DESIGN AND CONSTRUCTION OF A LIQUID LEVEL DETECTOR

BY

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A PROJECT REPORT SUBMITTED TO

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING,

SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY,

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA. NIGER STATE, NIGERIA.

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF BARCHELOR OF ENGINEERING (B. ENG) DEGREE IN ELECTRICAL AND COMPUTER ENGINEERING.

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MINNA, NIGER STATE.

NOVEMBER, 2004

DECLARATION

I **IKIE OTEJIRO PRECIOUS**, hereby declares that this project was carried out by me during 2002/2003 academic session under the supervision of **Engr. M.D ABDULAHI.** To the best of my knowledge this project has not been submitted elsewhere.

IKIE OTEJIRO 98/7113EE	9/12/04 DATE

CERTIFICATION

I certify that this project work presented for the award of bachelor of Engineering (B.ENG) in the Department of Electrical/Computer Engineering, Federal University of Technology, Minna, was carried out by me and has not been presented elsewhere for an award of any degree.

ENGR M.D ABDULAHI
(SUPERVISOR)

9/2/2004
Date

ENGR M.D ABDULAHI
(HEAD OF DEPARTMENT)

9/2/2004
Date

EXTERNAL EXAMINER

Date

DEDICATION

This project is dedicated to God for His several interventions, my brother; Ikie Aghogho who has developed interest in Engineering and little Oghenerukevwe "Uncle where have you been" she says!

If this write up encourages Eguono and Akpevwe, then they should work much more harder in their chosen professions.

ACKNOWLEDGEMENT

My parents, **Mr. & Mrs. Ejiro Lucky Ikie**, you are simply magicians! What did I ask for that was not provided classically!

My siblings; Eguono, Akpevwe, and Aghogho will probably never know how inspirational they were.

I wish to thank Mr. Johnson Iyoyin, Efe Eguridu, Mrs. Oghenekevwe Edafe and Mrs. Ruth Ikie for their love, support and encouragement.

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My Supervisor, **Engr. M.D Abdulahi**, what didn't I do wrong? I was not your only candidate, but how come you were so stuck on me! I am heavily indebted to you and I will work hard to pay up, even if I have to spend the remaining period of my life trying.

I am so much greatly indebted to the Staff of Well Cementing Cell, Schlumberger Nigeria Limited for their unflinching support and training.

Finally, I would like to express my profound gratitude to God for his immeasurable blessings and mercy throughout my academic pursuit.

ABSTRACT

The report presented here provides a description of the theory, Design and Construction of A LIQUID LEVEL DETECTOR. The device is electronically operated to detect the level of liquid in a vessel or container. This was achieved by the use of sensors which on coming in contact with the surface of the liquid generates an analogue signal. This signal is rectified by signal diodes. These signal diodes energize the triggering module and the triggering module in turn energizes the switching module via the resistors (R3 and R4 in parallel combination), the switching module via its relay, drives the alarm module that finally produces an output sound. The alarm module consists of two 555 timers, resistors, capacitors and transistor.

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CHAPTER ONE

1.0 INTRODUCTION

To many, "wastage" is just one of the many verbs in English Language, but those who have been exposed to the physiological and emotional breakdown which this experience brings have more to think of and take necessary precautions.

Furthermore, it is the goal of every management in any organization to ensure greater productivity and safe working environment, thus, maximizing its potentials to attain the anticipated height as contained in their blueprint. Kaduna Refining and Petrochemical Company (KRPC) located in the Southern part of Kaduna State experienced overflow in its generating, power plant where water in boilers are reserved for the running of the company. How was the operator of the generating power plant suppose to know that water had reached an unsafe level when he was tired and fell asleep!

If there was a device to detect that our overhead water tank which receives water from public water supply line was filled, my parents wouldn't have lost some of their valuables to water as a result of an over-flow from the tank.

Similarly, in the agricultural sector where water is needed for irrigation operations, it is important to control the flow of water from the reservoir to the site.

The need to design and construct a "Liquid level detector" is imperative in order to avoid and minimise losses.

The "Liquid level detector" is constructed based on the technical know-how of electrical and computer engineering and it is expected to operate by activating an alarm unit on sensing a liquid beyond the safe level, which may arise as a result of an over-flow of such liquid.

The device is subdivided into five hardware categories viz: the sensor module, which on touching the surface of the liquid sends signal to the coupling capacitor to the triggering module (which is triggered by the signal from the signal diodes). The triggering module in turn energizes the switching module. The switching module comprises of a voltage divider network, a transistor in common-emitter configuration and a relay that interfaces the triggering module to the alarm module.

The alarm module on receiving voltage signal via the switching of the relay, is activated and produces a sound. This module comprises of an astable mode meant to produce continuous pulses. These pulses energise a relay through a switching transistor, which subsequently energises the loudspeaker, hence, produces an output sound. Thus, an over-flow of liquid is detected and waste minimised or avoided.

1.1 LITERATURE REVIEW

Liquids refer to the second state of matter. The others are solids and gaseous states. Liquids are a condensed state of matter and are intermediate between gases and solids in their properties. They are fluids like gases, but normally have much higher densities, similar to those of the solids. Unlike solids, they flow when subjected to moderate shearing force.

A level could be seen as a height of liquids in their containers or as an instrument. When being considered as an instrument it can be used to measure the horizontality in liquids and gases. The ancient Egyptians level consisted of an isosceles 'A' shaped piece with a plumb bob hung from its apex. The only rival of the A-level until the 17th century was a simplified form of the Muslim astrolable suspended from its ring with its sighting piece clamped at 90degree to its vertical diameter, it produces a horizontal line of sight. Despite the description by Hero of Alexander of water made of two glass cylinders connected by a tube, the first such instrument was used by the Italian astronomers Giovanni Riccioli about 1630. This instrument was popular even after bubble level, which is a sealed glass tube containing water and a small air bubble, was invented in France by Melchise'dech. The venot about 1655, water was later replaced by alcohol or other spirits to prevent freezing.

