PROJECT REPORT ON

"DIGITAL CONTROL OF BLDC MOTOR BY USING MOSFET AND MICROCONTROLLER"

Project report submitted in partial fulfillment of the degree of

BACHELOR OF ENGINEERING

BY

SHAIKH SHAHBAZ AFTAB	**16DEE80**
ANSARI MOHD SHAZEB SALAM	**16DEE55**
SAYYED TOSIF YUSUF	**16DEE72**
SHAIKH MAIRAJ ALTAF	**16DEE77**

UNDER THE GUIDANCE OF

PROF. VIVEK TIWARI

DEPARTMENT OF ELECTRICAL ENGINEERING

ANJUMAN-I-ISLAM'S KALSEKAR TECHNICAL CAMPUS

SCHOOL OF ENGINEERING & TECHNOLOGY, NEW PANVEL

(Affiliated to University of Mumbai)

FOR

ACADEMIC YEAR 2018-19

CERTIFICATE

Certified that the project report entitled **"Digital Control of BLDC Motor using Microcontroller and MOSFET"**is a bonafied work done under my guidance by

- Shaikh Shahbaz Aftab 16DEE80
- Ansari Mohd Shazeb Salam 16DEE55
- Sayyed Tosif Yusuf 16DEE72
- Shaikh Mairaj Altaf 16DEE77

During the academic year **2018-19**in partial fulfillment of the requirements for the award of degree of **Bachelor of Engineering in Electrical Engineering** from

Date-

Approved by Guide:- (Prof. VIVEK TIWARI)

(Prof. SAYYED KALEEM) (Dr. ABDUL RAZZAK HONNUTAGI)

Head of Department Director

CERTIFICATE OF APPROVAL

The foregoing dissertation entitled **"Digital Control of BLDC Motor using Microcontroller and MOSFET"** is hereby approved as a creditable study of Electrical Engineeringpresented by

- Shaikh Shahbaz Aftab 16DEE80
- Ansari Mohd Shazeb Salam 16DEE55
- Sayyed Tosif Yusuf 16DEE72
- Shaikh Mairaj Altaf 16DEE77

In a manner satisfactory to warrant is acceptance as a pre-requisite to their Degree in Bachelor of Electrical Engineering.

InternalExaminer ExternalExaminer

(Prof.Vivek Tiwari)

DECLARATION

We declare that this written submission represents my ideas in my own words and where others ideas or words have been included; We have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not represented or fabricated or falsified any idea/data/fact/source in my submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission have not been taken whenneeded.

Shaikh Shahbaz Aftab

Signature :-

Ansari Mohd Shazeb Salam

Signature:-

Sayyed Tosif Yusuf

Signature :-

Shaikh Mairaj Altaf

Signature :-

Acknowledgement

It is indeed a matter of great pleasure and proud privilege to be able to present this project on "**DIDGITAL CONTROL OF BLDC MOTOR USING MOSFET AND MICROCONTROLLER**" The completion of the project work which is partial fulfillment of Degree academic works is a milestone in student's life and its execution is inevitable in the hands of guide. I am highly indebted to the project guide **Prof. VIVEK TIWARI** for their invaluable guidance and appreciation for giving form and substance to this report. It is due to their enduring efforts, patience and enthusiasm which has given a sense of direction and purposefulness to this seminar report and ultimately made it success.

I would also like to express my deep regards and gratitude to my director, **Dr. Abdul Razzak Honnutagi** and Head of the Electrical Engineering Department, HOD **Prof. Sayyed Kaleem** for moral support and considerate attitude towards my short comings if any.

I would like to tender my sincere thanks to all faculties of Electrical Engineering Department and from other departments for their cooperation and invaluable advice.

Last but not least I extend my sincere thanks to supporting staff and my friends who helped directly or indirectly to complete my academic work.

Shaikh Shahbaz Aftab

Ansari Mohd Shazeb Salam

Sayyed Tosif Yusuf

Shaikh Mairaj Altaf

ABSTRACT

Now a day BLDC motor is becoming very famous in the department of aerospace, automation, computers, military, household appliances and traction applications because of its high competency and low maintenance cost. Because of this the four quadrant operation of BLDC motor is extremely important. BLDC motor control requires rotor position and speed measurements. In this project the modeling of BLDC motor drive system along with its control system have been presented using H-bridge type arrangement MOSFET work like a drive and for controlling purpose we use microcontroller AT 89S52.

CONTENTS

CHAPTER 1

INTRODUCTION

Energy saving is the main aim behind all the development and control of motors. Conventional dc motors have good control characteristics but their performances are reduced due to commutation problems. This commutation problems are completely absent in induction motors, but they have limitations such as stumpy power factor and deviating speed torque features. As a result of focusing on energy saving, the demand for variable speed permanent magnet motor drives has increased. The usage of motor drives in the field of automation also resulted in the increased demand for high efficiency PM motor drives. This give rise to the emergence of BLDC motors. New energy efficient electric drives using BLDC motor have been introduced to overcome the above mentioned limitations. The permanent magnet machines have better power factor and very good dynamic characteristics and low inertia. Compared to induction motor and other brushed dc motors, BLDC motors have many advantages such as higher efficiency, long operating life, higher speed ranges, noiseless operation etc. These qualities of permanent magnet BLDC motor results in widespread applications like aerospace, automation, computers robotics, electric vehicles etc.

1.1 SYSTEM OVERVIEW

In this project we can achieve four quadrant operation like forward motoring, forward braking, reverse motoring and reverse braking by using MOSFET IRF730 and microcontroller AT89s52 here MOSFET used as a motor derive and microcontroller preferred as controller It's not only control overall circuit but also its commending logical operation like 1- starting the motor 0-for stopping etc. we can step down 230V ac supply to in 12V then this 12V AC supply regulated by voltage regulator LM7805 This regulated voltage transmitted different section of project like a 5V transmitted on microcontroller circuit and LCD 12V transmitted on motor Derive circuit after that current was controlling by as per mode of operation given circuit microcontroller controlled overall circuit with the help of ALU and AT89S52 IC. Mode of operation like this manner clock wise (CW), counter clock wise (CC), forward braking (FB) and Reverse braking (RB).

Cristal circuit arranged with filter system its remove unwanted harmonics to the system also its help for smooth in operation capacitor passed on ac supply and block DC supply .in voltage regulator circuit rectifier also joint to a convert ac into DC because BLDC motor required dc supply requirement satisfying by rectifier circuit .in a logical circuit (1111111- 0000000) type arrangement used, same as for commanding purpose touch button used in a circuit and for free run and half run mode other switching are used finally result was shown on LCD.

1.2BLDC MOTOR AND CONTROLLER

BLDC motor can be projected as a brushed DC motor twisted inside out, where the permanent magnets are fixed on the rotor and windings on the stator. As a result, there are no brushes and commutator in this motor and thus all the drawbacks are connected with the flashing of brushes are eliminated. This motor is devoted to as a DC motor because its coils are driven power source. The Dc power is given to the windings on the stator. Here MOSFET and microcontroller is use for controlling speed as well as direction.

1.3 FOUR QUADRANT OPERATION

For a BLDC motor, four modes of operations namely forward motoring, forward braking, reverse motoring and reverse braking are possible. The operating modes are shown in the fig 1. In the first quadrant, both speed and torque is positive so motor rotates in forward direction. In second quadrant speed remains in positive direction but torque is in reverse direction. Reverse torque is used to brake the motor. Third quadrant is just opposite of the first quadrant. i.e., both speed and torque is negative so rotating in reverse direction. Exactly opposite of second quadrant is fourth where power is being produced. The supplied voltage is greater than back EMF during the motoring mode and is less than back EMF during generating mode.

