Sudan University of Science and Technology

Collage of Graduate Studies

Department of Biomedical Engineering

Design of a Programmed Oxygen Delivery System

تصميم مبرمجة لنظام إمداد الأوكسجين

A Thesis Submitted In Partial Fulfillment For The Requirement of The Degree of M.Sc. In Biomedical Engineering

By:

SaharEmadOmer

Supervised by:

Prof.:AbdlrasoolJabbar

April 2014

الآيــة

قال تعالى:

بسم الله الرحمن الرحيم

﴿هُوَ الْأَوَّلُ وَالْآخِرُ وَالظَّاهِرُ وَالْبَاطِنُ ۖ وَهُوَ بِكُلِّ شَيْءٍ عَلِيمٌ﴾

صدق الله العظيم

[سوره الحديدالايه –(3)]

Dedication

To sweet tone in my song,the light in my heart,the sound of hope in the dark, to most beautiful pleas in my life, my dear parent.

To some one every words I can imagine, can’t thanks her enough, Sarah Taha

To my brothers, Moustafa Hassan & Omer Abdalla .

To my sun shine, Fatima Ibnouf

To everyone in my family, and all my friends

Acknowledgment

One crowded hour of glorious life is worth an age without a name ,so I'd like to express my all thanks, appreciation and respect to my enlighten soul ,to person help me and take me hand in darkest time and never give up of me ,to person made that hour to me , prof. Abdlrasool Jabbar.

My thankful extended to all fabulous,remarkable teachers in biomedical engineering department, Dr. Altaher Mohammed Hussein, Dr. Alnazer osman, Dr. Frijon, Dr. Maouia, Dr. Mohammed Yagoub, all the rest magnificent teachers and Special Thanks to Dr. Osman Ibrahim Osman.

Table of contents

List of Figure

List of Table

Abbreviations

FiO_2: Fraction of inspired oxygen (%).

$PaCO_2$: The partial pressure of CO_2 in the blood. It is used to assess the adequacy of ventilation.

PaO_2: The partial pressure of oxygen in the blood. It is used to assess the adequacy of oxygenation.

SaO_2: Arterial oxygen saturation measured from blood specimen.

SpO_2: Arterial oxygen saturation measured via pulse oximetry.

Psi:pounds per square inch

Flow: The velocity of gas flow per minute

SPV: pressure support ventilation.

SIMV: Synchronize inter mitten mandatory ventilation.

CMV: continuous mandatory ventilation.

LED: light Emitting diode.

LCD: liquid Crystal Display.

LTOT: long Term Oxygen therapy.

COPD: chronic obstructive pulmonary disease.

HB: Hemoglobin.

Abstract

This research aims to program a data base of prominent and the most common diseases, which require supplementary oxygen care, by determining the specific range between the maximum and minimum dose, those can give a satisfied result. The minimum level will be given automatically, to increase the oxygen level and to determine the patient timing that will be subject to medical consultation and doctor's recommendations.

The main objectives of this thesis are, over dose risk to be prevented, medical mistakes to be avoided, hypoxemia to be relived andadequate oxygenation of tissues to be maintained.

The methodology of the research is based on, designing the control circuit, through which the oxygen dose can be controlled via a stepper motor with valve, programming that is opened according to the signal coming from the microcontroller, will be determined the stepper motor steps . The microcontroller Atmage 32 is programmed by using the basic compiler language (BASCOM) to control the stepper motor KP35FM2-027.

Through The observation The results are confined in 10 L/min is the maximum output from the total open valve ,can be obtained by 39 steps from the stepper motor , according to this result the mathematical segmentation is done, finally the outputs obtained are acceptable.

المستخلص

يهدف هذا البحث الي برمجه قاعده بابرز الامراض واكثرها شيوعا لدي مرضى التي تتطلب اكسجين مساعد بتحديد مدي معين محصور بين ادني حد يعطي نتيجه مرضيه واعلي حد فالحد الادنى يعطي اليا،والزياده في الجرعات تتم باستشاره الطبيب بالاضافه الي تحديد مده امداد المريض بالاكسجين .

الاهداف الرئيسيه هي تلافي اخطار الزياده في جرعات الاكسجين وتفادي الاخطاء الطبيه والتخلص من نقص الاكسجين بالدم والحفاظ علي نسبه اكسجين مناسبه في الخلايا.

منهجيه هذا البحث تقوم علي تصميم دايره تحكم في جرعات الاكسجين عن طريق برمجه محرك متصل مع صمام بحيث يفتح الصمام بمدي معين تبعا لعدد لفات

الموتور التي تحددها الاشاره الصادره من المتحكم الدقيق .وتمت برمجه المحرك باحدي لغات البرمجه (BASCOM) لتحكم في حركه المحرك KP35FM2-027.

بالمشاهده النتيجه المتحصل عليها عند اكبر فتحه للصمام يكون الخرج 10 ليتر في الدقيقه ناتجه من حركه 39 خطوه للموتور وتبعا لذلك تم تقسيم حركه الموتور رياضيا حسب الخرج الاكسجين المطلوب ،والنتائج المتحصل عليها مرضيه.

Chapter One

Introduction

1.1 General view

Hypoxia literally means "low oxygen," but is defined as a deficiency in the amount of oxygen that **reaches the tissues** of the body. It differs from hypoxemia, which means an inadequate amount of oxygen traveling in the blood. Hypoxia may be due to hypoxemia, for example, if an inadequate amount of oxygen reaches the tissues because there is an inadequate amount of oxygen in the blood, or it may be due to other causes. The lack of oxygen in tissues is also known as "oxygen starvation." If a complete lack of oxygen occurs in the tissues, it is termed anoxia.

There are different types of hypoxia, or reasons that there is not enough oxygen in the tissues of the body. These include:

- **Hypoxic hypoxia (hypoxemic hypoxia)** –- In this type of hypoxia, the tissues do not have enough oxygen because there is a lack of oxygen in the blood flowing to the tissues. Hypoxic hypoxia can be caused by inadequate breathing as well as other causes.
  - **Anemic hypoxia** -- In the setting of anemia, low hemoglobin levels result in a reduced ability of the blood to carry oxygen that is breathed in, and hence, a diminished supply of oxygen available to the tissues. Anemia can be caused by many conditions.
  - **Stagnant hypoxia (circulatory hypoxia)** -- This form of hypoxia is caused by inadequate blood flow, which results in less oxygen available to the tissues.

- **Histiotoxic hypoxia** –- With histiotoxic hypoxia, an adequate amount of oxygen is inhaled through the lungs and delivered to the tissues, but the tissues are unable to use the oxygen that is present.
- **Metabolic hypoxia** -– Metabolic hypoxia occurs when there is more demand for oxygen by the tissues than usual. Oxygen may be absorbed, transported, and used properly by the tissues, but due to a condition that raises metabolism, it is still not enough. An example of this is sepsis (a serious and overwhelming infection.)

Effects of Hypoxia

The organs most affected by hypoxia are the brain, the heart, and the liver. If the hypoxia is severe, irreversible damage can begin within 4 minutes of the onset. Coma, seizures, and death may occur in severe cases. Chronic, milder hypoxia can also cause damage to the major organs of the body.

Treatment for Hypoxia

The treatment of hypoxia will depend upon the underlying cause, recommend oxygen therapy if short of breath or having other symptoms suggestive of moderate or severe. If symptoms are severe, mechanical ventilation with a ventilator may be needed[4].

The Oxygen therapy

Oxygen therapy is one of the most critical consideration in the management of diseases crossing different medical and surgical specialties. Oxygen is an atmospheric gas essential for survival of all living things. The gas was isolated by Joseph Priestley and its importance in respiratory physiology was described by Antoine Lavoisier. The problems of oxygen deficiency as well as the need and indications for oxygen therapy were subsequently recognized.

Oxygen is now considered as an important drug required for the management of hypoxaemia and several other diseases characterized by hypoxic conditions. It is, therefore, used for a large number of pulmonary and non-pulmonary diseases for itsDefinitive, supplementary or palliative role.

Hypoxia which constitutes the most important indication for oxygen therapy, is defined as lack of oxygen at the tissue level or is low arterial oxygen tension (PaO2) below the normal levels [5]Children with acute severe or life threatening asthma, or SaO2<92% should received high flow oxygen (8L/min) via a tight fitting face mask[20].

In severe pneumonia acute viral or bacterial pneumonias, there may be hypoxemia and respiratory failure.

Oxygen is given at a flow rate of 4-6 L/min to achieve PaO2 above 60 mmHg [23].

Patients with chronic obstructive pulmonary disease (COPD), had assessments for LTOT using both an oxygen-concentrator and piped hospital oxygen (wall-oxygen) as supply sources [25].

Most of the COPD patients are prescribed low flow

Concentrations at 1-2 L per minute [5].

1.2 Problem statement

Too much or too little oxygen can be harmful. To compensate the oxygen shortage, this compensation done manually through the flow meter, sometime inaccurate tuning, the flow meter repeatedly malfunction,mis-estimation attributed tothe adjustment of flow in liters per minute in stepped increment from 1to 15 or 25 is so large range, that range not limited ,some times lead to over dose, high oxygen exposure causes:

Oxygen toxicity or air sac collapse, Infant eye damage, Respiratory depression or respiratory arrest

1.3**Objective**

The main objective:

The aim of the project to program oxygen care for patient to Relieve hypoxemia and maintain adequate oxygenation of tissues.

To stricture the oxygen follow limit depend on the diseases.

The specific objectives:

1. To minimize the totally depend on doctor to determine the dose if the disease was known the nurse can determine the disease from the screen.
2. Disposalthe flowmeter.
3. Inventory the fresh doctor in specific level, the program according to Specialist doctors view.

1.4Methodology

Programming the microcontroller to control the stepper motor steps, those steps determine the valve opens area, depending on the must knownhypoxic disease , any disease have a level of specific (l/pm) can patient take ,this level from low severity to high severity, only the low severity dose will be given automatically. The sensor should exist, for follow up the patient status.

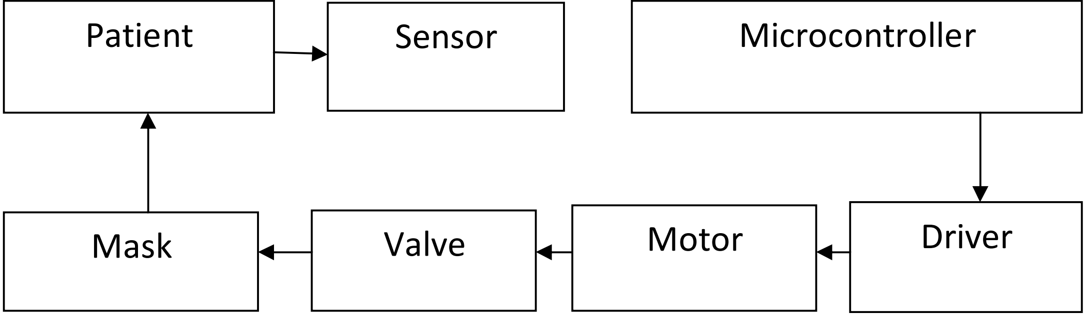


Fig (1.1) The project methodology

1.5 Project layout

Organization of this project consist of six chapters: chapter one is an introduction and background. Literature review are given in chapter two, chapter three includes the electronic circuit design. While chapter four includes the software of the circuit, the chapter five consist of result and discussion. Finally the conclusion and recommendations discus in chapter six.

Chapter two

The theoretical Background

2.1 The cardio respiratory system:

The human body has literally thousands of control systems in it. Many control systems operate within the organs to control functions of individual parts [1].

