CHAPTER TWO

LITRETURE REVIEW

2.1 Introduction

The problem of the project depend on electrical transformers from a lack of efficiency due to high temperature and lack of stability of the loads that lead to increased maintenance costs, it has been the work of control of the transformer circuit by PLC and implemented to reduce the problems.

2.2 Transformer

A transformer is a static (or stationary) piece of apparatus by means of which electric power in one circuit is transformed into electric power of the same frequency in another circuit. It can raise or lower the voltage in a circuit but with a corresponding decrease or increase in current.[1]

2.2.1 Transformer Construction

The simple elements of a transformer consist of two coils having mutual inductance and a laminated steel core. The two coils are insulated from each other and the steel core. Other necessary parts are: some suitable container for assembled core and windings; a suitable medium for insulating the core and its windings from its container; suitable bushings (either of porcelain, oil-filled or capacitor-type) for insulating and bringing out the terminals of windings from the tank. In all types of transformers, the core is constructed of transformer sheet steel laminations assembled to provide a continuous magnetic path with a minimum of air-gap included. The steel used is of high silicon content, sometimes heat treated to produce a high permeability and a low hysteresis loss at the iron core secondary coil secondary coil 110/120 volts 220/240 volts 110/120 volts' primary coil 220/240 volts Principle of transformer Figure (2.1) usual operating flux densities. [1]

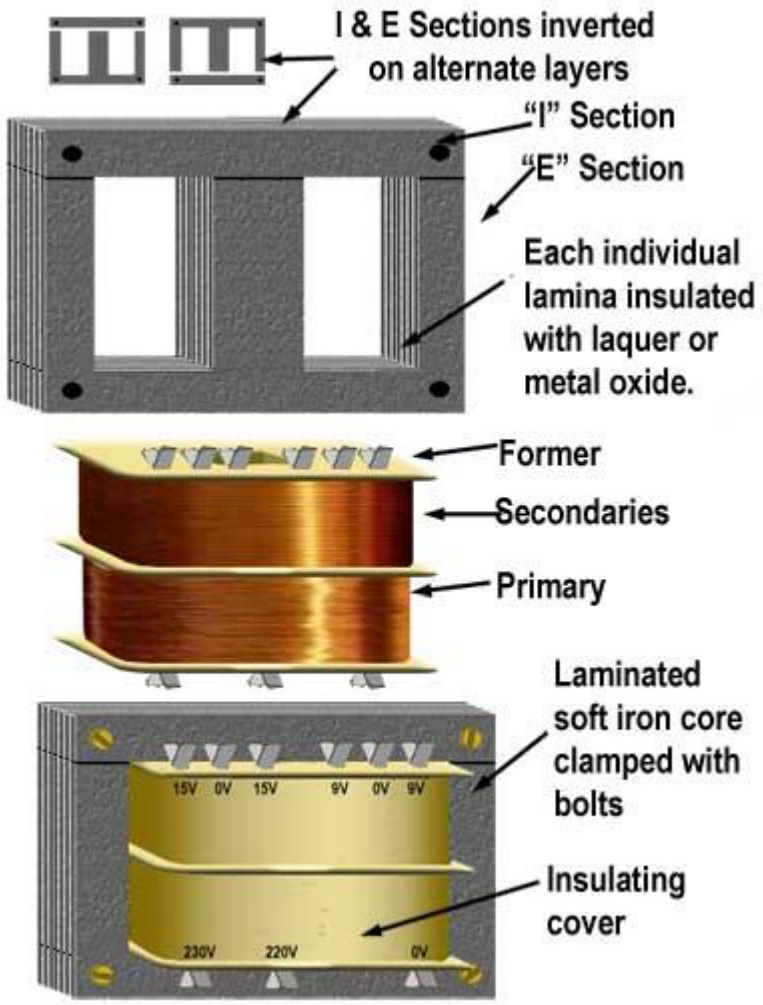

Figure 2.1 Transformer Construction

2.2.2 Working Principle of a Transformer

The physical basis of a transformer is mutual induction between two circuits linked by a common magnetic flux. In its simplest form, it consists of two inductive coils which are electrically separated but magnetically linked through a path of low reluctance as shown in Figure (2.2). The two coils possess high mutual inductance. If one coil is connected to a source of alternating voltage, an alternating flux is set up in the laminated core, most of which is linked with the other coil in which it produces mutually-induced e.m.f. (according to Faraday's Laws of Electromagnetic Induction . If the second coil circuit is closed, a current flows in it and so electric energy is transferred (entirely magnetically) from the first coil to the second coil. The first coil, in

which electric energy is fed from the a.c. supply mains, is called primary winding and the other from which energy is drawn out, is called secondary winding.[1]

