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Generation of a PLC based unit protection device to monitor the abnormal operation of transformer

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Abstract

Distribution transformers of substation are one of the most important equipment in power system network. Because of the large number of transformers and various components over a wide area in power systems, the data acquisition, condition monitoring, automatic controlling are the important issues. This paper presents design and implementation of automatic control circuits which is used in PLC automation to monitor as well as diagnose condition of transformers, like load currents, transformer temperatures and voltages. The proposed on-line monitoring system integrates a solid state device named PLC (programmable logic controllers). The suggested plc monitoring system will help to detect the fault. PLC based solution is to be provided to get a reliable and fail-safe TRIP signal for Unit Protection devices; in case of abnormal operating condition of a Generator Transformer. This device should monitor the status of large number of analog inputs of all the eighteen cooler units and on sensing failure should generate the respective output signal.

Keywords— *PLC, Transformers, ladder logic, Monitoring, Cooler Banks.*

I. INTRODUCTION

PLC based solution is to provide reliable and fail-safe TRIP signal for Unit Protection devices. This monitors the status of large number of analog devices of all the eighteen cooler units. Generates a TRIP signal on sensing failure in system, which is then processed by unit protection devices to safely shutdown the entire unit. Each single phase transformer of three phase bank have six cooler units. Each cooler unit consists of two fans and one oil circulating pump. So there are eighteen cooler units in the GT Cooling of the GT's is severely affected in case failure of these multiple cooler units and results in high operating temperatures of the GT's. Prolonged operation at elevated temperatures may result in permanent damage to the transformer winding insulation. This which affects the availability of the entire 660MW generating unit and consequential losses to the power utility.

For a three-phase transformer of capacity 750mv. NPTC has used 3 single phase transformers of 250mvarating to get 3 phase 750 mv rating. Each single-phase transformer has total 6 cooler banks. And a single cooler bank has 2 fans and one oil pump for cooling of the transformer oil. And for a single transformer 5 active cooler banks are required. The 6th cooler bank is kept as stand by. So for 3 transformers (r, y and b phase) total 18 cooler banks are there and hence we have total 18 inputs. Consider the following situations. In any one of the transformers (r, y or b) if one cooler bank fails then the 6th stand by cooler bank will come in service if in the same transformer another cooler bank fails the output of the transformer is reduced to 80% of it's capacity and a signal is generated if in the same transformer yet another cooler bank fails the signal is to be generated by the logic to shut down the generating unit above logic are to be generated in case of faults for all the 3 single-phase

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transformers. The generation of the output signals from the plc logic should happen only when the transformer in charge condition. If the unit is in off condition the above logic is disabled.

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II. LITERATURE SURVEY

1.Paper Title: Protection of Distribution Transformer using PLC and SCADA based System

In this paper we study that distribution transformer is an electrical transformer that is used to carry energy from a primary distribution circuit
to a secondary distribution circuit electrical. It can help to find the various faults which are over & under voltage, over & under current, and
over temperature faults at primary side of transformer as well as under & over voltage and over current faults at secondary side of
transformer. If any fault is observed during online operation of the transformer, a warning message appears on computer and then the
transformer is automatically OFF.

2.Paper Title: PLC Based Transformer Fault Detection and Protection

This design of protection system of transformer based on PLC that is used to observe a control the current, voltage and temperature of a
power and distribution transformer on both the primary and secondary sides. The system will help to detect inside fault as well as outside
fault of transformer and also rectify these faults with the help of desired range of parameters which is set by programmer operating person
who is on the desk of control panel. A monitoring is necessary to estimate transformer enforcement and safe operating conditions.

3.Paper Title: Three Phase Transformer Fault Detection and Protection using PLC

In this paper we studied that the transformer protection is to detect faults or abnormal operating conditions and to initiate corrective action.
The PLC system which has been designed to monitor the transformer's essential parameters, it continuously monitors the parameters
throughout its operation. When the PLC recognizes any increase or decrease in the level of voltage, current or temperature values the unit
has been made shutdown in order to prevent it from further damages with the help of relays in three phase system.

