PROJECT REPORT

ON

LINE FOLLOWER ROBOT

8 Th Semester
Electronics & Telecommunication Engineering

Acknowledgement

It is our privilege to express our sincerest regards to our project coordinator, Ms. Madhusmita Nahak & Ms Geetanjali Jena, for their valuable inputs, able guidance,

encouragement, whole-hearted cooperation and constructive criticism throughout the duration of our project.

We deeply express our sincere thanks to our Head of Department Dr Prof. K.C.Mohapatra for encouraging and allowing us to present the project on the topic **“Line Follower Robot “**at our department premises for the partial fulfillment of the requirements leading to the award of B-Tech degree.

We take this opportunity to thank all our lecturers who have directly or indirectly helped our project. We pay our respects and love to our parents and all other family members and friends for their love and encouragement through out our career. Last but not the least we express our thanks to our friends for their cooperation and support.

PADMANAVA COLLEGE OF ENGINEERING

ESTD - 1999 - ISO 9001:2000
SECTOR – 4, ROURKELA – 769002
(AFFILIATED TO BPUT, ROURKELA)

CERTIFICATE

This is to certify that Sonali Mishra, Balaram Panda, Sanyasi Barad, Pulkeshu Dash and Gaurav Singhdeo students of Padmanava College of Engineering, Sector-4, Rourkela-002, have successfully completed a project on **"Line Follower Robot"** in 8th semester at Department of Electronics & Telecommunication Engineering.

This report has not been submitted to any other Organization & does not form part of any Course undergone by then, for the award of B-Tech Degree.

Head of Dept (ETE)

Project Guide

Prof (Dr).K.C.Mohapatra

Ms Madhusmita Nahak

INDEX

INTRODUCTION

What is a line follower?

Line follower is a machine that can follow a path. The path can be visible like a black line on a white surface (or vice-versa) or it can be invisible like a magnetic field.

Why build a line follower?

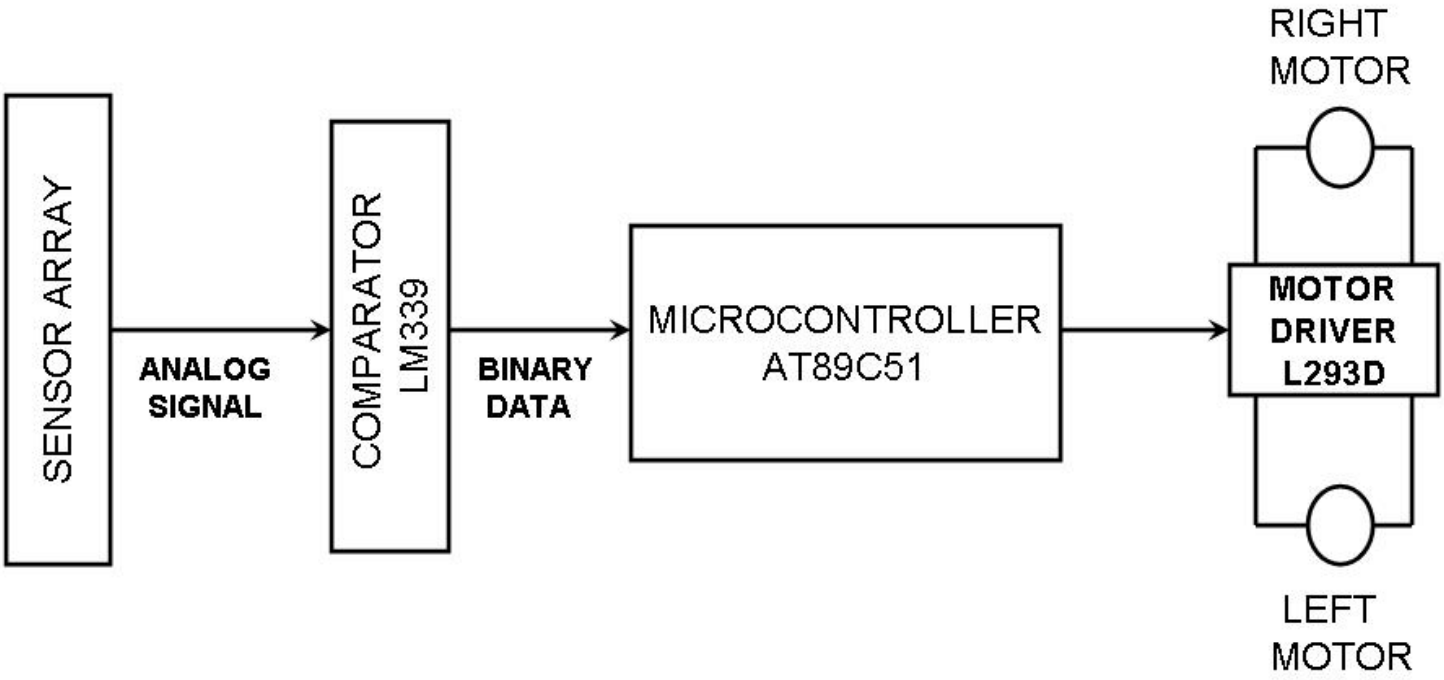
Sensing a line and maneuvering the robot to stay on course, while constantly correcting wrong moves using feedback mechanism forms a simple yet effective closed loop system. As a programmer you get an opportunity to 'teach' the robot how to follow the line thus giving it a human-like property of responding to stimuli.

Practical applications of a line follower: Automated cars running on roads with embedded magnets; guidance system for industrial robots moving on shop floor etc.

Prerequisites:
Knowledge of basic digital and analog electronics.

C Programming Sheer interest, an innovative brain and perseverance!

