DESIGN AND CONSTRUCTION OF WATER LEVEL INDICATOR WITH AUDIO ALARM

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DEDICATION

This project is mostly dedicated to the Almighty Allah, the beneficient and the merciful God and special thanks to my parents, Alhaji and Alhaja Magaji for their love, care, endurance and understanding throughout the period of the course.

DECLARATION

I MAGAJI OLAYIWOLA, declare that this work was done by me and has never been presented elsewhere for the award of a degree. I also hereby relinquish the copyright to the Federal university of Technology, Minna

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ABSTRACT

This project is based on the design and construction of an electronic device capable of detecting and control the pumping of water into the tank. The device is constructed using simple, low cost and low power consuming electronic components, metal probes are used as sensors, light emitting diodes as indicator, RS flip flop as switching device for the control of the pumping machine.

The device is reliable, affordable, it requires little or no technical knowledge for installation and can be operated using portable dc sources. If the tank geometry and dimensions are known, the volume of the water can be determined and the mass having known the density. The sensor probes are not liable to corrosion, this also give this design an edge above other approaches and current is passed through the water for a very short duration, this help in eliminating electrolysis and other chemical reaction that might occurred.

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CHAPTER ONE

1.1 INTRODUCTION

The most abundant liquid fluid on earth is water. It is an important constituent of all human life and it occupies 75% of the entire world land mass. There are some other fluids that are also very important to man; examples are petrol, lubricating oil, kerosene, and alcohol, just to mention but few. Petrol and lubricating oil forms an indispensable and integral part of automobile industry, for home cooking kerosene is mostly used while alcohol is used for preservation in the pharmaceutical and food industry.

Generally, water is stored in large tanks particularly in manufacturing industries where a steady and constant supply of water is mandatory. In these storage tanks, the level of the water must be properly and accurately monitored in order to effectively determine when refilling operation must commence or stop to prevent wastage and losses due to overflow. Knowing the volume of water in a tank is important in many industrial processes and even for domestic use. Over-flowing of the tank can cause an expensive and perhaps very dangerous accident. Conversely, having the tank dry may disrupt the process that was earlier scheduled to receive water from the now empty tank.

In both cases, million of naira may be lost and critical industrial processes, this may at times lead to loss of human life.

1.2 AIMS AND OBJECTIVE

The aim of this project is to design and construct an electronic device capable of sensing and indicating water level with auxiliary and audio output. It has wide areas of applications ranging from domestic use to industrial use and wherever water is used. For domestic use, the main problem is that of pumping water into the storage tank and ensuring the tank is refilled with water whenever the water falls below a pre-determined level. It can be used to monitor water level in storage tanks at industries – petrochemical industries, paint industry, perfume industry, pharmaceutical industry, irrigation systems etc, this project finds use in all areas of human endeavor where water is used.

In this project, a water level indicator was designed and constructed using simple electronic components. This circuit not only indicates the amount of water present in the overhead tank but also gives an alarm when the tank is full.

1.3 METHODOLOGY

The approach employed is first considering each element in the design on a descriptive basis in order to provide a clear understanding and intuitive insight into its performance and operation. After obtaining a physical insight into the operation of the circuit, mathematics and circuit theories are then applied in deriving the circuit parameters. The concluding steps include sourcing for the component, construction and testing of the water level indicator with alarm.

1.4 HISTORICAL BACKGROUND

In the past, Engineers had made efforts in finding means of achieving adequate management and control of liquid substances with analog devices (such as liquid level open-close valves) and little achievement was made and classically, these needs have been met by various mechanical approaches such as float valves or diaphragm actuated switches. These devices are bulky, inaccurate and because they contain moving parts, unreliable results usually arise from monitoring operations of the water level. The failure of these mechanical monitoring devices may at times be disastrous. They could also be affected by debris or environmental problems such as ice, fog and so on. They can be expensive and inaccurate when they are used to control and monitor large differences in depth, such as in municipal water towers. Mechanical control devices are prone to false actuation in vehicular application such as bilge pump control to their own inertia.

Most of the previous attempts on this project as mentioned above have been basically mechanical and in some cases the project was designed with thyristors and sometimes operational amplifiers. These attempt have resulted in solutions which were either too bulky, consumed too much power or were not so reliable and not economical. Most of the designs indicate a low or high level and not a proportionate level (i.e. the amount of water).

This project is thus an attempt to overcome these problems. The water level indicator will also save the personnel the exposure to danger or risk in the process of determining whether or not the tank is empty. For instance, climbing the overhead tank top to confirm if there is water in the tank, which in the process the personnel may fall and sustain injury. The present design is more durable than the float switch since there is no mechanical part that may fail. Other designs that use other approach asides mechanical only shows two levels – High and low which other designs suffer from electrolysis.

A number of additions have been made to improve upon previous designs, such as the incorporation of additional sensor to determine further levels of the water through which the volume of water in the tank at any time can be known, provision of an audio output as well as visual display for the level and switching ON/OFF of the connected pumping machine. The present design also ensures occurrence of electrolysis is eliminated. The design also provide a control measure to switch OFF the pumping machine when there is no water to pump from the source of water i.e. well, dam, etc., this will safeguard the machine from damages and increase its useful life.

In this design, the metal used as probes are resistant to corrosion or other chemical reactions when immerse in the water. Therefore, the physical and chemical characteristic of the probe material has been fully taken into consideration.

Chapter two focuses on the theory and the design specification of each stage constituting the water level indicator and reasons for the chosen specification. Chapter three deals with the design analysis of some of the units making up the device showing how values of the components used were realized. Chapter four focuses on Construction and Testing while chapter five discusses conclusion and recommendation for future work on the design.

CHAPTER TWO

LITERATURE REVIEW/ THEORETICAL BACKGROUND

In this chapter a comprehensive review is made on the project theory and design specification for better understanding of the project work. A detailed block diagram that depicts the entire water level indicator is shown in fig. 2.1 below.