Respiratory system helps to take oxygen in and out and circulatory helps the heart to take the blood cells and travel around the body to keep adequate amount of oxygen level in the body tissue.

The respiratory system composed of the airways and the lungs as well as the respiratory muscles that regulate gas movement into and out of these structure. Within the lungs, exchange of molecules of oxygen (O_2) and carbon dioxide (CO_2) between the gas and blood occurs (figure 2.1).

The primary function of the respiratory system is to deliver sufficient amounts of O_2 from the external environment to the tissues. Thus blood emerging from the lung on it is way to tissues must be adequately and efficiently oxygenated [2].

Air containing oxygen enters the body through the nose and mouth. From there it passes through the pharynx or throat on its way to the trachea (windpipe). The trachea divides into two main airways called bronchi upon reaching the lungs; one bronchus serves the right lung and the other the left. The bronchi subdivide several times into smaller bronchi, which then divide into smaller and smaller branches called bronchioles. These bronchi and bronchioles are called the bronchial tree because the subdividing that occurs is similar to the branching of an inverted tree. After a total of about 23 divisions, the bronchioles end at alveolar ducts. At the end of each alveolar duct, are clusters of alveoli (air sacs). The oxygen transported through the respiratory system is finally transferred to the bloodstream at the alveoli.

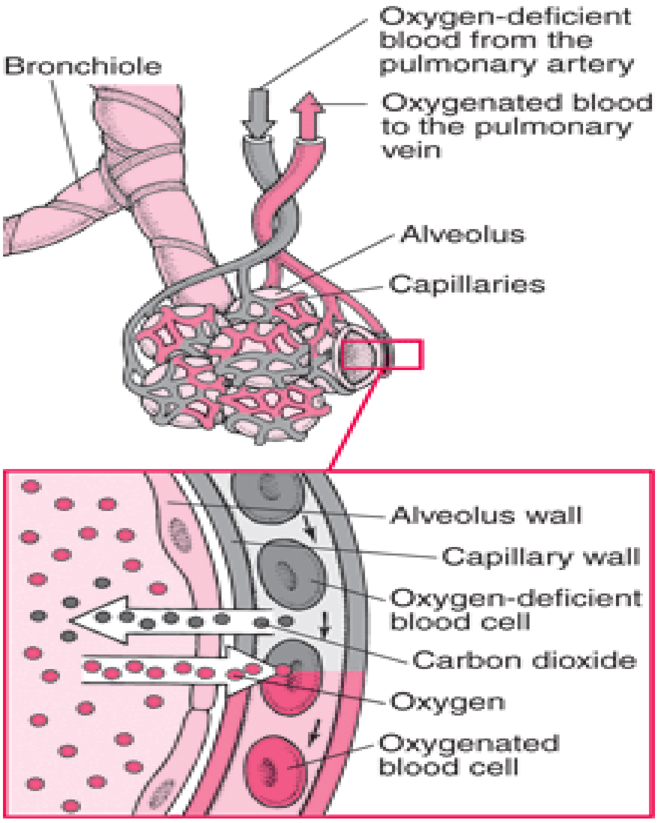


Fig (2.1) the Gas Exchange Between Alveolar Spaces and Capillaries

The heart has four different hallow areas called chambers. There are two chambers on each side of the heart. Each one is separated by a valve, a flap of tissue that opens and closes to keep the blood flowing in the right direction. The blood in our bodies is used over and over again. Its movement through the heart and around the body is called circulation and can be viewed as a cycle. Beginning at the left side of your heart, fresh, clean oxygen-rich blood is pumped around our bodies. The cells throughout our bodies remove the oxygen from the blood and use it, like fuel, to work and grow. In these processes, the cell creates carbon dioxide and other wastes that must be removed to keep the cells healthy. The blood is responsible for picking up this waste, delivering it to the kidneys where, except for the carbon dioxide, it is removed from the blood. The blood with its load of carbon dioxide returns to the right side of the heart where it is then pumped to the lungs to get rid of the carbon dioxide and to pick-up fresh oxygen. The oxygen-rich blood goes back to the left side of the heart and is then pumped around the body to complete the cycle [3].

Adult blood usually contains four species of hemoglobin:oxyhemoglobin (O2Hb), reduced hemoglobin (Hb), methemoglobin (MetHb) and carboxyhemoglobin (CO Hb) [16].

The respiratory pigment hemoglobin enables the blood to carry enough oxygen for the body's needs. The solubility of oxygen in the water of the plasma is low and decreases even further as the temperature rises. Thus the quantity of oxygen that could be carried by the plasma alone is not enough. The extra carriage of oxygen depends on the fact that one molecule ofhemoglobin can on load four molecules of oxygen, one on each of the four haem groups of the pigment .The equation for this association of oxygen with hemoglobin is[17]:

$$HB + 4O_2 = HbO_8 \longrightarrow \quad (2\text{-}1)$$

2.1.1Arterial Blood Gases

pH

The pH is a measurement of the acidity of the blood, indicating the number of hydrogen Ions [H+] present.

Partial Pressure of carbon Dioxide (PCO_2)

The normal pCO_2range reflects the amount of CO_2 dissolved in the blood. Carbon dioxide is produced by the internal respiration of tissue cells and excreted from the body by external respiration via the lungs.

Partial Pressure of Oxygen (pO_2)

The partial pressure of oxygen (pO_2) reflects the amount of oxygen gas dissolved in the blood.

O_2saturation

Oxygen saturation measures the percentage of hemoglobin that is fully combined with oxygen.

Base Excess (BE)

The BE is defined as the amount of acid or base (in mmol) required to titrate 1 L of blood to pH 7.4, at 37oC and pCO_2 of 40mmHg. The calculation of BE is dependent on hemoglobin, pH and pCO_2.
The BE does not distinguish a primary metabolic disorder from metabolic compensation for respiratory disorder.

Bicarbonate [HCO_3^-]

HCO_3^- represents the calculated amount of bicarbonate in the blood. [24]

Normal value range

Table (2.1) the normal blood gases range[19]

Ph	**7.35-7.45**
Pco2	**35-45mmgh**
Po2	**80-100mmgh**
Hco3-	**22-26meq/l**

In some cases disorder happened and that lead to reduce the amount of oxygen uptake and the amount of oxygen in the tissue.

Generally a reduce of oxygen in the living organism, implies total lack of oxygen Refers to hypoxia.
The use of oxygen therapy in clinical applications is a vital
Component to support patient recovery, by setting the correct flow-rates. Flowmeters are used to control the flow-rate of gases drawn from the central supply system or from a` compressed gas cylinder.
Most oxygen delivery systems contain several items: oxygen cylinders,pressure regulators,flowmeters and a delivery device when the patient is not breathing or is breathing inadequately.

2.2 Oxygen Therapy Equipment:

2.2.1Oxygen Cylinders

The standard source of oxygen is the oxygen cylinder**,** oxygen gas is pressurized to a highlevel and stored in steel or aluminum cylinders .The pressure is measured in pounds per square inch
PSI).The higher the pressure, the greater the amount of oxygen which can be compressed into the space of the cylinder.Oxygen cylinders are available in various sizes depending upon the size of the cylinder and the amount of oxygen patient use, the oxygen will last for different periods of timeThe most commonly used large cylinder is the H cylinder .the stander H weighs approximately 150 pound and is meant to be used as a stationary source, it contains over 6500 liters of oxygen. At 2 liters per minute, this is enough oxygen for over 2 days of continuous use patients needing a portable supply of oxygen use asmaller lightweight system. The weight of these portable cylinders ranges from 3.5 – 18 pound There

are several size of portable oxygen cylinder the most common are the M6(B),ML6, and E cylinders. The M6 or “B” cylinder is the smallest of these cylinders. It is made of aluminum and is almost always used with an oxygen conserving device , The M6 cylinder is usually carried When used in conjunction in a carrying case with a shoulder strap .The “E” cylinder is the largest of the portables and is often used with a wheeled cart [13].

- *D cylinder* contains about 350 liters of oxygen.
- *E cylinder* contains about 625 liters of oxygen.
- *M cylinder* contains about 3,000 liters of oxygen.
- *G cylinder* contains about 5,300 liters of oxygen.
- *H cylinder* contains about 6,900 liters of oxygen.

2.2.1.1Oxygen Cylinders: Duration of Flow

Gauge pressure in psi minus the safe residual pressure (always 200 psi) times the constant (see following list) divided by the flow rate in liters per minute _ duration of flow in minutes.

CYLINDER CONSTANTS

D = 0.16	G = 2.41
E = 0.28	H = 3.14
M = 1.56	K = 3.14

Determine the life of an M cylinder that has a pressure of 2,000 psi displayed on the pressure gauge and a flow rate of 10
Liters per minute[28].

$$\left((\mathbf{2,000-200}) * \mathbf{1.56}\right) \div \mathbf{10} = \mathbf{2,808} \div \mathbf{10} = \mathbf{280.8}\ \boldsymbol{minute}$$

Fig(2.2) the oxygen cylinder

The United States Pharmacopoeia has assigned a color code to distinguish compressed gases. Green and white cylinders have been assigned to all grades of oxygen [28].

2.2.2 The flowmeter types:

2.2.2.1 Conventional flowmeter

Conventional ‘ball and pressure dome’ type flowmeters, which have been build to last. The robust housing of powdercoated aluminum is designed to endure even themost difficult situations associated with every day use In a clinical environment (Figure 2-3). The pressure dome istested to withstand pressures up to approx 80 bar,which ensures the safety of both user and patient.

Fig(2-3) Theconventialflowmeter

2.2.2.2digital flowmeter

DigiFlow digital flowmeter has been developed using the sensor and measurement technology (figure 2-4). This convincingdevice, which has a digital display offers significantly morevalue than the existing range of conventional flowmeters.

Flow-rates set using Digiflow are far more accuratethan standard devices, and they can be set using muchsmaller increments.

DigiFlow works independent of primary pressure and isequipped with a flow indicator. Inspection, maintenanceand battery replacement is required after two years.

The fig(2-4) shown the digital flowmeter

2.2.2.3 Compactflowmeters

Compactflowmeters are the right solution forall applications which require fast setting of oxygenadministration. In one movement, you set the required flow (figure 2-5).They have a compact cabinet and can be also used in emergency medical services [34].

Fig(2.5)shown the compact flowmeter

2.2.3 Oxygen delivery systems

Oxygen can be administered conveniently by oronasal devices like nasal catheters, cannulae, and different types of masks. These are simple, less Expensive, and comfortable.

- **Nasal catheter**

The light rubber nasal catheter is inserted after lubricating its tip with liquid paraffin until the tip is visible behind the uvula in the oropharynx (figure 2-6) [27].

Fig(2-6) The nasal catheter

- **Nasal cannulae**

In hospitalised patients, these cannulae with two soft pronged plastic tubes are inserted about 1cm in each naris. These are comfortable and welltolerated(figure 2-7)[26].

Fig (2.7) the nasal cannulea

- **Venturi mask**

It fits lightly over the nose and mouth(figure 2.8) [28].figure(2.9) describes the vinturi with 6 diluters.

Fig(2.8) the venturi mask fig(2.9) the vinturiWith 6 diluters

- **Simple face mask**

  Is a basic disposable mask, made of clear plastic, to provide oxygen therapy for patients (figure 2.10),It is often set to deliver oxygen between 6-10 litres per minute. This mask is only meant for patients who are able to breathe on their own [33].

Fig (2.10) the simple face mask

- **Nonrebreather Mask**

The nonrebreather (NRB)it is the best way to deliver high concentrations of oxygen to a breathing patient. This device must be placed properly on the patient's face to provide the necessary seal to ensure high-concentration delivery (figure 2-11). Thereservoir bag must be inflated before the mask is placed on the patient's face [28].

