*International Journal of Research in Advent Technology, Vol.7, No.2, February 2019*
*E-ISSN: 2321-9637*
*Available online at www.ijrat.org*

# A Progressive Examining of Leakage Current Using Wireless Sensors in Electrical ubstations

P.M.BensonMansingh[1], Dr.M.Yuvaraju2
*[1]Assistant Professor, [2]Assistant Professor,*
*benson.ece@srit.org, rajaucbe@gmail.com*

**Abstract---:** The system for continuous monitoring of leakage currents and ground currents in high voltage electrical substation is mainly examined in variety of plant within the substation and has low power consumption with inbuilt overvoltage protection, based on Wireless Local Area Network (WLAN) technology. It consists of a transmitter module equipped with a data acquisition system connected to leakage current and voltage sensors, and a receiver module connected to a remote controller for data processing and storage. The principles of operation and its characteristics of various components in the system are described. Tests have been used to validate and verify its performance in three different test situations;(i) laboratory monitoring of the leakage current and voltage of a distribution surge arrester (ii) laboratory measurement of the leakage current of an outdoor insulator and (iii) field monitoring of the earth current and potential rise of high-voltage tower. The measured results are in close agreement with those recorded directly through a Data Acquisition (DAQ) card with fiber-optic and coaxial cable connected systems. Data processing is carried out at the receiving end so that the monitored quantity is displayed continuously or at specified time intervals. The working of this system has been performed under various successful tests and results generated by corona and surface discharges under high-frequency interference signals.

**Index Terms-** Data Acquisition (DAQ), WLAN, Validation tests, Sensors.

## 1. INTRODUCTION

### 1.1 IoT

The Internet of things in software, sensors, actuators, buildings and other items embedded with electronics that enable these objects to collect and exchange data. The Internet of Things (IoT) is a recent technology where electronic devices, software, sensors, vehicles, home appliances are interconnected with networks to transfer data without human or computer interaction.

In IoT, objects to be sensed and controlled remotely across the existing network infrastructure should results in improved efficiency and economic benefits. When IoT is augmented with sensors and actuators, the technology is more general class of cyber-physical systems, which also encompasses technologies such as smart grids, smart homes, intelligent transportation and smart cities. Each thing is uniquely identifiable through its interoperate within the existing internet infrastructure.

Several proven results show that the IoT will almost reaches 50 billion objects by 2020. IoT is expected to offer advanced connectivity of devices, systems, services, machine-to-machine communications, protocols, domains and applications. The interconnection of these embedded devices is expected to use in automation and advanced applications like a smart grid and converting the areas into smart cities.

Several devices such as heart beat monitoring implants, biochip transponders on animals, electric clams in sea waters, vehicles with sensors, DNA analysis equipments for environment, food, pathogen or military devices that assist soldiers in search and rescue operations. These devices collect needful data and then automatically transfer the data between other devices.

Present scenario in market examples, includes home automation such as control and lighting of bulbs, heating foods, ventilation, air conditioning systems and household appliances such as washing machines, dryers, robotic vacuums, air purifiers, ovens or refrigerators and freezers where all uses Wireless LAN for communication.

As well as the expansion of Inter-connected automation into a new application area, IoT is expected to generate large amounts of data from diverse locations. With the subsequent necessity for fast aggregation of data and to increase in the need more effectively. IoT is one of the bases for recent smart city and Smart Energy Management Systems. The Internet of Things concept was invented by and the term coined by Peter T. Lewis in September 1985.

## 2. VALIDATION TEST

This IoT based system design for validating and remote monitoring a system for continuous monitoring of leakage currents and ground currents in high voltage electrical substations is mainly based on Wireless Local Area Network (WLAN) technology. This technique is mainly for continuous monitoring in variety of plant within the substation. It has low power consumption with inbuilt overvoltage protection. It consists of a transmitter module equipped with a data acquisition system connected to leakage current circuit and voltage sensors. The receiver module is connected to a remote controller for data processing and storage. The principle and characteristics of the components in this system are described.

