

LABVIEW BASED ELECTRICAL PARTIAL DISCHARGE MEASUREMENT SYSTEM

¹Abhay W. Rawool, ²S. V. Kulkarni, ³P. P. Vaidya

¹M.E Student, ²Professor, ³Head of Department

^{1,3}Instrumentation Department, V.E.S. Institute of Technology Chembur, Mumbai, India

²Electrical Engineering Department Indian Institute of Technology Powai, Mumbai, India

Abstract: This paper presents a brief overview of a Partial discharge measurement implemented using LabVIEW. A Partial discharge is a localized electrical discharge that partially bridges the insulation between conductors and which can occur adjacent to a conductor. In high voltage devices such as transformers, a discharge is a sign of a problem due to aging, floating components and insulation breakdown. In this study, efforts have been made to investigate the partial discharge (PD) phenomenon in terms of phase, magnitude and number of PD pulses by using LabVIEW. A LabVIEW based program is developed to acquire continuous PD data.

Keywords: Partial discharge detection, measurement of ϕ -q-n analysis, LabVIEW based program for acquiring two channel data.

I. INTRODUCTION

The quality of insulation plays an important role in high voltage (HV) power equipment. Different types of materials like solid, gaseous, liquid or a combination of those materials are used for insulation purpose in high voltage power equipment. The insulation gradually degrades due to the cumulative effects of electrical, chemical and mechanical stresses caused by the partial discharges (PDs). Most of the insulators are not in pure form and contain impurities. Due to the presence of air, bubbles (voids) are formed within the insulating material. They weaken the insulation region and are responsible for appearance of PDs. Insulation failure occurs due to presence of PDs in high voltage power equipment. PD can be prevented through careful design and by selecting proper insulating material. PD detection and prevention is done to ensure long life of high voltage power equipments used for electric power utilities. LabVIEW software is proposed which gives the real time visualization of partial discharge signal produced inside the high voltage power equipment.

II. PD: SOURCES AND DETECTION

The Various methods are used for PD measurements which are based on both electrical and non-electrical phenomena. The methods which have been popularly used for measurement of PDs are,

A. PD Sources:

- 1) External Partial discharge: External Partial discharge takes place outside the power equipment. Such type of discharge occurs in overhead lines, armature etc.
- 2) Internal Partial discharge: The discharge which occurs inside the PD system is called internal discharge. The discharge which occurs in the void leads to such type of discharge and hence it is necessary for PD measurement. The monitoring and measurement of PD gives information related to properties of insulating material used in high voltage equipments. PD phenomena include several types of discharge which is surface discharge, cavity discharge, corona discharge, Treeing channel [2].
- 3) Corona discharge: Corona discharge takes place due to non-uniformity of electric field on sharp edges of conductor which are subjected to high voltage [1, 2]. Such type of discharge occurs for long duration but it does not directly affect the insulating system.

- 4) Surface discharge: Surface discharge takes place on interfaces of dielectric material. This may occur in bushing, cable ends or in any point on insulator surface between electrodes (high voltage terminal & ground).

Although acoustic and ultra-high frequency (UHF) has been extensively researched in recent times, the electrical method is most popular and widely used.

B. Electrical detection method:

Electrical detection method is one of the most popular methods in HV power equipment for partial discharge measurement. In this work, electrical detection method has been used to simulate the measurement of PDs in the model transformer. It focuses on appearance of the current and voltage pulse created because of void and impurities [2]. The shape of the pulse and occurrence of phase location within the ac cycle gives information about the type of PD and about insulation failure. This method is also applicable for online electrical PD detection.

Partial discharge can be characterized by a three dimensional plot namely for phase on the power line cycle, q for the apparent charge and n for the number of pulses. This 3D plot is represented as one of the most complete forms of graphical representation of a PD pulse distribution. Each discharge pulse in the pattern represents the physical process at the discharge site and there is an extremely strong co-relation between the features of these patterns and the type of defect causing them. The ϕ - q - n can be represented using LabVIEW program as shown in figure 1, where n can take any value.

