Research Paper

On

Design and Development of a Microcontroller-Based Cargo Lift Control System

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Declaration

This is to certify that this project report was done by us under the course research project (APE-598). It has not been submitted elsewhere for the requirement of any degree or any diploma or any other purpose.

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Acceptance

A paper is submitted to the Department of Electronics and Communication Engineering of East West University in partial fulfillment of the requirement for the degree of MS in Applied Physics and Electronics.

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Abstract

A cargo lift is a type of vertical transport equipment that efficiently moves people or goods between floors (levels, decks) of a building, vessel or other structure. Lifts are generally powered by electric motors that either drive traction cables or counterweight systems like a hoist, or pump hydraulic fluid to raise a cylindrical piston like a jack. In agriculture and manufacturing, a lift is any type of conveyor device used to lift materials in a continuous stream into bins or silos. Several types exist, such as the chain and bucket lift, grain auger screw conveyor using the principle of Archimedes' screw, or the chain and paddles/forks of hay lifts. Lifts are a candidate for mass customization. There are economies to be made from mass production of the components, but each building comes with its own requirements like different number of floors, dimensions of the well and usage patterns. This document is intended to reflect a cost efficient policy regarding design and construction of cargo lifts. This document has been developed to assist architects and engineers in the proper design of lifts with low cost. This is because modern lifts are complex multi-disciplined products, guidance is needed to cost efficient lifts production and help the architectural and engineering disciplines understand their roles in lift design.

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Chapter One

Introduction

1.1 Objectives

The first reference to lift is in the works of the Roman architect Vitruvius, who reported that Archimedes (c. 287 BC – c. 212 BC) built his first lift probably in 236 BC. In some literary sources of later historical periods, lifts were mentioned as cabs on a hemp rope and powered by hand or by animals. It is supposed that lifts of this type were installed in the Sinai monastery of Egypt.

All lifts, whether traction or hydraulic, require a machine room to store large electric motors (or hydraulic pumps) and a controller cabinet. This room is located above the hoistway (or below, for hydraulic lifts) and may contain machinery for a single or a group of lifts. Modern day traction motors boasting gearless and permanent magnet drive can be more compact and efficient; electronic microprocessors have replaced the mechanical relays. As a result, traction lifts can be built without a dedicated room above the shaft, saving valuable space in building planning.The new lift design presents a departure from the traditional, looped over-the-top traction rope routing of traction lifts. The ends of the cables are fixed to the supporting structure, and the length of the cable is connected to the car and counterweight by means of a force-multiplying, energy saving compound pulley system. Machine Room-less lifts have become a welcome alternative to the older hydraulic lift for low to medium rise buildings. This new design was first developed by Kone in 1996.This research paper is dealing to represent a brief study of cargo lift for multipurpose project from past to present. This research paper is capable to demonstrate an up gradation of previous experience of lifts and also very resourceful to all engineers, designer, architectures to forget previous error and limitation with lifts. In polite word it can be said that this book is very courageous to develop a new concept for mass lift and lifts production.

1.2 Content and Format

This guidance is arranged by design disciplines, and within each design discipline the chapter is arranged by the major lift component. This arrangement serves three purposes;

(1) Allows easy and ready access to lift requirements needed by each designer;

(2) Allows a checklist format for the designer to assure all requirements have been met;

(3) Allows the designer in charge of the overall facility to understand the roles of each of his architects and engineers by providing a tool for coordination of the design effort.

1.3Type of lifts addressed

1.3.1 Hydraulic

(1) Direct Plunger: A car is connected to the top of a single section piston, that moves up and down in a cylinder, which is below ground level. The car moves up when hydraulic fluid is pumped into the cylinder from a reservoir, raising the piston. Hydraulic systems are used primarily in low-rise installations where moderate car speed is required, up to 150 feet per minute. The typical extent of travel is 40 feet (12192 mm), do not exceed a maximum travel length of 44 feet (13411 mm) or a maximum building height of four floors.

(2) Holeless: The car is connected on each side with a single section piston that moves up and down in a cylinder, which is mounted on top of the pit floor. The car moves up when hydraulic fluid is pumped into the cylinder from a reservoir, raising the piston. Car speed up to 125 feet per minute (38.1 meters per minute) is attained and maximum travel length is 12 feet (3658 mm).

(3) Roped: The car is supported by steel hoist ropes and sheave, which are moved up and down by a holeless single section piston in a cylinder. Car speed up to 150 feet per minute is attained and maximum travel length is 48 feet (14630 mm). This is a sophisticated elevating system designed specifically for use in private residences. The system fits within a vertical lifthoistway connecting the floors to be serviced. Two different drive systems are available with your lift, the Hydraulic Drive and the In-line Drive. This Design Guide is intended to assist architects, contractors, home owners and lift professionals in planning for installation. We strongly recommend that you contact your local authority to discuss and become familiar with the code requirements in your area. It is extremely important for you to know and adhere to all local codes and regulations pertaining

1.3.2 Electric Traction

(1) Geared: The car is supported in a hoistway by steel hoist ropes, a sheave, and a counterweight. The car and counterweight ride along vertical guide rails. In a geared machine, the drive sheave is connected to the motor shaft through gears in a gearbox. This equipment is designed for mid-rise applications of five or more floors requiring typical speeds up to 350 feet per minute.

(2) Gearless: The car is supported in a hoistway by steel hoist ropes, sheaves, and a counterweight. The car, counterweight and guide rails operate like those in a geared system. The gearless machine has a motor that connects directly to the shaft of the drive sheave. The equipment is designed for high-rise applications of 10 or more floors requiring typical speeds of 500 or more feet 2-3 per minute.Hydraulic and electric traction lifts utilize controllers to coordinate systems and passenger calls. These lifts utilize either of these two types of controllers:

a. **Microprocessor**: Computer logic control is the standard for both electric traction and hydraulic lifts.

b. Relay **logic:**Mechanical electro-magnetic controller relays control the operation of the lift.

1.4 Machine Room

1. Locate hydraulic lift machine room on the lowest level served by the liftanddirectly adjacent to the hoistway. Machine room and hoistway must be on the same side of any building expansion joint.

2. Provide plans and sections for lift machine room. Show roof top machine room on elevations and plans for electric traction lifts.

3. Indicate 2 hour fire rating for floor, walls and ceiling construction. If required, indicate stair access, no ladders.

4. Machine room door (exiting to the interior of the building) shall be "B" Label, fire rated1 ½ hour with automatic closure, latching door hardware, panic hardware exit device from interior of room, key operated hardware from outside of room only. Machine room 2-4 door shall not contain ventilation louvers or undercuts.

5. There are two types of lift controllers, microprocessor and relay logic.(Microprocessors are typical in most installations. However, if we have a base that is located in a remote location or subject to erratic building power supply, a relay logic controller may be a better choice.)

6. Determine if emergency power is required. Emergency power is usually needed in healthcare facilities (with bed confinement) or high rise facilities (greater than 75'-0" (22860 mm) from ground floor to highest occupied floor). If emergency power is required, coordinate requirements with the Electrical Engineer (for example, the number of lifts to run on emergency power at the same time).

7. Most electric traction lift machines are lifted up the lifthoistway to gain access to roof top machine rooms during construction. Provide a lifting beam at the top of the machine room to accommodate installation of the lift machine.

8. Provide an unobstructed 7'-0" (2133 mm) minimum vertical clearance below all solid items (including the lifting beam for electric traction lifts) throughout the lift machine room. Provide a maximum machine floor to ceiling height of 12'-0" (3658 mm). Provide a suspended gypsum board or plaster ceiling if a ceiling is required below the structural ceiling.

9. The machine room design shall contain only equipment related to the lift operation as required.

10. Pipes, ducts and conduit not related to the lift system are not allowed to penetrate the machine room.

Chapter 2

Primary Planning&Design

2.1 LiftHoistway

2.1.1 Maximum travel length for direct plunger type hydraulic lift is 44 feet (13411mm) or a maximum building height of four floors, whichever is the lesser.

2.1.2 Telescopic hydraulic pistons are not acceptable for facilities. Provide only single section pistons for all hydraulic lifts.

2.1.3 Geared electric traction machines should be used for buildings of five or more floors.

2.1.4 Gearless electric traction should be used for buildings of ten floors or more where intensive traffic is anticipated.

2.1.5 The lift code does not allow anything to be installed in the hoistway not related to the lift operation.

2.1.6 Pipes, ducts and conduit not related to the lift system are not allowed to penetrate the hoistway.

2.1.7 Show locations of all support beams required in hoistway. Indicate beams on buildingsections and details. For multiple lifts in the same hoistway, provide divider beams for guiderail support brackets.

2.1.8 Eliminate all ledges (potential personnel standing locations, etc.) in hoist way construction. Provide details which indicate that all horizontal projections and recesses of 2" (50 mm) or more have been beveled back to hoistway wall at a 75-degree angle downward from horizontal.

2.1.9 Provide exterior ventilation of hoistway if the lift exceeds 15 feet (4572 mm) of travel. To obtain this ventilation, provide a weatherproof louver with a minimum free area of 3 1/2 % of the hoistway horizontal cross sectional area. The louver must have minimum free area of at least three square feet (0.3 square meters).

2.1.10 Detail grouted cast white bronze or nickel silver hoistway sills at lift landings. Match the material used in the cab sill.

2.1.11 Indicate all lift hoistway door frames grouted to a height of 5 feet (1524 mm).

2.1.12 On hydraulic lifts, design clear access for hydraulic oil line between machine room and hoistway. Hydraulic oil lines shall remain in or under conditioned space from end to end and remain within the building footprint. Provide straight pipe run inPVC pipe sleeves for oil spill containment of all buried hydraulic lines between machine room and the hoistway.

2.1.13 On hydraulic lifts, sprinkler protection is required at the top of the hoistwaywhen the hydraulic cylinder or supply piping extends above the second finished floor elevation.

2.1.14 Coordinate sprinkler and smoke detector requirements with fire protection engineer and electrical engineer. Confirm smoke detectors are shown on fire alarm plans and risers.

2.1.15 For interior cab dimensions of new lifts being installed in an existing hoistway,insure that the design meets the requirements. Passenger lifts frequently require greater capacity (pound per square foot (kilogram per square meter)) than freight lifts.

2.1.16 Indicate 2-hour fire rating for floor, walls, and top of hoistway (when terminated below roof level) construction.

2.2 Lift Cab

2.2.1 Coordinate thefollowinglift description information with the specification writer and appropriate design discipline(s):

1. Rated load
2. Rated speed
3. Travel length
4. Number of stops
5. Number of hoistway openings
6. Car inside dimension
7. Car door opening
8. Electrical design requirements
9. Coordinate the cab enclosures and hoistway door finishes with the specification writer:
    a. Floor finish
    b. Wall finish and accessories handrails
    c. Interior face of doors
    d. Ceiling finish and lighting
    e. Hoistway doors
    f. Hoistway frames.

2.2.2 The designer and client must decide whether a passenger or freight lift is most appropriate for the facility. This decision will be based on the anticipated usage. If theliftwill be used to carry people other than a freight handler, it must be designed as passengerlift.
2.2.3 Passenger lift design/selections: The design of passenger lifts requires obtaining and utilizing the appropriate data and criteria to calculate the correct lift size and rated load.

a. Preliminary design and layout of lifts shall be in accordance with Local Building Code or any Regulatory Commission

b. The Final lift design including the required number of cars, their capacity and car inside dimensions, speed, and operation is to be determined by a traffic study. The following factors will be utilized in this analysis, which should be performed by qualifiedlift consultant.

    1) Type and Use of Building
    2) Size and Height of Building.
    3) Exterior Traffic Consideration
    4) Population of Building
    5) Anticipated Traffic Flow

c. Determine minimum rated load of lift by utilizing

2.2.4Freightlift design/selection: If the lift will be used to carry passengers and general freight, it must be designed as a passenger lift.

2.2.5Provide a cast white bronze or nickel silver car sill. Match the material used in thehoistway sill.

2.3 Components of Strand Wire Rope and Cable

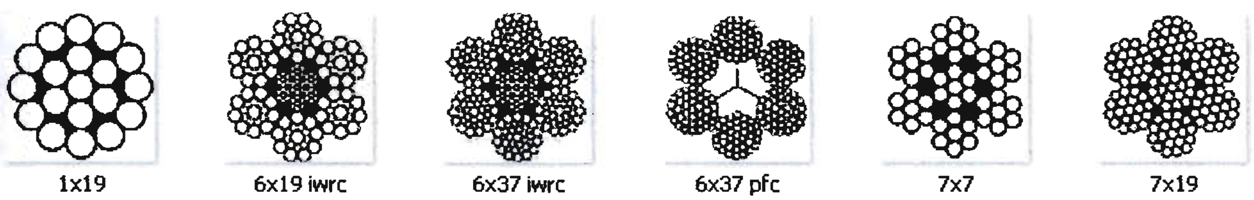


Figure 1: Components of strand wire rope and cable

Strand

Strand is two or more wires wound concentrically in a helix. They are usually wound around a center wire. Strand is normally referred to as 1 by the total number of wires in the given strand. Such as 1 x 7 (one group of seven wires) or 1 x 19 (one group of nineteen wires).

