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Study, Conception and Realization of a Controlled Elevator Prototype based on a Microcontroller (PIC)

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General Introduction:

Technology in the IT world is adapted. At this level, IT services and companies must follow and accompany this dynamic, and as a result, they are led to review their IT approaches in order to be more responsive, either in the face of competition or to maintain a lead. This is the context of our project.

This work is a contribution to the study of the man-machine system, the advent of which is the postulate that man is in a certain way forced to cohabit with an overly disciplined and algorithmic partner. Man and machine are side by side to manage and control the systems we use in our daily lives, especially systems of great complexity, where the "man-machine" mindset is clear.

The activities of man, showing his role and place, are materialized either by the performance of man-machine work or by the performance of the "man-machine" work is clear.

With the increasing urbanization of our society, the elevator has become an indispensable system for meeting the modern demands of our lives in terms of independence, mobility, accessibility and speed. It is an essential element in residential buildings, offices, museums, airports, healthcare centers, public buildings, etc..... It contributes to saving time, facilitating travel, transport and shopping.

Indeed, this project consists in studying, designing and realizing a control board for an elevator based on a PIC16F877 microcontroller.

This report presents the progress of the project and allows to follow the progress of our work as well as the results obtained and the possible improvements.

The initial objective of this project was to build a model of elevator. For this purpose, our project will be composed of three chapters:

- The first chapter will be devoted to a presentation on the elevator. The history and the different types and modes of operation, as well as the advantages and disadvantages of each type, then we discussed the different parts of the traction elevator which will be our interest in this project, and at the end, we made a presentation on the model (prototype).

- The second chapter represents a theoretical study on the microcontroller. We gave a generalization on the spike first after a study on the architecture and the choice of the spike and at the end the mode of operation.

- Finally the third chapter represents a design and implementation study. In this chapter we have analyzed and described the different components of our boards and presented them in our realization with, of course, the processing of the program of our control board.

Chapter I:

General Presentation On The Elevator

I. Chapter I: General Presentation On The Elevator

1 Introduction:

Humanity has always been innovative in finding creative ways when it comes to improving efficiency. Humans have been looking for a mechanism to transport freight and passengers vertically to different levels since the beginning. First elevators are these gadgets that elevator objects up and down.

Interesting Read: "Innovations in High-Rise Building Designs."

Most people don't pay much thought to how elevators work or how they grew so prevalent before becoming familiar with most buildings. Elevators are intriguing technological marvels that have a lengthy history.

1.1 Early History:

The history of elevators dates back many hundred years before Christ. The first elevators were known as hoists. To power these mechanisms, early humans used their physical strength and animal power, and water-driven systems. These mechanisms have been around since the 3rd century BC. People use this system for over 2000 years.

Several mountain monasteries employed miniature "basket" elevators to convey people and things up their high and solitary walls throughout the Middle Ages. Those constructed monasteries have no land access and only an elevator as a means of admittance.

King Louis XV of France in 1743 had the first human-powered, counter-weighted personal elevator built. It linked his Versailles apartment to his mistress, Madame de Chateauroux, who lived one floor above him. In 1793, a Russian mechanic and inventor invented the first elevator, which used screw mechanisms to hoist the cabin. The installation of his elevators is in two Russian imperial palaces, St. Petersburg and Moscow, and in London thirty years later.

1.2 The Advent Of Change:

The invention of hydraulic and electrical power ushered in a revolution in elevator technology. Hydraulic elevators were the most popular mode of transportation for freight commodities over short vertical distances. They worked on increasing the pressure of the primary plunger, which drove the freight compartment upwards.

Elevator technology advanced dramatically in the nineteenth century. Many elevators in warehouses, mines, and factories powered by steam became vital throughout the Industrial Revolution to allow people to transfer heavy products. These primitive elevators gradually progressed from smoke to hydraulic power. They use water pressure as the source of energy for the earliest hydraulic elevators.

Burton and Horner, two architects, erected an "ascending room" in 1823 to provide tourists a panoramic perspective of London. The "Teagle," a steam-powered belt-driven and counter-weighted elevator, was built in England by Frost and Stutt, who were also architects, in 1835. Sir William Armstrong invented the hydraulic crane in 1846. A massive piston that moved in a cylinder supported the system. The mechanism's power is by oil or water pressure inside the pump.

Elevator design, the ones we used until this day, dates back to 1852 when a safety system kept the cabin from plummeting if the main cable failed. Elisha Graves Otis, the inventor of this gadget, demonstrated in the New York Crystal Palace exposition of technical achievements in 1854. His elevator was put in the first skyscraper in New York City a few years later.

Otis founded an elevator manufacturing company, which went on to dominate the elevator industry. The Otis Elevator Factory is now the world's largest vertical transportation system manufacturer.

1.3 Elevator Technology Revolution:

The invention of hydraulic and electrical power ushered in a revolution in elevator technology. Electricity quickly became the recognized source of energy as motor technology and control systems advanced. These elevators' safety and speed improved considerably. Wener Von Siemens, a German inventor, created the first electric elevator in 1880.

In 1887, issuing a patent for an electric elevator with automatic doors that would block off the elevator shaft happened. Elevators became safer due to this development, and the erection of the first commercially practical electric elevator occurred in 1889. During World War II, significant developments in electronic systems led to many modifications in elevator design and installation.¹

¹ <https://www.accessdoorsandpanels.com/>

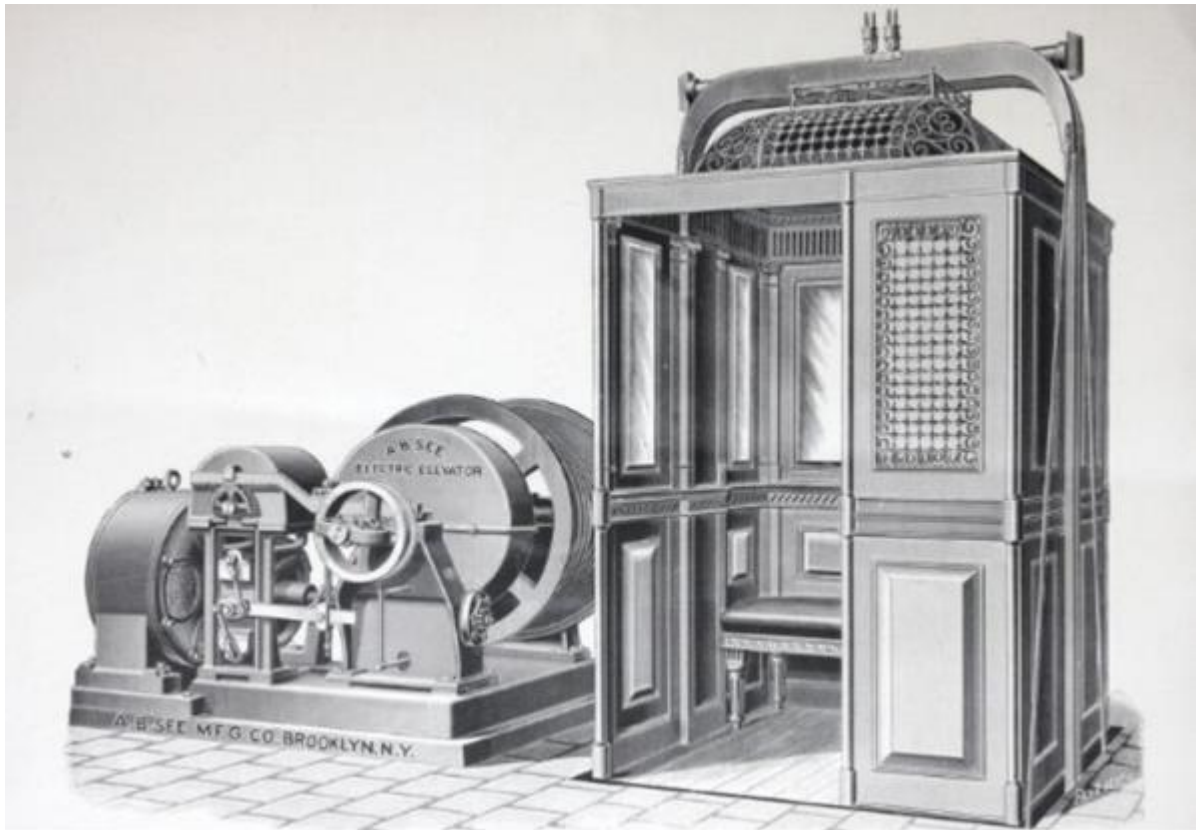


Figure I.1: Visual History Of Elevator Design

2 Definition:

An elevator is a platform that could either be open or closed and is used for lifting or lowering both people and goods to upper and lower floors. In the past, it was not mandatory for story buildings to have elevators. As a result, some real estate investors avoided installing elevators because they were expensive to install and maintain².

In high-rise buildings, elevators are typically combined into groups and the elevators in the same group are collectively controlled by an elevator group control system (EGCS). The task of the EGCS is to dispatch the elevators to passengers' requests, e.g., up and down calls, so that they get to their destinations fast and without waiting. In order to achieve this, modern EGCS use advanced mathematical optimization algorithms to minimize passenger waiting or journey time, or both. This optimization problem is called the Elevator Dispatching Problem

² <https://www.vacuumelevators.com/>

(EDP)3: 4. Given a set of pickup requests, a solution to the EDP defines optimal elevator routes, i.e., which requests and in which order each elevator will serve so that the selected service level criterion is optimized.

Elevators are the most commonly used mode of vertical transportation in modern buildings with more than three storeys. With the development of urbanization, elevators, especially traction-type passenger elevators, have played an important role in human life. More than a decade ago, it was estimated that there were more than half a million passenger elevators in the United States transporting people day and night throughout the year⁵

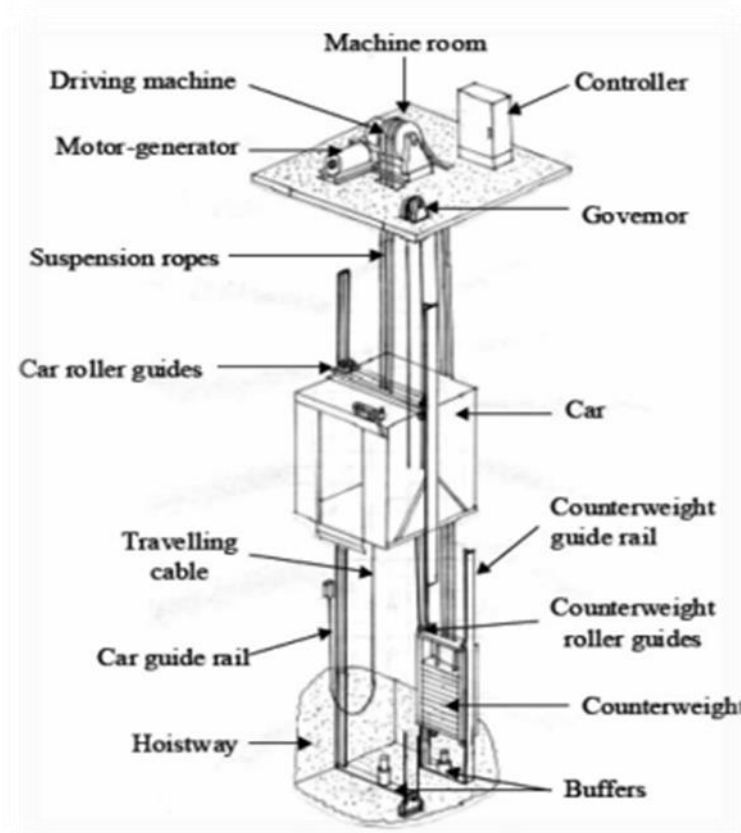


Figure I.2: Main Components Of A Typical Traction-Type Passenger Elevator⁶

³ - Universite C'ote d'Azur, CNRS, I3S, France ^

⁴ - KONE Corporation, 02150 Espoo, Finland

⁵ - Swerrie, D. A. The San Francisco earthquake of 1989 and an inspector's reflections. *Elevator World*, 1990, XXXVIII, 14–22.

⁶ - Rildova. Seismic performance of rail-counterweight system of elevator in buildings. PhD Thesis, Virginia Polytechnic Institute and State University, 2004.

3 Elevator Type:

Presently, in the market, the customer will find different kinds of elevators with their unique features. You have to choose what type of elevator will be best for you! Choose the best type of elevator as per your need. Every category is different and every type of elevator has different features and benefits. You just need to check and select the best type of elevator as per your need. First, you should understand what type of elevator will be best for you and then choose which one will be ideal for you. Whether you need a commercial elevator or residential or freight elevator and size, shape, and details all are matter. So, first, check properly and then select the best one⁷

3.1 Passenger Elevator:

The advent of high-rise buildings in modern cities requires high-speed elevator systems to provide quick access between floors in buildings, but with the increase of running speed and travelling height, the vibration of elevators become more and more serious. The concomitant excessive vibration and impact worsen the performances of high-speed elevators because of the additional dynamic load on its driving system. Additionally, the vibration and sound interfere with the comfort and health of the human passengers⁸.

⁷ - Rildova. Seismic performance of rail-counterweight system of elevator in buildings. PhD Thesis, Virginia Polytechnic Institute and State University, 2004.

⁸- Gang, X.Y.,Mei,D. Q., and Chen, Z. C. A horizontal vibration wave model for high speed elevators.Key Eng. Mater., 2005, 297–300, 1585–1591.



Figure I.3: Passenger Elevator

3.2 Freight Elevator:

Freight elevator is one of the best types of elevators which mainly used for load purposes. Mainly in a construction site, or manufacturing unit, or any place where the load needs to up and down, to those places freight elevator will be the best option all the time. Choose the best type of freight elevator as per your need. Before selecting any type of freight elevator there are certain things you have to consider. The installation process is very simple. If you will choose a local company or people they can easily install without any problem. The cost of installing a freight elevator is determined by specific parameters and specifications.

A series of parameters such as different loads, different floors, different decorations, and whether have machine rooms may affect the price of freight elevators, so the cost of installing freight elevators should be calculated according to specific parameters.⁹

⁹ - Gang, X.Y.,Mei,D. Q., and Chen, Z. C, the same previous source



Figure I.4: Freight Elevator

3.3 Sidewalk Elevator:

Sidewalk elevator is another type of elevator which is also mainly carry for move cargo. This type of elevator is mainly used to move materials directly. If you have business with loading and unloading then a sidewalk elevator will be ideal for you. This will reduce the load and safely move goods, heavy equipment, or tools from one floor to another floor. It saves your valuable time and cost both. Choose the best type of sidewalk elevator and install it now! The installation cost is also minimum than other types of the elevator. If you are looking for a quality sidewalk elevator then choose us. We are one of the best manufacturing companies who offer superior quality sidewalk elevators now! If you will choose us, you will get all types elevators you desire!¹⁰

¹⁰ - Gang, X.Y.,Mei,D. Q., and Chen, Z. C, the same previous source



Figure I.5: Sidewalk Elevator

3.4 Stage Lift:

Stage Lift systems allow for gentle quiet movement and stable support of stages, orchestras, equipment, and seating platforms. Combining strength and adaptability, the lifting systems are efficient and reliable. Hydraulic stages made it possible to raise sections of the stage, tilt them or even rock them to simulate, for example, the motion of a ship. All of these mechanisms required larger backstage facilities, higher-flying towers, greater depth and width of stages, and increased work pressure. There are many construction areas where people may use such type of lift always. Choose the best type of stage lift as per your need. Choose the best deal through us and get assured quality.¹¹

¹¹ - Gang, X.Y.,Mei,D. Q., and Chen, Z. C, the same previous source



Figure I.6: Stage Lift

3.5 Vehicle Elevator:

Vehicle elevator is another best type of elevator and this type of elevator is perfect for vehicle manufacturing plants or garage areas. Using this type of elevator, you can easily up and down a vehicle without any problem. This type of elevator is the very hard type and weighty. It will also increase efficiency. It will reduce energy costs. It also helps to reduce electromagnetic noise. For vehicle elevators, you don't need maintenance properly. This type of elevator is also good for the vehicle up and down and it's completely safe. Choose the best type of vehicle elevator as per your need.¹²

¹² - Gang, X.Y.,Mei,D. Q., and Chen, Z. C, the same previous source

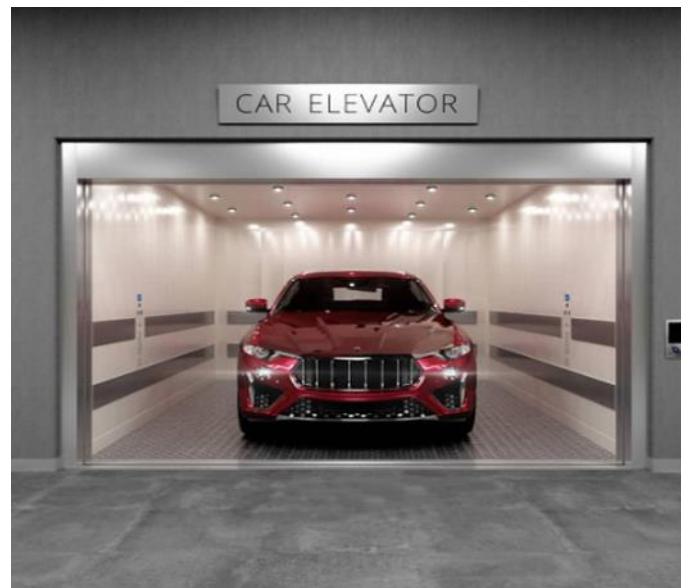


Figure I.7: Vehicle Elevator

3.6 Boat Lift:

There are many people who thought installing a boat lift is very simple but it is not truth! You have to install using proper tools and equipment otherwise you may face massive damage. You have to know about the typical locking system and you should control the water level. It actually moves the boat using lift from one place to another. If you are looking for quality boat lift within your budget, mail us your requirement. We are ready to provide you best support all the time. We also offer strong customer care support as well. The demand for boat lift is huge and we will be able to customize the boat lift always. Whether you need small in size or standard size, we can do this for you easily.¹³

¹³ - Gang, X.Y.,Mei,D. Q., and Chen, Z. C, the same previous source



Figure I.8: Boat Lift

3.7 Aircraft Lifts:

Aircraft lifts are very expensive and if you will use a modern aircraft lift then you will be able to keep your private jet or airport plane easily one after one. There are different types of aircraft lifts available in the market and you may choose any type of lift as per your need. If you will search the market, you will find different types of lifts and elevators. You just need to check and select the best type of aircraft lifts as per your need. Choose the best type of aircraft lifts as per your need.¹⁴



Figure I.9: Aircraft Lifts

¹⁴ - Gang, X.Y., Mei, D. Q., and Chen, Z. C, the same previous source

3.8 Residential Elevator:

A residential elevator is one of the best types of elevators and you can customize the shape and size of the elevator. We are able to make different types of designs with advanced safety feature residential elevators. The purpose of the residential elevator is to increase the luxury of the house and move from one floor to another floor without any hesitation. Choose the best type of elevator as per your need. You can build small, medium, or large size residential elevators as per your need. You can make different types of elevators based on uses. Choose the best deal now.¹⁵



Figure I.10: Residential Elevator

Elevator With Law:

Elevators were not widely used until the Americans with Disabilities Act was passed in 1990. Discrimination against people with impairments is prohibited under the law. All two- or three-story buildings must also include elevators, according to the regulation. People with impairments will be able to reach various floors more readily as a result of this.¹⁶

Elevators Work:

Elevators haven't changed much since the 1800s. Elevators still maintain their original purpose of transporting people across floors. The Otis Safety System is used in most elevator types and has been since the 1850s.

¹⁵ - Gang, X.Y., Mei, D. Q., and Chen, Z. C, the same previous source

¹⁶ -<https://www.vacuumelevators.com/> the same previous source.

Control systems have been altered for modern elevators in ways that improve on speed and safety. In most cases, elevators will apply the use of counterweight and 40% of the maximum rated load to balance the car.

The main purpose of the counterweight is to reduce the weight to be lifted by the motor and to keep the entire elevator in control with the cables intact. In order to ensure durability and strength, the car elevator is made from steel. The pulley used by the hoist cable is held in place by a spanned side-to-side elevator shaft. This span is controlled by a set of steel beams that are placed above the elevator car.

Modern elevator cars also have additional technology installed in them. Some have phones that allow the occupant to call for help in the event of an emergency. Others are fitted with a trap door located at the ceiling that make escape possible in emergency situations.

Elevators are designed and fitted into a building according to the building's population capacity and duties to be performed. For example, there are some buildings that will have large elevators to transport cargo to different floors. Hospitals have elevators that open on both sides to allow easy entry and movement of emergency patients.

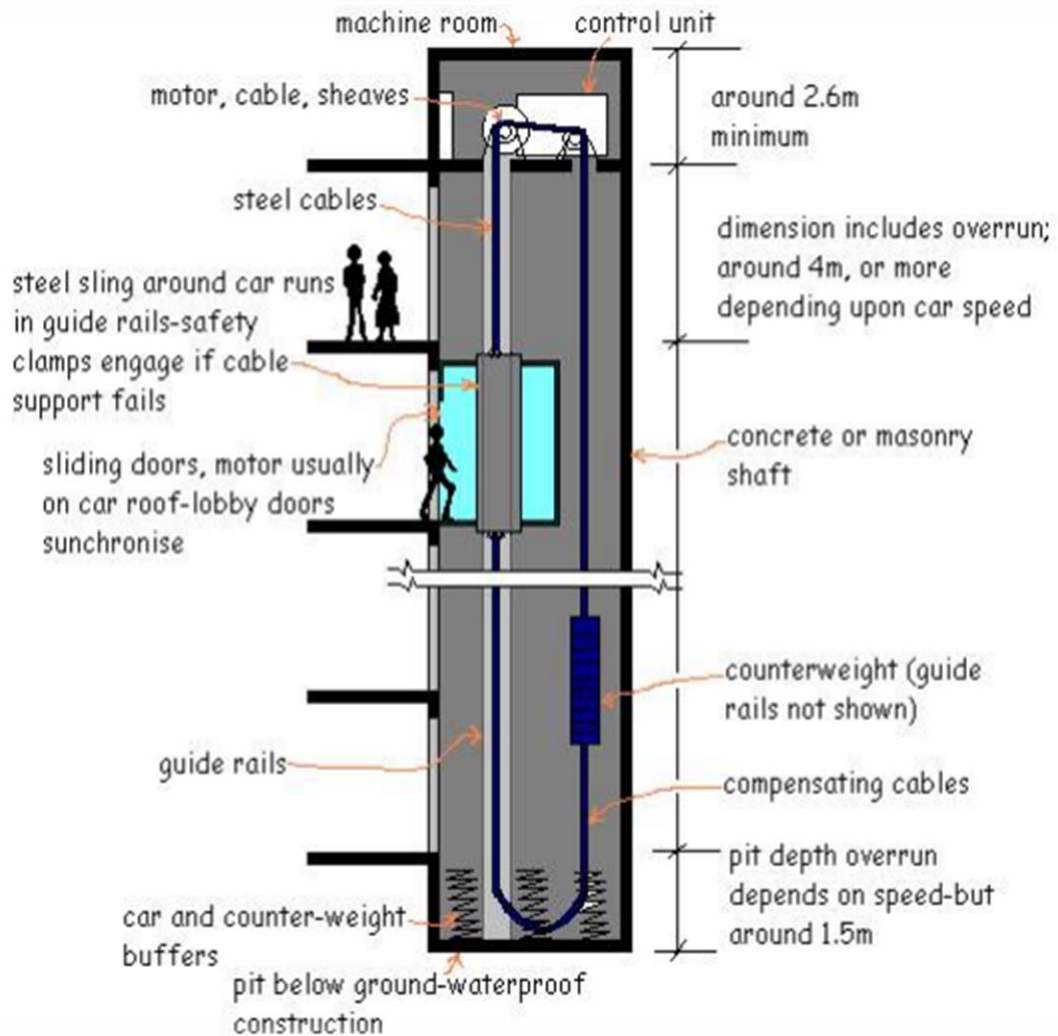


Figure I.11: Elevator Architecture

4 Types Of Elevators:

Most elevators had to be controlled by a centralized machine room in the past. Some elevators today do not require a machine room because they have a built-in safety mechanism. Elevators are classified as hydraulic, traction, machine-room-less, or vacuum.