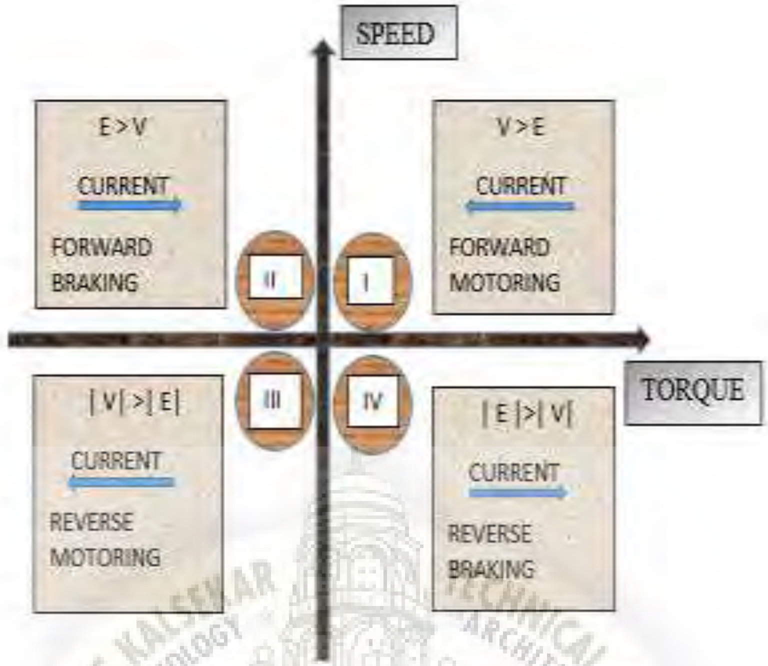


Fig. Four Quadrant Operation of BLDC Motor

CHAPTER 2

BLOCK DIAGRAM

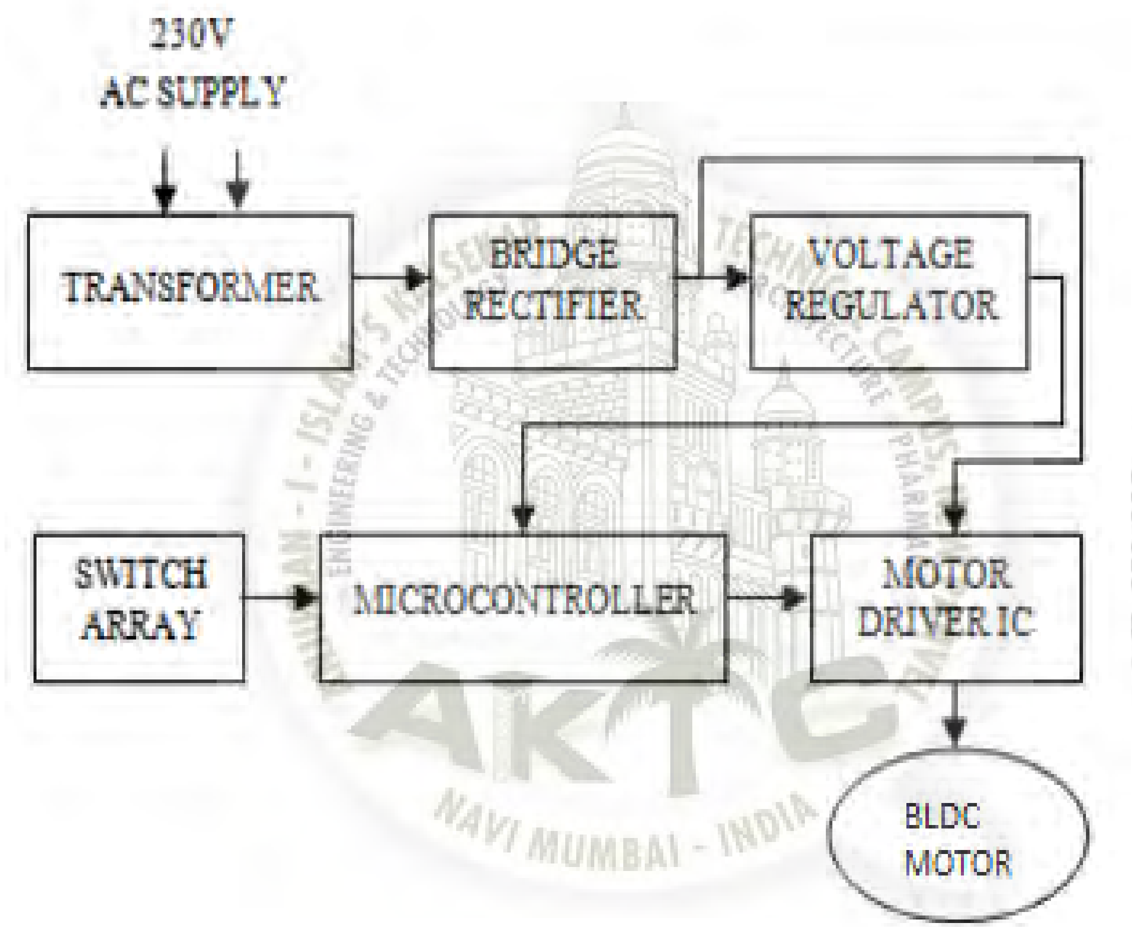


Fig. Block Diagram of Digital Control of BLDC Motor

CHAPTER 3

CIRCUIT DIAGRAM

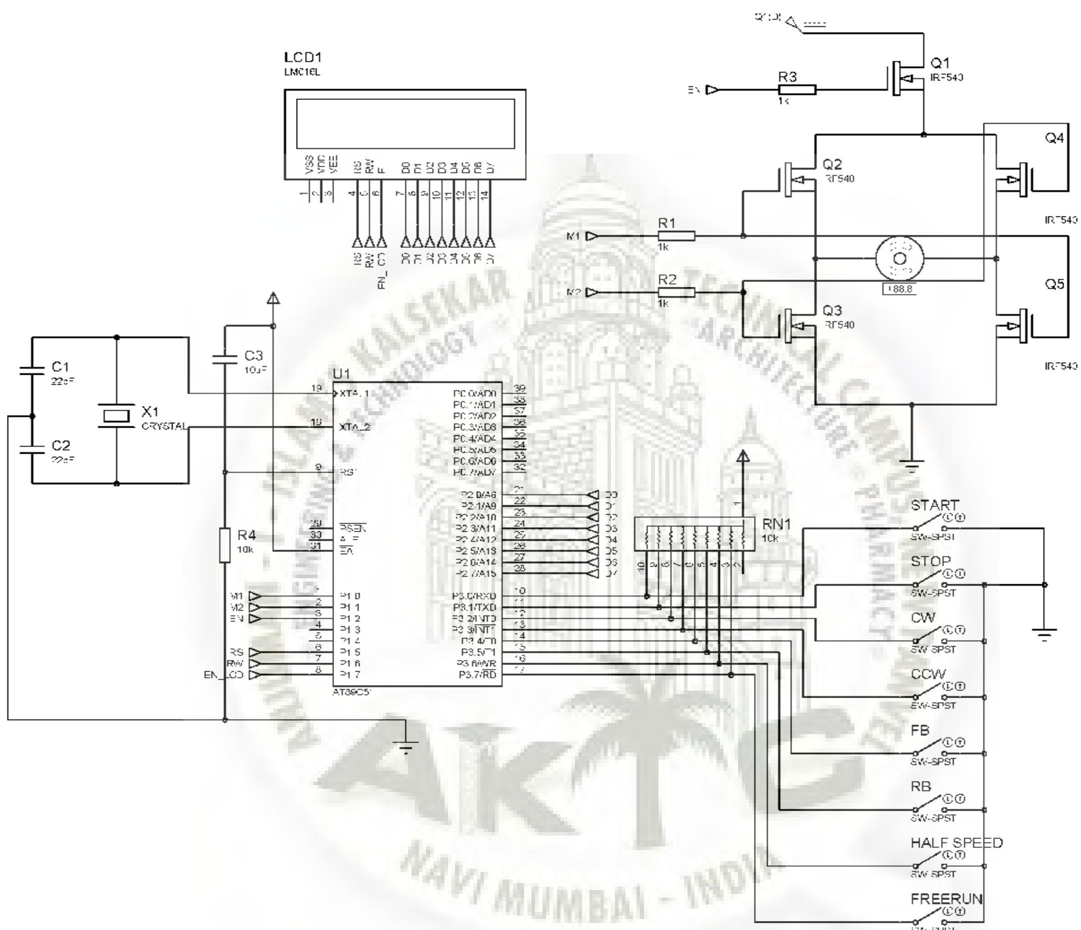


Fig. Circuit Diagram of Digital Control of BLDC Motor

CHAPTER 4

HARDWARE DESIGN

4.1 BLDC MOTOR

Fig. BLDC Motor

Description:

Geared DC motors can be defined as an extension of DC motor which already had its Insight details demystified here. A geared DC Motor has a gear assembly attached to the motor. The speed of motor is counted in terms of rotations of the shaft per minute and is termed as RPM .The gear assembly helps in increasing the torque and reducing the speed. Using the correct combination of gears in a gear motor, its speed can be reduced to any desirable figure. This concept where gears reduce the speed of the vehicle but increase its torque is known as gear reduction. This Insight will explore all the minor and major details that make the gear head and hence the working of geared DC motor. DC motors are used extensively in adjustable-speed drives and position control applications. Their speeds below the base speed can be controlled by armature-voltage control. Speeds above the base speed are obtained by field-flux control. As speed control methods for DC motors are simpler and less expensive than those for the AC motors, DC motors are preferred where wide speed range control is required.

4.2 LCD DISPLAY (JHD162A SERIES)

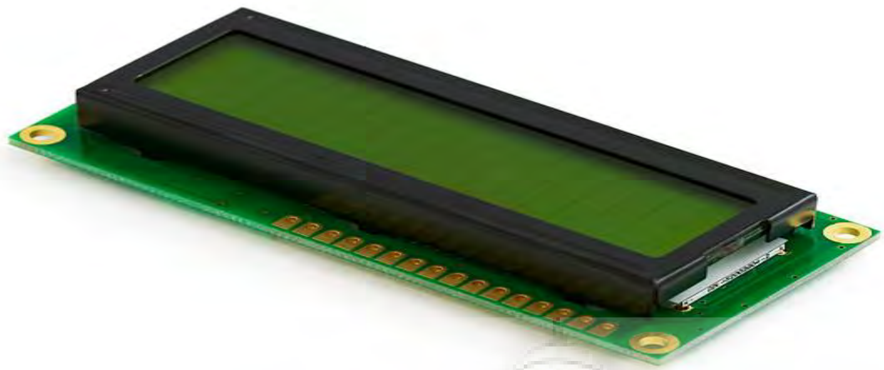


Fig. LCD Display

GENERAL SPECIFICATIONS

- Drive method: 1/16 duty cycle
- Display size: 16 character * 2 lines
- Character structure: 5*8 dots.
- Display data RAM: 80 characters (80*8 bits)
- Character generate ROM: 192 characters
- Character generate RAM: 8 characters (64*8 bits)
- Both display data and character generator RAMs can be read from MPU.
- Internal automatic reset circuit at power ON.
- Built in oscillator circuit.

Description

A liquid-crystal display (LCD) is a flat panel display, electronic visual display, or video display that uses the light modulating properties of liquid crystals. Liquid crystals do not emit light directly. LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images which can be displayed or hidden, such as preset words, digits, and 7-segment displays as in a digital clock.

LCD's are used in a wide range of application including computer monitors, television, instrument panels, aircraft cockpit displays, and signage. They are common in consumer devices such as video players, gaming devices, clocks, watches, calculators, and telephones, and have replaced cathode (CRT) displays in most applications. They are available in a wider range of screen sizes than CRT and plasma displays, and since they do not use phosphors, they do not suffer image burn-in. LCDs are, however, susceptible to image persistence.

The LCD screen is more energy efficient and can be disposed of more safely than a CRT. Its low electrical power consumption enables it to be used in battery-powered electronic equipment. It is an electronically modulated optical device made up of any number of segments filled with liquid crystals and arrayed in front of a light source (backlight) or reflector to produce images in color or monochrome.

