# DESIGN AND CONSRUCTION OF A MICROCONTROLLER BASED AUTOMATIC WATER PUMP CONTROLLER


**LATIFA YUSUF**

***2004/18888EE***

**DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING, FEDERAL UNIVERSITY OF TECHNOLOGY MINNA.**


**DECEMBER 2009**

# DECLARATION

I, YUSUF Latifa, declares that this project was done by me and has never been presented elsewhere for the award of degree. I also hereby relinquish the copyright to the Federal University of Technology, Minna.

Yusuf Latifa
Name of student

Signature and date

Mallam Bala Salihu
Name of Supervisor

14/01/10
Signature and date

Engr. Dr. Y.A. Adediran
Name of H.O.D

(May 6, 2010)
Signature and date

DR. (Ch Ltr.) B.A. Adegboye
Name of External Examiner

Signature and date

# ABSTRACT

This project deals with the design and construction of a microcontroller based Automatic water pump controller. The aim of this project is to design a system that will constantly supply water without manually checking water levels as a routine.

The microcontroller has been programmed to display low (L) on the seven segment display and to pump water into the tank (when tank is almost empty) and when to stop pumping water (when tank is full) and high (H) is displayed on the seven segment display.

# LIST OF FIGURES

# LIST OF TABLE

# CHAPTER ONE

# INTRODUCTION

## 1.1 0VERVIEW

Most buildings and housing complexes have a requirement for storage and handling of water. One may start the pump but often forget to switch it off resulting in overflow- wastage of both electricity and water in addition to messing up of surrounding and damaging walls and roof. In the industrial sector where manufacturing processes is continuous, there is a great consumption of water. It is very important to maintain the inflow and outflow of water so that there will be no wastage and also avoid stoppages in continuous industrial processing, so it became a great deal of importance for engineers to design an automated water supply pump to ensure that users never have to worry about handling pumps and checking levels as routine.

The history of automatic control system for water level can be traced back to 3rd century by Ctesibus of Alexandria when he used a floated valve to keep in a clock the flow of water in a container at a constant rate. Since then advanced inventions for the control of water level has effected even up to the 21st century where integrated circuits are used [1].

Automatic: The word automatic as applied to water regulation, it is any device, equipment that initiates a system function as a result of predetermined water level, without the necessity for human intervention.

The automatic water pump system effectively monitors the water levels in over head tanks. It eliminates the need for any manual switching of pumps installed for the purpose of pumping water from a reservoir to an overhead tank.

This project is designed to use a programmed microcontroller chip to automatically switch on the pump when the water level in the tank falls below a level (L) provided there is water in the underground of certain reasonable level and subsequently as the water level in the tank rises to an upper level, the pump switches off automatically. It is also designed to overlook the transient oscillations of the water level which would otherwise cause the logic to change its state rapidly and unnecessarily. No use of any moving electromechanical parts in the water level sensor has been made. This ensures quick response, no wear and tear and no mechanical failure.

Unlike previous work done on this topic, which most are not based on using programmable chips, this project is focused on reducing circuit complexity by programming a microcontroller to maintain water level in overhead tank either by triggering the water pump to pump when the tank is empty or triggering it stop when the water is full in the tank.

## 1.2 AIMS AND OBJECTIVES

The aims and objectives of the project are to:

1. Design a system that will constantly supply water without manually checking water levels as a routine.
2. To use a simpler technique with relatively low cost to achieve the desired goal with the use of a microcontroller.

## 1.3 METHODOLOGY

The desired result of this project is for the microcontroller to know when to pump water into the tank (when tank is almost empty) and when to stop pumping water (when tank is full).

The procedure used to achieve this desired result is by using quad LM324 comparator. From the inner circuitry of this comparator, it contains four comparators, but for the realization of this project, only three was used. The non inverting pin of the comparator (pins 3, 5 and 10) serves as the input and also as the sensing probe in the water tank. These inputs are grounded so that when water is not in contact with the probes, an output of 0v is gotten. The inverting pins of the comparator (pins 2, 6 and 9) are all connected to a variable resistor and also grounded so that the comparator will compare between 2.5v and 5v.

When the probe which serves as input has contact with water, it gives an output of 5v. This indicates logic state one (1). Since the theory of comparators is that the non inverting voltage should be greater than the inverting output for there to be an output. When the probes are not in contact with water, it gives output of logic state 000. When probes are in contact with water, an output of logic state 111 (full), 011 (almost full) and 001(almost empty) could be gotten.

The microcontroller is programmed in such a way that when input 001 is fed into its input port, a capital letter "L" is displayed on the seven segment display and also it gives an output via pin 32 through a transistor to energize the relay which activates the pump. When an output 111 is fed into it by the comparator, it displays capital letter "H" and no output will be gotten via pin 32 of the chip, hence the pump will not be activated.

## 1.4 SCOPE OF WORK AND LIMITATIONS

This project work is based on the design and construction of a microcontroller based automatic water pump systems to switch off the water pump when the tank is full by clearly indicating on a seven segment display as H, and also indicate H as averagely full, and to switch it on when the tank is almost empty by displaying L, by the seven segment display. Also it should be noted clearly that this device will work for only conducting fluids like water.

