Fully Automated Solar Grass Cutter with obstacle detection

CHAPTER-1

INTRODUCTION

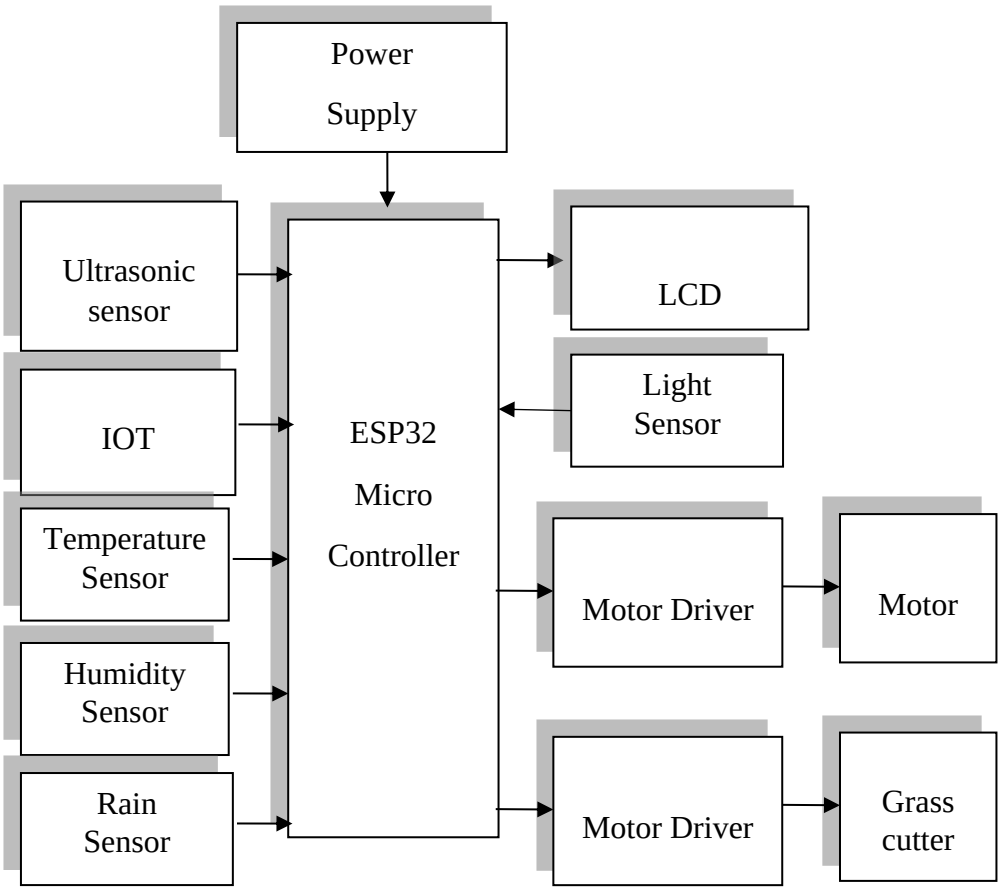
The fully automated solar grass cutter is a fully automated grass cutting robotic vehicle powered by solar energy that also avoids obstacles and is capable of fully automated grass cutting without the need of any human interaction. The system uses 12V batteries to power the vehicle movement motors as well as the grass cutter motor. We also use a solar panel to charge the battery so that there is no need of charging it externally.

The grass cutter and vehicle motors are interfaced to an ESP32 family microcontroller that controls the working of all the motors. It is also interfaced to an ultrasonic sensor for object detection. The microcontroller moves the vehicle motors in forward direction in case no obstacle is detected. On obstacle detection the ultrasonic sensor monitors it and the microcontroller thus stops the grass cuter motor to avoid any damage to the object/human/animal whatever it is. Microcontroller then turns the robotic as long as it gets clear of the object and then moves the grass cutter in forward direction again.

Proposed model also uses IOT through which user can change the direction grass cutter manually as well.

CHAPTER-2

BLOCK DIAGRAM



CHAPTER-3

HARDWARE DESCRIPTION

3.1. POWER SUPPLY

The power supply section is the section which provides +5V for the components to work. IC LM7805 is used for providing a constant power of +5V.

The ac voltage, typically 220V, is connected to a transformer, which steps down the ac voltage down to the level of the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation.

A regulator circuit removes the ripples and also retains the same dc value even if the input dc voltage varies, or the load connected to the output dc voltage changes. This voltage regulation is usually obtained using one of the popular voltage regulator IC units.

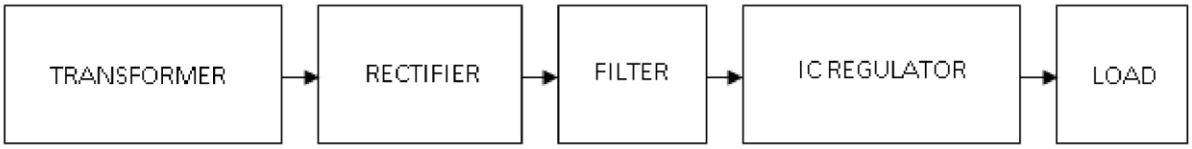


Figure7: Block Diagram of Power Supply

Transformer

Transformers convert AC electricity from one voltage to another with little loss of power. Transformers work only with AC and this is one of the reasons why mains electricity is AC.

Step-up transformers increase voltage, step-down transformers reduce voltage. Most power supplies use a step-down transformer to reduce the dangerously high mains voltage (230V in India) to a safer low voltage.

The input coil is called the primary and the output coil is called the secondary. There is no electrical connection between the two coils; instead they are linked by an alternating magnetic

field created in the soft-iron core of the transformer. Transformers waste very little power so the power out is (almost) equal to the power in. Note that as voltage is stepped down current is stepped up.

The transformer will step down the power supply voltage (0-230V) to (0- 6V) level. Then the secondary of the potential transformer will be connected to the bridge rectifier, which is constructed with the help of PN junction diodes. The advantages of using a bridge rectifier are it will give peak voltage output as DC.

Rectifier

There are several ways of connecting diodes to make a rectifier to convert AC to DC. The bridge rectifier is the most important and it produces full-wave varying DC. A full-wave rectifier can also be made from just two diodes if a centre-tap transformer is used, but this method is rarely used now that diodes are cheaper. A single diode can be used as a rectifier but it only uses the positive (+) parts of the AC wave to produce half-wave varying DC

Bridge Rectifier

When four diodes are connected as shown in figure, the circuit is called as bridge rectifier. The input to the circuit is applied to the diagonally opposite corners of the network, and the output is taken from the remaining two corners. Let us assume that the transformer is working properly and there is a positive potential at point A and a negative potential at point B. the positive potential at point A will forward bias D3 and reverse bias D4.

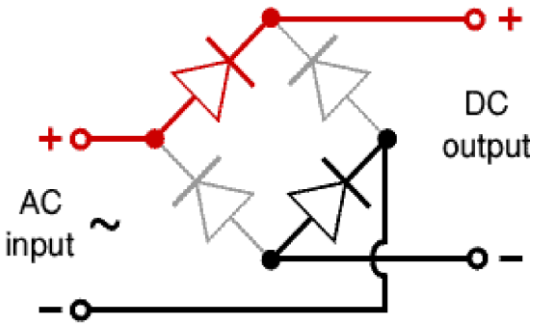


Figure 8: Bridge Rectifier

The negative potential at point B will forward bias D1 and reverse D2. At this time D3 and D1 are forward biased and will allow current flow to pass through them; D4 and D2 are reverse biased and will block current flow.

One advantage of a bridge rectifier over a conventional full-wave rectifier is that with a given transformer the bridge rectifier produces a voltage output that is nearly twice that of the conventional full-wave circuit.

The main advantage of this bridge circuit is that it does not require a special centre tapped transformer, thereby reducing its size and cost.

The single secondary winding is connected to one side of the diode bridge network and the load to the other side as shown below.

The result is still a pulsating direct current but with double the frequency.

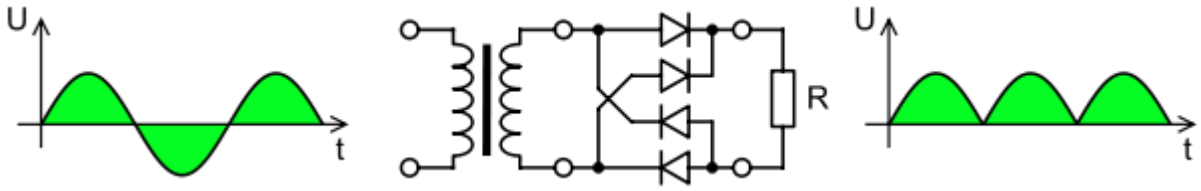


Figure 9: Output Waveform of DC

Smoothing

Smoothing is performed by a large value electrolytic capacitor connected across the DC supply to act as a reservoir, supplying current to the output when the varying DC voltage from the rectifier is falling. The capacitor charges quickly near the peak of the varying DC, and then discharges as it supplies current to the output.

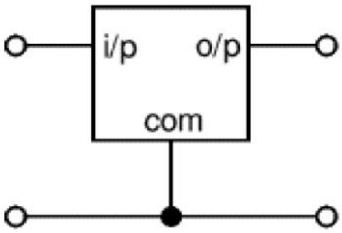
Voltage Regulators

Voltage regulators comprise a class of widely used ICs. Regulator IC units contain the circuitry for reference source, comparator amplifier, control device, and overload protection all in a single IC. IC units provide regulation of either a fixed positive voltage, a fixed negative voltage, or an adjustable set voltage. The regulators can be selected for operation with load currents from hundreds of milli amperes to tens of amperes, corresponding to power ratings from milli watts to tens of watts.

A fixed three-terminal voltage regulator has an unregulated dc input voltage, Vi, applied to one input terminal, a regulated dc output voltage, Vo, from a second terminal, with the third terminal connected to ground.

The series 78 regulators provide fixed positive regulated voltages from 5 to 24 volts. Similarly, the series 79 regulators provide fixed negative regulated voltages from 5 to 24 volts. Voltage regulator ICs are available with fixed (typically 5, 12 and 15V) or variable output voltages. They are also rated by the maximum current they can pass. Negative voltage regulators are available, mainly for use in dual supplies. Most regulators include some automatic protection from excessive current ('overload protection') and overheating ('thermal protection').

Many of the fixed voltage regulator ICs have 3 leads and look like power transistors, such as the 7805 +5V 1Amp regulator. They include a hole for attaching a heat sink if necessary.