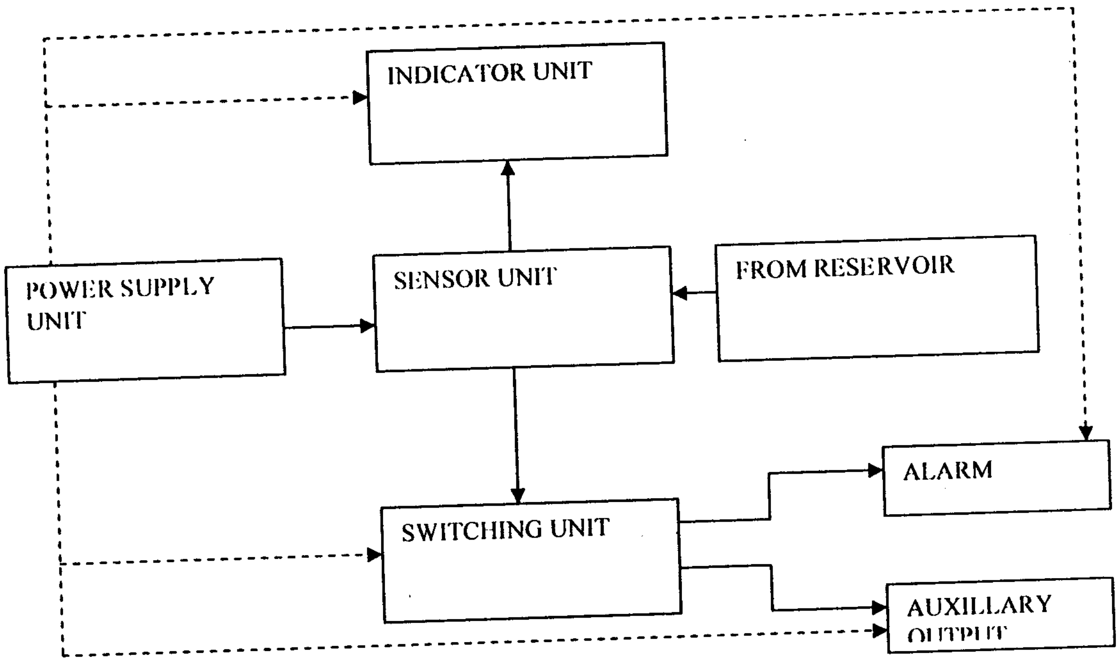


fig. 2.1 schematic block diagram of water level indicator

The integration of the various units shown in the block diagram above makes up the water level indicator. Each of these units is quite essential and plays very important roles in building the entire device.

2.1 POWER SUPPLY UNIT

Most of the electronics devices and circuits require a DC voltage source for their operation. Dry cells and batteries are one form of DC voltage source; they have the advantage of being portable and ripple free. However, they need frequent replacement and are expensive as compared to conventional DC power supplies. Since the most convenient and economical source of power is the domestic AC supply, it is advantageous to convert this alternating voltage to DC voltage. The process of converting AC voltage into DC voltage is called rectification and is accomplished with the help of a rectifier, filter and voltage regulator. These elements put together constitute DC power supply. [3] A typical power supply consists of four stages shown below in fig. 2.2.

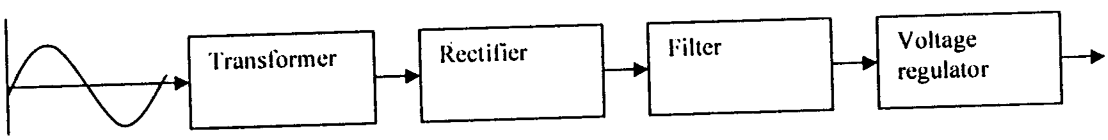


fig 2.2 Schematic block diagram of a D.C power supply

2.2 TRANSDUCER (SENSOR UNIT)

A transducer is an element, which senses the desired input in one physical form and converts it to an output in another physical form. [2] The main purpose of the sensor unit in the water level indicator is to automatically detect and indicate water level in tanks or any other vessels containing the water and send a control signal through the switching unit to the auxiliary output and to the pumping machine which pumps water into the tank. The control signal either starts the pumping machine to pump water into the tank or stops it from pumping into the tank. It also triggers the alarm to give audio output when the tank is full.

A large variety of sensing approaches and transducer types has been developed for the determination of the level of liquids, not only is the knowledge of the level itself important but other measurements can be inferred from the level. If the tank geometry and dimensions are additionally known, the volume of the liquid can be determined. If additionally the density of the liquid is known the mass can be calculated. [2]

2.2.1 TYPE OF LEVEL SENSORS

Level sensors may be classified broadly into two general groups, these are direct and inferred.

DIRECT LEVEL SENSORS are simple and economical usually they are visual for example, sight glasses, dip sticks and calibrated tapes and they are not easily adapted to signal generation. [2]

INFER LEVEL SENSORS depends upon the medium having a property that is related to the level and is measurable. For this method, many physical and electrical properties of the medium which are well suited for the generation of proportional output signals for remote sensing are taking into consideration. Some of these properties are listed below:

Buoyancy – the upward force of a submerged body that is equal to the weight of the liquid, which it displaces, or the upward displacement of a float on the surface. Strain gauges or displacement transducers are used in order to establish a suitable output signal.

Capacitance - The medium to be measured serves as a variable dielectric between two capacitor plates. Two substances form the composite dielectric, the medium whose measurement is desired and the vapor space above it. The total capacitance value changes as the volume of one material increase while that of other decreases.

Conductance - At the desired point or level of detection the medium to be measured conducts electricity between two fixed probe locations or between one probe and the tank wall.

Hydrostatic head- the force or weight produced by the height of the liquid which would be sensed by a pressure transducer placed at the bottom of the tank.

Sonic or ultrasonic – the medium to be measured reflects or affects in some other detectable manner high frequency sound signals generated at appropriate locations near the test medium.

In determining the method to be used for a particular application, certain operating conditions such as level range, liquid characteristics, temperature, pressure, and the state of the liquid around the operating area must be known.[2]

For this project conductive property of water was used because of the following reasons;

- It requires no mechanical parts.
- It is economical
- It requires little or no modification to the tank structure or the containing vessel.

The main components of the sensor unit are capacitors, resistor, and NAND gate and conducting probes such as copper wire, stainless steel, aluminums wire graphite, platinum or any good conductor. Copper probes are used in this project because of their high resistance to rust or corrosion or any other chemical reactions such as electrolysis that may take place. Another factor considers in selecting the copper probe is its low cost compared with platinum and graphite, which are inert electrodes.

For capacitor to be charged, an external voltage source is required to be connected across its terminals. Current flows through the capacitor; potential difference is developed across its plates, as soon as the voltage between the plates of the capacitor equals and opposite that of the supply, the flow of electron ceased i.e. current through the capacitor is stopped. When a capacitor is fully charged, it will remain charged until it is discharged. Capacitor can be discharged by short circuiting its two terminals or through a resistor. [7]

One terminals of the capacitor is connected to the supply, the other terminal is connected to the probes, when the circuit is powered the capacitor is charged, when water touches the probes the capacitor will be discharged and when water falls below the probes the capacitor will be charged again through a resistor. Current passes through the water for a very short duration (discharging period of the capacitor), this account for the elimination of electrolysis which is more pronounce in DC circuits than AC circuits.

NAND gate is used as an inverter by connecting its two inputs together. At the initial stage the input of the NAND gate is high and the output is low. When the probes detect water, the capacitor start discharging and input of the NAND gate is LOW and the output is HIGH. The output of the NAND gate serves as the triggering signal for the indicator unit and the switching unit.

In general, the circuit can be used in a wide variety of applications where a water level sensor is required. It can indicate the level of water in a container or simply the presence of water depending on the way the circuit is used.