## 1.5 BLOCK DIAGRAM

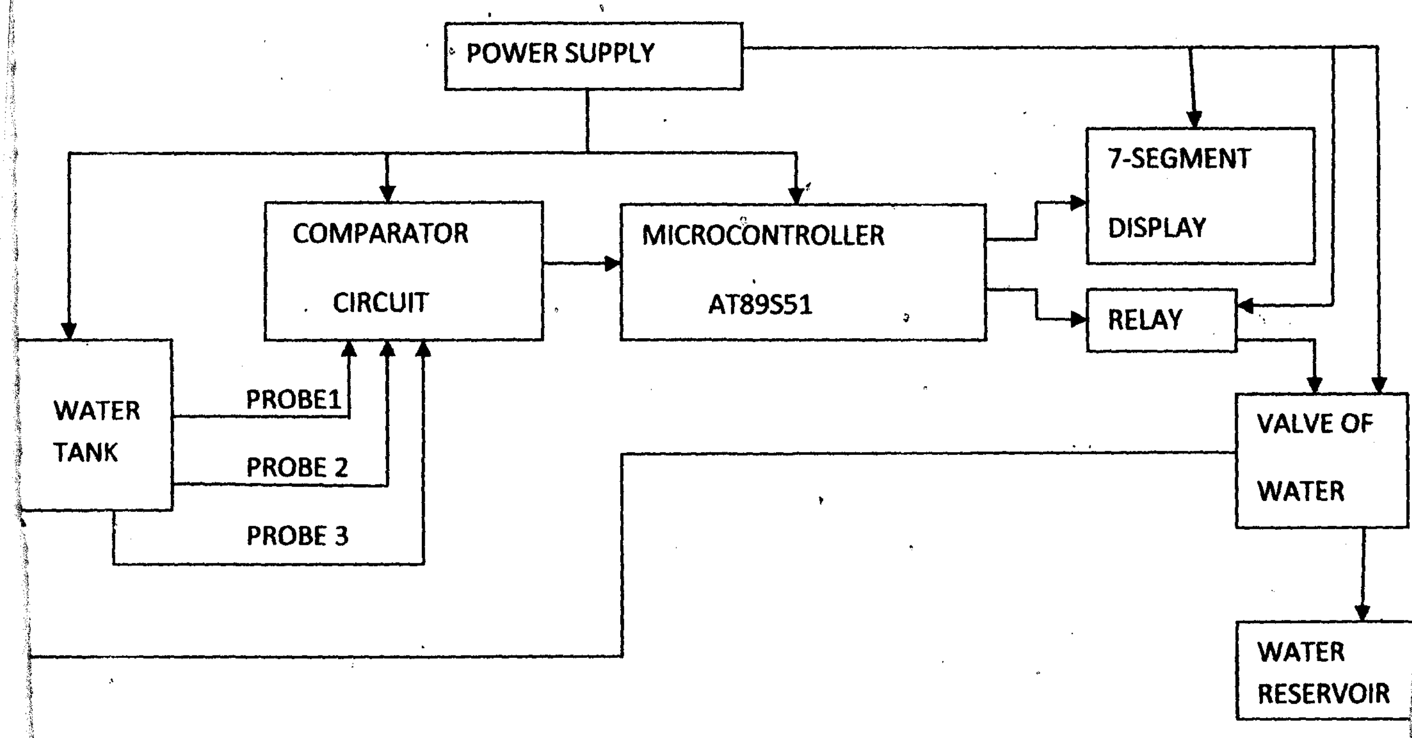



Fig1.1 Block Diagram of Microcontroller Based Automatic Water Pump Controller

## 1.6 MATERIALS USED

1. LM 324 quad comparator
2. 7805 voltage regulator
3. AT89S51 microcontroller chip
4. Common anode 7 segment display
5. 12MHz crystal oscillator
6. BC547 pnp transistor
7. 6 volt relay
8. 1µF,1000µFelectrolytic capacitors
9. 1KΩ,100KΩ, 165Ω, 4.7KΩ resistors
10. 230/12V transformer
11. 1.7V light emitting diode{LED}
12. Bridge Rectifier
13. Vero board
14. Flexible wires
15. Lead.

# . CHAPTER TWO

# LITERATURE REVIEW

## 2.1 HISTORICAL BACKGROUND

The oldest automatic control system dates back to Hellenistic era. The oldest application are flow rate control in water clock. The system was created by Ctesbus of Alexandria around the 3rd century BC, which regulates the water level in a vessel. The purpose of this system was to keep in a clock the flow of water in the container at a constant rate independent of level and pressure deviation, by using a floated valve. Although, Ctesbus left no written document, a reconstruction of his work is possible through the accounts of the Roman engineer Vitruvius [1].

Philo of Byzantium, a generation younger than that of Ctesbus {CA 200 BC} in his work titled "Pneumatica" gives example of automatic oil level control in oil candles.

The third important name in the history of automatic control is the Heron of Alexandria, who lived in the first century BC. In his work of pneumatica Heron described automatic control system as well as automata were designed to amuse, to arouse interest in the ancient temples or to water supply the bathhouse, attracted the attention of various circles[1].

The advancement of this technology continued into period of the Islam and reached its heights with Al Jazari, who served in the Artukid capital Amid {Diyar bakir}as court engineer(1200-1222).He his famous for his books Kitab-al-Hiyal (book of ingenious devices),where he explained the design, construction and principles of fifty different systems of practical use and aesthetic value such as water clocks, automata, water jets, vessels for blood collecting, water raising devices and ciphered keys[2,3].

The industrial revolution in Europe followed the introduction of prime movers or of control driven machines. It was marked by the invention of boilers and stem engine. These devices would not be adequately regulated by hand and so arouse a new requirement for control systems. A variety of control devices was invented including float regulators, temperature regulators, pressure regulators and speed control devices [2, 3].

Regulation of liquid level was needed in two main areas in the late 1700's, in the boiler of steam engine and in domestic water distribution system, therefore, the float regulator received new interest, especially in Britain. This regulated was used for maintaining the level of house water reservoirs [5, 6 & 7].

The earliest known use of a float valve regulator in a steam boiler is described in patent issued to J. Brindley in 1758.He used the regulator in a steam engine in his brewery in 1784 in Russia Siberia, the coal miner, I.I Polzunuv developed in 1765 a float regulator for a steam engine that drive fans for blast furnace [6, 7].

## 2.2 PREVIOUS WORKS

### 2.2.1 Servo Tank Guaging

Varec inc has developed a servo guage with the options you require to fulfil the exacting demand of the tank inventors management. It is available as a level only device when connected to companion devices, as a multi variable instrument. This work is based on the principle of displacement instrument. A small displacer on a measuring wire is un wound from a drum and accurately positioned in the liquid medium using a servo motor. The weight of the displacer is precisely balanced against a magnetic coupling and the wire drum. When the displacer is lowered and touches the liquid, the weight of the displacer is reduced because of the buoyant force of the liquid. As a result, the torque in the magnetic coupling is changed and the change is measured by a 5-set of hall sensors. This signal an indication of the position of the displacer is sent to the motor control circuit. As the liquid level rises and fall, the position of the displacer is automatically adjusted by the drive motor [8]. It should be noted that these method is capital intensive and numerous discrete components are used.

### 2.2.2 Pressure Tank Guaging

Pressure measuring device for water level measurements utilizes the principle that the hydrostatic pressure due to liquid is directly proportional to its depth and hence the level of its surface[9]. In open tapped vessels or covered ones that are vented to the atmosphere, the liquid level is measured using an appropriate pressure transducer inserted at the bottom of the vessel. The liquid level is then related to the measured pressure according to:

$h=p/\rho g$ where h= height of the liquid in the tank

$\rho$= density of the liquid

g= acceleration due to gravity

p= pressure

Pressure in the tank drops as water leaves the tank. A pressure control switch usually mounted on or near the water tank senses the pressure drop and a preset "pump cut in pressure" switches on the water pump (typically 20-30psi) the pump located at the tank or perhaps well, pumps water to the building from the well, simultaneously representing the water tank and providing water to the building. When water pressure in the pressure tank reaches the pump cut out pressure, the pressure switch turns off the well pump (typically 40 or 50psi)

Limitation

Frequent switching on and off of the pump due to pressure change in the tank can lead to the burning of the pump. The life cycle of the pump would be reduced and a puncture to the tank will reduce pressure. A pressure tank can also be very expensive.

### 2.2.3 Total Dissolved Solids (TDS)

Sensor which can be built using an older style telephone handset with all components (except the probe) included in the hand set. The circuit works by sensing the resistance in the probe which is inserted into the tank or reservoir e.g well. If the probe is open (not touching water), the circuit will produce an audio frequency around $4KH_Z$ (reference). When the probe touches quality water, the frequency doubles increasing the time by about one octave. If the water has dissolved solids in solution, the time will quickly go higher giving the person an approximate of the mineral content of water [10].

The major limitation in this work is that too many discrete components are used and the scarce nature of these components in the market place is another limiting factor.

### 2.2.4 Water level detector.

This design made use of numerous discrete component and is manually operated. The device has an alert system to signify when the water level in the tank is low. This design does not have any automated circuit to pump water directly into the over head tank. The pump is switched on manually.

All the previous design discussed above involves the use of numerous discrete components and are not cost effective.

## 2.3 Theoretical Background.

### 2.3.1 Microcontrollers

Like the microprocessor a microcontroller is a general purpose device, but one which is meant to fetch data, perform limited calculations on that data, and control its environment based on those calculations. The prime use of a microcontroller is to control the operation of a machine using a fixed program that is stored in the read only memory{ROM} and that does not change over the life time of the system.

The major differences between microprocessors and microcontrollers are that microprocessor is concerned with rapid movement of code and data from external addresses to the chip. The microcontroller is concerned with rapid movement of bus within the chip. The microcontroller can function as a computer with the addition of no external digital parts; the microprocessor must have additional parts to be operational [11].

**Pins configuration**

| | |
|---|---|
| Total pins | 40 |
| Address pins | 16 |
| Data pins | 8 |
| Interrupt pins | 2 |
| Input/output pins | 32 |

The pin out of the 89S51 packed in a 40 pin DIP is shown in the figure below with the full and abbreviated names of the signal of each pin.

