FACULTY OF ELECTRICAL ENGINEERING

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

LAPORAN PROJEK SARJANA MUDA

HIGH FREQUENCY RADIATION CHAOTIC LEADER VERSUS RETURN STROKE FROM CONVECTION AND FRONTAL THUNDERSTORM

Mohamad Suffian Bin Ahmad

Bachelor of Industry Power Engineering
June 2014

“ I hereby declare that I have read through this report entitle “ High Frequency Radiation Chaotic Leader Versus Return Stroke From Convection And Frontal Thunderstorm ” and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Industrial Power)”

Signature : ……..

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HIGH FREQUENCY RADIATION CHAOTIC LEADER VERSUS RETURN STROKE FROM CONVECTION AND FRONTAL THUNDERSTORM

MOHAMAD SUFFIAN BIN AHMAD

A report submitted in partial fulfillment of the requirements for the degree of Electrical Engineering (Power Industry)

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JUNE 2014

I declare that this report entitle “High Frequency Radiation Chaotic Leader Versus Return Stroke From Convection And Frontal Thunderstorm ” is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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Firstly, I would like to give my thanks to Allah for giving me strength and ability to complete the project from beginning until the end. Without His permission, I would not finish my final year project in successful.

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ABSTRACT

Lightning flash is one of the oldest natural phenomenon. Many researcher found that it difficult to understand. During lightning flash, there are several process will happen to complete it. One of the process lightning flash is return stroke. Return stroke shows that its have consistently strongest sources of high frequency radiation. Its also the fastest impulse that transfer charge to the ground. However, chaotic leader is the process of lightning flash that controversial and poorly defined. This chaotic leader also can be appear after or before return stroke . This project more focused return stroke process and chaotic leader process in lightning flash include their characteristics and parameters from waveform display by oscilloscope. Then, it discuss which appeared first between these two type of lightning during lightning flash. For measurement high frequency radiation, the circuit 3MHz and 30MHz were used to determined return stroke and chaotic leader. The measurement for this project were used parallel plate antenna, circuit setup and oscilloscope. Antenna was used for detected the signal and oscilloscope was used for display the signal. High speed buffer LHM6609 was used in this circuit to isolated the high input impedance of the antenna and to delivered a stable signal to the filter circuit while operational amplifier LHM6599 was used to increased the weak input signal. After recorded data measurement, analyze the data and made discussion based on data measurement. Last but not least, making good conclusion and recomendation for improving the project for future work.

ABSTRAK

Kilat adalah salah satu fenomena semula jadi yang paling lama. Ramai penyelidik mendapati bahawa ia sukar untuk difahami. Semasa berlakunya kilat, terdapat beberapa proses yang akan berlaku untuk menyempurnakan kejadian kilat.Salah satu proses kilat ialah 'Return Stroke'. 'Return Stroke' menunjukkan bahawa ia mempunyai sumber terkuat secara konsisten dalam radiasi frekuensi tinggi. Ia juga memindahkan cas ke tanah dengan paling cepat. Walau bagaimanapun, 'Chaotic Leader' adalah proses kilat yang kontroversi dan kurang jelas. 'Chaotic Leader' juga boleh muncul selepas atau sebelum ' Return Stroke'. Projek ini lebih fokus pada 'Return Stroke' dan 'Chaotic Leader' dalam kejadian kilat termasuk ciri-ciri dan parameter daripada gelombang osiloskop. Kemudian, ia membincangkan yang mana muncul dahulu antara dua proses kilat tersebut. Dalam pengukuran radiasi frekuensi tinggi, 3MHz dan 30MHz litar telah digunakan untuk mengenal pasti 'Return Stroke' dan 'Chaotic Leader'. Antena plat selari, persedian litar dan osiloskop telah digunakan untuk pengukuran dalam projek ini. Antena telah digunakan untuk mengesan isyarat dan osiloskop telah digunakan untuk memaparkan isyarat. Kelajuan tinggi penampan LHM6609 telah digunakan dalam litar ini untuk diasingkan nilai kemasukan galangan yang tinggi dan menghantar isyarat yang stabil manakala penguat operasi LHM6599 telah digunakan untuk meningkatkan isyarat kemasukan yang lemah. Selepas mencatakan ukuran data, analisis data dan perbincangan perlu dibuat bedasarkan pengukuran data. Akhir sekali, membuat satu kesimpulan yang baik dan mencadangkan untuk meningkatkan projek untuk kerja-kerja masa depan.

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LIST OF ABBREVATIONS

UTeM	-	University Teknikal Malaysia Melaka
FKE	-	Faculty of Electric
CGs	-	Cloud to Ground
ICs	-	Cloud flashes
VHF	-	Very High Frequency
PCB	-	Printed Circuit Board

LIST OF SYMBOLS

MHz	-	Megahertz
m	-	Meter
K	-	Kelvin
H	-	Henry
Ω	-	Ohm
V	-	Volt
s	-	Second
mV	-	Millivolt
ms	-	Millisecond
µs	-	Microsecond

CHAPTER 1

INTRODUCTION

1.1 Project Background

High frequency radiation of chaotic leader versus return stroke from convection and frontal thunderstorm was related the lightning phenomenon. During the lightning flash, there were several process happened include chaotic leader and return stroke. The first process was called preliminary breakdown process and it was followed by stepped leader process. After that, return strokes process had been appeared. There were several subsequent strokes after first return stroke. There were dart leaders, dart stepped leaders and chaotic leader. From all the process, return stroke shows that it have consistently strongest sources of high frequency radiation. It also the fastest impulse that transfer charge to the ground [1]. Return stroke happened after the stepped leader and the upward moving discharge. This high luminosity and also high current was move up the leader channel and out its branches at somewhere between one-half and one-tenth the speed of light. This movement of return stroke from ground to the cloud. However in the subsequent strokes, there is a controversial class that called as “chaotic leader”. There were more 30% of subsequent stroke in close lightning contain electric fields [3]. From the researched by Rakov and Uman, chaotic leader can appear before return stroke or after return stroke and they found that the chaotic leader was more strongest sources of high frequency radiation than return stroke [2]. This researched was cover the characteristic of chaotic leader and compared it with return stroke. There were some measurement devices had been used in this researched such as flat plate antenna, oscilloscope and electronic circuit.

1.2 Problem Statement

In lightning phenomenon, for the high frequency radiation there are several subsequent stroke not be clarify. One of the subsequent stroke is called chaotic leader. This chaotic leader was controversial and poorly defined [3]. This chaotic leader also can be appeared after or before return stroke. So, this project to analyse the chaotic leader characteristics. It also will define the duration of chaotic leader in lightning phenomenon which it will appear before or after return stroke. For chaotic leader, previously researched found that the direct measurement of narrowband is 10MHz high frequency radiation [3]. The researched for this project was used 3MHz and 30MHz circuit of high frequency radiation direct measurement of narrowband.

1.3 Objectives

1) To do comparative study between the characteristics of return stroke and chaotic leader.
2) To conduct electric field measurement in Universiti Teknikal Malaysia Melaka (UTeM) for data collection.
3) To investigate the radiation field of chaotic leader by analysing the frequency component at certain interests frequency range (3MHz and 30MHz,).

1.4 Project Scope

In order to achieve the project objectives, the project execution should be set parallel to the project objective. Specifically, these are the scopes for the project:

1) This project was measured the electromagnetic field that generated by lightning flashes in Malaysia.
2) This project focused on characteristics of return stroke process and chaotic leader process in lightning flash.
3) Location for measurement was conducted at Faculty of Electrical Engineering(FKE) in UTeM
4) Parallel plate antenna had been used for measured frequency radiation.

1.5 Motivation

The lightning flash was the one phenomenon that difficult to understand. Many researchers found that the process of lightning difficult to clarified. Sometime the data collection of lightning from their research differently from previous. Chaotic leader was the one of the subsequent return stroke. From previous researched, they found that chaotic leader was controversial and poorly defined. The researched was analysed the characteristic of chaotic leader. The electromagnetic field measurement was so important in determined and identified the characteristics and parameter for the subsequent stroke.

1.6 Significant Study

Lightning is a oldest natural phenomenon that difficult to understand until nowadays. Many researchers found that the process of the lightning have their sequence from beginning until it disappeared. One of the sequence it called chaotic leader. Chaotic leader can be classify as a controversial and poorly defined. Return stroke also the sequence of lightning process. This investigation was compared the characteristics of chaotic leader and return stroke from lightning process that happen in Malaysia by measurement electromagnetic field.

CHAPTER 2

LITERATURE REVIEW

In this chapter, it was about knowledge and previous researched of lightning that had been done by the researchers. The information about its can be in journal, paper, book and etc as the knowledge to conducted the project. The information also can be achieve and fulfill the requirement of the project.

2.1 Introduction to lightning.

Lightning was one of the oldest observed natural phenomenon on earth. Many researcher found that process of lightning flashes were difficult to understand. Lightning can be defined as transient, which produce high current electric discharge whose path length is generally measured by kilometres. Usually it occur when atmosphere at some region attains an electric charge sufficiently large that associated the electric field with the charge cause electrical breakdown of the air. However, lightning also can happen during sandstorms and in the clouds over erupting volcanos [1]. The process of lightning are relate with the motion of charge and the motion of charge are relate with the measurement of electrostatic fields, radiation field and magnetic fields. There are two types in lightning. One is cloud to ground (CGs) and another one is cloud flashes (ICs). In the cloud, major part all negative cloud-to-ground flashes be determine by electromagnetic field measurements [2].

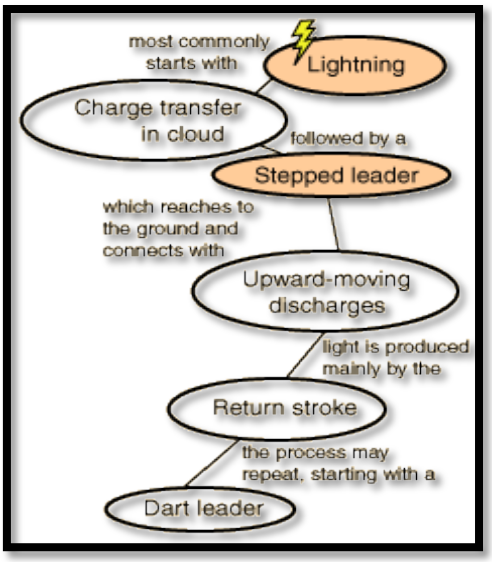

Figure 2.1: Lightning sequence [1]

2.2 The ground flash

In generally, a thundercloud consists two main charges centres which one positive and another one negative. The region for positive charge smaller than negative charge and it located at the base of the cloud. When positive charge downward to earth it called positive ground flash and when negative charge downward to earth it called negative ground flash. Ground flash will start with an electrical breakdown process in the cloud that called it preliminary breakdown by using electromagnetic field measurements. After that, column of charge will creation and travels from cloud to the ground in a stepped manner. This process called stepped leader. During its way to ground, a stepped leader will give rise to several branches. As the stepped leader arrive the ground the electric field at ground level increases instant. After the stepped leader reaches a height around few hundred or less metres from level ground, the electric field at the ground structures will increase to a level that electrical discharge are initiated from them. The discharge was called connecting leader will travel to down-coming stepped leader and become as a bridge of the gap between the ground and the down-coming stepped leader. The lightning will striking the connecting leader and it will be successfully connecting leader. When the connection between stepped leader and ground produce, a wave at ground potentials through the channel towards the cloud and associated luminosity event that travels upwards with a speed close to that of light is called the return stroke [1].

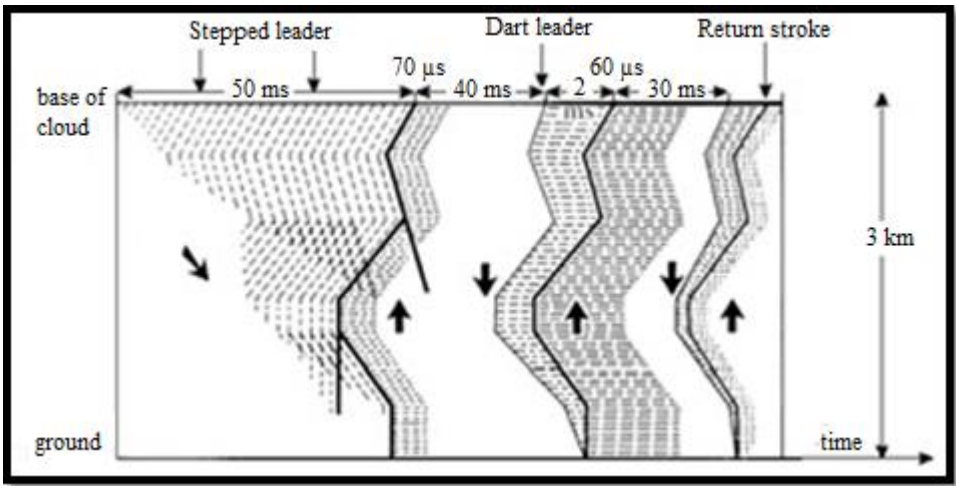

Figure 2.2: The ground flash process [1]

2.3 The cloud flash

Usually the cloud flash happen between main negative charge and upper positive charge of the cloud. The negative discharge from negative charge region through the positive centre in a more or less vertical direction. Then, charge will be moving from lower level to upper level along the vertical channel and make horizontal extension of the upper level channel. After that, there will be extension retrogressively at the lower channels. At the final stage, the conductivity of the vertical channel decreases and the upper level channels will be cut off from the low level channels [2].