Cable / Wire Rope

Cable is the generic term that refers to constructions of wire rope that fall into the category of aircraft cable. These constructions include 7 x 7 (seven groups of 1 x 7 strand) and 7 x 19 (seven groups of 1 x 19 strand) respectively. "Aircraft cable" ranges in size from 1/32" to 3/8".

Wire Ropes technically the correct term for groups of strand wrapped in a uniform helix around a core. Sizes over 3/8" are not considered aircraft cable, they are wire rope. The constructions included in wire rope are numerous, but the most common are 6 x 19 and 6 x 37 class wire ropes. These descriptions of the construction fail to include the core as a part of the primary number. Part of the reason for this is that the composition and the construction of the cores in these wire ropes is so numerous, that it is necessary to call out the outer construction of the wire rope and then describe the core. Such as 6 x 19 fiber core, or 6 x 37 IWRC (Independent Wire Rope Core). The terms CABLE and WIRE ROPE are synonymous for all intents and purposes.

Core

The core can be a variety of things, including: Strand in many constructions or even a cable or wire rope. The core can also be of a composition other than metal, such as polypropylene rope.

Whatever the construction or the composition of the core, it is the center member of the cable or wire rope.

Construction

Construction of strand, wire rope or cable is the nomenclature for describing the number of wires contained in and their relationships to each other in the particular product being described. 1 x 19 describes one group of nineteen wires; 7 x 19 describes seven groups of nineteen wires (or seven groups of 1 x 19); 6 x 37 IWRC describes six groups of thirty-seven wires wound around a core that might actually be 7 x 7 constructions itself. Thus the term Independent Wire Rope Core, since the core of 7 x 7 is actually a piece of wire rope. The construction of the core is partially determined by the diameter of the wire rope being described.

Composition

Composition of the wire rope or strand refers to the material used to manufacture the product being described. Strand, wire rope and cable are made from various grades of both stainless steel and carbon steel.

The STAINLESS STEEL grades that are the most common are Type 302/304, Type 305 (nonmagnetic), and Type 316.

Type 302/304 is 18-8 (18 parts chromium and 8 parts nickel) stainless steel and is most commonly used in the manufacture of wire rope. This type of stainless steel is commonly used in applications that require more corrosion protection than is available from galvanized carbon steel cable. Contrary to popular belief, stainless steel is not stronger than galvanized carbon steel cable. The fact is, it usually has a lower breaking strength than galvanized carbon steel cable of the same diameter and construction.

Type 305 S/S cable (nonmagnetic) is commonly available in 1/16" and 1/32" diameters. This type of S/S is generally used in applications where sensitive instrumentation or other systems might be affected by magnetism.

Type 316 S/S is increasingly popular in many outdoor salt air environments. It has excellent corrosion protection and is the preferred choice of the marine industry. The increase in popularity of Type 316 S/S has spurred the availability of many wire rope terminals also becoming available in Type 316 S/S.

Monel is an uncommon grade of stainless and is used in applications where added resistance to corrosive substances and liquids are required. The main drawbacks to Monel are that its minimum breaking strength is about 30% less than that of Type 302/304 S/S, and that it is not readily available.

Carbon Steel Wire is available in different grades, sometimes referred to as Plow Steel, Improved Plow Steel, or even Extra Improved Plow Steel. Wire rope manufactured from uncoated wire is commonly referred to as Bright. Bright wire rope is available in sizes 1/4 inch and over.

GALVANIZED carbon steel wire is frequently used to manufacture wire rope. Galvanized wire rope provides good corrosion protection in mild environments. In smaller sizes (less than 1/4 inch) it is almost automatically used when stainless steel is not specified.

Lay

The lay of the strand, wire rope or cable, is the direction in which the helix of the wires orbit the core. An easy way to determine the lay is to hold the specimen vertically in front of you and observe whether the strands or wires travel up and to the right or up and to the left. Just as you might visually determine the direction of a thread on a bolt. There are other types of lay or wire rope, such as Lang and Herringbone. These types of lays in wire rope are for special purposes, so we will not go into them here.

Performing

Performing of the wires refers to the forming of the individual wires of a strand into a helix so as to enable them to all be "closed" into a uniform cylinder capable of retaining its shape when cut. Furthermore, when wire rope or cable is made (using preformed strand) the strand (group of preformed wires) is also preformed into a helix so that the 6 or 7 groups of strand all lay together in a cylindrical form and remain that way when cut. Miniature diameters (smaller than 3/64 inch) often are not preformed and must be specified to be "stress relieved" at the time of ordering. Without performing or stress relieving, cable will typically "Broom" or fray when cut or disturbed. Miniature cable notwithstanding, it is not usually necessary to specify performing when ordering cable or wire rope since almost all wire rope and cable is preformed.

Coating

The coating of a cable is optional, but can serve many useful purposes. The most common types of coatings are PVC Polyvinylchloride, various Nylon compounds, and Teflon. These materials are referred to as compounds. These compounds are applied to the cable via the use of a plastic extrusion machine.

PVC

PVC is relatively inexpensive and is available in almost any color. PVC lends itself well to applications that are going to be exposed to sunlight. PVC would also be a good choice for an application that requires an increase in mass, or a particular color. PVC is relatively soft and does not have good abrasion resistance.

Nylon and Thermoplastic Elastomers

Nylon and thermoplastic elastomers are numerous in types of compounds, each with its own special properties that may be more or less suitable for a particular application. Most are suitable for cycling over pulleys. The differences vary from high temperature environments to specific chemical exposures.

2.4 Structural Lift Design (Mechanical Section Design)

2.4.1 Design Requirements

In all seismicity regions, provide adequate structural support to attach the elements of the lift support system as required by the lift manufacturers design and applicable codes. The lift manufacturers shall design the elements of the lift support system (all elements that are part of the lift system, such as the car and counterweight frames, guide rails, supporting brackets and framing, as well as supports and attachments for driving machinery, operating devices, and control equipment) with consideration to lateral seismic forces and displacement.

The lift shall also comply with the following:

a. Manufacturer shall design all supports and attachments for machinery and equipment with an asexual to 1.0 for rigid and rigidly attached items and equal to 2.5 for non-rigid or flexibly mounted equipment.

b. In structures conforming to Seismic Design Classification D, E, and F, the manufacturer shall provide guide rail tie brackets and intermediate spreader brackets as specified.

c. Avoid the use of tile or brick hoistway walls, particularly those conforming to Seismic Design Classification D, E, and F.

d. Indicate details for sump pump pit and the impact of the sump pit on the foundation for the structure.

e. Indicate water stops in the walls. Indicate waterproofing for the lift pit floor and walls if not indicated on the architectural drawings.

f. Avoid locating building expansion joints between the lifthoistway and lift room.

g. Design all exterior components of the lift or machine room to the same requirements used for the facility design in the absence of structural criteria for the exterior components use.

2.4.2 Lift Pit

(1)Anlift pit floor drain is not acceptable. Lift pit must have floor sump pit andpump. Pump to sanitary sewer through a 2" (50 mm) air gap or directly through an oil/water separator to storm sewer, or to grade outside the building line, each in accordance with discharge permits, regulations, and statutes. Coordinate sump pit pumpwith the Architect, Structural Engineer, and Electrical Engineer.

(2) On hydraulic lifts, sprinkler protection is required in the pit of each lift. Refer to local or overseas, "Fire Protection Lift Design Guide" for requirements.

(3) Size sump pump for a minimum of 20 gallons (76 liters) per minute. Coordinate pump size with Architect to assure the pump will completely fit within the sump pump pit and function correctly.

2.4.3 Electrical Planningand Design

a. Provide a shunt trip circuit breaker for each individual lift's main power and emergency power, if provided, located in the lift machine room. Circuit breaker shall be capable of being locked in the open position, and shall serve the power and control of the respective lift. Each shunt trip circuit breaker shall be served by another dedicated breaker in the main distribution electrical panel and in the emergency distribution electrical panel, if provided. Shunt trip breaker(s) shall be operated by the sprinkler flow switch(s) to automatically open the power supply. Power shall be restored manually.

b. Sprinkler protection and the related shunt trip breaker shallot are provided for Italian construction projects. Italian law does not allow sprinklers in thehoistway, pit, and machine room.

c. Designer shall consider types of lift drives specified, i.e., Silicon Controlled Rectifier (SCR), Variable Frequency Drive (VFD), motor generator, etc., and size service and wire for the worse case.

d. The guide specification requires the lift supplier to provide individual isolation transformers and individual choke reactors for each hoist motor, and filtering of harmonic distortion when SCR or Variable Voltage Variable Frequency (VVVF) AC controllers are utilized.

e. Provide a branch circuit separate from the main lift power supply, with a fused disconnectswitch capable of being locked in the open position, for lights, receptacles, and ventilation for each individual lift car. As an alternative, a lockable enclosed circuit breaker may be used as the over current protection device.

f. Locate all disconnecting means for lift(s) on the inside surface of the machine room wall next to the strike side of the machine room door. Ensure each disconnect is with insight of the lift equipment it controls.

g. A separate branch circuit shall supply each individual machine room with lighting andreceptacles.

h.All 120V receptacles installed in machine room shall be GFI type (Provide at least one Duplex receptacle)

i. Conductors and optical fibers, located in the machine room, shall be in conduit.

j. Coordinate the need for emergency power with the using activity and the project architect. Emergency power is usually needed for health care facilities (with bed confinement) or high-rise facilities (greater than 75'-0" from ground floor to highest occupied floor). Provide emergency power for health care facilities as required.

k. emergency power is used:

l. Disconnect the lift from normal power and from emergency power.

m. If more than one lift is provided, determine (with Activity input) how many lifts are tooperate on emergency power.

n. Design the emergency power to be able to operate selected lift(s) at rated loads and rated speeds.

o. System design must accommodate automatic sequential operation in order to bring alllifts to the designated floor level, as required and provide selected lift(s) with emergency power operations.

p. Provide manual override switch in main lift lobby area(s) to override the automaticemergency power selection.

q. Provide emergency power for machine room cooling/ventilation equipment andhoistway ventilating equipment, if the lift is on emergency power circuit.

r. Provide an extra set of contacts on transfer switch (when emergency power isprovided) and two-conductor 120-volt ac circuit in conduit from these contacts to junction box in machine room.

s. Provide telephone outlet with dedicated line next to each lift controller for emergency phone service in lift car. Indicate outlets on telephone riser.

t. Provide machine room smoke detectors to initiate actuation of Firefighters' Service, illuminate intermittently (flash) Firefighters' Service visual signal, and initiate actuation of the building fire alarm panel. Lift Design Guide" for requirements. Require smoke detectors to be mounted in the machine room by indicating detectors on the electrical drawings, unless shown on separate fire protection drawings. Coordinate with Fire Protection Engineer.

u. Only electrical wiring, raceways and cables used directly in connection with theliftshall be permitted in the machine room.