Fig(2.11) Thenon-re-breather mask

Tracheostomy Mask

A tracheostomy mask is designed to be placed over a stoma or tracheostomy tube to provide supplemental oxygen. It is typically a small cuplike mask that fits over the tracheostomy opening and is held in place by an elastic strap placed around the neck (figure 2-12).These masks are connected to 8 to 10 lpm of oxygen via supply tubing.

Fig (2.12) thetracheostmoy mask

Table (2.2) the oxygen delivery device and the concentration [28]:

Device	Flow rate	Oxygen concentration
Non rebreathe mask	12-15 l/min	80-90%
Nasal cannula	1-6 l/min	24-44%
Partial rebreathe mask	9-10 /min	40-60%
Venture mask	Varied, depending on device; up to 15 l/min	24-60%
Tracheostomy	8-10 l/min	

Oxygen equipment must be safe, lightweight, portable, and` dependable. Some field oxygen systems are very portable and can be brought almost anywhere, and others really heave.Other systems are installed inside the ambulance so that oxygen can be delivered during transportation to the hospital. Additional devices such as oxygen concentrator, a pocket mask, bag-valve mask, or ventilator can be used to force oxygen into the patient's lungs.

The oxygen concentrator is an electrically powered machine that separates the oxygen from the nitrogen in the atmosphere. The result is a high level of oxygen that nears 100%. The concentrator provides an endless supply of oxygen. With the concentrator, will not have to worry about running out of oxygen or waiting for oxygen deliveries. A backup cylinder of oxygen is provided in case of machine malfunction or power failures.

The Mechanical ventilation is instrumental in the rescue and maintenance of the patient with failing cardiorespiratory

Function[21].

Mechanical ventilation some mode:

- **CMV**

Continuous mandatory ventilation, Controlled mechanical ventilation, Continuous mechanical ventilation

Breaths can be

  - Patient triggered
  - Time triggered

Set minimum rate – patient can trigger additional breaths

Time triggered – if patient has not made an inspiratory effort, machine delivers a breath

Patient does not trigger breath

- **Synchronize Intermittent Mandatory Ventilation - SIMV**

A minimum mandatory breath rate is set, Patient may take spontaneous breaths between mandatory breaths

- **Pressure Support Ventilation (PSV)**

Provides consistent pressure during inspiration, Use of Pressure Support Ventilation [22].

2.2.4 The Oxygen therapy monitoring:

The effectiveness of the therapy can be continuously monitored using a pulse oximetry, though more clinically useful data can only by obtained by drawing arterial blood gas.

Measurement of arterial blood gases repeatedly is difficult so a simple and non-invasive technique[23]

Arterial blood gas analysis is a common investigation in emergency departments and intensive care units for monitoringpatients with acute respiratory failure.

An arterial blood gas result can help in the assessment of a patient's gas exchange, ventilatory control and acid–base balance. However, the investigation does not give a diagnosis and should not be used as a screening test. It is imperative that the results are considered in the context of the patient's symptoms. While non-invasive monitoring of pulmonary function, such as pulse oximetry, is simple, effective and increasingly widely used, pulse oximetry is no substitute for arterial blood gas analysis. Pulse oximetry is solely a measure of oxygen saturation and gives no indication about blood pH, carbon dioxide or bicarbonate concentrations.[35]

Chapter three

The literature review

The literature review:

3.1 CP Singh, Nachhattar Singh, Oxygen Therapy, Journal, Indian Academy of Clinical Medicine _ Vol. 2, No. 3 _ July-September 2001.

The primary goal of oxygen therapy is to correct alveolar and/or tissue hypoxia. Therefore, any disorder causing hypoxia is a potential indication for oxygen administration. But the tissue oxygen delivery depends upon an adequate function of cardiovascular (cardiac output and flow), hematological (Hb and its affinity for oxygen) and the respiratory

(Arterial oxygen pressure) systems. Therefore, tissue hypoxia is not relieved by oxygen therapy alone – functioning of all the three organ systems also needs to be improved. Oxygen therapy should be administered according to guidelines. The aims of therapy in respiratory failure are to achieve and maintain adequate gas exchange and reversal of the precipitating process that led to the failure.

Acute severe bronchial asthma:

Patients with acute severe asthma or statusasthmatics have severe air ways obstruction and inflammation. They are generally hypoxemic. Hypoxemia is corrected by giving oxygen via nasal cannula or face mask at a flow rate of 4-6 L/min to achieve FiO2 of 35-40%. Flow rate may be adjusted to maintain PaO2 of about 80 mmHg or more. The risk of hypercarbia and CO2 narcosisis more in COPD rather than acute severe asthma and in such cases assisted ventilation is required. Administration of sedatives and tranquilizers must be avoided. Sedatives may precipitate the CO2 retention not only in patients with COPD but also in asthma.

Severe pneumonia:

In severe acute viral or bacterial pneumonias, there may be hypoxemia and respiratory failure. Oxygen is given at a flow rate of 4-6 L/min toachieve PaO2 above 60 mmHg. Bronchial hygiene and treatment with antibiotics and other drugs is meanwhile continued.

Oxygen can be given in high or low concentration in all the conditions associated with hypoxemia. In conditions like COPD in which there is a riskfor hypercarbia, low concentration should be used. In acute lung conditions (without underlying chronic lung disease) like pulmonary embolism,pneumonia, tension pneumothorax, acute severe asthma, pulmonary edema, or myocardial infarction, a higher concentration of oxygen canbe given.

Weaning should be considered when the patient becomes comfortable, his underlying disease is stabilised, his BP, pulse rate, respiratory rate, skin colour, and oximetry are within normal range[23].

3.2 Ming Wong, Malcolm Elliott, The use of medical orders in acute care oxygen therapy, British Journal of Nursing, 2009, Vol 18, No 8

The life of every living organism is sustained by the presence of oxygen and the acute deprivation of oxygen will, therefore, result in hypoxia and ultimately death. Although oxygen is normally present in the air, higher concentrations are required to treat many disease processes. Oxygen is therefore considered to be a drug requiring a medical prescription and is subject to any law that covers its use and prescription. Administration is typically authorized by a physician following legal written instructions to a qualified nurse. This standard procedure helps prevent incidence of misuse or oxygen deprivation which could worsen the patient's hypoxia and ultimate outcome. Delaying the administration of oxygen until a written medical prescription is obtained could also have the same effect. Clearly, defined protocols should exist to allow for the legal administration of oxygen by nurses without a physician's order because any delay in administering oxygen to patients can very well lead to their death[37].

3.3 Josy Davidson, Precision and Accuracy of Oxygen Flow Meters Used at Hospital Settings, RESPIRATORY CARE • JULY 2012 VOL 57 NO 7.

Oxygen therapy is an important therapeutic resource used for patients with hypoxemia, in both hospital and ambulatory settings. There is evidence that oxygen therapy reduces morbidity and mortality rates among patients withchronic lung disease.

An experimental study was performed to test oxygen flow meters from a tertiary hospital, by using a calibrated flow analyzer.

Used and new flow meter accuracy was tested by reading in the gas analyzer a single measurement at flow rates of 1, 3, 5, and 10 L/min in 91 flow meters, and they were compared using the Student *t* test or Mann-Whitney U test. Flow meter precision was tested by reading in the flow analyzer 3 repetitive measurements set at flow rates of 1, 3, 5, and 10 L/min in 11 flow meters, and the reproducibility of these measurements was conducted by using the intraclass correlation coefficient and the Friedman test.

The mean measured flow rates were slightly lower than thestipulated flow rate at 1 L/min, very close for 3 L/min, and higher for the 5 and 10 L/min flow rates. There was a large variability among the measurements from different flow meters, mainly at lowflow rates (1 and 3 L/min). There was no difference between new and used flow meters at the flow rates measured, except at 10 L/min. Flow meters precision analysis showed a good reproducibilityin 3 repetitive measurements for each flow rate (minimum 0.95, maximum 0.99 intraclass correlations) [38].

Table(3.1) Reproducibility of Flow Meters at Flows of 1, 3, 5, and 10 L/min

Flow at flow meter (L/min)	**Measurement**	**Flow analyzer median(95%)**
1	1	0.30
	2	0.20
	3	0.30
3	1	1.80
	2	1.90
	3	1.90
5	1	4.00
	2	4.00
	3	4.00
10	1	8.90
	2	9.20
	3	9.20

The flow meters tested showed poor accuracy.

Chapter four

Design and implementation

Part (1)

4.1 part 1

This chapter illustrates the hardware and the software section, shed light on the structure and the function of each electronic component and other components on the part 1.

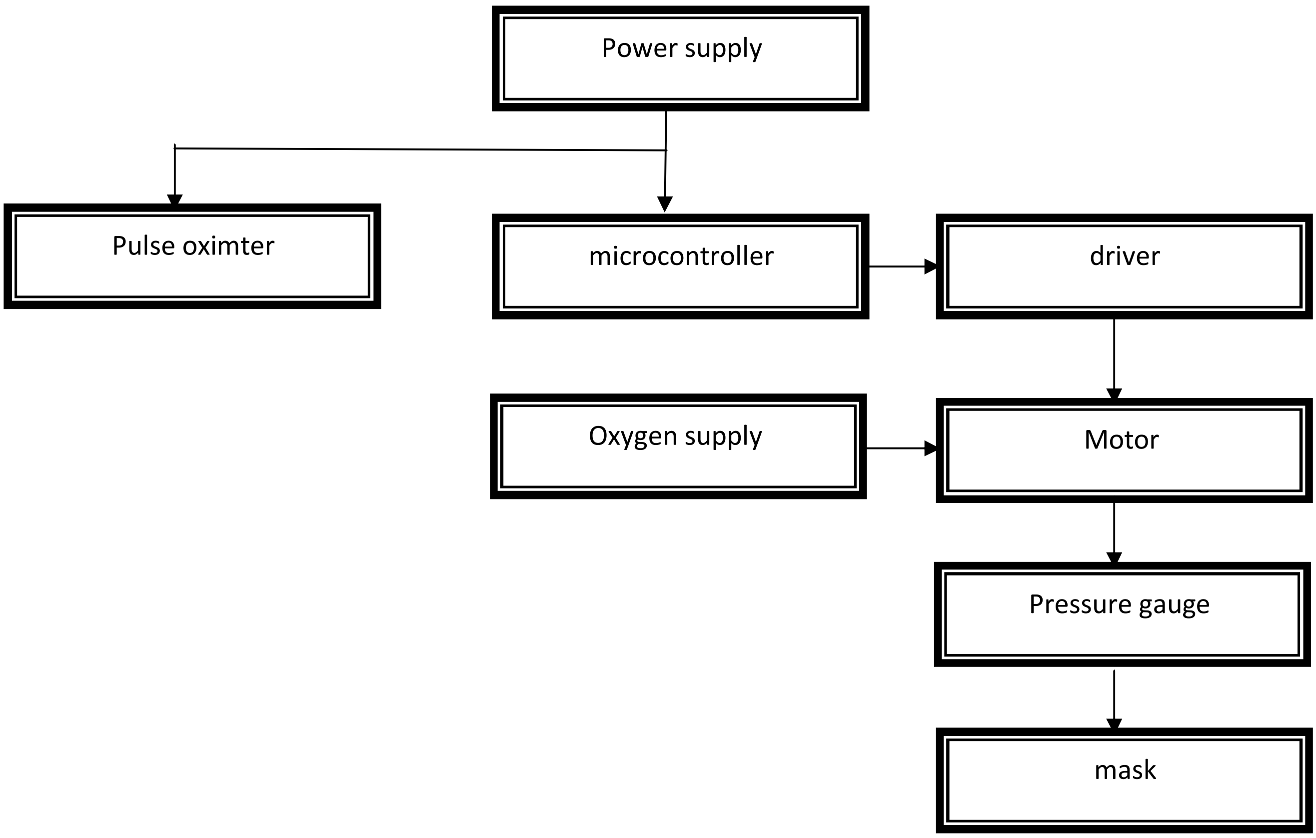


Fig (4-1) The block diagram of the system

4.1.1 Microcontroller Atmaga 32

Microcontroller is an electronics device which has all the required parts which make it capable to operate standalone. It is designed to monitor and control different asks. In consequence, in addition to the processor it includes memory, various interface controllers, one or more timers, an interrupt controller, and last but definitely not least general purpose Input / Output pins which allow it to directly interface to its environment(Figure 4-2).[6]

A 32 bit microcontroller is a tiny computer on a single integrated circuit that contains all the components comprising a controller.