Regulator

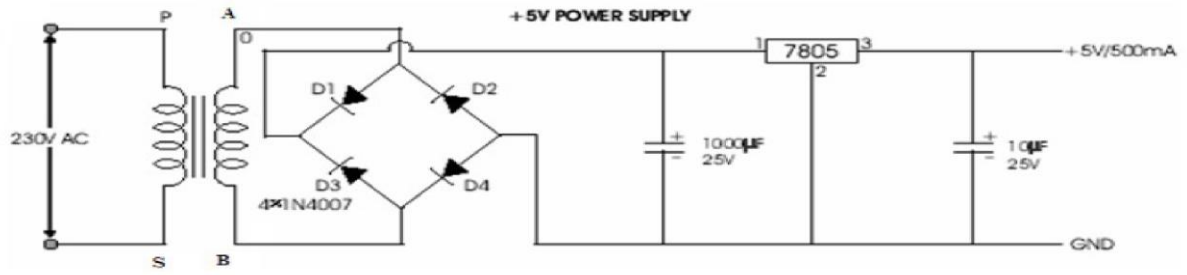
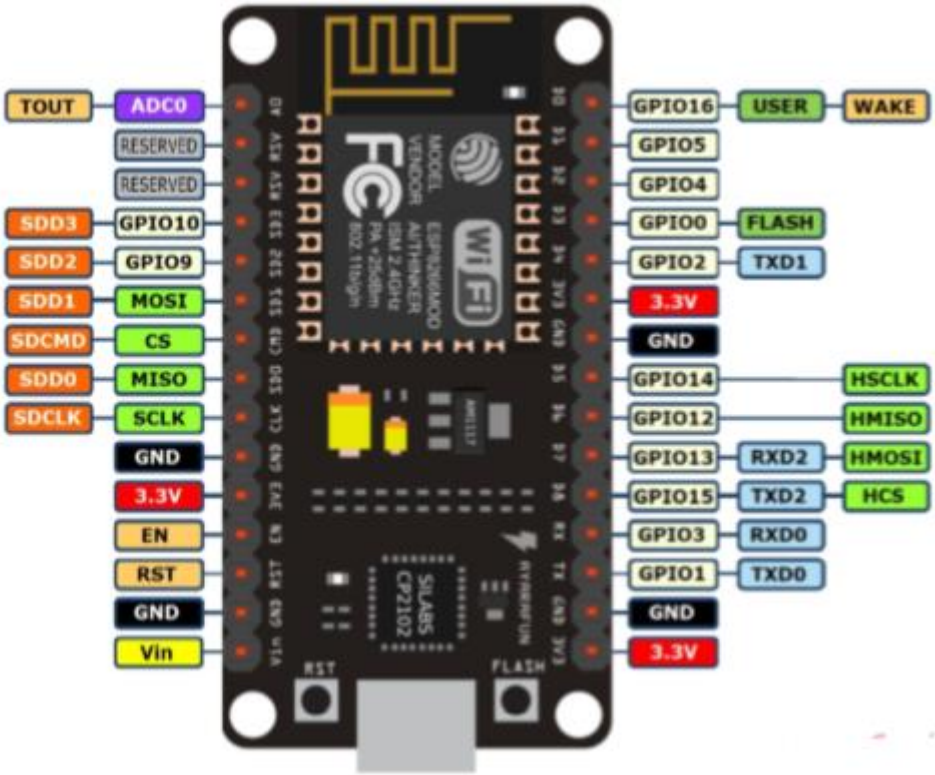


Figure 10: Circuit Diagram of Power Supply

3.2 ESP8266



A guide to setting up your ESP8266-12E

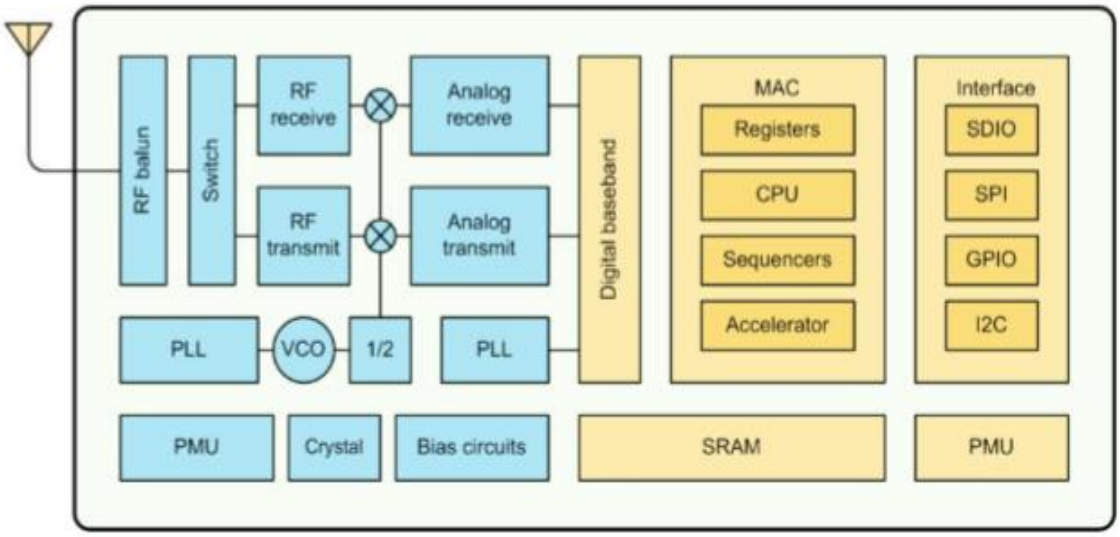
NodeMCU ESP8266 ESP-12E WiFi Development Board

Features Version : DevKit v1.0 Breadboard Friendly Light Weight and small size. 3.3V operated, can be USB powered. Uses wireless protocol 802.11b/g/n. Built-in wireless connectivity capabilities. Built-in PCB antenna on the ESP-12E chip. Capable of PWM, I2C, SPI, UART, 1-wire, 1 analog pin. Uses CP2102 USB Serial Communication interface module. Arduino IDE compatible (extension board manager required). Supports Lua (alike node.js) and Arduino C programming language. PINOUT DIAGRAM NodeMCU ESP8266 v1.0

NodeMCU is an open source IoT platform. It includes firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module. The term “NodeMCU” by default refers to the firmware rather than the DevKit.

The firmware uses the Lua scripting language. It is based on the eLua project, and built on the Espressif Non-OS SDK for ESP8266. It uses many open source projects, such as lua-cjson, and spiffs.

ESP-12E WiFi module is developed by Ai-thinker Team. core processor ESP8266 in smaller sizes of the module encapsulates Tensilica L106 integrates industry-leading ultra low power 32-bit MCU micro, with the 16-bit short mode, Clock speed support 80 MHz, 160 MHz, supports the RTOS, integrated Wi-Fi MAC/BB/RF/PA/LNA, on-board antenna. The module supports standard IEEE802.11 b/g/n agreement, complete TCP/IP protocol stack. Users can use the add modules to an existing device networking, or building a separate network controller. ESP8266 is high integration wireless SOCs, designed for space and power constrained mobile platform designers. It provides unsurpassed ability to embed Wi-Fi capabilities within other systems, or to function as a standalone application, with the lowest cost, and minimal space requirement.



ESP8266EX offers a complete and self-contained Wi-Fi networking solution; it can be used to host the application or to offload Wi-Fi networking functions from another application processor. When ESP8266EX hosts the application, it boots up directly from an external flash. In has integrated cache to improve the performance of the system in such applications. Alternately, serving as a Wi-Fi adapter, wireless internet access can be added to any micro controllerbased design with simple connectivity (SPI/SDIO or I2C/UART interface). ESP8266EX is among the most integrated WiFi chip in the industry; it integrates the antenna switches, RF balun, power amplifier, low noise receive amplifier, filters, power management modules, it requires minimal external circuitry, and the entire solution, including front-end module, is designed to occupy minimal PCB area.

Features

• 802.11 b/g/n

• Integrated low power 32-bit MCU

• Integrated 10-bit ADC

• Integrated TCP/IP protocol stack

• Integrated TR switch, balun, LNA, power amplifier and matching network

• Integrated PLL, regulators, and power management units

• Supports antenna diversity

• Wi-Fi 2.4 GHz, support WPA/WPA2

• Support STA/AP/STA+AP operation modes

• Support Smart Link Function for both Android and iOS devices

• Support Smart Link Function for both Android and iOS devices

• SDIO 2.0, (H) SPI, UART, I2C, I2S, IRDA, PWM, GPIO

• STBC, 1x1 MIMO, 2x1 MIMO

• A-MPDU & A-MSDU aggregation and 0.4s guard interval

• Wake up and transmit packets in < 2ms

• Standby power consumption of < 1.0mW (DTIM3)

• +20dBm output power in 802.11b mode

• Operating temperature range -40C ~ 125C

Pin Descriptions

There are altogether 22 pin counts, the definitions of which are described in Table 2 below

NO.	Pin Name	Function
1	RST	Reset the module
2	ADC	A/D Conversion result.Input voltage range 0-1v,scope:0-1024
3	EN	Chip enable pin.Active high
4	IO16	GPIO16; can be used to wake up the chipset from deep sleep mode.
5	IO14	GPIO14; HSPI_CLK
6	IO12	GPIO12; HSPI_MISO
7	IO13	GPIO13; HSPI_MOSI; UART0_CTS
8	VCC	3.3V power supply (VDD)
9	CS0	Chip selection
10	MISO	Salve output Main input
11	IO9	GPIO9
12	IO10	GBIO10
13	MOSI	Main output slave input
14	SCLK	Clock
15	GND	GND
16	IO15	GPIO15; MTDO; HSPICS; UART0_RTS
17	IO2	GPIO2; UART1_TXD
18	IO0	GPIO0
19	IO4	GPIO4
20	IO5	GPIO5
21	RXD	UART0_RXD; GPIO3
22	TXD	UART0_TXD; GPIO1

MCU ESP8266EX is embedded with Tensilica L106 32-bit micro controller (MCU), which features extra low power consumption and 16-bit RSIC. The CPU clock speed is 80MHz. It can also reach a maximum value of 160MHz. ESP8266EX is often integrated with external sensors and other specific devices through its GPIOs; codes for such applications are provided in examples in the SDK. 4.2. Memory Organization 4.2.1

Internal SRAM and ROM

ESP8266EX WiFi SoC is embedded with memory controller, including SRAM and ROM. MCU can visit the memory units through iBus, dBus, and AHB interfaces. All memory units can be visited upon request, while a memory arbiter will decide the running sequence according to the time when these requests are received by the processor. According to our current version of SDK provided, SRAM space that is available to users is assigned as below: ▪RAM size < 36kB, that is to say, when ESP8266EX is working under the station mode and is connected to the router, programmable space accessible to user in heap and data section is around 36kB.) ▪ There is no programmable ROM in the SoC, therefore, user program must be stored in an external SPI flash.