4.Paper Title: Real Time Monitoring & Protection of Transformer Using PLC

The main concern of this paper is to rescue the distribution transformer in power system network against the internal and external faults. The
system can protect and monitor a transformer by using the Programmable Logic Controller (PLC). Various parameters like current, voltage
and temperature and their real-time values can observed on the screen. Protection against the overcurrent, over voltage, phase to phase fault,
phase to neutral fault is done by PLC programming and sensors.

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III. METHODOLOGY

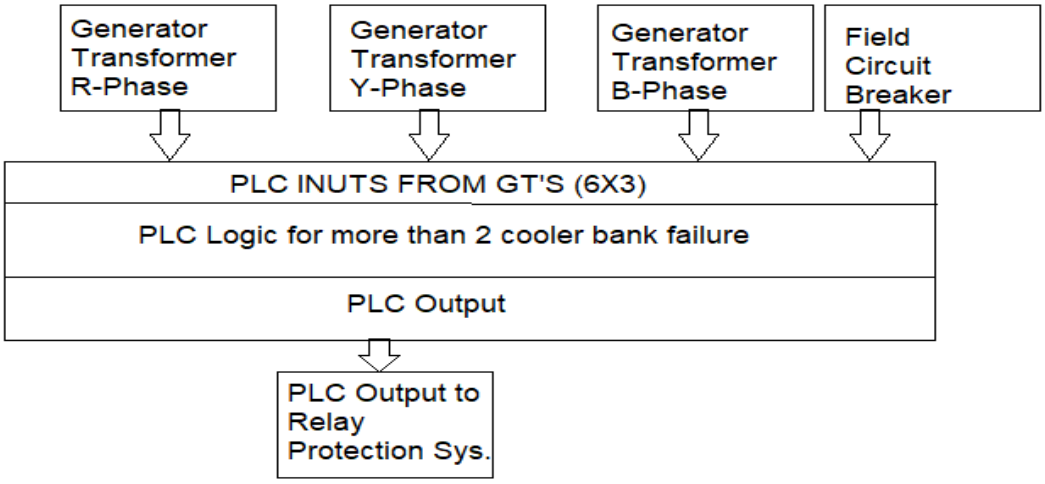

FIG. 1 DESIGN OF PLC BASED SOLUTION FOR TRANSFORMERS

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Fig.2 PLC based solution for Transformers

HARDWARE AND SOFTWARE SPECIFICATION

1.Three Phase Power Supply

Normally power system has a three-phase supply which is used for transmission of electrical power from one station to another station. A

three-phase system is usually more convenient and economical than the single-phase system. In three phase system used transformer are

three phase and bigger in size than that of the single-phase transformer and the protection of this equipment very essential to maintain the

continuity in the power system.

2.Single Phase Transformer

The conversion of the 21kV/400kV and voltage single- phase step-up transformer is used. Single phase transformer is used.

3.Switching Mode Power Supply (5 A, 24 V Output)

A switched-mode power supply is an electronic power supply that incorporates a switching regulator to

convert electrical power efficiently.

4.Relay

Relay is a static device which is the electrically operated switch. In this proposed system electromagnetic operated relay is used also other

operating principle used. Relays are used where it is essential to control a circuit by a low power signal or where number of circuits is

controlled by one signal.

5.Relay Channel Mode

In information theory, a relay channel is a probability model of the communication between a sender and a receiver aided by one or more

intermediate relay nodes.

6.PLC System

Recently Programmable Logic Controller is used for industrial automation and computer control system that regularly observes the state of

input devices and makes resolution based upon a custom program to control the state of output devices. Automated machine or a process is

called as a process control system. The main function of this process control system is regularly monitored by input devices (sensors) and

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gives signals to a PLC controller.

Fig 3. PLC System

7.Ethernet Cable

An Ethernet Cable is a network cable used for wired connections to the Internet. It will be used to connect our PLC to the laptop for the

proper operation of PLC.

8. Power supply

In this proposed system PLC, relay and micro- controller is used for both this regulated supply is required. For the PLC 24V for the relay

operation 12V DC and for the microcontroller 5V DC is required. The conversion of the 230V/12V and voltage is rectified in a pure DC

voltage and given to the PLC, relay board and micro-controller.