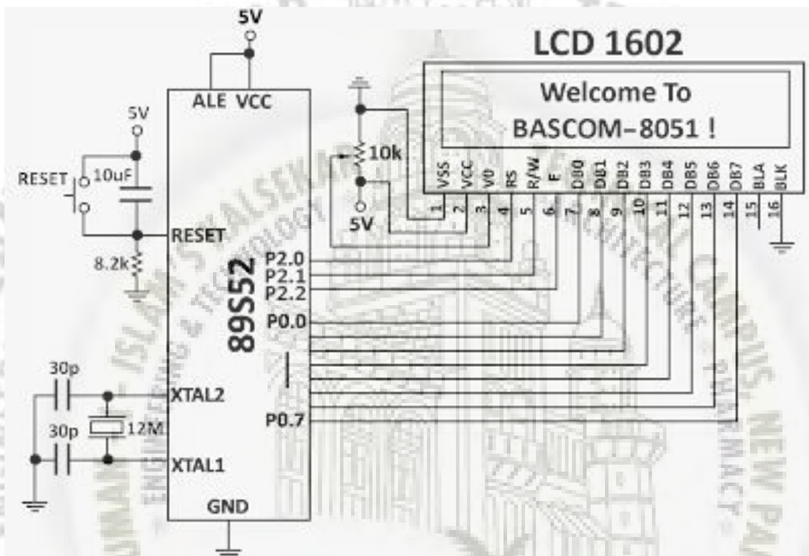


Fig. Connection of LCD

Important factors to consider when evaluating an LCD:

Resolution versus range: Fundamentally resolution is the granularity (or number of levels) with which a performance feature of the display is divided. Resolution is often confused with range or the total end-to-end output of the display. Each of the major features of a display has both a resolution and a range that are tied to each other but very different. Frequently the range is an inherent limitation of the display while the resolution is a function of the electronics that make the display work.

Spatial performance: LCDs come in only one size for a variety of applications and a variety of resolutions within each of those applications. LCD spatial performance is also sometimes described in terms of a "dot pitch". The size (or spatial range) of an LCD is always described in terms of the diagonal distance from one corner to its opposite. This is an historical remnant from the early days of CRT television when CRT screens were manufactured on the bottoms of glass bottles, a direct extension of cathode ray tubes used in oscilloscopes. The diameter of the bottle determined the size of the screen. Later, when televisions went to a more square format, the square screens were measured diagonally to compare with the older round screens. The spatial resolution of an LCD is expressed by the number of columns and rows of pixels (e.g., 1024×768). Each pixel is usually composed 3 sub-pixels, a red, a green, and a blue one. This had been one of the few features of LCD performance that was easily understood and not subject to interpretation. However there are newer schemes that share sub-pixels among pixels and to add additional colors of sub-pixels. So going forward, spatial resolution may now be more subject to interpretation. One external factor to consider in evaluating display resolution is the resolution of the viewer's eyes. Assuming 20/20 vision, the resolution of the eyes is about one minute of arc. In practical terms that means for an older standard definition TV set the ideal viewing distance was about 8 times the height (not diagonal) of the screen away. At that distance the individual rows of pixels merge into a solid. If the viewer were closer to the screen than that, they would be able to see the individual rows of pixels. When observed from farther away, the image of the rows of pixels still merge, but the total image becomes smaller as the distance increases. For an HDTV set with slightly more than twice the number of rows of pixels, the ideal viewing distance is about half what it is for a standard definition set. The higher the resolution, the closer the viewer can sit or the larger the set can usefully be sitting at the same distance as an older standard definition display. For a computer monitor or some other LCD that is being viewed from a very close distance, resolution is often expressed in terms of dot pitch or pixels per inch. This is consistent with the printing industry (another form of a display). Magazines, and other premium printed media are often at 300 dots per inch. As with the distance discussion above, this provides a very solid looking and detailed image. LCDs, particularly on mobile devices, are frequently much less than this as the higher the dot pitch, the more optically inefficient the display and the more power it burns. Running the LCD is frequently half, or more, of the power consumed by a mobile device. An additional consideration in spatial performance is viewing cone and aspect ratio. The Aspect ratio is the ratio of the width to the height (for example, 4:3, 5:4, and 16:9 or 16:10). Older, standard definition TVs were 4:3. Newer High Definition televisions (HDTV) are 16:9, as are most new notebook computers. Movies are often filmed in much different (wider) aspect ratios, which is why there will frequently still be black bars at the top and bottom of an HDTV screen. The Viewing Angle of an LCD may be important depending on its use or location. The viewing angle is usually measured as the angle where the contrast of the LCD falls below 10:1. At this point, the colors usually start to change and can even invert, red becoming green and so forth. Viewing angles for LCDs used to be very restrictive however; improved optical films have been developed that give almost 180 degree viewing angles from left to right. Top to bottom viewing angles may still be restrictive, by design, as looking at an LCD from an extreme up or down angle is not a common usage model and these photons are wasted. Manufacturers commonly focus the light in a left to right plane to obtain a brighter image here.

Temporal/timing performance: Contrary to spatial performance, temporal performance is a feature where smaller is better. Specifically, the range is the pixel response time of an LCD, or how quickly a sub-pixel's brightness changes from one level to another. For LCD monitors, this is measured in btb (black to black) or gtg (gray to gray). These different types of measurements make comparison difficult. Further, this number is almost never published in sales advertising.

Refresh rate or the temporal resolution of an LCD is the number of times per second in which the display draws the data it is being given. Since activated LCD pixels do not flash on/off between frames, LCD monitors exhibit no refresh-induced flicker, no matter how low the refresh rate. High-end LCD televisions now feature up to 240 Hz refresh rate, which requires advanced digital processing to insert additional interpolated frames between the real images to smooth the image motion. However, such high refresh rates may not be actually supported by pixel response times and the result can be visual artifacts that distort the image in unpleasant ways.

Temporal performance can be further taxed if it is a 3D display. 3D displays work by showing a different series of images to each eye, alternating from eye to eye. Thus a 3D display must display twice as many images in the same period of time as a conventional display, and consequently the response time of the LCD is more important. 3D LCDs with marginal response times will exhibit image smearing. These artifacts are most noticeable in a person's black and white vision (rod cells) than in color vision (cone cells). Thus they will be more likely to see flicker or any sort of temporal distortion in a display image by not looking directly at the display, because their eyes' rod cells are mostly grouped at the periphery of their vision.

Color performance: There are many terms to describe color performance of an LCD. They include color gamut which is the range of colors that can be displayed and color depth which is the color resolution or the resolution or fineness with which the color range is divided. Although color gamut can be expressed as three pairs of numbers, the XY coordinates within color space of the reddest red, greenest green, and bluest blue, it is usually expressed as a ratio of the total area within color space that a display can show relative to some standard such as saying that a display was "120% of NTSC". NTSC is the National Television Standards Committee, the old standard definition TV specification. Color gamut is a relatively straight forward feature. However with clever optical techniques that are based on the way humans see color, termed color stretch, colors can be shown that are outside of the nominal range of the display. In any case, color range is rarely discussed as a feature of the display as LCDs are designed to match the color ranges of the content that they are intended to show. Having a color range that exceeds the content is a useless feature.

Color depth or color support is sometimes expressed in bits, either as the number of bits per sub-pixel or the number of bits per pixel. This can be ambiguous as an 8-bit color LCD can be 8 total bits spread between red, green, and blue or 8 bits each for each color in a different display. Further, LCDs sometimes use a technique called dithering which is time averaging colors to get intermediate colors such as alternating between two different colors to get a color in between. This doubles the number of colors that can be displayed; however this is done at the expense of the temporal performance of the display. Dithering is commonly used on computer displays where the images are mostly static and the temporal performance is unimportant. When color depth is reported as color support, it is usually stated in terms of number of colors the LCD can show. The number of colors is the translation from the base 2-bit numbers into common base-10. For example, 8-bit color is 2 to the 8th power, which is 256 colors. 24-bit color is 2 to the 24th power, or 256 x 256 x 256, a total of 16,777,216 colors. The color resolution of the human eye depends on both the range of colors being sliced and the number of slices; but for most common displays the limit is about 28-bit color. LCD TVs commonly display more than that as the digital processing can introduce color distortions and the additional levels of color are needed to ensure true colors. There are additional aspects to LCD color and color management, such as white point and gamma correction, which describe what color white is and how the other colors are displayed relative to white. LCD televisions also frequently have facial recognition software, which recognizes that an image on the screen is a face and both adjust the color and the focus differently from the rest of the image. These adjustments can have important effects on the consumer, but are not easily quantifiable; people like what they like and everyone does not like the same thing. There is no substitute for looking at the LCD one is going to buy before buying it. Portrait film, another form of display, has similar adjustments built into it. Many years ago, Kodak had to overcome initial rejection of its portrait film in Japan because of these adjustments. In the U.S., people generally prefer a more colorful facial image than in reality (higher color saturation). In Japan, consumers generally prefer a less saturated image. The film that Kodak initially sent to Japan was biased in the wrong direction for Japanese consumers. Television monitors have their built-in biases as well.

Brightness and contrast ratio: Contrast ratio is the ratio of the brightness of a full-on pixel to a full-off pixel and, as such, would be directly tied to brightness if not for the invention of the blinking backlight (or burst dimming). The LCD itself is only a light valve and does not generate light; the light comes from a backlight that is either a fluorescent tube or a set of LEDs. The blinking backlight was developed to improve the motion performance of LCDs by turning the backlight off while the liquid crystals were in transition from one image to another. However, a side benefit of the blinking backlight was infinite contrast. The contrast reported on most LCDs is what the LCD is qualified at, not its actual performance. In any case, there are two large caveats to contrast ratio as a measure of LCD performance. The first caveat is that contrast ratios are measured in a completely dark room. In actual use, the room is never completely dark, as one will always have the light from the LCD itself. Beyond that, there may be sunlight coming in through a window or other room lights that reflect off of the surface of the LCD and degrades the contrast. As a practical matter, the contrast of an LCD, or any display, is over performance of the display.

