International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 04 | April - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

Distribution Transformer Protection and Automatic System Using PLC

Prachi Nagare[1], Deepak Adhav[2], Jayesh Kanmahale[3], Mr. Prakash Patil[5]

[1,2,3] *Department of Information Technology, Sir Visvesvaraya Institute of Technology, Nashik, Maharashtra, India*

[5]*Professor, Department of Information Technology, Sir Visvesvaraya Institute of Technology, Nashik, Maharashtra, India*

Abstract - Protection of transformers is a very challenging problem in power system relaying. Since it is very important to minimize the overcurrent and duration of unwanted outages, this is a high demand imposed on power transformer protective relays. Various relaying principles have been proposed and used to protect transformers against different types of faults. Relays that use over current, over flux and overheating principles protect the transformers against overloads and externally applied conditions. Differential relays protect the transformers against internal fault. In this research, software and hardware of microcontroller-based relay system has been explained and designed. The design implementation and testing of the system are also presented. Today the world is facing the most critical problem of not getting the sufficient power. In many countries including India, people are not getting their primary need of electricity because people are consuming more power than the given limit of the sanctioned load given by MSCBE. Instead, we can use available power in such a way that the specific user will only use the power which is allocated to the user according to the limit of sanctioned load provided by MSCBE. A properly installed and configured monitoring system is a valuable advantage to almost any type of energy consumer. Energy consumers have a wide variety of considerations and concerns where energy usage is involved.

Key Words: *PLC*

1.INTRODUCTION

Transformer is a necessary part of any system which have an important role. The load of the transformer is not constant but varies all time as per load. So that the current in the transformer is not constant but varies according the load. So that the temperature and other parameters also changes which are harmful for the transformer and reduces the life of transformer. Current variations and over current is a very common thing in power transformers. In this case if transformer gets so high current and unbearable than we shut off the transformer which is not a very suitable fir system.
Here we have designed a system to protect the transformer and as well if the transformer trips, it can restart automatically. So that no human efforts should require.

In modern electrical distribution systems, the reliable operation of distribution transformers is paramount for ensuring the uninterrupted supply of electricity to consumers. Distribution transformers are susceptible to various electrical faults and anomalies, which can lead to downtime, equipment damage, and safety hazards. To address these challenges, the implementation of a robust Distribution Transformer Protection and Recloser System using Programmable Logic Controllers (PLCs) offers an effective solution.

The Distribution Transformer Protection and Recloser System utilizing PLCs integrates advanced monitoring, control, and protection functionalities to safeguard distribution transformers and associated infrastructure. By leveraging PLCs, which are versatile and programmable industrial automation devices, this system provides real-time monitoring of electrical parameters, rapid fault detection, and automated reclosing capabilities.

2. LITERATURE SURVEY

Rahulkrishna P K , Eshwari R 2019-20
Heavy power consumer (Industrial applications) has to pay the fixed charges irrespective of the consumed power. Also, penalty is levied on such consumptions even if there is a slight overshoot in maximum consumption limit. There will not be any prior notification with this regard. In such situation, this implementation aims in providing details of overshoot time, peak power consumption, displaying the power consumption and the cost based on the tariff plans from any remote location.

Md Moktadir Rahman 2020-21
In the current financial climate, focus on energy saving within the home has intensified by the desire to reduce costs. Fossil fuel savings, as well as a permanent fall in electricity prices, are significant incentives for the residential consumers to look at different methods to reduce their energy consumption. Demand response method is an alternative method that provides an opportunity for consumers to reduce their energy consumption cost by shifting their electricity usage during peak periods. To this aim, this study evaluates the effectiveness of price-based DR techniques currently available in Western Australia based on the consumers cost of electricity and comfort level. The electricity tariffs are systematically examined.

Matteo Nardello 2019-21
Next generation Smart Cities have the potential to enhance the citizens quality of life and to reduce the overall energy expenditure. In particular, emerging smart metering

technologies promise to greatly increase energy efficiency in the residential and industrial areas. In this context, new power metering methods such as Non-Intrusive Load Monitoring (NILM) can provide important real-time information about the contribution of any single appliance. In this paper, we present a complete hardware-software design that concentrates locally an efficient event-based supervised NILM algorithm for load disaggregation. This new kind of power analysis, which usually requires high computing capability, is executed real-time on a low-cost and easy-to-install smart meter ready for the Internet of Things (IoT).