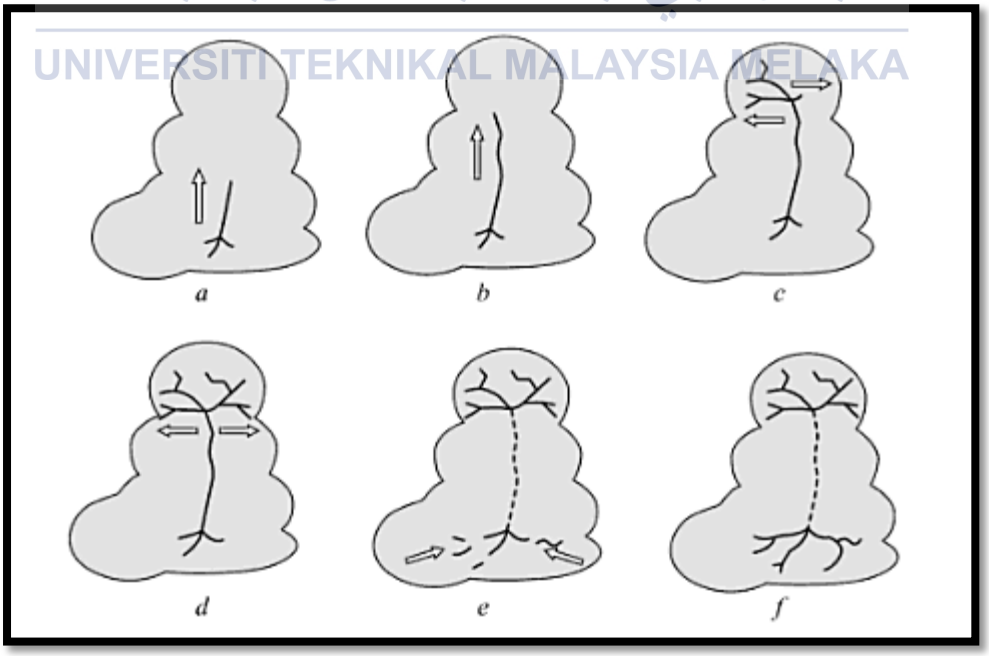

Figure 2.3: Process of the cloud flash [1]

2.4 Preliminary breakdown process

This preliminary breakdown process is the process before the stepped leader is launched. This process will generate electromagnetic fields at ground level. Preliminary breakdown process also generate slow electric fields and there are several steps to generate it. Firstly, the electrostatic field will increase slowly and increase constantly until some several tens to several hundreds of milliseconds. This called preliminary variation and it end with a burst of pulses. There are two names for pulse burst which are characteristics pulses or the preliminary breakdown pulse. The duration for pulse burst in millisecond. The total duration for preliminary breakdown process depend the time taken interval between first detectable static field change and the return stroke. There are three methods to determine the location of preliminary breakdown process in the cloud which are making multistation electric field measurement, based on single station measurement and based on the VHF radio imaging technique [1].

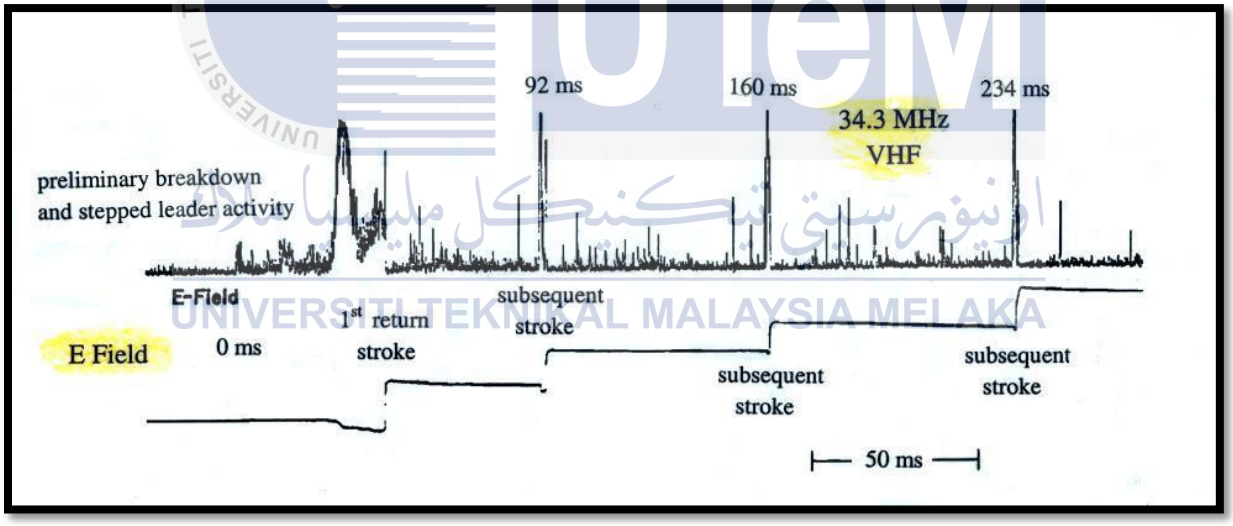

Figure 2.4: Example of lightning process [2]

2.5 Stepped Leader

Stepped leader is the process after preliminary breakdown process. In generally, stepped leader channel consists of a hot core surround by a cold, charged region called the corona sheath. The radius of the core between 0.1m and 0.5m. In initial, the channel remains dark until change to bright in between step formation. Leader also gives rise to several branches and the stepping process can be work simultaneously in several branches. Steps range are between 10 to 100m. The temperature of the leader can be raise until 30000 K. This measurement was measured by Orville. He also said the temperature of the leader cannot be lower than 15000 K. Stepped leader can generate the electric field at different distance. From that, the channel can describe as a uniform line charge with one end fixed at cloud height and uniform speed approaching the ground [1].

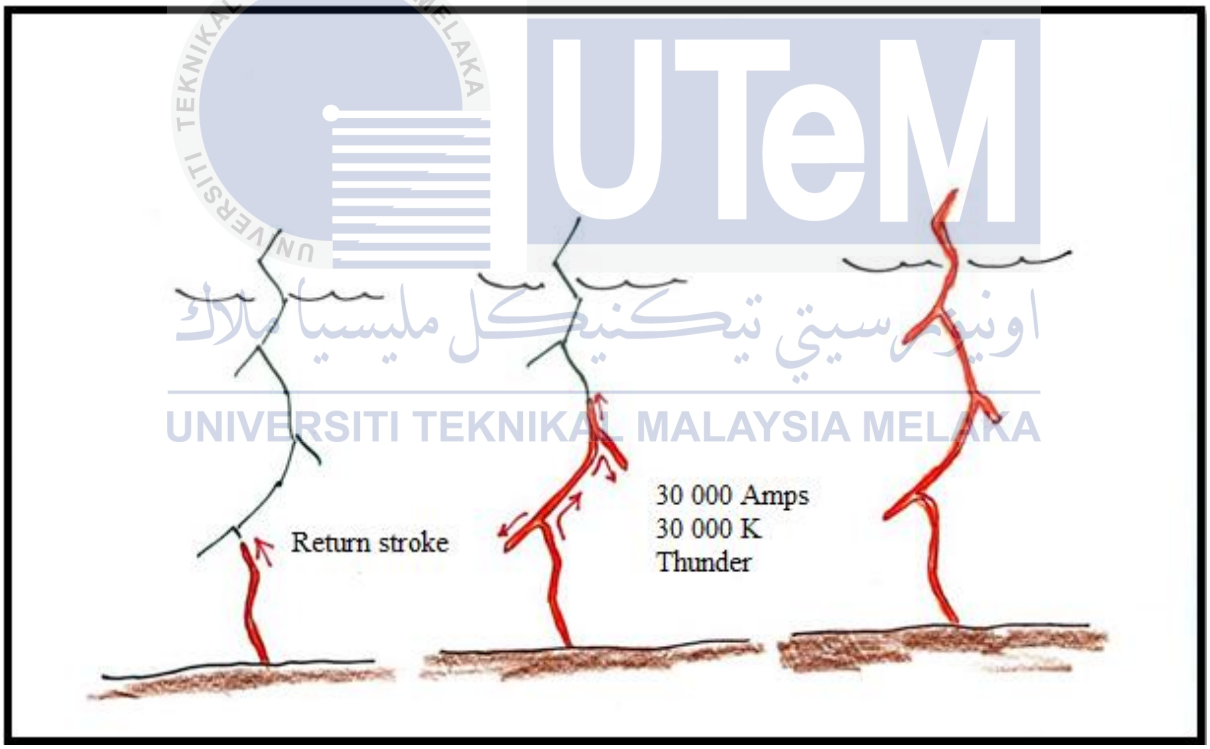

Figure 2.5: Process of stepped leader [2]

2.6 Return Stroke

Return stroke happen when streamer front makes a connection with a ground or with the streamer front of a connecting leader that rises to meet it. Stepped leader and the connecting leader will meet at one point. Therefore, the neutralisation process will progress with two different direction. One toward to the ground and another toward to cloud. When the stepped leader has lowered a charged column of high negative potential to near the ground, the resulting high electric field at the ground is sufficient to cause upward-moving discharges to be launched from the ground toward the leader tip. When one of these discharges contacts the leader, the bottom of the leader effectively connected to ground potential while the remainder of the leader is at negative potential and is negatively charged. Return stroke shows that it have consistently strongest sources of high frequency radiation. The return stroke wave front propagates at a velocity of typically one-third to one-tenth the speed of light. The return stroke is very visible bright and very fast so that the eye cannot capture the movement of the stroke. The movement of stroke can be obtained by using streak camera. The peak current of return stroke is very high around 100 000 amps or more. It also can be classify as high amplitude, long time duration of the continuing current and higher charge during transfer process.[1,3,5]

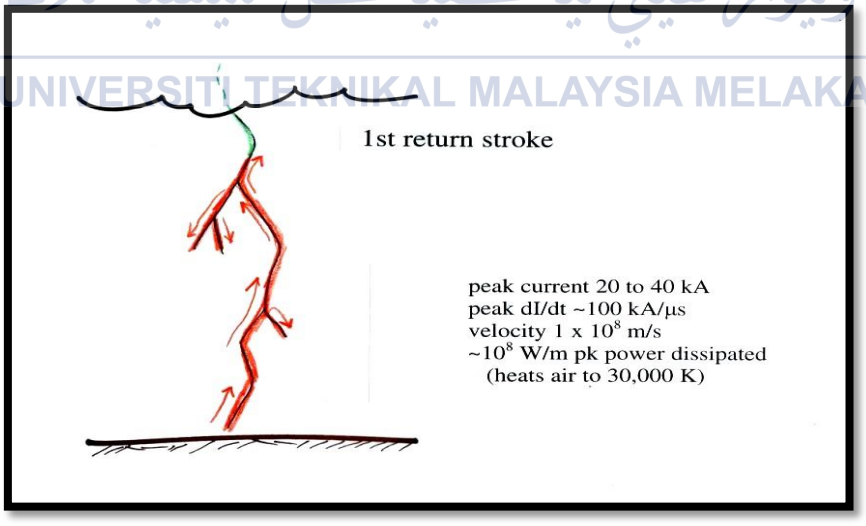

Figure 2.6: Example of first return stroke [3]

2.7 Chaotic Leader

After the return stroke, there are subsequent stroke occur in lightning. In subsequent stroke, it start with dart leader and followed by dart step leader. Then, chaotic leader produce after dart step leader process. Chaotic leader can be classify as a controversial and poorly defined. Chaotic leader got it name from the idea Weidman (1982) and it also got cited by Rakov and Uman (1990a). Chaotic leader can be found about 30% of subsequent strokes in close lightning flash from the researcher by Rakov and Uman (1990a). The direct measurement of narrowband of chaotic leader is 10MHz high frequency radiation. It also can be large subsequent strokes so that it can be strongest than return stroke. This process are related with “chaotic pulse” as defined by Gomes et al.(2004). Even two of these are irregular phenomena but it still same characteristics such as length and separation is 10μs range, duration for a few hundred microseconds and have noise level of the signal [1,2,3].

CHAPTER 3

METHODOLOGY

This chapter was described the method to conducted the project and process that had been taken to achieved the objectives of the project.

