter measured lower than expected. Further study revealed that the low efficiency is due to the adverse effects of the parasitic inductances on the energy transfer to the output. The effects of the parasitics on the converter efficiency are analytically investigated and new optimum design rules are developed, and the results of the analysis are graphically displayed to point to a practically viable and an efficient design of the proposed converter.

CHAPTER 2

PROJECT DESCRIPTION

2.1 CONCEPT EXPLANATION

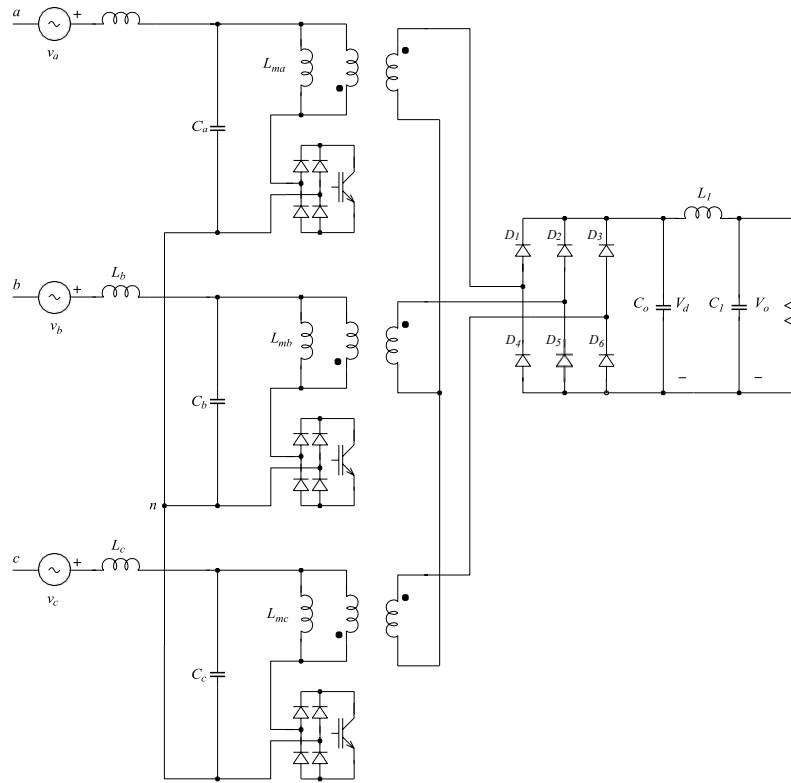


Fig 2.1 Existing circuit diagram

Existing converter, converter inputs can be connected directly to a three-phase □ or Y connected utility through a low pass LC filter placed at each stage. An LC filter is used to remove the high frequency components of the input current. Since the voltages used primarily for flyback transformers are AC waveforms, devices that can be controlled in series with primers must support both polarity of voltage and current. Thus, the switches are placed on the full-wave diode bridge to create a bipolar switch. In this case an IGBT is used as a control device. Since the currents transferred to the secondary also vary with the sinusoid, a three-phase full-wave rectifier bridge is required at the output of the converter.

CHAPTER 3

PROPOSED SYSTEM

3.1 PROPOSED CIRCUIT

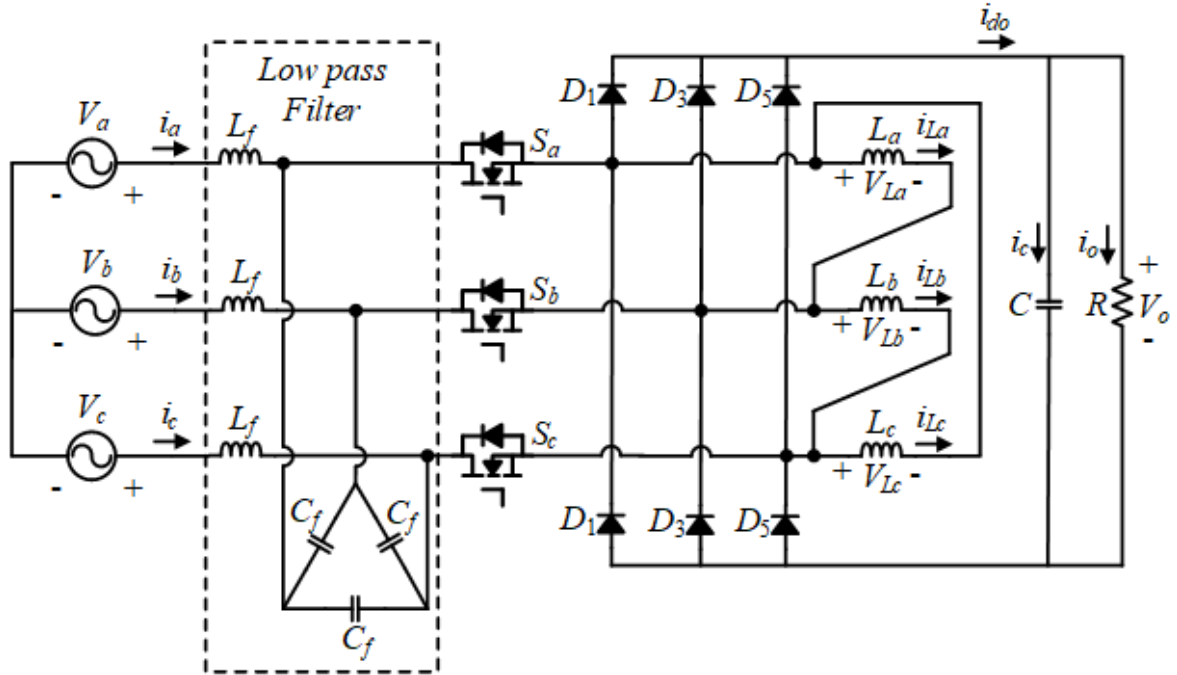


Fig 3.1 Proposed circuit diagram

The proposed converter is operated in discontinuous conduction mode to achieve PFC at ac input. single phase buck boost AC to DC converter with inductor on AC side for energy transfer, where a four quadrant switch is used for switching. The proposed converter . is derived by combining the three single phase structure into a three phase three wire system, where a three phase bridge rectifier is used in place of three single phase bridge rectifiers. For a balanced three phase system, the four quadrant switches are no more required and just three switches are sufficient when they are operated synchronously. The input inductors are connected in delta configuration, as it results in 20% less the peak inductor current when compared to the wye configuration. The LC filter placed at input side filters out the high frequency switching components of line currents and presents only the fundamental average component of line currents at mains supply, which are sinusoidal and in phase with the phase voltage

3.2 MODES OF OPERATION

Mode 1:

This mode starts when all the three power switches are turned on. Prior to this mode, the input inductors are in a fully demagnetized state. Hence, the switches turn on with zero current. The equivalent circuit of the converter in this mode is shown. In this mode, the input inductors store the energy according to the line voltages appearing across the inductors, while the output capacitor supplies the load.

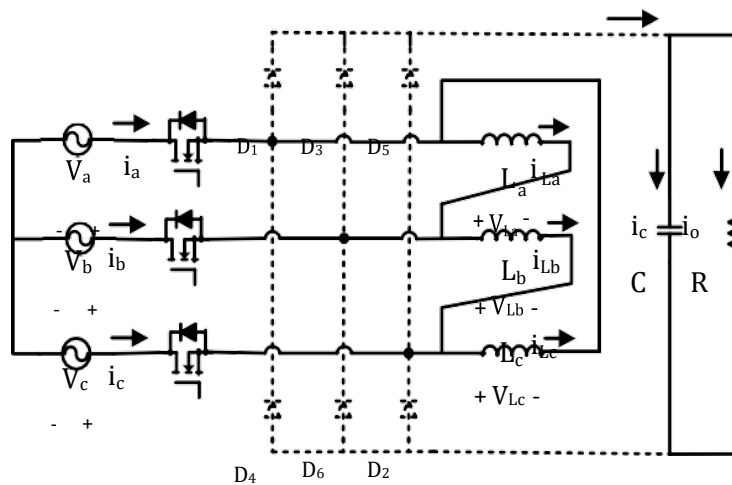


Fig 3.2 Mode 1 diagram

Mode 2:

This mode starts when the gating signal for the switches are withdrawn. The equivalent circuit of the converter of this mode is shown. In this mode, the inductors, start to reset by giving the stored energy to the load through diodes D2, D3, D4 at a rate of V_0/L and the inductor L_c retains its peak current value. This mode ends when the inductor L_a current ' i_{La} ' equals to the inductor L_c peak current.

