# CHAPTER THREE

# DESIGN OF CIRCUIT

## 3.1 Introduction

As previously it is seen that transformers have several types, so in this study we will look at the distribution transformers and the study depending ALNASR APARTEMENTS transformer [ step down transformer 33/11 kv]and using PLC XC Series.

## 3.2 Components of Circuit

The design of circuit are include transformer type tap changer device, which consist of 17 steps to maintain the stability of voltages, and it used two sets of fans they working to cool the oil and winding at high temperature, and it used temperature sensors to measure the temperature.

To control the oil pressure in gas inside a container of transformer it used pressure relive sensor, also to Control of the gases in the oil it used buchhloz relay.

And then look to a range of types of protection of the transformer including oil level sensor, isolator and Earthing switches, signals to control open and close of CB, VT, CT.

it used PLC unit for an operation controls where the PLC receives signals from the parts mentioned, and then the process of control depends on programming.

### 3.2.1 Transformer

ALNASR APARTEMENTS three phase power transformer contains of :

**Table 3.1: transformer specification**

| | | | |
|---|---|---|---|
| Type | SFZ9 20000/33 | DWGNO.of product | 1DQ.710.958 |
| Standard | IEC76 | Rated voltage | +4(33000 *1.25%)/11000V-12 |
| Rated power | 20000 KVA | Numberof phase | 3 |
| Insulation level | HV LI 170 AC 70 KV LV LI 75 AC 28 KV | Type of cooling | ONAN/ONAF |
| Connection symbol | DYALL | Service condition | OUTDOOR |
| Untacking weight | 18657 KG | Rated frequency | 50 Hz |
| Oil weight | 7485 KG | | |
| Total weight | 32775 KG | | |
| Transportation weight | 27126 KG | | |

## 3.2.2Oil / Winding Temperature Sensor

Oil Temperature Indicator**:** The Oil Temperature Indicator (OTI) measures the Top oil Temperature. It is used for control and protection for all transformers.

Winding Temperature Indicator**:** The Winding is the component with highest temperature within the transformer and, above all, the one subject to the fastest temperature increase as the load increases.

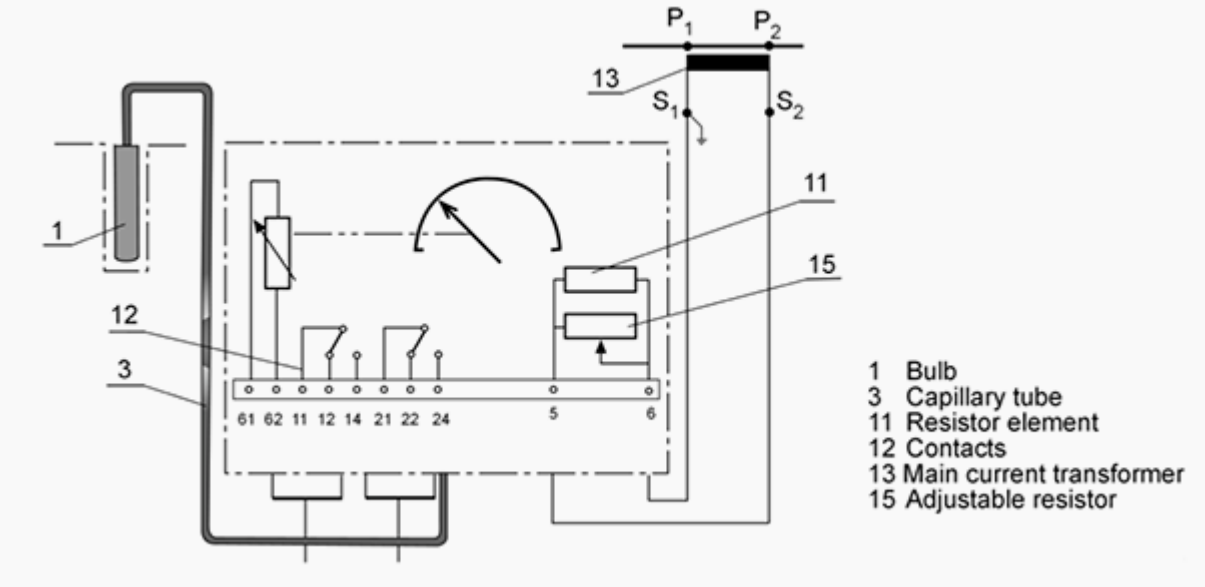


**Figure 3.1: Oil / Winding Temperature Sensor**

The measurement is further expanded with a current signal proportional to the loading current in the winding.

