Visvesvaraya Technological University

Belgaum, Karnataka-590 018

A Project Report on

"SOFT STARTER"

Project Report submitted in partial fulfillment of the requirement for the award of the degree of

Bachelor of Engineering
In
Electrical & Electronics Engineering

Submitted by

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2020-2021

CMR INSTITUTE OF TECHNOLOGY

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

AECS Layout, Bengaluru-560 037

Certificate

Certified that the project work entitled **"Soft Starter"** carried out by Mr. Manohar Reddy K L USN 1CR18EE406; Mr. Naveen Kumar K N, USN 1CR18EE408; Mr. Pratheep Kumar K S USN 1CR18EE410; are bonafied students of CMR Institute of Technology, Bengaluru, in partial fulfillment for the award of Bachelor of Engineering in Electrical & Electronics Engineering of the Visvesvaraya Technological University, Belgaum, during the year 2020-2021. It is certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in the Report deposited in the departmental library.

The project report has been approved as it satisfies the academic requirements in respect of Project work prescribed for the said Degree.

Signature of the Guide	*Signature of the HOD*	*Signature of the Principal*
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Dr .M. Lakshmanan Associate Professor EEE Department CMRIT, Bengaluru	Dr. K. Chitra Professor & HOD EEE Department CMRIT, Bengaluru	Dr. Sanjay Jain Principal, CMRIT, Bengaluru

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DECLARATION

We, [Mr. Manohar Reddy K L USN 1CR18EE406; Mr. Naveen Kumar K N, USN 1CR18EE408; Mr. Pratheep Kumar K S USN 1CR18EE410]**,** hereby declare that the report entitled **"Soft Starter" has** been carried out by us under the guidance of Dr .M. Lakshmanan Associate Professor, Department of Electrical & Electronics Engineering, CMR Institute of Technology, Bengaluru, in partial fulfillment of the requirement for the degree of **BACHELOR OF ENGINEERING in ELECTRICAL & ELECTRONICS ENGINEERING**, of Visveswaraya Technological University, Belgaum during the academic year 2020-21. The work done in this report is original and it has not been submitted for any other degree in any university.

Place: Bengaluru

Date:

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Abstract

The main aim of this project is to develop the automation system for residential electricity cut off using network based embedded controller.

The purpose of this project is to design an automatic sequential power supply to different areas in electricity department to give the power supply to the particular area in particular time by electricity board. This also helps in effective utilization of the available power supply.

The automation of the distribution feeders in the distribution substation is the latest technology that is developed using the Embedded system technology and microcontrollers. The concept of integrated systems approach is to protect, control and monitoring of thr given functions.

Acknowledgement

The satisfaction and euphoria that accompany the successful completion of any task would be incomplete without the mention of people, who are responsible for the completion of the project and who made it possible, because success is outcome of hard work and perseverance, but stead-fast of all is encouraging guidance. So with gratitude we acknowledge all those whose guidance and encouragement served us to motivate towards the success of the project work.

We take great pleasure in expressing our sincere thanks to ***Dr. Sanjay Jain****,* ***Principal, CMR Institute of Technology, Bengaluru*** *for providing an excellent academic environment in the college and for his continuous motivation towards a dynamic career. We would like to profoundly thank* ***Dr. B Narasimha Murthy****, Vice-principal of CMR Institute of Technology and the whole* ***Management*** *for providing such a healthy environment for the successful completion of the project work.*

We would like to convey our sincere gratitude to ***Dr. K Chitra****,* ***Head of Electrical and Electronics Engineering Department, CMR Institute of Technology, Bengaluru*** *for her invaluable guidance and encouragement and for providing good facilities to carry out this project work.*

We would like to express our deep sense of gratitude ***to Dr .M. Lakshmanan***

Associate Professor, Electrical and Electronics Engineering, CMR Institute of Technology, Bengaluru *for his/her exemplary guidance, valuable suggestions, expert advice and encouragement to pursue this project work.*

We are thankful to all the faculties and laboratory staffs of ***Electrical and Electronics Engineering Department, CMR Institute of Technology, Bengaluru*** *for helping us in all possible manners during the entire period.*

Finally, we acknowledge the people who mean a lot to us, our parents, for their inspiration, unconditional love, support, and faith for carrying out this work to the finishing line. We want to give special thanks to all our friends who went through hard times together, cheered us on, helped us a lot, and celebrated each accomplishment.

Lastly, to the ***Almighty****, for showering His Blessings and to many more, whom we didn't mention here.*

CONTENTS

LIST OF FIGURES

CHAPTER 1

1 INTRODUCTION

High wattage motors such pump motors or other forms of heavy industrial motors tend to draw huge current during their initial power switch ON, which in turn impacts the associated fuses and switches adversely causing these to either blow of or degrade overtime. To remedy the situation a soft start circuit becomes highly imperative and there are several techniques for controlling the speed of DC motor. Some of techniques used are by connecting rheostat in series with the armature of the motor which are not that much effective they have high power losses. In this project we are going to employ a much-sophisticated PWM based motor soft start controller circuit using buck converter which is also used for the speed control of DC motor. Speed Control of DC Motor is an electrical device which controls the output voltage given to the motor. This mainly consists of four circuits. Rectifier, filter, buck converter and control circuit. Rectifier which will convert 1 phase AC to pulsating DC. Filter which convert pulsating DC to pure DC. Buck converter is used to step down output voltage given to the motor and the control circuit designed using microcontroller is used to control the output voltage.