Han Lu 2019-20

Non-intrusive load monitoring is an important development direction of electric load monitoring. Traditional NILM mainly track and decompose the power voltage current, and other transient or steady-state parameters like power parameters at the monitoring system entrance, and then identify the specific type of load. The load identification method is complicated, and there are limitations on identifying multiple devices switching simultaneously. This paper studied on NILM oriented residential load identification methods and proposed one based on periodogram, and then made the detailed theoretical analysis and simulation verification of the selection and determination of electric appliances characteristic model.

3. HARDWARE REQUIRED

There are basically 5 components in hardware will be required which are shown below.

- PLC (DELTA DVP14SS2)
- SMPS
- Current Sensor
- Voltage Regulator
- Relay

3.1 PLC (Delta DVP14SS2)

PLC is a programmable logic controller which controls system with logical operations and make decisions using the program which is programmed in memory. A PLC is an example of a "hard" real-time system since output results must be produced in response to input conditions The first PLC was developed by Modicon in 1960. Which was able to control complex system and can be programmed.

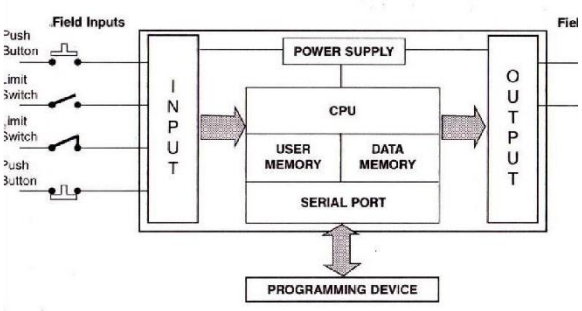


Fig 3.1:- Block Diagram of PLC

The PLC we are using In our System is Delta DVP14SS2 in which we have 8 inputs and 6 outputs. The DVP-SS2Series is Delta Electronics' second generation. The DVP14SS2 features high speed counters, a flexible serial port, real- time monitoring and an expansion bus.

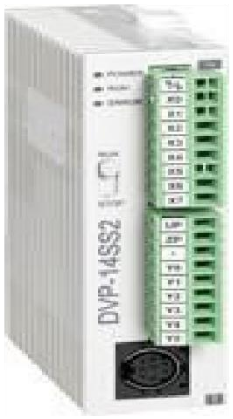


Fig. 3.2 DELTA DVP14SS2

Specifications

Power: 24V DC

Digital Inputs: 8 inputs, 24 VDC (sink or source)

Digital Outputs: 6 Digital outputs

Output Rating: 1.5A

Communication Port: RS-232 and RS-485, Modbus ASCII/RTU

Program Capacity: 8 k steps

IO Points: Up to 238

Software Up/Down Counters: Any input, up to 10 kHz on a single input

Software Quadrature Inputs: 2 - X4/X5 (5 kHz) and X6/X7 (5 kHz)

Hardware Up/Down Counters: 2 - X0 and X2, both 20 kHz

Hardware Quadrature Inputs: 2 - X0/X1 and X2/X3, both 10 kHz

Hardware Pulse/PWM Outputs: None

3.2 SMPS

A switched-mode power supply is an electronic circuit that converts power using switching devices that are turned on and off at high frequencies, and storage components such as inductors or capacitors to supply power when the switching device is in its nonconduction state..

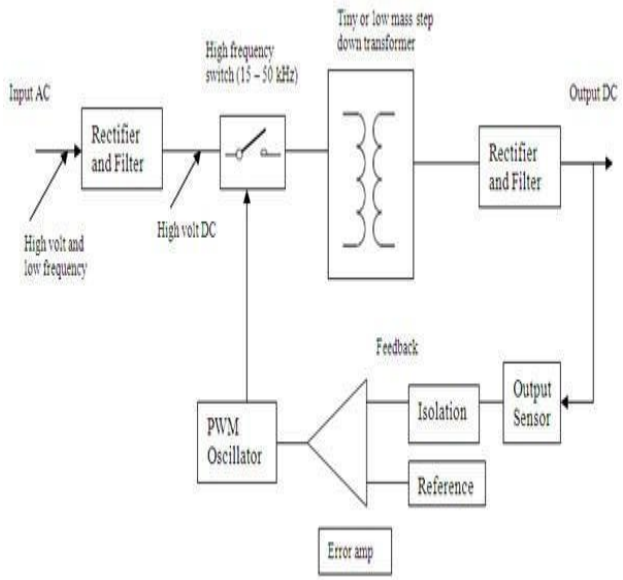


Fig. 3.3 Block Diagram of SMPS

A switched-mode power supply is also known as a switching-mode power supply or switch-mode power supply.

