

FAULT DETECTION AND RECTIFICATION OF INDUCTION MOTOR USING FUZZY LOGIC

Submitted in fulfilled of the requirement for the award of
Bachelor of Engineering Degree in
Electrical and Electrical Engineering

By

MOUNIKA V (Register No.37140703)

LAKSHMI R (Register No.37140070)



SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

Accredited with Grade "A" by NAAC

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI – 600 119

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the Bonafide work of **V MOUNIKA** (Register No.37140703) & **R LAKSHMI** (Register No. 37140070) who carried out the project entitled **"FAULT DETECTION AND RECTIFICATION OF INDUCTION MOTOR USING FUZZY LOGIC"** under our supervision from December 2020 to April 2021.

Mrs. A. SANTHI MARY ANTONY
Internal Guide

Dr. V. SIVACHIDAMBARANATHAN
Head of the Department

Submitted for Viva voce Examination held on_____

Name:

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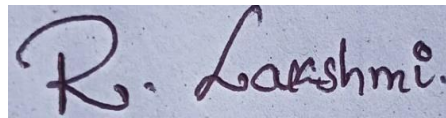
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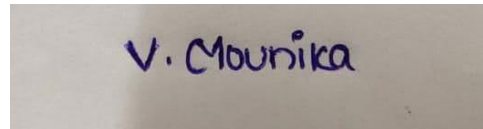
DECLARATION

We **V MOUNIKA** (Reg. No. 37140703) and **R LAKSHMI** (37140070) hereby declare that Project Report entitled “FAULT DETECTION AND RECTIFICATION OF INDUCTION MOTOR USING FUZZY LOGIC” done by us under the guidance of **Mrs. A. SANTHI MARY ANTONY** is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering Degree in Electrical and Electronics Engineering.

1.

Handwritten signature of R. Lakshmi in blue ink on a light blue background.

2.

Handwritten signature of V. Mounika in blue ink on a light beige background.

DATE: 13:04:2021

PLACE: CHENNAI

SIGNATURE OF THE CANDIDATES

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ABSTRACT

Faults in induction motor is a common problem which continues to grow in importance due to these induction motors are widely used in industries and have a great extent usage than any other motors nearly 80 percent of the total drives used. Thus, the need of protection to limit various faults is required. Due to continuous running nature of induction motor more advanced techniques are required to properly quantify their impact. This project proposes the utilization of fuzzy logic to analyze, compare & diagnose health condition of induction motor under various faults. Quasi-Z-source inverters (QZSI) are nowadays increasingly used owing to advantages like stage operation, lower component rating, and continuous input current, and common DC rail. These benefits lead to investigate this converter for induction motor connected applications. This project presents a induction motor connected quasi-Z-source inverter (QSZI) with both AC and DC side control. Fuzzy Mode Control (FMC) based controller for capacitor voltage regulation has been proposed to ensure a fast and dynamic response for wide variations in input voltage, output load, and reference-controlled quantity.

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CHAPTER 1

INTRODUCTION

1.1 GENERAL INFORMATION

Induction motor is that the single commonest mechanical device energy conversion device offered for varied industrial applications as a result of the explanation is that the wide selection of characteristics like hardiness, self beginning, high potency, low cost, responsibleness, speed management flexibility, etc. These area unit out there at totally different ratings; supported the load demand the motor is chosen. Running of a works within the safe and economical mode, electrical motors specially induction motors play important role. thence early detection of abnormalities within the motors can facilitate to avoid dear failures. whereas discussing the faults in induction motor, numerous parameters like voltage, current, temperature area unit thought of. If any fault occurs within the motor, then it's necessary to find and diagnose the fault with the assistance of one of the parameters from higher than. The planned work for project aims to find varied faults like underneath current, overload, single phasing, 2 section open by condition observance of induction motor taking current because the reference parameter mistreatment soft computing technique like mathematical logic by developing operating model of system.

1.2 PROBLEM DEFINITION

Our main objective is to develop the fault detection and rectification of Induction motor by mistreatment mathematical logic controller. within the existing system we tend to square measure mistreatment slippery mode management (SMC) that is incredibly tough and complexness. it's a 2-step method. We square measure finding the fault in induction motor that is running by AC offer therefore we'd like to convert the DC supply to AC a further demand of dc-dc convertor. Due to this the complexness of the system will be increase. Hence the price of this method are high. Coming to our projected system we have a tendency to area unit victimization mathematical logic within the model. it's one stage method we have a tendency to area unit giving AC offer on to the driving force circuit. we've got mathematical logic controller during this model by

victimization this we have a tendency to have gotten Associate in Nursing correct worth. and value is additionally less comparator the sloppy mode management

1.3 LITERATURE SURVEY

- [1] Mohammad Javad Morshed, “**Integral terminal sliding mode control to provide fault ride through capability to a grid connected wind turbine driven DFIG**”, in this paper, an integral terminal sliding mode controller is designed to control the Rotor Side Converter during deep voltage sags. In addition, to further improve the performance of the DFIG during voltage sags.
- [2] Hasan Koircugil, “**Rotating Sliding Line Based Sliding Mode Control for Single phase UPS Inverters**”, A new method to the Sliding mode control of single phase uninterruptible-power supply inverters is introduced. The main idea behind this new method is to utilize a time-varying slope in the sliding surface function.
- [3] En-chih-chang, “**Discrete- time fuzzy sliding mode control of a UPS inverter feeding nonlinear loads**”, This paper presents a discrete-time sliding mode controller based on fuzzy logic for high performance single-phase UPS inverters capable of maintaining low harmonic distortion in response to nonlinear loads.
- [4] AliMamizadeh, “**Designing of induction motor efficient monitoring system without using torque meter and speed sensor (2019)**”, To ensure an efficient operation of an electrical machine, its thermal aspects has to be dealt apart from the Electromagnetic parameters. The rise in temperature of an electrical machine depends mainly on the temperature rise in the motor winding. Here a new method is proposed for measuring and predicting the temperature rise in stator winding
- [5] E. Annie Elisabeth Jabaseeli, “**monitoring the thermal behaviour of induction motor using regression technique (2017)**”, the efficient and economical usage of energy sources is getting great importance. In a survey conducted among electric consuming machines, the electrical machines are consuming 40% of the total electrical energy consumed by electrical devices.

- [6] Kyusung Kim, **“Induction motor fault diagnosis based on neuropredictors and wavelet signal processing”**, early detection and diagnosis of incipient faults is desirable for online condition assessment, product quality assurance and improved operational efficiency of induction motor running off power supply mains. In this paper, a model based fault diagnosis system is developed for induction motors, using recurrent dynamic neural networks for transient response prediction and multi resolution signal processing for nonstationary signal feature extraction.
- [7] Sridhar S, **“Condition monitoring of induction motor using statistical processing(2013)”**, the parameter involved to bolster the monitoring is the stator current of Induction motor. The detection of the variations in the supply and the induction motor faults are processes using statistical methods.
- [8] Mohamed EiHachemi Benbpuzid, **“induction motor fault detection and Localization Using Stator Current Advances Signal Processing techniques”**, in this paper we present the comparison results of induction motor fault detection using stator current, vibration, and acoustic methods. A broken rotor bar fault and a combination of bearing faults were induced into variable speed three phase induction motors. Both healthy and faulty signatures were acquired under different speed and load conditions.

1.4 ADVANTAGES

1. They are cheaper to develop
2. They cover a wider range of operating conditions
3. It is in a simple language even normal people can also be understand
4. The system can be easy to construct
5. The fuzzy logic system is flexible

CHAPTER 2

PRINCIPLE AND OPERATION OF PROPOSED SYSTEM

2.1 CONCEPT OF EXISTING SYSTEM

In the existing system they were used sloppy mode management. sloppy mode management may be a nonlinear management technique that includes exceptional properties of accuracy, robustness, and simple standardization and implementation. SMS systems square measure designed to drive the system states onto a selected surface within the state house, named sloppy surface

2.1.1 SLIDING MODE CONTROL

Sliding mode management is explicit kind of variable structure management. the most benefits of sloppy management are strength, finite time convergence, and reduced-order remunerated dynamics. This style provides a scientific approach to the matter of maintaining stability and consistent performance.

2.1.1.1 METHODS OF SMC

There are four methods, they are

- I. Rotating surface method
- II. Mediating method
- III. Intelligent method
- IV. Moving method

1. Rotting surface method: An improved sloppy surface style methodology for higher controller performance is to deploy time variable linear sloppy surfaces rather than constant surfaces of classical strategies. The linear sloppy surface is often rapt by rotating in such a direction that the trailing behavior are often improved. Hence having the slippery part and sturdy behavior from early starting, the reaching part will be eliminated or reduced. The initial worth of the slippery surface ought to be designed such it includes

The existing diagram contains DC supply, LLC filter, H-Bridge electrical converter, slipper mode controller, driver circuit associate degree an induction motor. Here DC supply is connected to LLC filter then that LLC filter, slipper mode management connected to driver circuit and this driver circuit and LLC filter area unit connected to H-Bridge electrical converter and at last the H-Bridge electrical converter is connected to induction motor. Here we have a tendency to area unit exploitation DC provide as input voltage. we have a tendency to area unit detective work the fault within the induction motor, therefore we've got to convert that dc supply to AC supply therefore we'd like associate degree electrical converter.

