1. INTRODUCTION

LiFi is transmission of data through illumination by taking the fiber out of fiber optics by sending data through a LED light bulb that varies in intensity faster than the human eye can follow. Li-Fi is the term some have used to label the fast and cheap wireless-communication system, which is the optical version of Wi-Fi. The term was first used in this context by Harald Haas in his TED Global talk on Visible Light Communication. “At the heart of this technology is a new generation of high brightness light-emitting diodes”, says Harald Haas from the University of Edinburgh, UK, Very simply, if the LED is on, you transmit a digital 1, if it’s off you transmit a 0,”Haas says, “They can be switched on and off very quickly, which gives nice opportunities for transmitted data. It is possible to encode data in the light by varying the rate at which the LEDs flicker on and off to give different strings of 1s and 0s.The LED intensity is modulated so rapidly that human eye cannot notice, so the output appears constant. More sophisticated techniques could dramatically increase VLC data rate. Terms at the University of Oxford and the University of Edingburgh are focusing on parallel data transmission using array of LEDs, where each LED transmits a different data stream. Other group are using mixtures of red, green and blue LEDs to alter the light frequency encoding a different data channel. Li-Fi, as it has been dubbed, has already achieved blisteringly high speed in the lab. Researchers at the Heinrich Hertz Institute in Berlin, Germany, have reached data rates of over 500 megabytes per second using a standard white-light LED. The technology was demonstrated at the 2012 Consumer Electronics Show in Las Vegas using a pair of Casio smart phones to exchange data using light of varying intensity given off from their screens, detectable at a distance of up to ten meters.

2. LITRATURE SURVEY

Husain Fidvi ET. al [3] have proposed vehicle to vehicle communication system that does not require a tracking global positioning System or even a Wi-Fi or 3G wireless connectivity. It was proposed to use Programmable Interface Controller (PIC) sonar which sends 40 KHz short pulse of sound that is undetectable by human ear. The echo of the signal will be detected by microcontroller. The distance is calculated by the time required for echo signal to be transmitted and received [3].This technology is demonstrated in the figure below

Several research works have been attempted in literature for vehicle to vehicle communication using an advantage of light. As light frequency spectrum is huge, it is beneficial to be adopted in a short-range wireless communication [5]-[9]. In this work, we aim to develop a cost effective yet inexpensive mechanism for vehicle to vehicle. Which is light. The rest of the paper is organized as follows. Section II explains the details of the proposed system design. In section III, the system diagram is explained. Section IV provides details about the results of the system. Recently, light emitting diode (LED) based optical wireless communication (OWC) systems have been developed. Especially, an OWC technology using visible light communication (VLC), has been receiving much attention. The LED is suitable as an optical-signal-sending device because light intensity of the LED can be modulated at high speed in comparison with traditional lighting devices, such as incandescent bulbs and florescent lamps. Furthermore, LEDs are inexpensive, already used for lighting and sign-ages, and have high energy efficiency and long operating life. Moreover, basic performances of LEDs are being improved constantly while achieving even lower cost.

3. METHODOLOGY

3.1 Working:

In the process of data communication through the visible light on the transmitter side in one vehicle Switch is used as the input signal to transmit Horn Signal. The microcontroller receives the signal from the keypad and generates two outputs and gives that signal to the DTMF Encoder. The encoder will generate one tone and one frequency for every pressed key. That frequency is amplified by the amplifier circuits and fed into the power LED. At the receiver side light dependent resister will receive the light signal and correspondingly generate an electrical signal proportional to it. This electrical signal is processed by a demodulator circuit (DTMF Decoder), and the output of decoder is then fed to a microcontroller and the microcontroller activates the Buzzer for the pressed key in another vehicle.

In the process of voice communication through the visible light on the transmitter side in one vehicle Music is used as the input signal. This signal is converted to an electrical signal through a condenser or microphone. This electrical signal is amplified by the amplifier circuits and fed into the power LED. The light signal from the LED varies according to the intensity of the voice signal. The louder is Music (voice) the glow of the LED will be more. At the receiver side light dependent resister will receive the light signal and correspondingly generate an electrical signal proportional to it. This electrical signal is processed by a demodulator circuit, which is then fed to a speaker and it produces the audio signal in the another vehicle which was at the input of the transmitter side.