In order to obtain the level of a liquid, various methods have been employed in time past starting from the ancient eye level measurement, where the liquid is placed in a transparent container and the eye is placed at the line of best horizontality and at that point the measurement is taken as the level of the liquid. This is however prone to a lot of errors mostly arising from the observer. It therefore prompted the need for a more reliable method of detecting the level and controlling the liquid flow.

Feedback occurs in systems whose input has link to the output for the purpose of checkmating the operation of the system itself. It simply provides an easy technique for controlling the action of the system without altering any element of the system itself. It could be positive or negative and has wide application, which includes, computer controlled assembly line, self-regulatory action of the servomechanism, etc. A servomechanism is a device that responds to the discrepancy between the actual value of variable and the pre-determined ideal value of position. This deviation is expressed as a small electrical current. This current is amplified and then triggers an appropriate self-connecting response. Also in 1788, the Scottish engineer James Watt developed the flyball governor based on the feedback principle to control the speed of a steam engine.

The Russian Polzunov I invented the first historical feedback system for liquid level control in 1765. It was tested with water as the liquid. The system was used to control the value of water that covers the water inlet in a boiler and floats are used to determine the water level. Several other approaches towards controlling liquid flow in a tank have since been developed.

Detection and control of liquid level using float switches has been in existence for a very long time. These float switches are used in our homes and in industries where water level needs to be detected and controlled.

Float switches work with the principle that: while one of the switch contacts is made stationary, the other contact is made to float on water. As the liquid rises, the float rises until the switch becomes closed. This contact may be part of a motor control circuit, which drives a pump. Since there is movement before contact is made in float switches, this indicates that float switches have some mechanical elements in them. Electronic devices have also been used as switches. These include: Temperature operated switch, light operated switch, pressure operated switch etc Most of these switch makes use of sensors in their operation. The sensor may be in a voltage divider network to apply potential to a switching circuit. Some of the switching circuits include: single transistor circuit e.t.c.

Barry G.W. in 1984 revealed that a single transistor could be used as light operated switch. In his design, a photocell was used in a voltage divider network to forward bias or reverse bias a transistor depending on the intensity of light on the photocell.

Furthermore, William D.S. in 1989 used an op -amp to build a Schmitt trigger. He carried this out by providing a positive feedback in the operational amplifier circuit.

Charles A .H proved that discrete transistor Schmitt trigger also exist by building a Schmitt trigger using two transistors. He achieved this by introducing hystereses using positive feedback. This design employs the use of discrete transistors.

Conductivity of liquids is an important factor in the design of this proposed device.

Loach W. (1981) in his book, titled (handbook of water purification) second edition, chapter3, pages 68-81 revealed the conductivity of different liquids and different sources of water. The conductivity of water according to loach W. depends on the movement of ions in the water. These ions are dissolved spaces carrying an electric charge. Hence, the higher the number of number of ions, the greater the conductivity

1.2 PROJECT OBJECTIVE / MOTIVATION

Analysis of the aims and objectives of this project "Design and Construction of a liquid level detector" are:

a. To develop a simple low cost device which will ease the persistent wastage of water by villagers.

b. To stimulate the interest of upcoming students to take up research not only in this relevant field of study (Electrical and Computer Engineering) but also to extend their arms of research to other field like agriculture hereby demonstrating the versatility of electrical and computer engineering as a profession.

c. To develop a simple device that can be used even by the most local of individual.

d. To demonstrate the relevance of Electrical and Computer Engineering as the basic component of civilization.

1.3 PROJECT OUTLINE

Chapter one: This chapter gives general overview of the project. The general introduction to the project, literature review that highlights previous works on the subject aims and objectives of the project are also contained in this chapter.

Chapter two: This contains the detailed design analysis and considerations. The principle of operation and design calculations of all the units that makeup the system is discussed in this chapter.

Chapter three: This chapter covers the detailed construction and testing procedures employed to achieve the final product. It spans soldering of components on the Vero board, casing construction, testing, troubleshooting and results obtained.

Chapter four: contains the conclusion drawn from the results of testing, with reference to the objectives and goals of the project and recommendation.

Reference, which list the books and materials consulted and appendices that consist of final circuit diagram of the project.

CHAPTER TWO

2.1 DESIGN ANALYSIS

The advent of modern day liquid level detector is aimed at improving productivity, proving safety, protection, cost reduction and technological advancement in arresting natural or human disaster.

This chapter gives the complete description of the various components and modules used in designing the liquid level detector. The theoretical background as shown below is extremely examined. The block diagram of the liquid level detector is shown in fig below.

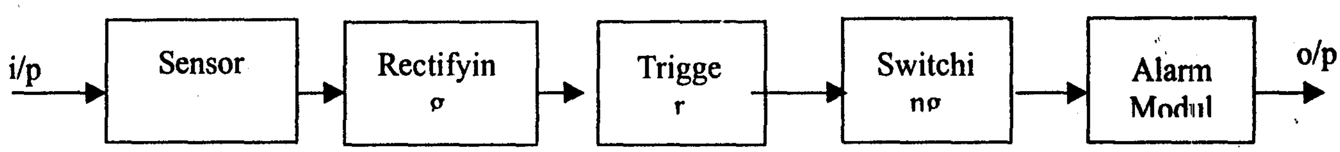


Fig 2.2 Block diagram of a liquid level detector

The five subsystems that makes up the liquid level detector are: the sensor module, rectifying module, triggering module, switching module and the alarm module as illustrated in the block diagram. This illustrates the process leading to wastage as a result of over flow.