CHAPTER 2

2 BLOCK DIAGRAM

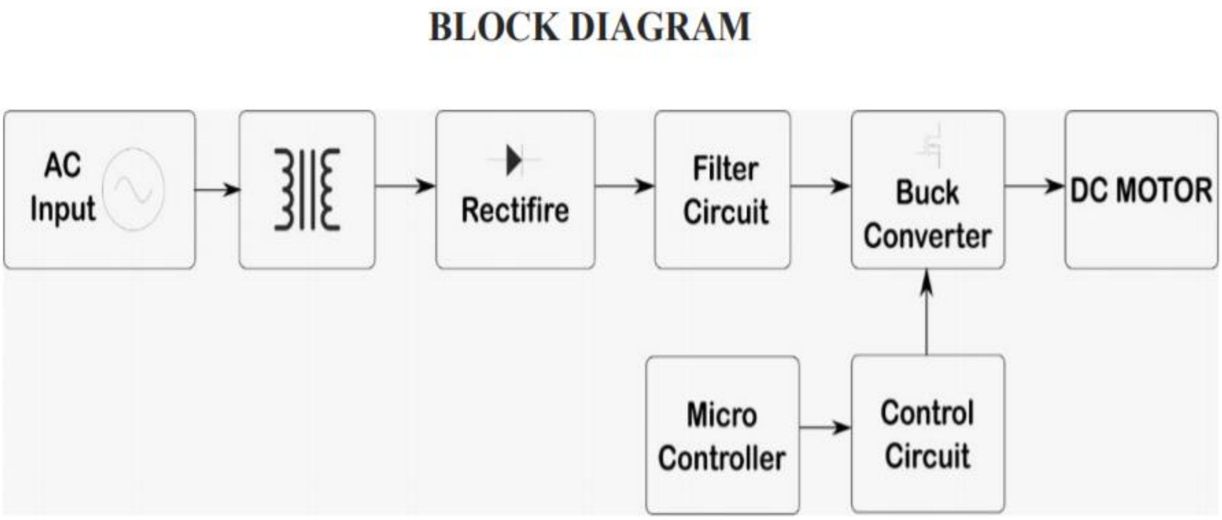


Figure 1 Block diagram

The above figure shows the block diagram for soft starter and speed control of DC Motor. The input we are giving to step down transformer is 230 volts AC and this is step down to 24 volt AC and this is fed to rectifier circuit where the 24 v AC is rectified into pulsating DC and this rectified output is given to filter circuit to remove the ripple content in the rectified output from the filter circuit we get pure DC supply. The DC supply is fed to Buck converter where the Buck converter step downs the voltage depending on the pulses given to the Buck converter. The pulses to the MOSFET is given by control circuit using pulse width modulation (PWM). PWM is generated programmatically by microcontroller. A gradually incrementing PWM is applied to the dc motor, each time it's switched ON, this action allows the motor to attain a linearly increasing speed from zero to maximum within a stipulated period of time, which may be adjustable through programming and also manual configuration provided.

2.1 AC INPUT

The input we are giving is 230V, 50 Hz, 1phase AC supply. As we are doing project on AC to DC conversion, the supply input is AC 230V.

2.2 STEP DOWN TRANSFORMER

The input 1 phase 230V 50 Hz ac supply is stepped down to 24V AC supply. So we are using a step down transformer to step down the voltage from 230V to 24V.

2.3 RECTIFIER CIRCUIT

Our main aim is to convert AC supply to DC supply. So, we are going for rectifier circuit. The AC input is given to rectifier and the output will DC with some ripple.

2.4 FILTER CIRCUIT

The output of rectifier is pulsating DC, that means ripple. So in order to remove that, the filters are used.

2.5 BUCK CONVERTER

In other words, buck converter can be called as DC-DC step down transformer. We will not get required output from rectifier, so buck converters are used.

2.6 CONTROL CIRCUIT

To control the output voltage given to the motor we are using a control unit to control the voltage given to the DC Motor .

2.7 MICRO CONTROLLER

A microcontroller is a highly integrated single chip, which consists of on chip CPU (central process unit) RAM (random Access Memory), EPROM /PROM /RON (Erasable Programmable Read only memory),I/O(input/out)-serial and parallel ,timer, interrupt controller. In this proposed system we are using both discrete component control circuit along with microcontroller to generate the PWM pulses. A toggle switch which helps with selection of automatic and manual control will helps in deciding whether the buck convertor control pulse is through discreet component or through microcontroller.

CHAPTER – 3

WORKING PRINCIPLE

CIRCUIT DIAGRAM

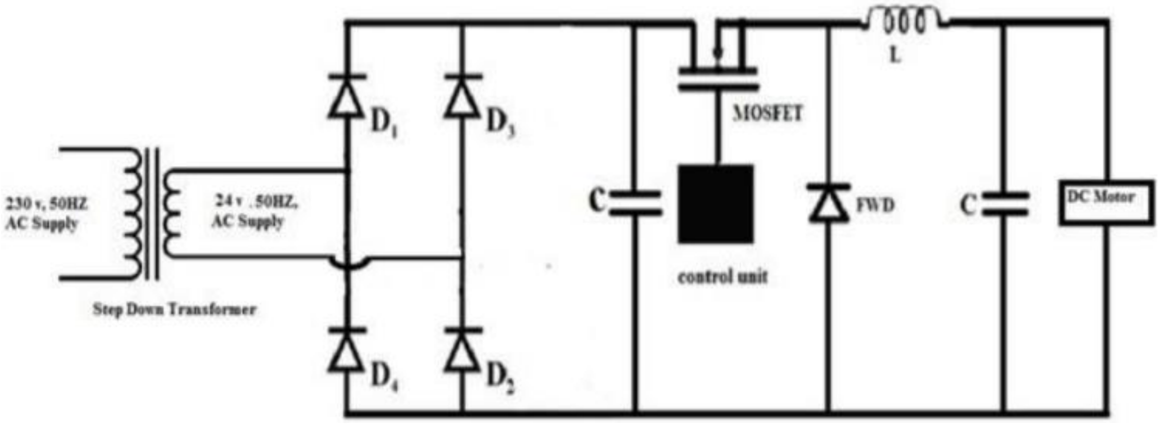


Fig.2. Main circuit of buck converter

The above fig shows the main circuit diagram of this project. The input power supply is 230v, 50Hz, 1phase AC supply is given to a step-down transformer of 220/24 volt and the 24 volt AC is given to rectifier as input. The rectifier is a bridge type consists of 4 diodes. D1, D3, are positive group of diodes and D2, D4, are negative group of diodes. The output of the rectifier is 22V DC approximately. The rectifier output is pulsating DC, which means it consists of AC component and that is called Ripple. In order to remove the ripple, 'C' filters are used which is less cost, less weight, cost efficient and small in size. The output of the rectifier 22 V DC is given to input of the filter. The capacitor filters the ripple and the output is approximately 32V DC. The final output is (0 – 24) volt variable DC. In order to get variable DC output, we are going for buck converter. Buck converter consists of MOSFET as switch. This converter operates in continuous mode. The MOSFET switches according to selected duty cycle and frequency. The 'L' and 'C' values are calculated with reference to duty cycle, frequency, input and output.

3.1 BRIDGE RECTIFIER

3.1.1 CIRCUIT DIAGRAM

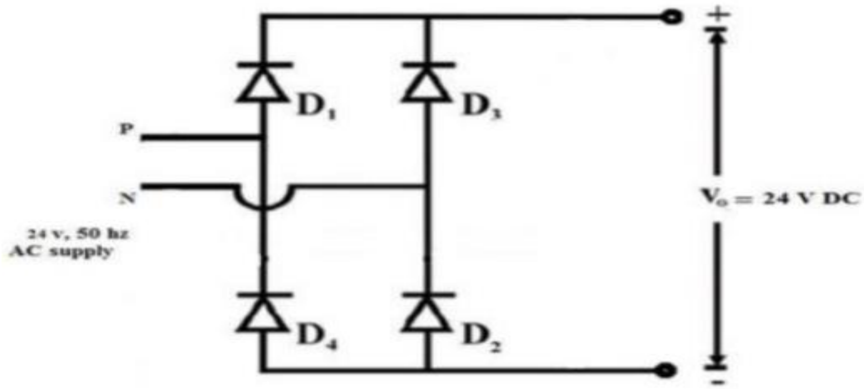


Fig.3. Bridge Rectifier

3.1.2 CONSTRUCTION

Circuit diagram for bridge rectifier using four diodes shown in the fig2. The diodes are arranged in two legs. Each leg has two series–connected diodes. Upper diodes D1, D3 constitute the positive group of diodes. The lower diodes D2, D4, form the negative group of diodes. Positive group of diodes conduct when these have the most positive anode positive anode. Similarly, negative group of diodes would conduct if these have the most negative anode. In other words, diodes D1, D3, forming positive group, would conduct when these experience the highest positive voltage. Likewise, diodes D2, D4, would conduct when these are subjected to the negative voltage.