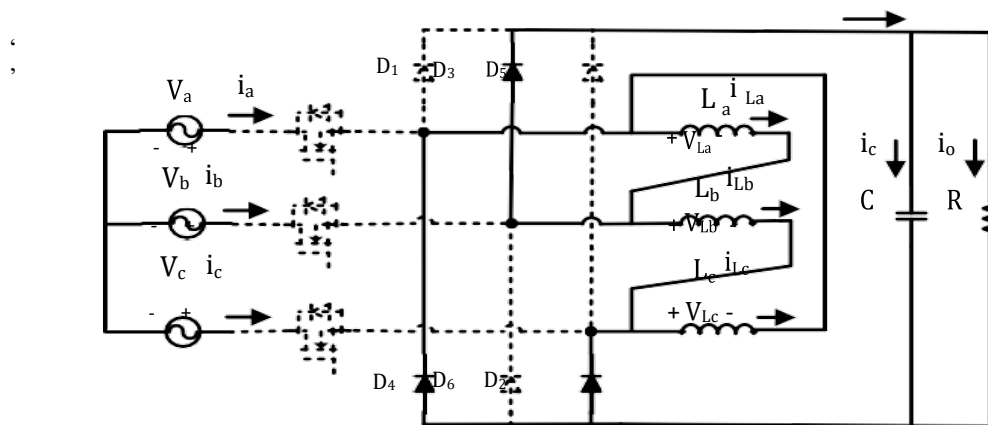


Fig 3.3 Mode 2 diagram

Mode 3:

The equivalent circuit of the converter in this mode is shown. In this mode, all three inductors, start to reset by giving the stored energy to the load through diodes D2, D3 at a rate of $V_0/2L$, V_0/L , $V_0/2L$ respectively. This mode ends when all the inductors currents reach zero as shown

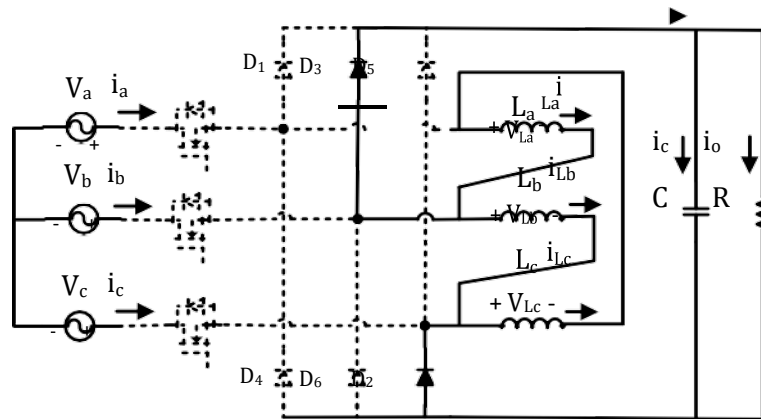


Fig 3.4 Mode 3 diagram

Mode 4:

The equivalent circuit of the converter in this mode is shown in fig 3.6. In this mode all input inductors are fully demagnetized condition and all the switches and diodes are in off state. The output filter capacitors supply the load. This mode is continuous till the next switching period start.

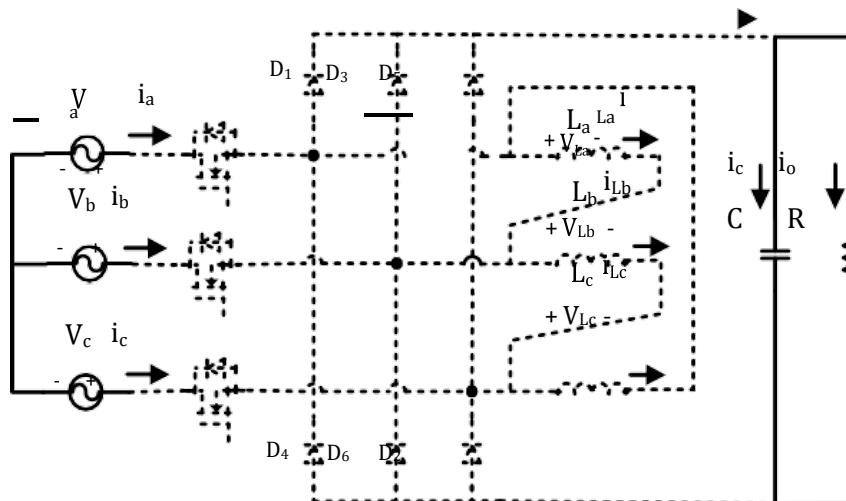


Fig 3.5 Mode 4 diagram

3.3 DIFFERENCE BETWEEN EXISTING AND PROPOSED SYSTEM

s.no	Existing system	Proposed system
1.	Boost operation is low so the boost value is low compare to proposed system	Boost operation is high so the boost value is high
2.	Here have isolation drop, and need more filter components	Here no isolation drop and no need more filter components
3.	Here we get Little harmonic dc output	Here we get high and stable output
4.	More Switches are needed to get the output	Switching loss is low compare to the existing system

CHAPTER 4

HARDWARE AND SOFTWARE DESCRIPTION

4.1 THREE PHASE BUCK-BOOST DERIVED PFC CONVERTER

The proposed converter to achieve PFC at the AC input is operated in a continuous transmission mode. This bypasses the internal current control loop, which further removes the current sensors. Unlike the five sensors in a conventional PFC converter, only one output voltage sensor is required for its control operation.

The conversion of electrical power from AC to DC is widely achieved by using different power converters while maintaining sinusoidal input currents in the uniform power factor. Many applications use the boost converter due to its simple design and switching control and the ability to generate a range of dc output voltages larger than the output voltage of a standard bridge rectifier, which is desirable in more applications. If only a low DC output voltage is required, a buck converter provides a higher power factor. This article outlines the new design of the three-phase buck-boost power converter. The function of the buck-boost converter has two distinct functions. First, the inductors are charged by switching the current through semiconductor switches. Second, usually through load filtration circuits, the stored energy is discharged to the load providing the power transmission. The output voltage varies by controlling the switching duty cycle of the semiconductor. Many existing three-phase buck-boost topologies require complex switching modes to provide a higher power factor, or modification of devices on both the power supply and the dc side of the inductors, requiring snaping and careful synchronization. The proposed topography requires only simple helicopter control so that all switches can be switched on at once. A new type of three-phase buck-boost power converter specifically designed as a prototype for a 20kW DC power supply, delivering 300-600V dc output. Voltage range from three phase power supply (415V).

4.2 THYRISTOR

Thyristors are a solid-state semiconductor device consisting of four layers of

alternating N and P-type materials. It operates exclusively as a two-position switch, which operates when the gate receives a current excitation, and operates continuously (forward-oriented) while the voltage across the device remains constant. Three-lead thyristors are designed to control the large current of its two leads, known as its control lead by connecting that current to the small current of its other lead. Conversely, two-lead thyristors are designed to switch if the potential difference between its leads is sufficient (breakdown voltage).

Some sources define silicon-controlled rectifier (SCR) and thyristor as similar. Other sources define thyristors as large devices with at least four layers of alternating N and P-type objects.