Validation tests are conducted to examine its performance in three different test situations;

(i) laboratory monitoring of the leakage current and voltage of a distribution surge arrester,

(ii) laboratory measurement of the leakage current of an outdoor insulator,

(iii) Field monitoring of the earth current and potential rise of high-voltage tower.

The processing of data is carried out at the receiver end, so that the monitored quantity is displayed continuously at specified time intervals. The working of this system has been tested and proven resilient under high-frequency interference signals.

Surge arresters possess highly nonlinear characteristics and are mainly used for protecting high-voltage substation equipment. Continuous monitoring of these devices can be achieved by measuring the online of leakage current.

Leakage current binded with the signal processing techniques is a reliable diagnostic tool which provides useful information on the state of the surge arrester. Commercial devices are available for condition monitoring of surge arresters, but these are not ideal for monitoring applications. Although they can be self-powered, they rely on the radio frequency communication and require the presence of an operator in-situ to download the measured values or datas for post-processing.

To validate the WLAN system for performing on-line continuous monitoring operation, these tests were carried out in a high-voltage laboratory using the arrangement as shown in figure. A high voltage transformer generates a controlled AC voltage applied to the surge arrester, which is a metal oxide surge arrester (MOSA) having a rated voltage of 15kV and a nominal discharge current of 10kA. These values corresponding to voltage are obtained through mixed resistive-capacitive voltage divider of ratio 4750:1. A suitable resistive sensor is used for the measurement of total leakage current of the surge arrester. The inputs of the LAN module are connected to both voltage and leakage current signal and the measurement of validation and Data Acquisition (DAQ) card through coaxial cables, as can be seen in figure.

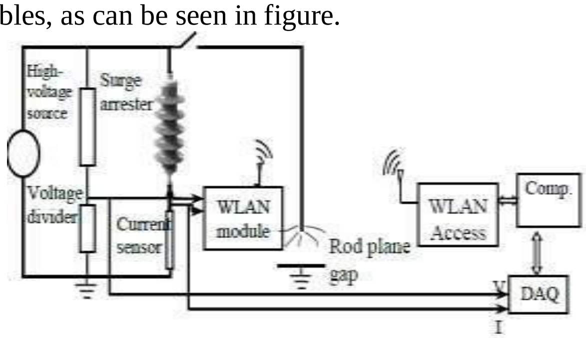



Fig: 2.1 Experimental validation set-ups for surge.

Measured values were carried out at several voltage levels up to the arrester rated voltage. Examples of the voltage and current signals recorded with a 12 Vrms applied voltage using the WLAN sensor and directly through the DAQ card are shown respectively. The characteristics reproduced by the WLAN sensor which shows signals are very close in magnitude and shape to those measured with the DAQ card. The phase difference between the voltage and current signals is also accurately measured and phase shift between the DAQ signal and WLAN signal is due to the delay occurred in the WLAN module and access point.

## 3. MEASUREMENT OF LEAKAGE CURRENT

Leakage current measurement in the presence of partial discharge such as corona from live conductors and equipment terminals radiates high-frequency signals and may affect the WLAN system performance. To execute such environment, a sharp rod-plane electrode gap was used to initiate air discharge at the test voltage. Under these conditions, the waveforms measured simultaneously with the WLAN system and the DAQ card is shown for an applied voltage of 14.5 Vrms. At this point, the voltage across the surge arrester exhibits a maximum leakage current with a large resistive component. The DAQ card and the WLAN system is able to reproduce the main features of the leakage current and the corona discharge pulses superimposed on the current signal. This occurs when the voltage exceeds a threshold value on the positive and negative half cycles.

Minor differences between the WLAN system and DAQ card signals could cause differences in the resolution and sampling rates of the two systems in addition to the transmission delay which causes the phase shift. In practice, bad weather conditions usually intensify the corona discharge and the pulse amplitude may exceed the input voltage limit of the WLAN module, which may activate the overvoltage protection circuit. Resistive capacity from high frequency and partial discharge noise is an important cause for long term continuous monitoring. Monitoring leakage current and dissipated the power of polluted insulators.

