LOW COST RADIO FREQUENCY CONTROLLED ROBOT FOR ENIVRONMENTAL CLEANING

Submitted in partial fulfillment of the
Requirements for the degree of

BACHELOR OF ENGINEERING

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Approval Sheet

Project entitled: **Low cost radio frequency-controlled robot for environmental cleaning.**

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In partial fulfillment of **BE ELECTRONICS & TELECOMMUNICATION.**

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Date:

Acknowledgment

We take this opportunity in representing the report on our project **"Low cost radio frequency-controlled robot for environmental cleaning.".** The completion of any project brings with it a sense of satisfaction, but it is never complete without the appreciating those people who made it possible and whose constant support crowned each effort with success. One cannot even imagine the power of the force that guides us and neither can we succeed without acknowledging it.

We place on record and warmly acknowledge the continuous encouragement, invaluable supervision, timely suggestions, and inspired guidance offered by our Project Guide **Dr.Mani roja** in bringing this report to a successful completion. We also thank her for showing keen interest and for providing all the facilities as and when we needed them.

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Finally, we would like to thank our entire Electronics and Telecommunication Department and Staff which instilled in us the self-discipline that was necessary in building the project.

Declaration

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

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ABSTRACT

The paper presents the technical construction of a robot which is used in cleaning. The term “cleaning” sounds simple, yet we humans face a lot of problems with the disease-ridden workplace, a few examples are factories, power plants, Bio-hazard chambers etc., where it is harmful for humans to work. RF signal is used to control this robot. It uses an Arduino (micro-controller) for its operation. The mechanical part is the base (metal chassis) with servo motor and the wheels (plastic wheels) in our case. The material used in mechanical part can be changed according to our prerequisite. The electronic part consisting of the RF signal receiver, Arduino and the surveillance Camera are mounted on the base of the robot. The camera acts as the “eye” of the operator transferring live video data wireless either using W-Lan or using cloud computing (in case of monitoring over large distance). The cleaning mechanism includes a normal brush (material of the brush is selected as required) with a servo motor attached to it. This robot not only helps in cleaning rather can be used to monitor things.

Keywords- Cleaning robot, surveillance robot, RF controlled robot.

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INTRODUCTION

1.1 Text Classification

The term “CLEANING” sounds simple yet we humans face a lot of problems with the disease-ridden workplace.

In recent years, robotic cleaners have taken major attention in robotics research due to their effectiveness in assisting humans in floor cleaning applications at industries, homes, hotels, restaurants, offices, hospitals, workshops, warehouses and universities etc. Basically, robotic cleaners are distinguished on their cleaning expertise like floor mopping, dry vacuum cleaning etc. Some products are based on simple obstacle avoidance using infrared sensors while some utilize laser mapping technique. Each cleaning and operating mechanism of robotic floor cleaners has its own advantages and disadvantages. For example, robots utilizing laser mapping are relatively faster, less time consuming and energy efficient but costly, while obstacle avoidance-based robots are relatively time consuming and less energy efficient due to random cleaning but less costly. Countries like India are way back in manufacturing robotic cleaners. Importing them from abroad increases their costs. The main objective of this work is to provide a substantial solution to assists humans in the purpose of cleaning in places where it is unsafe for the humans to work with while keeping it low costs.

1.2 Motivation of the Project

The Nováky Power Station (NPS) has been using since 1953 as fuel coal with a high content of As and with a low content of other metals. This involves a constant risk for the workers as well as pollution of the surroundings. Buchancováj Klimentová G, Knizková M, Mesko D, Gáliková E, Kubík J, Fabianová E and Jakubis M, analysts at Clinic of Occupational Medicine and Toxicology, Martin Faculty Hospital, Slovakia Republic described 16 cases of chronic as intoxication in NPS workers after 22.3+/- 8.4 years of exposure (especially stokers, maintenance workers, boiler Cleaners). Every person involved in the simple work of “CLEANING”. Among clinical symptoms prevailed sensory and motor polyneuropathy (13 cases), pseudo neurasthenic syndrome (10 cases), toxic encephalopathy (6 cases) and nasal septum perforation (2 cases). After 1989 the intoxications with as did not occur any more due to technical measures and health protection of the workers. The authors present a review

of actual results of clinical, hematological and biochemical investigations and tests for metals (AAS methods) in biological materials of workers at risk in NPS (n = 70), exposed on average for 11.9 +/- 0.5 years, of average age 35.91 +/- 1.7 years (mean +/- SE) and compared the results to a matched control group of blood donors not exposed to metals (n = 29). In NPS workers significantly lower Hb values, higher serum creatinine, higher serum beta 2-microglobulin, higher as content in hair as well as higher serum Mn and Pb concentrations compared with the C-group were found. The exposed group had significantly lower serum Se concentrations (0.64 +/- 0.025 mumol/l (mean +/- SE) compared to Se levels of persons from an adjacent district. The authors stress the necessity of individual evaluation of the metal concentrations in relation to clinical findings. With prolonged exposure the situation can become more urgent not only because of chronic poisoning but also because of the cancer genic effects of these elements on the human organism [1]. This robot can thus help us in this simple process of cleaning and saving precious human lives. Not only in power plant, humans are forced to work in a disease-ridden environment just for cleaning and maintenance work, such as bio-hazard chambers, Radiation laboratories etc.

1.3 Scope of the Project

Cleaning robots are autonomous devices that are capable of cleaning the floor, pool, windows, and lawns with very less or no intervention of humans. Cleaning robots, such as robot vacuum cleaner, are used for both residential and industrial purposes. Industrial cleaning robots are typically mobile, application-specific robots that automate industrial cleaning processes. These robots automate routine, dangerous, or dirty work for the sake of safety and efficiency. Increased adoption of smart devices is augmenting the growth of cleaning robotics for domestic as well as industrial uses.

- Also, the rise in labor costs and increasing safety concerns have further boosted the market growth. The various applications of cleaning robots range from floor cleaning, window cleaning, pool cleaning, etc. The use of cleaning robots minimizes human efforts and saves time, costs, and electricity.
- However, the costs involved in deploying the cleaning robots are a major factor restraining the market growth for the majority of the population. Cleaning robots are expected to replace the traditional vacuum cleaner as it replaces human efforts with automation and also saves electricity. However, the costs involved as compared to a vacuum cleaner is expected to hinder the adoption of cleaning robots.
- Also, the people in emerging economies such as India and China still rely on labor or traditional vacuum cleaner for cleaning purposes.

LITERATURE SURVEY

2.1 Domain

2.1.1 Robotics:

Robotics develops machines that can substitute for humans and replicate human actions. Robotics involves design, construction, operation, and use of robots. The goal of robotics is to design intelligent machines that can help and assist humans in their day-to-day lives and keep everyone safe. Robots may be equipped with the equivalent of human senses such as vision, touch, and the ability to sense temperature. Some are even capable of simple decision making, and current robotics research is geared toward devising robots with a degree of self-sufficiency that will permit mobility and decision-making in an unstructured environment the vast majority of robots use electric motors, often brushed and brushless DC motors in portable robots or AC motors in industrial robots and CNC machines. These motors are often preferred in systems with lighter loads, and where the predominant form of motion is rotational. This is the kind which we would be constructing here. These technologies deal with automated machines that can take the place of humans in dangerous environments or manufacturing processes, or resemble humans in appearance, behavior, and or cognition. Many of today's robots are inspired by nature contributing to the field of bio-inspired robotics

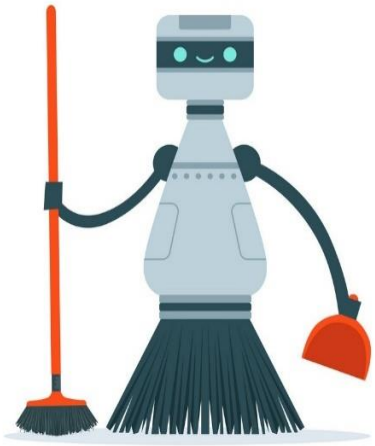

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fig 1: Robot

2.1.2 Sensors

A sensor is a device that responds to a physical stimulus (such as heat, light, sound, pressure, magnetism, or a particular motion) and transmits a resulting impulse (as for measurement or operating a control). There are numerous definitions as to what a sensor is but I would like to define a Sensor as an input device which provides an output (signal) with respect to a specific physical quantity (input).The term "input device" in the definition of a Sensor means that it is part of a bigger system which provides input to a main control system (like a Processor or a Microcontroller).

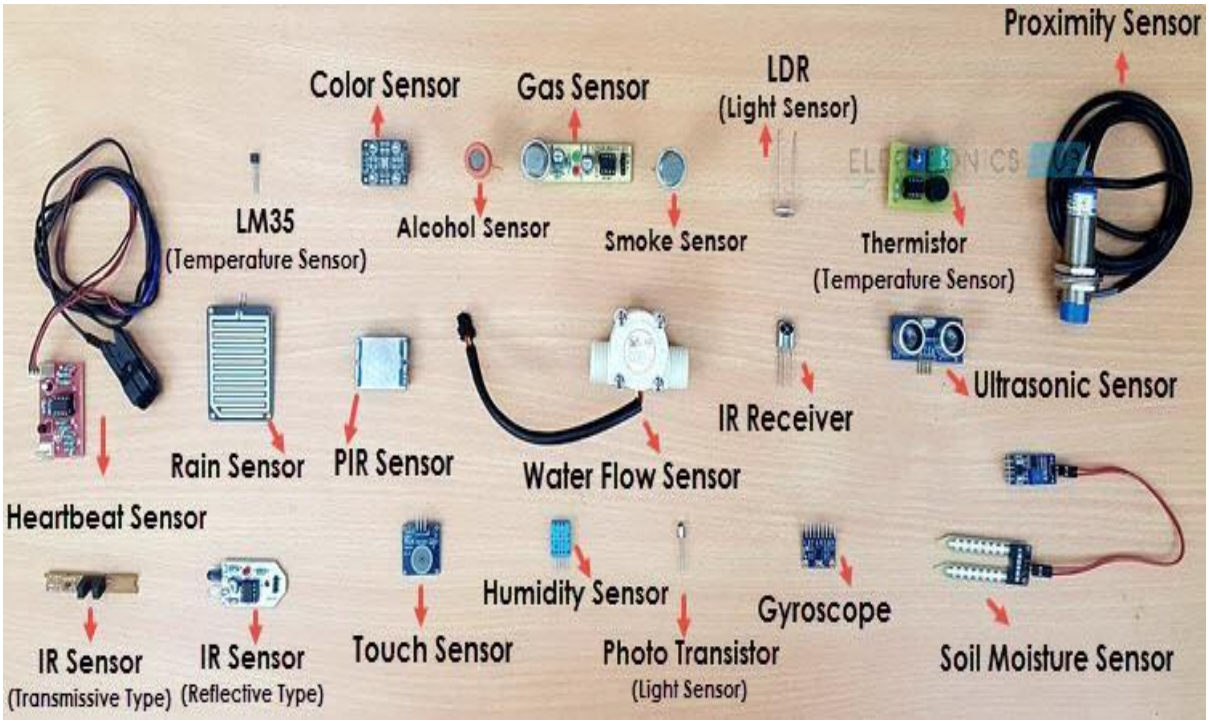

fig 2: Types of Sensor

2.2 Classification of Robotic Companies

2.2.1 Brain Crop

Founded in 2009, San Diego startup Brain Corp has taken in $125 million in funding so far to develop artificial intelligence software for commercial floor cleaning, like their BrainOS product, which can be used for janitor robots. In July of last year, we dedicated an entire article to writing about the Commercial Floor Cleaning Robots from Brain Corp. In that article, we talked about how Brain Corp is building something called Enabling Mobile Machine Automation or EMMA, an AI navigation system that's "capable of automating a range of commercial-grade equipment – everything from industrial floor care machines, to medical equipment and forklifts." Initially tested in San Diego's own Jimbo's grocery store, the software will soon be cleaning Walmart stores across the United States:

fig 3: Brain Crop

Expect the floor scrubbing robot to have routing algorithms, 4G LTE connectivity, sensors, and cameras.

2.2.2 SoftBank

A company that's been throwing $100 million at pretty much anything that moves. They've also been developing Whiz, a robot janitor designed specifically to vacuum clean commercial establishments, in collaboration with Brain Corp of course. With Japan's chronic labor shortage, SoftBank expects Whiz to be the perfect solution for the problem especially since the Japanese still have "unresolved feelings" about hiring immigrant workers. After Pepper, a talking humanoid robot they launched in 2014, this robot looks a little less human:

fig 4: SoftBank

According to the Nikkei Review, the Whiz can vacuum 1,500 sq. meters in three hours, moving along a route that a human need to "teach" it just once. At the same time, it's also been trained to dodge unexpected obstacles, like bowing Japanese people. Softbank plans to have the robot janitor rented for around 25,000 yen ($222 USD) per month starting in early 2019 with overseas markets targeted by the end of 2019.

2.2.3 Kärcher

A German family-owned company that operates worldwide with 10,000 employees as a world market leader in cleaning technology. They've managed to develop their own robotic janitor platform called Karcher Intelligent Robotic Applications or KIRA. According to Kärcher, KIRA was built in an "extremely flexible and demand-oriented manner," with a multisensory system that ensures the safety of the people and the properties around it. The robot you see below is the KIRA B 50, a professional automatic scrubber drier that marks the start of a complete range of autonomous cleaning machines the company is planning for.

fig 5: Kärcher

The robot comes equipped with GPS tracking and mobile data transmission to provide analysis data as well as send text notifications to its users. When it's done cleaning or completing janitor-type stuff, KIRA will automatically go back to its docking station where it will clean its tank, drain the dirty water, recharge its batteries, and refill with fresh water.

2.2.4 AVIDBOTS

Founded in 2014, Canadian startup Avidbots has taken in $3 million in funding so far to develop Neo, a purpose-built floor cleaning robot that uses 3D cameras, AI navigation, sensors, and lasers to clean floors around the world.

Update 03/22/19: Avidbots has raised $23.6 million in Series B funding to accelerate investment in talent acquisition, engineering, marketing, and sales to bring their cutting-edge robots to more customers worldwide. This brings total funding to $26.6 million to date.

Safety is also one of the primary concerns of this robot as it comes with features like collision avoidance technology, a low 72 dBA noise rating, an e-stop button, protective bumpers and flaps, and warning lights.

fig 6: AVIDBOTS

The company has rapidly expanded with a global service network covering North & South America, Europe, Middle East, and Asia Pacific. If you're passing through airports around the world, you may see it being used in places like Singapore's Changi Airport or France's Paris Charles De Gaulle Airport.

2.2.5 A&K ROBOTICS

Founded in 2015, Vancouver startup A&K Robotics has taken in an undisclosed amount in funding to develop an automation module that converts manual cleaning machines into self-driving robots. Founded by engineering students from the University of British Columbia (UBC), this startup had its pilot in the school which led to some real janitorial contracts with the Vancouver International Airport. The solution is particularly attractive because it consists of an automation module that is attached to the top of your bog-standard automatic floor cleaner.

fig 7: A&K ROBOTICS

Once it's activated, the machine will transform into a robotic floor scrubber. When it's done cleaning, the robot will send a text to the custodian on duty who will then be in charge of tasks like recharging the machine and replenishing its tank. Sounds like this company might make a good aqui-hire for Avidbots.

2.3 Global Market Outlook

2.3.1 Key Vendor Analysis

Intense Competition Among Vendors. There is an intense competition in the market as all the players are competing to gain market share. The market is also likely to witness increased market consolidation due to the intensely competitive landscape. These factors make it imperative for vendors to distinguish their products and service offerings through a clear and unique value proposition, or else they will not survive the highly competitive environment. ADLATUS Robotics, Alfred Kärcher, Avidbots, Cleanfix, Combijet, Cyberdyne, Fybots, Makita, MDB, Muratec, Nilfisk, P.T.C., Sealed Air (Taski). BioVac Systems, Danduct Clean, DIS Dry Ice System, IBAK, IBC Robotics, LIFA AIR, LLOYD's, Neovision (Jetty), Robosoft Systems, Robotics Design, Urakami Research & Development. GE Inspection Robotics, ID-Tec, Scantron Robotics, SOLEX Robotics, Wolftank, Aeffe, Alion Energy, CleanHull, ECA Group Hytec, Ecoppia, Gulf Agency Company, KTV Group, Remora Marine, SeaRobotics, Serbot, Weda poolcleaner.

2.3.2 Dynamics

Robot as a Service (RaaS) and increasing investment on the Industrial IoT to drive the market. Sales of industrial cleaning robot is sensitive to fluctuations in raw material prices, GDP growth, government regulations, and industrial construction activities. Further, the growth is mainly driven by increased GDP and the growth of the industrial automation market across the world. Establishments of manufacturing plants are also increasing as manufacturers are expanding their footprints worldwide. This could result in steady demand generation for industrial cleaning robot among manufacturers worldwide. The concept of using Robot as a Service (RaaS) and increasing investment on the Industrial IoT are the latest trends that are going to push the market growth. Further the limited availability of skilled labors, need to increase safety quotient for humans involved in industrial cleaning and increased industrial automation are the major factors that are going to bolster the global industrial cleaning robot market in the next few years.

2.3.3 Segmental Overview

Industrial Floor Cleaning Robot Market to Dominate Both in Terms of Revenue and Shipment. In 2016, the market was dominated by the floor cleaning robots that accounted for a share of 69.55% and 64.46% in terms of unit shipment and revenue, respectively. The segment is witnessing increased demand from the manufacturing industry in the developed regions such as the US and Germany. The duct and pipe cleaning device segment followed the floor cleaning segment. Industrial floor cleaning robots are further categorized into these categories: Sweeping, vacuuming, scrubbing, and high-pressure washing. In these categories, industrial scrubbing dominates the market for industrial floor cleaning, followed by high-pressure washing robots.

2.3.4 Geographical Analysis

North America to Remain the Largest Segment. This report considers four major regions: Europe, North America. In 2016, North America was the largest segment of the global industrial cleaning robot market. The demand for industrial cleaning robot depends on the growth of the manufacturing industry in the region. Globally, North America is the largest market for industrial automation, and the market is growing rapidly. This will fuel the demand for industrial cleaning robot in the region. The region is likely to account for market shares of 42.73% and 48.32% in terms of unit shipment and revenue, respectively, in 2022. North America is followed by Europe, led by Germany and Italy where industrial robot penetration is more and sales of industrial robots are high. Latin America had low shares in the global market in 2016 as there was low demand for industrial automation products in the region. Further, the concept of using industrial cleaning robots has not gained popularity in many the Middle Eastern, Latin American, and African countries (except GCC countries). Thus, the market demand and penetration of industrial cleaning robot is low in these regions. However, with many vendors expanding their operations in these countries for market share, the demand for these devices will grow during the forecast period.

PROBLEM FORMULATION

3.1 Desired Outcomes:

A LOW-COST RADIO FEQUENCY CONTROLLED ROBOT FOR CLEANING PURPOSE with surveillance features that is able to improve productivity and work conditions for the cleaning and security workers.

3.2 Background Problem:

Currently, the cleaners have to follow a schedule when operating the hard floor scrubber to sweep or mop the floor. To minimize disruption to consumers, the hard floor scrubber is only deployed during off-peak hours as the cleaning area needs to be cordoned off during the cleaning process.

Due to the large public space, the schedule for cleaning is also very tight as there is limited time available to clean all areas using the hard floor scrubber. Furthermore, not all cleaners are able to operate the hard floor scrubber and this further limit the efficient manpower deployment of manpower. The total cleaning manpower comprises 1 supervisor and 4 cleaners with an average age of 40+ years (2 shifts of 2 hours each from 7am to 10.30pm).

In terms of patrolling duties, the security guards currently patrol the premises on a fixed schedule. For large and inaccessible areas, security cameras are fixed on ceiling or walls, which mean that the cameras are immobile. The current manpower for patrolling involves 1 supervisor and 6 security officers with an average age of 40+ years (2 shifts of 12 hours each starting at 8am and 8pm).

The challenge is for the industry to come up with a solution that can perform both cleaning and security surveillance functions concurrently, so that the premises owner can channel existing manpower resources to other higher value-added work.

3.3 Technical Requirements:

1. It should automatically move to the designated area for cleaning and surveillance from the charging point. Thus, it should be able to take an elevator by itself. The device's location should be tracked during operation for security purpose.
2. It should ensure that the surveillance features are still functioning while making its way back to the charging point on its own when power is low.
3. The proposed solution to operate for at least 3 operation hours for every 2 hours charging duration.
4. There should an option for the device to be remotely operated.
5. The device must comply with the necessary building regulation requirements.
6. Operation of the device should be efficient (e.g. cost efficient, energy efficient, manpower). Minimal human intervention should be involved in carrying out its work.
7. The device should require minimal installation and noise disturbance to the public when in operation.
8. The device should be weather proof as some corridors is subjected to wet weather although it is mainly for indoor usage.
9. Device should not be too bulky as it should be transportable by a class 3 vehicle.
10. The surveillance camera must be able to record 24 hours with minimal charging. It should be able to have face-recognition technology, data analytics and detect any abnormalities (e.g. damage to property/theft/missing person/Lost and Found/trespassing/area not secure like door not lock or door open after office/operation hours) with alerts to be captured for back-end reporting.
11. The proposed solution should be easy to operate and should be able to effectively scrub the floors and provide reports for management reporting. For example, it should be able to report on the cleaning performance (frequency of cleaning, areas covered, photographs of defects, etc).

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DESGIN METHODOLOGY

4.1 Hardware Used

4.1.1 Arduino Uno

a. Introduction:

It is a microcontroller board developed by Arduino.cc and based on Atmega328. Microcontrollers are widely used in embedded systems and make devices work according to our needs and requirements. We have already discussed the controllers like 8051, Atmega16, Atmega328 and PIC16F877. Arduino Uno is a very valuable addition in the electronics that consists of USB interface, 14 digital I/O pins, 6 analog pins, and Atmega328 microcontroller. It also supports serial communication using Tx and Rx pins. The software used for Arduino devices is called IDE (Integrated Development Environment) which is free to use and required some basic skills to learn it. It can be programmed using C and C++ language. Some people get confused between Microcontroller and Arduino. While former is just an on system 40 pin chip that comes with a built-in microprocessor and later is a board that comes with the microcontroller in the base of the board, bootloader and allows easy access to input-output pins and makes uploading or burning of the program very easy.

The current version of Arduino Uno comes with USB interface, 6 analog input pins, 14 I/O digital ports that are used to connect with external electronic circuits. Out of 14 I/O ports, 6 pins can be used for PWM output.