External SPI Flash

This module is mounted with an 4 MB external SPI flash to store user programs. If larger definable storage space is required, a SPI flash with larger memory size is preferred. Theoretically speaking, up to 16 MB memory capacity can be supported. Suggested SPI Flash memory capacity: ▪OTA is disabled: the minimum flash memory that can be supported is 512 kB; ▪OTA is enabled: the minimum flash memory that can be supported is 1 MB. Several SPI modes can be supported, including Standard SPI, Dual SPI, and Quad SPI.

Therefore, please choose the correct SPI mode when you are downloading into the flash, otherwise firmwares/programs that you downloaded may not work in the right way.

Crystal

Currently, the frequency of crystal oscillators supported include 40MHz, 26MHz and 24MHz. The accuracy of crystal oscillators applied should be ±10PPM, and the operating temperature range should be between -20°C and 85°C. When using the downloading tools, please remember to select the right crystal oscillator type. In circuit design, capacitors C1 and C2, which are connected to the earth, are added to the input and output terminals of the crystal oscillator

respectively. The values of the two capacitors can be flexible, ranging from 6pF to 22pF, however, the specific capacitive values of C1 and C2 depend on further testing and adjustment on the overall performance of the whole circuit. Normally, the capacitive values of C1 and C2 are within 10pF if the crystal oscillator frequency is 26MHz, while the values of C1 and C2 are 10pF<C1, C2<22pF if the crystal oscillator frequency is 40MHz.

3.3 DC MOTOR

A DC motor in simple words is a device that converts direct current (electrical energy) into mechanical energy. It’s of vital importance for the industry today.

A DC motor is designed to run on DC electric power. Two examples of pure DC designs are Michael Faraday's homo-polar motor (which is uncommon), and the ball bearing motor, which is (so far) a novelty.

By far the most common DC motor types are the brushed and brushless types, which use internal and external commutation respectively to create an oscillating AC current from the DC source—so they are not purely DC machines in a strict sense.

We in our project are using brushed DC Motor, which will operate in the ratings of 12v DC 0.6A.

The speed of a DC motor can be controlled by changing the voltage applied to the armature or by changing the field current. The introduction of variable resistance in the armature circuit or field circuit allowed speed control. Modern DC motors are often controlled by power electronics systems called DC drives.

Fig. Motor

Usage

The DC motor or Direct Current Motor to give it its full title, is the most commonly used actuator for producing continuous movement and whose speed of rotation can easily be controlled, making them ideal for use in applications were speed control, servo type control, and/or positioning is required. A DC motor consists of two parts, a "Stator" which is the stationary part and a "Rotor" which is the rotating part. The result is that there are basically three types of DC Motor available.

- Output Type: NPN-NO
- Red LED checks the state of the proximity sensor
- High repeated positioning accuracy
- High switching frequency
- Wide voltage range
- Anti-vibration, dust, water and oil prevention
- Reverse power protection, short circuit protection, directly connecting with PLC
- Can replace small switches and limit switches

3.4 INTRODUCTION

L293D IC generally comes as a standard 16-pin DIP (dual-in line package). This motor driver IC can simultaneously control two small motors in either direction; forward and reverse with just 4 microcontroller pins (if you do not use enable pins).

Some of the features (and drawbacks) of this IC are:

1. Output current capability is limited to 600mA per channel with peak output current limited to 1.2A (non-repetitive). This means you cannot drive bigger motors with this IC. However, most small motors used in hobby robotics should work. If you are unsure whether the IC can handle a particular motor, connect the IC to its circuit and run the motor with your finger on the IC. If it gets really hot, then beware... Also note the words "non-repetitive"; if the current output repeatedly reaches 1.2A, it might destroy the drive transistors.
2. Supply voltage can be as large as 36 Volts. This means you do not have to worry much about voltage regulation.
3. L293D has an enable facility which helps you enable the IC output pins. If an enable pin is set to logic high, then state of the inputs match the state of the outputs. If you pull this low, then the outputs will be turned off regardless of the input states
4. The datasheet also mentions an "over temperature protection" built into the IC. This means an internal sensor senses its internal temperature and stops driving the motors if the temperature crosses a set point
5. Another major feature of **L293D** is its internal clamp diodes. This flyback diode helps protect the driver IC from voltage spikes that occur when the motor coil is turned on and off (mostly when turned off)
6. The logical low in the IC is set to 1.5V. This means the pin is set high only if the voltage across the pin crosses 1.5V which makes it suitable for use in high frequency applications like switching applications (upto 5KHz)
7. Lastly, this integrated circuit not only drives DC motors, but can also be used to drive relay solenoids, stepper motors etc.

Description

It works on the concept of H-bridge. H-bridge is a circuit which allows the voltage to be flown in either direction. As you know voltage need to change its direction for being able to rotate the motor in clockwise or anticlockwise direction, Hence H-bridge IC are ideal for driving a DC motor.

In a single l293d chip there two h-Bridge circuit inside the IC which can rotate two dc motor independently. Due its size it is very much used in robotic application for controlling DC motors. Given below is the pin diagram of a L293D motor controller.

There are two Enable pins on l293d. Pin 1 and pin 9, for being able to drive the motor, the pin 1 and 9 need to be high. For driving the motor with left H-bridge you need to enable pin 1 to high. And for right H-Bridge you need to make the pin 9 to high. If anyone of the either pin1 or pin9 goes low then the motor in the corresponding section will suspend working. It's like a switch.

Pin Diagram

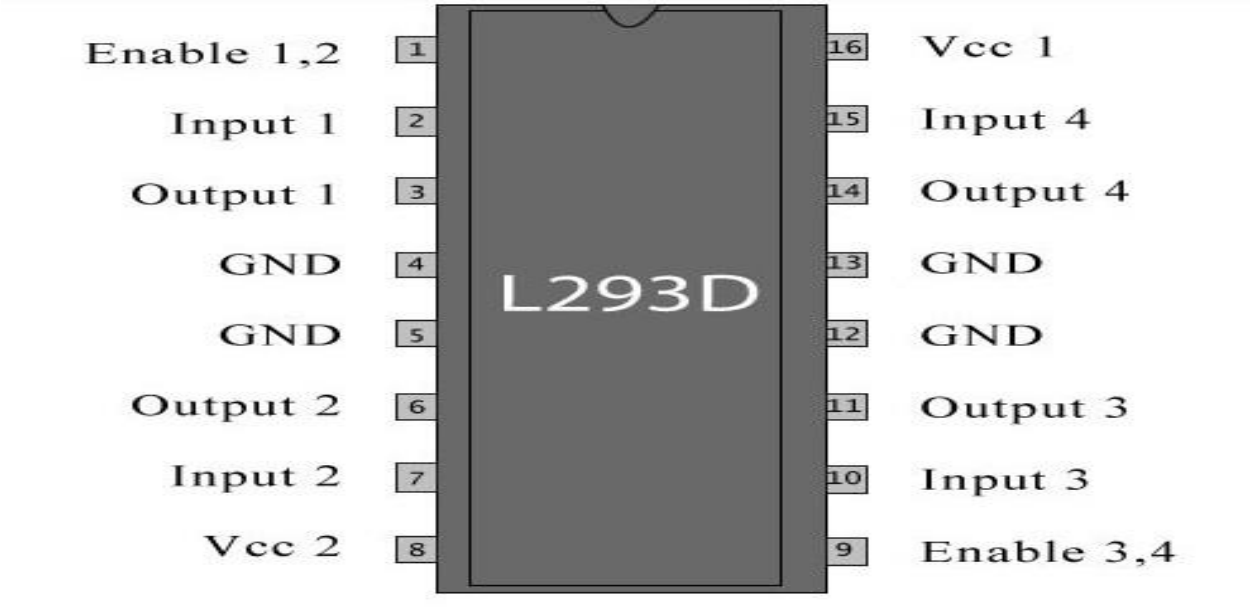


Fig showing pin diagram of L293D

Pin Description

Pin No	Function	Name
1	Enable pin for Motor 1; active high	Enable 1,2
2	Input 1 for Motor 1	Input 1
3	Output 1 for Motor 1	Output 1
4	Ground (0V)	Ground
5	Ground (0V)	Ground
6	Output 2 for Motor 1	Output 2
7	Input 2 for Motor 1	Input 2
8	Supply voltage for Motors; 9-12V (up to 36V)	$V_{cc\ 2}$
9	Enable pin for Motor 2; active high	Enable 3,4
10	Input 1 for Motor 1	Input 3
11	Output 1 for Motor 1	Output 3
12	Ground (0V)	Ground
13	Ground (0V)	Ground
14	Output 2 for Motor 1	Output 4
15	Input2 for Motor 1	Input 4
16	Supply voltage; 5V (up to 36V)	$V_{cc\ 1}$

Table Pin Description of L293D

Working of L293D

The 4 input pins for this l293d, pin 2,7 on the left and pin 15 ,10 on the right as shown on the pin diagram. Left input pins will regulate the rotation of motor connected across left side and right input for motor on the right hand side. The motors are rotated on the basis of the inputs provided across the input pins as LOGIC 0 or LOGIC 1.

In simple you need to provide Logic 0 or 1 across the input pins for rotating the motor.

Voltage Specification

VCC is the voltage that it needs for its own internal operation 5v; l293D will not use this voltage for driving the motor. For driving the motor it has a separate provision to provide motor supply VSS (V supply). L293d will use this to drive the motor. It means if you want to operate a motor at 9V then you need to provide a Supply of 9V across VSS Motor supply.

The maximum voltage for VSS motor supply is 36V. It can supply a max current of 600mA per channel. Since it can drive motors Up to 36v hence you can drive pretty big motors with this l293d.

VCC pin 16 is the voltage for its own internal Operation. The maximum voltage ranges from 5v and up to 36v.

3.5 ULTRASONIC SENSOR

Ultrasonic sensors are industrial control devices that use sound waves above 20,000 Hz, beyond the range of human hearing, to measure and calculate distance from the sensor to a specified target object.

Features of ultrasonic sensors:

- Devices with TEACH-IN functionality for fast and simple installation
- ULTRA 3000 software for improved adaptation of sensors to applications
- Adjustable sensitivity to the sound beam width for optimized adjustment of the sensor characteristics according to the application
- Temperature compensation - compensates for sound velocity due to varying air temperatures
- Synchronization input to prevent cross-talk interference when sensors are mounted within close proximity of each other
- Sensors with digital and/ or analog outputs

Description:

Ultrasonic sensors use electrical energy and a ceramic transducer to emit and receive mechanical energy in the form of sound waves. Sound waves are essentially pressure waves that travel through solids, liquids and gases and can be used in industrial applications to measure distance or detect the presence or absence of targets

Ultrasonic sensors (also known as tranceivers when they both send and receive) work on a principle similar to radar or sonar which evaluate attributes of a target by interpreting the echoes from radio or sound waves respectively. Ultrasonic sensors generate high frequency sound waves and evaluate the echo which is received back by the sensor. Sensors calculate the time interval between sending the signal and receiving the echo to determine the distance to an object.

