DESIGN AND CONSTRUCTION OF A MICROCONTROLLER BASED AUTOMATIC WATER LEVEL CONTROLLER WITH PUMP CONTROL.

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DEDICATION

I dedicate this project to my beloved

Parents,

Uncles and

My Siblings.

DECLARATION

I, OYANIYI RICHARD BABATUNDE declare that this work was carried out by me under the supervision of Mallam Suleiman Zubair and has never been presented elsewhere for the award of a bachelor degree. I also hereby relinquish the copyright to the Federal University of Technology, Minna.

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ABSTRACT

This project is designed to control the level of water in a storage tank via a four (4) robes connected to the microcontroller. Once the level of water in the overhead tank is at level , the controller detects it and sends electrical signal to the probe in the underground (reservoir) nd automatically trigger on the pumping machine to pump water into the overhead tank until e water level reaches the highest level-level 3 and then triggers off the machine automatically. here is also a visual display that shows the level of water at each stage on the controller device anel for the storage tank.

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CHAPTER ONE

1.1 INTRODUCTION

Engineering is concerned with the understanding and controlling the materials and forces of nature for the benefits of humankind. So, control system is an interconnection of components forming a system configuration that will provide a desired system response. [1]

Control systems are used to achieve: Increase productivity and improved performance of a device. [2] Automation is the automatic operation or control of a process, devices, or system. Automation is used to improve productivity and obtain high-quality products. We utilize automatic control of machines and processes to produce a product within specified tolerances and to achieve high precision. And through all these come about automatic water level controller. [1]

The automatic water level control system is a system that is specifically made for constant supply of water for domestic, commercial and industrial uses. In society like ours, where there is unavailability and irrational supply of water in some communities, there is need for alternative source of water supply. In order to achieve this, there is need for a pumping machine to pump water into storage tanks and a means of controlling the operation for adequate supply of water. [3]

In its modern usage, automatic can be defined as a technology that uses programmable commands to operate a given process, combined with feedback of information to determine that the commands have been properly executed. [1]

The automatic water level control system protects the electric motor from burning and it also provide interrupted water apply with indication of water level in the storage tank. This is achieved by placing sensors or probes, consisting of four (4) electrodes of non-metallic conduit pipe (generally used for domestic wiring) into the tank and positioning the three (3) electrodes at the descriptive level for the tanks i.e. underground (Borehole) and overhead storage tank.

The electric signal sent by the microcontroller to pumping machine can be used in different ways depending on the purpose of its usage either for domestic, hospitals or industrial uses. In case of domestic purpose, the signal is used to drive electromechanical relay connected to a single phase (φ) electric motor (i.e. pumping machine) and in the case of individual use, it is used to energize or de-energize magnetic contactor used in operating three (3) phase (φ) inductor motor.

1.1 SIGNIFICANCE

The concept presents a design technique for the implementation of the liquid level control system which based on the use of a single-chip microcontroller with a well-known fact that the digital control system can offer high accuracy and high speed response. This is by increase supply of water and reduces the stress or labour involves in switching the pumping machine ON and OFF manually through digitalization. It also protects the coils of the motor from burning due to the faulty current resulting from fluctuation in voltages and persisting switching thereby increasing the utility of the pumping machine.

1.2 THE AIMS AND THE OBJECTIVES

Aims:

The main aim of the project is to program a microcontroller chip that will control and maintain water level in storage tank with level indicator/display automatically using a simple techniques with very low cost implication.

Objectives:

- To control power supply to the pumping machine
- To detect the level of water in the tank to avoid seepage of roofs and walls due to overflowing tanks
- To save water and energy.

1.3 METHODOLOGY

This project is achieved by connecting four (4) probes to the control unit (controller) via four (4) resistors .Once the level of water in the overhead tank is at level 1, the controller detects it and send signals to the probe in the underground (reservoir) and it trigger on the pumping machine to pump water until the water reaches level 3 and then trigger off the motor.

1.4 REPORT ORGANISATION

Chapter one covers general introduction; the significance of the project; aims and objectives; methodology, chapter two discusses the background history; reviews some automatic water level control already implemented; theoretical background, chapter three; design and construction of the project, chapter four presents results testing and encasing of the project, and chapter five enumerates the problem encountered, conclusion and recommendation of the project

CHAPTER TWO

BACKGROUND HISTORY

Water is an essential commodity to livelihood and its importance to man can never be over-emphasized. So, water resources are sources of water that are useful or potentially useful to humans. Uses of water include agricultural industrial, household, recreation and environmental activities. Virtually all of these human uses require fresh water. The world's supply of clean water fresh water is steadily decreasing every day, water demand already exceeds supply in many parts of the World and as the world population continue to rise, so too does the water demand. Awareness of the global importance of pressing water for ecosystem services has only recently emerged during 20^{th} century, more than half of the world's wetlands have been lost along with their valuable environmental services as a result of inadequate proper water control channelization. [4]

In order to obtain the level of a liquid, various methods have been employed in the time past starting from ancient "eye level" measurement where liquid is placed in a transparent container and the eye is placed at the line of best horizontally and at that point the measurement is taking as the level of liquid.

These however are prone to a lot of error mostly arising from the observer. The need for a reliable method of detecting the level and controlling the original flow therefore arises.

The earliest record of water measurement (detection) was the use of the float regulator machine in Greece in the period of 300-1 BC using feedback control. The water clock invented by Ktesibios used a float regulator to measure the level of water in the container on which a scale attached is used to take reading of time. [5]

Russian Pulzunov I in 1765 invented the water level float regulator using feedback system, the float detect the water level and controls the valve that covers the water inlet in the boiler [6].

The past 100years have witnessed the emergence of various method water level measurements (detection) as a result of the improvement in technology witnessed within the period. The ordinary dipstick is a simple device use for measuring liquid level.

2.1 REVIEW OF SOME AUTOMATIC WATER LEVEL CONTROLLER

In recent years, there were different manufacturers who worked on several automatic water level controllers among which are:

1) Mobrey Technology whose work was based on vertical float level switch. A switching is achieved by 3-magnet system giving snap action latch on switching. This 3-magnet system enables the float magnet to pass on, and actuates switch mechanism at other level which gives the alarm shutdown duties and switch a mechanism already actuates cannot return until the return of the primary magnet magnetized the system once again [7].
2) Another manufacturer was Liamocon whose work was on automatic water level controller cum indicator. His work was summarized to work on certain voltage for the motor. The motor trips off if voltage is <250 or >160 AC (since they require input voltage is 230v ac 50Hz).Though, the motor can be operated both automatically and manually. Liamocon switches on the motor if:

The water in the overhead tank fall to prefixed value i.e. 75%, 50% and 25% [8].

3) JBJ (JOHNSON TECHNOLOGY) water level controller operates on automatic top off system (A.T.O) such that 2-float sensors sense the water level and lift water to refill as soon as the water level drops. The A.T.O automatically stops power supply to your pump in your reservoir in the event that there is no water [9].

