

MONITORING AND PROTECTION OF TRANSFORMER USING PLC AND SCADA

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Abstract: Transformers are an important component in distribution, substation, generation, transmission, industries, & then forth. As a prolonged time is needed for solving and opportunity of transformer it is essential to enhance a framework that's extra strong and effective. This file gives layout and execution of programmed control circuit that's hired in programmable common sense controller computerization to display screen at the same time as examine the nation of a transformer like voltage of phases, line modern-day, and temperature of the transformer. The programmable common sense controller will help to get the internal and outer failing of the transformer and decide this shortcoming to own the assist of the desired scope of limitations which is ready via way of means of the developer. at some point of this framework with programmable common sense controller sensors, transducer, and shielding relays are applied to renowned failing of transformers like overload, over-voltage, over-modern-day, under-voltage, over-temperature, and section to section fault. Likelihood of failing of transformers truly extra and therefore the safety of transformer is profoundly essential. the advantages of computerization are its redeem energy, material, and manpower, beautify merits, exactness, and accuracy, lower reliance on human presence and dynamic for any stem. at some point of this file, the Automation of the transformer has completed via way of means of using a PLC-primarily based totally framework. at some point of this framework, differing varieties of transducers and sensors are wanted for detecting numerous information limitations of the transformer.

Index Terms – PLC, Transformer, Relay, SCADA, Sensors.

I. INTRODUCTION

Nowadays, Programmable Logic Controller (PLC) automation has been performed a severe function in electricity reliability and economy. The transformer can be a totally precious and needy tool at some point of a electricity transmission. Monitoring is vital to estimate transformer enforcement and secure working situations. High reliability of the transformer is vital to keep away from disturbances inside the transmission of electricity, because of the numerous damaging situations inside the electricity grid. For this damaging circumstance PLC automation is used; the numerous kinds of fault inside the electricity transformer are frequently detected and rectified via way of means of the use of the PLC device.

A exceptional electricity transformer nicely designed and provided with appropriate protecting relays and video display units. When a fault takes place at some point of a transformer or at the cable, the harm is normally extreme way to the excessive score of electricity. The eventual intention is that to overcome the response time after happening fault. at some point of this device, the programmable common sense controller is hired for logging the present, voltage, and temperature of a power and distribution transformer at some point of a substation and to protect the device from any dangerous situations. the power distribution device without a transformer is form of a heartless human, if the transformer is out of provider is commonly very laborious to switch the power from one station to a exclusive station. The collision of a transformer fault is extra severe than a line outage.

There are differing varieties of fault which arise in electricity transformer, distribution transformer and at the cable. These faults are particularly internal and outdoor faults of the power transformer and electricity grid. the maximum goal of this proposed device is to the salvation of the transformer as opposed to internals nicely as outside faults and it offers the making sure protection of the transformer. Overloading of electricity transformers past the transformer score, way to this will increase the temperature of each oil and windings of the transformer. Overloading approach inrush over modern-day go with the drift inside the winding of the transformer this fault particularly takes place at the secondary aspect of the transformer. If the winding temperature can increase past the transformer limits, the insulation will damage and should fail prematurely. External faults of the power device past the transformer quarter will motive a extrude within the voltage stage are going to be excessive or low of the transformer. It outcomes in overvoltage fault and under-voltage fault.

A significant transformer safety scheme ought to encompass safety as opposed to over-voltage fault, transformer overload, and occasional voltage fault additionally as safety for inner faults. The fault impedance of the power line being low, the fault currents are rather excessive. During the incidence of faults, the power go with the drift is diverted closer to the fault and consequently the deliver to the neighboring.

II. TRANSFORMER CONDITIONS LEADING TO FAULTS

The transformer can be a totally precious and essential hyperlink at some point of a electricity transmission. High dependable of the transformer is consequently vital to protect from disturbances inside the transmission of electricity. A exceptional transformer nicely designed and provided with appropriate protecting relays and video display units is extraordinarily reliable. When a fault takes place at some point of a transformer, the harm is normally extreme. The transformer has were given to be transported to a workshop and repaired, which takes big time. to paintings a power transmission with a transformer out of provider is commonly difficult. Frequently, the effect of a transformer fault is extra severe than a line outage.