2.2 CONCEPT OF PROPOSED SYSTEM

In the planned we tend to are victimization symbolic logic management. symbolic logic comes with mathematical ideas of pure mathematics and also the reasoning of that's quite straightforward. It provides an awfully economical answer to advanced downside altogether fields of life because it resembles human reasoning and deciding. The algorithms are delineated with very little information, therefore very little memory is needed.

2.2.1 FUZZY LOGIC CONTROL

The reason we tend to choose formal logic management is formal logic has quickly become one in all the foremost made of today's technologies for developing subtle management systems. the most reason to pick out this methodology is it's terribly easy. whereas alternative approaches need correct equations to planet behaviors coming back to fuzzy there's no would like of accuracy. it'll be planet human language and logic. Fuzzy logic may be a style of several valued logic within which truth values of variables is also any imaginary number between zero and one each comprehensive. during a slim sense, the term symbolic logic refers to a system of approximate reasoning, however its widest that means is sometimes known with a mathematical theory of categories with unclear. symbolic logic system works on the principle of distribution a specific output betting on the chance of the state of the input. Fuzzy logic is employed within the language and numerous intensive applications in computing. mathematical logic extensively utilized in fashionable system like skilled systems.

Fuzzy set

Fuzzy set is a pair of set and a membership function.

Types of fuzzy sets

Interval type -2 fuzzy sets

- fuzzy set operations: union, intersection and complement.
- Centroid
- Other uncertainty measures
- Similarity.

Types of fuzzy interface systems

1. Mandani-type(1977)
2. Sugeno-type(1985)

The difference between these two interface are the way we are determining the output are somewhat vary.

Fuzzy logic controller uses a really versatile set of if-then rules. the answer is then applied to applicable membership functions. And why we tend to victimization this formal logic controller is there square measure some things wherever actual mathematical formulation isn't obtainable if it's obtainable it'll be terribly tough. therefore, finding that worth isn't attainable at a time. In these things we will follow the fuzzy system to develop and to unravel this kind of issues.

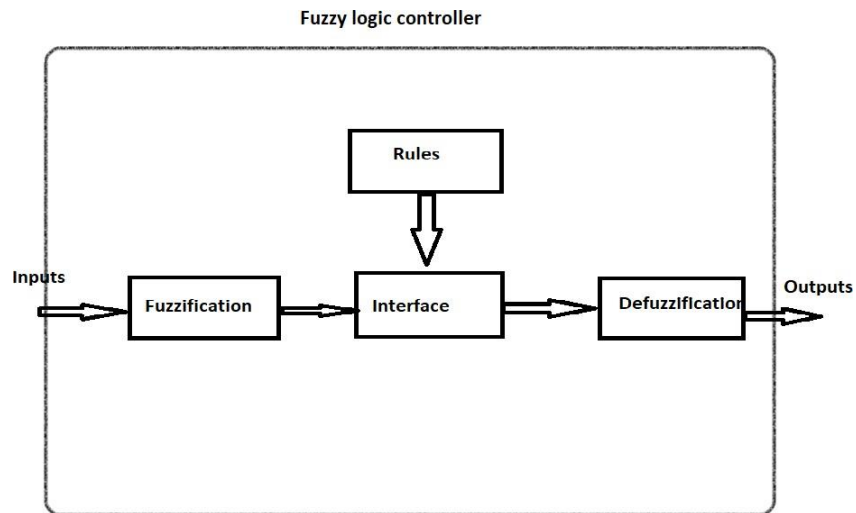


Fig.2.2. Block diagram of fuzzy logic controller

2.3 ARDUINO UNO

Arduino is associate degree ASCII text file physical computing platform supported a straightforward I/O board and a development atmosphere that implements the process language. Arduino uno could be a microcontroller board and all it's fourteen digital input and output pins, out of that half dozen will be used for PWM outputs, half dozen pins area unit analog inputs, a USB affiliation, an influence jack, sixteen-megahertz oscillator. These area unit the outline of Arduino that is employed within the planned system. Arduino is composed of two major parts there are:

2.3.1 The Arduino Hardware

Arduino is Associate in Nursing ASCII text file physical computing platform supported an easy I/O board and a development atmosphere that implements the process language. Arduino uno is also a microcontroller board and everyone it's fourteen digital input and output pins, out of that half-dozen is employed for PWM outputs, half-dozen pins square measure analog inputs, a USB association, an influence jack, sixteen-megahertz oscillator. These square measures the outline of arduino that's used the outline planned system. Arduino consists of 2 major parts there are:

2.3.2 The Arduino IDE

The Integrated Development surroundings (IDE) may be a special program running on pc| portable computer} the laptop that permits you to jot down sketches (a very little computer program) for the ARDUINO board in a simple language, the sketch tells the board what to try and do.



Fig 2.3 Photo copy of Arduino uno

2.3.3 The Arduino Specification

Table: 2.1. Technical specification

Microcontroller	ATMEGA328
Supply voltage	5V
Operating voltage	7 – 12V
Maximum supply voltage	20V
Digital I/O pins	14
Analog input pins	6
DC current for 3.3V Pin	50 mA
DC current per I/O pin	40 mA
Flash Memory	32 KB
SRAM	2KB
EEPROM	1KB
Clock Speed	16 MHz

- ❖ The biggest advantage of Arduino is its able to use structure. As Arduino comes during a complete package kind which incorporates the 5V

regulator, a burner, AN generator, a micro-controller, serial communication interface, light-weight electrode Diode (LED) and headers for the connections.

- ❖ The Arduino is programmed by a USB cable, not a interface. This feature is helpful, as a result of many trendy computers don't have serial ports.
- ❖ Another large advantage of Arduino is its library of examples present within the code of Arduino.
- ❖ The Arduino may be a multiplatform environment; it'll run on Windows, Macintosh, and Linux.
- ❖ The Arduino is an open-source hardware and code.

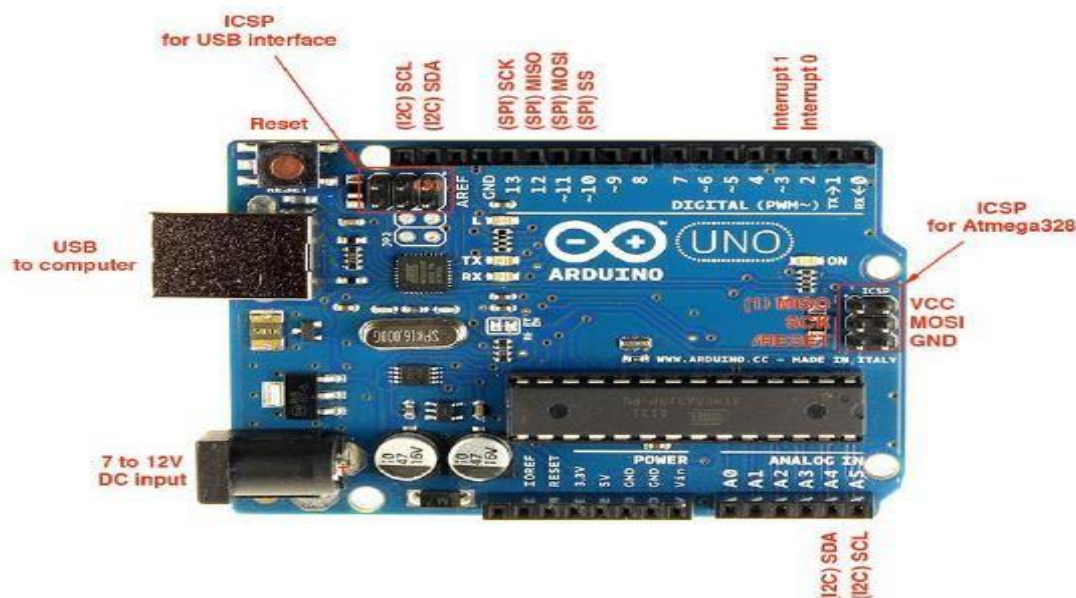


Fig.2.4 Arduino pin diagram

2.4 LIQUID CRYSTAL DISPLAY

The liquid show is employed during this projected methodology to seem at standing of the option. The options of liquid show area unit sixteen character * 2-line show, it's wont to produce interface between user and microcontroller. digital display attracts its definition from its name itself. it's combination of two states of matter, the solid and additionally the liquid. digital display uses a liquid to provide an apparent image. LCDs area unit economical, simply programmable, don't have any limitation of displaying special and even custom characters not like in seven segments.