This current signal is taken from a current transformer located inside the bushing of that particular winding. This current is lead to a resistor element in the main unit. This resistor heats up, and as a result of the current flowing through it, it will in its turn heat up the measurement bellow, resulting in an increased indicator movement.

With three contacts fitted, first used to start fans operation for forced cooling, the second level to initiate an alarm and the three step to trip load breakers or de-energize the transformer or both.

### 3.3.3 Buchholz Relay (Gas)

Buchholz relay is one of the protective device for electrical transformer from internal faults. It works with all gas and oil immersed transformer. Buchholz relay in transformer is an oil contained arrangement. Buchholz relay connected in between pipe from main tank to conservator tank and it is filled with oil throughout transformer operation. It is used for all power transformers, but not

economical in the case of low rated transformers. Mostly Buchholz relay employed for gas and oil operated transformer (rated >500 kVA).

The buchholz relay works on the principle of gas vaporization from insulating oil in the fault conditions.Buchholz relay protects power transformer from all internal faults such as breakdown of the insulating oil, insulation failure of winding,over heat generated in the coils due to failure of insulation etc.

Buchholz relay function is based on very simple mechanical phenomenon. It consists of two elements mounted in a metallic chamber located in the pipe connecting the conservator and the transformer tank. When minor fault occur, heat is produced due to current leakage, some of the oil in transformer tank evaporates and some of the vapor gets collected at the top of the chamber while passing it to the conservator.

When a predetermined amount of vapor accumulates at the top of the chamber, the oil level falls, the mercury switch attached to a float is tilted so it closes the alarm circuit and rings the bell. A release cock is provided at the top of the chamber, so that after operation, the pressure in the chamber can be released and the gas emitted allows the chamber to refill with oil.

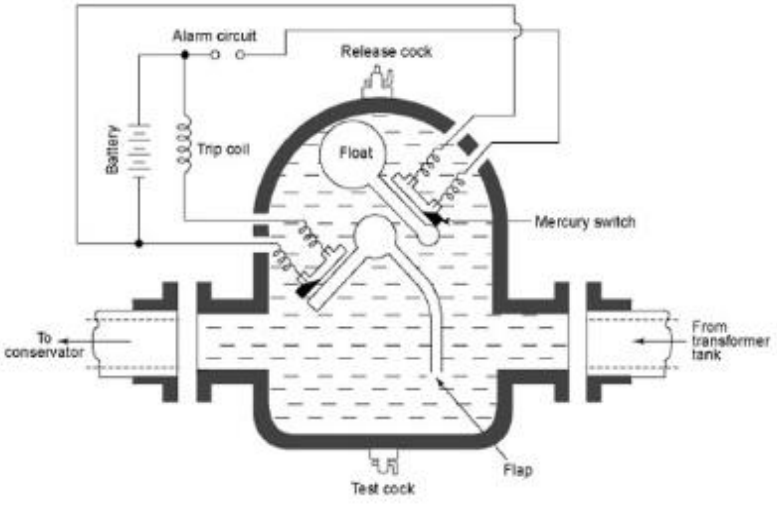


**Figure 3.2: Buchholz (Gas) Relay**

### 3.3.4 Oil Level Monitor Device

Transformers with oil conservator(s) (expansion tank) often have an oil level monitor. Usually, the monitor has two contacts for alarm. One contact is for maximum oil level alarm and the other contact is for minimum oil level alarm.


**Figure 3.3: Oil Level Monitor Device**

### 3.3.5 Pressure Relay

Many power transformers with an on-tank-type tap changer have a pressure protection for the separate tap changer oil compartment. This protection inside the tap changer oil enclosure.When the pressure in front of the piston exceeds the counter force of the spring, the piston will move operating the switching contacts. The micro switch inside the switching unit is hermetically sealed and pressurized with nitrogen gas.