The sensor module consists of a pair of coupling capacitor and non-corrosion metal. The sensor is suspended i.e. not touching the surface of the liquid, whenever the liquid level rises beyond the safe level (acceptable level) before getting to the unsafe level, it touches the sensor and this results in flow of electrical signal via the coupling capacitor. The a.c signal produced is further passed via signal diodes to buffer the signal after rectification. Subsequently, the signal is fed to the triggering module, causing it to trigger the switching module via the voltage divider network of R3 and R4 combination. The R3 and R4 combination is aimed at preventing thermal Runaway (a situation where there is an abnormal rise in base voltage). The switching module when triggered energizes the alarm module that gives an output sound, whenever the sensor touches the surface of the liquid.

2.3 POWER SUPPLY MODULE

Most electronic circuits make use of direct current (d.c) supply for their operations. The current from the power supply mains is alternating in nature, this current needs to be converted to a direct current. The process of converting an alternating current to direct current can be achieved as shown below.

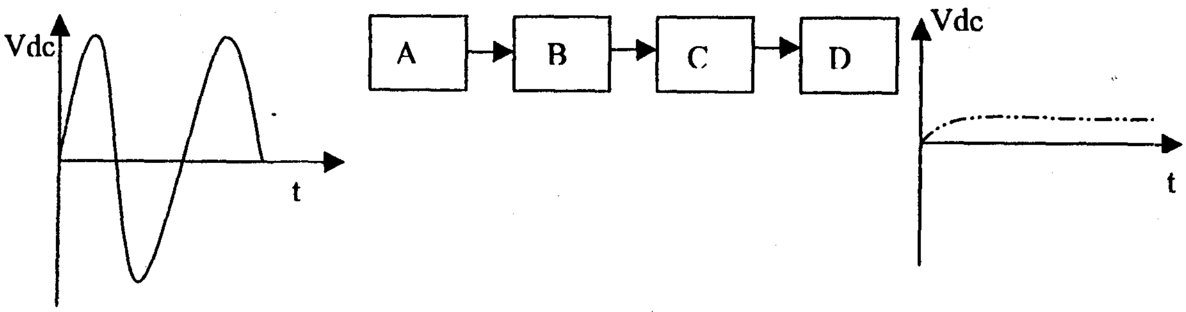


Fig 2.31 Block Diagram Showing The Stages Of A Regulated Power Supply.

KEY

A - Transformer

B - rectifier

C - Filter

D - Voltage regulator

The A C mains is supplied at 220V and 50Hz

2.4 TRANSFORMER

A 240Vr.m.s step-down transformer is used to reduce the 240 V alternating current *ac) from NEPA supply to 12V.a.c, which is rectified to give the required direct current (D.C) output voltage 12V dc

2.5 RECTIFICATION

The term rectification is defined as the process of changing a pulsating a.c voltage to a D.C voltage by eliminating the negative half cycle of the alternating voltage voltage. This project adopts the use of a full-wave bridge rectifier because of its ability to approximate varying and reference voltages.

The maximum instantaneous voltage between the terminals are

IK

: Vmax = Vrms√ 2

The four diodes in the figure below are arranged in a diamond configuration and it is called a bridge rectifier.

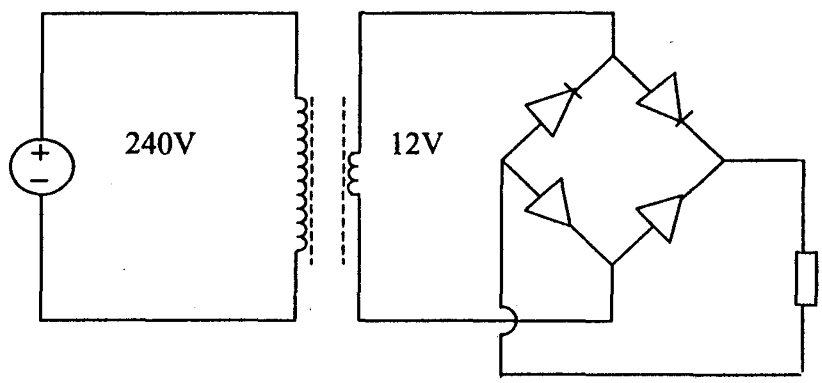


Fig 2.51

2.6 RECTIFIER CIRCUIT BRIDGE RECTIFIER CALCULATIONS.

The direct current voltage Vdc is given by

$$Vdc = \frac{2\ Vmax}{\pi} \qquad = 0.636Vmax\ (1)$$

It must be noted that the PIV (peak inverse voltage) be greater than Vmax

Also note that Vr.m.s = 12V

Hence, $\frac{Vmax}{2} = Vr.m.s$

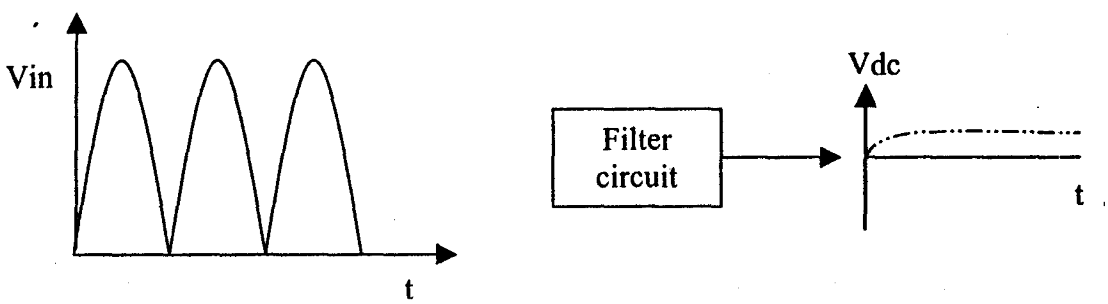
$Vmax = Vr.m.s \quad 2 = 12V \quad 2 = 16.968V$

Allowing a safety margin of 1.5, the PIV = 1.5 x 16.968V

This value of the PIV, 25.5V, prompted the need of selecting a 2A bridge rectifier with a maximum PIV of 100V.