2.2 THEORETICAL BACKGROUND.

Electrical materials could be divided into conductors, semiconductors and insulators. The parameter used to determine this classification is the resistivity (ρ) of such materials. Good conductors are usually metals and have resistivities in the order of 10^{-7} to 10^{-8} Ωm, semiconductors have resistivities in the order of 10^{-3} to 3×10^{3} Ωm, and the resistivities of insulators are in the order of 10^{4} to 10^{14} Ωm [10]. The resistance of an electrical conductor depends on four factors, these being: (a) the length of the conductor,

(b) the cross-sectional area of the conductor, (c) the type of material and (d) the temperature of the material. Resistance, R, is directly proportional to length, l, of a conductor and inversely proportional to cross-sectional area, A, of a conductor, i.e.

$R = \rho l/A$ 2.3

R is measured in Ω, l in m while A in m^2. Resistance is the opposition to the flow of electrons or simply the opposition to electric current [11]. It is required in electronic circuits to limit the current flow, limit the voltage drop and divide the voltage. In combination with capacitor, it is used as filter or it can be used to achieve time constant and so on. The pictures below reveal the different types of resistors used and the circuit representations.

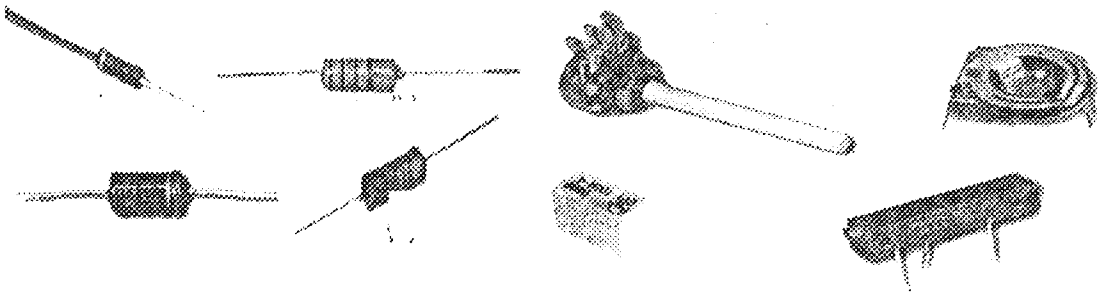


Plate 2.1. Various types of resistors

2.2.1. Capacitors: Two conductors that are not connected and are separated by an insulator constitute a capacitor. When a source of EMF such as a cell is connected to such an arrangement, current flows momentarily, transferring charge (in the form of electrons) from one conducting plate to the other. When a quantity of charge Q (measured in units of coulombs) has been transferred, the voltage across the plates equals the voltage V across the voltage source. For a fixed arrangement of conductors and insulator, the ratio Q/V is a constant called the capacitance, C.

$Q = CV$……………………………………………………………………………………2.3

Also the quantity of charge stored is related to the period (t) of charge storage and current (I) that flow through it as indicated below

$Q = It$……………………………………………………………………………………2.4

The picture below shows us the various common capacitors one can find around and the circuit symbol.

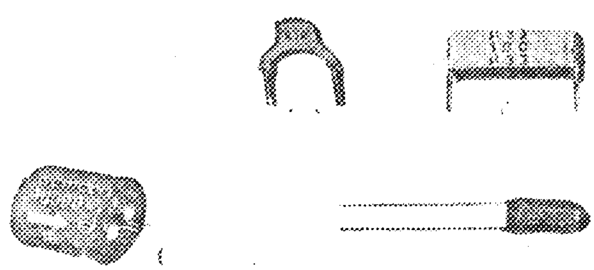


Plate 2.2. Various kind of capacitors.

2.2.2. Relays: A relay is an electromagnetic switch. A small current flowing through a coil in the relay creates a magnetic field that pulls one switch contact against or away from another [12].

2.2.3. Crystals: Quartz crystals, cut into thin plates and with electrodes plated onto opposite flat faces, can be used as resonant circuits with Q values ranging from 20 000 to 1 000 000 or more. They are all piezoelectric and can therefore be used as transducers (sender or receiver) for ultrasonic waves [13]. The equivalent circuit of a crystal is shown below.

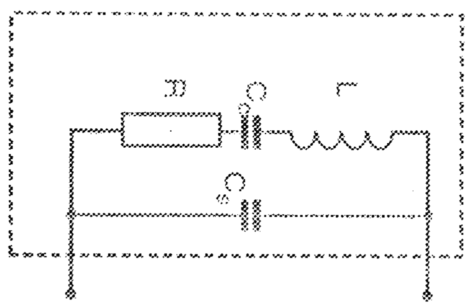


Fig. 2.1. Equivalent circuit for a quartz crystal.

The L and C values in this equivalent circuit are referred to as *motional inductance* and *motional capacitance*, and values will be specified by the manufacturer. These values, with a very high ratio of L to C, could not be provided by any assembly of separate components, and it is that which provides the very high Q-factor for a crystal. The crystal by itself acts as a series resonant circuit with a very large inductance, small capacitance and fairly low resistance (a few thousand ohms). The stray capacitance across the crystal will also permit parallel resonance to occur at a frequency that is slightly higher than that of the series resonance.

2.2.4. Semiconductor diodes: Semiconductors as we have seen fall into a class of electrical materials whose conductivities lie between that of conductors and insulators. Two charge carriers are used for conduction: the negative charge carriers (electrons) and the positive charge carriers (holes). It is these materials that are used to produce active devices such as diodes, transistors and integrated circuits etc. Silicon (Si) and Germanium (Ge) are common examples of semiconductors. There are two classes of semiconductors: intrinsic semiconductors and extrinsic semiconductors. Intrinsic semiconductors are semiconductors in their pure form. At room temperature, the number of free electrons and holes are insufficient for practical applications. For such conductors to be useful for practical applications, heat or light must be applied to provide excitation energy to the electrons to liberate them for conduction. Extrinsic semiconductors are semiconductors which are produced by adding impurities to the intrinsic semiconductors (*also known as doping*). Two types of extrinsic semiconductors exist: *N*-type semiconductors and the *P*-type semiconductors. The N-type semiconductors are produced by doping the pure Si or Ge with pentavalent impurity e.g. phosphorus, Arsenic, or antimony while the P-type semiconductors are produced by doping Si or Ge with trivalent impurity e.g. Boron, Aluminum, Gallium or Indium. By doping the pure semiconductor with a pentavalent impurity, we have a semiconductor with excess electrons and by doping the pure semiconductor with trivalent impurity, we have excess holes.

A P-N junction is formed by combining a P-type material with an N-type material together. It has the ability to conduct in one direction only. In the reverse direction, it offers a very high resistance. This P-N junction, with two terminals, one connected to the N-type material and the other to the P-type material is known as the *diode*. The diagram below shows the circuit symbol of a diode. There are different types of diodes: zener diodes, light emitting diodes (LED), tunnel diodes, e.t.c.

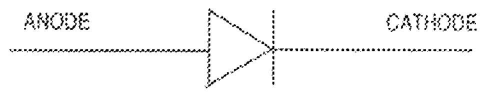


Fig 2.2. Circuit symbol of a diode.