OVERVIEW

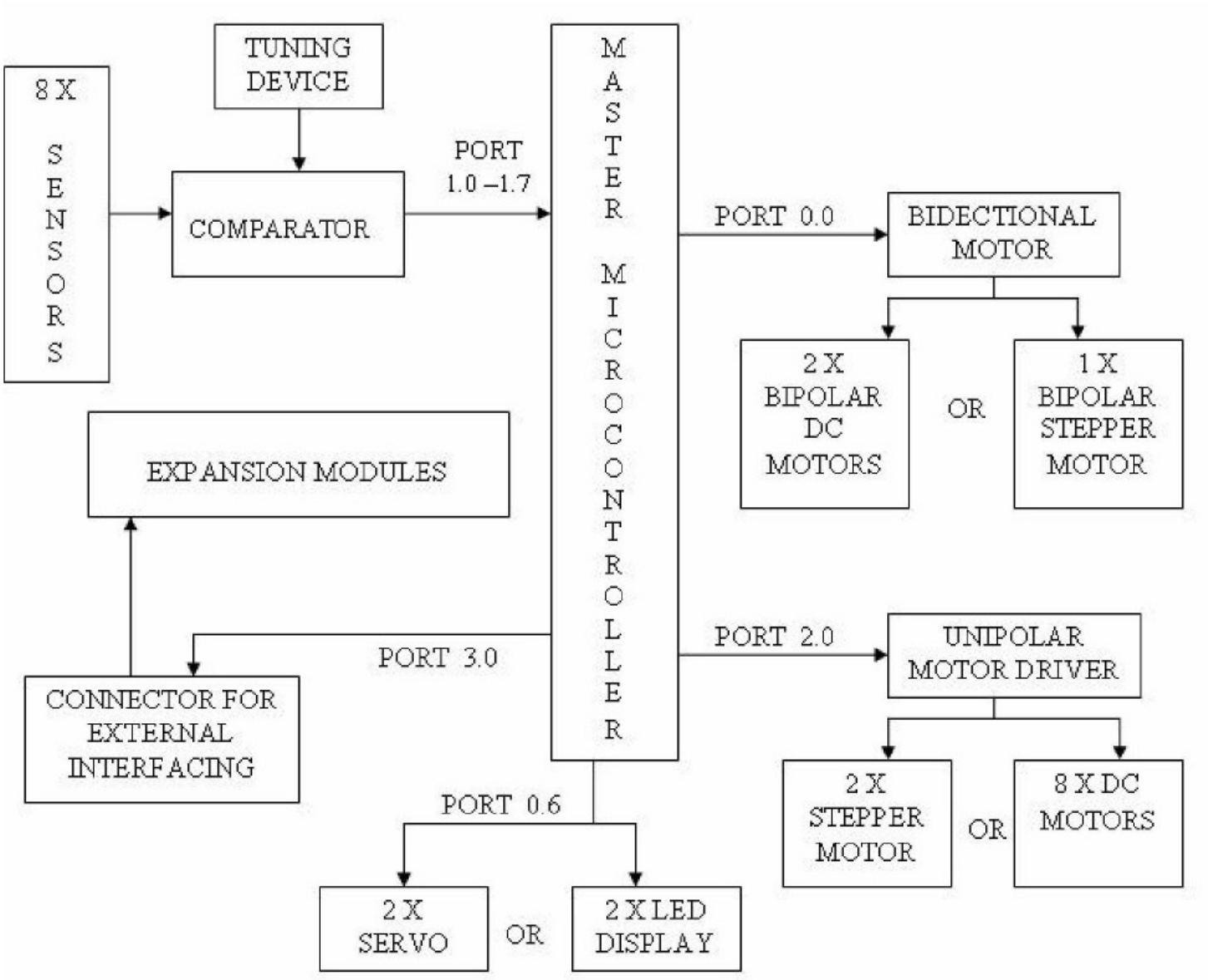


Circuit model of Line Follower Robot

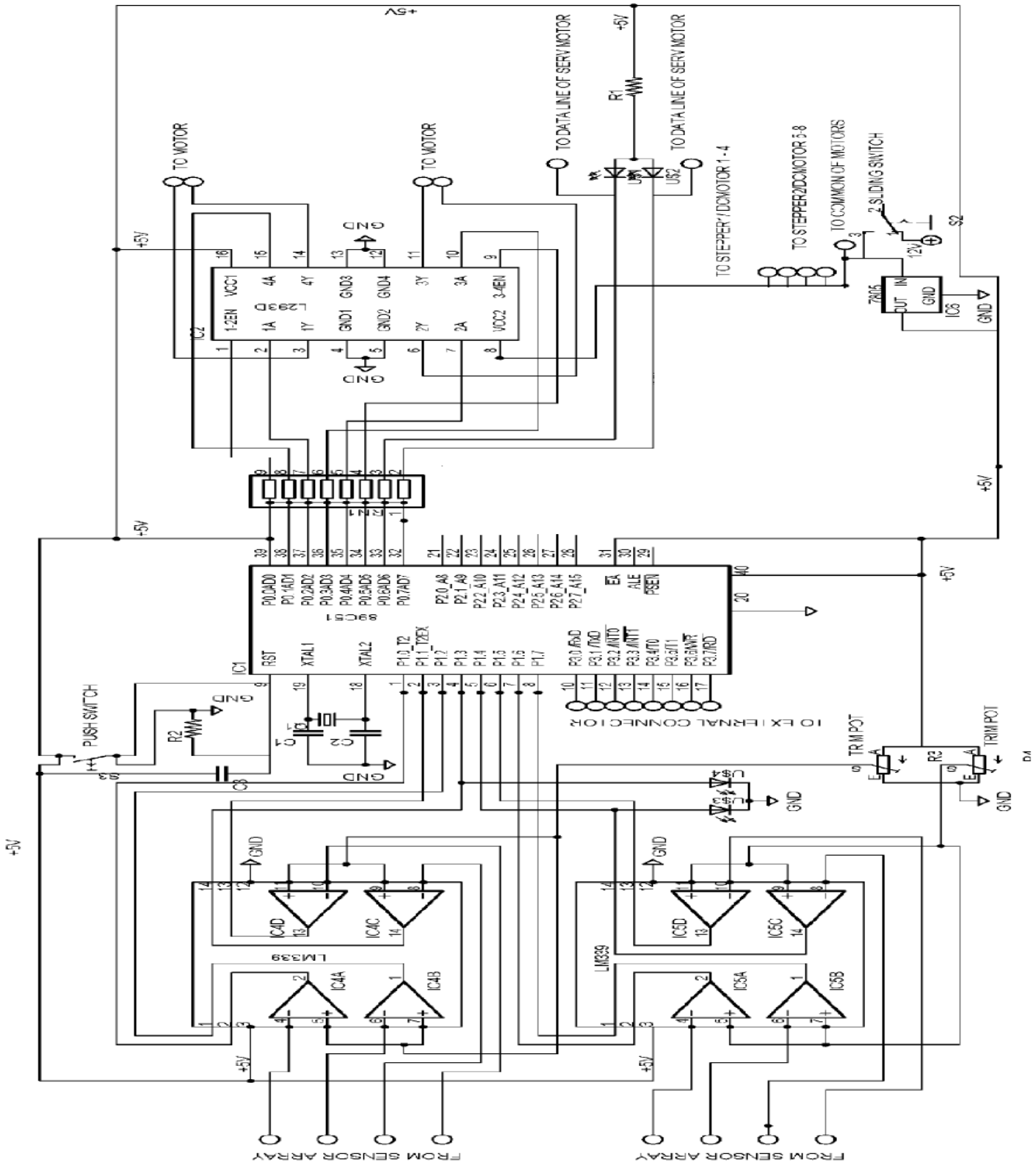
In the line follower robot project we have used 3 pairs of IR (infra-red) emitter/sensor. The sensor on getting blocked or unblocked sends combination of high/low signals to AT89C51 microcontroller which are processed and

appropriate signals are sent to L293D (motor driver chip) which switches on/off the motors so as to keep the robot moving in one direction.

BLOCK DIAGRAM OF LINE FOLLOWER ROBOT:-

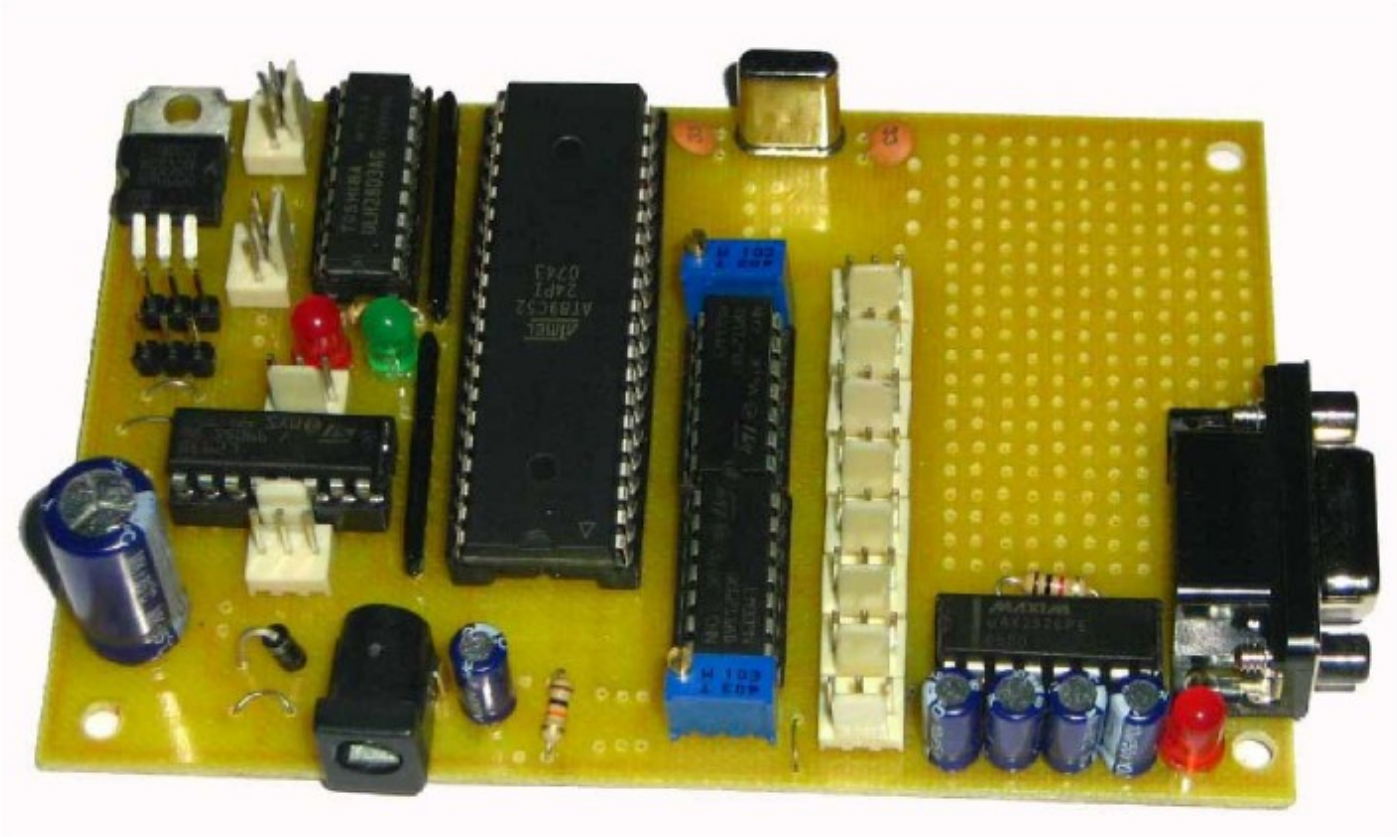


CIRCUIT DIAGRAM OF LINE FOLLOWER ROBOT:-



The microcontroller receives signals from the Infrared Sensor circuit. The code burnt inside the EEPROM processes

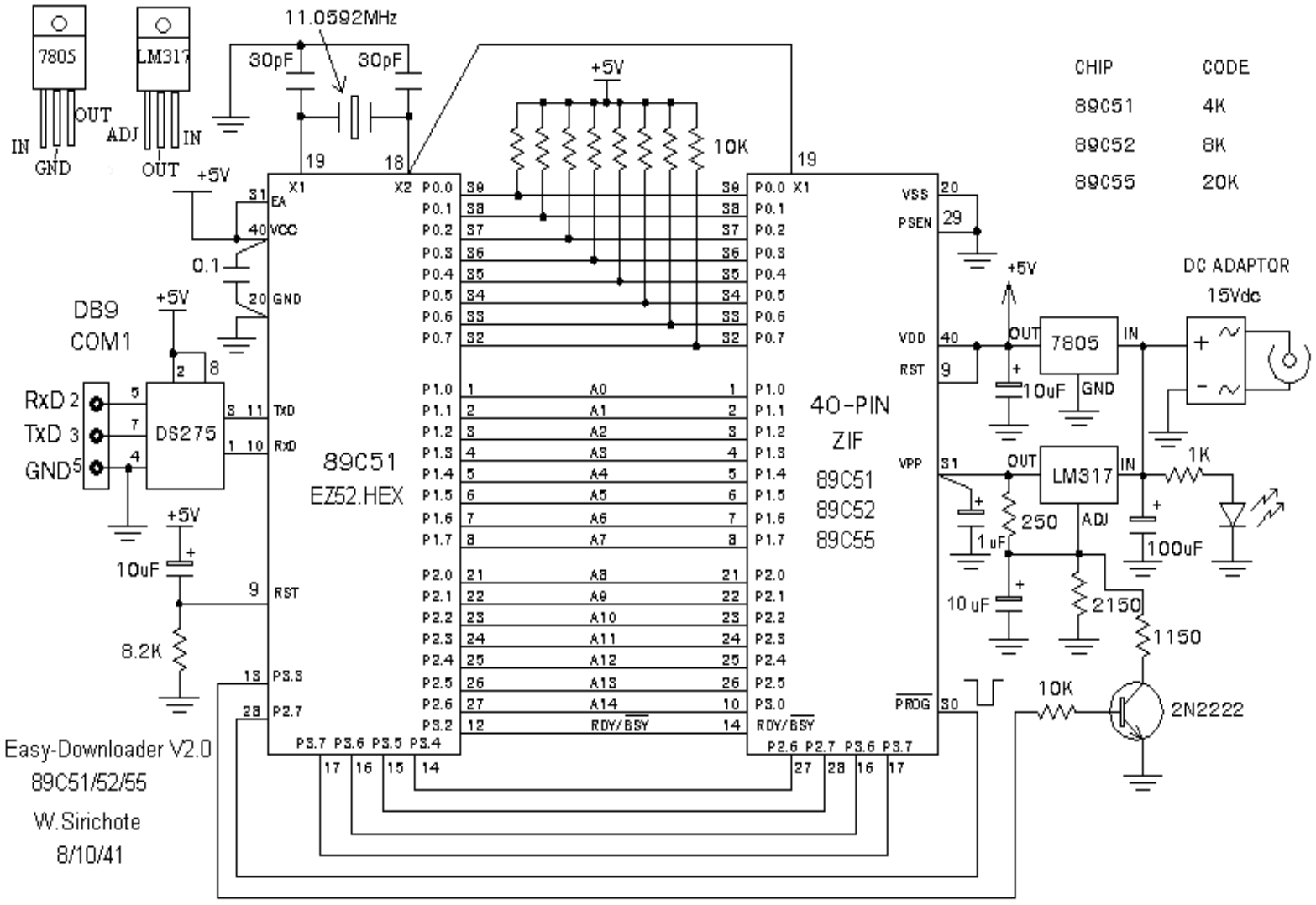
the signal and send appropriate signals to the L293D and turns on/off the motors shown in the figure above. The program that processes the signals received from the LM339 is given on the page later of this project report and the code has been implemented using microcontroller programming in assembly.