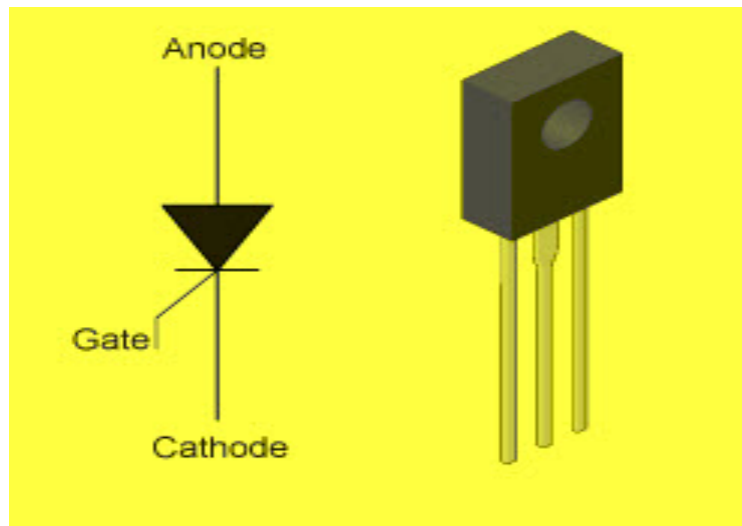


Fig 4.1 Thyristors Diagram

4.3 MOSFET

Metal-oxide-semiconductor field-effect transistor (MOSFET) is a type of transistor used to amplify or transmit electronic signals.

Although the MOSFET is a four-terminal device consisting of the source (S), gate (G), drain (D) and body (B) terminals, [1] the body (or substrate) of the MOSFET is often connected to the source. Terminal, which converts it into a three-terminal device like other field-effect transistors. Since these two terminals are usually connected to each other (short circuit) locally, only three terminals will appear on the electrical maps.

The main advantage of the MOSFET over a conventional transistor is that it requires a very low current (less than 1mA) to operate, while delivering more current to a load (10 to 50A or more).

In MOSFETs in upgrade mode, the voltage drop across the oxide triggers a conduction channel between the source and drain contacts via the field effect. "Upgrade mode" refers to the increase in conductivity with the increase of the oxide field, which add carriers to the channel, also referred to as the reverse layer. The electrons in the channel (called n-MOSFET or n-MOS) or holes (called p-MOSFET or p-MOS) may be opposite the substrate, so n-MOS is made with the p-type substrate. , And p-MOS with n-type substrate (see article on semiconductor devices). In the less common reduction mode MOSFET, then in detail, the channel has carriers in the surface impurity layer opposite to the substrate, and the conductivity decreases by applying a field that reduces the carriers from this surface layer.

The "metal" in the name of MOSFET is now often misnamed because the former metal gate material is now mostly a layer of polysilicon (polycrystalline silicon). Aluminum was the gate material until the mid-1970s, when polysilicon dominated, due to its ability to form self-aligning gates. Metal gates are becoming popular again because it is difficult to increase the speed of operation of transistors without metal gates. Similarly, the name "oxide" may be a misnomer because different conductive materials are used with the intention of obtaining stronger channels with smaller applied voltages. The insulated-gate field-effect transistor or IGFET is almost identical to the MOSFET. Many "MOSFETs" use a non-metallic gate and a non-oxide gate insulator, so the word may be more ambiguous. MISFET is another synonym for metal-insulator-semiconductor FET.

MOSFET was the most common transistor in digital and analog circuits, although bipolar junction transistor were once the most common.

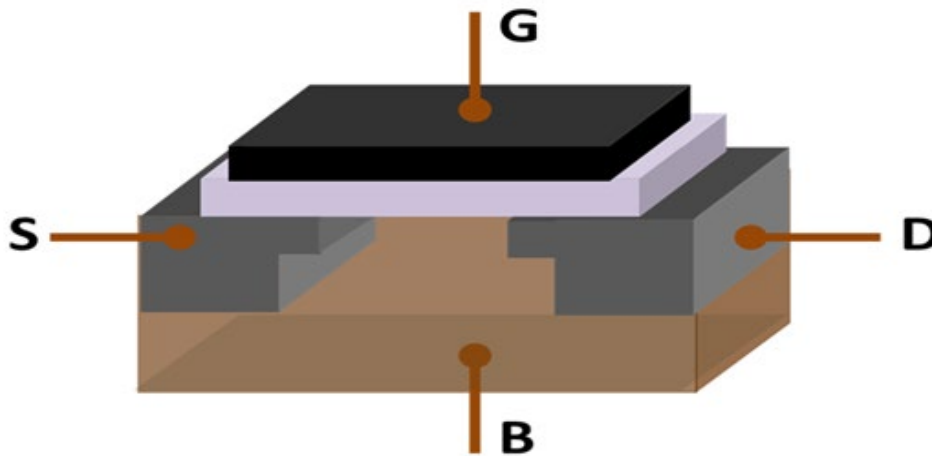


Fig 4.2 MOSFET Construction Diagram

4.3.1 OPERATION OF MOSFET

The traditional metal-oxide-semiconductor (MOS) structure is obtained by growing a layer of silicon dioxide (SiO_2) on top of a silicon substrate and then a layer of metal or polycrystalline silicon (the latter commonly used). Since silicon dioxide is a conductive material, its structure is similar to that of a planar capacitor, with one of the electrodes being replaced by a semiconductor. When voltage is applied to an MOS configuration, it modifies the distribution of charges across the semiconductor. Considering a p-type semiconductor (with density of loads, density of p holes; $p = N_A$ neutral sum), a positive voltage is created by forcing a positive charge from the gate to the body (see figure). The holes from the gate-insulator / semiconductor interface reveal the non-carrier portion of the immovable, negatively charged receptor ions (see doping (semiconductor)). If large enough, a high concentration of negative charge carriers is formed in an inverted layer located in a thin layer next to the interface between the semiconductor and the insulator. Unlike the MOSFET, the reverse layer electrons are delivered from the source or drain electrodes, while in the MOS capacitor they are produced very slowly by heat generation by the regenerative centers in the carrier formation and decay region. Normally, the gate voltage at which the density of the electrons in the reverse layer is equal to the density of the

holes in the body is called the threshold voltage. If the voltage between the transistor gate and the source exceeds the threshold voltage (V_{th}), it is called overdrive voltage.

This system with p-type body is the basis of n-type MOSFET, to which n-type source and drain parts must be added.

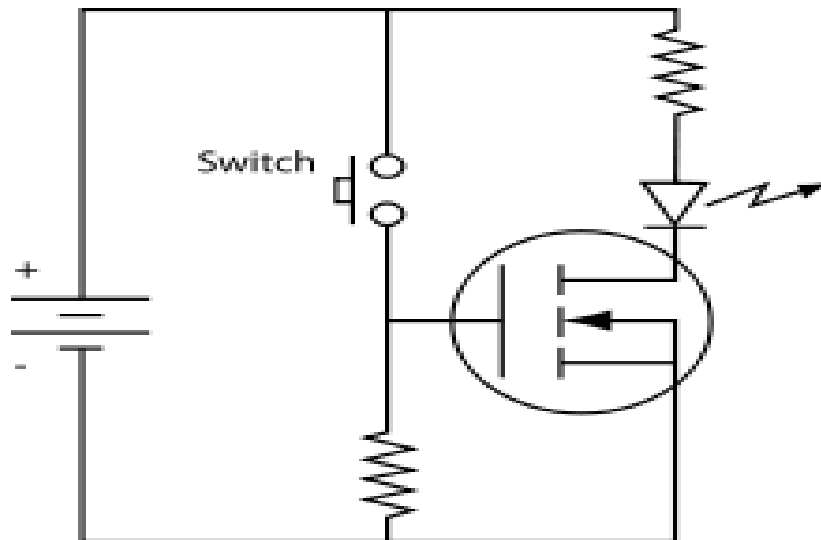


Fig 4.3 MOSFET Block Diagram

4.4 INDUCTOR

An inductor, also called as a coil or furnace, is a passive two-terminal electrical component that resists changes in the current passing through it. It consists of a conductor like a wire, usually wound on a coil. Energy is stored in the magnetic field in the coil until the current flows. When the current flowing through the inductor changes, according to Faraday's law of electromagnetic induction, a magnetic field that changes with time induces a voltage across the conductor. According to the law of the lens, the direction of the induced current (or "e.m.f.") will always resist the change of the current generated by it. As a result, the triggers always resist a change in current, as well as a change in the rotational speed of a flywheel. Care should be taken not to confuse this with the resistance provided by the resistor.