3.2 Block Diagram:

3.2.1 Transmitter:

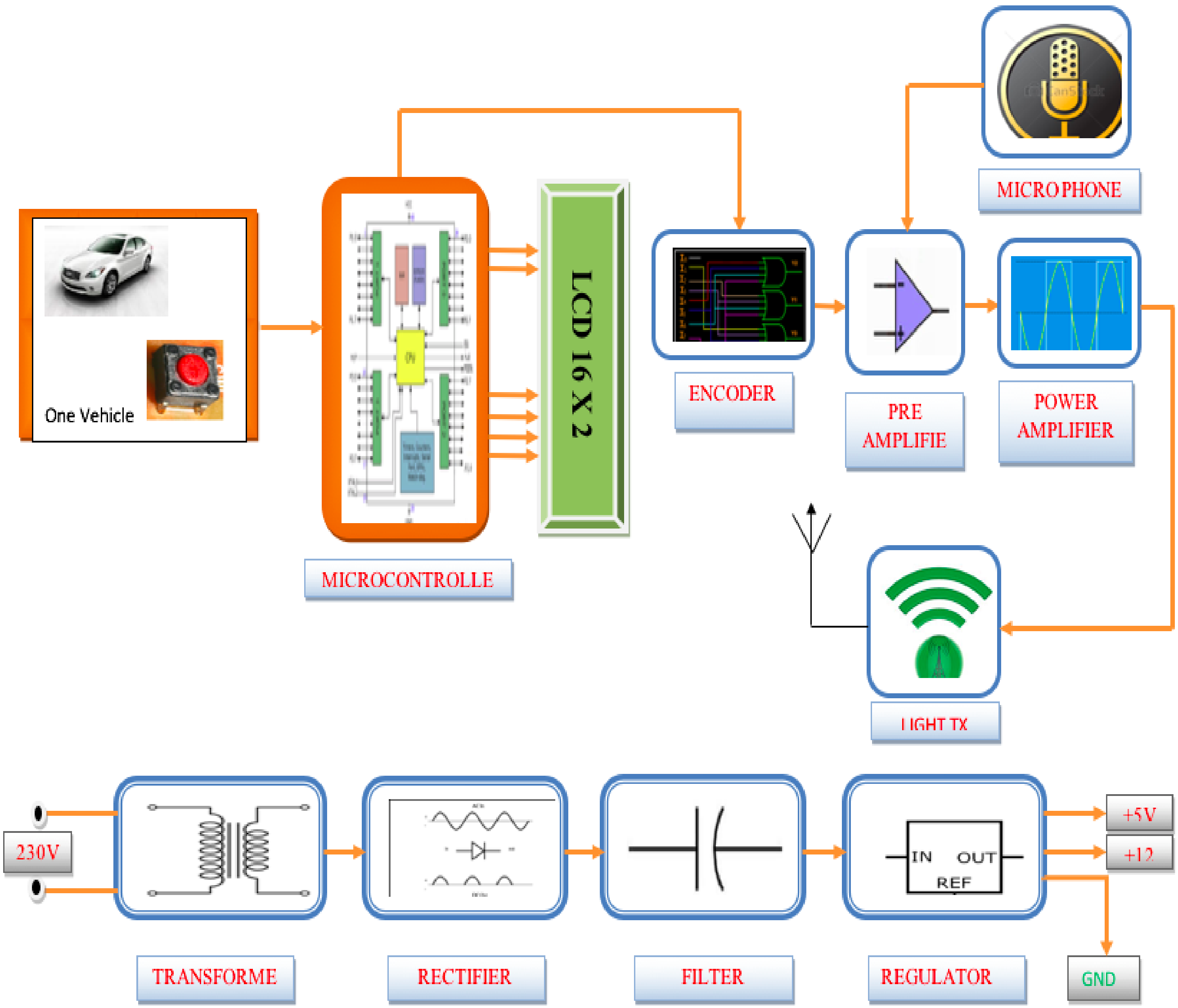
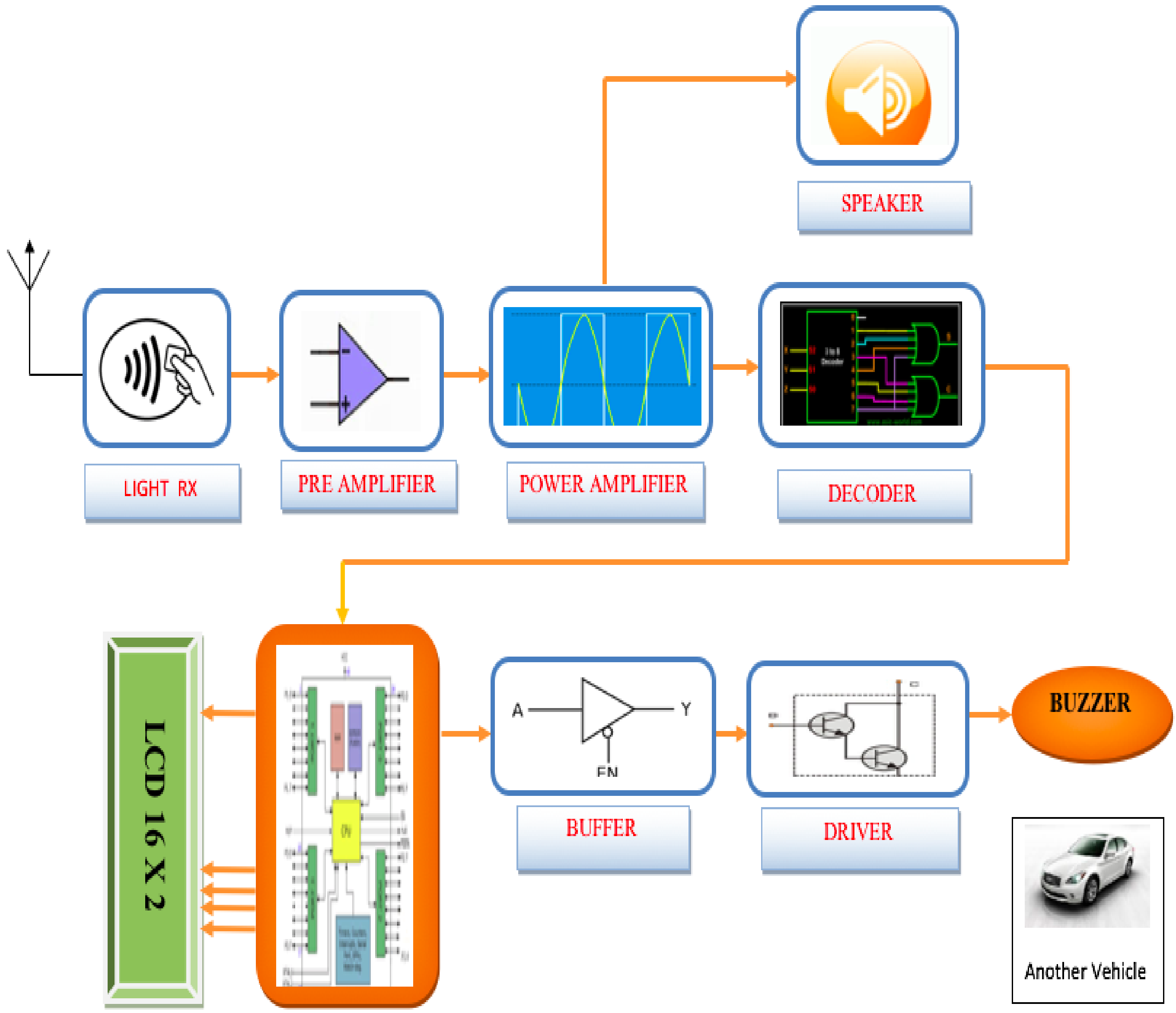


FIG: 3.1 LI-FI TRANSMITTER

3.2.2 Receiver:



HARDWARE REQUIREMENTS:	MICROCONTROLLER (89C51),LCD, Relay Driver, Relays, Resistors, Capacitors, LEDs, Crystal, Diodes, Transformer, Voltage Regulator, Push Button.
SOFTWARE REQUIREMENTS:	Keil compiler uVision 3, Language: Embedded C or Assembly, WLPRO Programmer

FIG 3.2: LI-FI RECEIVER

3.3 Description:

- **Power supply unit**

  This section needs two voltages viz., +12 V & +5 V, as working voltages. Hence specially designed power supply is constructed to get regulated power supplies.

- **Microcontroller**

The **Atmel AT89 series** is an Intel 8051-compatible family of 8 bit microcontrollers (µCs) manufactured by the Atmel Corporation. Based on the Intel 8051 core, the AT89 series remains very popular as general purpose microcontrollers, due to their industry standard instruction set, and low unit cost. This allows a great amount of legacy code to be reused without modification in new applications. While considerably less powerful than the newer AT90 series of AVR RISC microcontrollers, new product development has continued with the AT89 series for the aforementioned advantages

- **Preamplifier:**

A preamplifier (preamp) is an electronic amplifier that prepares a small electrical signal for further amplification or processing. A preamplifier is often placed close to the sensor to reduce the effects of noise and interference. It is used to boost the signal strength to drive the cable to the main instrument without significantly degrading the signal-to-noise ratio (SNR).

- **Power amplifier:**

An audio power amplifier is an electronic amplifier that amplifies low-power audio signals (signals composed primarily of frequencies between 20 - 20 000 Hz, the human range of hearing) to a level suitable for driving loudspeakers. It is the final electronic stage in a typical audio playback chain.

- **Li-Fi transmitter and Receiver:**

Li-Fi is implemented using white LED light bulbs at downlink transmitter. These devices are used for illumination only by applying a constant current. By fast and subtle variations of the current, optical output can be made to vary at extremely high speeds. This variation is used to carry high speed data.

- **Buffers**

Buffers do not affect the logical state of a digital signal (i.e. a logic 1 input results in a logic 1 output whereas logic 0 input results in a logic 0 output). Buffers are normally used to provide extra current drive at the output but can also be used to regularize the logic present at an interface.

- **Drivers**

This section is used to drive the relay where the output is complement of input which is applied to the drive but current will be amplified.

- **Relays**

It is a electromagnetic device which is used to drive the load connected across the relay and the o/p of relay can be connected to controller or load for further processing.

4. HARDWARE REQUIREMENT

4.1 Components Used

- Power supply unit
- Micro-controller (89C51)
- Monostable Multivibrators
- Buffers & Drivers
- LCD Display
- Piezo-electric sensor

4.1.1 Power Supply Unit

The circuit needs two different voltages, +5V & +12V, to work. These dual voltages are supplied by this specially designed power supply.

The power supply, unsung hero of every electronic circuit, plays very important role in smooth running of the connected circuit. The main object of this ‘power supply’ is, as the name itself implies, to deliver the required amount of stabilized and pure power to the circuit. Every typical power supply contains the following sections:

1. **Step-down Transformer:**

The conventional supply, which is generally available to the user, is 230V AC. It is necessary to step down the mains supply to the desired level. This is achieved by using suitably rated step-down transformer. While designing the power supply, it is necessary to go for little higher rating transformer than the required one. The reason for this is, for proper working of the regulator IC (say KIA 7805) it needs at least 2.5V more than the expected output voltage.