3.1.3 WORKING

During the Positive half cycle of the input AC waveform diodes D1 and D2 are forward biased and D3 and D4 are reverse biased. When the voltage, more than the threshold level of the diodes D1 and D2, starts conducting – the load current starts flowing through it, as shown as red lines path in the diagram below.

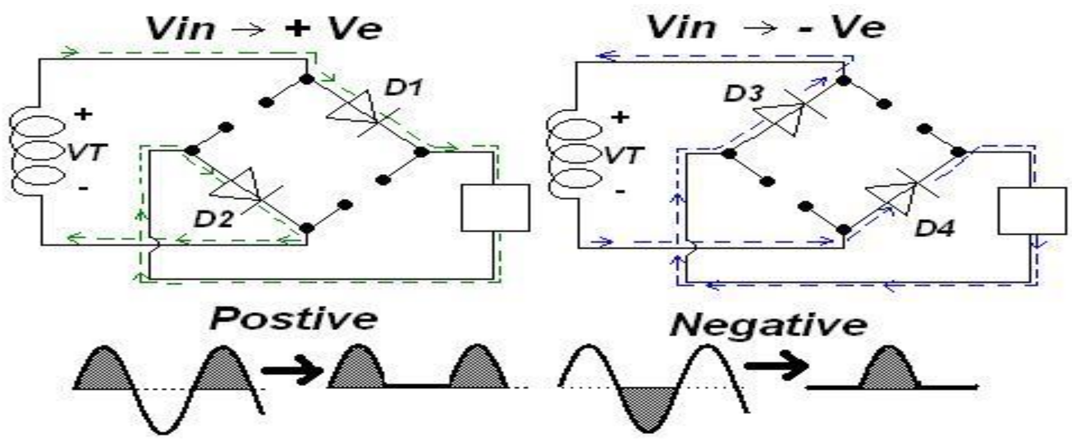


Fig.4. Working of Bridge Rectifier

During the negative half cycle of the input AC waveform, the diodes D3 and D4 are forward biased, and D1 and D2 are reverse biased. Load current starts flowing through the D3 and D4 diodes when these diodes starts conducting as shown in the figure.

3.1.4 WAVEFORMS

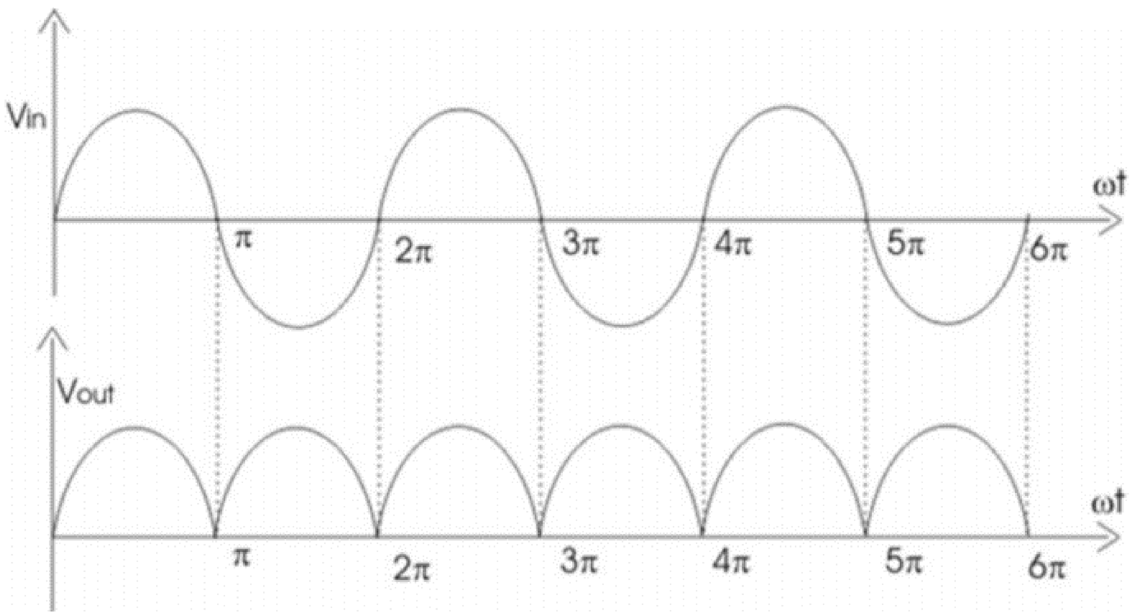


Fig.5. Waveforms of Bridge Rectifier

3.2 CAPACITOR FILTER

3.2.1 CIRCUIT DIAGRAM

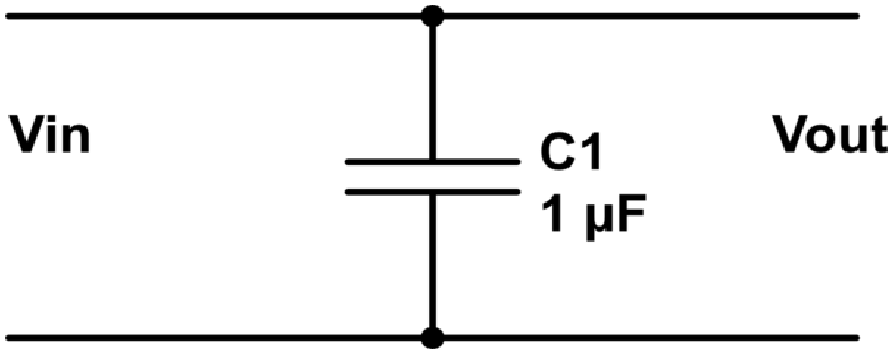


Fig.6. circuit diagram of capacitor filer circuit

3.2.2 CONSTRUCTION AND WORKING

The fig shows a typical capacitor filter circuit. It consists of a capacitor C placed across the rectifier. The pulsating DC voltage of the rectifier is applied across the capacitor. As the rectifier voltage increases, it charges the capacitor and also supplies the current to the load. At the end of quarter cycle, the capacitor C charged to the peak value VM of the rectifier voltage.