PICTURE OF THE DEVELOPMENT BOARD

IMPLEMENTATION

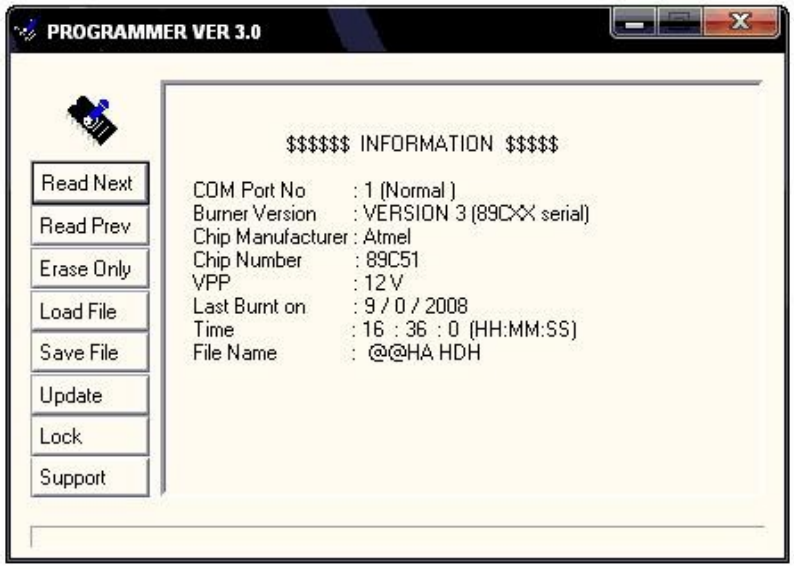
Design of Microc ontrolle r Programm er



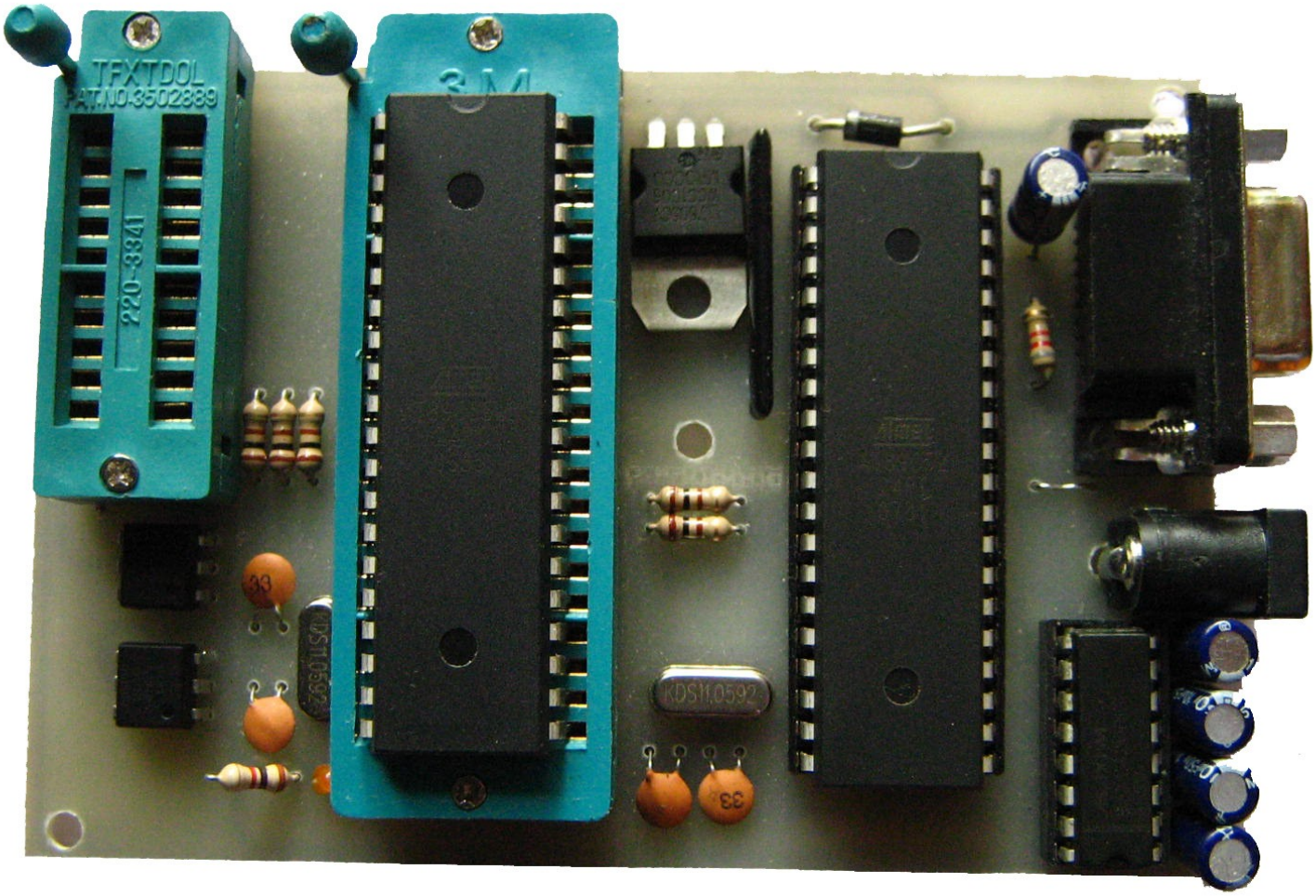
Design of microcontroller programmer

The circuit shown above is microcontroller programmer (AT89CXXseries). It burns the HEX code of the microcontroller program in the EEPROM of the microcontroller using the parallel port of the computer.

The ISP programmer shown below sends the HEX code to the programmer (hardware).



ISP (IN SYSTEM PROGRAMMING) PROGRAMMER



PICTURE OF THE PROGRAMMER BOARD

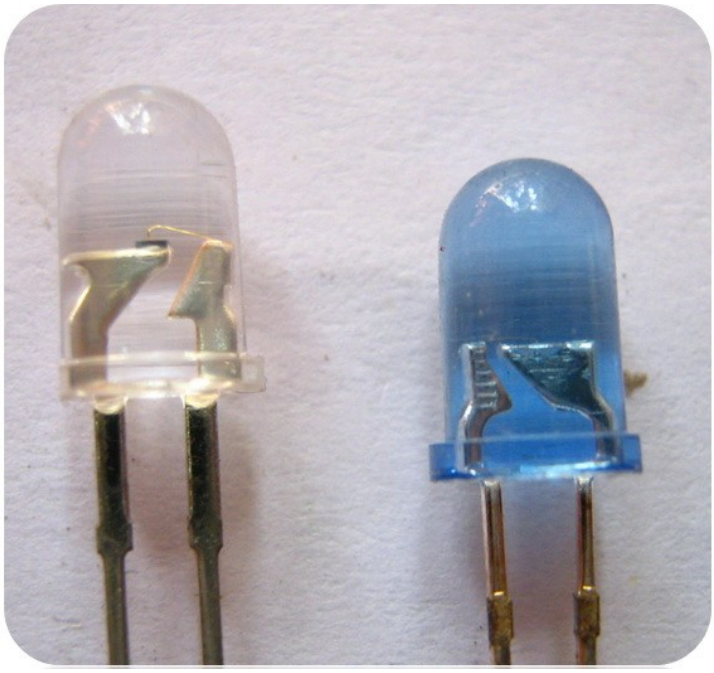
WHAT IS ISP?

In-System Programming (abbreviated ISP) is the ability of some programmable logic devices, microcontrollers, and other programmable electronic chips to be programmed while installed in a complete system, rather than requiring the chip to be programmed prior to installing it into the system.
The primary advantage of this feature is that it allows manufacturers of electronic devices to integrate programming and testing into a single production phase, rather than requiring a separate programming stage prior to assembling the system. This may allow manufacturers to program the chips in their own system's production line instead of buying preprogrammed chips from a manufacturer or distributor, making it feasible to apply code or design changes in the middle of a production run. Typically, chips supporting ISP have internal circuitry to generate any necessary programming voltage from the system's normal supply voltage, and communicate with the programmer via a serial protocol. Most programmable logic devices use proprietary protocols or protocols defined by older standards. In systems complex enough to require moderately large glue logic.