2.7 FILTER CIRCUIT

The main function of a filter is to minimize the ripple content of the full wave bridge rectifier output. The input and output waveform of the filter circuit is shown in fig 2.8 below.



Pulsating Vdc

filtered Vdc

Fig 2.8 DIAGRAM OF FILTER FUNCTION

The electrolytic capacitor depends on its operation, the property of the device to charge up, (i.e. store energy) during the conducting half – cycle and discharging during the non – conducting half – cycle.

Fig 2.9 shows the input and output waveform to the shunt capacitor and the approximated ripple voltage.

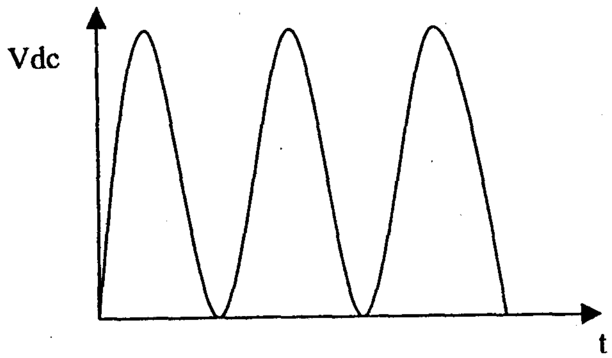


Fig 2.9 (a) input waveform to the shunt capacitor

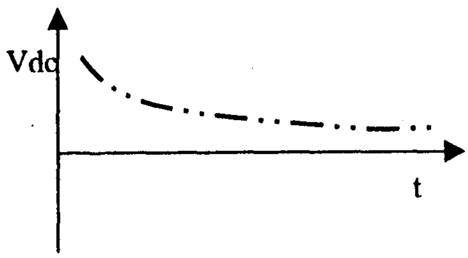


Fig 2.9 (b) output waveform of the shunt capacitor

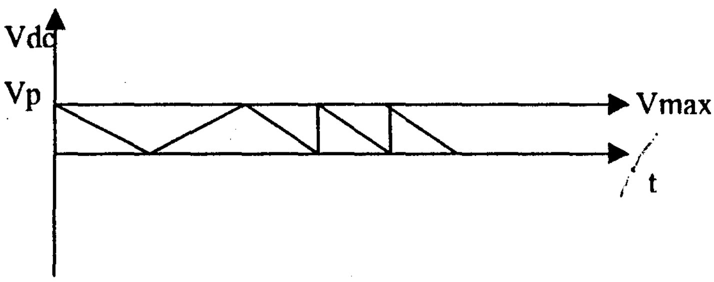


Fig 2.9 (c) Approximate ripple voltage

The ripple voltage can be approximated by a triangular wave form which has a peak – to –peak of Vr (p - p) and a period of Tr as in fig 2.9 (c) considering the charge lost during the discharge of the capacitor as dq in time T, is given as; Idc * T

$$Vr\,(p - p) = \underline{dq} = (Idc\ .\ Tr) / c \text{ ------------------------------i}$$

But $Idc = \dfrac{Vdc}{R_L}$ and $Tr = 1/Fr$ --------------------------------------ii

Substituting (ii) in (i) we have,

$$Vr\,(p - p) = dq / C = (Idc.\ Tr) / C = Vdc/R_L \times 1/Fr \times 1/C \text{--------iii}$$

But $V_{rms} = V_r(p - p)/ 2(3)^{1/2}$ --iv

Hence $V_{rms} = (V_{dc}/R_L \times 1/F_r \times 1/C)/ 2(3)^{1/2}$ ----------------------v

$= V_{dc}/ R_L F_r C \times 2(3)^{1/2}$ --vi

Knowing that $V_{rms}/V_{dc} = \gamma$

$= (V_{dc}/R_L F_r C \times 2(3)^{1/2}) / V_{dc}$

$\gamma = 1/ 2(3)^{1/2} R_L F_r C$ --vii

The parameters are defined as follows:

R_L is the load at the rectifier output terminal.

C is the capacitance of the filter circuit.

Fr is the ripple frequency.

Mathematically, Fr = 2F

Where F is the line frequency (50Hz)

Substituting into (vii) Fr = 2F we obtain

$$\gamma = \frac{1}{RL\ fr\ C.2\sqrt{3}} = \frac{1}{2\sqrt{3}RL2FC}$$

$4\sqrt{3}RL\ (50Hz)\ C$

With γ kept at a minimum of 0.0386 and F = 50, C =? UF Vmax = 16.968V

R_L = 215 n (Assume load)