The operation and renovation of a transformer are frequently a contributory reason behind a fault. If a transformer is operated at too heat, too excessive voltage, or uncovered to an immoderate wide variety of excessive modern-day outside faults, etc, the insulation can weaken to the cause of breakdown. On-load faucet-changers must be checked and maintained regular with the training guide to prevent any faults. A fault at some point of a faucet changer with separate housing can motive too excessive a strain inside the housing. A strain relay is frequently wont to ride the circuit breakers at a selected set strain. to prevent faults and to reduce the harm simply in case of a fault, transformers are ready with each protecting relays and video display units. the choice of protecting device varies relying on transformer Size, voltage stage, etc.

III. EXPERIMENTAL STUDY

In those structures, the PLC and SCADA play a totally critical position in non-stop tracking of the machine and regulation. The automatic power community statistics Acquisition and tracking for transformer automation had been applied the use of a part of software program and hardware. The hardware includes a specific kind of digital, communiqué device with a computing machine.

3.1 Major Hardware component used:

1. Transformer
2. PLC
3. Analog Input Module
4. Current Sensor
5. Voltage Sensor
6. Temperature Sensor
7. Relay
8. Circuit Breaker
9. SMPS

3.3.1 Transformer

A transformer may be defined as an electrical tool utilized in an electric powered transmitting system to transmit power among specific circuits, making use of the precept of electromagnetic induction. The switch of electricity from one circuit to some other uses fundamental magnetic fields. The float of electrical present day in a conductor induces a magnetic discipline round that specific conductor. If some other conductor is delivered within side the impact of the primary conductor, such that they're linked, voltage induction takes location within side the second conductor. Transformer idea and alertness are primarily based totally at the precept in which magnetic discipline in a single coil reasons voltage induction into some other coil. Sizes of transformers range consistent with their programs from the tiny ones utilized in microphones to those weighing loads of tones used machine grid. Transformers are utilized in digital home equipment and electric strength networks. Transformers are consequently very critical within side the transmission, distribution, and using of electrical power.

3.3.2 PLC

Currently, programmable logic controller (PLC) is used for laptop manage structures and business automation that regularly notices the circumstance of enter gadgets and makes the selection primarily based totally on a custom software to manipulate the circumstance of output gadgets. An computerized manner or a device is referred to as a manner manage machine. Regularly display through enter sensors or gadgets and gives indicators to a percent controller is the number one function of this manner manage machine. It is straightforward to programming and dealing with of operating man or woman who's at the display paintings area.

3.3.3 Analog Input Module

The Analog Input Module (AIN) is a key subsystem withinside the PLC. AINs are available many versions to circumstance actual-international bodily parameters, including Temperature, Pressure, Force, or Strain. Typically, those AIN inputs are command indicators in each voltage (e.g. $\pm 10V$) and present day form (e.g. 4-20mA).

3.3.4 Current Sensor

A current sensor is a electronic device that monitor and converts current to an without problems measurable output voltage, that's proportional to the present day thru the measured path. There is a huge type of sensors, and every sensor is appropriate for a particular present day variety and environmental circumstance. Among those sensors, a present day-sensing resistor is the maximum usually used. It may be taken into consideration a present day-to-voltage converter, wherein through placing a resistor into the present day path, the present day is linearly transformed to a voltage.

3.3.5 Voltage Sensor

A voltage sensor is a sensor used to calculate and display the quantity of voltage in an object. Voltage sensors can decide the AC voltage or DC voltage level. The fed of this sensor is the voltage, while the output is the switches, analog voltage sign, a current sign, or an audible sign.