3.1 Flow chart

Flow chart was the method that been used to plan the project achieved the objectives. Based on the flow chart below, it shows the overall project flew and activities that should be followed in order to measure the electromagnetic field that generate by lightning flashes from the beginning until the end of the project. Literature review was started in this flow chart which focused on the information and idea to conduct the project based on the previous researched. After that, it continued with problem statement of the project and how to overcome the problem. Then, after collected the information and gain knowledge that related to the project, the measurement data can be done. Before the measurement data carried out, the hardware must been prepared. After collected data from the measurement, the data have to analysis and make conclusion based on the title project.

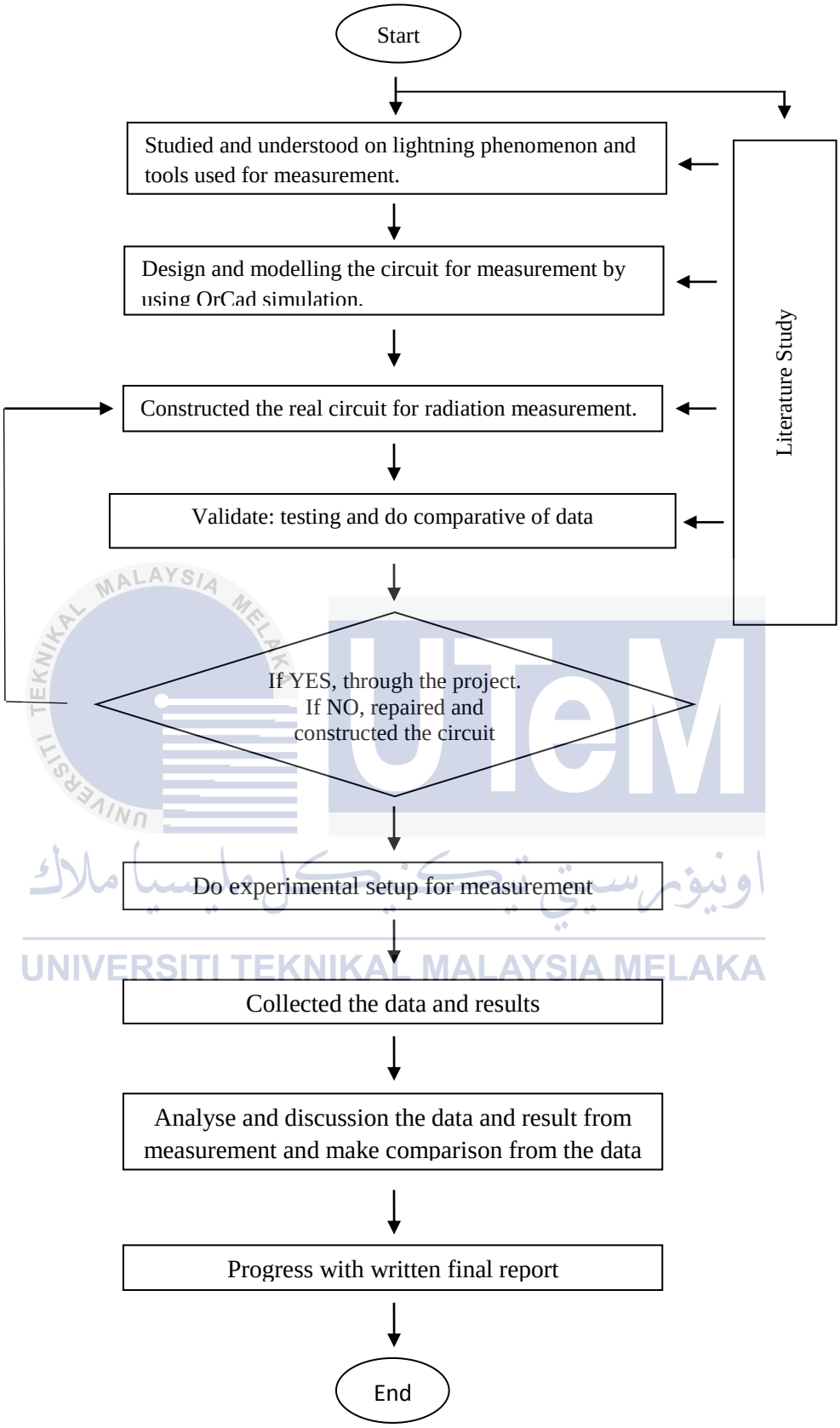

Figure 3.1: Process flow of the project methodology

3.2 Literature Review

Before start the project, first thing that should did was to collected the information and gain as many knowledge that related with the title project. The information can get from the internet, journal, book, previous research and also guideline from the supervisor that understood about the project. This project was been used ORCAD for the simulation. Before run the software, it should know how to design the circuit by using ORCAD software. After the information cleared, the project can been started by created introduction, identified main objectives, found problem statement and scope that cleared well-recognize about the project.

As know that literature review was very important to make sure the progress of the project was success. All the information were used to conducted the project. It was give the idea to did the project and overcome the problem statement. If there was got the problem during progress of the project, it can be helped to solved the problem.

3.3 Measurement Device

This project must had circuit for measurement data from the electromagnetic field. Before that, the circuit must did simulation from the ORCAD software to know it frequency circuit. After the simulation success, the hardware must be built based on the circuit simulation for measurement data.

3.3.1 Design Circuit by ORCAD

ORCAD software used to design the circuit for simulation to know it frequency and did printed circuit board (PCB) layout. The circuit was high frequency which it can measured the radiation generated by lightning flash. After constructed circuit at ORCAD software, the frequency can determined by run the simulation. There are two circuit had been built which are 3MHz and 30MHz [5]. For the circuit 3MHz, an inductance of 47 μH connected in series with the antenna capacitor and 50 Ω termination formed a simple RLC circuit [5]. For the circuit 30MHz, the components used in the circuit are such as high speed buffer LHM6609, operational amplifier LHM6599, resistors and capacitors.

High speed buffer LHM6609 was used in this circuit to isolated the high input impedance of the antenna and to delivered a stable signal to the filter circuit while operational amplifier LHM6599 was used to increased the weak input signal. LHM6609 was a type of operational amplifier used in this 30 MHz band pass filter circuit. After the simulation done, the next step was design PCB layout using the PCB Layout plus in ORCAD [5]. Figure 3.2 and Figure 3.3 showed the designed of 3MHz and 30MHz.

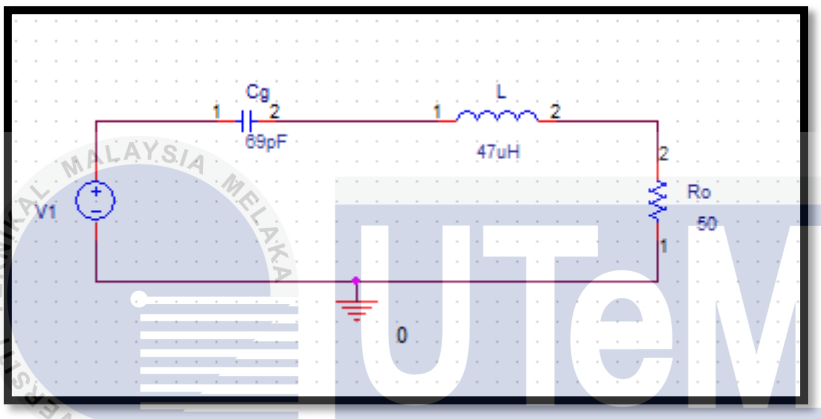

Figure 3.2 : Circuit 3MHz in ORCAD software

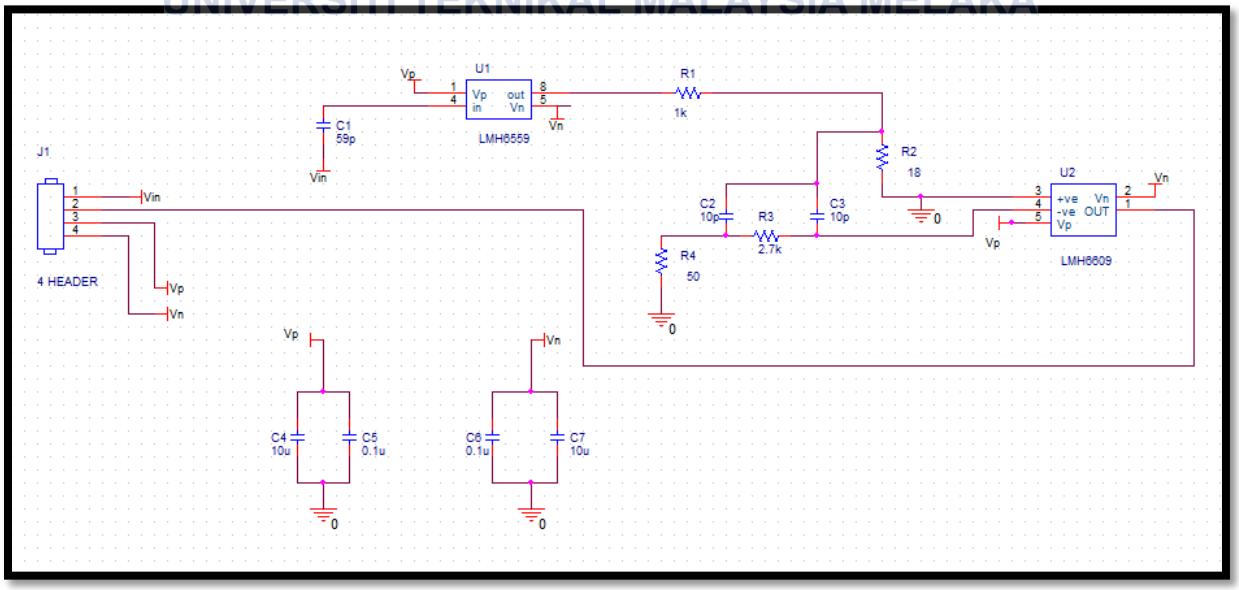

Figure 3.3 : Circuit 30MHz in ORCAD software

After the circuit was designed, the PCB layout must be created based on designed of the circuit. Then. The hardware for PCB circuit was built for the measurement data. Figure 3.4 and Figure 3.5 was showed the PCB layout and PCB hardware.

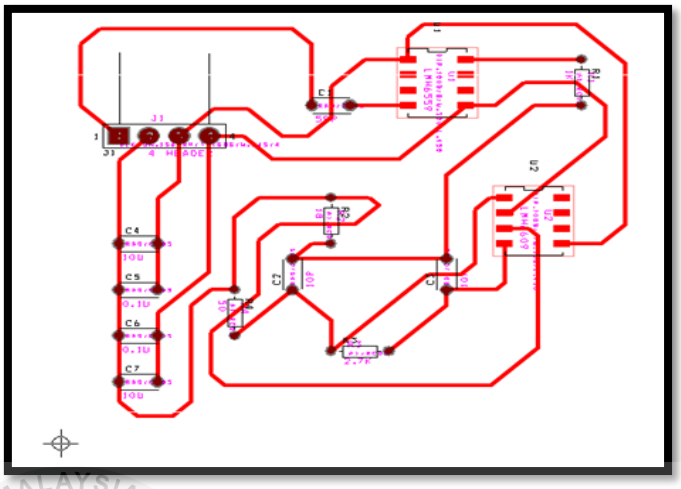

Figure 3.4 : PCB layout for 30MHz circuit

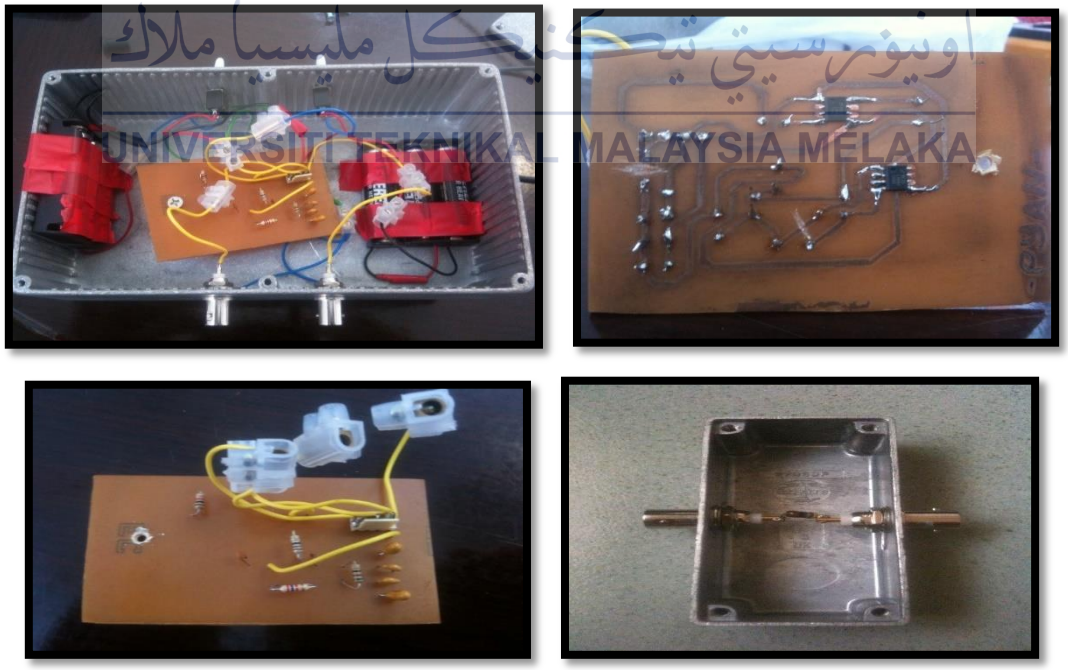

Figure 3.5 : Hardware circuit 3MHz and 3MHz for measurement

3.3.2 Parallel Plate Antenna

Parallel flat antenna was one of the device that used for measurement high frequency radiation. Basically, it was detected the frequency radiation by lightning flash and it was reacted as capacitor in circuit during measurement. The antenna was a metal object connected to ground through electric circuitry. The parallel plate antenna was built from metallic rod at upper and lower part [1,8]. The top of antenna was two plate that combined together with teflon.Teflon was a insultor to hold two metal plate. This antenna was measured by radius from its place until the lightning flash was strike. The signal that sense by the antenna was transferred to the circuit by coaxial cable taht connected to the electronic circuit and displayed the waveform on the oscilloscope. Figure 3.6 was showed the area detected of antenna during measurement. Figure 3.7 showed the placement of antenna during measurement.