Data Sheet

Parameters	Symbols	Testing Criteria	Standard values			Unit
			Min.	Typ.	Max.	
Supply voltage	VDD-VSS	-	4.5	5.0	5.5	V
Input high voltage	VIH	-	2.2	-	VDD	V
Input low voltage	VIL	-	-0.3	-	0.6	V
Output high voltage	VOH	- IOH=02mA	2.4	-	-	V
Output low voltage	VOL	IOL=1.2mA	-	-	0.4	V
Operating voltage	IDD	VDD=5.0V	-	1.5	3.0	mA

4.3 MICROCONTROLLER (AT89S52)

Fig. Microcontroller (AT89S52)

General Specifications

- Compatible with MCS®-51 Products
- 8K Bytes of In-System Programmable (ISP) Flash Memory – Endurance: 10,000 Write/Erase Cycles
- 4.0V to 5.5V Operating Range
- Fully Static Operation: 0 Hz to 33 MHz
- Three-level Program Memory Lock
- 256 x 8-bit Internal RAM
- 32 Programmable I/O Lines
- Three 16-bit Timer/Counters
- Eight Interrupt Sources
- Full Duplex UART Serial Channel
- Low-power Idle and Power-down Modes
- Interrupt Recovery from Power-down Mode
- Watchdog Timer

• Power-off Flag

• Fast Programming Time

Description

The AT89S52 is a low-power, high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory. The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the industry-standard 80C51 instruction set and pin out. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with in-system programmable Flash on a monolithic chip, the Atmel AT89S52 is a powerful microcontroller which provides a highly-flexible and cost-effective solution to many embedded control applications. The AT89S52 provides the following standard features: 8K bytes of Flash, 256 bytes of RAM, 32 I/O lines, Watchdog timer, two data pointers, three 16-bit timer/counters, a six-vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator, and clock circuitry. In addition, the AT89S52 is designed with static logic for operation down to zero

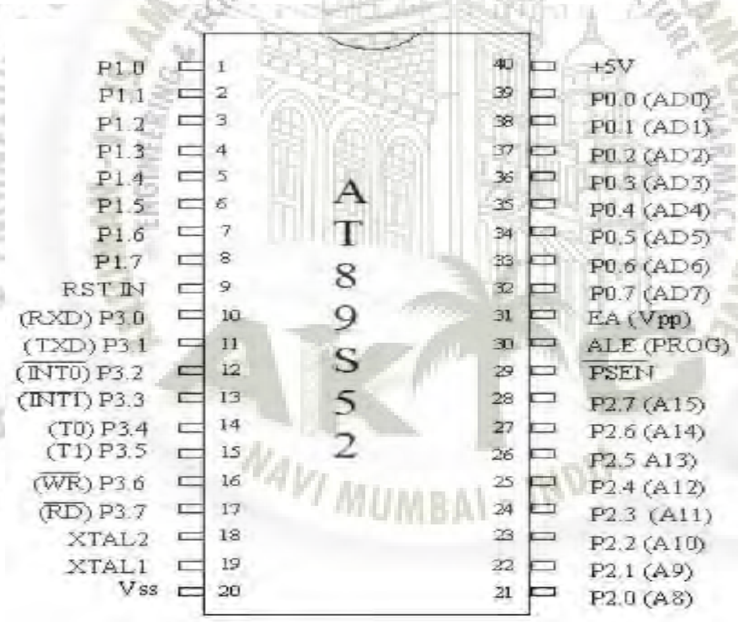


Fig. PIN Diagram of Microcontroller

frequency and supports two software selectable power saving modes. The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port, and interrupt system to continue functioning. The Power-down mode saves the RAM con-tents but freezes the oscillator, disabling all other chip functions until the next interrupt or hardware reset. 8-bit Microcontroller with 8K Bytes In-System Programmable Flash AT89S52.

4.4 MOSFET (IRF730)

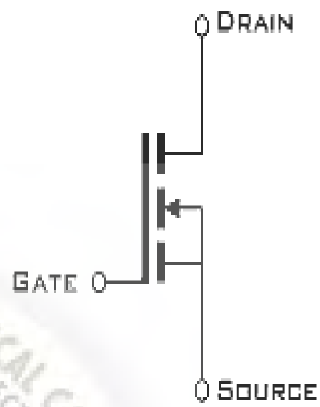


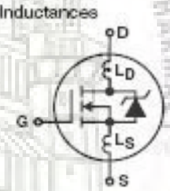
Fig. MOSFET (IRF730)

Description

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

Data Sheet

Electrical Specifications $T_C = 25^oC$, Unless Otherwise Specified

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Drain to Source Breakdown Voltage	BV_{DSS}	$I_D = 250\mu A$, $V_{GS} = 0V$ (Figure 10)	400	-	-	V
Gate Threshold Voltage	$V_{GS(TH)}$	$V_{DS} = V_{GS}$, $I_D = 250\mu A$	2.0	-	4.0	V
Zero Gate Voltage Drain Current	I_{DSS}	V_{DS} = Rated BV_{DSS}, $V_{GS} = 0V$	-	-	25	μA
		V_{DS} = 0.8 x Rated BV_{DSS}, $V_{GS} = 0V$, $T_J = 125^oC$	-	-	250	μA
On-State Drain Current (Note 2)	$I_{D(ON)}$	$V_{DS} > I_{D(ON)} \times r_{DS(ON)MAX}$, $V_{GS} = 10V$ (Figure 7)	5.5	-	-	A
Gate to Source Leakage Current	I_{GSS}	$V_{GS} = \pm 20V$	-	-	±100	nA
Drain to Source On Resistance (Note 2)	$r_{DS(ON)}$	$I_D = 3.0A$, $V_{GS} = 10V$ (Figure 8, 9)	-	0.800	1.000	Ω
Forward Transconductance (Note 2)	g_{fs}	$V_{DS} \geq 10V$, $I_D = 3.3A$ (Figure 12)	2.9	4.4	-	S
Turn-On Delay Time	$t_{d(ON)}$	$V_{DD} = 200V$, $I_D \approx 5.5A$, $R_{GS} = 12\Omega$, $R_L = 35\Omega$ MOSFET Switching Times are Essentially Independent of Operating Temperature	-	10	17	ns
Rise Time	t_r		-	20	29	ns
Turn-Off Delay Time	$t_{d(OFF)}$		-	35	56	ns
Fall Time	t_f		-	15	24	ns
Total Gate Charge (Gate to Source + Gate to Drain)	$Q_{g(TOT)}$	$V_{GS} = 10V$, $I_D = 5.5A$, V_{DS} = 0.8 x Rated BV_{DSS}, $I_{g(REF)} = 1.5mA$, (Figure 14) Gate Charge is Essentially Independent of Operating Temperature	-	20	35	nC
Gate to Source Charge	Q_{gs}		-	3.0	-	nC
Gate to Drain "Miller" Charge	Q_{gd}		-	10	-	nC
Input Capacitance	C_{ISS}	$V_{DS} = 25V$, $V_{GS} = 0V$, f = 1MHz (Figure 11)	-	600	-	pF
Output Capacitance	C_{OSS}		-	150	-	pF
Reverse Transfer Capacitance	C_{RSS}		-	40	-	pF
Internal Drain Inductance	L_D	Measured From the Contact Screw on Tab to Center of Die; Modified MOSFET Symbol Showing the Internal Device Inductances 	-	3.5	-	nH
		Measured From the Drain Lead, 6mm (0.25in) From Package to Center of Die	-	4.5	-	nH
Internal Source Inductance	L_S	Measured From the Source Lead, 6mm (0.25in) From Header to Source Bonding Pad	-	7.5	-	nH
Thermal Resistance Junction to Case	$R_{\theta JC}$		-	-	1.67	$^oC/W$
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	Free Air Operation	-	-	80	$^oC/W$

4.5 VOLTAGE REGULATOR

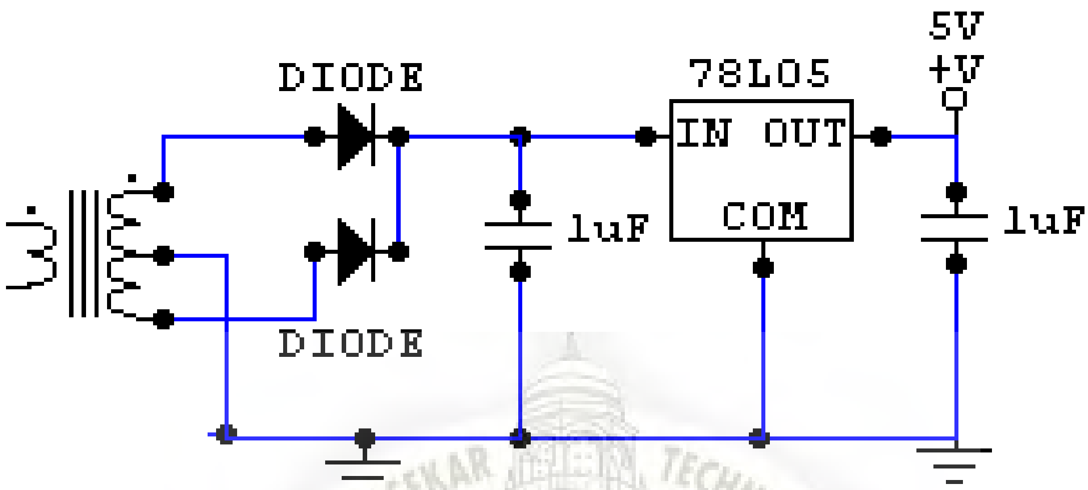


Fig. Voltage Regulator

LM7805 SERIES VOLTAGE REGULATOR

A voltage regulator is an electrical regulator designed to automatically maintain a constant voltage level. It may use an electromechanical mechanism, or passive or active electronic components. Depending on the design, it may be used to regulate one or more AC or DC voltages. With the exception of shunt regulators, all voltage regulators operate by comparing the actual output voltage to some internal fixed reference voltage. Any difference is amplified and used to control the regulation element. This forms a negative feedback servo control loop. If the output voltage is too low, the regulation element is commanded to produce a higher voltage. If the output voltage is too high, the regulation element is commanded to produce a lower voltage. In this way, the output voltage is held roughly constant.