3.3.6 Temperature Sensor

The Temperature sensor LM35 is used to the measured specific centigrade temperature. LM35 having an analog output in phrases of voltage respective to the temperature. It offers output voltage in Celsius (centigrade). It does not now no longer require some other outside calibration tool. LM35 having sensitivity is 10mV consistent with diploma Celsius. For example, 280 mV approach 28 tiers Celsius. It is a three terminal sensor having a variety of -fifty five to a hundred and fifty tiers Celsius. As examine to thermistor output with LM35 offers temperature output is extra precise.

3.3.7 Relay

Relay is an electromechanical operated transfer that may be used to closed or open an electrical circuit. There are specific varieties of relay and each relay having a specific operation as required for its programs. The maximum usually used relay is an electromechanical relay. It includes a bendy transferring mechanical element that may be operated electronically thru an electromagnet; generally, a relay is sort of a mechanical transfer however we will perform it with a digital sign. It is generally used to perform excessive powered circuit the use of a low strength sign. Normally, A DC sign is used to perform the circuit that's pushed through excessive voltage.

3.3.8 Circuit Breaker

Miniature Circuit Breaker is an mechanically operated electric transfer designed to defend an electrical circuit from damage resulting from overload or a quick circuit. The predominant characteristic is to stumble on a fault and transfer the circuit. It may be bodily switched ON and OFF like a normal transfer if required.

3.3.8 SMPS

A switch-mode power supply (SMPS) is an electronics switching tool along with switching additives for changing DC or AC delivers to a small required DC voltage variety. SMPS basically does essential converting sports to smother the furnished voltage score to the same operating scope of the machine. Their convert given deliver voltage to the voltage score of which calls for this is 12V or 24V is described to all different elements.

IV. RESEARCH METHODOLOGY

A PLC is primarily used to control a machinery system. The programs written for PLCs consist in simple terms of instructions to turn on and off outputs based on input conditions and the internal program of PLC. One is designed to be programmed once and run repeatedly as needed. If a process is controlled by a PLC it uses inputs from sensors to make decisions and update outputs to drive actuators as shown in fig. 1.5.2. The PLC-based model process is a real process that will change over time. The actuators will drive the system to new states (or modes of operation). It means that the controller is limited by the sensors available. If an input of PLC is not available then the controller will have no way to detect conditions.

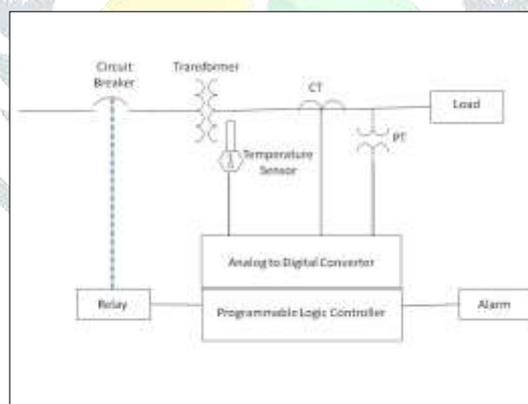


Fig.4.1: Proposed circuit diagram

The project was designed by using a programmable logic controller (PLC) to control and monitor the load condition of each one of the three phases of the transformer. The control circuit is designed to monitor each phase voltage, current, and power rating during the load connected round the clock. The CT (current sensor) is used to monitor the current level at the load whereas the PT is the potential transformer used as a voltage-sensing device on each phase to monitor the voltage magnitude. If it is in the under load condition and in the range, the system works smoothly, as it reaches to mark where the load has a remarkable position and touching to overload mark, the system will auto shut down to protect the transformer from any damage or harmful impact. At the same time information of the overload conditions caused by short circuit overload and overheat conditions will be fed to the control room and screen on the SCADA system in the monitor room.

The PLC-based monitoring and protection system was made with the help of the main controller which controls throughout the system is PLC, Analogue module, Glass type relay for protection, CT (Current Transformer) used as a current sensor to give the information of current increasing and decreasing, PT (Potential Transformer) used as a voltage sensor to fed the information of over and under voltage.