2.2.5. Transistors: A transistor consists of two P-N junctions formed by sandwiching either P-type or N-type semiconductor between a pair of opposite types. When a third doped element is added to a crystal diode in such a way that two P-N junctions are formed, the resulting device is known as a transistor [14]. They are capable of amplifying weak signals. Transistors fall into two main classes – *bipolar junction transistors (BJT)* and *field effect transistors (FET)* [15]. A BJT consists of two back to back *PN* junctions manufactured in a single piece of semiconductor material [14]. These junctions give rise to three regions called *emitter*, *base* and *collector*. The emitter is heavily doped since it is to supply majority charge carriers to the base which is lightly doped and at the middle section of the transistor. The collector is physically larger than the emitter because it has to dissipate more power. The transistor is operated by forward biasing the emitter – base junction and reverse biasing the collector – base junction. The diagrams below show the representations of a transistor.

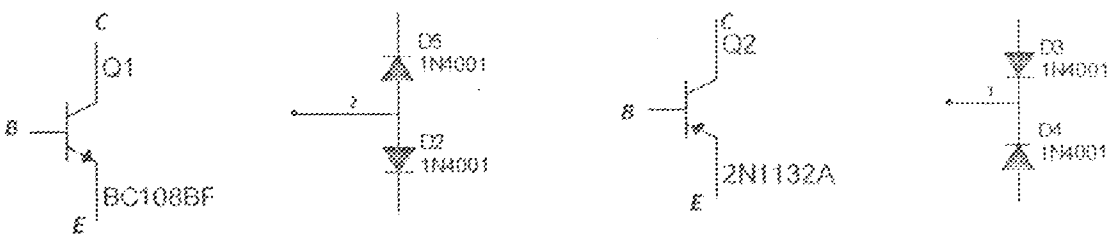


Fig 2.3. (a) *NPN* transistor (b) Equivalent pair of diodes (c) *PNP* transistor and (d) It's equivalent pair of diodes.

2.2.6. Microcontrollers: They are also known as *dedicated* or *embedded controllers*. These devices are used to control *smart machines* such as microwave ovens, clothes washers, sewing machines, auto ignition systems and metal lathes. Some currently available devices in this category- the Intel 8051 and Motorola MC6801, for example- contain programmable counters and a serial port (UART) as well as a CPU, RAM, ROM and parallel I/O ports. The diagram below reveals the architecture of the common 8051 microcontroller.

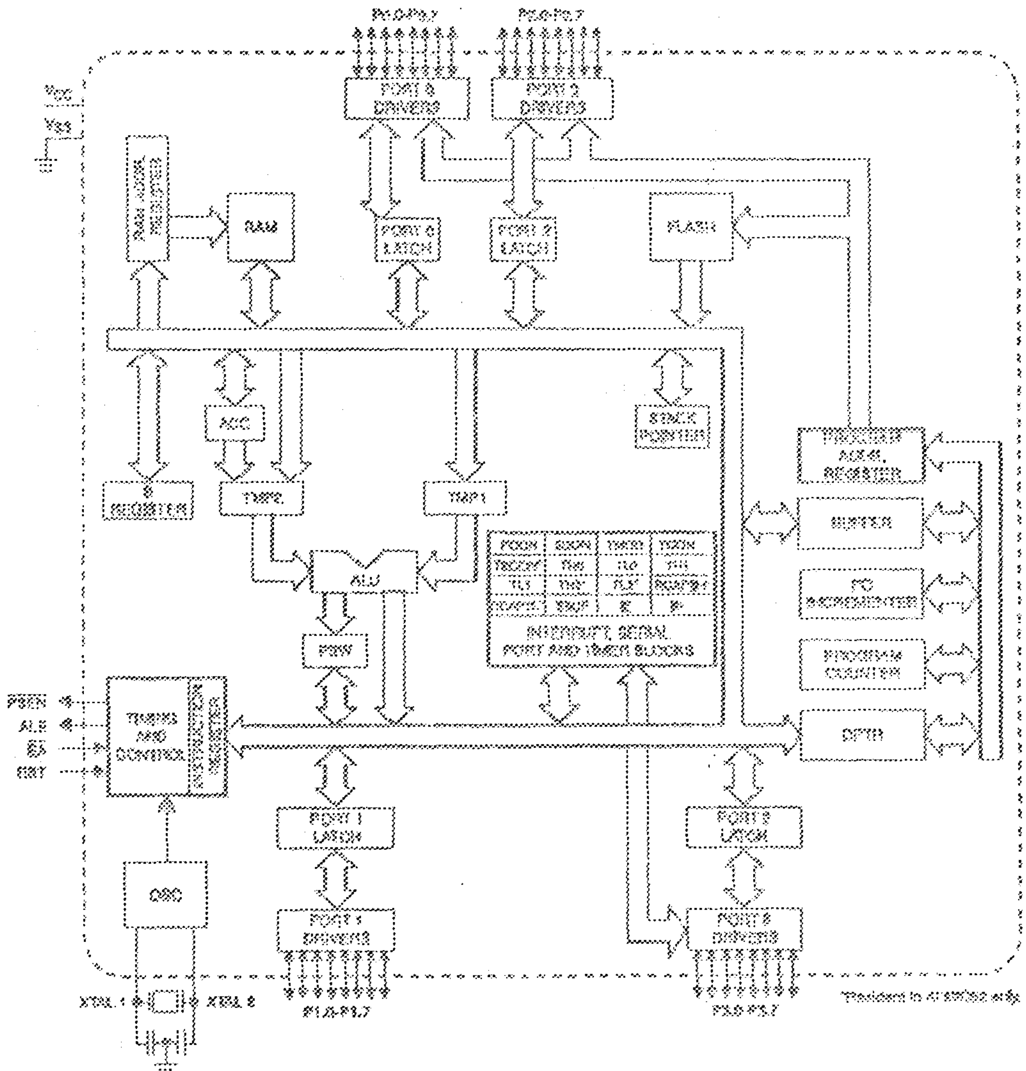


Fig 2.4. Intel 8051 standard

The 8051 chip has three general types of memory and they are *on chip memory, external code memory and external RAM* [16]. The on chip memory refers to any memory that physically exists on the microcontroller itself. It is made up of the code memory, internal RAM (IRAM), register banks and special function registers (SFRs). External code memory is code memory that resides off chip. This is usually in the form of external EEPROM. External RAM is RAM memory that resides off chip. It is usually in the form of standard static RAM or flash RAM. The diagram below shows the pin out diagram of the chip.

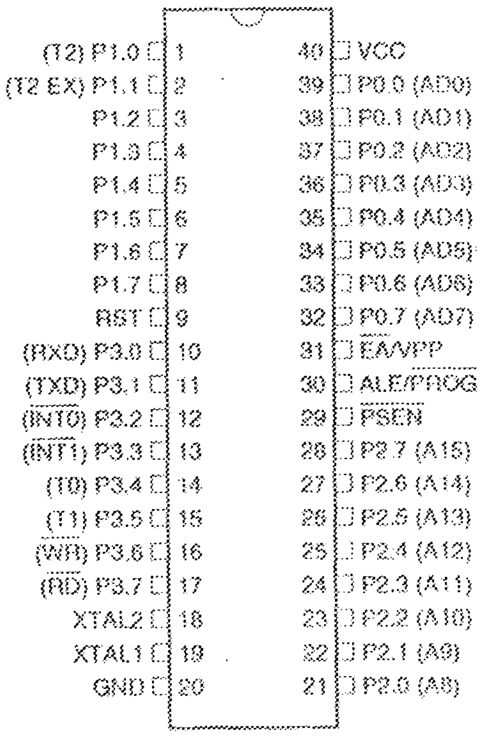


Fig 2.5. Pin out Diag ram for 8051 chip.