Lcd consists of the many layers that embody a pair of polarized panel filters

and electrodes. light-weight is projected from a lens on a layer of liquid. this mix of colored light-weight with the gray-scale image of the crystal (formed as electrical flows through the crystal) forms the colored image.

This image is then displayed on the screen. The principle behind the LCD's is that once associate electrical current is applied to the liquid molecule, the molecule tends to straighten. This causes the angle of sunshine, that's passing through the molecule of the polarized glass and additionally cause a modification at intervals the angle of the best polarizing filter. As a result, slightly light-weight is allowed to pass the polarized glass through a particular area of the alphanumeric display. Thus, that specific area will become dark compared to completely different. The digital display works on the principle of obstruction lightweight.

While constructing the LCD's, a reflected mirror is organized at the rear. Associate in Nursing conductor plane is made of indium-tin substance that's unbroken on prime and a polarized glass with a polarizing film that's to boot further on very cheap of the device. the complete region of the alphanumeric display has to be embedded by a typical conductor and better than it has to be compelled to be the liquid matter. Next involves the second piece of glass with a conductor among the range of the quadrangle on all-time low and on high is another polarizing film. It ought to be thought-about that every of the things square measure unbroken at right angles. Once there is no current, the sunshine passes through the front of the digital display it's going to be mirrored by the mirror and bounced back. as a result of the conductor is connected to battery the present from it's going to cause the liquid crystals between the common-plane conductor and conjointly the conductor formed style of a parallelogram to straighten. Thus, the sunshine is blocked from passing through. Shown in fig 2.3.

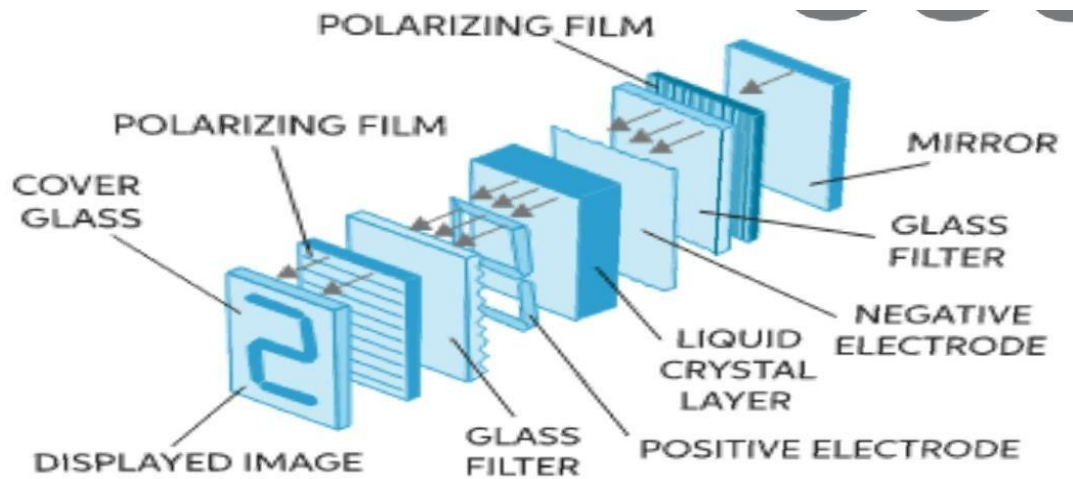


Fig 2.5. Layer diagram of LCD

2.4.1 PIN DIAGRAM

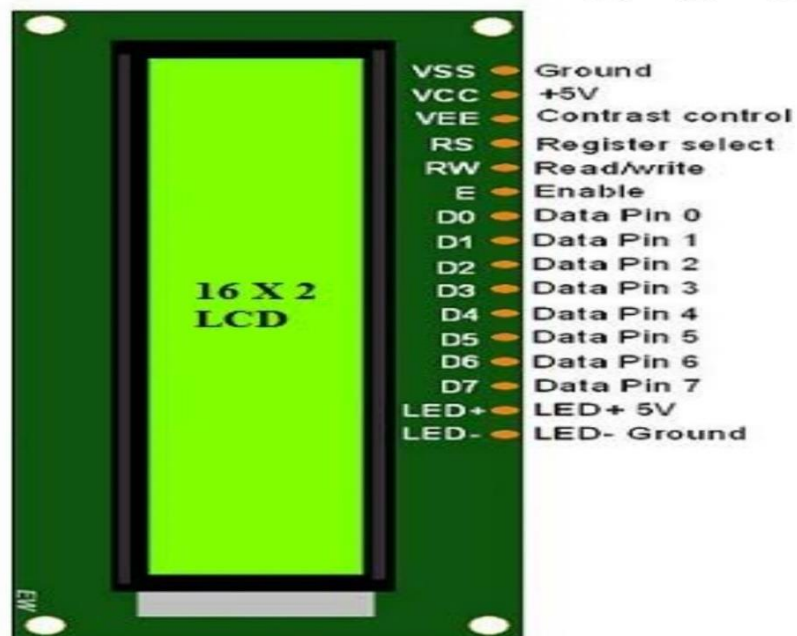


Fig. 2.6 pin diagram of LCD

PIN DETAILS

Table.2.2 pin details of LCD

PIN	DISCRIPTION
VSS	Ground

VCC	+5V
VEE	Contrast Control
RS	Register Select
RW	Read/Write
E	Enable
D0	Data pin 0
D1	Data pin 1
D2	Data pin 2
D3	Data pin 3
D4	Data pin 4
D5	Data pin 5
D6	Data pin 6
D7	Data pin 7
LED+	LED +5V
LED-	LED -Ground

2.5 RECTIFIER

A rectifier is a device that converts alternating current (AC) into a direct current (DC). Rectifiers can take a wide variety of physical forms, from vacuum tube diodes a crystal radio receiver to modern silicon-based design.

There are two types of rectifiers. They are,

- a) Half wave rectifier
- b) Full wave rectifier

2.5.1 USE OF A RECTIFIER

Rectifiers square measure basic to what proportion whole fully totally different devices operate. as a results of the quality electrical distribution grid uses AC power, would force a rectifier to regulate properly. around all trendy physics would love the steady, constant power of DC to work properly. Additionally, we tend to use rectifiers to alter voltage in DC power systems. as a result of it's comparatively tough to convert DC voltage directly in some situations, the best answer is also the subsequent method.

- I. Convert DC to AC
- II. Change the voltage using a transformer
- III. Convert AC back to DC using a rectifier

In a few applications, the rectifier itself serves a promptly perform on the most side high-voltage AC to DC. Take, as associate degree example, one in all the earliest radio designs: a crystal radio. This device used a fine wire swish against a crystal, that corrected the voltage radio wave directly, so extracting the audio and manufacturing sound in earphones. truth rectifiers unit of measurement still in use in some varieties of radios presently. Flame rectification is another example of applying rectification directly. throughout this application, a flame acts as a rectifier due t the differential in quality between natural science associate degreeed positive particle gift in AN passing flame. we have a tendency to tend to use the rectifying impact of the fireside on AC in gas heating systems to direct the flame's presence.

a) HALF WAVE RECTIFIER

A half wave rectifier is outlined as a kind of rectifier that solely permits one half-cycle of Associate in Nursing AC voltage wave shape to pass, block the opposite half-cycle. Half-wave rectifiers are accustomed convert AC voltage to DC voltage, and solely need one diode to construct

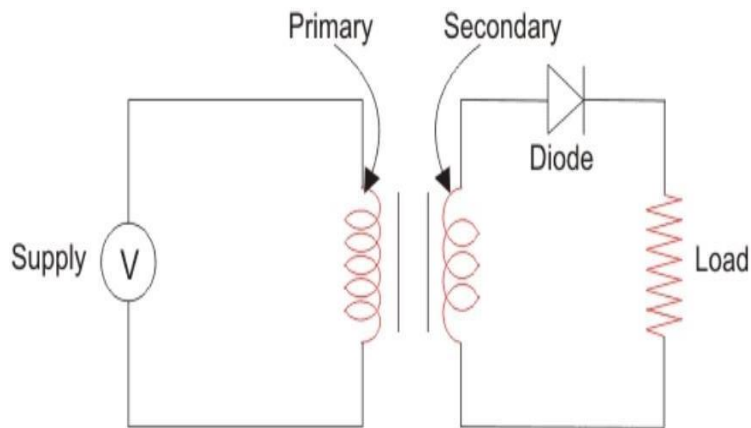


Fig.2.7(a) circuit diagram of half wave rectifier

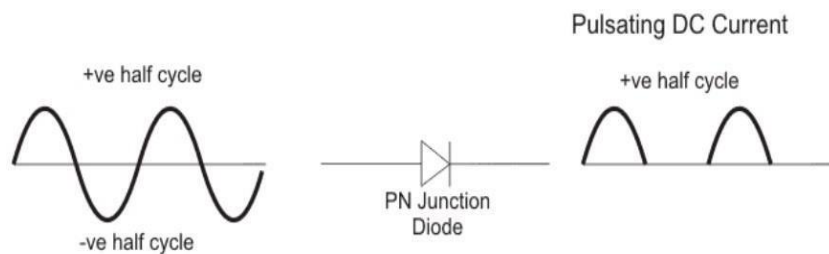


Fig. 2.7(b) output of half wave rectifier

a) FULL WAVE RECTIFIER

A full wave rectifier converts both halves of each cycle of an alternating wave (AC signal) into pulsating DC signal.