The capacitor discharges through the load RL and voltage across it decreases slightly. It is recharged by next voltage peak. This process repeats and it may be seen that very little ripple is left in the output shown in fig

3.2.3 ADVANTAGES OF C FILTER

1. Low cost
2. Small in size
3. Less weight
4. Good characteristics

3.3 BUCK CONVERTER

A buck converter, the average output voltage Va, is less than the input voltage, Vs. hence the name “buck” a very popular converter.

The conceptual model of the buck converter is best understood in terms of the relation between current and voltage of the inductor. Beginning with the switch open (in the "off" position), the current in the circuit is 0. When the switch is first closed, the current will begin to increase, and the inductor will produce an opposing voltage across its terminals in response to the changing current. This voltage drop counteracts the voltage of the source and therefore reduces the net voltage across the load.

Over time, the rate of change of current decreases, and the voltage across the inductor also then decreases, increasing the voltage at the load. During this time, the inductor is storing energy in the form of a magnetic field. If the switch is opened while the current is still changing, then there will always be a voltage drop across the inductor, so the net voltage at the load will always be less than the input voltage source.

When the switch is opened again, the voltage source will be removed from the circuit, and the current will decrease. The changing current will produce a change in voltage across the inductor, now aiding the source voltage. The stored energy in the inductor's magnetic field supports current flow through the load. During this time, the inductor is discharging its stored energy into the rest of the circuit. If the switch is closed again before the inductor fully discharges, the voltage at the load will always be greater than zero.

3.3.1 CIRCUIT DIAGRAM

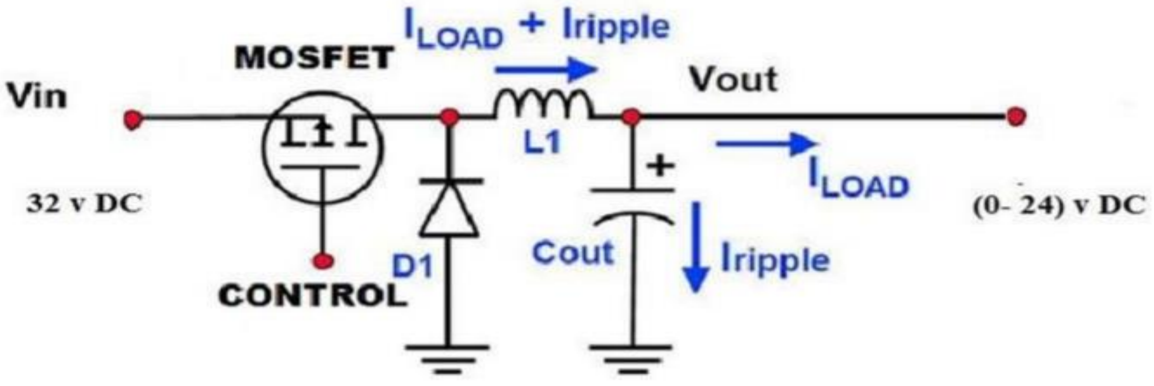


Fig.7. Buck converter circuit diagram

The circuit diagram of a buck converter using MOSFET is shown fig. and this is a DC-DC step down converter.

The circuit operation can be divided into two modes.

1. Continuous mode
2. Discontinuous mode

3.3.1.1 CONTINUOUS MODE

CASE 1

When the MOSFET is ON at time t=0.the input current, which rises, flows through filter inductor L, filter capacitor C , and load resistor R.

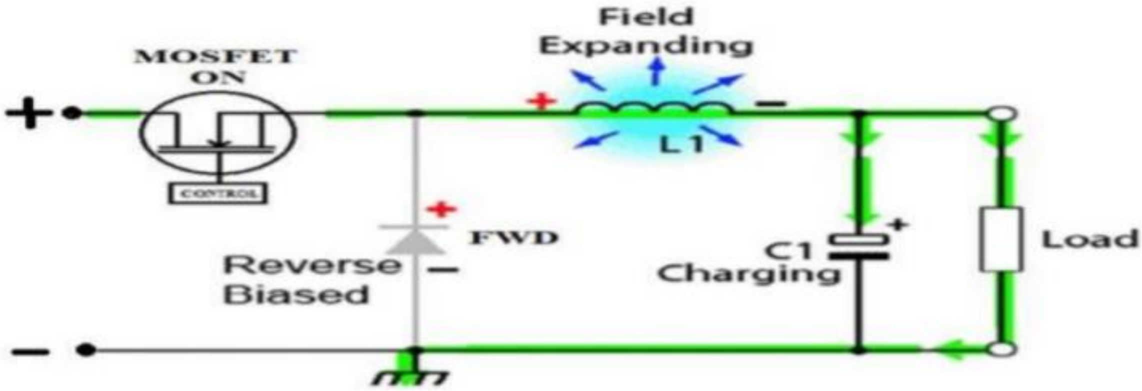


Fig.8. When MOSFET is switch on

3.3.1.2 DISCONTINUOUS MODE

CASE 2

When MOSFET is switched off at t=t1. The freewheeling diode Dm conducts due to energy stored in the inductor and the inductor current continues to flow through L, C, load and diode Dm. The inductor current falls until MOSFET is switched on again in the next cycle.