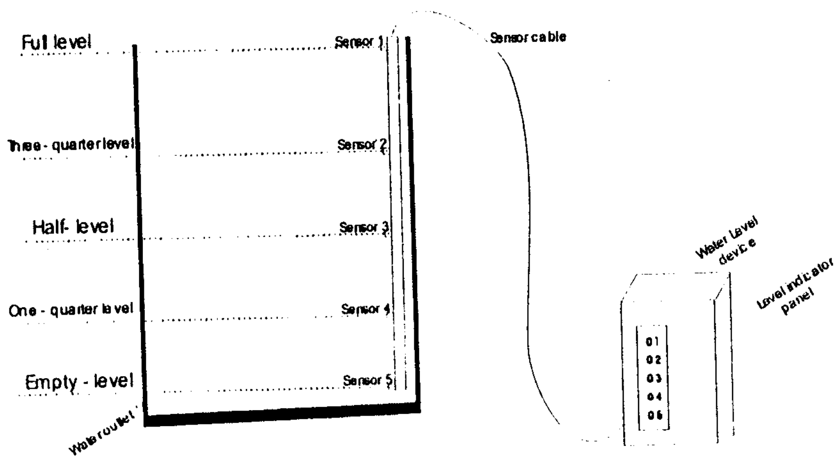


Fig 2.3 sensor probes in the water tank with indicator

2.3 INDICATOR UNIT

Indicators are part of opto-electronic devices that can show letters or numbers. Opto-electronics devices include light emitting diodes and displays based on other technologies such as liquid crystals, fluorescence and discharge. It also includes optical electronics used for purposes other than indicators and displays: high-coupled isolators (opto-isolators), solid-state relays, position sensors (interrupters and reflective sensors), diodes lasers, array detectors (charge-coupled devices CCDs), linkage transistors, and a variety of components used in fiber optics. The dominant display technologies today are light emitting diodes (LEDs) and liquid crystal display (LCDs). LCDs are the newer technology with the following features:

- It does not emit light energy like LEDs, and so it requires an external source of light. Good for equipment for outdoors use or in high ambient input level thus restricts the optimization to require custom.
- Display many digits or characters.
- Widely used in battery-powered devices, due to its very low power dissipation.

For display of many characters say a line or two of text gas discharge ('plasma') display panels compete with LCDs particularly if there is their need for high clarity, gas discharge display requires significant power. [1]

2.3.1 THE LED INDICATOR

LEDs by comparison are somewhat simpler to use, particularly if you only need a few digits or characters. They also come in three colors and they are good in subdued input or low ambient light, where their good contrast make them easier to read than LCD displays. [4]

Light emitting diodes look electrically like a diode; they are manufactured with compound semi-conductors such as gallium or indium phosphide. When it is forward bias current passes, light is emitted from the junction. The color of the light depends on the material used for the junction and the brightness is approximately proportional to forward current. A series resistor is usually connected with the LEDs in order to limit the forward current. LEDs emits no lights when reversed biased, in fact operating LEDs in reverse direction will quickly destroy them. [3]

The light emitting diodes (LEDs) is used to indicate the water level in the tank. LEDs have the following features:

- Being made of semiconductor material, it is rugged.
- It operates at voltage levels from 1.5 V to 3.3 V and requires no dual polarity supply, which LCD requires.
- It works independent of ambient light unlike LCD.
- It is very visible and unlike LCD which has low readability.

2.4 SWITCHING UNIT

The function of this unit is to provide signal for the auxiliary output in order to switch the pumping machine ON / OFF. The switching unit consists of NAND gates, OR gate and RS flip flop. In digital electronics we have two types of logic circuits viz. combinational circuits and sequential circuits. [6]

2.4.1 COMBINATIONAL CIRCUIT

Combinational circuits are logic circuits in which the outputs depend on the present input; the output does not depend on the previous inputs. Combinational circuits consist essentially logic gates and their outputs are two either HIGH (1) or LOW (0). The basic logic gates are AND gates, OR gates, and NOT gates (inverters). The functional description of these gates is given below.

AND gates— the output of an AND gate is HIGH only when all the inputs of AND gate is HIGH and the output is LOW whenever one of the input is LOW. The truth table of a two input AND gate is given below. X and Y are the inputs to the AND gate and Z is the output.

Table 1: truth table of an AND gate

X	Y	Z
LOW (0)	LOW (0)	LOW (0)
LOW (0)	HIGH (1)	LOW (0)
HIGH (1)	LOW (0)	LOW (0)
HIGH (1)	HIGH (1)	HIGH (1)

OR Gate— the output of an OR gate is HIGH whenever one of the inputs is HIGH and the output is LOW only when all the input is LOW. The truth table of a two input OR gate is given below. X and Y are the inputs to the OR gate and Z is the output.

Table 2.truth table of an OR gate

X	Y	Z
LOW (0)	LOW (0)	LOW (0)
LOW (0)	HIGH (1)	HIGH (1)
HIGH (1)	LOW (0)	HIGH (1)
HIGH (1)	HIGH (1)	HIGH (1)

NOT Gate – NOT gate is basically an inverter, it invert the input i.e. it gives an inverter input at the output. The truth table of a NOT gate is given below.

Table 3 truth table of a NOT gate

INPUT	**OUTPUT**
LOW(0)	HIGH(1)
HIGH(1)	LOW(0)

Other logic gates are obtained by combining two or more of the basic logic gates. NAND gates are obtain by combining AND gate and NOT gate, combination of NOT gate and OR gate gives NOR gates, e.t.c. AND gate was realized in this project by combining two NAND gates, [5] A quad 2 input NAND gate and a quad 2 input NOR gate were used.

2.4.2 SEQUENTIAL CIRCUIT

Sequential circuits are essentially combinational circuits with memory elements. The output of circuits depends on the present input as well as the past input. Example of sequential circuits is flip flops. [5] RS flip flop is used in this project to set and reset the auxiliary output.

2.5 AUXILIARY UNITS

The function of this unit is to switch ON or OFF supply to the pumping machine when the water reaches a certain level. It consists basically of a relay controlled by the output of the RS flip flop and a transistor is used to drive the relay.

2.5.1 RELAY

Relay a specialized electrical switch by means of which a high-power device can be controlled by a device of much lower power. It consists of an electromagnet coil and mechanical switch contacts that are pushed and pulled by the electromagnet. The electromagnet requires a current of only a few hundred milliamps, produced by only a few volts, whereas the contacts may be subject to hundreds of volts and tens of amperes of current may pass through them. The switch therefore enables a small electric current and voltage to control a much larger current and voltage. Many small switches and electronic circuits cannot withstand large electric currents (often, no more than 1 ampere) and would be unable to control, for example, a car headlamp bulb, which requires a current of many amps. This may be achieved by placing a relay between the small switch on the car dashboard and the high-powered headlamp bulb. Relay coils are available for a wide range of voltages, and some are designed to control many different switch contacts simultaneously. Relay is used in this design to switch ON / OFF AC supply to the pumping machine. [9] A diode is connected across the relay to prevent reverse current from damaging the transistor. Transistors are made from semiconductors materials, such as silicon or germanium, that are "doped" (have minute amounts of foreign elements added) so that either abundance or a lack of free electrons exists. In the former case, the semiconductor is called n-type, and in the latter case, p-type. It consists of three layers of doped material, forming two p-n (bipolar) junctions with configurations of p-n-p or n-p-n. If one junction is connected to a battery so as to allow current flow (forward bias), and the other junction has a battery connected in the opposite direction (reverse bias), if the current in the forward-biased junction is varied by the addition of a signal, the current in the reverse-biased junction of the transistor will vary accordingly. The principle can be used to construct amplifiers in which a small signal applied to the forward-biased junction causes a large change in current in the reverse-biased junction. [4] A general purpose small signal NPN transistor is used in this design to drive the relay. A diode is connected to the base of the transistor to prevent reverse current flow.