We can further classify into two:

- a. Centre-tapped full wave rectifier
- b. Full wave bridge rectifier

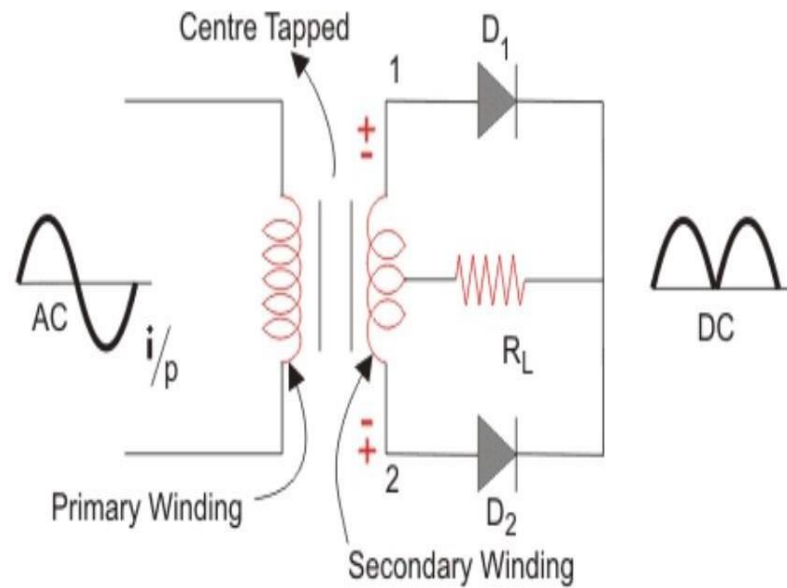


Fig. 2.8 Centre-tapped full wave rectifier

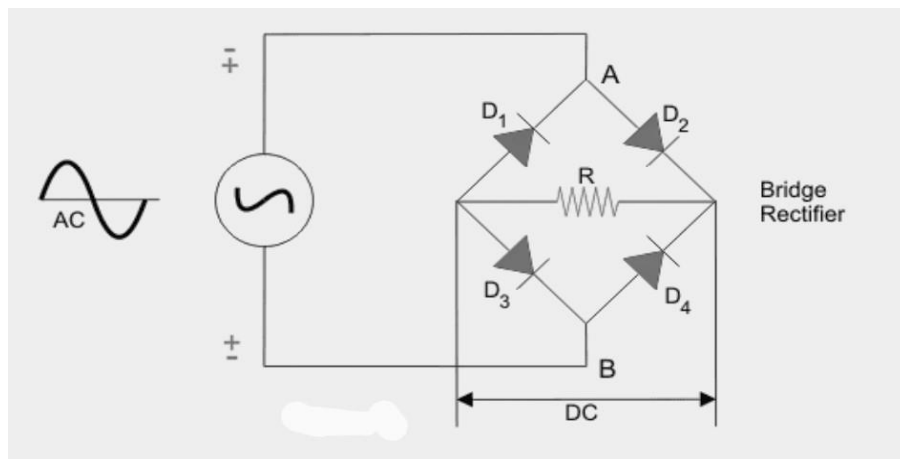


Fig.2.9 full wave bridge rectifier

2.6 CAPACITOR

Capacitor is additionally referred to as condenser. this can be one among the passive elements like resistance. electrical device is usually wont to store the charge. In electrical device the charge is hold on within the type of “electrical field”. Capacitors play a serious role in several electrical and electronic circuits. Generally, a condenser has 2 parallel metal plates that aren't connected to every different. the 2 plates within the condenser area unit separated by non-conducting medium (insulating medium) this medium is

usually called stuff. There are a unit differing kinds and totally different shapes of capacitors on the market, from terribly little capacitors that area unit employed in resonance circuits to giant capacitors for stabilizing HVDC lines. however, all capacitors do a similar work that's storing the electrical charge. The shape of a electrical condenser is rectangular, square, circular, cylindrical or spherical form. in contrast to a resistance, a perfect electrical condenser doesn't dissipate energy. because the differing kinds of capacitors area unit out there totally different symbols were out there to represent them that area unit shown below.

Capacitors properties

Capacitors have many properties like

- They will store the energy and it will dissipate this energy to the circuit whenever needed.
- They will block DC and permit AC to flow through it, and this may couple one a part of the circuit with the opposite.
- Circuits with capacitors rely upon the frequency, thus may be accustomed amplify sure frequencies.
- As the capacitors once applied with AC input, this leads the voltage and so in power applications it will increase the pay load power and makes it additional economical.
- It permits high frequencies so it may be used as a filter either to filter low frequencies or to gather high frequencies.
- As the electrical phenomenon and frequency of the electrical condenser area unit reciprocally connected, this may be wont to increase or decrease the circuit resistance at sure frequency and may be used as filter.

Likewise, capacitors exhibit several properties, once utilized in AC or DC circuits and therefore they play vital role in electrical and electronic circuits.

2.6.1 Construction of capacitor

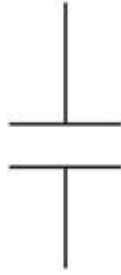


Fig.2.10. (a) Capacitor

As same before, there are unit differing kinds of capacitors. These differing kinds can have totally different sort of construction. A Parallel plate electrical device is that the simplest electrical device. allow us to perceive the development of this electrical device. It consists of 2 metal plate separated by a distance. The area between these 2 plates is stuffed with a insulator material. {the 2|the 2} leads of the electrical condenser area unit taken from these two plates. The capacitance of the electrical device depends on the gap between the plates and space of the plates. Capacitance price is modified by varied any of those parameters. A variable capacitance is created by creating one in every of these plates fastened and alternative moving.

Working

As same before electrical device consists of 2 conductors separated by a non conductor, once there's any potential drop between the 2 conductors potential drop is developed. This causes the electrical device to charge and discharge. Let us perceive this in an exceedingly sensible manner. once the capacitance is connected to battery (a DC source), current starts flowing through the circuit. Thus, electric charge is accumulated on one plate and charge is accumulated on the opposite plate. This method continuous till the capacitance voltage reaches provide voltage. When the charging voltage is adequate to the provision voltage condenser stops charging more despite the fact that the battery is connected. once the battery is removed 2 plates are going to be accumulated with positive and negative charges. therefore, the charge is hold on within the condenser. stops charging more despite the fact that the battery is connected. once the battery is removed 2 plates are going

to be accumulated with positive and negative charges. therefore, the charge is hold on within the condenser. But once the availability voltage is from Associate in Nursing AC supply it charges and discharges unendingly. The rate of charging and discharging depends on the frequency of the supply.

2.7 DIODE (IN 4007)

A diode is a device which only allows unidirectional flow of current if operated within a rated specified voltage level. A diode solely blocks current within the reverse direction whereas the reverse voltage is at intervals a restricted vary otherwise reverse barrier breaks and also the voltage at that this breakdown happens is termed reverse breakdown voltage. The diode acts as a valve within the electronic and electrical circuits. A PN junction is that the simplest sort of the diode that behaves as ideally contact once it's in forward biased and behaves as ideally circuit once it's within the reverse biased. Beside easy PN junction diodes, there area unit differing kinds of diodes though the basic principles area unit additional or less same. thus a specific arrangement of diodes will convert AC to beating DC, and hence, it's generally additionally known as as a rectifier. The name diode comes from "di - ode" which suggests a tool having 2 electrodes.

Symbol of Diode

The symbol of a diode is shown below. The arrowhead points in the direction of conventional current flow.

Diode Circuit Symbol



P-N Junction

Fig.2.10. (b)p-n junction diode

We can produce a straightforward PN junction diode by doping donor impurity in one portion and acceptor impurity in alternative portion of semiconducting material or atomic number 32 crystal block. These doping create a PN junction at the center a part of the block beside that one portion becomes p-type (doped with power or acceptor impurity), and another portion becomes n-type (doped with power or donor impurity). we will conjointly type a PN junction by change of integrity a p-type (intrinsic semiconductor doped with a power impurity) and semiconductor (intrinsic semiconductor doped with a power impurity) alongside a special fabrication technique. Hence, it's a tool with 2 components, the p-type forms anode, and therefore the n-type forms the cathode. These terminals square measure brought bent create the external connections.