Also, $V_{max} = I_{dc} R_L$

$R_l = V_{max}$

$$\text{Hence } \gamma = \frac{1}{4\sqrt{3}\ Fc} [V_{max} / I_{dc}]$$

$$= \frac{I_{dc}}{4\sqrt{3}\ Fc\ V_{max}}$$

Where Vdc = 0.636 Vmax

But Vmax = 16.968V

Vdc = 0.636 X 16.968V = 10.792V

$$\text{Therefore, } I_{dc} = \frac{V_{dc}}{R_L}$$

$$= \frac{10.792V}{215\Omega}$$

= 0.05A

$$\text{Hence,} \gamma = \frac{I_{dc}}{4 \sqrt{3} \, F c \, V_{amx}}$$

$$= \frac{0.05A}{4 \sqrt{3} \times 50 \times C \times 16.968}$$

$$0.0386 = \frac{0.05A}{4 \sqrt{3} \times 50 \times C \times 16.968V}$$

$$C = \frac{0.05A}{0.0386 \times 4 \sqrt{3} \times 50Hz \times 16.968V}$$

C = 0.00220381 farad

$C = 2.2 \times 10^{-4}$ F

Converting to microfarad, we have

$1 \upsilon f = 10^{-6} F$

$$\text{Hence, } \frac{2.2 \times 10^{-4} F \times I\upsilon f}{10^{-6}}$$

$= 2.2 \times 10^{-4} \times 10^{6} \upsilon f$

$= 2.2 \times 10^{2} uF$

= 220uf

Hence, the capacitance of the capacitor used in designing the power supply module is 220uf with 16V rating.

2.91 VOLTAGE REGULATOR

In order to obtain the desired regulated output voltage (Vdc) required to drive the operation of the circuit, voltage regulated IC was employed .In course of this project, the voltage regulator used is the 7812 A i.e. a 12 V IC

2.92 ANTI – SURGE

Owing to the overhead high tension, power supply from the generating station is susceptible to surge. This surge occurs as a result of falling of big trees on the high tension power line during storm, bird perching on the power line, which eventually results in either line – to –line fault, line – to earth fault i.e. short circuit fault, etc. hence, the supply of faulty voltage (abnormal supply).

In most cases consumer is affected in an area where the step – down transformer has no fuse and as such, the fault current then flows through a conductor (put in place of the fuse, usually a cable) to the consumer electrical appliances and in the absence of any anti – surge system, the appliance can be damaged easily. Thus, the need to include an anti – surge system in the power supply module is to ensure that the entire system connected to the power supply module gets protected from any possible surge occurrence. The figure below depicts an anti – surge for the 12-v power supply circuit.

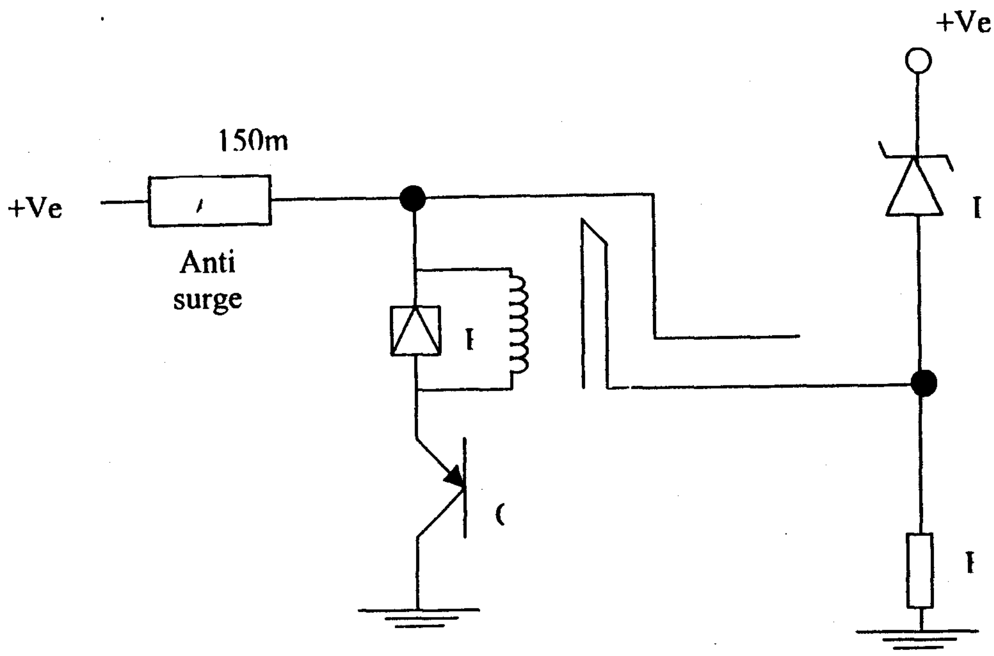


Fig 2.93 SHOWS THE ANTI - SURGE CIRCUIT OF THE LIQUID LEVEL DETECTOR

Key:-

A – Anti – surge fuse (150mA)

B – Relay

C – Switching transistor

D - Zener diode (12.6v)

E – Resistor (1k)

2.94 SENSOR MODULE

This module consists of a pair of metallic sensor, which is resistant to corrosion. Usually, it is made up of a bicycle spoke (chrome), which is suspended in such a manner that it does not touch the surface of the liquid. As the liquid level rises and touches the sensor, an a.c signal is generated, this signal, flows across the electrolytic capacitor pair. The figure below illustrates the sensory module of the liquid level detector

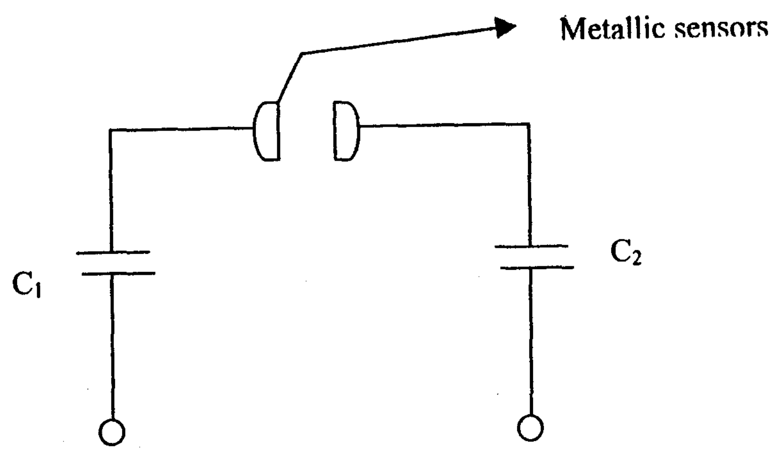


FIG 2.941 Sensory Module Of The Liquid Level Detector

SWITCHING MODULE

This module consists of a voltage divider, relay and a switching transistor. It interfaces the rectifying module to the oscillating module of the liquid level detector via the terminal of the relay, thus delivering voltage required to drive the oscillatory module via the voltage regulator. The figure below shows the diagram of the switching module