4.1 Traction Elevator:

Traction elevators are the most common elevator design. They are used all over the world. The elevator car and a counterweight are connected by steel ropes that are looped around the sheave. The sheave is a pulley with grooves all the way around it. The strew is

powered by an AC or DC motor. The sheave grips the hoist ropes and rotates with them. Ropes move as well. Traction is the cause of this gripping.¹⁷

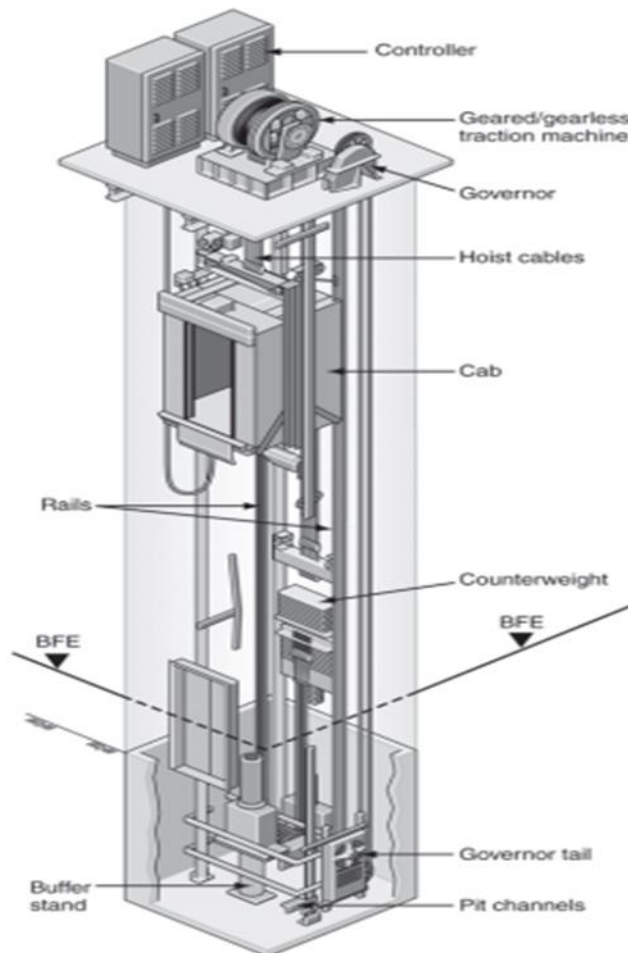


Figure I.12: Traction Elevator

4.1.1 Roping Arrangements:

A roping system is used to attach the motor/gear reducer, the elevator car and the counterweight. There are many different kinds of arrangements that can be used; the two most common are: 1. One to One roping (1:1) also called traction drum arrangement 2. Two to One Roping (2:1) also called lifting drum arrangement.

¹⁷ - PDHonline Course M376 (4 PDH)

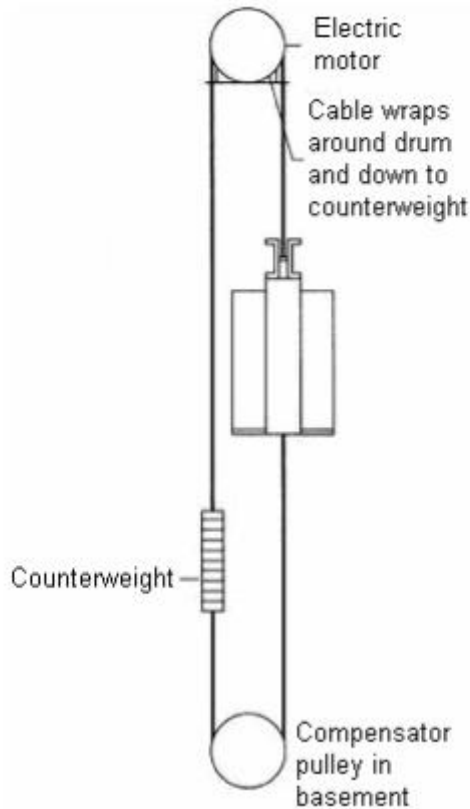


Figure I.13: Traction Drum Arrangement

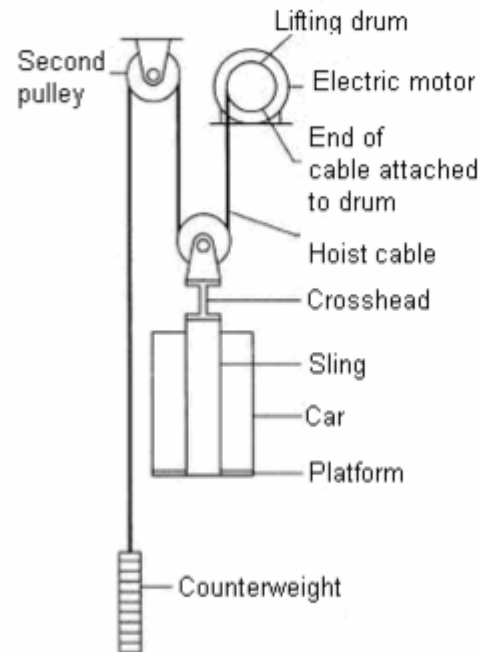


Figure I.14: Lifting Drum Arrangement

One To One Roping (1:1) Or Traction Drum Arrangement:

The hoist ropes run from the elevator car hitch over the machine sheaves to the counterweight hitch in a One to One roping (1:1) arrangement. Each set of guide rails runs the elevator car and the counterweight separately. From the car, a second governor cable runs up to a governor pulley, then down to a tension pulley at the bottom of the elevator shaft, and up to a tension pulley at the top of the elevator shaft. The car once more the governor pulley is rotated by this cable at a speed that is directly proportional to the car's speed. When a car speeds up too fast, the governor uses another cable to slow it down. Activate the emergency brake jaws, which grip the guide rails and bring the vehicle to a complete stop.¹⁸

¹⁸ - PDHonline Course M376 (4 PDH)/ the same previous source

Two To One Roping (2:1) Or Lifting Drum Arrangement:

Arrangement of hoist ropes in which one end of each hoist rope passes from a dead-end hitch in the overhead, under a car sheave, up over the drive sheave, down around a counterweight sheave and up to another dead-end hitch in the overhead. The car speed is one-half the rope speed.¹⁹

4.1.2 Counterweight:

Power is transferred from the traction drive to the elevator car and counterweight when the traction drive is rotated. When the elevator car is ascending, the counterweight provides an accelerating force, and when the car is descending, it provides a retarding force.

The counterweight is typically equal to the car's weight plus about half of its maximum rated capacity. When the car is full or empty, it saves energy equivalent to the unbalanced load between the elevator and the counterweight. While the cable is intact, the counterweight ensures that the elevator does not lose control.

¹⁹ - PDHonline Course M376 (4 PDH)/ the same previous source

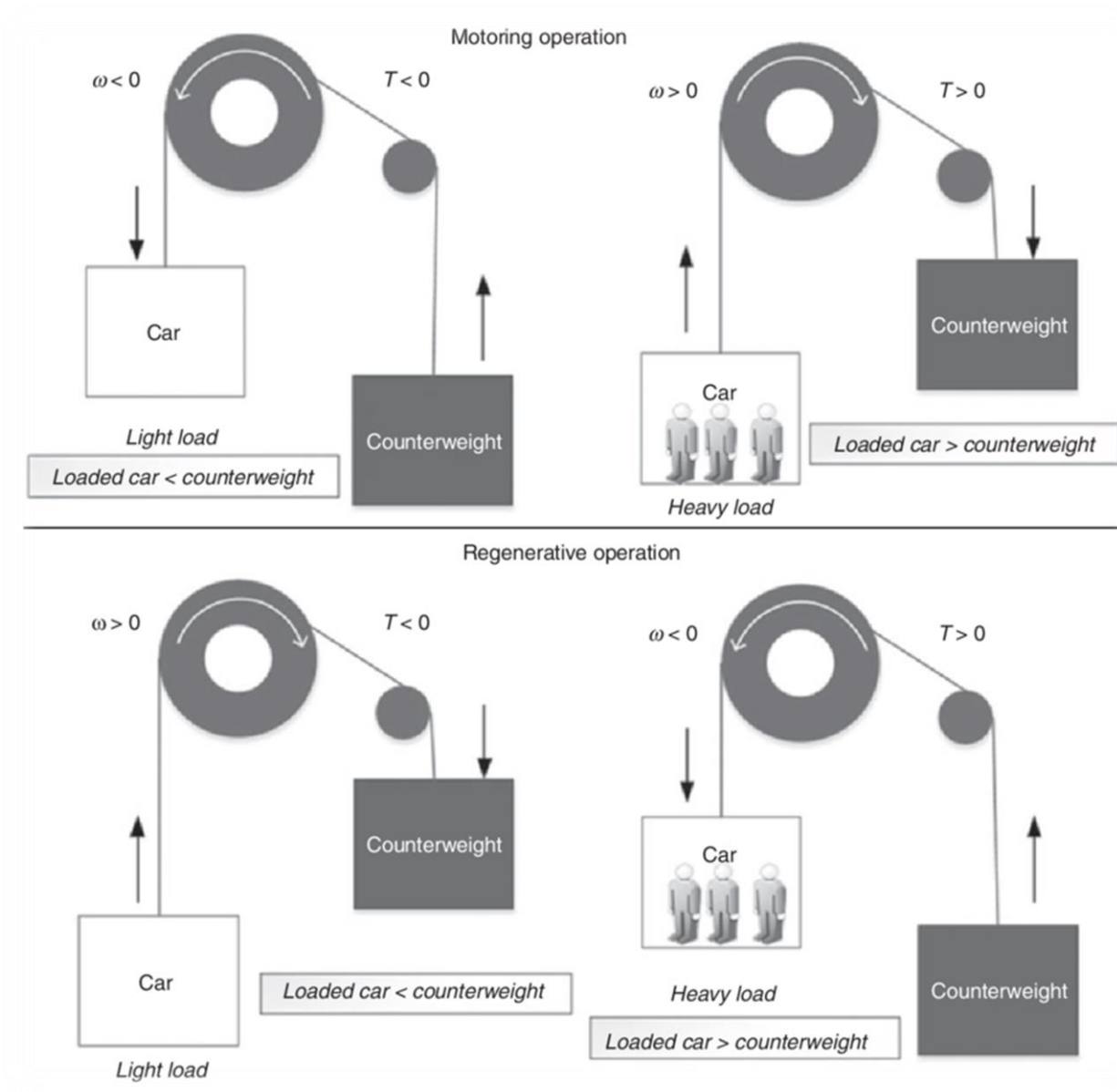


Figure I.15: Counterweight

4.1.3 Hoist Mechanisms:

The purpose of an elevator is to convert the electrical power that drives the motor into mechanical power. Hoisting mechanisms are divided into two categories: geared and gearless.

- Geared Type:

The motor in a geared machine drives a gear train that rotates the sheave. Medium-speed applications require geared traction machines, which have effective speeds ranging

from 0.5 m/s (100 fpm) to 2.0 m/s (400 fpm). The slower speeds are used for freight, while the faster speeds are used for passenger service in buildings with ten stories or less.

Most geared elevator systems use a worm gear reducer, which is made up of a worm gear, also known as the worm, and a larger round gear, also known as the worm gear.

These two gears, which have perpendicular rotational axes, not only reduce the traction pulley's rotational speed, but also change the plane of rotation. We increase the ability to lift larger objects for a given pulley diameter by decreasing the rotation speed and increasing the output torque.

Because of its compactness, precise speed control, quiet operation, and ability to withstand higher shock loads, worm gears are preferred over other types of gearing options. It's also simple to install on the motor shaft and has a high resistance to shaft rotation in the reverse direction.

The efficiency of the gear train is a consideration in the selection of the type of hoisting machine. Following key facts should be noted, when specifying geared machines:

1. The efficiency of the gear train depends on the lead angle of the gears and the coefficient of friction of the gear materials. The lead angle is the angle of the worm tooth or thread with respect to a line perpendicular to the worm axis. As this angle approaches zero degrees, the reduction ratio increases and the efficiency decreases due to increased sliding along the gear teeth. For optimum efficiency, the lead angle should be high usually in the range of 50% to 94%
2. The efficiency also depends on the operating parameters of the gear train. Usually, smaller reduction ratios, higher input speeds, and larger gear reducer sizes shall result in greater efficiencies. However, it does not mean to intent ally over-size the gear train because the large gear train will operate less efficiently at partial load condition. The gear reduction ratios typically vary between 12:1 and 30:1.

Geared Traction machines can be driven by AC or DC motors. The machines are normally located overhead, directly over the hoistway but can be mounted to the side and below; and when this is done, it is termed as "basement traction" application.

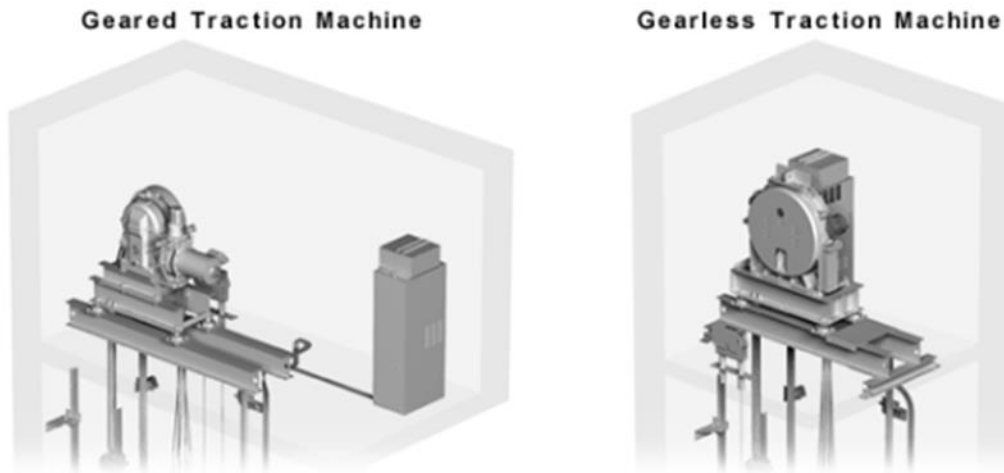


Figure I.16: Geared and Gearless Traction Machine

The disadvantage of geared hoisting is that friction causes the gear train to lose energy, and thus the transmission efficiency of a geared elevator is lower than that of a gearless machine.²⁰

- **Gearless Type:**

In a gearless elevator, the motor directly turns the sheave. To keep the elevator stationary at a floor, a brake is installed between the motor and the drive sheave. This type of brake is usually an external drum brake that is operated by spring force.

Gearless traction elevators are designed for applications requiring high speeds.

Ranging from 2.5 to 10.0 m/s (400 to 1200 fpm) (2000 fpm). These are typically used on taller people. Structures with a height of more than ten stories In terms of energy efficiency, gearless drive is ineffective. As a result, gear transmission loss has a transmission efficiency of 100%.

Gearless traction machines use low torque electric motors (generally DC motors) driven by motor generator (MG) drive or silicon-controlled rectifiers (SCR). Modern gearless traction machines use variable-voltage; variable frequency (VVVF) drives systems.²¹

²⁰ - PDHonline Course M376 (4 PDH)/ the same previous source

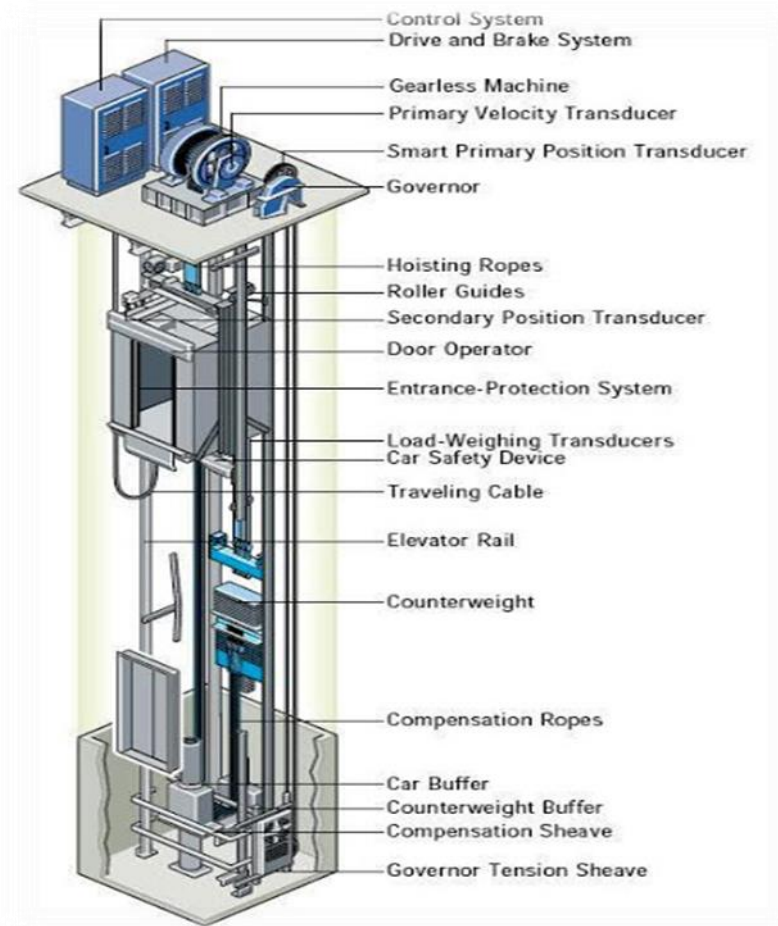


Figure I.17: Gearless Type Machine

4.1.4 Engineering Design:

The traction drive depends on the friction, or traction, between the hoisting ropes and the drum. The hoisting ropes are wound over the drum (possibly several turns are made) and down to the counter weight, which compensates for the weight of the empty elevator car and vastly reduces the power needed by the hoisting motor.

The traction force between the traction drive and the rope is initiated by friction between the ropes and the sheave grooves cut on the pulley. According to ASME A17.1, sufficient traction between the rope and groove must be provided to safely stop and hold the car with the rated load in the down direction. In most mechanical systems, reducing friction between parts is a top priority; however, this is not the case in elevators.

²¹ - PDHonline Course M376 (4 PDH)/ the same previous source

When it comes to traction-driven machines, friction is given a lot more weight. Traction, in layman's terms, is the force that grips the surface. Traction is the frictional force in technical terms.

4.1.5 Traction Calculation:

Consider a rope passing over a driving sheave. Let T_1 be the tension in the car side, and T_2 in the counterweight side.

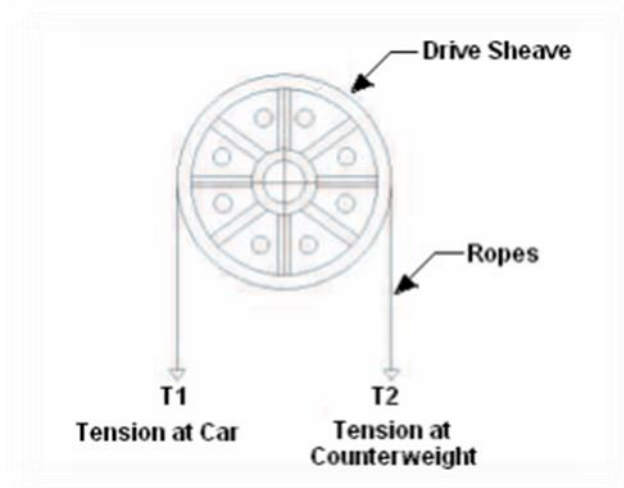


Figure I.18: Traction Calculation

The required traction for the elevator system is expressed as T_1 / T_2 .

T_1 is the addition of all weights (i.e. 125% of rated load, car weight and traveling cable weight), whereas T_2 is the tension at counterweight.

The maximum available traction that can be developed is a function of the actual coefficient of friction between the rope and groove, the shape of groove and angle of contact. Maximum available traction = $\exp(f\theta)$

Where

- \exp = the base of natural logarithm
- f = coefficient of friction
- θ = angle of contact

Hence the condition so that the elevator does not lose traction is given by:

$$T_1/T_2 * C < \exp(f\theta)$$

Where, C is a constant, considering acceleration and deceleration, and is given by:

$$C = (gn + a) / (gn - a),$$

Where

- gn = acceleration due to gravity and
- a = rated speed of the elevator.

Obviously, from the above expressions, we can conclude that the maximum traction can be achieved when the value of $f\Theta$ is increased.²²

- Factors Affecting Traction:

1. **Sheave Diameter:** Increase the arc of contact that the rope makes with the sheave to increase available traction. In traction, the ratio of rope diameter to sheave diameter is critical. The sheave diameter should be 40 times the rope diameter as a good engineering practice. The larger the sheave diameter, the greater the area of contact between the rope and the sheave.

The sheave diameter should also be large enough to accommodate the ropes' bending stresses. However, when determining the final diameter, cost must be taken into account. It will also lead to a larger machine assembly, which will cause installation issues.

2. **Shape of the Groove:** The available traction can be increased by altering the groove's shape.

- **The V-groove** is the most common groove type. These provide the most bearing pressures, resulting in the most traction. The groove angle is kept between 32° and 40°. While decreasing the angle of the groove increases traction, it also reduces rope life.

- **The U-groove** is the sheave of choice for optimum life. Abrasion and fatigue are reduced thanks to its large size and supportive grooves. The groove cradles the rope, resulting in low groove pressures that allow the wires and strands to move freely while the rope is in use. The U-grooved sheave, on the other hand, provides the least amount of traction.

²² - PDHonline Course M376 (4 PDH)/ the same previous source

3. **Coefficient of Friction:** Lastly but not the least, the available traction can be increased by increasing the actual coefficient of friction of the material. Note that all the above parameters are dependent on one another. Compromising on any of the above factors should not change the final traction value. With this background, elevator system designers need to be very careful in estimating traction and establishing their designs.

4.1.6 Construction Of Traction Elevators:

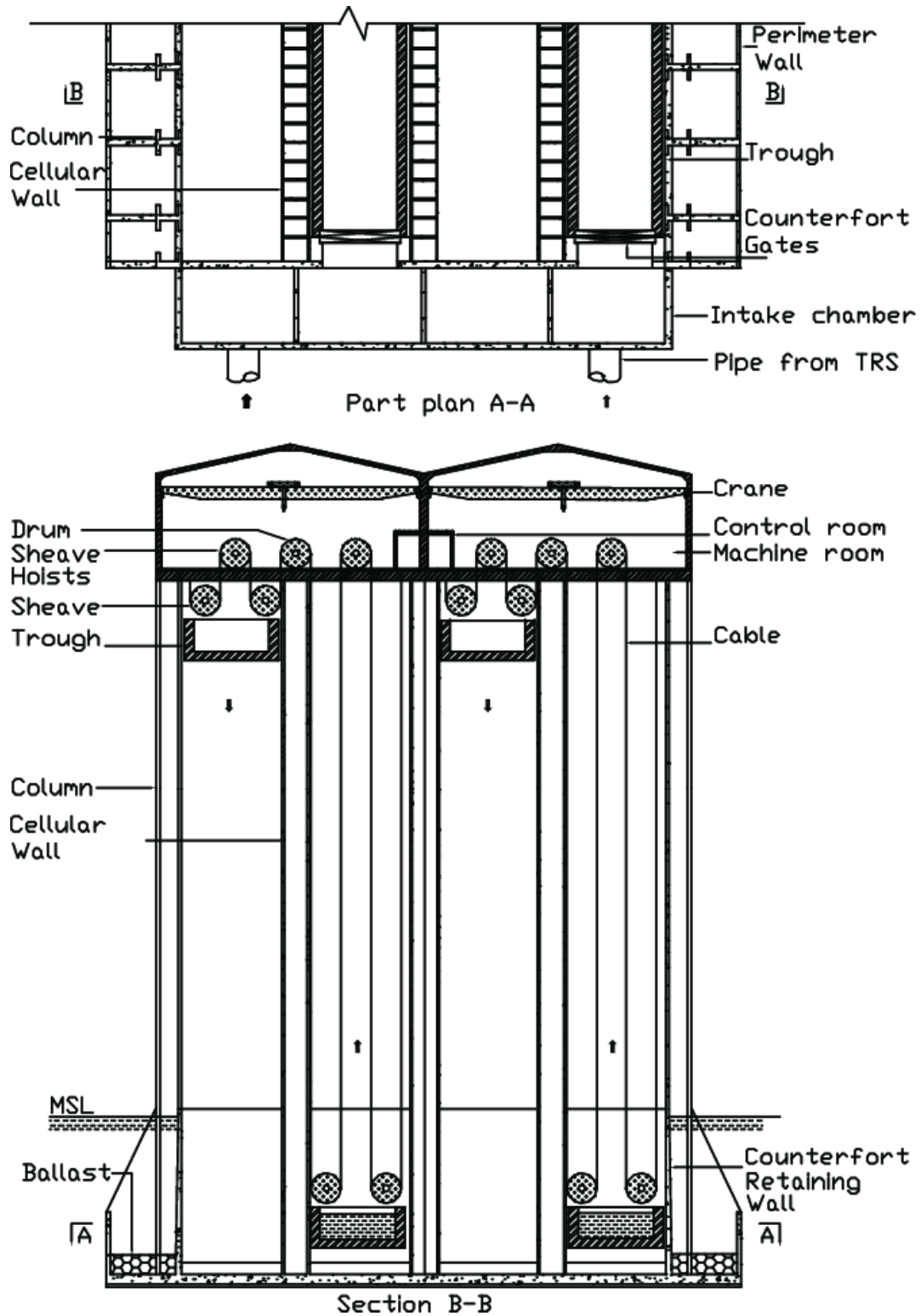


Figure I.19: Construction Of Traction Elevators

The elevator car itself is constructed with a steel framework for durability and strength. A set of steel beams above the car, called the crosshead, span the elevator shaft from side to side and hold the pulley for the hoist cable. A steel structure, called the sling, extends down

the sides of the car from the crosshead and cradles the floor, or platform. The sides of a passenger elevator car are usually made from steel sheet and are trimmed on the inside with decorative paneling. The floor of the car may be tiled or carpeted.