9.Ladder Logic Programming

In this project we are using Ladder logic which is widely used to program PLCs, where sequential control of a process or manufacturing

operation is required. Ladder logic is useful for simple but critical control systems or for reworking old hardwired relay circuits. Recently

Programmable Logic Controller is used for industrial automation and computer control system that regularly observes the state of input

devices and makes resolution based upon a custom program to control the state of output devices. Automated machine or a process is called

as a process control system. The main function of this process control system is regularly monitored by input devices (sensors) and gives

signals to a PLC controller. Ladder logic has evolved into a programming language that represents a program by a graphical diagram based

on the circuit diagrams of relay logic hardware. Ladder logic is used to develop software for programmable logic controllers (PLCs) used in

industrial control applications. The name is based on the observation that programs in this language resemble ladders, with two vertical rails

and a series of horizontal rungs between them. We are using CC Workbench version 10 software to design and implement the PLC logic for

the Transformer logic.

IV. RESULTS DISCUSSION

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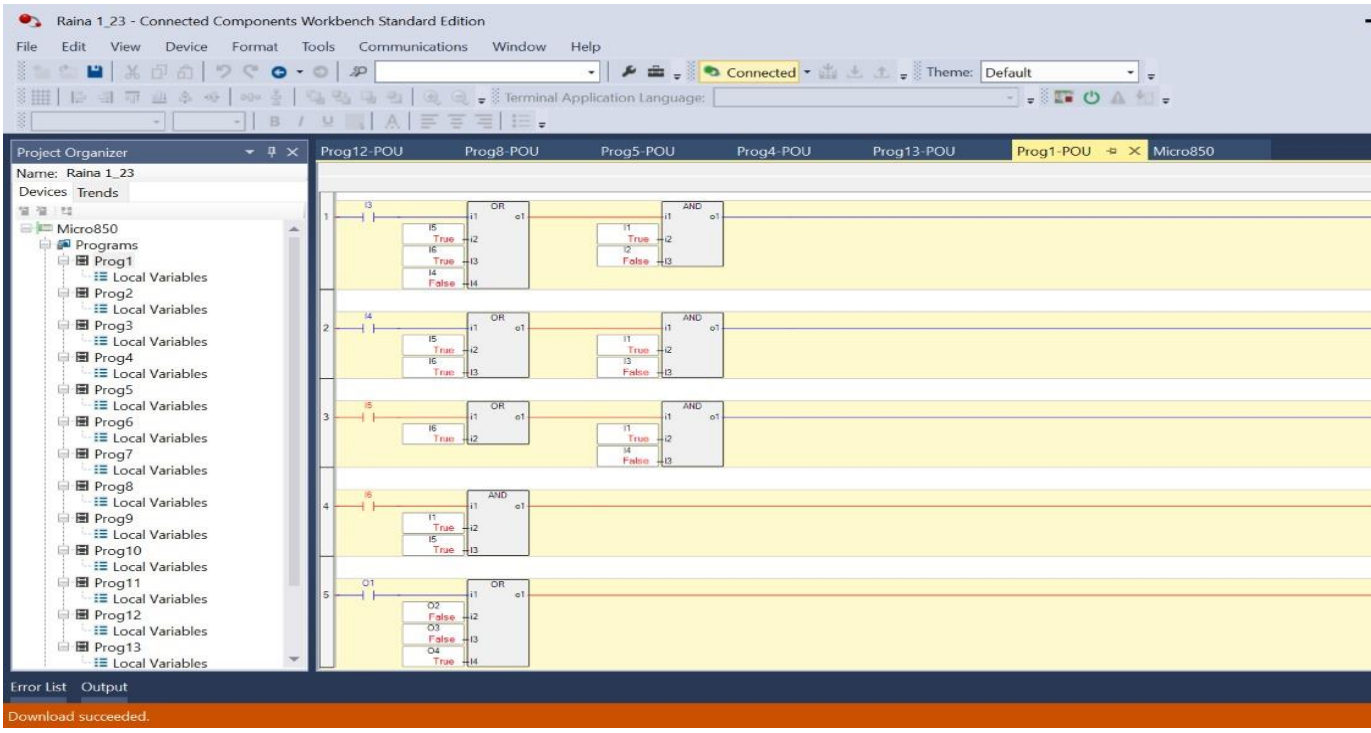