2.5 Hoistway Construction

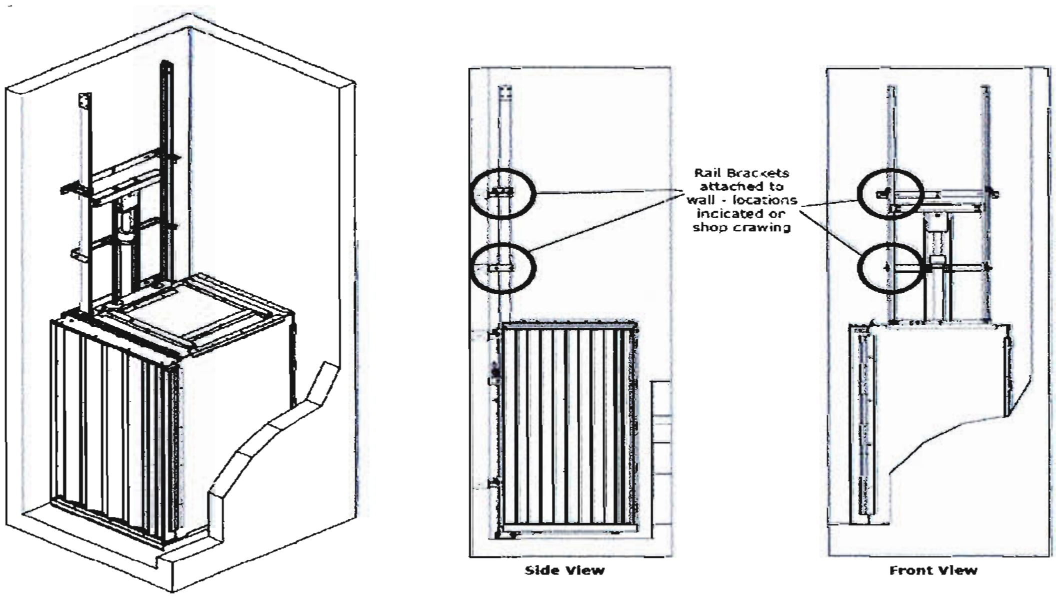


Figure 2 : Hydraulic Drive System (Drawn by CAD software)

All the walls of the hoistway, especially the supporting wall, need to be smooth, square and plumb from the bottom of the pit to ceiling. This is to allow for the required running clearances. No light is required at the top of the hoistway. A light is required in the pit (see Construction of Pit for details).

Wood Construction

2" x 4" wood studs should be used, 2" x 12"'s laid flat are then fastened between the studs. Consult with your local Lift representative if you plan on using wood studs larger than 2" x 4", as this can affect clearances controlled by code. The hoistway dimensions indicate the clear inside finished hoistway. Please ensure you allow for wall finishing (plywood/drywall) on top of the studs.

Masonry Construction

It is not necessary to make the return walls on either side of the doors in concrete. More flexibility in door positioning during the installation can be achieved with wood framing around hoistway entrances.

2.6 Construction of Pit

The pit must be the same width and length as thehoistway, and should have a minimum 4" thick concrete floor. Reactions are indicated on each project's shop drawings. A pit depth of 8" (200 mm) is recommended; a 6" (152 mm) pit depth is available.A pit ladder is required only if the pit depth exceeds 3' (900 mm).

1. Pit Lighting

A pit light is required if the lighting is less than 50 lax the pit floor with the lowest door open. The general contractor can install a light in the hoistway pit or provide a separate 110v duplex receptacle outsidethehoistway, within 10' (3000 mm) of either side ofthe lowest landing door.

2. Overhead Clearance

84" (2134 mm) Cab Height - Standard

• 96" (2440 mm) is required from top landing to the ceiling of hoistwayIf an In-line Drive system is used and the electrical control box is located at the top of the hoistway, extra overhead clearance is required, 108" (2745 mm)

96" (2438 mm) Cab Height

• 108" (2745 mm) is required from top landing to the ceiling of hoistwayIf an In-line Drive system is used and the electrical control box is located at the top of the hoistway, extra overhead clearance is required, 120" (3050 mm)

2.7 Hoistway Doors

Residential solid core doors must be used as the hoistway doors for the lift. The doors are equipped with an interlock, during installation, to lock the doors when the lift is not present at that landing. The doors need to comply with the "3 & 5 Rule" which references the positioning of the door in relation to the lifthoistway.

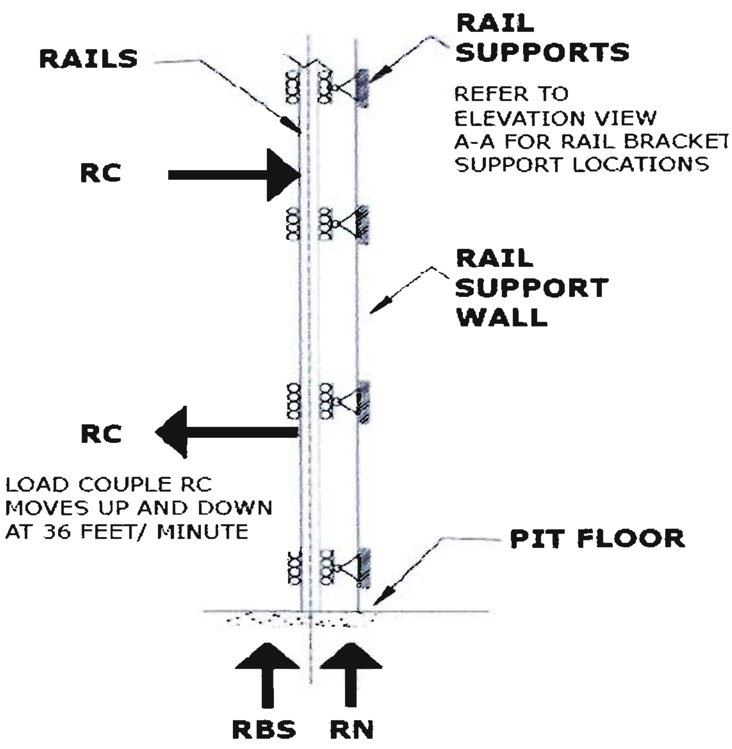
Automatic Cab Gate (Optional)
The cab gate(s) can be equipped with a power operator for automatic gate opening and closing when the cab arrives at a landing or the landing door is opened.

Hall Door Operator (Optional)
Each hall door may be supplied with a power door operator. This feature will open the landing door when the cab arrives at a landing or when the hall station is pressed. The operator is mounted abovethe door frame and requires extra support or blocking and a separate 110 VA C power supply above the door header.

Hoistway Door Interlock
The hoistway door is fitted with an interlock that ensures the car cannot be moved from a landing unless all the hall doors and cab gate(s) are both closed and locked

2.8 Loading Diagram

The walls of the lifthoistway can be constructed of wood, poured concrete or concrete block. The wall behind the rails must be load bearing and able to withstand the loads imposed by the lift. The guide rails are mounted to the wall with steel brackets. These rail brackets are fastened to the load bearing wall at regular intervals.



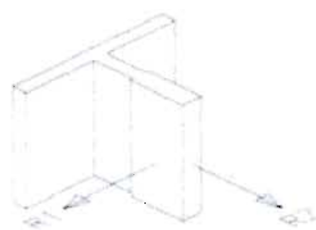


Figure 3: Loading Diagram (Drawn by CAD software)

Table of load

Load	Description	lbf [N]
RBS	Reaction due to buffer safety engagement	4569 [20321.74]
RN	Reaction due to normal operation	2619 [11647.71]
RC	Load imposed during normal or emergency operation maximum pull-out force on rail support	636 [2829.797]
R1	Rail Reaction	318 [1415
R2	Rail Reaction	94 [420]

2.9 Hydraulic Drive System - Machine Room & Electrical Requirements

In order to satisfy code requirements, the hydraulic pump unit and fused disconnect switches must be located in a room or area which is lockable. A lockable cabinet is acceptable. However, to meet electrical code, Service Personnel must have the following clearance in front of the electrical box:

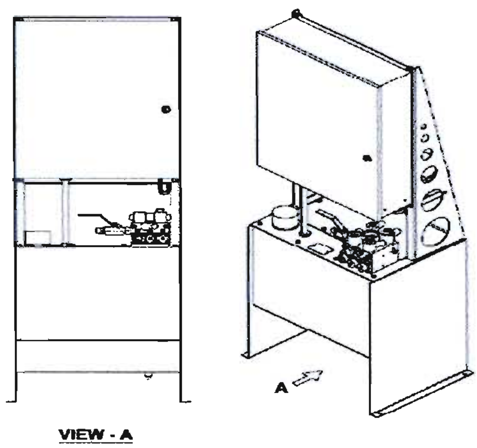


Figure 4 : Machine Room

The machine room does not have to be a separate, dedicated room. The machinery could be located in a closet or under the stairs, as long as the above requirements are met. The optimum location is at the lowest level, adjacent to the hoistway, preferable on the same side as the guide rails. The dimensions of the pump unit are 23" wide x 16 ½" deep x 59 ¼" high (585 x 420 x 1505 mm).To save space the electrical control box can be disconnected from the tank. They can be separated up to 10' (3048 mm) away. The control box is 23" wide x 6" deep x 30" high (585 x 155 x 765 mm). The tank for the pump and motor is 23" wide x 16 ½" deep x 31" high (585 x 420 x 790 mm). You will need 4" (155 mm) above the pump and motor tank for servicing purposes. One PVC sleeve, at least 4" (105 mm) in diameter, will be required between the hoistway and the machinery for the hydraulic hose and electrical conduit. This is to enable the installers to make the connection between the cylinder and the pumping unit. The sleeves should enter the hoistway at either corner of the support wall.

Lighting
We must provide at least 100 lx lighting over the pumping unit and disconnect switches.

Ventilation Requirements
No special requirements needed. The lift pump unit will generate approximately 3200 BTU per hour under normal operating conditions. Recommended temperature for lift equipment is 50º – 90º F (15º – 32º C) and 5% – 90% non-condensing. Please contact your local Garaventa Lift representative for possible local code variations.

Mains Power Requirements

The standard motor on the pump unit is 3 HP and it can be ordered to suit either single or three phase power.

- 230 VAC Single phase 30 amps
- 208 VAC Three phase 20 amps

2.10 In-line Drive System Overview

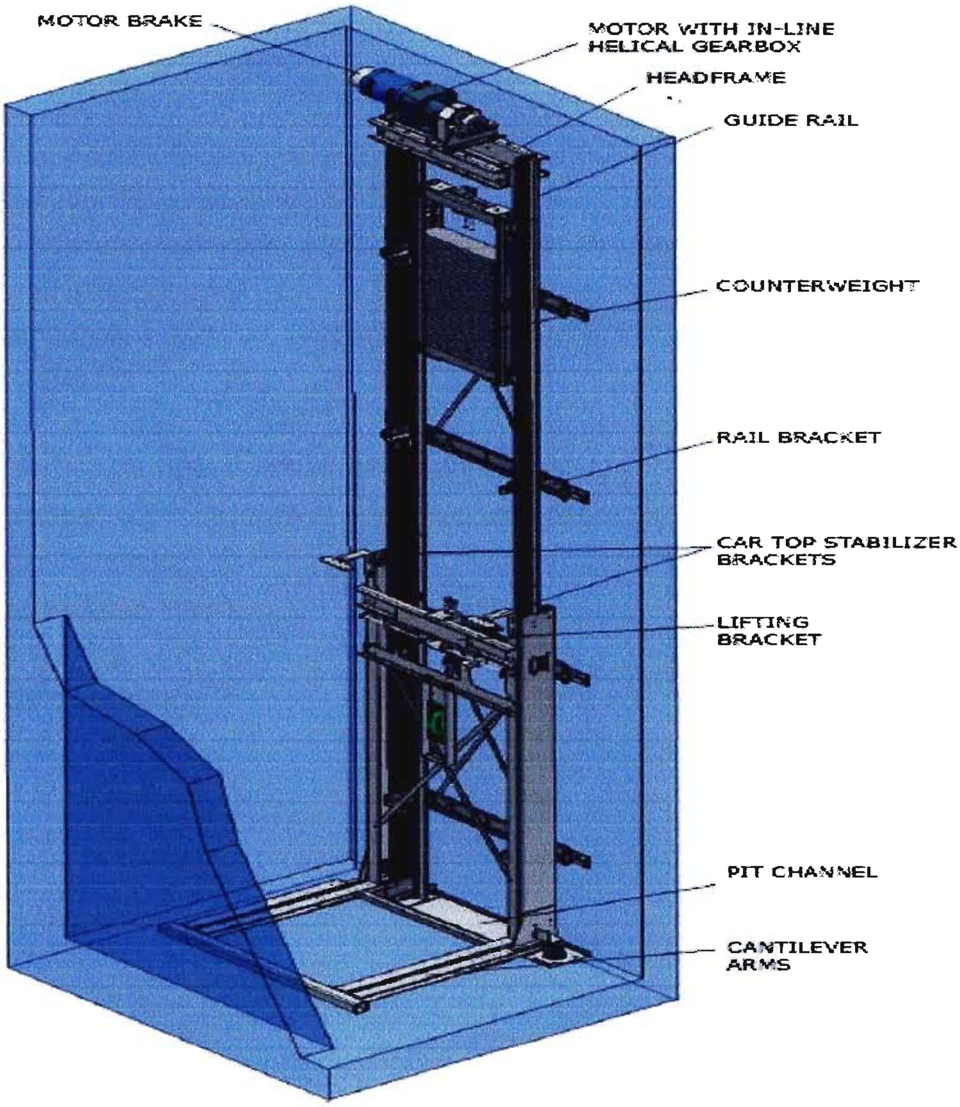


Figure 5: In-line Drive System Overview

2.11 In-line Drive System -Technical Reference

General

- Capacity - 750 lbs, 1000 lbs optional
- 40' (12.2 M) per minute nominal car speed
- Up to 6 stops, Maximum 6 landing doors
- Maximum floor total travel of 50' (15240 mm)
- Pit depth of 8" (200 mm) is recommended
- Overhead clearance of 96" (2440 mm) from upper landing with standard 84" (2135 mm) cab. 12" (305 mm) of extra overhead must be added to locate the electrical control box at the top of the rails