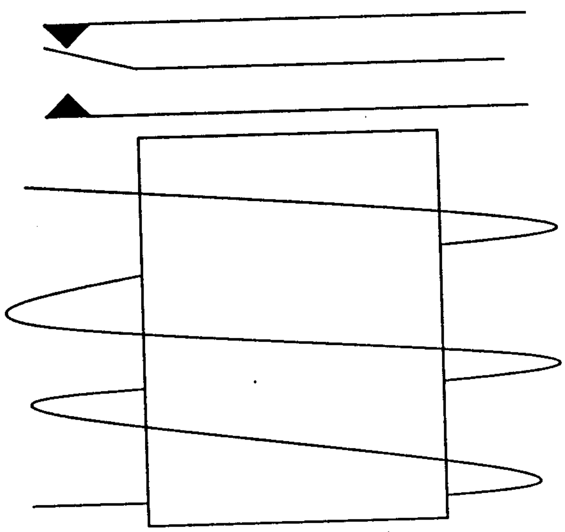


Fig 2.5 symbol of relay

2.6 ALARM UNIT

The alarm unit consists of a timer and a buzzer. The timer is used to time the buzzer while the buzzer gives an audio sound when the reservoir is full. It requires little current for its operation. The versatile integrated circuit 555 timer is used to time the alarm.

The versatile integrated circuit 555 timer is use to time the buzzer so as to turn it OFF after the time has elapsed. The 555 monolithic timing circuits is a highly stable controller capable of producing accurate time delays, or oscillation. In the time delay mode of operation, one external resistor and capacitor precisely control the time. For a stable operation as an oscillator, the free running frequency and the duty cycle are both accurately controlled with two external resistors and one capacitor. The figure below illustrates a monostable circuit. In this mode, the timer generates a fixed pulse whenever the trigger voltage falls below Vcc/3. When the trigger pulse voltage applied to the pin 2 falls below Vcc/3 while design the timer output is low, the timers' internal flip-flop turns the discharging Tr. Off and causes the timer output to become high by charging the external capacitor C1 and setting the flip-flop output at the same time. The voltage across the external capacitor C1, VCC increases exponentially with the time constant T= RaC and reaches 2Vcc/3 at Td = 1.1RaC. Hence, capacitor C1 is charged through resistor Ra. The greater the time constant RaC, the longer it takes for the Vc1 to reach 2Vcc/3. In other words, the time constant RaC controls the output pulse width.

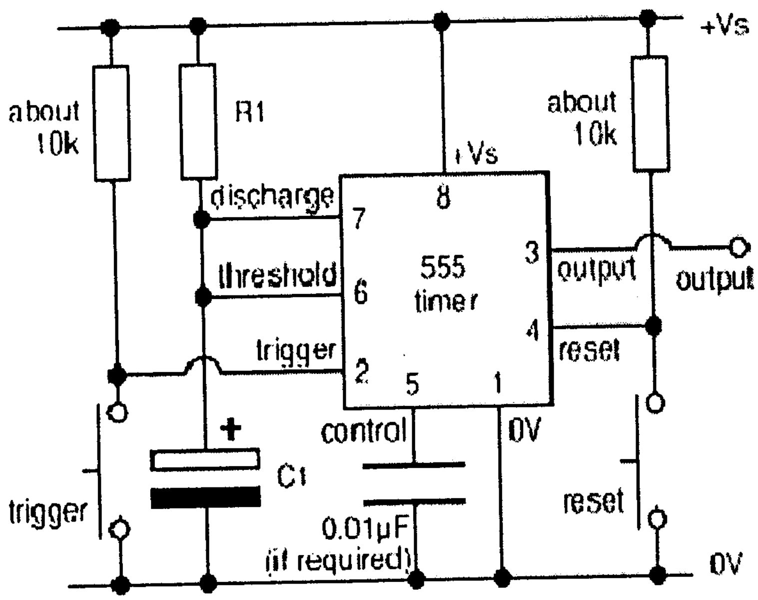


Fig 2.7 Monostable circuit

When the applied voltage to the capacitor C1 reaches 2Vcc/3, the comparator on the trigger terminal resets the flip-flop, turning the discharging Tr. On. At this time, C1 begins to discharge and the timer output converts to low. In this way, the timer operating in monostable repeats the above process. It must be noted that, for normal operation, the trigger pulse voltage needs to maintain a minimum of Vcc/3 before the timer output turns low.

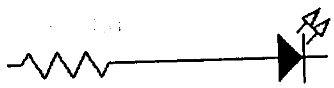
That is, although the output remains unaffected even if a different trigger pulse is applied while the output is high, it may be affected and the waveform not operate properly if the trigger pulse voltage at the end of the output pulse remains at below Vcc/3. [8]

CHAPTER THREE

DESIGN AND IMPLEMENTATION

This chapter focuses on the design analysis of the various units making up the water level indicator and a brief description of the operation of the device is also given. It is worthy of note that IC types and component values are chosen by making use of the manufacturers data sheet and are attached as the appendices.

3.1 INDICATOR CIRCUIT



To limit the current through the LEDs, it is usually connected in series with a resistor.

The value of the resistor is calculated as follows

$$\frac{Vs-Vr}{Ir} = R$$

Where

Vs is the DC supply voltage = 6V

Vr is the LEDs forward voltage = 1.8V

If is the LEDs current =10mA

Total resistance value = 1.02kΩ

Use nearest available standard value is 2.2Kohm

3.2 SENSOR CIRCUIT

The capacitance of water was measured within the limits of test it varies between 30nF and 35nF (volume of water is taken into consideration) and by experiment it was discover that the circuit will work if the value of the capacitance is less than the capacitance of water hence 10nF was chosen. One terminals of the capacitor is connected to the supply, the other terminal is connected to the probes, when the circuit is powered the capacitor is charged, when water touches the probes the capacitor will be discharged and when water falls below the probes the capacitor will be charged again through a resistor. Current passes through the water for a very short duration (discharging period of the capacitor), this account for the elimination of electrolysis which is more pronounce in DC circuits than AC circuits.

NAND gate is used as an inverter by connecting its two inputs together. At the initial stage the input of the NAND gate is high and the output is low. When the probes detect water, the capacitor start discharging and input of the NAND gate is LOW and the output is HIGH. The output of the NAND gate serves as the triggering signal for the indicator unit and the switching unit.

A quad 2-Input NAND gate CMOS IC was used as an inverter. The circuit diagram of the sensor unit is shown in the figure below;