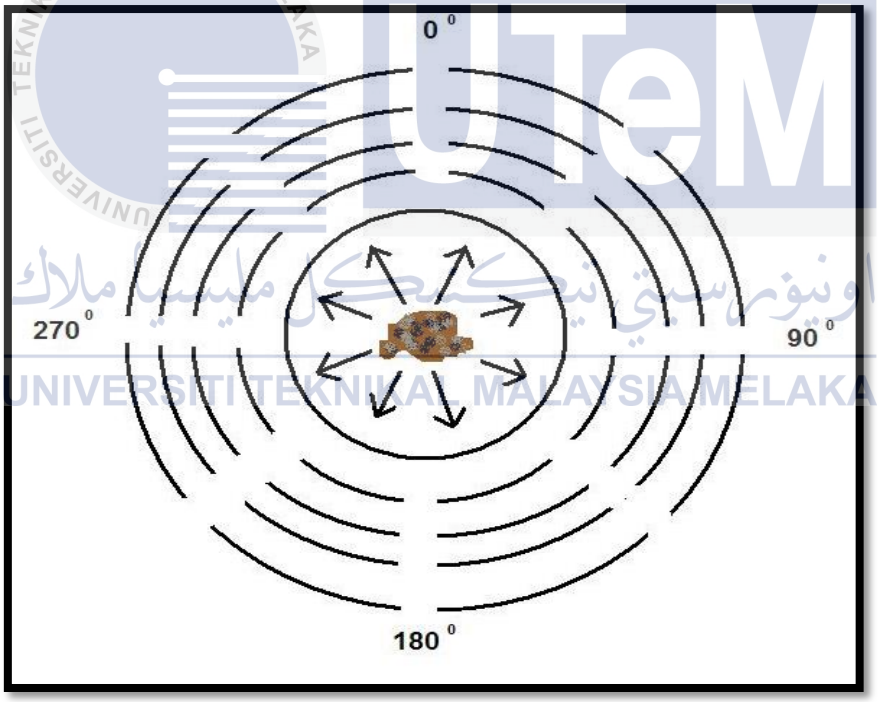

Figure 3.6 : Signal of parallel plate antenna

Figure 3.7 : The parallel plate antenna for measurement

These antenna were place at the top of the building Faculty Of Electric (FKE) at Universiti Teknikal Malaysia Melaka (UTeM). Basically, the the bottom of metal plate was connected at the input of circuit by used coaxial cable. The output of the circuit was connected to the channel at the oscilloscope. So, the oscilloscope can displayed the waveform that captured from the antenna. The antenna also can detected the disturbing waveform but the waveform are differently with the lightning waveform. So, it can be identified which one that the waveform had been measured. Figure 3.8 showed the type of coaxial cable.

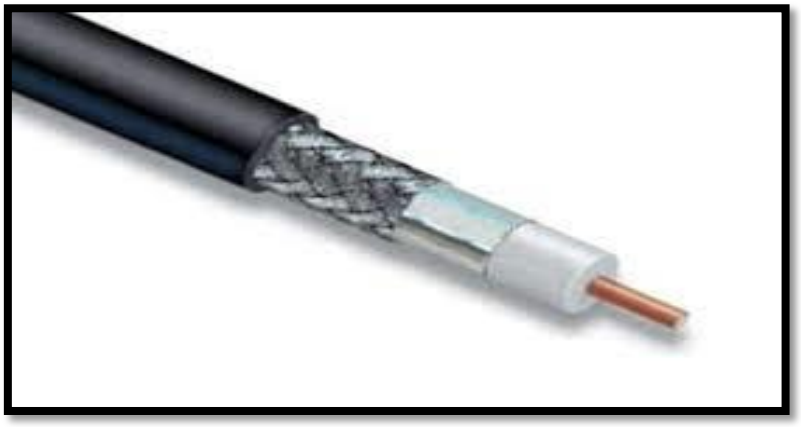

Figure 3.8 : Coaxial Cable

The coaxial cable was used to transmit the data that detected by the antenna to the circuit and then sent the data to the oscilloscope for displayed the waveform. This cable was very sensitive and it might be influence the signal. If centre conductor and aluminium braided shield had connection, the signal detected by antenna become noise signal and the data no accurate. Therefore, the cable must be proper during installations to ensure that the data was accurate and precise.

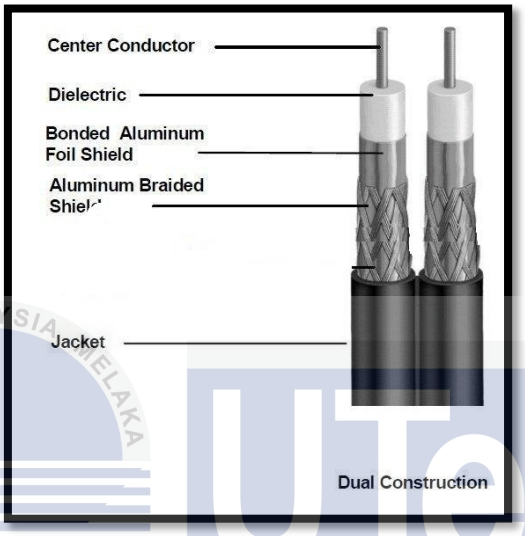

Figure 3.9 : Coaxial cable construction

3.3.3 Oscilloscope

The oscilloscope was used to observed the change of an electrical signal over time. When the antenna detected signal during measurement, the signal was transmited to the oscilloscope by coaxial cable to displayed the waveform of the signal. From the waveform, the characteristics of signal can be determined by its parameter. Futhermore, it make the data more easily to analyze. The type oscilloscope that used for measurement was Teledyne LeCroy HDO4024. Figure 3.10 showed the oscilloscope that used for displayed the waveform of data.

Figure 3.10 : The oscilloscope used for measurement

Figure 3.11 : Connection coaxial cable to channel oscilloscope

CHAPTER 4

ANALYSIS AND DISCUSSION OF RESULT

In this chapter, it discusses about the result and analysis the data that obtained from the measurement of the project.

4.1 Data Measurement and Analysis

The data that obtained from measurement was analyse based on some characteristic. There were few data that obtained from the measurement of frequency radiation that generated by lightning flashes at Universiti Teknikal Malaysia Melaka (UTeM). From the data, there were some information that can be analyse such as the duration of waveform, the amplitude of data and others that can make comparisons.

In this project, there were two circuit that used during measurement. First circuit was fast field and second circuit either 3MHz or 30MHz. The circuit 3MHz or 30MHz was measured the high frequency radiation and circuit fast field was measured the lightning flash. Firstly, the measurement had referred to the data that obtained from high frequency radiation. If the channel showed the waveform, then referred to the channel connected to fast field circuit.

The data that obtained from measurement were combined each other to know the location exactly same. The upper waveform showed the fast field measurement and the bottom waveform showed the high frequency radiation. From the data, it can analyse the parameters of return stroke and chaotic leader. The parameter more focus on peak value and durations of the signal.

4.2 Measurement Data using 30MHz high frequency radiation

1.

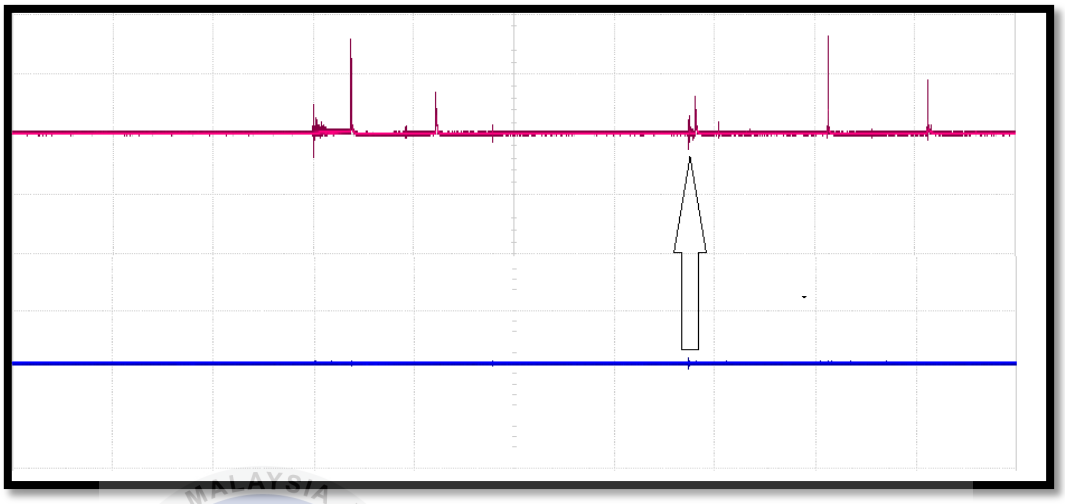

Figure 4.1: First data that detected by the antenna during measurement

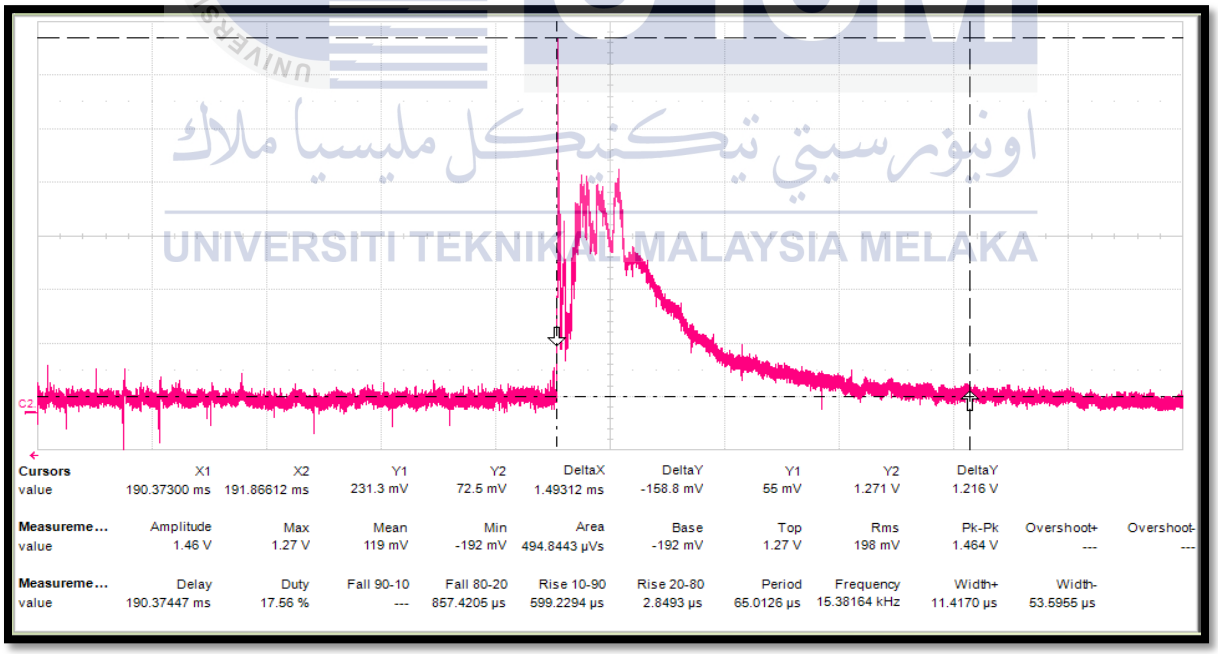

Figure 4.2: First data with measurement

Figure 4.1 showed the data measurement by compared between two channel. The 30MHz circuit was used as high frquency radiation for this data measurement. The high frequency radiation circuit was detected the signal. The signal must to zooming to clearly the signal. After zoom the waveform, its showed type of return stroke flash. The figure 4.2 showed the parameter of data that obtained from the oscilloscope.