2. **Rectifier stage:**

Then the step-downed Alternating Current is converted into Direct Current. This rectification is achieved by using passive components such as diodes. If the power supply is designed for low voltage/current drawing loads/circuits (say +5V), it is sufficient to employ full-wave rectifier with center-tap transformer as a power source. While choosing the diodes the PIV rating is taken into consideration.

3. **Filter stage:**

But this rectified output contains some percentage of superimposed A.C. ripples. So to filter these A.C. components filter stage is built around the rectifier stage. The cheap, reliable, simple and effective filtering for low current drawing loads (say upto 50 mA) is done by using shunt capacitors. This electrolytic capacitor has polarities, take care while connecting the circuit.

4. **Voltage Regulation:**

The filtered D.C. output is not stable. It varies in accordance with the fluctuations in mains supply or varying load current. This variation of load current is observed due to voltage drop in transformer windings, rectifier and filter circuit. These variations in D.C. output voltage may cause inaccurate or erratic operation or even malfunctioning of many electronic circuits. For example, the circuit boards which are implanted by CMOS or TTL ICs.

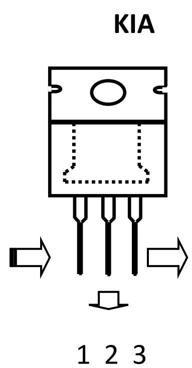


Fig 4.1: Regulator IC

The stabilization of D.C. output is achieved by using the three terminal voltage regulator IC. This regulator IC comes in two types: 78xx for positive voltage output and 79xx for negative voltage output. For example, 7805 gives +5V output and 7905 gives -5V stabilized output.

These regulator ICs have in-built short-circuit protection and auto-thermal cut out provisions. If the load current is very high the IC needs 'heat sink' to dissipate the internally generated power.

Circuit Description:

A D.C. power supply which maintains the output voltage constant irrespective of A.C. mains fluctuations or load variations is known as regulated D.C. power supply. It is also referred as full-wave regulated power supply as it uses four diodes in bridge fashion with the transformer. This laboratory power supply offers excellent line and load regulation and output voltages of +5V & +12 V at output currents up to one amp.

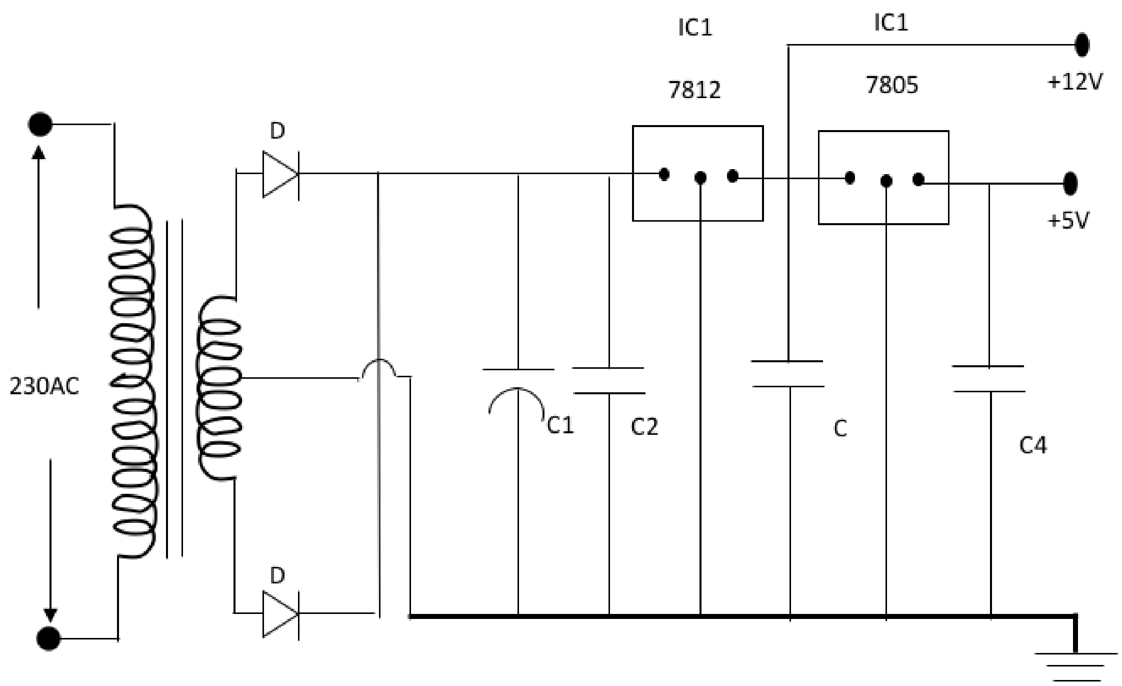


Fig 4.2: Circuit diagram of full wave regulated power supply

Parts List:

SEMICONDUCTORS

IC1	7812 Regulator IC	1
IC2	7805 Regulator IC	1
D1& D2	1N4007 Rectifier Diodes	2

CAPACITORS

C1	1000 µf/25V Electrolytic	1
C2 to C4	0.1µF Ceramic Disc type	3

MISCELLANEOUS

X1	230V AC Pri,14-0-14 1Amp Sec Transformer	1

1. Step-down Transformer:

The transformer rating is 230V AC at Primary and 12-0-12V, 1Ampers across secondary winding. This transformer has a capability to deliver a current of 1Ampere, which is more than enough to drive any electronic circuit or varying load. The 12VAC appearing across the secondary is the RMS value of the waveform and the peak value would be 12 x 1.414 = 16.8 volts. This value limits our choice of rectifier diode as 1N4007, which is having PIV rating more than 16Volts.

2. Rectifier Stage:

The two diodes D1 & D2 are connected across the secondary winding of the transformer as a full-wave rectifier. During the positive half-cycle of secondary voltage, the end A of the secondary winding becomes positive and end B negative. This makes the diode D1 forward biased and diode D2 reverse biased. Therefore diode D1 conducts while diode D2 does not. During the negative half-cycle, end A of the secondary winding becomes negative and end B positive. Therefore diode D2 conducts while diode D1 does not. Note that current across the centre tap terminal is in the same direction for both half-cycles of input A.C. voltage. Therefore, pulsating D.C. is obtained at point ‘C’ with respect to Ground.

3. Filter Stage:

Here Capacitor C1 is used for filtering purpose and connected across the rectifier output. It filters the A.C. components present in the rectified D.C. and gives steady D.C. voltage. As the rectifier voltage increases, it charges the capacitor and also supplies current to the load. When capacitor is charged to the peak value of the rectifier voltage, rectifier voltage starts to decrease. As the next voltage peak immediately recharges the capacitor, the discharge period is of very small duration. Due to this continuous charge-discharge-recharge cycle very little ripple is observed in the filtered output. Moreover, output voltage is higher as it remains substantially near the peak value of rectifier output voltage. This phenomenon is also explained in other form as: the shunt capacitor offers a low reactance path to the A.C. components of current and open circuit to D.C. component. During positive half cycle the capacitor stores energy in the form of electrostatic field. During negative half cycle, the filter capacitor releases stored energy to the load.

4. Voltage Regulation Stage:

Across the point ‘D’ and Ground there is rectified and filtered D.C. In the present circuit KIA 7812 three terminal voltage regulator IC is used to get +12V and KIA 7805 voltage regulator IC is used to get +5V regulated D.C. output. In the three terminals, pin 1 is input i.e., rectified & filtered D.C. is connected to this pin. Pin 2 is common pin and is grounded. The pin 3 gives the stabilized D.C. output to the load.