For appearance and wearability, stainless steel handrails and other inside trim may be used. A suspended ceiling is typically installed below the car's actual top and may include fluorescent lighting above plastic diffuser panels. Behind panels on the front of the car, near to the doors, are the elevator controls, alarm buttons, and emergency telephone.

In a simple installation, the service core is made up of the lift shaft, which is made of concrete or masonry.

The vehicle and counterweight are kept from wobbling or twisting by guide rails that traverse the length of the shaft. To provide smooth movement over the guide rails, steel guide rollers or guide shoes are mounted to the top and bottom of the sling construction. The emergency brake mechanism consists of two clamping faces that can be squeezed together on the guide rail by a wedge. A screw cranked by a drum attached to the emergency cord activates the wedge.

For further details, refer to Section-3 “Design Criteria of Elevator Systems”.²³

- **Benefits:**

- Faster and smoother ride;
- More energy efficient;
- Cost little more to buy.

- **Drawbacks:**

- Installation costs can cost you higher than the hydraulic elevators.
- Traction lifts are difficult to maintain, as the control of the machine are placed in the shaft area. This area could be difficult to access.
- Getting spare parts will be a biggest challenge and servicing can only be done by original installer or by the service partner.
- Rescue of passengers during an emergency situation can be a challenge also, because the traction lifts requires special training for functioning and difficult to reach in shaft.²⁴

²³ - PDHonline Course M376 (4 PDH)/ the same previous source

²⁴ - <http://vinteelevators.com/>

4.2 Hydraulic Elevators:

A hydraulic ram, a fluid-driven piston positioned inside a cylinder, is used to lift a car in hydraulic elevator systems. The piston bears the entire weight of the elevator cab.

The cylinder is coupled to a fluid-pump system (hydraulic systems like this commonly utilize oil, although other incompressible fluids could be used as well).

The hydraulic system has three parts:

- A tank (the fluid reservoir).
- A pump, powered by an electric motor.
- A valve between the cylinder and the reservoir.

The pump pushes fluid from the tank into a cylinder-connected pipe. When the valve is opened, the pressured fluid will return to the fluid reservoir along the route of least resistance. When the valve is shut, however, the pressured fluid has nowhere else to go but inside the cylinder. As the fluid builds up in the cylinder, the piston is pushed upward, elevating the elevator car.

The control system sends a signal to the electric motor to gradually shut off the pump when the automobile approaches the correct floor. There is no more fluid coming into the cylinder with the pump turned off, but the fluid that is currently there can't exit (it can't flow backward via the pump because the valve is still closed). The piston sits on the fluid, and the vehicle remains stationary.

The elevator control system sends a signal to the valve to lower the car. A simple solenoid switch controls the valve electrically. The fluid that has accumulated in the cylinder can flow out into the fluid reservoir when the solenoid opens the valve. The piston is pushed down by the weight of the automobile and its load, which forces the fluid into the reservoir. The automobile begins to drop gradually. The control system closes the valve again to halt the automobile at a lower floor. During descent, the electric motor is no longer required.

This system is incredibly simple and highly effective, but it does have some drawbacks.

- Hydraulic elevators are more energy-intensive. When building up hydraulic pressure, a significant amount of energy is lost heating the hydraulic fluid; certain systems may even require separate coolers to cool the fluid to avoid overheating.

- A counterweight is typically not included with hydraulic elevators. As a result, the lift motor must be capable of lifting the rated load as well as the dead weight of the car cage. Under typical operation, the greatest weight that can be lifted by a traction lift is only around half of its rated load.

- Hydraulic elevators have rated speeds of 0.25 m/s (50 fpm) to 0.75 m/s (14 meters rise) and are employed in buildings with up to 5 stories (14 meters rise) (150 fpm).²⁵

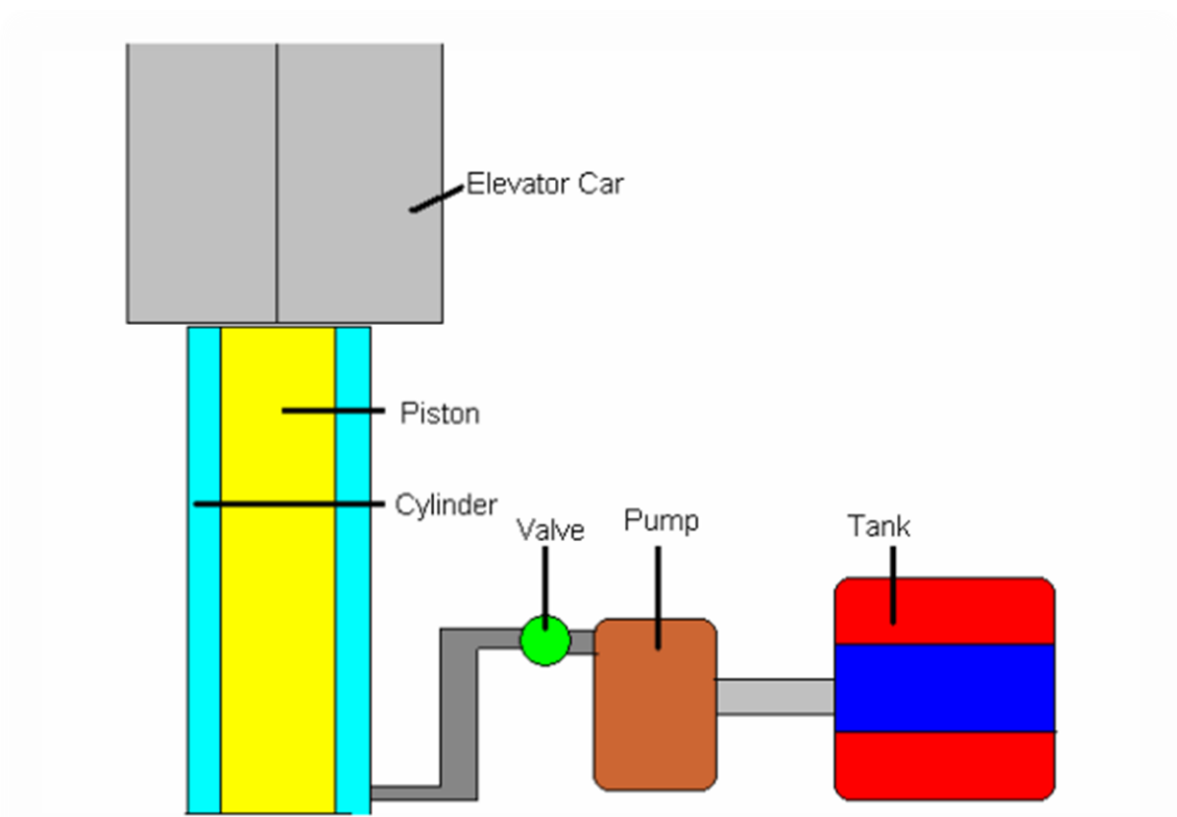


Figure I.20: Hydraulic Elevator

4.2.1 Basic Types Of Hydraulic Elevators:

The hydraulic lifts are of two types. They are

1. Direct-acting hydraulic lift.
2. Suspended hydraulic lift.

²⁵ - PDHonline Course M376 (4 PDH)/ the same previous source

- Direct Acting Hydraulic Lifts:

A ram moves within a fixed cylinder to operate the device. The cylinder is intended to allow the ram to glide up and down and has adequate apertures at the bottom for the hydraulic fluid to enter. The ram is coupled to the car's roof, which functions as a capsule that transports passengers or things. The hydraulic fluid operating beneath the ram pushes the ram higher. As a result, the cage may travel up to different floors depending on the situation. The cage is lowered, allowing oil to be drained from the cylinder and returned to the oil reservoir.

The ram must be guided in a vertical plane, which necessitates the use of guide rails. The car can reach speeds of up to 125 feet per minute (38.1 meters per minute), with a maximum travel distance of 12 feet (3.6m).²⁶

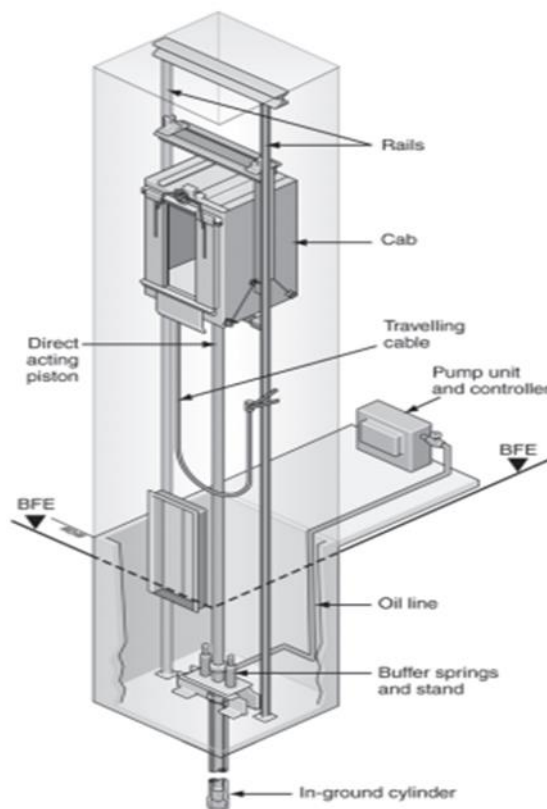


Figure I.21: Simple Mechanism Machine

²⁶ - PDHonline Course M376 (4 PDH)/ the same previous source

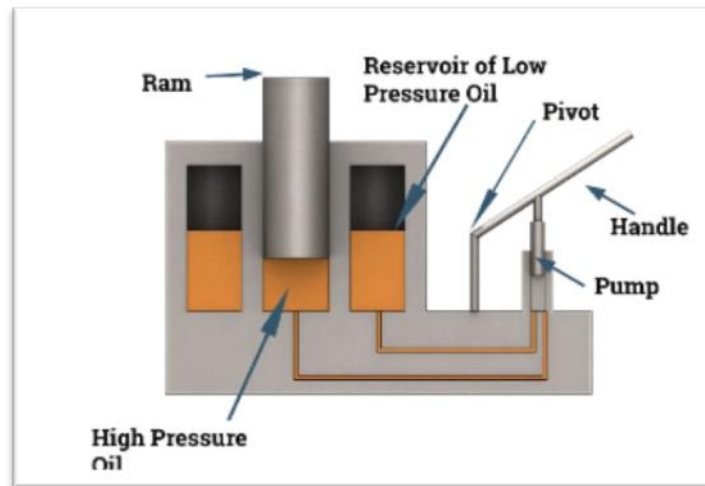


Figure I.22: Direct Acting Hydraulic Elevator

- **Working:**

Because the re-circulation valve is closed when the pump feeds oil to the bottom of the cylinder, the oil beneath the bottom of the ram becomes pressured, and this pressurized oil raises the ram (cage). When the cage must be lowered, the oil is drained back into the reservoir with the valve open. The electro-magnetic switch, which receives its signal from the individuals who use the elevator, determines how long the valve is maintained open.

- **Suspended Hydraulic Lifts:**

It consists of a cage hanging from a wire cable (on which people may stand or items can be placed) and a jigger consisting of a stationary cylinder, a sliding ram, and a pair of two pulley blocks located at the foot of the cage's hole. One pulley block may be moved while the other cannot. The moveable pulley block is attached to the sliding ram end. From the opposite end of the rope, the cage is hanged. The jigger is in charge of raising and lowering the cage of the lift. This design uses a 2:1 roping ratio to boost the lift's speed. The car can reach speeds of up to 150 feet per minute, with a maximum travel distance of 48 feet (14m).

- **Working:**

Water or other high-pressure hydraulic fluid is pumped into the jigger's fixed cylinder. The sliding ram is pushed to the left by this high-pressure hydraulic fluid, as indicated in the diagram. The cage is hoisted up as the sliding ram advances to the left side, increasing the distance between the fixed and moveable pulleys. When the high-pressure water or hydraulic fluid inside the cylinder is released, the gap between the two pulleys narrows, and the cage descends. As a result, suspended-type hydraulic lifts are more common than direct-type

hydraulic lifts. Hydraulic elevators can be set up with more than one cylinder in addition to the standard configurations shown above. The hydraulic piston (plunger) on some is made up of telescoping concentric tubes, which allows the mechanism to be contained in a shallow tube beneath the lowest floor. Others require a deeper hole below the lowest landing for the piston, which is normally protected by a PVC casing (also known as a caisson).

- **Benefits:**

Hydraulic elevators move at a slower pace and can travel up to 14 meters. Low-height installations are ideal for light usage.

- Lower ownership costs;
- Quick installation;
- Doesn't need a penthouse or overhead support to house the machinery;
- Flexibility in the location of the motor room;
- Upon power failure the lift lowers to the ground floor and releases the door.

- **Drawbacks:**

- Noisy, slow and poor ride quality;
- High on energy consumption;
- May cause potential environmental damage from leaking hydraulic fluid.

- **Speed Comparison:**

As part of the elevator traffic study, the elevator speed must be within the following ranges and chosen to fit the individual building requirements:

- Hydraulic passenger elevators - 0.25 to 0.75 m/s;
- Geared traction passenger elevators - 0.5 to 2.0 m/s;
- Gearless traction passenger elevators - 2.5 m/s and greater.

4.3 Machine Room-Less Elevators:

A machine room is required for all elevators, whether traction or hydraulic, to store huge electric motors (or hydraulic pumps) and a controlling cabinet. This chamber is above the hoistway (or below, in the case of hydraulic elevators) and may include equipment for a single or several elevators.

The advent of Motor Room Less (MRL) elevators was the most significant breakthrough in modern elevator history. The majority of MRL systems are gearless.²⁷

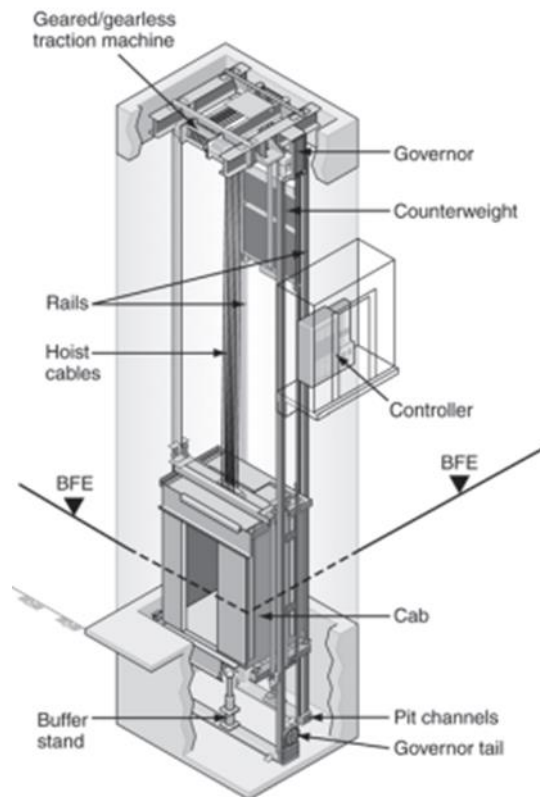


Figure I.23: Machine Room-Less (MRL) Traction Elevator

4.3.1 Technology:

Traditionally in motor room configurations the sheave, motor and control system are all housed in a machine room above the elevator shaft but in MRL elevators, the machinery is installed in the elevator shaft itself.

The discovery and implementation of permanent magnet (PM) system technology in the lift motor, which decreased the motor's size by up to four times, made this possible. Increases in the density of the armature winding in the PM, as well as the use of their own patented joint-lapped core, helped to minimize the motor's size while boosting its power output. To date, all manufacturers have focused on increasing the motor's power output while minimizing its physical size.

²⁷ - <https://continuingeducation.bnpmmedia.com/>

MRL installations are often less expensive to install, provide more architectural freedom, and enhance the amount of space that may be rented. Currently, the speed and number of floors restrict their installation; MRL systems can achieve speeds of 2.5m/s and can cover up to 30 storeys. Because the use of MRL technology is still relatively new, and each of the major manufacturers offers exclusive goods, maintenance must be carefully considered. As a result, when assessing technical elements, the end-user or building owner should be mindful of the risks of getting locked into a high-cost maintenance contract with no way out.²⁸

- **Benefits:**

- Save you money when it comes to maintenance
- Require less space
- Reduce the initial cost of construction

- **Drawbacks:**

- Noise, vibration and limitations of using
- Temperature Influence
- Malfunction Repair and Rescue

5 Elevator Safety:

A major attribute of an elevator system is safety and reliability. Lack of an effective safety system could lead to injury, or possibly death of users or maintenance personnel. The elevator system must be designed so as to protect riders with multiple backup systems for use in the event of failure of one or more than one critical mechanism. Elevator systems today have a range of measures aimed at reducing the risk of accidents and providing passengers with a rapid and dependable journey. The following are the basic characteristics:²⁹

5.1 Brakes:

A compressive spring assembly, brake shoes with linings, and a solenoid assembly make up the most common elevator brake. The spring forces the brake shoes to grip the brake

²⁸ - <https://continuingeducation.bnpmmedia.com/>

²⁹ - <https://user.eng.umd.edu/>

drum and create braking torque when the solenoid is not triggered. The magnet has the ability to apply a force. For the break release, use horizontal force. This can be done on one of the operational arms directly.

Alternatively, you might use a linking system. The outcome is the same in both cases. The break is being dragged away.

The elevator's velocity is restored after the shaft is removed.

Within the breaks, a substance with a high coefficient of friction, such as zinc bonded asbestos, is employed to improve stopping ability. A car's jerky motion can be caused by a material having a high coefficient of friction. This is a material that must be picked with care.³⁰

5.2 Over-Speed Safety Brake:

If an elevator overspeeds in the down direction, the safety brake, in conjunction with a speed-sensing governor, operates to halt it. If an elevator car travels at a preset over-speed in the down direction, the elevator opens a switch that cuts off power to the drive motor and brake. If the car speeds up in the up direction, some governors will open the governor switch and cut off power to the drive motor and brake.

5.3 Safety Edge:

When an older elevator system's doors come into touch with a person or an object, mechanical "safety edges" trigger the doors to halt or retract. This gadget is used in conjunction with the Photo Eye component.

5.4 Photo Eye:

This gadget is installed on the elevator doors, and it uses two light beams to detect any impediments in the doorway. If the beam is disrupted, the doors will not close and, if they are already closed, will automatically reopen. This device works in conjunction with Safety Edge.

5.5 Micro Light:

Modern elevator systems identify people or items in the doorway using a high number of invisible laser rays and reverse or stop the doors without making physical contact. If one of these rays is disrupted, the doors will not automatically close or open. Both the Safety Edge and Photo Eye systems are replaced by the Micro Light door protection system.

³⁰ - <https://user.eng.umd.edu/>

5.6 Control Philosophy During Power Black Out / Emergency Power Operation (EPR):

When power is lost **in a traction** elevator system, all elevators will initially come to a halt. One by one, each car in the group will return to the lobby floor, open its doors and shut down. People in the remaining elevators may see an indicator light or hear a voice announcement informing them that the elevator will return to the lobby shortly. Once all cars have successfully returned, the system will then automatically select one or more cars to be used for normal operations and these cars will return to service. The car(s) selected to run under emergency power can be manually overridden by a key or strip switch in the lobby.

In hydraulic elevator systems, emergency power will lower the elevators to the lowest landing and open the doors to allow passengers to exit. The doors then close after an adjustable time period and the car remains unusable until reset, usually by cycling the elevator main power switch. Typically, due to the high current draw when starting the pump motor, hydraulic elevators aren't run using standard emergency power systems.³¹

6 Simplex Controls:

Elevator control can be accomplished using a variety of systems. All new elevators will be operated by a microprocessor. A single-car system is called "simplex," a two-car system is called "duplex," and a three-car system is called "group supervisory operation."

There are several subsystems, including independent service, attendant service, and inspection service. That can be added to the primary control system, such as fire service, etc.³²

6.1 Independent Service:

The elevator can be operated from within the car without responding to hall calls thanks to independent service. (Traffic would be diverted to other elevators in a bank of elevators, but the hall buttons would be deactivated in a single elevator.) Until a floor is selected and the door shut button is held until the elevator begins to travel, the elevator will remain parked on that floor with its doors open. When hauling bulky items or moving groups of people between floors, an independent service is beneficial. This service will be provided on all vehicles.

³¹ - <https://user.eng.umd.edu/>

³² - <https://www.cedengineering.com/> Building Elevator Systems / Course No: A06-001

6.2 Attendant Service:

A key switch in the automobile activates the attendant service. It allows the car's attendant to regulate the doors' opening and closing, the direction of travel, and whether or not to stop or bypass hall calls. A car on attendant service is normally called by a separate, inconspicuous hallway push-button riser when there are more than one car in a group. For integrated passenger/service applications, the attendant service operation is widely used.

6.3 Inspect Service:

When an elevator is set to inspect mode, it will no longer react to calls and will come to a complete stop. If you don't have a stop switch key, this mode might theoretically be used to stop the car in mid-flight. The elevator vehicle will remain idle for the time being.

until a command is issued by a corresponding access key switch The access switches are key switches. The bottom and top floors are usually where you'll find them. This allows the Elevator Mechanic to acquire an advantage. access to the elevator's pit or the car's top

6.4 Fire Service:

Fire service is usually split up into two modes; 'phase-I' and 'phase-II'.

Phase-I mode is activated by smoke sensor or heat sensor in the building. Once the fire alarm is activated, the elevator will wait an amount of time, and then proceed to go into nudging mode to tell everyone the elevator is leaving the floor. Once the elevator has left the floor, depending on where the alarm was set off, the elevator will go to the Fire Recall Floor.

Phase-II mode can only be activated by a key switch located inside the elevator, on the centralized control panel (CCP). This mode is created for firefighters so that they may rescue people from a burning building. The phase-II key switch located on the CCP has three positions: off, on, and hold. By turning phase-II on, you enable the car to move in direction. However, like independent service mode, the car will not respond to a car call unless you manually push and hold the door close button. Once the elevator gets to the desired floor, it will not open its doors unless you hold door open. This is in case the floor is burning and the firefighter can feel the heat and knows not to open the door.³³

³³ - <https://www.cedengineering.com/> Building Elevator Systems / Course No: A06-001

Conclusion:

Multiple elevators with a unified control system are prevalent in today's business buildings. Furthermore, all modern elevators feature unique override settings that allow elevators to proceed straight to a designated floor without stopping. In many nations nowadays, there are many regulations for the usage of elevators in multi-story buildings.

In addition, modern elevators also have additional safety and convenient features like fire-rated access panels for all surfaces installed on the elevator's ceiling for ease of access for maintenance and emergencies. This feature can function as an escape hatch if people get trapped inside the elevator.

Chapter II:
Study Of Microcontroller
(16F877A)

II. Chapter II: study of microcontroller (16F877A)

Introduction:

Microcontrollers are nowadays implemented in most consumer and professional applications, and there are several families. In the 1990s, the American company Micro Chip Technology developed a CMOS microcontroller: the PIC (Peripheral Interface). This component, which is still widely used today, is a compromise between simplicity of use, speed and cost. In this chapter, we will study the microcontroller, as it is the basic element of our microcontroller control board.

1 Embedded System:

An embedded system is a computer system a combination of a computer processor, computer memory, and input/output peripheral devices that has a dedicated function within a larger mechanical or electronic system. It is embedded as part of a complete device often including electrical or electronic hardware and mechanical parts. Because an embedded system typically controls physical operations of the machine that it is embedded within, it often has real-time computing constraints.



Figure II.1: Hardware Of Embedded Systems

Embedded systems control many devices in common use today. In 2009 it was estimated that ninety-eight percent of all microprocessors manufactured were used in embedded systems.

Modern embedded systems are often based on microcontrollers (i.e. microprocessors with integrated memory and peripheral interfaces), but ordinary microprocessors (using external chips for memory and peripheral interface circuits) are also common, especially in more complex systems. In either case, the processor(s) used may be types ranging from

general purpose to those specialized in a certain class of computations, or even custom designed for the application at hand. A common standard class of dedicated processors is the digital signal processor (DSP).

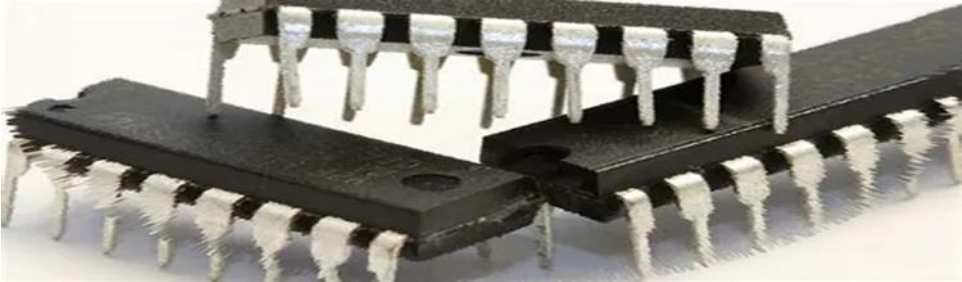


Figure II.2: Microcontrollers

Since the embedded system is dedicated to specific tasks, design engineers can optimize it to reduce the size and cost of the product and increase the reliability and performance. Some embedded systems are mass-produced, benefiting from economies of scale.