This technology can be used for measuring: wind speed and direction (anemometer), fullness of a tank, and speed through air or water. For measuring speed or direction a device uses multiple detectors and calculates the speed from the relative distances to particulates in the air or water. To measure the amount of liquid in a tank, the sensor measures the distance to

the surface of the fluid. Further applications include: humidifiers, sonar, medical ultrasonography, burglar alarms, and non-destructive testing.

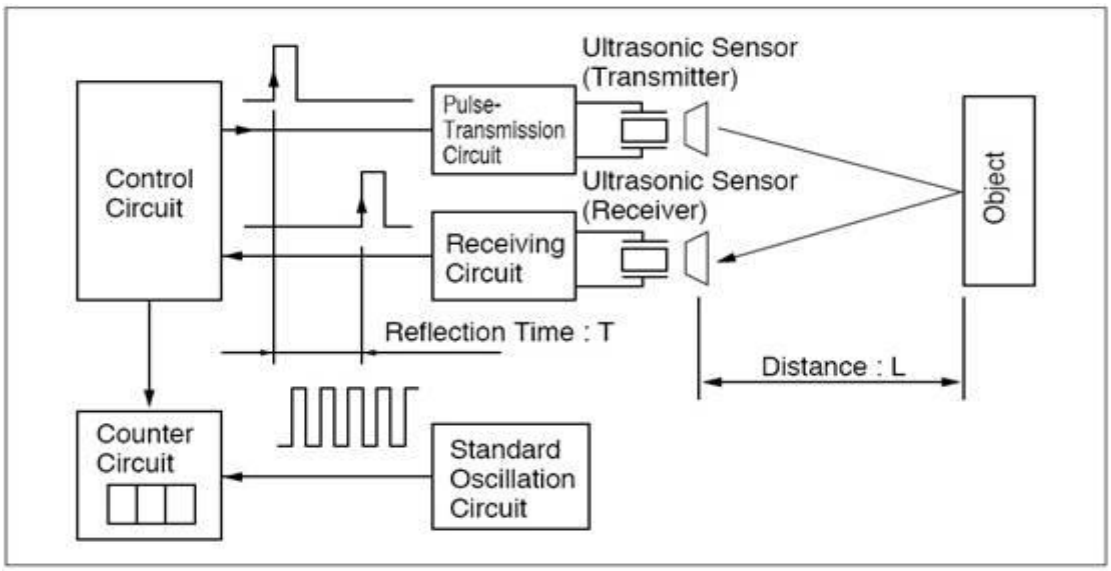


Fig: Block Diagram of Ultrasonic Sensor

Systems typically use a transducer which generates sound waves in the ultrasonic range, above 20,000 hertz, by turning electrical energy into sound, then upon receiving the echo turn the sound waves into electrical energy which can be measured and displayed.

The technology is limited by the shapes of surfaces and the density or consistency of the material. For example foam on the surface of a fluid in a tank could distort a reading.

Transducers

Sound field of a non focusing 4MHz ultrasonic transducer with a near field length of N=67mm in water. The plot shows the sound pressure at a logarithmic db-scale. Sound pressure field of the same ultrasonic transducer (4MHz, N=67mm) with the transducer surface having a spherical curvature with the curvature radius R=30mm

An ultrasonic transducer is a device that converts energy into ultrasound, or sound waves above the normal range of human hearing. While technically a dog whistle is an ultrasonic transducer that converts mechanical energy in the form of air pressure into ultrasonic sound waves, the term is more apt to be used to refer to piezoelectric transducers that convert electrical energy into sound. Piezoelectric crystals have the property of changing size when a voltage is

applied, thus applying an alternating current (AC) across them causes them to oscillate at very high frequencies, thus producing very high frequency sound waves.

The location at which a transducer focuses the sound, can be determined by the active transducer area and shape, the ultrasound frequency and the sound velocity of the propagation medium.

The example shows the sound fields of an unfocused and a focusing ultrasonic transducer in water.

Range

This ultrasonic rangefinder can measure distances up to 2.5 meters at an accuracy of 1 centi-meter.

Working

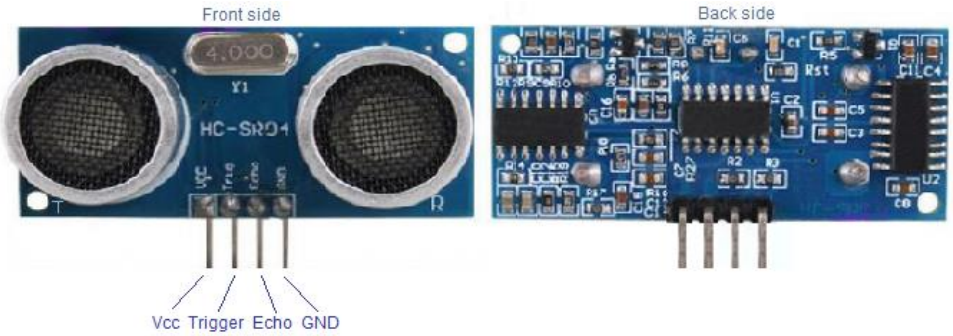
The sensor has a ceramic transducer that vibrates when electrical energy is applied to it. The vibrations compress and expand air molecules in waves from the sensor face to a target object. A transducer both transmits and receives sound. The ultrasonic sensor will measure distance by emitting a sound wave and then "listening" for a set period of time, allowing for the return echo of the sound wave bouncing off the target, before retransmitting.

Microcontroller and the ultrasonic transducer module HC-SR04 forms the basis of this circuit. The ultrasonic module sends a signal to the object, then picks up its echo and outputs a wave form whose time period is proportional to the distance. The microcontroller accepts this signal, performs necessary processing and displays the corresponding distance on the 3 digit seven segment display. This circuit finds a lot of application in projects like automotive parking sensors, obstacle warning systems, terrain monitoring robots, industrial distance measurements etc.

It has a resolution of 0.3cm and the ranging distance is from 2cm to 500cm. It operates from a 5V DC supply and the standby current is less than 2mA. The module transmits an ultrasonic signal, picks up its echo, measures the time elapsed between the two events and outputs a waveform whose high time is modulated by the measured time which is proportional to the distance.

The supporting circuits fabricated on the module makes it almost stand alone and what the programmer need to do is to send a trigger signal to it for initiating transmission and receive the echo signal from it for distance calculation.

The HR-SR04 has four pins namely Vcc, Trigger, Echo, GND and they are explained in detail below.



Pin: Pin Description and View of Ultrasonic Sensor

1) **VCC** : 5V DC supply voltage is connected to this pin.

2) **Trigger**: The trigger signal for starting the transmission is given to this pin. The trigger signal must be a pulse with 10uS high time. When the module receives a valid trigger signal it issues 8 pulses of 40KHz ultrasonic sound from the transmitter. The echo of this sound is picked by the receiver.

3)**Echo**: At this pin, the module outputs a waveform with high time proportional to the distance.

4) **GND**: Ground is connected to this pin.

The transmitter part of the circuit is build around IC1(NE 555).The IC1 is wired as an astable multi vibrator operating at 40KHz.The output of IC1 is amplifier the complementary pair of transistors (Q1 & Q2) and transmitted by the ultrasonic transmitter K1.The push button switch S1 is used the activate the transmitter.

The receiver uses an ultrasonic sensor transducer (K2) to sense the ultrasonic signals. When an ultrasonic signal is falling on the sensor, it produces a proportional voltage signal at its output. This weak signal is amplified by the two stage amplifier circuit comprising of transistors Q3 and Q4.The output of the amplifier is rectified by the diodes D3 & D4.The rectified signal is given to the inverting input of the opamp which is wired as a comparator. Whenever there is an ultrasonic signal falling on the receiver, the output of the comparator

activates the transistors Q5 & Q6 to drive the relay. In this way the load connected via the relay can be switched. The diode D5 is used as a free-wheeling diode.

Detectors

Since piezoelectric crystal generate a voltage when force is applied to them, the same crystal can be used as an ultrasonic detector. Some systems use separate transmitter and receiver components while others combine both in a single piezoelectric transceiver.

Alternative methods for creating and detecting ultrasound include magnetostriction and capacitive actuation.

Application

Ultrasonic sensors use sound waves rather than light, making them ideal for stable detection of uneven surfaces, liquids, clear objects, and objects in dirty environments. These sensors work well for applications that require precise measurements between stationary and moving objects.

Ultrasonic sensor provides a very low-cost and easy method of distance measurement. This sensor is perfect for any number of applications that require you to perform measurements between moving or stationary objects. Naturally, robotics applications are very popular but it is also find in product which is useful in security systems or as an infrared replacement if so desired.

Use in medicine

Medical ultrasonic transducers (probes) come in a variety of different shapes and sizes for use in making pictures of different parts of the body. The transducer may be passed over the surface of the body or inserted into an body opening such as the rectum or vagina. Clinicians who perform ultrasound-guided procedures often use a probe positioning system to hold the ultrasonic transducer.

Use in industry

Ultrasonic sensors are used to detect the presence of targets and to measure the distance to targets in many automated factories and process plants. Sensors with an on or off digital output are available for detecting the presence of objects, and sensors with an analog output

which varies proportionally to the sensor to target separation distance are commercially available.

Other types of transducers are used in commercially available ultrasonic cleaning devices. An ultrasonic transducer is affixed to a stainless steel pan which is filled with a solvent (frequently water or isopropanol) and a square wave is applied to it, imparting vibrational energy on the liquid.

Application In Industries

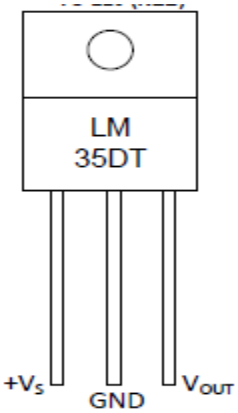
- Measurement of dynamically changing diameters
- Measurement of dynamically changing distances
- Measurement of dynamically changing heights
- Measurement of dynamically changing depths
- Counting number of units.

3.6 Temperature sensor

Temperature is the most-measured process variable in industrial automation. Most commonly, a temperature sensor is used to convert temperature value to an electrical value. Temperature Sensors are the key to read temperatures correctly and to control temperature in industrials applications.

A large distinction can be made between temperature sensor types. Sensors differ a lot in properties such as contact-way, temperature range, calibrating method and sensing element. The temperature sensors contain a sensing element enclosed in housings of plastic or metal. With the help of conditioning circuits, the sensor will reflect the change of environmental temperature.