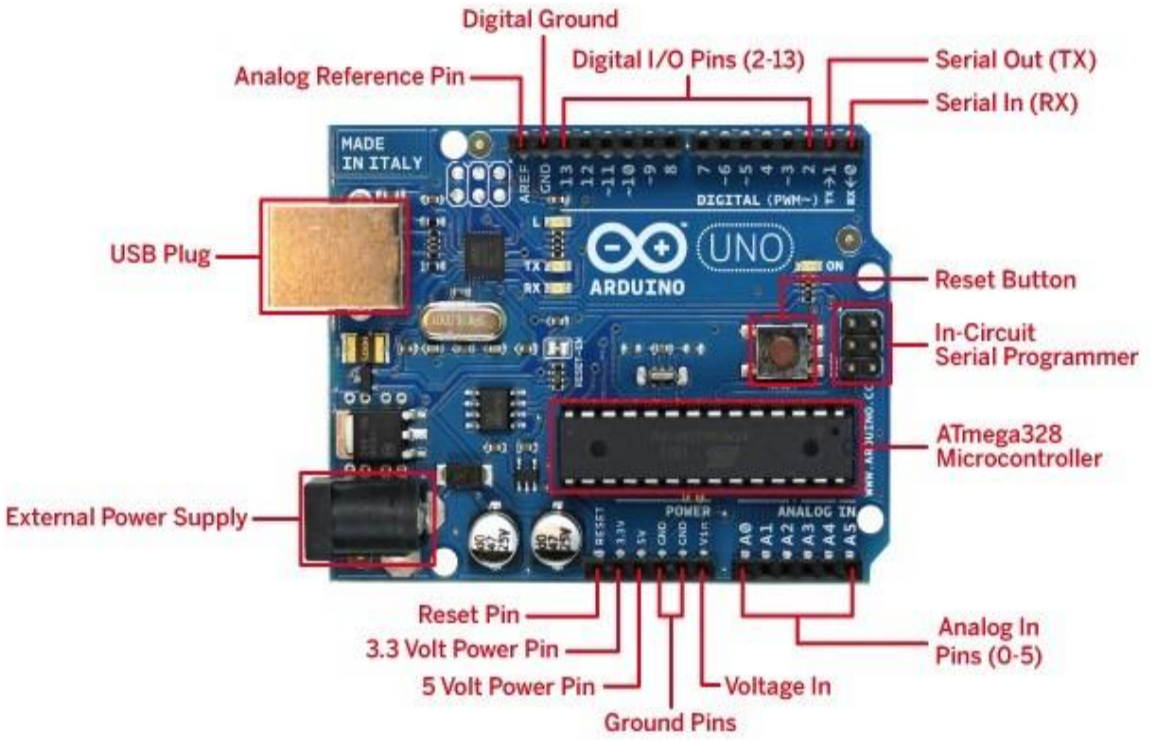


fig 8: Arduino Uno

b. Features:

- This board comes with all the features required to run the controller and can be directly connected to the computer through USB cable that is used to transfer the code to the controller using IDE (Integrated Development Environment) software, mainly developed to program Arduino.
- IDE is equally compatible with Windows, MAC or Linux Systems; however, Windows is preferable to use. Programming languages like C and C++ are used in IDE. Apart from USB, battery or AC to DC adopter can also be used to power the board.
- Atmega328 microcontroller is placed on the board that comes with a number of features like timers, counters, interrupts, PWM, CPU, I/O pins and based on a 16MHz clock that helps in producing more frequency and number of instructions per cycle.

4.1.2 ATMEGA 328 Microcontroller

a. Introduction:

The computer on one hand is designed to perform all the general purpose tasks on a single machine like you can use a computer to run a software to perform calculations or you can use a computer to store some multimedia file or to access internet through the browser, whereas the microcontrollers are meant to perform only the specific tasks, for e.g., switching the AC off automatically when room temperature drops to a certain defined limit and again turning it ON when temperature rises above the defined limit.

There are number of popular families of microcontrollers which are used in different applications as per their capability and feasibility to perform the desired task, most common of these are 8051, AVR and PIC microcontrollers. In this we will introduce you with AVR family of microcontrollers.

History of AVR:

AVR was developed in the year 1996 by Atmel Corporation. The architecture of AVR was developed by Alf-Egil Bogen and Vegard Wollan. AVR derives its name from its developers and stands for Alf-Egil Bogen Vegard Wollan RISC microcontroller, also known as Advanced Virtual RISC.

AVR microcontrollers are available in three categories:

Tiny AVR – Less memory, small size, suitable only for simpler applications.

Mega AVR – These are the most popular ones having good amount of memory (up-to 256 KB), higher number of in-built peripherals and suitable for moderate to complex applications.

Xmega AVR – Used commercially for complex applications, which require large program memory and high speed?

b. Features:

- RISC Architecture with CISC Instruction set
- Powerful C and assembly programming
- Scalable

- Same powerful AVR microcontroller core
- Low power consumption
- Both digital and analog input and output interfaces

c. **Description:**

The Atmel ATmega48/88/328 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega48/88/328 achieves throughputs approaching 1 MIPS per MHz allowing the system designed to optimize power consumption versus processing speed.

The Atmel ATmega48/88/328 provides the following features: 4K/8K/16K bytes of In-System Programmable Flash with Read-While-Write capabilities, 256/512/512 bytes EEPROM, 512/1K/1K bytes SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible Timer/Counters with compare modes, internal and external interrupts, a serial programmable USART, a byte-oriented 2-wire Serial Interface, an SPI serial port, a 6-channel 10-bit ADC (8 channels in TQFP and QFN/MLF packages), a programmable Watchdog Timer with internal Oscillator, and five software selectable power saving modes. The Idle mode stops the CPU while allowing the SRAM, Timer/Counters, USART, 2-wire Serial Interface, SPI port, and interrupt system to continue functioning. The Power-down mode saves the register contents but freezes the Oscillator, disabling all other chip functions until the next interrupt or hardware reset. In Power-save mode, the asynchronous timer continues to run, allowing the user to maintain a timer base while the rest of the device is sleeping. The ADC Noise Reduction mode stops the CPU and all I/O modules except asynchronous timer and ADC, to minimize switching noise during ADC conversions. In Standby mode, the crystal/resonator Oscillator is running while the rest of the device is sleeping. This allows very fast start-up combined with low power consumption.

The ATmega48, ATmega88 and ATmega328 differ only in memory sizes, boot loader support, and interrupt vector sizes. Table 2-1 summarizes the different memory and interrupts vector sizes for the three devices.

Device	Flash	EEPROM	RAM	Interrupt vector size
ATmega48	4Kbytes	256Bytes	512Bytes	1 instruction word/vector
ATmega88	8Kbytes	512Bytes	1Kbytes	1 instruction word/vector
ATmega168	16Kbytes	512Bytes	1Kbytes	2 instruction words/vector

ATmega88 and ATmega328 support a real Read-While-Write Self-Programming mechanism. There is a separate Boot Loader Section, and the SPM instruction can only execute from there. In ATmega48, there is no Read-While-Write support and no separate Boot Loader Section. The SPM instruction can execute from the entire Flash.

d. Processor Architecture:

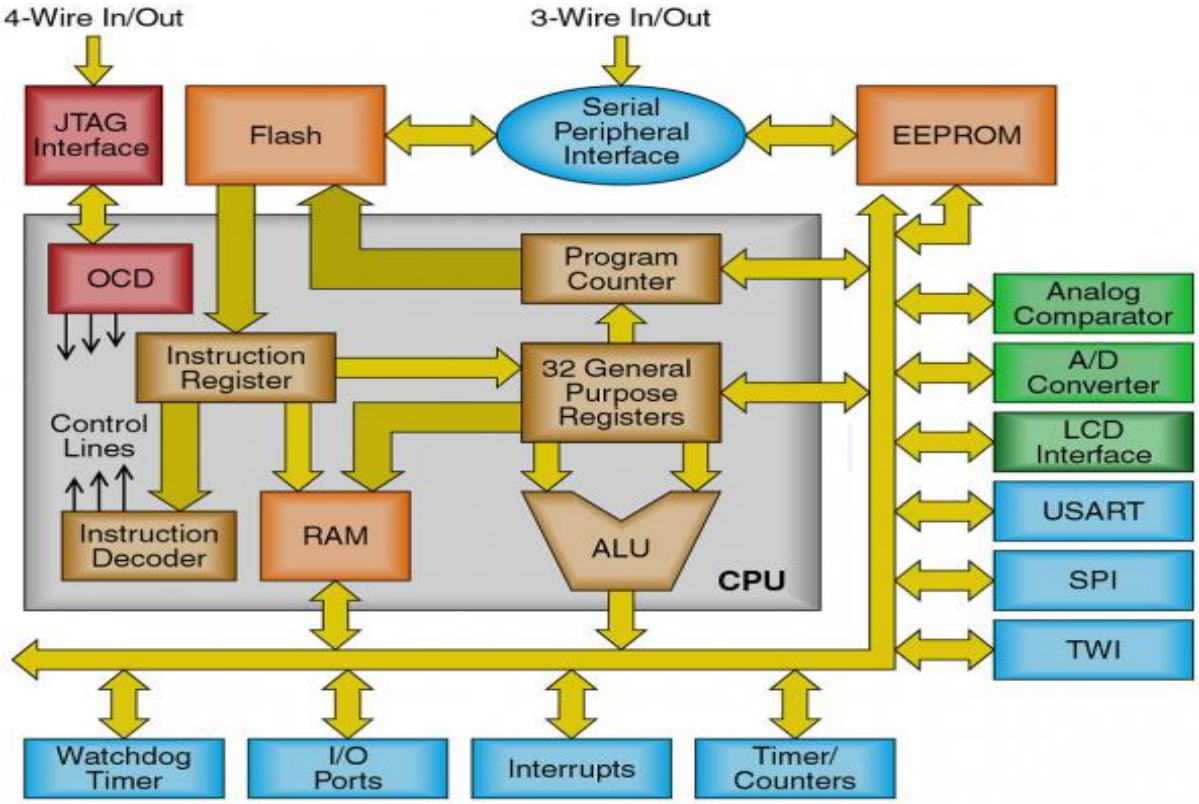


fig 9: Architecture of ATMEGA 328 Microcontroller

AVR follows Harvard Architecture format in which the processor is equipped with separate memories and buses for Program and the Data information. Here while an instruction is being executed, the next instruction is pre-fetched from the program memory.

ALU: The high-performance AVR ALU operates in direct connection with all

the 32 general purpose working registers. Within a single clock cycle, arithmetic operations between general purpose registers or between a register and an immediate are executed. The ALU operations are divided into three main categories – arithmetic, logical, and bit-functions. Some implementations of the architecture also provide a powerful multiplier supporting both signed/unsigned multiplication and fractional format.

In-system reprogrammable flash program memory: The ATmega48/88/328 contains 4K/8K/16K bytes On-chip In-System Reprogrammable Flash memory for program storage. Since all AVR instructions are 16 or 32 bits wide, the Flash is organized as 2K/4K/8K × 16. For software security, the Flash Program memory space is divided into two sections, Boot Loader Section and Application Program Section in ATmega88 and ATmega328.

EEPROM data memory: The Atmel ATmega48 /88/328 contains 256/512/512 bytes of data EEPROM memory. It is organized as a separate data space e, in which single bytes can be read and written. The EEPROM has an endurance of at least 100,000 write/erase cycles. The access between the EEPROM and the CPU is described in the following, specifying the EEPROM Address Registers, the EEPROM Data Register, and the EEPROM Control Register.

Program counter: A program counter is a register in a computer processor that contains the address (location) of the instruction being executed at the current time. As each instruction gets fetched, the program counter increases its stored value by 1. After each instruction is fetched, the program counter points to the next instruction in the sequence. When the computer restarts or is reset, the program counter normally reverts to 0. In computing, a program is a specific set of ordered operations for a computer to perform. An instruction is an order given to a computer processor by a program. Within a computer, an address is a specific location in memory or storage. A register is one of a small set of data holding places that the processor uses. Program counter is very important feature in the microcontrollers.

RAM: RAM stands for random access memory. This type of memory storage is temporary and volatile. You might have heard that if your system is working slowly you say that increase the RAM processing will increase. Let us understand in detail. Let us consider two cases to execute a task first the complete task is executing at one place(A), second the task is distributed in parts and the small tasks are executed at different places (A, B C) and finally assembled. It is clear the work will be finished in second case earlier. The A, B, C basically represent different address allocation for temporary processing. This is the case with RAM

also if you increase the RAM the address basically increases for temporary processing so that no data has to wait for its turn. On major importance of the RAM is address allocations. However, the storage is temporary every time u boots your system the data is lost but when you turn on the system The BIOS fetch number of addresses available in the RAM. This memory supports read as well as write operations both.

Instruction execution section (IES): It has the most important unit—instruction register and instruction decoder to control the flow of the instruction during the processing's.

INPUT/OUTPUT PORTS: To interact with the physical environment there are different input and output ports in every system like in PC we have VGA port to connect the monitor, USB port for flash memory connections and many more ports. Similarly, ATMEGA 328 has its input and output ports with different configurations depending on the architecture like only input, only output and bi-directional input output ports. The accessing of this port is referred as input output interface design for microcontrollers. IT has analog input port, analog output port, digital input port, digital output port, serial communication pins, timer execution pins etc.

Analog Comparator & A/D converters: The major question is that how a controller manage to detect variation of voltage in-spite it could not understand the voltage but understand only digital sequence

Most of the physical quantities around us are continuous. By continuous we mean that the quantity can take any value between two extremes. For example, the atmospheric temperature can take any value (within certain range). If an electrical quantity is made to vary directly in proportion to this value (temperature etc.) then what we have is Analogue signal. Now we have we have brought a physical quantity into electrical domain. The electrical quantity in most case is voltage. To bring this quantity into digital domain we have to convert this into digital form. For this a ADC or analog to digital converter is needed. Most modern MCU including AVRs has an ADC on chip. An ADC converts an input voltage into a number. An ADC has a resolution. A 10 Bit ADC has a range of 0-1023. (2^{10} =1024) The ADC also has a Reference voltage (ARef). When input voltage is GND the output is 0 and when input voltage is equal to ARef the output is 1023. So, the input range is 0-ARef and digital output is 0-1023.

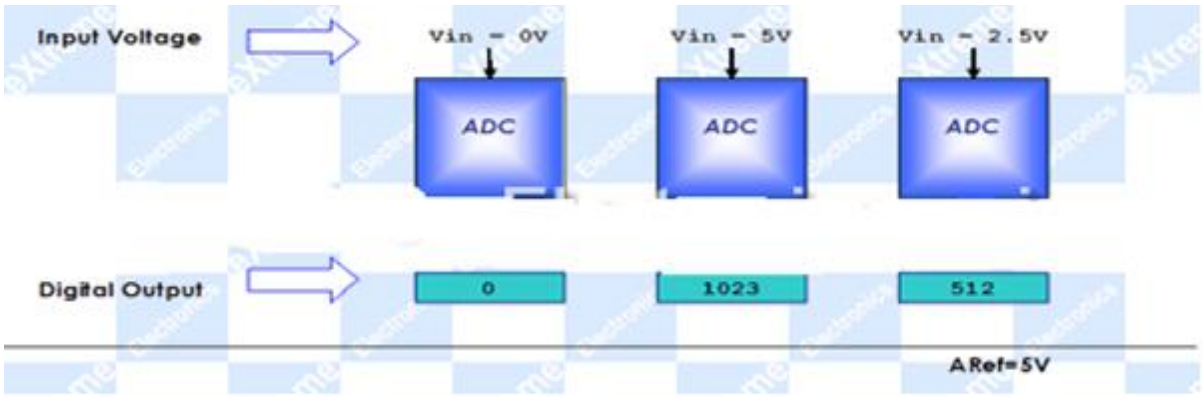


fig 10: Analog Comparator & A/D converters

- **Inbuilt ADC of AVR:**

  Now you know the basics of ADC let us see how we can use the inbuilt ADC of AVR MCU. The ADC is multiplexed with PORTA that means the ADC channels are shared with PORTA. The ADC can be operated in single conversion and free running more. In single conversion mode the ADC does the conversion and then stop. While in free it is continuously converting. It does a conversion and then start next conversion immediately after that.

- **ADC Pre-scalar:**

  The ADC needs a clock pulse to do its conversion. This clock generated by system clock by dividing it to get smaller frequency. The ADC requires a frequency between 50 KHz to 200 KHz. At higher frequency the conversion is fast while a lower frequency the conversion is more accurate. As the system frequency can be set to any value by the user (using internal or externals oscillators) (In board™ a 16MHz crystal is used). So, the Pre-scalar is provided to produces acceptable frequency for ADC from any system clock frequency. System clock can be divided by 2, 4,16,32,64,128 by setting the Pre-scalar.

- **ADC Channels:**

  The ADC in ATmega328 has 6 channels that mean you can take samples from eight different terminals. You can connect up to 8 different sensors and get their values separately.

e. Pin Diagram & Description:

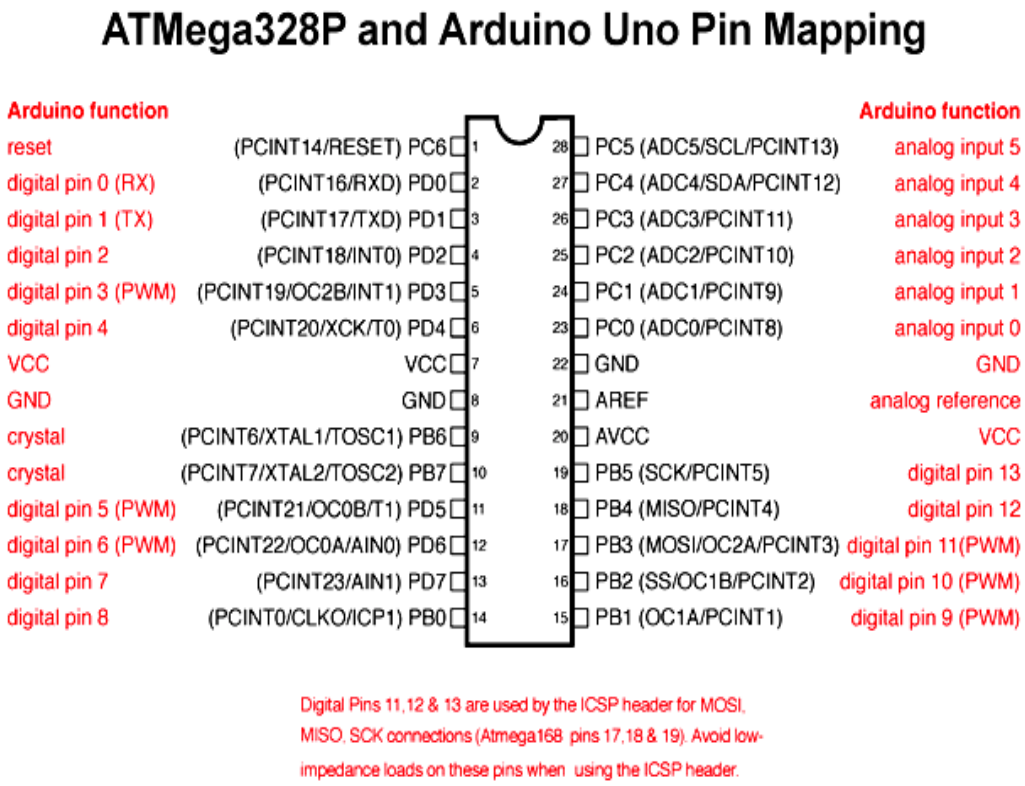


fig 11: Pin Diagram of ATMega328P

- **VCC:**

  Digital supply voltage.

- **GND:**

  Ground.

- **Port B (PB7:0) XTAL1/XTAL2/TOSC1/TOSC2:**

  Port B is an 8-bit bi-directional I/O port with internal pull- up resistors (selected for each bit). The Port B output buffers have symmetrical drive characteristics with both high sink and source Capability. As inputs, Port B pins that are externally pulled low will source current if the pull-up resistors are activated. The Port B pins are tri-stated when a reset condition becomes active, even if the clock is not running. Depending on the clock

selection fuse settings, PB6 can be used as input to the inverting Oscillator amplifier and input to the internal clock operating circuit. Depending on the clock selection fuse settings, PB7 can be used as output from the inverting Oscillator amplifier. If the Internal Calibrated RC Oscillator is used as chip clock source, PB7.6 is used as TOSC2.1 input for the Asynchronous Timer/Counter2 if the AS2 bit in ASSR is set.

- **Port C (PC5:0):**

  Port C is a 7-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The PC5.0 output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port C pins that are externally pulled low will source current if the pull-up resistors are activated. The Port C pins are tri-stated when a reset condition becomes active, even if the clock is not running.

- **PC6/RESET:**

  If the RSTDISBL Fuse is programmed, PC6 is used as an I/O pin. Note that the electrical characteristics of PC6 differ from those of the other pins of Port C. If the RSTDISBL Fuse is un-programmed, PC6 is used as a Reset input. A low level on this pin for longer than the minimum pulse length will generate a Reset, even if the clock is not running. Shorter pulses are not guarantee to generate a reset.

- **Port D (PD7:0):**

  Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port D output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port D pins that are externally pulled low will source current if the pull-up resistors are activated. The Port D pins are tri-stated when a reset condition becomes active, even if the clock is not running.

- **AVCC:**

  AVCC is the supply voltage pin for the A/D Converter PC3:0 , and ADC7:6. It should be externally connected to VCC, even if the ADC is not used. If the ADC is used, it should be connected to VCC through a low-pass filter. Note that PC6.4 use digital supply voltage, VCC.

- **AREF:**

  AREF is the analog reference pin for the A/D Converter.

Minimum Interface circuit for Atmega328 controller:

According the minimum interface discussed for the microcontrollers earlier, the minimum interface circuit for ATMEGA328 is:

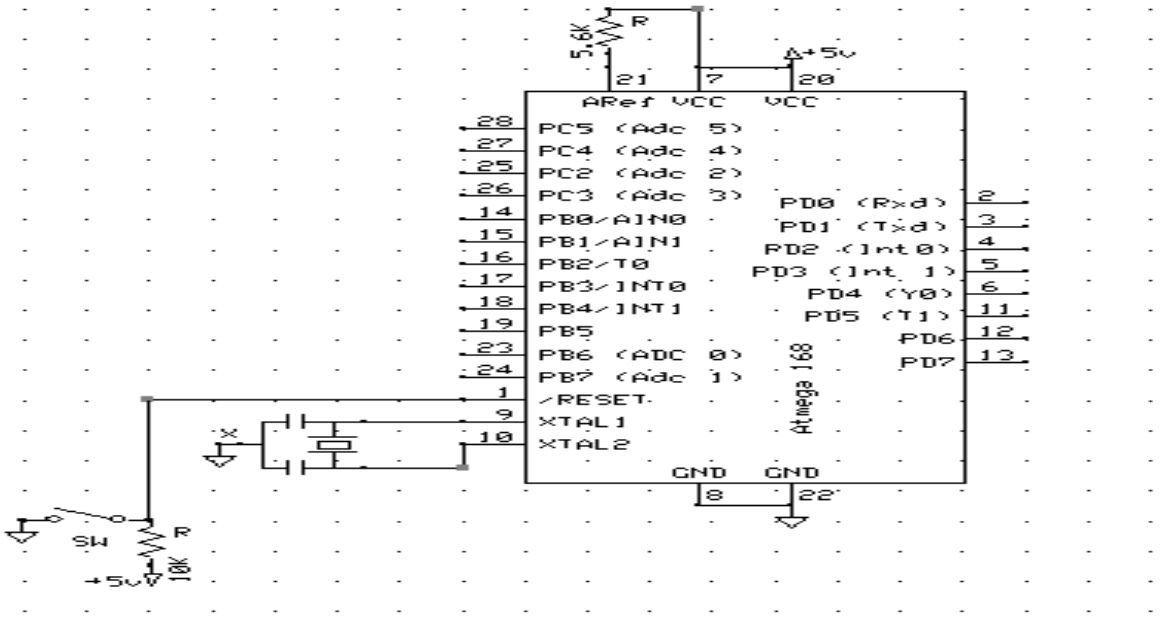


fig 12: Interface circuit for Atmega328 controller

Things to remember about ATMEGA328 controllers:

The ATMEGA controllers are strong controllers but you have to take some small points in mind always like:

When you go for the programming of atmega328 consider the pin no. as configures in red color in Pin diagram shown before (like controller's pin number 2 is digital pin number 0 for input or output, pin23 is analog pin A0). Sao you will address the pin according to that number.