DESIGN OF INFRARED SENSOR CIRCUIT:

Principle of operation of the I.R. L.E.D. and Phototransistor: -

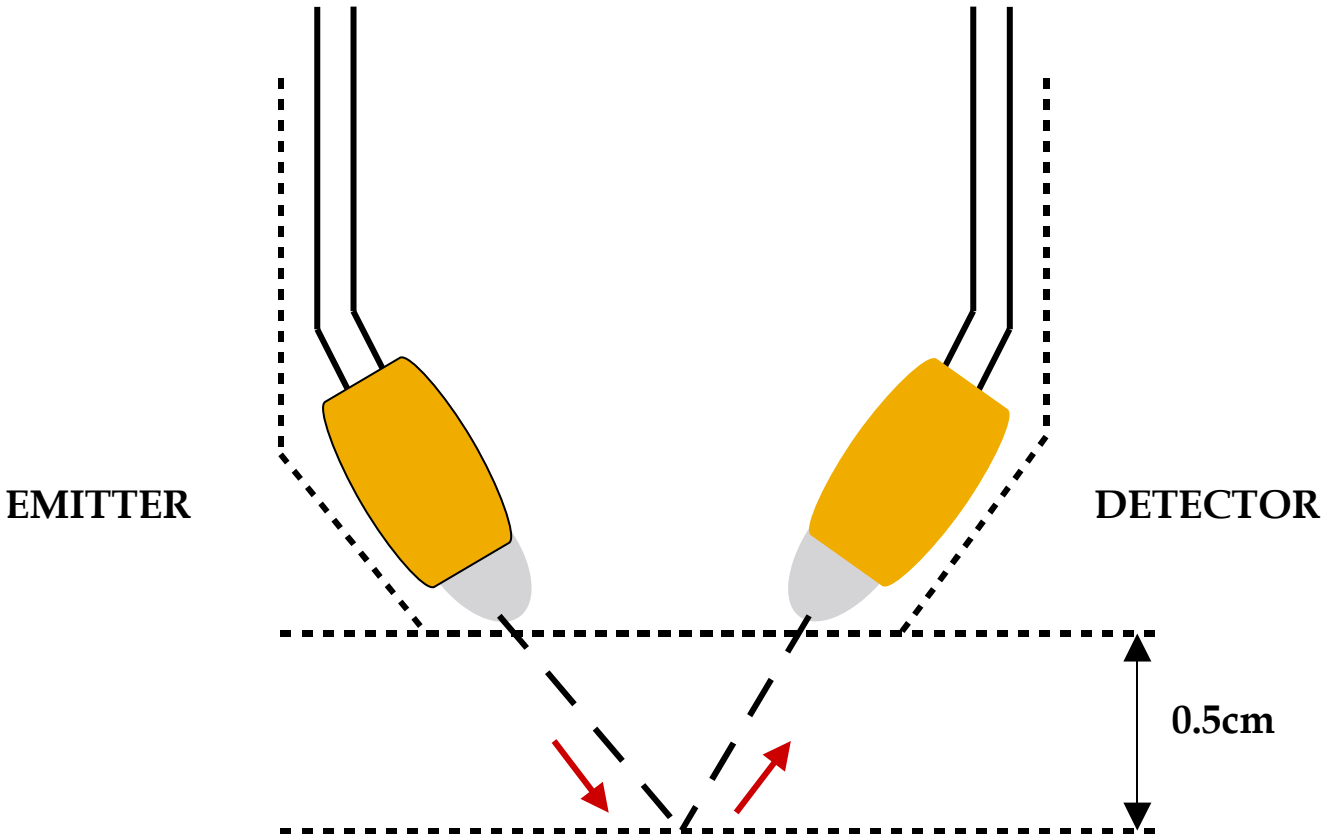
A Photodiode is a p-n junction or p-i-n structure. When an infrared photon of sufficient energy strikes the diode, it excites an electron thereby creating a mobile electron and a positively charged electron hole. If the absorption occurs in the junction's depletion region, or one diffusion length away from it, these carriers are swept from the junction by the built-in field of the depletion region, producing a photocurrent. Photodiodes can be used under either zero bias (*photovoltaic mode*) or reverse bias (*photoconductive mode*). Reverse bias induces only little current (known as saturation or back current) along its direction. But a more important effect of reverse bias is widening of the depletion layer (therefore expanding the reaction volume) and strengthening the photocurrent when infrared falls on it. There is a limit on the distance between I.R. L.E.D. and infrared sensor for the pair to operate in the desired manner. In our case distance is about 5mm.



Infra-Red emitter sends out IR pulses.

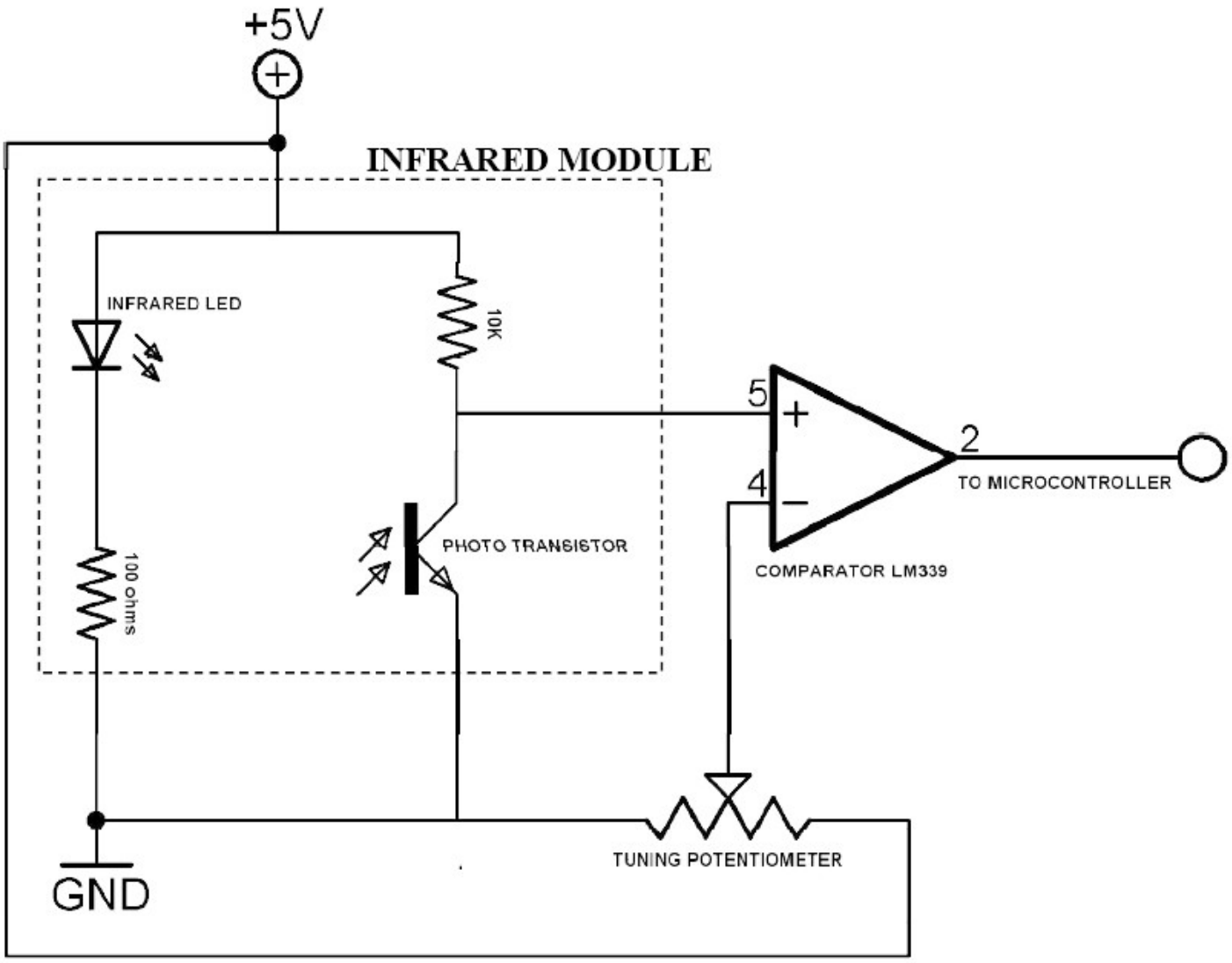
Position calculation is done through intensity of reflected light received by the detector.
Ambient interference is negligible.

POS IT IONI NG OF SEN SOR S:-



The resistance of the sensor decreases when IR (infrared) light falls on it. A good sensor will have near zero resistance in presence of light and a very large resistance in absence of light. Whether the sensors are Light Dependent Resistors, laser diode, Infrared Sensors, Ultrasonic Sensors or anything else,the outputs of the sensor modules are fed to the Non-inverting input of a comparator . The reference voltage of the comparator is fed to the inverting input of the comparator by a trim pot or a tuning device connected between the supply lines. LM339 is a comparator IC that digitizes the analog signal from the sensor array. Since the output of LM339 is TTL compatible it can be directly fed to the master microcontroller.

