American International University- Bangladesh
Department of Electrical and Electronic Engineering
EEE 4227: Power System Protection Laboratory

Title: Study of the performance of different protection schemes of a power transformer.

Introduction:

In this experiment, the performance of the following schemes of a power transformer will be observed:

1. Buchholz alarm
2. Buchholz trip
3. Temperature alarm
4. Temperature trip
5. Differential relay trip due to phase to phase and ground fault
6. Restricted E/F relay trip

Theory and Methodology:

The choice of the protection for any power transformer depends upon a number of factors such as its size, importance and cost.

Buchholz relay (Gas relay / Gas actuated relay):

All faults below oil in a transformer result is the localized heating and break down of the oil; some degree of arcing will always take place in a winding fault and resulting decomposition of the oil will release gas such as hydrogen, Carbon monoxide and light hydro carbons. When the fault is of a very minor type, such as a hot joint, gas is released slowly, but a major fault involving severe arcing causes rapid release of large volumes of gas as well as oil vapor. The action is so violent that the gas and oil vapor do not have time to escape but instead build up pressure and bodily displace the oil.

When such faults occur in transformers having oil conservators, the faults cause a blast of oil to pass up the relief pipe to the conservator.

(a)Buchholz Alarm:

The incipient faults (gradually developing faults in the winding below oil level) produce the gas and it gets collected in the upper portion of the relay, thereby the oil level in the relay drops down. The float, floating in the oil in the relay tilts down with lowering the oil level. While doing so the mercury switch attached to the float is closed on to the alarm circuit.

(b)Buchholz trip:

The short circuit fault causes a blast of oil rushes towards the conservator through Buchholz relay. The baffles (plate) in the Buchholz relay get pressed by the rushing oil. Thereby it closes another switch which in turn closes the trip circuit of the circuit breaker.

(c) and (d) Overheating Protection:

The rating of the transformer is based on the temperature rise above an assumed maximum ambient temperature; under this condition no sustained overload is usually permissible. At lower ambient temperature some degree of overload can be safely applied. Short time overloading are also permissible to an extent dependent on the previous loading conditions. No precise ruling applicable to all conditions can be given concerning the magnitude and direction of safe overload.

Thermocouples or resistor temperature detectors are kept near each winding. These are connected to a bridge circuit. When temperature increases above safe value, an alarm is given. If measures are not taken, the circuit breaker is tripped after a certain temperature. Some typical settings for oil temperature are as follows-

At 60^0C, Switch on fans

At 95^0C, give an alarm

At 120^0C, give a trip signal to trip the CB.

A temperature of about 95^0C is considered to be the normal maximum working value. Any further rise of 8^0-10^0C beyond this 95^0C will make the life of the transformer half if this rise is sustained.

(e) Protections of transformer against internal fault by differential relay:

In protection of a transformer, CTs are connected at both sides of the transformer. The CT secondaries are connected in star or delta and pilot wires are connected between the CTs of each end. The CT connections and CT ratios are such that current fed into the pilot wires fron both the ends are equal during normal and for through fault conditions. During any kind of internal fault, like phase to phase faults or phase to ground faults, the balanced is disturbed. The out of balance current (I_1-I_2) flows through the relay operating coils. To avoid unwanted relay operation on through faults, restraining coils are provided in series with the pilot wires. The average current through the restraining coil is (I_1+I_2)/2. As a result the restraining current increases with the increase of (I_1-I_2) in the operating coil for a through fault condition.

(f) Restricted Earth Fault Protection of Y-winding

When E/F occurs very near to the neutral point of Y-winding of the transformer, the voltage available for driving earth fault current is small. Hence the fault current is low. If the normal biased different relay is to sense such faults, it has to be too sensitive and would therefore operate for spurious signal like, external faults and switching surges, under this condition restricted earth fault protection scheme has evolved. Here the practice is to set the relay such that it operates for earth fault current of the order of 15% of rated winding current, such setting protects restricted portion of the winding.

Apparatus:

- Relay Module

- Instruction Manual

Precautions:

- Do not touch the bare conductors or connecting junctions.
- Do not switch on/off anything in the circuit without following the hierarchy.
- Be careful when power is supplied to the module and if any casing is kept open.