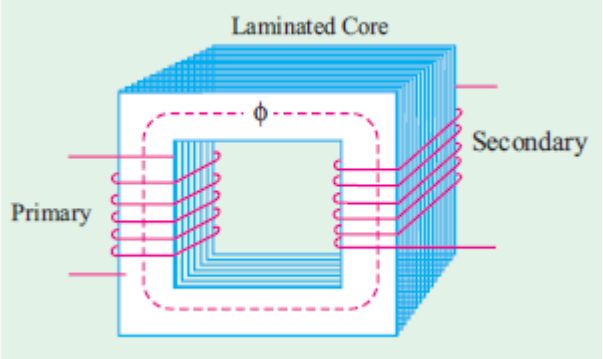

Figure 2.1 Working Principle of a Transformer

2.2.3 Type of transformer

Transformers several types divided on the basis of cooling, connection, insulating and use:

2.2.3.1 Terms of cooling

contains several types of themAir Natural, Oil Natural Air Natural, Oil natural Air Forced, Oil Forced Air Forced and Oil Forced Water Forced.

- **Air Natural Transformer Cooling (A.N.):**

This type of Transformer Cooling method applies to dry type transformer of small rating. The surrounding air in the vicinity of the transformer is used for cooling. Small transformers below 25kVA can be readily cooled by air natural cooling. However, air natural cooling is also used for large dry type transformers. Cooling takes place by convection air currents.[3]]

- **Oil Natural Air Natural Transformer Cooling (O.N.A.N.):**

This type of Transformer cooling is widely used for oil filled transformers up to about 30MVA. In Natural cooling, the oil in the tans gets heated due to the heat generated in the core and windings. The hot Oil flows upward and the cold Oil comes down according to the principle of convection. The oil flows in the transformer tank by the principle of natural convection hence this type of cooling

is called Oil Natural Cooling. Heat is transferred from core and transformer windings to the oil and the heated oil is cooled by the natural air. Cooling area is increased by providing the cooling tubes.[3]

- **Oil natural Air Forced Transformer Cooling (O.N.A.F.) :**

In this method, air fans are mounted near the Transformer and the forced air is directed on to the cooling tubes to increase the rate of cooling. The fans are provided with automatic starting. When the temperature of the oil and windings increases above a permissible value the thermostats switch on cooling fans. This happens during heavy load condition and during higher ambient temperatures[3]

- **Oil Forced Air Forced Transformer Cooling (O.F.A.F.):**

Transformers above 60 MVA employ a combination of Forced Oil and Forced Air Cooling. Oil Natural Air Forced type of cooling is not adequate to remove the heat caused by the losses which is approximately equal to 1% of the transformer rating (0.6MW). In case of Forced Oil and Forced air cooling system a separate cooler is mounted away from the transformer tank. This cooler is connected to the transformer with pipes at the bottom and the top. The oil is circulated from the transformer to the cooler through the pump. The cooler is provided with the fans which blast air on the cooling tubes. This type of cooling is provided for the higher rating transformers available at the Substations and Power Stations.[3]

- **Oil Forced Water Forced Transformer Cooling(O.F.W.F):**

This type of cooling system needs a heat exchanger in which the heat of the transformer oil is given to the cooling water. The cooling water is taken away and cooled in separate coolers.[3]

2.2.3.2 Terms of connection

contains several types of them One phase transformer and three phase transformer.

➢ One phase transformer

Transformers divided into two general types, the core type and shell type transformers.[1]

➢ Core Type Transformer

In this type of transformers the copper windings surround the iron core. The core made in form of a hallow squires made up from sheeted-steel laminations of 14 mills thickness, the core produced in the L shape pieces then this L shapes are stacked together.[1]

➢ Shell Type Transformers

In this type of transformer, the iron core surrounds the copper windings; also have a better characteristic than the core type transformer so the flux will divide into two parts.