Use the proper pin for proper input output interface that analog input should be configured at analog pin analog output should be configured on PWM pins and likewise the digital inputs and outputs.

4.1.3 RF 433 Mhz Wireless Module

a. Introduction:

RF (Radio Frequency) concept is used in this robot as it can be used in various industries and radiation labs. The same robot can be controlled by Dual Tone Multiple Frequency (DTMF) signals but the disadvantage is that the mobile network coverage cannot be guaranteed. Moreover, if it's done by DTMF and the network coverage is cutoff in between the working of the robot then the robot travels in the last received signal until it regains the network coverage and might collide on or fall from a certain height. But in case of Radio Frequency (RF), if the signal is cutoff in between the working of the robot then the robot stops at the same place and does not travel in the previous received signal and thus can avoid any damage done to the robot or the surroundings.

The rate of oscillation of frequency of alternating currents and radio waves which carry radio waves in the frequency range of 3 kHz to 300 GHz is called as radio frequency. Radio frequency technology is divided into two types: mechanical radio frequency technology (like radio frequency MEMS and mechanical filter) and electrical radio frequency technology.

If you consider, electrical radio frequency technology, the RF currents have some special properties. The basis of wireless radio frequency is electromagnetic waves or radio waves radiated off from a conductor into space as electromagnetic waves or radio waves using the energy in RF current.

Radio frequency remote consists of transmitter at the transmitter end and a receiver at the receiver end connected, which is connected to a remote circuit that is to be controlled. A control signal is transferred from transmitter end in the form of electromagnetic waves or radio waves such that to control the device remotely, which is connected to the receiver end. This control signal is transmitted using electromagnetic waves or radio waves of radio frequency. Thus, the control signal received at the receiver end can be used to control any object such as robotic vehicle, special purpose robot, communication purpose device, and so on.

Radio frequency controlled robotic vehicle is designed using a robotic vehicle

that is interfaced with radio frequency remote control. RF transmitter is used by control panel or controlling person and RF receiver is connected to the robotic vehicle that is to be controlled remotely.

This circuit utilizes the RF module (Tx/Rx) for making a wireless remote, which could be used to drive an output from a distant place. RF module, as the name suggests, uses radio frequency to send signals. These signals are transmitted at a particular frequency and a baud rate. A receiver can receive these signals only if it is configured for that frequency. A four-channel encoder/decoder pair has also been used in this system. The input signals, at the transmitter side, are taken through four switches while the outputs are monitored on a set of four LEDs corresponding to each input switch. The circuit can be used for designing Remote Appliance Control system. The outputs from the receiver can drive corresponding relays connected to any household appliance.

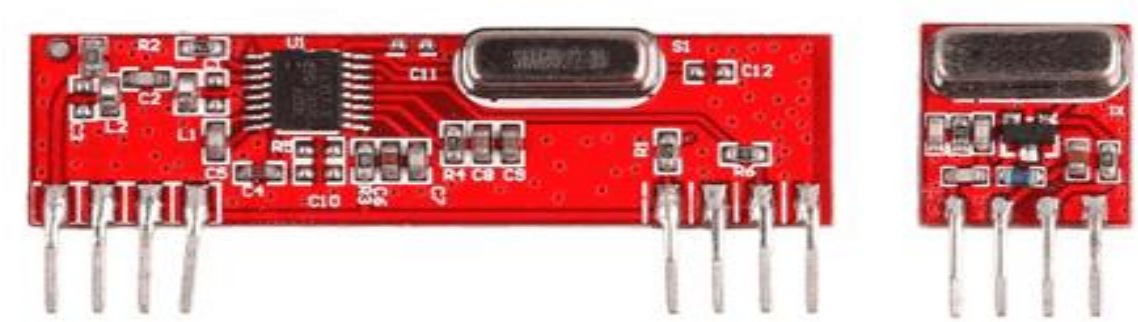


fig 13: RF 433 Mhz Wireless Module

b. Description:

This radio frequency (RF) transmission system employs Amplitude Shift Keying (ASK) with transmitter/receiver (Tx/Rx) pair operating at 433 MHz. The transmitter module takes serial input and transmits these signals through RF. The transmitted signals are received by the receiver module placed away from the source of transmission. The system allows one-way communication between two nodes, namely, transmission and reception. The RF module has been used in conjunction with a set of four channel encoder/decoder ICs. Here HT12E & HT12D have been used as encoder and decoder respectively. The encoder converts the parallel inputs (from the remote switches) into serial set of signals. These signals are serially transferred through RF to the reception point. The decoder is used after the RF receiver to decode the serial format and retrieve the original signals as outputs. These outputs can be observed on corresponding LEDs.

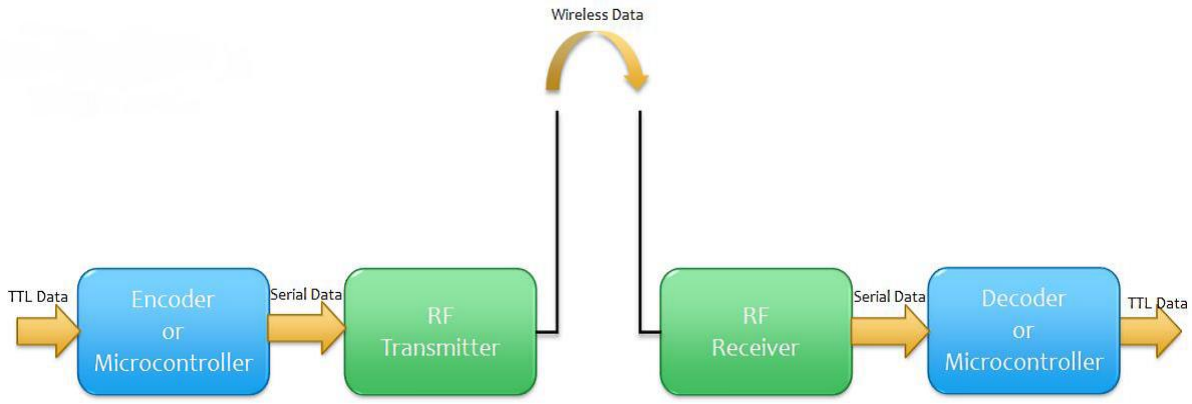


fig 14: Block Diagram of RF 433 Mhz Wireless Module

Encoder IC (HT12E) receives parallel data in the form of address bits and control bits. The control signals from remote switches along with 8 address bits constitute a set of 12 parallel signals. The encoder HT12E encodes these parallel signals into serial bits. Transmission is enabled by providing ground to pin14 which is active low. The control signals are given at pins 10-13 of HT12E. The serial data is fed to the RF transmitter through pin17 of HT12E.

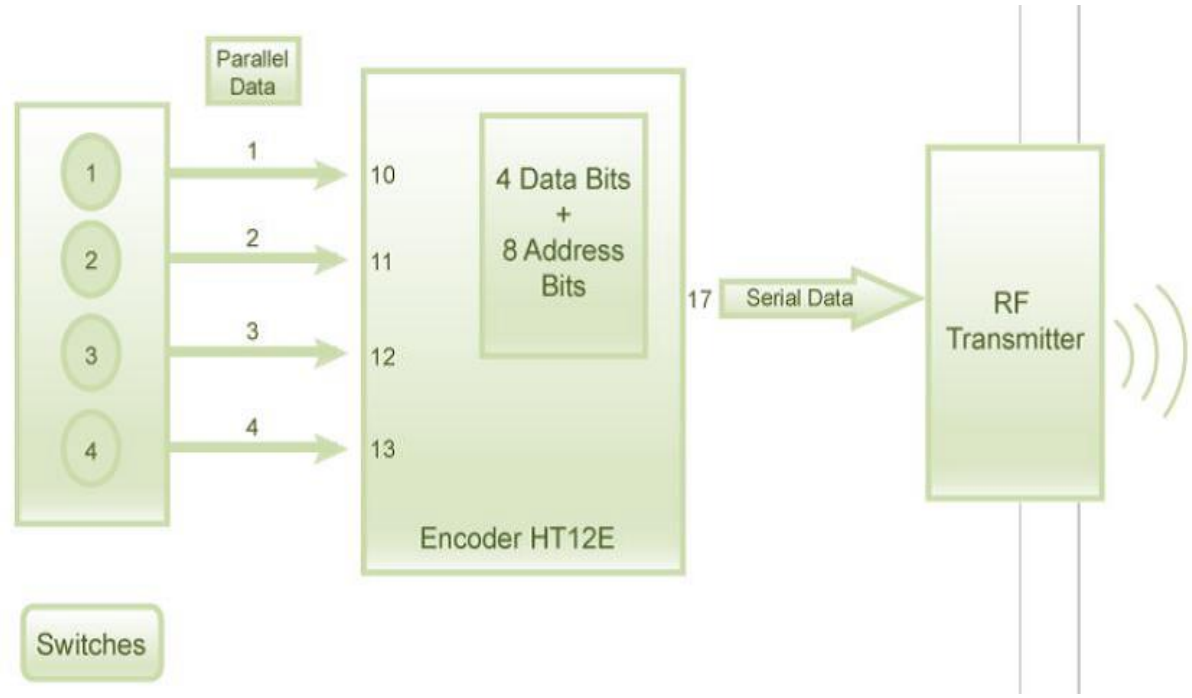


fig 15: RF Transmitter

Transmitter, upon receiving serial data from encoder IC (HT12E), transmits it wirelessly to the RF receiver. The receiver, upon receiving these signals, sends them to the decoder IC (HT12D) through pin2. The serial data is received at the data pin (DIN, pin14) of HT12D. The decoder then retrieves the original parallel format from the received serial.

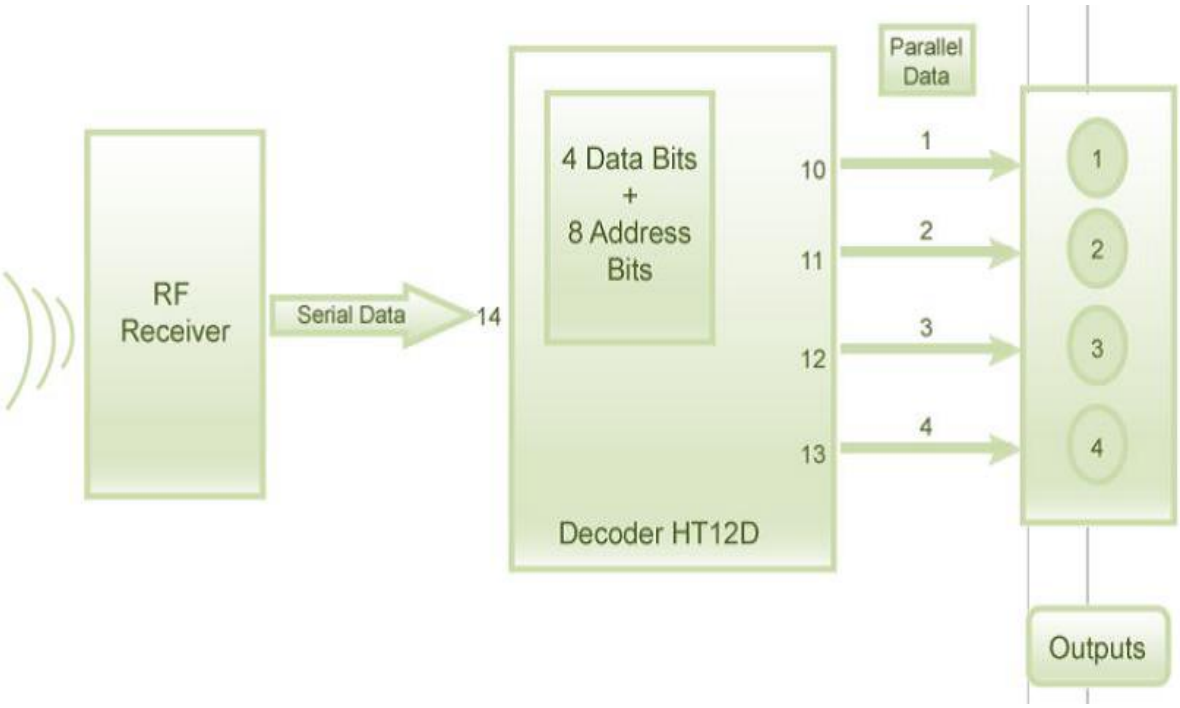


fig 16: RF Receiver

When no signal is received at data pin of HT12D, it remains in standby mode and consumes very less current (less than 1μA) for a voltage of 5V. When signal is received by receiver, it is given to DIN pin (pin14) of HT12D. On reception of signal, oscillator of HT12D gets activated. IC HT12D then decodes the serial data and checks the address bits three times. If these bits match with the local address pins (pins 1-8) of HT12D, then it puts the data bits on its data pins (pins 10-13) and makes the VT pin high. An LED is connected to VT pin (pin17) of the decoder. This LED works as an indicator to indicate a valid transmission. The corresponding output is thus generated at the data pins of decoder IC.

A signal is sent by lowering any or all the pins 10-13 of HT12E and corresponding signal is received at receiver's end (at HT12D). Address bits are configured by using the by using the first 8 pins of both encoder and decoder ICs. To send a particular signal, address bits must be same at encoder and decoder ICs. By configuring the address bits properly, a single RF transmitter can also be used to control different RF receivers of same frequency.

To summarize, on each transmission, 12 bits of data is transmitted consisting of 8 address bits and 4 data bits. The signal is received at receiver's end which is then fed into decoder IC. If address bits get matched, decoder converts it into parallel data and the corresponding data bits get lowered which could be then used to drive the LEDs. The outputs from this system can either be used in negative logic or NOT gates (like 74LS04) can be incorporated at data pins.

c. 433MHz RF Transmitter Pinout:

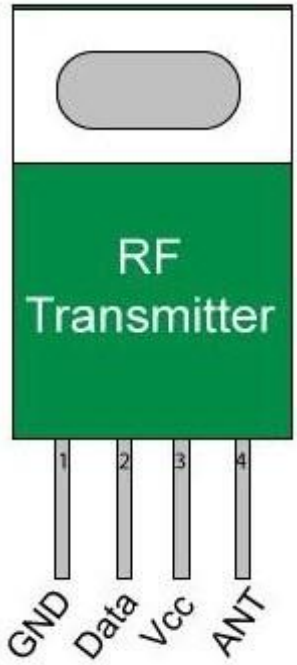


fig 17: Pin Diagram of RF Tx

- **Data:**

  Pin accepts digital data to be transmitted.

- **VCC:**

  Supplies power for the transmitter. This can be any positive DC voltage between 3.5V to 12V. Note that the RF output is proportional to the supply voltage i.e. the higher the Voltage, the greater the range will be.

- **GND:**

  It is a ground pin.

- **Antenna:**

  It is a pin for external antenna. As discussed earlier, you will want to solder a 17.3 cm piece of solid wire to this pin for the improved range

d. 433MHz RF Receiver Pinout:

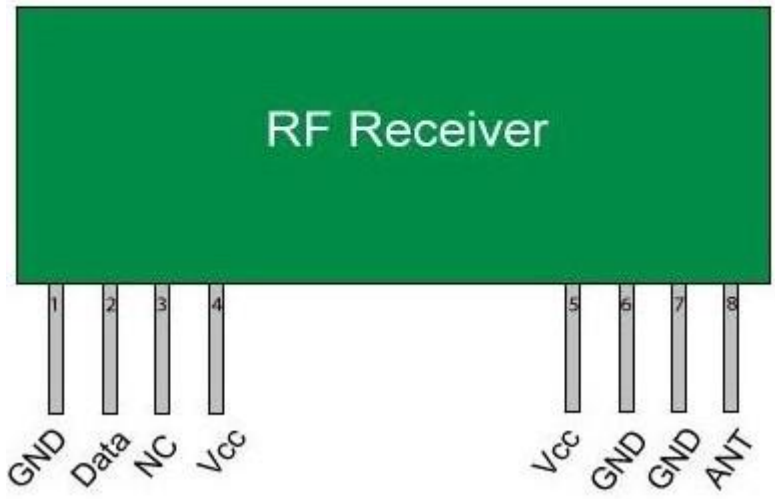


fig 18: Pin Diagram of RF Rx

- **VCC:**

  Supplies power for the receiver. Unlike the transmitter, supply voltage for receiver needs to be 5V.

- **DATA:**

  Pins output the digital data received. The two center pins are internally tied together, so you can use either one for data out.

- **GND:**

  It is a ground pin.

- **Antenna:**

  It is a pin for external antenna which is often unmarked. It is the pad in the lower left of the module, right next to the small coil. Again, you will want to solder a 17.3 cm piece of solid wire to this pin for the improved range.

e. HT12D RF Decoder IC:

fig 19: HT12D RF Decoder IC

HT12D IC comes from HolTek Company. HT12D is a decoder integrated circuit that belongs to 212 series of decoders. This series of decoders are mainly used for remote control system applications, like burglar alarm, car door controller, security system etc. It is mainly provided to interface RF and infrared circuits. They are paired with 212 series of encoders. The chosen pair of encoder/decoder should have same number of addresses and data format.

In simple terms, HT12D converts the serial input into parallel outputs. It decodes the serial addresses and data received by, say, an RF receiver, into parallel data and sends them to output data pins. The serial input data is compared with the local addresses three times continuously. The input data code is decoded when no error or unmatched codes are found. A valid transmission in indicated by a high signal at VT pin.

HT12D is capable of decoding 12 bits, of which 8 are address bits and 4 are data bits. The data on 4-bit latch type output pins remain unchanged until new is received.

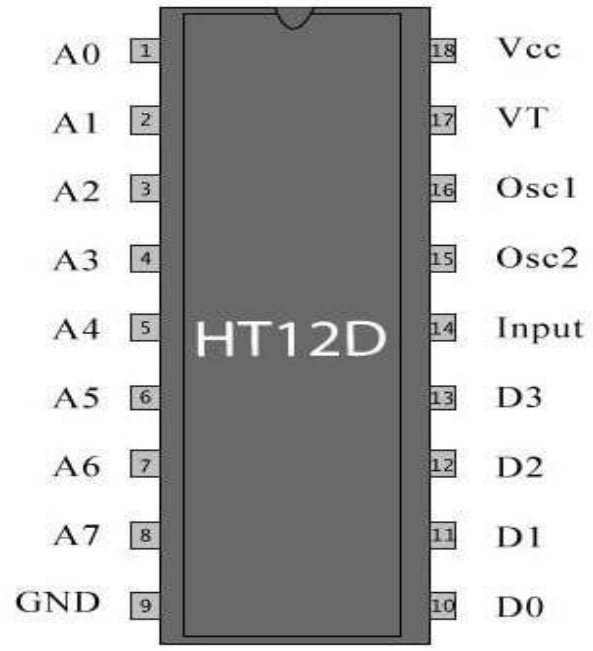


fig 20: Pin Diagram of HT12D RF

- **VCC:**

  This pin is used to provide power to the IC.

- **GND:**

  It is a ground pin.

- **Input:**

  This pin is the serial data input and can be connected to a RF receiver output.

- **A0 – A7:**

  This is the address input. Status of these pins should match with status of address pin in HT12E (in transmitter) for receiving data. These pins can be connected to VSS or left open.

- **D0 – D3:**

  This is the data output pins. Status of these pins can be VSS or VDD depending upon the received serial data through pin DIN.

- **VT:**

  stand for Valid Transmission. This output pin will be HIGH when valid data is available at D8 –D11 data output pins.

- **Osc1 and Osc2**

  These pins are used to connect external resistor for internal oscillator of HT12D. Osc1 is the oscillator input pin and Osc2 is the oscillator output pin.

f. HT12E RF Encoder IC:

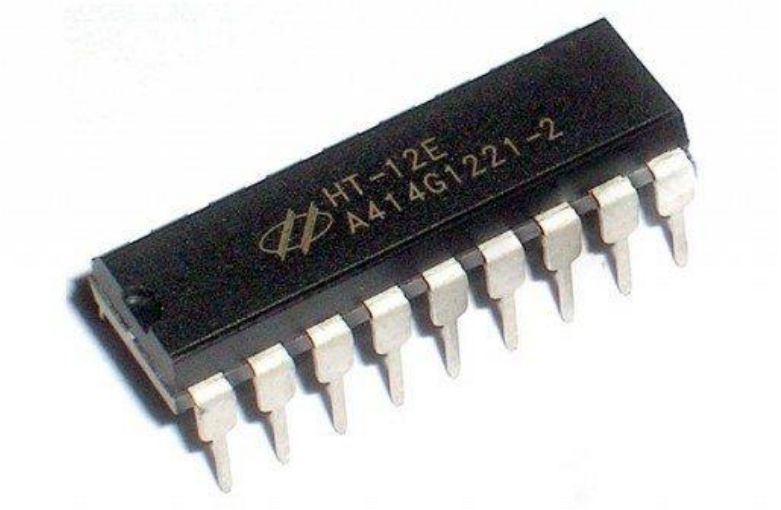


fig 21: HT12E RF Encoder IC

HT12E is an encoder integrated circuit of 212 series of encoders. They are paired with 212 series of decoders for use in remote control system applications. It is mainly used in interfacing RF and infrared circuits. The chosen pair of encoder/decoder should have same number of addresses and data format.

Simply put, HT12E converts the parallel inputs into serial output. It encodes the 12-bit parallel data into serial for transmission through an RF transmitter. These 12 bits are divided into 8 address bits and 4 data bits.

HT12E has a transmission enable pin which is active low. When a trigger signal is received on TE pin, the programmed addresses/data are transmitted together with the header bits via an RF or an infrared transmission medium. HT12E begins a 4- word transmission cycle upon receipt of a transmission enable. This cycle is

repeated as long as TE is kept low. As soon as TE returns to high, the encoder output completes its final cycle and then stops.

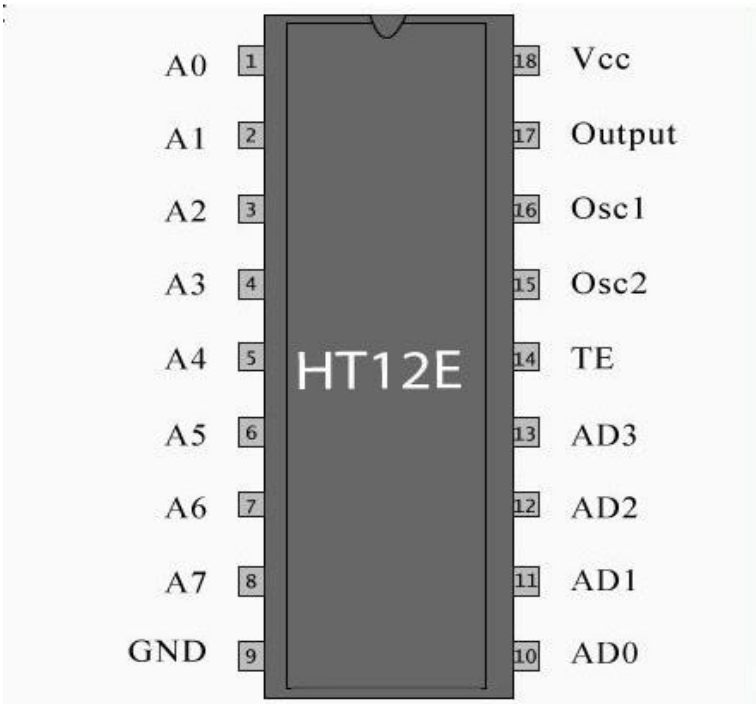


fig 22: Pin Diagram of HT12E RF

- **VCC:**

  This pin is used to provide power to the IC.