The generalized connection diagram of Sensor Interfacing with microcontroller is shown below:-

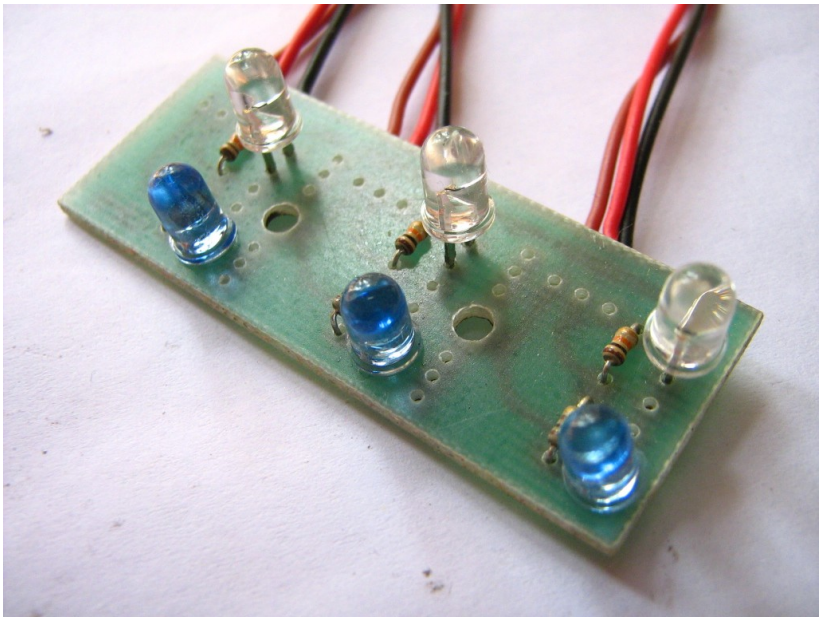


CONNECTING INFRARED MODULE WITH MICROCONTROLLER MCS-51

When the sensor/emitter pair is on shining surface sensor is on i.e. in low impedance mode which one can easily view as L.E.D. corresponding to that sensor doesn't glow. The output of the opamp is ***HIGH SIGN AL*** and this ***HIGH SIGNAL*** is given to the microcontroller and

when the sensor is on normal non-reflecting surface it's off i.e. in ***HIGH IMPEDANCE*** state which one can easily view as L.E.D. corresponding to that sensor glows up and ***LOW SIGNAL*** is given to the microcontroller.

Infra-Red Sensor Array



Black Wire – Output Voltage

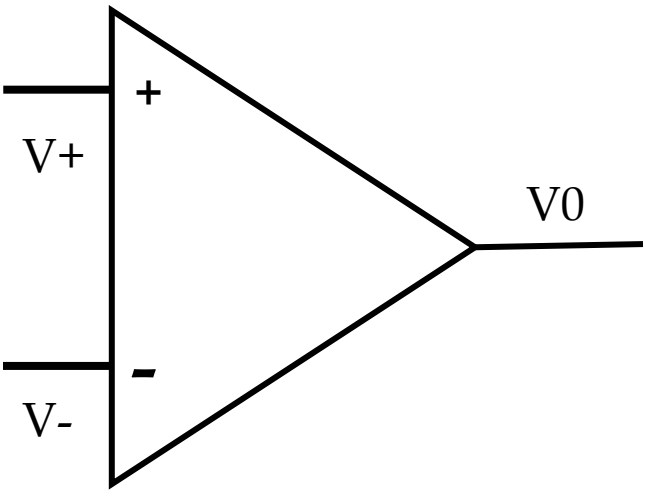
Red Wire - +5V

Brown Wire - Gnd

ANALOG TO DIGITAL CONVERTER:-

It is clear that the output of the potential divider is an analog voltage. But Microcontroller does not accept the analog voltage. So we need to convert the analog voltage to digital before we feed it to the microcontroller.
For this conversion we can use
1. Comparators
2. ADCs

COMPARATOR LM339

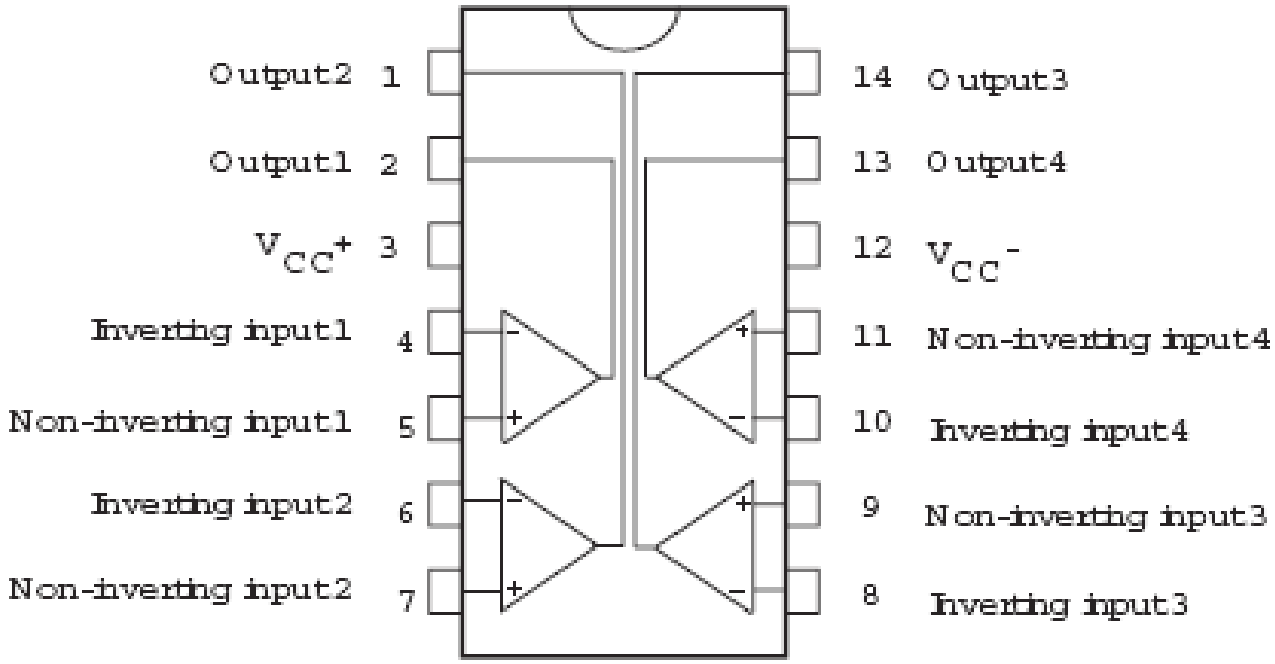


V0 = High when V+ > V-
V0 = Low when V+ < V-

V0 = High when V+ > V-
V0 = Low when V+ < V-

LM339 COMPARATOR:-

PIN DI AGRAM OF LM339:-

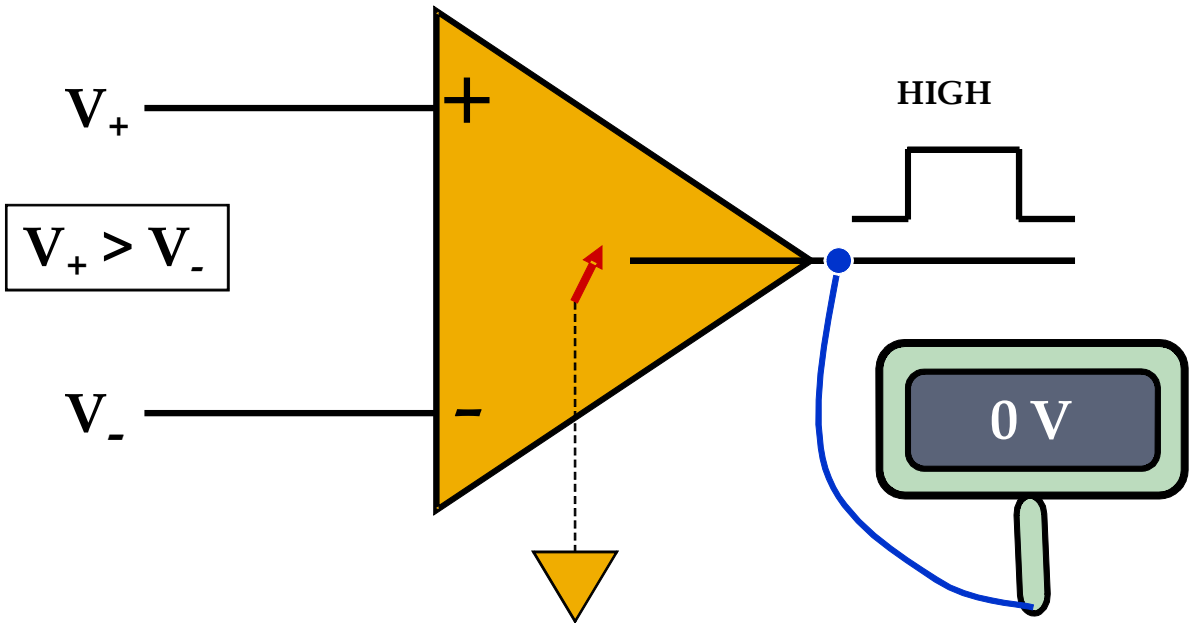


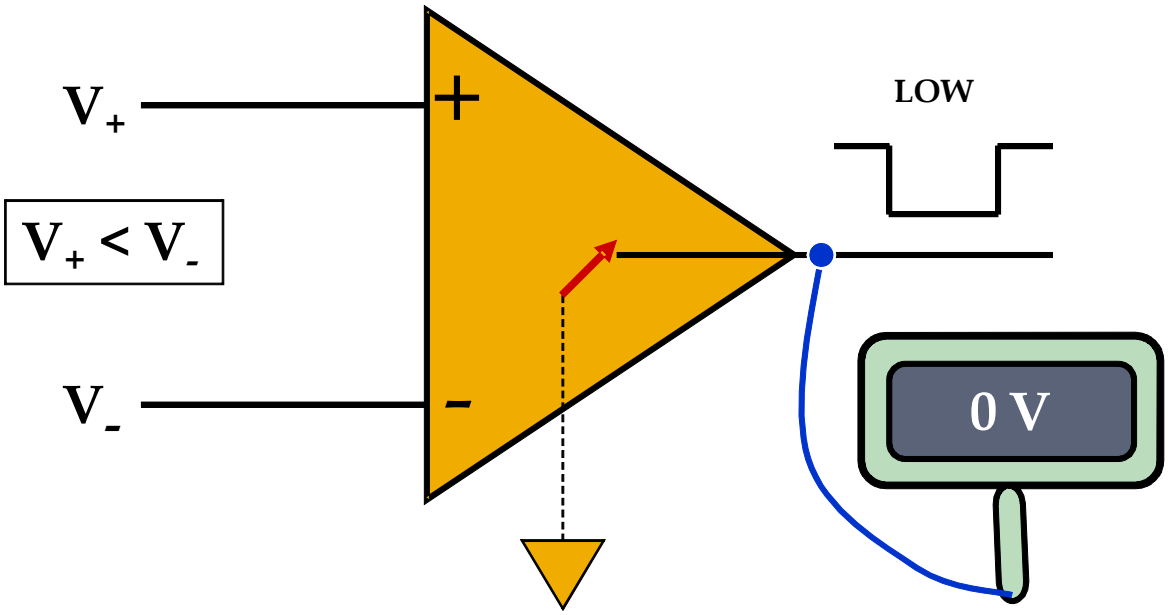
PIN DIAGRAM OF LM339

This device consists of four independent precision voltage comparators with an offset voltage specifications as low as 2mV. This comparator is designed to specifically operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible. This comparator also has a

unique characteristic which is that the input common-mode voltage range includes ground even though operated from a single power supply voltage.