Temperature sensor (LM35)



Pin Definition

The definition of gray-scale sensor pin is

1. Signal Output
2. GND
3. Power

Features Of Temperature Sensor

- Calibrated directly in Celsius (centigrade)
- 0.5^0 C Ensured accuracy (at $+25^0$ C)
- Suitable for remote applications

- Operate from 4 to 30 V
- Low cost due to wafer-level trimming

Specifications

- Type: Analog
- Sensitivity: 10mV per degree Celcius
- Functional range: 0 degree Celsius to 100 degree Celsius

Description

The LM35 series are precision integrated-circuit temperature sensors, with an output voltage linearly proportional to the Centigrade temperature. Thus LM35 has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient Centigrade scaling.

In the temperature functional module we developed, we use the LM34 series of temperature sensors. The LM34 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Fahrenheit temperature. The LM34 thus has an advantage over linear temperature sensors calibrated in degrees Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Fahrenheit scaling. The LM34 does not require any external calibration or trimming to provide typical accuracies of $\pm_{1.2}$°F at room temperature and $\pm 1_{1.2}$°F over a full -50 to +300°F temperature range. The LM34 is rated to operate over a -50° to +300°F temperature range.

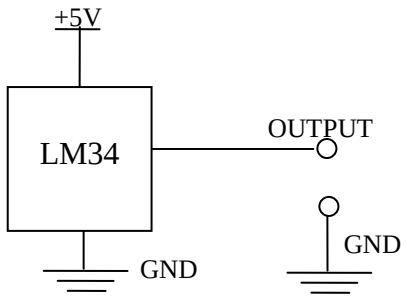


Figure 1 Circuit diagram for the LM34 temperature sensor functional module

It is easy to include the LM34 series in a temperature measuring application. The output voltage of LM34 is linearly proportional to the Fahrenheit temperature, it has a Linear +10.0

mV/°F scale factor which means that you will get n*10.0 mV output voltage if the environment temperature is n°F.

The LM34 series is available packaged in hermetic TO-46 transistor packages, while the LM34C, LM34CA and LM34D are also available in the plastic TO-92 transistor package. The LM34D is also available in an 8-lead surface mount small outline package. In our functional module, LM34H in metal can package (TO-46) is used in the functional module, it is very important to know that the wiring of sensor should be based on the positions of the leading pins in different packages.

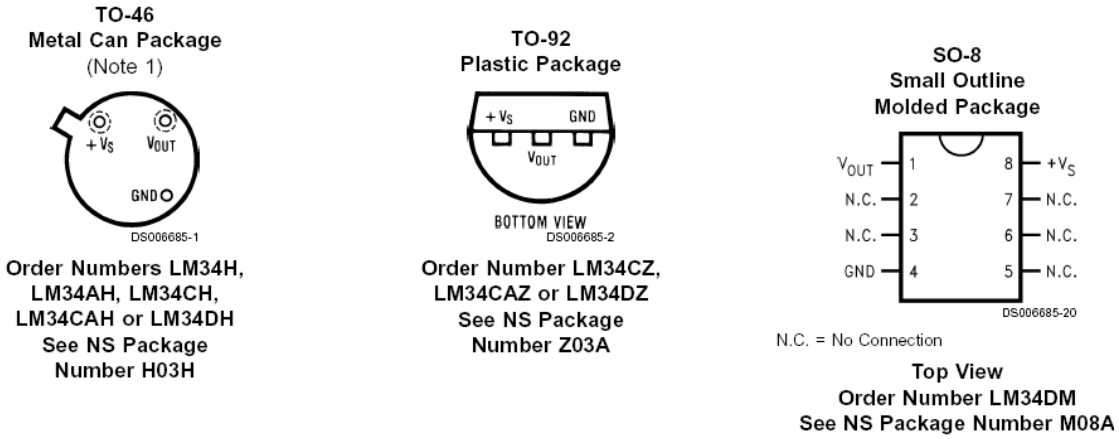


Figure 2 Package Diagram of LM34

2. DESCRIPTION OF TEMPERATURE SENSOR FUNCTIONAL MODULE

The temperature sensor functional module consists of two parts: the function module box and the probe head. The LM34 temperature sensor is mounted on the probe head. Be careful to make sure that the sensor is properly mounted on the probe head. (refer to Figure 4 Labeled picture of the probe head.)

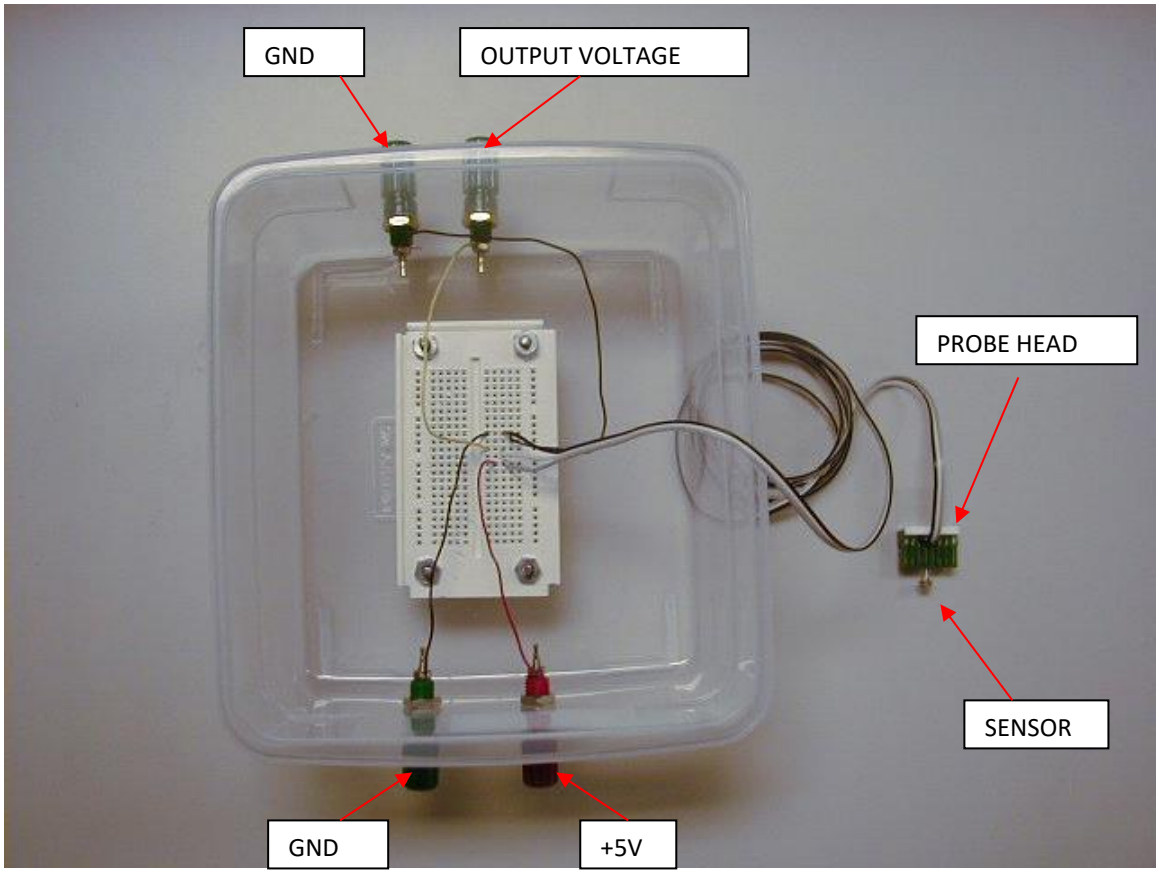


Figure 3 Labeled picture of the temperature sensor circuit functional module.

By replacing the LM34 with another precision integrated-circuit temperature sensor LM35, we can easily get an output voltage proportional to the centigrade temperature. The LM35 sensor has a linear +10.0 mV/°C scale factor and a temperature range from -55°C to +150°C.In fact LM34 and LM35 are among the same series of temperature sensors so that they can be easily exchanged in different applications. The wiring for LM 35 is the same as that of LM34. Please refer to the datasheets of LM34 and LM35 for more detailed packaging and features information.

APPLICATIONS

The LM35 is applied easily in the same way as other integrated-circuit temperature sensors. Glue or cement the device to a surface and the temperature should be within about 0.01°C of the surface temperature.

This presumes that the ambient air temperature is almost the same as the surface temperature. If the air temperature were much higher or lower than the surface temperature, the actual temperature of the LM35 die would be at an intermediate temperature between the surface temperature and the air temperature, which is especially true for the TO-92 plastic package where the copper leads are the principal thermal path to carry heat into the device, so its temperature might be closer to the air temperature than to the surface temperature.

To minimize this problem, ensure that the wiring to the LM35, as it leaves the device, is held at the same temperature as the surface of interest. The easiest way to do this is to cover up these wires with a bead of epoxy which will insure that the leads and wires are all at the same temperature as the surface, and that the temperature of the LM35 die is not affected by the air temperature.

3.7 LIQUID CRYSTAL DISPLAY(LCD)

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on.

A **16x2 LCD** means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data.

The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD.

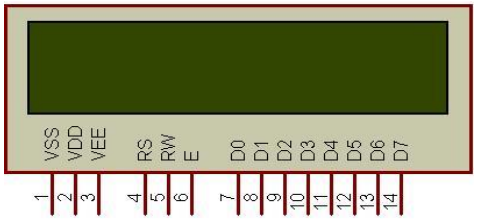


Fig. 16x2 LCD

Introduction

The most commonly used Character based LCDs are based on Hitachi's HD44780 controller or other which are compatible with HD44580.

Pin Description

Most LCDs with 1 controller has 14 Pins and LCDs with 2 controller has 16 Pins (two pins are extra in both for back-light LED connections). Pin description is shown in the table below.

Pin Configuration table for a 16X2 LCD character display:-

Pin Number	Symbol	Function
1	Vss	Ground Terminal
2	Vcc	Positive Supply
3	Vdd	Contrast adjustment
4	RS	Register Select; 0→Instruction Register, 1→Data Register
5	R/W	Read/write Signal; 1→Read, 0→ Write
6	E	Enable; Falling edge
7	DB0	Bi-directional data bus, data transfer is performed once, thru DB0 to DB7, in the case of interface data length is 8-bits; and twice, through DB4 to DB7 in the case of interface data length is 4-bits. Upper four bits first then lower four bits.
8	DB1	
9	DB2	
10	DB3	
11	DB4	
12	DB5	
13	DB6	
14	DB7	
15	LED-(K)	Back light LED cathode terminal
16	LED+(A)	Back Light LED anode terminal

Table Pin Description Of LCD

Data/Signals/Execution of LCD

Coming to data, signals and execution.

LCD accepts two types of signals, one is data, and another is control. These signals are recognized by the LCD module from status of the RS pin. Now data can be read also from the LCD display, by pulling the R/W pin high. As soon as the E pin is pulsed, LCD display reads data at the falling edge of the pulse and executes it, same for the case of transmission.