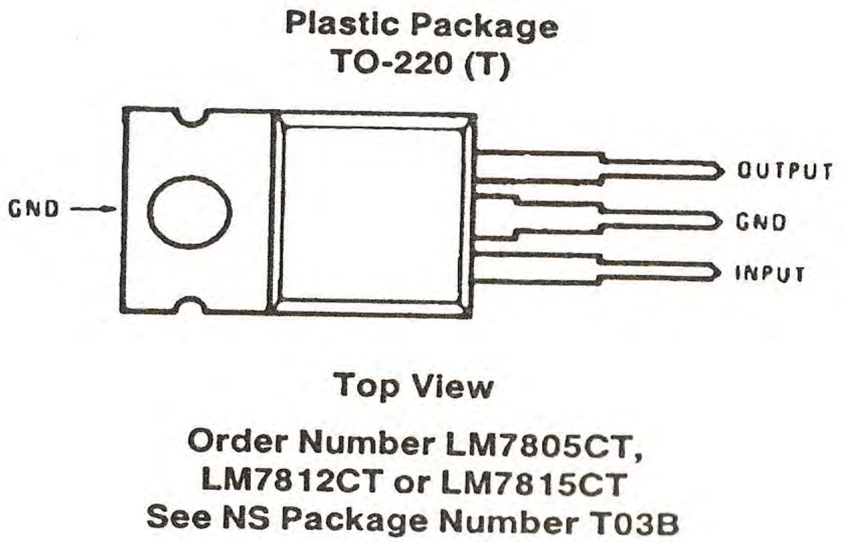


Fig. 7805 IC DIAGRAM

Description

The LM78XX series of three terminal regulators is available with several fixed output voltages making them useful in a wide range of applications.

One of these is local on card regulation, eliminating the distribution problems associated with single point regulation.

The voltages available allow these regulators to be used in logic systems, instrumentation, Hi-Fi, and other solid-state electronic equipment.

Although designed primarily as fixed voltage regulators these devices can be used with external components to obtain adjustable voltages and currents.

The LM78XX series is available in an aluminumTO-3 package, which will allow over 1.0A load current if adequate heat sinking is provided.

Current limiting is included to limit the peak output current to a safe value.

Safe area protection for the output transistor is provided to limit internal power dissipation.

If internal power dissipation becomes too high for the heat sinking provided, the thermal shutdown circuit takes over preventing the IC from overheating.

Considerable effort was expanded to make the LM78XX series of regulators easy to use and minimize the number of external components. It is not necessary to bypass the output, although this does improve transient response.

Input bypassing is needed only if the regulator is located far from the filter capacitor of the power supply.

For output voltage other than 5V, 12V and 15V the LM117series provides an output voltage range from 1.2V to 57V.

4.6 TYPICAL APLLICATION CIRCUIT

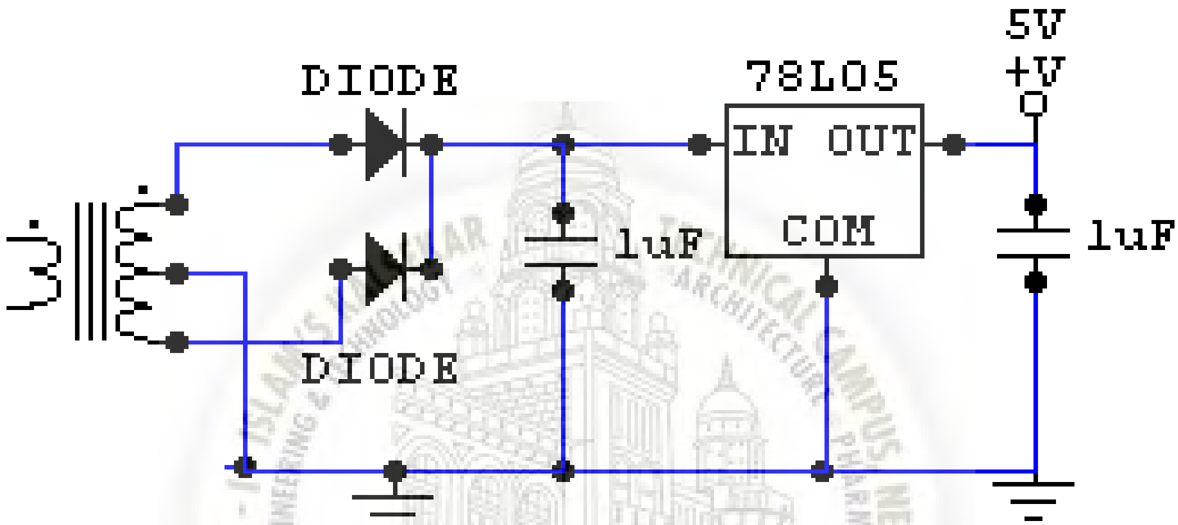


Fig. Typical Application Circuit

In our project we require power supply of 5V. From the mains supply we get 230V, 50 Hz. So to convert that configuration into the required configuration we need to use following circuits with signal conditioners:

- STEP DOWN TRANSFORMER
- FULL WAVE BRIDGE RECTIFIER
- FILTER CONDENSER
- D.C. REGULATED 3 PIN I .C.

Transformer here used is the center tapped step down transformer. The primary winding turns are greater than that of the secondary. Input supply to primary is 230V, 50 Hz that produces the 0-24V at the secondary. Secondary of the transformer is connected to the full wave bridge rectifier. It gives unipolar waveform of the transformer output. It converts the a.c. supply into d.c. voltage.

Output at the bridge rectifier is:

$$Vdc=2*(Vin)/pi$$

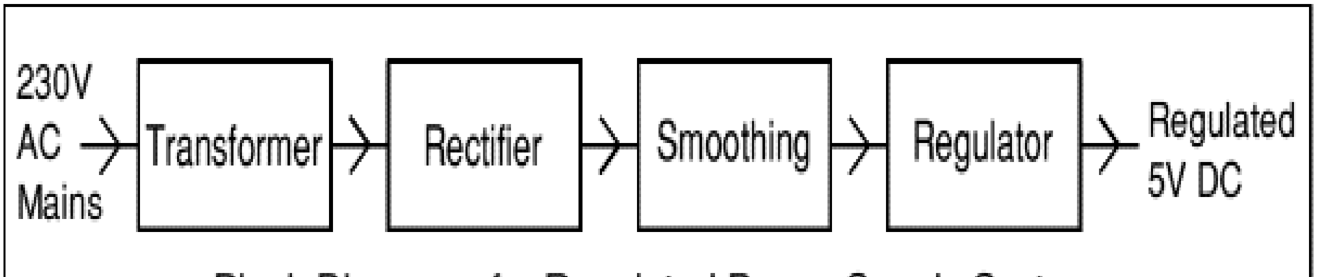
$$Vrms=Vm/\sqrt{2}$$

But output obtained from the rectifier is not complete ripple free and contains the ac nature. Thus it needs to be smoothened using filter condenser. Here the capacitor assembly allows only its rated voltage through it for one cycle. Property of capacitor to be insensitive to the high frequency at the input side helps to have smooth output.

Sometimes, due to mains power supply fluctuation and the ageing of the circuit components the output fails to remain at constant level. Thus we need to add the voltage regulators.

Due to the high voltage operating temperatures there may be heat generation, which leads to the sparks or may even catch fire and damage the whole circuitry. Thus we use heat sink. All the output is then connected to the connector to provide the supply for remaining circuit.

4.7 POWER SUPPLY



Block Diagram of a Regulated Power Supply System

Description:

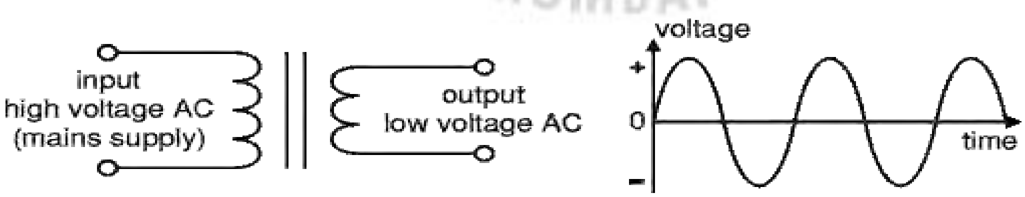
There are many types of power supply. Most are designed to convert high voltage AC mains electricity to a suitable low voltage supply for electronic circuits and other devices. A power supply can by broken down into a series of blocks, each of which performs a particular function. For example a 5V regulated supply: Each of the blocks is described in more detail below:

- Transformer - steps down high voltage AC mains to low voltage AC.
- Rectifier - converts AC to DC, but the DC output is varying.
- Smoothing - smoothes the DC from varying greatly to a small ripple.
- Regulator - eliminates ripple by setting DC output to a fixed voltage.