Atmaga 32 is powerful microcontroller that provides highly flexible and low cost .effective solution to may embedded control application, contain 32 input/output, 32 register and 32 data line [7].

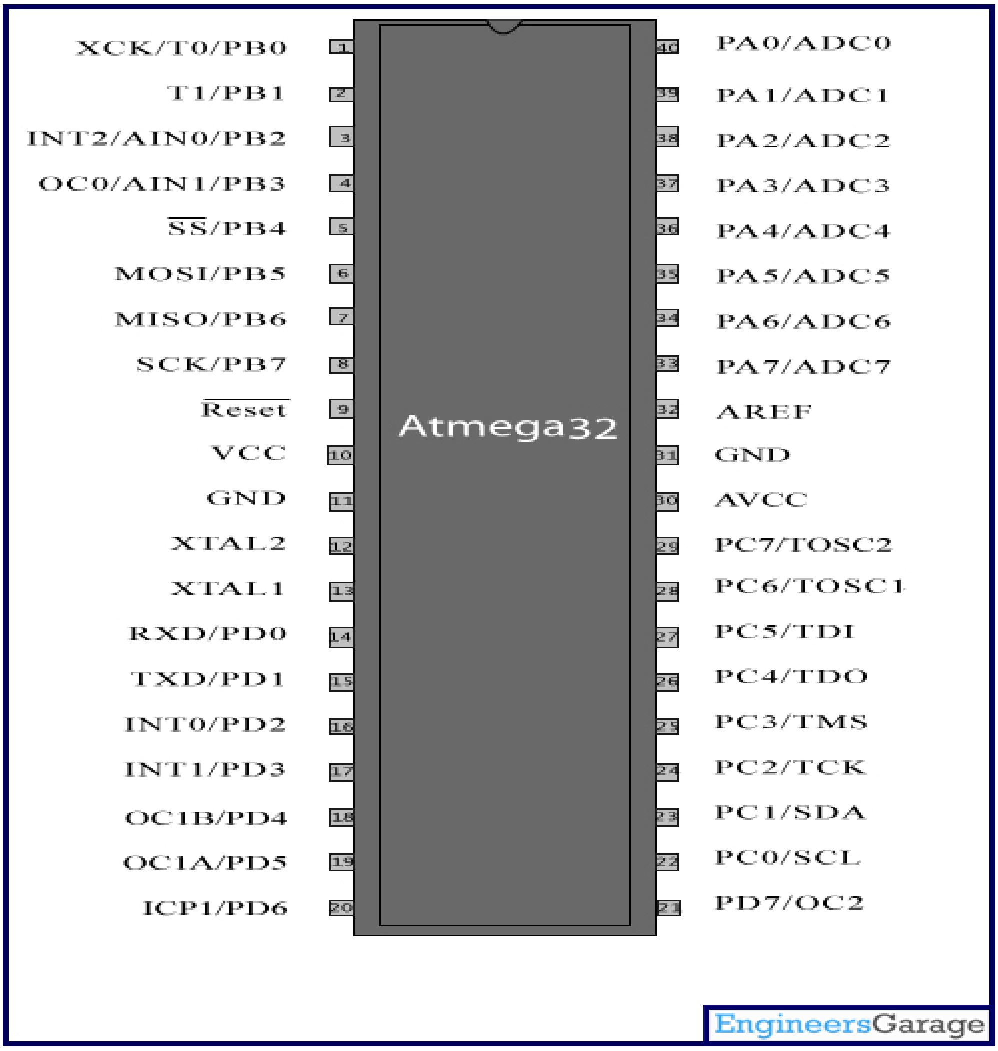


Figure (4-2) The microcontroller pins

Table(4.1) The microcontroller pin link with LED to show the system on

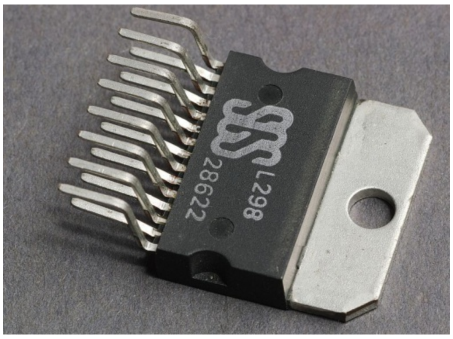
The microcontroller pin	The connection with
d.0	LED

4.1.2 Driver l298

The L298 is a dual H-bridge driver for DC brushed motors and stepper motors. It supports a wide operating voltage range (fig 4-3) [14].

This driver is capable of driving loads up to 2A continuously. [15]

(Fig 4-4) describes the L298 pins.



Fig(4.3) the l298 chip

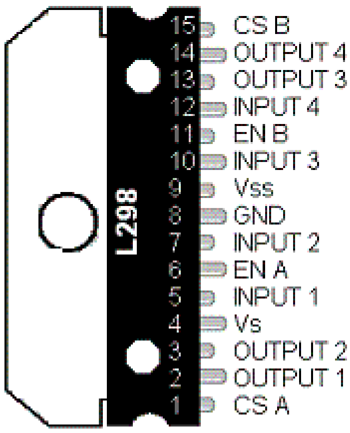


Fig (4.4) The l298 pins

Table(4.2) The l298 links

Microcontroller pins	L298N pins
C.0	Output 1
C.1	Output 2
C.2	Output 3
C.3	Output 4

4.1.3Stepper motor

A stepper motor is an electromechanical device which converts electrical pulses intodiscrete mechanical movements. The shaftor spindle of a stepper motor rotates in discrete step increments when electrical command pulses are applied to it in theproper sequence. The motors rotation has several direct relationships to these applied input pulses. The sequence of the applied pulses is directly related to the direction ofmotor shafts rotation. The speed of the motor shafts rotation is directly related to the frequency of the input pulses and thelength of rotation is directly related to the number of input pulses applied.

A stepper motor can be a good choice whenever controlled movement is required.

The Advantages of stepper motor:

1. The rotation angle of the motor isproportional to the input pulse.
2. Excellent response to starting /stopping/reversing.

The disadvantage of stepper motor:

It is possible to achieve very low speed synchronous rotation with a load that is directly coupled to the shaft[8].

4.1.3.1BIPOLAR PERMANENT MAGNET STEPPING MOTOR

The stepper motor is an incremental drive actuator or in other words it is an electromechanical device which actuates a train of step angular movements in response to a train of input pulses on a one-to-one basis. This means that the motor moves one step for one input pulse.

A bipolar PM stepper motor has a single winding for each phase and the current must be reversed to reverse the stator field(fig 4-5). Bipolar motors, however, have two windings wound in opposite directions for each phase so that the field can be reversed with a single polarity drive [36].

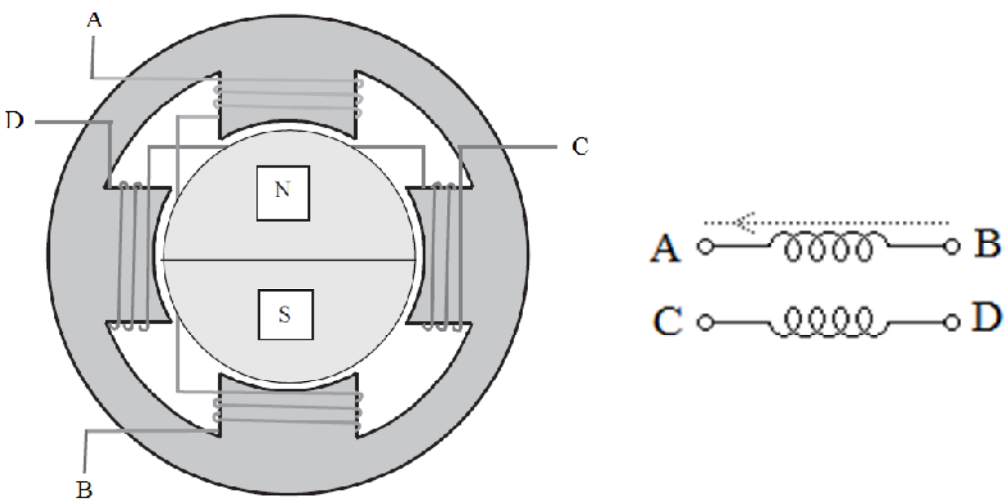


Fig (4-5) the bipolar stepper motor cross section

The KP35FM2-027 is bipolar stepper motor with this specifications

Table(4.3) shown the stepper motor current & voltage values

Voltage	12V
Current	2A

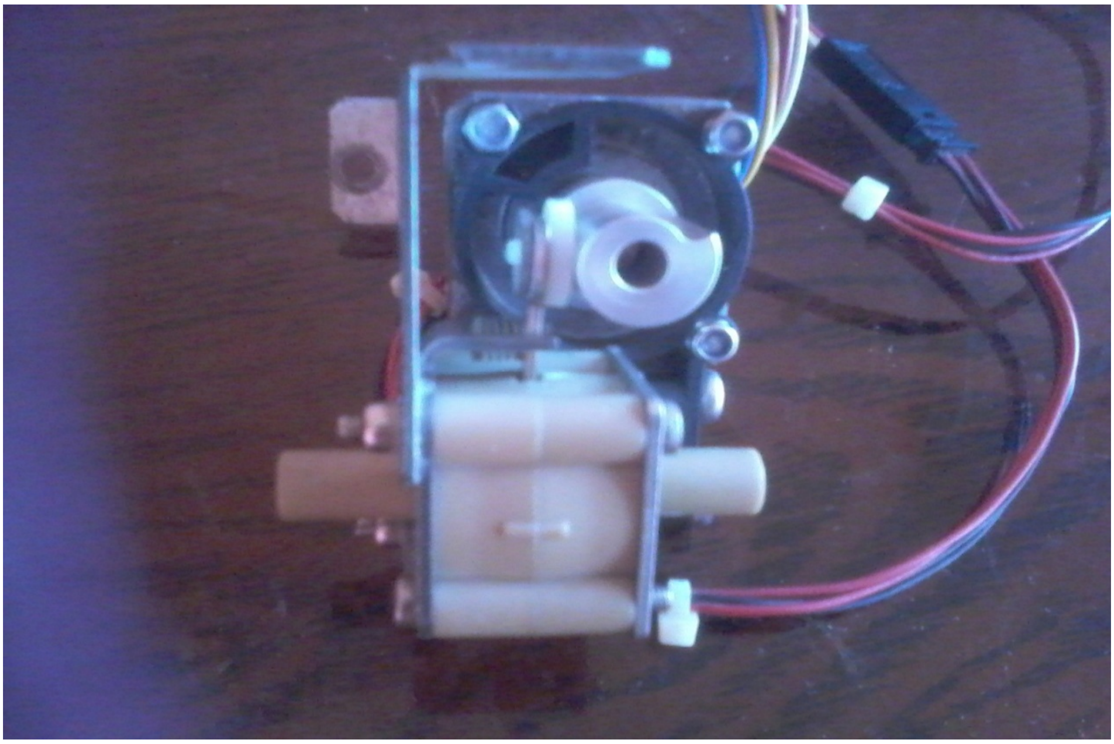


Fig (4.6)The motor kp35FM2-027

4.1.4pulseoximeter

The greatest advance in patient monitoring in many years. It has the unique advantage of continuously monitoringthe saturation of hemoglobin with oxygen, easily andnoninvasively, providing a measure of cardio-respiratoryfunction. By virtue of its ability to quickly detect Hypoxemia, it has become the standard of care duringanesthesia as well as in the recovery room and intensivecare unit. Pulse oximetry should be used to monitor anypatient who is heavily sedated or is likely to becomehypoxic.