Embedded systems range in size from portable personal devices such as digital watches and MP3 players to bigger machines like home appliances, industrial assembly lines, robots, transport vehicles, traffic light controllers, and medical imaging systems. Of ten they constitute sub systems of other machines like avionics in aircraft and spacecraft. Large installations like factories, pipelines and electrical grids rely on multiple embedded systems networked together. Generalized through software customization, embedded systems such as programmable logic controllers frequently comprise their functional units.



Figure II.3: Some Applications Of Embedded Systems

Embedded systems range from those low in complexity, with a single microcontroller chip, to very high with multiple units, peripherals and networks, which may reside in equipment racks or across large geographical areas connected via long-distance communications lines.

As a Conclusion embedded systems have requirements that differ significantly from general purpose computers. The main goal of an embedded system developer is to design a lowest cost system, that performs the desired tasks. without failing. Algorithms can be implemented in hardware or software. While the hardware. Approach improves performance the software approach provides flexibility. Recent developments in hardware-software co-design permit tradeoffs between hardware and software for cost-effective embedded systems.

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2 Definition Of A Microcontroller:

A microcontroller is a computer. All computers -- whether we are talking about a personal desktop computer or a large mainframe computer or a microcontroller -- have several things in common:

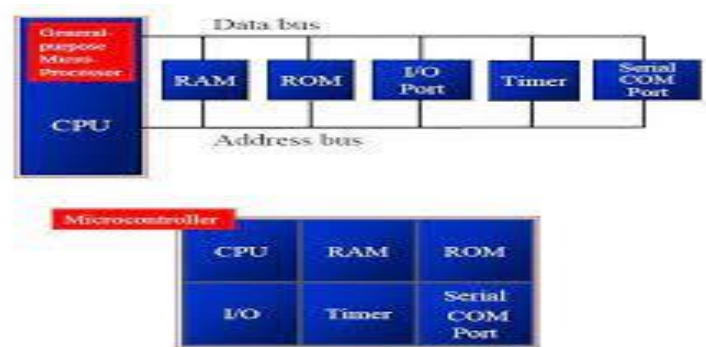


Figure II.4:Diagramme Microcontroller And Microprocessor

- All computers have a CPU (central processing unit) that executes programs. If you are sitting at a desktop computer right now reading this article, the CPU in that machine is executing a program that implements the Web browser that is displaying this page.
- The CPU loads the program from somewhere. On your desktop machine, the browser program is loaded from the hard disk.

³⁴ -https://en.wikipedia.org/wiki/Embedded_system

- The computer has some RAM (random-access memory) where it can store "variables."
- And the computer has some input and output devices so it can talk to people. On your desktop machine, the keyboard and mouse are input devices and the monitor and printer are output devices. A hard disk is an I/O device -- it handles both input and output.

The desktop computer you are using is a "general purpose computer" that can run any of thousands of programs. Microcontrollers are "special purpose computers." Microcontrollers do one thing well. There are a number of other common characteristics that define microcontrollers. If a computer matches a majority of these characteristics, then you can call it a "microcontroller":

- Microcontrollers are "**embedded**" inside some other device (often a consumer product) so that they can control the features or actions of the product. Another name for a microcontroller, therefore, is "embedded controller."
- Microcontrollers are **dedicated** to one task and run one specific program. The program is stored in ROM (read-only memory) and generally does not change.
- Microcontrollers are often **low-power devices**. A desktop computer is almost always plugged into a wall socket and might consume 50 watts of electricity. A battery-operated microcontroller might consume 50 milliwatts.
- A microcontroller has a **dedicated input device** and often (but not always) has a small **LED or LCD display for output**. A microcontroller also takes input from the device it is controlling and controls the device by sending signals to different components in the device. For example, the microcontroller inside a TV takes input from the remote control and displays output on the TV screen. The controller controls the channel selector, the speaker system and certain adjustments on the picture tube electronics such as tint and brightness. The engine controller in a car takes input from sensors such as the oxygen and knock sensors and controls things like fuel mix and spark plug timing. A microwave oven controller takes input from a keypad, displays output on an LCD display and controls a relay that turns the microwave generator on and off.



Figure II.5: LCD Display Interfacing With Pic Microcontroller

- A microcontroller is often **small and low cost**. The components are chosen to minimize size and to be as inexpensive as possible.
- A microcontroller is often, but not always, **ruggedized** in some way. The microcontroller controlling a car's engine, for example, has to work in temperature extremes that a normal computer generally cannot handle. A car's microcontroller in Alaska has to work fine in -30 degree F (-34 C) weather, while the same microcontroller in Nevada might be operating at 120 degrees F (49 C). When you add the heat naturally generated by the engine, the temperature can go as high as 150 or 180 degrees F (65-80 C) in the engine compartment. On the other hand, a microcontroller embedded inside a VCR hasn't been ruggedized at all.

The actual **processor** used to implement a microcontroller can vary widely. For example, the cell phone shown on Inside a Digital Cell Phone contains a Z-80 processor. The Z-80 is an 8-bit microprocessor developed in the 1970s and originally used in home computers of the time. The Garmin GPS shown in How GPS Receivers Work contains a low-power version of the Intel 80386, I am told. The 80386 was originally used in desktop computers.



Figure II.6: Microprocessor

In many products, such as microwave ovens, the demand on the CPU is fairly low and price is an important consideration. In these cases, manufacturers turn to **dedicated microcontroller chips** -- chips that were originally designed to be low-cost, small, low-power, embedded CPUs. The Motorola 6811 and Intel 8051 are both good examples of such chips. There is also a line of popular controllers called "PIC microcontrollers" created by a company called Microchip. By today's standards, these CPUs are incredibly minimalistic; but they are extremely inexpensive when purchased in large quantities and can often meet the needs of a device's designer with just one chip.

A typical low-end microcontroller chip might have 1,000 bytes of ROM and 20 bytes of RAM on the chip, along with eight I/O pins. In large quantities, the cost of these chips can sometimes be just pennies. You certainly are never going to run Microsoft Word on such a chip -- Microsoft Word requires perhaps 30 megabytes of RAM and a processor that can run millions of instructions per second. But then, you don't need Microsoft Word to control a microwave oven, either. With a microcontroller, you have one specific task you are trying to accomplish, and low-cost, low-power performance is what is important.³⁵

2.1 Introduction PIC Microcontrollers :

PIC microcontrollers (Programmable Interface Controllers), are electronic circuits that can be programmed to carry out a vast range of tasks. They can be programmed to be timers or to control a production line and much more. They are found in most electronic devices such as alarm systems, computer control systems, phones, in fact almost any electronic device. Many types of PIC microcontrollers exist, although the best are probably found in the GENIE

³⁵ -<https://electronics.howstuffworks.com/microcontroller1.htm>(howstuffworks)

range of programmable microcontrollers. These are programmed and simulated by Circuit Wizard software.

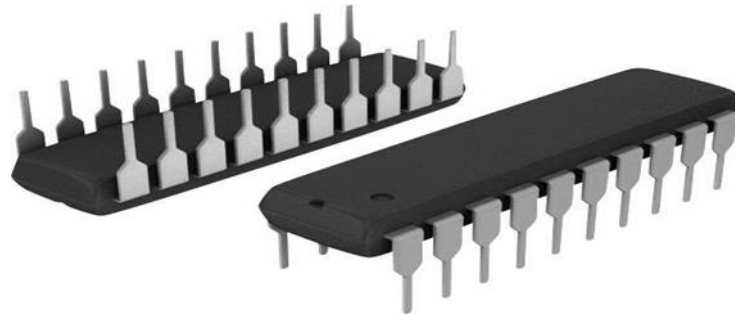


Figure II.7: Pic (Microcontroller)

PIC Microcontrollers are relatively cheap and can be bought as pre-built circuits or as kits that can be assembled by the user.

You will need a computer to run software, such as Circuit Wizard, allowing you to program a PIC microcontroller circuit. A fairly cheap, low specification computer should run the software with ease. The computer will need a serial port or a USB port. This is used to connect the computer to the microcontroller circuit.



Figure II.8: Circuit Wizard On Computer

Software such as, Genie Design Studio can be downloaded for free. It can be used to program microcontroller circuits. It allows the programmer to simulate the program, before downloading it to a PIC microcontroller IC (Integrated Circuit).

Simulating the program on screen, allows the programmer to correct faults and to change the program.

The software is quite easy to learn, as it is flow chart based. Each 'box' of a flow chart has a purpose and replaces numerous lines of text programming code. This means that a program can be written quite quickly, with fewer mistakes.

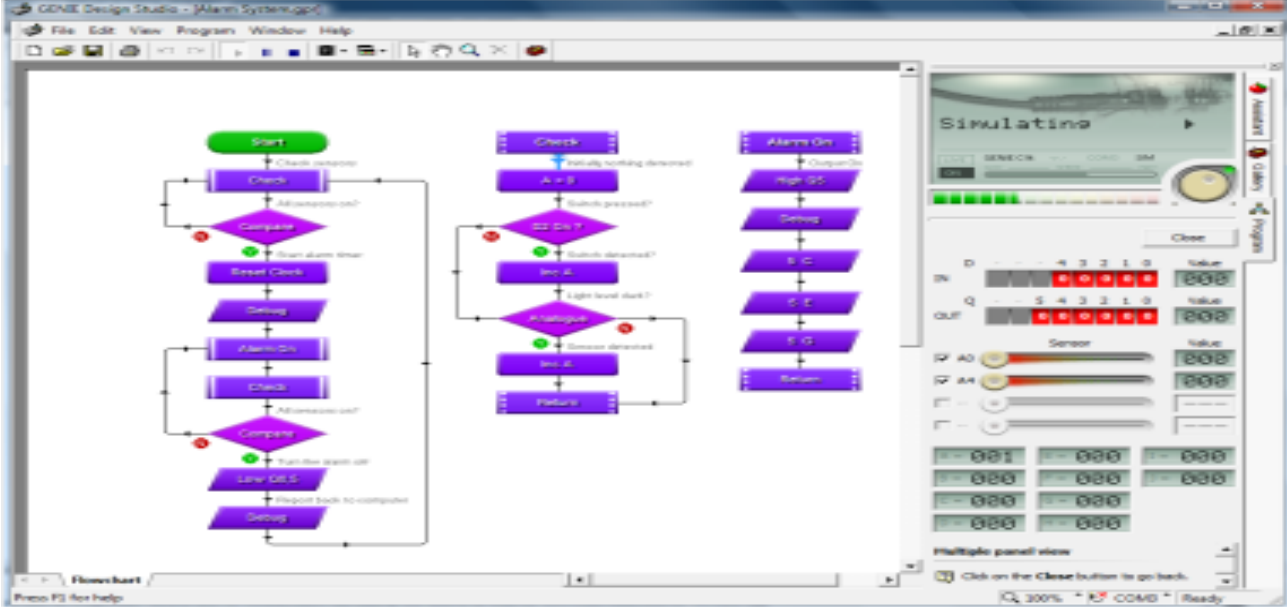


Figure II. 9: Simulating The Program On Screen

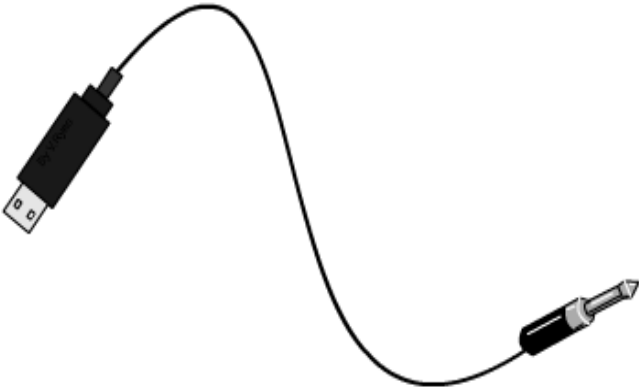


Figure II.10:USB

A USB lead connects the computer to the programmable circuit, allowing the transfer of the program to the PIC microcontroller IC.

When the program has been simulated and works, it is downloaded to the PIC microcontroller circuit. The USB lead can be disconnected and the microcontroller circuit can be used independently. The diagram below, shows a GENIE Project Board being programmed by Circuit Wizard software (recommended software for programming microcontroller circuits).³⁶

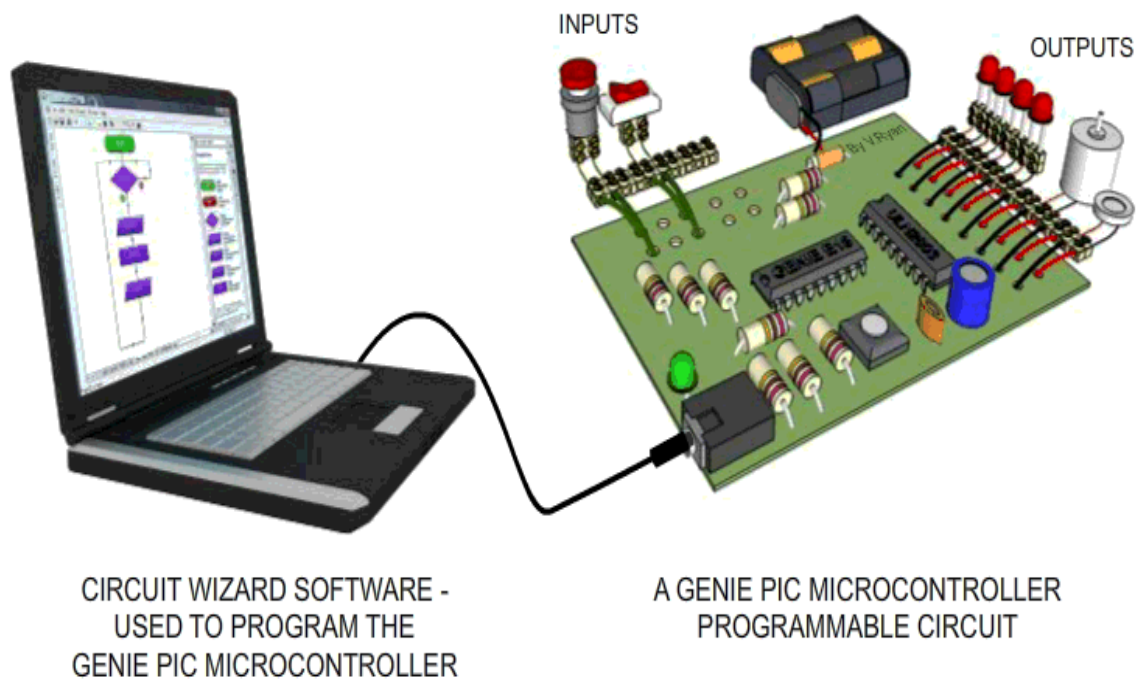


Figure II.11: Circuit WIZARD Software-Used To Program The Genie PIC Microcontroller

2.2 Circuit WIZARD Software :

Circuit Wizard software has major advantages over free downloads. It is a 'simple to use' electronics software package. Basic up to complex circuits, can be built on screen and simulated. This means that circuits can be tested before they are manufactured.

Circuit Wizard also allows a range of GENIE Microcontroller circuits/project boards, to be 'dragged' on to the screen, from a menu. Inputs and outputs can be added using further menus.

³⁶ - [https://technologystudent.com/pics/picgen1.html\(pic\)](https://technologystudent.com/pics/picgen1.html(pic))

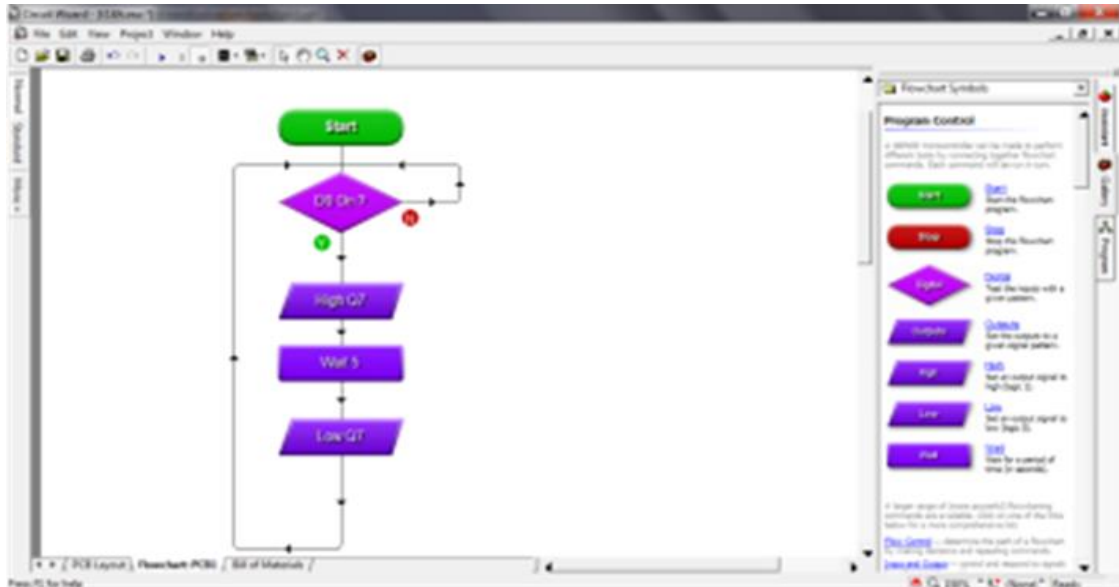


Figure II.12: Circuit WIZARD Software Simulated

Then, the GENIE microcontroller circuit/project board can be programmed, using Circuit Wizard’s flow charting menu. It can be fully tested/simulated on screen and faults corrected or alterations made. This software is strongly recommended, when designing and manufacturing microcontroller programmable circuits.

The genie MICROCONTROLLER circuit above) being programmed using circuit WIZARD software

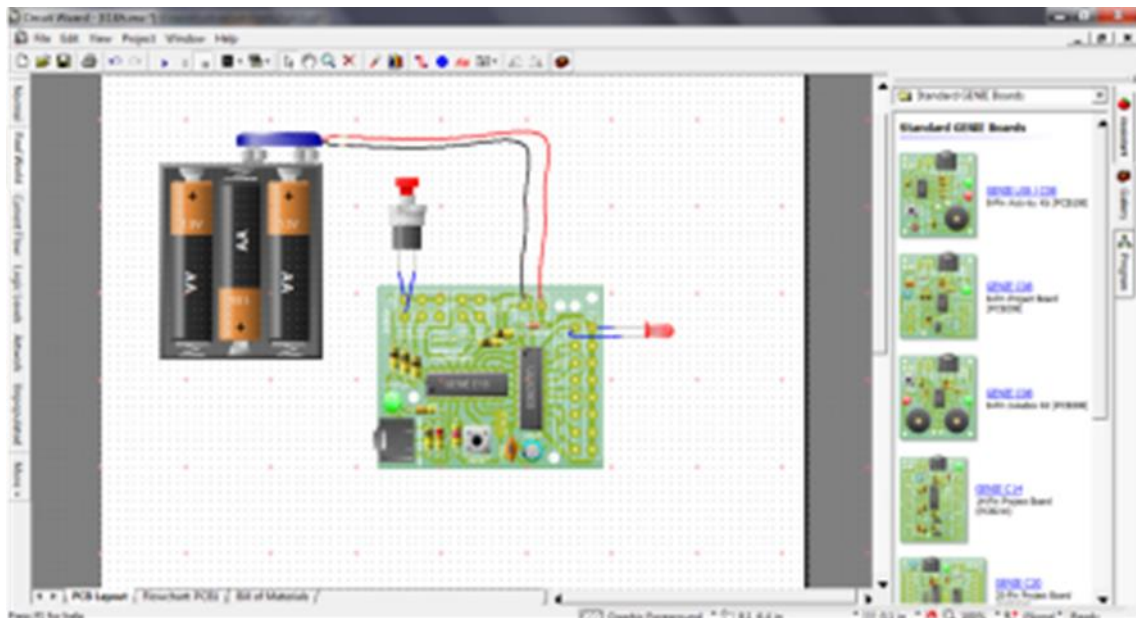


Figure II.13: Circuit Wizard Software

Simple genie MICROCONTROLLER circuit being built on screen using

2.3 Family Pic :

Microcontrollers PIC micro MCU from Microchip Company divided into 4 large families. Each family has a variety of components that provide built-in special features.³⁷³⁸

2.3.1 The First Family, PIC10 (10FXXX) - Is Called Low End:

The PIC10FXXX devices from Microchip Technology are low-cost, high-performance, 8-bit, fully static, Flash-based CMOS microcontrollers. They employ a RISC architecture with only 33 single-word/ single-cycle instructions. The 12-bit wide instructions are highly symmetrical. The easy-to-use and easy to remember instruction set reduces development time significantly. The PIC10FXXX devices contain an 8-bit ALU and working register.

2.3.2 The Second Family, PIC12 (PIC12FXXX)- Is Called Mid-Range :

The PIC12FXXX most popular among these starter their way in this field. Mid-Range devices feature 14-bit program word architecture and are available in 8 to 64-pin packages that offer an operating voltage range of 1.8-5.5V, small package footprints, interrupt handling, an 8-level hardware stack, multiple A/D channels and EEPROM data memory. Mid-range devices offer a wide range of package options and a wide range of peripheral integration. These devices feature various serial analog and digital peripherals, such as: SPI, I2C™, USART, LCD and A/D converters.

2.3.3 The Third Family Is PIC16(16FXXX) :

With six variants ranging from 3.5K-14 Kbytes of Flash memory, up to 256 bytes of RAM and a mix of peripherals including EUSART, CCP and onboard analog comparators. These devices are well suited for designers with applications that need more code space or I/O than 14-pin variants supply, and are looking to increase system performance and code efficiency by employing hardware motor control and communications capability.

2.3.4 The Fourth Family Is PIC 17/18(18FXXX) :

The PIC18 family utilizes a 16-bit program word architecture and incorporates an advanced RISC architecture with 32 level-deep stack, 8x8 hardware multiplier, and multiple internal and external interrupts. With the highest performance in Microchip's 8-bit portfolio,

³⁷ -<https://www.mepits.com/tutorial/431/pic/introduction-to-pic16f877>

³⁸ - <https://microcontrollerslab.com/pic16f877a-introduction-features/>

the PIC18 family provides up to 16 MIPS and linear memory. PIC18 is the most popular architecture for new 8-bit designs where customers want to program in C language.³⁹

3 Using Language :

1. C language has less number of keywords, as we know that in a standard version of C programming language there are only 32 keywords and 32 keywords are easy to remember.
2. C language has less number of standard libraries and library functions (those are well-established and standardized portable) but they can be used to design any kind of (almost) functions.
3. C language has rich set of data types with awesome features of type qualifiers like const, volatile etc.
4. We have already discussed in previous post about low level and high level languages. C language is one of the most popular programming languages which are able to make low level applications like device drivers, operating systems, firmware etc along with the high level applications like desktop applications. Note that: due to this amazing feature C programming language is known as “Middle Level programming language”.
5. C language is very efficient, popular and well understood.
6. C language is much popular for embedded systems programming due to its flexibility.
7. Programs written in C programming language are easy to read, understand and edit.
8. C language is free, and you do not have to pay anything even if you are using C language for embedded systems. We can easily access any hardware device attached with the microcontroller (please, don't confuse here, in embedded systems micro-controllers are like processors), for example: we can capture images through the camera, record videos by writing functions (known as device drivers) for it.
9. C language has other features like Portability, Modularity, and Structure Oriented. Since C programming language is very old language (developed around 1970-1972) still it is more popular due to its features.⁴⁰

³⁹ - <https://microcontrollerslab.com/pic16f877a-introduction-features/>

⁴⁰ - <https://www.newbiehack.com/MicrocontrollersABeginnersGuideIntroductionandInterfacinganLCD.aspx>

I personally like C programming languages due to two reasons:

1. It's flexible; I can do whatever I want to do. There is no restriction even I can access restricted memory locations too using pointers. Since C language lacks some safety features but this makes C language more flexible as you can access anything from anywhere.
2. It's really easy and short: using few library functions and data types, I can design functions for any kind of problems.