• Minimum distance between floors is 10" (255 mm)

Equipment

• Variable frequency drives for smooth start and stop
• Two #60 AN SI Roller Chain Suspension
• Heavy duty cantilever design utilizing 8 lbs per foot steel lift guide rail system
• High Efficiency Helical reduction gear
• Standard power supply is 230 VAC single phases – 60/50 Hz

Controls

• Collective automatic operation with illuminated push buttons
• PLC (Programmable Logic Controller) with backup system for lights, locks, gate and/or door operator(s) where equipped
• Digital position indicator in cab
• Automatic cab lighting
• Emergency stop and alarm

Chapter Three

Control System

3.1 Block Diagram

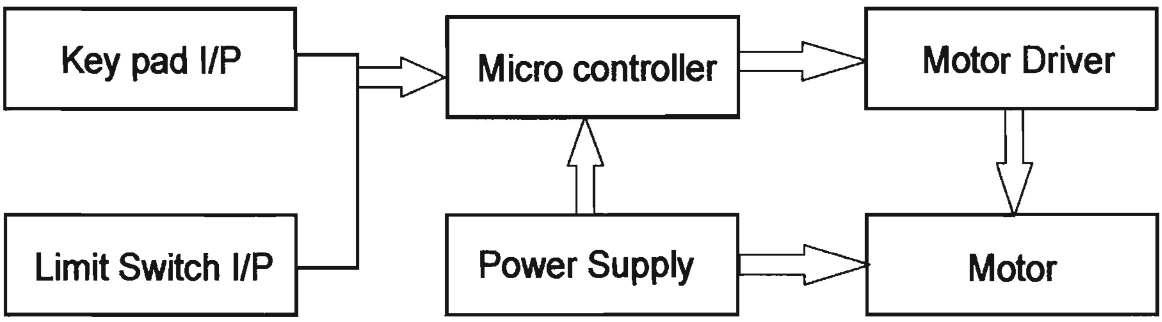
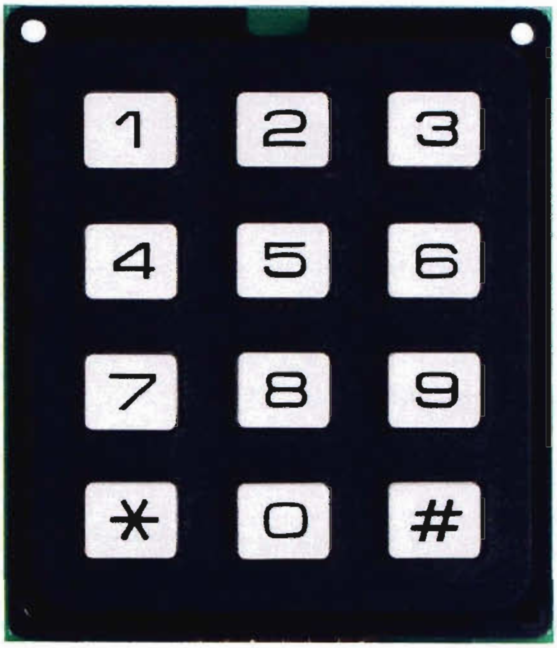


Figure 6: Block Diagram of control circuit

3.2 Details of Block Diagram



Data Output				Data Input			Key Pressed
R1	R2	R3	R4	C1	C2	C3	
0	1	1	1	0	1	1	1
0	1	1	1	1	0	1	2
0	1	1	1	1	1	0	3
1	0	1	1	0	1	1	4
1	0	1	1	1	0	1	5
1	0	1	1	1	1	0	6
1	1	0	1	0	1	1	7
1	1	0	1	1	0	1	8
1	1	0	1	1	1	0	9
1	1	1	0	0	1	1	*
1	1	1	0	1	0	1	0
1	1	1	0	1	1	0	#

Figure 7: Keypad and output table

4X3 Matrix Keypad

A keypad is the most widely used input devices of a microcontroller. In order to use it effectively, we need a basic understanding of them. In this section, we discuss keyboard fundamentals, along with key press and key detection mechanisms, and then we show how a keyboard is interfaced to a microcontroller.

Scanning and Identifying the Key Pressed

Figurer 8 shows a 4X3 matrix connected to port 1. The rows (R1 through R4) are connected to an output port and the columns (C1 through C3) are connected to an input port If the data read from the columns is C1 C2 C3 =011, this means that a key in the R1 row and C1 column has been pressed. That is '1'.In the subroutine 'Check Column', the value of 'Digit' is increased. The value of 'Digit' represents the key pressed. Before leave this subroutine, microcontroller set 'Key Pressed' to indicate there is a key pressed. If the data read from the columns is C1 C2 C3 =101, this means that a key in the R1 row and C2 column has been pressed. That is '2'. Table 1 represents the meaning of each combination of data received at C1 C2 C3.

I Type limit switch

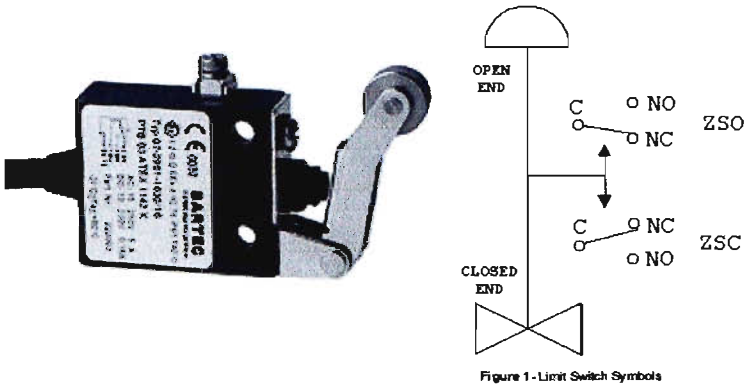


Figure 8: Limit switch and its symbol

Limit switch as a sensor

Limit switches are a type of sensor that detects presence and absence. Specifically, mechanical limit switches are switches that are mechanically activated, meaning that they have some sort of arm, lever, knob, plunger, etc., which is physically—or mechanically—activated by making contact with another object. As the object makes contact with the actuator of the switch, it eventually moves the actuator to its "limit" where the contacts change state. Other varieties of sensors/switches exist, including proximity sensors, light sensors, electric switches, among others. In its simplest form, a limit switch is a "switch" that can be mounted into remote locations so that it is actuated by an object other than a human operator.

PIC16F72 Microcontroller

There are two memory blocks in the PIC16F72 device. These are the program memory and the data memory. Each block has separate buses so that concurrent access can occur. Program memory and data memory are explained in this section. Program memory can be read internally by the user code (see Section 7.0). The data memory can further be broken down into the general purpose RAM and the Special Function Registers (SFRs). The operations of the SFRs that control the "core" are described here. The SFRs used to control the peripheral modules are described in the section discussing each individual peripheral module.

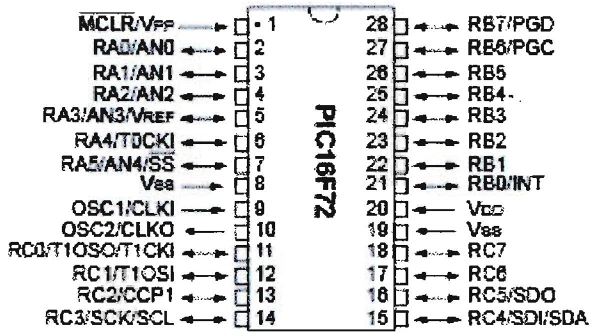


Figure 5: Pin Diagrams of PIC16F72 microcontroller

Device features of PIC16F72

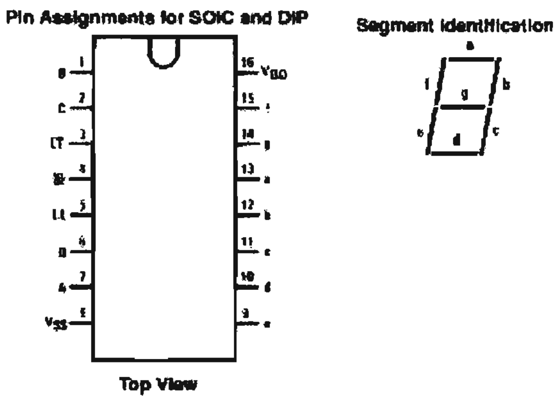
- Only 35 single word instructions to learn
- All single cycle instructions except for program branches, which are two-cycle
- Operating speed: DC - 20 MHz clock input DC - 200 ns instruction cycle
- 2K x 14 words of Program Memory, 128 x 8 bytes of Data Memory (RAM)
- Pin out compatible to PIC16C72/72A and PIC16F872
- Interrupt capability
- Eight-level deep hardware stack
- Direct, Indirect and Relative Addressing modes
- 1,000 erase/write cycle FLASH program memory typical
- Power-on Reset (POR), Power-up Timer (PWRT) and Oscillator Start-up Timer (OST)
- Watchdog Timer (WDT) with its own on-chip RC oscillator for reliable operation
- Programmable code protection
- Power saving SLEEP mode
- Selectable oscillator options
- In-Circuit Serial Programming via 2 pins
- Processor read access to program memory

DC Gear Motor (12V DC)

DC Gear motors (also known as mini-geared motors and micro-geared motors) are specifically designed for present and future applications. Our gear motors are used for various applications in the areas of medicine and healthcare, automobile systems, drive systems, or as a variety of positioning or industrial / consumer actuators. These miniature gear motors have also various much-needed characteristics, such as form factors, strength, torque, linear performance and other technical capabilities. All of which are important for such applications.

Figure 6: DC Gear Motor (12V DC)

Seven Segment and its driver CD4511



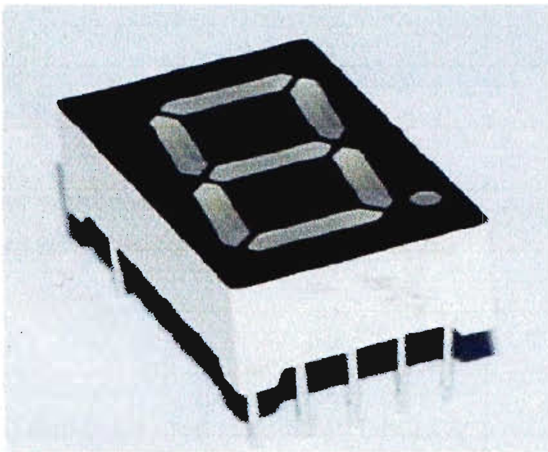


Figure 11 (a) 11 (b)

(a)CD4511BC BCD-to-7 Segment, (b) 20X15mm seven segments (Common Cathode)

VoltageRegulator

Voltage regulator is an integrated circuit. It is a member of 78xx series of fixed linear voltage regulator ICs. The voltage source in a circuit may have fluctuations and would not give the fixed voltage output. The voltage regulator IC maintains the output voltage at a constant value. The xx in 78xx indicates the fixed output voltage it is designed to provide. 7805 provides +5V regulated power supply. Capacitors of suitable values can be connected at input and output pins depending upon the respective voltage levels.

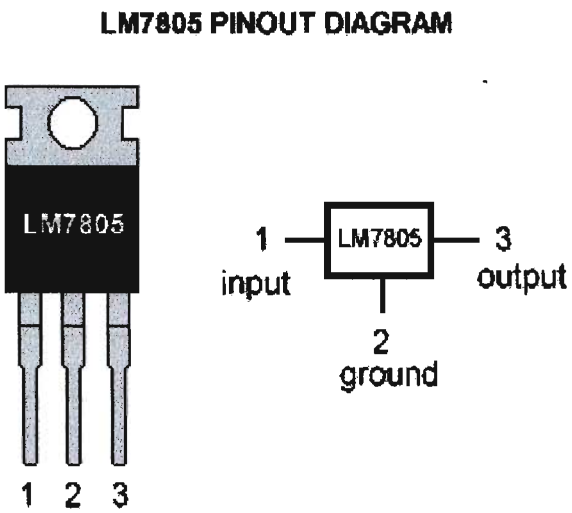


Figure 7: Voltage Regulator (LM7805)

Features:

-Output current in excess of 1.0 A
- Fixed Output voltage +5V DC
-Internal Short-Circuit Current Limiting or Output is short-circuit protected
-Internal Thermal Overload Protection or Current limit constant with temperature
-Output-Transistor Safe Operating Area Compensation
-TO-220 Package
-There are 1% output voltage Durability
-There are max. 0.01%/V line regulation(LM317) and 0.3% load regulation (LM117)
-There are 80 dB ripple rejection

C1815 Transistor

The C1815 transistor is a general-purpose NPN transistor and can also used as an audio frequency amplifier. The majority of transistors are coded for easy identification although these designations can vary by manufacturer. One or two letters are usually followed by a series of numbers, and then possibly more numbers. Therefore, a C1815 transistor may also be identified as a 2SC1815 transistor.

