



Intelligent Load Monitoring System of 11KV/440V Multi Distribution Transformers Using SCADA

S. SRI KRISHNA KUMAR

Assistant Professor, Department of Electrical and
Electronics Engineering
Vel Tech High Tech Dr.Rangarajan Dr.Sakunthala
Engineering College,
Chennai, India
krishnakumar.rvs@gmail.com

R.BALADHANDAPANI

Assistant Professor, Department of Electrical and
Electronics Engineering
P.S.N.A College of Engineering and Technology,
Dindigul
balasree86@gmail.com

G.SATHEESH KUMAR

Assistant Professor, Department of Electrical and
Electronics Engineering
SSM Institute of Engineering and Technology,
Dindigul
satheesh5361@gmail.com

A.MOHAMMED OVAIZ

Assistant Professor, Department of Electrical and
Electronics Engineering
Vel Tech High Tech Dr.Rangarajan Dr.Sakunthala
Engineering College,
Chennai, India
ovaiz.eee@gmail.com

K R SUGAVANAM

Department of Electrical and Electronics Engineering
Vel Tech High Tech Dr.Rangarajan Dr.Sakunthala Engineering College,
sugavanamkr@gmail.com

Abstract

*Transformer gets a vital role in transmission
and distribution of electric power. Reducing the*

*failures ensures an increased chance of
uninterrupted power to be supplied to consumers.
Overload, Voltage fluctuations and heating up of
transformers causes severe damages to the*

transformers, which takes much time and a lot of expenses. Major portion of the losses in the power system networks is attributed towards the use of distribution transformers (DT). Excess thermal losses in DT become an unsolved major hazard. Only under heavy loads, the winding losses and saturation comes into consideration.

A proper monitoring scheme is designed based on the monitoring of key operating parameters of the distribution transformer. The system is intended on providing essential data regarding the wellbeing of DT. The utility system would make use of the data for optima avocation of available resources, which is DT in this case. The monitoring provides an easier approach to deal with all interruptions, from minor to the most catastrophic failure. In other words, an optimal monitoring setup to maintain the reliability of DT's.

Index Terms— Load monitoring, on-line monitoring, Distribution transformer (DT), SCADA.

Introduction

DT, like the other machines, proves to have a reliable operation throughout its lifetime only if operated under prescribed conditions. However overloading of DT results in unanticipated failures, which in turn results in discontinuous power to the consumers. Insufficient or ineffective cooling system provides evidence causing the DT prone to failures.

Supervisory Control And Data Acquisition (SCADA) system is made use for online monitoring of transformers in transmission and distribution networks. The main purpose of SCADA is collection and logging of data. The SCADA can be pulled out towards DT's also, but proving to be costlier.

Typically the consumer side of the single phase transformer is designed to operate at 230V AC. When the consumer side voltage is maintained more than 250V AC for a prolonged duration, subsequently there is a possibility of a risk that the damage to the due to over voltage is excessive. As a defensive measure, the primary is supplied through a relayed contact which disconnects the supply whenever the relay is energized. The data from SCADA system; namely load levels, temperature levels and voltage, are fed through a series of digital communication channels towards a primary controller for prompt action. The scheme, designed taking into account the practical difficulties, biases its objective towards a mobile based embedded system. This embedded system monitors and collects data of key markers such as winding current, oil levels and temperature of the DT. The planned on-line observance system incorporates a Global System for Mobile

communications (GSM) Modem, with impartial single-chip microcontroller and set of transducers/sensor.

Distribution transformers are currently observed manually wherever someone sporadically by visiting the transformer site at the time of maintenance and keeps track of the necessary data. This kind of monitoring cannot endow with information about intermittent overloads and heating-up of transformer oil and windings. All these factors will considerably cut back transformer life.

1. Load Monitoring

Load monitoring is performed by applying instrumentation towards the power system from the main supply to consumer end. This monitoring emphasizes on locating the key equipments and locations for monitoring. The fundamental load data obtained such comprises of voltage, current and frequency. The monitoring equipment varies for single phase system and three phase systems. For example, voltage measurement/power monitoring for single phase system and three phase system has one and three probes respectively, apart from a separate reference or ground probe.

One main difficulty faced is placing these monitoring instruments at required locations. Whenever the data is to be monitored, the instrument is connected, which is mostly kept connected to the system almost permanently. The instruments may not be able to operate at higher voltage levels. Under such circumstances, where direct connection to the facility is complex, the current and voltage values are provided through CT or PT.

The load monitoring is done regularly and the data log is maintained at an interval of 3 to 5 days, depending on the size of the system. The instrumentation is calibrated for accurate measurements over a period of 7 to 30 days depending on the deviations. The harmonics and other values can be monitored if a necessity arises. The load monitoring data with respect to the load levels is continuously mapped.