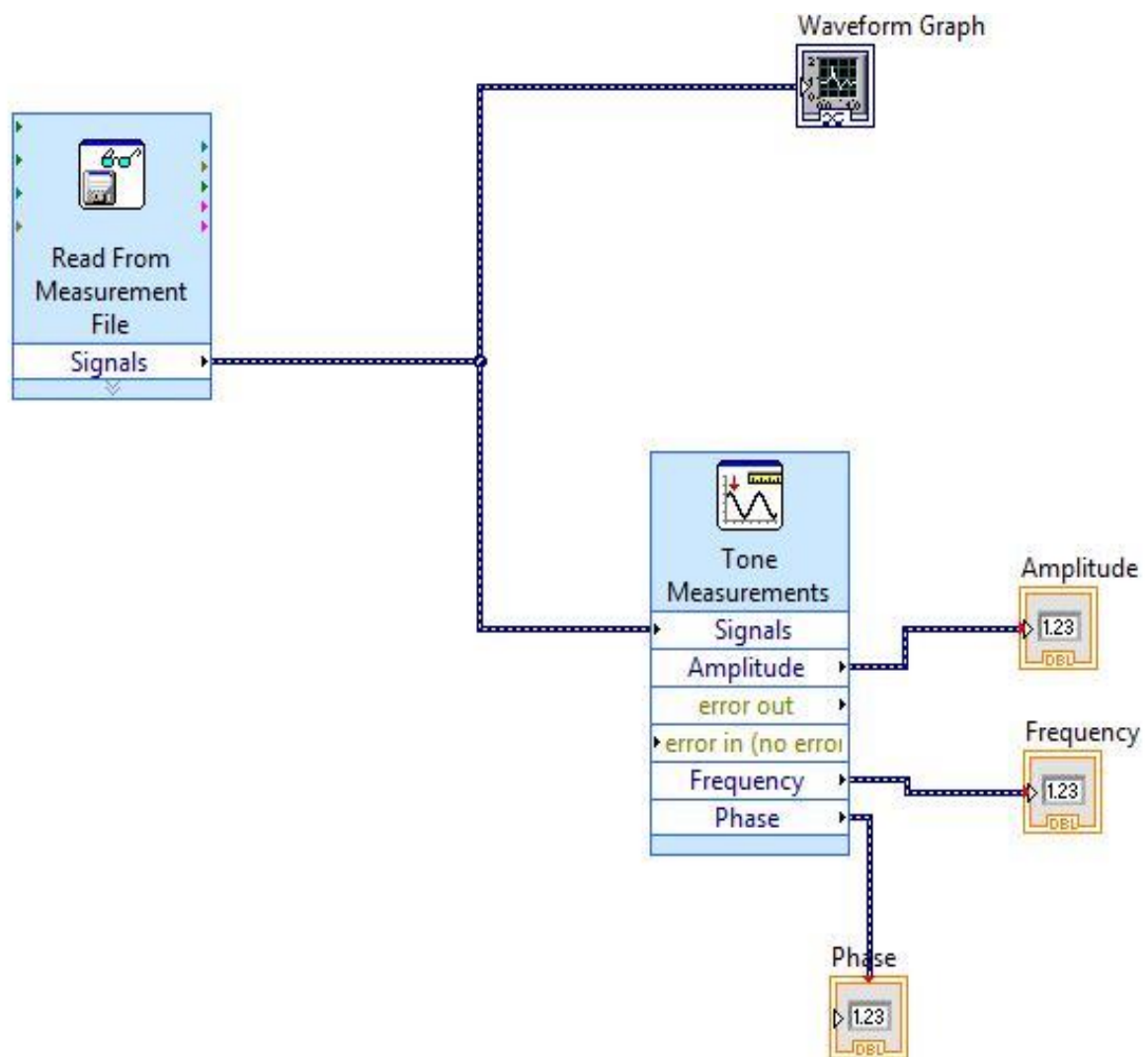


Fig. 1: ϕ - q - n pattern in LabVIEW

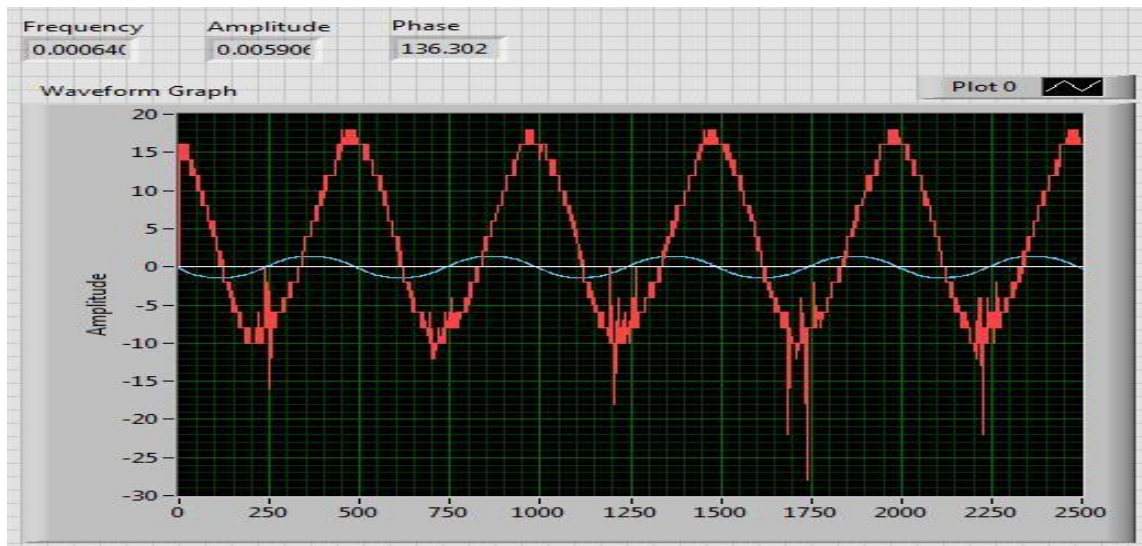


Fig. 2: -q-n pattern

The recurrence is caused by the periodic polarity reversals of the applied electric field due to alternating 50-Hz sinusoid voltage waveform. On an average one pulse is observed on the Partial discharge per cycle. The maximum charge and phase angle observed is given in figure 2.

III. LABVIEW BASED PARTIAL DISCHARGE

MEASUREMENT:

LabVIEW program is developed to acquire and analyse signals received from a non-intrusive partial discharge measurement. The PD measurement system is followed by Digital storage oscilloscope and LabVIEW. The basic idea is to generate signals from LabVIEW and store the acquired signals so that they can be utilised for analysis. The main advantage is that we can acquire live data from the PD setup and can make necessary changes in the program whenever required. Partial discharge produces characteristic patterns for an insulation system. These patterns can be studied and explained on the basis of mathematical models using various softwares. In addition, PD increases with the increase of applied voltage inside the solid insulation. In this study efforts have been made to investigate the PD magnitude, number of PDs and other PD related parameters like amplitude and phase. The most important thing is to have necessary drivers which support LabVIEW with the required DSO model so that it becomes easy to acquire data from DSO in to LabVIEW. The program developed in this paper is based on acquiring continuous two channel data from the PD setup in to LabVIEW. The data acquired can be stored in LabVIEW in any required format such as Excel, TDMS etc. The TDMS format is one the best method to store data in LabVIEW because it stores continuous data from any device