The fundamental physical property that allows thepulse oximeter to measure the oxygen saturation ofhemoglobin is that blood changes colour as hemoglobinabsorbs varying amounts of light depending on its saturation with oxygen. Oxyhemoglobin does not absorbmuch red light, but as the hemoglobin oxygen saturationdrops, more and more red light is absorbed and the bloodbecomes darker. At the near infrared range of lighthowever, oxyhemoglobin absorbs more light than reduced Hemoglobin.

Pulse oximetry is thus based upon two physical principles:

a) The light absorbance of oxygenated hemoglobin isdifferent from that of reduced hemoglobin, at theoximetry's two wavelengths, which include red andnear infrared light; and

b) The absorbance of both wavelengths has a pulsatilecomponent, which is due to the fluctuations in thevolume of arterial blood between the source and the detector.

4.1.4.1Principle of pulse oximetry

The use of the oximetry's two wavelengths of lightis predicated on the following: red and near infrared lightreadily penetrate tissue, while blue, green, yellow andlonger wavelength infrared light are absorbed by tissue and water. Light emitting diodes (LEDs), which reliablyemit a specific wavelength of light are widely availableat the red and near infrared wavelengths, to use as light sources.Each pulse oximetry probe contains LEDs, whichemit two wavelengths of light, (red and near infrared) through a cutaneous vascular bed. The probe is commonlyplaced on the digits or earlobe. A photo detector on theother side measures the intensity of transmitted light ateach wavelength from which oxygen saturation is derived,based on human volunteer data stored in the memory ofthe oximetry.Red and infrared light transmitted through a tissuebed are measured using the finger or ear as a cuvettecontaining hemoglobin.

Modern pulse oximetry consist of a peripheralprobe together with a microprocessor unit displaying awaveform, the oxygen saturation and the pulse rate(Figure 4-7) . Theprobe is placed on the digit, earlobe or nose. Within theprobe are two LEDs, one in the visible red spectrum(660nm) and the other in the infrared spectrum (940nm).The beams of light pass through the tissues to the photodetector shown in (figure 4-8). During passage through the tissues some light isabsorbed by blood and soft tissues depending on the concentration of hemoglobin. The amount of lightabsorption at each frequency depends upon the degree of oxygenation of hemoglobin within the tissues [9]

Fig (4.7) The portable pulse oximeter

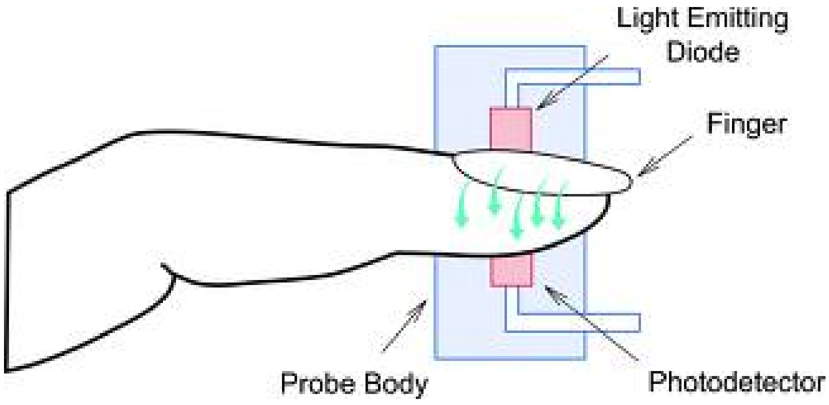


Fig (4.8) the photodetector and LED

4.1.5Oxygen cylinder

Compressed oxygen cylinders are commonly used in hospitals, community-based care centres, and in patient's homes for the provision of oxygen enriched air to patients in need.[31] discussed in chapter 2

4.1.6Pressure gauge

Oxygen regulators are essentially valves that control the flow of oxygen from a tank to the outlet or delivery instrument(Figure 4-9). The main uses of oxygen tanks are for industrial, medicinal and scuba diving for sports and exploration. The oxygen regulator is the valve that cuts of the flow of high-pressure oxygen and allows only a controlled amount of the gas to reach the outlet instrument[30].

Fig (4.9)The oxygen regulator and the flow meter

4.1.7Humidifier

Humidifiera device connected to the flow meter to provide moisture to the dry oxygen coming from the supply cylinder (figure 4-10) . Oxygen without humidification can dry out the mucous membranes of the patient’s airway and lungs. In most short-term use, the dryness of the oxygen is not a problem; however, the patient is usually more comfortable when given humidified oxygen [28].

Fig (4.10) The humidifier

4.1.8 The mask

An oxygen mask provides a method to transfer breathing oxygen gas from a storage tank to the lungs. Oxygen masks may cover the nose and mouth (oral nasal mask) or the entire face (full-face mask) (Figure 4-11). They may be made of plastic, silicone, or rubber.In certain circumstances, oxygen may be delivered via a nasal cannula instead of a mask [10].

Fig (4.11) a plastic oxygen mask on the patient

4.1.9Push button switch

A device designed to close or open an electric circuit when a button or knob is depressed, and to return to a normal position when it is released (figure 4-12) [29].

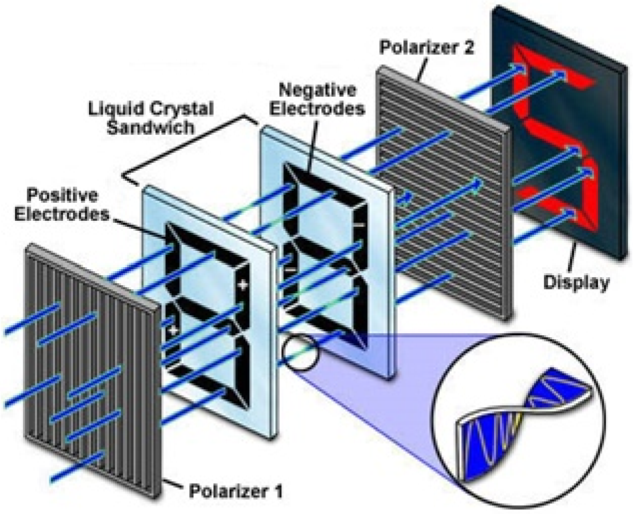
Fig (4-12) the push button switch

Table (4.4) the microcontroller links with switches

The microcontroller pins	The switches
B.0	1
B.1	2
B.2	3
B.3	4
B.4	5
B.5	6

4.1.10 LCD

Liquid crystals are a state of matter that has the properties between solid crystal and common liquid.The most common application of LCs are in liquid crystals displays (LCD). Is a simple demonstration of how LCD works in digit calculators? There are two crossed polarizers in this system, and liquid crystal sandwich with positive and negative charging is located between these two polarizers. When the liquid crystal is charged, waves can pass through without changing orientations. When the liquid crystal is out of charge, waves will be rotated 90° as it passes through LCs so it can pass through the second polarizer. There are seven separately charged electrodes in the LCD, so the LCD can exhibit different numbers from 0 to 9 by adjusting the electrodes (Figure 4-13). For example, when the upper right and lower left electrodes are charged, we can get 2 on the display [11].



Fig(4-13) shown the Demonstration of a seven-segment liquid crystal display.[15]

16 x 2 character LCD module with yellow/green backlight:

These are backlit character based LCD modules with 2 lines of 16 characters (figure 4-14)[12]. (Figure 4-15) described the LCD pins.

Table (4.5) shown the lCD specification

Size:	80 x 36mm
Viewing area:	64.5 x 13.8mm
Supply Voltage:	5V
Characters per row:	16
Number of rows:	2
Dots per character:	5 x 7
Backlight	Yellow / green

Fig (4-14) The LCD 16*2

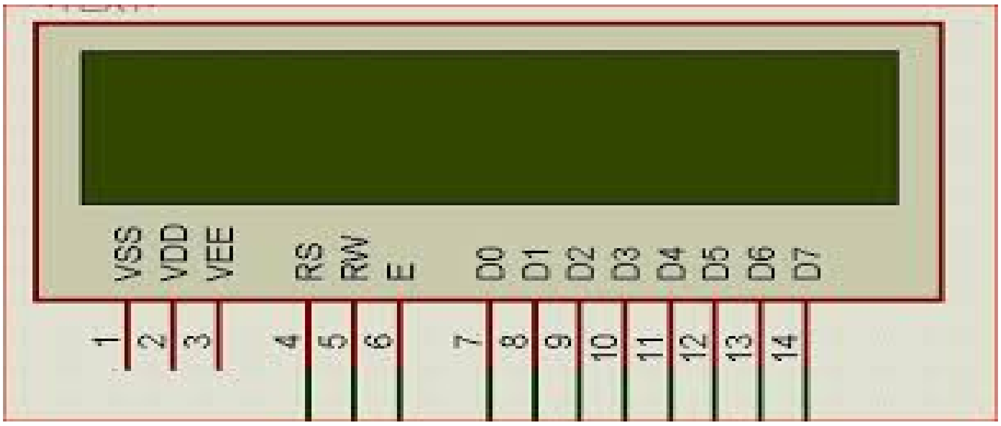


Fig (4.15) The LCD pins

Table (4.6) The microcontroller links with LCD

The LCD PINS	THE CONNECTIONS
Pin 1/3/5	Ground
Pin 2	Vcc
Pin 4	Microcontroller pin d.2
Pin 6	Microcontroller pin d.3
Pin d4	Microcontroller pin d.4
Pin d5	Microcontroller pin d.5
Pin d6	Microcontroller pin d.6
Pin d7	Microcontroller pin d.7