Transformers are designed in three phases because distribution and substations have high power ratings; here we show the distribution of electricity through three-phase transformers. When talking about the technology, now a day's IR (Infra-red), RF

(Radiofrequency), GPRS (General Packet Radio Service), GSM, and SCADA technologies became very famous, it is convenient to use for any application with the help of a PLC controller like industrial automation and status of data.

The advanced controllers used in automation are very effective in providing operational control and functionality in embedded systems electronics. Their Addressing designs have an excellent architecture for interfacing different electronic/electrical devices via the same controller. Through this method, device communication will surely be in order. This reduces the time of processing and shortens the chances of data collision malfunctions.

V. RESULTS AND DISCUSSION

Case-1: Normal Operating Condition:

A prototype has been designed for transformer monitoring and protection system, from that prototype design we are measuring the current, voltage, and temperature, and by observing this parameter of transformer we can monitor and analyze of transformer abnormal condition. Table 5.1 the observed reading at the normal operating condition of the transformer.

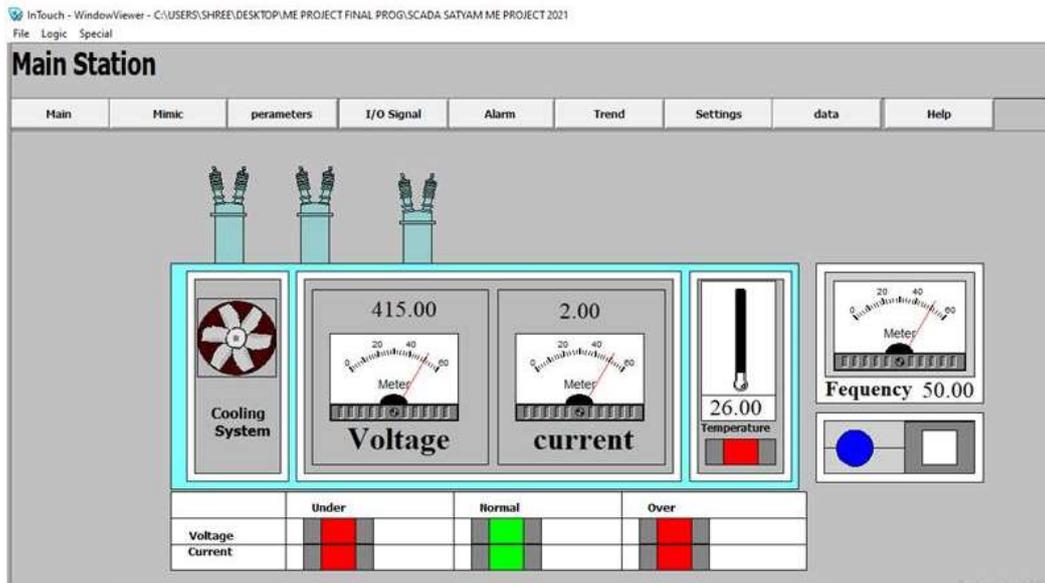


Fig.5.1 SCADA window for Normal operating condition of Transformer.

Table 5.1 Normal Operating Condition

	Voltage (Volts)	Current (Amperes)	Temperature (Celsius)
Pre Define Value	373-456	<2.5	<45
SCADA Display	415	2	26
Operation	Normal	Normal	Normal

Case-2: Over Load Fault Condition:

When an Overload fault occurs on the transformer then the respective system gives an alarm and provides a signal to relay and circuit breaker. Table 5.2 shows the observed readings at over Load fault condition occur on the transformer.

