

**THE EFFECT OF MULTIPLE LIGHTNING IMPULSE ON THE
ELECTRICAL CHARACTERISTICS OF TRANSIENT VOLTAGE
SUPPRESSION DIODE AS LOW VOLTAGE
LIGHTNING PROTECTIVE DEVICE**

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LOW VOLTAGE LIGHTNING PROTECTIVE DEVICE

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Specially dedicated to
my beloved father, mother and wife.

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ABSTRACT

The behaviour and performance of surge protective devices such as transient voltage suppression (TVS) diode under the application of multiple lightning impulses are different from the single lightning impulse. Since TVS diode is commonly used and reliable device for low voltage and telecommunication systems lightning protection, a precise method of testing has to be applied based on the natural characteristics of lightning to accurately determine its performance and capability. In this work, laboratory studied are to be carried out on 1 kV voltage with multiple lightning impulse using Multiple Impulse Generator (MIGe) and 1.5 kW rating of TVS diode. The electrical response of the device such as standby current (I_D), breakdown voltage (V_{BR}) and capacitance (C) characteristic are then being analyzed to determine the effect on the TVS diode performance. The experiment results show that after applying single impulse and multiple impulse voltage produces the changes in electrical characteristic of TVS diode.

ABSTRAK

Sifat dan prestasi sesuatu peranti perlindungan dedenyut seperti penyerap voltan seketika (TVS) diod dibawah aplikasi dedenyut kilat berbilang adalah berbeza dari dedenyut kilat tunggal. Sejak penyedut voltan seketika diod seringkali digunakan dan keboleharapan untuk digunakan sebagai perlindungan kilat pada voltan rendah dan sistem telekomunikasi, langkah yang tepat bagi pengujian perlu diaplikasikan berdasarkan ciri-ciri kilat yang tepat bagi mengenalpasti prestasi dan ketahanan peranti ini. Didalam kerja ini, kajian makmal dilaksanakan menggunakan voltan 1 kV dengan dedenyut kilat berbilang menggunakan Penjana Dedenyut Berbilang (MIGe) dan 1.5 kW taraf TVS diod. Tindak balas elektrik bagi ciri-ciri peranti seperti arus sedia (I_D), voltan pecah tebat (V_{BR}) dan pemuat (C) akan dinilai bagi mengenalpasti perubahan terhadap prestasi TVS diod. Keputusan kajian menunjukkan dedenyut kilat tunggal dan dedenyut kilat berbilang menghasilkan perubahan kepada sifat elektrik bagi TVS diod.

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LIST OF SYMBOLS

I_D	-	Standby current
V_{BR}	-	Voltage breakdown
C	-	Capacitance
L	-	Inductance
R	-	Resistor
V_{WM}	-	Rated standoff voltage
I_{FSM}	-	Rated forward surge current
V_{FS}	-	Forward voltage
V_C	-	Voltage clamping
t_f	-	Front time wave
t_t	-	Tail time wave
Ω	-	ohm

LIST OF ABBREVIATIONS

TVS	-	Transient Voltage Suppression
MIGe	-	Multiple Impulse Generator
SPD	-	Surge Protective Devices
MOV	-	Metal Oxide Varistor
GDT	-	Gas Discharge Tube
AC	-	Alternating current
DC	-	Direct current

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CHAPTER I

INTRODUCTION

1.1 Background of project

Nowadays, there are a lot of electronic equipment using the low voltage lightning protective device such as Surge Protection Device (SPD) as a protection from lightning surge especially in telecommunication industries. Any disturbance by surge even in voltage and current can cause damage and failure of functioning to the equipment connected to signal or power lines.

Most of the lightning strike has produced multiple strokes between 60 % to 70 % of ground flashes that contain average of three or four stroke/flash. For stroke more than ten strokes/flash is about 5 %. This multiple stroke has a common time interval between strokes is 40 ms with range of 10 to 30 ms [1].

The principle component of SPD is to reduce or limit high voltages usually used such as metal oxide varistor (MOV), opto-isolator, transient voltage suppression (TVS) diode, thyristor, gas discharge tube (GDT) and others.

TVS diode is a class of diodes that are designed to conduct the surge current which is necessary to provide transient voltage protection in electrical circuits. TVS diodes exhibit relatively high impedance at normal system voltage before and after occurrence of the surge. It limits the surge voltages on equipment by providing low impedance to conduct the surge discharge current.

1.2 Problem statement

Lightning surge is one of the most common causes that damage the electrical and electronic system. In order to solve this problem, the suitable low voltage lightning protective device should be employed. Experimental results are studied in detailed and the performance of TVS diode is determined so that TVS diode can be used as reliable SPD under application of single and multiple lightning impulses.

1.3 Objectives

The objectives of this project are as follow:

1. To generate standard single lightning impulse and multiple lighting impulses by using Multiple Impulse Generator (MIGe).
2. To apply the impulse on TVS diode.
3. To analyze the electrical characteristic of TVS diode under single and multiple lightning impulse.

1.4 Scope of research project

Scope of work of this project is:

1. To study characteristic and behaviour of transient voltage suppression (TVS) diode.
2. To generate 1 kV standard single voltage and multiple voltage impulse waveform of 1/1000 μ s using Multiple Impulse Generator (MIGe) on protective device.

3. To measure and compare the changes of parameter and characteristic of transient voltage suppression (TVS) diode (stand by current, breakdown voltage, capacitance and inductance) before and after application of the standard single and multiple lightning impulse.