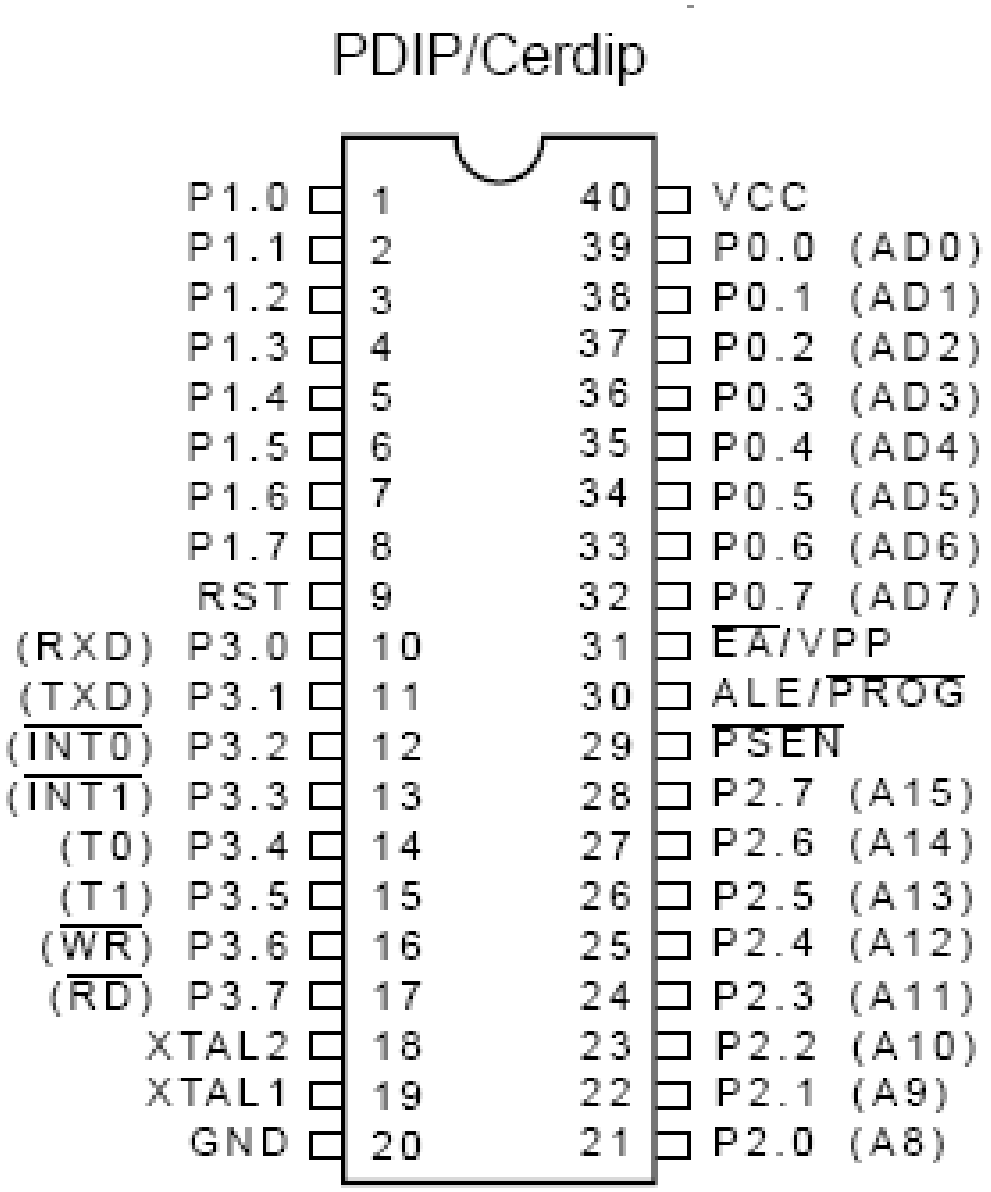
FUNCTION OF THE COMPARATOR:-





MICROCONTROLLER:-

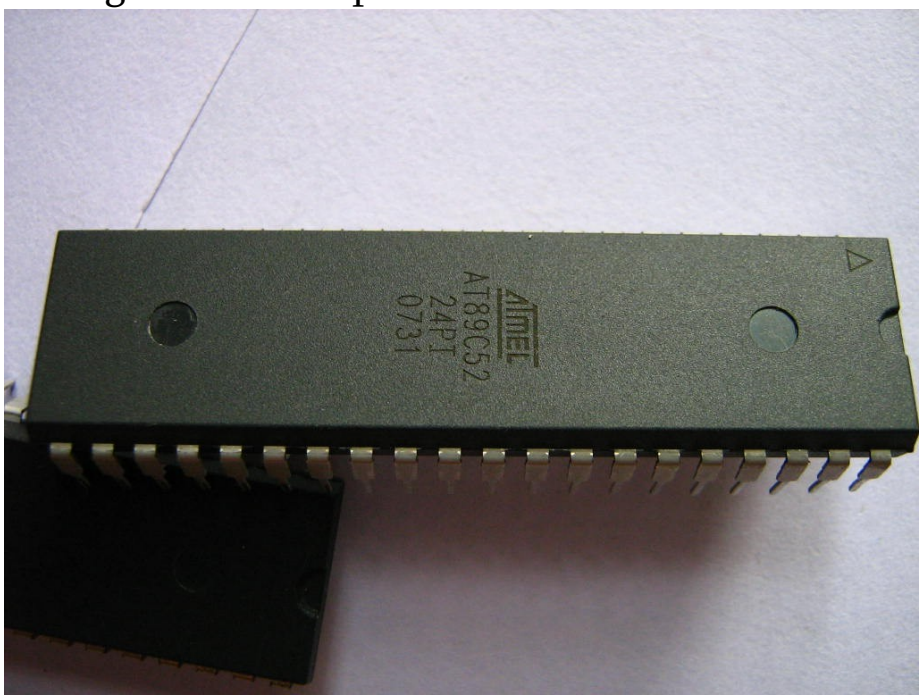
PIN DIAGRAM OF AT89C51: -



PIN DIAGRAM OF AT89C51

The AT89C51 is a low-power, high-performance CMOS 8-bit microcomputer with 4Kbytes of Flash Programmable and Erasable Read Only Memory (PEROM). The device is manufactured using Atmel's high density nonvolatile memory technology and is compatible with the industry standard MCS-51Ô instruction set and pinout. 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 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 AT89C51 provides the following standard features: 4Kbytes of Flash, 128 bytes of RAM, 32 I/O lines, two 16-bit timer/counters, five vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator and clock circuitry. In addition, the AT89C51 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 Power down Mode saves the RAM contents but freezes the oscillator disabling all other chip functions until the next hardware reset.



PICTURE OF THE MICROCONTROLLER

ONBOARD PIN CONNECTIONS:-

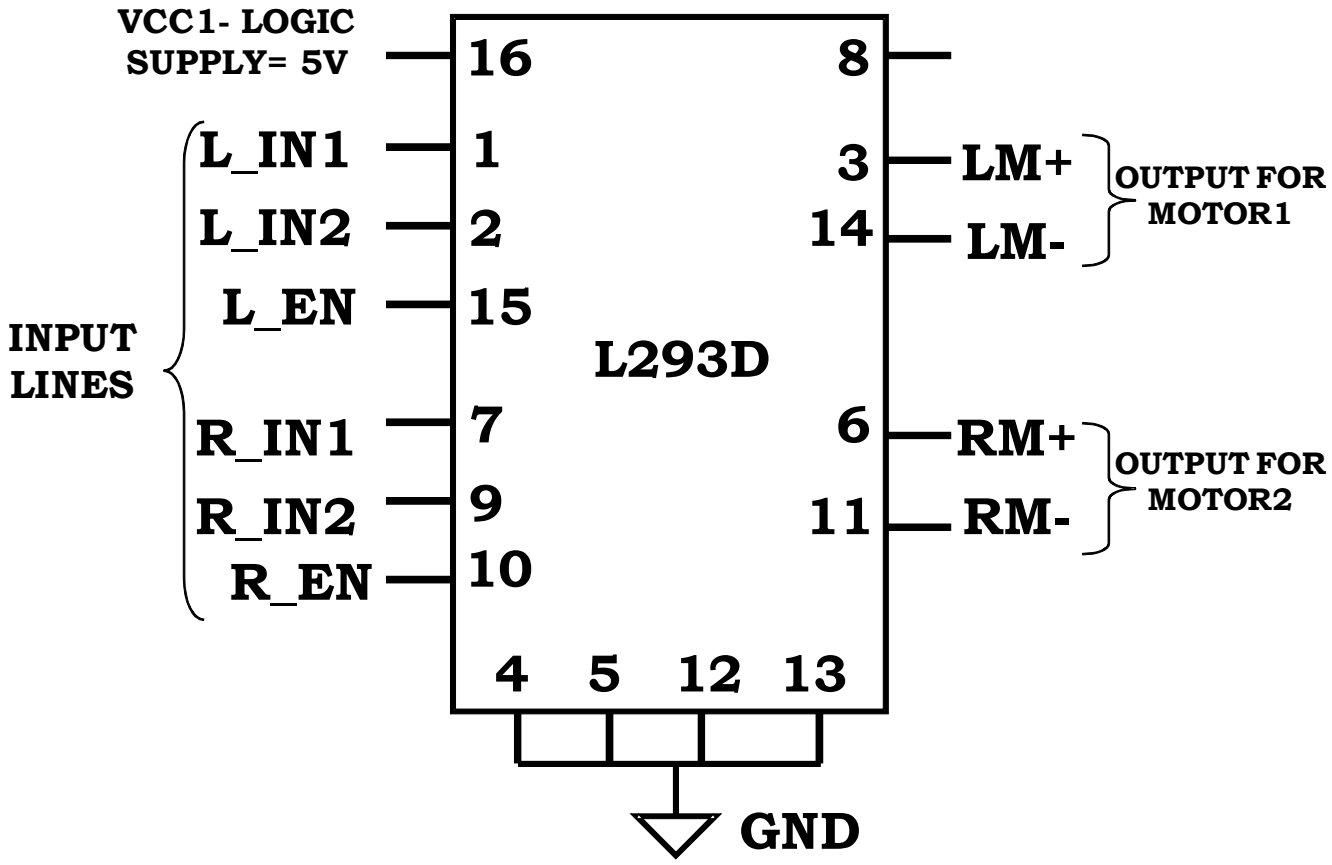
Port Number	Bit	Connections
P-0	0	DC MOTOR #1 – INPUT A
	1	DC MOTOR #1 – INPUT B
	2	DC MOTOR #1 – EN
	3	DC MOTOR #2 – INPUT A
	4	DC MOTOR #2 – EN
	5	DC MOTOR #2 – INPUT B
	6	RED LED / SERVO MOTOR 1
	7	GREEN LED / SERVO MOTOR 2
P-1	0	SENSOR # 4
	1	SENSOR # 2
	2	SENSOR # 3
	3	SENSOR # 1
	4	SENSOR # 7
	5	SENSOR # 8
	6	SENSOR # 5
	7	SENSOR # 6