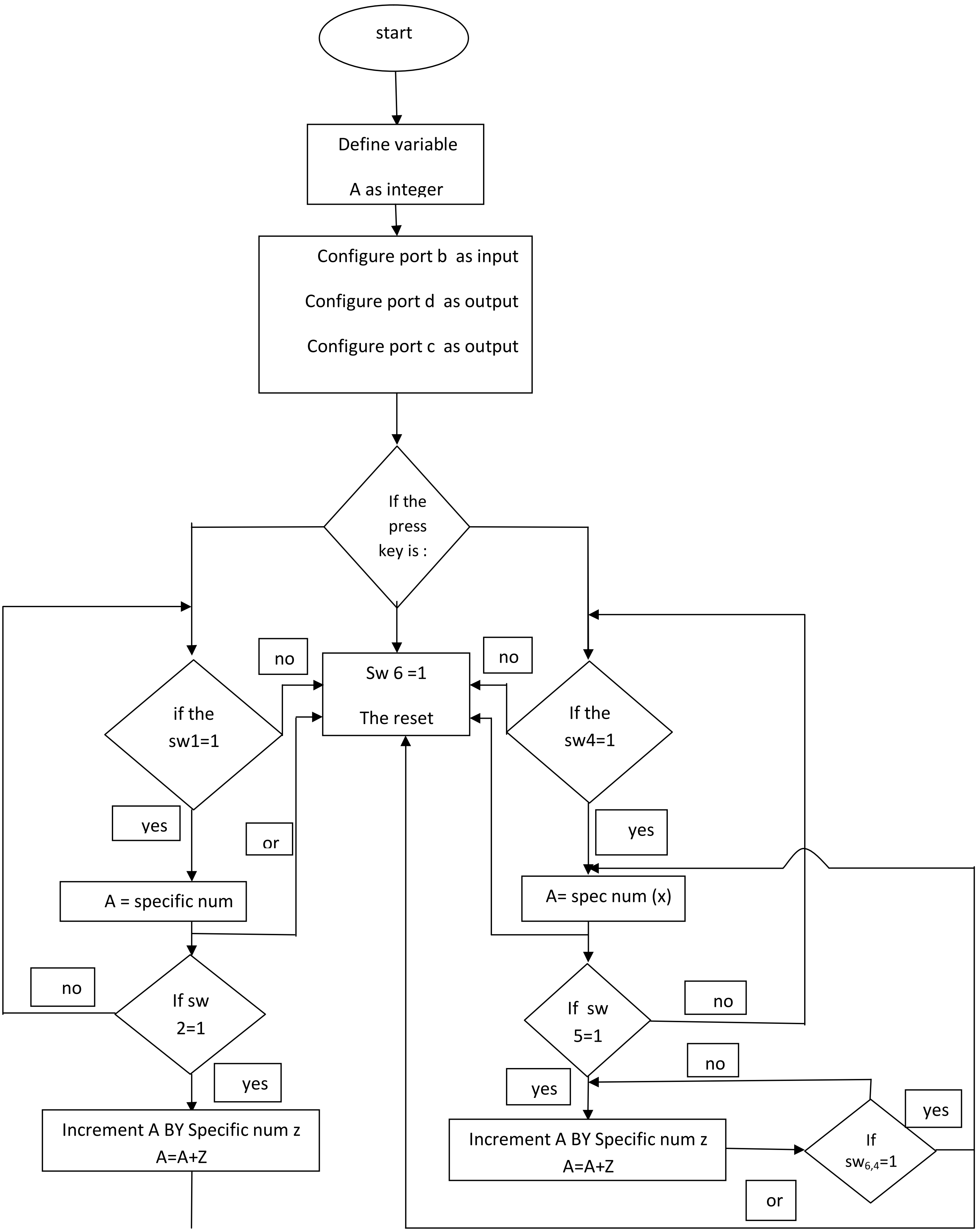
Chapter Four

Design and implementation

Part 2

4.2 part 2

This part discusses the project software, Demonstrate the flow chart of the operation. The circuit was designed to support patient with low oxygen level in their blood by adequate oxygen amount depending on the known diseases level to move specific motor in order to open a valve with a certain limit space as result of accounted motor steps according to the signal coming from the microcontroller (at mega 32)[discussed in chapter [4] was programmed by using BASCOM AVR software.


start
Define variable
A as integer
Configure port b as input
Configure port d as output
Configure port c as output
If the
press
key is :
no
Sw 6 =1
The reset
no
if the
sw1=1
If the
sw4=1
yes
or
yes
A = specific num
A= spec num (x)
no
If sw
2=1
If sw
5=1
no
yes
no
yes
yes
Increment A BY Specific num z
A=A+Z
Increment A BY Specific num z
A=A+Z
If
sw6,4=1
or

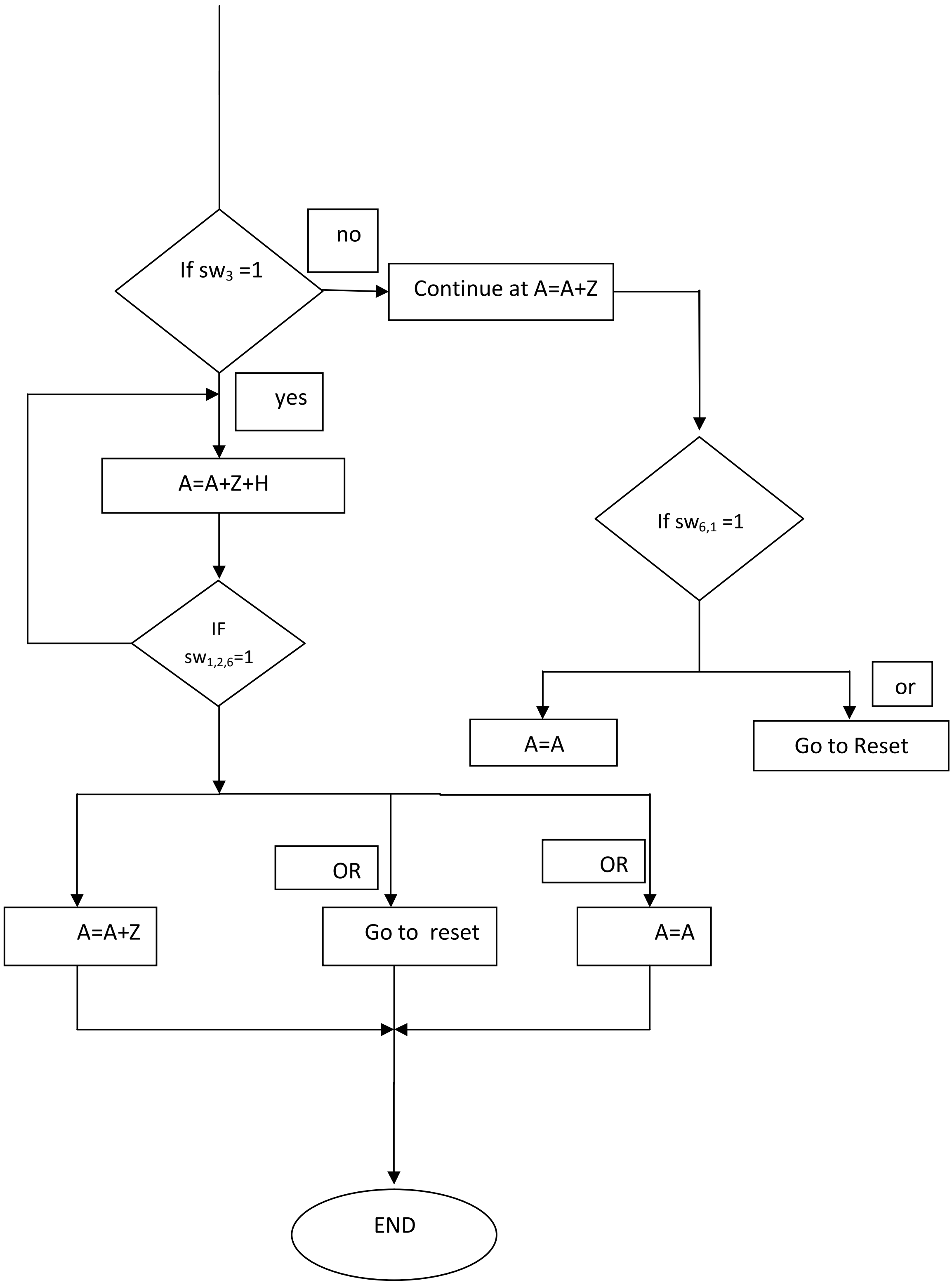


Fig (4.16) The chart of the program

There:

A≡the number of motor steps

This motor the total step =39 steps

Sw≡the select switch

Z,H≡ specific numbers that change the motor step .

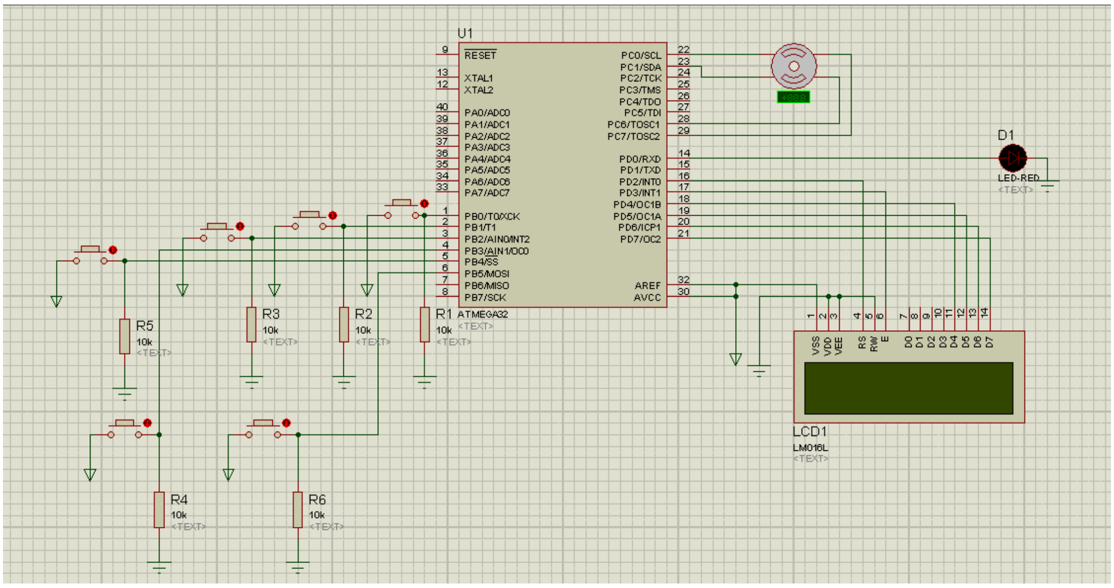
In the prototype circuit, the manual flow meter was put in order to recognize and show the maximum out put that the valve can reach.

From the observations the maximumoutput =10L/min.

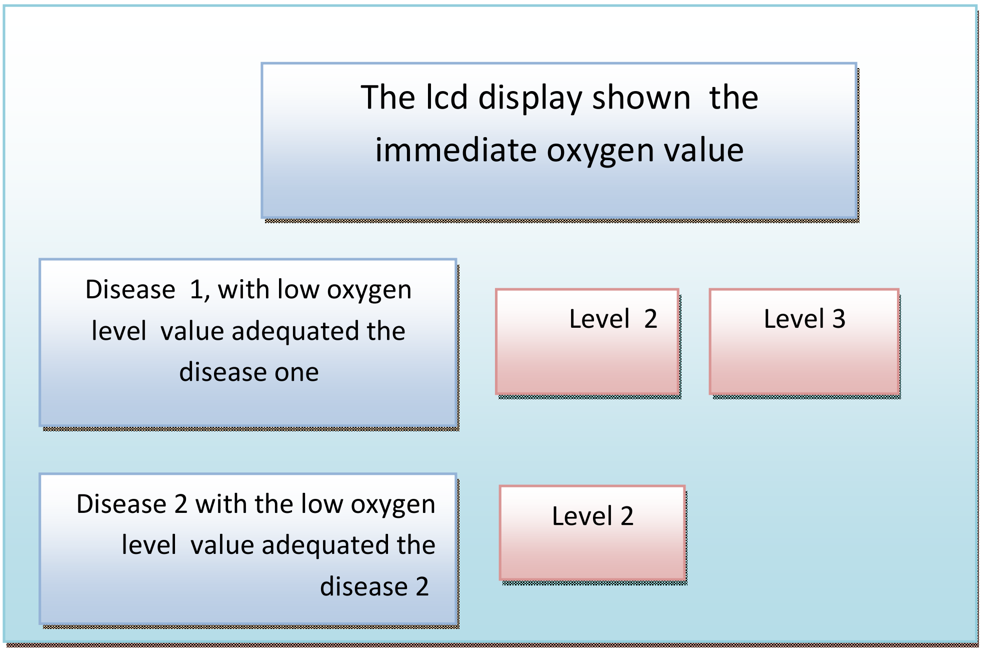
That main 39steps=10L/min.