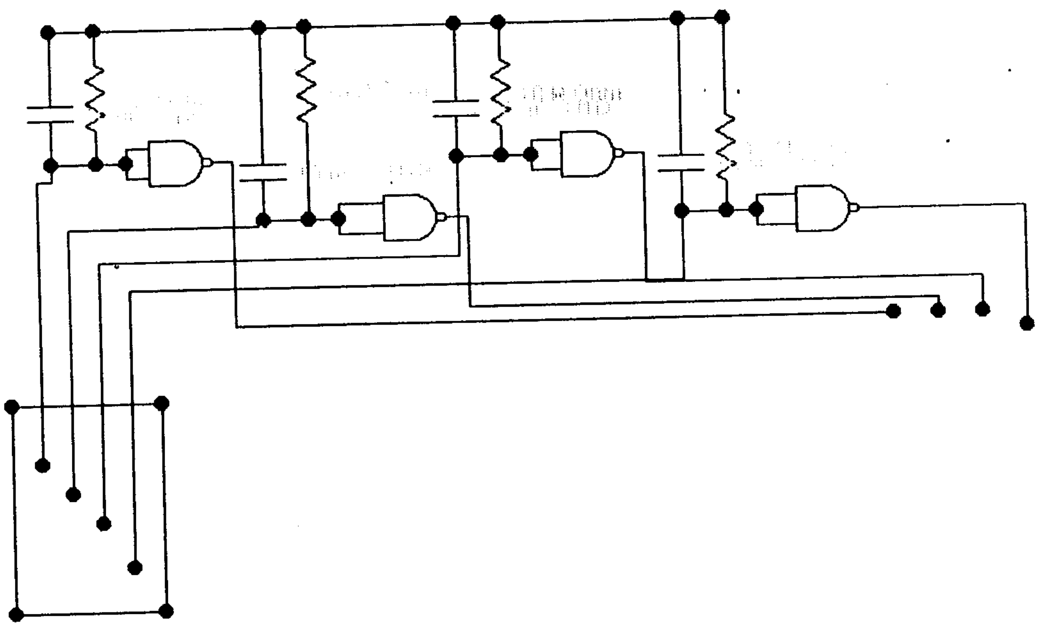


Fig 3.2 Sensor unit circuit diagram

3.3 SWITCHING CIRCUIT

The switching unit control the auxiliary output, to turn the machine OFF when the water reservoir is full and turn it ON when falls below a predetermined level, meaning that we have two level which can be called a LOW level (when water falls below the predetermined level) and HIGH level (i.e. when the water reservoir is full). A CMOS IC D flip flop was used to energize and de-energize the auxiliary output. The flip flop has to be SET and CLEAR in order to control the auxiliary output. Two NAND gate was used to realize an AND gate in order to SET the auxiliary output (i.e. turn it OFF) When ever there is HIGH level is a LOW level at the input of the NOR gate.

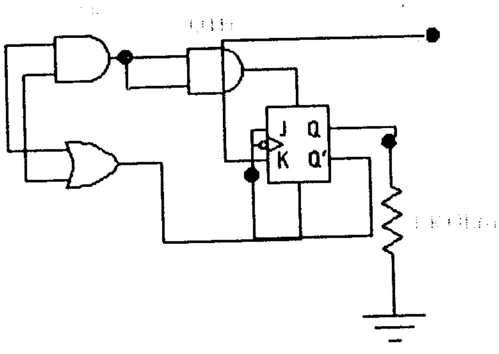


Fig 3.3 Switching circuit

3.4 ALARM CIRCUIT

The alarm circuit consists of a buzzer and a timer. The timer is used to time the buzzer while the buzzer gives an audio sound when the reservoir is full. It require little current for it operation. The versatile integrated circuit 555 timer is used to time the buzzer so as to turn it Off after the timer has elapsed. The 555 monolithic timing circuit is highly stable controller capable of producing accurate time delay mode of operation, one external resistor and one capacitor.

The circuit may be triggered and reset on falling waveform (i.e it is negatively edge trigger).[1]

A monostable circuit in this mode the timer generated a fixed pulse<whenever the trigger voltage falls below Vcc/3. when the trigger pulse voltage applied to the pin 2 fall below Vcc/3 while the timer output is low , the timer 's internal flip – flop turns the discharging Tr Off and causes the timer output to become high by charging the external capacitor C1 and setting the flip _ flop output at the same time. The voltage across the external capacitor C1, VC1 increases exponentially with the time constant T = 1.1Rac. Hence, capacitor C1 is charged through resistor Ra. The alarm circuit is shown in the figure below.

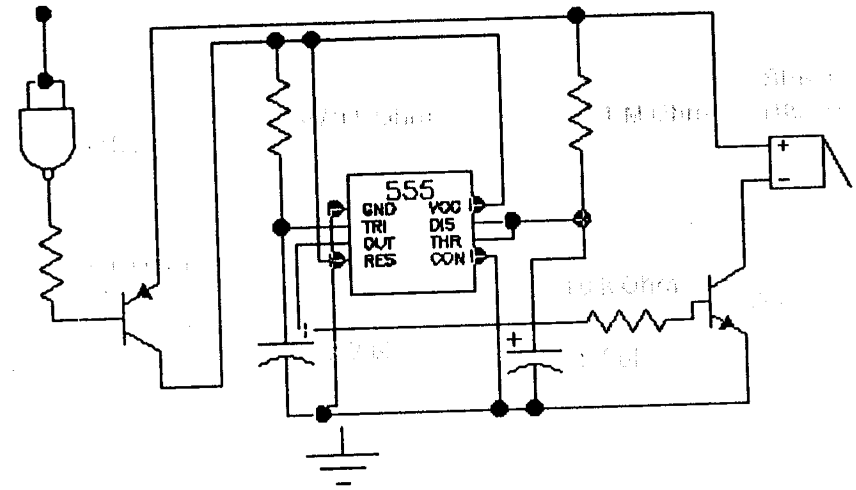


Fig 3.5 circuit diagram of the alarm circuit.

IC 555 timer was used in monostable mode. A resistor and a capacitor determine the ON time and they are connected externally to the IC 555 timer as shown in figure 3.5 above.

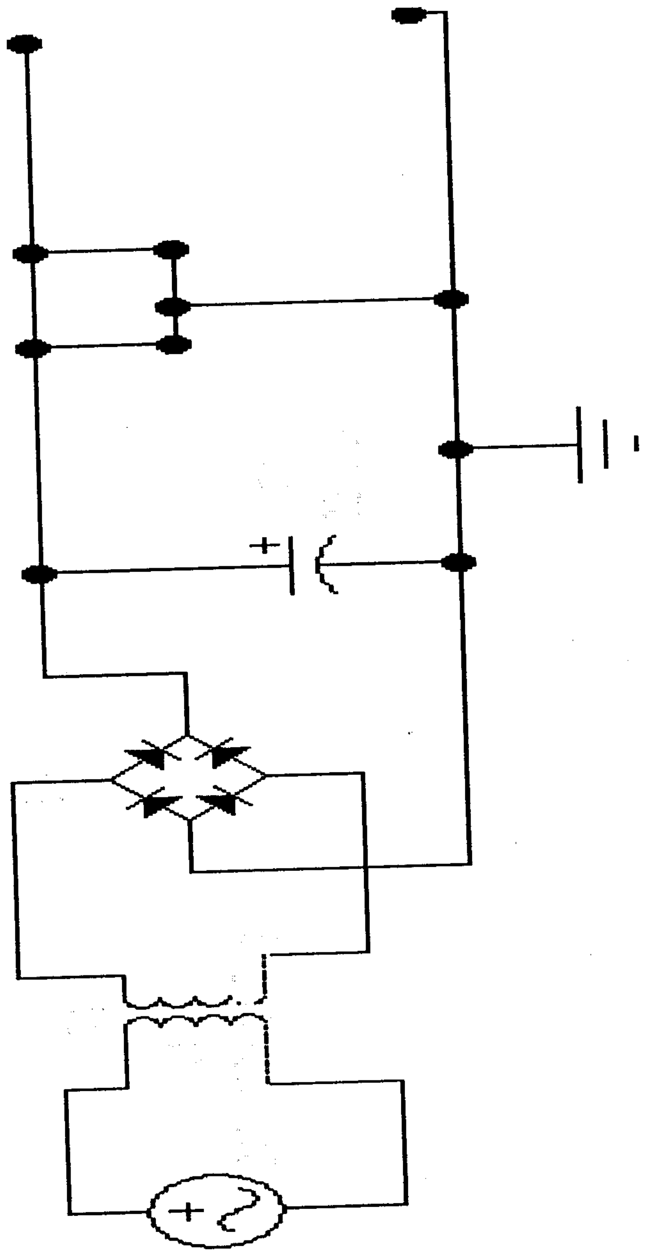
For monostable operation of the timer, ON time is given by