CHAPTER THREE

CIRCUIT DESIGN AND ANALYSIS

This project is modularized into six modules namely: .

1. Power supply unit
2. Control unit
3. Sensor unit
4. Indicator/Display unit
5. Pump trigger unit
6. Motor
7. Coupling of the units

A simple block diagram to realized the project is given below

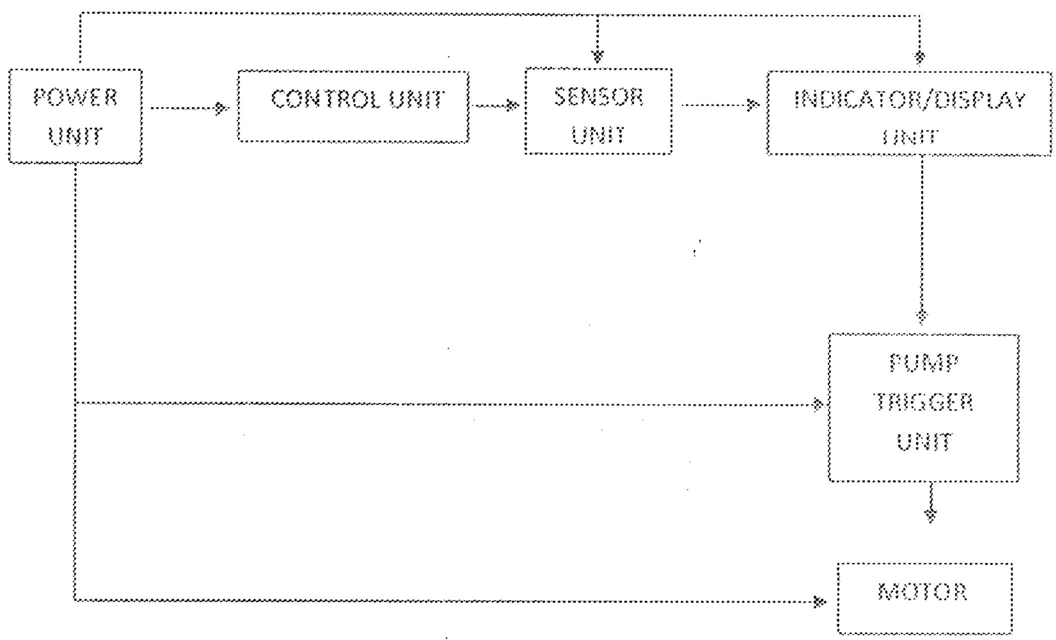


Fig.3.1 A Simplified Block Diagram Microcontroller-Based Automatic Water Level Controller

3.1 Power Supply Unit:

The power supply unit is divided into two sections; the first section is the supply to the control panel, while the second is the main power supply to the whole operating system.

i. The first section which is the supply to the control panel is the main purpose of this power supply unit which is to convert main supply (230v ac at 50Hz) to a lower direct current (dc) voltage that is suitable for the control of the system.

Basically, it involves four steps viz:

1. Transforming alternating current (ac) voltage to a lower voltage
2. Rectifying
3. Smoothening/filtering
4. Regulating

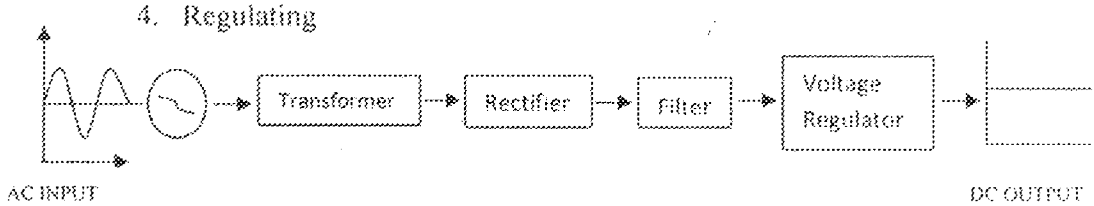


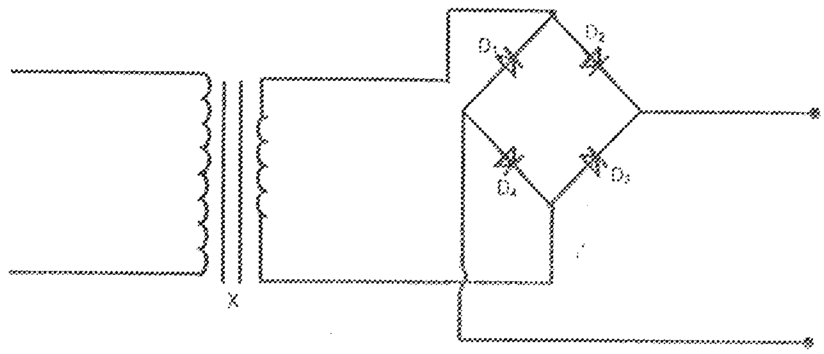
Fig. 3.2 Block diagram of power supply stages

3.1.1 Transformer:

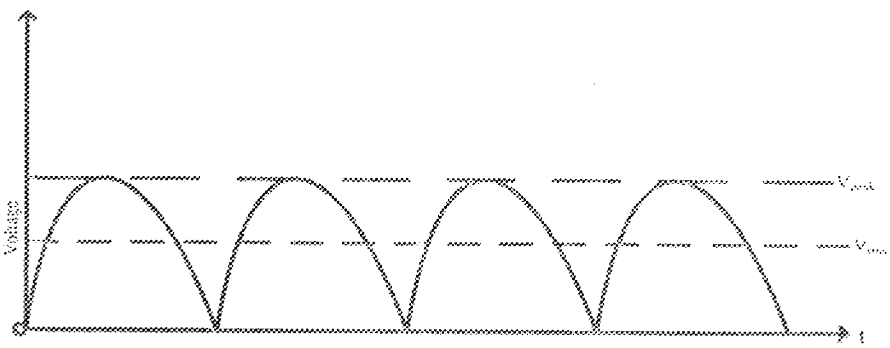
The transformer step down the main supply (240v) to a lower voltage (9v).The current rating of the transformer to supply is 300mA.The connection of the transformer is shown in fig. 3.2[10]

3.1.2 Rectification:

Rectification is the process whereby one or more diodes is used to convert ac voltage into pulsating dc voltage. The diodes are able to perform such function because of its unique characteristics of being a unidirectional conductor. The rectification process is full-wave bridge rectifier which is shown in fig 3.3[17]



(a)



(b)

Fig. 3.3 (a) Full-wave bridge Rectifier Circuit of a step-down Transformer (b) Output signal of rectification

The voltage of the transformer's secondary side is express as root mean square(r,m,s) value, which is the voltage rather than the peak value.