- **GND:**

  It is a ground pin.

- **TE:**

  This pin has to be connected to Ground (0V) to enable the Transmission.

- **A0 – A7:**

  These are the 8-bit address bits, which is used to protect your data. We should set the bits in same pattern on Encoder and Decoder IC to pair them.

- **AD0 – AD3:**

  These four pins are used to send data, the data encoded here will be

decoded on HT12D IC sharing the same address bits

- **Output:**

  The Encoded 12-bit output data can be obtained from this pin.

- **Osc1 and Osc2**

  The IC has a built-in oscillator. This oscillator can be used by connecting these two pins through a 1M Resistor

4.1.4 Servo Motor

a. Introduction:

Servo implies an error sensing feedback control which is utilized to correct the performance of a system. It also requires a generally sophisticated controller, often a dedicated module designed particularly for use with servomotors. Servo motors are DC motors that allows for precise control of angular position. They are actually DC motors whose speed is slowly lowered by the gears. The servo motors usually have a revolution cutoff from 90° to 180°. A few servo motors also have revolution cutoff of 360° or more. But servo motors do not rotate constantly. Their rotation is limited in between the fixed angles.

fig 23: Servo Motor

The servo motor is actually an assembly of four things: a normal DC motor, a gear reduction unit, a position-sensing device and a control circuit. The DC motor is connected with a gear mechanism which provides feedback to a position sensor which is mostly a potentiometer. From the gear box, the output of the motor is delivered via servo spline to the servo arm. For standard servo motors, the gear is

normally made up of plastic whereas for high power servos, the gear is made up of metal.

A servo motor consists of three wires- a black wire connected to ground, a white/yellow wire connected to control unit and a red wire connected to power supply. The function of the servo motor is to receive a control signal that represents a desired output position of the servo shaft and apply power to its DC motor until its shaft turns to that position. It uses the position sensing device to figure out the rotational position of the shaft, so it knows which way the motor must turn to move the shaft to the instructed position. The shaft commonly does not rotate freely around similar to a DC motor, however rather can just turn 200 degrees.

From the position of the rotor, a rotating magnetic field is created to efficiently generate toque. Current flows in the winding to create a rotating magnetic field. The shaft transmits the motor output power. The load is driven through the transfer mechanism. A high-function rare earth or other permanent magnet is positioned externally to the shaft. The optical encoder always watches the number of rotations and the position of the shaft.

b. Working of a Servo Motor:

The Servo Motor basically consists of a DC Motor, a Gear system, a position sensor and a control circuit. The DC motors get powered from a battery and run at high speed and low torque. The Gear and shaft assembly connected to the DC motors lower this speed into sufficient speed and higher torque. The position sensor senses the position of the shaft from its definite position and feeds the information to the control circuit. The control circuit accordingly decodes the signals from the position sensor and compares the actual position of the motors with the desired position and accordingly controls the direction of rotation of the DC motor to get the required position. The Servo Motor generally requires DC supply of 4.8V to 6 V.

c. Controlling a Servo Motor:

A servo motor is controlled by controlling its position using Pulse Width Modulation Technique. The width of the pulse applied to the

motor is varied and send for a fixed amount of time.

The pulse width determines the angular position of the servo motor. For example, a pulse width of 1 ms causes a angular position of 0 degrees, whereas a pulse width of 2 ms causes a angular width of 180 degrees.

Advantages:

- If a heavy load is placed on the motor, the driver will increase the current to the motor coil as it attempts to rotate the motor. Basically, there is no out-of-step condition.
- High-speed operation is possible.

Disadvantages:

- Since the servomotor tries to rotate according to the command pulses, but lags behind, it is not suitable for precision control of rotation.
- Higher cost.

When stopped, the motor's rotor continues to move back and forth one pulse, so that it is not suitable if you need to prevent vibration.

d. Applications of Servo Motors:

Servomotors are used in applications requiring rapid variations in speed without the motor getting overheated.

- In Industries they are used in machine tools, packaging, factory automation, material handling, printing converting, assembly lines, and many other demanding applications robotics, CNC machinery or automated manufacturing.
- They are also used in radio-controlled airplanes to control the positioning and movement of elevators.
- They are used in robots because of their smooth switching on and off and accurate positioning.
- They are also used by aerospace industry to maintain hydraulic fluid in their hydraulic systems.
- They are used in many radio-controlled toys.
- Used in automobiles to maintain the speed of vehicles.

4.1.5 LCD 16*2 Display

a. Introduction:

An LCD (Liquid Crystal Display) screen is an electronic display module and has a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. 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. The 16 x 2 intelligent alphanumeric dot matrix display is capable of displaying 224 different characters and symbols. This LCD has two registers, namely, Command and Data. Frequently, an 8051 program must interact with the outside world using input and output devices that communicate directly with a human being. One of the most common devices attached to an 8051 is an LCD display. Some of the most common LCDs connected to the 8051 are 16x2 and 20x4 displays. This means 16 characters per line by 2 lines and 20 characters per line by 4 lines, respectively.

Fortunately, a very popular standard exists which allows us to communicate with the vast majority of LCDs regardless of their manufacturer. The standard is referred to as HD44780U, which refers to the controller chip which receives data from an external source (in this case, the 8051) and communicates directly with the LCD.

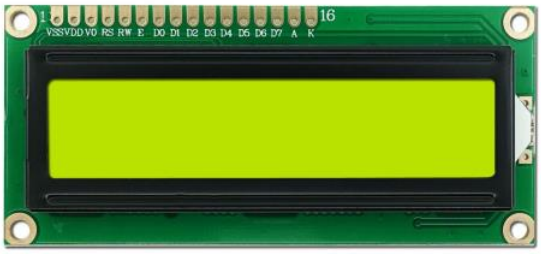


fig 24: LCD 16*2 Display

44780 LCD BACKGROUND:

The 44780 standard requires 3 control lines as well as either 4 or 8 I/O lines for the data bus. The user may select whether the LCD is to operate with a 4-bit data bus or an 8-bit data bus. If a 4-bit data bus is used the LCD will require a total of 7 data lines (3 control lines plus the 4 lines for the data bus). If an 8-bit data bus

is used the LCD will require a total of 11 data lines (3 control lines plus the 8 lines for the data bus).

b. Description:

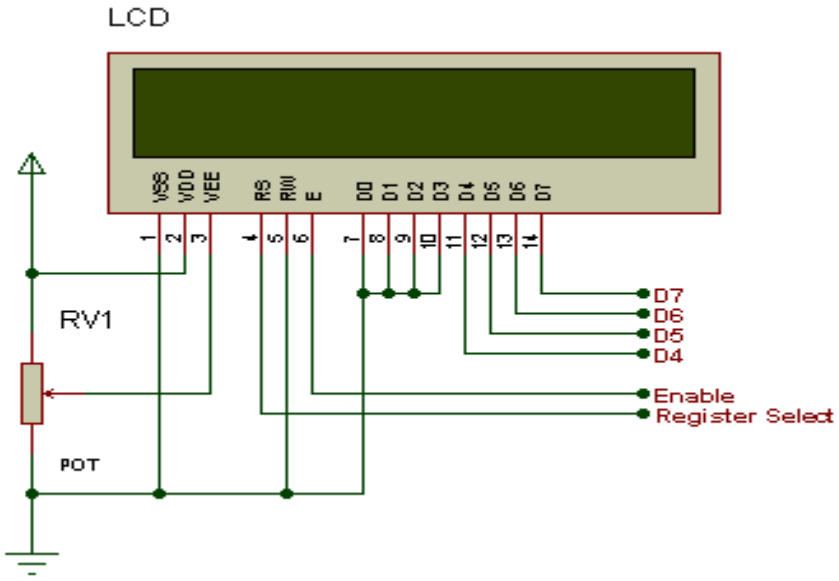


fig 25: Pin Diagram of LCD 16*2 Display

The three control lines are referred to as EN, RS, and RW.

The EN line is called "Enable." This control line is used to tell the LCD that you are sending it data. To send data to the LCD, your program should make sure this line is low (0) and then set the other two control lines and/or put data on the data bus. When the other lines are completely ready, bring EN high (1) and wait for the minimum amount of time required by the LCD datasheet (this varies from LCD to LCD), and end by bringing it low (0) again.

The RS line is the "Register Select" line. When RS is low (0), the data is to be treated as a command or special instruction (such as clear screen, position cursor, etc.). When RS is high (1), the data being sent is text data which should be displayed on the screen. For example, to display the letter "T" on the screen you would set RS high.

The RW line is the "Read/Write" control line. When RW is low (0), the information on the data bus is being written to the LCD. When RW is high (1), the program is effectively querying (or reading) the LCD. Only one instruction ("Get LCD status") is a read command. All others are writing commands so RW

will almost always be low. Finally, the data bus consists of 4 or 8 lines (depending on the mode of operation selected by the user). In the case of an 8-bit data bus, the lines are referred to as DB0, DB1, DB2, DB3, DB4, DB5, DB6, and DB7.

This is the example for the Parallel Port. This example doesn't use the Bi-directional feature found on newer ports, thus it should work with most, if not all Parallel Ports. It however doesn't show the use of the Status Port as an input for a 16 Character x 2 Line LCD Module to the Parallel Port. These LCD Modules are very common these days, and are quite simple to work with, as all the logic required running them is on board.

Advantages:

- Very compact and light
- Low power consumption
- No geometric distortion
- Little or no flicker depending on backlight technology
- Not affected by screen burn-in
- No high voltage or other hazards present during repair/service
- Can be made in almost any size or shape
- No theoretical resolution limits

Disadvantages:

- Each panel has a fixed pixel resolution format determined at the time of manufacture that cannot be changed. All other image resolutions require rescaling, which generally results in significant image degradation, particularly for fine text and graphics. For most applications should only be used at the native resolution of the panel. If you need fine text and graphics at more than one resolution do not get an LCD display.
- LCDs using an analog input require careful adjustment of pixel tracking/phase in order to reduce or eliminate digital noise in the image. Automatic pixel tracking/phase controls seldom produce the optimum setting. Timing drift and jitter may require frequent readjustments during the day. For some displays and video boards you may not be able to entirely eliminate the digital noise
- Limited viewing angle. Brightness, contrast, gamma and color mixtures vary with the viewing angle. Can lead to contrast and color reversal at large angles. Need to be viewed as close to straight ahead as possible.
- LCDs have a fixed resolution and aspect ratio. For panels with a resolution of 1280x1024 the aspect ratio is 5:4=1.25, which is noticeably smaller than the 4:3=1.33 aspect ratio for almost all other standard display modes.

4.1.6 IR Object Detection Module

a. Introduction:

Infrared technology addresses a wide variety of wireless applications. The main areas are sensing and remote controls. In the electromagnetic spectrum, the infrared portion is divided into three regions: near infrared region, mid infrared region and far infrared region. The wavelengths of these regions and their applications are shown below:

- Near infrared region — 700 nm to 1400 nm — IR sensors, fiber optic
- Mid infrared region — 1400 nm to 3000 nm — Heat sensing
- Far infrared region — 3000 nm to 1 mm — Thermal imaging

The frequency range of infrared is higher than microwave and lesser than visible light. For optical sensing and optical communication, photo optics technologies are used in the near infrared region as the light is less complex than RF when implemented as a source of signal. Optical wireless communication is done with IR data transmission for short range applications. An infrared sensor emits and/or detects infrared radiation to sense its surroundings. The working of any Infrared sensor is governed by three laws: Planck's Radiation law, Stephen – Boltzmann law and Wien's Displacement law.

Planck's law states that "every object emits radiation at a temperature not equal to 00K". Stephen – Boltzmann law states that "at all wavelengths, the total energy emitted by a black body is proportional to the fourth power of the absolute temperature". According to Wien's Displacement law, "the radiation curve of a black body for different temperatures will reach its peak at a wavelength inversely proportional to the temperature". The basic concept of an Infrared Sensor which is used as Obstacle detector is to transmit an infrared signal, this infrared signal bounces from the surface of an object and the signal is received at the infrared receiver.

There are five basic elements used in a typical infrared detection system: an infrared source, a transmission medium, optical component, infrared detectors or receivers and signal processing. Infrared lasers and Infrared LED's of specific wavelength can be used as infrared sources. The three main types of media used for infrared transmission are vacuum, atmosphere and optical fibers. Optical components are used to focus the infrared radiation or to limit the spectral response. Optical lenses made of Quartz, Germanium and Silicon are used to focus the infrared radiation. Infrared receivers can be photodiodes,

phototransistors etc. some important specifications of infrared receivers are photosensitivity, detectivity and noise equivalent power. Signal processing is done by amplifiers as the output of infrared detector is very small.

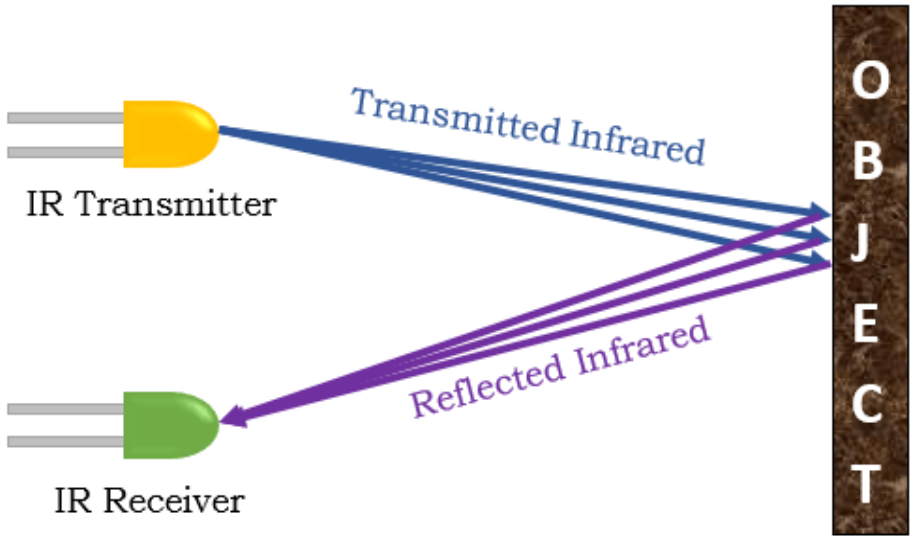


fig 26: IR Object Detection Module

b. Types of IR Sensors:

Infrared sensors can be passive or active. Passive infrared sensors are basically Infrared detectors. Passive infrared sensors do not use any infrared source and detects energy emitted by obstacles in the field of view. They are of two types: quantum and thermal. Thermal infrared sensors use infrared energy as the source of heat and are independent of wavelength. Thermocouples, pyroelectric detectors and bolometers are the common types of thermal infrared detectors. Quantum type infrared detectors offer higher detection performance and are faster than thermal type infrared detectors. The photosensitivity of quantum type detectors is wavelength dependent. Quantum type detectors are further classified into two types: intrinsic and extrinsic types. Intrinsic type quantum detectors are photoconductive cells and photovoltaic cells. Active infrared sensors consist of two elements: infrared source and infrared detector. Infrared sources include an LED or infrared laser diode. Infrared detectors include photodiodes or phototransistors. The energy emitted by the infrared source is reflected by an object and falls on the infrared detector.

IR Transmitter

Infrared Transmitter is a light emitting diode (LED) which emits infrared radiations. Hence, they are called IR LED's. Even though an IR LED looks like a normal LED, the radiation emitted by it is invisible to the human eye. The picture of a typical Infrared LED is shown below.

fig 27: IR Transmitter

There are different types of infrared transmitters depending on their wavelengths, output power and response time. A simple infrared transmitter can be constructed using an infrared LED, a current limiting resistor and a power supply. When operated at a supply of 5V, the IR transmitter consumes about 3 to 5 mA of current. Infrared transmitters can be modulated to produce a particular frequency of infrared light. The most commonly used modulation is OOK (ON – OFF – KEYING) modulation. IR transmitters can be found in several applications. Some applications require infrared heat and the best infrared source is infrared transmitter. When infrared emitters are used with Quartz, solar cells can be made.

IR Receiver

Infrared receivers are also called as infrared sensors as they detect the radiation from an IR transmitter. IR receivers come in the form of photodiodes and phototransistors. Infrared Photodiodes are different from normal photo diodes as they detect only infrared radiation. The picture of a typical IR receiver or a photodiode is shown below.

fig 28: IR Receiver

Different types of IR receivers exist based on the wavelength, voltage, package, etc. When used in an infrared transmitter – receiver combination, the wavelength of the receiver should match with that of the transmitter. It consists of an IR phototransistor, a diode, a MOSFET, a potentiometer and an LED. When the phototransistor receives any infrared radiation, current flows through it and MOSFET turns on. This in turn lights up the LED which acts as a load. The potentiometer is used to control the sensitivity of the phototransistor.

c. Principle of Working:

The principle of an IR sensor working as an Object Detection Sensor can be explained using the following figure. An IR sensor consists of an IR LED and an IR Photodiode; together they are called as Photo – Coupler or Opto – Coupler.

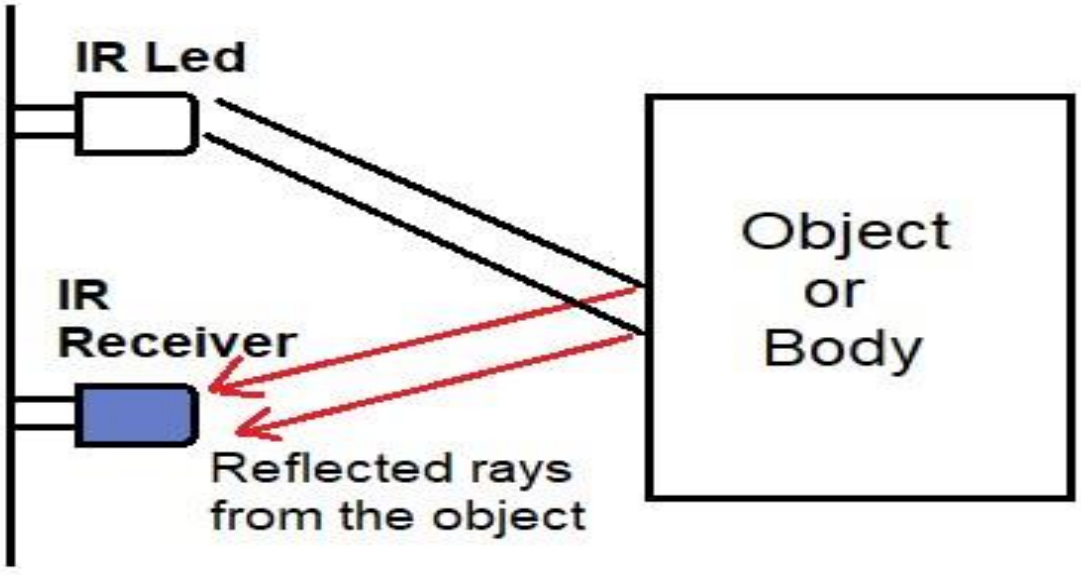


fig 29: Working Module

When the IR transmitter emits radiation, it reaches the object and some of the radiation reflects back to the IR receiver. Based on the intensity of the reception by the IR receiver, the output of the sensor is defined.

Obstacle Sensing Circuit or IR Sensor Circuit

It consists of an IR LED, a photodiode, a potentiometer, an IC Operational amplifier and an LED.

IR LED emits infrared light. The Photodiode detects the infrared light. An IC Op – Amp is used as a voltage comparator. The potentiometer is used to calibrate the output of the sensor according to the requirement.

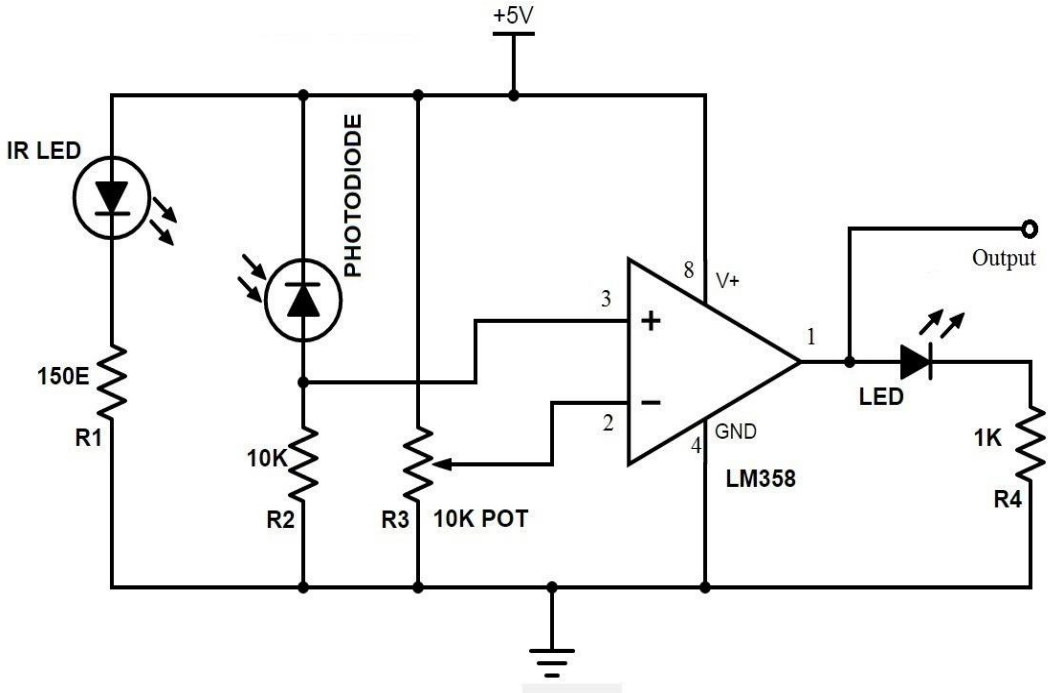


fig 30: Circuit Diagram

When the light emitted by the IR LED is incident on the photodiode after hitting an object, the resistance of the photodiode falls down from a huge value. One of the inputs of the op – amp is at threshold value set by the potentiometer. The other input to the op-amp is from the photodiode's series resistor. When the incident radiation is more on the photodiode, the voltage drop across the series resistor will be high. In the IC, both the threshold voltage and the voltage across the series resistor are compared. If the voltage across the resistor series to photodiode is greater than that of the threshold voltage, the output of the IC Op – Amp is high. As the output of the IC is connected to an LED, it lightens up. The threshold voltage can be adjusted by adjusting the potentiometer depending on the

environmental conditions. The positioning of the IR LED and the IR Receiver is an important factor. When the IR LED is held directly in front of the IR receiver, this setup is called Direct Incidence. In this case, almost the entire radiation from the IR LED will fall on the IR receiver. Hence there is a line of sight communication between the infrared transmitter and the receiver. If an object falls in this line, it obstructs the radiation from reaching the receiver either by reflecting the radiation or absorbing the radiation.