Once the data has been gathered and put together for a loading profile, a report is generated that includes:

- System Voltage
- Winding current,
- Real power, reactive power
- Harmonics, PQ problems (if required)

1.1 Needs of Electrical load monitoring

Load data is a prerequisite for planning, restructuring and dimensioning of power system at

generation, transmission, distribution and utilization networks. When a need for expansion or restructuring arises, the existing load data is analyzed at the first place. In fact, in most countries, the government has laid down few regulations and procedures for such expansion or renovation. Also when a new equipment or device with much power consumption is to be installed, the existing load data provides the vital details for further proceedings. Incorporation of renewable energy systems in existing networks demands a safe and reliable way for the power flow in two-way.

In large companies or factories, load monitoring is performed when the authorities are concerned to know whether the facility optimally utilizes or over-utilizes the power. Load monitoring is also done in major concerns since consumption of excess power is an economic burden. Unbalances in load, improper utilization of power, overloads, open circuit or short circuited conditions, harmonic problems, voltage profile, power factor and minor issues are observed in utility system

Load monitoring also presents the clear picture about the tolerable capacity of connected loads and the quantity of load to be operated for optimal performance.

2. Existing Method

Conventional approach to ensure the power system continuity during failure of a transformer is to make use of an additional transformer. The additional transformer placed along with the existing one is termed as a stand-by transformer or a reserve transformer. The main transformer and the additional transformer is arranged in such a way that the supply is diverted through the additional transformer when the main transformer fails. In some cases, the additional transformer is arranged to just share the load instead of diverting the entire power flow from the main transformer. This diversion or load sharing is carried out to provide an un-interrupted supply to the consumers.

In high power consuming industries like smelters or furnaces, the load is categorized into multiple phases and each phase is fed through separate transformers, in such cases, stand-by transformers are used to provide continuous supply in case of any failure or regular maintenance conditions. Hence there would not be any loss in production.

Even though this method ensures continuous supply of power to consumers, it faces few demerits. The main disadvantage is the power consumption by the control circuitry. This power

consumption is not taken into account at many instances during load monitoring. It may seem to be a minor portion compared to the total power consumption. But when multiple stand-by transformers are used, it poses a great problem.

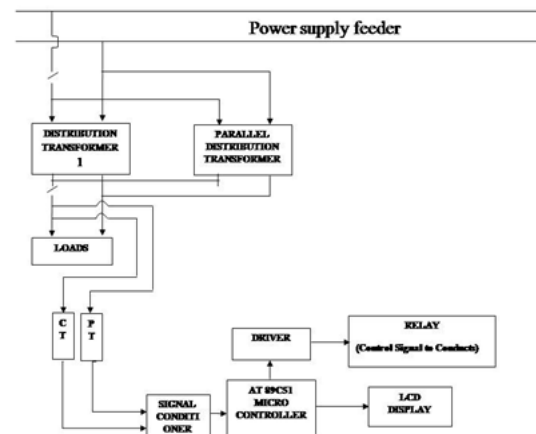


Fig 1: Block Diagram of Existing Method

3. Proposed Topology

The planned topology is developed keeping its foremost endeavor to provide the consumers with un-interrupted power supply. To ensure the continuous power supply to consumers, distribution transformers with multi-winding configuration is made use. Hence during abnormalities, the consumers are provided continuous supply without any damage to transformers.

The proposed system is designed to follow the given order.

Step 1: Consumer side of the step-down distribution transformers is considered and all parameters are considered.

Step 2: All distribution transformers are continuously monitored.

Step 3: Monitored parameters are transmitted, received and displayed using PC.

Step 4: Measured values are compared with the standard preset values.

Step 5: If error in any parameter incurs excessive values, the system automatically cuts-off 3 ϕ supply in particular transformer where the values exceeds preset values.

Step 6: At the same instance, the system sends exact status and error messages to the concerned personnel.

A set of sensors and a local communication

channel like a zigbee is assimilated with a GSM modem. This setup transmits the error status in a predetermined format through an SMS (Short Message Service). Since the monitoring is done online, the DT's are prone to extended life by a considerable duration.