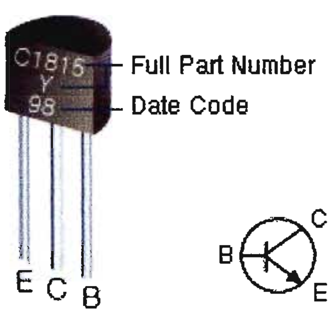


Figure 8:C1815 Transistor

CD40193 (4 bits Up/Down Binary Counter)

These up/down counters are monolithic complementary MOS (CMOS) integrated circuits. The CD40192BM and CD40192BC are BCD counters, while the CD40193BM and CD40193BC are binary counters. Counting up and counting down is performed by two count inputs, one being held high while the other is clocked. The outputs change on the positive-going transition of this clock. These counters feature preset inputs that are enabled when load is a logical ``0" and a clear which forces all outputs to ``0" when it is at logical ``1". The counters also have carry and borrow outputs so that they can be cascaded using no external circuitry. All inputs are protected against damage due to static discharge by clamps to V_{DD} and V_{SS}.

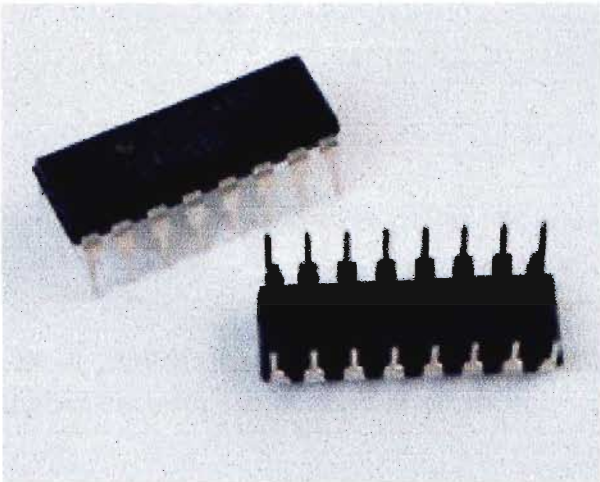


Figure 9: CD40193 4 bit Up/Down Binary Counter

3.3 Schematic Diagram

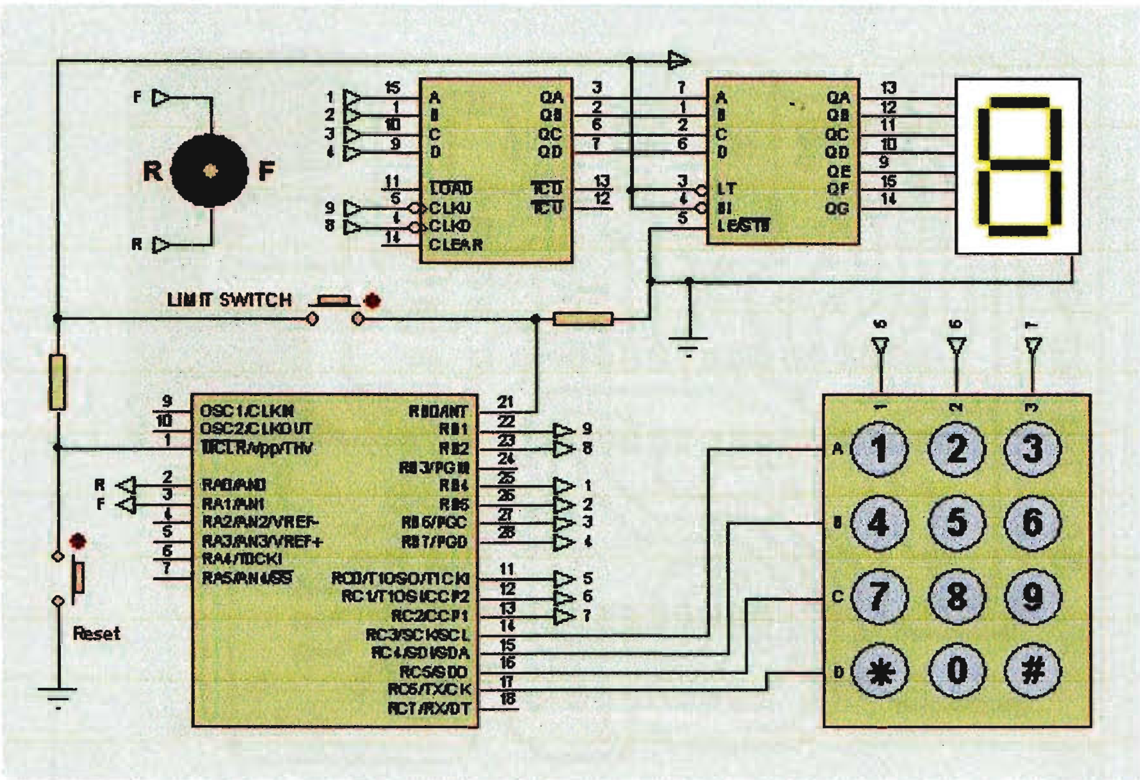


Figure 10: Schematic Diagram of control circuit is created in ISIS proteus simulation program

This is the Schematic Diagram of control circuit is created in ISIS proteus simulation program. ISIS Proteus PRO 7.8 (Simulation) has been for simulating the Microcontroller Based Control Circuit of Cargo Lift.

3.4 PCB Layout (Solder side)

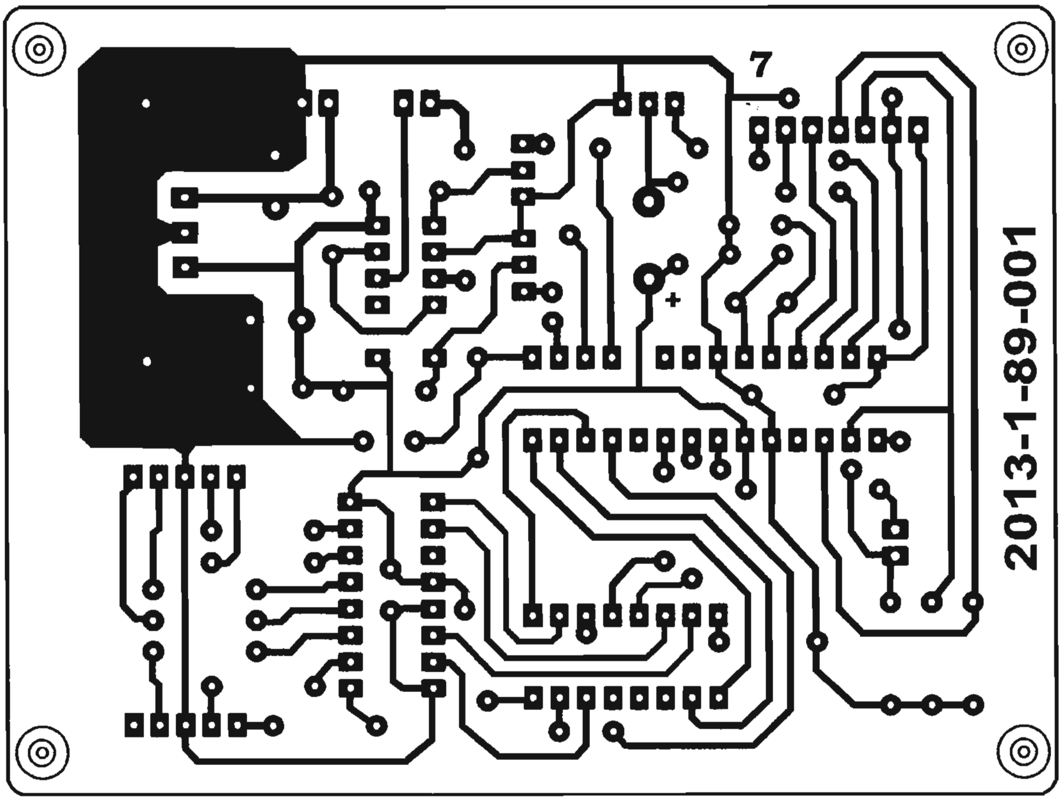


Figure 11: PCB Layout drawn with CAD software

The above picture is the PCB layout of Microcontroller Based Cargo Lift Control Circuit. This design has been made by CAD software. We have used Coral Draw software for designing the PCB layout.

3.5 Program Flow Chart

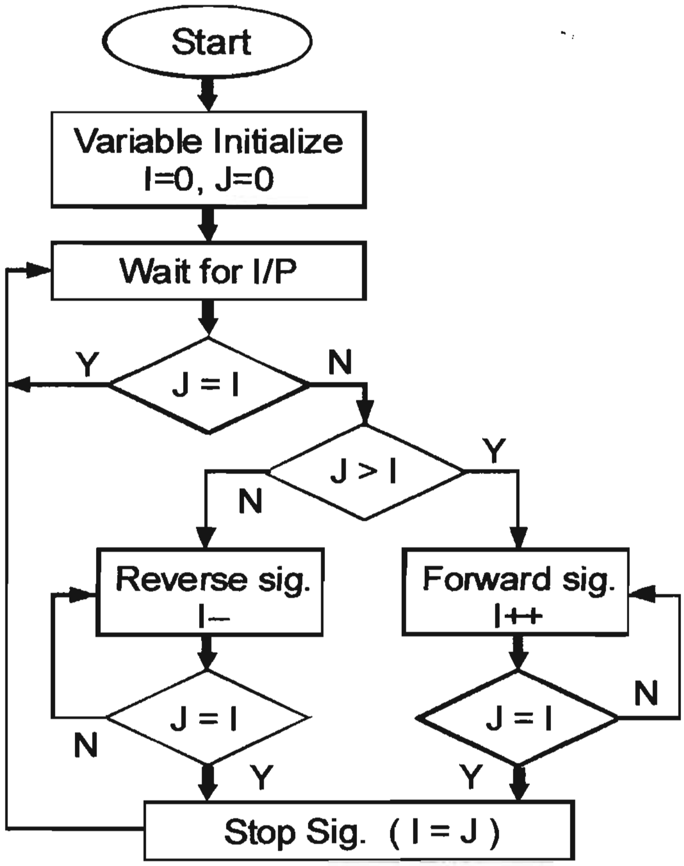


Figure 12: Program Flow Chart

We are using tools for this project:

1. MikroC PRO 4.60 — for compile the program code
2. ISIS Proteus PRO 7.8 — for simulation
3. Smart PRO-5 program — for microcontroller write

3.6 PrototypeControl Circuit Board

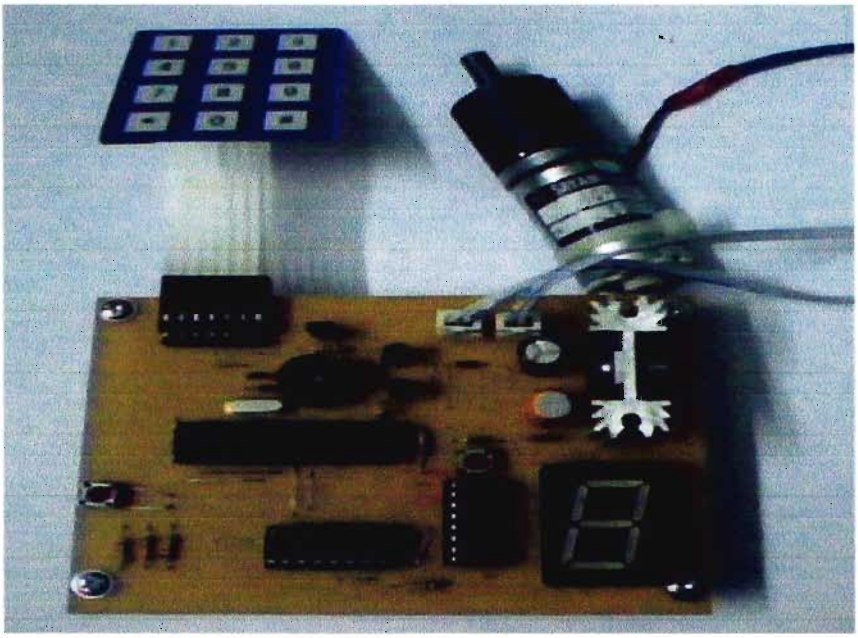


Figure 13: Prototype Control Circuit Board

3.7 Working Procedure of the control System

The keypad is used to give the desired floor number. The limit switch is another I/P(acts as a sensor) that will count the floor number where the lift is.