An induction is characterized by its induction, the ratio of the voltage to the rate of change of current, which contains the henries (H) units. Triggers typically have

values ranging from 10^{-6} H to 1 H. Many inductors have a magnetic core made of iron or ferrite inside the coil, which helps to increase the magnetic field and excitation. Inductors are one of three passive linear circuit elements that make up circuits, along with capacitors and resistors. Generators are widely used in alternating current (AC) electronics, especially in radio equipment. They are used to block the AC while allowing the DC to pass; Triggers designed for this purpose are called socks. They are also used in electronic filters to separate signals of different frequencies, and are used to create tuned circuits in conjunction with capacitors and to replace radio and TV receivers.

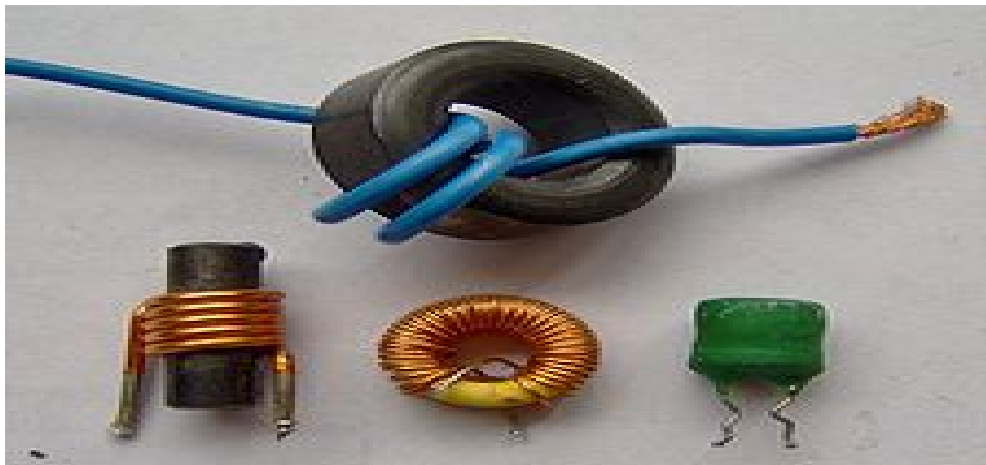


Fig 4.4 Inductor Diagram

4.5 CAPACITOR

A capacitor is a passive two-terminal component that is used to temporarily store electrical energy in an electric field. The shapes of practical capacitors vary widely, but most consist of at least two conductors (plates) separated by a conductor (i.e. an insulator that can save energy by being polarized). Conductors can be thin films, foils or metal or bent sintered beads of

conductive electrolyte. Increases the charging capacity of the non-conductive capacitor. Commonly used materials for dielectrics include glass, porcelain, plastic film, paper, mica and oxide layers. Capacitors are widely used as components of electrical circuits in many common electrical devices. Unlike a resistor, a good capacitor will not dissipate energy. Instead, a capacitor stores energy in the form of an electric field between its plates.

When there is a potential difference across the conductors (e.g., when the capacitor is connected across the capacitor), an electric field is generated across the conductor so that the positive current $+Q$ accumulates on one plate and the negative charge $-Q$ on the other. Plate. If the battery is connected to a capacitor long enough, no current can flow through the capacitor. However, if a time-varying voltage is applied to the leads of the capacitor, a displacement current may flow.

An ideal capacitor is characterized by a constant value and its capacitance. Capacitance is defined as the ratio of the electric charge Q in each conductor and the potential difference between them to V . The SI unit of capacitance is the Farad (F), which is equal to one volt per volt ($1 \text{ C} / \text{V}$). Typical capacitance values range from about 1 pF (10^{-12} F) to 1 mF (10^{-3} F).

The larger the area of the "plates" (conductors), the narrower the gap between them and the larger the capacity. In practice, the conductivity between the plates passes a small amount of leakage current and also has an electric field strength limit, which is called the breakdown voltage. Conductors and tracks introduce an undesirable induction and resistance.

Capacitors are widely used to block direct current in electrical circuits, while allowing alternating current to pass through. In analog filter networks, they soften the output of the power supply. In resonant circuits they convert radios to specific frequencies. In electrical energy transfer systems, they ensure voltage and current flow.

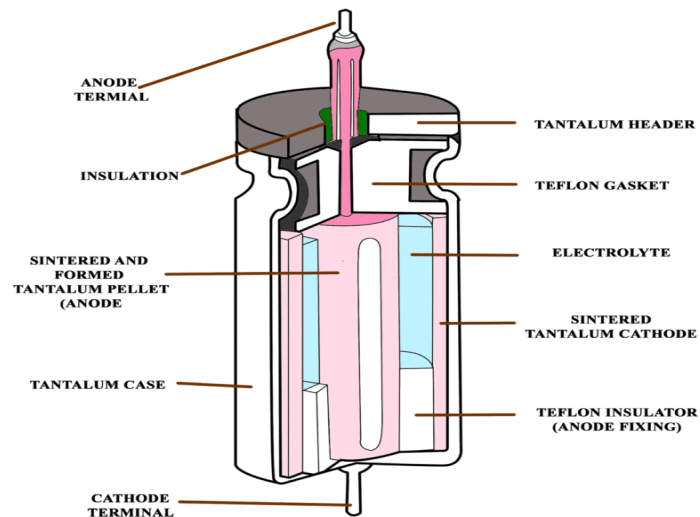


Fig 4.5 Capacitor Diagram

4.5.1 OPERATION OF CAPACITOR

A capacitor consist of two conductors separated by a non-conductive part. The non-conductive part may be a vacuum or an electrical insulator material called a conductor. Examples of conductive media are semiconductor reduction area similar to conductors in glass, air, paper and chemically. A capacitor is considered to be self-contained and isolated, without any impact from the net electric charge and external electric field. The conductor hold equal and opposite charges on their facing surfaces, and the conductor creates an electric field. In SI units, the capacitance of a Farat is equal to one volt across each conductor across a coulomb charging device.

An optical capacitor is characterized entirely by a constant capacitance C , defined as the ratio of the charge Q ratio of each conductor to the voltage between them.

$$C = Q / V$$

Because the conductors (or plates) are close together, the opposite charges on the conductors attract each other due to their electric fields.

This allows the capacitor to store more charge for a given voltage than the conductors are separated, which gives the capacitor a larger capacity. Early capacitors were called capacitors, which are still rarely used

Today, especially in high power applications such as automotive systems.

4.6 Transformer

A transformer is made up of twisted wires in a common hub that are connected in such a way that they can be induced into each other. This is significant when connecting to high voltage (mains) sources because the induction connection disconnects the mains from adjacent circuits, which is a much safer display than a direct connection. The galvanic isolation controls the maximum energy that can cause electric shock or harmful spark discharge to the energy stored in the magnetic field flux lines of the transformer. The energy storage capacity of the transformer (as a function of quantity and material) is important in converter design because it determines how successfully the transformer can deliver the energy required to maintain the correct voltage capacity under changing load conditions. The theory and operation of transformers can be seen in detail. Due to a magnetizing current inherent in the construction, a module transformer called 'Make amp reset' is attached to the magnetization. If this is not done, the resilient power level of the core material will complete it in a few cycles of PWM.

Although this extra round is more complicated to discuss in this course, it can be very confusing when looking at converter circuit maps, so it can be helpful to know why this is needed. When the power stage switch is turned off, a demagnetizing current is supplied to the pin diode by a separate auxiliary torque, which is the simplest method of demagnetization. The highest PWM duty cycle with this circuit is limited to 50%, although more complex approaches can be used to allow higher duty cycles.

Information signals are usually transmitted between the primary and secondary pages by transformers or other galvanic isolation methods (such as optocouplers). This is required to allow a control circuit on the main side to respond to the level of the secondary side load and to allow more complex control of the switching process, such as adjusting the current to achieve less noise and higher efficiency.