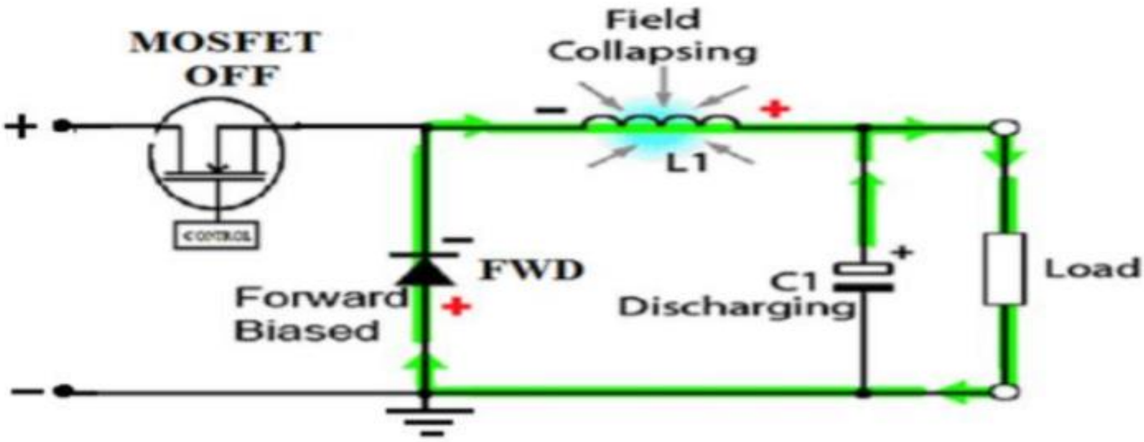


Fig.9. When MOSFET is switch off

3.3.2 WAVEFORMS

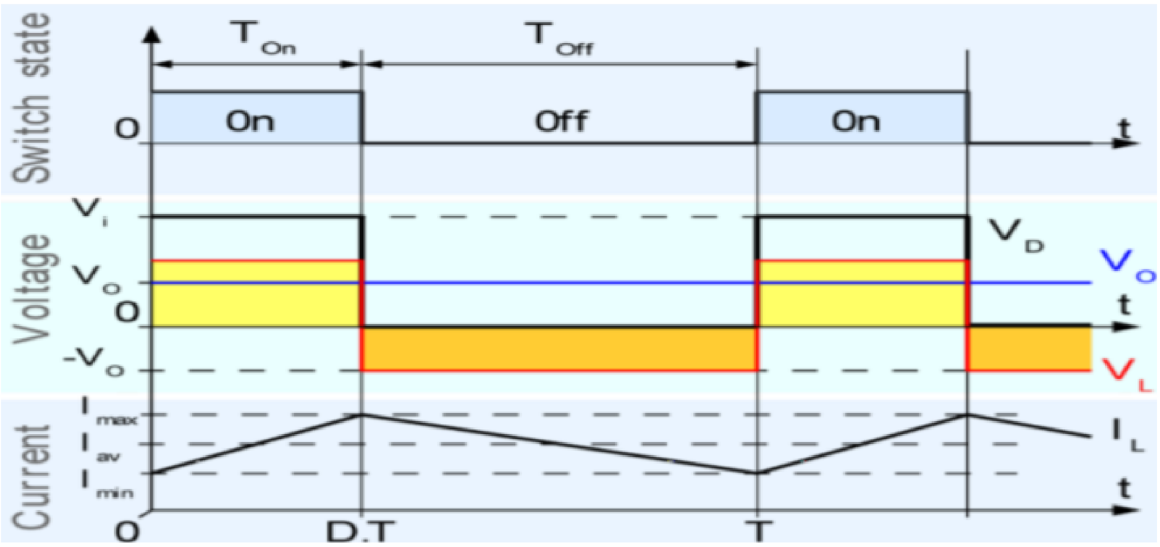


Fig.10 Buck converter wave forms

4.1 CIRCUIT DIAGRAM

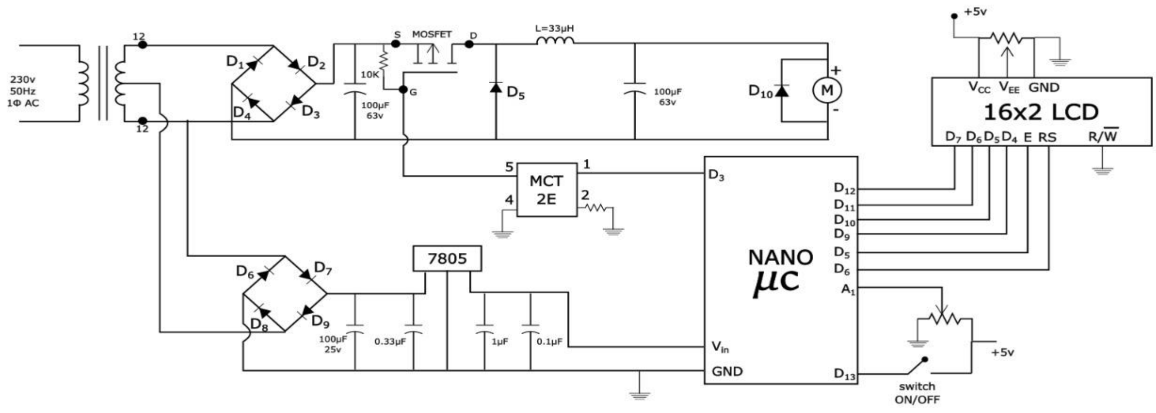


Fig.11. control circuit

The above figure shows the circuit description of control circuit. First the IC 555 timer is used to generate ramp wave. The generated ramp is given to LM 339 IC and it coverts ramp wave to square wave.

Again this square is given to opto isolator MCT2E IC to isolate between pulse generating circuit and current driver IC 4424 to prevent from over current flow into pulse generating circuit. From opto isolator, the output is taken to current driver IC 4424 and from this the pulse is given gate terminal of MOSFET.

4.2 LM339 COMPARATOR IC

LM339 Comparator IC is a Comparator IC with four inbuilt comparators. A comparator is a simple circuit that moves signals between the analog and digital worlds. It compares two input voltage levels and gives digital output to indicate the larger one. The two input pins are termed asinverting (V-) and non-inverting (V+). The output pin goes high when voltage at V+ is greater than that at V-, and vice versa. In common applications, one of the pins is provided with a reference voltage and the other one receives analog input from a sensor or any external device. If inverting pin (V-) is set as reference, then V+ must exceed this reference to result in high output. For inverted logic, the reference is set at V+ pin.