The circuit shows two more decoupling capacitors C2 & C3, which provides ground path to the high frequency noise signals. Across the point ‘E’ and ‘F’ with respect to ground +5V & +12V stabilized or regulated d.c output is measured, which can be connected to the required circuit.

Note: While connecting the diodes and electrolytic capacitors the polarities must be taken into consideration. The transformer’s primary winding deals with 230V mains, care should be taken with it.

4.1.2 Microcontroller:

The Atmel AT89 series is an Intel 8051-compatible family of 8-bit microcontrollers (µCs) manufactured by the Atmel Corporation. Based on the Intel 8051 core, the AT89 series remains uy8very popular as general-purpose microcontrollers, due to their industry standard instruction set, and low unit cost. This allows a great amount of legacy code to be reused without modification in new applications. While considerably less powerful than the newer AT90 series of AVR RISC microcontrollers, new product development has continued with the AT89 series for the aforementioned advantages.

The field parameters are monitored by this Microcontroller chip with the help of user written program and generates alert message for LCD display and fault code for remote monitoring end transmission. The Microcontroller Chip has input port for getting fault condition of field parameters and 'Stop' signal through RF Receiver and output port for sending fault code to DTMF Encoder and switching Relay [MCB] for isolating power line from load.

4.1.2.1 Introduction of Microcontroller

The general definition of a microcontroller is a single chip computer, which refers to the fact that they contain all of the functional sections (CPU, RAM, ROM, I/O, ports and timers) of a traditionally defined computer on a single integrated circuit. Some experts even describe them as special purpose computers with several qualifying distinctions that separate them from other computers. Microcontrollers are "embedded" inside some other device (often a consumer product) so that they can control the features or actions of the product. Another name for a microcontroller, therefore, is "embedded controller."

Microcontrollers are dedicated to one task and run one specific program. The program is stored in ROM (read-only memory) and generally does not change. Microcontrollers are often low-power devices. A desktop computer is almost always plugged into a wall socket and might consume 50 watts of electricity. A battery-operated microcontroller might consume 50 mill watts.

A microcontroller has a dedicated input device and often (but not always) has a small LED or LCD display for output. A microcontroller also takes input from the device it is controlling and controls the device by sending signals to different components in the device. A microcontroller is often small and low cost. The components are chosen to minimize size and to be as inexpensive as possible. A microcontroller is often, but not always, ruggedized in some way. The microcontroller controlling a car's engine, for example, has to work in temperature extremes that a normal computer generally cannot handle. A car's microcontroller in Kashmir regions has to work fine in -30 degree F (-34 °C) weather, while the same microcontroller in Gujarat region might be operating at 120 degrees F (49 °C). When you add the heat naturally generated by the engine, the temperature can go as high as 150 or 180 degrees F (65-80 °C) in the engine compartment. On the other hand, a microcontroller embedded inside a VCR hasn't been ruggedized at all.

Clearly, the distinction between a computer and a microcontroller is sometimes blurred. Applying these guidelines will, in most cases, clarify the role of a particular device.

4.1.2.2 ATMEL 89C51 Technical Description:

The ATMEL 89C51 is a low-power, high-performance CMOS 8-bit microcomputer with 4K bytes of Flash programmable and erasable read only memory (PEROM). The ATmel 89C51 device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the industry-standard MCS-51 instruction set and pinout. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional non-volatile memory programmer. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel AT89C51 is a powerful microcomputer which provides a highly-flexible and cost-effective solution to many embedded control applications. The Atmel 89C51 provides the following standard features: 4K Bytes of Flash, 128 bytes of RAM, 32 I/O lines, two 16-bit timer/counters, a five vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator and clock circuitry. In addition, the 89C51 is designed with static logic for operation down to zero 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 AT89C51 Power-down Mode saves the RAM contents but freezes the oscillator disabling all other chip functions until the next hardware reset.

- Compatible with MCS-51 Products
- 4K Bytes of In-System Reprogrammable Flash Memory
- Fully Static Operation: 0 Hz to 24 MHz
- Three-level Program Memory Lock
- 128 x 8-bit Internal RAM 32
- Programmable I/O Lines
- Two 16-bit Timer/Counters
- Six Interrupt Sources Programmable Serial Channel
- Low-power Idle and Power-down Modes 40-pin D

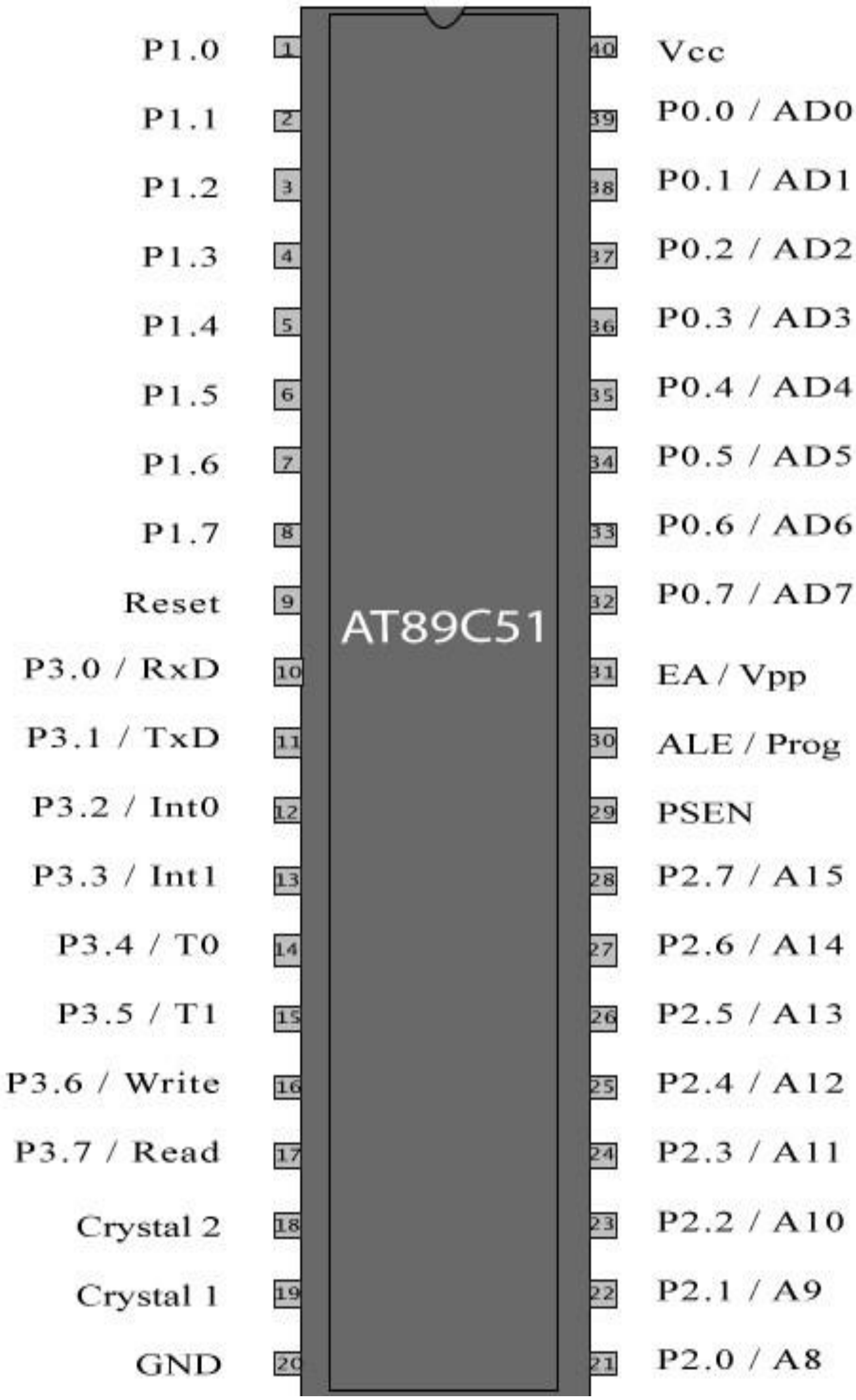


Fig 4.3: Atmel Microcontroller (AT89C51)

4.1.2.3 Circuit Description

The mother board of 89C51 has following sections: Power Supply, 89C51 IC, Oscillator, Reset Switch & I/O ports. Let us see these sections in detail.