Ton =R15C6

For an operating period of 4 seconds, with R = 1 MΩ, The value of R is given by

$C = 4/(1 \times 10^3) = 4\ \mu F$

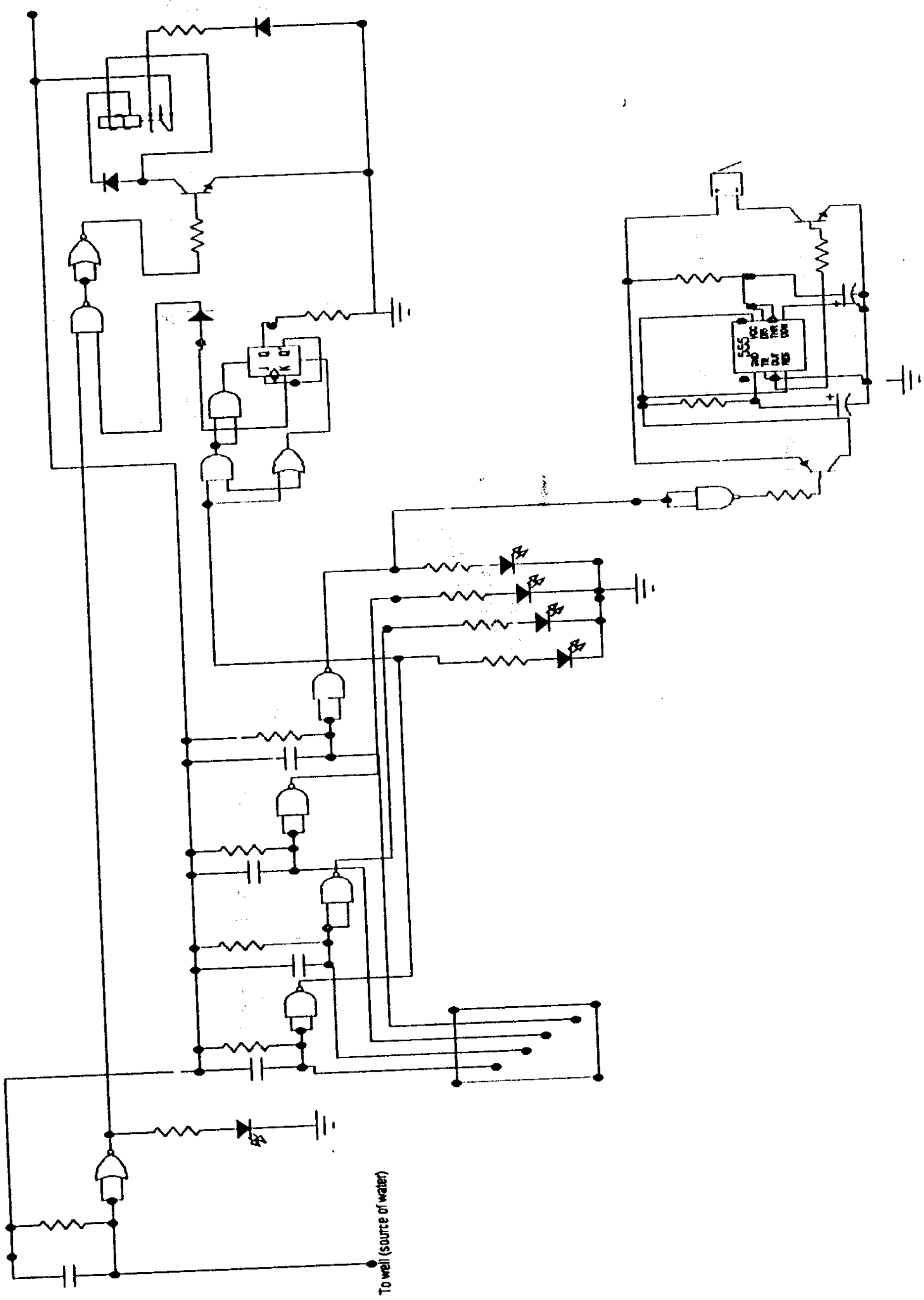
The preferred value is 4.7µF



T1 = 230/6V Transformer D1 = Bridge Rectifier C1= 2200μF Capacitor

U1= 7806 1C Voltage Regulator

FIG. 3.6 CIRCUIT DIAGRAM OF POWER SUPPLY UNIT



CIRCULT DIAGRAM OF WATER LEVEL INDICATOR WITH ALARM

3.5 LIST OF COMPONENTS

s/n	Components	Value
1	Resistor, R1, R2, R3, R4, R16	10M Ohm
2	Resistor, R5, R6, R7, R8, R17	2.2K Ohm
3	Resistor, R9, R10, R11, R13	10 K Ohm
4	R12	470 K Ohm
5	R14	47 K Ohm
6	R15	1 M Ohm
7	Capacitor, C1, C2, C3, C4, C7,	10 uF
8	C5	2.2 uF
9	C6	4.7 uF
10	NAND gate, UIA, U1B, U1C, U1D, U2A, U6A, U2D	CMOS IC CD4011
11	NOR gate, U5A, U5B, U5C,	CMOS IC CD4001
12	D FLIP FLOP	CMOS IC CD4013
13	D1, D2, D3, D4, D8	LEDs
14	D5, D7	IN4148
15	NPN transistor	C945
16	PNP Transistor	2N4403
17	RELAY 1	6V DC relay
18	SPEAKER 1	6V Buzzer
19	TIMER U4	IC NE555

CHAPTER FOUR

TESTING AND RESULTS

4.1 INITIAL TESTING OF THE CIRCUIT

The project was firstly carried out on a bread board, it involved the temporary connections of the altogether circuit(the involved components).

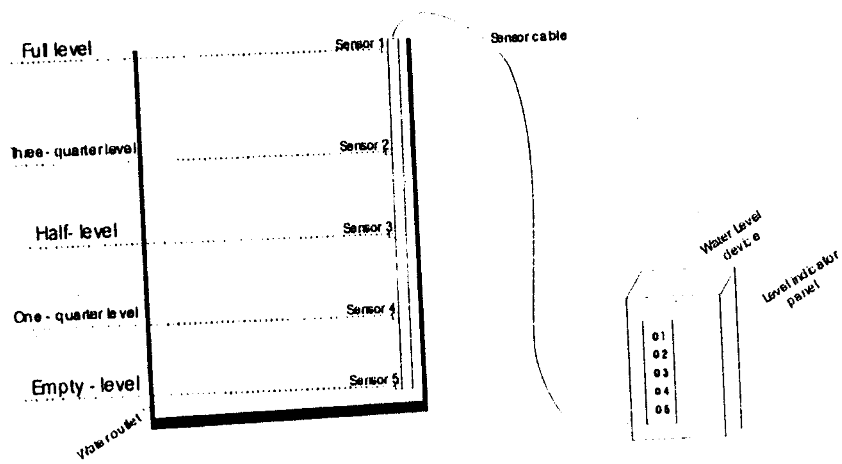
The connection involved placing each component into the breadboard and linking them together through jumper wires according to the circuit.