By using information parameter at figure 4.2, the peak value of the return stroke and its duration can been determined. The peak value was 1.216 V and the duration of this signal wa 1.49312 ms.. From the measurement data, its found that the signal was smaller and had lower peak value. Its can categorized that its duration are not very fast and not strong high frequency emitter. The high frequency radiation circuit not detected chaotic leader flash.

2.

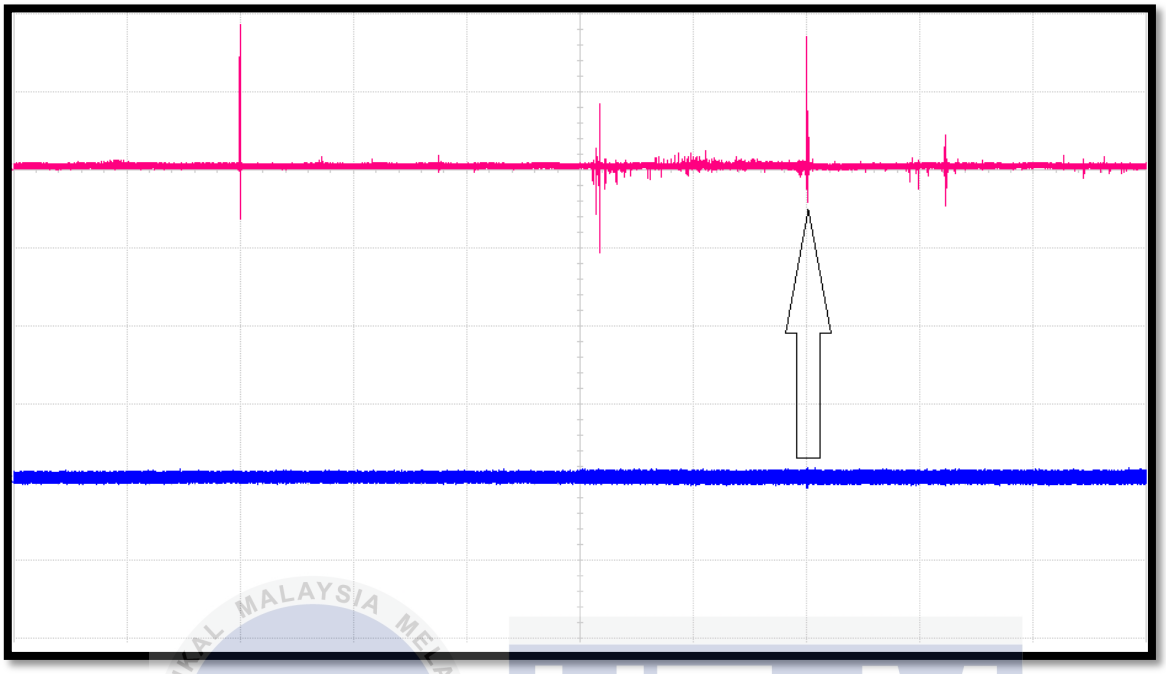

Figure 4.3: Second data that detected by the antenna during measurement

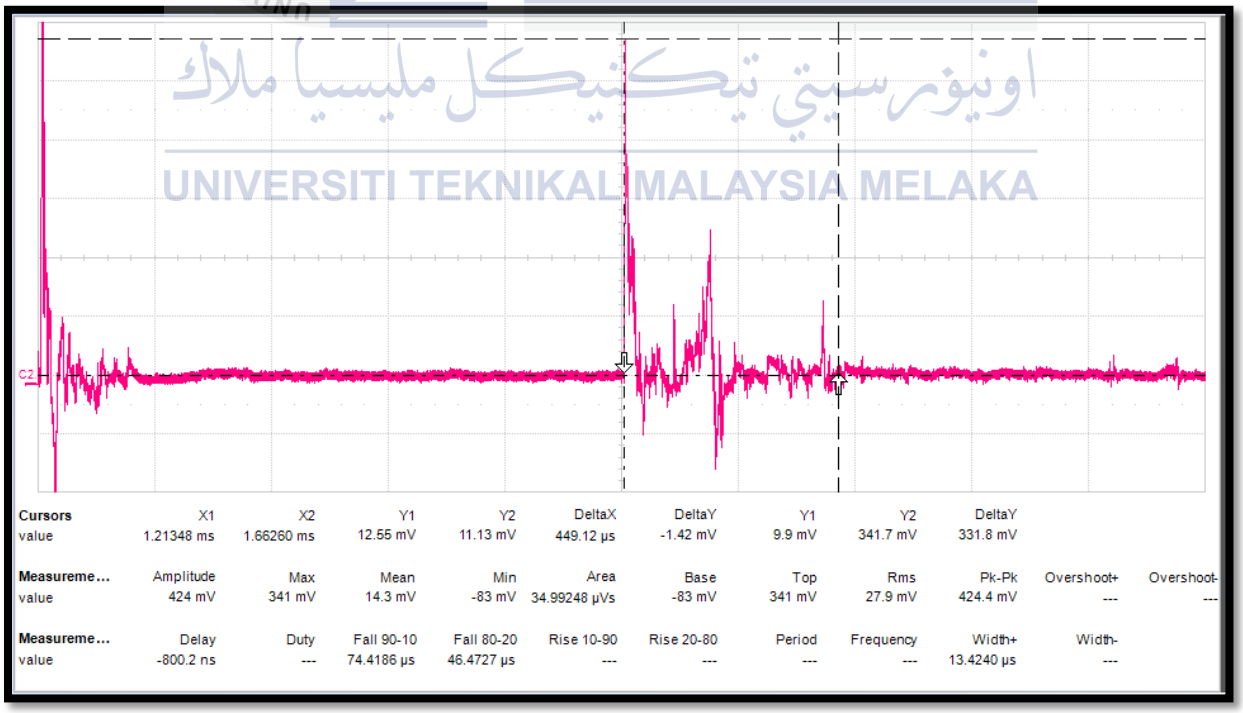

Figure 4.4 : Second data with measurement

The second data that obtained from the measurement of two channel were showed at figure 4.3. The signal that detected by high frequency radiation are very smallest. Usually, when high frequency radiation were smaller, the signal from fast field also smaller. After zoom the signal, it showe the type of return stroke flash.

Then, figure 4.4 showed the parameters of second data of measurement. This data more focus its peak value and durations. The peak value was 331.8 mV and its time duration was 449.12 µs.For the second data, the return stroke was smaller that return stroke that obtained from first data because its peak value are less compared with peak value of first data. The time duration are more faster compared with first data. The chaotic leader are not detected by the antenna for second data.

3.