1. **Power Supply**

This section provides the clean and harmonic free power to IC to function properly. The output of the full wave rectifier section, which is built using two rectifier diodes, is given to filter capacitor. The electrolytic capacitor C1 filters the pulsating dc into pure dc and given to Vin pin-1 of regulator IC 7805.This three terminal IC regulates the rectified pulsating dc to constant +5 volts. C2 & C3 provides ground path to harmonic signals present in the inputted voltage. The Vout pin-3 gives constant, regulated and spikes free +5 volts to the mother board.

The allocation of the pins of the 89C51 follows a U-shape distribution. The top left-hand corner is Pin 1 and down to bottom left hand corner is Pin 20. And the bottom right hand corner is Pin 21 and up to the top right-hand corner is Pin 40. The Supply Voltage pin Vcc is 40 and ground pin Vss is 20.

2. **Oscillator**

If the CPU is the brain of the system then the oscillator, or clock, is the heartbeat. It provides the critical timing functions for the rest of the chip. The greatest timing accuracy is achieved with a crystal or ceramic resonator. For crystals of 2.0 to 12.0 MHz, the recommended capacitor values should be in the range of 15 to 33pf2.

Across the oscillator input pins 18 & 19 a crystal x1 of 4.7 MHz to 20 MHz value can be connected. The two ceramic disc type capacitors of value 30pF are connected across crystal and ground stabilizes the oscillation frequency generated by crystal.

3. **I/O Ports**

There are a total of 32 i/o pins available on this chip. The amazing part about these ports is that they can be programmed to be either input or output ports, even "on the fly" during operation. Each pin can source 20 mA (max) so it can directly drive an LED. They can also sink a maximum of 25 Ma current.

Some pins for these I/O ports are multiplexed with an alternate function for the peripheral features on the device. In general, when a peripheral is enabled, that pin may not be used as a general purpose I/O pin. The alternate function of each pin is not discussed here, as port accessing circuit takes care of that.

This 89C51 IC has four I/O ports and is discussed in detail:

- P0.0 TO P0.7

PORT0 is an 8-bit [pins 32 to 39] open drain bi-directional I/O port. As an output port, each pin can sink eight TTL inputs and configured to be multiplexed low order address/data bus then has internal pull ups. External pull ups are required during program verification.

- P1.0 TO P1.7

PORT1 is an 8-bit wide [pins 1 to 8], bi-directional port with internal pull ups. P1.0 and P1.1 can be configured to be the timer/counter 2 external count input and the timer/counter 2 trigger input respectively.

- P2.0 TO P2.7

PORT2 is an 8-bit wide [pins 21 to 28], bi-directional port with internal pull ups. The PORT2 output buffers can sink/source four TTL inputs. It receives the high-order address bits and some control signals during Flash programming and verification.

- P3.0 TO P3.7

PORT3 is an 8-bit wide [pins 10 to 17], bi-directional port with internal pull ups. The Port3 output buffers can sink/source four TTL inputs. It also receives some control signals for Flash programming and verification.

- PSEN

  Program Store Enable [Pin 29] is the read strobe to external program memory.

- ALE

  Address Latch Enable [Pin 30] is an output pulse for latching the low byte of the address during accesses to external memory.

- EA

  External Access Enable [Pin 31] must be strapped to GND in order to enable the device to fetch code from external program memory locations starting at 0000H upto FFFFH.

- RST

Reset input [Pin 9] must be made high for two machine cycles to resets the device's oscillator. The potential difference is created using 10MFD/63V electrolytic capacitor and 20KOhm resistor with a reset switch.

4.1.3 Monostable Multivibrator

Monostable Multivibrator have only ONE stable state (hence their name: "Mono"), and produce a single output pulse when it is triggered externally. Monostable Multivibrator only return back to their first original and stable state after a period of time determined by the time constant of the RC coupled circuit.

The following figure is the schematic of IC 555 as a Monostable Multivibrator. This is the basic mode of operation of the IC 555.

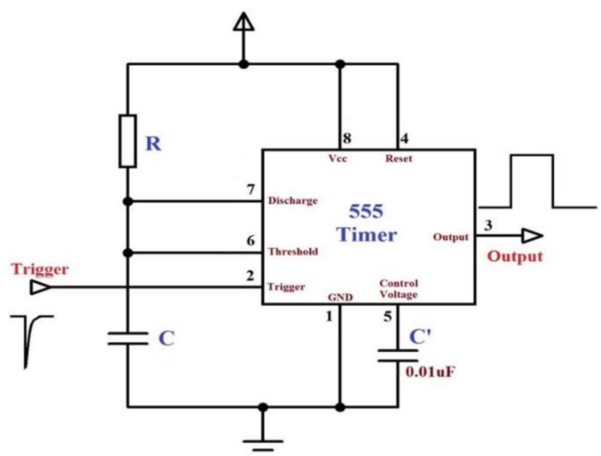


Fig 4.4: Pin diagram of 555 Timer

As the name specifies, a monostable multivibrator has only one stable state. When a trigger input is applied, a pulse is produced at the output and returns back to the stable state after a time interval. The duration of time for which the pulse is high will depend on the timing circuit that comprises of a resistor (R) and a capacitor (C). The details of the connection are as follows. The pins 1 and 8 are connected to ground and supply (VCC) respectively. Output is taken at pin 3. To avoid accidental reset of the circuit, pin 4 is connected to the VCC. Pin 5, which is the control voltage input, should be grounded when not in use. To filter the noise, it is connected to the ground via a small capacitor of capacitance 0.01µF.

4.1.3.2 Operation:

The monostable mode is also called “one-shot” pulse generator. The sequence of events starts when a negative going trigger pulse is applied to the trigger comparator. When this trigger comparator senses the short negative going trigger pulse to be just below the reference voltage (1/3 VCC), the device triggers and the output goes HIGH. The discharge transistor is turned OFF and the capacitor C that is externally connected to its collector will start charging to the max value through the resistor R. The HIGH output pulse ends when the charge on the capacitor reaches 2/3 VCC. The internal connection of the IC 555 in monostable mode along with the RC timing circuit is shown below.