There was no requirement for soldering operation,therefore different adjustments were performed on board to make the circuit okay and acceptable by standard.

The major change was at the audio alarm output, where the output or alarm frequencies Were altered for more audibility. The circuit ended up working according to the specified aim.

4.2 THE MAIN TESTING

The five water sensors were placed at different position in open – top plastic water bucket, where the bucket served as the water tank, the number five, four, three, two and one water sensors were placed at ground, one – quarter, half, three quarter and top levels respectively (see fig 4a).



4.3 TEST SET-UP

The next step was the connection of the circuit to the A.C main supply and power switch of the device was moved Off to On mode. The next step was the attempt to gradually fill up the container with water while the indicators were carefully observed for any change. Moreover, when the container was finally filled, the water was driven out of the container through a floor outlet. The response of the level indicators were carefully observed throughout the exercise and the audio alarm output was also monitored for any sound.

4.4 RESULT OF THE TEST

The moment the device was powered with electricity ,the power indicator came on. A loud audio alarm was heard at the buzzer. It was observed that none of the involved indicator panel was on, but as water got into the container, the initial audio alarm got off, it was followed by the number five light indicator and the alarm was heard again when the tanks was fulled with water. The number four light emitting diode came on as the water got the three- quater level of the container, the number three indicator also came on as the water reached its of middle level of the container. The number two indicator also came ON when the water reached one-quarter level of the container. But as the container was not filled with water , the first light indicator came On and alarm was no heard. There was no sound when the water was empty from the container.

As the water in the container was trapped out, the initial audio alarm became off along with the switching Off of the first light indicator and switching OFF of the pumping machine . As the water was down – passed the one – quarter level, the number two ,three and five light indicators were Off. At the empty –container condition, the fifth light indicator went Off and the pumping machine turn ON while the alarm was OFF.

4.5 DISCUSSION OF RESULT

The light indicator panel merely described the response of respective water sensors to water at particular levels through visual indication. The logic was that as water touches a particular water sensor at a specified level, a corresponding light indicator comes On. Also, as water leaves a particular level , the corresponding light indicator goes Off. The sound effect of the full and empty levels defines their importance and sensitivity, the sound alarms responds only to the two levels therefore, for a proper water level monitoring , the five sensors must be placed at right position in a given container or tank. Generally, the device can be used for both domestic and industrial application for detecting, controlling and monitoting the water level within a given vessel or storage tank.

4.6 COST ANALYSIS

The cost of the various components and other material used in contructing the water level indicator with alarm is given in the table below.

Description	Quantity	Unit cost (N)	Total Cost (N)
240/12 V Transformer	1	200	200
7806 Voltage Regulator	1	100	100
IC NE555	1	100	100
LEDs	5	10	50
Breadboard	2	450	900
Veroboard	2	40	80
Bridge Rectifier	1	90	90
Capacitors	8	50	400

IC CD 4001	2	100	200
IC CD 4003	2	100	200
IC CD 4011	4	100	400
1N4148 Diodes	2	30	60
C945 Transistors	2	40	80
2N4403 Transistors	2	40	80
6v Relay	1	1	100
Buzzer	1	1	100
Motor Dc	1	300	300
Power Switch	1	60	60
Power Cable	1	50	50
Resistors	17	10	170
Water Vessel	2	50	100
Soldering Lead	5 yard	20	100
Casing	1	500	500
Total			4520

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

This chapter concludes the design and construction of a water level indicator alarm and useful suggestions were also presented for future work or further studies in designing and constructing this type of device.

This simple but reliable device has been designed to monitor (indicate) water level in any vessel and also ensure that the water does not fall below a predetermined level. It is ideal for monitoring the level of water and it indicate five different levels though the level can be increased to the desired number of levels. Not only is the knowledge of the level itself important but also other measurements can be inferred from the level. If the tank geometry and dimensions are additionally known, the volume of the liquids can be determined. If additionally the density of the liquid is known the mass can be calculated. The device can be used in automated water distributors, water dispensers, washing machines irrigation systems, water tanks, and e.t.c. The circuit will turn the machine Off once the liquid has reached a preset maximum level. The device has in built control to switch the machine Off when there is no water to pump from the water source(ie well reservoir e.t.c) in order to protect the machine from damage. It work with both metallic and non-metallic containers.

This device is very useful as it keeps the level a water within limits in a container as it switches the motor On and Off only when the two extremes are reached. Obviously, if it had to keep the maximum level constant the situation would have been different and the machine would have to be switch On and Off frequently and this will reduce the useful life of the machine. Keeping the level within certain limits only operates the pump occasionally which reduces wear to the machine, noise and running costs.

The following recommendations are made for further work on this project.

- The versatility of the device can be improved upon so that it can be used to monitor the level of any liquid or fluid not only water alone.
- For advance automation of this device, means of incorporating microprocessor as the switching device can be explored.
- Pre- recorded voice message alarm is more interactive technology that could be incorporated into the design.
- Further work on this project can look into the ways by which the device can be used for automatic transfer or fluid from one vessel to another.
- As the evident from the above, the design and construction of the water level indicator with alarm was achieved with the use of simple electronic components which are low cost with efficiency, durability and reliability improved upon over a previous designs.
- Further work can be done in the areas highlighted above.

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APPENDIX

Timer NE/SA/SE555/SE555C

2003 Feb 14 2

DESCRIPTION

The 555 monolithic timing circuit is a highly stable controller capable of producing accurate time delays, or oscillation. In the time delay mode of operation, the time is precisely controlled by one external resistor and capacitor. For a stable operation as an oscillator, the free running frequency and the duty cycle are both accurately controlled with two external resistors and one capacitor. The circuit may be triggered and reset on falling waveforms, and the output structure can source or sink up to 200 mA.

FEATURES

- Turn-off time less than 2 µs
- Max. operating frequency greater than 500 kHz
- Timing from microseconds to hours
- Operates in both astable and monostable modes
- High output current
- Adjustable duty cycle
- TTL compatible
- Temperature stability of 0.005% per °C

APPLICATIONS

- Precision timing
- Pulse generation
- Sequential timing
- Time delay generation
- Pulse width modulation

PIN CONFIGURATION

1
2
3
4 5
6
7
GND 8
TRIGGER
OUTPUT
RESET
DISCHARGE
THRESHOLD
CONTROL VOLTAGE
VCC

D and N Packages

SL00349

Figure 1. Pin configuration

BLOCK DIAGRAM

COMPARATOR
COMPARATOR
FLIP FLOP
OUTPUT
STAGE
THRESHOLD
Vcc
6
7
3 1
4
2
5
8
R
R
R
CONTROL
VOLTAGE
TRIGGER
RESET
DISCHARGE
OUTPUT GND

SL00350
Figure 2. Block Diagram

ORDERING INFORMATION

DESCRIPTION TEMPERATURE RANGE ORDER CODE DWG #
8-Pin Plastic Small Outline (SO) Package 0 to +70 °C NE555D SOT

CD4013BC Dual D-Type Flip-Flop

CD4013BC
Dual D-Type Flip-Flop

General Description

The CD4013B dual D-type flip-flop is a monolithic complementary MOS (CMOS) integrated circuit constructed with N- and P-channel enhancement mode transistors. Each flip-flop has independent data, set, reset, and clock inputs and "Q" and "Q" outputs. These devices can be used for shift register applications, and by connecting "Q" output to the data input, for counter and toggle applications. The logic level present at the "D" input is transferred to the Q output during the positive-going transition of the clock pulse. Setting or resetting is independent of the clock and is accomplished by a high level on the set or reset line respectively.