without any limit. It is very well defined as technical data management system. The Excel data stored can also be converted to TDMS format by using LabVIEW programming. When data sets cannot be located, tests or simulations must be recreated. As a result, many companies see decreased efficiency and drastically increased development costs. To meet these challenges, National Instruments has defined a technical data management (TDM).

The program shown in figure 3 is based on two channel data acquisition from the PD setup by a source DSO Tektronix model 2002B which will acquire two channel data. The data is taken from PD meter to DSO and further it can be seen on LabVIEW for storing and using it for further purposes. The most important parameter for interfacing with LabVIEW and DSO is VISA source that is TEKVISA which will detect the DSO in LabVIEW by any physical connection such as serial port, USB etc. The above program should be properly identified by VISA resource name. The auto setup mode in the program helps to automatically adjust the data in correct format without any distortion. The above configuration is serial configuration. Two separate data from two different channels is acquired and displayed on the waveform chart or waveform graph. The basic step is to increase the applied voltage and then observe the discharge in the form of pulse which occurs on the PD signal and the other signal will be standard reference signal. The PD signal will be used for Φ -q-n analysis which easily determines the angle, apparent charge, and the number of pulses occurring on the PD signal. The while loop helps to acquire continuous data from the PD setup. The data can be temporarily stored in excel format if not, the same data can be converted to TDMS or can be stored directly in TDMS file format by using program shown in figure