The microcontroller takes input command from the keypad and the limit switch. If the desired floor number is lower than the floor count then the microcontroller will send a forward signal to the motor driver. If the desired floor number is greater than the floor count, then the microcontroller will send a reverse signal to the motor driver. But when the two numbers are same then the MC will send a stop signal to the motor driver.

The motor driver will take the forward, reverse and stop signals from the MC. When it gets forward signal it will drive the motor in such a way that the lift will go up. When it gets reverse signal it will drive the motor in such a way that the lift will go down. For stop signal it will just stop the motor.

The power supply unit produces necessary voltages required for all units.

ChapterFour

Resultsand Analysis

4.1 Results

First Step

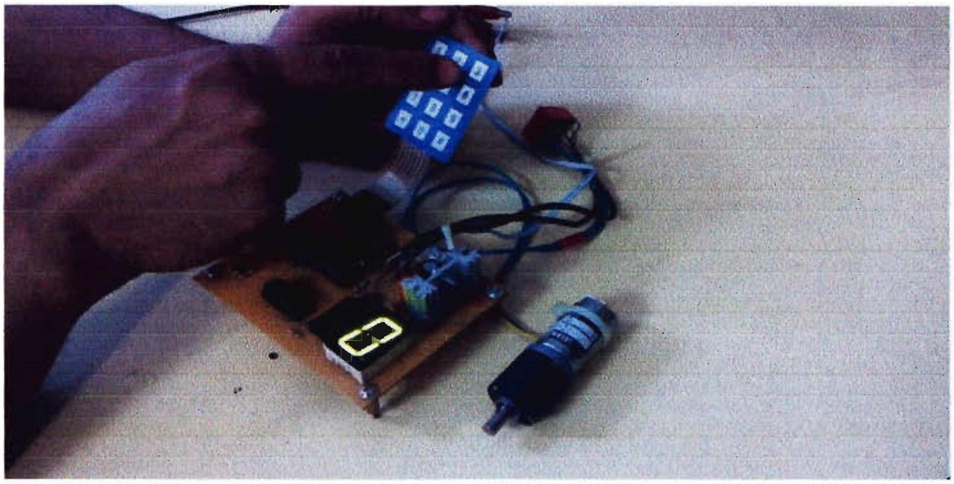


Figure 14: First step of the control circuit

It is the first step of the control circuit. "0" indication of the display means that the lift is now in first floor. The lift is prepared to go upper side.Let consider to make the lift to go in third floor and then the operator press the button "3" in key pad. Immediately the motor will moving forward, as well as the lift will go upper side.

Second Step

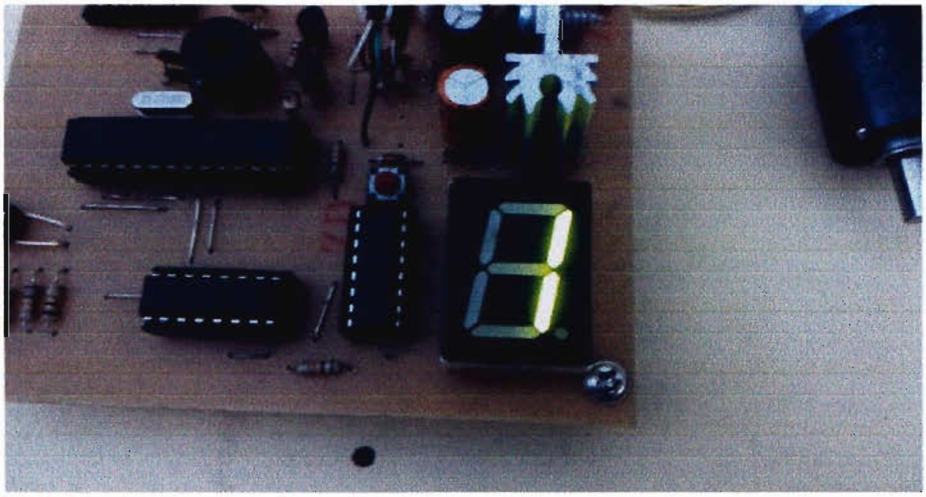


Figure 15: Second step of the control circuit

The lift is moving upper side and when it will reach in first floor, the display will show "1". Every time the display will indicates the exact count number of the floor, before reaching its expected floor.

Third Step

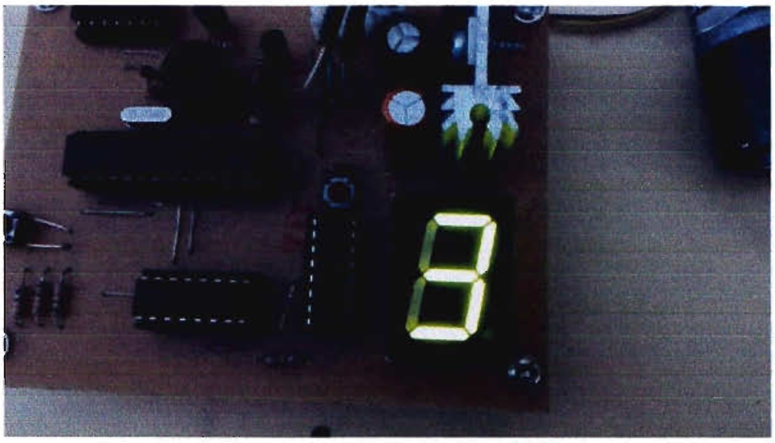


Figure 16: Third step of the control circuit

The lift has reached at third floor and its motor has been stopped. That means the control circuit has successfully controlled the lift to reach upper side.

Final Step

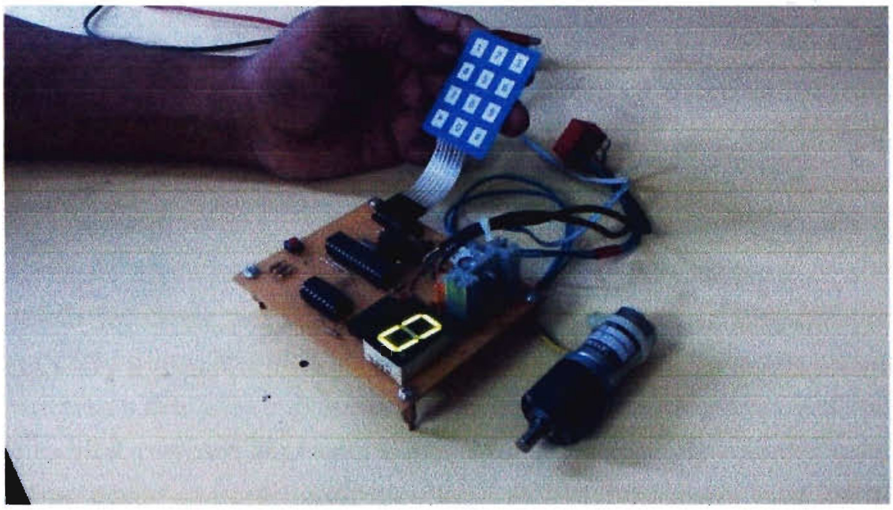


Figure 17: Final step of the control circuit

If we want to move the cargo lift towards first floor, we have to again follow the first step. We will press the button "0" in the key pad and then the motor will moving reversely. Following the previous step the lift will again able to go downside.

4.2 Analysis

Figure 18: Conventional Cargo Lift

4.3 Discussion

Our Microcontroller based control system use less energy: It also consumes less energy than hydraulic elevators. 70-80% less than hydraulic elevators. Also modern lifts can generate extra energy when these go up and down via a dynamo. We can hope we are going to get some very good energy efficient elevators soon. Another benefit of elevators is elevators create more usable space. Lift helped us a lot to use our spaces more effectively. If we compare with stairs we would see lift takes less space than a stair. As nowadays we have to manage our spaces due to increment of population and other construction so we can say elevators let us minimize space consumption and so we can now use our lands more efficiently. Thus elevators save our farming lands, forests, industrial lands and so on. Modern elevators don't use oil. Almost all lifts are operated using electricity. So no oil needed. After hard fight for oil we can now understand oil is one of the main life supporting elements nowadays. We need huge amount of oil to drive cars and industries. Ok but to drive elevators we don't need oil. Even though some industrial elevators require oil to lift goods, products or carry things but 90% lift s are operated using only electric power. Well another benefit is all components are above ground similar to roped hydraulic type elevators. This takes away the environmental concern that was created by the hydraulic cylinder on direct hydraulic type elevators being stored underground. Also elevators slightly lower cost solution than stairs. For building stairs we need more rod, cement and concrete and elevator are less expensive for big multi storied building. Another awesome benefit of elevators is we can operate at faster speeds than hydraulics but not normal traction units. Also if you want to carry any lots of people or goods within small time then elevators can do it. Otherwise primitive stairs are really time consuming solution. Elevators helped us to build multi storied buildings. Otherwise it was nearly impossible for us to build multi storied buildings and towers. Because it could be extremely difficult for anyone to ride on top floors of even a10 storied building without elevators.

4.4 Bill of Materials (BOM)

Sl.	Name of the Component	Qty.	Cost (BDT)
1.	PIC16F72 microcontroller	1	70
2.	CD40193 4bitUp/Down binary counter	1	15
3.	CD4511 BCD to 7 segment driver	1	15
4.	DC gear motor 12VDC	1	150
5.	Seven Segment 28X20mm	1	10
6.	4X3 Keypad	1	60
7.	1/4W Resistor	16	1.6
8.	Capacitor 100uf/50V	2	4
9.	Capacitor 22pf/25V	2	0.4
10.	Capacitor 0.1uf/25V	3	0.6
11.	1N4148 Diode	2	1
12.	LM7805 voltage regulator	1	6
13.	C1815 Transistor	3	3
14.	Buzzer 10mm	1	10
15.	12MHz Oscillator	1	8
16.	DPDT Latch relay	1	50
Miscellanies			
17.	PCB 102X76mm	1	24
18.	Heatsink	1	5
19.	2 pin connector	3	9
20.	7 pin connector	1	4
21.	28 pin IC base	1	3
22.	16 pin IC base	2	4
23.	Limit Switch I type	1	7
24.	Micro Push button	1	2
25.	Star cot screw	2	0.4
26.	Solder lead		5
27.	PCB pole	4	12
		Total Cost	480

Note:
The cost calculated for local market price in Taka: 480.00 (USD: $ 6.00)

4.5 Cost Comparison

From the price index of Alibaba Group, a privately owned Hangzhou-based group of Internet-based e-commerce businesses, the minimum price of a Building Construction lift is US $16,000 as well as 1242400.00 Bangladeshi Taka. Which is not having any automated control system and it is manually operated by heavy diesel engine. The minimum price of diesel engine is US $900 (69885.00 Bangladeshi Taka). So now we can calculate the complete cost of importing a new cargo lift set for ten storied building. We will consider minimum 15% VAT on each product.

Product	Price In USD	Price in BDT	Including 15% VAT	Cost in BDT
Building Construction Lift Frame	US $16,000	12,42,400.00	186360.00	14,28,760.00
Diesel Engine	US $900	69,885.00	10,482.00	80,367.75
Transport Cost	US $400	31,060.00	N/A	31,060.00
Installation Charge	US $200	15,530.00	N/A	15,530.00
Total Cost	US $17500.00	13,58,875.00		15,55,717.75

So, Initial cost of a complete set of cargo lift is **15, 55,717.75 BDT** (Including VAT)

If we build the frame of building construction lift with our local technology and install our Microcontroller based control system within it then our cost will be following.