2.7.1 Working Principle of Diode

Unbiased Diode

N-side can have a major variety of free electrons, and extremely few holes (due to thermal excitation) whereas the p facet can have a high concentration of holes and extremely few free electrons. thanks to this, a method referred to as diffusion takes place. during this method free electrons from n facet can diffuse (spread) into the p facet and recombine with holes gift there, deed positive immobile (not moveable) ions in n facet and making negative immobile ions within the p-type facet of the diode. Hence, uncovered positive donor ions gift within the n-type facet close to the junction edge. Similarly, uncovered negative acceptor ions gift within the p-type facet close to the junction edge. thanks to this, numbers of positive ions and negative ions can accumulate on n-side and p-side severally. This region thus shaped is named as depletion region thanks to the "depletion" of free carriers within the region. thanks to the presence of those positive and negative ions a static force field known as as barrier potential is formed across the PN junction of the diode. it's known as "barrier potential" as a result of it acts as a barrier and opposes the any migration of holes and free electrons across the junction.

2.7.1.1 Forward Biased Diode

In a PN junction diode once the forward voltage is applied i.e. positive terminal of a supply is connected to the p-type facet, and also the negative

terminal of the supply is connected to the n-type facet, the diode is alleged to be in forward biased condition. we all know that there's a barrier potential across the junction. This barrier potential is directed within the opposite of the forward applied voltage. therefore, a diode will solely enable current to flow within the forward direction once forward applied voltage is over barrier potential of the junction. This voltage is named forward biased voltage. For atomic number 14 diode, it is 0.7 volts. For atomic number 32 diode, it is 0.3 volts. once forward applied voltage is over this forward biased voltage, there'll be forward current within the diode, and also the diode can become short circuited. Hence, there'll be no additional fall across the diode on the far side this forward biased voltage, and forward current is barely restricted by the external resistance connected serial with the diode. Thus, if forward applied voltage will increase from zero, the diode can begin conducting solely once this voltage reaches simply higher than the barrier potential or forward biased voltage of the junction. The time, taken by this input voltage to succeed in that price or in different words, the time, taken by this input voltage to beat the forward biased voltage is named recovery time.

2.7.1.2 Reverse Biased Diode

Now if the diode is reverse biased i.e. positive terminal of the supply is connected to the n-type finish, and therefore the negative terminal of the supply is connected to the p-type finish of the diode, there'll be no current through the diode except reverse saturation current. this is often as a result of at the reverse biased condition the depletion layer of the junction becomes wider with increasing reverse biased voltage. though there's a small current flowing from n-type finish to p-type finish within the diode because of minority carriers. this small current is termed reverse saturation current. Minority carriers square measure chiefly thermally generated free electrons and holes in semiconductor device and semiconductor unit severally. currently if reverse applied voltage across the diode is frequently inflated, then when sure applied voltage the depletion layer can destroy which can cause an enormous reverse current to flow through the diode.

2.8 TRANSFORMER

An electrical device could be a device that transfers voltage from one circuit to a different through the method of magnetic attraction induction. it's principally wont to boost up or step-down voltage levels between circuits. The electrical device works on the principle of magnetic attraction induction

2.8.1 ELECTROMAGNETIC INDUCTION

Mutual induction between 2 or a lot of windings permits for electricity to be transferred between circuits. According to Faraday's law of magnetic attraction induction, there'll be an voltage evoked within the second winding. If the circuit of this secondary is closed, then a current can flow through it. this is often the fundamental working rule of a electrical device.



Fig.2.11transformer

2.8.2 SPECIFICATION OF TRANSFORMER

- ❖ Step down Centre tapped transformer
- ❖ Input voltage: 220v AC at 50Hz
- ❖ Output voltage: 24V, 12v or 0V
- ❖ Output current: 1A
- ❖ Vertical mount type
- ❖ Low cost and small package

2.9 INDUCTION MOTOR

Induction Motors unit of measurement the foremost typically used motors in many applications. These are called Asynchronous Motors, as a results of associate induction motor forever runs at a speed not up to synchronous speed. Synchronous speed means the speed of the rotating flux

inside the machine. There essentially two kinds of induction motor relying upon the kind of input offer-(i) Single part induction motor and (ii) 3-part induction motor. Or they will be divided in step with sort of rotor-(i) cage motor and (ii) connector motor or wound sort.

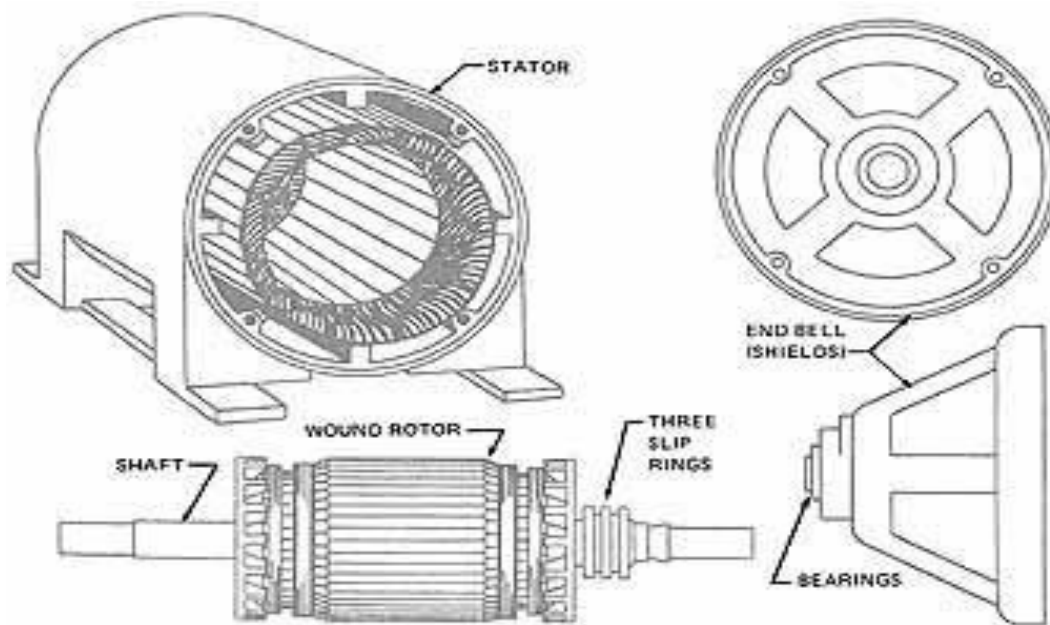


Fig 2.12 Induction motor

2.9.1 Basic Working Principle of An Induction Motor:

In a DC motor, offer is needed to incline for the machine winding equally because the rotor winding. However, in associate induction motor only the machine winding is fed with associate AC offer. Alternating flux is made round the mechanical device winding because of AC offer. This alternating flux revolves with synchronous speed. The revolving flux is termed as "Rotating Magnetic Field" (RMF). The relative speed between machine RMF associated rotor conductors causes an elicited physical phenomenon inside the rotor conductors, per the Faraday's law of attraction induction. The rotor conductors ar short circuited, and so rotor current is created because of elicited physical phenomenon. that is why such motors ar cited as induction motors. (This action is same as that happens in transformers; so, induction motors could also be cited as a rotating transformers). Now, evoked current in rotor can manufacture alternating flux around it. This rotor flux lags behind the stator flux. The direction of evoked rotor current, per Lenz's law, is specified it will

tend to oppose the explanation behind its production. because the reason behind production of rotor current is that the relative rate between rotating machine flux and thus the rotor, the rotor will commit to catch up with the machine RMF. therefore, the rotor rotates inside an equivalent direction as that of machine flux to cut back the relative rate. However, the rotor not at all succeeds in contact the synchronous speed. this will be the essential regulation of induction motor of either kind, single section of 3 section.

2.10 MOSFET

MOSFET stands for Metal chemical compound Semiconductor Field result semiconductor unit. The MOSFET may be a four-terminal device. Before looking the working rule of MOSFET we should always explore the fundamental constructional feature of a MOSFET that makes our plan clearer. The drain and supply terminals area unit connected to the heavily doped regions. The gate terminal is connected prime on the chemical compound layer and also the substrate or body terminal is connected to the intrinsic semiconductor. MOSFET has four terminals that is already declared higher than, they're gate, supply drain and substrate or body. MOS capability gift within the device is that the main half. The physical phenomenon and valance bands are position relative to the Fermi level at the surface could be a operate of MOS capacitance voltage. The metal of the gate terminal and also the Sc acts the parallel and also the compound layer acts as material of the state MOS capacitance. Between the drain and supply terminal inversion layer is made and thanks to the flow of carriers in it, this flows in MOSFET the inversion layer is properties are controlled by gate voltage. so, it's a voltage-controlled device. Two basic sorts of MOSFET are n channel and p channel MOSFETs. In n channel MOSFET is current is thanks to the flow of electrons in inversion layer and in p channel current is thanks to the flow of holes. Another sort of characteristics of clarification will be made from those are sweetening sort and depletion sort MOSFETs. In sweetening mode, these are commonly off and turned on by applying gate voltage. the alternative development happens in depletion sort MOSFETs.