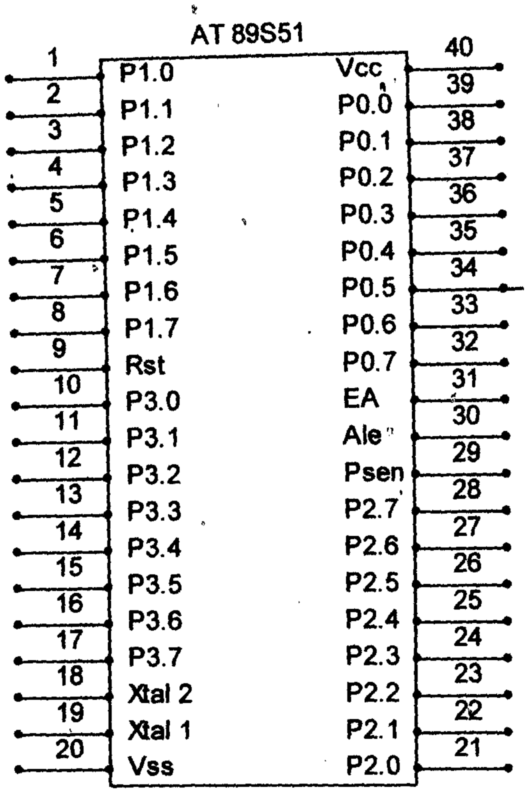



Fig 2.1 Diagram of an AT89S51 Microcontroller

**Output pins, ports and circuits**

One major feature of a microcontroller is the versatility built into the input/output {I/O} circuits that connects the 89S51 to the outside world. Different opcodes access the latch or pin states appropriately. Port operations are determined by the manner in which the 89S51 is connected to external circuitry. Programmable port pins have completely different alternate function. The configuration of the control circuitry between the output latch and the port pin determines the nature of any particular port pin function.

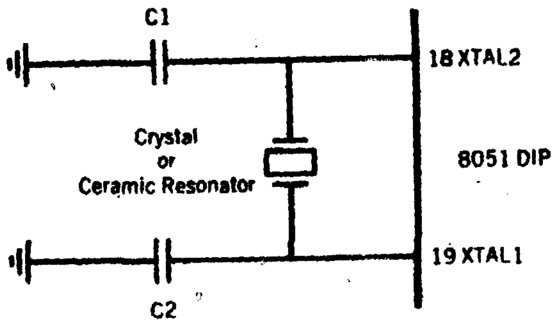
### 2.3.2 Crystal Oscillator.

A crystal oscillator is an electronic circuit that uses the mechanical resonance of a vibrating crystal of piezoelectric material to create an electric signal with a very precise frequency. The most common type piezoelectric resonator used is quartz crystal, so oscillator circuits designed around them are crystal oscillator.

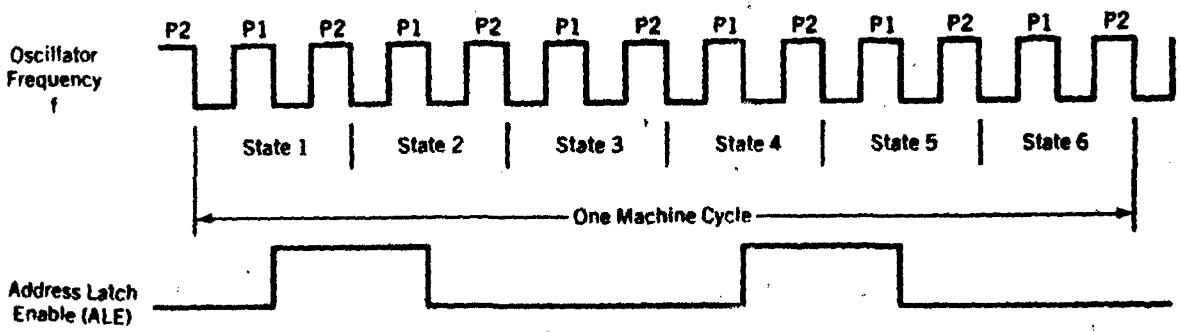
Piezoelectricity was discovered by Jacques and Pierre Curie in 1880.Paul Langevin first investigated quartz resonator for use in sonar during World War 1.The first crystal oscillator using a crystal of Rochelle salt was built in 1917 and patented [12].

### 2.3.3 8051 Oscillator and Clock

Pins XTAL1 and XTAL2 are provided for connecting a resonant network to form an oscillator. The crystal frequency of a quartz crystal of a quartz crystal is employed as shown in fig below. The crystal frequency is the basic internal clock frequency of the microcontroller [11].




Crystal or Ceramic Resonator Oscillator Circuit




8051 Timing

Fig 2.2 **Clocking Frequency of an 8051 Microcontroller**

. The clock frequency, f, establishes the smallest interval of time within the microcontroller called the pulse, P time. The smallest interval of time to accomplish any simple instruction or part of a complex instruction is the machine cycle. The machine cycle is itself made up of six states.

A state is the basic time interval for discrete operations of the microcontroller such as fetching an opcode byte, decoding an opcode, executing an opcode or writing a data byte. Two oscillator pulses define each state.[11]

### 2.3.4 The LM 324 quad comparator

A comparator is a device which compares 2 voltages or current and switches its output to indicate which is larger. An op amp combines both the null detector amplifier and the feedback signal source into one single unit [12].

The LM324 series consists of four independent high gain internally compensated operational amplifiers which were designed specifically to operate from a single power supply over a wide range of voltages. It is has unity gain and also have a large DC voltage of gain of 100dB.

### 2.3.5 LM 7805 voltage regulator

A device which maintains the output voltage of an ordinary power supply constant irrespective of load variations or changes in input ac is known as voltage regulator.

The LM7805 is a three terminal positive voltage regulator. It has an output current in excess of 0.5A.It has an internal thermal overload protection. It has a safe operating area protection which makes them virtually immune to damage from output overloads. It gives an output of 5V.

### 2.3.6 Transformer

A transformer is a static piece of apparatus by means of which electric power in one circuit is transformed into electric power of the same frequency in another circuit [12]. It can raise or lower the voltage in a circuit but with a corresponding decrease or increase in current.

The physical basis of transformer is mutual induction between two circuits linked by a common magnetic flux. In its simplest form, it consists of two inductive coils which are electrically separated but magnetically linked through a path of low reluctance. The two coils possess high mutual inductance. If one coil is connected to a source of alternating voltage, an alternating flux is set up in laminated core, most of which is linked with the other coil in which it produces mutually induced e.m.f (Faraday laws). If the second coil circuit is closed, a current flows in it and so electric energy is transferred (entirely magnetically) from the first coil to the second coil. The first coil in which electric energy is fed from the a.c supply mains is called primary winding and the other from which energy is drawn out, is called secondary windings. In summary, a transformer

1. Transfers electric power from one circuit to another.
2. It does so without a change of frequency
3. It accomplishes this by electromagnetic induction and
4. Where the two electric circuits are in mutual inductive influence of each other.

### 2.3.7 Seven segment display

A seven segment display is a form of electronic display device for displaying decimal numerals that is an alternative to the more complex dot matrix display. A seven segment display as its name implies is composed of seven elements. Individually ON or OFF they can be combined to produce simplified representations of the Arabic numeral. Often the seven segment display is arranged in an oblique or italic arrangement which aids readability.

The seven display may use liquid crystal display {LCD}, arrays of light emitting diodes {LED} and other light generating or controlling techniques such as cold gas discharge, vacuum fluorescent incandescent filaments and others.

In a simple LED package, each LED is typically connected with one terminal to its own pin on the outside of the package and the other LED terminals connected in common with all other LED in the device and brought to a shared pin. This shared pin will then make up all of the cathodes {negative terminal} or the entire anode {positive terminal} of the LED in the device and so will be either a common cathode or common anode device depending how it is and constructed.

