A

TERM PAPER REPORT

ON

LINE FOLLOWER ROBOT

Submitted by:

Priya Hada

B.Tech (ECE)

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Amity School of Engineering & Technology

AMITY UNIVERSITY RAJASTHAN

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CERTIFICATE

This is to certify that Priya Hada, student of B.Tech. in Electronics and Communication Engineering has carried out the work presented in the project of the Training entitled "**LINE FOLLOWER ROBOT**" as a part of third Year programme of Bachelor of Technology in of B.Tech. in Electronics and Communication Engineering from Amity School of Engineering and Technology, Amity University Rajasthan, under my supervision.

STUDENT

(Priya Hada)

Guide

(Achyut Sharma)

ASET (AUR)

Date:22/10/13

ACKNOWLEDGEMENT

It has come out to be a sort of great pleasure and experience for me to work on the project line follower robot(LFR).I wish to express my indebtedness to those who helped us i.e. the faculty of our Institute Mr. Achyut Sharma during the preparation of the manual script of this text. This would not have been made successful without his help and precious suggestions. Finally, I also warmly thanks to all our colleagues who encouraged us to an extent, which made the project successful.

Priya Hada

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1. INTRODUCTION

1.1 INTRODUCTION TO LINE FOLLING ROBOT

A line follower robot is basically a robot designed to follow a 'line' or path already predetermined by the user. This line or path may be as simple as a physical white line on the floor or as complex path marking schemes e.g. embedded lines, magnetic markers and laser guide markers. In order to detect these specific markers or 'lines', various sensing schemes can be employed. These schemes may vary from simple low cost line sensing circuit to expansive vision systems. The choice of these schemes would be dependent upon the sensing accuracy and flexibility required. From the industrial point of view, line following robot has been implemented in semi to fully autonomous plants. In this environment, these robots functions as materials carrier to deliver products from one manufacturing point to another where rail, conveyor and gantry solutions are not possible. Apart from line following capabilities, these robots should also have the capability to navigate junctions and decide on which junction to turn and which junction ignore. This would require the robot to have 90 degree turn and also junction counting capabilities. To add on to the complexity of the problem, sensor positioning also plays a role in optimizing the robots performance for the tasks mentioned earlier.

Line-following robots with pick- and- placement capabilities are commonly used in manufacturing plants. These move on a specified path to pick the components from specified locations and place them on desired locations. Basically, a line-following robot is a self-operating robot that detects and follows a line drawn on the floor. The path to be taken is indicated by a white line on a black surface. The control system used must sense the line and man oeuvre the robot to stay on course while constantly correcting the wrong moves using feedback mechanism, thus forming a simple yet effective closed- loop system.

1.2 BLOCK DIAGRAM:

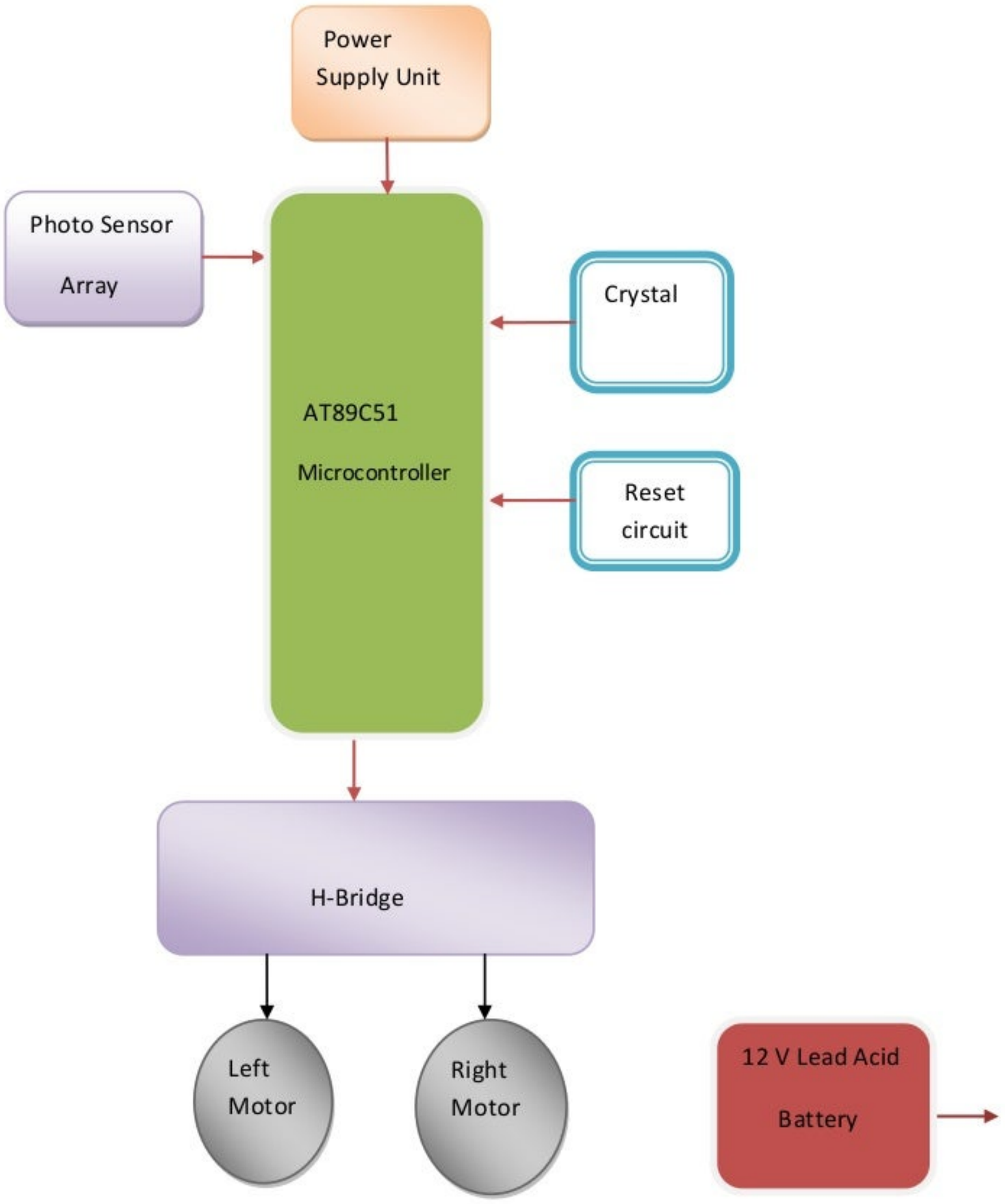


Fig.1.1 Block diagram of line follower

1.3 INTRODUCTION TO EMBEDDED SYSTEMS

An embedded system is a system which is going to do a predefined specified task is the embedded system and is even defined as combination of both software and hardware. A general-purpose definition of embedded systems is that they are devices used to control, monitor or assist the operation of equipment, machinery or plant. "Embedded" reflects the fact that they are an integral part of the system. At the other extreme a general-purpose computer may be used to control the operation of a large complex processing plant, and its presence will be obvious.