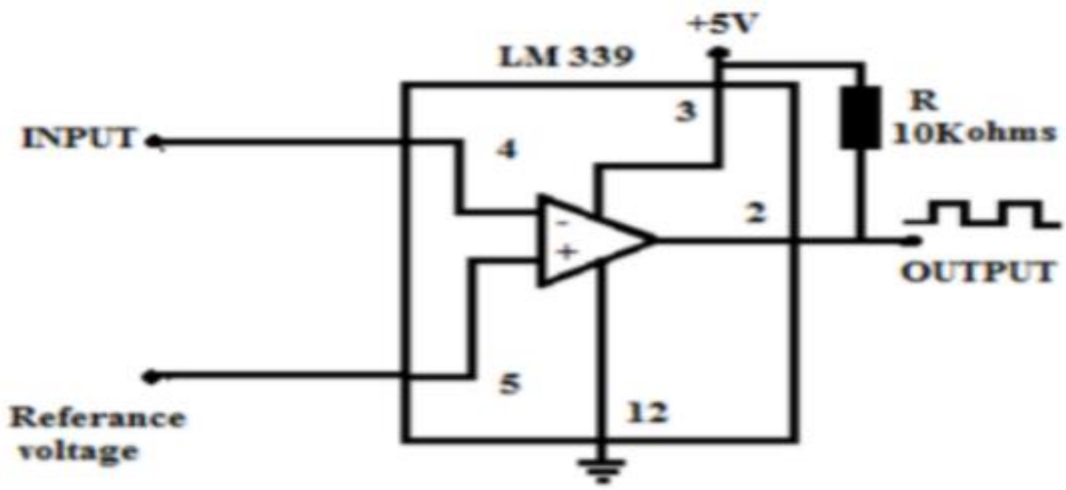


Fig.14. LM 339 pin connection

4.2.1 PIN CONNECTION

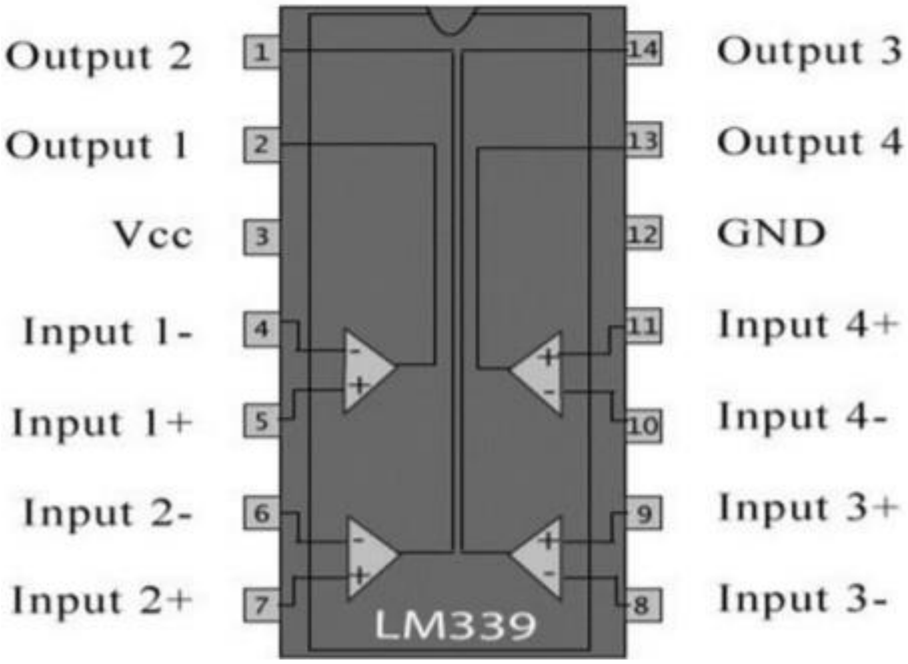


Fig.15. Pin configuration of LM 339

4.3 MCT2E OPTO ISOLATOR IC

In electronics, an opto-isolator, also called an optocoupler, photo coupler, or optical isolator, is a component that transfers electrical signals between two isolated circuits by using light. Optoisolators prevent high voltages from affecting the system receiving the signal. Commercially available opto-isolators withstand input-to-output voltages up to 10 KV and voltage transients with speeds up to 10 KV

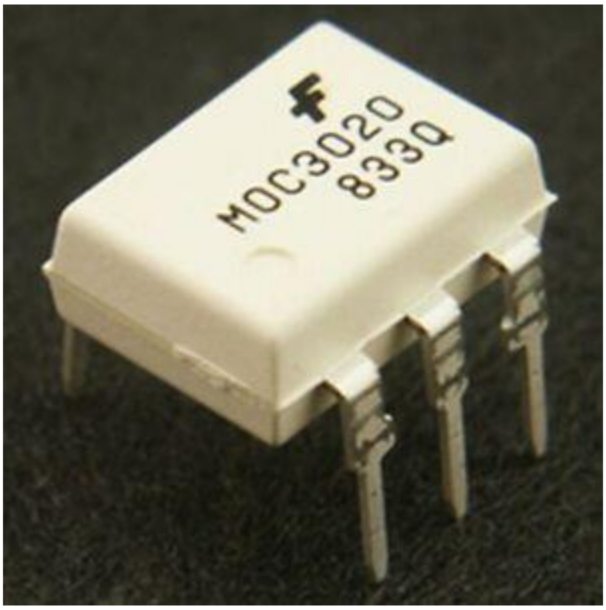


Fig.16. Opto isolator

4.3.1 PIN CONFIGURATION

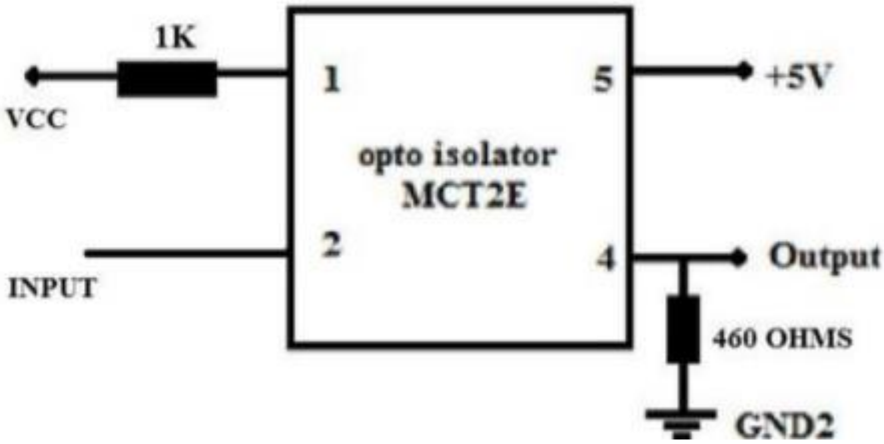


Fig.17. Opto isolator connection

4.4 IC 4424 CURRENT DRIVER

The TC4423/4424/4425 are higher output current versions of the new TC4426/4427/4428 buffer/drivers, which, in turn, are improved versions of the earlier` TC428/427/428series. All three families are pin-compatible. The TC4423/4424/4425 drivers are capable of giving reliable service far more demanding electrical environments than their antecedent's .Although primarily intended for driving power MOSFETs, the TC4423/4424/4425 drivers are equally well suited to drive any other load (capacitive, resistive or inductive) which requires a low impedance driver capable of high peak current and fast switching times. For example, heavily loaded clock lines, coaxial cables, or piezoelectric transducers can also be driven from the TC4423/4424/4425. The only known limitation on loading is the total power dissipated in the driver must be kept within the maximum power dissipation limits of the package.