3.1 Choose/Select A PIC Microcontroller :

Each type of PIC microcontroller provides a different combination of features, thus the most suitable can be selected for any given application. Some of the main selection criteria are:

- number of I/O pins available
- program memory size
- program memory type (ROM, EPROM, Flash)
- EEPROM data memory
- timers (8-bit or 16-bit), CCP
- interrupt sources
- analog inputs (8-bit or 10-bit)
- serial communication interfaces (USART, SPI, I2C, CAN)
- internal oscillator
- in-circuit debugging
- package (DIP, SOIC, PLCC, QFP)
- price

When developing an embedded system, the number and type of inputs and outputs need to be determined. After the hardware requirements have been established, the program need to be written and tested. Once the size of the program known, the chip memory size can be determined.⁴¹

⁴¹ - http://www.microcontrollerboard.com/pic_microcontroller.html

The following table is the summary information for selected PIC flash microcontrollers as a guide to the features available:

Table 1: Guide To The Features Available For Pic

PIC #	# of pins	I/O pins	Program ROM words	File RAM bytes	EEPROM bytes	Analogue inputs	Timers 8/16 bits	Max clock (MHz)	Internal osc. (MHz)	In-circuit debug	Serial comms
12F675	8	6	1k	64	128	4x10-bit	1/1	20	4	YES	NO
16F628A	18	16	2k	224	128	NO	2/1	20	4	NO	UART
16F630	14	12	1k	64	128	NO	1/1	20	4	YES	NO
16F648A	18	16	4k	256	256	NO	2/1	20	4	NO	UART
16F676	14	12	1k	64	128	8x10-bit	1/1	20	4	YES	UART
16F73	28	22	4k	192	NO	5x8-bit	2/1	20	NO	NO	ALL
16F77	40	33	8k	368	NO	8x8-bit	2/1	20	NO	NO	ALL
16F818	18	16	1k	128	128	5x10-bit	2/1	20	8	YES	I2C,S PI
16F84	18	13	1k	64	64	NO	1/0	10	NO	NO	NO
16F84A	18	13	1k	64	64	NO	1/0	20	NO	NO	NO
16F88	18	16	4k	368	256	7x10-bit	2/1	20	8	YES	ALL
16F874A	40	33	4k	192	128	8x10-bit	2/1	20	NO	YES	ALL
16F876A	28	22	8k	256	368	5x10-bit	2/1	20	NO	YES	ALL
16F877A	40	33	8k	256	368	8x10-bit	2/1	20	NO	YES	ALL
18F2320	28	25	4k	512	256	10x10-bit	1/3	40	8	YES	ALL
18F6520	64	52	16k	2048	1024	12x10-bit	1/3	40	NO	YES	ALL
18F8621	80	68	32k	3840	1024	16x8-bit	1/3	40	10	YES	I2C,S PI
18F8720	80	68	64k	3840	1024	16x10-bit	1/3	40	NO	YES	ALL

3.2 Simple Programs Using Pic16f877 Microcontroller :

PIC16F877 is one of the advanced and commonly used Peripheral Interface Microcontroller from Microchip. Simplicity, quality, ease of availability and low price makes them ideal for different applications. Also, this PIC features all components that modern microcontrollers have.

Some of the remarkable features of this PIC microcontroller are listed below.

4 General Features:

35 instructions are only there.

Single-cycle instructions are used here. While, two-cycle instructions are used for program branches.⁴²

DC – 20 MHz clock input DC – 200 ns instruction cycle is the operating speed. 8K x 14 words of Flash Program Memory, Data Memory RAM of 368 x 8 bytes, EEPROM Data Memory of 256 x 8 bytes. Pin out compatible to other 28-pin or 40/44-pin. Voltage range of 2 to 5.5 V.

Low-power, high-speed Flash/EEPROM technology.

Low-power consumption.

Static design.

4.1 Some Of The Peripheral Features:

3 timers are present: Timer0, Timer1, and Timer2.

Two Compare and Capture PWM modules. Synchronous Serial Port (SSP).

Universal Synchronous Asynchronous Receiver Transmitter with the capability of 9-bit address detection.

Parallel Slave Port.

Brown-out detection circuitry.

4.2 Analog Features:

Analog Comparator module present.

10-bit, up to 8-channel Analog-to-Digital Converter (A/D).

4.3 Other Features:

Selectable oscillator options.

Data EEPROM Retention > 40 years.

⁴²

In-Circuit Debug (ICD) via two pins.

100,000 erase/write cycle Enhanced Flash program memory.

1,000,000 erase/write cycle Data EEPROM memory.

Self-reprogrammable.

In-Circuit Serial Programming via two pins.

Programmable code protection.

Power saving Sleep mode.

Watchdog Timer with RC oscillator.

5 Pin Diagram :

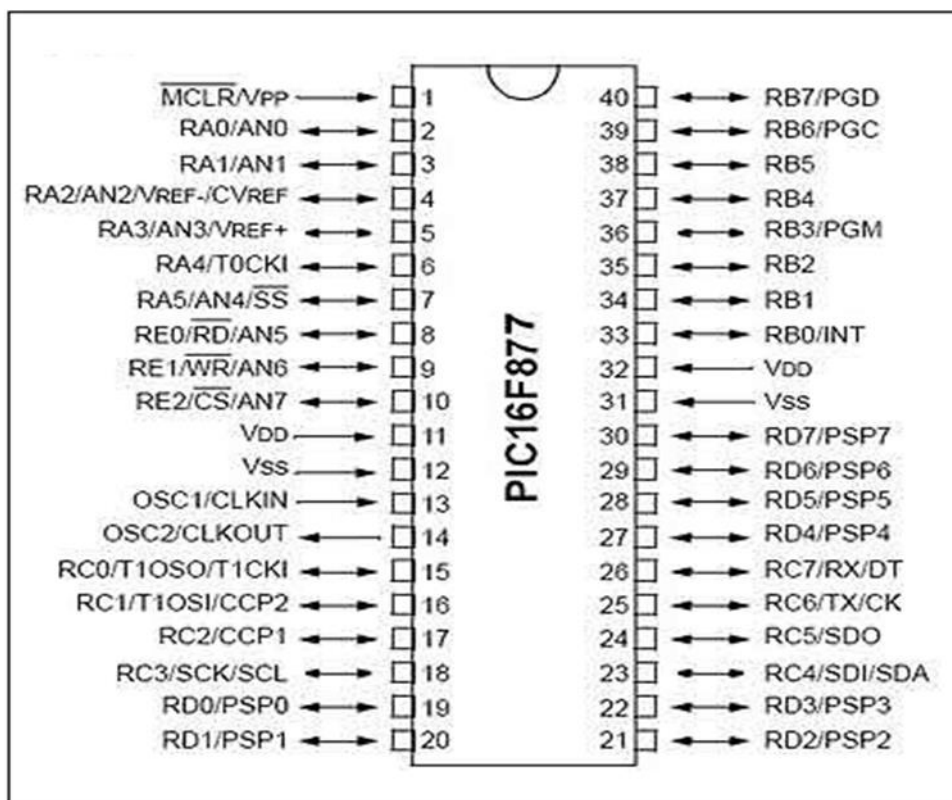


Figure II.14: Pin Of Microcontroller Pic 16F877A

5.1 Input/Output Ports :

PIC16F877 has 5 basic I/O ports. These are denoted by PORT A, PORT B, PORT C, PORT D, and PORT E. These ports are used for input/ output interfacing.

Table 2: Ports Used For Input/Out

PORT-A	RA-0 to RA-5	6 bit wide
PORT-B	RB-0 to RB-7	8 bit wide
PORT-C	RC-0 to RC-7	8 bit wide
PORT-D	RD-0 to RD-7	8 bit wide
PORT-E	RE-0 to RE-2	3 bit wide

5.1.1 Features Of Input / Output Ports :

- All these ports are bi-directional.
- Directions of ports are controlled by using TRIS(X) registers.
- TRIS A helps in setting PORT-A direction. Likewise, TRISB, TRIS C and TRIS D set the direction of other ports.
- Setting a TRIS(X) bit '1' will set the corresponding PORT(X) bit as input.
- Clearing a TRIS(X) bit '0' will set the corresponding PORT(X) bit as output.

5.1.2 Sample Program :

Program1:

```
// the port testing program which toggles all the port pins
#include <pic.h>
#include "delay.h"// THE DELAY FUNCTION IS ATTACHED
//This sub function configures the ports of pic as output

void TRISCONFIG ()
{
    TRISA = 0; //configuring portA
    TRISB = 0; //configuring portB
    TRISC = 0; //configuring portC
    TRISD = 0; //configuring portD

    TRISE = 0; //configuring portE
```

```

        // INTIALISING ALL THE PORTS WITH ZEROS
        PORTA=0;
        PORTB=0;
        PORTC=0;
        PORTD=0;
        PORTE=0;
    }

void main (){

    TRISCONFIG (); // CALLING OF PORT CONFIG FUNCTION

    while (1)//looping continuously
    {
        PORTA=~PORTA; // toggling the port values so as to make it blink
        PORTB=~PORTB;
        PORTC=~PORTC;
        PORTD=~PORTD;
        PORTE=~PORTE;
        Delay_ms (500); // CALLING A DELAY OF 500 MS TWICE : REFER DELAY.C
        Delay_ms (500); }
}

```

Program2: 2ND PORT

// THE PORT program for interfacing switches and led

// connect the switches in pull up state to portb

// connect the leds to portd

// whenever a switch in the portb is kept pressed the leds in portd toggles

#include <pic.h>

#include "delay.h" // THE DELAY FUNCTION IS ATTACHED

//This subfunction configures the ports of pic as output and input

```
void TRISCONFIG()
```

```
{
```

```
    TRISB = 0xFF; //configuring portB as input
```

```
    TRISD = 0; //configuring portD as output
```

```
    // INTIALISING ALL THE PORTD WITH ZEROS
```

```

PORTD=0;
PORTE=~PORTE;
DelayMs 500);// CALLING A DELAY OF 500 MS TWICE : REFER DEL
AY.C

DelayMs(500);
}
void main(){
TRISCONFIG(); // CALLING OF PORT CONFIG FUNCTION
while(1)//looping continuously
{
if(PORTB!=0XFF) //check for key press in portb
{
PORTE=~PORTE;
Delay-Ms(500);// CALLING A DELAY OF 500 MS TWICE : REFER DE
LAY.C

Delay-Ms(500);
}}}
```

5.2 USART :

The Universal Synchronous Asynchronous Receiver Transmitter (USART) present in PIC16F877 is one among the two serial I/O modules. It can be used as a full-duplex asynchronous system which can communicate with the peripheral devices. The peripheral devices can be a CRT terminal, personal computer. Also the UART of PIC16F877 can be used as a half-duplex synchronous system. This half duplex system can communicate with peripheral devices like A/D or D/A integrated circuits, serial EEPROMs etc.

The **USART** can be configured in the following modes:

- Synchronous – Master (half-duplex)
- Asynchronous (full-duplex)
- Synchronous – Slave (half-duplex)

Bit SPEN (RCSTA<7>) and TRISC<7:6> is to be set to configure RC6/TX/CK and RC7/RX/DT as USART. USART in PIC16F877A has multi-processor communication capability using 9-bit address detection.⁴³

R/W-0	R/W-0	R/W-0	R/W-0	U-0	R/W-0	R-1	R/W-0
CSRC	TX9	TXEN	SYNC	—	BRGH	TRMT	TX9D
bit 7							bit 0

Figure II.15: TXSTA: Transmit Status And Control Register (ADDRESS 98h)

Bit 7 CSRC: clock source select bit

Asynchronous mode

1= master mode (clock generated internally from BRG)

0= slave mode (clock from external source)

Bit 6 TX9 9 bit transmit enable bit

1= select 9 bit transmission

0= select 8 bit transmission

Bit 5 TXEN transmit enable bit

transmit enabled

transmit disabled

NOTE SPRENCREN over rides TXEN in sync mode.

Bit 4 SYNC: USART Mode select bit

1= synchronous mode

0= asynchronous mode

Bit 3 Unimplemented : read as '0'

Bit 2 BRGH : high baud rate select bit

asynchronous mode :

⁴³

1=high speed

0=low speed

synchronous mode :

unused in this mode.

Bit 1 TRMT transmit shift register status bit

1=TRS empty

0=TRS full

Bit 0 TX9D: 9th bit of transmit data, can be parity bit

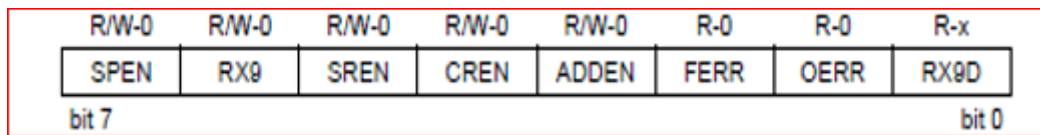


Figure II.16: RCSTA: Receive Status And Control Register

(Address 18h)

Bit 7 SPEN: serial port enable bit

1=serial port enable(configures RC7/RX/DT pins as serial port pins)

0= serial port disable

Bit 6 RX9: 9bit receive enable bit

1=selects 9 bit reception

0= selects 8 bit reception

Bit 5 SREN single receive enable bit

synchronous mode :

don't care

asynchronous mode-master :

1=enables single receive

0= disables single receive

This bit is cleared after reception is complete

asynchronous mode-slave:

don't care

bit 4 CREN: continuous receive enable bit

asynchronous mode:

1=enable continuous receive

0=disable continuous receive

synchronous mode:

1= enable continuous receive until enable bit CREN is cleared (CREN overrides SREN)

0= disable continuous receive

ADDEN: address detect enable bit

asynchronous mode 9-bit(RX9=1):

1=enable address detection, enable interrupt and load of the receive buffer when RSR<8> is set

0= disable address detection, all bytes are received and ninth bit can be used as parity bit FFRR: Framing error bit

1=framing error(can be updated by reading RCREG register and receive next valid byte)

0=no framing error

OERR: over run error bit

1=over run error (can be cleared by clearing bit CREN)

0= no over run error

RX9D: 9th bit of received data (can be parity bit but must be calculated by user firmware)

5.3 UART Transmission :

When setting up an UART Transmission, follow these steps:

1. Initialize SPBRG for baud rate. In order to set a high-speed baud rate, set BRGH.

2. Enable asynchronous serial port by clearing SYNC and set SPEN.
3. If interrupts are desired, then set TXIE.
4. For 9-bit transmission set TX9.
5. Enable transmission by setting TXEN and TXIF.
6. If 9-bit transmission is used; ninth bit must be loaded in TX9D.
7. Load data to the TXREG register.
8. If interrupts are used, make GIE and PEIE of INTCON register to set mode.

5.3.1 Sample Program :

```

//transmits a string

#include <pic.h>

#include "delay.h" // including the delay header

#define BAUD 9600 // defining the required baud rate

#define FOSC 4000000L // define the xtal frequency provided

#define DIVIDER ((int)(FOSC/(16UL * BAUD) -1)) // equation for calculating the divider value to store in baud rate register

//refer the uart tutorial

// function to transmit a single byte through uart

void putchs(unsigned char byte)
{
    TXREG = byte; /* output one byte */

    while(!TRMT) /* set when register is empty */
        continue;
}

// this function transmits a string through uart

void prints(const char *uptr)

```

```

    {
    while(*uptr != '\0')
        {
        putchar(*uptr);
        uptr++;
        DelayMs(1);
        }
    }

// uart initialising refer the uart tutorial for register details
void uart_Init()
{
RCSTA = 0;
TXSTA = 0;
RCREG = 0;
BRGH = 1; //set high baud rate
SYNC = 0; //select async communication
SPBRG = DIVIDER;// calculated from above equation, if BRGH=1;
SPEN = 1; // serial port enable
TXEN = 1; // transmission enable
GIE = 0; // disabling the interrupts
RCIF = 0;
PEIE = 0;
RCIE = 1; //enabling the reception notification flag
CREN = 1; // enabling continous reception }
void main() {
    uart_Init(); // initialising uart
    prints("hello world");// trasmitting string
    while(1);// stopping from overrun
}

```

5.3.2 UART Reception :

When setting up an UART Reception, follow these steps:

1. Initialize SPBRG for baud rate. In order to set a high-speed baud rate set BRGH.
2. Enable the asynchronous serial port by clearing SYNC and set SPEN.
3. If interrupts are desired, then set RCIE.
4. If 9-bit reception is used, set RX9.
5. Enable reception by setting CREN.
6. Flag bit RCIF will be set when reception is complete and an interrupt will be generated if enable bit RCIE is set.
7. Read the RCSTA register.
8. Read RCREG register.
9. Clear error by CREN.
10. If using interrupts, ensure that GIE and PEIE (bits 7 and 6) of the INTCON register are set.

5.3.3 Sample Program :

```

//transmits a a recieved byte
#include <pic.h>
#include "delay.h" // including the delay header
#define BAUD 9600 // defining the required baud rate
#define FOSC 4000000L // define the xtal frequency provided
#define DIVIDER ((int)(FOSC/(16UL * BAUD) -1)) // equation for calculating the divider value to store in baud rate register

void puts(unsigned char byte)
{
    TXREG = byte; /* output one byte */
    while(!TRMT) /* set when register is empty */
        continue;
}

// this function transmits a string through uart
void prints(const char *uptr)
{

```

```
while(*uptr != '\0')
{
    puts(*uptr);
    uptr++;
    DelayMs(1);
}
}

// uart initialising refer the uart tutorial for register details
void uart_Init()
{
    RCSTA = 0;
    TXSTA = 0;
    RCREG = 0;
    BRGH = 1;           //set high baud rate
    SYNC = 0;          //select async communication
    SPBRG = DIVIDER;// calculated from above equation, if BRGH=1;
    SPEN = 1;          // serial port enable
    TXEN = 1;          // transmission enable
    GIE = 0;           // disabling the interrupts
    RCIF = 0;
    PEIE = 0;
    RCIE = 1;          //enabling the reception notification flag
    CREN = 1;          // enabling continous reception
}

void main()
{
    uart_Init(); // intialising uart
    while(1)// looping for ever
    {
        while(RCIF==0);// waiting for reception
        {
            RCIF=0; // CLEARING THE BIT
            puts(RCREG);// trasmitting byte
```

```
    }  
    }  
}
```

5.4 Analog To Digital Converter :

Analog-to-Digital Converter for 28-pin devices has five inputs and for 40/44-pin devices has eight inputs. In PIC16F877, conversion of analog signal results in 10-bit digital number. A/D module has low and high voltage reference input. It is software selectable for VSS, VDD, RA2, RA3. The A/D converter device can operate in Sleep mode. During Sleep, clock of the converter must be derived from the RC oscillator.

The A/D in PIC16F877A has four registers. These registers are:

- A/D Control Register 0 (ADCON0)
- A/D Result High Register (ADRESH)
- A/D Result Low Register (ADRESL)
- A/D Control Register 1 (ADCON1)

To do an A/D Conversion, follow these steps:

1. Configure A/D module

- Configure analog pins and digital I/O (ADCON1)
- Select A/D input channel (ADCON0)
- Select A/D conversion clock (ADCON0)
- Turn ON A/D module (ADCON0)

2. Configure A/D interrupt (if desired)

- Clear ADIF
- Set ADIE

- Set PEIE
 - Set GIE
3. Wait for acquisition time.
 4. Start conversion
 - Set GO/DONE bit (ADCON0)
 5. Wait for A/D conversion to complete by either:
 - Polling GO/DONE bit to be cleared or,
 - Wait for A/D interrupt.
 6. Read A/D Result register, clear ADIF.

7. For next conversion, go to step 1 or step 2 as required. A/D conversion time per bit is defined as TAD.⁴⁴

5.4.1 Sample Program :

```
#include <pic.h>
#include "delay.h"
int adcval; // defining adc integer
void ADC_Init()
{
    TRISA = 0XEF; // configuring adc ports as input
    TRISE = 0X07;
    ADCON1 = 0X80; // configuring all ports as analog ports
}
// function for reading the adc value
int read_adc(char channel)
```

⁴⁴

```

    {
    Int val;
    ADCON1 = 0x80; //port config
    ADCON0 = 0x81 | channel << 3; // channel selection SET THE CHANNEL NUMBE
R
    Delay_ms(50);
    ADGO = 1; //turn on the adc
    while(ADGO) // checking the adc conversion
        continue;
    Val = ADRESH;
    Val = val<<8 | ADRESL; // combining the both address
    and address values to a single variable
    return (val);
    }

    void main()
    {
    TRISD=0X00;
    PORTD=0X00;
    ADC_Init(); // adcintialising
    while(1) // loop for ever
    {
    adcval=read_adc(0);
    if(adcval> 500) //checking the adc value
    {
    PORTD=0XFF; //setting the port value as high if adc value greater than 500
    }
    else // reseting the port value
    {
    PORTD=0X00;}}}}

```

5.5 PWM :

A PWM output has a time base and a time that the output stays high. Frequency of PWM is inverse of period.⁴⁵

5.5.1 PWM PERIOD :

PWM period is specified by PR2 register. PWM period can be calculated using the formula:

$$\text{PWM Period} = [(PR2) + 1] \cdot 4 \cdot TOSC \cdot (\text{TMR2 Prescaler Value})$$

PWM frequency is defined by $1 / [\text{PWM period}]$.

When TMR2 is equal to PR2, first:

- TMR2 is cleared.
- CCP1 pin is set.
- PWM duty cycle is passed from CCPR1L to CCPR1H.

5.5.2 PWM duty cycle :

$$\text{PWM Duty Cycle} = (\text{CCPR1L:CCP1CON}\langle 5:4 \rangle) \cdot TOSC \cdot (\text{TMR2 Prescaler Value})$$

The following steps should be taken when configuring the CCP module for PWM operation:

1. Set PWM period by PR2 register.
2. Set PWM duty cycle by writing to CCPR1L register and CCP1CON
3. Make the CCP1 pin an output.
4. Set TMR2 prescaler value and enable Timer2 by writing to T2CON.

⁴⁵

5. Configure CCP1 module for PWM operation.

5.5.3 Sample Program :

```
//generating the pwm from pwm1 module
#include <pic.h>
void pwm_Init(){
    PR2 = 41;//setting the pwm frequency
    CCP1CON = 0X0C;//configuring the pwm
    CCPR1L = 0x13; // setting the duty cycle
    T2CKPS1 = 0; //setting the prescalar
    T2CKPS0 = 0;
    TMR2IF = 0;
    TMR2IE = 0;
    TMR2ON = 1;      //timer 2 on
}
void main(){
    pwm_Init();// intialising the pwm
    while(1); //stopping the program}
//configuring the different timers
//subroutines for configuring the different timers
#include <pic.h>
// timer 0 intialising function
void Timer0_Init()
{
    TOCS =1;// timer clock source select
    TOIF =0; // timer set flag
    PSA =0; //prescalar assingment
    PS2 =1; // prescale bits
    PS1 =1;
    PS0 =1;
    TMR0 =160;
    GIE =1;      //interrupts flag set
    TOIE =1;     // timer interrupt set
```

```
        PEIE =1;}

// timer 2 intialising function
void Timer2_Init(){
    PR2 = 95;           // period register
    TOUTPS0 = 1;
    TOUTPS1 = 1;       // post scale bit
    TOUTPS2 = 1;
    TOUTPS3 = 1;
    TMR2ON = 0;        // timer on bit
    TMR2 = 0;
    T2CKPS1 = 1;       // timer prescale bit
    T2CKPS0 = 1;
    TMR2IF = 0;        //interrupt enable bits
    TMR2IE = 1;
    PEIE = 1;}

// timer 1 intialising function
void Timer1_Init(){
    T1CON = 0;
    TMR1H = 0x00;      // timer register
    TMR1L = 0x00;
    TMR1ON = 0;        // timer on bit
    TMR1CS = 0;
    T1OSCEN = 0;       // timer oscillator bit select
    T1CKPS1 = 0;
    T1CKPS0 = 0;       // prescale bit select
    TMR1IE = 0;
    TMR1IF = 0;        // interrupt bit select}

// counter 1 intialising function
void counter_Init() {
    T1CON = 0;
    TMR1H = 0x00;
    TMR1L = 0x00;
    TMR1ON = 0;
```

```
TMR1CS = 1;
T1SYNC = 1;
T1OSCEN = 0;
TRISC0 = 1;
}
```

5.6 Pin Configuration And Description Of PIC16F877A Microcontroller :

- As it has been mentioned before, there are 40 pins of this microcontroller IC. It consists of two 8 bit and one 16 bit timer. Capture and compare modules, serial ports, parallel ports and five input/output ports are also present in it. This picture shows the **pinout diagram** of PIC16F877A.