LCD display takes a time of 39-43µS to place a character or execute a command. Except for clearing display and to seek cursor to home position it takes 1.53ms to 1.64ms. Any attempt to send any data before this interval may lead to failure to read data or execution of the current data in some devices. Some devices compensate the speed by storing the incoming data to some temporary registers.

Instruction Register (IR) and Data Register (DR)

There are two 8-bit registers in HD44780 controller Instruction and Data register. Instruction register corresponds to the register where you send commands to LCD e.g LCD

shift command, LCD clear, LCD address etc. and Data register is used for storing data which is to be displayed on LCD. when send the enable signal of the LCD is asserted, the data on the pins is latched in to the data register and data is then moved automatically to the DDRAM and hence is displayed on the LCD. Data Register is not only used for sending data to DDRAM but also for CGRAM, the address where you want to send the data, is decided by the instruction you send to LCD. We will discuss more on LCD instruction set further in this tutorial.

Commands and Instruction set

Only the instruction register (IR) and the data register (DR) of the LCD can be controlled by the MCU. Before starting the internal operation of the LCD, control information is temporarily stored into these registers to allow interfacing with various MCUs, which operate at different speeds, or various peripheral control devices. The internal operation of the LCD is determined by signals sent from the MCU. These signals, which include register selection signal (RS), read/write signal (R/W), and the data bus (DB0 to DB7), make up the LCD instructions (Table 3). There are four categories of instructions that:

- Designate LCD functions, such as display format, data length, etc.
- Set internal RAM addresses
- Perform data transfer with internal RAM
- Perform miscellaneous functions

Command	Code										Description	Execution Time
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		
Clear Display	0	0	0	0	0	0	0	0	0	1	Clears the display and returns the cursor to the home position (address 0).	82μs~1.64ms
Return Home	0	0	0	0	0	0	0	0	1	*	Returns the cursor to the home position (address 0). Also returns a shifted display to the home position. DD RAM contents remain unchanged.	40μs~1.64ms
Entry Mode Set	0	0	0	0	0	0	0	1	I/D	S	Sets the cursor move direction and enables/disables the display.	40μs
Display ON/OFF Control	0	0	0	0	0	0	1	D	C	B	Turns the display ON/OFF (D), or the cursor ON/OFF (C), and blink of the character at the cursor position (B).	40μs
Cursor & Display Shift	0	0	0	0	0	1	S/C	R/L	*	*	Moves the cursor and shifts the display without changing the DD RAM contents.	40μs
Function Set	0	0	0	0	1	DL	N$	F	*	#	Sets the data width (DL), the number of lines in the display (L), and the character font (F).	40μs
Set CG RAM Address	0	0	0	1	A_{CG}						Sets the CG RAM address. CG RAM data can be read or altered after making this setting.	40μs
Set DD RAM Address	0	0	1	A_{DD}							Sets the DD RAM address. Data may be written or read after making this setting.	40μs
Read Busy Flag & Address	0	1	BF	AC							Reads the BUSY flag (BF) indicating that an internal operation is being performed and reads the address counter contents.	1μs
Write Data to CG or DD RAM	1	0	Write Data								Writes data into DD RAM or CG RAM.	46μs
Read Data from CG or DD RAM	1	1	Read Data								Reads data from DD RAM or CG RAM.	46μs
	I/D = 1: Increment I/D = 0: Decrement S = 1: Accompanies display shift. S/C= 1: Display shift S/C = 0: cursor move R/L= 1: Shift to the right. R/L= 0: Shift to the left. DL = 1: 8 bits DL = 0: 4 bits N = 1: 2 lines N = 0: 1 line F = 1: 5x10 dots F = 0: 5 x 7 dots BF = 1: Busy BF = 0: Can accept data *# Set to 1 on 24x4 modules* *$ With KS0072 is Address Mode.*											DD RAM: Display data RAM CG RAM: Character generator RAM A_{CG}: CG RAM Address A_{DD}: DD RAM Address Corresponds to cursor address. AC: Address counter Used for both DD and CG RAM address.	Execution times are typical. If transfers are timed by software and the busy flag is not used, add 10% to the above times.

Table Showing various LCD Command Description

Although looking at the table you can make your own commands and test them. Below is a brief list of useful commands which are used frequently while working on the LCD.

List Of Command

No.	Instruction	Hex	Decimal
1	Function Set: 8-bit, 1 Line, 5x7 Dots	0x30	48
2	Function Set: 8-bit, 2 Line, 5x7 Dots	0x38	56
3	Function Set: 4-bit, 1 Line, 5x7 Dots	0x20	32
4	Function Set: 4-bit, 2 Line, 5x7 Dots	0x28	40
5	Entry Mode	0x06	6
6	Display off Cursor off (clearing display without clearing DDRAM content)	0x08	8
7	Display on Cursor on	0x0E	14
8	Display on Cursor off	0x0C	12
9	Display on Cursor blinking	0x0F	15
10	Shift entire display left	0x18	24
12	Shift entire display right	0x1C	30
13	Move cursor left by one character	0x10	16
14	Move cursor right by one character	0x14	20
15	Clear Display (also clear DDRAM content)	0x01	1
16	Set DDRAM address or coursor position on display	0x80+add*	128+add*
17	Set CGRAM address or set pointer to CGRAM location	0x40+add**	64+add**

Table : Frequently Used Commands And Instructions For Lcd

* DDRAM address given in LCD basics section see Figure 2,3,4
** CGRAM address from 0x00 to 0x3F, 0x00 to 0x07 for char1 and so on.

Liquid crystal displays interfacing with Controller

The LCD standard requires 3 control lines and 8 I/O lines for the data bus.

- **8 data pins D7:D0**

Bi-directional data/command pins.

Alphanumeric characters are sent in ASCII format.

• **RS: Register Select**

RS = 0 -> Command Register is selected

RS = 1 -> Data Register is selected

• **R/W: Read or Write**

0 -> Write, 1 -> Read

• **E: Enable (Latch data)**

Used to latch the data present on the data pins.

A high-to-low edge is needed to latch the data.

3.8 Rain Sensor

The Raindrops Detection sensor module is used for rain detection. It is also for measuring rainfall intensity. Rain sensor can be used for all kinds of weather monitoring and ranslated into output signals and AO

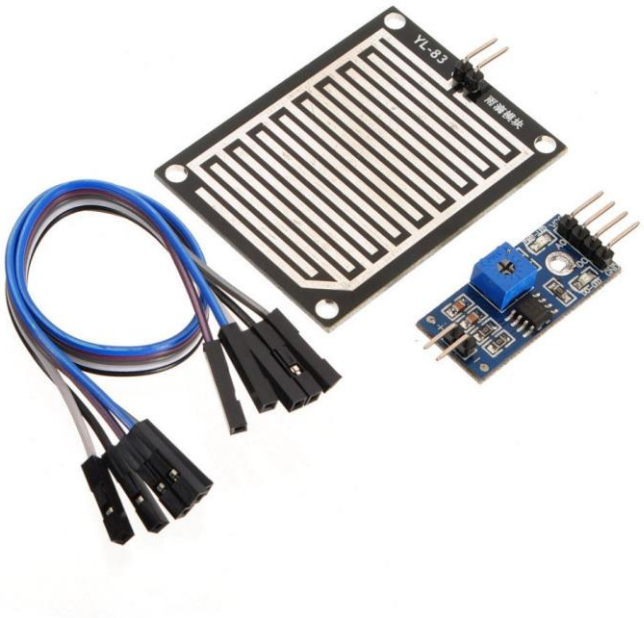
Raindrops Detection Sensor Module Rain Weather Module for Arduino, etc. Rain sensor can be used to monitor a variety of weather conditions and turned into several fixed output signal and Analog output.

It includes a printed circuit board (control board) that “collects” the raindrops. As raindrops are collected on the circuit board, they create paths of parallel resistance that are measured via the op-amp. The lower the resistance (or the more water), the lower the voltage output. Conversely, the less water, the greater the output voltage on the analog pin. A completely dry board, for example, will cause the module to output 5V.

The module includes a rain board and a control board that is separate for more convenience. It has a power indicator LED and an adjustable sensitivity through a potentiometer. The module is based on the LM393 op-amp.

Features:-

- The LM393, use of the wide voltage comparator
- Provide both digital and analog output
- Output LED indicator
- Compatible with Arduino
- TTL Compatible
- The sensor uses the high-quality FR – 04 double material, the large area of 5.5 * 4.0 CM
- Treatment of nickel plating and surface, have fight oxidation, electrical conductivity, and life has more superior performance
- The comparator output, signal clean, good waveform, driving ability is strong, for more than 15 mA;
- With potentiometer sensitivity adjustment
- The output format: digital switch output (0 and 1) and analog AO voltage output;
- Has a fixed bolt hole, convenient installation


YL-83

3.9 BATTERY

A battery is a device consisting of one or more electrochemical cells that convert stored chemical energy into electrical energy. Batteries are another way to produce electricity. They are smaller and safer. Batteries have one end that is positive and one end that is negative. For batteries to work, you need to make sure you put them in the right way. Batteries have become a common power source for many household and industrial applications.

There are two types of batteries: primary batteries (disposable batteries), which are designed to be used once and discarded, and secondary batteries (rechargeable batteries), which are designed to be recharged and used multiple times. Batteries come in many sizes, from miniature cells used to power hearing aids and wristwatches to battery banks the size of rooms that provide standby power for telephone exchanges and computer data centers.

A battery is a device that converts chemical energy directly to electrical energy. It consists of a number of voltaic cells; each voltaic cell consists of two half-cells connected in series by a conductive electrolyte containing anions and cations. One half-cell includes electrolyte and the electrode to which anions (negatively charged ions) migrate, i.e., the anode or negative electrode; the other half-cell includes electrolyte and the electrode to which cation (positively charged ions) migrate, i.e., the cathode or positive electrode. In the redox reaction that powers the battery, cations are reduced (electrons are added) at the cathode, while anions are oxidized (electrons are removed) at the anode. The electrodes do not touch each other but are electrically connected by the electrolyte. Some cells use two half-cells with different electrolytes. A separator between half-cells allows ions to flow, but prevents mixing of the electrolytes

Batteries are classified into two broad categories, each type with advantages and disadvantages.

- *Primary* batteries irreversibly (within limits of practicality) transform chemical energy to electrical energy. When the initial supply of reactants is exhausted, energy cannot be readily restored to the battery by electrical means.
- *Secondary* batteries can be recharged; that is, they can have their chemical reactions reversed by supplying electrical energy to the cell, restoring their original composition.