Power supplies made from these blocks are described below with a circuit diagram and a graph of their output:

- Transformer only
- Transformer + Rectifier
- Transformer + Rectifier + Smoothing
- Transformer + Rectifier + Smoothing + Regulator

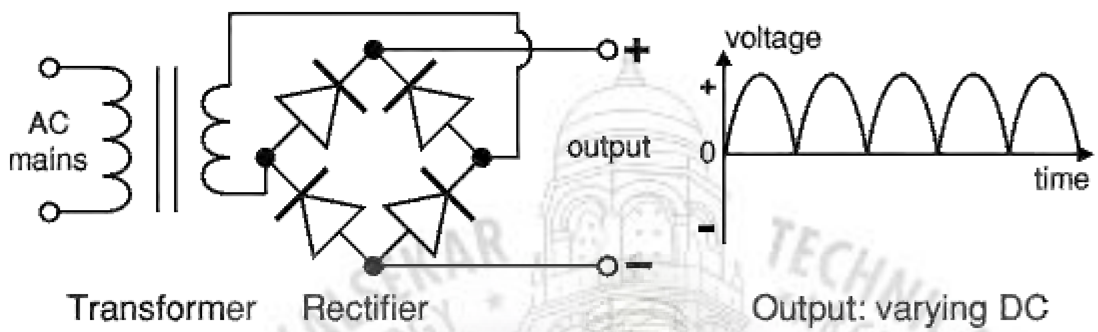
Transformer only:



Transformer Output: low voltage AC

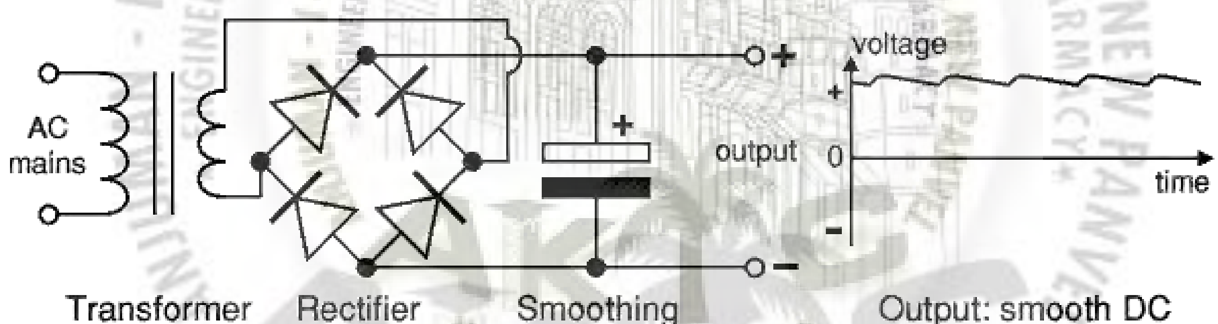
The low voltage AC output is suitable for lamps, heaters and special AC motors. It is not suitable for electronic circuits unless they include a rectifier and a smoothing capacitor.

Transformer + Rectifier



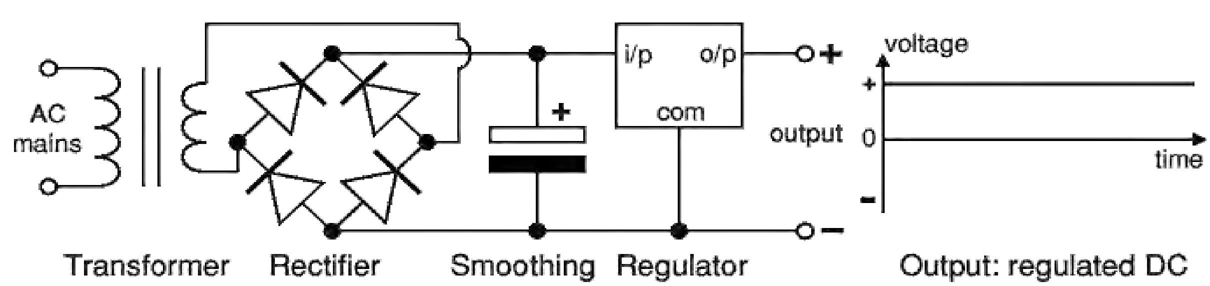
The varying DC output is suitable for lamps, heaters and standard motors. It is not suitable for electronic circuits unless they include a smoothing capacitor.

Transformer + Rectifier + Smoothing



The smooth DC output has a small ripple. It is suitable for most electronic circuits.

Transformer + Rectifier + Smoothing + Regulator:



The regulated DC output is very smooth with no ripple. It is suitable for all electronic circuits.

The fig. above shows the circuit diagram of the power supply unit. This block mainly consists of a two regulating IC 7805 and a bridge rectified and it provides a regulated supply approximately 5V.

The transformer used in this circuit has secondary rating of 7.5V. The main function of the transformer is to step down the AC voltage available from the main. The main connections are given to its primary winding through a switch connected to a phase line. The transformer provides a 7.5V AC output at its secondary terminals and the maximum current that can be drawn form the transformer is 1 Amp which is well above the required level for the circuit

The bridge rectified the AC voltage available from the secondary of the transformer, i.e. the bridge rectifier convert the AC power available into DC power but this DC voltage available is not constant. It is a unidirectional voltage with varying amplitude.

To regulate the voltage from the bridge rectifier, capacitors are connected. Capacitors C1 filter the output voltage of the rectifier but their output is not regulated and hence 7805 is connected which is specially designed for this purpose.

Although voltage regulators can be designed using op-amps, it is quicker and easier to use IC voltage regulator. Furthermore, IC voltage regulators are available with features such as programmable output current/ voltage boosting, internal short circuit current limiting, thermal shut down and floating operation for high voltage applications.

The 78 XX series consists of three terminals viz, input, output & ground. This is a group of fixed positive voltage regulator to give and output voltage ranging form 5V to 24V. These IC's are designed as fixed voltage regulators and with adequate heat sinking, can delivery output current in excess of 1 Amp

Although these devices do not require external components and such components can be used to obtain adjustable voltage and current limiting. In addition, the difference between the input and output voltages (V in Vo) called the dropout voltage must be typically 2V even from a power supply filter. Capacitors C2, C3, C4, and C5 are small filters which are used for extra filtering.LED1& LED2 are used for Power ON indicator for IC1 and IC2, current-limiting resistors R2&R4, which prevents the LED's from getting heated and thus damaged.

4.8PCB DESIGN:-

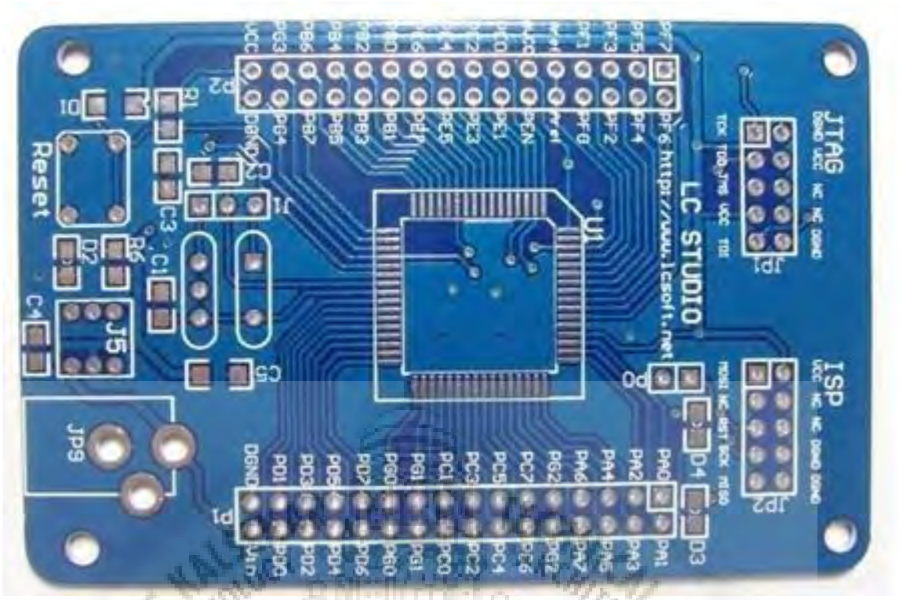


Fig. PCB Design

P.C.B. is printed circuit board which is of insulating base with layer of thin copper-foil. The circuit diagram is then drawn on the P. C. B. with permanent marker and then it is dipped in the solution of ferric chloride so that unwanted copper is removed from the P.C.B., thus leaving components interconnection on the board.

The specification of the base material is not important to know in most of the application, but it is important to know something about copper foil which is drawn through a thin slip.

The resistance of copper foil will have an effect on the circuit operation. Base material is made of lamination layer of suitable insulating material such as treated paper, fabric; or glass fibers and binding them with resin. Most commonly used base materials are formed paper bonded with epoxy resin.

It is possible to obtain a range of thickness between 0.5 mm to 3 mm. Thickness is the important factor in determining mechanical strength particularly when the commonly used base material is “**Formea”** from paper assembly.

Physical properties should be self-supporting these are surface resistivity, heat dissipation, dielectric, constant, dielectric strength. Another important factor is the ability to withstand high temperature.

Design and Layout:

While designing a layout, it must be noted that size of the board should be as small as possible. Before starting, all components should be placed properly so that an accurate measurement of space can be made. The component should not be mounted very close to each other or far away from one another and neither one should ignore the fact that some component reed ventilation, which considerably the dimension of the relay and transformer in view of arrangement, the bolting arrangement is also considered. The layout is first drawn on paper then traced on copper plate which is finalized with the pen or permanent marker which is efficient and clean with etching. The resistivity also depends on the purity of copper, which is highest for low purity of copper. The high resistance path is always undesired for soldered connections.

The most difficult part of making an original printed circuit is the conversion from, theoretical circuit diagram into wiring layout without introducing cross over and undesirable effect. Although it is difficult operation, it provides greatest amount of satisfaction because it is carried out with more care and skill.

The board used for project has copper foil thickness in the range of 25 40 75 microns. The soldering quality requires 99.99% efficiency. The copper may be required to carry an extra-large overall current:-It acts like a kind of screen or ground plane to minimize the effect of interaction. The first function is to connect the components together in their right sequence with minimum need for interlinking i.e. the jumpers with wire connections. It must be noted, that when layout is done, on the next day it should be dipped in the solution and board is move continuously right and left after etching perfectly the board is cleaned with water and is drilled. After that holes are drilled with 1 mm or 0.8 mm drill. Now the marker on the P. C. B. is removed. The Printed Circuit Board is now ready for mounting the components on it.