Fig 3.4 SMPS

3.3 Current Sensor WCS2202

The Wison WCS2202 provides economical and precise output for both DC and AC current sensing in industrial and commercial systems. The unique package of this sensor allows for easy implementation by the user. Typical applications include motor control, load detection and monitoring, over current fault detection and any intelligent power management system. The WCS2202consists of a precise, low temperature drift linear hall effect sensor IC with temperature compensation and AC to DC rectifier circuit and a path with 8.3mΩ internal conductor resistance. This extremely low resistance can effectively reduce power loss, operating temperature and increase the reliability greatly. Applied current flowing through this conduction path generates a magnetic field which is sensed by the integrated Hall IC and converted into a proportional rectified DC voltage.

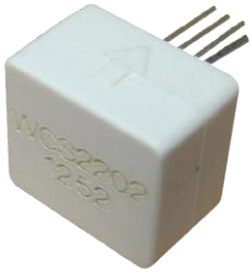


Fig 3.5 Current sensor WCS2202

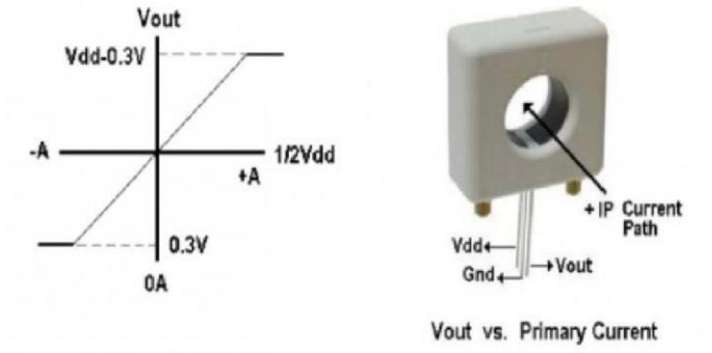
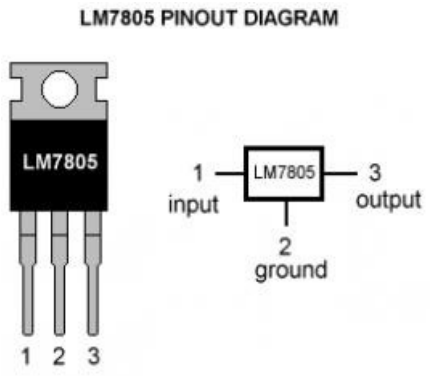


Fig. 3.6 Hall Effect Sensor

3.4 Voltage Regulator 7805

Voltage sources in a circuit may have fluctuations resulting in not giving fixed voltage outputs. Voltage regulator IC maintains the output voltage at a constant value. 7805 IC, a voltage regulator integrated circuit (IC) is a member of78xx series of fixed linear voltage regulator ICs used to maintain such fluctuations. The xx in 78xx indicates the fixed output voltage it provides. 7805 IC provides +5 volts regulated power supply with provisions to add heat sink as well. Let's look into some of the basic ratings to get an overview.

Input voltage range 7V- 35V Current rating Ic = 1A



Output voltage range VMax=5.2V ,VMin=4.8V

Fig 3.7 Voltage Regulator 7805

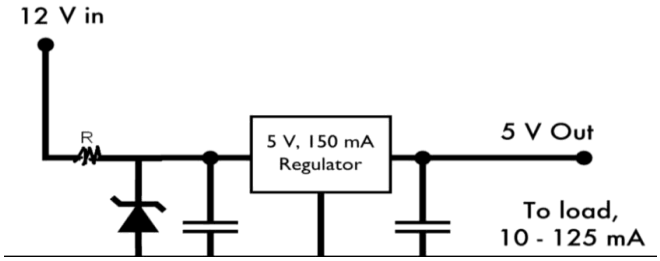


Fig. 3.8 Internal circuit of 7805

3.5 Relay

A relay is an electrically operated switch which can switch on or of high level voltage using a low voltage. usually relays use electromagnet to mechanically operated switch, but other operating principles are also used for switching , like solid state relays. Relays are used where it is necessary to control a high voltage circuit by a separate low-power power, or where several circuits must be switched by single signal. The first relays were used in long distance telegraph circuits to transmit: they repeated the signal coming in from a circuit and retransmitted it on another one circuit.