Features

_ Wide supply voltage range: 3.0V to 15V
_ High noise immunity: 0.45 V_{DD} (typ.)
_ Low power TTL: fan out of 2 driving 74L compatibility: or 1 driving 74LS

Applications

- Automotive
- Data terminals
- Instrumentation
- Medical electronics
- Alarm system
- Industrial electronics
- Remote metering
- Computers

Ordering Code:

Devices also available in Tape and Reel. Specify by appending the suffix letter "X" to the ordering code.

Connection Diagram

Top View

Truth Table

No Change
x Don't Care Case
Note 1: Level Change

Order Number Package Number Package Description
CD4013BCM M14A 14-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow
CD4013BCSJ M14D 14-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide
CD4013BCN N14A 14-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide

CL
(Note 1)
D R S Q Q
_ 0 0 0 0 1
_ 1 0 0 1 0
_ x 0 0 Q Q
x x 1 0 0 1
x x 0 1 1 0
x x 1 1 1 1

Quadruple 2-input NOR gate
HEF4001B
gates

DESCRIPTION

The HEF4001B provides the positive quadruple 2-input NOR function. The outputs are fully buffered for highest noise immunity and pattern insensitivity of output impedance.

Fig.1 Functional diagram.

HEF4001BP(N): 14-lead DIL; plastic (SOT27-1)

HEF4001BD(F): 14-lead DIL; ceramic (cerdip) (SOT73)

HEF4001BT(D): 14-lead SO; plastic (SOT108-1)

( ): Package Designator North America

Fig.2 Pinning diagram.

FAMILY DATA, I_{DD} LIMITS category GATES

See Family Specifications

Quadruple 2-input NOR gate
HEF4001B

gates

AC CHARACTERISTICS

V_{SS} = 0 V; T_{amb} = 25 °C; C_L = 50 pF; input transition times ≤ 20 ns

V_{DD}

V

SYMBOL TYP MAX

TYPICAL EXTRAPOLATION

FORMULA

Propagation delays

$I_n \rightarrow O_n$ 5 60 120 ns 33 ns + (0,55 ns/pF) C_L

HIGH to LOW 10 t_{PHL} 25 50 ns 14 ns + (0,23 ns/pF) C_L

15 20 40 ns 12 ns + (0,16 ns/pF) C_L

5 50 100 ns 23 ns + (0,55 ns/pF) C_L

LOW to HIGH 10 t_{PLH} 25 45 ns 14 ns + (0,23 ns/pF) C_L

15 20 35 ns 12 ns + (0,16 ns/pF) C_L

Output transition times 5 60 120 ns 10 ns + (1,0 ns/pF) C_L

HIGH to LOW 10 t_{THL} 30 60 ns 9 ns + (0,42 ns/pF) C_L

15 20 40 ns 6 ns + (0,28 ns/pF) C_L

5 60 120 ns 10 ns + (1,0 ns/pF) C_L

LOW to HIGH 10 t_{TLH} 30 60 ns 9 ns + (0,42 ns/pF) C_L

15 20 40 ns 6 ns + (0,28 ns/pF) C_L

V_{DD}

V

TYPICAL FORMULA FOR P (μW)

Dynamic power 5 1100 $f_i + \sum (f_oC_L) \times V_{DD}$

2 where

dissipation per 10 5000 $f_i + \sum (f_oC_L) \times V_{DD}$

2 f_i = input freq. (MHz)

package (P) 15 14 200 $f_i + \sum (f_oC_L) \times V_{DD}$

2 f_o = output freq. (MHz)

C_L = load capacitance (pF)

$\sum(f_oC_L)$ = sum of outputs

V_{DD} = supply voltage (V)

Small-signal Transistors

LEADED DEVICES

NPN GENERAL PURPOSE LOW-POWER TRANSISTORS

TYPE NUMBER	PACKAGE	V_{CEO} max (V)	I_C max. (mA)	P_{tot} max. (mW)	h_{FE} min.	h_{FE} max.	f_T min. (MHz)	PNP COMPL.	PAGE
2N2484	TO-18	60	50	360	250	800	60	–	131
2N4124	TO-92	25	200	500	120	360	300	2N4126	161
2N5088	TO-92	30	100	500	350	1050	50	2N5087	175
2PC945	TO-92	50	100	500	135	600	150	2PA733	208
2PC945K	TO-92	50	100	500	300	600	150	2PA733K	208
2PC945P	TO-92	50	100	500	200	400	150	2PA733P	208
2PC945Q	TO-92	50	100	500	135	270	150	2PA733Q	208
2PC1815	TO-92	50	150	500	120	700	80	2PA1015	202
2PC1815BL	TO-92	50	150	500	350	700	80	2PA1015BL	202
2PC1815GR	TO-92	50	150	500	200	400	80	2PA1015GR	202
2PC1815Y	TO-92	50	150	500	120	240	80	2PA1015Y	202
BC107	TO-18	45	100	300	110	450	100	BC177	222
BC107A	TO-18	45	100	300	110	220	100	BC177A	222
BC107B	TO-18	45	100	300	200	450	100	BC177B	222
BC108	TO-18	20	100	300	110	800	100	–	222
BC108A	TO-18	20	100	300	110	220	100	–	222
BC108B	TO-18	20	100	300	200	450	100	–	222
BC108C	TO-18	20	100	300	420	800	100	–	222
BC109	TO-18	20	100	300	200	800	100	–	222
BC109B	TO-18	20	100	300	200	450	100	–	222
BC109C	TO-18	20	100	300	420	800	100	–	222
BC237	TO-92	45	100	500	120	460	100	BC307	234
BC237B	TO-92	45	100	500	200	460	100	BC307B	234
BC337	TO-92	45	500	625	100	600	100	BC327	244
BC337A	TO-92	50	500	625	100	400	100	BC327A	244
BC337-16	TO-92	45	500	625	100	250	100	BC327-16	244
BC337-25	TO-92	45	500	625	160	400	100	BC327-25	244
BC337-40	TO-92	45	500	625	250	600	100	BC327-40	244
BC338	TO-92	25	500	625	100	600	100	BC328	244
BC338-16	TO-92	25	500	625	100	250	100	BC328-16	244
BC338-25	TO-92	25	500	625	160	400	100	BC328-25	244
BC338-40	TO-92	25	500	625	250	600	100	BC328-40	244
BC546	TO-92	65	100	500	110	450	100	BC556	261
BC546A	TO-92	65	100	500	110	220	100	BC556A	261
BC546B	TO-92	65	100	500	200	450	100	BC556B	261
BC547	TO-92	45	100	500	110	800	100	BC557	261