The Effect of Fast Rise Multiple Lightning Impulse on the Physical and LC Circuit Parameters of MOV (Experimental)

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ABSTRACT

The behaviour and performance of lightning protective devices such as metal oxide varistor under the application of multiple lightning impulse are different from the standard single stroke test. Since metal oxide varistor is the most common, economical and reliable device for low voltage and telecommunication systems lightning protection, a precise method of testing has to be adopted based on natural characteristics of lightning to accurately determine its performance and capability. In this work, laboratory studies are to be carried out on 1kV voltage and 250A current rating metal oxide varistor (MOV). The test samples are to be subjected to multiple lightning impulses with fast rise time using the constructed Multiple Impulse Generator, MIGe. The physical and circuit parameters of the device are to be analyzed. The experiment results have shown that fast rise multiple lightning impulse have caused significant degradation on physical and LC circuit parameters of MOV.

ABSTRAK

Kelakuan and Kecekapan alat perlindungan kilat berasaskan Metal Oxide Varistor adalah berbeza dibawah kajian gelombang dedenyut voltan and arus berbilang dengan masa menaik yang cepat daripada keputusan yang diperolehi daripada gelombang dedenyut piawai. Metal Oxide Varistor merupakan alat perlindungan kilat yang paling luas gunaannya dalam peralatan voltan rendah dan telekomunikasi kerana murah and tahap kecekapan yang tinggi. Oleh sebab itu, cara penentuan ciri-ciri kecekapan MOV harus dilakukan dengan betul bersesuaian dengan gelombang dedenyut kilat sebenar di makmal. Dengan itu, kerja makmal harus dilakukan terhadap MOV pada voltan 1kV dan arus 250A. Gelombang dedenyut berbilang dengan masa menaik yang cepat yang dijanakan oleh janakuasa dedenyut kilat akan dilancarkan pada MOV. Sampel MOV yang dikenakan gelombang dedenyut akan dikaji untuk menentukan keadaan fizikal and juga parameter litar LC. Keputusan makmal menunjukkan bahawa gelombang dedenyut voltan and arus berbilang dengan masa menaik yang cepat membawa kesan teruk yang ketara pada bentuk fizikal and juga parameter litar LC.

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A	-	Ampere
AC	-	Alternative Current
DC	-	Direct Current
mA	-	mili Ampere
kA	-	kilo Ampere
kV	-	kilo Volt
μF	-	micro Farad
μH	-	micro Henry
μs	-	micro second
Hz	-	Hertz
Ω	-	Ohm
^{o}C	-	Degree Celsius
L	-	Inductor
R	-	Resistor

CHAPTER 1

INTRODUCTION

1.1 Introduction

Today's society is greatly dependent on electronic technology where electronic systems and equipment are widely used. These highly sensitive electronic equipments are vulnerable to the effects of electrical overstress causing devices failure, permanent degradation or malfunction.

Electrical overstresses are mainly originated from lightning, switching of inductive loads and electrostatic discharge. However, lightning is the most common threat to the stability and reliability of the electronic equipment and systems. Lightning is a transient, high-current and high-voltage discharge which will propagates into the power line, data line, telecommunication systems and other low voltage system. It will cause damage to the equipment and endanger the safety of the user. Thus, life saving of this equipment and users has become vitally important.

The most common, economical and reliable method of suppressing transient voltages is through the application of metal oxide varistors (MOVs). Metal oxide varistors are commonly constructed by bonding zinc oxide grain particles in a ceramic matrix with highly nonlinear electrical characteristics similar to back to back zener diodes [1]. MOVs exhibit large non-linearity in current voltage (I-V) characteristics with high energy absorption capability provides excellent voltage-limiting for surge-current applications. A proper protective measure has to be adopted to predict the performance and capability of MOV against breakdown due to lightning surge.

Presently, standards procedures of testing MOV require only an effective single stroke. However, it is known that most lightning ground flashes consist of more than one stroke. The average strokes occurred within one second is between 3 to 4 strokes with time intervals between strokes is about 40ms with a range of 10 to 30ms [2]. Since the lightning parameters are different from stroke to stroke, it is important to study the response of MOV under the application of multiple lightning impulses.

This project is to investigate the effects of multiple lightning impulse on the physical and LC circuit parameters of MOV through the experimental studies. Comparison on the physical and LC circuit parameters response of the MOV is made between the standard testing and multiple impulse testing.

1.2 Objective

The objectives of the project are as follow:

1. To generate the fast rise multiple lightning impulse and the standard lightning impulse
2. To apply the multiple lightning impulse on MOV
3. To analyze the physical, capacitance, inductance and temperature of MOV under multiple and standard waveshapes.

1.3 Scope of Work

MOV is the most common, economical and reliable protection device for low voltage and telecommunication equipments. Presently, standards procedures of testing MOV require only an effective single stroke. This is clearly different from natural characteristics of lightning where multiple strokes occur. A precise method of testing has to be adopted based on the natural characteristics of lightning to accurately determine its performance and capability. In this work, laboratory studies are to be carried out on 1kV voltages with 250A current rating MOVs. The test samples of MOVs are to be subjected to multiple lightning impulses with fast rise time using the constructed Multiple Impulse Generator, MIGe. The physical and LC circuit parameters of the devices are to be analyzed.

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