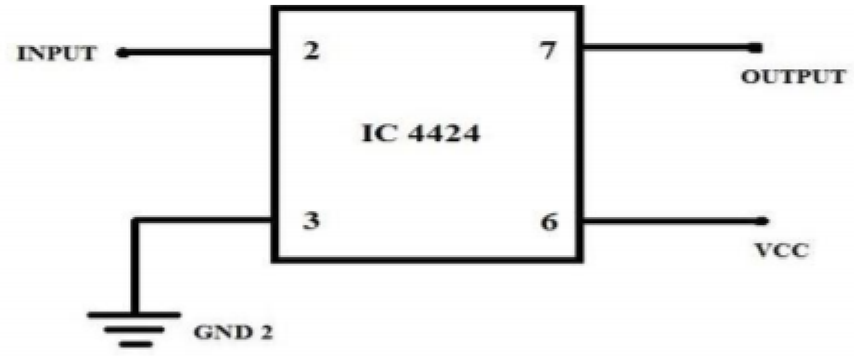


Fig.18 Current driver IC Connection

4.5 Microcontroller

A microcontroller is a computer present in a single integrated circuit which is dedicated to performing one task and execute one specific application. It contains memory, programmable input/output peripherals as well a processor. Microcontrollers are mostly designed for embedded applications and are heavily used in automatically controlled electronic devices such as mobile, cameras, microwave ovens, washing machines, etc

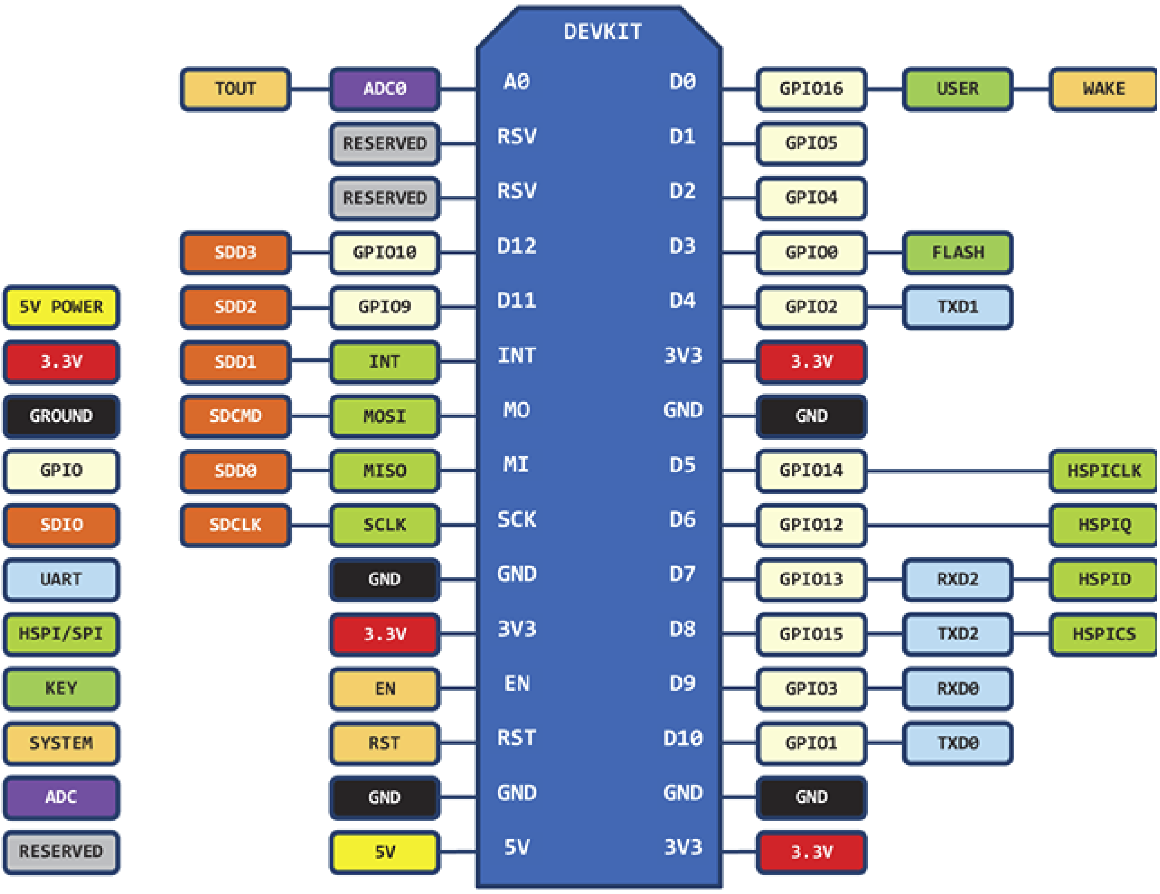
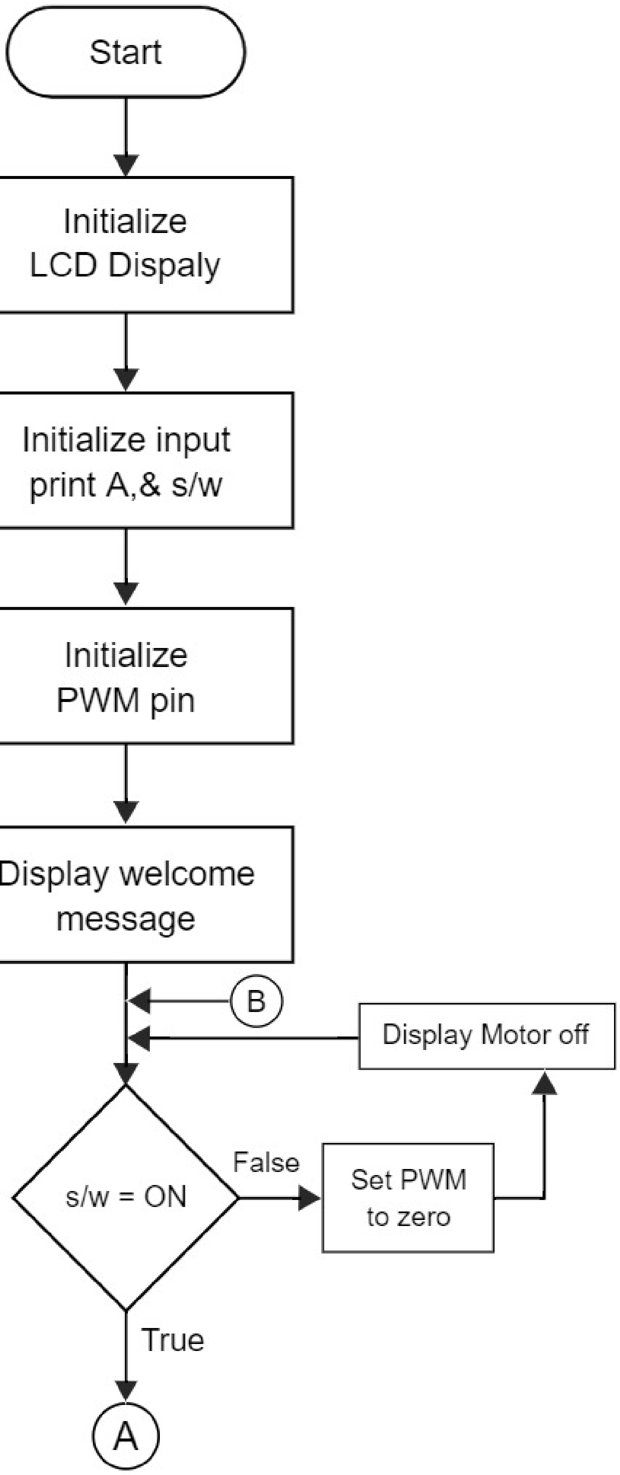
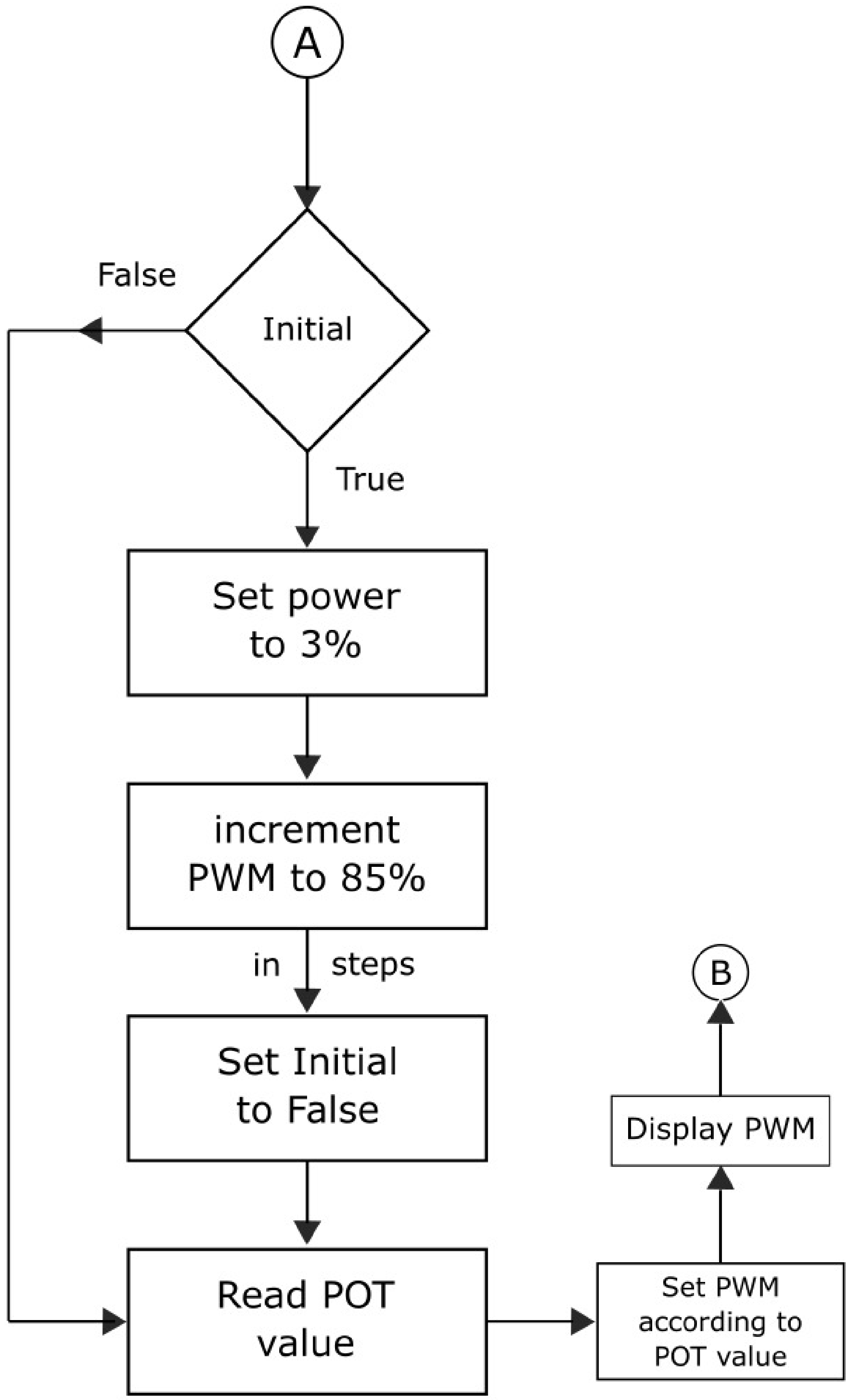