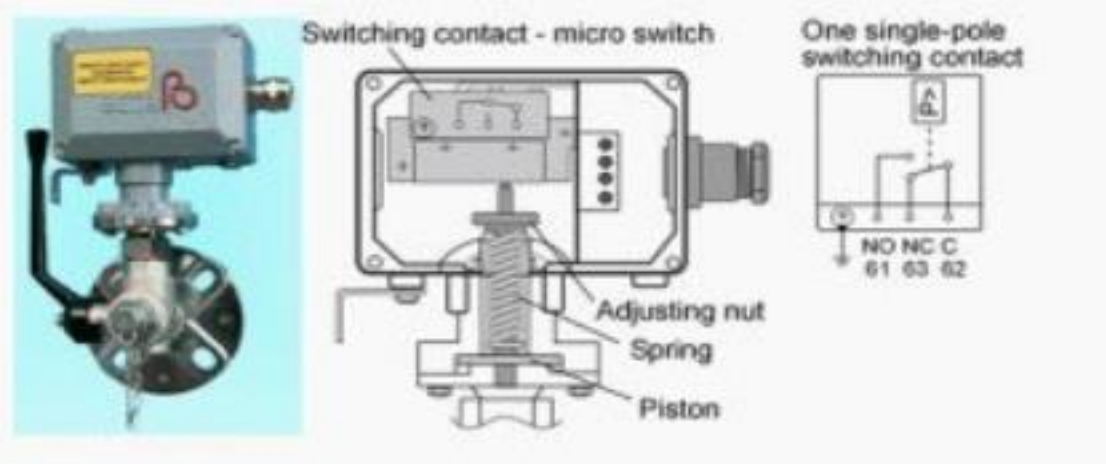


**Figure 3.4: Pressure Relay**

### 3.3.6 current transformer (C.T)

A current transformer (CT) is a transformer that is used to produce 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.

When a current is too high to measure directly or the voltage of the circuit is too high, a current transformer can be used to provide an isolated lower current in its secondary which is proportional to the current in the primary circuit. The induced secondary current is then suitable for measuring instruments or processing in electronic equipment. Current transformers also have little effect on the primary circuit. Often, in electronic equipment, the isolation between the primary and secondary circuit is the important characteristic.

Current transformers are used in electronic equipment and are widely used for metering and protective relays in the electrical power industry.

Like any transformer, a current transformer has a primary winding, a core and a secondary winding, although some transformers, including current transformers, use an air core. In principle, the only difference between a current transformer and a voltage transformer (normal type) is that the former is fed with a 'constant' current while the latter is fed with a 'constant' voltage, where 'constant' has the strict circuit theory meaning.

The alternating current in the primary produces an alternating magnetic field in the core, which then induces an alternating current in the secondary. The primary circuit is largely unaffected by the insertion of the CT. Accurate current transformers need close coupling between the primary and secondary to ensure that the secondary current is proportional to the primary current over a wide current range. The current in the secondary is the current in the primary (assuming a single turn primary) divided by the number of turns of the

secondary. In the illustration on the right, 'I' is the current in the primary, 'B' is the magnetic field, 'N' is the number of turns on the secondary, and 'A' is an AC ammeter.

Current transformers are used extensively for measuring current and monitoring the operation of the power grid. Along with voltage leads, revenue-grade CTs drive the electrical utility's watt-hour meter on virtually every building with three-phase service and single-phase services greater than two hundred amperes.

High-voltage current transformers are mounted on porcelain or polymer insulators to isolate them from ground. Some CT configurations slip around the bushing of a high-voltage transformer or circuit breaker, which automatically centers the conductor inside the CT window.

Current transformers can be mounted on the low voltage or high voltage leads of a power transformer; sometimes a section of a bus-bar can be removed to replace a current transformer.

Often, multiple CTs are installed as a "stack" for various uses. For example, protection devices and revenue metering may use separate CTs to provide isolation between metering and protection circuits, and allows current transformers with different characteristics (accuracy, overload performance) to be used for the devices.

The burden (load) impedance should not exceed the specified maximum value to avoid the secondary voltage exceeding the limits for the current transformer. Also, the primary current rating of a current transformer should not be exceeded or the core may enter its nonlinear region and ultimately saturate. This would occur near the end of the first half of each half (positive and negative) of the AC sine wave in the primary and would compromise the accuracy.