Structure OF PIC 16F877A⁴⁶

⁴⁶_

<https://www.newbiehack.com/MicrocontrollersABeginnersGuideIntroductionandInterfacinganLCD.aspx>

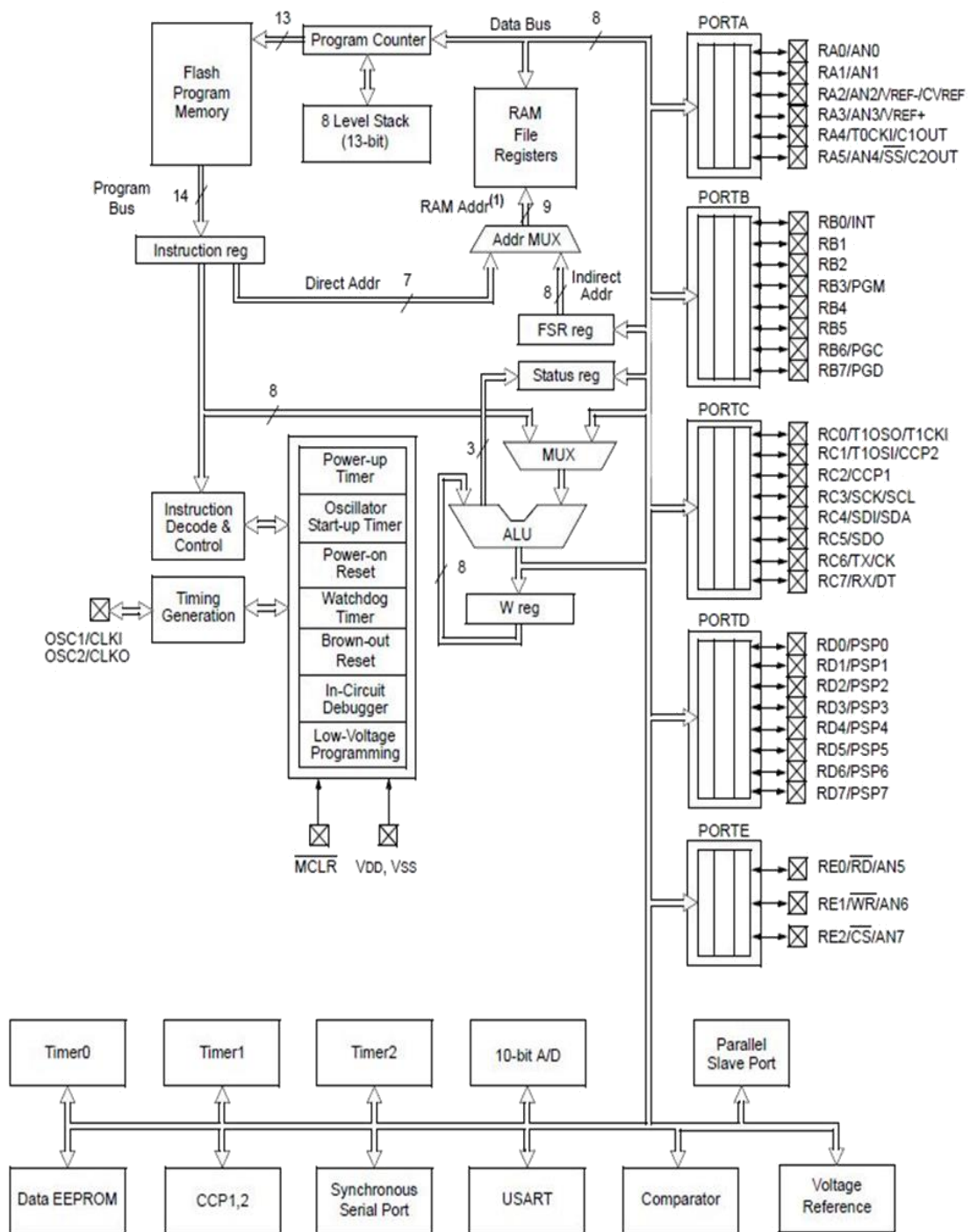


Figure II.17: Architecture Of PIC 16F877A Microcontroller

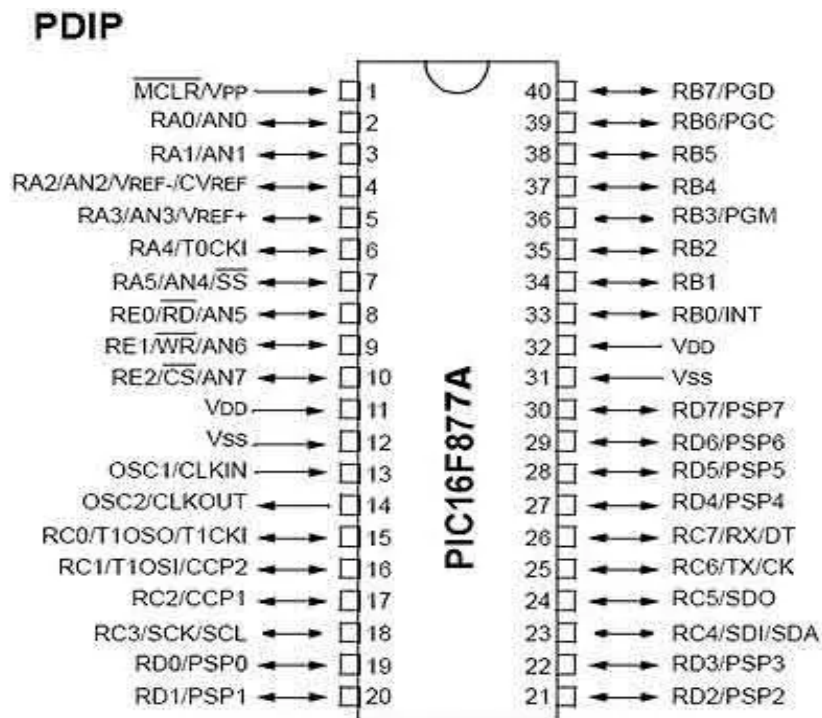


Figure II-1.: Pin Description

- **PIN 1: MCLR** :The first pin is the master clear pin of this IC. It resets the microcontroller and is active low, meaning that it should constantly be given a voltage of 5V and if 0 V are given then the controller is reset. Resetting the controller will bring it back to the first line of the program that has been burned into the IC.

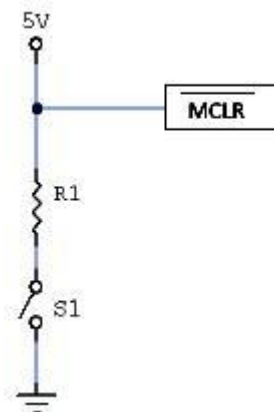


Figure II.18: MCLR

- A push button and a resistor is connected to the pin. The pin is already being supplied by constant 5V. When we want to reset the IC we just have to push the button which will bring the MCLR pin to 0 potential thereby resetting the controller.

- **PIN 2:RA0/AN0**:PORTA consists of 6 pins, from pin 2 to pin 7, all of these are bidirectional input/output pins. Pin 2 is the first pin of this port. This pin can also be used as an analog pin AN0. It is built in analog to digital converter.
- **PIN 3:RA1/AN1**:This can be the analog input 1.
- **PIN 4:RA2/AN2/Vref-**:It can also act as the analog input2. Or negative analog reference voltage can be given to it.
- **PIN 5:RA3/AN3/Vref+**:It can act as the analog input 3. Or can act as the analog positive reference voltage.
- **PIN 6:RA0/T0CKI** :To timer0 this pin can act as the clock input pin, the type of output is open drain.
- **PIN 7:RA5/SS/AN4**:this can be the analog input 4. There is synchronous serial port in the controller also and this pin can be used as the slave select for that port.
- **PIN 8: RE0/RD/AN5**: PORTE starts from pin 8 to pin 10 and this is also a bidirectional input output port. It can be the analog input 5 or for parallel slave port it can act as a ‘read control’ pin which will be active low.
- **PIN 9: RE1/WR/AN6**: It can be the analog input 6. And for the parallel slave port it can act as the ‘write control’ which will be active low.
- **PIN 10: RE2/CS/A7**: It can be the analog input 7, or for the parallel slave port it can act as the ‘control select’ which will also be active low just like read and write control pins.
- **PIN 11 and 32: VDD**: These two pins are the positive supply for the input/output and logic pins. Both of them should be connected to 5V.
- **PIN 12 and 31: VSS**: These pins are the ground reference for input/output and logic pins. They should be connected to 0 potential.
- **PIN 13: OSC1/CLKIN**: This is the oscillator input or the external clock input pin.
- **PIN 14: OSC2/CLKOUT**: This is the oscillator output pin. A crystal resonator is connected between pin 13 and 14 to provide external clock to the microcontroller. $\frac{1}{4}$ of the frequency of OSC1 is outputted by OSC2 in case of RC mode. This indicates the instruction cycle rate.
- **PIN 15: RC0/T1OCO/T1CKI**: PORTC consists of 8 pins. It is also a bidirectional input output port. Of them, pin 15 is the first. It can be the clock input of timer 1 or the oscillator output of timer 2.

- **PIN 16: RC1/T1OSI/CCP2:** It can be the oscillator input of timer 1 or the capture 2 input/compare 2 output/ PWM 2 output.
- **PIN 17: RC2/CCP1:** It can be the capture 1 input/ compare 1 output/ PWM 1 output.
- **PIN 18: RC3/SCK/SCL:** It can be the output for SPI or I2C modes and can be the input/output for synchronous serial clock.
- **PIN 23: RC4/SDI/SDA:** It can be the SPI data in pin. Or in I2C mode it can be data input/output pin.
- **PIN 24: RC5/SDO:** It can be the data out of SPI in the SPI mode.
- **PIN 25: RC6/TX/CK:** It can be the synchronous clock or USART Asynchronous transmit pin.
- **PIN 26: RC7/RX/DT:** It can be the synchronous data pin or the USART receive pin.
- **PIN 19,20,21,22,27,28,29,30:** All of these pins belong to PORTD which is again a bidirectional input and output port. When the microprocessor bus is to be interfaced, it can act as the parallel slave port.
- **PIN 33-40: PORT B:** All these pins belong to PORTB. Out of which RB0 can be used as the external interrupt pin and RB6 and RB7 can be used as in-circuit debugger pins.

Note: All pins have multiple functionalities. Like PORTC pins can be used as digital input pins, digital output pins, for UART communication, I2C communication. But, we can use one function of each port at a time or you have to program it smartly so that you can switch between different functionalities. Like once you need one pin to read analog signal, define it for analog purpose and then switch to other functions like digital output etc. For beginners, we suggest to use one pin for single functionality and you can use multi-function mode, once you become an expert in programming.

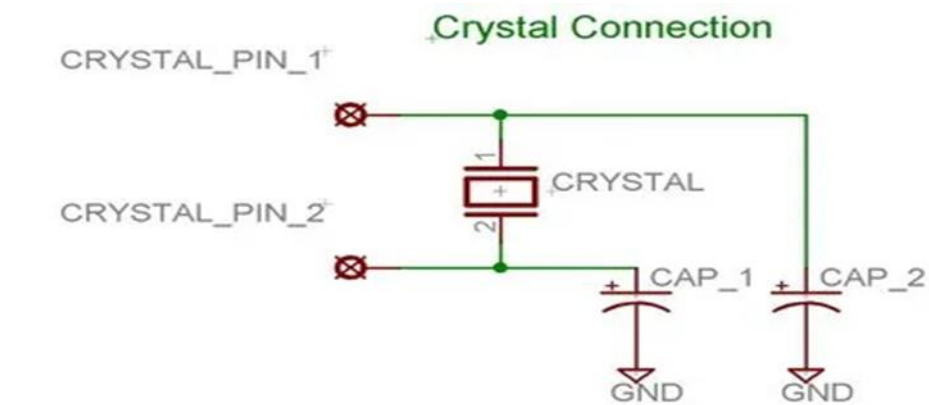


Figure II.19: Crystal Connection

Conclusion:

In this chapter we have studied the different families of microcontrollers, as well as the architecture and characteristics of the PIC16F877 which will be our choice for the control board. In the next chapter we will discuss the simulation of the control board and other boards in our project.

Chapter III:
System components
description and circuit
design

III. Chapter III: System Component Description And Circuit Design

Introduction:

This last chapter presents a simulation study of our project, we have divided this chapter into parts, first we will make a description of the different components of our cards, then the simulation of the cards for the latter,

1 MicroC Pro For Pic Compiler:

The mikroC PRO for PIC is a powerful, feature-rich development tool for PIC microcontrollers. It is designed to provide the programmer with the easiest possible solution to developing applications for embedded systems, without compromising performance or control.

PIC and C fit together well: PIC is the most popular 8-bit chip in the world, used in a wide variety of applications, and C, prized for its efficiency, is the natural choice for developing embedded systems. mikroC PRO for PIC provides a successful match featuring highly advanced IDE, ANSI compliant compiler, broad set of hardware libraries, comprehensive documentation, and plenty of ready-to-run examples.

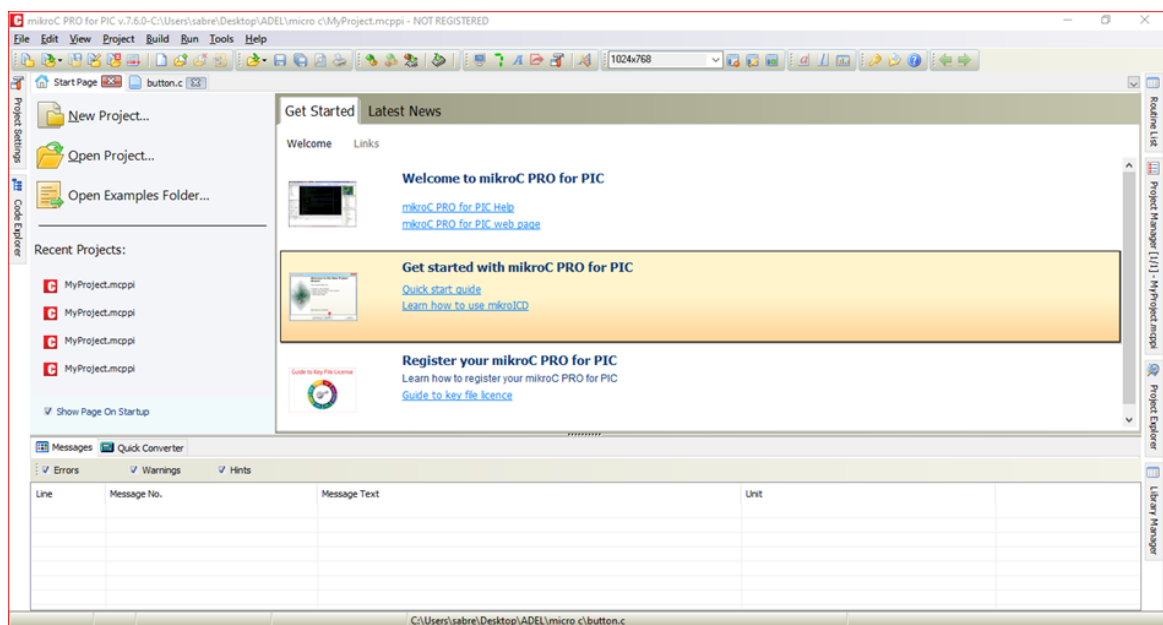


Figure III.1: Front Of Micro C For Pic

1.1 Features:

mikroC PRO for PIC allows you to quickly develop and deploy complex applications:

- Write your C source code using the built-in Code Editor (Code and Parameter Assistants, Code Folding, Syntax Highlighting, Auto Correct, Code Templates, and more.)
- Use included mikroC PRO for PIC libraries to dramatically speed up the development: data acquisition, memory, displays, conversions, communication etc.
- Monitor your program structure, variables, and functions in the Code Explorer.
- Generate commented, human-readable assembly, and standard HEX compatible with all programmers.
- Use the integrated mikroICD (In-Circuit Debugger) Real-Time debugging tool to monitor program execution on the hardware level.
- Inspect program flow and debug executable logic with the integrated Software Simulator.
- Generate COFF(Common Object File Format) file for software and hardware debugging under Microchip's MPLAB software.
- Active Comments enable you to make your comments alive and interactive.
- Get detailed reports and graphs: RAM and ROM map, code statistics, assembly listing, calling tree, and more.
- mikroC PRO for PIC provides plenty of examples to expand, develop, and use as building bricks in your projects. Copy them entirely if you deem fit – that's why we included them with the compiler.

2 Proteus 8 Software:

- **Proteus Design Suite** (designed by **Labcenter Electronics Ltd.**) is a software tool set, mainly used for creating schematics, simulating Electronics & Embedded Circuits and designing PCB Layouts.
- Proteus ISIS is used by Engineering students & professionals to create schematics & simulations of different electronic circuits.

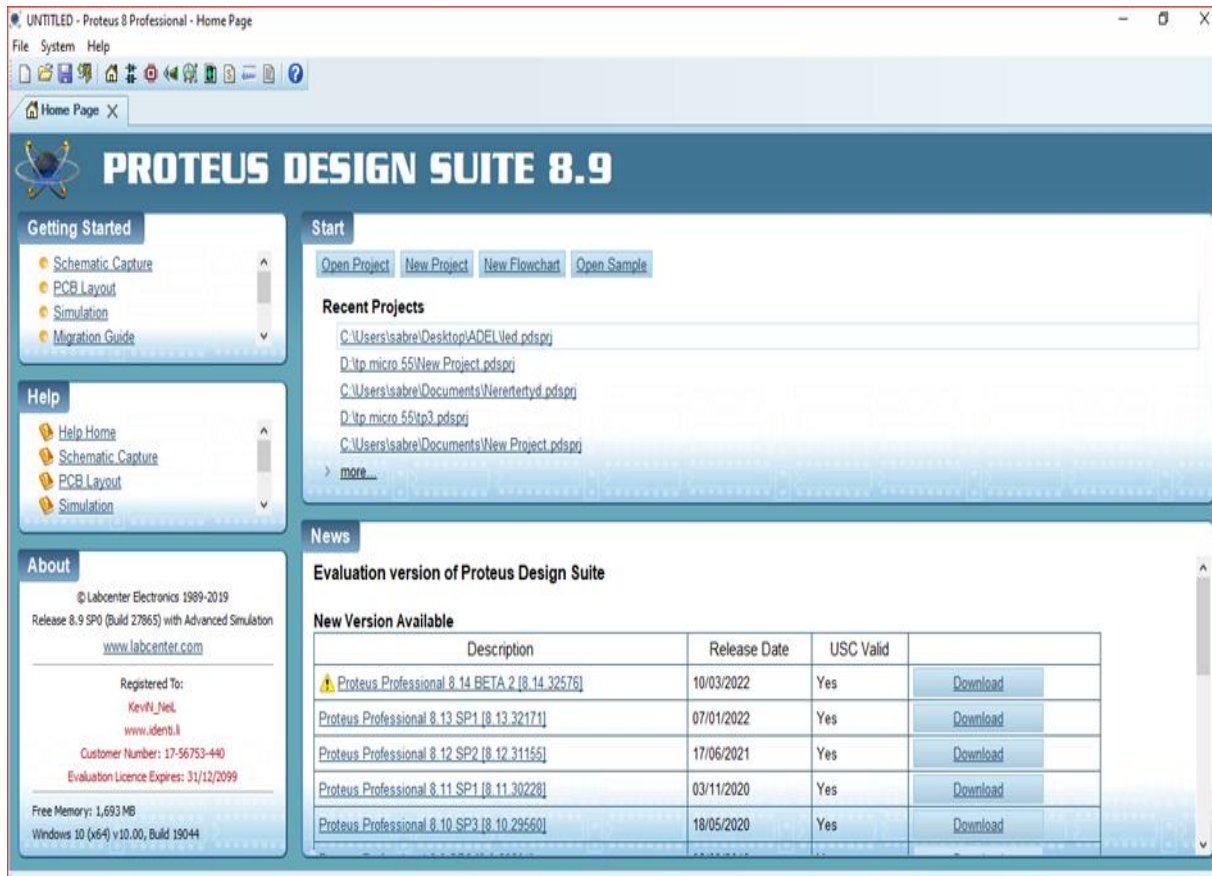


Figure III.2: Front Of Proteus

2.1 Features of Proteus 8 :

- Easy to use tool.
- Simple but effective interface.
- Circuit designing and schematic making made easy.
- Provides a powerful working environment.
- Real time design simulation with VSM.
- Can route and edit different components using ARES feature.

3 The LCD:

The LCD is a much more informative output device than a single LED. The LCD is a display that can easily show characters on its screen. LCDs range in size, price and configuration, from having a couple of lines to large displays.. We will be using an LCD that has the ability to display two (2) lines and 16 character per line length. This is popular LCD.

3.1 LCD 16×2 Pin Diagram The 16×2 LCD Pinout :

- Pin1 (Ground/Source Pin): This is a GND pin of display, used to connect the GND terminal of the microcontroller unit or power source.
- Pin2 (VCC/Source Pin): This is the voltage supply pin of the display, used to connect the supply pin of the power source.
- Pin3 (V0/VEE/Control Pin): This pin regulates the difference of the display, used to connect a changeable POT that can supply 0 to 5V.
- Pin4 (Register Select/Control Pin): This pin toggles among command or data register, used to connect a microcontroller unit pin and obtains either 0 or 1(0 = data mode, and 1 = command mode).
- Pin5 (Read/Write/Control Pin): This pin toggles the display among the read or writes operation, and it is connected to a microcontroller unit pin to get either 0 or 1 (0 = Write Operation, and 1 = Read Operation).
- Pin 6 (Enable/Control Pin): This pin should be held high to execute Read/Write process, and it is connected to the microcontroller unit & constantly held high.
- Pins 7-14 (Data Pins): These pins are used to send data to the display. These pins are connected in two-wire modes like 4-wire mode and 8-wire mode. In 4-wire mode, only four pins are connected to the microcontroller unit like 0 to 3, whereas in 8-wire mode, 8-pins are connected to microcontroller unit like 0 to 7.
- Pin15 (+ve pin of the LED): This pin is connected to +5V
- Pin 16 (-ve pin of the LED): This pin is connected to GND

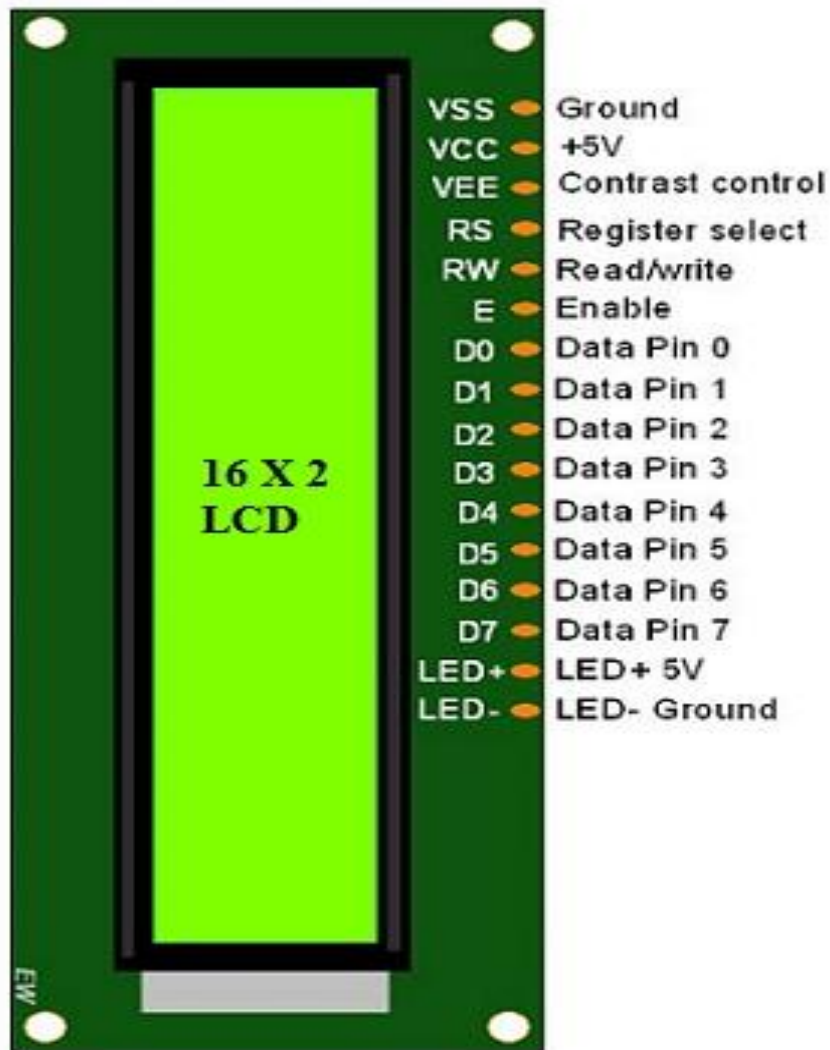


Figure 3:LCD-16×2-Pin-Diagram

3.2 Features of LCD16x2 :

The features of this LCD mainly include the following.

- The operating voltage of this LCD is 4.7V-5.3V
- It includes two rows where each row can produce 16-characters.
- The utilization of current is 1mA with no backlight
- Every character can be built with a 5×8 pixel box
- The alphanumeric LCDs alphabets & numbers
- Its display can work on two modes like 4-bit & 8-bit
- These are obtainable in Blue & Green Backlight

- It displays a few custom generated characters

Example About How To Connected Pins Of LCD With Microcontroller On Protues And Its Code.