The low voltage windings are made up from strapped copper wounded over the core then the high voltage windings are wounded over the low voltage windings by this way a better insulation characteristic will be obtained also the leakage flux will be reduced to the minimum value.[1]

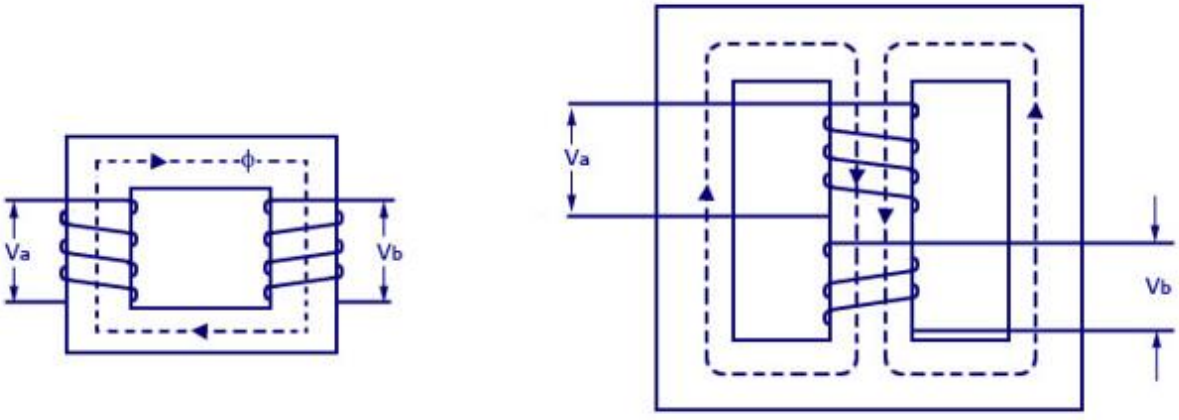

Figure 2.3 core type and shell type

- **Three phase transformer**

The three phase transformer has a less weight compared with three single phase transformers also less cost and spacing with the same total ratings.[1]

- **Core Types**

In this case the primary and the secondary windings are wounded together over one of the legged of the transformer core, so as shown Φ1, Φ2, Φ3 are differ by an angle of 120 degrees so that at any instant the sum of the individual fluxes is zero.[1]

- **Shell Type**

In this type each coil group consist of primary and secondary coils placed together in order that to minimize the leakage flux.[1]

- **Three phase Transformer Connection**

contains several types of connections star star (YY), delta star (ΔY), star delta (YΔ), Open Delta(V) and Scott or (T).[1]

- **Y Y Connection**

This configuration is used for stepping up or stepping down. [1]

- **Δ Y Connection**

This configuration is used for the distribution system so that the ground or the neutral may needed (stepping down). [1]

- **Y Δ Connection**

This configuration is used for stepping up so that no need for the neutral wire. [1]

- **V or Open Delta Connection**

This type of connection is obtained when the coil voltage exist between two open ends of two coils in the delta connection before the third coil is connected. At no load with only two transformers with 3 phase voltages are exist in the

secondary and the 3 phase transformation by using two phase transformer this type of Connection is called V, or open delta connection. [1]

- **Scott or T Connection**

By mean of T connection it is not only possible to transform the 3 Φ to 3 Φ only also the transformation from 2 Φ to 3 Φ and vice versa. [1]

2.2.3.3 Term of insulating

Transformers can be classified according to the insulating

- liquid-filled transformers
- gas-filled transformers (mainly with SF6)
- dry-type transformers

2.2.3.4 Term of use

contains several types of distribution transformers, power transformers, Auto transformer and instrument transformer. [1]

- **distribution transformer (service transformer)**

It is a transformer that provides the final voltage transformation in the electric power distribution system, stepping down the voltage used in the distribution lines to the level used by the customer. [1]

- **power transformers**

used in transmission network of higher voltages for step-up and step down application (400 kV, 200 kV, 110 kV, 66 kV, 33kV) and are generally rated above 200MVA. Power transformer is used for the transmission purpose at heavy load, high voltage greater than 33 KV & 100% efficiency. It also having a big in size as compare to distribution transformer, it used in generating station and Transmission substation. high insulation level.

Power Transformers are used in Transmission network so they do not directly connect to the consumers, so load fluctuations are very less. These are loaded

fully during 24 hr.’s a day, so Cu losses & Fe losses takes place throughout day the specific weight i.e. (iron weight)/ (cu weight) is very less. [1]

- **Auto transformer**

It is an electrical transformer with only one winding. The "auto" (Greek for "self") prefix refers to the single coil acting alone and not to any kind of automatic mechanism. [1]

- **instrument transformer**

contains two types Potential transformer and current transformer .