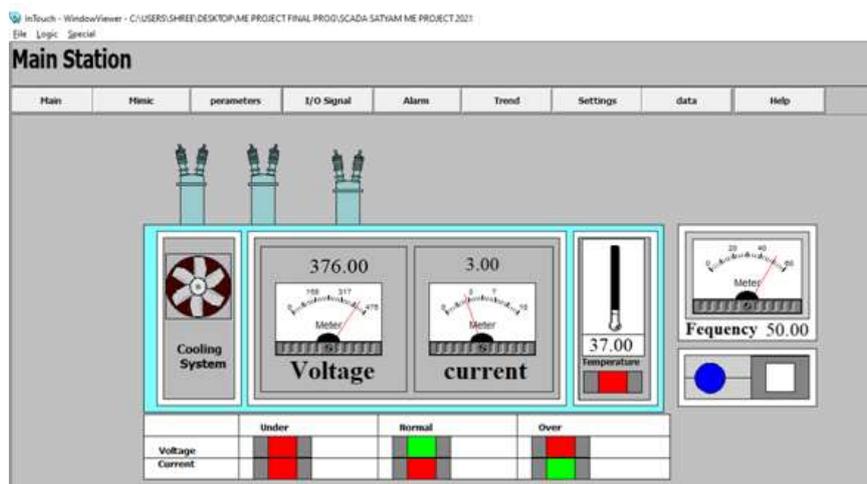


Fig.5.2 SCADA window for over-load fault condition of the transformer.

Table5.2 Over Load Fault Condition of the Transformer

	Voltage (Volts)	Current (Amperes)	Temperature (Celsius)
Pre Define Value	373-456	<2.5	<45
SCADA Display	376	3	37
Operation	Normal	Fault	Normal

When overload fault happens then the current of the transformer is raised inversely voltage value is decreased with a respective temperature of transformer is also increases these value compared with pre-defined value and then system fid signal to protective system and protective system clear this fault within 3-5 sec after clear this fault we have achieved normal operation condition of the transformer. The observed readings at the post-over Load fault condition on the transformer are the same as case 1.

Case-3: Over Voltage Fault Condition:

When Over voltage fault is occur on the transformer then the respective system gives an alarm and provide a signal to relay and circuit breaker. Table5.3 the observed readings at over-voltage fault condition occur on the transformer.

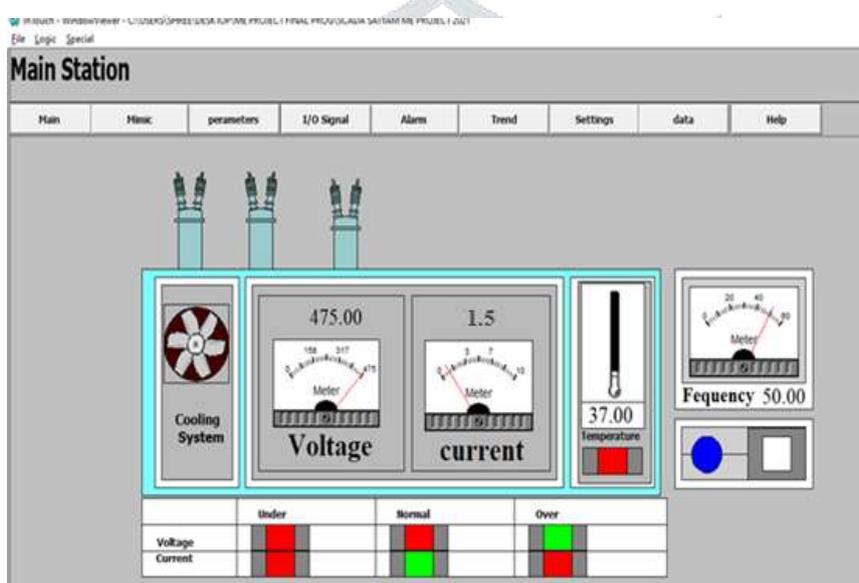


Fig.5.3. SCADA window for over-voltage fault condition of the transformer.

Table5.3. Over-voltage Fault Condition of the Transformer

	Voltage (Volts)	Current (Amperes)	Temperature (Celsius)
Pre Define Value	373-456	<2.5	<45
SCADA Display	475	1.5	37
Operation	Fault	Normal	Normal

When an over-voltage fault happens then the current of the transformer is decreased inversely voltage value increases with the respective temperature of transformer is also increases these value compared with pre-defined value and then system fid signal to protective system and protective system clear this fault within 3-5 sec after clear this fault we have achieved normal operation condition of the transformer. The observed readings at the post-over-voltage fault condition on the transformer are the same as case-1.