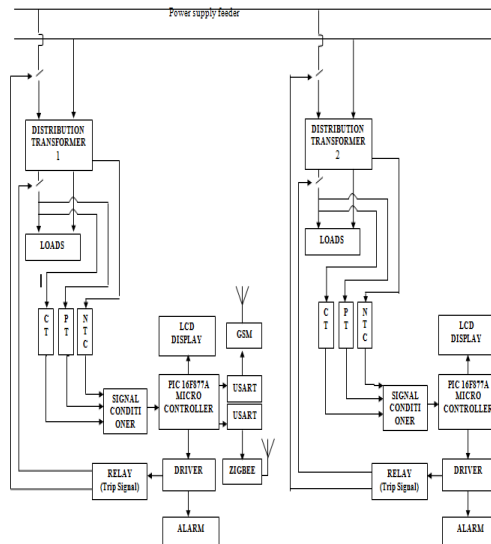
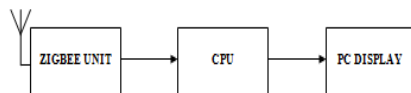


Fig 2: Block Diagram of Transmitter

1. DISPLAY UNIT:



2. MOBILE RECEIVER:

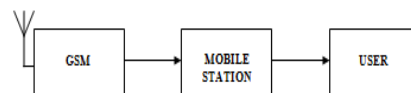


Fig 3: Block Diagram of Receiver

3.1 General Functions

The system has the general functionalities like managing the data of the consumer end, maintaining a log of load data and the alarm/rectification events. Some concerns offers to provide the consumer data to be available for them such as to verify for themselves. The load data from the transformer provides the base for analysis, load allocation and other network related operations. The alarm or rectification is enabled during fault conditions. Also a historical data of these triggers are maintained to understand the dynamics of the system.

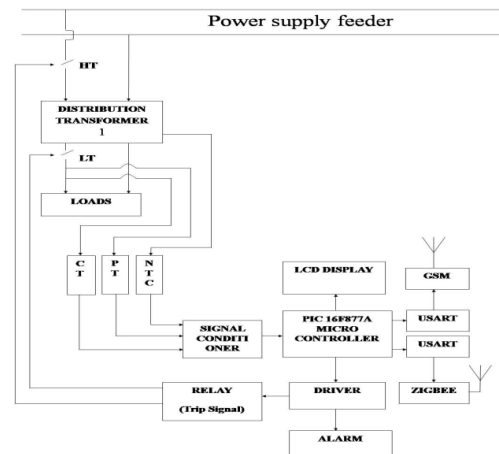


Fig 4: Block diagram of single module

3.2 Subsystem Functions

Subsystem functions monitor equipment status for the entire subsystem, as well as display detailed information on individual equipment and their control. For example, subsystem functions include selecting cameras for the CCTV System, image display, and pan/tilt/zoom (PTZ) operation of the cameras. The Passenger Information System, such as the selection of the display zones and message display, are integrated with SCADA.

The Public Address System and Telephone System are also integrated to include announcement functions, the selection of announcement zones, and the receiving and making of calls, which can all be handled on one operation terminal.

4. Hardware Implementation

Remote load monitoring is enabled using such a scheme. Also the distribution system is made open to diagnostic control. A PIC 86F77A microcontroller interfacing with display circuit is shown below circuit. By using this PC, we see all the parameters like voltage, current and temperature etc., here, implementation of communication protocols in embedded software is a challenge posed, since the limitation in the memory of the local resources may cause a shortfall in the operating system.

And also used Zigbee module for transmit and receiving the measured parameters to computer. Now display the multi distribution transformers load current, voltage and winding temperature using PC.

The entire hardware unit can be subdivided into various parts.

- Power circuit
- Controller circuit
- Driver circuit
- Sensing circuit
- Zigbee circuit

4.1 Power Circuit:

The power circuit consist of the two bridge units, 230 /12 – 0 – 12 Volt, 1 Amp transformer, voltage regulator IC 7805 and IC 7905 and By Pass capacitors. The output of this power supply unit is used to give the power to all the circuit used in this project. The voltage +5V and – 5 are used for Microcontroller input. The voltage +12V and -12V are used input for all parameter sensing unit.

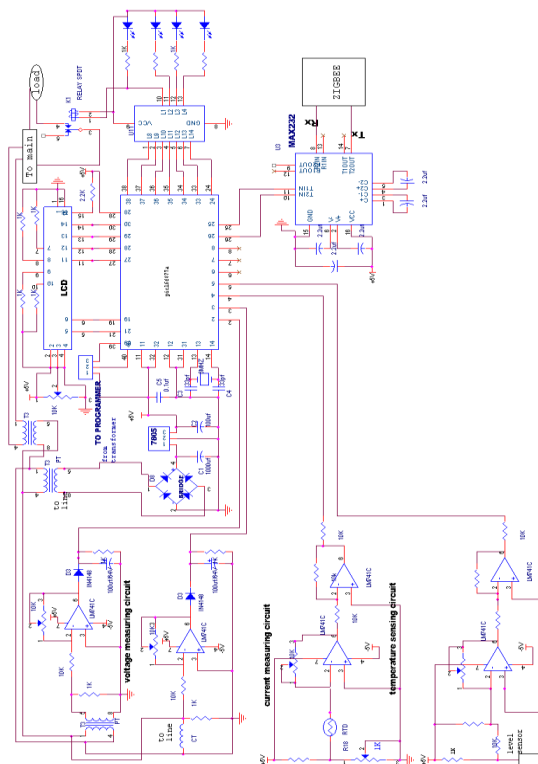


Fig 5: Circuit diagram of DT load monitoring system

4.2 Controller Circuit:

The controller is to provide gate pulses for the switches with necessary delay. The controller program is created using Embedded C. Then the program is fed to the controller using Embedded C software and the programmer hardware which is

connected as an external peripheral device of a computer.