The current due to surface conduction on outside insulators is a planned remedy for insulators and also to the detect core faults and defective insulators. In heavily polluted areas, the conduction increases due to contamination by wetted salts and other conducting particles.

The implementation of leakage current sensors on substations and lines located in these areas can be very much useful for monitoring the pollution severity and the surface condition of insulators.

### 3.1 TESTING

The wireless performance of the WLAN sensor and access point was tested both in the outdoor test field described with no wireless networks detectable in the vicinity and in the high voltage laboratory, where a relatively large number of 802.11 networks using the 2.4GHz spectrum exist. For the field test set-up, The WLAN sensor, which was controlled by a laptop computer, was placed at a distance of 60m from a DI-524 link. An AirPcap Tx USB adapter was used in conjunction with the protocol analyzer Wireshark to capture wireless 802.11b/g traffic on the channel the WLAN Sensor was transmitting onto.

An analyzer named cascade pilot PE is used to examine channel usage, carry out traffic analysis errors and retransmissions. A Wi-spy 2.4x USB spectrum analyzer was used in conjunction with the spectrum analysis software Chanalyzer Pro to measure the 2.4-GHz ISM spectrum. To enable the discovery of noisy channels spotted from interfering devices and to start the optimum WLAN speed and performance. The user associated with the WLAN sensor, USB adapters and software will be referred to as the Wi-Fi interference monitor. At the receiver location a 10dB directional antenna was placed at a height of 2.6m, and connected through a low loss coaxial cable to the DI-524 access point, which is connected to a second user which controls the triggering and interruption commands for the wireless transmission.

The performance was measured in the 2.4-2.5

GHz spectrum over a 10-minute transmission period, for 802.11 channels 1, 6 and 11, which are considered non-overlapping channels. Several tests based on wireless performance were conducted on both with and without high voltage energization, with a distance of 2.3m between the Wi-Fi interference monitor and the access point. Regular traffic and retransmitted data exchanged between the DI-524 access point and the WLAN sensor, recorded on channel 11 in both the field and the laboratory. Both cases show a steady data throughput, averaging about 720 kbps and 780 kbps respectively, with low re-transmitted data throughout the test. In the laboratory test, the normal traffic waveform experiences a small drop about 360 seconds into the measurement, corresponding to a small dip in the access points signal strength from - 37dBm to - 44dBm. When a large number of highly active interfering access points exist, the retransmitted data waveform would exhibit more pronounced spikes, which causes the DC power supply part consist of ac supply of 230v is step down using transformer and a bridge rectifier converts ac signal to dc & regulator is used to produce constant dc voltage.

## 4. HARDWARE DESCRIPTION

- Embedded Controller
- Relay
- Potential transformer
- Temperature sensor
- Current transformer

A microcontroller can be compared with the processor, but the operations assigned to do cause the major differences between memory and peripherals in the embedded system. The maximum usages of microcontrollers today are embedded with other machines and appliances such as automobiles, telephones and peripherals for computer systems. These systems are called as embedded systems.

### Potential Transformer

The potential transformer works similar to the principle of transformers. It converts high voltage to low. It will consume thousands of volts behind power transmission systems and step the voltage down so that meters can handle. Normally these transformers work for single and three phase systems, and it is attached at a point where we can measure the voltage.

### Voltage measurement

The load voltage is measured using a potential transformer. It is stepped down to a low value by using a potential transformer. The output voltage of the potential transformer is connected to an variable resistor which reduces the voltage to a certain level. The temperature sensor namely, Thermistor is used to sense the temperature level.

An amplifier is an electric circuit which produces output voltage to the product of input voltage with a value called voltage gain. A current transformer is a measuring device designed to provide current in its secondary coil proportional to the current flowing in its primary. The Current transformers are mainly used in metering and protective relaying in the electrical industry, where they offer the safe measurement of large currents, often in the presence of high voltages. This transformer safely isolates measurement and control circuitry from the high voltages typically present on the circuit being measured.