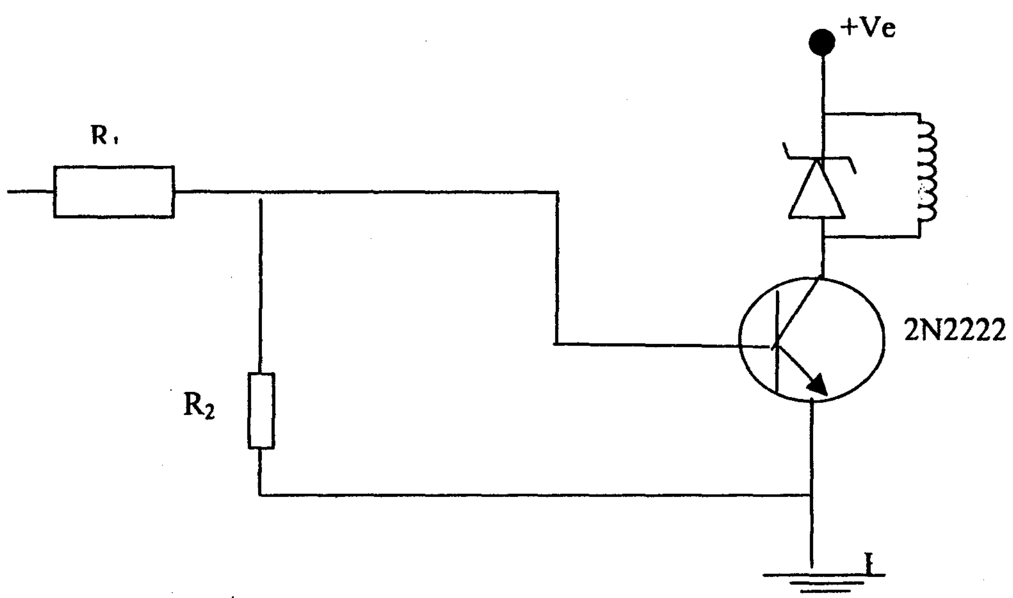


Fig 2.951 Showing switching module of the liquid level detector

Characteristic of 2N2222A

I_{Amax} = 0.02A (maximum base current)

Icmax = 0.8A (maximum collector current)

V_{BE} = 0.6v (emitter base voltage)

B = 40 (gain)

Vcc = 12v

Vin = 6v (from simulation)

R1 =? KR (input resistor)

R2 =? KR (base resistor w.r.t ground)

V_{BB} = 2v (base voltage)

Ohm's law can be applied from the switching module

$Ic = \frac{Vcc}{R_L}$, where R_L is the load resistance (relay resistance)

On the measurement of the relay resistance from simulation and use of digital multimeter, the resistance obtained is 410R.

$$\text{Therefore } Ic = \frac{12v}{410R} == 0.029A$$

Ignoring any leakage current, I_{CBO},

$$I_{Bmin} = \frac{Ic}{B} = \frac{0.029A}{40} = 0.000725A$$

The current through R necessary to ensure cut – off for an over – driven switch (by rule of thumb) equals to $2I_{Bmin}$

Therefore, $I_2 = 2I_{Bmin}$

$$= 2 \times 0.000725A = 0.00145A$$

Applying kirchoff voltage rule,

$I_2R_2 = \underline{V_{BB} - V_{BE}} = \underline{(2 - 0.6)\ v}$

I_2 0.00145A

$= \underline{1.4V} = 965.5R = 0.966K$

0.00145A

$= 1K$

Using the kirchoff voltage rule on the input with

$I_B = I_{Bmin}$

$I1R1 = Vin - V_{BE}$

$0.000725A \times R1 = (8 - 0.6)\ V$

Therefore, $R1 = \underline{7.4v} = 10.20K$

0.000725A

$= 10K\Omega$

2.96 MODE OF OPERATION

When the liquid level rises beyond the safe level, the sensor comes in contact with the surface of the liquid and this causes an analogue signal to be generated. This signal is further rectified by the signal diodes D1 and D2 and this energizes the triggering module, which comprises of a Schmitt trigger. The triggering module in turn energizes the switching module via the resistor (R3 and R4 parallel combination). The switching module via its relay drives the alarm module that finally produces an output sound, thus, indicating the presence of a liquid beyond the safe level.

CHAPTER THREE

3.1 CONSTRUCTIONS AND TESTING

In the hardware construction, the overall system was broken down into module for easy construction, testing and trouble – shooting. The various modules are as follows:-

i. Power supply module

ii. Sensory module

iii. Rectifying module

iv. Triggering module

v. Switching module

vi. Alarm module

3.2 POWER SUPPLY MODULE

In the building of this module, the bridge rectifier was the first component to be placed on the Vero-board. This bridge rectifier has four terminals denoted by the signs or symbols Viz; +; ~; -; such that the positive terminal (+ve) was connected to the zero voltage line, while the negative terminal to which the alternating voltage symbol is indicated was connected to the transformer secondary. In same manner, the capacitors: 220uf and 100nf was connected across thc rectifier output as a filter. A voltage regulator was also connected across the filter output so as to produce a regulated output voltage, usually a D.C required to drive the liquid level detector.