4.7 DRIVER CIRCUIT

From our Transformer tutorials, we know that they can provide not only step-down voltage, but also "electrical isolation" between high voltages on the main side and low voltages on the second side. In other words,

transformers use an electromagnetic connector to separate the primary input voltage from the secondary output voltage. However, by using the ubiquitous and valuable electronic components, the optocoupler, electrical isolation between the input source and the output load can be achieved using light. The optocoupler, also known as the opto-isolator or photo-coupler, is an electronic component that connects to two separate circuits using a light-sensitive optical interface.

- It acts just like a pulse generator.
- It consists of TLP250.
- TLP250 can with stand the voltage up to 500volts

The MOSFET requires 10-15v supply to operate

4.8 MICROCONTROLLER

4.8.1 DSPIC30F2010

dsPIC30F is an advanced 16-bit processor that provides precise DSP capabilities with the basic real-time control capabilities of the microcontroller. Comprehensive built-in devices, interference prioritization and power management features are integrated with the full-featured DSP engine. Features that make it a very efficient DSC include single-rotation 16×16 MAC, dual 40-bit accumulators, dual-avant-garde fixtures, 40-bit barrel shifter and zero-overhead looping.

dsPIC30F2010 devices have an extensive digital signal processor functionality within a high-performance 16-bit microcontroller configuration

28-Pin SDIP and SOIC

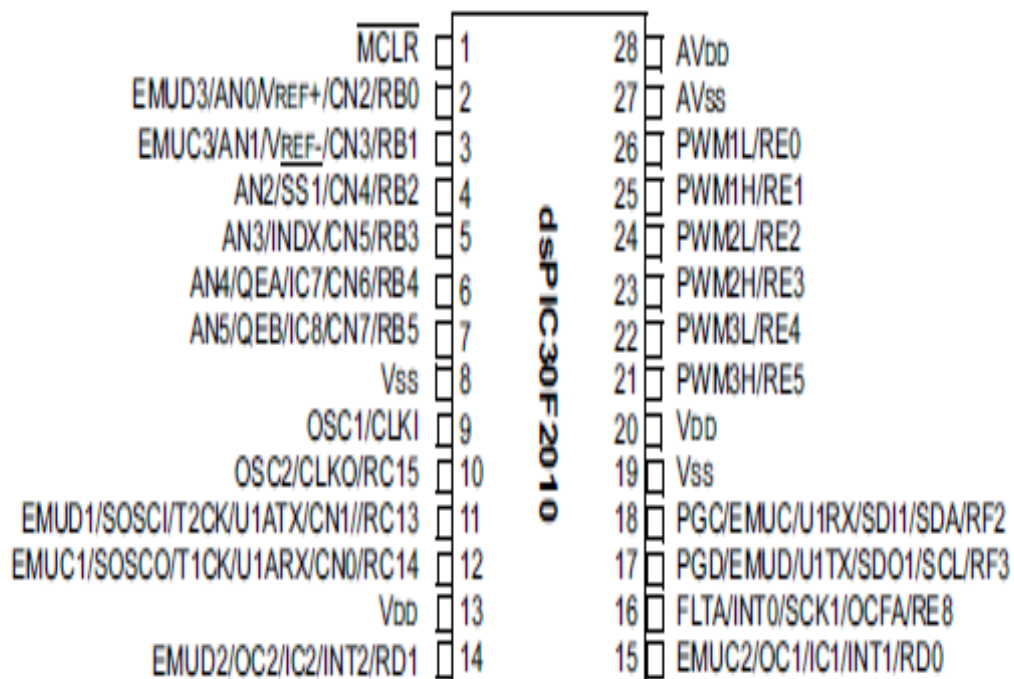


Fig 4.6 28-PIN SDIP AND SOIC

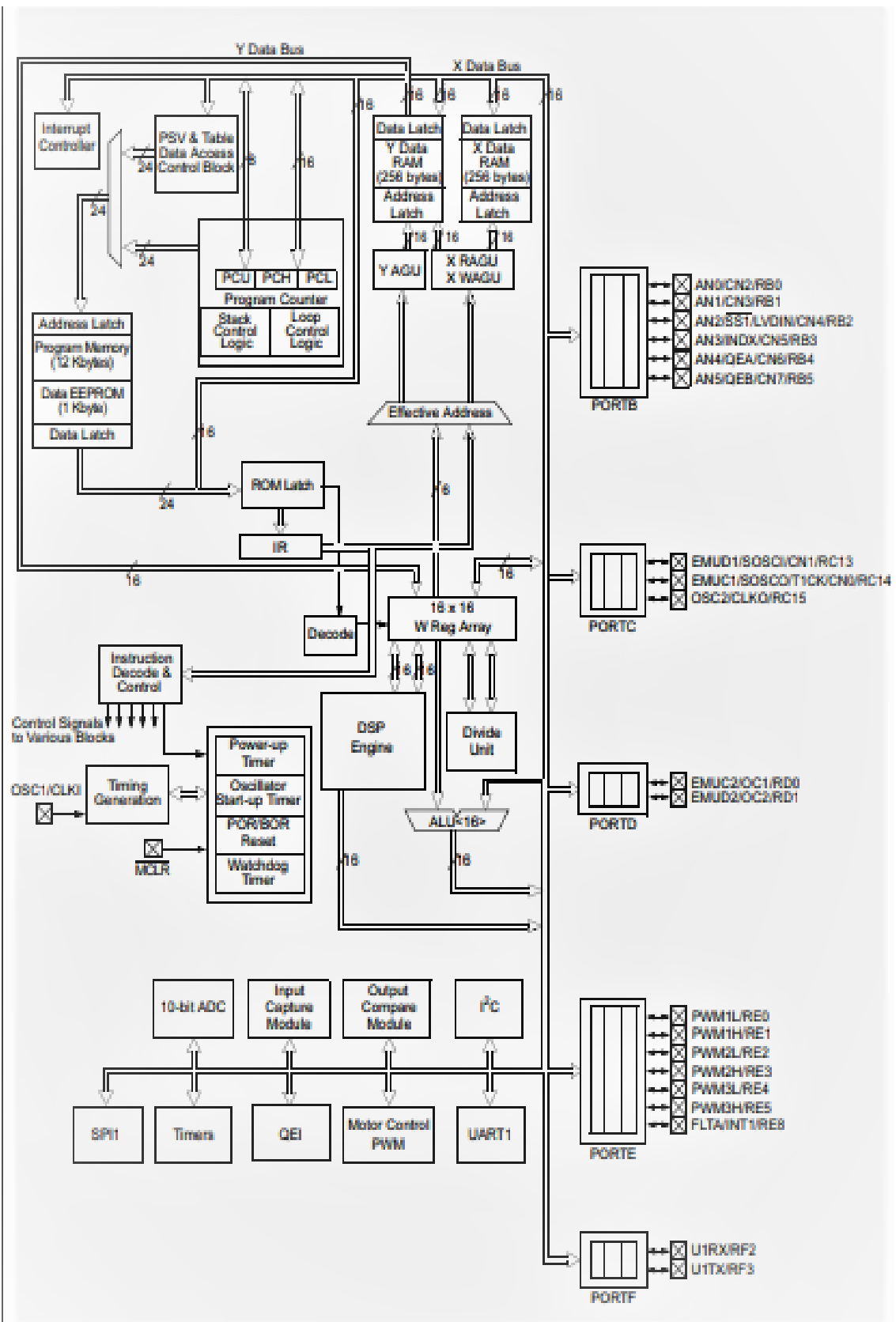


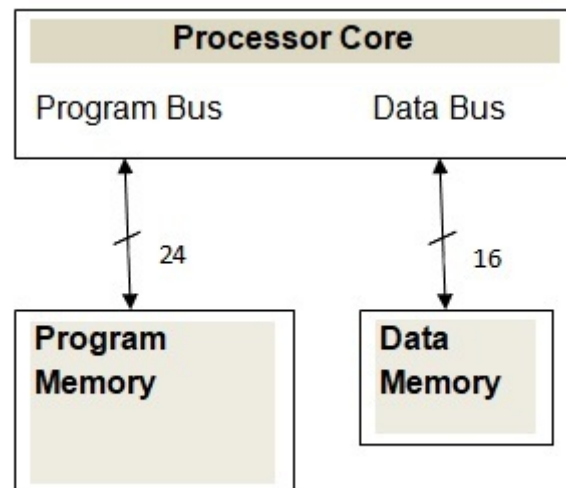
Fig 4.7 BLOCK DIAGRAM OF DSPIC30F2010 MICROCONTROLLER

4.8.2 Architecture of dspic microcontrollers

Harvard Architecture

The dsPIC processor (DSP) uses the Harvard architecture with individual program and data memory buses, as shown in Figure Data and Program Buses.