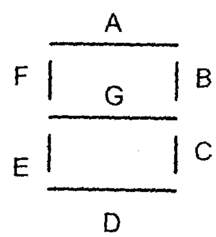



Fig 2.3 Diagram of a Seven Segment Display

# CHAPTER THREE

# DESIGN AND CONSTRUCTION

This project work comprises different unit which functions together to give the desired result. The block diagram and flow chart for the efficient realization of this project is shown below:

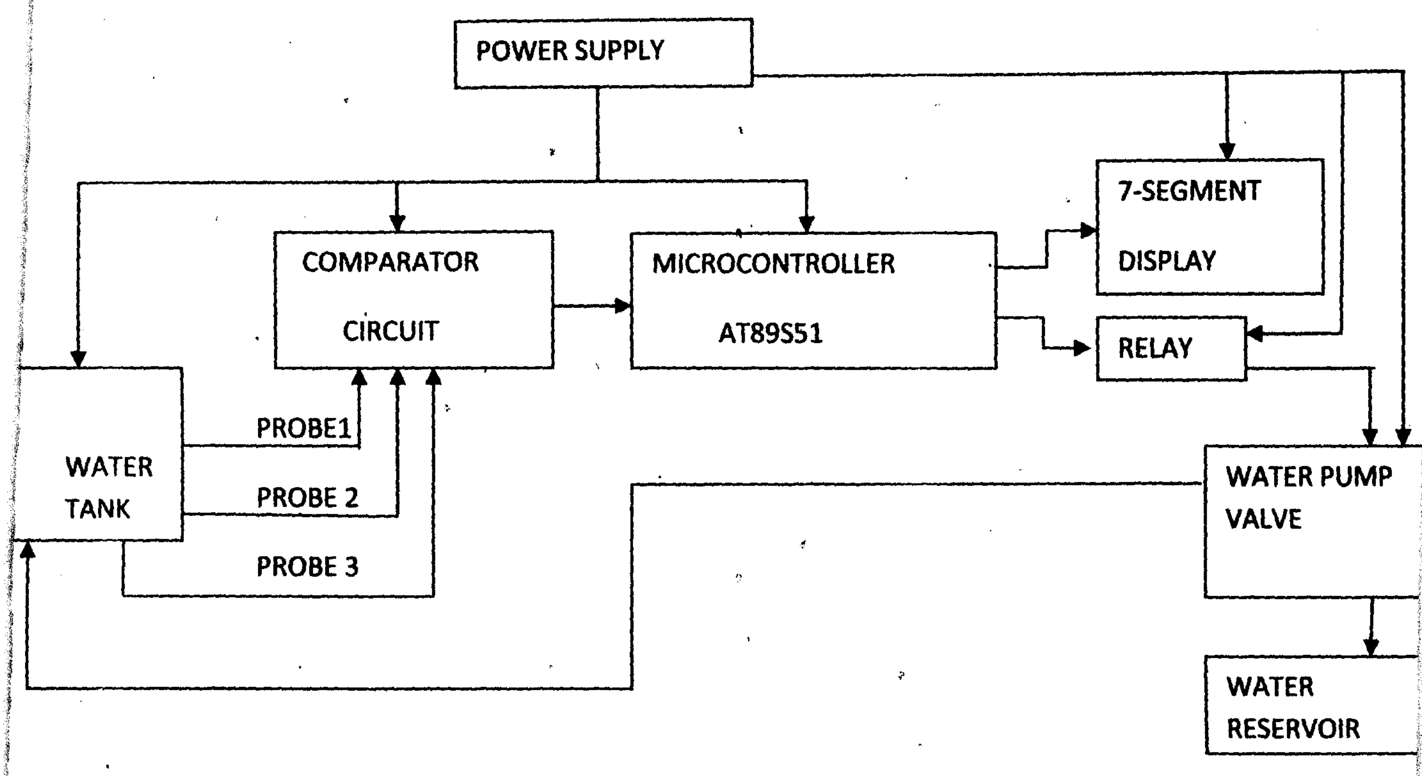



Fig3.1 Block Diagram of A Microcontroller Based Automated Water Pump Controller

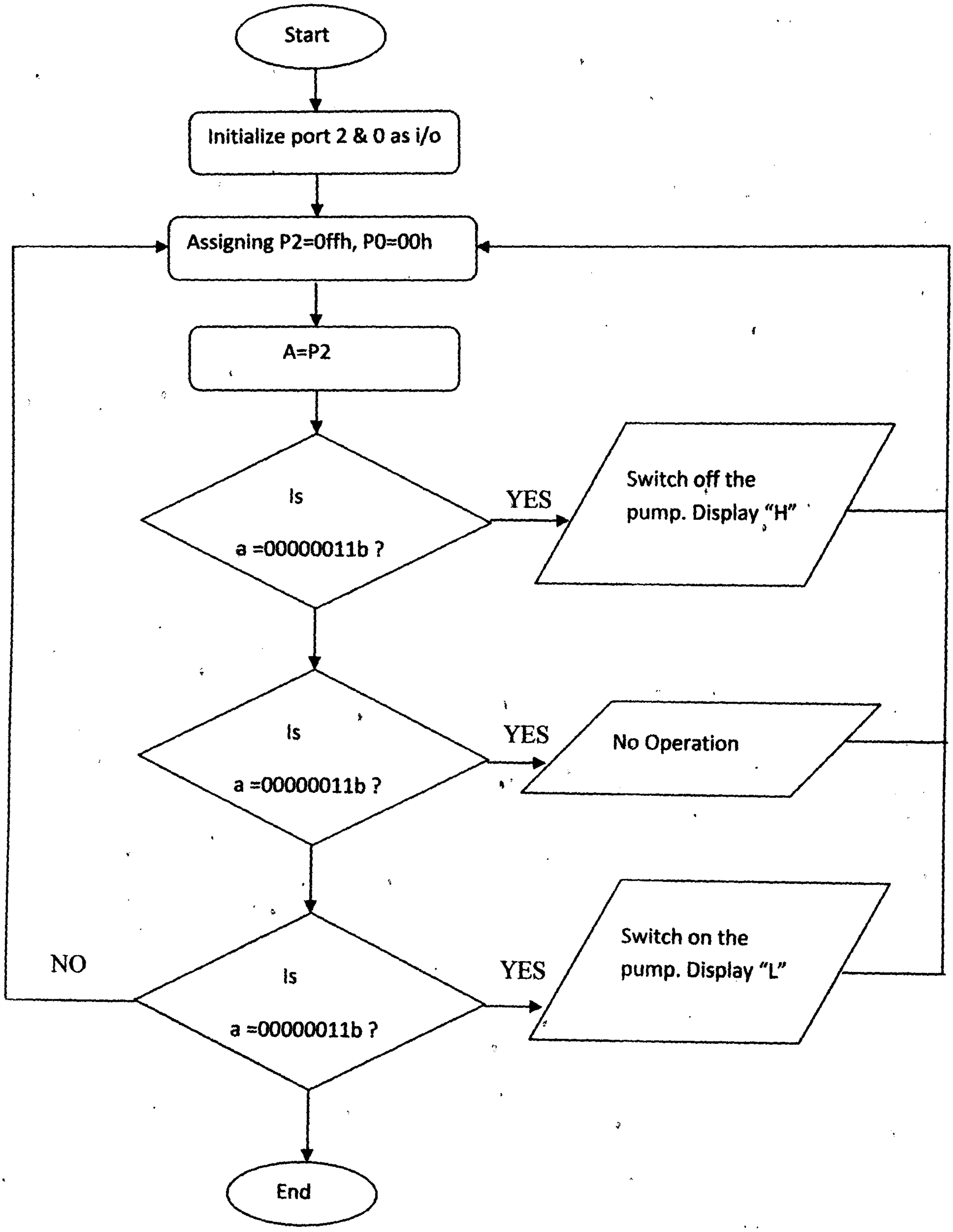



Fig 3.2 Program flow Chart

## 3.1 CIRCUIT ANALYSIS

For effective design and efficient analysis, the various units below are considered.