3.3 SENSORY MODULE

This module was built on the Vero-board upon successful completion of the power supply module. It consists of water corrosion resistant metal (usually a bicycle chrome) and a capacitor connected to the sensor and the rectifying module.

3.4 RECTIFYING MODULE

This is the next to be built on the Vero board after the sensory module. This module consists of two signal diodes meant to rectify the input to the triggering module. It was connected to the sensory module output via its anodes and cathodes, which is connected to the input of the trigger. (Schmitt trigger).

3.5 TRIGGERING MODULE

The Schmitt trigger is a snap -- action electronic switch that turns on and off at two specific input voltage, which are the upper and lower threshold voltage. In this design, the Schmitt trigger was built on the Vero-board immediately after the rectifying module. The output voltage of the triggering module drives the switching module, which in turn drives the alarm module.

3.6 SWITCHING MODULE

This module comprises of a relay and a transistor. Using a digital multimeter, the collector, base and emitter of the transistor terminals were identified and consequently soldered on the Vero-board. Furthermore, the relay terminals viz normally open (N/O), normally closed (N/C), the common pin, the relay coils where checked to ensure that it is working very fine. Connected across the relay is a free – wheeling diode, which is aimed at eliminating the sparking of the relay coil and back emf, which may be induced whenever the relay turns – off. This module also allows for the interfacing of the liquid level detector circuit and its alarm module.

It is also worthy of note that the parallel combination of R3 and R4 was connected to avoid thermal run away (a situation where there is an abnormal rise in base voltage)

3.7 ALARM MODULE

This module was soldered to the Vero-board after soldering the entire system to the board. It consists of oscillators, capacitors and resistors. On receiving voltage signal from the switching module, an audible sound is produced via transducer / loudspeaker with an impedance matching of 8Ω indicating the presence of liquid beyond the safe level.

3.8 CONSTRUCTION AND TESTING

The following materials were used in the construction of this module viz:

i. Plywood

ii. Regulator /power switch

iii. Nails

iv. Hacksaw

v. Sand – paper

vi. Measuring tape

vii. Chisel

The construction steps are as follows,

1) With the aid of the measuring tape and hacksaw, the required length, breadth and width of the casing was measured and cut accordingly to form a rectangular shape.

2) The cut plywood was the joined together using nails and hammer, thus forming a rigid rectangular wooden box.

3) Smoothening of the rectangular wooden box was carried out using a sand paper.

4) Using a chisel, an opening was created for the insertion of the power switch. The power switch must be held firmly by the casing.

3.81 COMPONENT LAYOUT

i) The IC was mounted on an IC socket already soldered to the Vero-board to ease the replacement of any faulty IC in the future.

ii) Interconnection was made through the earthen of the Vero-board and use of insulated copper wire connected at the bottom of the Vero-board. While components were mounted on top of the Vero-board and then soldered underneath thus giving the components good layout and space to give room for trouble – shooting and replacement of faulty components.

iii) The long leads /terminals of various components such as transistors, resistors and capacitors were reduced so as to prevent short circuit.

iv) Haven made necessary connections on the Vero-board, proper examination of the connecting lines and non – connecting lines was carried out to avoid bridging of lines.

3.9 CONSTRUCTION TOOLS USED

Most of the construction tools used during the hardware design are as follows:-

i) Project – board and insulating copper wire; this is used as jumpers/ connecting wire. This component was used in building part of the prototype / model for testing the circuit before final soldering on the Vero board.

ii) Soldering iron and lead: A 60watt soldering iron and a tiny lead was employed to hold the components firmly to the Vero-board.

iii) Digital multimeter: this electronic device was used in carrying out various tests on the entire system. For instance, any open circuit fault was detected with the aid of the meter and rectified. Identification of the base, emitter and collector as well as the relay normally open and normally closed were carried out using the digital multimeter.

iv) Precision screw driver: the different shapes and sizes of this set of screw – drivers made it possible for it to be used in regulating the amount of current entering the switching module via the variable resistor.

v) Lead sucker: This was employed in removing molten lead while de soldering components from the Vero – board.

3.91 HARDWARE TESTING

Upon successful completion of the hardware construction a careful hardware testing of the complete system was carried out as follows.

Step 1. Continuities of copper wire used in the construction using a digital multimeter.

Step 2. A digital multimeter was also used to ascertain the absence of short circuit between the supply line (+ve) and the ground (0V).

Step 3. Polarity of the power supply out put voltage was also tested using a digital multimeter to ensure adequate link to the liquid level detector i.e. not mistaking negative / ground for supply and supply for ground.

Step 4. Identification of the cathode and anode of the signal diode was also checked before soldering on the board.

Step 5. The output voltage of the transformer was observed and measured to be 12 V ac as required.

Step 6. The anti-surge module, which comprises of the relay, transistor, zener diode and resistor was thoroughly checked and tested to ensure normal working condition of the system.

Step 7. The trigger (Schmitt trigger M 40106) was tested to conform pin configuration.

3.92 CONSTRUCTION PRECAUTIONS

1. All soldered joint were tested for continuity so as to avoid open circuits.
2. All excessive lead were removed to avoid bridges (short circuit of the board)
3. IC's were mounted on IC sockets to avoid over-heating them and for easier troubleshooting.
4. Excessive heating of the components was avoided so that they do not burn out.

3.93 PROBLEMS ENCOUNTERED

During the testing period, it was discovered at some points that the system was no longer responding to the presence of a liquid. It was checked and discovered that there was no continuity in the common probe. It was fixed and the system functioned normally thereafter.

Drilling and cutting of the metal parts of the casing to desired shape and filing the edge was not an easy task at all, particularly, in the absence of precision machine.