All embedded systems are including computers or microprocessors. Some of these computers are however very simple systems as compared with a personal computer. The simplest devices consist of a single microprocessor (often called a "chip"), which may itself be packaged with other chips in a hybrid system or Application Specific Integrated Circuit (ASIC). Its input comes from a detector or sensor and its output goes to a switch or activator which (for example) may start or stop the operation of a machine.

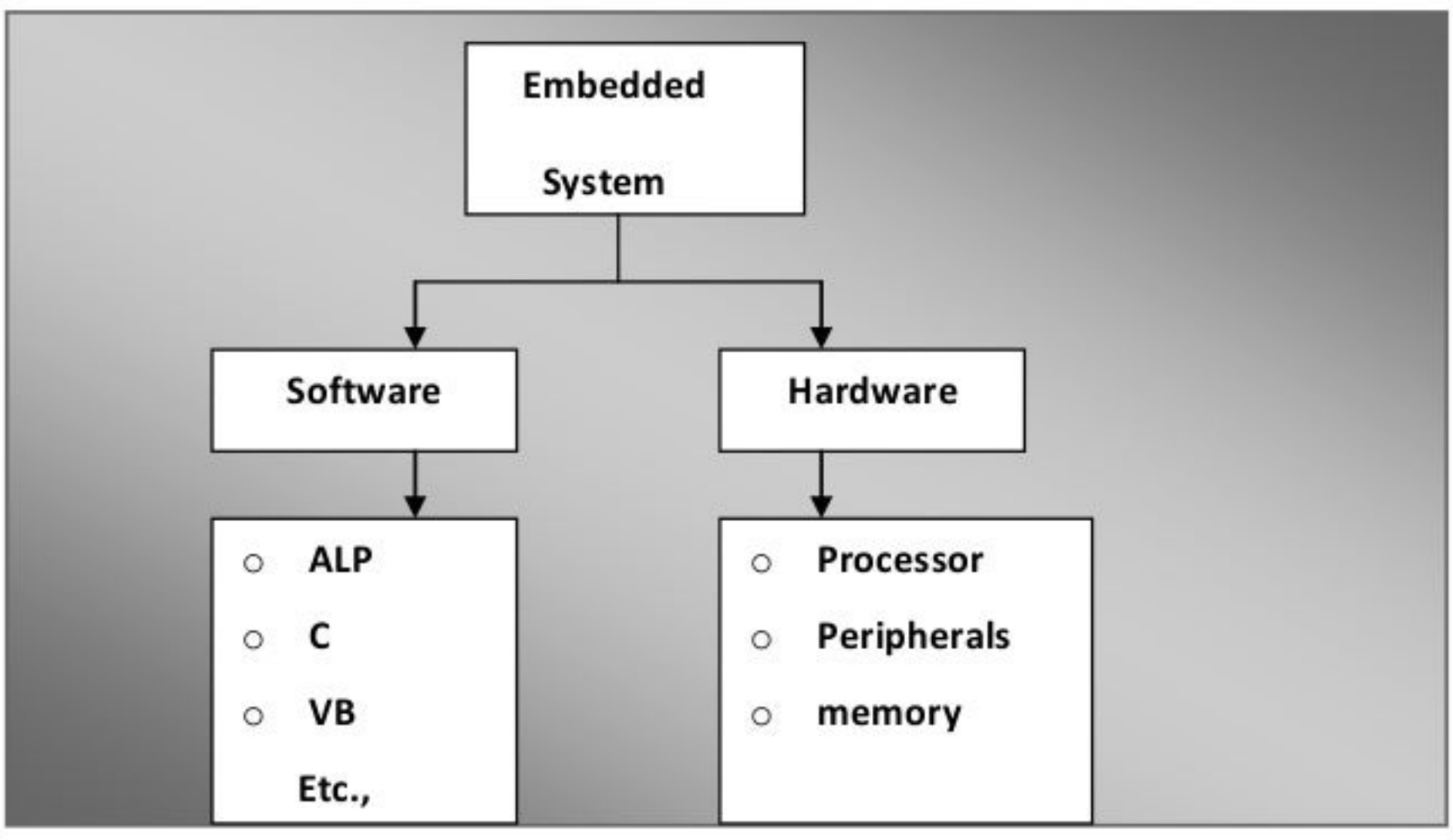


Figure: 1.2 Block diagram of Embedded System

Embedded consist of both software and hardware :

Memory: It is used to store data or address.

Peripherals: These are the external devices connected

Processor: It is an IC which is used to perform some task

Applications of embedded systems

- Manufacturing and process control
- Construction industry
- Transport
- Buildings and premises
- Domestic service
- Communications
- Office systems and mobile equipment
- Banking, finance and commercial
- Medical diagnostics, monitoring and life support
- Testing, monitoring and diagnostic systems

2. HARDWARE EXPLANATION

2.1 BASIC HARDWARE

2.1.1 BLOCK DIAGRAM FOR REGULATED POWER SUPPLY :

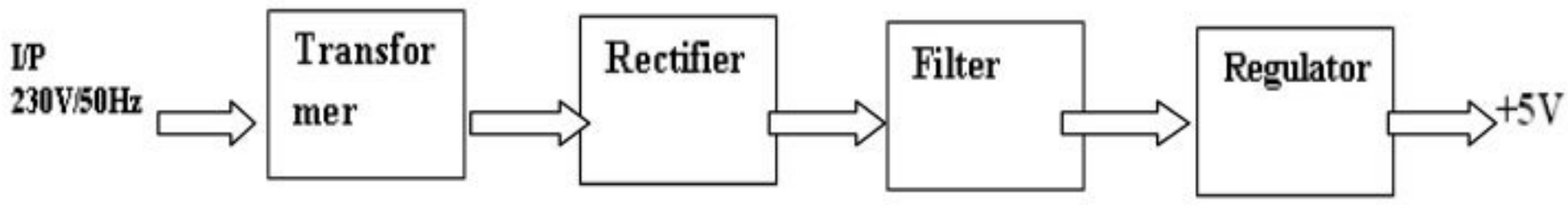


Fig: 2.1 Power Supply

2.1.2 DESCRIPTION OF TRANSFORMER

A **transformer** is a device that transfers electrical energy from one circuit to another through inductively coupled conductors—the transformer's coils. A varying current in the first or primary winding creates a varying magnetic flux in the transformer's core, and thus a varying magnetic field through the secondary winding. This varying magnetic field induces a varying electromotive force (EMF) or "voltage" in the secondary winding. This effect is called mutual induction.