Product	Price in USD	Price in BDT	Including 15% VAT	Cost in BDT
Building Construction Lift Frame& Related Accessories	US $8000	6,21,200.00	N/A*	6,21,200.00
60HP Motor	US $400	31,060.00	N/A*	31,060.00
Microcontroller based Control Circuit	US $6	480.00	N/A*	480.00
Transport Cost	US $50	3882.50	N/A	3882.50
Installation Charge	US $150	11647.50		
Total Cost	US $ 8606	6,68,270.00		6,68,270.00

*VAT is not applicable on locally and manually manufactured products

So, the locally and manually manufacturing cost is **6, 68,270.00 BDT**

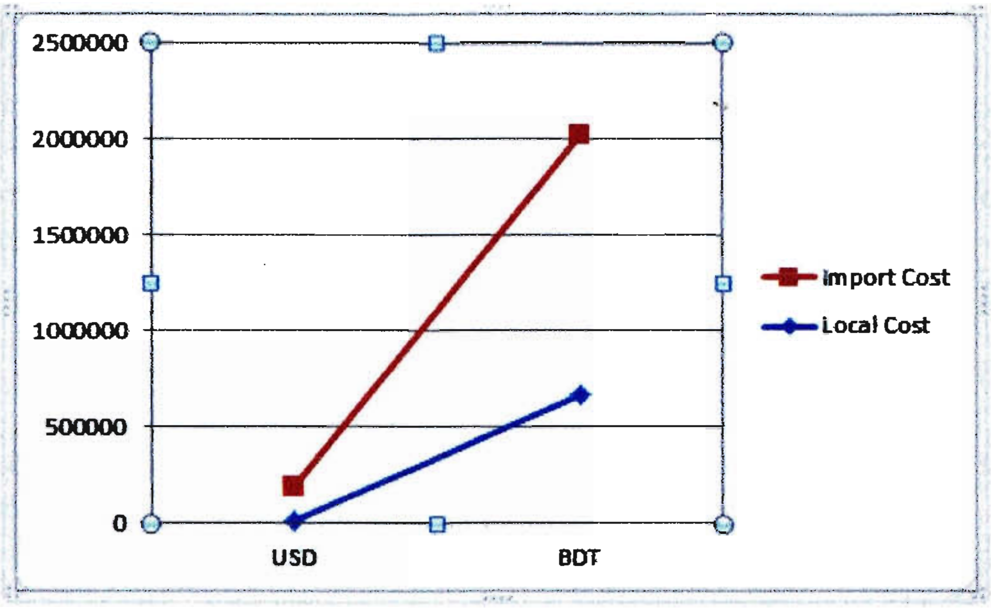


Figure 19: Cost Comparison chart 1

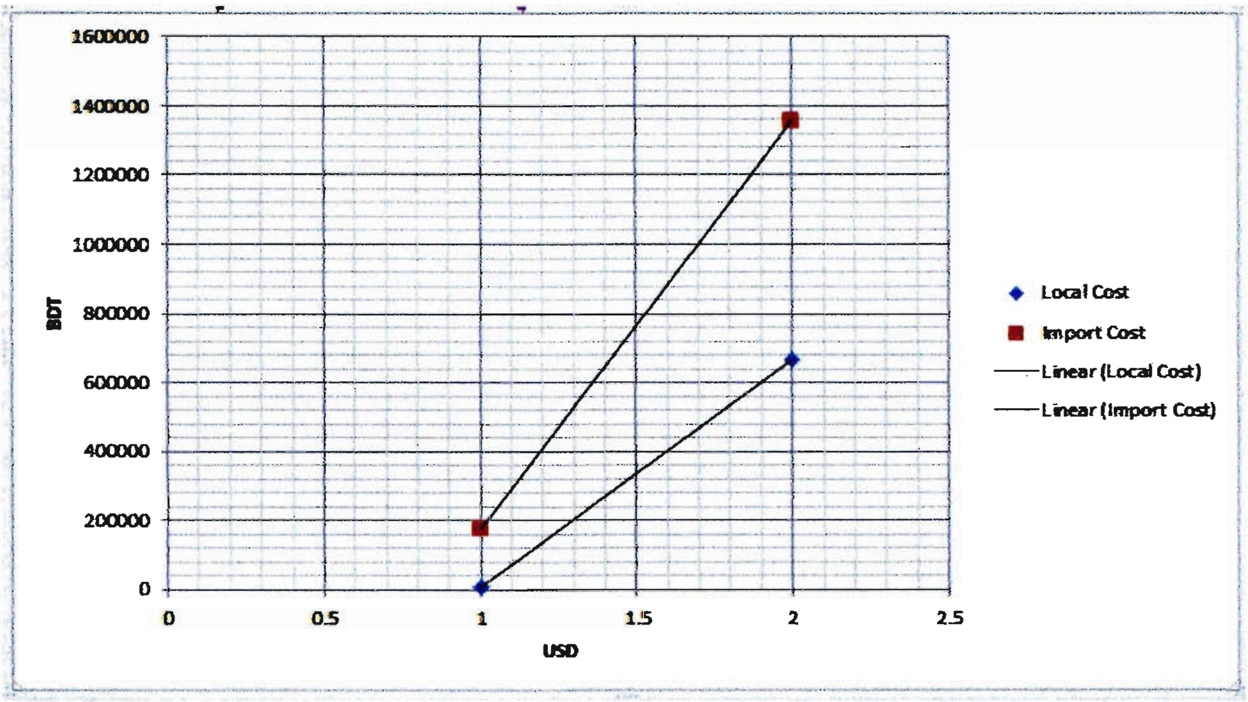


Figure 20: Cost Comparison chart 2 (Graphical Representation)

4.6 Practical Application

We already have applied our experimented proposal in a running building construction project and our invented control system has been successfully running since last four months. Due to some intellectual property issue and formal official rules, we have not mentioned the name of our clients. So in this document we only added one picture of that project.

4.7

Distinguish between Ordinary Cargo Lift and Microcontroller Based Cargo Lift

Sl.	**Ordinary Cargo Lift**	**Microcontroller Based Cargo Lift**
1	Need oil or fuel to drive the lift motor.	No oil or fuel is needed.
2	Ordinary Cargo Lift is expensive.	Microcontroller Based Cargo Lift is cost efficient.
3	Ordinary Cargo lift is operated by manually.	Ordinary Cargo Lift has a complete automatic system.
4	Extra man power is essential to monitor Ordinary Cargo lift.	Microcontroller based cargo lift has need less man power to monitor.
5	Installation procedure of Ordinary Cargo Lift is very complicated.	Installation procedure of Microcontroller Based Cargo Lift is very simple.
6	The maintenance process of Ordinary Cargo Lift is very hard and time wasting.	It is very easy to maintain Microcontroller Based Cargo Lift.
7	Ordinary Cargo Lift cannot be used for long time.	Microcontroller Based Cargo Lift is very wise decision for long time use.
8	Multiple lift features like fire sensor, thermal sensor, telephone, electric door lock etc. are not available in Ordinary Cargo Lift.	Microcontroller Based Cargo Lift is very friendly to adding different lift features.
9	Ordinary Cargo Lift is very risky to nearest human or animal being.	Microcontroller Based Cargo Lift is less risky rather than Ordinary Cargo lift
10	Ordinary Cargo Lift is commonly used in building construction.	Microcontroller Based Cargo Lift is very potential application in building construction, ship or vessel, aircraft, factory etc.

4.8 Conclusion

In the contrary, we can say that, our Microcontroller Based Cargo Lift use less energy: It also consumes less energy than hydraulic elevators. 70-80% less than hydraulic elevators. We can hope we are going to get some very good energy efficient lifts soon. Another benefit of elevators is elevators create more usable space. Lift helped us a lot to use our spaces more effectively. If we compare with stairs we would see lift takes less space than a stair. As nowadays we have to manage our spaces due to increment of population and other construction so we can say elevators let us minimize space consumption and so we can now use our lands more efficiently. For building stairs we need more rod, cement and concrete and elevator are less expensive for big multi storied building. Another awesome benefit of Microcontroller Based Cargo Lift is we can operate at faster speeds than hydraulics but not normal traction units.

Chapter Five

Appendix

Operation Steps:

The 12 steps of cargo lift operation are:

1. Visually Inspect
Inspect the unit for evidence of frayed or misaligned cable. The stainless steel aircraft cable is a critical element of the ability to lift.

2. Power On
Turn the power on at the control unit.

3. Load the Cargo
Open the access gates and evenly load your cargo.

4. Secure the Load
After the cargo is loaded secure the load with straps or netting.

5. **Close the Gate and Stand Clear**
Close the gate and with a clear view of the lift cage, stand at least 10 ft. from the lift.

6. **Alert Others**
Alert anyone in the immediate area that you are about to raise the cargo lift.

7. **Raise the Lift**
Press the UP button located on the wireless transmitter to lift the cargo.

8. **Secure the Gates**
After extracting the cargo, again secure the access gates.

9. **Inspect the Lower Level**
Walk to the lower level to assure that the areas clear before lowering the lift cage.

10. **Alert Others**
Again alert anyone in the immediate area that you are operating the lift before lowering the cage.

11. **Lower the Lift**
Press the DOWN button and watch the lift as it descends and stops.

12. **Power Off**- After the lift is lowered to the desired level, cut the power off to the unit.

Pre-Lift Safety and Warnings

•Operator should visually inspect the stainless steel aircraft cable before each cargo lift.

• All obstructions, including debris, toys, other cargo, animals, and bystanders should be well away from the cage prior to activating Cargo Lift.

• Operator will alert anyone in the immediate area that the lift will be activated before using it to raise cargo.

• Operator will stand clear while maintaining a clean line of vision to the entire lift area while the lift is in operation.

•Cargo raised in a Cargo Lift should never exceed the capacity in volume (aluminum cage is 4 Ft. x 4 Ft.) and/or weight (limits either 400 or 1,000 lbs.) as recommended.

• Cargo should always be secured with straps or netting before operating the lift.

• Operator will ensure that all access gates are secured before and after each lift.

• It is the responsibility of the Original Purchaser and/or Authorized Operators to ensure that the handheld transmitter is never placed, carried, or stored in an area where it becomes unknowingly engaged.

• Cargo Lifts were not designed to lift human or animal cargo.

• No one under the age of 18 is authorized to operate a Cargo Lift.

• No one should operate a Cargo Lift while under the influence of either drugs or alcohol.

Fire Protection Planning for Lift

Provide dual-contact smoke detectors or addressable fire alarm system smoke detectors and control modules at:

- All lift lobbies.
- Top of the hoistway. (Only if sprinklers are provided at the top of the hoistway).
- Lift machine room.

In lift section, provide connections to lift controls, which will, when smoke is detected by any smoke detector, activate visual and audible signals and send each lift to the designated floor as. Indicated electors and connections on fire protection drawings or on electrical drawings if fire protection drawings are not provided.

For electric traction lift with 2-hour fire rated hoistway, sprinkler(s) are not requiredby code for the hoistway. Sprinklers are required in the electric traction liftmachineroom. Actuation of the flow switch shall remove power to the liftby shunt trip breaker operation. The flow switch shall have no time delay.

In buildings protected with an automatic sprinkler system, provide protection of hydraulic Lift installations as follows:

a. Machine Room: Provide a sprinkler(s) with sprinkler guards in the machine room.Provide a supervised shut-off valve, check valve, flow switch, and test valve in thesprinkler line supplying the machine room. These items shall be located outside of and adjacent to the machine room. Actuation of the flow switch shall remove power to the lift by shunt trip breaker operation. The flow switch shall have no time delay.

b. Lift Pit: Provide a sidewall sprinkler(s) with sprinkler guards in the pit for hydraulic lifts. Locate the sprinkler no more than 2'-0" (609 mm) above the pit floor. Provide a supervised shut-off valve in the sprinkler line supplying the pit. Locate the valve outside of and adjacent to the pit. Actuation of the pit sprinkler shall not disconnect power to the lift.

c. LiftHoistway: Provide a sprinkler(s) at the top of the hoistway for hydraulic lifts with cylinder or supply piping extending above the second finished floor elevation. Provide a supervised shut-off valve, check valve, flow switch, and testvalve in the sprinkler line supplying the hoistway. These items shall be located outsideof and adjacent to the hoistway. Actuation of the flow switch shall disconnect powerto the lift by shunt trip breaker operation. Flow switch shall have no time delay. Coordinate with Electrical Engineer.

d. Test Valve: Provide inspector's test connection for each flow switch associated withthelift machine room and/or lifthoistway sprinklers. Locate the test = connection outside the rated enclosure. Route test connection piping to a floor drain location that can accept full flow or where water may be discharged without property damage. Discharge to a floor drain shall be permitted only if the drain is sized to accommodate full flow. Discharge to janitor sinks or similar plumbing fixtures are notpermitted.