$V_{peak} = \sqrt{2}\, V_{rms} - 2V_D$ ……………………………………………………………3.1

Where,

$V_{rms} = 9v$, V_D is the diode voltage drop (0.7v for silicon and 0.3v for germanium diode)

$V_{peak} = V_{DC} = \sqrt{2} \times 9 - 2(0.7)$

$= 12.73 - 1.4$

$V_{DC} = 11.33v.$

3.1.3 Filtering:

The output voltage from rectification contains a lot of ripple voltage (pulsations).This voltage cannot be fed into the control circuit; it will make the chip to malfunction. In order to filter the ripple voltage, there is need to connect the capacitor across the dc voltage output. The capacitor offers very high impedance for the dc component to flow and also offer a lower resistance for the ac component to pass through it to ground. The waveform after capacitor has been connected in the circuit is shown in fig 3.4[17]

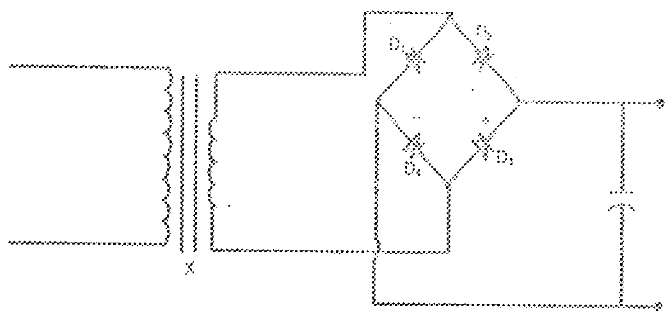


Fig. 3.4 D.C output with smoothening capacitor

The filtering capacitor is calculated below:

dQ = CdV 3.2

dQ = Idt 3.3

CdV = Idt 3.4

Period, T = 1/f

For a complete cycle,

$$T = \frac{1}{2f}$$

$$T = \frac{1}{2 \times 50} = \frac{1}{100} = 0.01s$$

$V_{DC} = V_{peak} = 9 \times \sqrt{2}$

$= 12.73v$

If the ripple is 25%, then 20%Vp of the input value:

$$\frac{20}{100} \times 12.73 = 2.546v$$

I_{load} = Transformer current rating =300mA

$$C = \frac{Idt}{dV}$$

$$= \frac{300 \times 10^{-3} \times 0.01}{2.546}$$

$= 1.178 \times 10^{-3}$

$C = 1178 \times 10^{-6}F$

However, the preferred value used is $1000\mu F$

3.1.4 Regulator:

After the ripple voltages have been reduced, there is still variation in the output voltage due to fluctuation in ac supply. Voltage regulator integrated circuit (IC) L7805 was connected in the circuit to give a constant +5v dc needed to power the microcontroller.

The pin description of L7805 is shown in fig. 3.5 [17]

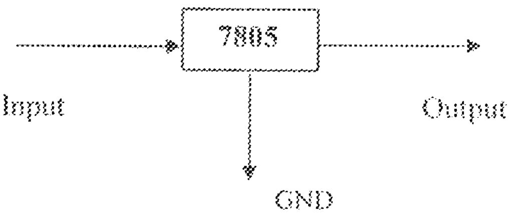


Fig. 3.5 Block diagram of 7805 voltage regulator

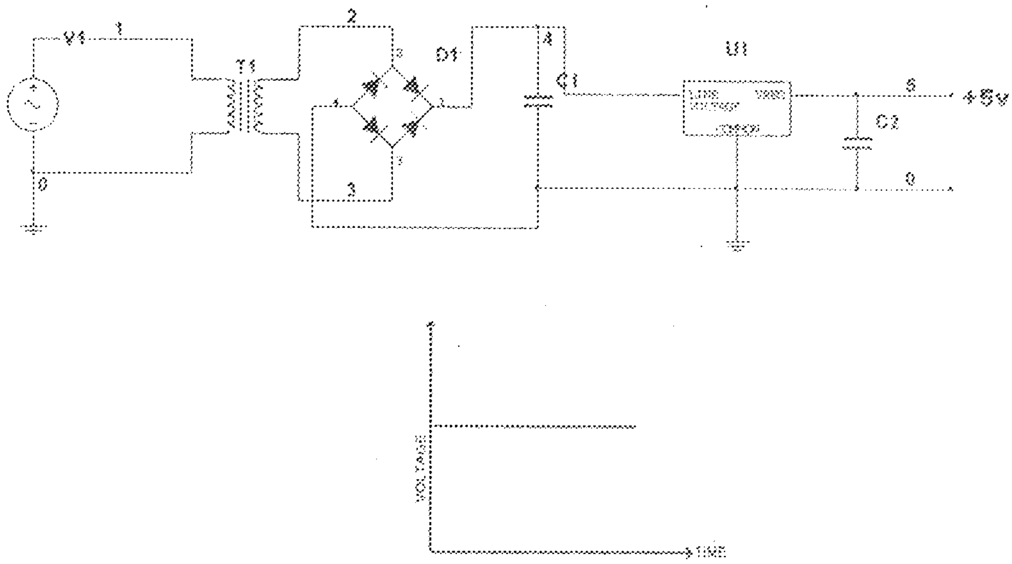


Fig. 3.6 (a) Smoothening capacitor effect from output voltage (b) output dc signal

ii. The main power supply to the whole operating system is the section that protects the control panel and the motor. It protects the control panel and motor against low and high voltage. When the voltage is low, the motor tends to force itself to operate normal by drawing high current from supply. This high current flows through the coils, which leads to development of heat. The heat developed increases and it eventually burns the insulation of the coil leading to short circuit.

which eventually destroy the pumping machine or motor and also if the current is high burn the microcontroller.

In light of this, a protective device (fuse) is connected on or before the transformer whose value depends on the load.

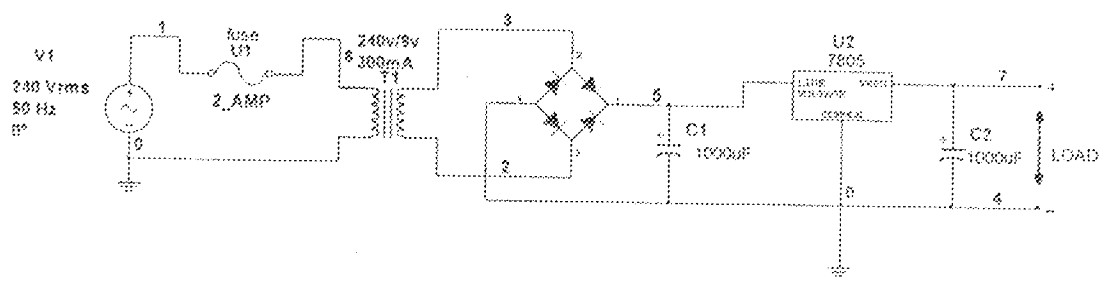


Fig.3.7 A power supply circuit with protective device (fuse).