I. Power Supply Unit

II. Water detector and comparator unit

III. Microcontroller unit

IV. Display unit

V. Water Pump Unit

## 3.2 POWER SUPPLY UNIT

Power supply unit provides the required voltage and current for the electronic device. This could also be seen as the energy house of the circuit. The unit consists of:

I. Rectification unit

II. Filtering and Regulator unit

### 3.2.1 Rectification unit

Rectification is a process of converting an alternating current (AC), to direct current (DC), which flows only in one direction. A device known as a rectifier, which permits current to pass in only one direction, effectively blocking its flow in the other direction is inserted into the circuit for the purpose of rectification. A bridge rectifier makes use of four diodes in a bridge arrangement to achieve full wave rectification. The single component bridge rectifier where the diode bridge is wired internally is shown below:

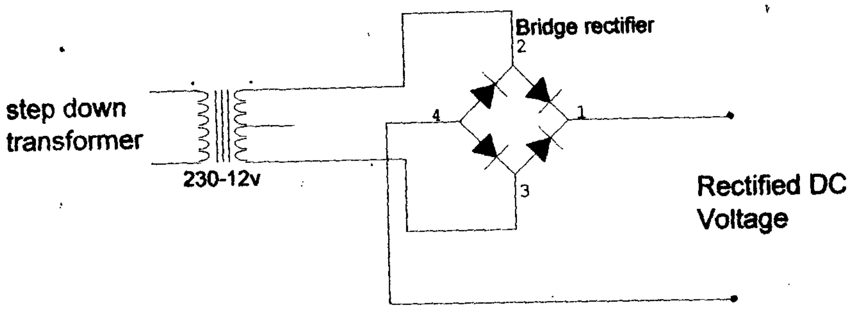



Fig 3.3 Rectified DC Voltage

After the rectification, all negative voltage are rectified into positive voltage as shown below

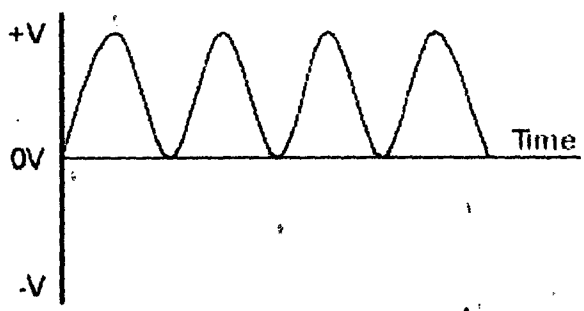



Fig 3.4 Rectified DC Voltage Wave Form.

### 3.2.2 Filtering unit

The rectified DC voltage is passed through a capacitor so as to filter the ripples. 1000uf capacitor was used to filter the ripples, after which the 12v rectified DC voltage was passed through a 7805 voltage regulator so as to obtain the desired 5v. The rating of the capacitor required in order to achieve desired result is calculated below:

From:

$$Q = I \times T = CV$$

$$C = \frac{I \times T}{V}$$

$$T = \frac{1}{F}$$

$$C = \frac{1}{V \times F}$$

Given that I (from the transformer) = 500mA

V = 12v

F = 50Hz

$$C = \frac{500}{12 \times 50 \times 10^{\wedge}3}$$

C = 0.000833F

C = 8333μF

The calculated value of the capacitor is the minimum value of the capacitance needed to eliminate ripples. The higher the capacitance of the capacitor, the better the filtering effect. The smoothing capacitor shown below requires just one single rated capacitor placed across the output from the rectifier with a voltage rating far above the rectified voltage so that any slight voltage drop would be compensated.

The circuit diagram of this unit is shown below:

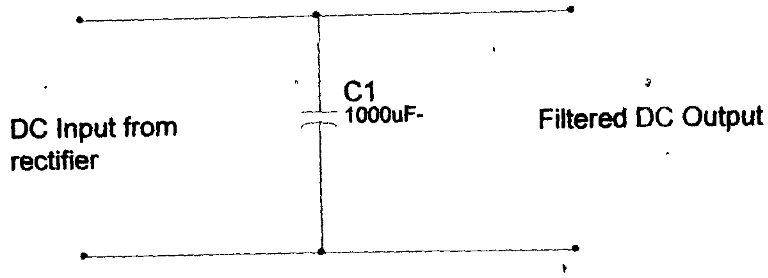



Fig 3.5 Filtered DC Voltage

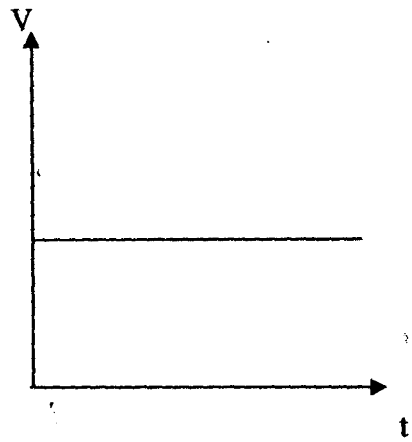



Fig 3.6 Graphical illustration of DC Voltage

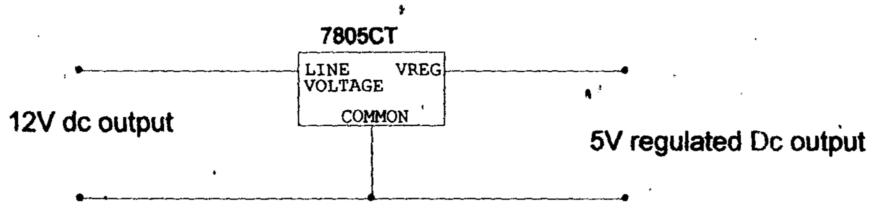



Fig 3.7 5v Regulated DC Voltage

A light emitting diode is used as an indicator to detect the presence or absence of power. The calculation involved in the introduction of the led as an indicator is shown below:

$$Vcc = 5V$$

$$Vled = 1.7V$$

$$I_{led} = 20mA$$

$$R = \frac{Vcc - Vled}{I}$$

$$= \frac{5V - 1.7V}{20 \times 10^{\wedge}(-3)}$$

$$R = 165\Omega$$

## 3.3 WATER SENSOR & COMPARATOR UNIT

This unit comprises of three metal probes and the LM324 comparator. The LM324 quad comparator has an internal circuitry comprising four comparators all in one single chip. For the purpose of this design, only 3 out of 4 comparators are used in the chip. The three metal probes serve as the non-inverting input into the quad LM324 comparator. These probes are used to sense the three (3) different water levels at low level (L), medium level and high level (H).

An input voltage of 5v is passed into the water tank. The essence of this is to make the water in the tank conductive with the probes in contact with the water. These probes are connected to a 4.7 ohms resistor each which is grounded, so that the voltage fed into the non inverting terminal of the comparator ( pin 3, 5 and 10) at any point in time when the probes are in contact with water is approximately 5V. All the inverting terminals (pin 2, 6 and 9) are all connected to a 100 kΩ variable resistor which is also grounded. The variable resistor is set to a value such that the input to the inverting terminal is 2.5V.This value is 50% of its resistance.

For there to be an output in the comparator, the voltage in the non-inverting terminal should be greater than the voltage in the inverting terminal. When probe A is in contact with water, it gives an output of approximately 5V which signifies logic state one (1), otherwise 0V which signifies logic state zero (0). Same principle applies for probe B and C.

When probes A,B,C are in contact with water, an output of logic state "111" is gotten displaying "H" on the seven segment display. When probes A and B are in contact with water, an output of logic state "011" is gotten signifying no operation. When only probe "A" is in contact with water, an output of logic state "001" is gotten displaying "L" on the 7-segment display, this activate the water pump to starts pumping water.