Table(4.7) The motor steps and the equivalent out puts

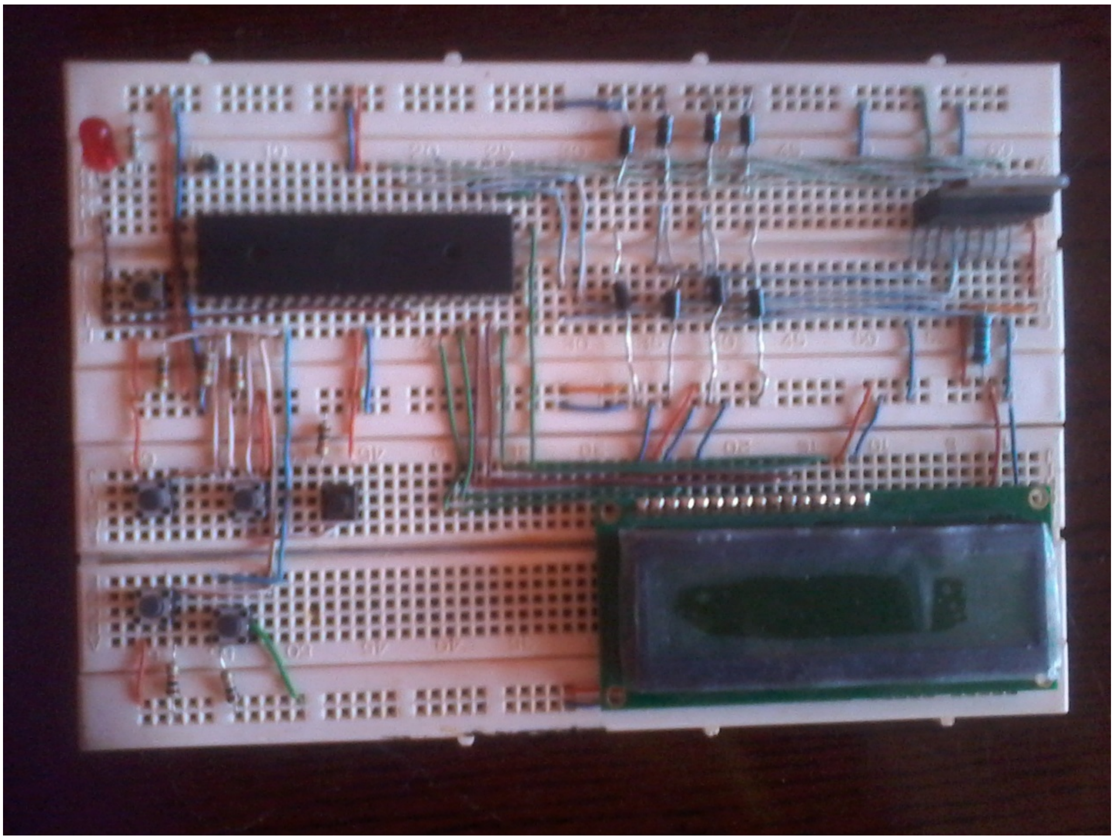
Number of steps(A)	L/min
4	1 L/min
8	2 L/min
11	3 L/min
15	4 L/min
19	5 L/min
23	6 L/min
27	7 L/min
31	8 L/min
35	9 L/min
39	10 L/min



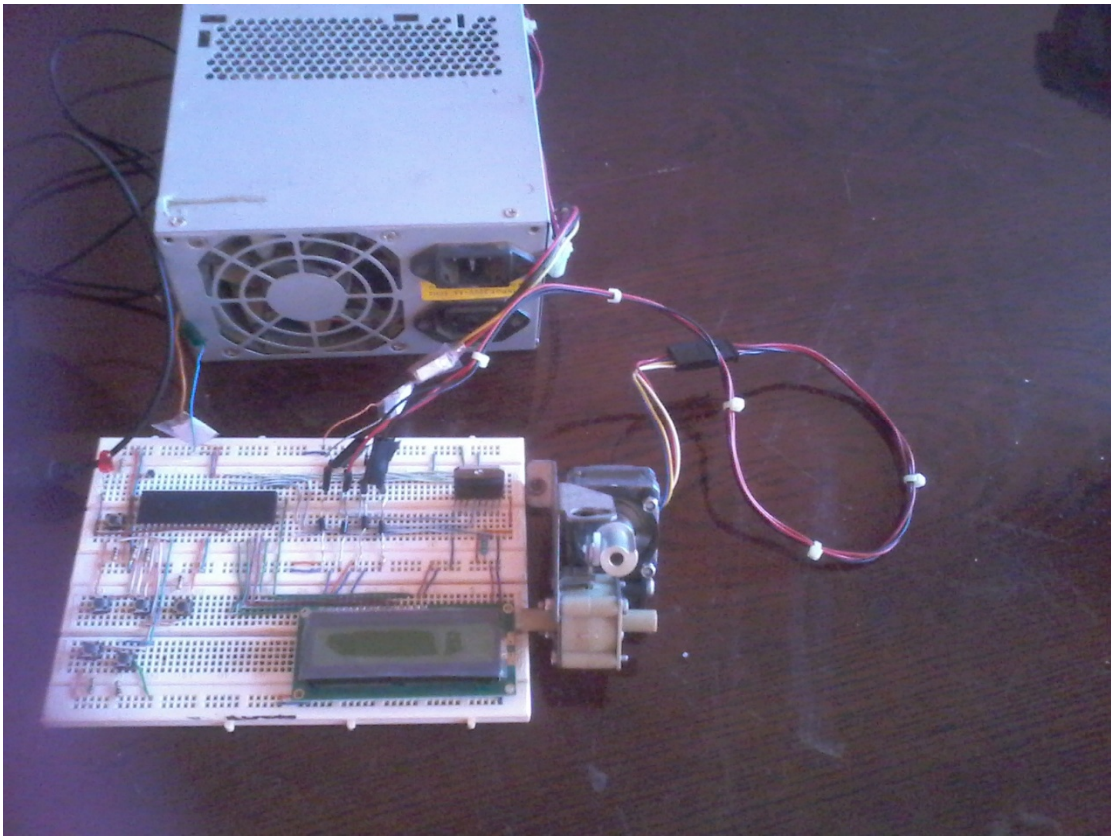
The fig (4.17) the circuit simulation



Fig(4.18) The project vision contains two diseases and their severity levels.



Fig(4.19) The circuit without the motor, the circuit contains the microcontroller, the LCD to display the disease and the LPM ,and two lines of switches the upper line represent the first disease and three level of severity from the minimum dose to maximum dose and the lower line represent another disease with minimum and maximum level.



Fig(4.20) The circuit and the kp35FM2-027 motor, the motor receives the signal from microcontroller according to press switch, the motor moves specific steps and the valve opens specific area.

Chapter Five

The result and discussion

5.1 The Results

Oxygen therapy is the administration of oxygen , which can be for a variety of purposes in both chronic and acute patient care. Oxygen is essential for cell metabolism. High blood and tissue levels of oxygen can be helpful or damaging, depending on circumstances and oxygen therapy should be used to benefit the patient by increasing the supply of oxygen to the lungs and thereby increasing the availability of oxygen to the body tissues. The Oxygen therapy should be administered according to specific guidelines. Proper monitoring of oxygen therapy is recommended to ensure adequate oxygenation and to save precious oxygen from wastage. The use of pulse oximeter is a simple, quick, non-invasive, and reliable method to assess it.

The prototype pressed on certain disease lead to move the motor a specific steps that allow the specific oxygen flow reached the patient.

the motor received the signal comes from microcontroller Atmage 32 ,it response moves forward and reverse ,forward cause the valve attach with it opened and reverse cause the valve closed.

-The maximum layout flow rate of the valve in the complete motor steps (39 steps) is 10 l/min, according to this result the mathematical segmentation in the stepper motor steps is done, to get the right oxygen flow rate.

-the prototype containing of switches to select the disease , and the disease severity ,the minimum disease level will be given automatically , the reset switch to close the system, moving the motor in reverse or forward direction to increase the dose depend on the doctor prescription duration.

5.2 The discussion

The major finding from this process is that it is feasible to deliver oxygen mount fit the patient'sneeds, in a very narrow level to decreased the over load dose to minimum level as could as possible .

The oxygen supplemented is very sensitive issue, it depends on large amount of guidelines, this research depending on the dose range of each disease.

The prototype at most gave acceptable results .the Most of the COPD patients are prescribed low flow Concentrations at 1-2 L per minute, the stepper motor is programmed to give the 1 L/min automatically when the switch of COPD is pressed directly, the steps required to achieve this result are four steps. The 2L/min will be given to the patient, when doctor's ordered to rise the oxygen level.

Chapter Six

The conclusion and recommendations

6.1 The conclusion:

Oxygen therapy requires two things: Simplicity & accuracy .Flow meters should be simple to use and easy to read, they should provide a consistent flow of gas to the patient and in order to work effectively, they need to be accurate.

With these basic guidelines, depending on the most common diseases dose rang, it can easily deliver a fairly consistent concentration and accurate flow rate.

The prototype met the design specifications, through using the stepper motor KP35FM2-O27 attached with a certain valve allows the oxygen gas goes off patient in adequate mount according to right selection of patient disease, the minimum level reach to patient automatically and the high level, just press According to doctor order.

6.2 The recommendations:

-Develop the prototype by using valve and connection specially design to deliver tolerated mount of the oxygen and met the project demand, the motor and the valve in this project ware designed to another a certain machine, it just scrub without data sheet to know it is a specifications to do this mathematically and to be more accurate not just by observation.

-design a integrate computer program includes the all factors such as age, weight and other; those contribute to determine the accurate oxygen dose and decreasing the dose range to minimum.

The references:

[1] Susanne Timischl , A Global Modelfor theACardiovascular and Respiratory System, Karl-Franzens University of Graz, August 1998

[2] MickaelP.hlastala,AlbertJ.Berger.2nd ed . Oxford university Perss,Inc,2001.

[3] Jim Cornish, The Human Heart, Gander, Newfoundland, 2003

[4] Lynne Eldridge MD,Hypoxia;Symptoms, Causes, and Treatment, board-certified health professional , *September 16, 2013* .

[5]S.K. Jindal, Oxygen Therapy: Important Considerations, The Indian Journal of Chest Diseases & Allied Sciences, 2008.

[6] http://electrapk.com/microcontroller-definition

[7]http://www.webopedia.com

[8] http://www.solarbotics.net/library/pdflib/pdf/motorbas.pdf

[9] martin Griffin and Kevin Byrne Curriculum Press, Unit 305B, The Big Peg, 120 Vyse Street, Birmingham. B18 6N,Bio facts sheet, Oxygen Dissociation Curves, January1998,november9

[10] http://en.wikipedia.org/wiki/Oxygen_mask

[11] http://cnx.org/content/m38343/1.2/

[12] http://www.protostack.com/led-lcd/lcd-modules/16-x-2-character-lcd-module-with-yellow-green-backlight

[13] http://www.bolhme.com/education/OxygenCylinders.pdf

[14] http://www.pololu.com/product/924

[15] http://www.datasheetarchive.com

[16]martin Griffin and Kevin Byrne Curriculum Press, Unit 305B, The Big Peg, 120 Vyse Street, Birmingham. B18 6N,Bio facts sheet, Oxygen Dissociation Curves, January1998,november9

[17] Arterial Blood Gases,Clementine YF Yap, Mt(asCP), DLM(asCP) Tar Choon Aw, FrCP (Edin), FrCPa,Department of Lab Medicine, Changi General Hospital, Singapore,Proceedings of Singapore Healthcare Volume 20, Number3, 2011.