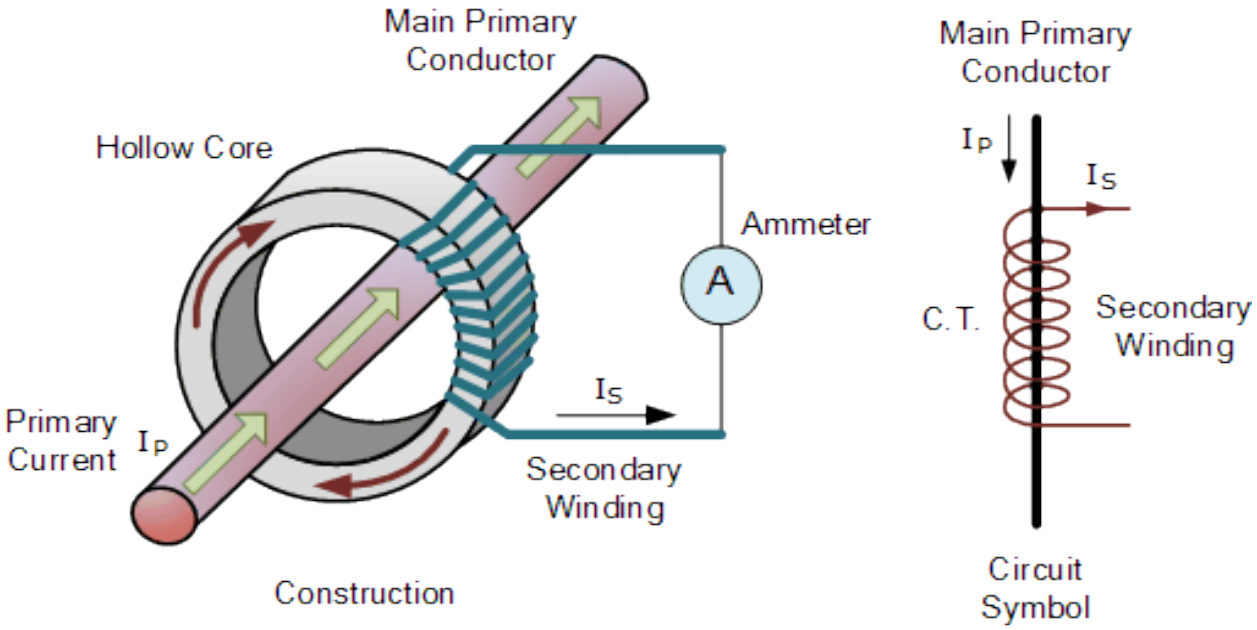


**Figure 3.4: current transformer**

### 3.3.7 Circuit breaker (CB)

A circuit breaker is an automatically operated electrical switch designed to protect an electrical circuit from damage caused by overcurrent or overload or short circuit. Its basic function is to interrupt current flow after protective relays detect a fault. Unlike a fuse, which operates once and then must be replaced, a circuit breaker can be reset (either manually or automatically) to resume normal operation. Circuit breakers are made in varying sizes, from small devices that protect an individual household appliance up to large switchgear designed to protect high voltage circuits feeding an entire city.

A circuit breaker essentially consists of fixed and moving contacts, called electrodes. Under normal operating conditions, these contacts remain closed and will not open automatically until and unless the system becomes faulty.

The contacts can be opened manually or by remote control whenever desired. When a fault occurs on any part of the system, the trip coils of the breaker get energized and the moving contacts are pulled apart by some mechanism, thus opening the circuit.

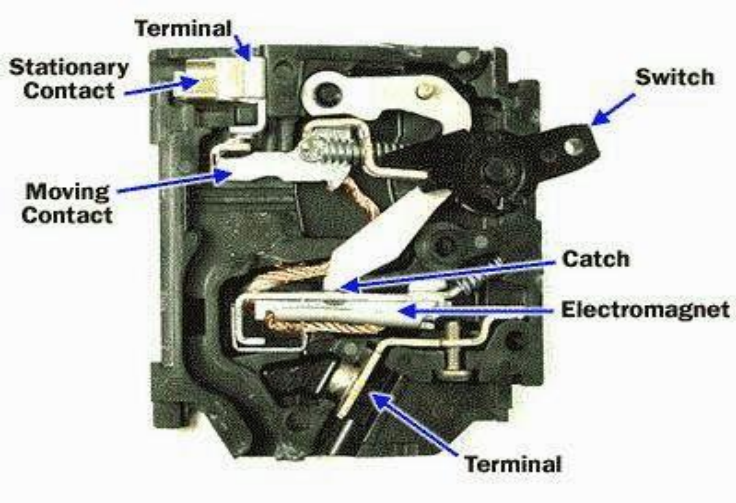


**Figure 3.6: Circuit breaker**

## 3.3.8 Earthing Switches

Earthing switches are safety devices which are integral parts of circuit breakers. When a circuit breaker is removed and racked out, the sections of the bus bar adjacent to the circuit breaker are automatically earthed by means of these switches.

This protects the maintenance personnel from accidental voltages. The closing action of the earthing switch is of snap action type. Earthing switches are usually dimensioned to withstand short circuit currents. Earthing switches can also be motorized.