Fig 4: R-Phase Simulation Result

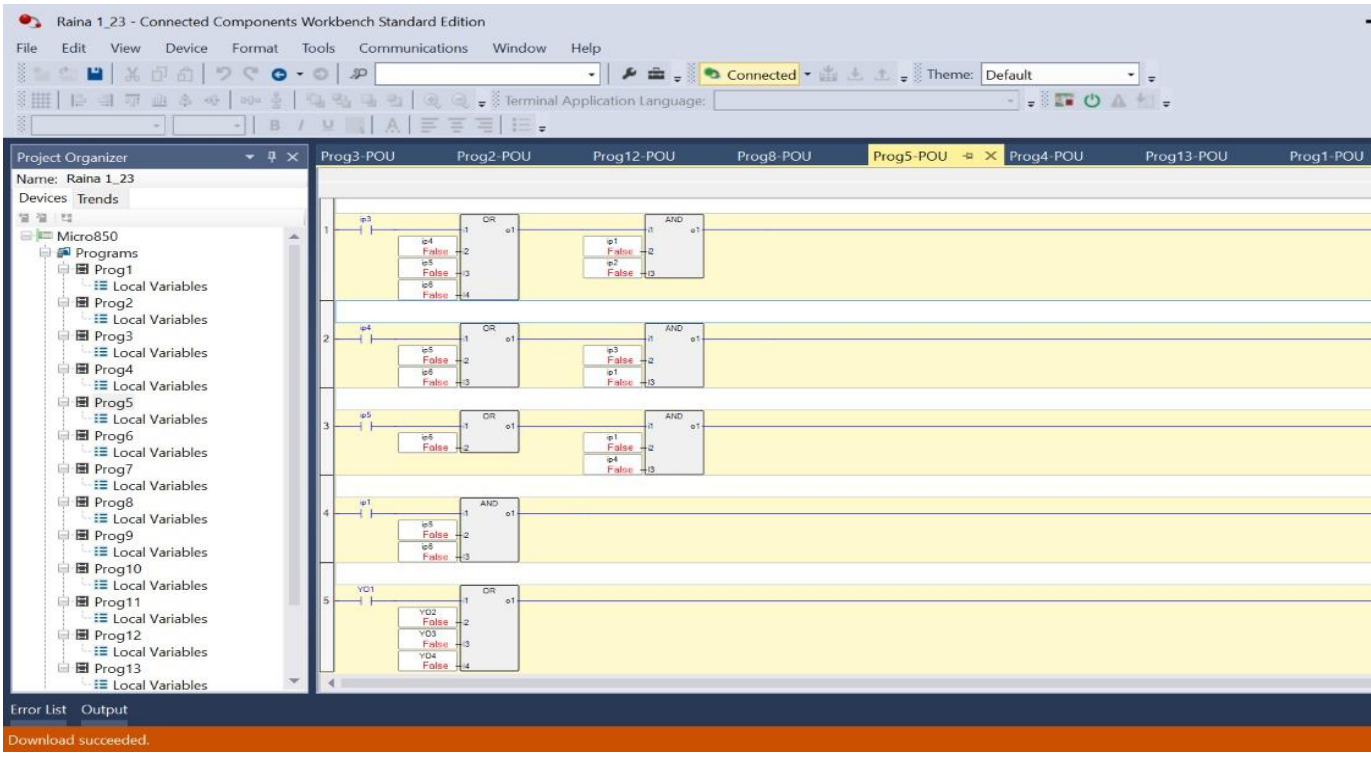

Fig 5: Y-Phase Simulation Result