A transformer makes use of Faraday's law and the ferromagnetic properties of an iron core to efficiently raise or lower AC voltages. It of course cannot increase power so that if the voltage is raised, the current is proportionally lowered and vice versa.

A transformer consists of two coils (often called 'windings') linked by an iron core, as shown in figure below. There is no electrical connection between the coils; instead they are linked by a magnetic field created in the core.

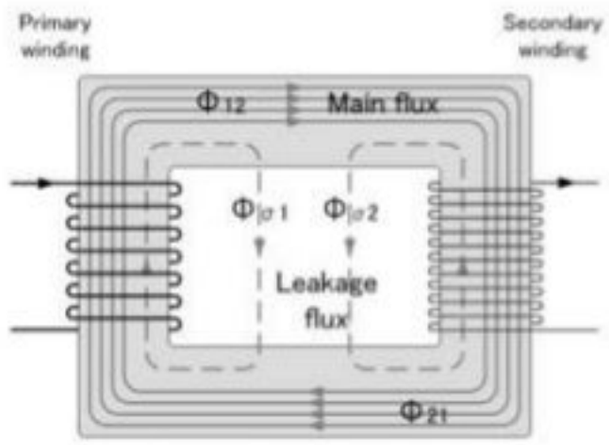


Fig: 2.2 Basic Transformer

Transformers are used to convert electricity from one voltage to another with minimal loss of power. They only work with AC (alternating current) because they require a changing magnetic field to be created in their core. Transformers can increase voltage (step-up) as well as reduce voltage (step-down).

2.1.3 Rectifier

The purpose of a rectifier is to convert an AC waveform into a DC waveform (OR) Rectifier converts AC current or voltages into DC current or voltage. There are two different rectification circuits, known as 'half-wave' and 'full-wave' rectifiers. Both use components called diodes to convert AC into DC.

2.1.3.1: The Half-wave Rectifier-

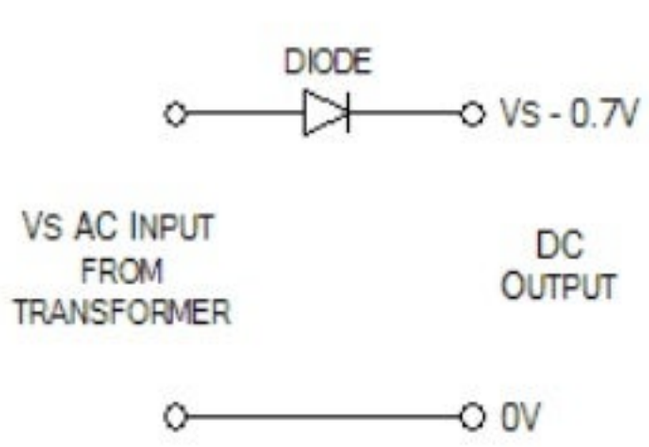


Fig: 2.3.1(a) Half Wave Rectifier

While the output of the half-wave rectifier is DC (it is all positive), it would not be suitable as a power supply for a circuit. Firstly, the output voltage continually varies between 0V and Vs-0.7V, and secondly, for half the time there is no output at all.

2.1.3.2 The Full-wave Rectifier

The circuit in figure addresses the second of these problems since at no time is the output voltage 0V. This time four diodes are arranged so that both the positive and negative parts of the AC waveform are converted to DC.

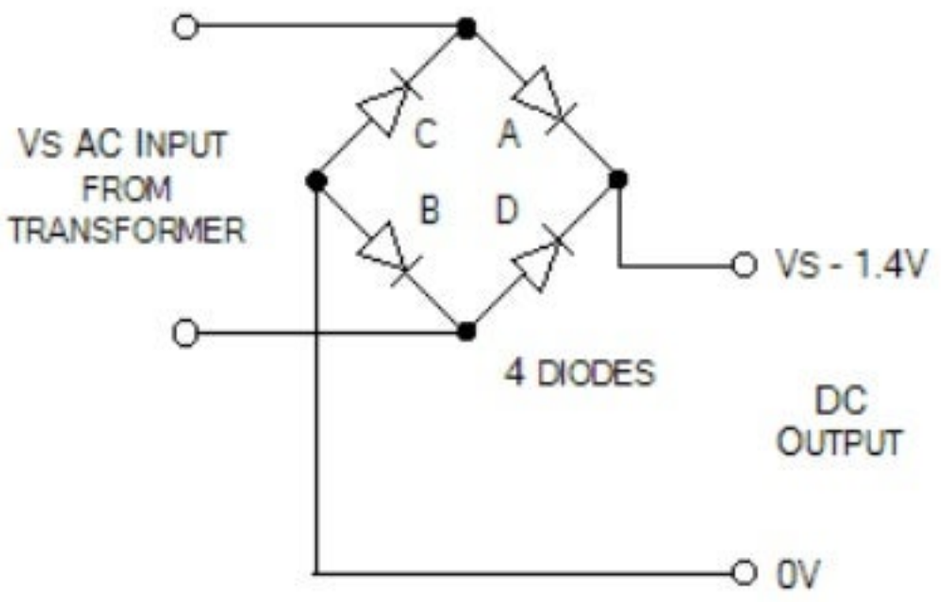


Fig: 2.3.2(a) Full-Wave Rectifier

When the AC input is positive, diodes A and B are forward-biased, while diodes C and D are reverse-biased. When the AC input is negative, the opposite is true - diodes C and D are forward-biased, while diodes A and B are reverse-biased.

While the full-wave rectifier is an improvement on the half-wave rectifier, its output still isn't suitable as a power supply for most circuits since the output voltage still varies between 0V and Vs-1.4V. So, if you put 12V AC in, you will 10.6V DC out.

2.1.4 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. There are two types of regulator are they.

- Positive Voltage Series (78xx) and
- Negative Voltage Series (79xx)

78xx: '78' indicate the positive series and 'xx'indicates the voltage rating.
Suppose 7805 produces the maximum 5V.'05'indicates the regulator output is 5V.

79xx: '78' indicate the negative series and 'xx'indicates the voltage rating.
Suppose 7905 produces the maximum -5V.'05'indicates the regulator output is -5V.

These regulators consists the three pins there are

Pin1: It is used for input pin.

Pin2: This is ground pin for regulator

Pin3: It is used for output pin. Through this pin we get the output.