2.10.1 Working Principle of MOSFET

The regulation of MOSFET depends on the MOS electrical condenser. The MOS electrical condenser is that the main half. The semiconductor surface at below the compound layer and between the drain and supply terminal are often inverted from p-type to n-type by applying a positive or negative gate voltage severally. After we apply positive gate voltage the holes drift below the compound layer exert force and therefore the holes are pushed downward with the substrate. The depletion region is inhabited by the sure negative charges, that are related to the acceptor atoms. The positive voltage conjointly attracts electrons from the n+ supply and drain regions into the channel. The electron channel is created. Now, if a voltage is applied between the supply and also the drain, current flows freely between the supply and drain gate voltage controls the electrons concentration in the channel. Rather than positive if apply negative voltage a hole channel is fashioned to a lower place the chemical compound layer. Now, the dominant of supply to gate voltage is to blame for the physical phenomenon of current between supply and therefore the drain. If the gate voltage exceeds a given worth, known as the threshold voltage then the physical phenomenon begins.

The current equation of MOSFET in triode region is –

$$I_D = u_n C_{ox} \frac{W}{L} [(V_{GS} - V_{TH})V_{DS} - \frac{1}{2}V_{DS}^2]$$

Where, u_n = Mobility of the electrons

C_{ox} = Capacitance of the oxide layer

W = Width of the gate area

L = Length of the channel

V_{GS} = Gate to Source voltage

V_{TH} = Threshold voltage

V_{DS} = Drain to Source voltage.

2.10.1.1 The MOSFET can function in two ways

- Depletion Mode
- Enhancement Mode

Depletion Mode

When there's no voltage on the gate, the channel shows its most electrical phenomenon. Because the voltage on the gate is either positive or negative, the channel conduction decreases.

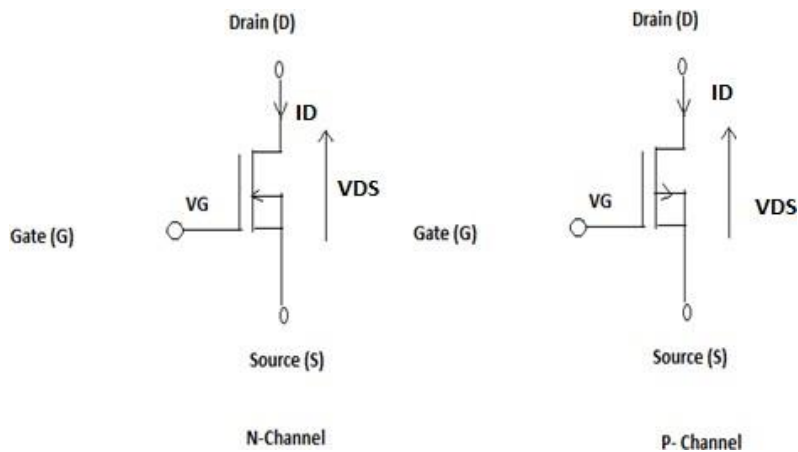


Fig.2.13(a) N-channel and P-channel for depletion mode

Enhancement mode

When there is no voltage on the gate the device does not conduct. More is the voltage on the gate, the better the device can conduct.

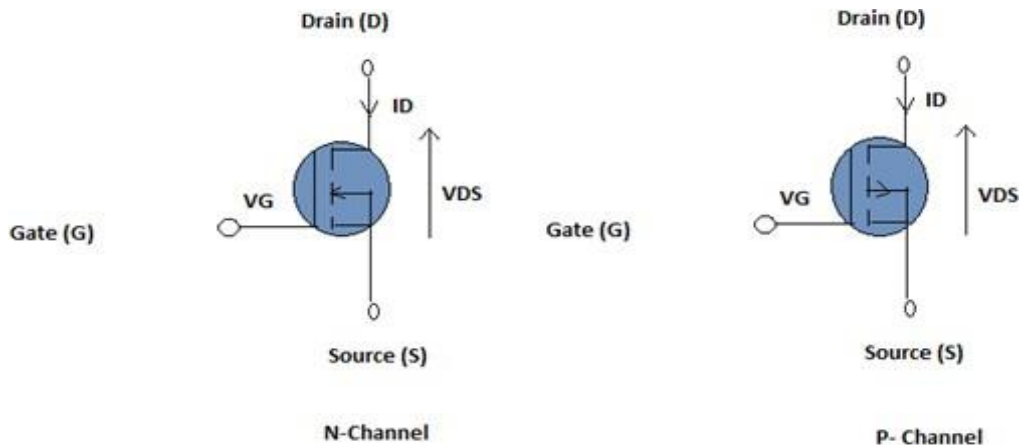


Fig.2.13 (b)N-channel and P-channel for enhancement mode

2.10.1.2 N-Channel MOSFET (IRF 840500V - 0.75Ω - 8A TO-220)

MOSFET having n-channel region between supply and drain is understood as n-channel MOSFET. It's a four-terminal device, the terminals are gate, drain, supply and substrate or body. The drain and supply are heavily doped n⁺ regions and also the substrate is p-type. This flows because of the flow of the charged electrons, that's why it's called n-channel MOSFET.

When we apply the positive gate voltage, the holes get pushed to a lower place, the channel layer experiences force and also the holes are pushed downward into the certain negative charges that are related to the acceptor atoms. The positive gate voltage conjointly attracts electrons from the n⁺ supply into the channel region. Therefore, an electron channel is created, currently if a voltage is applied between the supply and drain. The gate voltage controls the electron concentration within the channel. n-channel MOSFET is most well-liked over p-channel MOSFET because the quality of electrons is on top of holes.

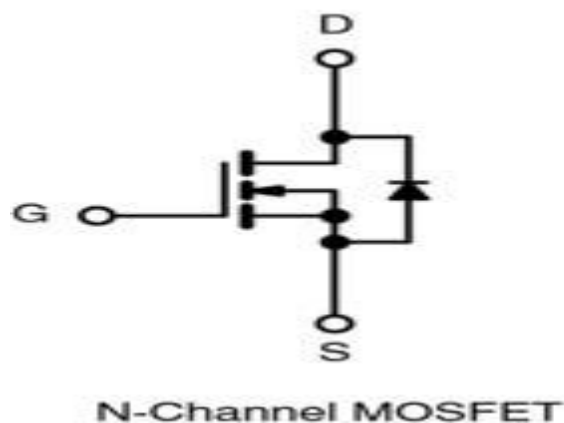


Fig.2.13. (c) N-channel MOSFET

FEATURES

- 8A, 500V
- $R_{DS(ON)} = 0.850\Omega$
- Single Pulse Avalanche Energy Rated
- SOA is Power Dissipation Limited
- Nanosecond Switching Speeds
- Linear Transfer Characteristics
- High Input Impedance

APPLICATIONS

- High current, high speed switching
- Switch mode power supplies (SMPS)
- Dc-ac converters for welding equipment and uninterruptible power supplies and motor drives

MOSFET DRIVER

MOSFET driver is main part of power natural philosophy circuits. MOSFET drivers are dedicated integrated circuits that are accustomed drive MOSFETs in low aspect and high aspect configuration.

MOSFET gate driver

MOSFET driver TL250 like alternative MOSFET drivers have input stage and output stage. It even has power provide configuration. TLP250 is additional appropriate for MOSFET and IGBT. the most distinction between TLP250 and alternative MOSFET drivers is that TLP250 MOSFET driver is optically isolated. Its mean input and output of TLP250 MOSFET driver is isolated from one another. Its works sort of a optocoupler. Input stage have a light-weight emitting diode and output stage have ikon diode. Whenever input stage semiconductor diode light-weight falls on output stage ikon detector diode, output becomes high.

2.10.1.3 Pin configuration isolated MOSFET driver TL250

Pin layout of TLP250 is given below. it's clearly shown in figure that junction rectifier at input stage and exposure detector diode at output stage is employed to supply isolation between input and output. number one and four aren't connected to any purpose. thus, they're not in use. Pin a pair of is anode purpose of input stage light-weight emitting diode and pin three is cathode purpose of input stage. Input is provided to number a pair of and three. number eight is for offer affiliation. number five is for ground of power offer.