- **Potential transformer (V.T)**

Potential transformer or voltage transformer gets used in electrical power system for stepping down the system voltage to a safe value which can be fed to low ratings meters and relays. [1]

- **current transformer (CT)**

It is an electric device that produces an alternating current(AC) in its secondary which is proportional to the AC current in its primary. Current transformers, together with voltage transformers (VTs) or potential transformers (PTs), which are designed for measurement, are known as instrument transformers. [1]

2.3 Control

control, or controlling, is one of the managerial functions like planning, organizing, staffing and directing. It is an important function because it helps to check the errors and to take the corrective action so that deviation from standards are minimized and stated goals of the organization are achieved in a desired manner.

According to modern concepts, control is a foreseeing action whereas earlier concept of control was used only when errors were detected. Control in

management means setting standards, measuring actual performance and taking corrective action.[2]

2.3.1 Type of control

There are types:

2.3.1.1 Open-loop and closed-loop control

There are two common classes of control systems, open loop control systems, and closed loop control systems.

In an open loop control system, the control action from the controller is independent of the "process output".

In a closed loop control system, the control action from the controller is dependent on the process output. A closed loop controller therefore has a feedback loop which ensures the controller exerts a control action to give a process output the same as the "Reference input" or "set point". For this reason, closed loop controllers are also called feedback controllers. [2]

2.3.1.2 Logic control

Logic controllers may respond to switches, light sensors, pressure switches, etc., and can cause the machinery to start and stop various operations. Logic systems are used to sequence mechanical operations in many applications. PLC software can be written in many different ways – ladder diagrams, SFC – sequential function charts or in language terms known as statement lists. [2]

2.3.1.3 PID control

A proportional–integral–derivative controller (PID controller) is a control loop feedback mechanism (controller) commonly used in industrial control systems. A PID controller continuously calculates an error value e (t).

as the difference between a desired set point and a measured process variable and applies a correction based on proportional, integral, and derivative terms,

respectively (sometimes denoted P, I, and D) which give their name to the controller type. [2]

2.3.1.4 Fuzzy logic

Fuzzy logic is an attempt to apply the easy design of logic controllers to the control of complex continuously varying systems. Basically, a measurement in a fuzzy logic system can be partly true, that is if yes is 1 and no is 0, a fuzzy measurement can be between 0 and 1. [2]

2.3.2 Elements

The four basic elements in a control system:

2.3.2.1 The characteristic or condition to be controlled

The first element is the characteristic or condition of the operating system which is to be measured. We select a specific characteristic because a correlation exists between it and how the system is performing. The characteristic can be the output of the system during any stage of processing or it may be a condition that is the result of the system. [2]

2.3.2.2 The sensor

The sensor is a means for measuring the characteristic or condition. For example, in a home heating system this device would be the thermostat, and in a quality-control system this measurement might be performed by a visual inspection of the product. [2]

2.3.2.3 The comparator

The third element of control, The comparator, determines the need for correction by comparing what is occurring with what has been planned. Some deviation from the plan is usual and expected, but when variations are beyond those considered acceptable, corrective action is required. It involves a sort of preventative action which indicates that good control is being achieved. [2]

2.3.2.4 The activator

The fourth element of control, the activator, is the corrective action taken to return the system to its expected output. [2]

2.3.3 Process

Step 1. Setting performance standards.

Standards are the criteria against which actual performance will be measured. Standards are set in both quantitative and qualitative terms.

Step 2. Measurement of actual performance Performance

is measured in an objective and reliable manner. It should be checked in the same unit in which the standards are set.

Step 3. Comparing actual performance with standards.

Step 4. Analysis deviations.

Step 5. Taking corrective measures.

2.4 Programmable logic controller (P.L.C)

A PLC (i.e. Programmable Logic Controller) is a device that was invented to replace the necessary sequential relay circuits for machine control. The(PLC) works by looking at its inputs and depending upon their state, turning on/off its outputs. The user enters a program, usually via software, that gives the desired results.[7]

2.4.1 Historical background

The first PLC Construction by General Motors in 1968 , in **1977** Microprocessor-based PLC with logic processor , in **1978** Universal input/output structure , in**1979** Bit-slice processor architecture , in**1980** High -performance remote input/output with intelligent input/output Modules and block Transfer , in **1981** Medium speed data highway (token passing) , in**1982** Macrocode, multiprocessing 4th generation PLC , in**1983** Basic language coprocessor Bulk storage1986 Flexible multi language programmable Controllers. [7]

2.4.2 PLC Components

PLC device has multi components as follows as:

2.4.2.1 Central Processing Unit (CPU)

Central Processing Unit (CPU) Microprocessor based, may allow arithmetic operations, logic operators, block memory moves, computer interface, local area network, functions, etc.