Earthing switches are usually used in conjunction with isolators. When the isolator isolates the circuits, the earthing switches make contact with the bus bar and discharge any charges which may have accumulated there.

## 3.3.9 Tap changer

A tap changer is a connection point selection mechanism along a power transformer winding that allows a variable number of turns to be selected in discrete steps. A transformer with a variable turns ratio is produced, enabling stepped voltage regulation of the output. The tap selection may be made via an automatic or manual tap changer mechanism.

Figure 3.7: Tap changer

### 3.2.10 PLC XC Series

This sub-series belongs to the standard models of XC series PLC. They could fulfill most using requirements. If no special demonstrate, this manual's content are all written for XC3 series PLC.

**Table 3.2: PLC specification**

| | | |
|---|---|---|
| Model: | XC 3-60R-E(CLOCK) | Ver. |
| QTY: | 1 | V3.2 |
| 36DI/24DO/2COM PORTS | | |
| Xinje Electronic Co., ltd. | | |

## 3.4 Block Diagram

Block diagram showed inputs and outputs of plc

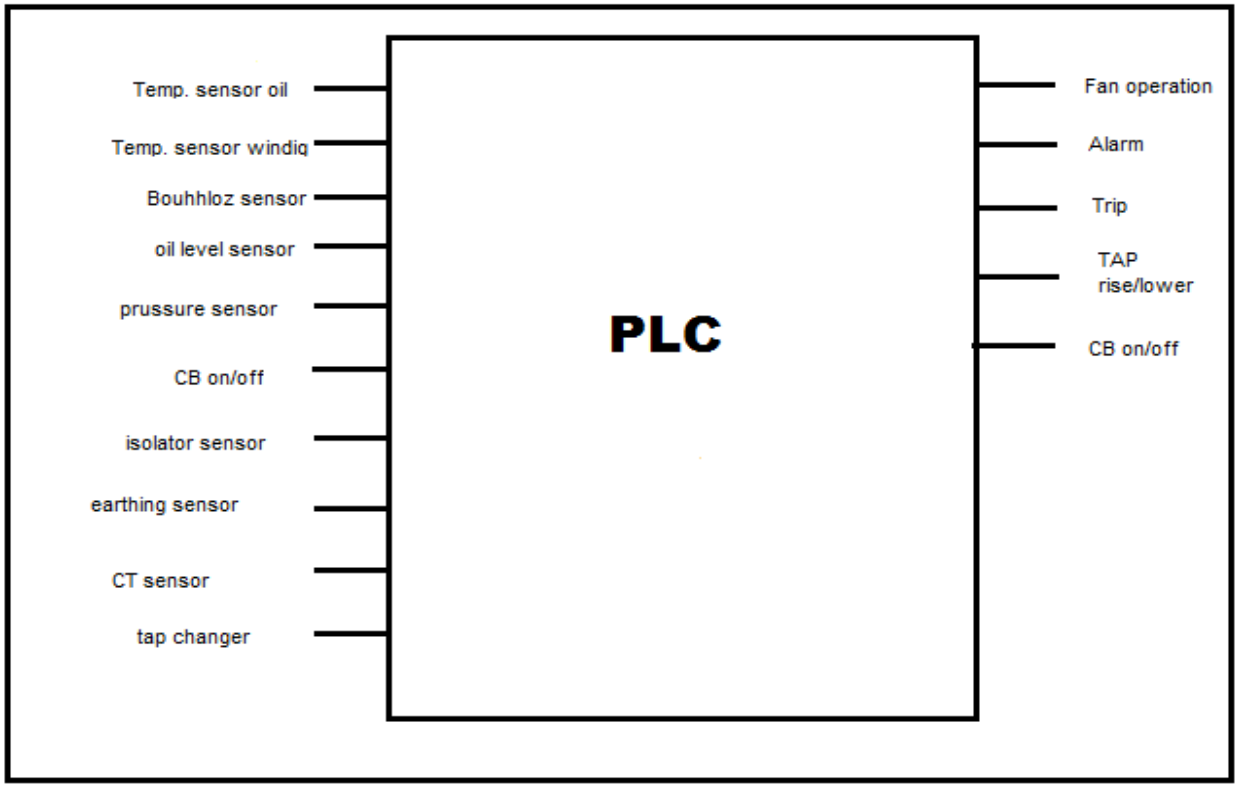


**Figure 3.4: input/output of PLC**