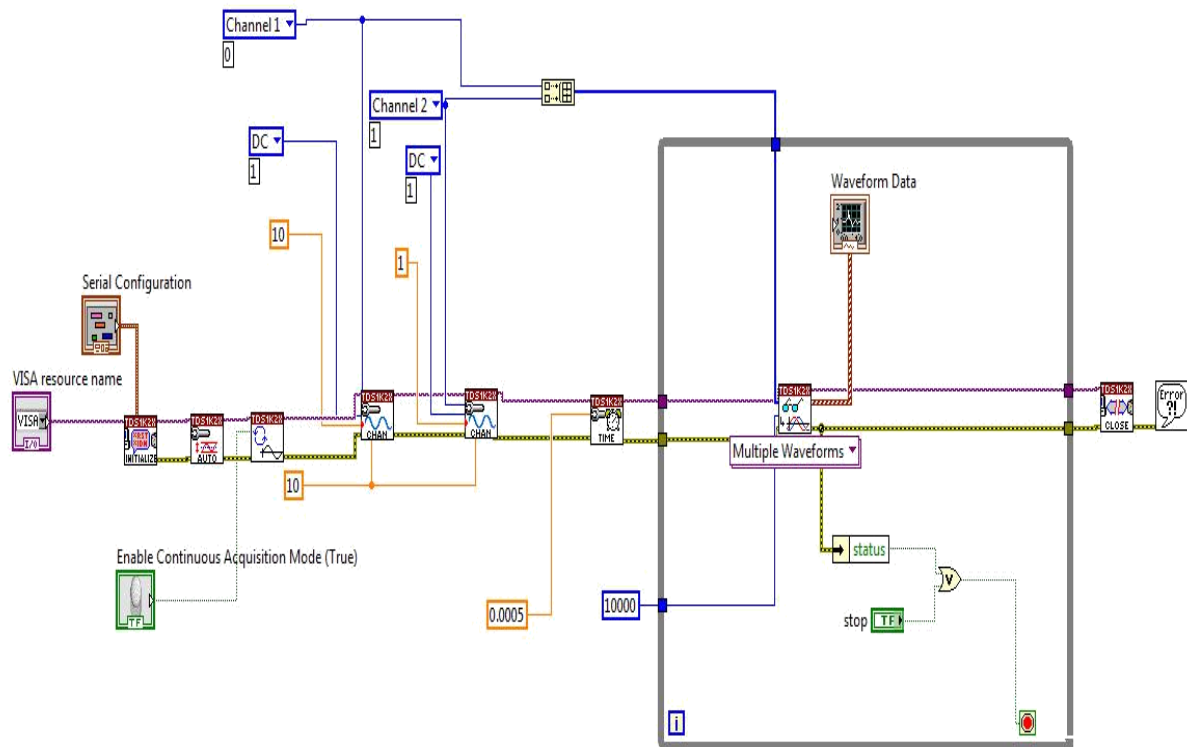


Fig. 3: Two channel data acquisition using LabVIEW

4. But for storing data directly to TDMS file format, the Diadem software is required. NI Diadem is a single software tool that can be used to quickly locate, load, visualize, analyse, and report measurement data collected during data acquisition and/or generated during simulations. It is designed to meet the demands of today's testing environments, which require quick access, processing, and reporting on large volumes of scattered data in multiple custom formats to make informed decisions. Diadem is a component of the NI Technical Data Management (TDM) solution.

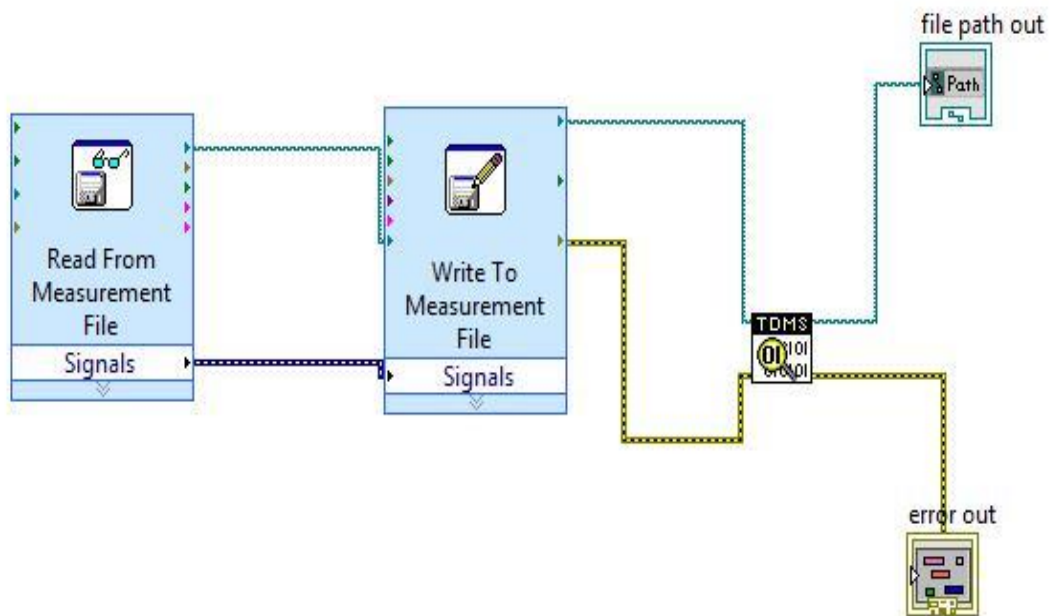


Fig. 4: Program for Excel to TDMS conversion

In LabVIEW based PD measurement, continuous data can be acquired and the program can be modified as per the requirement of the user. LabVIEW helps to design any system by using a visual programming language which can run on any operating system such as Microsoft Windows, UNIX, Linux, and Mac OS.