Soldering:

For soldering of any joints first the terminal to be soldered are cleaned to remove oxide film or dirt on it. If required flux is applied on the points to be soldered.

Now the joint to be soldered is heated with the help of soldering iron. Heat applied should be such that when solder wire is touched to joint, it must melt quickly.

The joint and the soldering iron is held such that molten solder should flow smoothly over the joint.

When joint is completely covered with molten solder, the soldering iron is removed. The joint is allowed to cool, without any movement. The bright shining solder indicates good soldering.

In case of dry solder joint, a air gap remains in between the solder maternal and the joint. It means that soldering is improper. This is removed and again soldering is done. Thus is this way all the components are soldered on P. C. B.

CHAPTER 5

SOFTWARE DESIGN

5.1SOFTWARE PROJECT MANAGEMENT PLAN

Project Deliverables:

The following are the deliverables of the Project:

1. GUIs made using Microsoft Visual Studio
2. Database using Microsoft Access
3. Executable Files.
4. DLL Files.
5. Help Files.

Project Organization

Software Process Model

The model used is Classic Life Cycle Model

- The Project team is meeting once a week to discuss the progress made by each member and to share the relevant information and be documents that have been prepared. The number of meetings may increase during the final semester as the team members will have more time.
- The major milestones to be achieved are as follows:
    1. Results of research of existing system and discussions with the Project leader.
    2. Results of interview with experts and team meetings to finalize the requirements of the software.
    3. Results of the Design Phase, which include a number of modeling diagrams, like the use cases, class diagrams, etc.
    4. Results of the first coding phase will be an initial code that will be then tested.
    5. Based on the results of the testing, they code will be reviewed in the second coding phase.

Tools and Techniques

We will require the following tools:

1. Microsoft Visual Studio 2005.
2. Microsoft Office 2003.

Project Management Plan:

Tasks

The following tasks are to be executed:-

1. Requirement Analysis Phase 1
2. Requirement Analysis Phase 2
3. Design of System
4. Coding Phase 1
5. Coding Phase 2
6. Testing Phase 1

Requirement analysis:

1. Requirement Analysis Phase 1: This will include the research of existing software and a discussion with the Project guide.
2. Requirement Analysis Phase 2: Based on the above results, the project team will discuss and finalize the requirements that are to be provided. We shall consult a number of experts during this phase. The SPMP shall also be prepared during this phase.

Design Phase: The design phase will involve the design of the static view, dynamic view, and the functional view of the software. A number of diagrams including the Use case, class diagram, activity diagram, and data flow diagrams will be used to model the software. Also, the GUIs will be designed during this phase

Coding Phase 1: The prerequisite to this phase is the study of Microsoft Visual basic6. After this study, an initial code of the entire project will be written. Also, the database will be created during this phase. Finally, we shall conduct unit tests.

Coding Phase 2: This phase will include a review of the code created in Phase 1. After the review, the necessary code and database will be modified to include the results of review.

Testing Phase: We shall be following a testing program that will involve unit testing, integration testing, and validation testing. More information will be known after further discussion.

5.2 EMBEDDED C:

Embedded C is a set of language extensions for the C Programming language by the C Standards committee to address commonality issues that exist between C extensions for different embedded. Historically, embedded C programming requires nonstandard extensions to the C language in order to support exotic features such as fixed-point arithmetic, multiple distinct memory, and basic I/O operations.

In 2008, the C Standards Committee extended the C language to address these issues by providing a common standard for all implementations to adhere to. It includes a number of features not available in normal C, such as, fixed-point arithmetic, named address spaces, and basic I/O hardware addressing.

Embedded C use most of the syntax and semantics of standard C, e.g., main () function, variable definition, data type declaration, conditional statements (if, switch. case), loops (while, for), functions, arrays and strings, structures and union, bit operations, macros, unions, etc.

5.3 FLASH MAGIC:

Flash Magic is a tool which used to program hex code in EEPROM of micro-controller. it is a freeware tool. It only supports the micro-controller of Philips and NXP. You can burn a hex code into that controller which supports ISP (in system programming) feature. To check whether your micro-controller supports ISP or not take look at its datasheet. So if your device supports ISP then you can easily burn a hex code into EEPROM of your device. Flash magic supports several chips like ARM Cortex M0, M3, M4, ARM7 and 8051

Flash Magic is an application developed by Embedded Systems Academy to allow you to easily access the features of a microcontroller device. With this program you can erase individual blocks or the entire Flash memory of the microcontroller.

This application is very useful for those who work in the electronics field. The main window of the program is composed of five sections where you can find the most common functions in order to program a microcontroller device. Using the “Communications” section you will be able to choose the way a specific device connects to your computer. Select the COM port to be used and the baud rate.

It is recommended that you choose a low baud rate first and increase it afterwards. This way you will determine the highest speed with which your system works. In order to select which parts of the memory to erase, choose from the items in the “Erase” section. The third section is optional. It offers you the possibility to program a HEX file. In the next section you will be able to find different programming options, such as “verify after programming”, “gen block checksums”, “execute” and others. When you’re done, click the Start button that can be found in the “Start” section. The program will start the device, and you will able to see the progress of the operations at the bottom of the main window. Using Flash magic, you are to perform different operations to microcontroller device, operations like erasing, programming and reading the flash memory, modifying the Boot Vector, performing a blank check on a section of the Flash memory and many others.

5.4KEIL U VISION SOFTWARE:

Keil development tools for the 8051 Microcontroller Architecture support every level of software developer from the professional applications engineer to the student jus learning about embedded software development. The industry-standard Keil C Compilers, Maco Assemblers, Debuggers, Real time Kernrls, Single-board Computers, and Emulators support all 8051 derivatives and help you get your projects completed on schedule.

The Keil 8051 Development Tools are designed to solve the complex problems facing embedded software developers.

- When starting a new project, simply select the microcontroller you use from the Device Database and the µVision IDE sets all compiler, assembler, linker, and memory options for you.
- Numerous example programs are included to help you get started with the most popular embedded 8051 devices.
- The Keil µVision Debugger accurately simulates on-chip peripherals (I^2C, CAN, UART, SPI, Interrupts, I/O Ports, A/D Converter, D/A Converter, and PWM Modules) of your 8051 device. Simulation helps you understand hardware configurations and avoids time wasted on setup problems. Additionally, with simulation, you can write and test applications before target hardware is available.

5.5EXPRESS PCB SOFTWARE:

PCB is an open source software suite for electronic design automation (EDA) - for printed circuit boards (PCB) layout.

HISTORY:

PCB was first written by Thomas Nau for an Atari ST in 1990 and ported to UNIX and X11 in 1994. Initially PCB was not intended to be a professional layout system but as a tool for individuals to do small-scale development of hardware.[1][2]Harry Eaton took over pcb development beginning with Release 1.5, although he contributed some code beginning with Release 1.4.3

FEATURES:

- Scalable fonts
- Layer groups to keep signals together
- Add on device drivers
- Gerber RS-274X and NC Drill output support
- Centeroid (X-Y) data output

- PostScript and Encapsulated PostScript output
- Rats-nest generation from simple net lists
- Automatic clearance around pins that pierce a polygon
- Flags for pins and vias
- Groups of action commands can be undone by a single undo
- Simple design rule checker (DRC) - checks for minimum spacing and overlap rules
- Drawing directly on the silk layer
- Viewable solder-mask layers and editing
- Netlist window
- Netlist entry by drawing rats
- Auto router
- Snap to pins and pads
- Element files and libraries that can contain whole sub-layouts, metric grids
- Up to 16 copper layer designs by default
- Trace optimizer
- Rats nest
- Connectivity verification
- Can interoperate with free schematic capture tools such as gEDA and XCircuit