### Current measuring circuit

The current produced by the load is monitored using current transformer. The primary coil of the transformer is connected in series with the load. Whereas a resistance of exact value is connected across the secondary coil of the current transformer. At this stage, the current is converted into voltage, and the voltage drop across the resistor is applied to the variable resistor which reduces the voltage to a measured level.

### LM35

LM35 is an IC temperature sensor with its output proportional to the temperature. This sensor circuits are sealed so that it is not subjected to oxidation and other process. With this sensor the temperature can be measured is more accurate than the temperature measured across a thermistor.

This sensor also possess low self heating and does not cause more than 0.1 $^{0}$C temperature rise in still air. Operating temperature range - -55°C to 150°C. Output voltage - varies by 10mV in response to every $^{0}$C rise/fall in ambient temperature, i.e., its scale factor is 0.01V/ °C .

## 5. MICRO CONTROLLER PIC16F877

When the sufficient voltage is applied across the electrodes, the liquid crystal molecules are arranged in a specific direction. The light rays passing through materials that combines the properties of liquid and crystal. Instead of having a melting point, they have a temperature range within in which the molecules are almost mobile in a liquid, but these molecules are grouped together to form a similar crystal. PIC 16F877 is one of the most advanced microcontroller from Microchip.This controller is widely used for experimental and modern applications because of its low price, wide range, high quality, and ease of availability. It is ideal for applications such as machine controlled applications, measurement devices, study purpose, and so on.

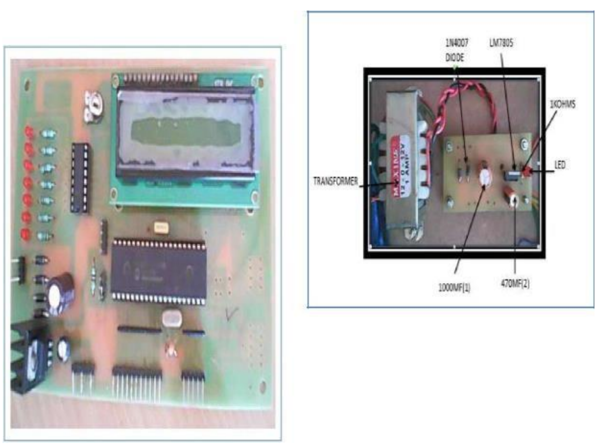



Fig.5.1.PIC Controller Circuit Diagram

## SINGLE POWER SUPPLY

Power supply is the source of power needed for the components. It is used in circuits mainly to convert AC voltage into DC voltage. Transformers are used to convert 230V into 12V AC, and the 12V AC is given to diode. Diode range is 1N4007, which is used to convert AC voltage into DC voltage. AC capacitor used to charge AC components and discharge on the ground. The LM 7805 regulator is used to maintain voltage as constant and the signal will be given to the next capacitor, which filters the undesired AC component. The load will be LED and resistor. LED voltage is 1.75V. If the voltage is above the beyond limit, then it will be dropped on register.

All the electronic circuits require DC voltage sources or power supplies. If the electronic device is to be portable, then one or more batteries are usually needed to provide the DC voltage required by electronic circuits. Yet batteries have a limited life span and cannot be recharged. The solution is to convert the alternating current lose hold line voltage to a DC voltage source.