The circuit Diagram of this unit is shown below

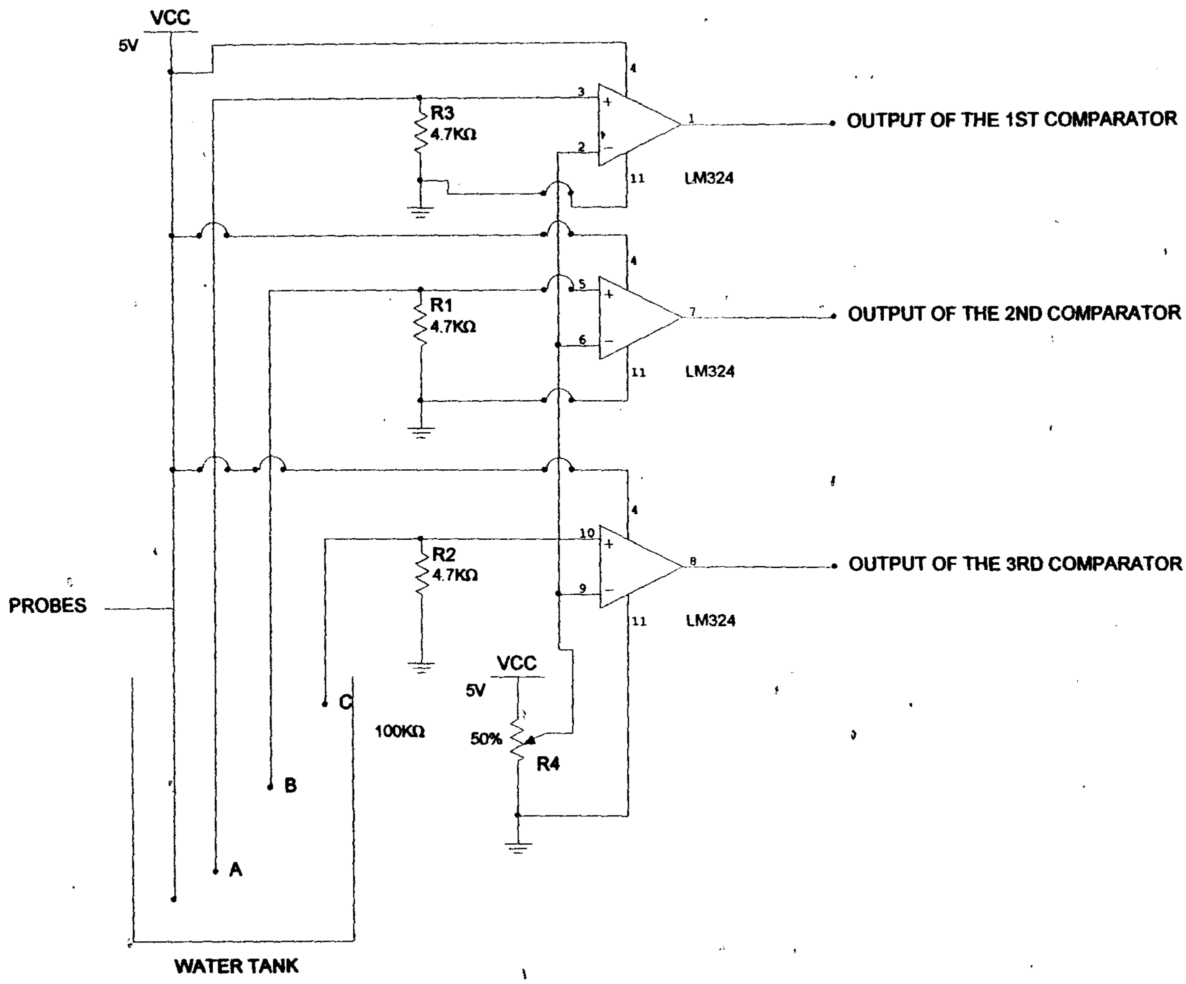



Fig 3.8 Water Sensor and Comparator Unit Circuit Diagram

## 3.4 MICROCONTROLLER UNIT

This unit is the most important unit in the design. It controls basically the circuit operation. It gets its digital input from the water sensor and the comparator unit, and performs its function based on the instructions written onto it. This unit sends a signal to the display unit when the tank is both full and almost empty. It also sends an output to the water pump unit only when probe "A" is in contact with water. The source code and algorithm of this unit is shown below:

### 3.4.1 Source Code for an Automated Water Pump Controller

```
Start:
CLR A
MOV p2, #11111111b
MOV p1, #00000000b
check:
MOV A, p2
check1:
CJNE A, #00000111b, check2
MOV p1, #00001001b
SJMP check
check2:
CJNE A, #00000011b, check3
NOP
SJMP check
check3:
CJNE A, #00000001b, check
MOV p1, #11000111b
SJMP check
End
```

### 3.4.2 Algorithm for Automated Pump Switch

I. comment, describing the function of the program

II. the beginning of the program

III. assigning ff to port 2 and declaring it as an input port

IV. assigning 00 to port 1 and declaring it as an output port

V. sub routine check

VI. move the content of port 2 to accumulator A

VII. sub routine check1

VIII. compare and jump to sub routine check2 if what is in accumulator A is not 00000111b

IX. but if it is equal to the content of accumulator A, display "H" and switch off the pump

X. short jump back to check

XI. sub routine check2

XII. compare and jump to sub routine check3 if what is in accumulator A is not 00000011b

XIII. but if it is equal to the content of accumulator A, no operation should be performed

XIV. short jump back to check

XV. sub routine check3

XVI. compare and jump to sub routine check if what is in accumulator A is not 00000001b

XVII. but if it is equal to the content of accumulator A, display "L" and switch on the pump

XVIII. short jump back to check

XIX. end the program

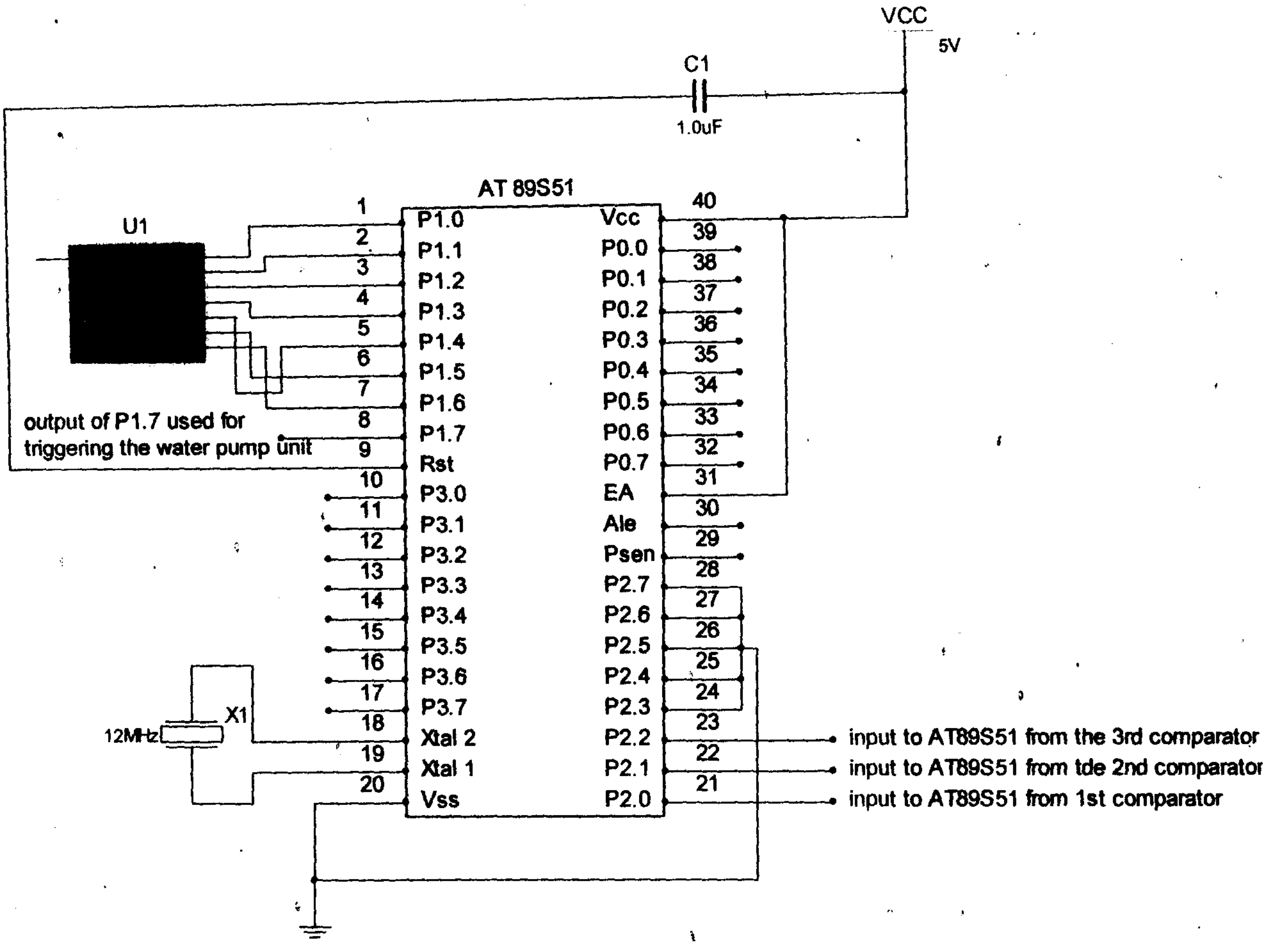
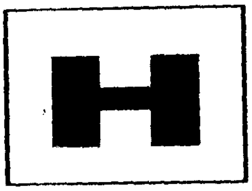
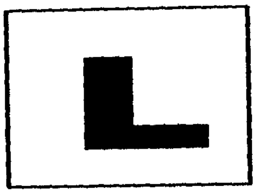