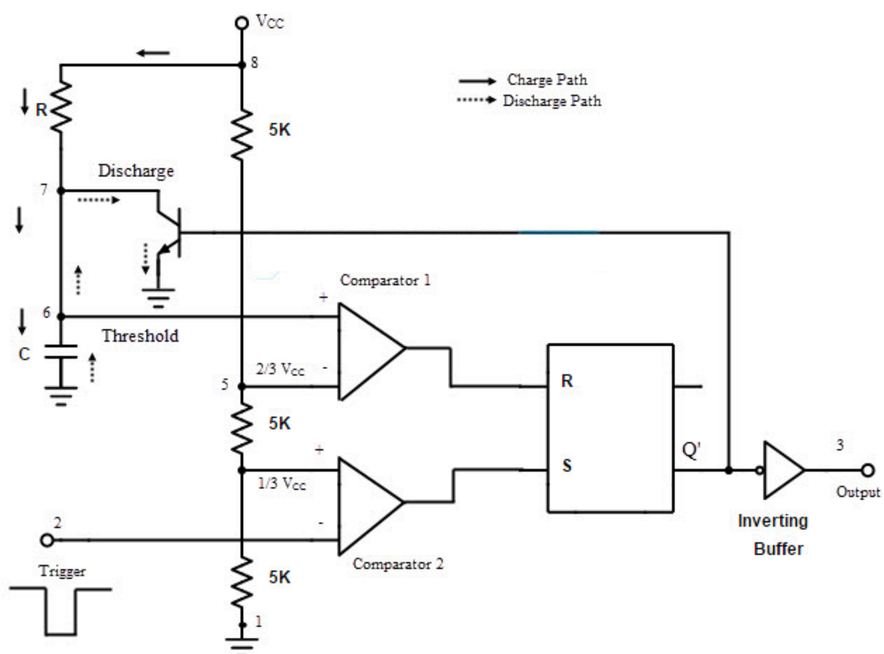


Fig 4.5: RC timing circuit of 555 Timer

The detailed operation can be explained as follows. Initially, the flip-flop is RESET. This will allow the discharge transistor to go to saturation. The capacitor C, which is connected to the open collector (drain in case of CMOS) of the transistor, is provided with a discharge path. Hence the capacitor discharges completely and the voltage across it is 0. The output at pin 3 is low (0). When a negative going trigger pulse input is applied to the trigger comparator (comparator 2), it is compared with a reference voltage of 1/3 VCC. The output remains low until the trigger input is greater than the reference voltage. The moment trigger voltage goes below 1/3 VCC, the output of comparator goes high and this will SET the flip-flop. Hence the output at pin 3 will become high. At the same time, the discharge transistor is turned OFF and the capacitor C will begin to charge and the voltage across it rises exponentially. This is nothing but the threshold voltage at pin 6. This is given to the comparator 1 along with a reference voltage of 2/3 VCC. The output at pin 3 will remain HIGH until the voltage across the capacitor reaches 2/3 VCC.

The instance at which the threshold voltage (which is nothing but the voltage across the capacitor) becomes more than the reference voltage, the output of the comparator 1 goes high. This will RESET the flip-flop and hence the output at pin 3 will fall to low (logic 0) i.e. the output returns to its stable state. As the output is low, the discharge transistor is driven to saturation and the capacitor will completely discharge. Hence it can be noted that the output at pin 3 is low at start, when the trigger becomes less than 1/3 VCC the output at pin 3 goes high and when the threshold voltage is greater than 2/3 VCC the output becomes low until the occurrence of next trigger pulse. A rectangular pulse is produced at the output. The time for which the output stays high or the width of the rectangular pulse is controlled by the timing circuit i.e. the charging time of the capacitor which depends on the time constant RC.

4.1.4 Buffer & Drivers

When the user programs the schedule for the automation using GUI [Graphical User Interface] software, it actually sends 5-bit control signals to the circuit. The present circuit provides interfacing with the Microcontroller and the controlling circuitry. This circuit takes the 5-bit control signal, isolates the controller from this circuitry, boosts control signals for required level and finally fed to the rider section to actuate relay. These five relays in turn sends RC5 coded commands with respect to their relay position. First the components used in this Module are discussed and then the actual circuit is described in detail.

1. **Hex Buffer / Converter [Non-Inverter] IC 4050:** Buffers does not affect the logical state of a digital signal (i.e. logic 1 input results into logic 1 output where as logic 0 input results into logic 0 output). Buffers are normally used to provide extra current drive at the output but can also be used to regularize the logic present at an interface. And Inverters are used to complement the logical state (i.e. logic 1 input results into logic 0 output and vice versa). Also, Inverters are used to provide extra current drive and, like buffers, are used in interfacing applications. This 16-pin DIL packaged IC 4050 acts as Buffer as-well-as a Converter. The input signals may be of 2.5 to 5V digital TTL compatible or DC analogue the IC gives 5V constant signal output. The IC acts as buffer and provides isolation to the main circuit from varying input signals. The working voltage of IC is 4 to 16 Volts and propagation delay is 30 nanoseconds. It consumes 0.01 mill Watt power with noise immunity of 3.7 V and toggle speed of 3 Megahertz.

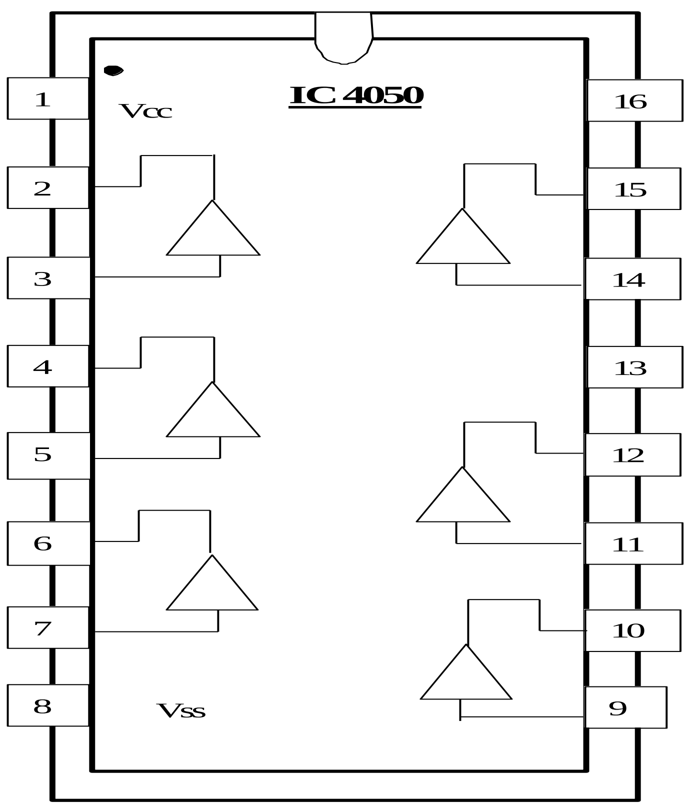


Fig 4.6: PIN Diagram of IC 4050

2. ULN 2003:

Since the digital outputs of some circuits cannot sink much current, they are not capable of driving relays directly. So, high-voltage high-current Darlington arrays are designed for interfacing low-level logic circuitry and multiple peripheral power loads. The series ULN2000A/L ICs drive seven relays with continuous load current ratings to 600mA for each input. At an appropriate duty cycle depending on ambient temperature and number of riders turned ON simultaneously, typical power loads totaling over 260W [400mA x 7, 95V] can be controlled. Typical loads include relays, solenoids, stepping motors, magnetic print hammers, multiplexed LED and incandescent displays, and heaters. These Darlington arrays are furnished in 16-pin dual in-line plastic packages (suffix A) and 16-lead surface-mountable SOICs (suffix L). All devices are pinned with outputs opposite inputs to facilitate ease of circuit board layout.