This is the capability of Harvard architecture that allows different amounts of data (16 bits) and instruction (24 bits) words. This modified design improves the performance of the instruction set. This also allows for faster processing as the dsPIC processor (DSP) can retrieve the next algorithm from the program memory while running the current instruction to access the data RAM.



ARCHITECTURE OF DSPIC 30F2010 MICROCONTROLLER

4.8.3 OVERVIEW OF CONTROLLER

- Operating Speed Max 20 MHz, Voltage-(2-5.5) v
- Memory:
- Flash Program 8Kx14 Words,
- RAM 368 Bytes,
- EEPROM Data Memory 256 Bytes

Low power, High speed Flash/EEPROM Technology

4.8.4 FEATURES OF MICROCONTROLLER

- It has 5 Ports for Internal and External usage
- It has on chip Timers. 3 Timers are avail
- It has in built Analog to Digital Converter
- In built Multiplexer availability for signal Selection
- It has serial as well as Parallel Communication facilities
- In built Capture, Compare and Pulse width modulation

4.9 MATLAB

Simulation has become a very powerful tool in industrial use

As well as in education, nowadays. It is now essential for an electrical engineer to understand the concept of simulation and to learn its application in a variety of applications. Simulation is one of the best ways to study without damaging the system or circuit behavior. Equipment for simulation in various fields are available in the market for engineering professionals. Many businesses spend a considerable amount of time and money on simulation before making their products. In most research and development (R&D) jobs, simulation plays a very important role. Without simulation, it is impossible to proceed further. It should be noted that in Power Electronics, computer simulation and proof of concept hardware prototype in the laboratory are mutually exclusive. However, computer simulation should not be considered as an alternative to the hardware prototype. The purpose of this chapter is to illustrate the simulation of a resistive source inverter with R, R-L and RLE loads using the MATLAB tool.

4.9.1 INTRODUCTION TO MATLAB

MATLAB is a high performance language for technical computing purpose. It

integrates computing, visualization and programming into an easy-to-use environment where problems and solutions are expressed in familiar mathematical code. Includes regular applications

1. Mathematics and Computation
2. Algorithm development
3. Data Acquisition
4. Modeling, simulation and emulation
5. Data analysis, analysis and visualization
6. Science and Engineering Graphics
7. Application development, including building a graphical user interface

MATLAB is an interactive system in which its basic data element dimension is an array that does not require it. It allows you to solve many technical computer problems in a fraction of the time it takes to write a program in non-scalar interactive language, such as C or FORTRAN, especially with matrix and vector formulations. The name MATLAB stands for Matrix Laboratory. MATLAB was originally written for easy access to matrix software developed by the LINPACK and EISPACK program. Today, MATLAB engines combine the LAPACK and BLAS libraries, embedding the latest in software for matrix computation. MATLAB has evolved over many years with the inclusion of multiple users. In university contexts, it is a standard instructional tool for introductory and advanced courses in mathematics, engineering and science. In industry, MATLAB is the choice tool for high productivity research, development and analysis. MATLAB has a family of additional application-specific solutions called toolboxes. Most importantly for most users of MATLAB, toolboxes allow you to learn and use specialized technology. Toolboxes are comprehensive sets of MATLAB functions (M-files) that extend the MATLAB environment to solve specific types of problems. Areas where toolboxes are available include signal processing, control systems, neural networks,

ambiguous logic, bandwidth, simulation, and more.

4.9.2 THE MATLAB SYSTEM.

The MATLAB system consists of five main components: the desktop tools and the development environment. Most of these tools are graphical user interfaces. This includes the MATLAB desktop and command window, a command history, an editor and debugger, a code analyzer and other reports and browsers for browsing the workstation, files and search path. The MATLAB language is a high-level matrix / sequence language with control flow reports, functions, data structures, input / output and object-oriented programming features. It allows you to quickly create both "small-scale programming" and dirty-throw programs, and "large-scale programming" to create large and complex application programs.

4.9.3 GRAPHICS

MATLAB has extensive capabilities for displaying vectors and metrics as maps and for annotating and printing these maps. It includes high-level functions for two-dimensional and three-dimensional data visualization, image processing and presentation graphics. This includes low-level functionality that allows you to fully customize the graphics look and create complete graphical user interfaces in your MATLAB applications. MATLAB External Interfaces or API This is a library that allows you to write C and Fortran programs that interact with MATLAB. These include MATLAB (Dynamic Linking), calling MATLAB as a computing machine, and the ability to read and write MAT-files.

4.9.4 MATLAB DOCUMENTATION

MATLAB provides comprehensive documentation in printed and online form to help you learn about and use all of its features. If you are a new user, get started with this Getting Started book. It covers all primary MATLAB features at the highest level, including many examples. MATLAB Online Assistance provides work-related and specific information about MATLAB features. MATLAB

documents are available in print and PDF format. MATLAB Online Help To view online documents, select MATLAB Help from the Help menu in MATLAB. MATLAB documents are organized under these key topics:

4.9.5 THE ROLE OF SIMULATION IN DESIGN

Electrical systems are a combination of electrical circuits and electro-mechanical devices such as motors and generators. Engineers working in this field are constantly improving the performance of systems. The requirements for drastically increased performance have forced electrical system designers to use traditional electronics and sophisticated control system concepts to tax traditional analysis tools and techniques. What further complicates the role of the analyst is the fact that the system is often not linear, and the only way to understand it is by simulation. Land-based power generation from hydropower, steam or other devices is not the only use of power systems. A common feature of these systems is the use of power electronics and control systems to achieve their performance objectives. Sim Power Systems is a state-of-the-art design tool that allows scientists and engineers to quickly and easily create models that simulate power systems. Sim Power

Systems uses the Simulink environment, which allows you to create a model using simple click and drag procedures. Not only can you quickly draw circuit topology, but your analysis of the circuit will include its interactions with the mechanical, thermal, control and other fields. This is possible because all the electrical components of the simulation interact with the extensive simulating modeling library. Since Simulink uses MATLAB as its computing machine, designers can also use MATLAB toolboxes and Simulink module packages. SIM Power Systems and SIM Mechanics share a specialized physics modeling module and connection line interface.

4.9.6 SIM POWER SYSTEMS LIBRARIES

You can get SIM power systems to work faster. Libraries contain models of conventional electrical devices such as transformers, lines, machines and power electronics. These models are proven to come from textbooks, and their validity is based on the experience of Hydro-Quebec's Power Systems testing and simulation laboratory in a large north.