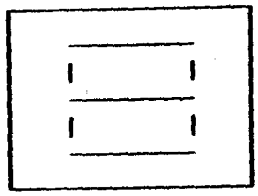

Fig 3.9 Circuit Diagram for Microcontroller Unit

## 3.5 Display Unit

This unit generates visual display of "H" whenever the tank is full (i.e whenever all the probes are touching water). A display of "L" is seen on the seven segment display whenever the water level in the tank is low (i.e only when the probe closest to the base of the tank touches water). The circuit inter-connection of this unit is shown below:







Display showing that tank is filled

Display showing that tank is almost empty

Display at neutral condition

Fig 3.10

### 3.6 Water Pump Unit

This unit is responsible for the pumping of water whenever the water level drops to the level of the probe closest to the base of the water tank. The unit consists of relay switch, water pump and its valve. This unit is activated whenever the output from the AT89S51 Micro-controller is 001. The base resistance calculation and the circuit diagram of this unit is shown below:

From $Vcc = IcRc + Vce$

At saturation, Vce = 0

Vcc = 5v & Rc = 110 ohms (Rc- Relay resistance)

$Ic = \frac{5}{110} = 0.045A$

From hfe (gain) $= \frac{Ic}{Ib}$

Using hfe = 150

$$Ib = \frac{Ic}{hfe} = \frac{0.045}{150} = 0.0003A$$

$$Vb = Ib \times Rb$$

$$Rb = \frac{Vb}{Ib}$$

$$Vb = 4.5v$$

$$Rb = \frac{4.5}{0.0045} = 15000\Omega = 15k\Omega$$

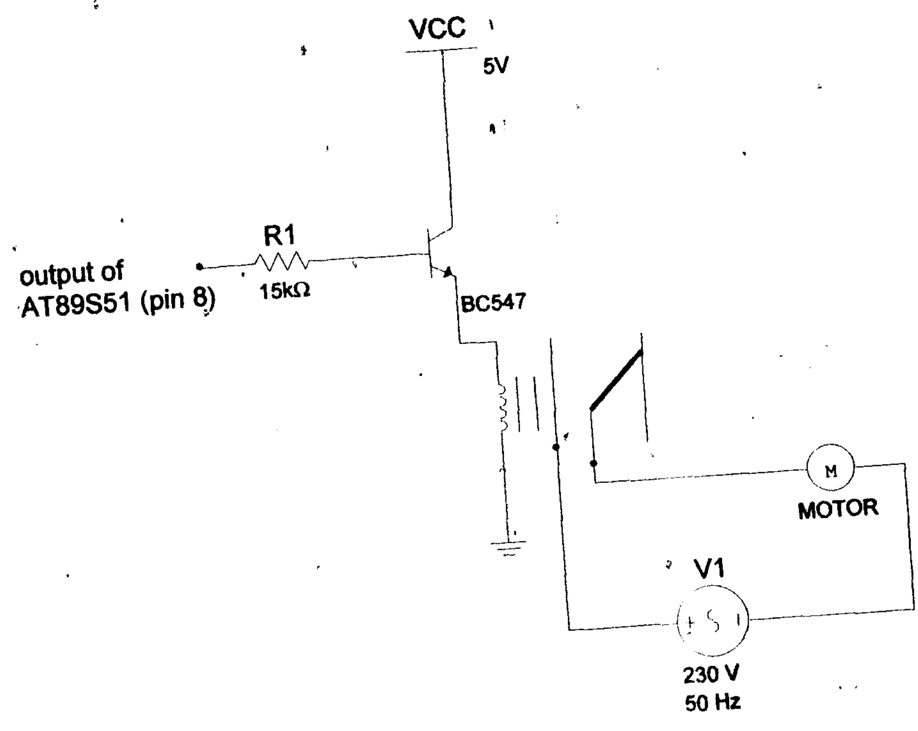



Fig 3.11 Circuit Diagram for Water Pump Unit

When the transistor is energized, the relay clicks and the water pump is activated, therefore water is being pumped to the over head tank.

The circuit diagram of the project is shown below:

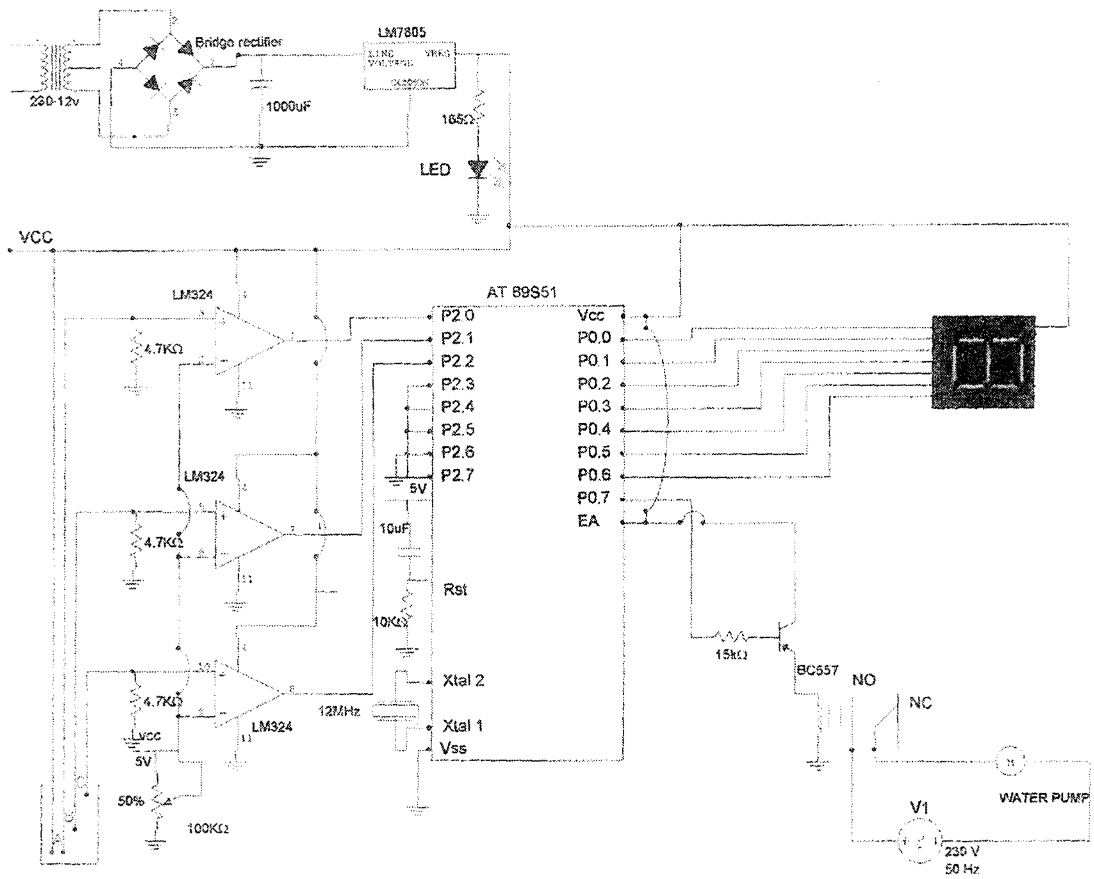



Fig 3.12 Circuit Diagram of a Microcontroller Based Automatic Water Level Controller.