CPU makes a great number of check-ups of the PLC controller itself so eventual errors would be discovered early. [7]

2.4.2.2 System Busses

The internal paths along which the digital signals flow within the PLC are called

busses.

The system has four busses:

The CPU uses the data bus for sending data between the different elements,

The address bus to send the addresses of locations for accessing stored data,

The control bus for signals relating to internal control actions,

The system bus is used for communications between the I/O ports and the I/O unit. [7]

2.4.2.3 Memory

System (ROM) to give permanent storage for the operating system and the fixed data used by the CPU.

RAM for data. This is where information is stored on the status of input and output devices and the values of timers and counters and other internal devices. EPROM for ROM's that can be programmed and then the program made permanent. [7]

2.4.2.4 I/O Sections

Inputs monitor field devices, such as switches and sensors.

Outputs control other devices, such as motors, pumps, solenoid valves, and lights. [7]

2.4.2.5 Power Supply

Most PLC controllers work either at 24 VDC or 220 VAC. Some PLC controllers have electrical supply as a separate module, while small and medium series already contain the supply module. [7]

2.4.2.6 Programming Device

The programming device is used to enter the required program into the memory and processor. The program is developed in the programming device and then transferred to the memory unit of the PLC. [7]

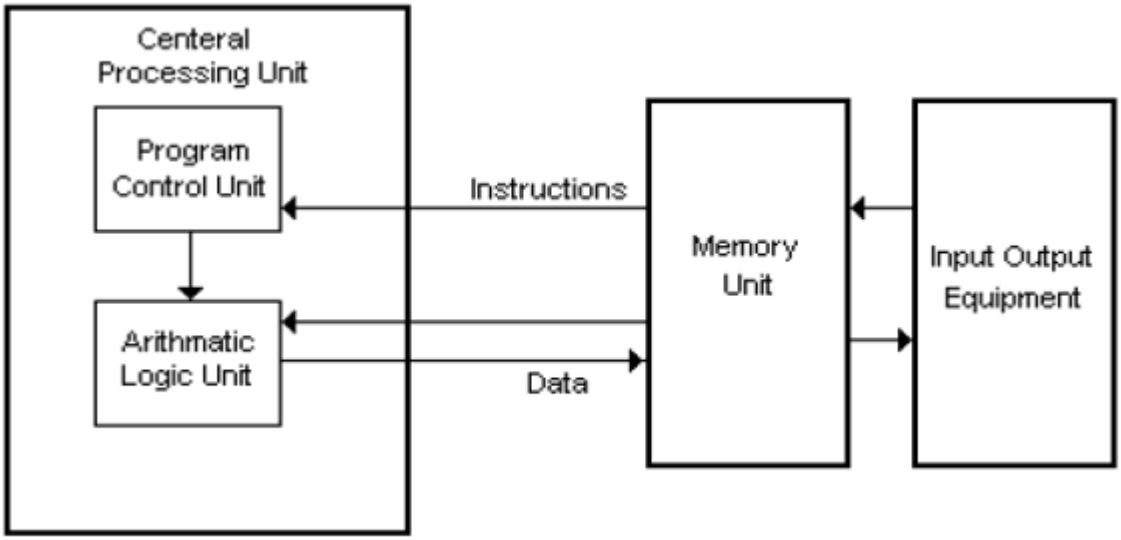

Figure 2.4 PLC Components

2.4.3 PLC Languages

There are several languages: ladder logic, Mnemonic Instruction, Sequential Function Charts, Structured Text and Function Block Diagram. [7]

2.4.3.1 Ladder Logic

Ladder logic was originally a written method to document the design and construction of relay racks as used in manufacturing and process control. Each device in the relay rack would be represented by a symbol on the ladder diagram with connectors between those devices shown. In addition, other items external to the relay rack such as pumps, heaters, and so forth would also be shown on the ladder diagram. [7]

2.4.3.2 Mnemonic Instruction

There are other methods to program PLCs. One of the earliest techniques involved mnemonic instructions. These instructions can be derived directly from the ladder logic diagrams and entered into the PLC through a simple programming terminal. [7]

2.4.3.3 Sequential Function Charts (SFC)

SFC have been developed to accommodate the programming of more advanced systems. These are similar to flowcharts, but much more powerful. This method is much different from flowcharts because it does not have to follow a single path through the flowchart. [7]

2.4.3.4 Structured Text (ST)

Programming has been developed as a more modern programming language. It is quite similar to languages such as BASIC and Pascal.