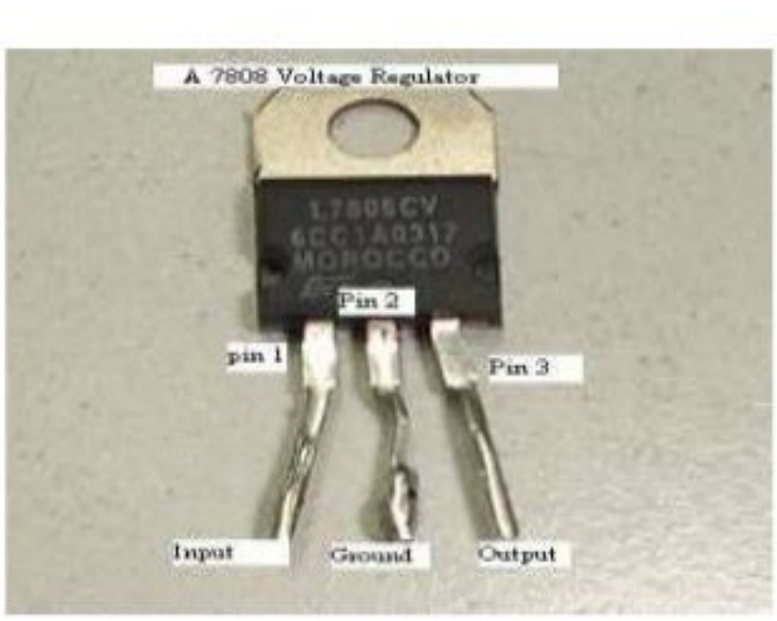
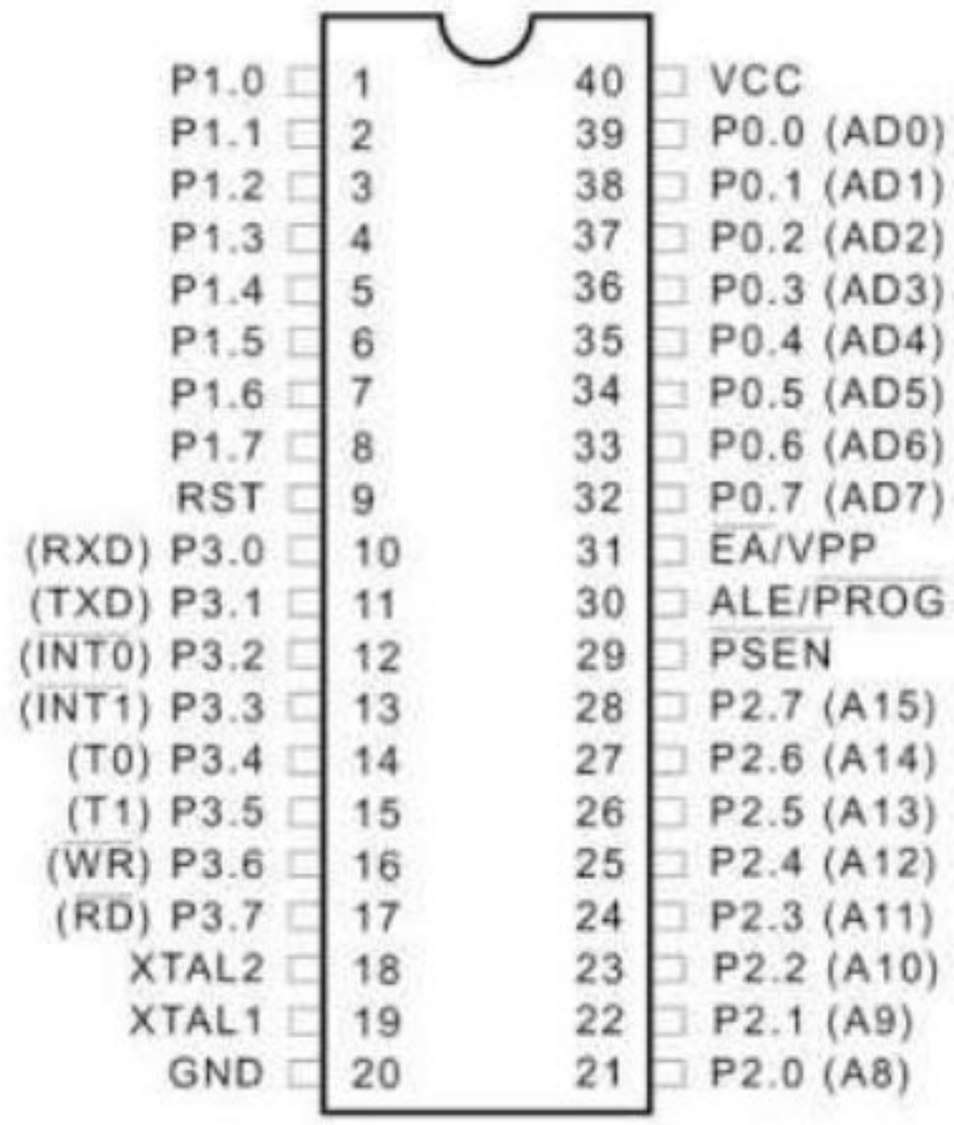


Fig: 2.4 Regulator (photo courtesy: positron technologies)

2.2 AT89C51 MICROCONTROLLERS:

The AT89C51 is a low-power, high-performance CMOS 8-bit microcontroller with 4K bytes of programmable Flash memory 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-51 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 Flash on a monolithic chip, the Atmel AT89C51 is a powerful microcontroller which provides a highly-flexible and cost-effective solution to many embedded control applications.

2.2.1 PIN CONFIGURATIONS



2.2.2 Standard Features

- 4K bytes of Flash,
- 128* 8 bits of internal RAM,
- 32 programmable I/O lines,
- Full static operation: 0Hz to 24 Mhz
- Three level program memory Lock
- two 16-bit timer/counters,
- a six-vector two-level interrupt architecture,

2.2.3 PIN DESCRIPTION

VCC

Supply voltage.

Port 0

Port 0 is an 8-bit open drain bidirectional I/O port. As an output port, each pin can sink eight TTL inputs. When 1s are written to port 0 pins, the pins can be used as high impedance inputs. Port 0 can also be configured to be the multiplexed low order address/data bus during accesses to external program and data memory. In this mode, P0 has internal pull ups. Port 0 also receives the code bytes during Flash programming and outputs the code bytes during program verification. External pull ups are required during program verification.

Port 1

Port 1 is an 8-bit bidirectional I/O port with internal pull ups. The Port 1 output buffers can sink/source four TTL inputs. When 1s are written to Port 1 pins, they are pulled high by the internal pull ups and can be used as inputs. As inputs, Port 1 pins that are externally being pulled low will source current (IIL) because of the internal pull ups. Port 1 also receives the low-order address bytes during Flash programming.

Port 2

Port 2 is an 8-bit bidirectional I/O port with internal pull ups. The Port 2 output buffers can sink/source four TTL inputs. When 1s are written to Port 2 pins, they are pulled high by the internal pull ups and can be used as inputs. As inputs, Port 2 pins that are externally being pulled low will source current (IIL) because of the internal pull ups. Port 2 emits the high-order address byte during fetches from external program memory and during accesses to external data memory that use 16-bit addresses (MOVX @ DPTR). In this application, Port 2 uses strong internal pull-ups when emitting 1s. During accesses to external data memory that use 8-bit addresses (MOVX @ RI), Port 2 emits the contents of the P2 Special Function Register. Port 2 also receives the high-order address bits and some control signals during Flash programming and verification.