Some types of primary batteries used, for example, for telegraph circuits, were restored to operation by replacing the components of the battery consumed by the chemical reaction. Secondary batteries are not indefinitely rechargeable due to dissipation of the active materials, loss of electrolyte and internal corrosion.

Primary batteries can produce current immediately on assembly. Disposable batteries are intended to be used once and discarded. These are most commonly used in portable devices that have low current drain, are used only intermittently, or are used well away from an alternative power source, such as in alarm and communication circuits where other electric power is only intermittently available.

Secondary batteries must be charged before use; they are usually assembled with active materials in the discharged state. Rechargeable batteries or secondary cells can be recharged by applying electric current, which reverses the chemical reactions that occur during its use. Devices to supply the appropriate current are called chargers or rechargers.

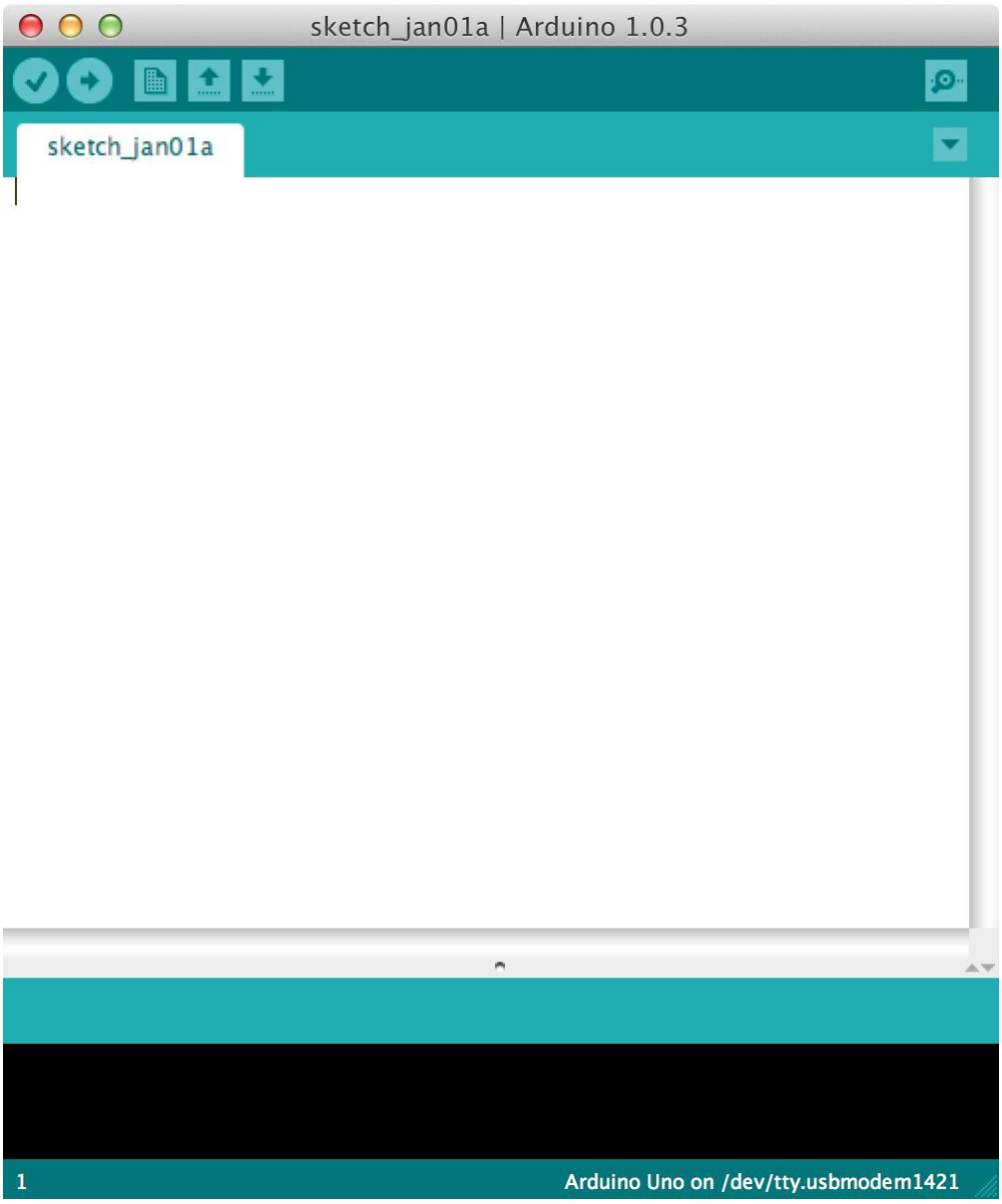
CHAPTER-4

SOFTWARE SPECIFICATION

IDLE

Arduino Software

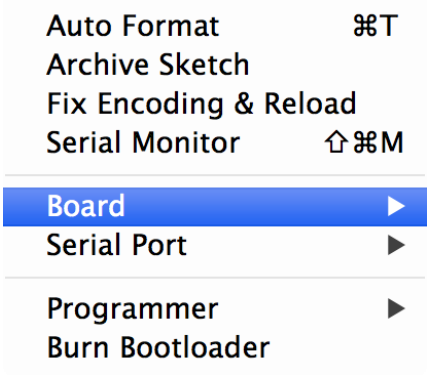
You'll need to download the Arduino Software package for your operating system. When you've downloaded and opened the application you should see something like this:



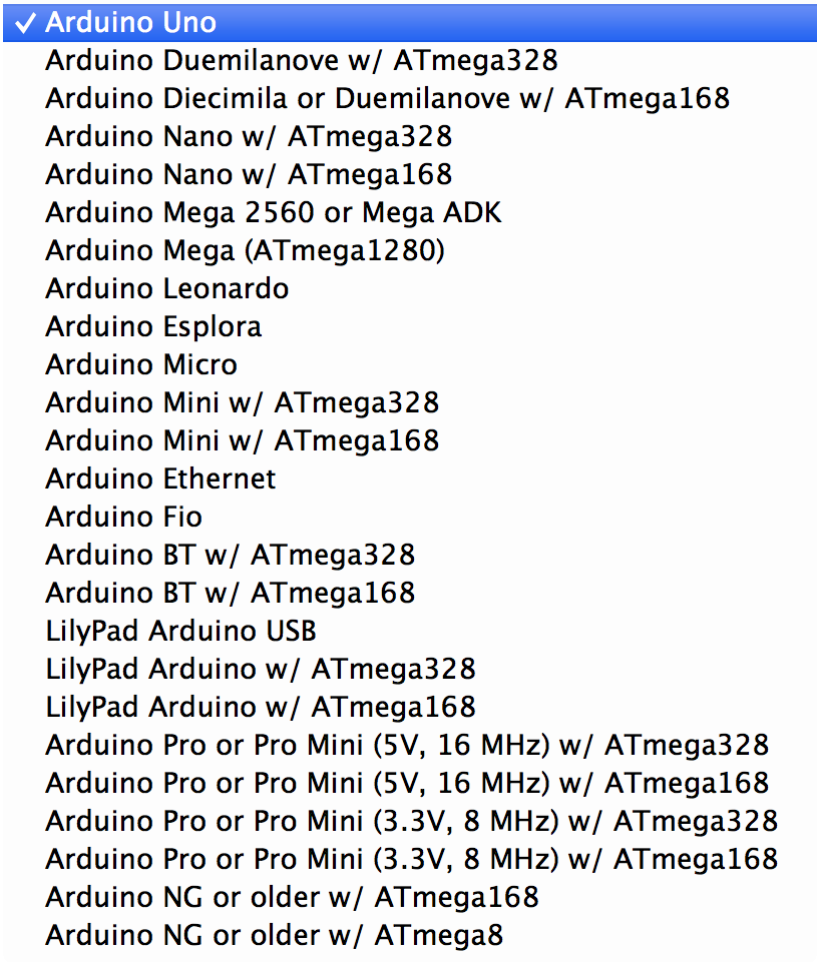
This is where you type the code you want to compile and send to the Arduino board.

The Initial Setup

We need to setup the environment to **Tools** menu and select **Board**.



Then select the type of Arduino you want to program, in our case it's the **Arduino Uno**.



The Code

The code you write for your Arduino are known as **sketches**. They are written in **C++**.

Every sketch needs two *void type functions*, setup() and loop(). A void type function doesn't return any value.

The setup() method is ran once at the just after the Arduino is powered up and the loop() method is ran continuously afterwards. The setup() is where you want to do any initialisation steps, and in loop() you want to run the code you want to run over and over again.

So, your basic sketch or program should look like this:

```
void setup()
{

}

void loop()
{

}
```

Now we have the basic skeleton in place we can now do the **Hello, World** program of microcontrollers, a blinking an LED.

Headers and Pins

If you notice on the top edge of the board there's two black rectangles with several squares in. These are called **headers**. Headers make it easy to connect components to the the Arduino. Where they connect to the board is called **pins**. Knowing what pin something is connected to is essential for programming an Arduino.

The pin numbers are listed next to the headers on the board in white.

The onboard LED we want to control is on pin 13.

In our code above the setup() method let's create a variable called ledPin. In C++ we need to state why type our variable is before hand, in this case it's an integer, so it's of type int.

```
int ledPin = 13;
void setup()
{
```

```
}

void loop()
{

}
```

Each line is ended with a semicolon (;).

In the setup() method we want to set the ledPin to the output mode. We do this by calling a special function called pinMode() which takes two variables, the first the pin number, and second, whether it's an input or output pin. Since we're dealing with an output we need to set it to a constant called OUTPUT. If you were working with a sensor or input it would be INPUT.

```
int ledPin = 13;

void setup()
{
        pinMode(ledPin, OUTPUT);
}

void loop()
{

}
```

In our loop we are going to first switch off the LED to make sure our program is being transferred to the chip and overriding the default.

We do this by calling another special method called digitalWrite(). This also takes two values, the pin number and the level, HIGH or the on state or LOW the off state.

```
int ledPin = 13;

void setup()
{
        pinMode(ledPin, OUTPUT);
}
```

```
void loop()
{
        digitalWrite(ledPin, LOW);
}
```

Next we want to compile to machine code and deploy or *upload* it to the Arduino.