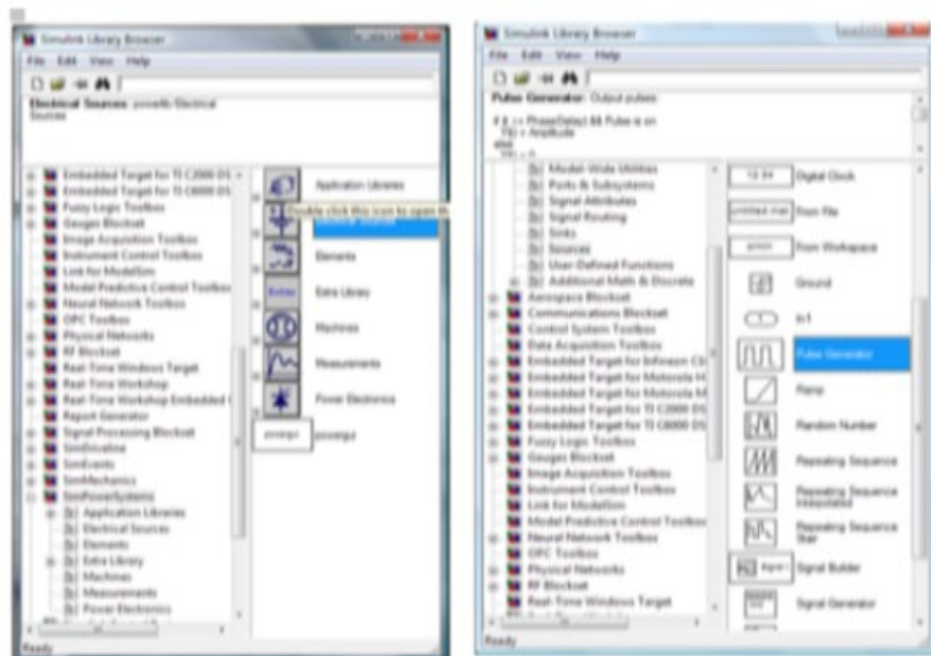


Fig 4.8 SIM POWER SYSTEMS LIBRARIES DIAGRAM

Fig 4.9 SIMULINK MODEL

4.9.7 MATLAB LIBRARY

The US application, located in Canada, also has experience at EcoLeve Technologies' Advanced and Laval University. The capabilities of SIM power systems for modeling a typical electrical system are described in the description files. There are also self-learning case studies for users who want to update their knowledge of Power System theory. SIM Power Systems Main Library, Power Lip, organizes its volumes into libraries according to their behavior. The Power Lip Library window module displays library icons and names. Open the library and double-click the library icon to access the modules. The main SIM Power Systems Power Library window also has a powerful module that opens a graphical user interface for static-level analysis of circuits.