Port 3

Port 3 is an 8-bit bidirectional I/O port with internal pullups. The Port 3 output buffers can sink/source four TTL inputs. When 1s are written to Port 3 pins, they are pulled high by the internal pullups and can be used as inputs. As inputs, Port 3 pins that are externally being pulled low will source current (IIL) because of the pullups. Port 3 also serves the functions of various special features of the AT89C51, as shown in the following table. Port 3 also receives some control signals for Flash programming and verification.

Port Pin	Alternate Functions
P3.0	RXD (serial input port)
P3.1	TXD (serial output port)
P3.2	$\overline{\text{INT0}}$ (external interrupt 0)
P3.3	$\overline{\text{INT1}}$ (external interrupt 1)
P3.4	T0 (timer 0 external input)
P3.5	T1 (timer 1 external input)
P3.6	$\overline{\text{WR}}$ (external data memory write strobe)
P3.7	$\overline{\text{RD}}$ (external data memory read strobe)

Table: 2.2.1 port 3 alternate functions

RST

Reset input. A high on this pin for two machine cycles while the oscillator is running resets the device.

ALE/PROG

Address Latch Enable (ALE) is an output pulse for latching the low byte of the address during accesses to external memory. In normal operation, ALE is ~~emitted~~ at a constant rate of 1/6 the oscillator frequency and may be used for external timing or clocking purposes. Note, however, that one ALE pulse is skipped during each access to external data memory. If desired, ALE operation can be disabled by setting bit 0 of SFR location 8EH. With the bit set, ALE is active only during a MOVX or MOVC instruction. Otherwise, the pin is weakly pulled high.

PSEN

Program Store Enable (PSEN) is the read strobe to external program memory. When the AT89C51 is executing code from external program memory, PSEN is activated

twice each machine cycle, except that two PSEN activations are skipped during each access to external data memory.

EA/VPP

External Access Enable. EA must be strapped to GND in order to enable the device to fetch code from external program memory locations starting at 0000H up to FFFFH. Note, however, that if lock bit 1 is programmed, EA will be internally latched on reset. EA should be strapped to VCC for internal program executions.

XTAL1

Input to the inverting oscillator amplifier and input to the internal clock operating circuit.

XTAL2

Output from the inverting oscillator amplifier.

2.3 IR Sensors

An Infra-Red sensor detects Infra-Red light/white light from a particular object/line and then converts light energy to electrical energy. An IR sensor pair consists of an emitter and a detector. The emitter is blue in color and the detector can be grey, black or white in color.

Fig.2.3.1 TX- Emitter & RX- Detector (Photo courtesy: positron technologies)

2.3.1 IR Emitter:

An infra-red emitter is a Light Emitting Diode (LED) made from Gallium Arsenide. It detects IR energy at a wavelength of 880nm and emits the same. The infrared phototransistor acts as a transistor with the base voltage determined by the amount of light hitting the transistor. Hence it acts as a variable current source. Greater amount of IR light cause greater currents to flow through the collector-emitter leads.

The variable current traveling through the resistor causes a voltage drop in the pull-up resistor. This voltage is measured as the output of the device.

2.3.2 IR Detector:

An infra-red detector is a photo detector. It detects IR energy emitted by the emitter and converts it into electrical energy.

The main principle involved in the conversion of light energy to electrical energy is PHOTOELECTRIC EFFECT.

IR sensor circuit to detect a black line on white background:

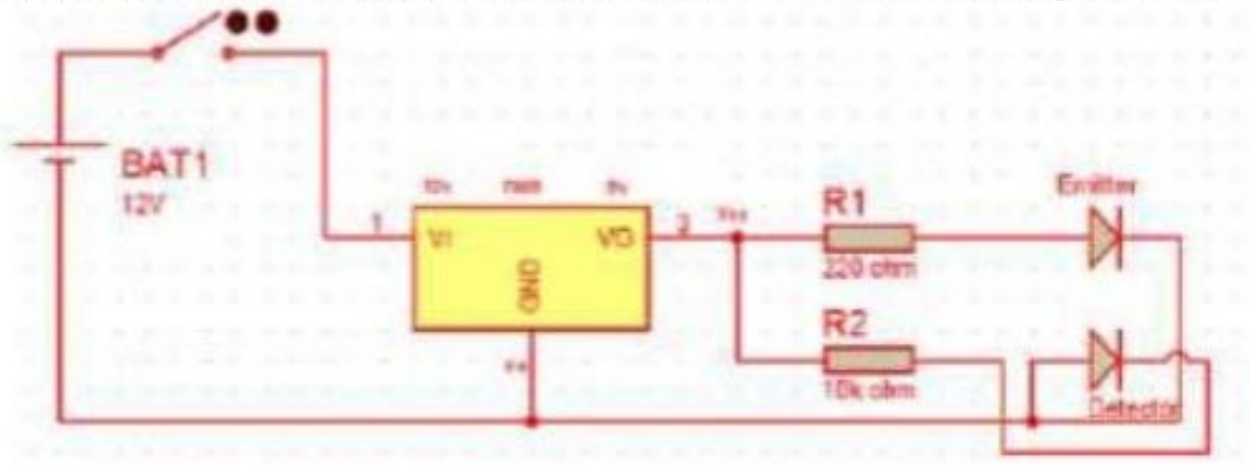


Fig: 2.3.2. IR sensor circuit

The output is taken at negative terminal of IR detector.

The output can be taken to a microcontroller either to its ADC (Analog to Digital Converter) or LM 339 can be used as a comparator.

2.4 LM 324

2.4.1 FEATURES:

- Wide gain bandwidth : 1.3MHZ input common-mode voltage range
- Includes ground .large voltage gain: 100DB .very low supply current/ampli : 375ma low input bias current : 20NA low input offset voltage : 5mv max.
- Low input offset current : 2NA wide power supply range :
- Single supply : +3v to +30v
- Dual supplies : ±1.5v to ±15v

2.4.2 DESCRIPTION

These circuits consist of four independent, high gain, internally frequency compensated operational amplifiers .They operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage.

