PLC Based Software Approach for ICT Protection and Control

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Abstract—**Inter Connecting Transformer is a high power capacity transformer located between 230 and 400 KV grid lines.It is an auto transformer having capacity of 250 MVA.It connects 230 KV and 400 KV buses.It's a single winding transformer connected in star and the neutral is brought out and earthed.A 33 KV tertiary winding is available and it is delta connected.The transformer has got an on load tap changer with 16 taps.There are many problems associated with power loss in transformer but this paper mainly focuses on efficient cooling system designed for overcoming heating and insulation losses. For the effective cooling system there are 12 numbers of 3ph fans which are used for Air forced(AN) technique and Oil pumps used for Oil forced technique(OF).The operation of those drives mainly depends on the temperature of the oil and winding. Ideally PLC is used for online monitoring and data recording.In our paper,we have proposed an intelligent cooling system based on Programmable Logic Controller(PLC) which eradicates the problem of manual transformer cooling control system.PLC logic is used for controlling all the components which are involved in the protection of transformer and also using the component only when needed eradicates the wastage of power and unnecessary operations.**

Keywords—Ladder Logic,TMCScomponent

I. Introduction

In this world of technology,the demand for better and hassle-free electrical energy is an absolute necessity.One of the most crucial roles played in supply of electrical energy is by the transformer.The different types of false occurring inside a transformer are overload,short circuit,over excitation,oil level fault,insulation breakdown etc.The overload fault leads to large current which increases the oil as well as the winding temperature thereby decreasing the insulation lifespan.Over excitation leads to excessive flux which causes heating and increased current,noise and vibration.When the temperature of the transformer goes high,oil level in the tank decreases due to heating effect.If the oil level goes beyond marked level,it will affects the cooling and insulation of transformer.Insulation breakdown can occur between winding and earth, between transformer resulting in local hotspots and even the insulation failure.Initially, the degradation of insulation occurs slowly but increases at faster rate in due course of time which leads to final failure of transformer.So,it is necessary to ensure proper working of cooling system when required.In this paper an attempt has been made to operate the cooling system in a smarter way by using PLC.

II. Literature Survey

Traditionally the transformer cooling system is controlled via contactors,intermediate relays,timer relays,temperature relays etc .But with the continuous promotion of intelligent electricity grid.The control mode of ICT cooling system cannot meet the new demand.On-line monitoring via internet allows the detection of developing faults in transformer operation.This allows reduction in fault probability,longer response time to take corrective actions and reduction in cost for repair or replacement of the damaged equipment.

PLC based transformer monitoring and control system(TMCS) meet these objectives.The designed TMCS is for permanent installation or close to a specific transformer and is intended for monitoring a single unit.Computer with PLC ladder logic for controlling transformer cooling system is automatic,reliable and cost effective.

In earlier system designs,the transformer cooling system suffered from the problem of redundancy of standby cooling system.The lack of operation resulted in damage/failure of transformer.The monitoring and switching between different cooling systems of a transformer was manually done where a person would visit the transformer site for periodic switching of cooling system,maintenance and recording the various necessary parameters.This type of switching usually leads to human errors and was also time consuming.It also needed skilled labor for switching operations which increased labor cost.