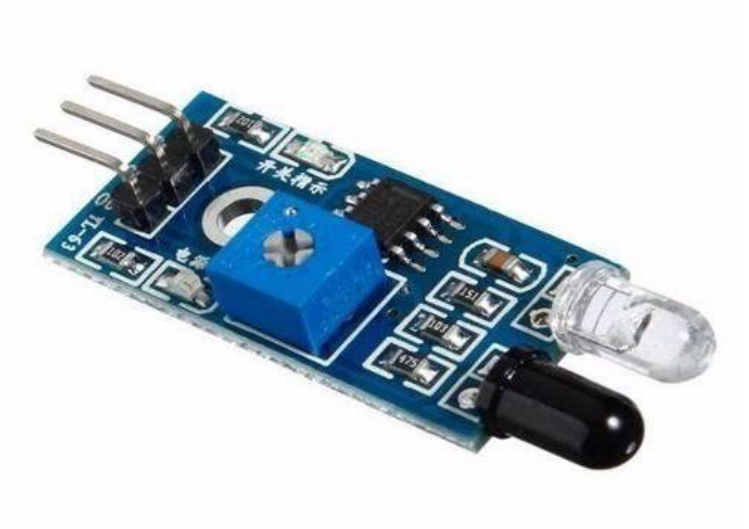


fig 31: IR Sensor

4.1.7 12V DC Motor

A DC motor is an electric motor that runs on direct current (DC) electricity. In any electric motor, operation is based on simple electromagnetism. A current-carrying conductor generates a magnetic field; when this is then placed in an external magnetic field, it will experience a force proportional to the current in the conductor, and to the strength of the external magnetic field. As you are well aware of from playing with magnets as a kid, opposite (North and South) polarities attract, while like polarities (North and North, South and South) repel. The internal configuration of a DC motor is designed to harness the magnetic interaction between a current-carrying conductor and an external magnetic field to generate rotational motion.

Let's start by looking at a simple 2-pole DC electric motor (here red represents a magnet or winding with a "North" polarization, while green represents a magnet or winding with a "South" polarization).

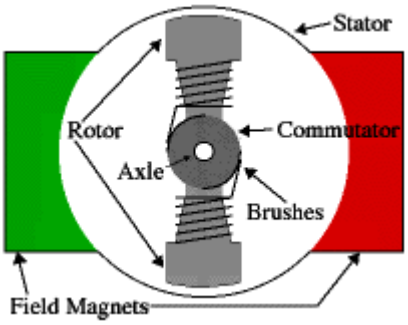


fig 32: Top View of DC Motor

Every DC motor has six basic parts -- axle, rotor (a.k.a., armature), stator, commutator, field magnet(s), and brushes. In most common DC motors, the external magnetic field is produced by high-strength permanent magnets1. The stator is the stationary part of the motor -- this includes the motor casing, as well as two or more permanent magnet pole pieces. The rotor rotates with respect to the stator. The rotor consists of windings (generally on a core), the windings being electrically connected to the commutator. The above diagram shows a common motor layout -- with the rotor inside the stator (field) magnets.

The geometry of the brushes, commutator contacts, and rotor windings are such that when power is applied, the polarities of the energized winding and the stator magnet(s) are misaligned, and the rotor will rotate until it is almost aligned with the stator's field magnets. As the rotor reaches alignment, the brushes move to the next commutator contacts, and energize the next winding. Given our example

two-pole motor, the rotation reverses the direction of current through the rotor winding, leading to a "flip" of the rotor's magnetic field, driving it to continue rotating.

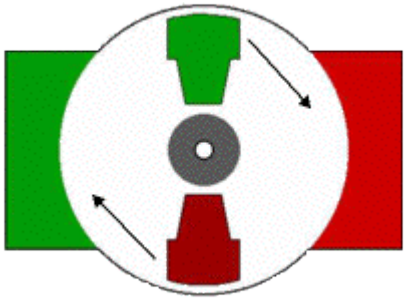


fig 33: Two Pole Design

In real life, though, DC motors will always have more than two poles (three is a very common number). In particular, this avoids "dead spots" in the commutator. You can imagine how with our example two-pole motor, if the rotor is exactly at the middle of its rotation (perfectly aligned with the field magnets), it will get "stuck" there. Meanwhile, with a two-pole motor, there is a moment where the commutator shorts out the power supply (i.e., both brushes touch both commutator contacts simultaneously). This would be bad for the power supply, waste energy, and damage motor components as well. Yet another disadvantage of such a simple motor is that it would exhibit a high amount of torque "ripple".

So since most small DC motors are of a three-pole design, let's tinker with the workings of one via an interactive animation (JavaScript required):

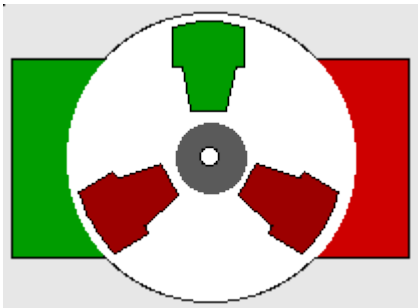


fig 34: Three Pole Design

You'll notice a few things from this -- namely, one pole is fully energized at a time (but two others are "partially" energized). As each brush transitions from one commutator contact to the next, one coil's field will rapidly collapse, as the next coil's field will rapidly charge up (this occurs within a few microsecond). We'll see more about the effects of this later, but in the meantime, you can see that this is a direct result of the coil windings' series wiring.

4.1.8 L293D Motor Driver IC

a. Introduction:

The L293D is a popular 16-Pin Motor Driver IC. As the name suggests it is mainly used to drive motors. A single L293D IC is capable of running two DC motors at the same time; also, the direction of these two motors can be controlled independently. So, if you have motors which has operating voltage less than 36V and operating current less than 600mA, which are to be controlled by digital circuits like Op-Amp, 555 timers, digital gates or even Micron rollers like Arduino, PIC, ARM etc. this IC will be the right choice for you.

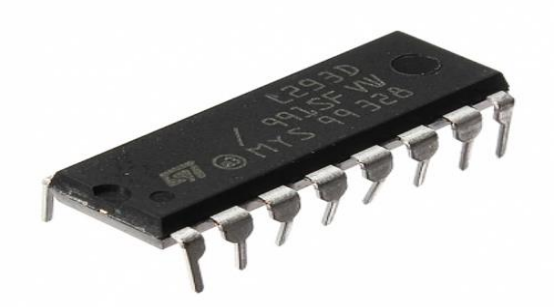


fig 35: L293D Motor Driver IC

b. Features:

- Wide supply-voltage range: 4.5V to 36V
- Separate input- logic supply
- Internal ESD protection
- Thermal shutdown
- High-Noise-Immunity input
- Functional Replacements for SGS L293 and SGS L293D
- Output current 1A per channel (600 mA for L293D)
- Peak output current 2 A per channel (1.2 A for L293D)
- Output clamp diodes for Inductive Transient Suppression(L293D)

c. Description:

L293D is a dual H-bridge motor driver integrated circuit (IC). Motor drivers act as current amplifiers since they take a low-current control signal and provide a higher-current signal. This higher current signal is used to drive the motors.

L293D contains two inbuilt H-bridge driver circuits. In its common mode of

operation, two DC motors can be driven simultaneously, both in forward and reverse direction. The motor operations of two motors can be controlled by input logic at pins 2 & 7 and 10 & 15. Input logic 00 or 11 will stop the corresponding motor. Logic 01 and 10 will rotate it in clockwise and anticlockwise directions, respectively.

Enable pins 1 and 9 (corresponding to the two motors) must be high for motors to start operating. When an enable input is high, the associated driver gets enabled. As a result, the outputs become active and work in phase with their inputs. Similarly, when the enable input is low, that driver is disabled, and their outputs are off and in the high-impedance state.

d. Block diagram:

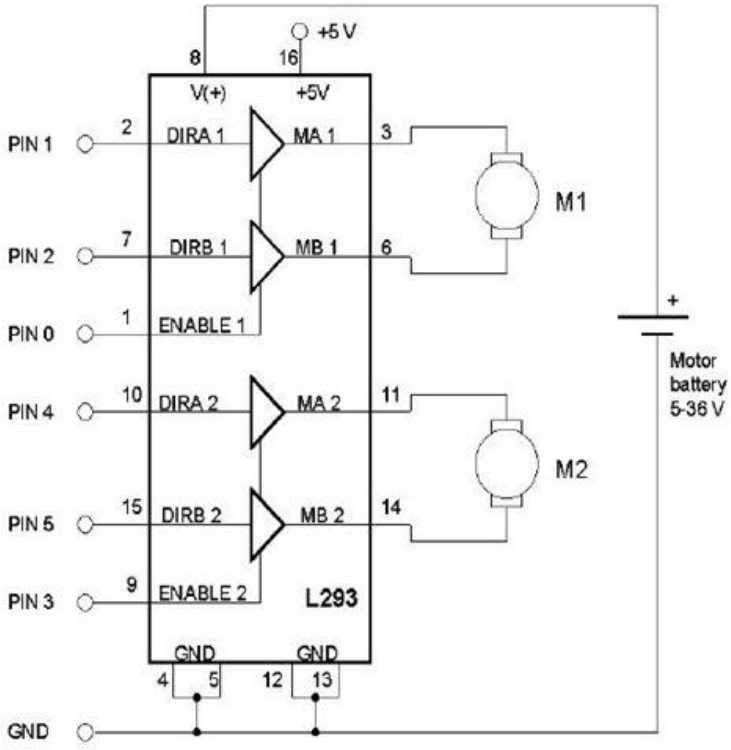


fig 36: Block diagram of L293D

e. Pin Diagram:

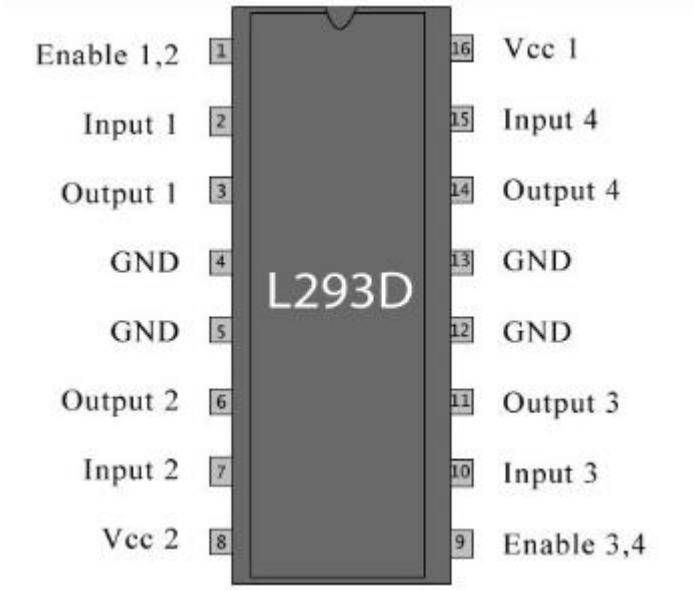


fig 37: Pin Diagram of L293D

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)	Vcc 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)	Vcc 1

4.1.9 Buzzer

a. Introduction:

A buzzer or beeper is an audio signaling device which may be mechanical, electromechanical, or piezoelectric (piezo for short). Typical uses of buzzers and beepers include alarm devices, timers, and confirmation of user input such as a mouse click or keystroke.

fig 38: Buzzer

b. Features:

- Rated Voltage: 6V DC
- Operating Voltage: 4-8V DC
- Rated current: <30mA
- Sound Type: Continuous Beep
- Resonant Frequency: ~2300 Hz
- Small and neat sealed package
- Breadboard and Perf board friendly

c. Description:

A buzzer is a small yet efficient component to add sound features to our project/system. It is very small and compact 2-pin structure hence can be easily used on breadboard, Perf Board and even on PCBs which makes this a widely used component in most electronic applications. There are two types are buzzers

that are commonly available. The one shown here is a simple buzzer which when powered will make a Continuous Beeeeeeppp.... sound, the other type is called a readymade buzzer which will look bulkier than this and will produce a Beep. Beep. Beep. Sound due to the internal oscillating circuit present inside it. But the one shown here is most widely used because it can be customized with help of other circuits to fit easily in our application. This buzzer can be used by simply powering it using a DC power supply ranging from 4V to 9V. A simple 9V battery can also be used, but it is recommended to use a regulated +5V or +6V DC supply. The buzzer is normally associated with a switching circuit to turn ON or turn OFF the buzzer at required time and require interval.

A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers, and confirmation of user input such as a mouse click or keystroke. It generates consistent single tone sound just by applying D.C voltage. Using a suitably designed resonant system, this type can be used where large sound volumes are needed. At Future Electronics we stock many of the most common types categorized by Type, Sound Level, Frequency, Rated Voltage, Dimension and Packaging Type.

Buzzer is an integrated structure of electronic transducers, DC power supply, widely used in computers, printers, copiers, alarms, electronic toys, automotive electronic equipment, telephones, timers and other electronic products for sound devices. Active buzzer 5V Rated power can be directly connected to a continuous sound, this section dedicated sensor expansion module and the board in combination, can complete a simple circuit design, to "plug and play."

d. Pin Diagram:

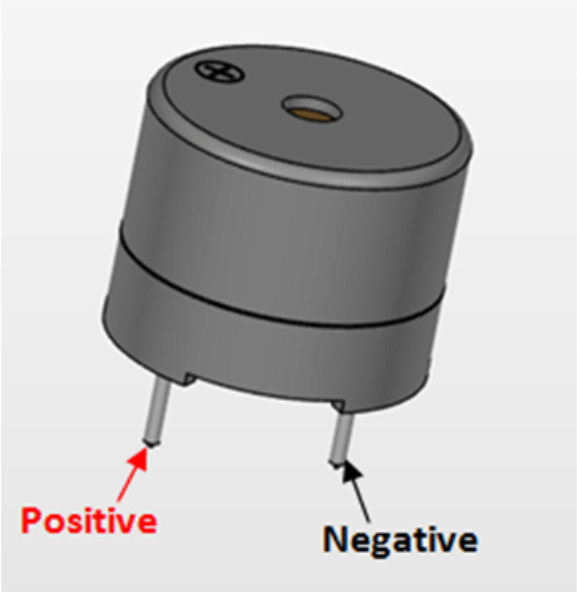


fig 39: Pin Diagram of Buzzer

Pin description:

Pin Number	Pin Name	Description
1	Positive	Identified by (+) symbol or longer terminal lead. Can be powered by 6V DC
2	Negative	Identified by short terminal lead. Typically connected to the ground of the circuit

e. Application:

- Alarming Circuits, where the user has to be alarmed about something
- Communication and Portable equipment

4.1.10 LED

a. Introduction:

A light-emitting diode (LED) is a semiconductor light source. LEDs are used as indicator lamps in many devices, and are increasingly used for lighting. When a light-emitting diode is forward biased (switched on), electrons are able to recombine with holes within the device, releasing energy in the form of photons. This effect is called electroluminescence and the color of the light (corresponding to the energy of the photon) is determined by the energy gap of the semiconductor. An LED is often small in area (less than 1 mm2), and integrated optical components may be used to shape its radiation pattern. LEDs present many advantages over incandescent light sources including lower energy consumption, longer lifetime, improved robustness, smaller size, faster switching, and greater durability and reliability.

b. Types of LED:

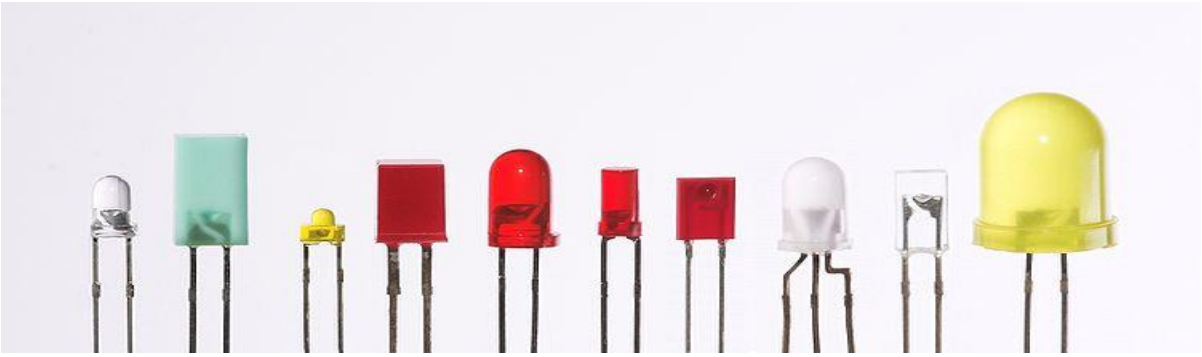


fig 40: Types of LED

Light-emitting diodes are used in applications as diverse as replacements for aviation lighting, automotive lighting as well as in traffic signals. The compact size, the possibility of narrow bandwidth, switching speed, and extreme reliability of LEDs has allowed new text and video displays and sensors to be developed, while their high switching rates are also useful in advanced communications technology.

c. Electronic Symbol:

fig 41: Electronic Symbol of LED

d. White LED:

Light Emitting Diodes (LED) have recently become available that are both white and bright, so bright that they seriously compete with incandescent lamps in lighting applications. They are still pretty expensive as compared to a GOW lamp but draw much less current and project a fairly well focused beam. When run within their ratings, they are more reliable than lamps as well. Red LEDs are now being used in automotive and truck tail lights and in red traffic signal lights. You will be able to detect them because they look like an array of point sources and they go on and off instantly as compared to conventional incandescent lamps.

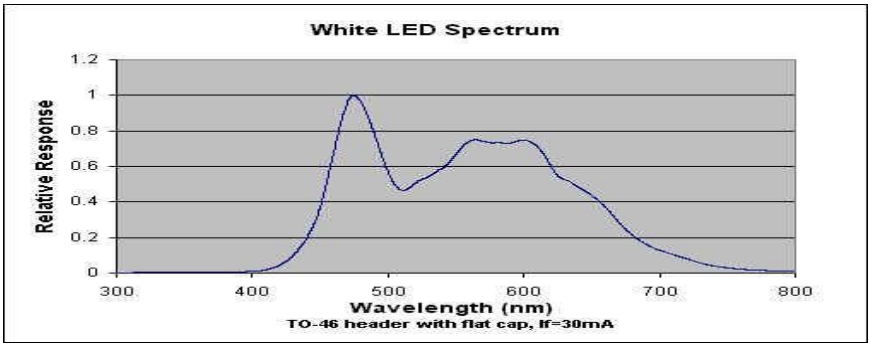


fig 42: Spectrum of white LED

LEDs are monochromatic (one color) devices. The color is determined by the band gap of the semiconductor used to make them. Red, green, yellow and blue LEDs are fairly common. White light contains all colors and cannot be directly created by a single LED. The most common form of "white" LED really isn't white. It is a Gallium Nitride blue LED coated with a phosphor that, when excited by the blue LED light, emits a broad range spectrum that in addition to the blue emission, makes a fairly white light. There is a claim that these white LED's have a limited life. After 1000 hours or so of operation, they tend to yellow and dim to some extent. Running the LEDs at more than their rated current will certainly accelerate this process.

There are two primary ways of producing high intensity white-light using LED'S. One is to use individual LED'S that emit three primary colours-red, green, and blue—and then mix all the colours to form white light. The other is to use a phosphor material to convert monochromatic light from a blue or UV LED to broad-spectrum white light, much in the same way a fluorescent light bulb works. Due to metamerism, it is possible to have quite different spectra that appear white

.

4.1.11 Switches

a. Introduction:

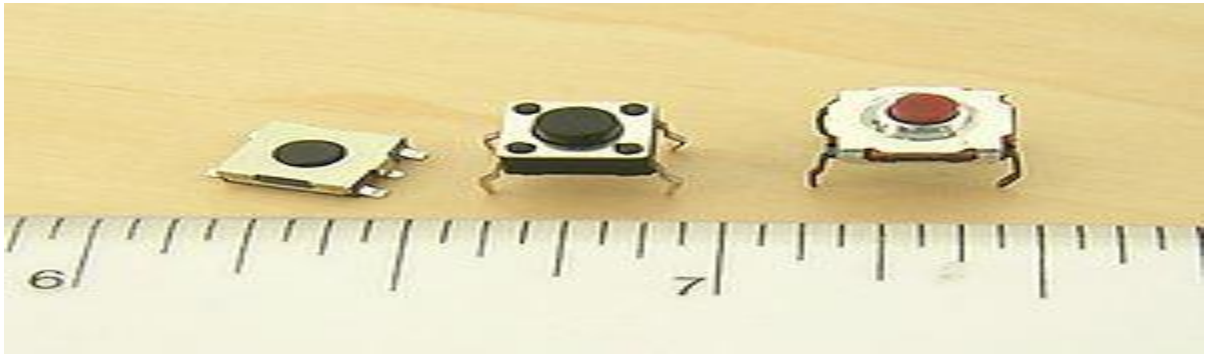


fig 43: Switches

A push-button or simply button is a simple switch mechanism for controlling some aspect of a machine or a process. Buttons are typically made out of hard material, usually plastic or metal. The surface is usually flat or shaped to accommodate the human finger or hand, so as to be easily depressed or pushed. Buttons are most often biased switches, though even many un-biased buttons (due to their physical nature) require a spring to return to their un-pushed state. Different people use different terms for the "pushing" of the button, such as press, depress, mash, and punch.

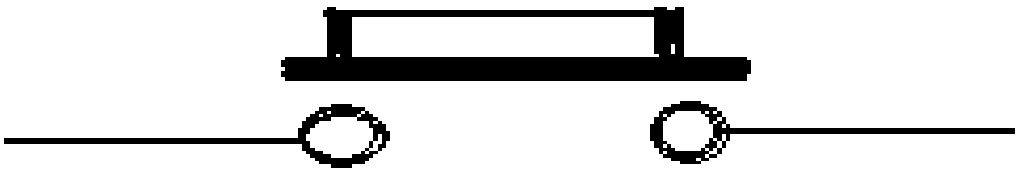


fig 44: Block Diagram of Switches

Initially the two contacts of the button are open. When the button is pressed, they become connected. This makes the switching operation using the push button.

b. Uses:

In industrial and commercial applications push buttons can be linked together by a mechanical linkage so that the act of pushing one button causes the other button to be released. In this way, a stop button can "force" a start button to be released. This method of linkage is used in simple manual operations in which the machine or process have no electrical circuits for control.

Pushbuttons are often color-coded to associate them with their function so that the operator will not push the wrong button in error. Commonly used colors are red for stopping the machine or process and green for starting the machine or process.

Red pushbuttons can also have large heads (mushroom shaped) for easy operation and to facilitate the stopping of a machine. These pushbuttons are called emergency stop buttons and are mandated by the electrical code in many jurisdictions for increased safety. This large mushroom shape can also be found in buttons for use with operators who need to wear gloves for their work and could not actuate a regular flush-mounted push button. As an aid for operators and users in industrial or commercial applications, a pilot light is commonly added to draw the attention of the user and to provide feedback if the button is pushed. Typically, this light is included into the center of the pushbutton and a lens replaces the pushbutton hard center disk.

The source of the energy to illuminate the light is not directly tied to the contacts on the back of the pushbutton but to the action the pushbutton controls. In this way a start button when pushed will cause the process or machine operation to be started and a secondary contact designed into the operation or process will close to turn on the pilot light and signify the action of pushing the button caused the resultant process or action to start.

In popular culture, the phrase "the button" refers to a (usually fictional) button that a military or government leader could press to launch nuclear weapons.