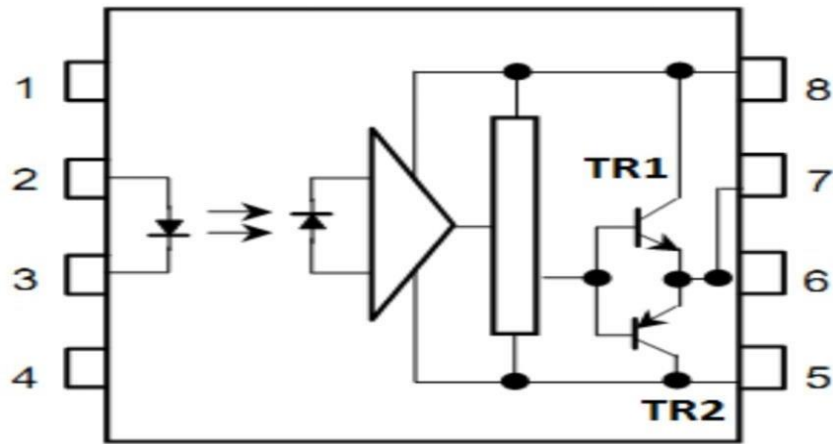


Fig.2.14 Pin configuration

PIN DETAILS

Table 2.10.1 Pin configuration

PIN NO.	DISCRIPTION
1	NC
2	Anode
3	Cathode
4	NC
5	GND
6	VO(OUTPUT)
7	VO
8	VCC

- Pin most wanted and 4 isn't connected to any purpose physically. so, they're not in use.
- Pin variety eight is use to {supply to produce} power offer to TLP250 and identification number five is ground pin that provides come back path to power supply ground. most power offer potential unitage between 15-30-volt dc are often given to TLP250. However, it additionally depends on temperature of setting within which you're victimization TLP250.

- Pin range a pair of and three are anode and cathode points of input stage LED. It works sort of a traditional lightweight emitting diode. It's similar characteristics of forward voltage and input current. Most input current is within the vary of 7-10mA and forward fall is regarding zero.8 volt. TLP250 provides output from low to high with minimum threshold current of one.2mA and on top of.
- Pin variety six and 7 is internally connected to every alternative. Output will be taken from either number vi and seven. Emblem configuration of 2 semiconductor is employed in TLP250. Just in case of high input, output becomes high with output voltage capable offer voltage and just in case of low input, output become low with output voltage level capable ground.
- MOSFET driver TLP250 may be exhausted to 25KHZ frequency because of slow propagation delay.

2.10.1.4 TLP250 as a low side MOSFET driver

Circuit diagram of low aspect MOSFET driver exploitation tlp250 is shown below. during this circuit diagram, tlp250 is employed as non-inverting low aspect MOSFET driver. Connect Associate in Nursing capacitor valuable zero.47uf between power provide. It give protection to tlp250 by providing stabilize voltage to IC. Vin is consistent with signal ground. It mustn't be connected with provide ground and output ground. it's clearly shown in higher than figure TLP250 and cargo ground is documented to the facility ground and it's isolated from signal reference ground. once input is high, MOSFET Q1 get high signal from TLP250 and it's driven by power provide and current flows through the load. once input is low, MOSFET Q1 get low signal from TLP250 output pin and MOSFET Q1 remains off and there's no current flow to load. price of provide Voltage ranges between 10-15 volt. Input electrical device at gate of MOSFET is employed rely upon amplitude of signal. Typically, signal is provided through microcontroller and microcontroller signal level is within the order of five V. Capacitance C1 is employed as decoupling capacitance.

TLP250 as a high side MOSFET driver

Circuit diagram of MOSFT driver tlp250 used as high aspect driver is shown below. it's used as non-inverting high aspect MOSFET driver. as a result of input ground is connected to cathode of input stage lightweight emitting diode. so, it's used

as a non-inverting high aspect MOSFET driver. In high aspect configuration there are 3 grounds as shown in figure higher than. Ground of signal, ground of offer voltage and ground of power offer voltage. bear in mind that whereas mistreatment TLP250 as high aspect MOSFET driver, all grounds ought to be isolated from one another.

CHAPTER 3

MATLAB

Matlab could also be a superior language for technical computing. It integrates computation, representation, Associate in Nursing programming in AN easy-to-use atmosphere where problems and solutions unit of measurement expressed in familiar with notation. Typical uses embody science and computation rule development information acquisition Modeling, simulation, and prototyping information analysis, exploration, and representation Scientific and engineering graphics Application development, likewise as graphical interface building. Matlab is associate interactive system whose basic info element is associate array that does not would like familiarizing. this allows you to resolve many technical computing problems, notably those with matrix and vector formulations, throughout a fraction of the time it'd fancy write a program throughout a scalar no interactive language like C or FORTRAN. The name matlab stands for matrix laboratory. Matlab was originally written to supply fast access to matrix code developed by the linpack and mispack comes. Today, matlab engines incorporate the lapack and blas libraries, embedding the state of the art in code for matrix computation. Matlab has evolved over a quantity of years with input from many users. In university environments, it is the quality academic tool for introductory and advanced courses in arithmetic, engineering, and science. In business, matlab is that the tool of choice for high-productivity analysis, development, and analysis. Matlab choices a family of add-on application-specific solutions referred to as toolboxes. vital to most users of matlab, toolboxes modify you to seek out and apply specialized technology. Toolboxes unit comprehensive collections of matlab functions (M-files) that reach the matlab atmosphere to resolve specific classes of problems. Areas throughout that toolboxes unit out there embrace signal method, management systems, neural networks, system of logic, wavelets, simulation, and much of others.

The Matlab system consists of five main parts

Development setting. this can be the set of tools and facilities that assist you use matlab functions and files. several of those tools area unit graphical user

interfaces. It includes the matlab desktop and Command Window, a command history, associate editor and program, and browsers for viewing facilitate, the space, files, and also the search path. The matlab mathematical relation Library. this can be a huge assortment of machine algorithms starting from elementary functions, like sum, sine, cosine, and complicated arithmetic, to additional refined functions like matrix inverse, matrix eigen values, Friedrich Wilhelm Bessel functions, and quick Fourier transforms.

The matlab language. this can be a high-level matrix/array language with management flow statements, functions, knowledge structures, input/output, and object-oriented programming options. It permits each "programming within the small" to apace produce fast and dirty throw-away programs, and "programming within the giant" to make large and complicated application programs.

Matlab has in depth facilities for displaying vectors and matrices as graphs, in addition as expansion and printing these graphs. It includes high-level functions for two-dimensional and three-dimensional knowledge visual image, image process, animation, and presentation graphics. It additionally includes low-level functions that permit you to totally customize the looks of graphics in addition on build complete graphical user interfaces on your matlab applications. The matlab application Interface (API). this can be a library that permits you to put in writing C and algebraic language programs that act with matlab. It includes facilities for job routines from matlab (dynamic linking), job matlab as a process engine, and for reading and writing.

CHAPTER 4

SIMULATION

Simulink could be a code add-on to matlab that could be a mathematical tool developed by the maths works, (<http://www.mathworks.com>) an organization primarily based in Natick. Matlab is power-driven by intensive numerical analysis capability. Simulink could be a tool accustomed visually program a dynamic system (those ruled by Differential equations) and appearance at results. Any logic circuit, or system for a dynamic system are often designed by mistreatment customary building blocks obtainable in Simulink Libraries. numerous toolboxes for various techniques, like formal logic, Neural Networks, dsp, Statistics etc. square measure obtainable with Simulink, that enhance the process power of the tool. the most advantage is that the accessibility of templates / building blocks, that avoid the requirement of writing code for little mathematical processes.

Concept of signal and logic flow

In Simulink, data/information from numerous blocks area unit sent to a different block by lines connecting the relevant blocks. Signals may be generated and fed into blocks dynamic / static). Data may be fed into functions. information will then be drop into sinks, that may be scopes, displays or may be saved to a file. information may be connected from one block to a different, may be branched, multiplexed etc. In simulation, information is processed and transferred solely at separate times, since all computers area unit separate systems. Thus, a simulation time step (otherwise referred to as associate degree integration time step) is important, and therefore the choice of that step is decided by the quickest dynamics within the simulated system.