A. Compenents:

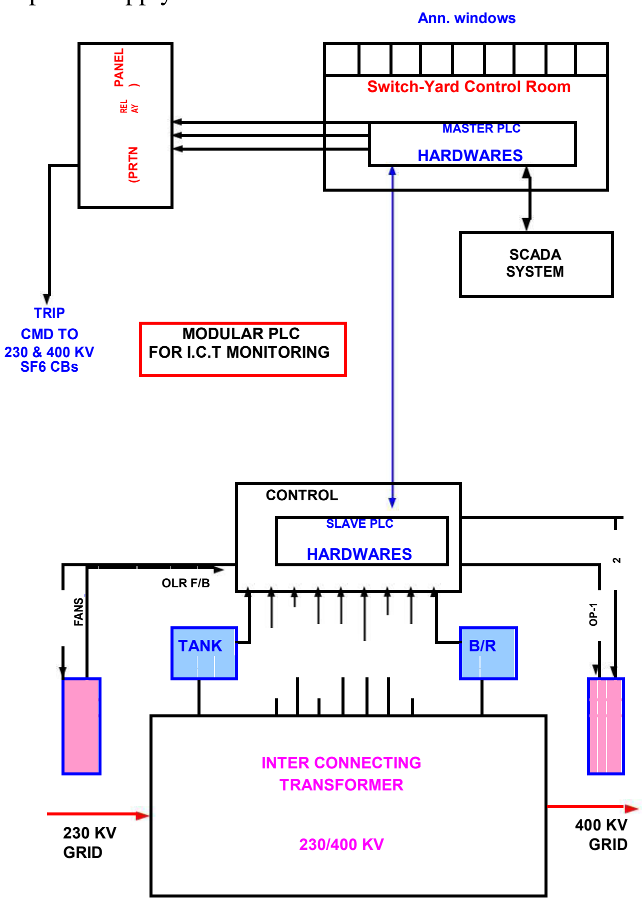
The various components for the main operation of transformer coolings are SMPS, PLC, relays, 3phasefans, pumps, breakers, isolators.There are two types of isolators(line isolator,bus isolators),SF6 circuit breakers are used in this operation.

B. Programable logic controller(PLC):

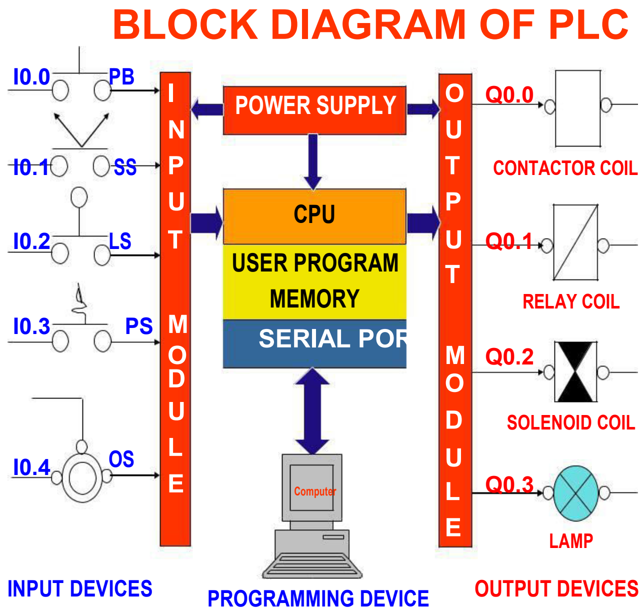
A PLC is a device that was invented to replace the necessary sequential relay circuits for machine control.The PLC works by looking at its inputs and depending upon their state,turning on/off its outputs.The user enters a program,usually via software that gives desired results. PLC in the designed transformer cooling system is being used for sequential logic operation,timing,counting and for autonomous control of various components e.g.relays,fans,pumps,switches etc.

IV.SYSTEM CONFIGURATION

All the output pins of the PLC are connected to the output device like cooling fans and pumps.All 12 output pins are connected to pumps and fans.The input pins are connected to power supply which is a 24V DC SMPS.



V.BLOCK DIAGRAM



PLCs consist of input modules or points,a Central Processing Unit(CPU),and output modules or points.An input accepts a variety of digital or analog signals from various field devices(sensors) and converts them into a logic signal that can be used by the CPU.The CPU makes decisions and executes control instructions based on program instructions in memory.Output modules convert control instructions from the CPU into a digital or analog signal that can be used to control various field devices(actuators).A programming device is used to input the desired instructions.These instructions determined what the PLC will do for a specific input.An operator interface device allows process information to be displayed and new control parameters to be entered.

VI.WORKING AND LADDER

LOGIC *A.WORKING:*

1)Transformer starts Operating:

Inter Connecting Transformer starts operating and performing its function of Stepping UP or Stepping DOWN the voltage.As long as the process keeps on happening and a lot of current keeps on flowing through the coils,a large amount of heat energy is generated.This Heat Energy causes the temperature inside the Transformer to raise.