Experimental Procedure:

A 3ϕ, 28 MVA, 132/33KV, Δ- connected power transformer feeds power to a 33 KV bus from a 132 KV bus as shown in the figure 10.1.-

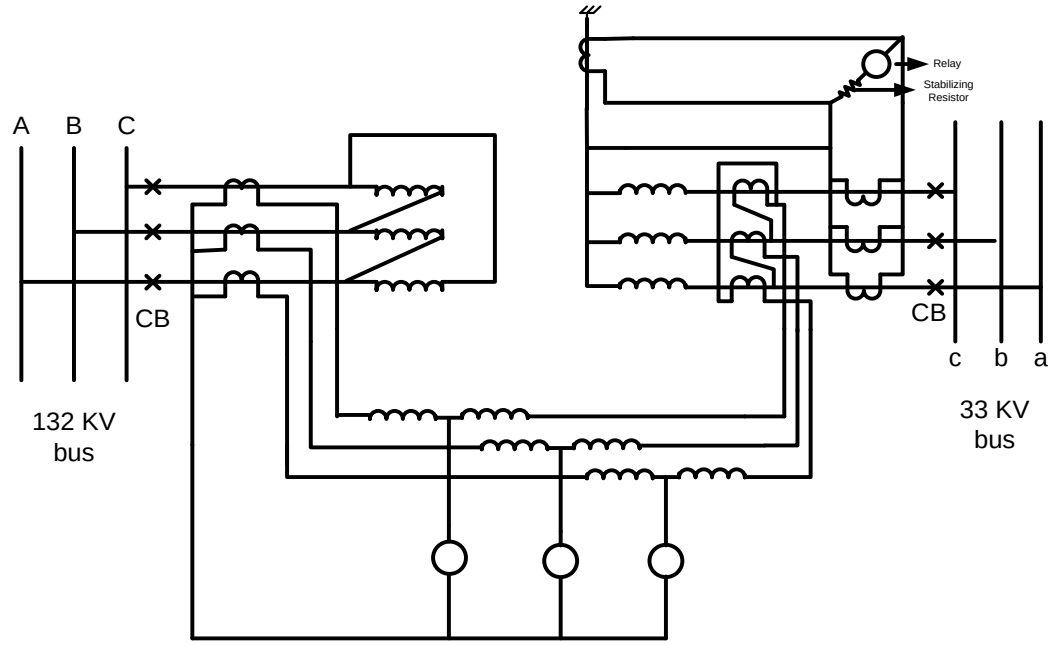

Fig 9.1. Experimental setup for analysis of transformer protection schemes

Temperature Alarm:

For pushing the temperature alarm switch, which represents the closing of a contact due to rise in winding temperature, an alarm signal will be displayed on the relay display board.

Temperature trip:

If the winding temperature goes to a very high level, the transformer should be isolated from the system. By pushing the temperature trip switch, the temperature relay essentially closes the trip circuit and fault is cleared by two breaker on the two sides of the transformer.

Buchholz Alarm:

Pushing this button means closing the contact of Buchholz relay as an indication of incipient fault in the winding inside the oil, so an alarm indication is displaced on the relay.

Buchholz trip:

Pushing this button means closing the contact of Buchholz rely as an indication of internal short circuit fault. So the breakers on both sides of the transformer are tripped.

Internal Fault:

A short circuit fault in the winding is created by pushing the correct button. This fault is detected by the differential relay and the breakers on both sides of the transformer are tripped to isolate the fault.

Restricted E/F Protection:

An earth fault close to the neutral end of the Y- winding of the transformer is created by pushing the relevant button. This fault is detected by the concerned relay and the breakers on both sides of transformer are tripped to isolate the fault.

Questions for report writing:

1. What do you mean by incipient faults in the transformer winding? What are the possible causes if this fault?
2. Is the earth fault close to neutral end of an wye connected winding very common? Why?
3. Explain why percentage differential relay is not suitable for detecting the E/F near neutral end of an wye connected winding whose neutral is grounded through high resistance.

Reference(s):

1. "Switchgear Protection and Power Systems" by Sunil S Rao .