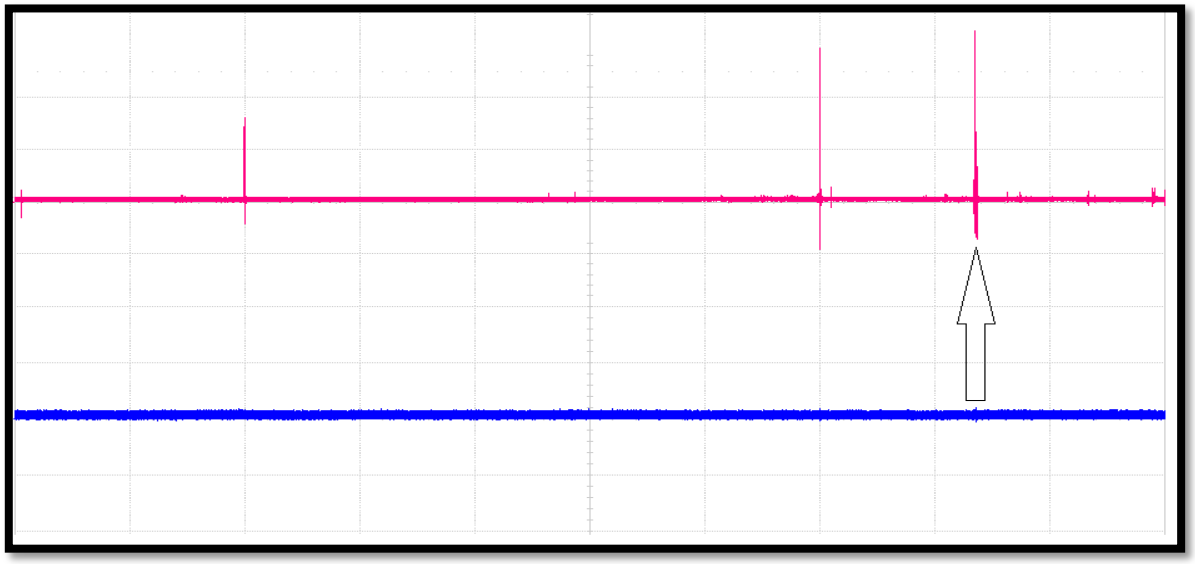

Figure 4.5: Third data that detected by the antenna during measurement

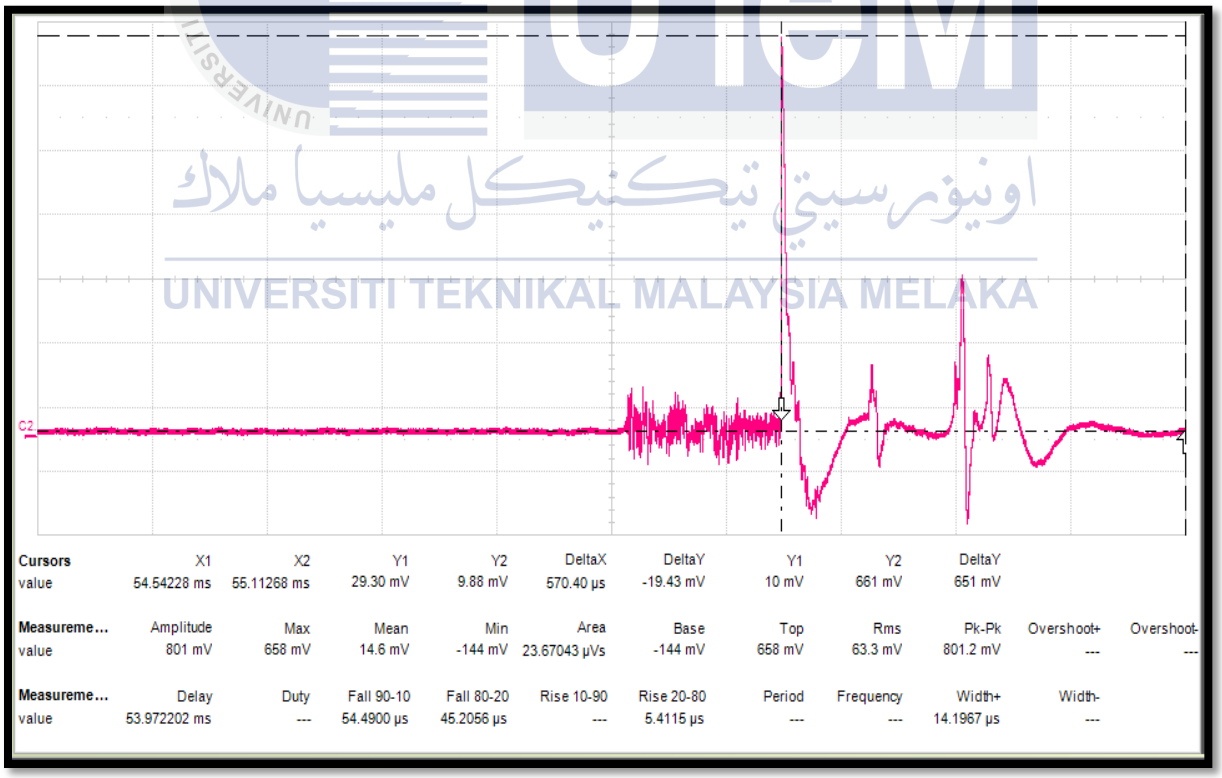

Figure 4.6 : Third data with first measurement

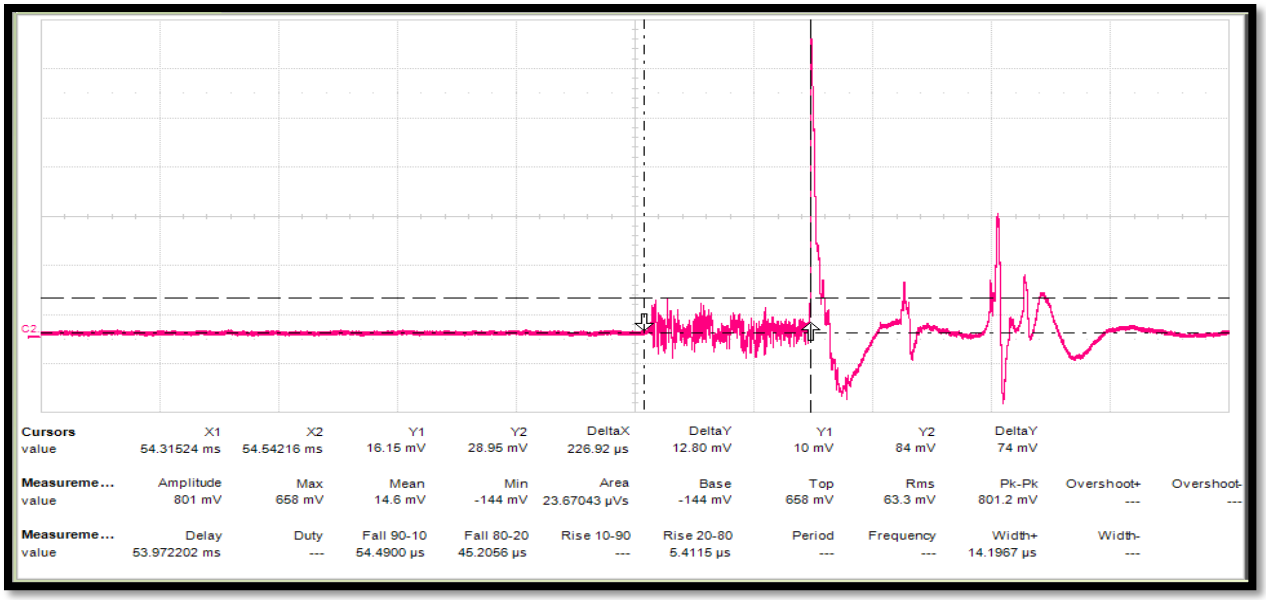

Figure 4.7 : Third data with second measurement

Figure 4.5 showed the comparison waveform between high frequency radiationand fast field. For this data, it differently with first and second data. By zooming the signal, there were two type of lightning flash.

For the first type of lightning flash was shown at figure 4.6. It was a type of return stroke. This return stroke likely combined with another type of lightning flash. The second type of lightning flash that shown in figure 4.6 was chaotic leader. This was a first data that antenna detected type of chaotic leader.

After measurement parameter had been done in figure 4.6 and figure 4.7, the peak value of these two type of lightnig flash can be identified. The peak value for return stroke was 651 mV while peak value of chaotic leader was 74 mV. The time durations of return stroke and chaotic leader were 570.40 µs and 226.92 µs.

By comparison between these two data, the return stroke had higher peak value than chaotic leader. The duration of the chaotic leader were more faster than return stroke. Even the chaotic leader happened first than return stroke, it had lower of peak value.

4.

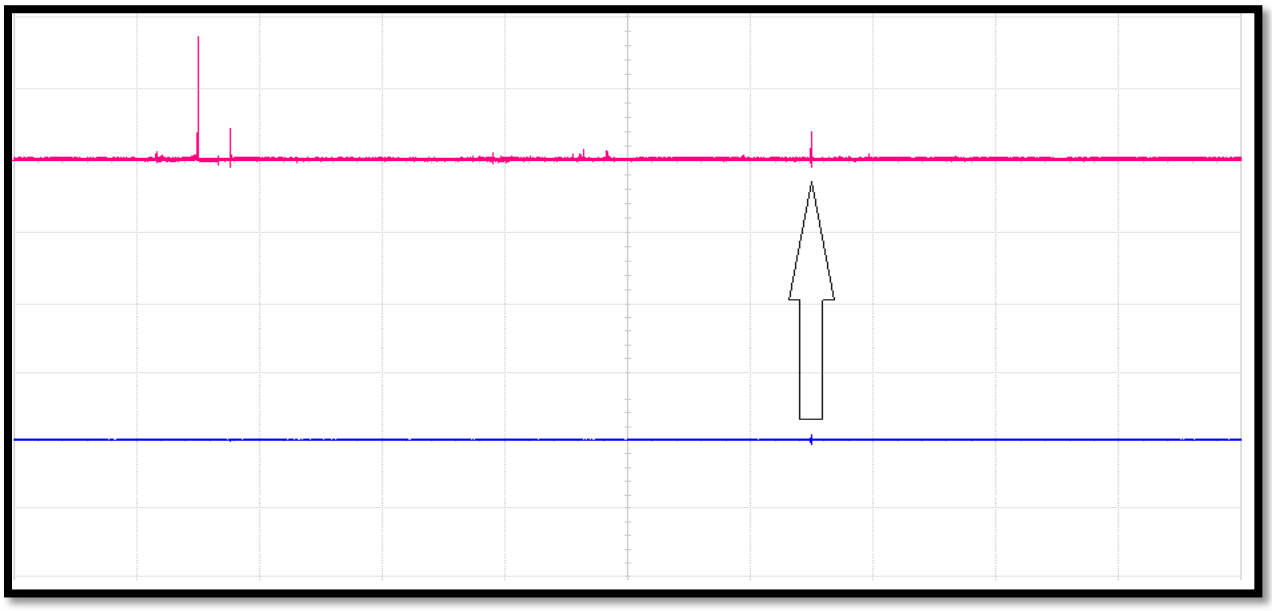

Figure 4.8 : Fourth data that detected by the antenna during measurement

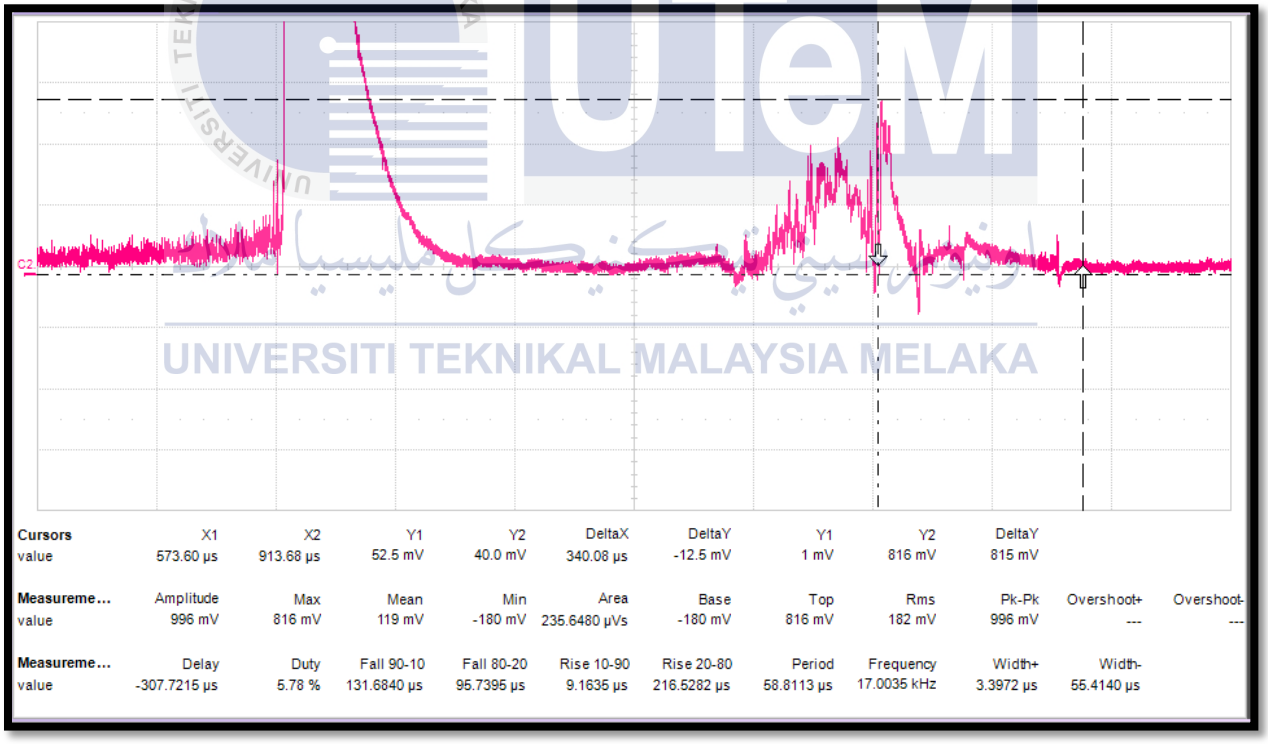

Figure 4.9 : Fourth data with first measurement

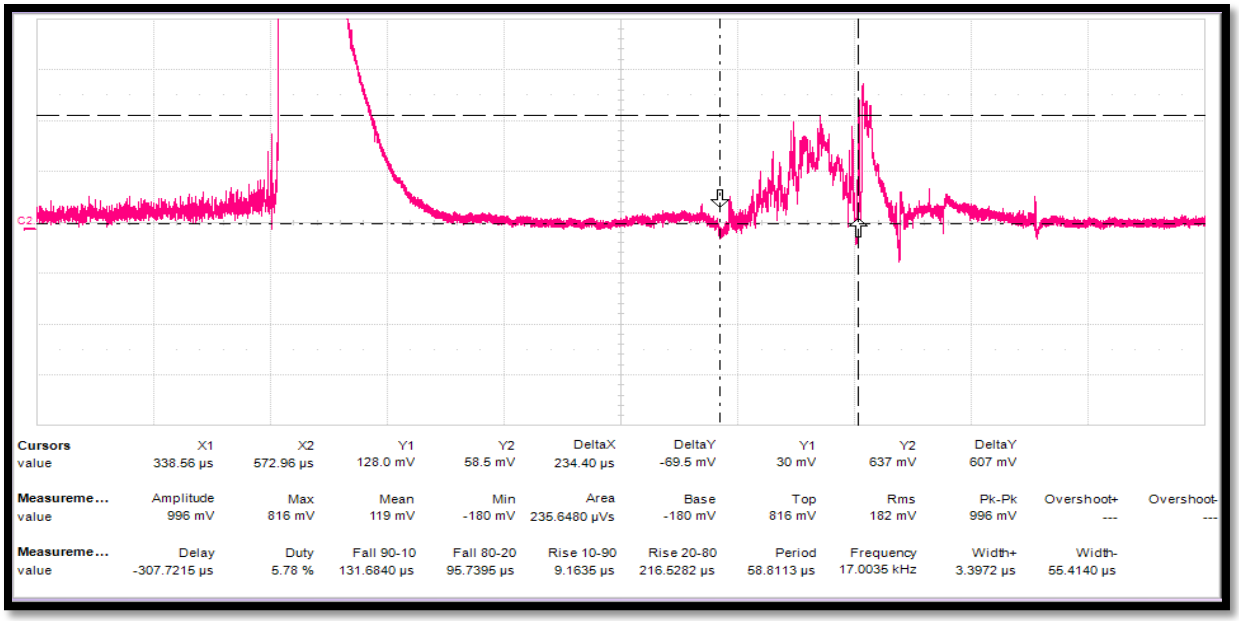

Figure 4.10 : Fourth data with second measurement

This was the last data that obtained from using 30MHz as high frequency radiation. For the fourth data, its was weird compared with previous data. Figure 4.8 showed initial signal that detected by antenna. To more clearly the signal, the waveform must zooming to identified which type of lightning flash. After zooming the data, there were two type of lightning flash was recorded.

Based on the figure 4.9 and figure 4.10, the data likely as third data of measurement. The type of lightning flash were return stroke and chaotic leader. For this chaotic leader, its waveform seen differently compared with third data. Then, the peak value of return stroke was 851 mV and its duration was 340.08 µs while the peak value of chaotic leader was 607 mV and its duration was 234.40 µs

After know its peak value and durations waveform, its can been compared each other. The peak value of chaotic leader was higher than previous data but its lower than return stroke in this data. Its duration are more faster than return stroke duration.

4.3 Measurement Data using 3MHz high frequency radiation

1.