4.1 INDUCTION MOTOR TORQUE OUTPUT

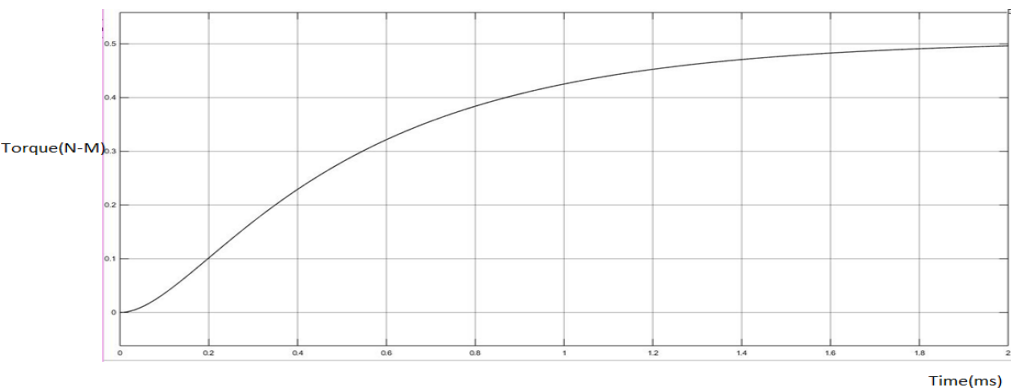


Fig.4.1(a) Induction motor output

4.2 FUZZY OUTPUT

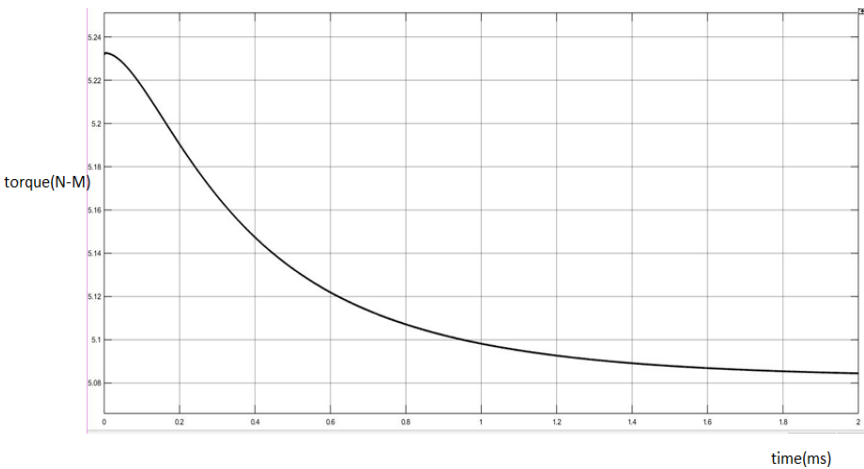


Fig 4.2Fuzzy output

4.3 MOTOR TORQUE OUTPUT BY SLIDING MODE

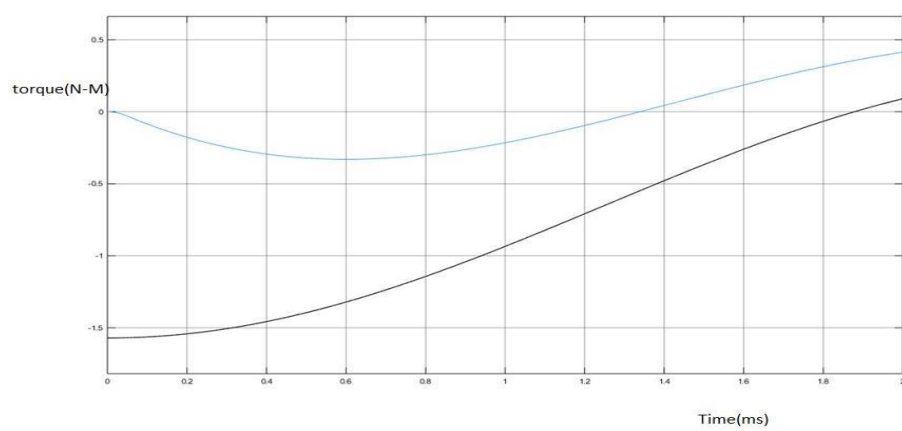


Fig.4.3 Sliding mode output

4.4 COMPARISON OF SLIDING MODE CONTROL AND FUZZY LOGIC CONTROL

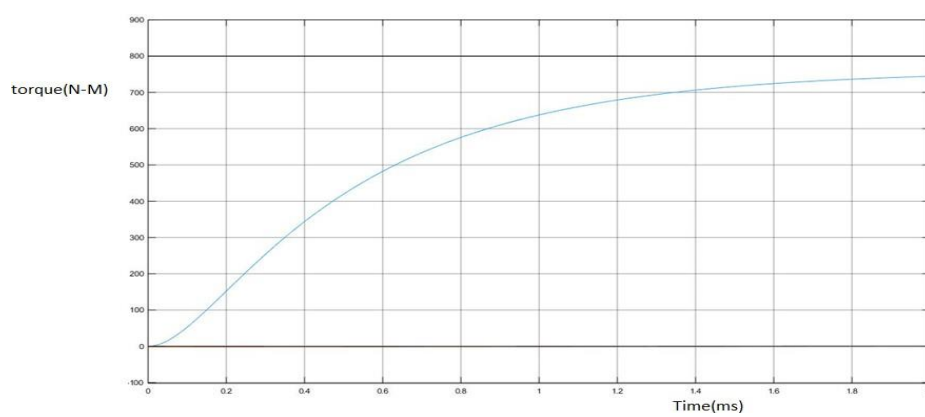


Fig.4.4 Comparison of sliding mode control and fuzzy logic control

CHAPTER 5

Hardware results

5.1 Implementation of hardware

In this project, slippery mode management and mathematical logic is employed for dominant the dynamic response of the grid connected QZSI system. numerous aspects of the controller, square measure mentioned within the paper, that embody the choice methodology of the slippery surface, and therefore the existence condition. The simulation and experimental result shows that the electrical device voltage controller provides a really quick response to a step modification in reference price. Also, the controller is stable and strong for wide variations in input and output. A comparison of the projected controller, with the PI controller, additionally clearly, over the classical controller.

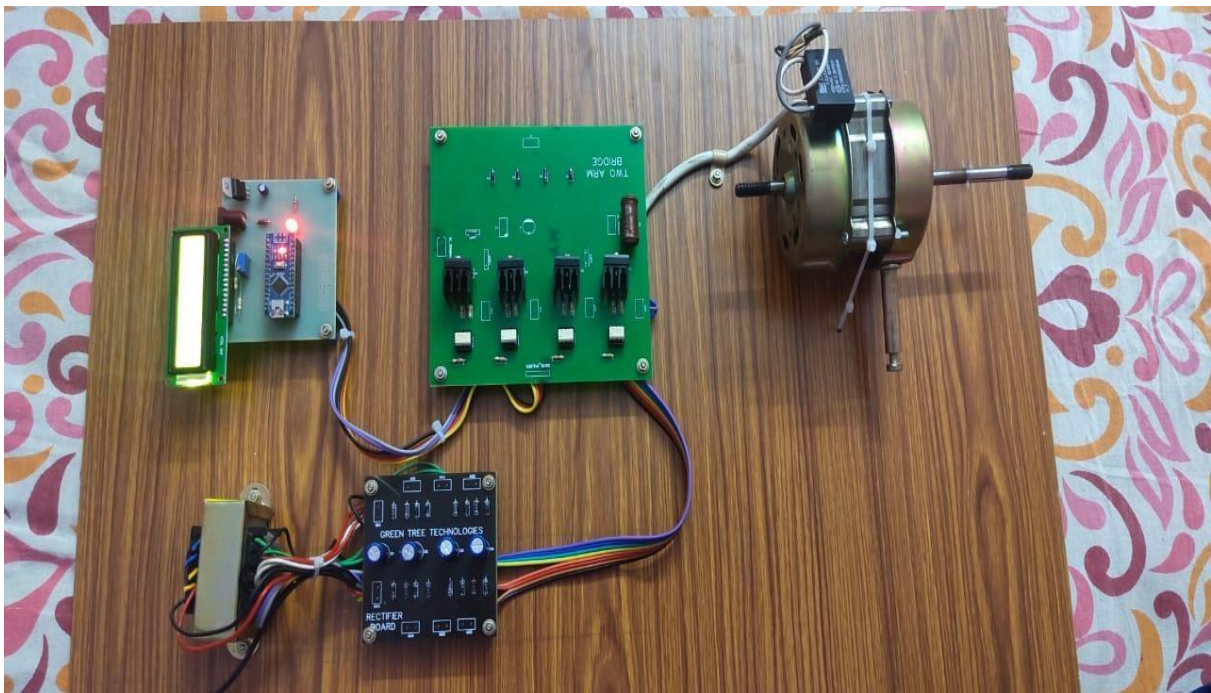


Fig.5.1 Hardware

5.2 Result



Fig.5.2 Pulse in the CRO

Here we are getting the output in the CRO. The pulse will increase to peak value and decrease to zero. From this we can tell that we are rectifying the fault that occurs in the induction motor.

GEO-TAGGED PHOTOS





CHAPTER 6

CONCLUSION AND FUTURE SCOPE

In this thesis the speculation of slippery mode controller is studied thoroughly. The equations of the induction motor model square measure reorganized thus on apply management technique. The controller considering numerous factors like rotor resistance variation, model in accuracies, load force disturbance and conjointly to own a perfect speed pursuit. Considering the case like load disturbance, the response of the designed slippery mode controller is satisfactory. It conjointly offers smart mechanical phenomenon pursuit performance. The speed regulation characteristic is additionally satisfactory. Only load disturbance is that the downside thought-about during this case and therefore the hardness of the controller is verified. Since the machine rating is tiny, the resistance variation result is extremely little. thence has negligible result. As a future work this controller is applied to the other drive system with higher rating wherever parameter variation result is studied. symbolic logic principle is used wont to this controller to create it additional economical and strong.

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