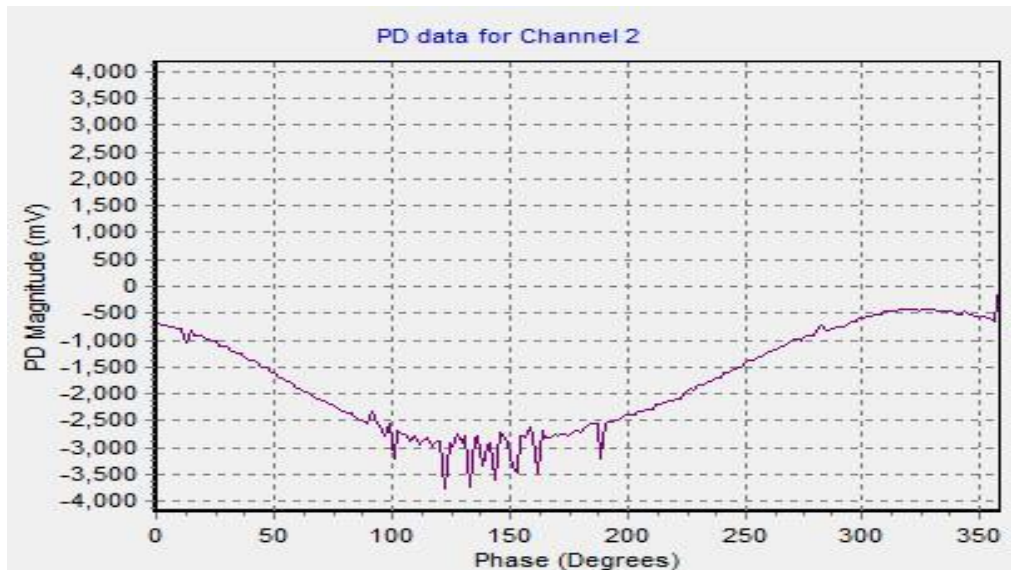


Fig. 5: PD gold phase signal

IV. CONCLUSION

Partial discharges are a major source of insulation failure in high voltage power system which needs to be monitored continuously to avoid incipient failure in the power system network. In this paper, LabVIEW based program has been generated to acquire continuous PD signal with standard reference signal and to observe the Φ -q-n pattern from the PD signal. The PD data is monitored and stored in TDMS format so that large amount of continuous data can be stored or else PD data can be stored in excel format and then can be converted to TDMS format by using LabVIEW program.

ACKNOWLEDGEMENT

The authors would like to thank IIT Bombay, Electrical Department for providing necessary equipments and softwares.

REFERENCES

- [1] R. J. Van Brunt, Physics and Chemistry of partial discharges and corona, IEEE Trans. on dielectric and Electrical Insulation, Vol. 1, No. 5, pp. 761-784, October 1994.
- [2] R. Bartnikas, Partial Discharge their mechanism, Detection and Measure-ment, IEEE Trans. Elect. Insul, Vol. 9, pp. 763-808, 2002.
- [3] A.M. Gaouda, et al., "On-line detection and measurement of partial discharge signals in a noisy environment," Dielectrics and Electrical Insulation, IEEE Transactions on, vol. 15, pp. 1162-1173, 2008
- [4] P. Morshuis and J. Smit, "Partial Discharges at de Voltage: Their Mechanism, Detection and Analysis," IEEE Transactions on Dielectrics and Electrical Insulation, vol. 12, pp. 328-340, April 2005.
- [5] John M. Cimbala, "LabVIEW - instructions for building a virtual instrument: sample and display voltage data", Penn State University, pp. 1-4, 08 October 2009.
- [6] A. Natrass, Partial Discharges in Power Transformers, "Equ@ment Lksagn, 1978. Elect. Review 2, June 78 Vol. 202, No. 21.
- [7] F.H. Krueger, "Partial Discharge Detection in High-Voltage Equipment", London, U.K.: Butterworth, 1989.
- [8] S. Karmakar, N. K. Roy and P. Kumbhakar, Monitoring of high voltage power transformer using direct Optical Partial Discharges detection technique, journal of Optics, Vol. 38, No. 4, pp. 207-215, 2009.