# CHAPTER FOUR

# CONSTRUCTION, TESTING AND RESULT

## 4.1 CONSTRUCTION

The construction of this system was in units, each unit was first considered as a separate entity on the bread board before they were all transferred to a vero board. The power supply unit, Water detector and comparator unit, Microcontroller unit, Display unit and the Water Pump Units were all tested independently during the construction process. The construction achieved the desired result in terms of size, weight and packaging.

## 4.2 UNITS CONNECTION AND INTERCONNECTION

The system was connected to the 230v mains. The step down transformer in the power supply unit stepped the voltage down to 12v, rectification was carried out and the voltage was then regulated to give an output of 5v using the 7805 voltage regulator.

The 5v energized the water detector &comparator unit, microcontroller unit, display unit and the water pump unit. The output from the comparator units were fed into the input port of the microcontroller which has been programmed to give an output to the water pump unit and the Display unit. The entire units were interconnected together and the desired result was achieved.

## 4.3 TESTING

The Design was tested on bread board and the program code was simulated using Edsim (an application software) in order to make sure the program gave the desired result. The program code was then burnt into the AT89S51 Microcontroller chip using a programmer, after which the chip was inserted into the circuit on the bread board, the circuit was again tested, and the circuit behavior was in accordance with the anticipated result. The entire design was then transferred to the veroboard and the component that made up each of the units was sequentially tested as the system implementation progresses.

The entire system was powered, when the three probes (A,B,C) were in contact with water in the bucket which served as the water tank, it displayed 'H' on the seven segment display triggering off the water pump. This signifies that the water tank is full.

The water was gradually reduced until probe "C" was no more in contact with water, no operation was carried out by the microcontroller. The water was continuously reduced until only probe "A" was in contact with water, at this level the water pump was triggered on displaying "L" on the seven segment display. This signifies that water tank is almost empty, hence water should be pumped into the tank.

The output gotten from each of the comparator when probes were in contact and when not in contact with water were measured and recorded. The result obtained, diagram of the water tank and the calculations that were carried out for the successful realization of this project are shown below:

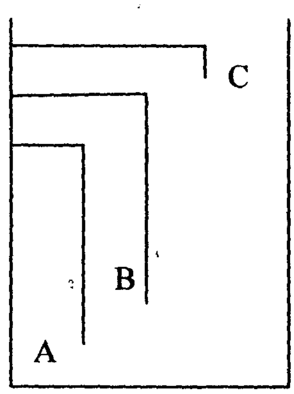



Fig4.12 Diagram of Water Tank

**Input To the Non Inverting Terminals of the Comparators**

Expected Result:

The expected voltage into the non inverting terminal of the comparator is 5V

Results Obtained:

The inputs into the non inverting terminals of the comparator when probes A, B and C are in contacts with water is measured with the aid of a multimeter to be 4.2V each

**Input To the Inverting Terminals of the Comparators**

Expected Results:

From fig 3.6;

The expected voltage into the inverting terminal of the comparator was calculated to be 2.5V as shown below;

Resistance of the Resistor to the input of the inverting terminal = 50kΩ

Total resistance value to the input of the inverting terminal = 100kΩ

From voltage divider theorem

Voltage to the inverting terminal

$$= \frac{50K\Omega}{100K\Omega} \times 5V$$

$$= 2.5V$$

Results Obtained:

The inputs into the inverting terminals of the comparator was measured with the aid of a multimeter to be 2.5V each

The outputs from the comparators were measured to be 3.5V each when the probes are in contact with water, and 0V when the probes are not in contact with water.

The circuit behavior of the design is shown in the table below:

Table 4.1 Truth Table of the comparator's output to microcontroller

| Probe C | Probe B | Probe A | Output from the microcontroller | Output from the display |
|---|---|---|---|---|
| 0 | 0 | 1 | 1 | L |
| 0 | 1 | 1 | 0 | - |
| 1 | 1 | 1 | 0 | H |

## 4.4 RESULTS

Output from the bridge rectifier = 11.8V

Output from the 7805 regulator = 4.97V

Output from each of the comparators when probes were not in contact with water = 0V

Output from each of the comparators when probes are in contact with water = 3.1V

Output was only gotten from the Water pump Unit when only probe "A" is in contact with water.

Port 1.0 to p1.6 was connected to the common anode display and port 1.7 was connected to the water pump unit via the use of a transistor (for the purpose of current amplification) and a relay (for the purpose of switching)

## 4.6 PRECAUTIONARY MEASURES

A number of precautions were observed in the design and construction of this system. The various action taken to protect against un-wanted circuit behaviors are listed below:

I. All components used for the design were tested before soldering them on the veroboard

II. Unwanted lead was melted and sucked away using lead sucker during soldering

III. Proper component placement was ensured on the board so as to get the desired result.

# CHAPTER FIVE

# CONCLUSION AND RECOMMENDATION

## 5.1 CONCLUSION

A microcontroller based automatic water pump controller has been successfully designed, constructed and implemented. Manual switching on and off of pump has being drastically reduced. Water Shortages in water tank has being eliminated and the result obtained was in accordance with the Expected result.

## 5.2 RECOMMENDATION

Future design should incorporate a unit to detect the presence or absence of water in the underground Reservoir such that when there is no water in the reservoir, the pump should not pump water even when the tank is empty. This will increase the lifespan of the water pump unit

# REFERENCES

[1] D.Hill Donald R., The Book of Knowledge of Ingenious Mechanic Devices, D.Reidel Dordrecht Boston 1974, 255pp.

[2] D.Hill, Donald R, The Book of Ingenious Devices (Kital-Al-Hiyal) D.Reidel Dordrecht Boston 1979.107pp

[3] Atil Bir, the Book "Kital-Al-Hiyal interpreted in sense of Modern System Control and Control Engineering" IRCICA, Istanbul 1990.450pp

[4] Doracto P, A Historical Review of Robust Control IEEE Control System Magazine April 1987 pp44-47.

[5] Bokharale, M, A Summary of the History of Control Theory Internal Representation School of Electrical Engineering Ga Institute of Technology Atlanta, Ga 30332 1973.

[6] Fuller, A.T the early Development of Control Theory II volume 98G September 1976 pp 224-235.

[7] http://www.theorem.net/theorem/lewsil.html access date 20th march 2009.

[8] http://www.tankguaging.com/tech-servo access date 20th march 2009.

[9] DORF RC and Bishop R.H, Modern Control System 8th edition Addisin Wesley Longman Inc Eng 1998 pp71

[10] http://www.inspect-ny.com access date 2nd June 2009.

[11] Keneth Ayala, The 8051 Microcontroller Architecture, Programming and Applications. Western Carolina University, West Publishing Company New York, 255pp.

[12] B.L Theraja and A.K Theraja, A Textbook of Electrical Technology, 2750pp.