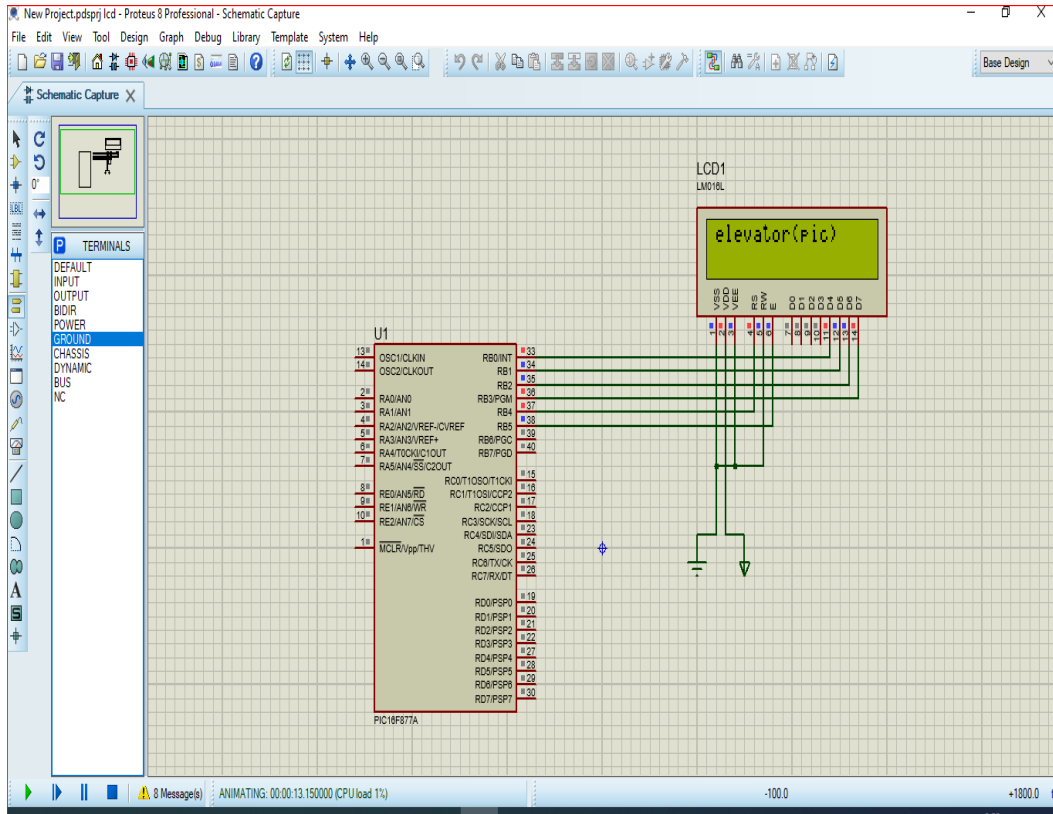
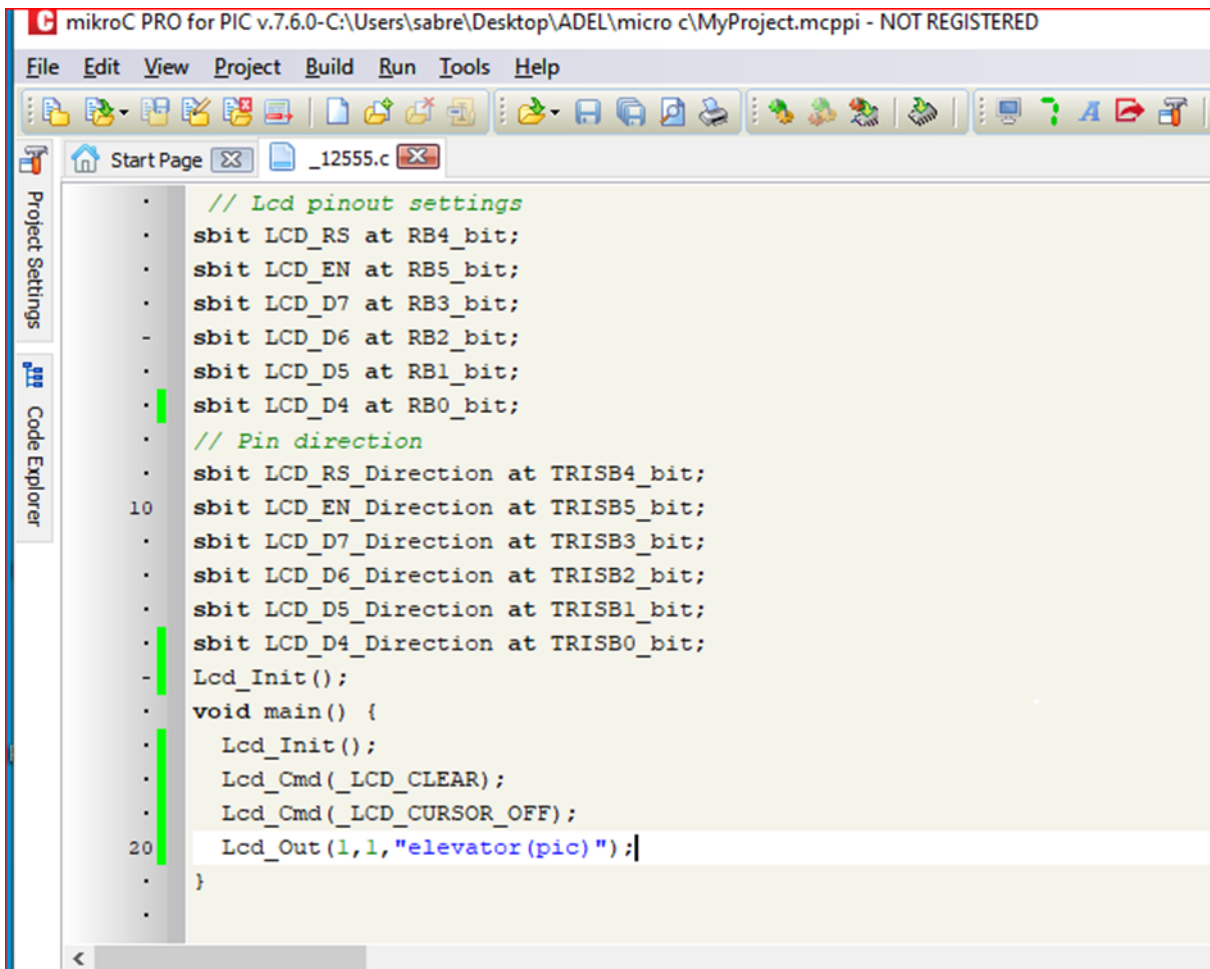


Figure III.4: LCD Screen On Protues



```
mikroC PRO for PIC v.7.6.0-C:\Users\sabre\Desktop\ADEL\micro c\MyProject.mcppi - NOT REGISTERED
File Edit View Project Build Run Tools Help
Start Page _12555.c
Project Settings
Code Explorer
// Lcd pinout settings
sbit LCD_RS at RB4_bit;
sbit LCD_EN at RB5_bit;
sbit LCD_D7 at RB3_bit;
sbit LCD_D6 at RB2_bit;
sbit LCD_D5 at RB1_bit;
sbit LCD_D4 at RB0_bit;
// Pin direction
sbit LCD_RS_Direction at TRISB4_bit;
10 sbit LCD_EN_Direction at TRISB5_bit;
sbit LCD_D7_Direction at TRISB3_bit;
sbit LCD_D6_Direction at TRISB2_bit;
sbit LCD_D5_Direction at TRISB1_bit;
sbit LCD_D4_Direction at TRISB0_bit;
Lcd_Init();
void main() {
Lcd_Init();
Lcd_Cmd(_LCD_CLEAR);
Lcd_Cmd(_LCD_CURSOR_OFF);
20 Lcd_Out(1,1,"elevator(pic)");
}
```

Figure III.5 : LCD Simulated With mikroC

3.3 Push Button :

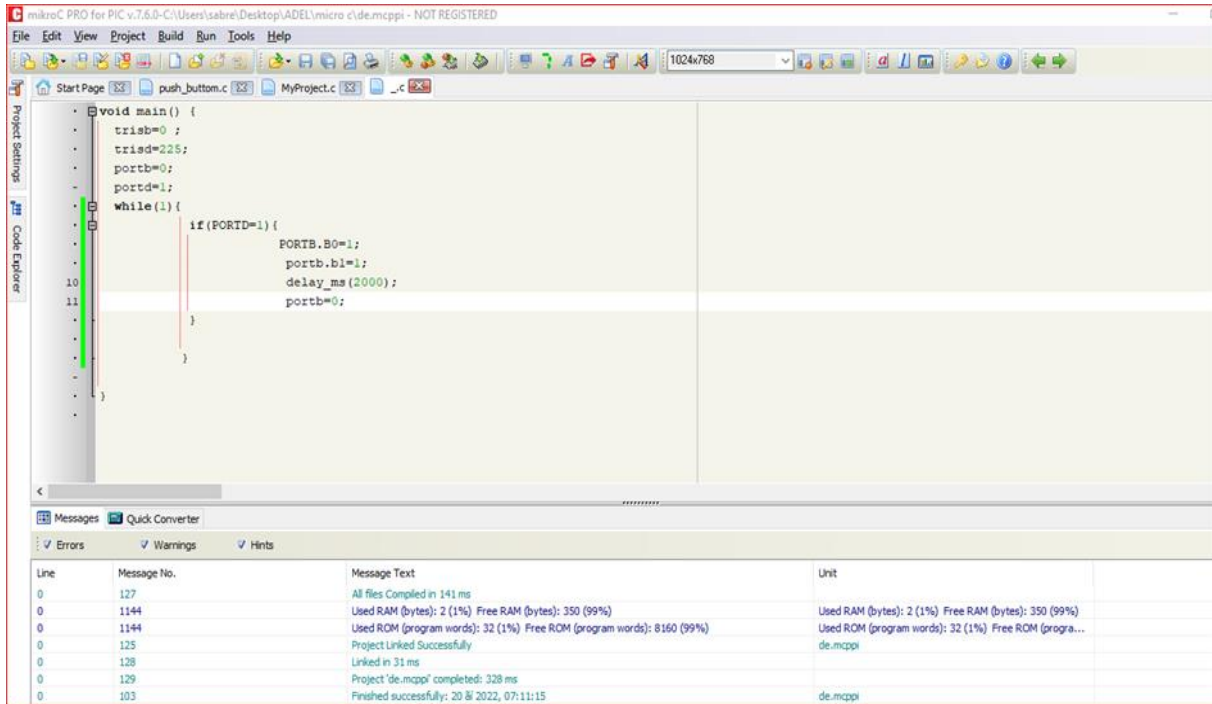


Figure III.6 : Push Button

A **push-button** is a simple switch mechanism to control 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.

Note: in our project we used pushbutton for call a car elevator to specific floor

Example About How To Connected Pins Of PUSH BUTTOM With Microcontroller On Protues And Its Code



```

void main() {
    trisb=0 ;
    trisd=225;
    portb=0;
    portd=1;
    while(1){
        if(PORTD=1){
            PORTB.B0=1;
            portb.b1=1;
            delay_ms(2000);
            portb=0;
        }
    }
}

```

Line	Message No.	Message Text	Unit
0	127	All files Compiled in 141 ms	
0	1144	Used RAM (bytes): 2 (1%) Free RAM (bytes): 350 (99%)	Used RAM (bytes): 2 (1%) Free RAM (bytes): 350 (99%)
0	1144	Used ROM (program words): 32 (1%) Free ROM (program words): 8160 (99%)	Used ROM (program words): 32 (1%) Free ROM (progra...
0	125	Project Linked Successfully	de.mcppi
0	128	Linked in 31 ms	
0	129	Project 'de.mcppi' completed: 328 ms	
0	103	Finished successfully: 20/08/2022, 07:11:15	de.mcppi

Figure III.7 : Push Button Simulated with mikroC

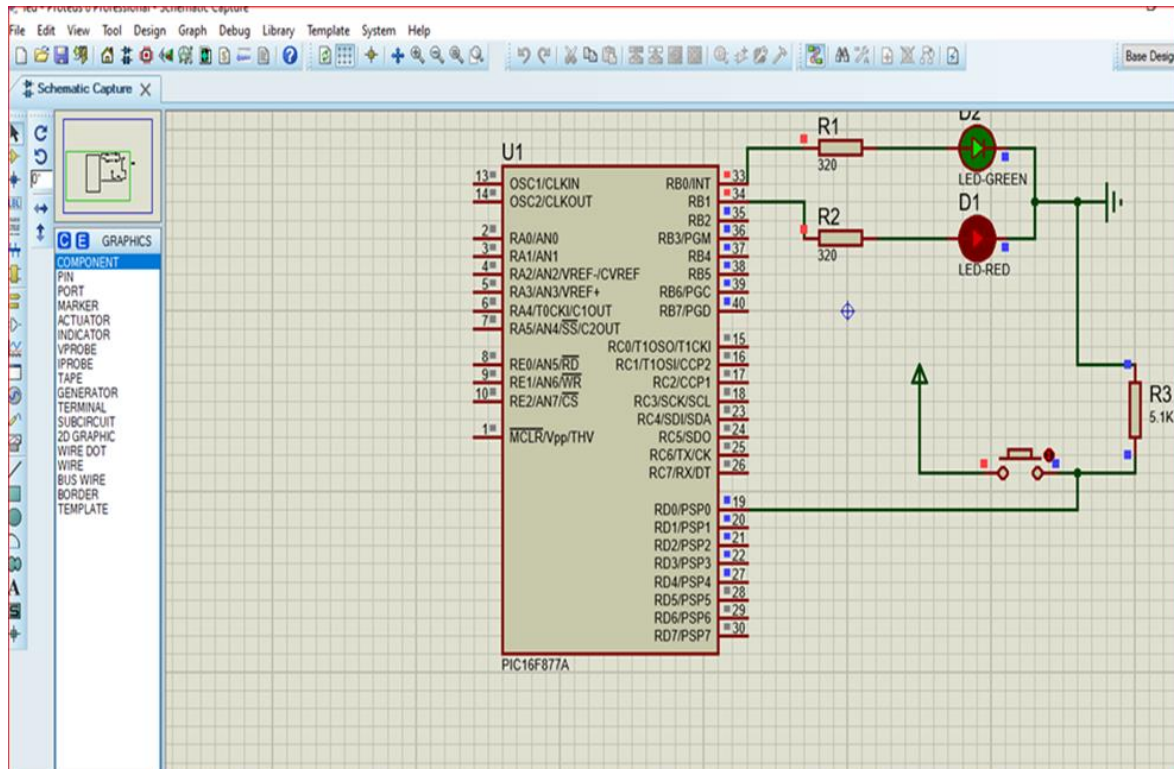


Figure III.8 : Circuit Push Button Simulated with Protues

4 Sensors :

Level sensors transmits floor number of car to control center in order to activate brake mechanism and make sure elevator stops desired level.

A door sensor (photoelectric or infrared beam) is an elevator device that detects a passenger or an object on the doorway which prevents the doors from closing.

If a person or thing stops the entryway and the sensors detect it, the door will reopen and remain open until the person or object goes away or the object is removed from the doorway.

If the doors are left open for longer than the specified time, the elevator will enter nudge mode, slowing closing the doors with a continuous beep.

Door sensors are also possible to detect an object or obstacle blocking the doorway.

5 Seven Segment Display :

Seven segment displays are commonly used in many electrical applications.

A 7-segment display is an electronic device that can be used for displaying numerals and some letters.,

there are two types of LED 7-segment displays: common cathode (CC) and common anode (CA). The difference between the two displays is the common cathode has all the

cathodes of the 7-segments connected directly together and the common anode has all the anodes of the 7-segments connected together.

In this tutorial, we will use common cathode 7-segment displays.

A common cathode seven segment is cathodes of all the LEDs are connected together. For the use of this seven segment the common cathode connection must be grounded and power must be applied to appropriate segment in order to illuminate that segment.

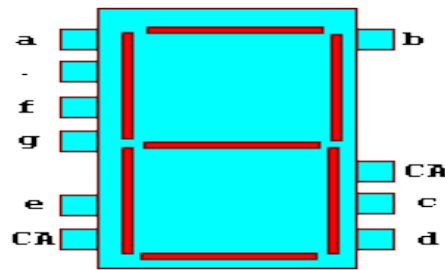


Figure III.9 : Seven Segment Display

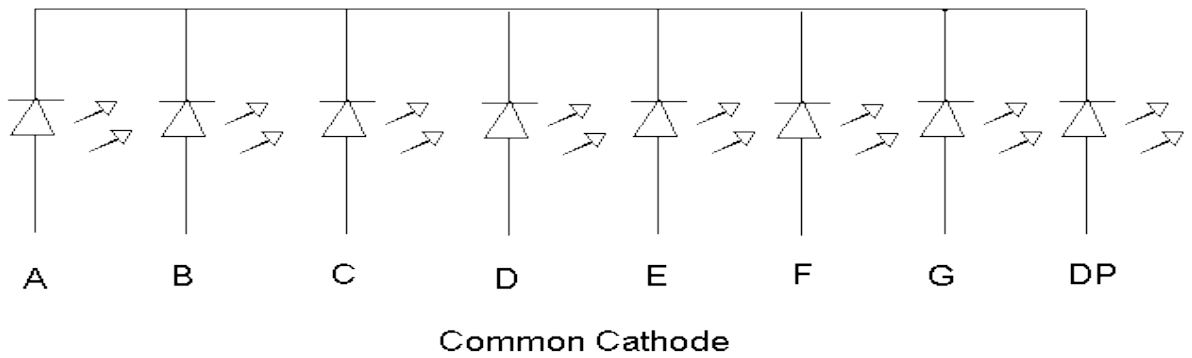


Figure III.10 : Common Cathode

Example About How To Connected Pins Of Common Cathode With Microcontroller On Protues And Its Code

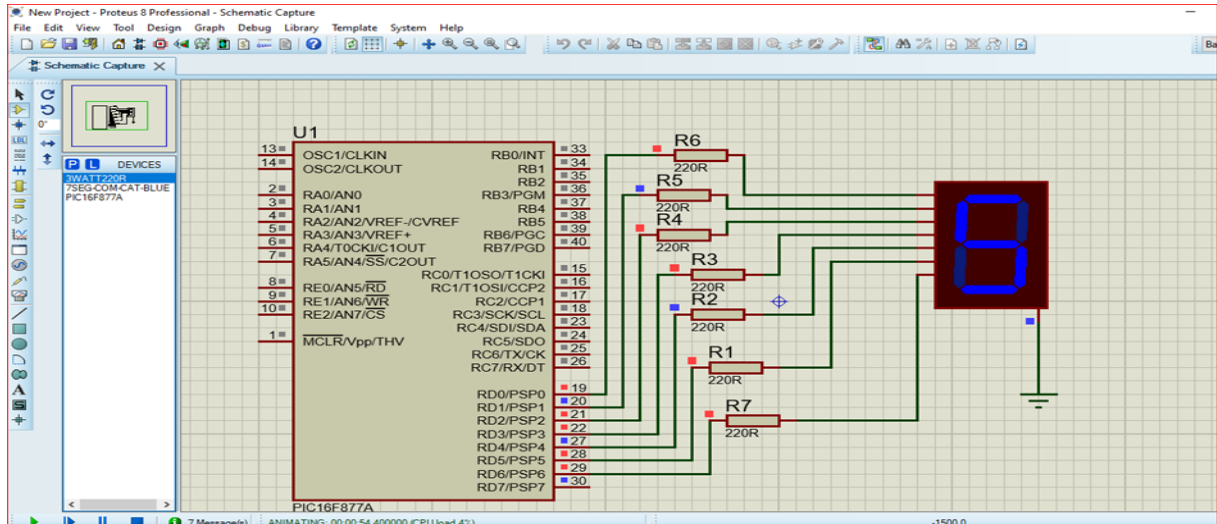


Figure III.11 : Pins Of Common Cathode Connected With Microcontroller

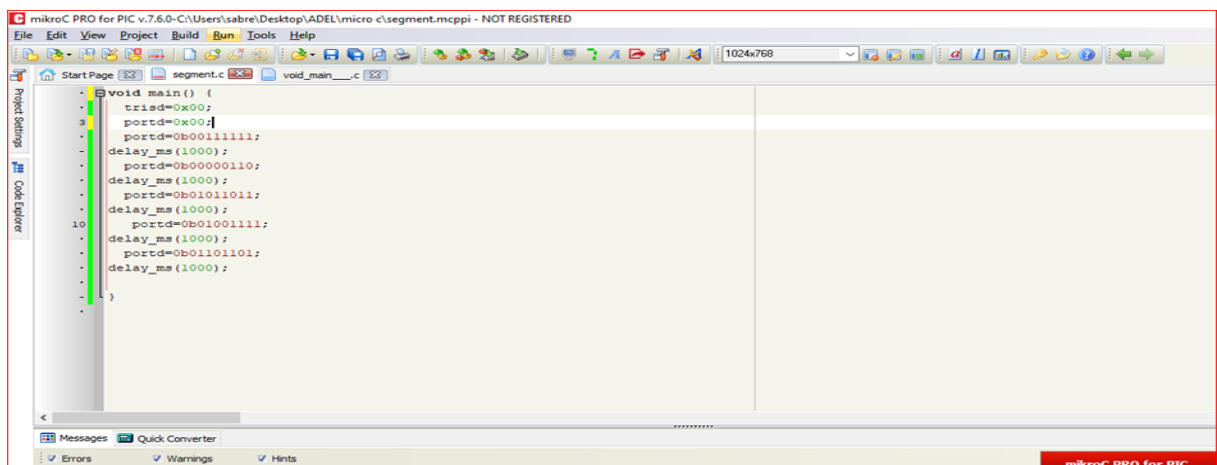


Figure III.12 : Pins Common Cathode Simulated

6 BCD To Seven Segment Display :

Decoder Circuit using IC 7447

BCD means Binary Coded Decimal. We can represent each of the decimal numbers by its four-bit binary numbers.

To drive a Seven Segment Display we need BCD to Seven Segment Display Decoder circuit. So here we used an IC 74LS47 for our work.

So before making the circuit let's know about the IC 74LS47

7 Pin Diagram of IC 74LS47 :

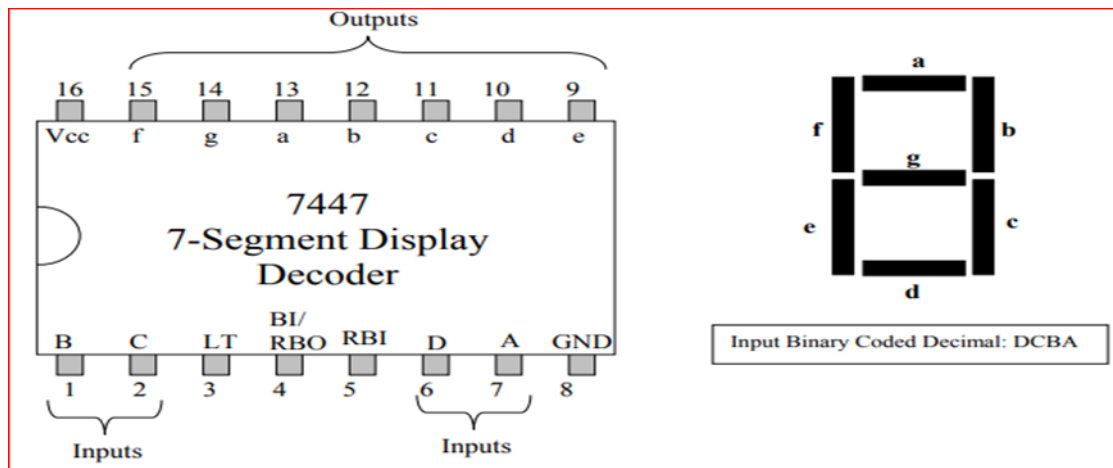


Figure III.13: Pin Diagram of IC 74LS47

- A, B, C, D are the BCD input pins.
- LT - for display test
- RBO, RBI is the Ripple blanking output and Ripple blanking Input pins respectively.
- a, b, c, d, e, f, g are the outputs for seven segment display.