4.1.12 Resistors

a. Introduction:

A resistor is a two-terminal electronic component designed to oppose an electric current by producing a voltage drop between its terminals in proportion to the current, that is, in accordance with Ohm's law:

$$V = IR$$

Resistors are used as part of electrical networks and electronic circuits. They are extremely commonplace in most electronic equipment. Practical resistors can be made of various compounds and films, as well as resistance wire (wire made of a high-resistivity alloy, such as nickel/chrome). The primary characteristics of resistors are their resistance and the power they can dissipate. Other characteristics include temperature coefficient, noise, and inductance. Less well-known is critical resistance, the value below which power dissipation limits the maximum permitted current flow, and above which the limit is applied voltage. Critical resistance depends upon the materials constituting the resistor as well as its physical dimensions; it's determined by design. Resistors can be integrated into hybrid and printed circuits, as well as integrated circuits. Size, and position of leads (or terminals) are relevant to equipment designers; resistors must be physically large enough not to overheat when dissipating their power.

fig 45: Types of resistor

A resistor is a two-terminal passive electronic component which implements electrical resistance as a circuit element. When a voltage V is applied across the terminals of a resistor, a current I will flow through the resistor in direct proportion to that voltage. The reciprocal of the constant of proportionality is known as the resistance R, since, with a given voltage V, a larger value of R

further "resists" the flow of current I as given by Ohm's law:

$$\mathbf{I} = \frac{\mathbf{V}}{\mathbf{R}} \quad \text{.....(1)}$$

Resistors are common elements of electrical networks and electronic circuits and are ubiquitous in most electronic equipment. Practical resistors can be made of various compounds and films, as well as resistance wire (wire made of a high-resistivity alloy, such as nickel-chrome). Resistors are also implemented within integrated circuits, particularly analog devices, and can also be integrated into hybrid and printed circuits. The electrical functionality of a resistor is specified by its resistance: common commercial resistors are manufactured over a range of more than 9 orders of magnitude. When specifying that resistance in an electronic design, the required precision of the resistance may require attention to the manufacturing tolerance of the chosen resistor, according to its specific application. The temperature coefficient of the resistance may also be of concern in some precision applications. Practical resistors are also specified as having a maximum power rating which must exceed the anticipated power dissipation of that resistor in a particular circuit: this is mainly of concern in power electronics applications. Resistors with higher power ratings are physically larger and may require heat sinking. In a high voltage circuit, attention must sometimes be paid to the rated maximum working voltage of the resistor. The series inductance of a practical resistor causes its behavior to depart from ohms law; this specification can be important in some high-frequency applications for smaller values of resistance. In a low-noise amplifier or pre-amp the noise characteristics of a resistor may be an issue. The unwanted inductance, excess noise, and temperature coefficient are mainly dependent on the technology used in manufacturing the resistor. They are not normally specified individually for a particular family of resistors manufactured using a particular technology. A family of discrete resistors is also characterized according to its form factor, that is, the size of the device and position of its leads (or terminals) which is relevant in the practical manufacturing of circuits using them.

b. Units:

The ohm (symbol: Ω) is the SI unit of electrical resistance, named after Georg Simon Ohm. The reciprocal of resistance R is called conductance G = 1/R and is measured in Siemens (SI unit), sometimes referred to as a mho.

4.1.13 Capacitor

A capacitor or condenser is a passive electronic component consisting of a pair of conductors separated by a dielectric. When a voltage potential difference exists between the conductors, an electric field is present in the dielectric. This field stores energy and produces a mechanical force between the plates. The effect is greatest between wide, flat, parallel, narrowly separated conductors.

An ideal capacitor is characterized by a single constant value, capacitance, which is measured in farads. This is the ratio of the electric charge on each conductor to the potential difference between them. In practice, the dielectric between the plates passes a small amount of leakage current. The conductors and leads introduce an equivalent series resistance and the dielectric have an electric field strength limit resulting in a breakdown voltage.

The properties of capacitors in a circuit may determine the resonant frequency and quality factor of a resonant circuit, power dissipation and operating frequency in a digital logic circuit, energy capacity in a high-power system, and many other important aspects.

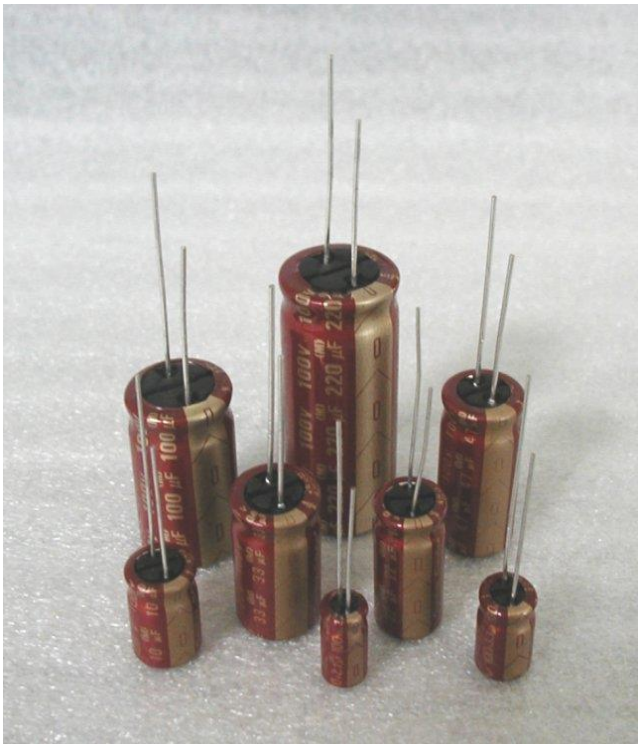


fig 46: Capacitors

A capacitor (formerly known as condenser) is a device for storing electric charge. The forms of practical capacitors vary widely, but all contain at least two conductors separated by a non-conductor. Capacitors used as parts of electrical systems, for example, consist of metal foils separated by a layer of insulating film.

Capacitors are widely used in electronic circuits for blocking direct current while allowing alternating current to pass, in filter networks, for smoothing the output of power supplies, in the resonant circuits that tune radios to particular frequencies and for many other purposes.

A capacitor is a passive electronic component consisting of a pair of conductors separated by a dielectric (insulator). When there is a potential difference (voltage) across the conductors, a static electric field develops in the dielectric that stores energy and produces a mechanical force between the conductors. An ideal capacitor is characterized by a single constant value, capacitance, measured in farads. This is the ratio of the electric charge on each conductor to the potential difference between them.

The capacitance is greatest when there is a narrow separation between large areas of conductor, hence capacitor conductors are often called "plates", referring to an early means of construction. In practice the dielectric between the plates passes a small amount of leakage current and also has an electric field strength limit, resulting in a breakdown voltage, while the conductors and leads introduce an undesired inductance and resistance.

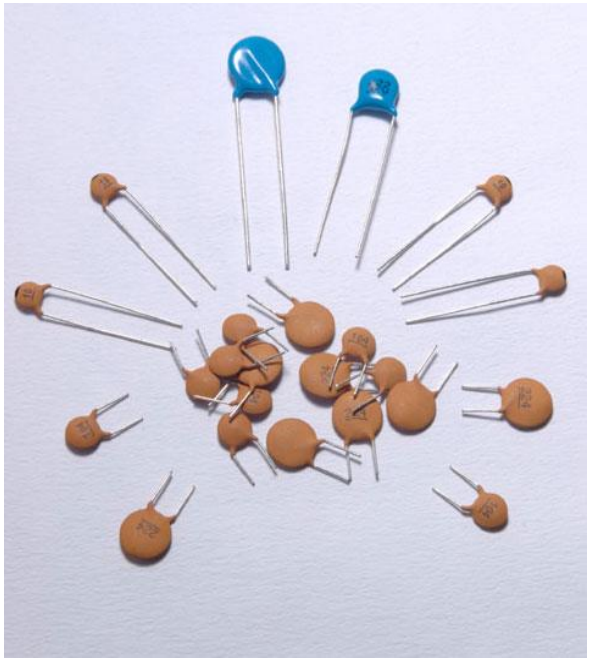


fig 47: Capacitors

4.1.14 Crystal 16 Mhz

a. Introduction:

A crystal oscillator is an electronic oscillator circuit which is used for the mechanical resonance of a vibrating crystal of piezoelectric material. It will create an electrical signal with a given frequency. This frequency is commonly used to keep track of time for example: wrist watches are used in digital integrated circuits to provide a stable clock signal and also used to stabilize frequencies for radio transmitters and receivers. Quartz crystal is mainly used in radio-frequency (RF) oscillators. Quartz crystal is the most common type of piezoelectric resonator, in oscillator circuits we are using them so it became known as crystal oscillators. Crystal oscillators must be designed to provide a load capacitance.

There are different types of oscillator electronic circuits which are in use they are namely: Linear oscillators – Hartley oscillator, Phase-shift oscillator, Armstrong oscillator, Clapp oscillator, Colpitts oscillator. Relaxation oscillators – Royer oscillator, Ring oscillator, Multivibrator and Voltage Controlled Oscillator (VCO). Soon we are going to discuss in detail about crystal oscillator like, working and applications of a crystal oscillator.

What is a Quartz Crystal?

A quartz crystal exhibits a very important property known as the piezoelectric effect. When a mechanical pressure is applied across the faces of the crystal, a voltage which is proportional to mechanical pressure appears across the crystal. That voltage causes distortion in the crystal. Distorted amount will be proportional to the applied voltage and also an alternate voltage applied to a crystal it causes to vibrate at its natural frequency.

The below figure represents the electronic symbol of a piezoelectric crystal resonator and also quartz crystal in an electronic oscillator that consists of resistor, inductor, and capacitors.

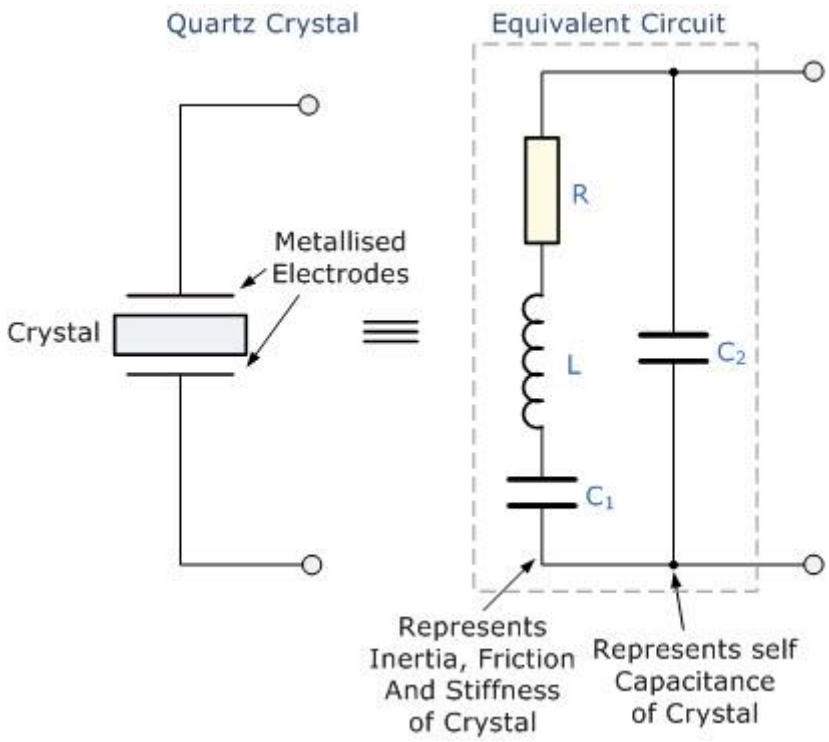


fig 48: Crystal 16 Mhz

b. Working:

Crystal oscillator circuit usually works on the principle of the inverse piezoelectric effect. The applied electric field will produce a mechanical deformation across some materials. Thus, it utilizes the vibrating crystal's mechanical resonance, that is made with a piezoelectric material for generating an electrical signal of a particular frequency.

Usually quartz crystal oscillators are highly stable, consists of good quality factor(Q), they are small in size, and are economically related. Hence, quartz crystal oscillator circuits are more superior compared to other resonators like LC circuits, turning forks. Generally, in Microprocessors and Micro controllers we are using an 8MHz crystal oscillator.

The equivalent electrical circuit is also describing the crystal action of the crystal. Just look at the equivalent electrical circuit diagram shown in the above. The basic components used in the circuit, inductance L represents crystal mass, capacitance C2 represents compliance, and C1 is used to represent the capacitance that is formed because of crystal's mechanical molding, resistance R represents the crystal's internal structure friction, The quartz crystal oscillator circuit diagram

consists of two resonances such as series and parallel resonance, i.e., two resonant frequencies.

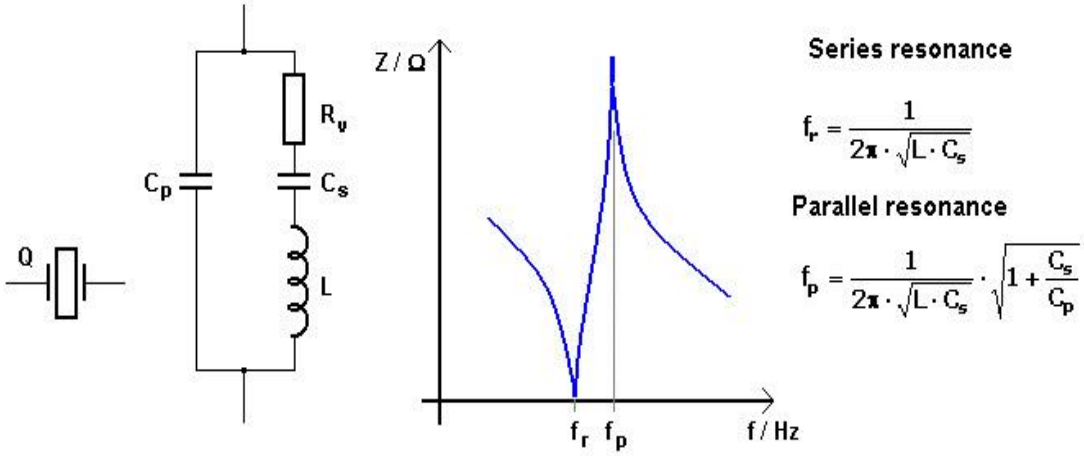


fig 49: Graphical Representation and Circuit Diagram

The series resonance occurs when the reactance produced by capacitance C1is equal and opposite to the reactance produced by inductance L. The fr and fp represents series and parallel resonant frequencies respectively, and the values of 'fr' and 'fp' can be determined by using the following equations shown in the figure below. The above diagram describes an equivalent circuit, plot graph for Resonant frequency, Formulae for Resonant frequencies.

c. Uses:

In general, we know that, in the design of microprocessors and microcontrollers, crystal oscillators are used for the sake of providing the clock signals. For instance, let us consider 8051 microcontroller, in this particular controller an external crystal oscillator circuit will work with 12MHz that is essential, even though this 8051 microcontroller (based on model) is capable to work at 40 MHz (max) have to provide 12MHz in most of the cases because for a machine cycle 8051 requires 12 clock cycles, so that to give effective cycle rate at 1MHz (taking 12MHz clock) to 3.33MHz (taking the maximum 40MHz clock). This particular crystal oscillator which is having cycle rate at 1MHz to 3.33MHz is used to generate clock pulses which are required for the synchronization of all the internal operations.

4.1.15 PCB

A basic PCB consists of a flat sheet of insulating material and a layer of copper foil, laminated to the substrate. Chemical etching divides the copper into separate conducting lines called tracks or circuit traces, pads for connections, vias to pass connections between layers of copper, and features such as solid conductive areas for electromagnetic shielding or other purposes. The tracks function as wires fixed in place, and are insulated from each other by air and the board substrate material. The surface of a PCB may have a coating that protects the copper from corrosion and reduces the chances of solder shorts between traces or undesired electrical contact with stray bare wires. For its function in helping to prevent solder shorts, the coating is called solder resist or solder mask. A printed circuit board can have multiple copper layers. A two-layer board has copper on both sides; multi-layer boards sandwich additional copper layers between layers of insulating material. Conductors on different layers are connected with vias, which are copper-plated holes that function as electrical tunnels through the insulating substrate. Through-hole component leads sometimes also effectively function as vias. After two-layer PCBs, the next step up is usually four-layer. Often two layers are dedicated as power supply and ground planes, and the other two are used for signal wiring between components. "Through hole" components are mounted by their wire leads passing through the board and soldered to traces on the other side. "Surface mount" components are attached by their leads to copper traces on the same side of the board. A board may use both methods for mounting components. PCBs with only through-hole mounted components are now uncommon. Surface mounting is used for transistors, diodes, IC chips, resistors and capacitors. Through-hole mounting may be used for some large components such as electrolytic capacitors and connectors.

The pattern to be etched into each copper layer of a PCB is called the "artwork". The etching is usually done using photoresist which is coated onto the PCB, then exposed to light projected in the pattern of the artwork. The resist material protects the copper from dissolution into the etching solution. The etched board is then cleaned. A PCB design can be mass-reproduced in a way similar to the way photographs can be mass-duplicated from film negatives using a photographic printer. In multi-layer boards, the layers of material are laminated together in an alternating sandwich: copper, substrate, copper, substrate, copper, etc.; each plane of copper is etched, and any internal vias (that will not extend to both outer surfaces of the finished multilayer board) are plated-through, before the layers are laminated together. Only the outer layers need be coated; the inner copper layers are protected by the adjacent substrate layers.

FR-4 glass epoxy is the most common insulating substrate. Another substrate material is cotton paper impregnated with phenolic resin, often tan or brown. When a PCB has no components installed, it is less ambiguously called a printed wiring board (PWB) or etched wiring board. However, the term "printed wiring board" has fallen into disuse. A PCB populated with electronic components is called a printed circuit assembly (PCA), printed circuit board assembly or PCB assembly (PCBA). In informal usage, the term "printed circuit board" most commonly means "printed circuit assembly" (with components). The IPC preferred term for assembled boards is circuit card assembly (CCA),[4] and for assembled backplanes it is backplane assemblies. "Card" is another widely used informal term for a "printed circuit assembly". For example, expansion card. A PCB may be "silkscreen" printed with a legend identifying the components, test points, or identifying text. Originally, an actual silkscreen printing process was used for this purpose, but today other, finer quality printing methods are usually used instead. Normally the screen printing is not significant to the function of the PCBA. A minimal PCB for a single component, used for prototyping, is called a breakout board. The purpose of a breakout board is to "break out" the leads of a component on separate terminals so that manual connections to them can be made easily. Breakout boards are especially used for surface-mount components or any components with fine lead pitch. Advanced PCBs may contain components embedded in the substrate. [citation needed].

4.1.16 Voltage Regulator

a. Introduction:

A voltage regulator is a system designed to automatically maintain a constant voltage level. A voltage regulator may use a simple feed-forward design or may include negative feedback. It may use an electromechanical mechanism, or electronic components. Depending on the design, it may be used to regulate one or more AC or DC voltages.

Electronic voltage regulators are found in devices such as computer power supplies where they stabilize the DC voltages used by the processor and other elements. In automobile alternators and central power station generator plants, voltage regulators control the output of the plant. In an electric power distribution system, voltage regulators may be installed at a substation or along distribution lines so that all customers receive steady voltage independent of how much power is drawn from the line.

b. Features:

- Output Current up to 1A.
- Output Voltages of 5, 6, 8, 9, 10, 12, 15, 18, 24 V.
- Thermal Overload Protection.
- Short Circuit Protection.
- Output Transistor Safe Operating Area Protection.

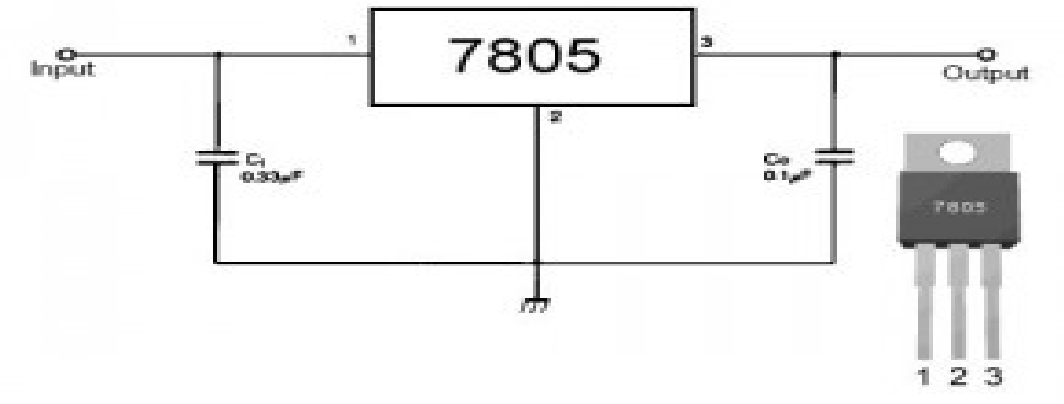


fig 50: Circuit Diagram of Voltage Regulator

c. Description:

The LM78XX/LM78XXA series of three-terminal positive regulators are available in the TO-220/D-PAK package and with several fixed output voltages, making them useful in a Wide range of applications. Each type employs internal current limiting, thermal shutdown and safe operating area protection, making it essentially indestructible. If adequate heat sinking is provided, they can deliver over 1A output Current. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltages and currents.

Internal Block Diagram

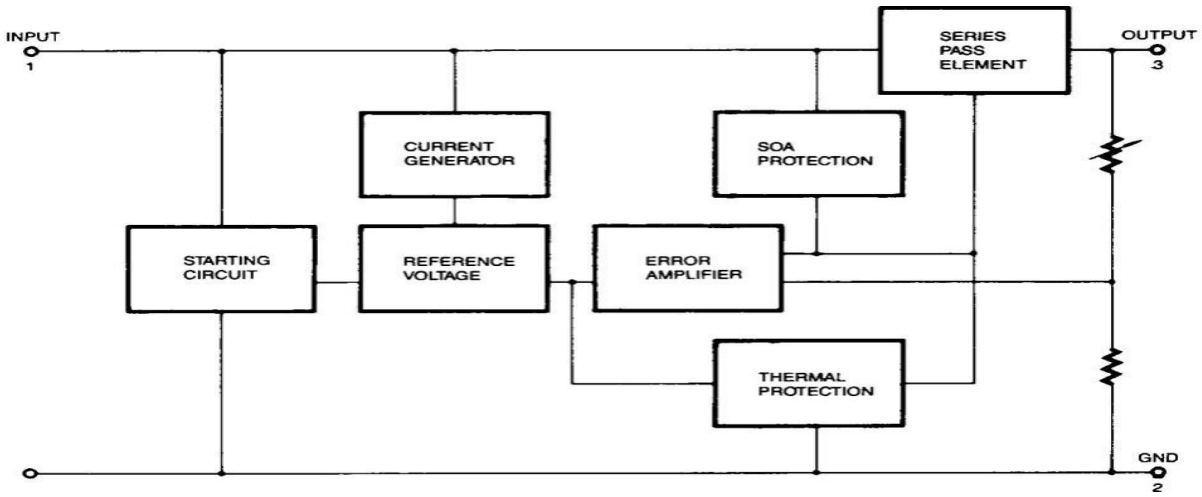


fig 51: Internal Block Diagram

Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
Input Voltage (for V_O = 5V to 18V) (for V_O = 24V)	V_I V_I	35 40	V V
Thermal Resistance Junction-Cases (TO-220)	$R_{\theta JC}$	5	°C/W
Thermal Resistance Junction-Air (TO-220)	$R_{\theta JA}$	65	°C/W
Operating Temperature Range (KA78XX/A/R)	T_{OPR}	0 ~ +125	°C
Storage Temperature Range	T_{STG}	-65 ~ +150	°C

4.1.17 Power Supply

Motors need a lot of energy, especially cheap motors since they're less efficient. The first important thing to figure out what voltage the motor is going to use. If we're lucky our motor came with some sort of specifications. Some small hobby motors are only intended to run at 1.5V, but it's just as common to have 6-12V motors. The motor controllers on this shield are designed to run from 4.5V to 25V. MOST 1.5-3V MOTORS WILL NOT WORK. The second thing to figure out is how much current our motor will need. The motor driver chips that come with the kit are designed to provide up to 600 mA per motor, with 1.2A peak current. Note that once we head towards 1A we'll probably want to put a heatsink on the motor driver, otherwise we will get thermal failure, possibly burning out the chip.