P-2	0	NO CONNECTION – EXPANSION
	1	NO CONNECTION – EXPANSION
	2	NO CONNECTION – EXPANSION
	3	NO CONNECTION – EXPANSION
	4	NO CONNECTION – EXPANSION
	5	NO CONNECTION – EXPANSION
	6	NO CONNECTION – EXPANSION
	7	NO CONNECTION – EXPANSION
P-3	0	NO CONNECTION – EXPANSION
	1	NO CONNECTION – EXPANSION
	2	NO CONNECTION – EXPANSION
	3	NO CONNECTION – EXPANSION
	4	NO CONNECTION – EXPANSION
	5	NO CONNECTION – EXPANSION
	6	NO CONNECTION – EXPANSION
	7	NO CONNECTION – EXPANSION

BIPOLAR MOTOR DRIVER:-

L293D is a bipolar motor driver IC. This is a high voltage, high current pushpull four channel driver compatible to TTL logic levels and drive inductive loads. It has 600 mA output current capability per channel and internal clamp diodes.
The L293 is designed to provide bidirectional drive currents of upto 1 A at voltages from 4.5 V to 36 V. The L293D is designed to provide bidirectional drive currents of up to 600-mA at voltages from 4.5 V to 36 V. Both devices are designed to drive inductive loads such as relays, solenoids, dc and bipolar stepping motors, as well as other high-current/high-voltage loads in positive supply applications. All inputs are TTL compatible. Each output is a complete totem-pole drive circuit, with a Darlington transistor sink and a pseudo-Darlington source. Drivers are enabled in pairs, with drivers 1 and 2 enabled by 1,2EN and drivers 3 and 4 enabled by 3,4EN. When an enable input is high, the associated drivers are enabled, and their outputs are active and in phase with their inputs. When the enable input is low, those drivers are disabled, and their outputs are off and in the high-impedance state. With the proper data inputs, each pair of drivers forms a full-H (or bridge) reversible drive suitable for solenoid or motor applications.

PIN DIAGRAM OF L293D:-



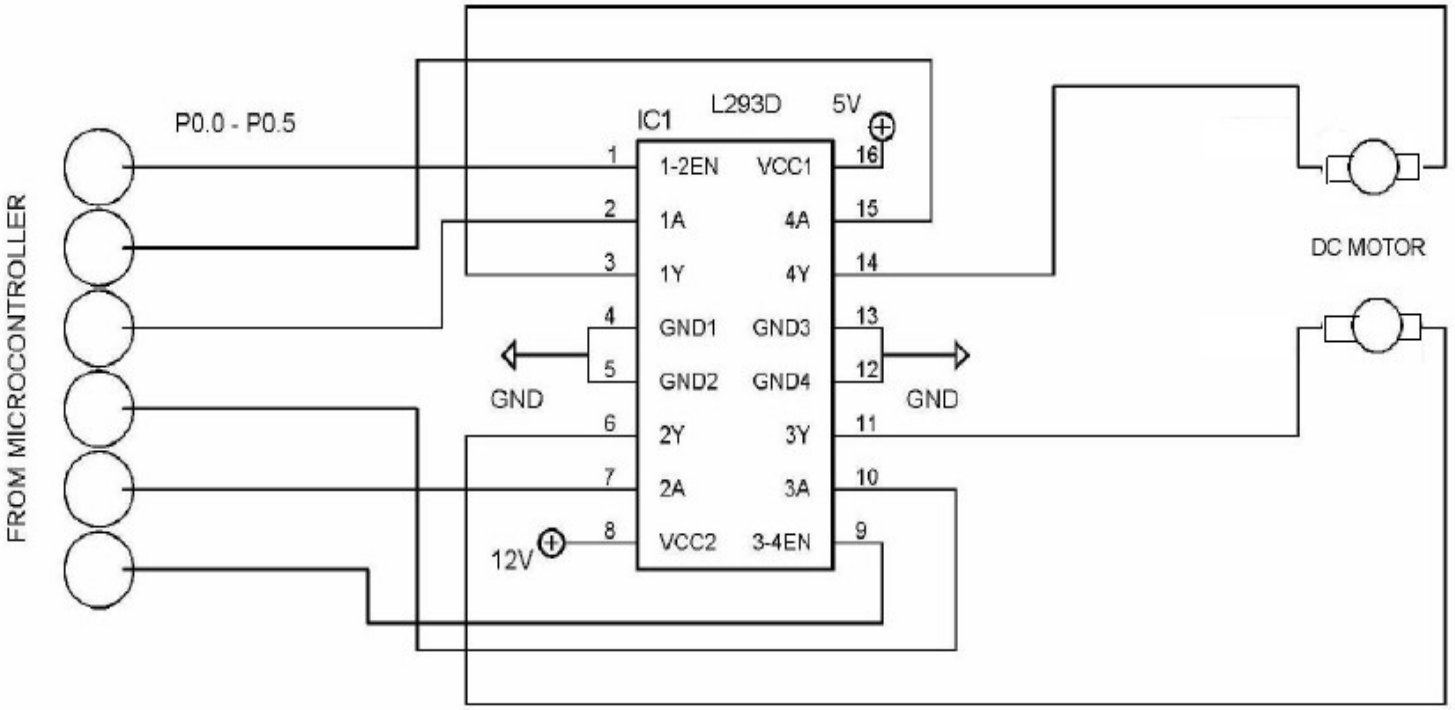
PIN DIAGRAM OF L293D

The Device is a monolithic integrated high voltage, high current four channel driver designed to accept standard DTL or TTL logic levels and drive inductive loads (such as relays solenoides, DC and stepping motors) and switching power transistors. To simplify use as two bridges each pair of channels is equipped with an enable input. A separate supply input is provided for the logic, allowing operation at a lower voltage and internal clamp diodes are included. This device is suitable for use in switching applications at frequencies up to 5 kHz.

The L293D is assembled in a 16 lead plastic packaage which has 4 center pins connected together and used for heatsinking The L293DD is assembled in a 20

lead surface mount which has 8 center pins connected together and used for heatsinking.