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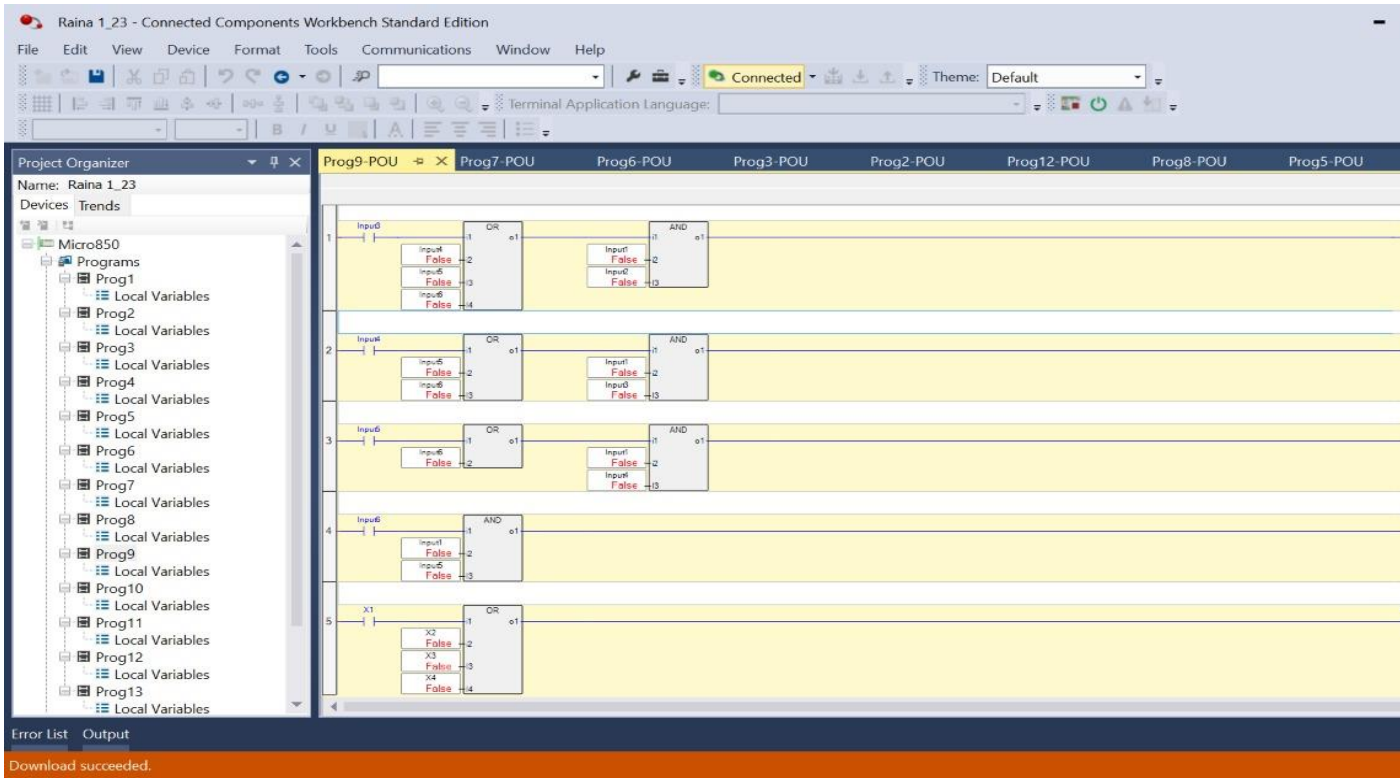