Fig.19.pin connection of Micro controller

There are 9 possible software programmable pins [D1, D2, D3, D4, D5, D6, D7, D8, D9] and 4 Hardware programmable pins [D2, D5, D6, D8]. PWM frequency range is adjustable from 1000 µs to 10000 µs, i.e., between 100 Hz and 1 kHz while using hardware programmable pins the same can be extended using software programmable pins from 1 Hz to 100KHz with timer interruption method in NODEMCU ESP8266.


Start
Initialize
LCD Dispaly
Initialize input
print A,& s/w
Initialize
PWM pin
Display welcome
message
B
Display Motor off
s/w = ON
False
Set PWM
to zero
True
A


A
False
Initial
True
Set power
to 3%
increment
PWM to 85%
in steps
Set Initial
to False
Read POT
value
Set PWM
according to
POT value
Display PWM
B

CHAPTER 5

ADVANTAGES

- PWM duty cycle techniques provides greater efficiency of the DC Motor.
- PWM switching control methods improve speed control and reduce the power losses the system.
- Motor consumes less power.
- Speed can be controlled smoothly.
- Low cost and simplicity

CHAPTER 6

APPLICATIONS

- Steel Industries (Rolling mills and processing lines)
- Sugar plants
- Paper and pulp
- Rubber and plastic
- Textile industries
- Machine tool applications
- Power sector
- Water supply scheme
- Various control applications

CHAPTER 7

FUTURE WORK

- IOT can be introduced by using raspberry pi for remote control
- Mobile application can be developed to switch on and off and control the speed

CHAPTER 8

CONCLUSION

This project provides efficient speed control of the DC Motor by using Buck Converter. As a supply voltage is directly proportional to the speed, by varying the voltage, the speed of a DC Motor can be controlled. This project provides precise and accurate control of speed and turning on of dc motor with reduced voltage method using PWM technique, where pulses are produced by microcontroller

From the project, following points can be concluded

The AC supply is converted into DC and it is fed to Buck converter here the DC voltage is reduced

- Changing the duty cycles of the pulses which in turn change the voltage level which helps in the smooth start of dc motor.
- The speed of the DC motor is controlled by varying the pwm pulse fed to the buck convertor.
- It is possible to improve the performance of the motor speed.
- It provides low cost and simple circuit

We have concluded that, the smoot start and speed control of dc motor is possible by using buck converter. The use of both microcontroller and comparator circuit gives us vast range of options to vary the pwm pulse, which intern helps us to control the speed of the dc motor easily. This project offers low cost, high efficiency and portability.

CHAPTER 9

REFERENCE

- Power Electronics Circuits, Devices and Application (third edition) - Muhammad H. Rashid
- Power Electronics - B.H Bimhra