Structured Text (ST) is a high level textual language that is a Pascal like language. It is very flexible and intuitive for writing control algorithms. [7]

2.4.3.5 Function Block Diagram (FBD)

FBD is another graphical programming language. The main concept is the data flow that start from inputs and passes in block(s) and generate the output. [7]

2.5 Sensor

A device that detects the changes in electrical or physical or other quantities and thereby produces an output as an acknowledgement of change in the quantity is called as a Sensor. Generally, this sensor output will be in the form of electrical or optical signal. [6]

2.5.1 Different types of Sensors

The most frequently used different types of sensors are classified based on the quantities such as Electric current or Potential or Magnetic or Radio sensors, Humidity sensor, Fluid velocity or Flow sensors, Pressure sensors, Thermal or Heat or Temperature sensors, Proximity sensors, Optical sensors, Position sensors, Chemical sensor, Environment sensor, Magnetic switch sensor , etc. [6]

- **Speed Sensor**

Sensors used for detecting speed of an object or vehicle is called as Speed sensor. There are different types of sensors to detect the speed such as Wheel speed sensors, speedometers, LIDAR, ground speed radar, pitometer logs, Doppler radar, air speed indicators, pitot tubes and so on.

Application of Speed Sensor PIC microcontroller based project for speed synchronization of multiple motors in industries using wireless technology is a typical application of the speed sensor. One of the multiple motors in the industry is considered as a main motor which act as transmitter and remaining motors acting as receivers, will follow the speed of the main motor. The main motor and receiver motors used in this project are BLDC motors that are

controlled using PWM control with the radio frequency wireless communication mode. [6]

- **Temperature Sensor**

A device which gives temperature measurement as an electrical signal is called as Temperature sensor. This electrical signal will be in the form of electrical voltage and is proportional to the temperature measurement.

There are different types of sensors used for measuring temperature, such as Contact type temperature sensors, Non-contact type temperature sensors. These are again subdivided as Mechanical temperature sensors like Thermometer and Bimetal. Electrical temperature sensors like Thermostat, Thermocouple, Resistance thermometer and Silicon band gap temperature sensor. [6]

Application of Temperature Sensor Design of Industrial Temperature Controller for controlling temperature of devices used in industrial applications is one of the frequently used practical applications of the temperature sensor. In this circuit IC DS1621, a digital thermometer is used as a temperature sensor, thermostat, which provides 9-bit temperature readings. The circuit mainly consists of 8051 microcontrollers, EEPROM, temperature sensor, LCD display and other components. [6]

- **PIR Sensor**

An electronic sensor used for measuring the infrared light radiation emitted from objects in its field of view is called as a PIR sensor or Pyroelectric sensor. Every object that has a temperature above absolute zero emit heat energy in the form of radiation radiating at infrared wavelengths which is invisible to the human eye, but can be detected by special purpose electronic devices such as PIR motion detectors.

Application of PIR Sensor Automatic Door Opening System is a typical application of PIR sensors which is intended for automatic door closing and opening operations based on body movement near the door. PIR-sensor-based-

automatic-door- opening system circuit mainly consists of a PIR sensor, an 8051 microcontroller, a driver IC, a door motor. [6]

- **Ultrasonic Sensor**

The principle of ultrasonic sensor is similar to sonar or radar in which interpretation of echoes from radio or sound waves to evaluate the attributes of a target by generating the high-frequency-sound waves (around 40kHz). The transducer used for converting energy into ultrasound or sound waves with ranges above human hearing range is called an ultrasonic transducer. Application of Ultrasonic Sensor The distance measurement at inaccessible areas is a typical application of ultrasonic sensors. The circuit consists of an ultrasonic module, LCD display and microcontroller. The ultrasonic module is interfaced with the microcontroller and this ultrasonic transducer consists of a transmitter and receiver. [6]