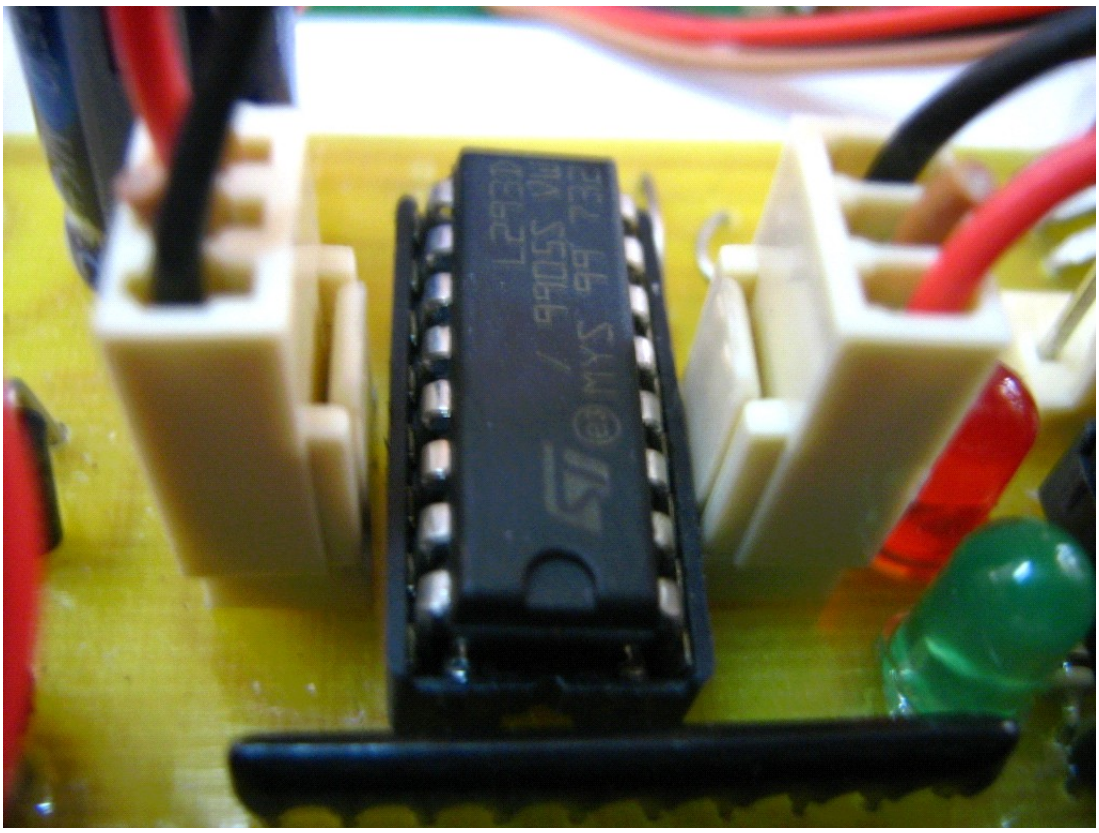
PIN CONNECTIONS:-



CONNECTION DIAGRAM FOR DRIVING BIPOLAR DC MOTOR

MOTOR DRIVING:-

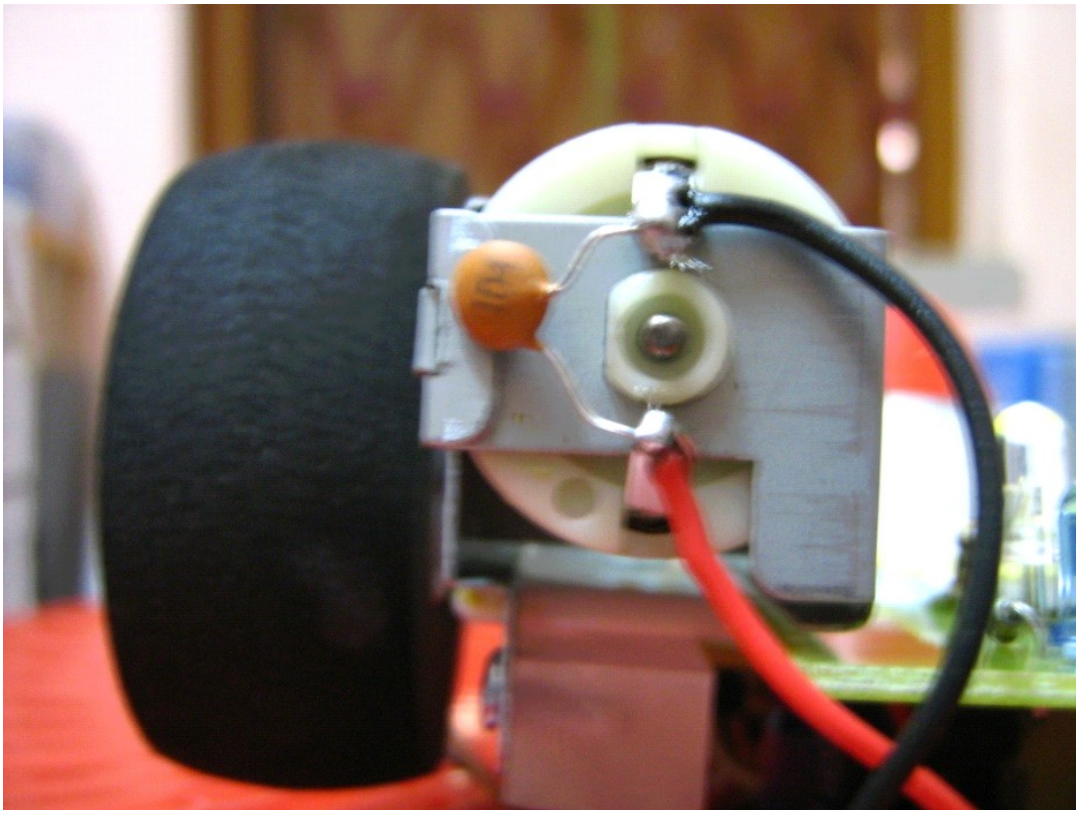
EN	***IN 1***	***IN 2***	***Motor Status***
0	***X***	***X***	***Stopped***
1	***0***	***0***	***Stopped***
1	***1***	***1***	***Stopped***
1	***1***	***0***	***CW***
1	***0***	***1***	***CCW***



PICTURE OF BIPOLAR MOTOR DRIVER

DC MOTORS:-

These are very commonly used in robotics. DC motors can rotate in both directions depending upon the polarity of current through the motor. These motors have free running torque and current ideally zero. These motors have high speed which can be reduced with the help of gears and traded off for torque. Speed Control of DC motors is done through Pulse Width Modulation techniques, i.e. sending the current in intermittent bursts. PWM can be generated by 555 timer IC with adjusted duty cycle. Varying current through the motor varies the torque.



PICTURE OF DC MOTOR USED

SOURCE CODE:-

```
PROGRAM FOR  LINE FOLLOWER
=======SYSTEM REGISTERS==============

P0     EQU 080H
P1     EQU 090H
P2     EQU 0A0H
P3     EQU 0B0H

TH1    EQU 08DH
TL1    EQU 08BH
TCON   EQU 088H
TMOD   EQU 089H
IE     EQU 0A8H
SP     EQU 081H
FLAG1  EQU 0D0H

;======= PORT PIN DEFINITIONS ========
SENSOR1 EQU P1.0
SENSOR2 EQU P1.1
LED_RED  EQU P0.6
LED_GREEN EQU P0.7
L_EN  EQU P0.2
R_EN  EQU P0.4
L_MO1 EQU P0.1
L_MO2 EQU P0.0
R_MO1 EQU P0.3
R_MO2 EQU P0.5
```

```
 ; X X X X M X L R

 ; X X X X 1 X 0 0 - FWD  --  03
 ;           0 1 -  TR      01
 ;           1 0 -   TL     02
 ;           00  - STOP    00

;========== HERE THE MAIN PROGRAM STARTS ==========

ORG 0000H
        AJMP START

ORG 0050H
START:  MOV R1,#0FFH
        MOV R2,#004H
        MOV P2,#000H

LOOP:       MOV C,SENSOR1
        MOV LED_RED,C
        MOV C,SENSOR2
        MOV LED_GREEN,C

        MOV A,P1
        ANL A,#003H

        CJNE A,#000H,CHECK_LEFT ;////// GO FORWARD /////////
        SETB R_MO1
        CLR  R_MO2
        SETB L_MO1
        CLR  L_MO2
        MOV R1,#0FFH
```

```
        MOV R2,#004H
        AJMP LOOP


CHECK_LEFT:
        CJNE A,#001H,CHECK_RIGHT ;////// TURN LEFT //////////
        SETB R_MO1
        CLR  R_MO2
        CLR L_MO1
        SETB L_MO2
        MOV R1,#0FFH
        MOV R2,#004H

HERE_LEFT:
        MOV A,P1
        ANL A,#003H
        CJNE A,#003H,LEFT_CONT
        DJNZ R1,LEFT_CONT
        DJNZ R2,LEFT_CONT
        AJMP STOP


LEFT_CONT:
        JB P1.0,HERE_LEFT
        AJMP LOOP




CHECK_RIGHT:
        CJNE A,#002H,CHECK_STOP   ;/////// TURN RIGHT ///////
```

```
        CLR  R_MO1
        SETB R_MO2
        SETB L_MO1
        CLR  L_MO2
        MOV R1,#0FFH
        MOV R2,#004H
HERE_RIGHT:
        MOV A,P1
        ANL A,#003H
        CJNE A,#003H,RIGHT_CONT
        DJNZ R1,LEFT_CONT
        DJNZ R2,LEFT_CONT
        AJMP STOP
RIGHT_CONT:
        JB P1.1,HERE_RIGHT
        AJMP LOOP
CHECK_STOP:
        DJNZ R1,LOOP
STOP:       SETB R_MO1
        SETB R_MO2
        SETB L_MO1
        SETB L_MO2

HERE_STOP:
        AJMP HERE_STOP

END
```

HEX CODE GENERATED FOR THE CODE:-

: 020000000150AD
: 1000500079FF7A0475A000A2909286A2919287E51A
: 10006000905403B4000ED283C285D281C28079FF3E
: 100070007A040157B4011ED283C285C281D280792D
: 10008000FF7A04E5905403B40306D904DA0201B8F8
: 100090002090F00157B4021EC283D285D281C28063
: 1000A00079FF7A04E5905403B40306D9E3DAE10159
: 1000B000B82091F00157D99FD283D285D281D280C6
: 0200C00001C07D
: 00000001FF

PROBLEMS ENCOUNTERED:-

• The ISP programmer requires dedicated supply of 9V from the USB of your P.C. Extern supply of other than 9V generates error while writing the HEX code to the Microcontroller. The programmer was soldered 3 times before it could successfully program the chip.

• The program was difficult to implement as it was our first encounter with microcontroller programming in assembly.

• The large number of interconnections in the circuit made it too difficult to solder.

• The IR sensors burnt up on soldering so we have to use temperature controlled soldering iron.

• In the model designed to show line follower robot, electric motors ought to be bidirectional and of low wattage i.e. should draw lesser current otherwise the motor can draw current to such a level to burn up the entire circuit.

REFERENCES AND RESOURCES:-

Books:

1) The 8051 Microcontroller and Embedded Systems Using Assembly and C By Muhammad Ali Mazidi, Janice Gillispie Mazidi **&** **Rolin D.** McKinlay

Websites referred:

1) Atmel Corp. Makers of the AVR microcontroller www.atmel.com
2) One of the best sites AVR site www.avrfreaks.net
3) One of the best site for Microcontroller projects www.kmitl.ac.th
4) Keil™, the developer of Keilμvision www.keil.com
5) Information from www.wikipedia.com