4.3 Driver Circuit:

Driver performs the following operations.

Buffering

Isolation

Amplification

For buffering purpose IC's are incorporated. For amplification isolation purposes, optocouplers are used.

4.4 Sensing circuit:

It is used to sense the load current, voltage and temperature of the distribution transformer. The temperature variations in the transformer are sensed using the 1 kilo ohm NTC thermistor. This thermistor is connected in series with the 2.2 kilo ohm potentiometer & a +5V is applied. The output is taken across the 2.2 kilo ohm preset when the temperature is normal, the preset is adjusted to produce a 2.5V DC output.

The output voltage of attenuator is used in the inverting mode. Diode IN4148 is used to convert AC voltage into DC voltage to set point value. A capacitor is connected across the rectifier to filter out the ripples and the output is given to the microcontroller input Port A.

4.5 Zigbee Circuit:

Zigbee circuit is utilized for local communication in a separate channel. Zigbee modules are either operated in a hand-shake mode or master/slave configuration. This can be chosen as per the design needs. Also any low power consuming communication protocol, such as a BLE (Bluetooth Low Energy), can be utilized with an optimal design.

5. Conclusion and Future Work

The research work on "INTELLIGENT LOAD MONITORING OF MULTI DISTRIBUTION TRANSFORMERS (11KV/440V) USING SCADA" is successfully implemented as an hardware unit. The system is designed to monitor the primary parameters such as winding current, voltage levels and ambient temperature. This remote monitoring data provides the base for protection of DT and ensures continuous power flow for consumers. Other parameters like the power, frequency, harmonics and oil level can be monitored with slight modifications in the circuitry. Investing in such a system protects the expensive power system components, and the same scheme can be extended to other sets of transformers also.

References

- [1] Domagoj Pehardaa, Igor Ivankovićb , Nikola Jamanb, "Using Data from SCADA for Centralized Transformer Monitoring Applications", 4 th International Colloquium "Transformer Research and Asset Management"
- [2] Kim, W.H. and Lee, S. and Hwang, J., "Real-time Energy Monitoring and Controlling System based on ZigBee Sensor Networks", Elsevier Procedia Computer Science(PCS), 2011.
- [3] Bai, Y.W. and Hung, C.H., "Remote power On/Off control and current measurement for home electric outlets based on a low-power embedded board and ZigBee communication", IEEE 2008.
- [4] S.Gayathiri, R.Gokulapriya, V.S.Arulmurugan. "An Improved Channel Aware Smart Grid Transmission for MANET", International Journal of Innovations in Scientific and Engineering Research (IJISER), Vol.1, No.4, pp.212-219, 2014.
- [5] Zhang, Q. and Sun, Y. and Cui, Z., "Application and analysis of ZigBee technology for Smart Grid", IEEE International Conference on Computer and Information Application (ICCIA), 2010.
- [6] Chen, B. and Wu, M. and Yao, S. and Binbin, N., "ZigBee Technology and Its Application on Wireless Meter-reading System", IEEE International Conference on Industrial Informatics, 2006.
- [7] Intelligent Distribution Automation System. "Customized SCADA Based RTU For Distribution Automation System", M.Sc. Research Project, UTeM, 2005-2007.
- [8] G. Pudlo, S. Tenbohlen, M. Linders and G. Krost, "Integration of Power Transformer Monitoring and Overload Calculation into the Power System Control Surface", IEEE/PES Transmission and Distribution Conference and Exhibition, Vol. 1, pp: 470-474 Asia Pacific, 2002.
- [9] "Intelligent Distribution Automation System: Customized SCADA Based RTU For Distribution Automation System", M.Sc. Research Project, UTeM, 2005-2007.
- [10] Sandip C.Patel, Pritimoy Sanyal " Securing SCADA System" Information Management & Computer Security Journal Volume: 16 Issue: 4 Page: 398 – 414 Year: 2008
- [11] Zhi-Hua Zhou, Yuan Jiang, Xu-Ri Yin, and Shi-Fu Chen, "The Application of Visualization and Neural Network Techniques in a Power Transformer Condition Monitoring System", In: T. Hendtlass and M. Ali eds. Lecture Notes in Artificial Intelligence 2358, Berlin: Springer-Verlag, pp: 325-334, 2002.