Coordinate the requirements of the lift specification section with the applicable Fire Protection systems specifications as listed below:

a. Interior Fire Detection and Alarm System
b. Analog/Addressable Interior Fire Alarm System
c. Wet-Pipe Fire Suppression Sprinklers
d. Interior Distribution System

There are certain industries in which many would think innovation was rare. Lifts would be one of them. They go up, they go down. What could change? As it turns out, plenty, Lifts have achieved greater efficiency in recent years through savvy innovations, saving building owner's money and, just as importantly, saving the average person time.

Possibly the most vital change in the last two decades has been destination dispatching. "You walk into a lobby of a hotel and instead of just stepping to anlift, there's a keypad to type in your floor and, when the lift comes, it's going to floors based on efficiency," says John Mundt, Jr., vice president of Simsbury, Connecticut-based Sterling Lift Consultants, LLC. In the past, with passengers headed to floors not near each other or in a car serving a wide grouping of floors, it could create a major slowdown, especially in high rises. The dispatch system takes into account where everyone's going, choosing floors for each car that will serve the best. So, the soon-to-be passenger may be waiting for the next car, but that doesn't mean you won't hit your destination faster when you consider that you might not have to wait for so many others to get off on their floors first.

Cost and Safety

There's also been a migration away from in-ground hydraulic lifts to machine-room-less lifts (MRLs). "They don't have to drill a hole in the ground and put a pipe in it when you're making MRLs," Mundt says. "Also, there's a worry about environmental fluid leakage with hydraulics and they weren't as energy efficient. It simplifies the construction of these devices so there isn't a need for as much labor expense." It allows the lift industry design team a potentially lower maintenance cost as well, he says.

But safety is also critical, especially considering lifts continue to be a leading phobia. "The biggest development right now in safety is the rope-gripper device or unintended motion device that protects anlift from crashing in the up direction," Mundt says. "People are always afraid of freefalling but most accidents occur when 'over speed' going up causes lack of control of the counterweight. A rope-gripper device applies pressure to the pads, to the joust ropes," he adds.

Innovations on the Horizon

"In the future, they're talking about lifts sharing a common hoistway in high rises, so two lifts can go up and down within the same shaft with dispatching and move that many more people," Mundt says. "That could have a huge effect on traffic."

James Fortune, president of Morrison, Colorado-based Fortune Lift Consulting, adds: "Face recognition is on the way—you won't even has to swipe a card now. It will know who you are and where you're going. The same thing with your phone, an app will let the lift know which floor you're headed to. With lifts, there are always new possibilities."

Energy Efficient Lift Technologies

Lift manufacturers are producing premium lifts for mid- and high-rise buildings that are extremely energy efficient. These traction lifts have improved controls, hardware, and other systems that not only use less energy, but are much more compact, efficient, and even generate electricity that a facility can use.

Reducing Overall Energy Usage with Control Strategies

The most energy efficient lifts now have:

- Software- and microprocessor-based controls instead of electromechanical relays
- In-cab sensors and software that automatically enter an idle or sleep mode, turning off lights, ventilation, music, and video screens when unoccupied
- Destination dispatch control software that batches lift stop requests, making fewer stops and minimizing wait time, reducing the number of lifts required
- Personalized lift calls used with destination dispatch controls that eliminate the need for in-cab controls.

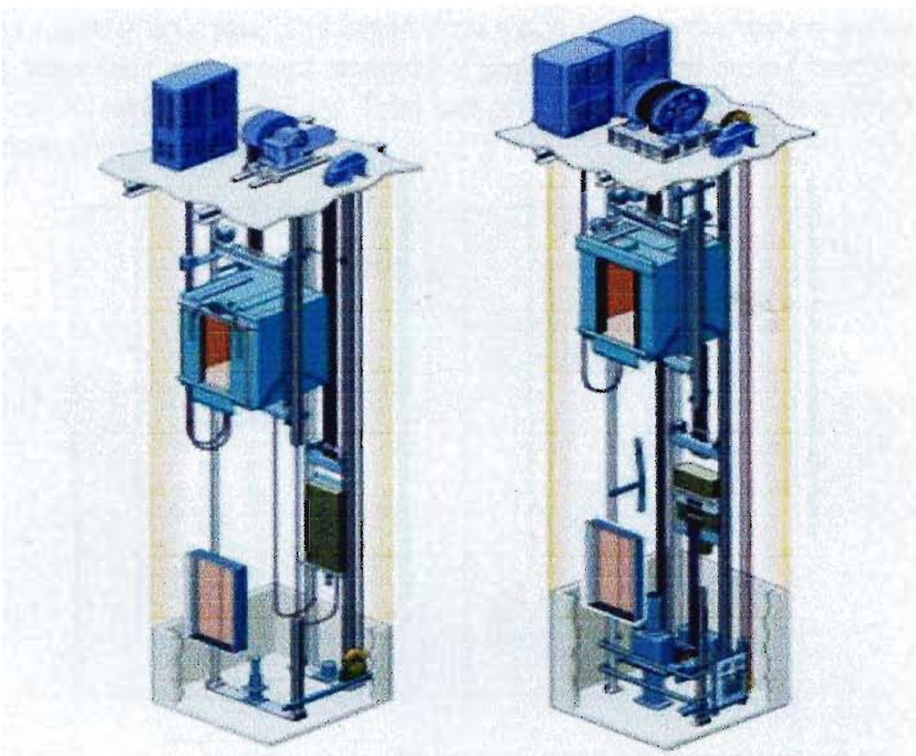


Figure 26: Diagram of a geared traction lift (left) and a gearless traction lift (right).

Mid- and high-rise buildings typically have geared or gearless traction lifts capable of high or variable speed operation. One energy-saving change manufacturers have recently begun to offer is double-deck lifts. They are two cabs tall, one stopping at even-numbered floors and one serving odd. They can reduce a building's overall energy usage by reducing the number of stops and even the total number of lifts required when used with destination dispatch controls.

New lift control software provides tools that lift consultants use to perform lift bank traffic studies. How a lift cycles affects its energy flow. By observing the sporadic nature of lift operation, number of floors traveled, periods of peak load, and the fact that lifts are not always loaded to rated capacity, consultants create energy consumption estimates. These models help a consultant create efficient control strategies and make hardware recommendations.

Energy Efficient Hardware

Regenerative drives are another remarkable advancement in energy-efficient lift technology. They recycle energy rather than wasting it as heat. The permanent magnet motors in Otis' ReGen drives are capable of bidirectional energy flow. Magnatek's Donald Vollrath explains how they operate in his Lift World Continuing Education Program "Regenerative Lift Drives: What, How and Why." When power flows into the motor, it creates a lifting torque on the shaft and lift sheave, lifting the carriage. When the carriage travels down, the motor acts as a generator, transforming mechanical power into electrical power and pumping current back into the facility's electrical grid to use elsewhere.

When a cab goes up with a light load and down with a heavy load, the system generates more power than it uses. Over time these small amounts of power generated during each lift's sporadic decelerations add up to noticeable savings. They use less energy than non-regenerative drives, and reducing the excess heat in the building.

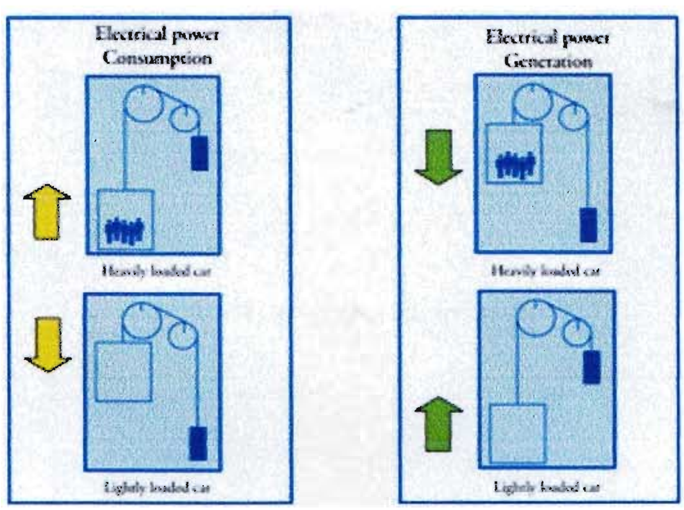


Figure27: Diagram depicting how the Regenerative Drive system works.

The most energy efficient types of lifts are machine-roomless (MRL) traction lifts. Manufacturers redesigned the motors and all of the other equipment normally housed in a machine room above conventional lifts to fit into the hoistway. These space-saving improvements eliminate the need to build and supply energy to a machine room and consume significantly less energy than the larger versions previously used. They also generate less heat.

Otis offers additional energy savings in its state-of-the-art Gen2 MRL lift. They also compacted the controller and moved it into the hoistway, eliminating the need for a separate control room. Manufacturers are now giving more attention to improving energy usage in the other systems such as cab lighting, fans, doors, brakes, and lift controls. They use efficient LED lights in cab panels, overhead, and in floor indicators. They include door drive motors that that can enter a standby mode or efficiently recover from removal of power when not in use. These motors also support variable door-open and -close times, and their energy use is factored into the overall control strategy.

Machine-Room lessLifts

The latest major innovation in lift technology came in the 1990s with the introduction of "machine-room less lifts," or MRLs, which allow most of the components to fit within the shaft where the car runs. Only a small cabinet houses the lift controller. MRLs also save on construction and operational costs.

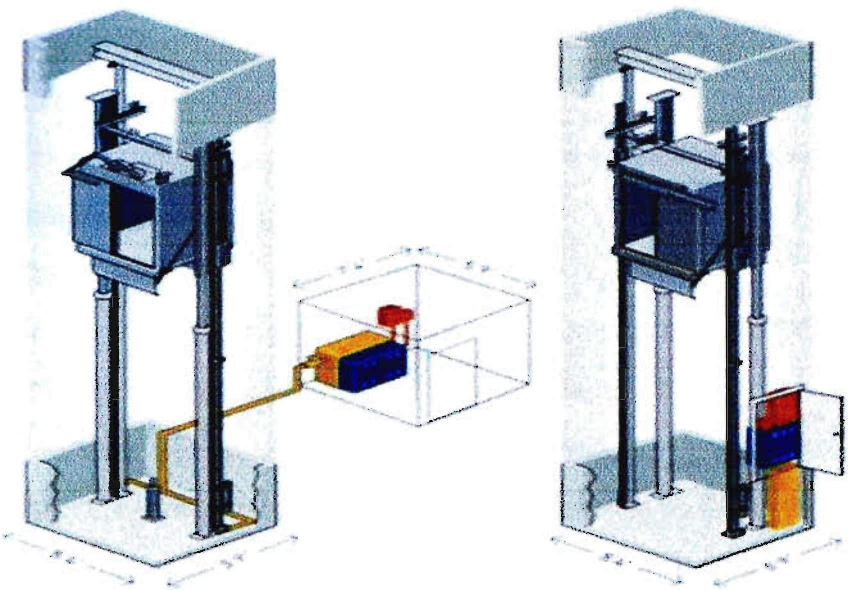


Figure 28: Machine-RoomlessLift

References

1. Lift Technology - An Insight on Design Basics and its EvolutionPIC by K Subramaniam
2. Give Your Elevator Speech a Lift! By Lorraine Howell (Author)
3. http://www.mikroe.com/en/books/picbook/picbook.htm
4. http://www.societyofrobots.com/
5. http://www.google.com/imgres
6. http://en.wikipedia.org/wiki/Microcontroller
7. http://www.indiamart.com/lifttech-elevators/Intermediate Robot Building (Technology in Action) David Cook (Author)
8. The Microcontroller Idea Book: Circuits, Programs & Applications Featuring the 8052-BASIC Single-Chip Computer
9. Servo Motor and Motion Control: Yasuhiko Dote (Author)
10. Lifted: A Cultural History of the Elevator, by by Andreas Bernard (Author)
11. Vertical Transportation Technology Review, Volumes 1 & 2, http://www.elevatorworldindia.com/ewbooks_eng.php
12. CAD/CAM: Computer-Aided Design and Manufacturing by Groover
13. Automation, Production Systems, and Computer-integrated Manufacturing, by Mikell P. Groover
14. Introduction to Electronic Circuit Design, by Richard Spencer (Author), Mohammed Ghausi (Author)
15. http://www.corel.com/corel/pages/index.jsp?pgid=1400065&storeKey=us&languageCode=en
16. http://tmpgenc.pegasys-inc.com/en/product/taw4_tutorial/taw4_tu_vid_basic.html
17. Power Electronics: Circuits, Devices, and Applications, by Rashid (Author)
18. Power Electronics for Technology by Ashfaq Ahmed
19. Fundamentals of Electrical Drives by Gopal K. Dubey
20. http://www.alibaba.com/showroom/cargo-lift-price.html