CHAPTER 6
PROGRAMING

6.1 PROJECT OPERATION CODE:

```
#include<reg52.h>

#include<stdio.h>

#include<lcd.h>

sbit motor_pin_1 = P1^0;

sbit motor_pin_2 = P1^1;

sbitmotor_en = P1^2;

sbit START = P3^0; //FE

sbit STOP = P3^1; // FD

sbit CW = P3^2; // FB

sbit CCW = P3^3; // F7

sbit FB = P3^4; // EF

sbit RB = P3^5; // DF

sbit HALF_SPEED = P3^6; // BF

sbit FREERUN = P3^7; // 7F

sfr input = 0xB0;

voidmsdelay(unsigned int value)

{

unsignedintx,y;

for(x=0;x<value;x++)

for(y=0;y<1275;y++);

}

void main()
```

```
{
lcd_ini();
motor_en = 0;
motor_pin_1 = 0;
motor_pin_2 = 0;
lcd_command(0x80);
lcd_dataa("DIGITAL CONTROL ");
lcd_command(0xC0);
lcd_dataa(" FOR BLDC MOTOR ");
msdelay(1000);
while(1)
{
 if(input==0xFE) // MOTOR START   -  MOMENT SWT
  {
  lcd_command(0x80);
  lcd_dataa("MOTOR START     ");
  lcd_command(0xC0);
  lcd_dataa("                ");
  motor_en = 1;
  motor_pin_1 = 0;
  motor_pin_2 = 1;
  }
 else if(input==0xFD) //MOTOR STOP  - MOMENT SWT
  {
 lcd_command(0x80);
```

```
lcd_dataa("MOTOR STOP      ");
lcd_command(0xC0);
lcd_dataa("                ");
motor_en = 1;
motor_pin_1 = 0;
motor_pin_2 = 0;
}
else if(input==0xFB) //MOTOR CW    MOMENT SWT
{
lcd_command(0x80);
lcd_dataa("MOTOR CW        ");
lcd_command(0xC0);
lcd_dataa("                ");
motor_en = 1;
motor_pin_1 = 0;
motor_pin_2 = 1;
}
else if(input==0xF7) //MOTOR CCW  -  MOMENT SWT
{
lcd_command(0x80);
lcd_dataa("MOTOR CCW       ");
lcd_command(0xC0);
lcd_dataa("                ");
motor_en = 1;
motor_pin_1 = 1;
```

```
motor_pin_2 = 0;
}
 else if(input==0xEF) //MOTOR RB  - MOMENT SWT
{
lcd_command(0x80);
lcd_dataa("MOTOR RB        ");
lcd_command(0xC0);
lcd_dataa("                ");
motor_en = 1;
motor_pin_1 = 0; //cw
motor_pin_2 = 1;
msdelay(300);
motor_pin_1 = 0; //cw
motor_pin_2 = 0;
}
else if(input==0xDF) //MOTOR FB - MOMENT SWT
{
lcd_command(0x80);
lcd_dataa("MOTOR FB        ");
lcd_command(0xC0);
lcd_dataa("                ");
motor_en = 1;
motor_pin_1 = 1; //cw
motor_pin_2 = 0;
msdelay(300);
```

```
motor_pin_1 = 0; //cw
motor_pin_2 = 0;
}
else if(input==0xBF) //MOTOR HALF SPEED  - LATCHED SWT
{
lcd_command(0x80);
lcd_dataa("MOTOR HALF SPEED");
lcd_command(0xC0);
lcd_dataa("                ");
motor_pin_1 = 0; //fw
motor_pin_2 = 1;
while(input==0xBF)
{
motor_en = 1;
msdelay(200);
motor_en = 0;
msdelay(200);
}
motor_pin_1 = 0; //STOP
motor_pin_2 = 0;
}
else if(input==0x7F) //MOTOR FREE RUN  - LATCHED SWT
{
lcd_command(0x80);
lcd_dataa("MOTOR FREE RUN  ");
```

```
lcd_command(0xC0);
lcd_dataa("                ");
motor_en = 1;
motor_pin_1 = 0;
motor_pin_2 = 1;
 }
 else
{
 motor_en = 1;
 }
 }
 }
```

CHAPTER 7

TESTING AND TROUBLE SHOOTING

Before you apply power, read the instructions carefully to check you haven't missed anything, and whether there are any specific instructions for switching on and testing. Check again that you have all polarity sensitive components the right way around, and that all components are in the correct places. Check off - board components are connected correctly. Check the underside of the board carefully for short circuits between tracks - a common reason for circuits failing to work.

When you are sure everything is correct, apply power and see if the circuit behaves as expected, again following the kit manufacturer's instructions.

If it works, WELL DONE! You have your first working circuit - be proud of it! Skip the rest of this page and click the right arrow at the bottom, or here.

If it doesn't quite work as expected, or doesn't work at all, don't despair. The chances are the fault is quite simple. However, disconnect the power before reading on.

Check the basic's first - is the battery flat? Are you sure the 'On' switch really is on? (Don't laugh, it's easily done) If the project has other switches and controls check these are set correctly.

Next - check again all the components are in the correct place - refer to the diagram in the instructions. Look again at the underside of the board - are there any short circuits? These can be caused by almost invisible 'whiskers' of solder, so check for these with a magnifying glass in good light. Brushing the bottom of the board vigorously with a stiff brush can sometimes remove these.

Pull the components gently to see if they are all fixed into the board properly. Check the soldered joints - poor soldering is the most common cause of circuits failing to work. The joints should by shiny, and those on the circuit board should be volcano shaped with the component wire end sticking out of the top. If any look suspect then redo them. Remove the solder with a solder sucker or braid and try again.

Check for solder splashes shorting across adjacent tracks on the circuit board, especially where connections are very close such as on integrated circuits ('chips'). Solder splashes are most likely on stripboard. You can check for shorts using a multimeter set it to its continuity range, or low resistance range. Be aware if you do this though, that there will be a resistance between some tracks due to the components. Any resistance below 1 ohm between tracks is likely to be a solder splash. Run the soldering iron between tracks on stripboard to remove any solder bridges.

If the circuit still fails to work you will need to refer to the circuit diagram and take voltage readings from the circuit to find out what's wrong. You will need a multimeter to do this (see tools). Remember that if you find one fault such as a reversed component and correct it, it might have caused damage to other components.

CHAPTER 8

BEGINNERS GUIDE - MORE TOOLS & TEST EQUIPMENT

To design your own circuits, or build more complex kits, you will probably need more in the way of tools and test equipment. If you did not buy a multimeter before then this is essential now, a basic power supply is also very useful. More expensive items such as an oscilloscope can be useful, but think carefully about whether you really need them - after all, you can build a lot of projects for the price of an oscilloscope. PC-based virtual instruments could perhaps be more suitable. Other tools can be useful too.

Here is a list of other useful items, although this by no means covers all the tools and equipment available. Maplin codes are included, however similar items are available from most suppliers.

8.1 Tools

Helping Hands - Useful for holding PCB's, connectors etc. while you solder them. Also normally have a magnifying glass to help see small components. Can save hours of aggravation! Maplin code YK53H A small vice can also be useful and provides a more rigid mounting than a Helping Hands.

Pearl Catcher - Useful for the retrieving those screws that inevitably fall into the most inaccessible corner of a project! Maplin code BK43W

Heat Shunt - an inexpensive item for soldering heat sensitive devices. Clipped onto the component lead between the joint and the component it will soak up the heat to save you melting your components. As you get faster at soldering you probably won't need it so much. Maplin code FR10L

RCD Circuit Breaker - If you start building mains projects (only do this when you are more experienced and are aware of the safety requirements) then one of these is ESSENTIAL. It could also prevent a shock if you accidentally melt through the soldering iron flex. These are sold very cheaply in most electrical shops. Well worth the price, although check if your building wiring is already protected by an RCD in the consumer unit first.

Breadboard - If you want to test a circuit without soldering it together permanently then these are useful. Just push the wires into holes joined by metal strips to build the circuit. If the circuit doesn't work, you can easily make changes. Different sizes are available, e.g. Maplin code AG10L

Other items - Other sizes of screwdriver, 0.5Kg reel of solder, tool roll or box etc.

8.2 Test Equipment:

Multimeter - almost essential for all but the absolute beginner. See the tools section for more information.

Power Supply - Also very useful for powering circuits that you are testing. One with a variable voltage up to at least 12V is best. The current rating doesn't need to be that high, 1A maximum is fine for most jobs. If you can afford it then one with an adjustable current limit is useful - set right it can prevent damage to an incorrect circuit, rather than frying it instantly!

Oscilloscope - Quite expensive and not really worth it for all but the advanced constructor.Nonetheless a very useful piece of test equipment, especially on audio circuits. There are some cheaper PC based alternatives, and some hand - held 'scopes now, although I haven't tried them.

Signal Generator - Useful when testing audio circuits, again not really necessary for beginners. Produces variable frequency waves of several different waveforms (sine, square, triangle)

CHAPTER 9

APPLICATIONS

- Variable Frequency Drive (VFD)
- For Motor Four Quadrant Operation
- Elevator System
- Electric vehicle

CHAPTER 10

ADVANTAGES AND DISADVANTAGES

10.1 ADVANTAGES

- High Accuracy
- High Reliability
- Compact size
- High voltage motor operation capability
- Higher control capacity

10.2 DISADVANTAGES

- Maximum output power limited
- Program implementation is complex

CHAPTER 11

FUTURE SCOPE

- Can increase maximum output power.
- Multiple speed tap control can be implemented.
- Dual motor implementation can be done
- Replace MOSFET to IGBT switching range will increase.
- Using IGBT mode of operation also more possible.
- Using IGBT also get regeneration.

CHAPTER 12
CONCLUSION

In this project we had completely studies about four quadrant operation of BLDC motor. We can achieve all four quadrant operations like forward motoring, forward braking, reverse motoring and reverse braking with the help of MOSFET IRF 730 and microcontroller AT 89S52.

We can conclude following points:-

1. Speed varies directly with the armature voltage by keeping field voltage constant.
2. Speed varies inversely with field voltage by keeping armature voltage constant.
3. Armature voltage control gives the speed below the base speed varies field control gives the speed control above the base speed.

Device have drawn closer to ideal switch with typical voltage rating of 600-1700V on-state voltage of 1.7-20V at current of upto 1000A and switching speed 200-500NS.

CHAPTER 13
REFRENCES

1. 5.Bimal K Bose," Modern power electronics and AC drives", *Pearson Education Publications, New Delhi, Chapter 9, pp513-615,2002*
2. Bhim Singh and Sanjeev Singh," State of art on permanent magnet brushless DC motor drives", *J. Power Electron.,vol.9, no. 1, Jan. 2009.*
3. Yedamale. P, Microchip Technology Inc., "Brushless DC motor fundamentals," *AN885, 2003.*
4. K. Shivanarayana, G. Anil and K. Srividya Savitri," Simulation of four quadrant operation and speed control of BLDC motor on MATLAB/SIMULINK", *International Journal of Modern Science and Engineering, July 2013*
5. Basic Electronics – B.Ram
6. B.K Bose., Power electronics and motor drives recent technology advances, Proceedings of the IEEE International Symposium on Industrial Electronics, IEEE, 2002, pp 22-25.
7. Devika R. Yengalwar, Samiksha S. Zade, Dinesh L. Mute "Four Quadrant Speed Control Of Dc Motor Using Chopper" International Journal Of Engineering Sciences & Research Technology, vol. 4 issue 2: February, 2015, ISSN: 2277-9655,pp 401-406.
8. Muhammad Ali Mazidi and Janice Gillispie Mazidi, "The 8051 Microcontroller and Embedded Systems, Pearson Prentice Hall Publication". www.elctronicsforu.com