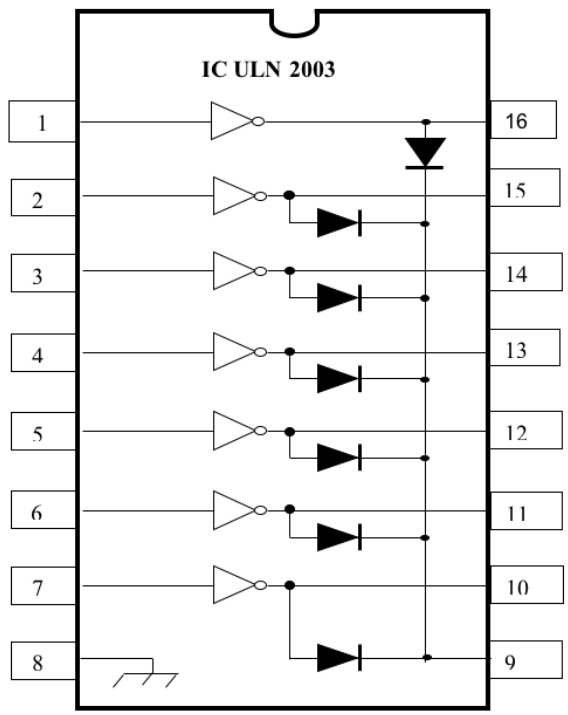


Fig 4.7: PIN diagram of IC 2003

The input of ULN 2003 is TTL-compatible open-collector outputs. As each of these outputs can sink a maximum collector current of 500 mA, miniature Controller relays can be easily driven. No additional free-wheeling clamp diode is required to be connected across the relay since each of the outputs has inbuilt free-wheeling diodes. The Series ULN20x4A/L features series input resistors

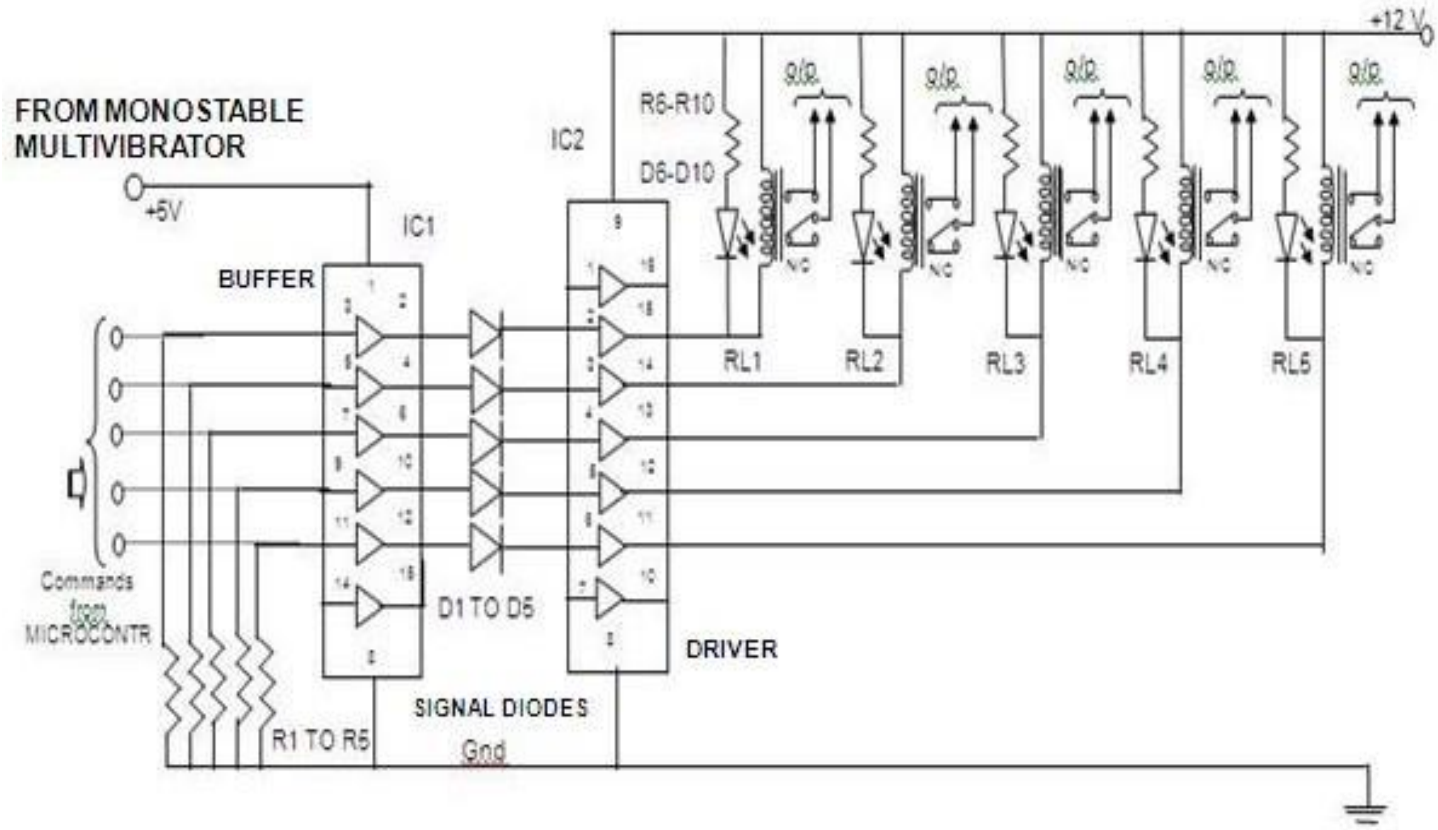


Fig 4.8: Buffer Driver Circuit

4.1.5 LCD Module

LCDs can add a lot to any application in terms of providing a useful interface for the user, debugging an application or just giving it a "professional" look. The most common type of LCD controller is the Hitachi 44780 which provides a relatively simple interface between a processor and an LCD. Using this interface is often not attempted by inexperienced designers and programmers because it is difficult to find good documentation on the interface, initializing the interface can be a problem and the displays themselves are expensive.

The most common connector used for the 44780 based LCDs is 14 pins in a row

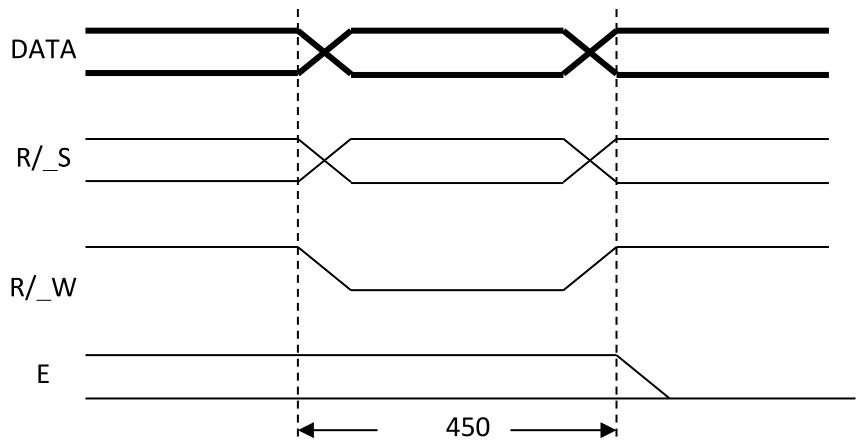


Fig 4.9: LCD data waveform

Pins	Description
1	Ground
2	Vcc
3	Contrast Voltage
4	“R/S”_Instruction/Register Select
5	"R/W"_Read/Write LCD Registers
6	"E" Clock
7 -14	Data I/O Pins

Table no. 4.1: Pin details of LCD

The interface is a parallel bus, allowing simple and fast reading/writing of data to and from the LCD. The LCD Data Write Waveform will write an ASCII Byte out to the LCD's screen. The ASCII code to be displayed is eight bits long and is sent to the LCD either four or eight bits at a time. If four-bit mode is used, two "nibbles" of data (Sent high four bits and then low four bits with an "E" Clock pulse with each nibble) are sent to make up a full eight-bit transfer. The "E" Clock is used to initiate the data transfer within the LCD. Sending parallel data as either four or eight bits are the two primary modes of operation. While there are secondary considerations and modes, deciding how to send the data to the LCD is most critical decision to be made for an