Fig 3.9 Relay

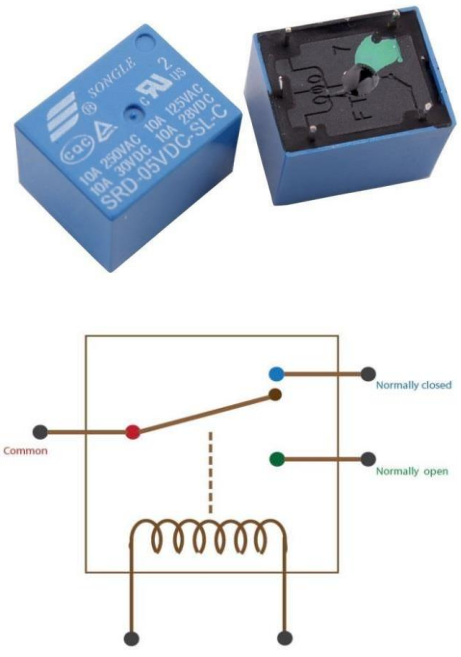


Fig. 3.10 Working of Relay

4. Software Required

In this system Basically 3 Softwares will be required listed below.

- WPL Soft
- Wonderware Intouch
- Kep Server

3.6 WPL Soft

WPL soft is A programming software which is used to program PLC. Specially Delta series PLC are programmed using WPL soft Software using different programming Languages.

The main System requirements for WPL soft are given below-

4. System Requirement

Operation system:-	95/98/2000/NT/ME
CPU:-	Pentium 90/dual core/Core2Duo/i3 or Above
Memory:-	16MB or above (32MB or above is recommended)
Hard drive:-	Capacity: at least 50MB or above
Monitor Resolution:-	640 × 480, 16 colors or above
Mouse:-	Mouse of general use
Printer:-	Not Required
RS-232 port:-	At least one of the among COM1-COM4 should be connected with PLC.

After openong the software we have to choose the model of PLC that is DVP14SS2 and than the programming windowwill be automatically opened.

After programming we have to configure the communication path that is defined in communication option in which com port is selected in order to make the communication.

4.2 Wonderware Intouch

Wonderware InTouch is HMI visualization software that empowers customers to achieve their quest for operational excellene with a graphical interface

InTouch goes beyond graphics to enable application builders to focus on creating new content that will drive enterprise-wide operations productivity and cost savings. InTouch empowers operators to optimize their routine human interface with automation systems. Our unique approach through situational awareness libraries provides Exact information that operators need to quickly and accurately address faulty situations before they impact operations.

This system is used in more than one-third of the world's industrial facilities, in virtually every country and industry, InTouch HMI software continues to deliver business value in engineering simplicity, accuracy and real-time performance mastery.

Experience Wonderware InTouch:

A huge symbol factory ti use in graphical representation Increase effectiveness with improved situational conditions Make better control and monitoring decisions in real time Increase operational productivity Accelerate operator training and skill Securely access your system from any device with compatible system

5. WORKING

As we know, we are using conventional Relay Switch for automation by using PLC system and the Relay Switch is normally used for the disconnection or to de-energize the supply from the line.

The main working of the Relay Switch is to disconnect the faulty section the faulty section using current sensor, which is connected in series with the without interrupting the whole section or feeder line. Project's main purpose is to disconnect AB switch which detect the current value as the current value is increases then PLC is gives instruction to circuitry to open or disconnect the Relay which is instructed by PLC from Substation and faulty section is easily disconnected and after 5 second of time PLC gives instruction to circuit to close the open contact for trial of the faulty section if once again fault is detected on line it declared as faulty section.

In this recloser system we are going to use relay to connect and disconnect the system from the faulty system. Whenever any fault occurs in the system, our current sensor will sense the fault and will give a signal to the PLC so that as per program PLC will automatically give the command to the relay which is connected to the output of PLC and relay will disconnect the faulty section from the transformer. Also we have used the buzzer to alert the nearby people from the fault. We have used SCADA system which will continuously observe the system and if any fault detected it will automatically turn on the led or an indication. Also we can control the system manually so that we can operate the system from software only.