Fig 6: B-Phase Simulation Result

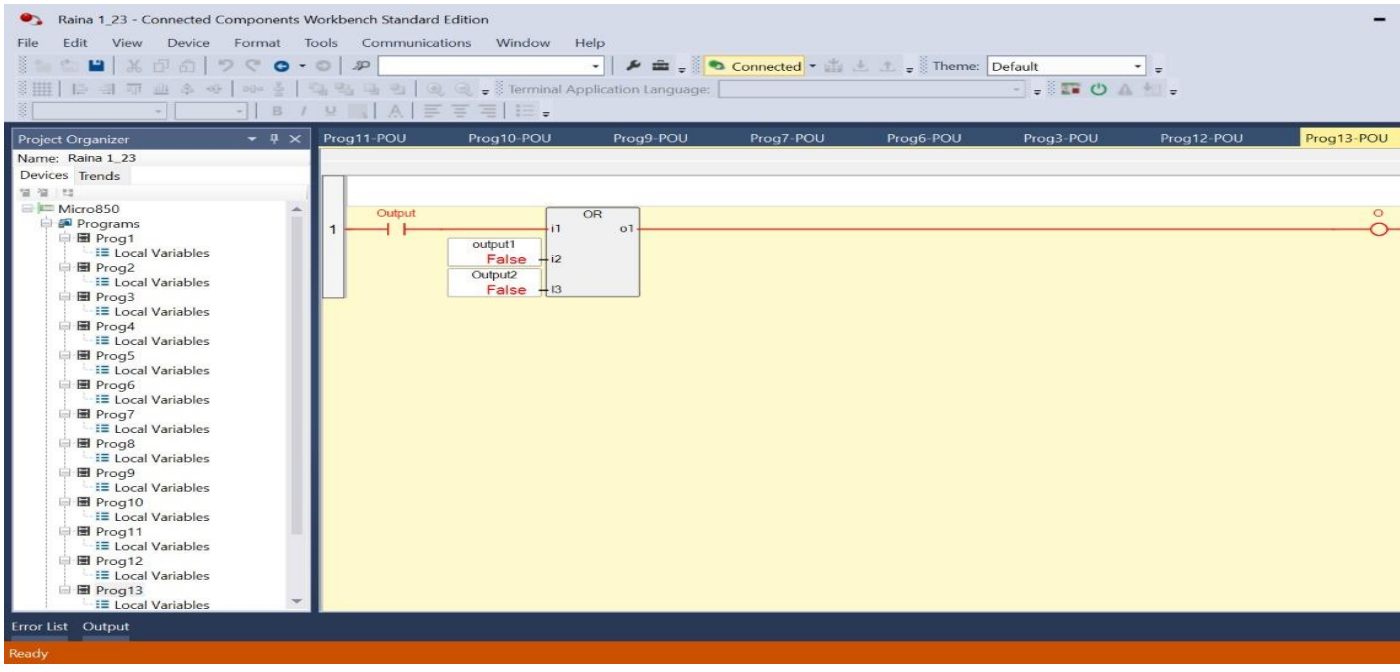

Fig 7: Final combined R-Y-B Simulation Result

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Fig 8: PLC Hardware Solution

V.CONCLUSION

In this proposed system we are going to design a protection system of transformer based on the proposed PLC system which will be designed to monitor the transformer's required parameter outputs continuously through out it's operation. When the PLC will identify any changes in the outputs of cooler banks, the transformer has to be shut-down in order to protect from damages with the help of relays in single and three phase system. Pushing the GT output load to 80% if two cooler banks stop working. Generating a Trip signal within 10 minutes if 2 or more cooler banks fail.

REFERENCES

[1] Prof.A.H. Asim, Mr. S. H Shah "PLC based transformer protection" in 2012.

[2] Prof. M. A Trivedi, Mr. S.Dalvi, Mr. R. Devaiya, Mr. R. Raju, Mr. Y. Modi " Transformer Protection using PLC and GSM Technology" in 2014.

[3]Mr. S. K.Behera and Mrs. S.Manikpuri and Y. R. Sahu,"Protection of Distribtion Transformer using PLC and SCADA based System" in 2015.

[4] Prof. S. G. Kashid and Mr.B. B. and Mr.P. P. Ingawle and Mr.A. D. Halade,"PLC Based Transformer Fault Detection And Protection" in the year 2017.

ISSN: 2233-7853 IJFGCN

[5] Mrs. S. Rupali and Mr. K. Wakode and D. Salve and S. Punde ,“Three Phase Transformer Fault Detection and Protection using PLC”,in Feb,2018.

[6]Mrs. S. S. Singh , Mr. A. Jana , Mr. A. Kumar , Mr. H. Singh, “Protection of tranformers using sensors” in April, 2018.

[7]Mrs. R. R. Dhapte and Mrs. S. A. Bharane and K. N. Kazi, “Real Time Monitoring & Protection of Transformer Using PLC” in May, 2018.

[8] N. G. Chothani ,M. B. Raichura, D. D. Patel, K. D. Mistry" Real-Time Monitoring & Protection of Power Transformer to Enhance Smart Grid Reliability" in 2018.

[9] Mr. D. Kumar, A. Basit, A. Saleem, Engr. Ghulam Abbas "PLC Based Monitoring & Protection of 3-Phase Induction Motors against Various Abnormal Conditions" in 2019.

[10] Mr. E. Solomon , Shivakumar , Niruba , Priya and Sharmila "Fault detection and Induction motor safety using Programmable Logic Controller and Supervisory Control and Data Acquisition system" in 2020.

ISSN: 2233-7853 IJFGCN