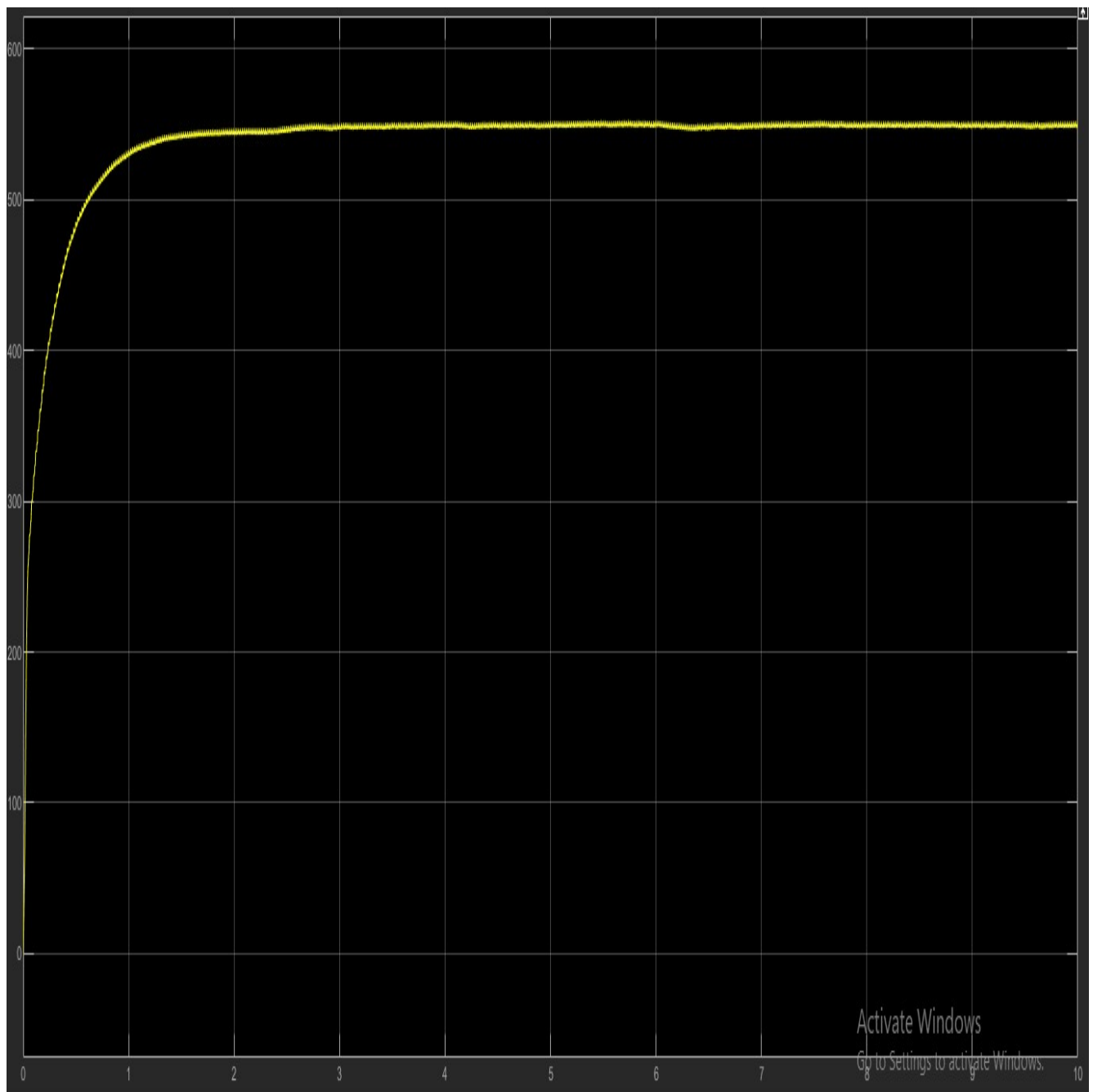


Fig 4.10 DC BOOST OUTPUT

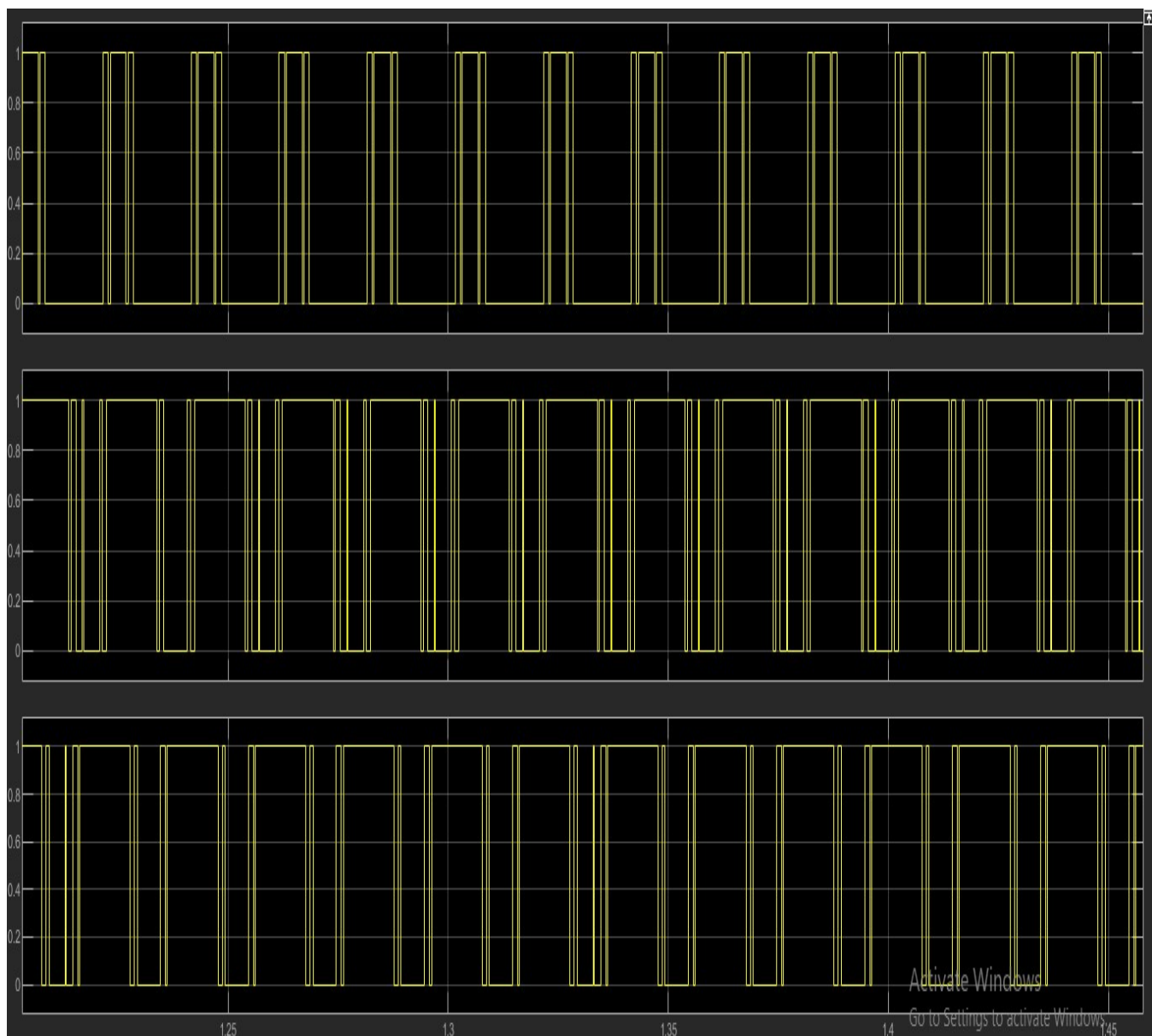
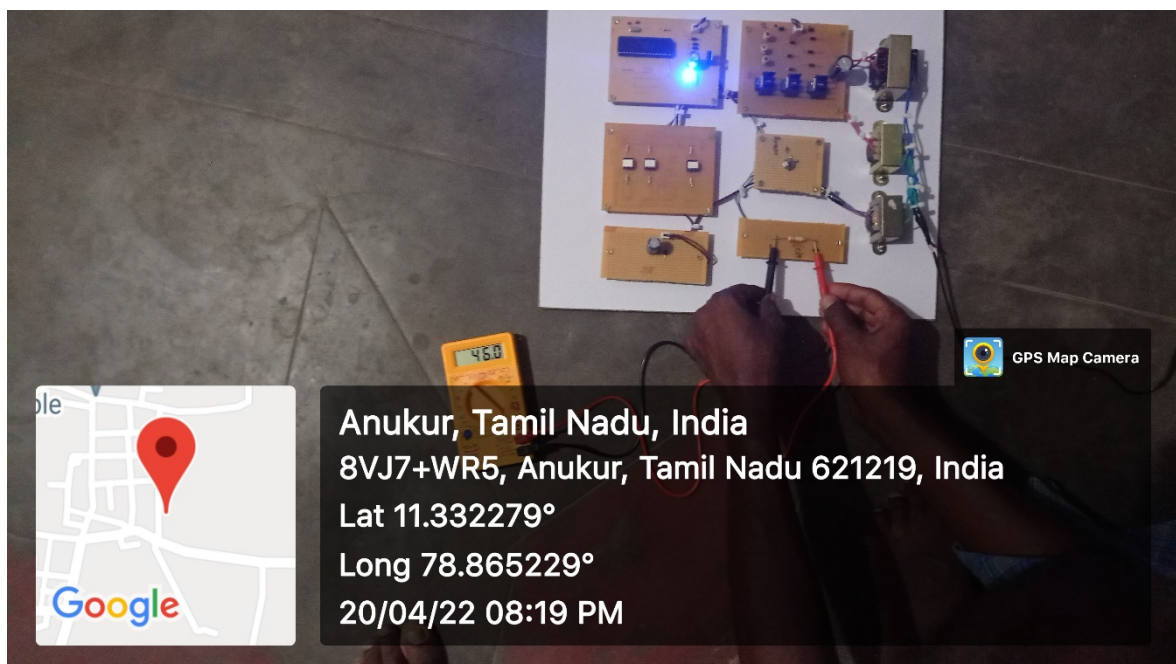
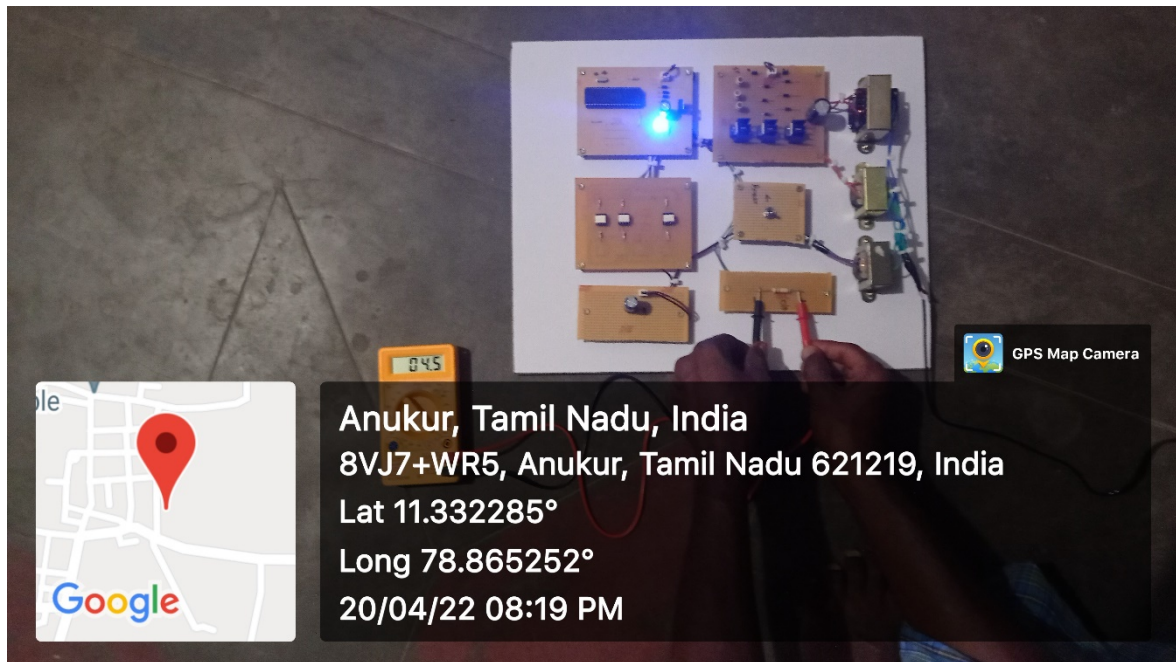


Fig 4.11 GATE PULSE

4.10 HARDWARE OUTPUT



CHATER 5

CONCLUSION & FUTURE SCOPE

5.1 conclusion

New three-phase buck-boost derived PFC converter connected to inductors. A delta configuration was proposed for greater electric aircraft use. The proposed converter uses only three power switches and all switches are operated. By the same gate signal. The AC input is converted to DCM to achieve PFC. Converter control is very simple and requires only one simple voltage control Ring to control the output voltage. Therefore, this requires only one output voltage sensor. Unlike the five sensors in a regular PFC converter, this increases the cost of the syste. Effective, more reliable and robust. Constant operation of the converter, Detailed design calculations are provided. Analytical expressions for each power component stresses are obtained to simplify Converter design. The small signal of the converter is obtained by using the sample. CIECA approach to assist controller design. Due to the DCM function, the converter. Requires high rated current switches. the advantages of the proposed converter. Less number of components and sensors and less control complexity. A 2 kW laboratory prototype is provided to confirm the proposed operation replace. The results demonstrate that the input currents are sinusoidal and converter. The power factor is almost identical. Converter input voltage is disturbed and subject. Load step change. In both cases, the output voltage monitors the reference voltage well. The solution will be available within 30 minutes. Shown to be the proposed converter. In the event of a phase open fault, it provides 50% of the rated power. From Developed prototype, input current THD 2.76% and high efficient 96% achieved

5.2 FUTURE SCOPE

Energy has always been a major global issue. The United States consumes about 106.96 quadrillion BTU of energy per year, of which about 30% is used for transportation purpose. The main objectives of high power aircraft (MEA) are to reduce aircraft empty weight, reduce engine emissions, reduce engine noise and reduce fuel consumption, making air travel more efficient and environmentally friendly.

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