3.2 CONTROL UNIT:

This unit is the centre of the control for this project, because almost everything depends on the execution of the microcontroller. As far as this chip is concerned, AT89C51 has 40 pins (or 4 I/O ports) of which require 3-5v for it to work effectively. Max. Total I_{OL} for all output pins is 71mA and port 1, 2, 3 is 1.6mA each

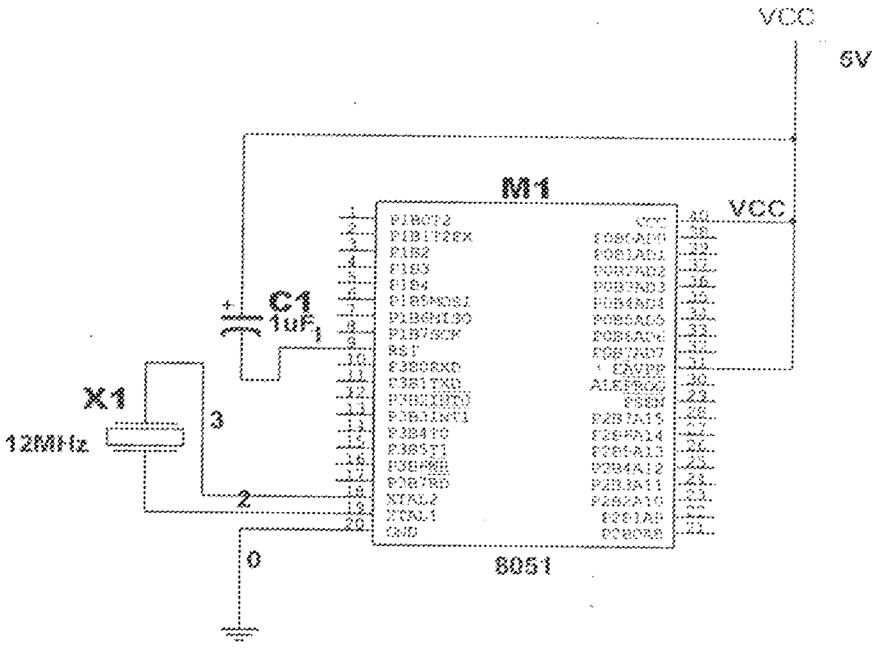


Fig. 3.8 Microcontroller with reset and external crystal oscillator circuit

Then, the 5v regulated from power unit is fed into the microcontroller through pin 40 and pin31 (is the external access, EA to execute code from internal memory) which must be connected to V_{cc}. Pin 9 is the reset which when held at logic 0 the chip run normally. Pin 18 and 19 are used to connect an external crystal oscillator of 12MHz, pin 20 is connected to ground for effective execution of the instruction.

Calculation from the crystal oscillator:

1 Machine cycle (12 crystal pulses) = 12MHz (frequency clock of the microcontroller)

For 1 sec.: $= \frac{12 \times 10^6}{12} = 1 \times 10^6$ instruction will be executed.

So, 1 instruction will take $\frac{1}{10^6} = 1\mu s$.

3.3 SENSOR UNIT:

The output from pin 21-24 of port 2 is connected to resistor of known value which limits the current from the pins. The water level sensor comprises of four probes which are positioned base on descriptive level of the water in the tank. These probes are able to indicate the level of water by making use of the property of water as a good conductor of electricity.

However, the limiting resistor is calculated as:

From Ohm's Law,

$$V = IR \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.5$$

$$R = \frac{V}{I} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.6$$

$$R = \frac{5}{1.06^{-3}}$$

$$= 4716.98\Omega$$

V_{cc} = 5v, output current I_o = 1.06mA

Therefore, the preferred value is 4.7kΩ

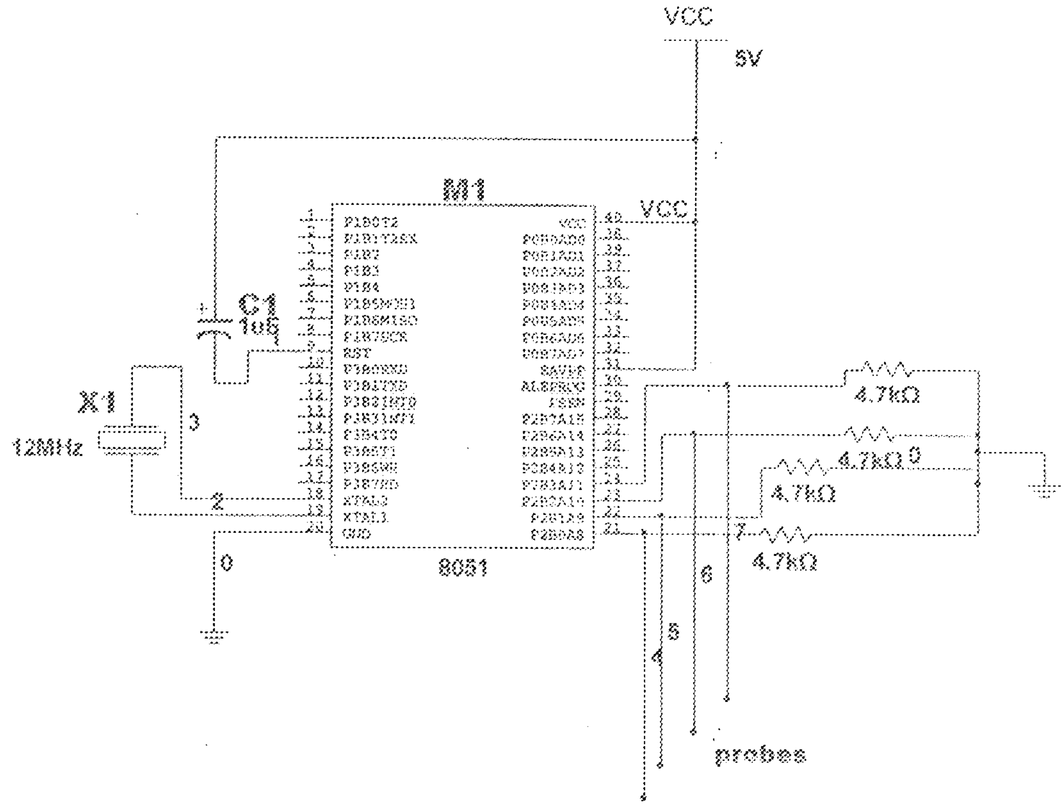


Fig.3.9 Microcontroller with probe sensors

3.4 DISPLAY UNIT:

The display unit is used in displaying the result of water level measured by this device in decimal form is the 7 segment display, which comes in form of an integrated circuit(IC).The common anode are used such that one is displaying L as level and second displaying number is connected to pin 1-7 of port 1 of the microcontroller. When the water level in the tank is full, L3 (level 3) is displayed and when the water goes low an L1 is displayed, and between L3andL1 is L2, also LE indicates that the water in the tank is empty.