[18] David W. Woodruff, MSN, RN-BC, CNS, CMSRN, CEN,571 Ledge Road, Macedonia,6Easy Steps to ABG Analysis, E-Booklet.

[19]T. JMORGAN,intensive Care FacilityDivision of Anaesthesiology and Intensive Care ,royal Brisbane hospital ,Brisbane, Basic sciences review,The Oxyhaemoglobin Dissociation Curve in Critical Illness.

[20] http://www.paediatrics.org.nz

[21] John J Marini, Mechanical ventilation: past lessons and the near future, BioMed Central Ltd,2013.

[22]Kathe Rowe, B.S.Ed., RRT, Respiratory Therapist Program, The Basics of Mechanical Ventilation, Rose State College,2011

[23] CP Singh, Nachhattar Singh, Jagraj Singh, Oxygen Therapy, Journal, Indian Academy of Clinical Medicine _ Vol. 2, No. 3 _ July-September 2001

[24] Kimberly G Lee, MD, MSc, IBCLC, Oxygen therapy – infants, VeriMed Healthcare Network,11.2011

[25] K. Dheda,K. Lim, Assessments for oxygen therapy in COPD: are we under correcting arterial oxygen tensions?
,EUROPEAN RESPIRATORY JOURNAL,AUGEST 3,2004.

[26] http://www.myrespiratorysupply.com/respiratory-care-nasal-cannula-c-10_21.html

[27]http://www.flexicare.com/en/educational/oxygen--aerosol-therapy/oxygen.aspxv

[28] www.bradybooks.com

[29] http://dictionary.reference.com/browse/push+button

[30]http://www.ehow.com/how-does_5021896_oxygen-regulators-work.html

[31] *H.B. Muhammad*, D. Carpanen*, A. Hassani,*
A LOW PRESSURE ALARM DEVICE FOR MEDICAL OXYGEN CYLINDERS: A DESCRIPTION OF A PROTOTYPE ,Appropriate Healthcare Technologies for Developing Countries, 7th International Conference on , 18-19 Sept. 2012

[32] Your LungHealth.org/health_Living/Living/home_oxygen_therapy/. Revised May 26, 2005.

[33] http://en.wikipedia.org/wiki/Simple_face_mask

[34]http://www.isa-digiflow-pi-9066107-en

[35]*Abhishek K Verma,* The interpretation of arterial blood gases ,Australian prescriber Volume 33 | NumBeR 4 | AuGuST 2010

[36] Maher Dababneh , Chopper Control of a Bipolar Stepper Motor, International Journal of Engineering (IJE), Volume (7) : Issue (2) : 2013 .

[37] Ming Wong, Malcolm Elliott, The use of medical orders in acute care oxygen therapy , British Journal of Nursing, 2009, Vol 18, No 8

[38]Josy Davidson, Precision and Accuracy of Oxygen Flow MetersUsed at Hospital Settings , RESPIRATORY CARE • JULY 2012 VOL 57 NO7.

Appendix

```
$regfile = "m32def.dat"

$crystal = 1000000

Config Portb.0 = Input                    'adema main

Config Portb.1 = Input                    'adema 9L

Config Portb.2 = Input                    'adema 10L

Config Portb.3 = Input                    'COBD 1

Config Portb.5 = Input                    'COBD 2

Config Portb.4 = Input                    'RESET

Config Portd.0 = Output

ConfigPortc = Output

ConfigLcd = 16 * 2

ConfigLcdpin = Pin , Db4 = Portd.4 , Db5 = Portd.5 , Db6 = Portd.6 , Db7 = Portd.7 , E = Portd.3 , Rs = Portd.2

Dim A As Integer

Portd.0 = 1

Cursor Off

Locate 1 , 5

Lcd "wellcom"

Wait 2

Cls

Locate 1 , 2

Lcd "SPO2 CONTROLE"

Locate 2 , 2

Lcd " By: SAHAR EMAD"
```

```
Wait 2

Main:

Cls

Do

Locate 1 , 1

Lcd "SELECT KEY"

'================================adema=====================

If Pinb.0 = 1 Then

A = 13                                    ' adema main in initial state (8L)

Gosub Motor

Cls

Locate 1 , 1

Lcd "ADEMA 8LITER/MIN"

Do

'======================9L=================================

If Pinb.1 = 1 Then

A = 13                                              ' adema (9L) 13 initial + 13 9l =26 total
'                                         '

Gosub Motor

Cls

Locate 1 , 1

Lcd "ADEMA 9LITER/MIN"

Do

'==========
```

```
If Pinb.2 = 1 Then

A = 13

Gosub Motor

Cls

Locate 1 , 1

Lcd "ADEMA 10LITER/MIN"

'=====

Do

If Pinb.1 = 1 Then

A = 13

GosubMotorinverse

Cls

Locate 1 , 1

Lcd "ADEMA 9LITER/MIN"

End If

If Pinb.0 = 1 Then

A = 26

GosubMotorinverse                                    ' adema main in initial state (8L)

Cls

Locate 1 , 1

Lcd "ADEMA 8LITER/MIN"

End If

If Pinb.4 = 1 Then

Cls
```

```
Locate 1 , 1
Lcd "WAIT TO RESET"
A = 39
Gosub Motorinverse1
Gosub Main
End If
Loop
'====
End If
'=============
If Pinb.0 = 1 Then
A = 13
GosubMotorinverse
Cls
Locate 1 , 1
Lcd "ADEMA 8LITER/MIN"
'=====
Do
If Pinb.1 = 1 Then
A = 13
Gosub Motor
Cls
Locate 1 , 1
Lcd "ADEMA 9LITER/MIN"
```

```
End If
If Pinb.2 = 1 Then
A = 26
Gosub Motor
Cls
Locate 1 , 1
Lcd "ADEMA 10LITER/MIN"
End If
If Pinb.4 = 1 Then
Cls
Locate 1 , 1
Lcd "WAIT TO RESET"
A = 13
Gosub Motorinverse1
Gosub Main
End If
Loop
End If
'==============
If Pinb.4 = 1 Then
A = 26
Cls
Locate 1 , 1
Lcd "WAIT TO RESET"
```

```
Gosub Motorinverse1

Gosub Main

End If

Loop

End If

'========================10L=============================

If Pinb.2 = 1 Then

A = 26                              ' adema (10L) 13 +26=39 total

Gosub Motor

Cls

Locate 1 , 1

Lcd "ADEMA 10LITER/MIN"

Do

If Pinb.1 = 1 Then

A = 13

GosubMotorinverse

Cls

Locate 1 , 1

Lcd "ADEMA 9LITER/MIN"

'======

Do

If Pinb.2 = 1 Then

A = 13                              ' adema (10L) 13 +26=39 total

Gosub Motor
```

```
Cls
Locate 1 , 1
Lcd "ADEMA 10LITER/MIN"
End If
If Pinb.0 = 1 Then
A = 13
GosubMotorinverse
Cls
Locate 1 , 1
Lcd "ADEMA 8LITER/MIN"
End If
If Pinb.4 = 1 Then
A = 26
Cls
Locate 1 , 1
Lcd "WAIT TO RESET"
Gosub Motorinverse1
Gosub Main
End If
Loop
'========
End If
'===========
If Pinb.0 = 1 Then
```

```
A = 26

GosubMotorinverse

Cls

Locate 1 , 1

Lcd "ADEMA 8LITER/MIN"

'=====

Do

If Pinb.1 = 1 Then

A = 13

Gosub Motor

Cls

Locate 1 , 1

Lcd "ADEMA 9LITER/MIN"

End If

If Pinb.2 = 1 Then

A = 26                                      ' adema (10L) 13 +26=39 total

Gosub Motor

Cls

Locate 1 , 1

Lcd "ADEMA 10LITER/MIN"

End If

If Pinb.4 = 1 Then

A = 13

Cls
```

```
Locate 1 , 1

Lcd "WAIT TO RESET"

Gosub Motorinverse1

Gosub Main

End If

Loop

'======

End If

'==============

If Pinb.4 = 1 Then

A = 39

Cls

Locate 1 , 1

Lcd "WAIT TO RESET"

Gosub Motorinverse1

Gosub Main

End If

Loop

End If

'============================RESET==========================

If Pinb.4 = 1 Then

A = 13

Cls

Locate 1 , 1
```

```
Lcd "WAIT TO RESET"                              ' RESET
Gosub Motorinverse1
Gosub Main
End If
Loop
End If
'===============================adema end===================
===============================COBD=========================
If Pinb.3 = 1 Then
A = 3                              ' COBD 1
Gosub Motor
Cls
Locate 1 , 1
Lcd "COBD 1"
Do
'===================COBD2============
If Pinb.5 = 1 Then
A = 3
Gosub Motor
Cls
Locate 1 , 1
Lcd "COBD 2"
Do
If Pinb.3 = 1 Then
```

```
A = 3

GosubMotorinverse

Cls

Locate 1 , 1

Lcd "COBD 1"

Do

If Pinb.5 = 1 Then

A = 3

Gosub Motor

Cls

Locate 1 , 1

Lcd "COBD 2"

End If

If Pinb.4 = 1 Then

A = 3

Cls

Locate 1 , 1

Lcd "WAIT TO RESET"

Gosub Motorinverse1

Gosub Main

End If

Loop

End If

If Pinb.4 = 1 Then
```

```
A = 6

Cls

Locate 1 , 1

Lcd "WAIT TO RESET"

Gosub Motorinverse1

Gosub Main

End If

Loop

End If

'===============RESET===================

If Pinb.4 = 1 Then

A = 3

Cls

Locate 1 , 1

Lcd "WAIT TO RESET"

Gosub Motorinverse1

Gosub Main

End If

Loop

End If

Loop

'=========================

 Motor:

Do
```

```
Cls

Locate 1 , 1

Lcd "WAIT TO SET"

Portc.0 = 1

Portc.1 = 0

Portc.6 = 0

Portc.7 = 0

Waitms 150

Portc.0 = 0

Portc.1 = 1

Portc.6 = 0

Portc.7 = 0

Waitms 150

Portc.0 = 0

Portc.1 = 0

Portc.6 = 1

Portc.7 = 0

Waitms 150

Portc.0 = 0

Portc.1 = 0

Portc.6 = 0

Portc.7 = 1

Waitms 150

Decr A
```

```
Loop Until A = 0

Return

Motorinverse:

Do

Cls

Locate 1 , 1

Lcd "WAIT TO SET"

Portc.0 = 0

Portc.1 = 0

Portc.6 = 0

Portc.7 = 1

Waitms 150

Portc.0 = 0

Portc.1 = 0

Portc.6 = 1

Portc.7 = 0

Waitms 150

Portc.0 = 0

Portc.1 = 1

Portc.6 = 0

Portc.7 = 0

Waitms 150

Portc.0 = 1

Portc.1 = 0
```

```
Portc.6 = 0

Portc.7 = 0

Waitms 150

Decr A

Loop Until A = 0

Return

 Motorinverse1:

Do

Portc.0 = 0

Portc.1 = 0

Portc.6 = 0

Portc.7 = 1

Waitms 150

Portc.0 = 0

Portc.1 = 0

Portc.6 = 1

Portc.7 = 0

Waitms 150

Portc.0 = 0

Portc.1 = 1

Portc.6 = 0

Portc.7 = 0

Waitms 150

Portc.0 = 1Portc.1 = 0
```

```
Portc.6 = 0

Portc.7 = 0

Waitms 150

Decr A

Loop Until A = 0

Return
```