LCD interface application. The various instructions available for use with the 44780 are shown in the table below:

R/S	R/W	D7	D6	D5	D4	D3	D2	D1	D0	Instruction/Description
4	5	14	13	12	11	10	9	8	7	Pins
0	0	0	0	0	0	0	0	0	1	Clear Display
0	0	0	0	0	0	0	0	1	*	Return Cursor and LCD to Home Position
0	0	0	0	0	0	0	1	ID	S	Set Cursor Move Direction
0	0	0	0	0	0	1	D	C	B	Enable Display/Cursor
0	0	0	0	0	1		RL	*	*	Move Cursor
0	0	0	0	1	DL	N	F	*	*	Set Interface Length
0	0	0	1	A	A	A	A	A	A	Move Cursor into CGRAM
0	0	1	A	A	A	A	A	A	A	Move Cursor to Display
0	1	BF	*	*	*	*	*	*	*	Poll the "Busy Flag"
1	0	D	D	D	D	D	D	D	D	Write a Character to the Display at the Current Cursor Position
1	1	D	D	D	D	D	D	D	D	Read the Character on the Display at the Current Cursor Position

Table no. 4.2: LCD instruction table

Most LCD displays have a 44780 and support chip to control the operation of the LCD. The 44780 is responsible for the external interface and provides sufficient control lines for sixteen characters on the LCD. The support chip enhances the I/O of the 44780 to support up to 128 characters on an LCD. From the table above, it should be noted that the first two entries ("8x1", "16x1") only have the 44780 and not the support chip. This is why the ninth character in the 16x1 does not "appear" at address 8 and shows up at the address that is common for a two-line LCD.

The Character Set available in the 44780 is basically ASCII. It is "basically" because some characters do not follow the ASCII convention fully (probably the most significant difference is 0x05B or "\" is not available). The ASCII Control Characters (0x008 to 0x01F) do not respond as control characters and may display funny (Japanese) characters.

The last aspect of the LCD to discuss is how to specify a contrast voltage to the Display. Experts typically use a potentiometer wired as a voltage divider. This will provide an easily variable voltage between Ground and Vcc, which will be used to specify the contrast (or "darkness") of the characters on the LCD screen. You may find that different LCDs work differently with lower voltages providing darker characters in some and higher voltages do the same thing in others.

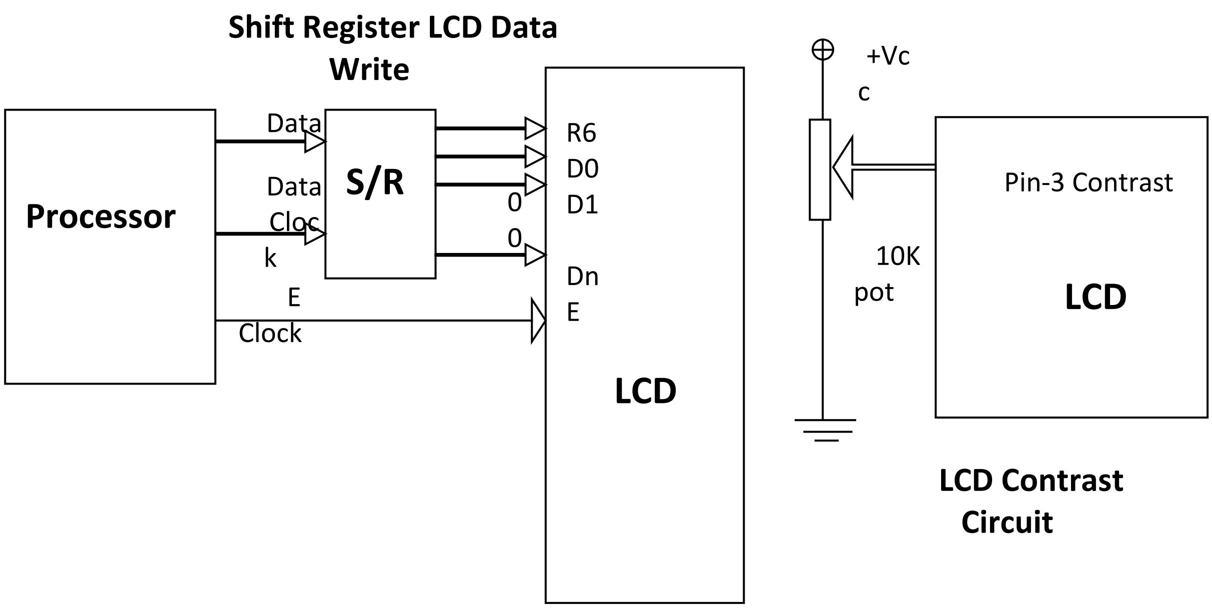


Fig 4.10: LCD data write and contrast circuit

Liquid crystal panel service life 100,000 hours minimum at 25 ºC -10 ºC

- Contrast becomes 30% of initial value
- Current consumption becomes three times higher than initial value
- Remarkable alignment deterioration occurs in LCK cell layer
- Unusual operation occurs in display functions

- Safety
- If the LCD panel breaks, be careful not to get the liquid crystal in your mouth. If the liquid crystal touches your skin or clothes, wash it off immediately using soap and plenty of water.
- Handling
- Avoid static electricity as this can damage the CMOS LSI.
- The LCD panel is plate glass; do not hit or crush it.
- Do not remove the panel or frame from the module.
- The polarizing plate of the display is very fragile; handle it very carefully
- Mounting and Design
- Mount the module by using the specified mounting part and holes.
- To protect the module from external pressure; leave a small gap by placing transparent plates (e.g. acrylic or glass) on the display surface, frame, and polarizing plate
- Design the system so that no input signal is given unless the power-supply voltage is applied.
- Keep the module dry. Avoid condensation; otherwise the transparent electrodes may break.
- Storage
- Store the module in a dark place, where the temperature is 25 ^{o}C - 10 ^{o}C and the humidity below 65% RH.

Do not store the module near organic solvents or corrosive gases.

4.1.6 Piezoelectric Transducer

Certain crystals like Barium titanate, Quartz, Lithium tantalite, etc. have the property of producing electricity on applying a force or pressure over them under specific arrangement. Also, they can work in inverse by transforming the electrical signal applied across them into vibrations. Hence, they are used as transducers in many applications. They are called as piezoelectric materials. Hence, a Piezoelectric Transducer produces voltage when applying a force over them and vice versa. First, let us look at some of the applications of Piezoelectric Transducer followed by the definition.

4.1.6.1 Piezoelectric Effect

1. Mechanical stress analyzer:

The major application is stress analyzer for columns in building where the proportional voltage produced upon stress over crystal is measured and the corresponding stress can be calculated.

2. Lighters:

Gas burner lighter and cigarette lighter also abide the same rule of piezoelectric effect which produces electric pulse upon the force produced by sudden impact of trigger over the material inside them.

Piezo Electric effect is defined as the change in electric polarization that is produced in certain materials when subjected to mechanical stresses.

4.1.6.2 Inverse Piezoelectric Effect

1. Quartz Watch:

Inside our watch, there is quartz resonator which works as oscillator. The element is silicon dioxide. The electric signal applied across the crystal makes it to vibrate periodically which in turn regulates the gears inside our watch.

2. Piezo Buzzers:

Buzzers are widely used in many applications like car reverse indicator, Computers and etc. In this case, on applying of voltage at certain magnitude and frequency across the above mentioned crystal they tend to vibrate. The vibration can be diverted into a housed space with small opening making it into audible sound.

Inverse Piezo Electric effect is defined as the strain or deformation produced in certain materials when subjected to electric field.