Example About How To Connected Pins Of Decoder 7 Segment With Microcontroller On Proteus And Its Code

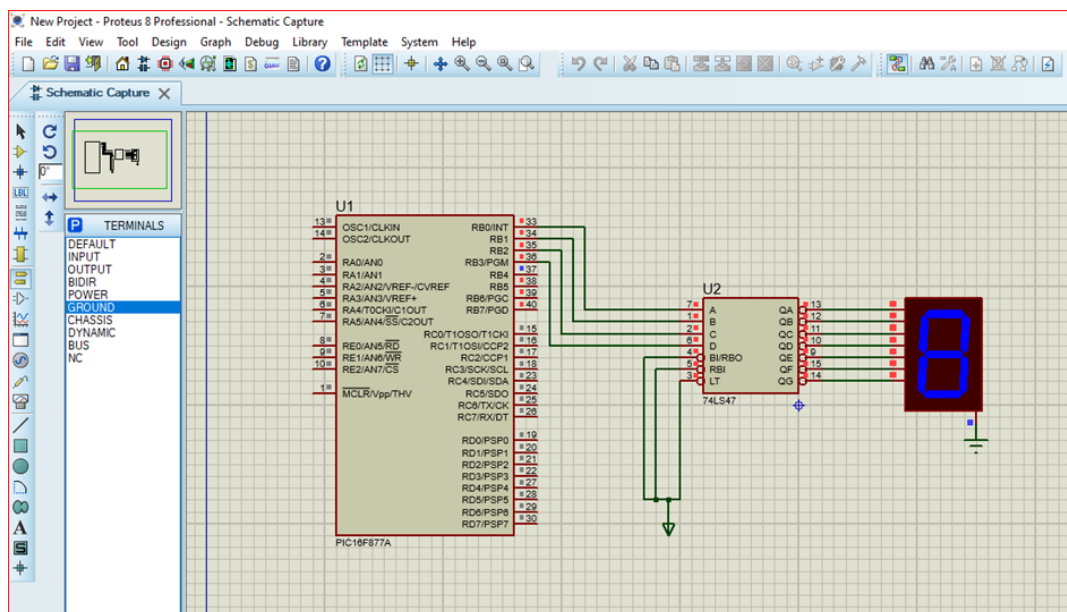


Figure III.14 : Pins Of Decoder 7 Segment Connected With Microcontroller

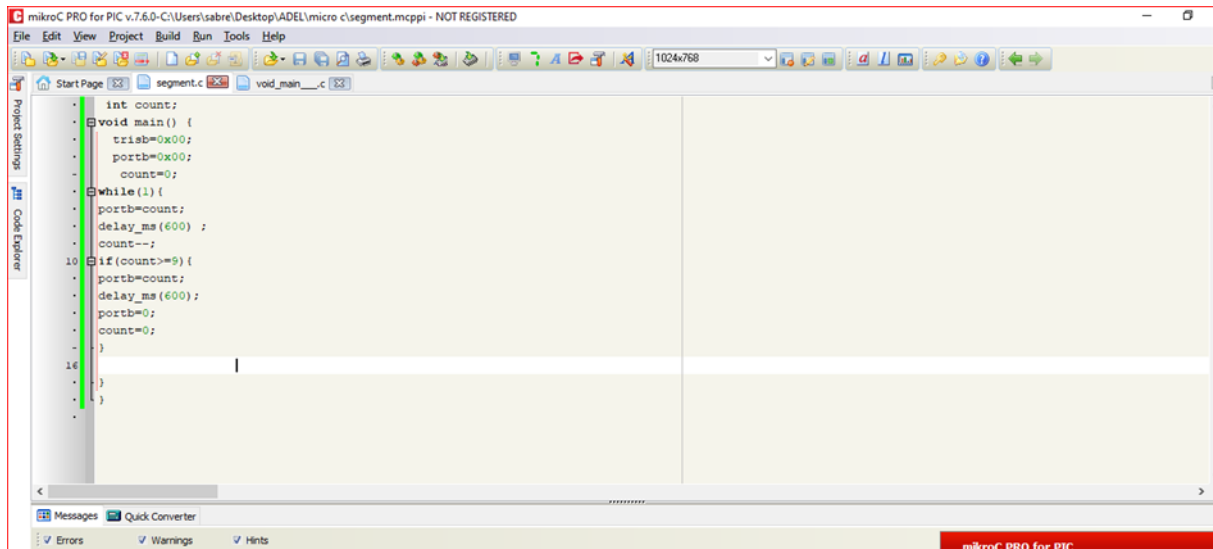


Figure III.15 : Pins Of Decoder 7 Segment Connected With Microcontroller

8 Motor DC :

A motor is defined as a device that converts electrical energy into mechanical work using rotary motion. In elevators, motors of all types are used in various hoisting machine applications to raise and lower the load being transported, to open and close car. Advances in magnetic technology, such as rare earth magnets, demonstrated improvements in a PM motor's steady state performance and power density. As a result, the permanent magnet DC motor has seen broad adoption in today's global market place. Permanent-Magnet DC motors are used by vendors of computer peripherals, office equipment, medical instruments, automobiles, robots and elevators.

The permanent-magnet DC motor is an excellent choice for mechanical systems that require accurate speed control. Altering the magnitude of voltage provided to the armature circuit of a permanent-magnet DC motor is as simple as changing the polarity of the supply voltage; to make the motor work in the opposite direction, the polarity of the supply voltage just needs to be reversed. This was accomplished with the help of a switching power supply and a microcontroller system.

8.1 Working Principle of DC Motor :

The working principle of Permanent Magnet DC motor is just similar to the general working principle of DC motor. That is when a carrying conductor comes inside a magnetic field, a mechanical force will be experienced by the conductor and the direction of this force is governed by Fleming's left hand rule. As in a permanent magnet dc motor, the armature is

placed inside the magnetic field of permanent magnet; the armature rotates in the direction of the generated force.

8.2 L293D DC Motor Driver :

L293D is a typical Motor driver or Motor Driver IC which allows DC motor to drive on either direction. L293D is a 16-pin IC which can control a set of two DC motors simultaneously in any direction. It means that you can control two DC motor with a single L293D IC. Dual H-bridge Motor Driver integrated circuit(IC).

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

8.3 Working of L293D :

There are four input pins for this l293d, pin 2, 7 on the left and pin 15, 10 on the right as shown on the pin diagram. Left input pins will regulate the rotation of motor connected

across left side and right input for motor on the right hand side. The motors are rotated on the basis of the inputs provided across the input pins as LOGIC 0 or LOGIC 1.

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

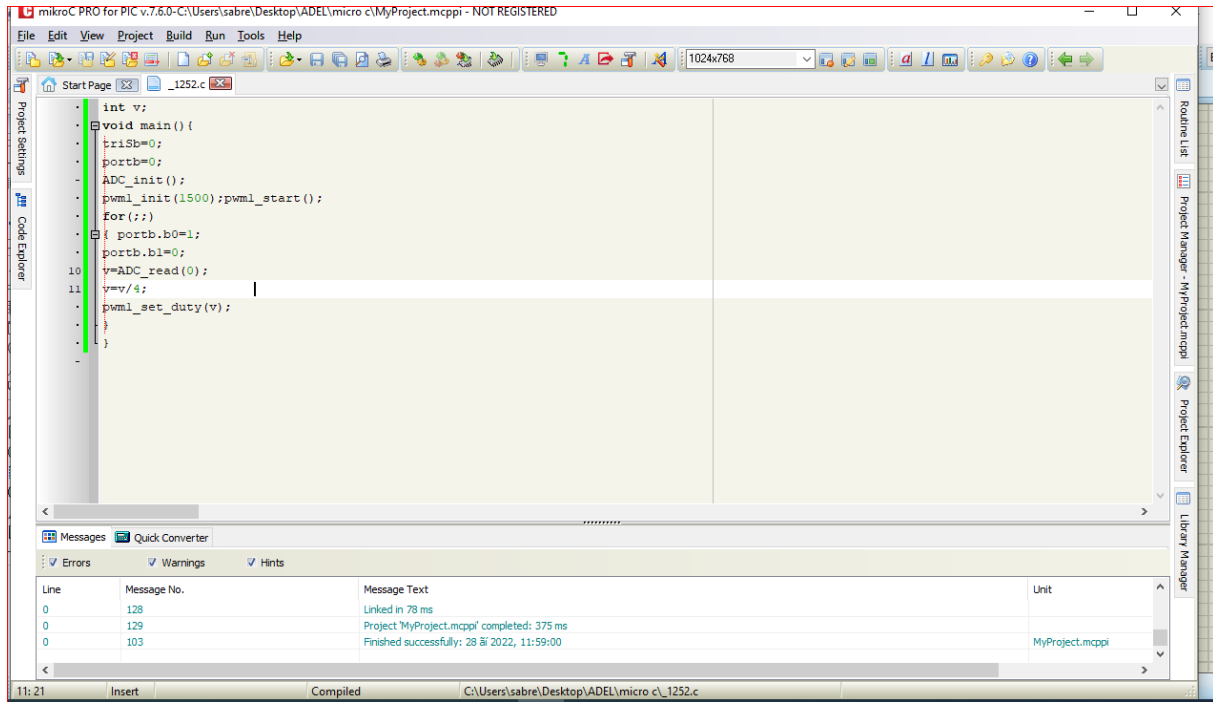


Figure III.16 : Motor DC

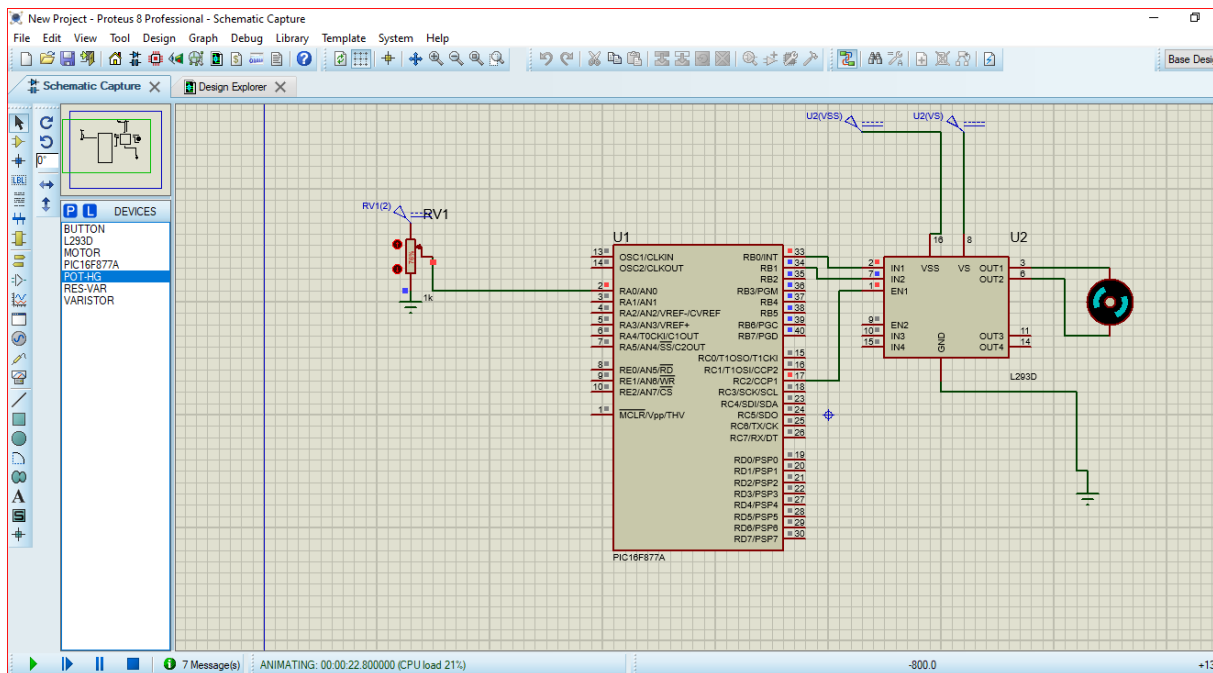


Figure III.17 : Motor DC Simulated

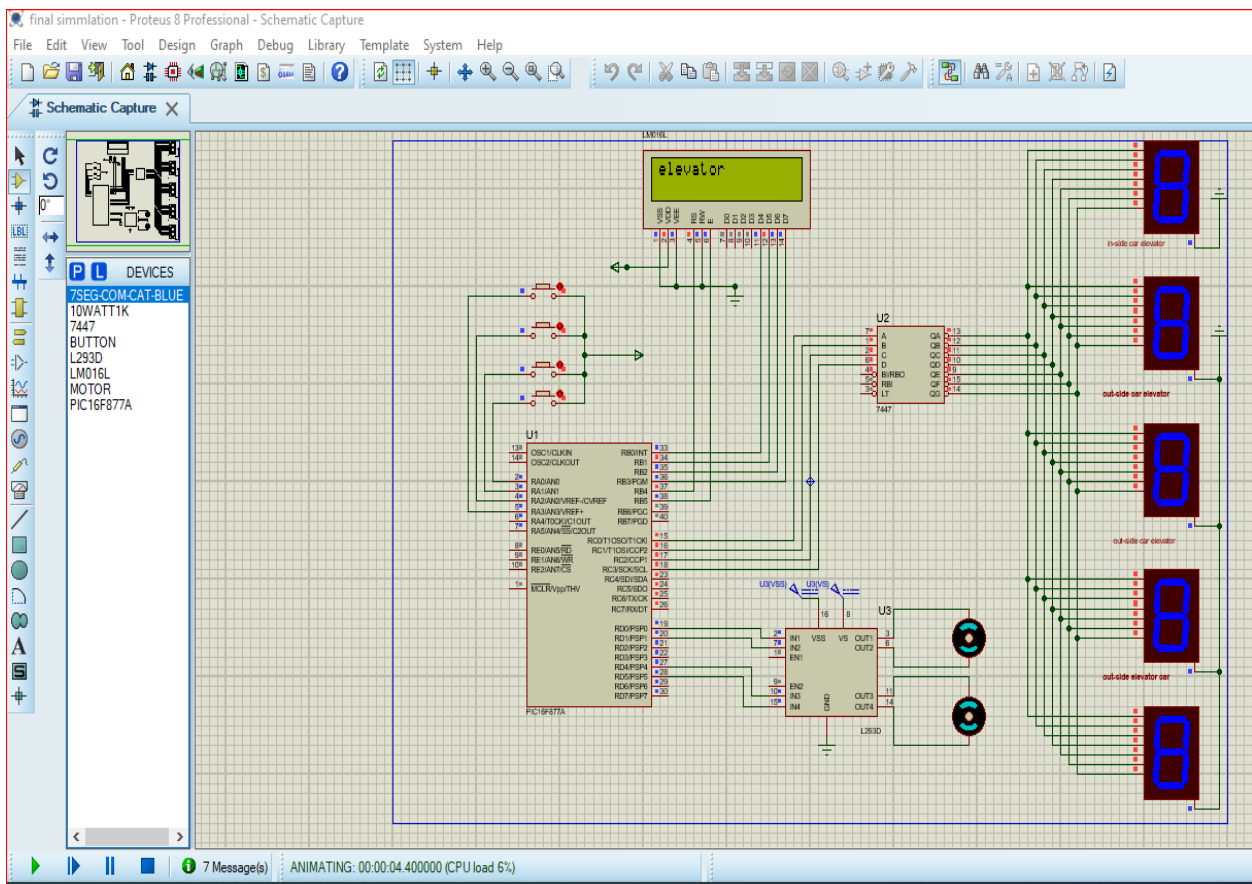


Figure III.18: Final Simulation Elevator With Proteus

Algorithms :

A:When call car elevator from ground , there are three cases.

- 1:first case : if the car elevator at first floor , it goes down to ground
- 2: second case : if the car elevator at second floor , it goes down to first floor and then ground.
- 3: third case : if the car elevator at third floor , it goes down to second floor then first and ground.

B:When call car elevator from first floor , there are three cases.

- 1: first case : if the car elevator at ground , it goes up to first floor.
- 2: second case : if the car elevator at second floor , it goes down to first floor .
- 3: third case : if the car elevator at third floor , it goes down to second floor then first .

C:When call car elevator from second floor ,there are three cases.

1: first case : if the car elevator at ground, it goes up to first then second floor.

2: second case : if the car elevator at first floor , it goes up to second floor .

3: third case : if the car elevator in third floor , it goes down to second floor .

D: When call car elevator from third floor ,there are three cases.

1: first case : if the car elevator at ground, it goes up to first then second and third floor.

2: second case : if the car elevator at first floor , it goes up to second floor then third floor .

3: third case : if the car elevator at second floor , it goes up to third floor .

Description about systeme elevator

At the starting the LCD display the word “elevator” and after we press any push button(RB0,RB1,RB2,RB3) . The car elevator door open with [M2] rotation to open door .also LCD displays “DOOR OPEN” ,and then any button pressed activate [M2] to rotation invers for close the door car elevaton , and LCD display “door closed”.

After the door closed elevator car motor [M1] start rotation and move the car down or up depends the persone if he wants go up or down floor.

Final Mikroc Code To Control The Elevator System

```

mikroC PRO for PIC v.7.6.0-C:\Users\sabre\Desktop\ADEL\micro c\my.mcppi - NOT REGISTERED
File Edit View Project Build Run Tools Help
1024\768
Start Page my.c
// Lcd pinout settings
sbit LCD_RS at RB4_bit;
sbit LCD_EN at RB5_bit;
sbit LCD_D7 at RB3_bit;
sbit LCD_D6 at RB2_bit;
sbit LCD_D5 at RB1_bit;
sbit LCD_D4 at RB0_bit;

// Pin direction
sbit LCD_RS_Direction at TRISB4_bit;
sbit LCD_EN_Direction at TRISB5_bit;
sbit LCD_D7_Direction at TRISB3_bit;
sbit LCD_D6_Direction at TRISB2_bit;
sbit LCD_D5_Direction at TRISB1_bit;
sbit LCD_D4_Direction at TRISB0_bit;
Lcd_Init();

void open() { // FOR OPEN DOOR ELEVATOR CAR
    delay_ms(100);
    portd.RD4=1; portd.RD5=0;
    delay_ms(700);
    lcd_cmd(_lcd_clear); lcd_out(1,1,"DOOR OPEN");
    portd.RD4=0; portd.RD5=0;
}

void close() { // FOR CLOSE DOOR ELEVATOR CAR
    delay_ms(100);
    portd.RD4=0; portd.RD5=1;
    delay_ms(700);
    lcd_cmd(_lcd_clear); lcd_out(1,1,"DOOR CLOSED");
    portd.RD5=0;
}
    
```

Figure III.19 : Code microC code 1/6

```

mikroC PRO for PIC v.7.6.0-C:\Users\sabre\Desktop\ADEL\micro c\my.mcppi - NOT REGISTERED
File Edit View Project Build Run Tools Help
1024\768
Start Page my.c
29 portd.RD5=0;
30 delay_ms(500);
void main() {
    int pos=0;
    trisd=0; // TRIS=0 FOR output ( trisd be output )
    portd=0; // PORT=0 FOR LOW ( portd be low )
    trisa=0; // TRIS=0 FOR output ( trisa be output )
    porta=0; // PORT=0 FOR LOW ( portd be low )
    trisc=0X00;
    portc=0Xff;
    Lcd_Init(); // Initialize LCD

    Lcd_Cmd(_LCD_CLEAR); // Clear display
    Lcd_Cmd(_LCD_CURSOR_OFF); // Cursor off
    Lcd_Out(1,1,"elevator"); //text on Lcd starting from specified position
    while(1) { // CONDITION
        if(PORTA.RA0==1) { // CONDITION untill press button RA0
            if(pos==1) { // CONDITION ABOUT POSITION CAR ELEVATOR
                close();
                portd.RD0=0; portd.RD1=1;
                delay_ms(3000); //Three second pause
                portc=0;
                portd.RD1=0;
                lcd_cmd(_lcd_clear); lcd_out(1,1,"GROUND");
                open();
            }
            if(pos==2) {
                close();
            }
        }
    }
}
    
```

Figure III.20: Code microC code 2/6

```

close();
portd.RD0=0; portd.RD1=1;
delay_ms(3000); portc=1;
delay_ms(3000); portc=0;
portd.RD1=0;
lcd_cmd(_lcd_clear); lcd_out(1,1,"GROUND");
open();
}
if(pos==3){
close();
portd.RD0=0; portd.RD1=1;
delay_ms(3000); portc=2;
delay_ms(3000); portc=1;
delay_ms(3000); portc=0;
portd.RD1=0;
lcd_cmd(_lcd_clear); lcd_out(1,1,"GROUND");
open();
}
pos=0;
}
if(PORTA.RA1==1){
if(pos==0){
close();
portd.RD0=1; portd.RD1=0;
delay_ms(3000); portc=1;
portd.RD0=0;
lcd_cmd(_lcd_clear); lcd_out(1,1,"FIRST FLOOR");
open();
}
}

```

Figure III.21: Code microC code 3/6

```

}
if(pos==2){
close();
portd.RD0=0; portd.RD1=1;
delay_ms(3000); portc=1;
portd.RD1=0;
lcd_cmd(_lcd_clear); lcd_out(1,1,"FIRST FLOOR");
open();
}
if(pos==3){
close();
portd.RD0=0; portd.RD1=1;
delay_ms(3000); portc=2;
delay_ms(3000); portc=1;
portd.RD1=0;
lcd_cmd(_lcd_clear); lcd_out(1,1,"FIRST FLOOR");
open();
}
pos=1;
}
if(PORTA.RD2==1){
if(pos==0){
close();
portd.RD0=1; portd.RD1=0;
delay_ms(3000); portc=1;
delay_ms(3000); portc=2;
portd.RD0=0;
lcd_cmd(_lcd_clear); lcd_out(1,1,"SECOND FLOOR");
open();
}
}

```

Figure III.222: Code microC code 4/6

```

open();

if(pos==1){
close();
portd.RD0=1;      portd.RD1=0;
delay_ms(3000);   portc=2;
lcd_cmd(_lcd_clear); lcd_out(1,1,"SECOND FLOOR");
portd.RD0=0;
open();
}

if(pos==3){
close();
portd.RD0=0;      portd.RD1=1;
delay_ms(3000);   portc=2;
portd.RD1=0;
lcd_cmd(_lcd_clear); lcd_out(1,1,"SECOND FLOOR");
open();
}

pos=2;
}

if(PORTA.F3==1){
if(pos==0){
close();
portd.RD0=1;      portd.RD1=0;
delay_ms(3000);   portc=1;
delay_ms(3000);   portc=2;
delay_ms(3000);   portc=3;
portd.RD0=0;
Lcd_cmd(_lcd_clear); lcd_out(1,1,"THIRD FLOOR");
open();
}

if(pos==1){
close();
portd.RD0=1;      portd.RD1=0;
delay_ms(3000);   portc=2;
delay_ms(3000);   portc=3;
portd.RD0=0;
Lcd_cmd(_lcd_clear); lcd_out(1,1,"THIRD FLOOR");
open();
}

if(pos==2){
close();
portd.RD0=1;      portd.RD1=0;
delay_ms(3000);   portc=3;
portd.RD0=0;
Lcd_cmd(_lcd_clear); lcd_out(1,1,"THIRD FLOOR");
open();
}

pos=3;
}
}
    
```

Figure III.233: Code microC code 5/6

```

delay_ms(3000); portc=1;
delay_ms(3000); portc=2;
delay_ms(3000); portc=3;
portd.RD0=0;
Lcd_cmd(_lcd_clear); lcd_out(1,1,"THIRD FLOOR");
open();
}

if(pos==1){
close();
portd.RD0=1; portd.RD1=0;
delay_ms(3000); portc=2;
delay_ms(3000); portc=3;
portd.RD0=0;
Lcd_cmd(_lcd_clear); lcd_out(1,1,"THIRD FLOOR");
open();
}

if(pos==2){
close();
portd.RD0=1; portd.RD1=0;
delay_ms(3000); portc=3;
portd.RD0=0;
Lcd_cmd(_lcd_clear); lcd_out(1,1,"THIRD FLOOR");
open();
}

pos=3;
}
}
    
```

Figure III.244: Code microC code 6/6

Conclusion:

Elevator Control System using microcontroller is the system responsible for coordinating all aspects of elevator service such as travel, speed, and accelerating, decelerating, door opening speed and delay, leveling and hall lantern signals by using PIC microcontroller.

PIC16F877A microcontroller is chosen as the core control component for elevator control system and DC motor. Based on the key pressed the elevator moves either in upward or downward direction and infrared tubes are used for detecting the location of the elevator, thus acquiring real-time information for opening and closing of the door of elevator. To make the elevator more comfortable for passenger, PWM signal based on load factor of elevator car and maintain the constant speed of the DC motor for smooth running of elevator system.

General Conclusion:

The control system that we design is optimal control system means that control system gives faster performance by reducing the average waiting time (AWT) of the passengers. It also reduces the power consumption of the elevator system. For this we take different algorithms. Depending on thus algorithms if two calls coming at the same time, then the car goes to the call that have high priority.

Even if we deign the lift control system for only 4 floors, it is possible to design for more than 4 floors. The only thing is selecting the microcontroller family which has more than 33 input output pins. The c code can be written as the same way as the 4 floor. And also the components used are similar to that of our design.

The Obstacles :

- One of the obstacles that we faced is lack of materials that make up our project, which led us to abandon the implementation of our project study, conception and realization of a controlled elevator prototype based on a microcontroller (PIC) on the ground.(Main reason).
- Second of the obstacles appeared problem with microC in the libraries especially LCD library (but problem solved).

Future Scopes :

As for the future work, we will write the c program for the optimal control system and also we will implement this project. We can also show the interference of microcontroller with temperature sensors for displaying the temperature or provide safety from accident like fire to save human beings and elevator. If any accident like fire occurs an alarm attached to the elevator starts. We can also connect the RTC module with the microcontroller to display 24 hour display in the elevator and a small DC motor represent fan in the elevator.

In general we desire for the future to design and implement an elevator system for a building with any number of floor by selecting other microcontroller chip with more number of pins or by using two pic16f877a microcontrollers.

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