2)Rise in Temperature Detection & PLC Operation:

Temperature sensors are installed inside the transformer which indicate the rise or fall in the temperature.The temperature sensor is connected to the analog pins of a PLC which later convert the data to digital from analog and actuate commands accordingly.Here in the project,the rise in temperature is shown by the use of a delay command.Now,as soon as there is a rise in the temperature,the PLC detects it and sends a command to the Cooling System to act accordingly.

3)Operation of Cooling System as per PLC Logic:

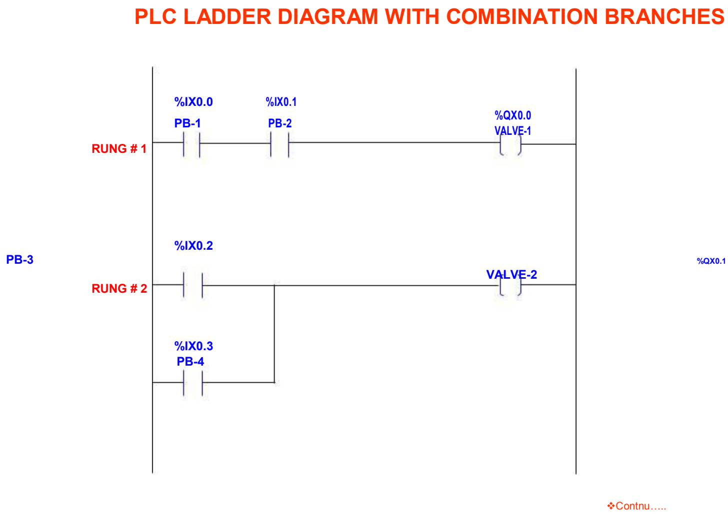
PLC is to sense the temperature of oil& winding of IC transformer, If the temperature reaches the rated value an alarm is set, in case the temperature exceeds tripping of transformer takes place and the Cooling system is introduced with oil forced air forced system. PLC is introduced to reduces down time of the ICT feeder by improving its control technology

4)Fault condition in cooling system:

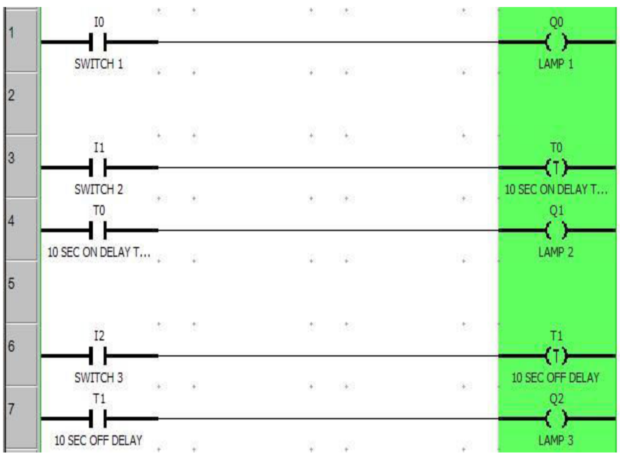
Consider a scenario where a fault is developed inside the cooling fan or the cooling pumps due to some arbitrary reason.As soon as a fault develops the corresponding fan or pump would stop operating.If in case this is not rectified soon enough,the temperature inside would exceed and it could lead to faults in the transformer as well.To avoid this from happening,our ladder logic has incorporated solutions for problems in the cooling system as soon as a fault is developed,the ladder logic intercepts it and gives a command to the entire cooling system to stop operating.This results in an entire cooling system to stop even if there is a fault in either the fan or the pump or both.This is the flexibility of the ladder logic.