Servos are powered off of the same regulated 5V that the Arduino uses. This is OK for the small hobby servos suggested. If we want something beefier, cut the trace going to + on the servo connectors and wire up our own 5-6V supply. The DC motors are powered off of a 'high voltage supply' and NOT the regulated 5V. Don't connect the motor power supply to 5V line. There are two places we can get our motor 'high voltage supply' from. One is the DC jack on the Arduino board and the other is the 2-terminal block on the shield that is labelled EXT_PWR. The DC Jack on the Arduino has a protection diode so we won't be able to mess things up too bad if we plug in the wrong kind of power. However, the EXT_PWR terminals on the shield do not have a protection diode (for a fairly good reason). Be utterly careful not to plug it in backwards or we will destroy the motor shield and/or our Arduino!

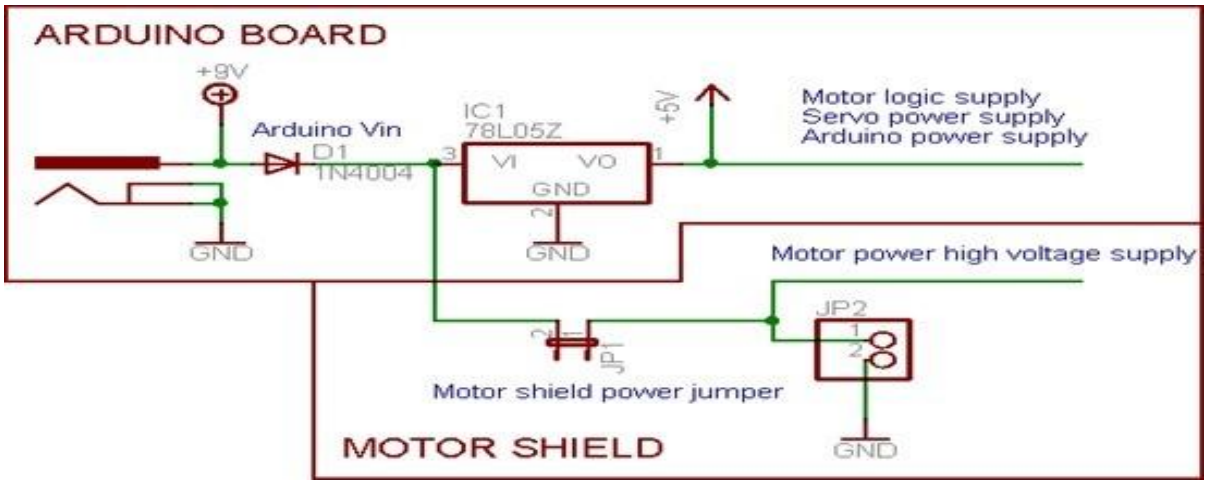


fig 52: Power Supply

4.2 Software Used

4.2.1 MC programming language

Embedded C is most popular programming language in software field for developing electronic gadgets. Each processor used in electronic system is associated with embedded software. Embedded C programming plays a key role in performing specific function by the processor. In day-to-day life we used many electronic devices such as mobile phone, washing machine, digital camera, etc. These all device working is based on microcontroller that are programmed by embedded C. Let's see the block diagram representation of embedded system programming:

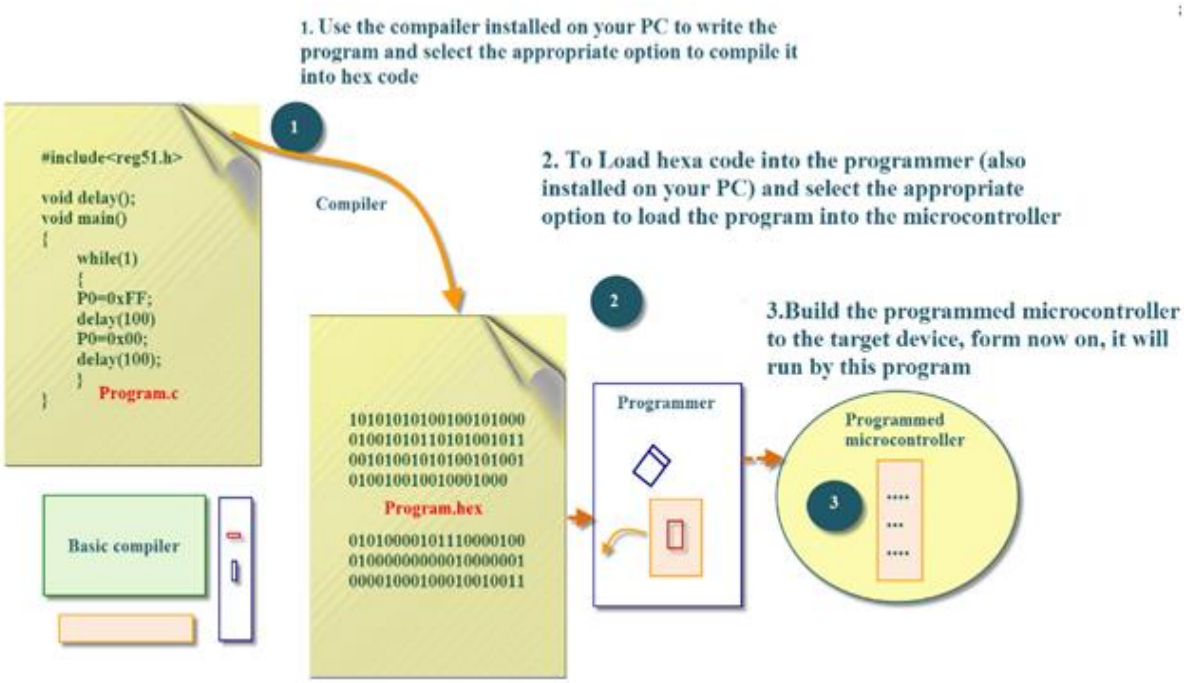


fig 53: Block Diagram of Embedded C

The Embedded C code written in above block diagram is used for blinking the LED connected with Port0 of microcontroller.

In embedded system programming C code is preferred over other language. Due to the following reasons:

- Easy to understand
- High Reliability
- Portability

Basic Declaration

Let's see the block diagram of Embedded C Programming development:

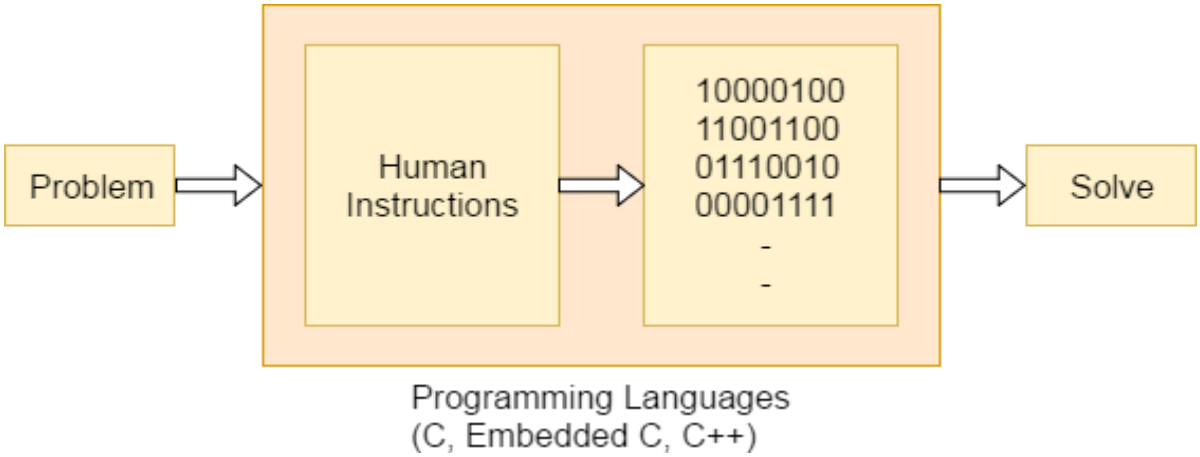


fig 54: Basic Declaration of Embedded C

Function is a collection of statements that is used for performing a specific task and a collection of one or more functions is called a programming language. Every language is consisting of basic elements and grammatical rules. The C language programming is designed for function with variables, character set, data types, keywords, expression and so on are used for writing a C program.

The extension in C language is known as embedded C programming language. As compared to above the embedded programming in C is also have some additional features like data types, keywords and header file etc is represented by

#include<microcontroller name.h>

Let's see the block diagram representation of Embedded C Programming Steps:

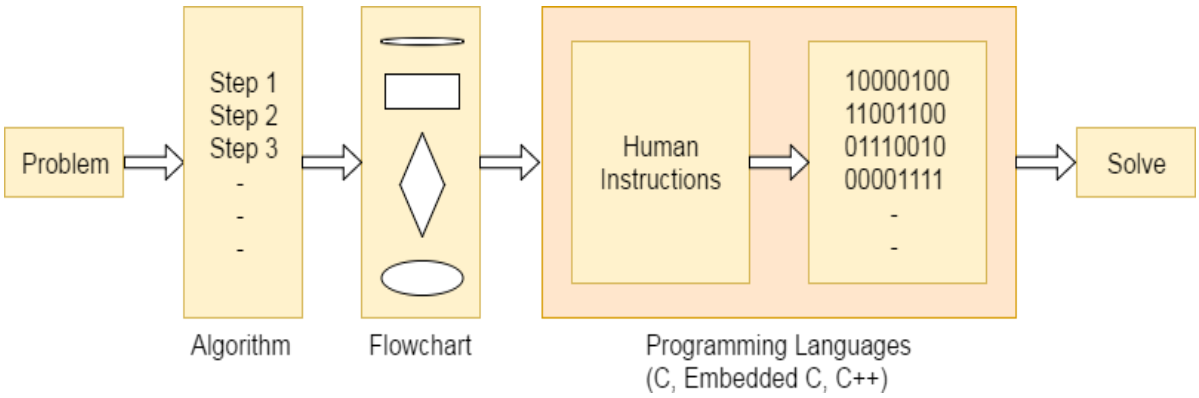


fig 55: Block Diagram of Programming Steps

4.2.2 Arduino IDE For Programming

a. Introduction:

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing.

Over the years Arduino has been the brain of thousands of projects, from everyday objects to complex scientific instruments. A worldwide community of makers - students, hobbyists, artists, programmers, and professionals - has gathered around this open-source platform, their contributions have added up to an incredible amount of accessible knowledge that can be of great help to novices and experts alike.

Arduino was born at the Ivrea Interaction Design Institute as an easy tool for fast prototyping, aimed at students without a background in electronics and programming. As soon as it reached a wider community, the Arduino board started changing to adapt to new needs and challenges, differentiating its offer from simple 8-bit boards to products for IoT applications, wearable, 3D printing, and embedded environments. All Arduino boards are completely open-source, empowering users to build them independently and eventually adapt them to their particular needs. The software, too, is open-source, and it is growing through the contributions of users worldwide.

b. Description:

Arduino has been used in thousands of different projects and applications. The Arduino software is easy-to-use for beginners, yet flexible enough for advanced users. It runs on Mac, Windows, and Linux. Teachers and students use it to build low cost scientific instruments, to prove chemistry and physics principles, or to get started with programming and robotics. Designers and architects build interactive prototypes, musicians and artists use it for installations and to experiment with new musical instruments. Makers, of course, use it to build many of the projects exhibited at the Maker Faire, for example. Arduino is a key tool to

learn new things. Anyone - children, hobbyists, artists, programmers - can start tinkering just following the step by step instructions of a kit, or sharing ideas online with other members of the Arduino community.

There are many other microcontrollers and microcontroller platforms available for physical computing. Parallax Basic Stamp, Netmedia's BX-24, Phidgets, MIT's Handyboard, and many others offer similar functionality. All of these tools take the messy details of microcontroller programming and wrap it up in an easy-to-use package. Arduino also simplifies the process of working with microcontrollers, but it offers some advantage for teachers, students, and interested amateurs over other systems:

- **Inexpensive** - Arduino boards are relatively inexpensive compared to other microcontroller platforms. The least expensive version of the Arduino module can be assembled by hand, and even the pre-assembled Arduino modules cost less than $50.
- **Cross-platform** - The Arduino Software (IDE) runs on Windows, Macintosh OSX, and Linux operating systems. Most microcontroller systems are limited to Windows.
- **Simple, clear programming environment** - The Arduino Software (IDE) is easy-to-use for beginners, yet flexible enough for advanced users to take advantage of as well. For teachers, it's conveniently based on the Processing programming environment, so students learning to program in that environment will be familiar with how the Arduino IDE works.
- **Open source and extensible software** - The Arduino software is published as open source tools, available for extension by experienced programmers. The language can be expanded through C++ libraries, and people wanting to understand the technical details can make the leap from Arduino to the AVR C programming language on which it's based. Similarly, you can add AVR-C code directly into your Arduino programs if you want to.
- **Open source and extensible hardware** - The plans of the Arduino boards are published under a Creative Commons license, so experienced circuit designers can make their own version of the module, extending it and improving it. Even relatively inexperienced users can build the breadboard version of the module in order to understand how it works and save money.

4.2.3 Proteus Software for Circuit & PCB Design

a. Introduction:

The Proteus Design Suite is a proprietary software tool suite used primarily for electronic design automation. The software is used mainly by electronic design engineers and technicians to create schematics and electronic prints for manufacturing printed circuit boards.

b. Product Module:

The Proteus Design Suite is a Windows application for schematic capture, simulation, and PCB (Printed Circuit Board) layout design. It can be purchased in many configurations, depending on the size of designs being produced and the requirements for microcontroller simulation. All PCB Design products include an auto router and basic mixed mode SPICE simulation capabilities.

- **Schematic Capture**

Schematic capture in the Proteus Design Suite is used for both the simulation of designs and as the design phase of a PCB layout project. It is therefore a core component and is included with all product configurations.

- **Microcontroller Simulation**

The micro-controller simulation in Proteus works by applying either a hex file or a debug file to the microcontroller part on the schematic. It is then co-simulated along with any analog and digital electronics connected to it. This enables its use in a broad spectrum of project prototyping in areas such as motor control,[2][3] temperature control [4][5] and user interface design.[6] It also finds use in the general hobbyist community[7][8] and, since no hardware is required, is convenient to use as a training[9][10] or teaching tool.[11][12] Support is available for co-simulation of:

Microchip Technologies PIC10, PIC12, PIC16, PIC18, PIC24, dsPIC33 Microcontrollers.

Atmel AVR (and Arduino), 8051 and ARM Cortex-M3 Microcontrollers

NXP 8051, ARM7, ARM Cortex-M0 and ARM Cortex-M3 Microcontrollers.

Texas Instruments MSP430, PICCOLO DSP and ARM Cortex-M3 Microcontrollers.

Parallax Basic Stamp, Freescale HC11, 8086 Microcontrollers.

- **PCB Design**

The PCB Layout module is automatically given connectivity information in the form of a netlist from the schematic capture module. It applies this information, together with the user specified design rules and various design automation tools, to assist with error free board design. PCB's of up to 16 copper layers can be produced with design size limited by product configuration.

- **3D Verification**

The 3D Viewer module allows the board under development to be viewed in 3D together with a semi-transparent height plane that represents the boards enclosure. STEP output can then be used to transfer to mechanical CAD software such as Solid works or Autodesk for accurate mounting and positioning of the board.

c. Transmitter Side Schematics:

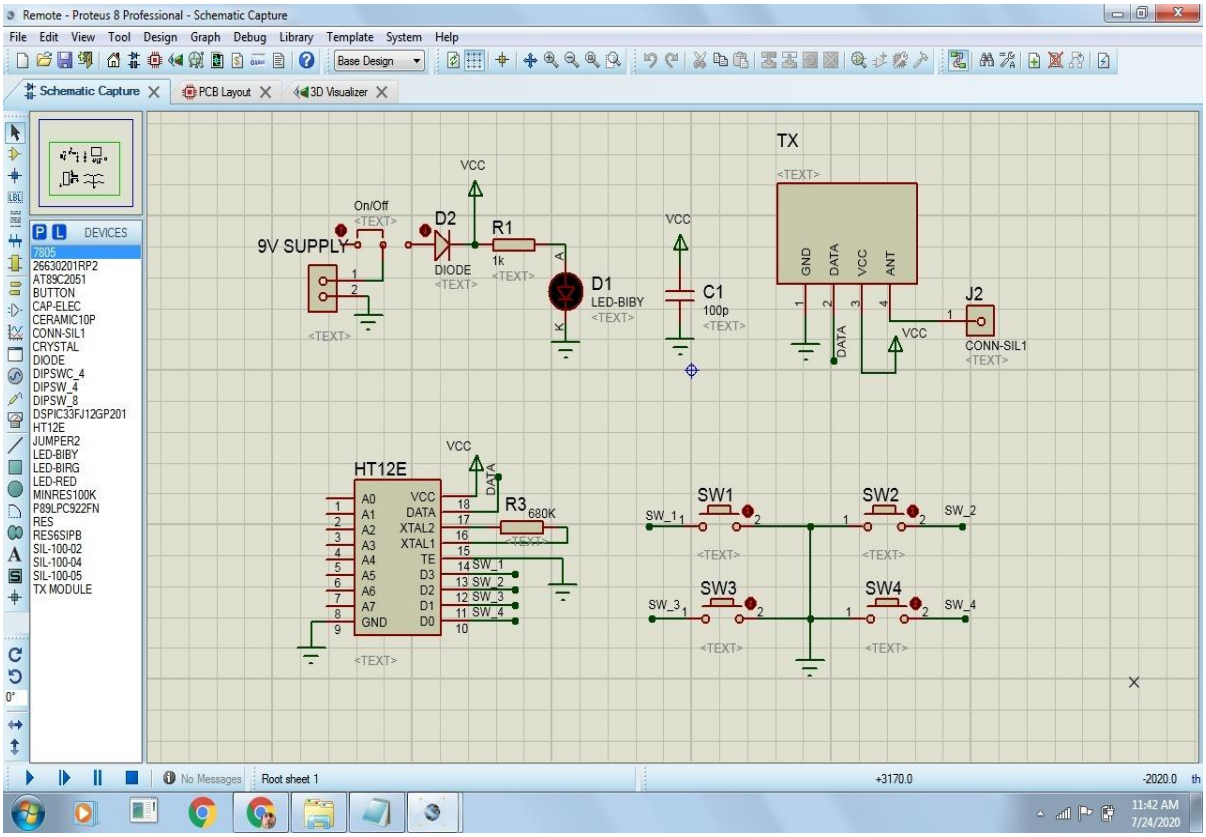


fig 56: Circuit Diagram

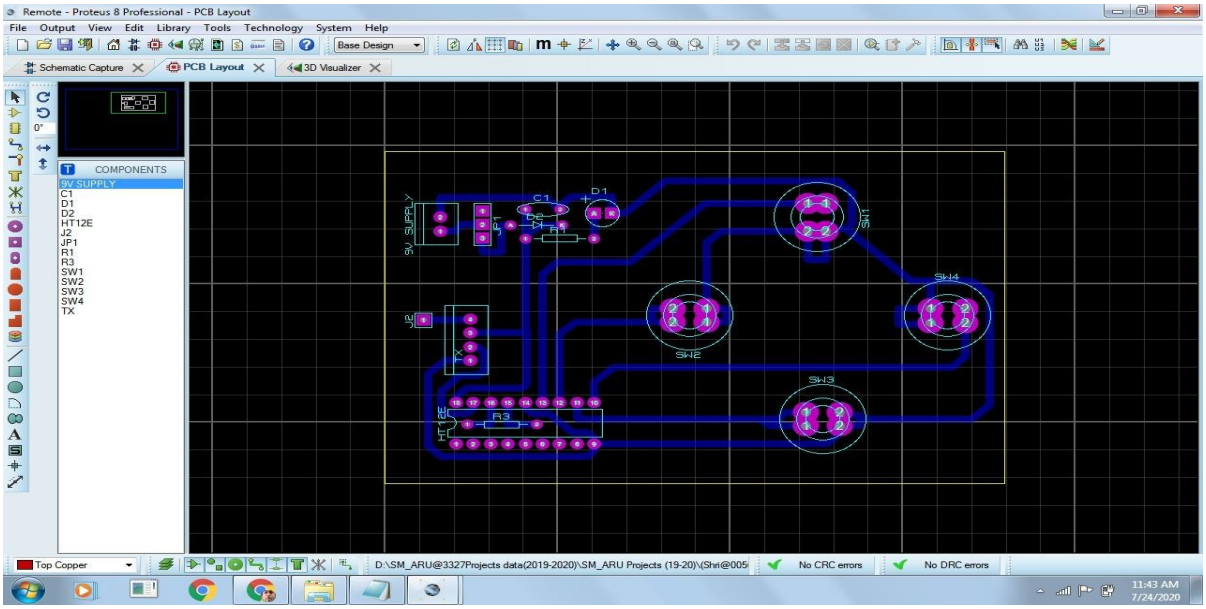


fig 57: PCB Layout

d. Receiver Side Schematics:

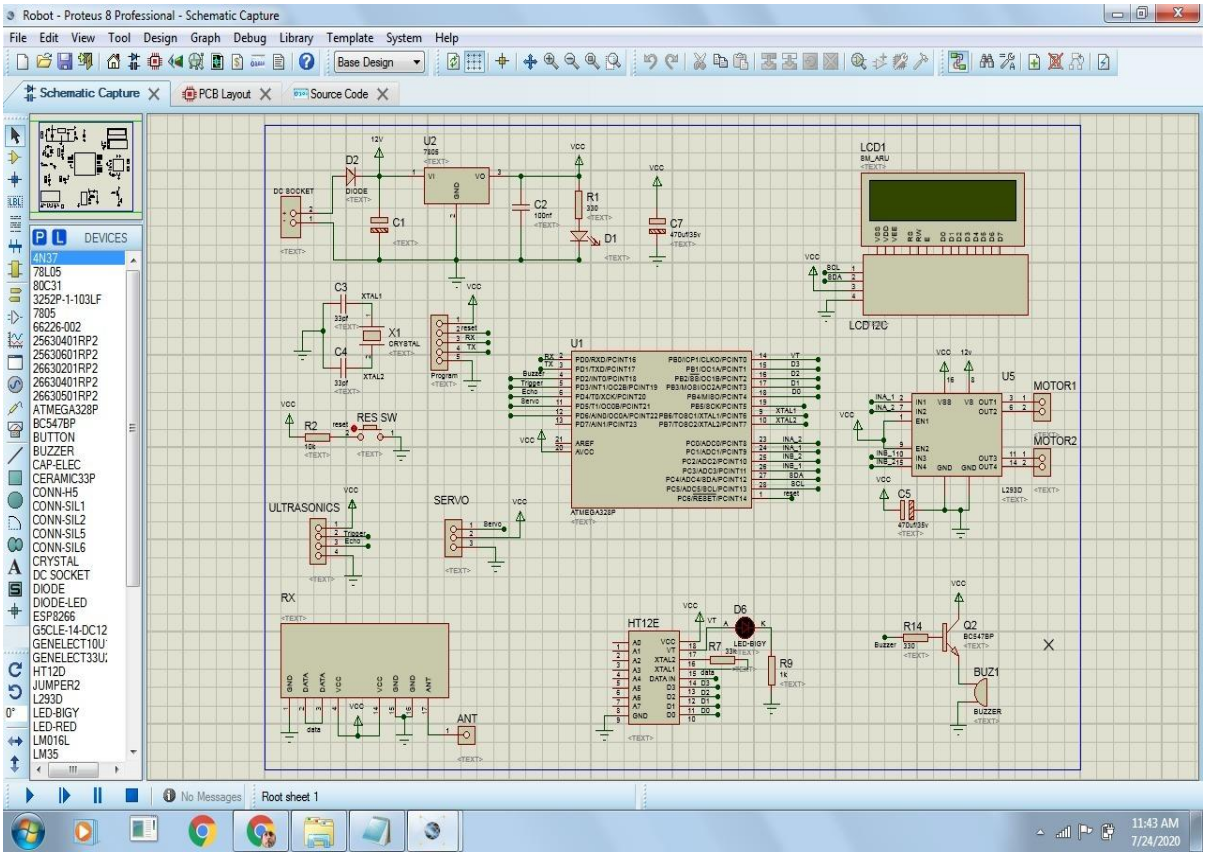


fig 58: Circuit Diagram of Receiver side

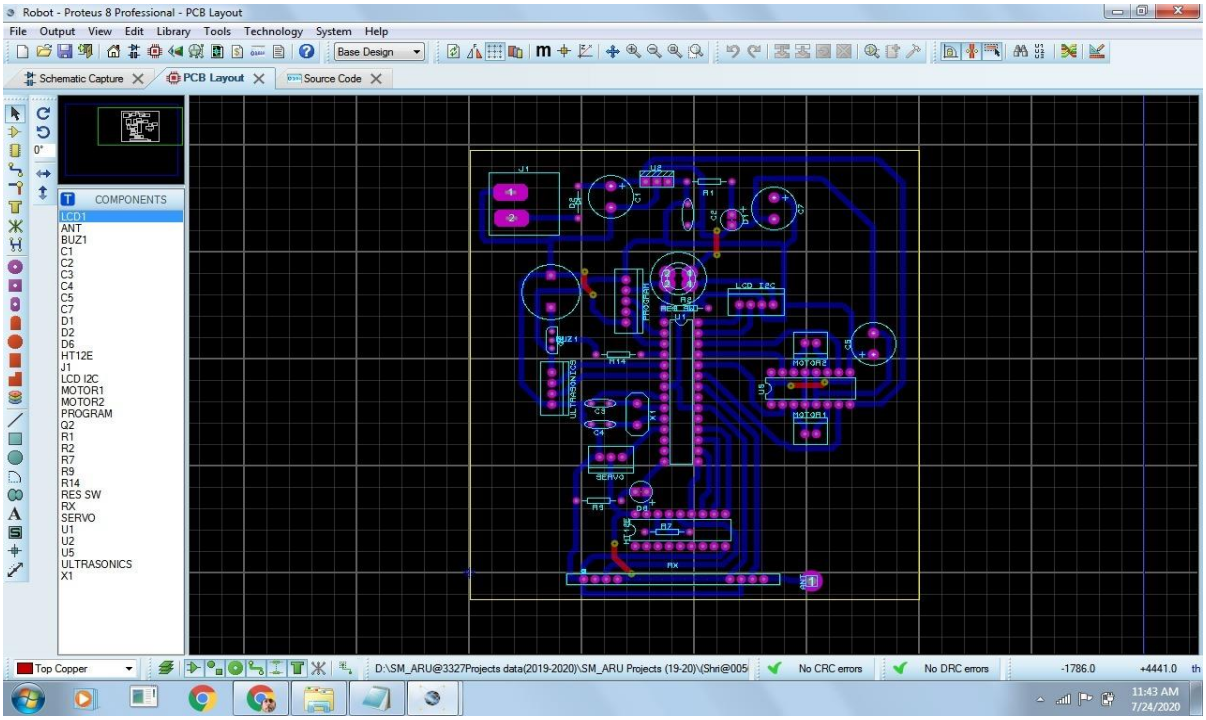
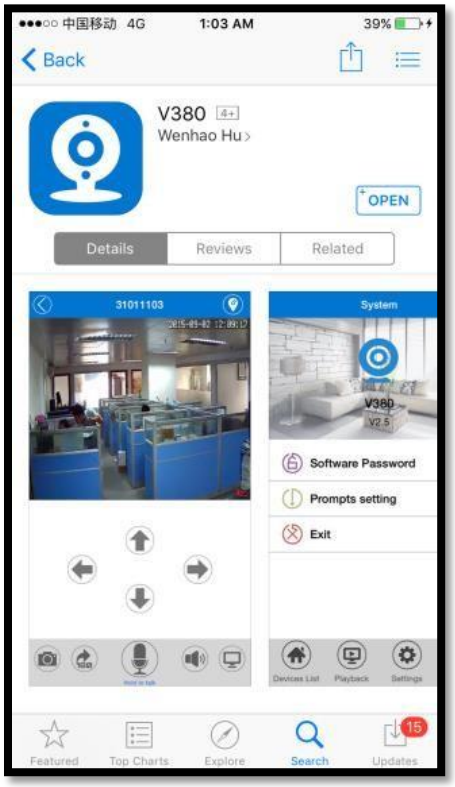


fig 59: PCB Layout of Receiver side

4.2.4 Smart Phone Installation of WiFi Camera (V380)

a. iPhone IOS (With WiFi Network):

Step 1: Open Apple App Store, search, download, and install V380



Step 2: Connect the power plug to the camera and place the camera "right next" to your WiFi router:

Camera sound: "System is starting"

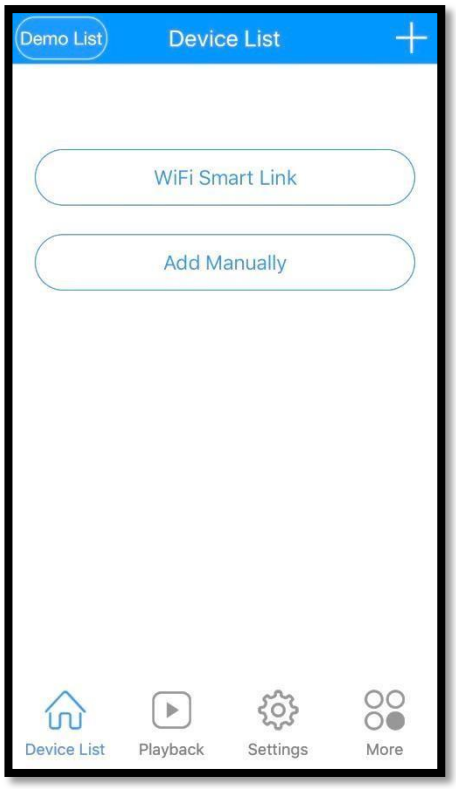
Camera sound: "System startup completed"

Step 3: Press and hold the reset button on the back of the camera until you hear the following sound:

Camera sound: "Restore factory default setting"

Camera sound: "Waiting for WiFi smart link configuration"

Step 4: Open the app V380
Click on “WiFi Smart Link”



Step 5: Your phone has to be connected to your WiFi network. You should then see your network name under WiFi Name. Enter your WiFi

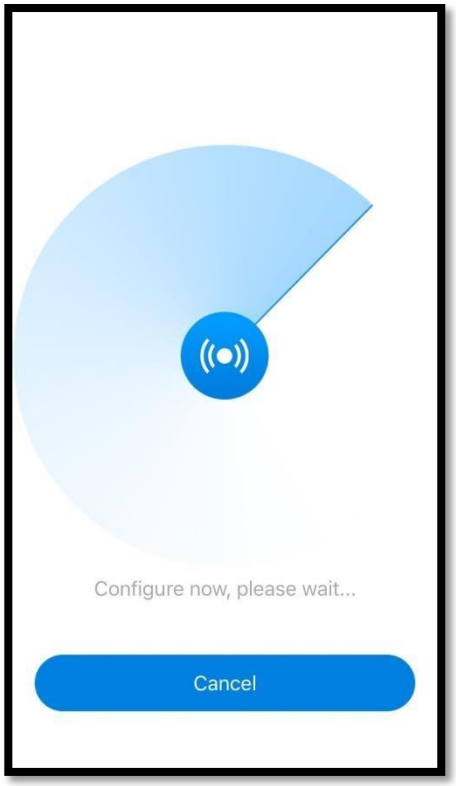
password and press next on the following screen.

Step 6: You will see the following screen, searching for the camera through your WiFi connection:

Camera sound: “Configuration received”

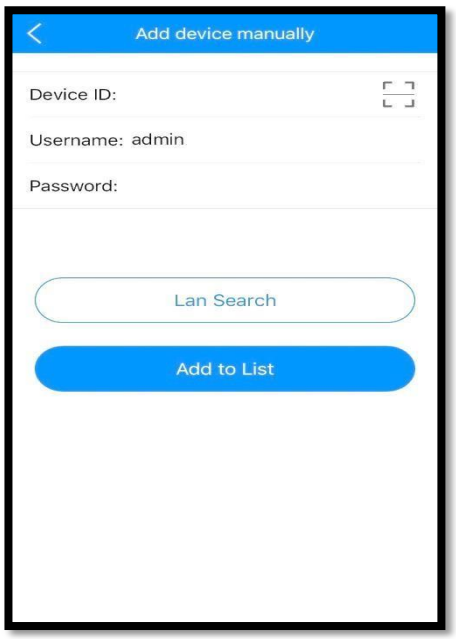
Camera sound: “WiFi connecting”

Camera sound: “WiFi connected”



Step 7: Successfully installed

Note: "Add manually" option is for when a camera is already connected to your home network and you would like add the camera to another phone. You can



simply press “Lan Search” or Type in the Device ID (located on the bottom of the camera) and click “Add to list” on the following page to add an already configured camera to your phone

b. Android (With WiFi Network):

Step 1: Open Google Play Store, search, download, and install V380

Step 2: Connect the power plug to the camera and place the camera “right next” to your WiFi router.

Camera sound: “System is starting”

Camera sound: “System startup completed”

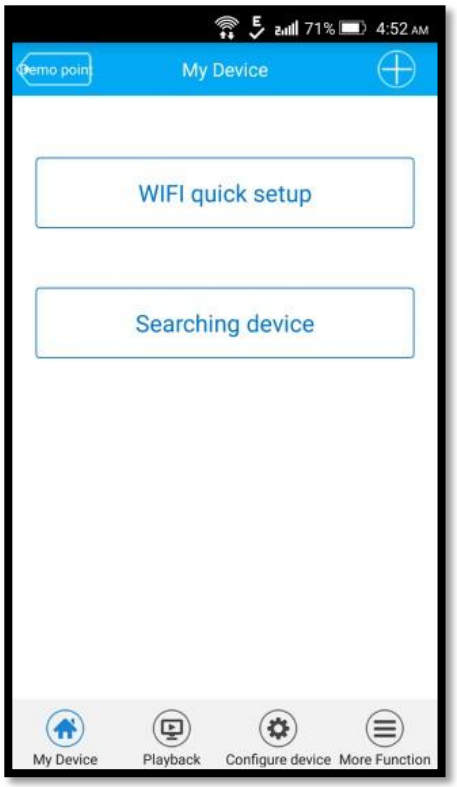
Step 3: Press and hold the reset button on the back of the camera until you hear the following sound:

Camera sound: “Restore factory default setting”

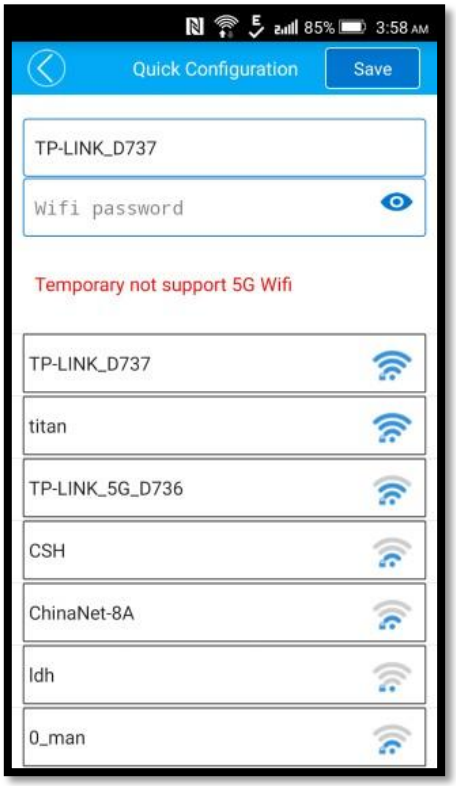
Camera sound: “Waiting for WiFi smart link configuration”

Step 4: Open the app V380

Click on “WIFI quick setup”



Step 5: Your phone has to be connected to your WiFi network. You should then see your network name under WiFi name. Enter your WiFi password and press “Next step” on the following screen:



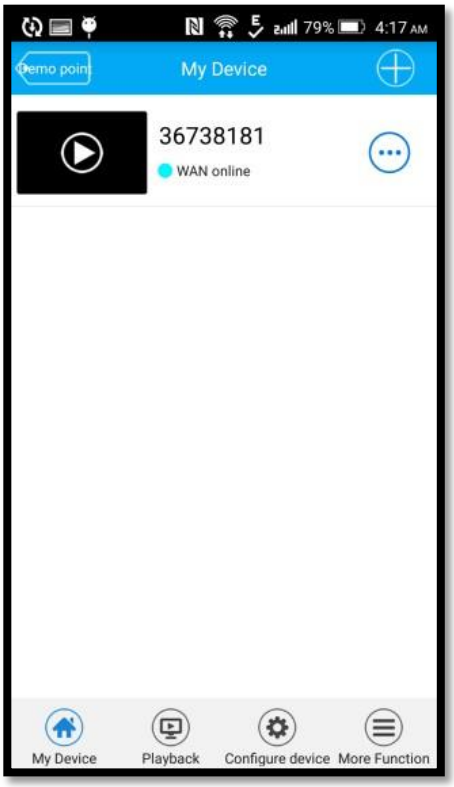
Step 6: You will see the following screen, searching for the camera through your WiFi connection.

Camera sound: “Configuration received”

Camera sound: “WiFi connecting”

Camera sound: “WiFi connected

Step 7: Successfully installed



Note: “Searching device” and “Device Linked” option is for when a camera is already connected to your home network and you would like add the camera to another phone. Simply clicking “Searching device” will add an already configured camera to your phone. Or you can click the + icon on the top right and click Device Linked, then click “Lan Search” or Type in the Device ID (located on the bottom of the camera) and click “Confirm Add” on the following screen to add an already configured camera to your phone.

IMPLEMENTATION

5.1 Working

In this To Control Robot Car & Servo Motor We use rf remote with 433mhx frequency based

Remote has 4 input switches based on that we have to control the robot & also control the servo motor up down position.

For process all this we use only 4 switches As Name SW1 SW2 SW3 SW4.

When we press SW1 & SW2 combine then System in robot Control mode & when We Press SW3 & SW4 Combine Then System in Servo Motor Control Mode.

Robot Control Mode: -

In the Mode Now Each Switch Act in Robot Direction Control as following Movement

SW1 -> Forward

SW2 -> Backward

SW3-> Left

SW4-> Right

In this motor control IC l293d Control Motor Direction in Clockwise or Anticlockwise.

Servo Motor Mode: -

SW1-> Move Servo Motor Up Direction Like 0 to 180 Degree

SW2-> Move Servo Motor Down Direction Like 180 to 0 Degree

It’s also had IR Sensor in front & back Side Which stop the robot Movement if some object comes in between the robot path

Also, IP camera V380 is there to View live video on Mobile app.

5.2 Block Diagram

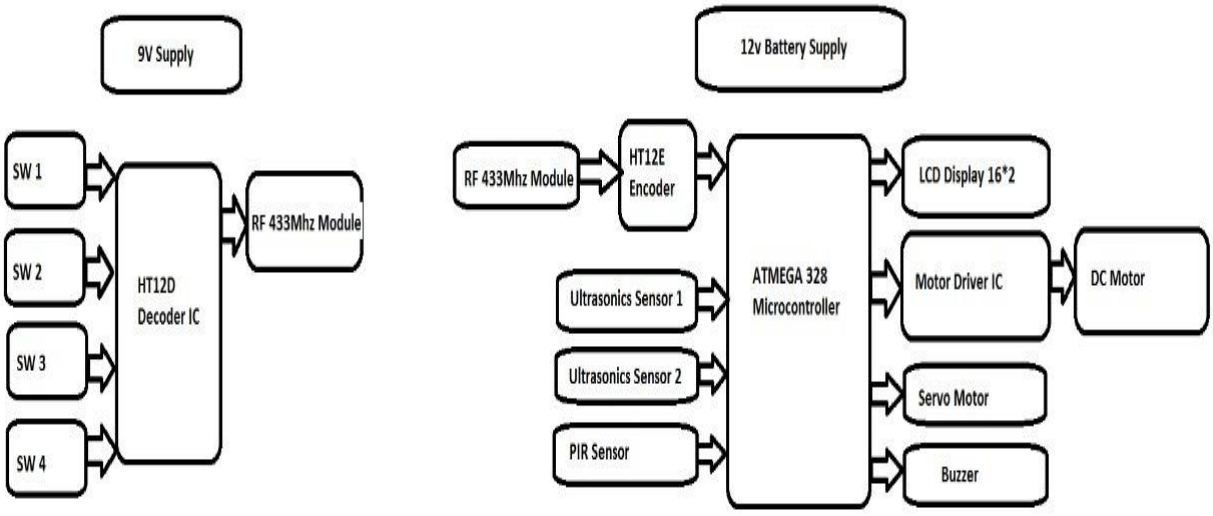


fig 60: Block Diagram of Robot Car

5.3 Flowchart

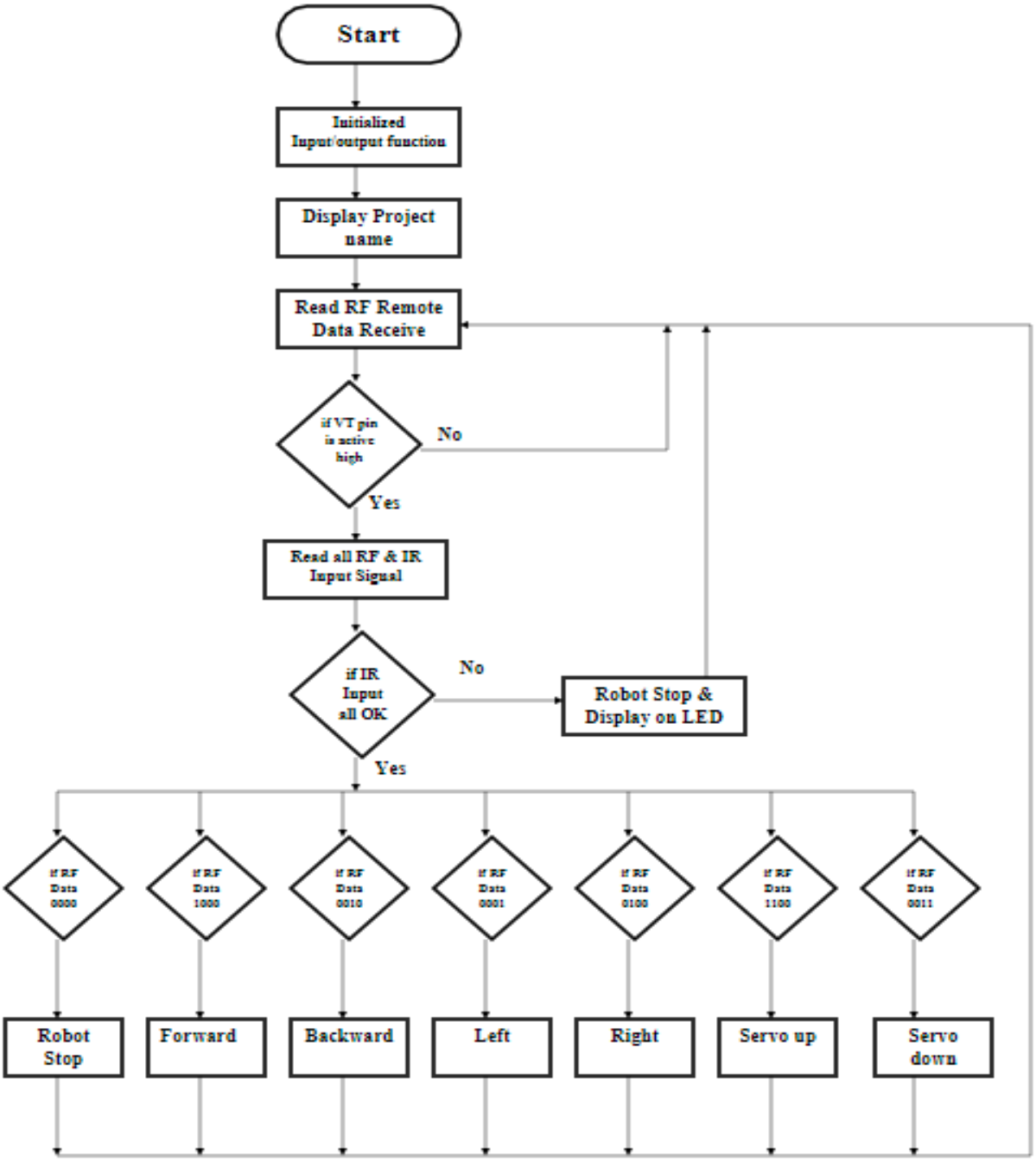


fig 61: Flowchart

CONCLUSION AND FUTURE SCOPE

6.1 Conclusions

The main idea of this paper was to construct a simple robot that assists humans in the purpose of cleaning in places where it is unsafe for the humans to work with. The advantage is that with the additional facilities such as the wireless camera, it makes the robot easy and user friendly for the human to work with. Using nano- tech this robot can be used in places such as air-craft vents were even human hands could not get through and thereby avoiding blockages. Thus, with this simple robot that helps us in the purpose of cleaning will save a lot of human lives.

6.2 Scope for future Work

- It can be used in the nuclear power plant to clean the D2O (heavy water) on the surface of nuclear power plant, which act as a moderator to slow down the neutrons from which nuclear radiations can occur.
- It can also be used in various radiation labs, bio-hazard chambers.
- In labs where carcinogenic radiations occur which cause cancer.
- It can also be used in thermal power plant where the ash obtained after burning coal is cleaned before mixing with the sea water and can be used in cement factories.
- It can be used in various areas which are very small for the humans to clean for which the robot is resized according to the specifications like ventilation shafts, to remove the blockages in pipes or tunnels etc.
- With proper lever mechanism this can be used to clean windows and this at greater heights. The base must be fabricated as a homonymic bot to move with greater degree of freedom.
- With sand papers attached to the wheels of the robot and with vacuum suction technology it can also climb walls and clean the ceilings of the wall and other equipment.

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