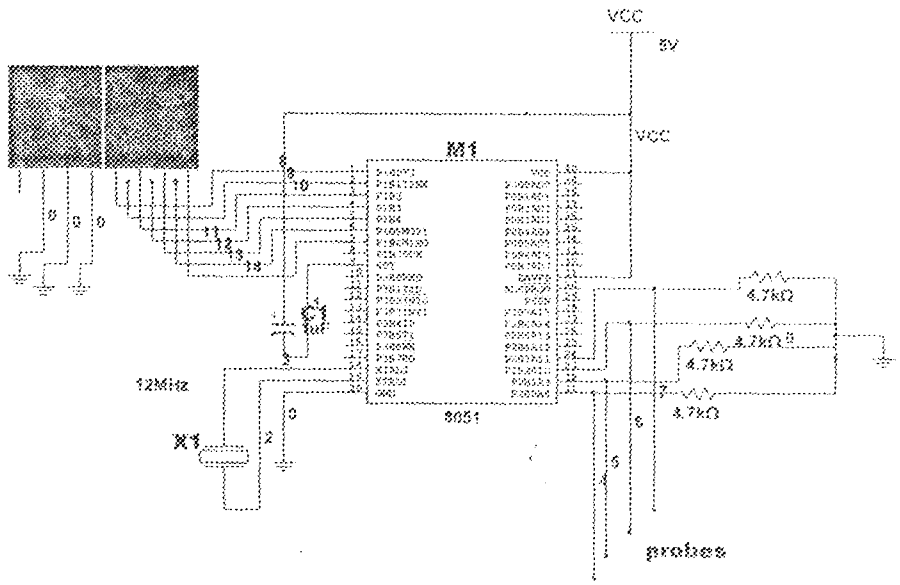


Fig. 3.10 Microcontroller with displaying circuit

3.5 PUMP TRIGGER UNIT:

This unit comprises of an inverter transistor switch and a relay. Here the transistor uses a robust current to drive DC relay as a collector load. The DC relay used as collector load of transistor (PNP 1015A) which energizes and biased when a positive signal is driven to saturation. Now the DC relay has one of its normally close contact connected to live Ac main. The other contact goes to the coil of the relay this time an AC relay, that is, a relay whose coil operate on AC mains. The contact of this AC relay whose close gives mains supply to the pump. This way, the DC relay serves as switch to the AC relay and normally open contact of the AC relay serves as a switch to the pump. To bias the transistor, a base resistor is used.

Calculation of Base resistor of 1015A is:

Coil resistance of the relay, $R_C = 99\Omega$

$V_{CC} = I_C R_C + V_{CE}$ 3.7

$h_{fe} = I_C / I_B$ 3.8

$V_B = I_B R_B + V_{BE}$ 3.9

From the datasheet,

$h_{fe} = 16$ (min)

V_{CE} = Collector to emitter voltage ($V_{CE} = 0$)

$V_{BE} = 0.6v$ (silicon)

From equation 3.7

$V_{CC} = I_C R_C + V_{CE}$

$5 = I_C (99) + 0$

$$I_C = \frac{5}{99} = 0.0505A$$

$\rightarrow I_C \cong 50mA$

From equation 3.8

$h_{fe} = I_C / I_B = 16$

$$I_B = \frac{0.0505}{16} = 3.156 \times 10^{-3}A$$

$\rightarrow I_B = 3.16mA$

So, from the microcontroller the output voltage is 3.67v.However, to calculate base resistor, using equation 3.9:

$V_B = I_B R_B + V_{BE}$

$V_{out} = V_B = 3.67v$

$I_B = 3.16mA$

$V_{BE} = 0.6v$

$3.67 = 3.16 \times 10^{-3} R_B + 0.6$

$$R_B = \frac{3.67 - 0.6}{3.16 \times 10^{-3}}$$

$\rightarrow R_B = 971.52\Omega$

However, the preferred value 1000Ω

So, $R_B \approx 1k\Omega$

The relay receives a signal when the level is at level 1 (L1), it then sends a 0 (binary) to port 0.0 (pin 39) to switch ON the pump that is connected to AC mains supply.

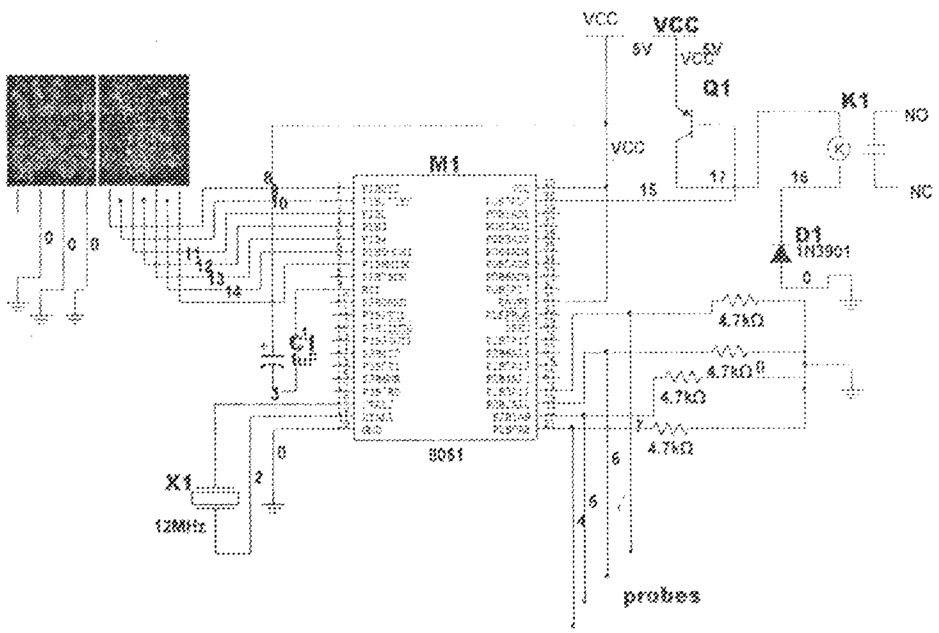


Fig. 3.11 Microcontroller with pump triggering circuit

3.6 MOTOR:

The motor (pump machine) here receives an electric signal from the relay to pump water to the overhead tank.

The nameplate of the pumping machine shown below:

1□ Motor	V.240 max.240v	Hz. 50/60
kW 0.06	0.0805HP	Input current0 .25A
CL.B	2400/3000 rpm	Plastic Blade

Table 3.1 Nameplate of the pumping machine

From the nameplate above the maximum voltage of the pumping machine is 240v, so there is need to protect it against any voltage 240<V<180.A power diode of IN5391 is used to block the reverse flow of AC supply into the microcontroller and a fuse of 2A is used to protect the circuit against a load current that might exceed 1.25A from the pumping machine.

3.7 COUPLING OF THE UNITS:

The various units discussed above were coupled together as given in the block diagram to perform the expected result of the project.