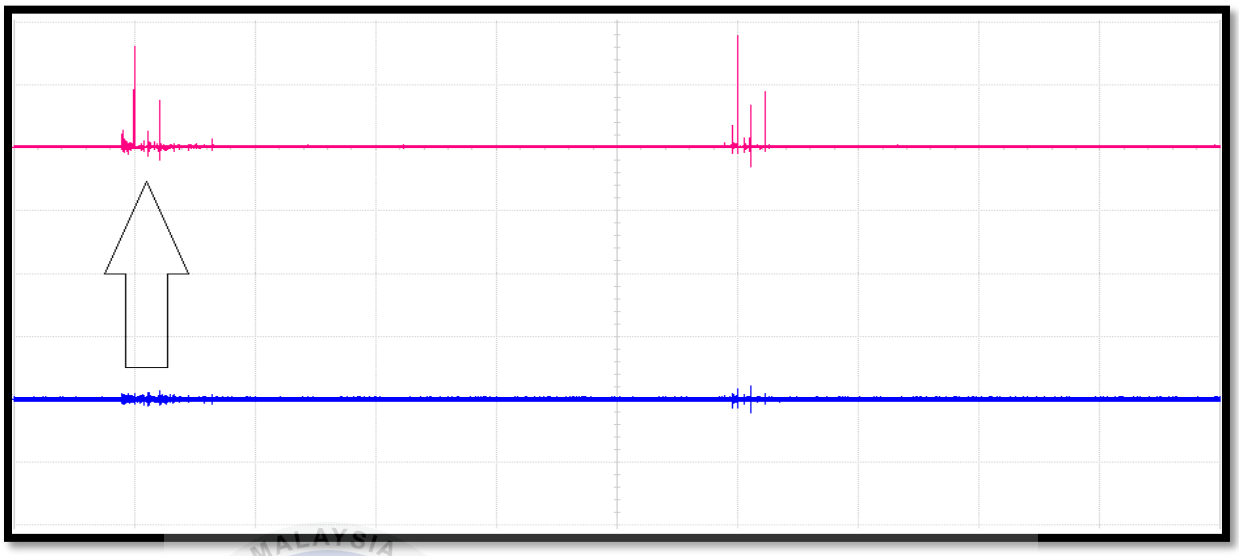

Figure 4.11 : Fifth data that detected by the antenna during measurement

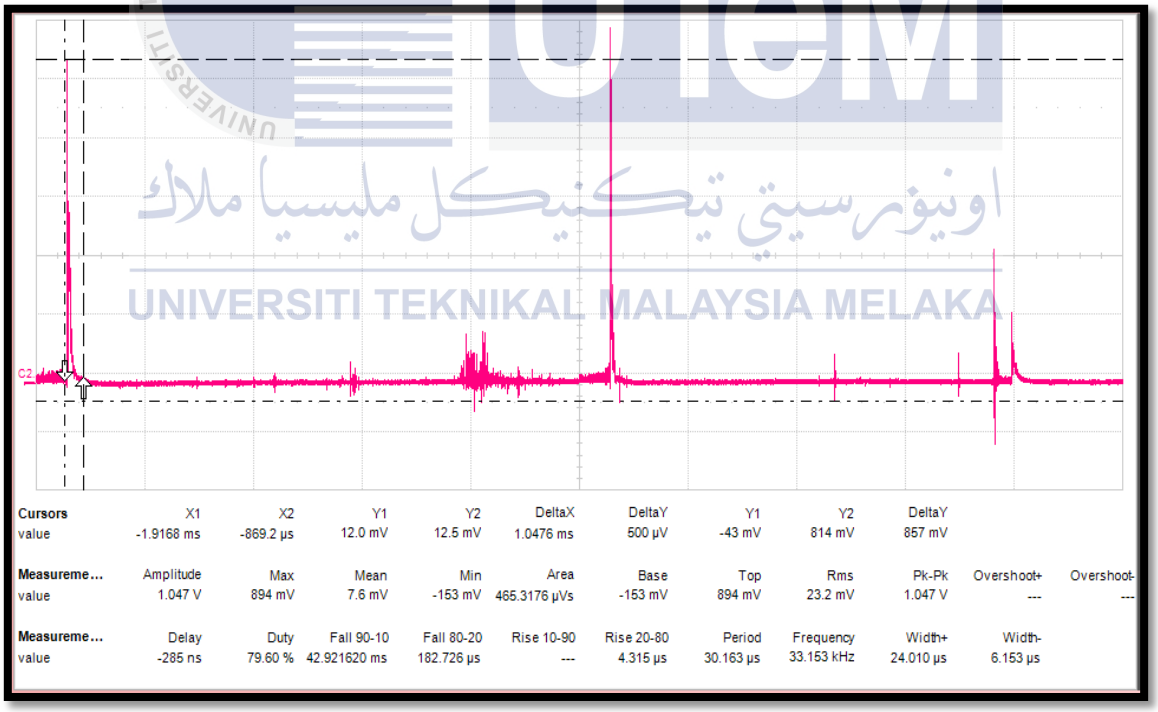

Figure 4.12 : Fifth data with first measurement

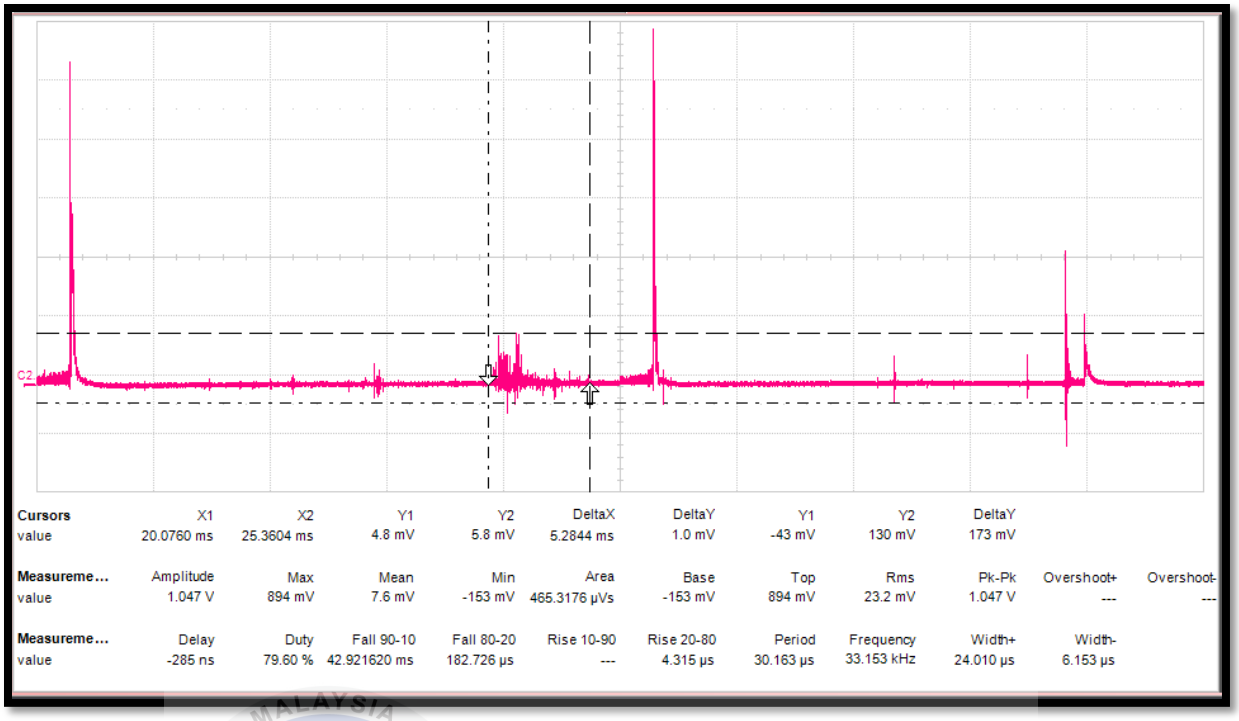

Figure 4.13 : Fifth data with second measurement

The first data that obtained from measurement by using 3MHz shown in figure 4.11. This data had two type of lightning flash. These two type of lightning flash were similar with return stroke and chaotic leader. Eventhough, chaotic leader appear as subsequence return stroke.

Figure 4.12 and figure 4.13 shows the parameters of these two signal. For the return stroke, the peak value was 857 mV and its duration was 1.0476 ms. For the chaotic leader, the antenna detected the peak value was 173 mV and its durations was 5.2844 ms.

By comparing of these two type of lightning flash, return stroke shows it had higher peak value than chaotic leader and its more faster than chaotic leader based on their time duration.

2.

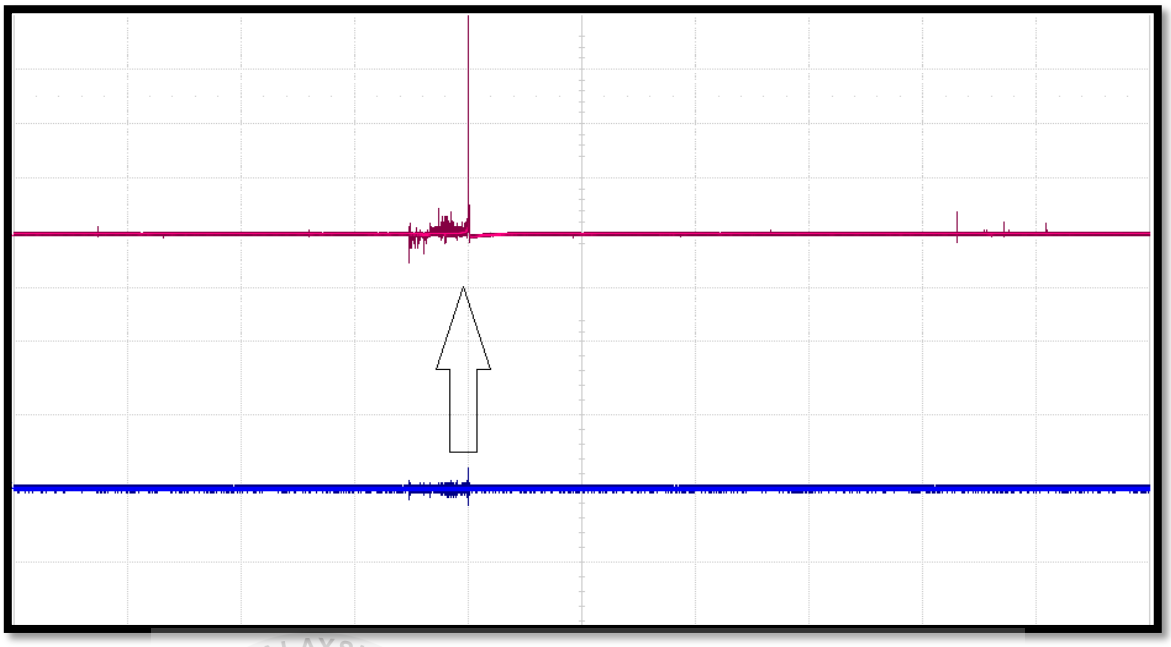

Figure 4.14 : Sixth data that detected by the antenna during measurement

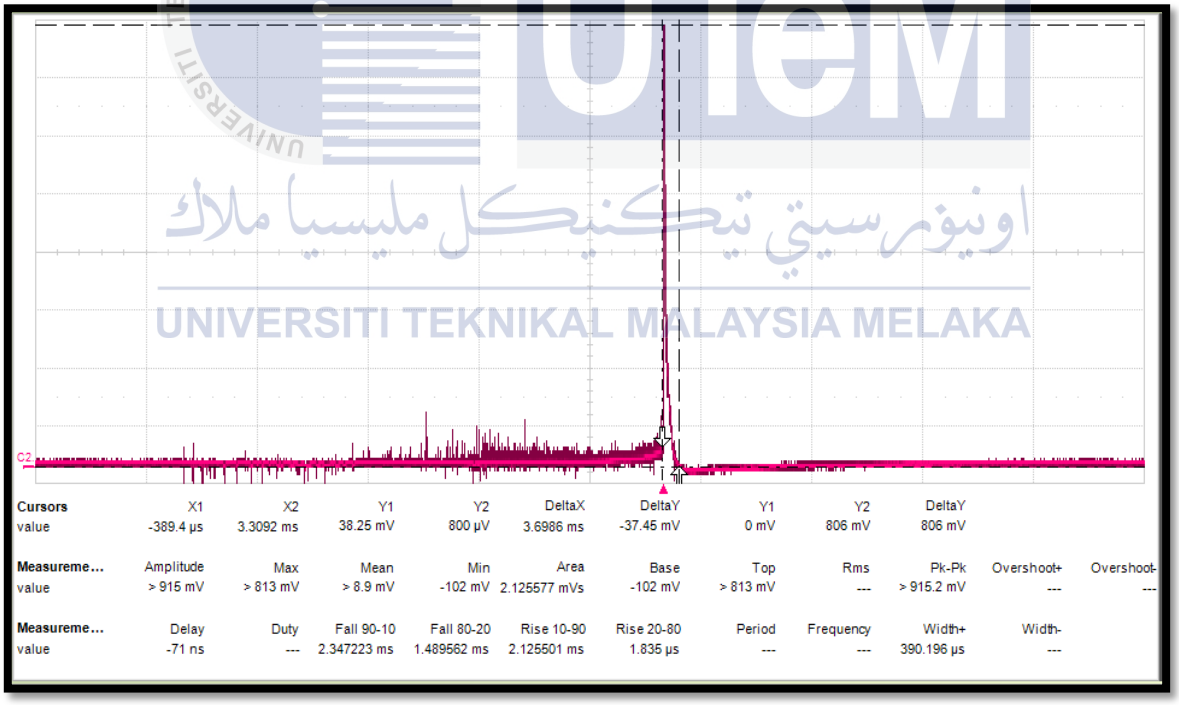

Figure 4.15 : Sixth data with measurement

Refer to the figure 4.14, the signal were differently with previous. This was a type of return stroke that happened only one time strike in nearest time. Usually, the return stroke with followed by subsequence return stroke. For this data, only one return stroke that detected by antenna.