CHAPTER FOUR.

DISCUSSION OF RESULTS, CONCLUSION, RECOMMENDATION AND REFERENCES.

4.1 DISCUSSION OF RESULTS

The result obtained after the simulation of the liquid level detector circuit reveals that, the sensor on touching the surface of the liquid results in an outburst of the alarm module. This was achieved when the signal generated by the sensor on touching the surface of the liquid is amplified by the buffer diodes and subsequently fed into the switching circuit via the Schmitt trigger module. The switching circuit finally energized the alarm module.

The alarm output was measured based on the variation of the resistance as well as the output of the trigger charges.

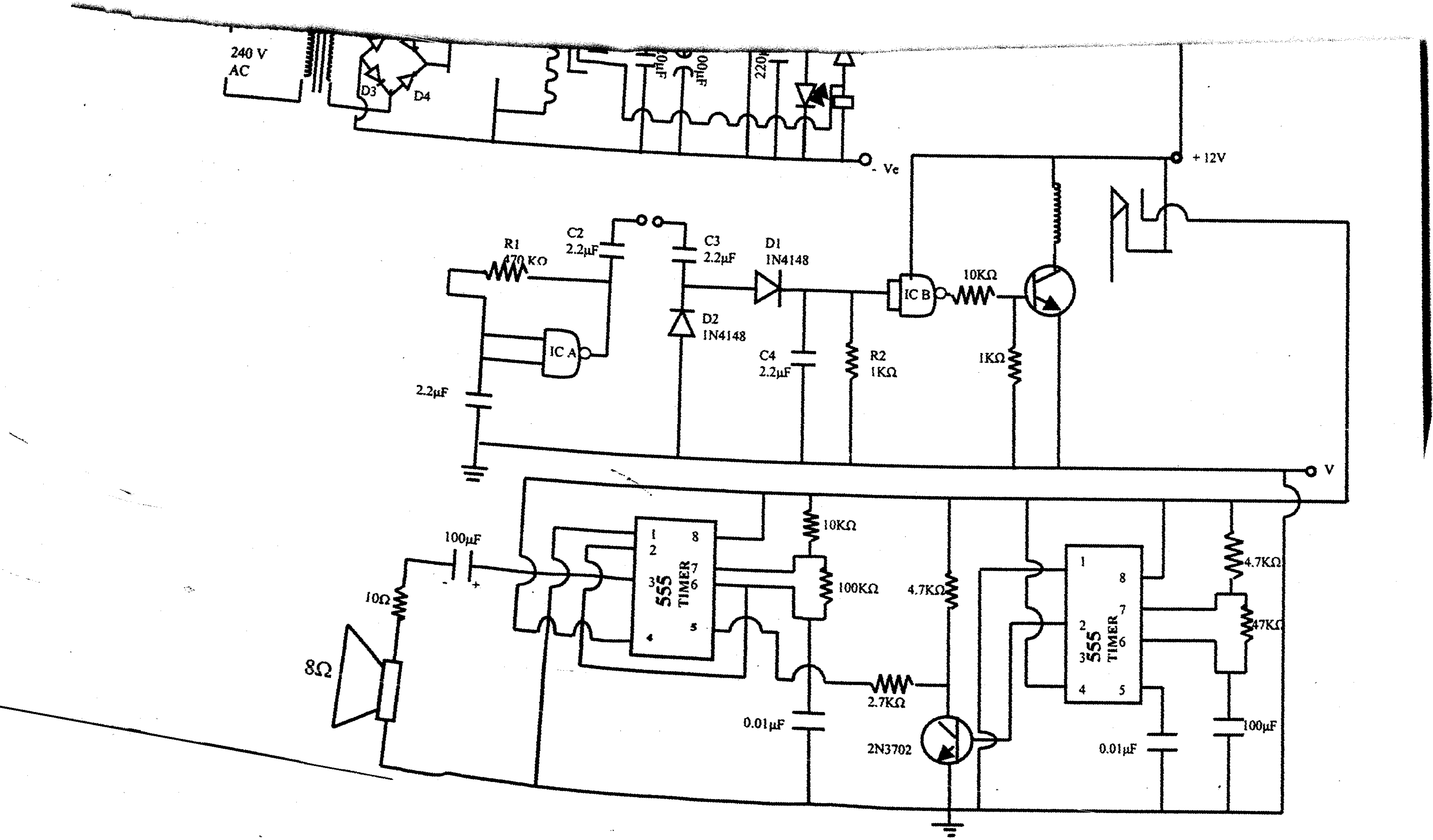
4.2 CONCLUSION

The motive of the project was realized as observed during the hardware testing. This proved that the liquid detector can be designed and constructed using hydro sensitive principle by the use of metallic sensor amplifier circuit, Schmitt trigger, switching circuit as well as the alarm circuit.

The low operating voltage and low power consumption of the system allows for longer life, better maintenance, low overall cost in construction and operation, hence, resulting in high reliability.

4.3 RECOMMENDATIONS

I recommend that capacitive sensors be used in order to cater for non-conductive liquids. The fact that the device may be used to sound a warning, the power supply LED must be checked ON to ensure that there is supply to the device. The vessel containing the liquid should be properly positioned to prevent splashing of the liquid which may result in false sensing.


240 V
AC
D3
D4
- Ve
+ 12V
R1
470 KΩ
C2
2.2μF
C3
2.2μF
D1
1N4148
D2
1N4148
IC A
IC B
10KΩ
C4
2.2μF
R2
1KΩ
1KΩ
2.2μF
V
100μF
10Ω
8Ω
555
TIMER
10KΩ
100KΩ
4.7KΩ
2.7KΩ
0.01μF
2N3702
4.7KΩ
47KΩ
100μF
0.01μF

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