Compiling the Code

If this is your first time you've ever compiled code to your Arduino before plugging it in to the computer go to the **Tools** menu, then **Serial Port** and take note of what appears there. Here's what mine looks like before plugging in the Arduino UNO:

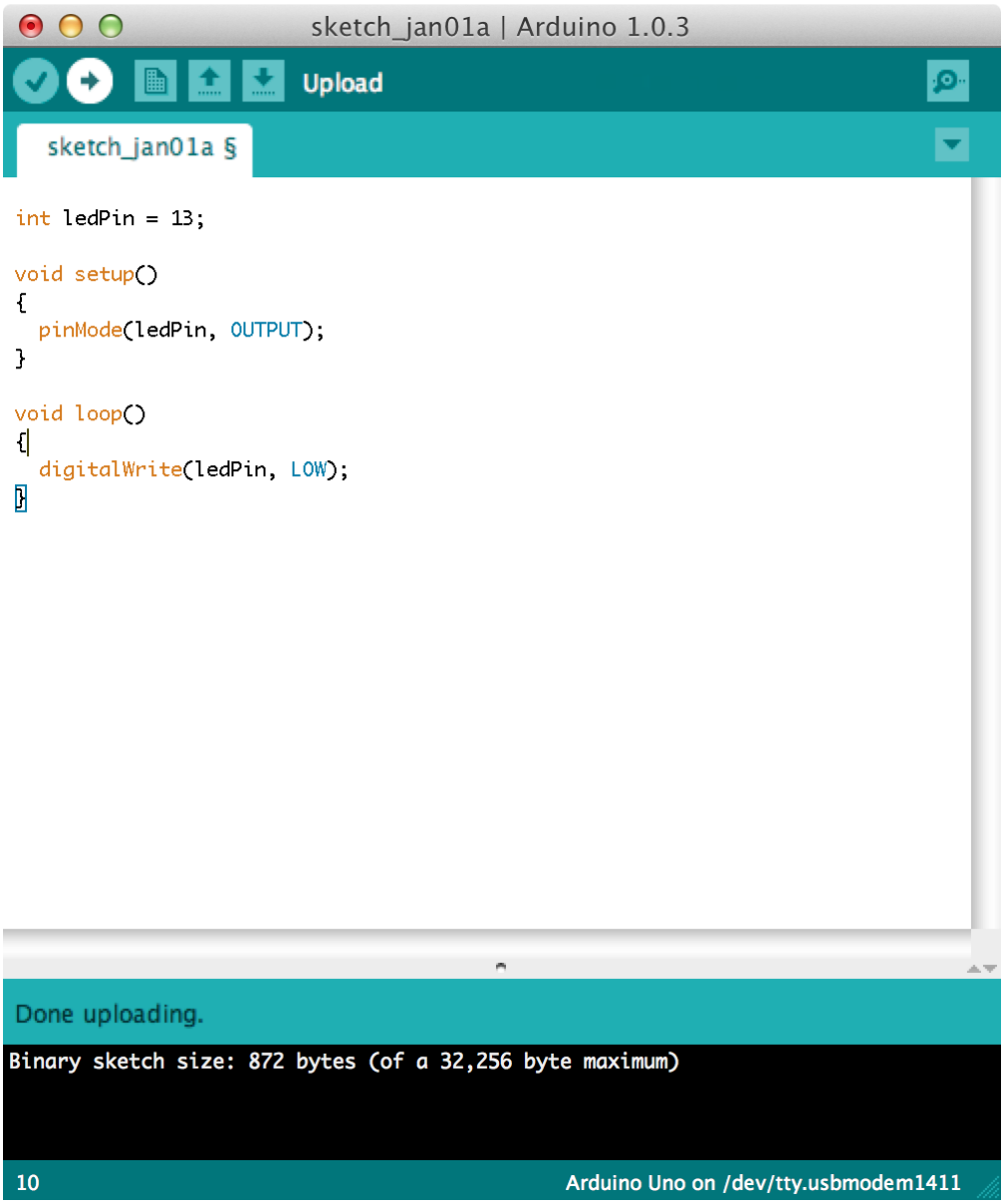
```
/dev/tty.Bluetooth-PDA-Sync
/dev/cu.Bluetooth-PDA-Sync
/dev/tty.Bluetooth-Modem
/dev/cu.Bluetooth-Modem
```

Plug your Arduino UNO board in to the USB cable and into your computer. Now go back to the **Tools > Serial Port** menu and you should see at least 1 new option. On my Mac 2 new serial ports appear.

```
/dev/tty.Bluetooth-PDA-Sync
/dev/cu.Bluetooth-PDA-Sync
/dev/tty.Bluetooth-Modem
/dev/cu.Bluetooth-Modem
✓ /dev/tty.usbmodem1411
/dev/cu.usbmodem1411
```

They *tty* and *cu* are two ways that computers can talk over a serial port. Both seem to work with the Arduino software so I selected the tty.* one. On Windows you should see *COM* followed by a number. Select the new one that appears.

Once you have selected your serial or COM port you can then press the button with the arrow pointing to the right.



Once that happens you should see the **TX** and **RX** LEDs below the **L** LED flash. This is the communication going on between the computer and the Arduino. The **L** may flicker too. Once this dance is complete your program should be running. And your LED should be off. Now let's try and switch it on using the HIGH constant.

```
int ledPin = 13;

void setup()
{
        pinMode(ledPin, OUTPUT);
}
```

```
void loop()
{
        digitalWrite(ledPin, HIGH);
}
```

Press *Upload* again and you should see your LED is now on!

Let's make this a little more interesting now. We're going to use another method called delay() which takes an integer of a time interval in milliseconds, meaning the integer of 1000 is 1 second.

So after where we switch the LED on let's add delay(2000) which is two seconds, then digitalWrite(ledPin, LOW) to switch it off and delay(2000) again.

```
int ledPin = 13;

void setup()
{
        pinMode(ledPin, OUTPUT);
}

void loop()
{
        digitalWrite(ledPin, HIGH);
        delay(2000);
        digitalWrite(ledPin, LOW);
        delay(2000);
}
```

CHAPTER-5

ALGORITHM & FLOWCHART

5.1. ALGORITHM:

Step 1 - Initialization WIFI, Motors

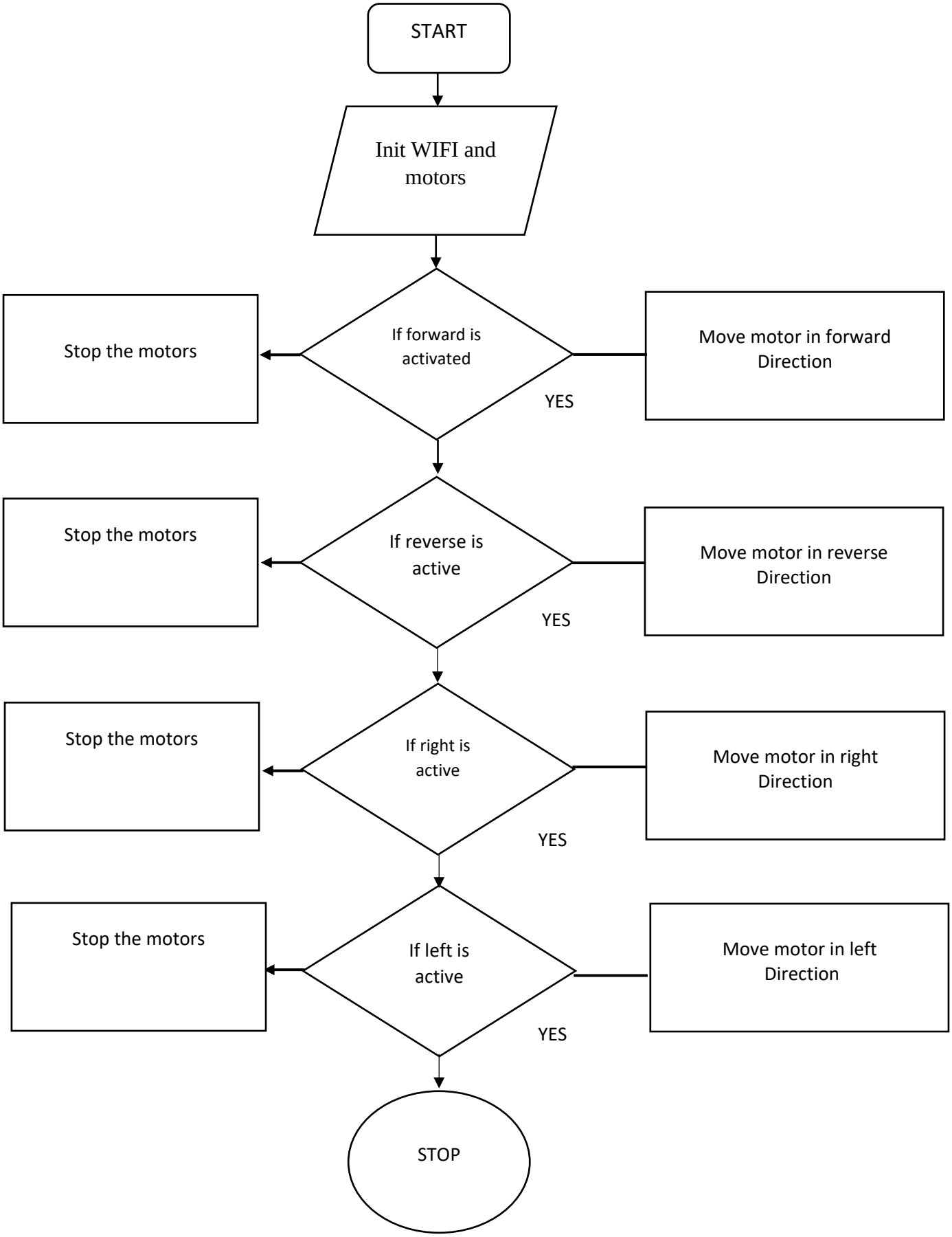
Step 2 – Waiting for the signal from the application

Step 3 – Checking if the signal for the direction

Step 4 – Move the motor is particular direction

Step5 – Stop

5.2. FLOWCHART:



CHAPTER-6

RESULT & ANALYSIS

We have finally reached our goal. We have to implement the hardware as all equipment is at our hands. So, in a nutshell the whole procedure is as follows

6.1. PROCEDURE

1. Initialization WIFI and motors

2. Checking for input signal from WIFI application

3. Trigger the motor in the specific direction

6.2. Result

Finally, we have successfully implemented the circuit .It can be easily implemented in elections and remote and local services.

6.3. Advantages and applications:

Advantages:

1. Remote Control of the devices.
2. Easy implementation.
3. Planting efficiency get increased.
4. Optimum crop yield achieved
5. Seed can be placed uniformly in a row with required distance between plants and required depth.
6. Maintenance cost is less.
7. Less labor required.

Applications:

The following are some of the applications of this project

1. Industrial garden

2. Farms and resorts

6.4. Limitations of this project

- Robot has a Limited range of control

CHAPTER-7

CONCLUSION

The project "**Fully Automated Solar Grass Cutter with obstacle detection**" has been successfully designed and tested. It has been developed by integrating features of all the hardware components used. Presence of every module has been reasoned out and placed carefully thus contributing to the best working of the unit. Secondly using highly advanced IC's and with the help of growing technology the project has been successfully implemented.

FUTURE SCOPE

- Scope for public places
- Improves remote control and accessibilities