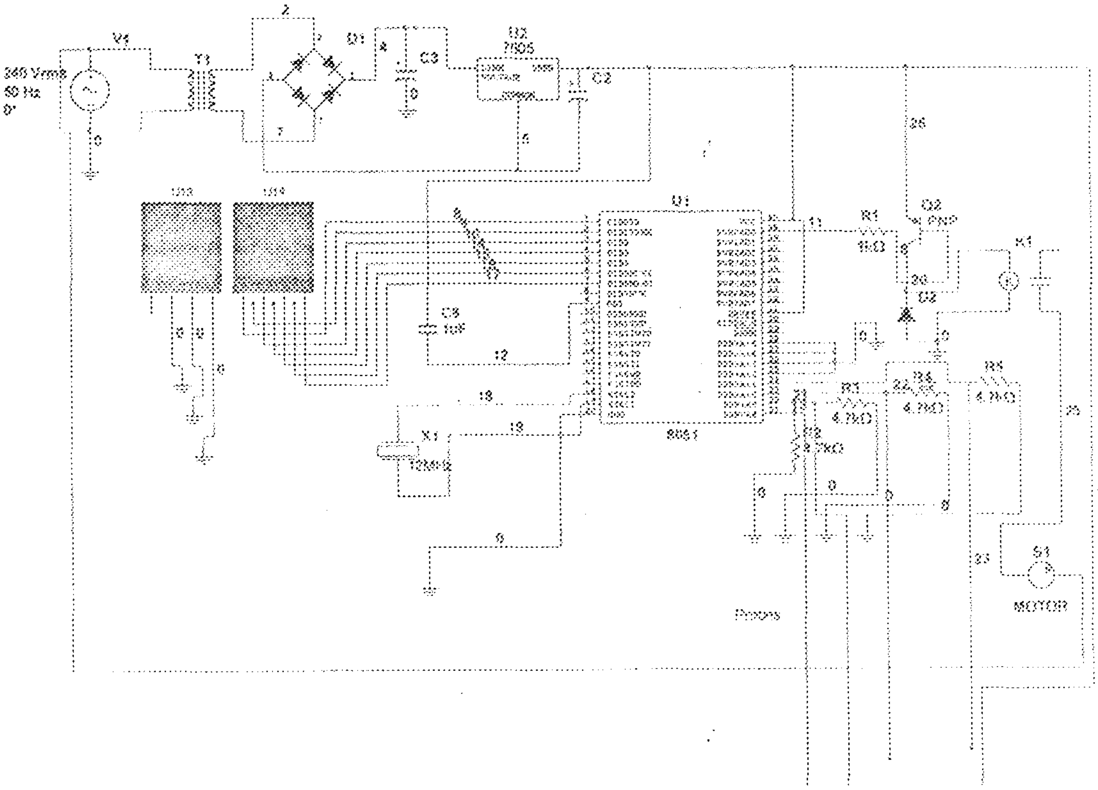


Fig.3.12 A microcontroller-based automatic water level controller circuit

CHAPTER FOUR

TESTS, RESULTS AND DISCUSSION

4.1 Testing of the Project Operation

4.1.1 Construction of the project casing:

The project casing is made of hardcover paper (strawboard & emboss paper) was carefully constructed to make provision for the probes, power supply switch and 7-segment display.

The casing that housed this project is of the following dimensions:

Length 29.4cm

Breadth 12.6cm

Height 6.5cm

4.1.2 Sensor:

The sensor is made of 4 copper wired of 0.3mm which is a good conductivity of electricity. This materials are not liable to rust and corrosion. The probes are positioned to prescribed levels 1, 2, 3 in the overhead tank. When the water in the overhead tank goes low to level 1, the 7-segment indicate L1,then the pump started pumping and reaches L2 until L3 which is the highest of the tank and the motor stop pumping.

4.2 Results of the test:

The result of the project tested was summarized in the table 4.1 below for easy understanding and accessibility.

Water level	E	0	1	2	3	Pump
Without Probe	ON	OFF	OFF	OFF	OFF	OFF
Probe 0	OFF	ON	OFF	OFF	OFF	OFF
Probe 1	OFF	OFF	ON	OFF	OFF	ON
Probe 2	OFF	OFF	OFF	ON	OFF	ON
Probe 3	OFF	OFF	OFF	OFF	ON	OFF

Table 4.1 Output of 7- Segment Display

4.3 Discussion of Result:

The result obtained from the table 4.2 is such that when there is no probe in the tank, empty level is indicated but no pumping and as soon as the probes were placed in the tank, the first probe indicates 0, second probe show L 1 which sends signal to the controller informing the motor to start pumping until level 3, L3 is reached it then stop.

CHAPTER FIVE

Conclusion and Recommendations

From the result of the tests carried out after construction of the project, the water level was able to detect and control the pump when water in the tank is at level 0,1,2,3 to avoid seepage of roofs and walls due to overflowing tank.

When the microcontroller-based automatic water level was installed, the following items were observed:

1. The project takes responsibility of a man who goes from time to time to pull-off or on the pump based on the instruction receives from the microcontroller.
2. Increase the pump set life and reduces electricity bills
3. Water reserve in the tank can be visually observed anytime.

5.1 Problems Encountered:

In the course of soldering the components on the veroboard, the following challenges were encountered:

- When the power supply unit circuit was first soldered, output was not satisfactory and this leads to destruction of the microcontroller and rectifier diode due to excessive current flow and overheat from the soldering iron.
- The 7-segment display got burnt in the course of testing
- The relay switch was not switching as expected to switch ON or OFF the pump as expected.

- The initial stage of my soldering was not neat enough, overflowing of molten lead burning my fingers with iron. But with time and advice from my supervisor and help from my technical supervisor all these difficulties was overcome.

5.2 Recommendations:

I want to recommend that this piece of work should be furthered work on by adding other components like buzzer to alert the user each level of the water in the storage tank. Another most important aspect of it is to ensure its installation in every home. Since one might not know when there will be supply of electricity, so that when PHCN supply comes up; it will switch ON or OFF itself depend on the water level.

Finally, the department should ensure that adequate knowledge especially in practical is intensive during the course of student being an undergraduate to really enhance the productivity of the nation and solve economic problems.

REFERENCES

[1] Richard C. Dorf, Robert H.Bishop "Modern Control Systems",10th Edition pp2-11

[2] R.C Dorf, "Robotic & Automated Manufacturing "Reston Publishing,Reston,Va.,1983

[3] Thesis Work on automatic water level 2007/2008, 2005/2006.

[4] http/www.google.com,wikipedia.Water source

[5] O.Mayr, the origins of feedback control, MIT press,Cambridge, mass, 1970.

[6] E.P Popov, "The Dynamic of Automatic Control Systems", Gosekhizdat, Moscow, 1956; Addison-Wesley, Reading, Mass,1962.

[7] http/www.leetechonic.com Automatic Water Level control

[8] http/www.com.Vertical Float Level Swtiches.

[9] http/www.com.jbjtech con.JBJ Automatic water Level Controller (Automatic Top-off, A.T.O)

[10] Joh O' Malley Ph.D. sham's outline of theory & problems of basic circuit analysis 2nd, McGRAW-Hill, 1992,pp28.

[11] Ian Sinclair,John Dunton "Practical Electronics Handbook" 6th Edition,Elsevier Ltd.2007,p28

[12] Ron Mancin, Richard Palmer,"Sine Wave Oscillators",Texas Instruments Application Report,Mar.,2001,pp3

[13] B.L. Theraja, A.K. Theraja,"My Textbooks of Electrical Technology", S.Chad and Company Ltd, Ram Nagar, New Delhi, 1999, pp

[14] O.N. Bishop, "Basic Electronics", Macmillan, pp30-40

[15] John Bird, "Electric & Electronic Principles & Technology", 3rd Edition,Elsevier Ltd,2007,pp157

[16] http/www.google.com "Datasheet 8051 Family"pdf

[17] Hill W. and Horowitz,P[1989]; "The Art of Electronics" 2nd Edition,USA Cambridge University Press

APPENDIX

PROGRAMMED CODE FOR MICROCONTROLLER

```
;RICHARD
START:
MOV P1, #00000000B
MOV P2, #11111111B
MOV P0, #10000000B
DE:
MOV A, P2
RICH:
CJNE A, #00001000B, SAM
MOV P1, #11000000B
SETB P0.1
SJMP DE
SAM:
CJNE A, #00001001B, PAUL
MOV P1, #11111001B
SETB P0.1
SJMP DE
PAUL:
CJNE A, #00001011B, JUDE
MOV P1, #10100100B
SJMP DE
JUDE:
CJNE A, #00001111B, MIC
```

```
MOV P1, #10110000B
CLR P0.1
SJMP DE
MIC:
MOV P1, #10000110B
SJMP DE
END.
```