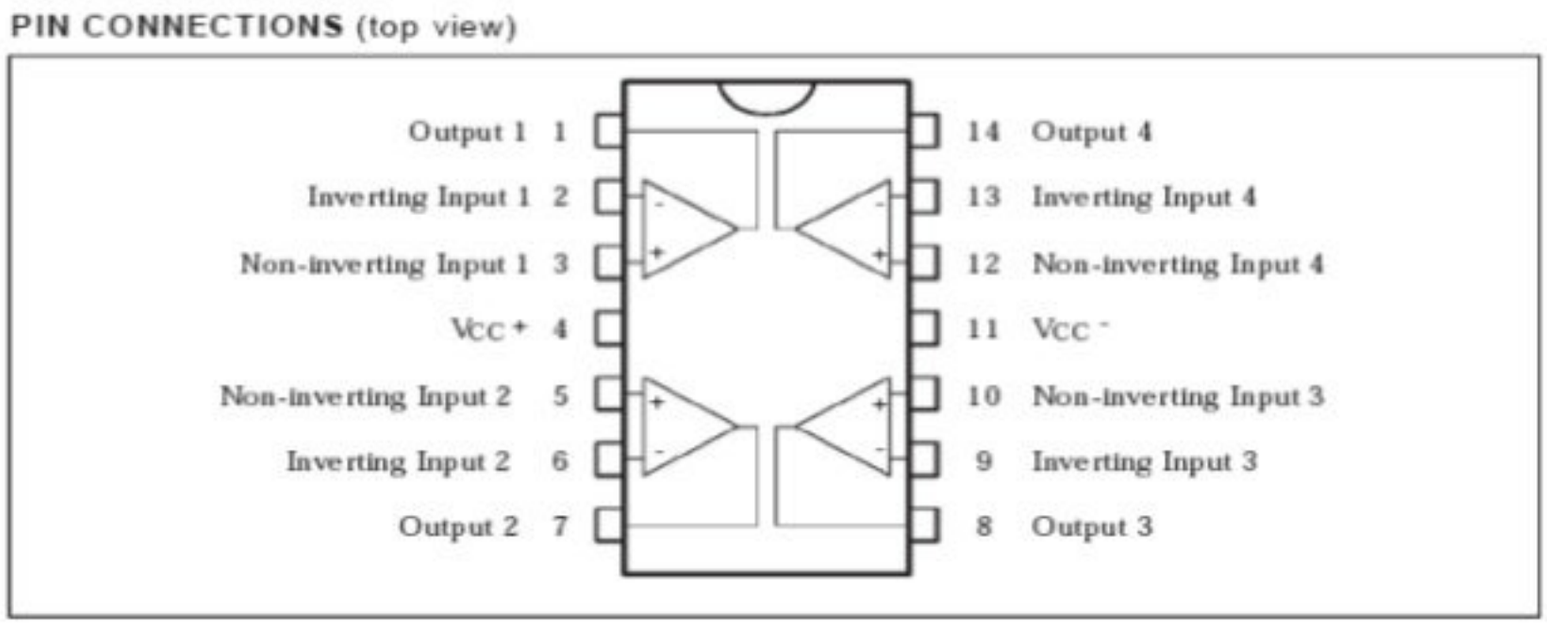


Fig:2.4.1. pin configuration (top view)

2.5 H-BRIDGE:

An H-bridge is an electronic circuit which enables DC electric motors to be run forwards or backwards. These circuits are often used in robotics. H-bridges are available as integrated circuits, or can be built from discrete components.

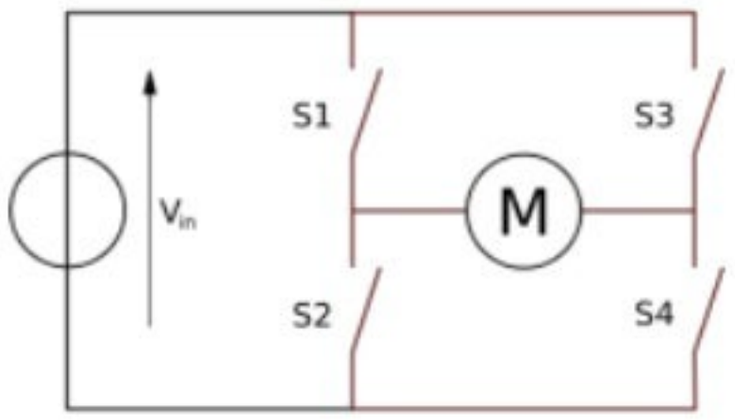


Fig: 2.5.1.H-bridge switch diagram

The two basic states of a H-bridge. The term "H-bridge" is derived from the typical graphical representation of such a circuit. An H-bridge is built with four switches (solid-state or mechanical). When the switches S1 and S4 (according to the first figure) are closed (and S2 and S3 are open) a positive voltage will be applied across the motor. By opening S1 and S4 switches and closing S2 and S3 switches, this voltage is reversed, allowing reverse operation of the motor.

Using the nomenclature above, the switches S1 and S2 should never be closed at the same time, as this would cause a short circuit on the input voltage source. The same applies to the switches S3 and S4. This condition is known as shoot-through.

2.5.1 Operation

The H-Bridge arrangement is generally used to reverse the polarity of the motor, but can also be used to 'brake' the motor, where the motor comes to a sudden stop, as the motors terminals are shorted, or to let the motor 'free run' to a stop, as the motor is effectively disconnected from the circuit. The following table summarizes operation.

S1	S2	S3	S4	Result
1	0	0	1	Motor moves right
0	1	1	0	Motor moves left
0	0	0	0	Motor free runs
0	1	0	1	Motor brakes

Table: 2.5.1 H-bridge switch operation

2.5.2 H-Bridge Driver:

The switching property of this H-Bridge can be replaced by a Transistor or a Relay or a Mosfet or even by an IC. Here we are replacing this with an IC named L293D as the driver whose description is as given below. 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 as 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 package which has 4 center pins connected together and used for heat sinking The L293D is assembled in a 20 lead surface mount which has 8 center pins connected together and used for heat sinking.

2.5.3 Features:

- 600mA OUTPUT CURRENT CAPABILITY
- PER CHANNEL
- 1.2A PEAK OUTPUT CURRENT (non repetitive)
- ENABLE FACILITY
- OVERTEMPERATURE PROTECTION
- LOGICAL "0" INPUT VOLTAGE UP TO 1.5 V
- (HIGH NOISE IMMUNITY)
- INTERNAL CLAMP DIODES