B.LADDER LOGIC:

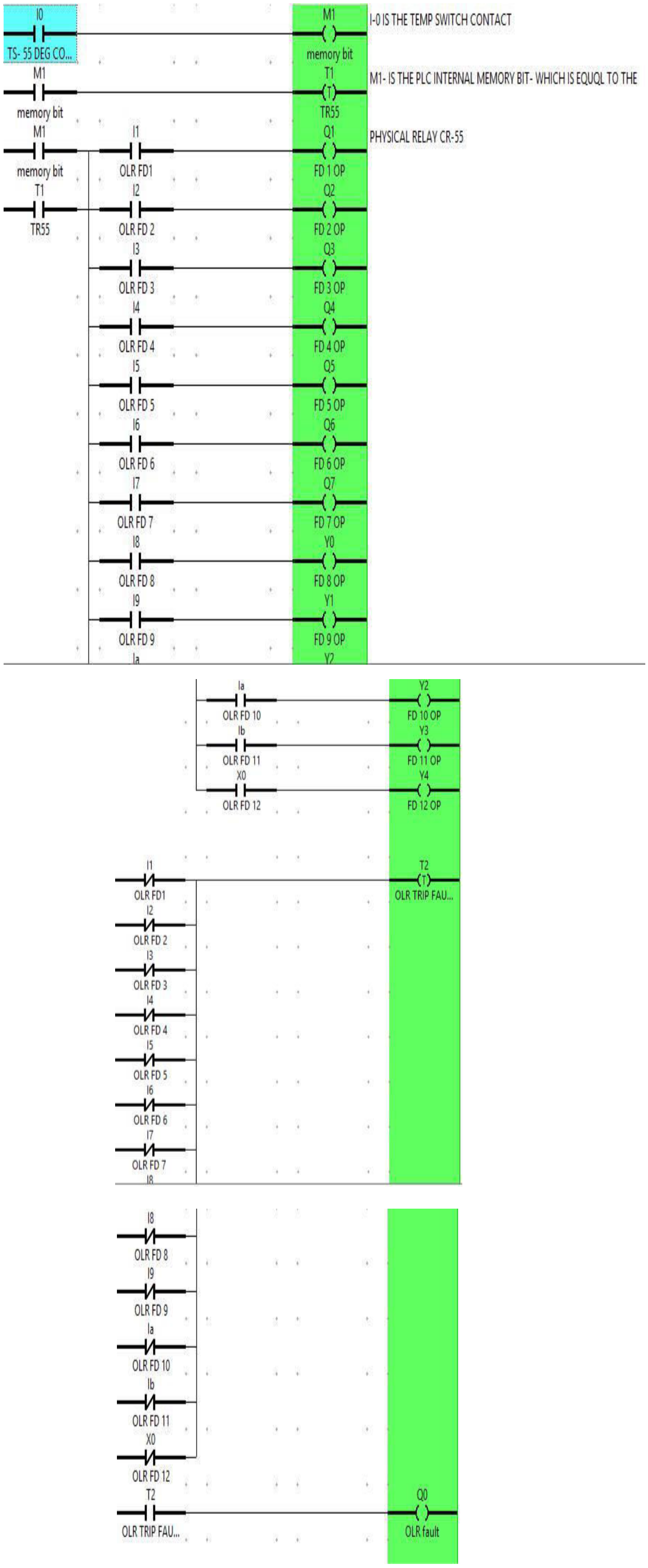
A PLC ladder logic program closely resembles an electrical ladder diagram. On an electrical diagram,the symbols represents real world devices and how they are wired.A ladder logic program exists only in PLC software-it is not the actual power bus or the flow of current through circuits.Another differences is that in an electrical diagram,devices are described as being open or closed (OFF or ON).In a ladder logic program,instructions are either true or false.