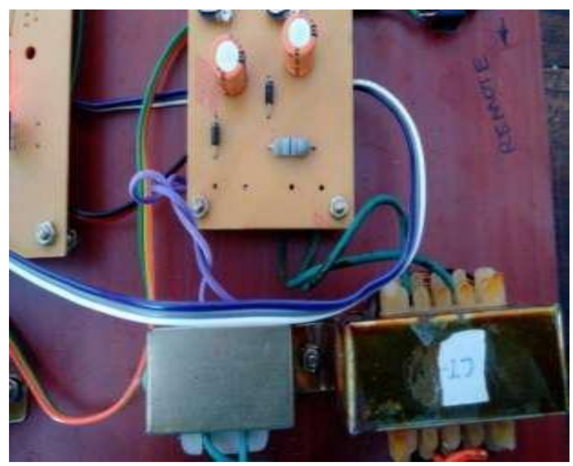


Fig 5.2 IOT Control process


Fig 5.3 IP address generation

1. Transformer: Turns the household line voltage up or down as required

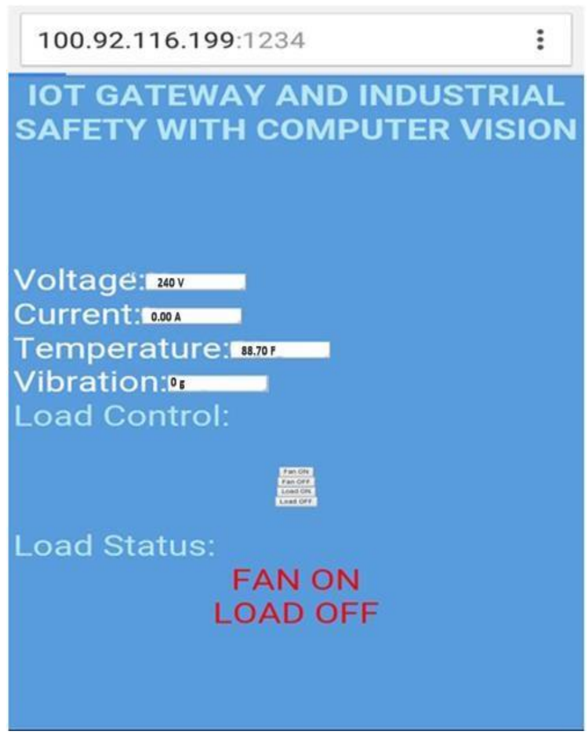
2. Rectifier: Converts AC voltage into DC voltage.

3. Filter: Smooth the pulsating DC voltage to a varying DC voltage.

4. Regulator: Fix the output voltage to constant value.

## 6. RESULT


a. Leakage current with load ON




b. Leakage current when load OFF

## 7. CONCLUSION

This paper has demonstrated the feasibility of a novel wireless based leakage current monitoring system and its application in high voltage electrical substations. This system can be used as a standalone device to measure leakage current and voltage in a variety of equipments and machinery. It has been successfully tested in three different monitoring applications: (i) in monitoring of leakage current in surge arrester, (ii) in monitoring the surface conduction current of polluted insulators and (iii) in monitoring the earth current flowing through the footings of a high-voltage tower. Further work is required to improve accuracy, account for transmission delays, and extend the application to multiple sensors.

**REFERENCES**

[1] M. ŠONKA, V. Hlavac, R. Boyle: ”Image Processing, Analysis, and Machine Vision”, Thomson Learning, part of the Thomson Corporation 2008 ISBN: 10: 0-495-24438-4, ISBN: 13: 978-0-495-24428-7

[2] E. Scott Geller, Behavior-based safety in industry: Realizing the large-scale potential of psychology to promote human welfare, Applied and Preventive Psychology, Volume 10, Issue 2, Spring 2001, Pages 87-105, ISSN 0962-1849.

[3] Qureshi, Faisal, et al. "A Computer Vision System for Spaceborne Safety Monitoring." Proceedings, 8th International Symposium on Artificial Intelligence, Robotics and Automation in Space (iSAIRAS), Munich. 2005.

[4] O. Ková , M. Koval ík, P. Fecilak, F. - Jakab.:”Learning module of non-periodic signal digitization using ATMega328 microcontoller",ICETA 2014, 12th IEEE International Conference on Emerging eLearning Technologies and Applications : proceedings : December 4-5, 2014, Starý Smokovec. - Danvers : IEEE, 2014 S. 255-260. - ISBN 978-1-4799-7738-3

[5] E. Albrechtsen: "A qualitative study of users' view on information security." Computers & security 26.4 (2007): 276-289.

[6]C. Alippi and C. Galperti, ‗An adaptive system for optimal solar energy harvest