2.5.4 BLOCK DIAGRAM:

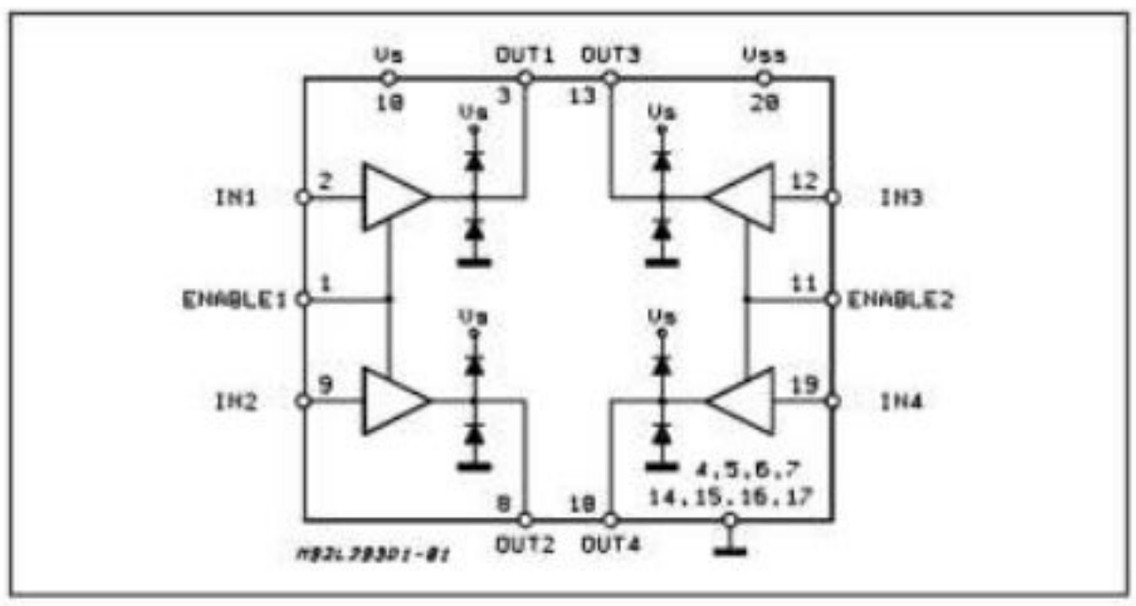


Fig: 2.5.2. block diagram of H-bridge

2.5.5 PIN CONNECTIONS

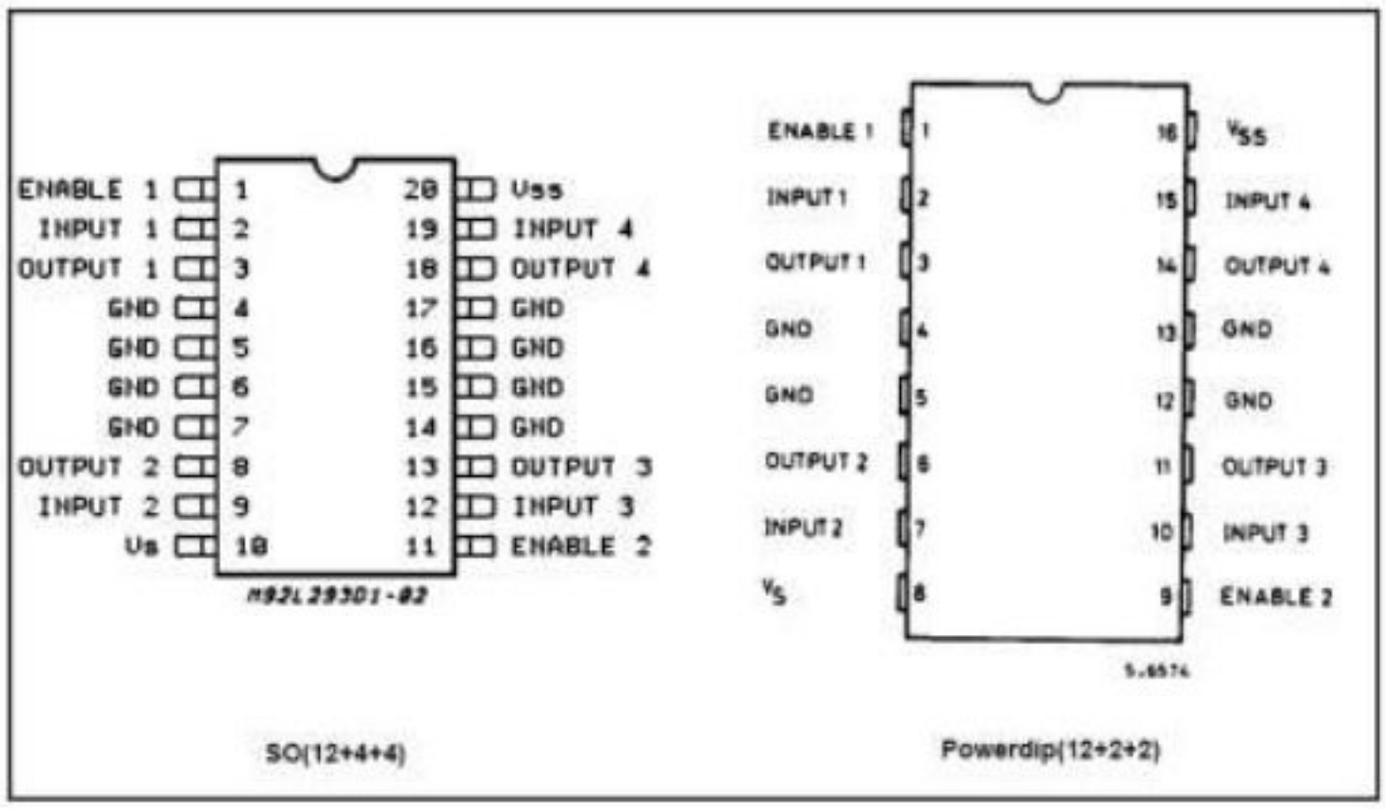


Fig: 2.5.3 pin configuration of H-bridge

3. WORKING PROCEDURE

3.1 WORKING

Robotics is an interesting subject to discuss about and in this advanced world Robots are becoming a part of our life. In this project we are going to discuss about a robot which is capable of following a line without the help of any external source.

The Embedded Line following robot uses two motors to control rear wheels and the single front wheel is free. It has 3-infrared sensors on the bottom for detection of black tracking tape. When the middle sensor detects the black color, this sensor output is given to the comparator LM324. The output of comparator compares this sensor output with a reference voltage and gives an output. The output of comparator will be low when it receives an input from the sensor.

We follow a simple logic to implement this project. As we know that black colour is capable of absorbing the radiation and white colour or a bright colour reflects the

radiation back. Here we use 3 pairs of IR TX and Rx .The robot uses these IR sensors to sense the line and the arrangement is made such that sensors face the ground. The output from the sensors is an analog signal which depends on the amount of light reflected back and this analog signal is given to the comparator to produce 0s and 1s.

Internally we have an OTP (one time programmable) processor which is used to control the rotation of the wheels. The rotation of these wheels depends up on the response from the comparator. Let us assume that when a sensor is on the black line it reads 0 and when it is on the bright surface it reads 1.

Here we can get three different cases, they are:

1. Straight direction
2. Right curve
3. Left curve

3.1.1 Straight direction:

We can expect our robot to move in straight direction when the middle sensors response is low and the remaining two sensors response is high. i.e., according to our arrangement the middle sensor will always be on the line and as the line is black in colour it will not reflect the emitted radiation back and the response of the sensor will be low and the response of the remaining two sensors will be high as they will be on the bright surface.

