

# HIGH RESOLUTION IMPULSE ANALYSING SYSTEM

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*Specially dedicated to  
My beloved family, and those who have guided and inspired me  
Throughout my journey of learning*

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## ABSTRACT

An impulse is an intentionally applied aperiodic transient voltage or current which usually rises rapidly to a peak value and then falls more slowly to zero. The aim of this project is to analysis of the lightning impulses according to IEC 60060-1: 2010. The main purpose of developing the system is so that it is comparable to Haefely High Impulse Analysing System 743 (HIAS 743). LabVIEW program has been developed to analyse key parameters normally front time, time to half, peak value, of full and chopped lightning impulses. The program has a procedure for obtaining the parameters of the impulse waveform. The system has been tested with impulse voltages up to 500V. This system also accommodate the use of attenuators Attenuator Type 9410-1. Contribution from this project is that, it is a cost saving project, where to develop this system equipment that is need is a laptop to read the impulse waveform. Besides that, portability is one of the main issues, by developing this system, the high voltage equipment can be tested at the field with no hassle.

## ABSTRAK

Impuls adalah voltan fana sengaja digunakan tak berkala atau semasa yang biasanya meningkat dengan cepat kepada nilai puncak dan kemudian jatuh lebih perlahan kepada sifar. Tujuan projek ini adalah untuk analisis impuls kilat mengikut IEC 60060-1: 2010. Tujuan utama membangunkan sistem ini supaya ia setanding dengan Haefly tinggi Impulse Menganalisis Sistem 743 (HIAS 743). Program LabVIEW telah dibangunkan untuk menganalisis parameter utama biasanya masa depan, masa kepada separuh, nilai puncak, impuls kilat penuh dan dicincang. Program ini mempunyai prosedur untuk mendapatkan parameter bentuk gelombang gerak hati. Sistem ini telah diuji dengan voltan impuls sehingga 500V. Sistem ini juga menampung penggunaan attenuators Atenuator Jenis 9410-1. Sumbangan daripada projek ini adalah bahawa, ia adalah projek penjimatan kos, di mana untuk membangunkan peralatan sistem ini yang perlu adalah sebuah komputer riba untuk membaca gelombang gerak hati. Di samping itu, mudah alih adalah salah satu isu utama, dengan membangunkan sistem ini, peralatan voltan tinggi boleh diuji di lapangan tanpa kerumitan.

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**LIST OF ABBREVIATIONS**

V <sub>p</sub>	-	Peak Voltage
T <sub>1</sub>	-	Front Time/ Rise Time
T <sub>2</sub>	-	Time to Half Value
IEC	-	International Electrotechnical Commission
HIAS	-	High Impulse Analysing System
T <sub>c</sub>	-	Time to Chopping
VI	-	Virtual Instrument
VISA	-	Virtual Instrument Software Architecture
RSG	-	Recurrent Surge Generator
K	-	Attenuation Ratio

# CHAPTER 1

## INTRODUCTION

### 1.1 Background

In this new era, power demand is rising rapidly. Electrical power system should be upgraded time by time to cater this demand. Hence, high voltage system becomes most essential requirement for power transmission. The equipment used in these high voltage transmission system, should be capable of withstanding this high voltage stress.

In addition to that, normal high voltage withstanding capability, a high voltage equipment must also be capable of withstanding different over voltages during its operational life span. These different over voltages may occur during various abnormal conditions.

These abnormal over voltages cannot be avoided hence, the insulation level of the equipment is so designed and manufactured, that, it can withstand all these abnormal conditions.

To ensure the capabilities of withstanding these abnormal over voltages, the equipment must go through different high voltage testing procedures [1]

Some of these tests are used to ensure, permittivity, dielectric losses per unit volume and dielectric strength of an insulating material. These tests are generally carried out on a specimen of insulating material. Some other high voltage tests are carried out on the complete equipment [10,11]. These tests are for measuring and ensuring, capacitance, dielectric losses, break down voltage, and flash over voltage etc. of the equipment as a whole.

High voltage equipment specifically installed outdoor are prone to be strike by lightning. These phenomena can breakdown transmission line insulator and it may also attack, the electrical power transformer connected at the end of the transmission lines. Surge test or impulse tests are very high or extra high voltage tests, carried out for investigating the influences of surges or lightning on the transmission equipment. Normally direct lightning strokes on transmission line is very rare. But when a charged cloud comes closer to the transmission line, the line is oppositely charged due to the electrical charge inside the cloud [2]. When this charged cloud is suddenly discharged due to lightning stroke nearby, the induced charge of the line no longer bound but travel through the line with velocity of light. So it is understood that even when the lightning do not strike the transmission conductor, directly, still there will be a transient over voltage disturbance [3-5].

During traveling of this wave, high voltage stress occurred on the insulator. Due to which violent rupture of insulators is often caused by such lightning impulse. So proper investigation, of the insulator and insulating parts of high voltage equipment, should be done properly by high voltage testing [3-5]. The lightning impulse is totally natural phenomenon so it does not have any predetermined shape and size of the steep-fronted voltage. So, for performing this high voltage testing, a standard voltage wave is applied. Although this standard voltage may not have any similarity in height and shape with the actual impulse voltage due to lightning or surges [6].



## 1.2 Problem Statement

For the new high voltage equipment before it being installed in the field it must undergo certain test in order to know the withstand voltage of its rated voltage. After getting the withstand voltage, Basic insulation level (BIL) can be applied. Basic impulse level/ basic insulation level (BIL) which implies the limit up to which an insulator could withstand impulse due to lightning strikes. Impulse is generated on the insulation due to the high voltage surges and spikes due to lightning strikes. BIL is generally much higher as compared to power frequency withstand voltage. However, the major reason that insulation levels differ among different types of equipment relates to the equipment's role in the distribution system.

The needed impulse voltages are usually measured using an accurate impulse analyzing system such as the commercially available Haefely High Impulse Analysing System (HIAS 743). However the system is expensive. This project aims to develop an alternative system that perform task similar to Haefely High Impulse Analysing System (HIAS743).

## 1.3 Objective

In this thesis, the main objective is to develop a measuring system consisting of two input channels for lightning impulse waveforms of voltage with suitable attenuators (voltage dividers) if required. Data acquisition and display system

- ADC, processor or analyzer, display and controlling software like LabVIEW software.

Generally, the measurements in this thesis project compliance with the international standards (IEC).

## 1.4 Scope of Project

The scopes of the project:

i. Analyse

Paper reviews from recent researchers, IEC standards studies, analyse Oscilloscope's system on how it works, LabVIEW with Tektronix TDS 3000 Series Oscilloscope instrument driver.

ii. Follow specification and conduct experiment

The input for this project is up to 1kV, with the parameters as below:-

- Speed: 1.2us front time, 50us tail time
- 12-bit - 14-bit ADC
- All parameters automatically computed according to standard definitions, example front time, peak time, tail time, oscillations and more.

The scope of this thesis is mainly according to the IEC standard, certain parameters should be take into account in order to compliance with the HIAS 743.

## 1.5 Thesis Organization

This thesis consists of five chapters including this chapter. The content of each chapter are outlined as follow:

- Chapter 2      Contained a detailed description each part of project. It will explain about the characterization of impulse voltages by lightning impulse.
  
- Chapter 3      Include the project methodology. This will explain how the project is organized and the flow of the process in completing this project
  
- Chapter 4      Present the expected result from the LabVIEW software, the process of saving data in spreadsheet format and graph plotting by using Microsoft Excel

Finally the conclusion and the future recommendation of this project and presented in chapter 5

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