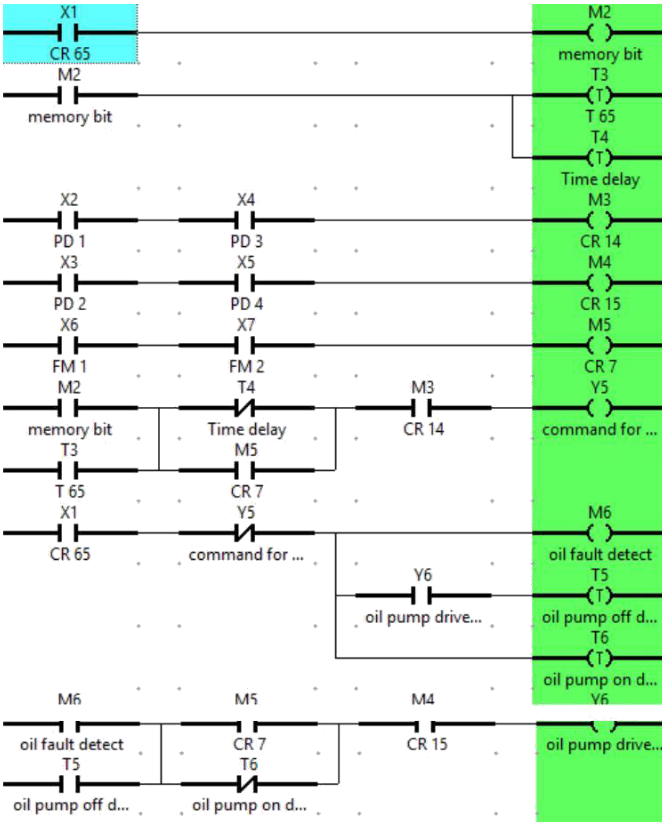
LADDER DIAGRAM:



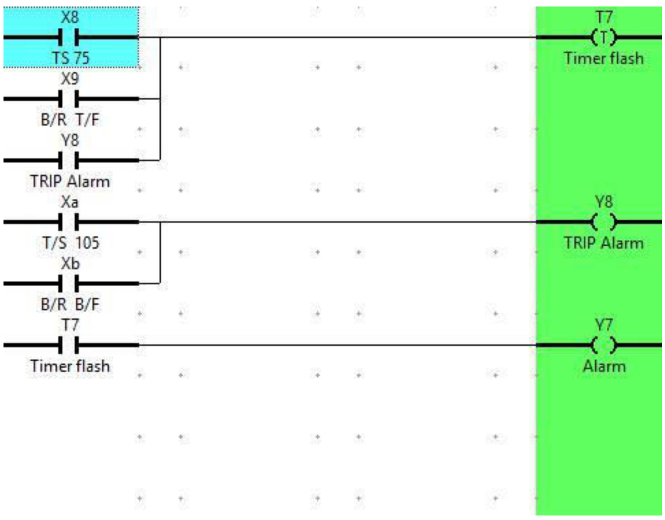
VII.SIMULATION



(i)For Fan Operation



(ii)For Pump Operation



(iii)For Alarm Operation

VII.RESULTS AND CONCLUSION

1)PLC based transformer cooling control system is successfully designed and efficiently implemented. Cooling inside the transformer to counter the rise in temperature is adequately achieved.

2)The PLC based system provided the following advantages:

- The process inputs are connected directly to the PLC input module.Hence it doesn't require any additional interfacing agent like the other available technologies.
- The executed results of our process activates are also taken directly from PLC ,Through its output module.
- More than 80% of physical wiring will be avoided using this intelligent hardware, whose operation purely depends on software.
- No limitation for the auxiliary contacts as in the case of hard-wired logic.We can use thousands of NO-NC for a programed coil or register
- It doesn't require physical timers,counters.All these will be availed as software.It just need the delay time.
- Trial running is possible.This very useful because we first check our logic for results that we need for our process requirments.If the results are correct or our program is correct then we will command PLC to run our program.

3)The PLC is more user friendly and easy to understand when compare to other systems.

4)This system also helped in saving enormous amount of energy.

5)By using PLC with interconnected PC we may controlled the ICTs.Introduction of PLC into any system automation will make the system control into a simple platform.

6)Monitoring and control via PC will render great visualiuzed facilities for the end-user.

VIII.FUTURE SCOPE

- Using analog card for integrating temperature sensors or other sensors.
- Sending data over large distances and displaying it via a webpage.
- HMI activities can be availed to have better visualization of process and control.
- With continuous development of PLCs.It is expected that larger amount of data storage,faster computing speed and protection of each individual component can be performed.
- Parallel operation and cooling of transformers.
- Dealing with issues related to insulation of sensors used along with the transformer operating at high voltages.

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