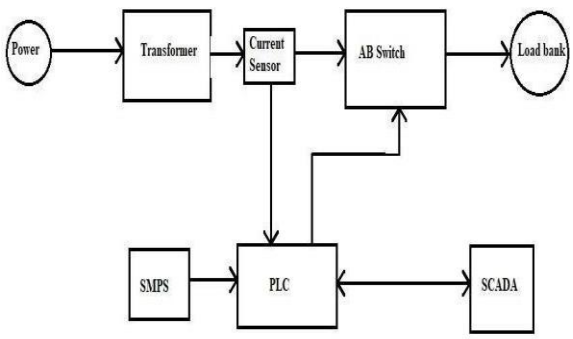
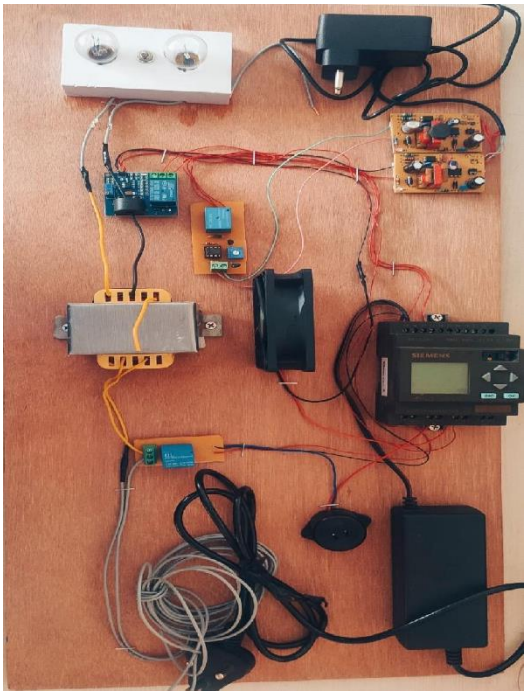


Fig:- Block Diagram

6. RESULT



CONCLUSION

In this project , the Dristibution transformer protection And Recloser Using PLC is proposed . For transformer voltage and current sensing , a current sensing circuit and voltage sensing circuits were designed and the results have been verified with proteus simulation . Hardware with an AVR microcontroller was implemented to verify the proposed technique and the performance of the real time hardware was compared with the proteus computer simulation . Throughthe transformer current analysis , we can see that the current of the transformer rises as load increases , whenever the load current goes above the transformer rated current , the microcontroller detects an overcurrent and it sends a trip signal to over current relay thereby protecting the transformer from burning .

The implementation of a Distribution Transformer Protection and Recloser System using PLCs represents a proactive approach to enhancing the reliability and efficiency of electrical distribution networks. By leveraging PLC technology, this system provides comprehensive protection against electrical faults while enabling remote monitoring and control capabilities. With its versatility, reliability, and scalability, PLC-based solutions are poised to play a crucial role in modernizing and optimizing distribution infrastructure for the future.Finally , the practical results matched with the simulation perfectly , therefore the aim and objectives of the project were all achieved successfully and project is said to be industrious and fully automated with no manual interface required .

The successful implementation of such a system requires careful consideration of system requirements, selection of appropriate PLC hardware and software, thorough design and testing of protection and recloser logic, integration with

Supervisory Control and Data Acquisition (SCADA) systems for centralized monitoring and control, and establishment of maintenance procedures for ongoing support and upkeep.

Overall, a well-designed Distribution Transformer Protection and Recloser System using PLCs can significantly improve the performance and resilience of electrical distribution networks, ensuring uninterrupted power supply to consumers while minimizing the impact of faults and disturbances on the system.

REFERENCES

[1]. Okakwu K. Ignatius, Abagun K. Saadu and Oluwasogo S. Emmanuel, "Analsis of copper loses due to unbalanced load in a transformer", International Journal of Research and Reviewers in Applied Sciences, Vol. 23, Issue 1 (April, 2015).

[2]. K. Sridhar, M. Assarudeen, J.Ranjith Kumar, E.Sarathbabu Transformer Health Monitoring And Control Through Arduino, IJAERD International Journel of Advanced Engineering and Research, vol. 5, Issue 04, 2018.

[3]. Xiaojing Wang, Dongmei Lei, Jing Yong, Liqiang Zeng "An Online Load Identification Algorithm for Non-
Intrusive Load Monitoring in Homes" IEEE, ISSNI, pp 1-6, 2013

[4]. N.M.Sapari, H. Mokhlis, A.H.A. Bakar, M.R.M.Dahalan "Online Stability Index Monitoring for Load Shedding Scheme in Islanded Distribution Network" IEEE, 8th international power engineering and optimization conference, pp 445-449, 2014

[5]. SHRUTI RANJA , MINI THOMAS "An efficient home energy management algorithm for demand response analysis in Indian scenario" IEEE, 2015 Md. Moktadir Rahman, Ahmed Alfaki, GM Shafiullah, Md.
Asaduzzaman

[6]. Shoeb, Taskin Jamal "Demand Response Opportunities in Residential Sector Incorporated with Smart Load Monitoring System" IEEE, innovative smart grid technologies-asea, pp 1183-1188, 2019

[7]. Hung-Yuan Chen "Identifying Variable-Power Appliances in Non-intrusive Load Monitoring Systems" IEEE, 10th international conference on innovative mobile and internet services in ubiquitous computing, pp 452-457, 2019