Case-4: Over Temperature Fault Condition:

When the Over Thermal fault is occurs on the transformer then the respective system gives an alarm and provides a signal to relay and start the cooling system. Table 5.4 shows the observed readings at over-temperature fault conditions that occur on the transformer.

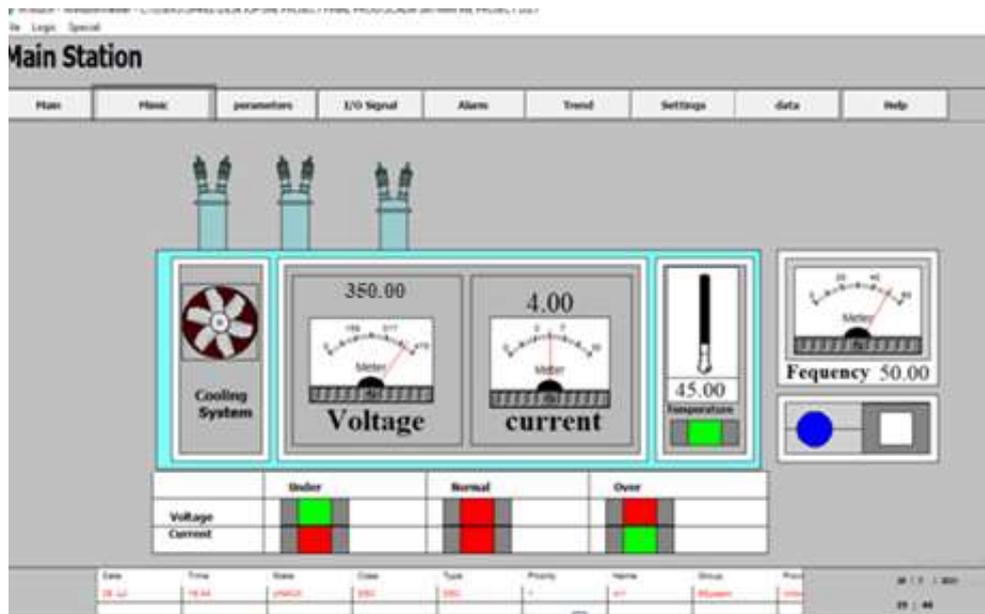


Fig.5.4. SCADA window for over-temperature fault condition of the Transformer.

Table5.4. Over-Temperature Fault Condition of the Transformer

	Voltage (Volts)	Current (Amperes)	Temperature (Celsius)
Pre Define Value	373-456	<2.5	<45
SCADA Display	475	1.5	37
Operation	Fault	Normal	Normal

When over Temperature fault is happened then the current of the transformer is increases inversely voltage value decreases with a respective temperature of transformer is also increases these value compared with pre-defined value and then system fid signal to protective system and protective system provide a cooling system and clear this fault, after clear this fault we have achieved normal operation condition of the transformer. The observed readings at the post-over Temperature fault condition on the transformer are the same as case-1.

I. CONCLUSION

In this proposed model we have designed to provide a protection system to the transformer by using PLC that is used to monitor and control the current, voltage, and temperature of a transformer on the primary and secondary sides. This model has been designed to observe the transformer required parameter. It continuously observes these parameters throughout its work.

When the PLC detects any change in the rating of current, voltage, and temperature values exceeding the above or below the limit of values respectively, then the system takes automatic action. For example provide alarm, provide a signal to the circuit breaker and relay and provide cooling system transformer these actions take place as per which abnormal condition detected in system for protecting transformer from damages. So, power delivery is made reliable, more secure, and highly efficient by providing the proposed design system. This proposed model protects the transformer from the faulty condition hence transformer life span is increase.

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