3.1.2 Right curve:

When a right curve is found on the line the responses will change i.e. the response of the first sensor which is to the right will become low as that sensor will be facing the black line and the reaming sensors response will be high. We this data is achieved the control of the wheels is changed i.e. the right wheel is held and the left wheel is made

to move freely until the response from the middle sensor becomes low. Then the same process repeats again.

3.1.3 Left curve:

When a left curve is found on the line the response of the left most sensor will be changed from high to low as the sensor will now face the black or the dark surface. Then the control of the wheel changes i.e. by holding the left wheel and allowing the right wheel to move freely until the middle sensor changes it is response from high to low.The same process continues for all the turns and the robot moves continuously until the supply is remove

3.1.4 ADVANTAGES

- Robot movement is automatic.
- Fit and Forget system.
- Used for long distance applications.
- Defense applications.
- Used in home, industrial automation.
- Cost effective.
- Simplicity of building

3.1.5 DISADVANTAGES

- LFR follows a black line about 1 or 2 inches in width on a white surface.
- LFR are simple robots with an additional sensors placed on them.
- Needs a path to run either white or black since the IR rays should reflectfrom the particular path.
- Slow speed and instability on different line thickness or hard angles.

3.1.6 APPLICATIONS:

- Guidance system for industrial robots moving on shop floor etc.
- Industrial applications.
- Home applications.

4. SOFTWARE TOOLS

4.1 KEIL SOFTWARE:

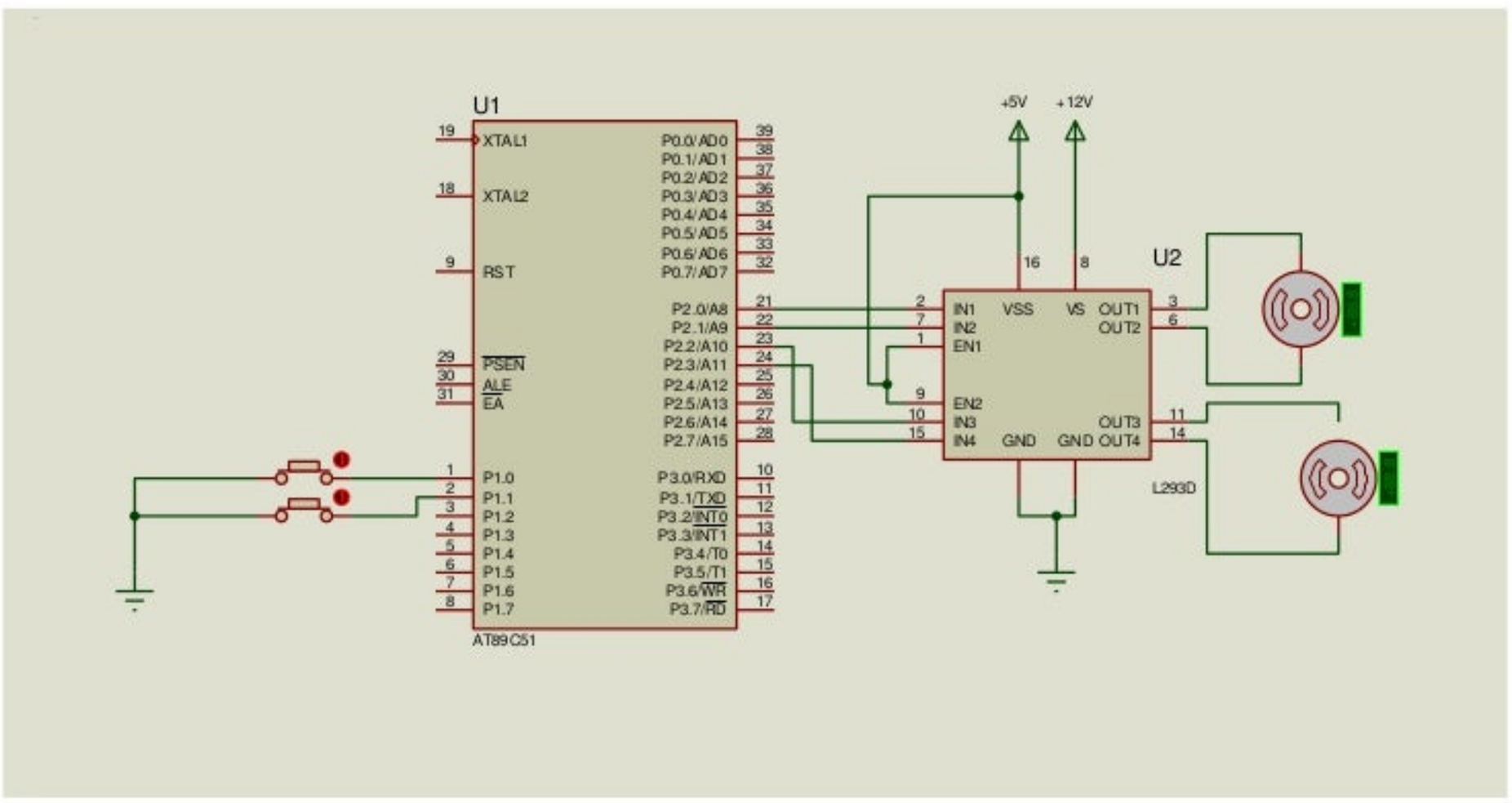
Keil compiler is a software used where the machine language code is written and compiled. After compilation, the machine source code is converted into hex code which is to be dumped into the microcontroller for further processing. Keil compiler also supports C language code.

4.2 LANGUAGE PROGRAM :

```
#include<regx51.h>
void main()
{
        while(1)
        {
                if(P1_0==0&&P1_1==0)
                {
                        P2=0x00;
                }
                if(P1_0==1&&P1_1==1)
```

```
{
        P2=0xF5;
}
if(P1_0==0&&P1_1==1)
{
        P2=0xF4;
}
if(P1_0==1&&P1_1==0)
        {
                P2=0xF1;
        }
    }
}
```

4.3 PROTEUS SIMULATION



4.4 RESULT

The objective of the line following robot is to follow a line on its given path which is obtained for which it uses IR sensors which detects the line and sends the information to LM324 comparator and then to H bridge which controls the working of the wheel's. Microcontroller controls the other operations.

5.CONCLUSION AND FUTURE SCOPE

CONCLUSION:

In this project we have studied and implemented a Line Following Robot using a Microcontroller for blind people. The programming and interfacing of microcontroller has been mastered during the implementation.

FUTURE SCOPE:

- Smarter versions of line followers are used to deliver mails within office building and deliver medications in a hospital.
- This technology has been suggested for running buses and other mass transit systems and may end up as a part of autonomous cars navigating the freeway.

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