Figure 4.15 shows the data measurement of its parameter. Basically, it focus the peak value and its durations. After make measurement its parameter, the peak value and duration can been determined. The peak value was 806 mV and time durations was 3.6986 ms.

For this data, the actual peak value were more than measurement value. During the measurement, the the antenna detected that the signal were higher than value setting at oscilloscope. If the signal more higher, the value setting must be increase until it higher the actual peak value of the signal. There were no chaotic leader that not appear in this signal.

4.4 Data Analysis

After the data was recorded from measurement, it had to analyze the data by using Microsoft Excel. The average value, maximum value, minimum value, and standard deviation were calculated based on the peak value and time duration of return stroke and chaotic leader.

Table 4.1 : The data analysis from measurement

Flash	Vpeak for Return Stroke , (V)	Time duration of Return Stroke , (ms)	Vpeak for Chaotic Leader , (V)	Time duration of Chaotic Leader , (ms)
1	1.216	1.49312	-	-
2	0.3318	0.44912	-	-
3	0.651	0.5704	0.074	0.22692
4	0.851	0.34008	0.607	0.2344
5	0.857	1.0476	0.173	5.2844
6	0.806	3.6986	-	-
Total	4.7128	7.59892	0.854	5.74572
Average	0.785466667	1.266486667	0.284666667	1.91524
Min	0.3318	0.34008	0.074	0.22692
Max	1.216	3.6986	0.607	5.2844
Standard Deviation	0.289512326	1.266909905	0.283503674	2.917780546

1. Average value

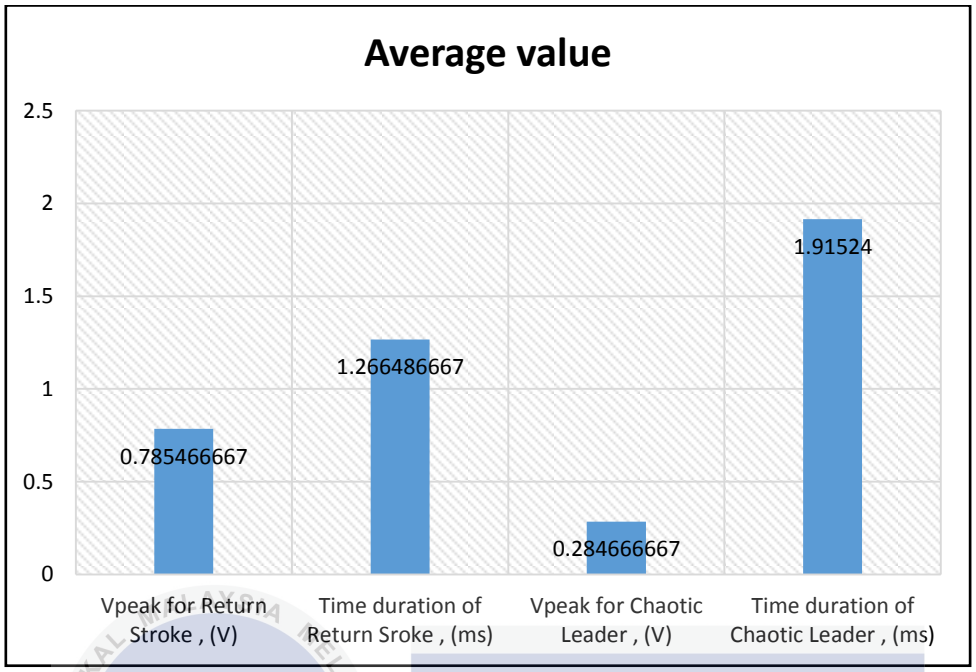

Figure 4.16 : Average value for data measurement

2. Minimum value

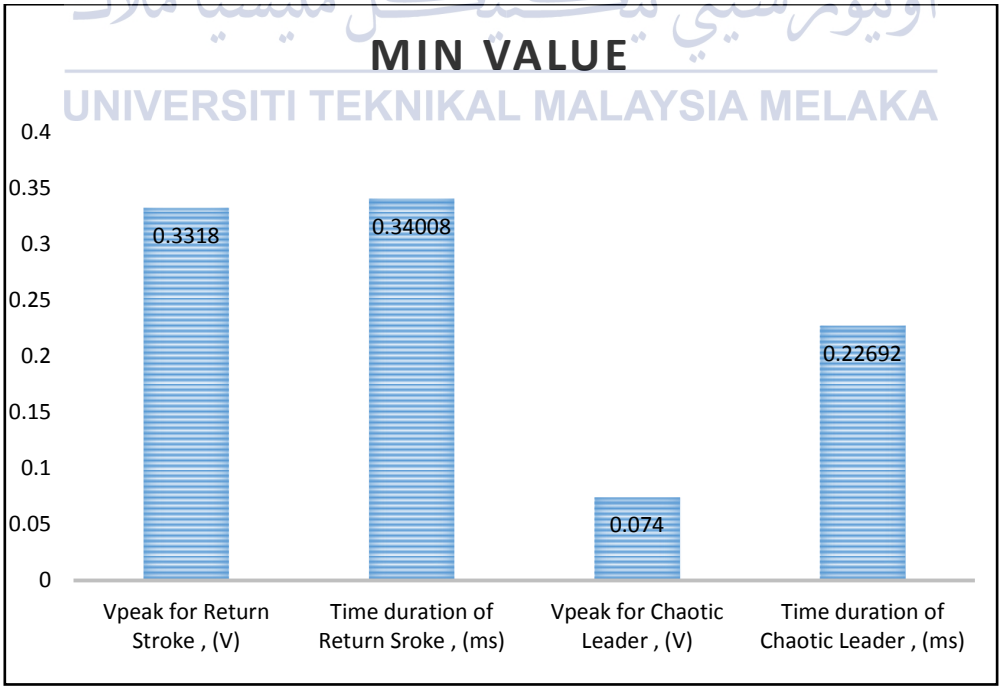

Figure 4.17 : Minimum value for data measurement

3. Maximum value

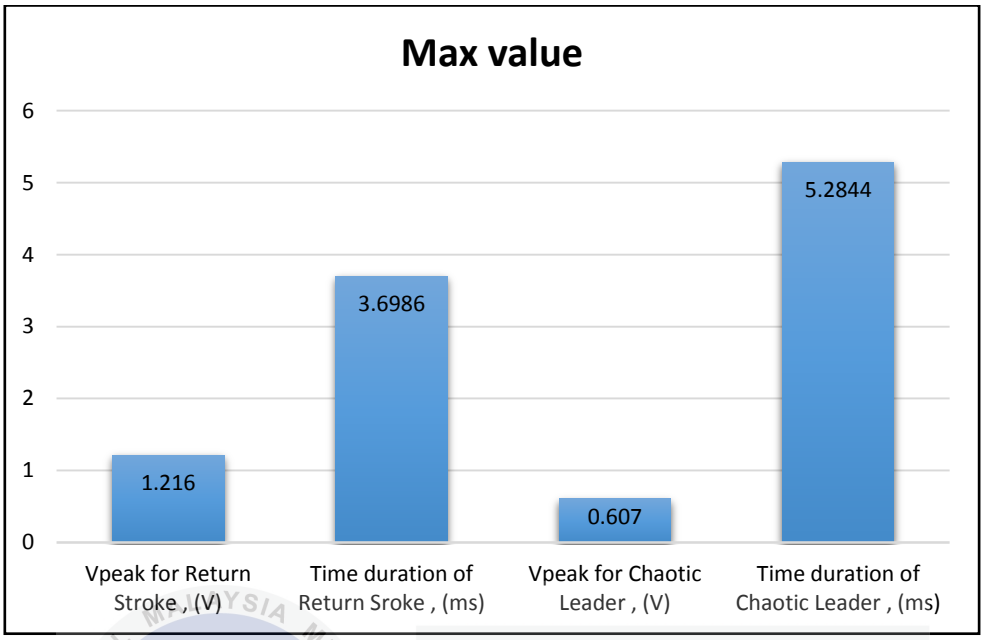

Figure 4.18 : Maximum value for data measurement

4. Standard deviation value

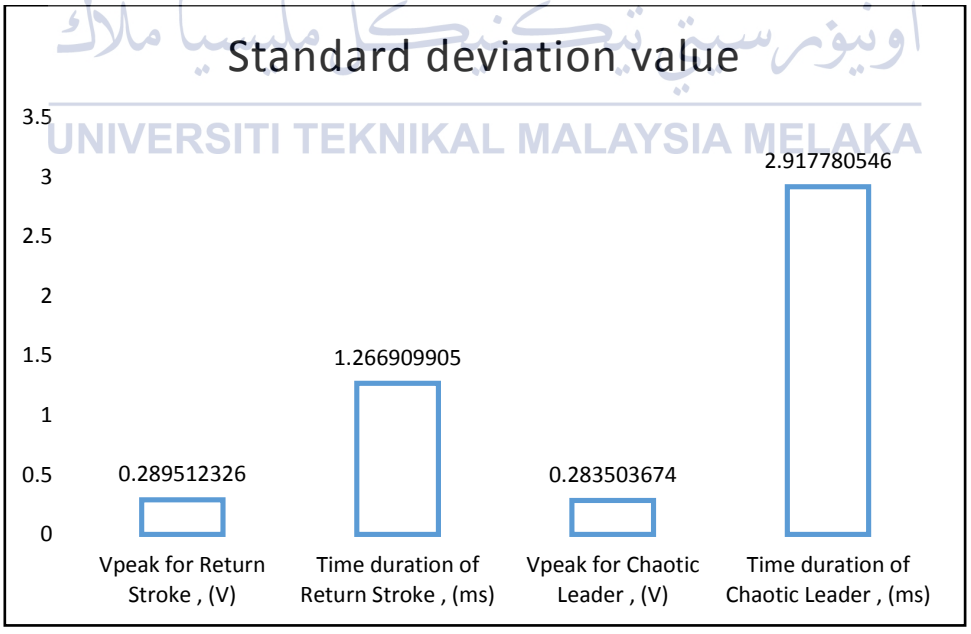

Figure 4.19 : Standard deviation value for data measurement

Figure 4.16 shows the the average value between data measurement. Average value was a median value between maximum and minimum value of the data that obtained from measurement. The average value of Vpeak return stroke was 0.7785 V while average value for chaotic leader was 0.285 V. Its shows that return stroke had higher average value than chaotic leader. For time duration, average value of return stroke was 1.266 ms while chaotic leader had 1.915 ms. Return stroke more faster than chaotic leader.

After that, the second calculation of data measurement were minimum value. Compared with six data that obtained by measurement, the minimum value had to identified to know it level of waveform. The minimum value for Vpeak return stroke was 0.3318 V and minimmum duration was 0.34 ms. For chaotic leader part, the minimum value of Vpeak was 0.074 and time duration was 0.227 ms. Chaotic leader had lower level that return stroke and it more faster compared it minimum value.

Basically, the maximum value is important during measurement. By using figure 4.17, the maximum value for data measurement can been determined. By compared six data, the maximum value for Vpeak return stroke was 1.216 V compared with chaotic leader was 0.607 V. Return stroke shows it more higher level than chaotic leader during lightning flash. After that, the maximum time duration of return stroke and chaotic leader were 3.7 ms and 5.28 ms. Compared maximum time duration of these two type of lightning flash, chaotic leader more slower than return stroke during strike happened.

Standard deviation was a measure of how spread out of number are. From the standard deviation, the standard range from the average value can been identified. Figure 4.18 show standard deviation value for data measurement. Vpeak return stroke had 0.29 V and time duration was 1.27 ms. Then, Vpeak for chaotic leader was 0.28 V and it time duration was 2.92 ms. By using these value, the standard level range of return stroke and chaotic leader were exactly same.

4.5 Discussion

Based on all the data that obtained from measurement of chaotic leader and return stroke by using high frequency radiation, it difficult to understand and analyse. Compared with previous research result by Rakov and Uman (1990a) [2,3], they found 15 such chaotic leaders among 76 Florida flashes with a total of 270 subsequent strokes. When their measurement at Sri Lanka, their data contains 34 flashes with 74 subsequent strokes. More than 30% of the subsequent strokes contain example of what appear to be "chaotic leader". For this measurement, more than 50 flashes that captured by antenna. From 50 flashes, only six flash that can been used for analysis of this project. There are only three from six data that contain chaotic leader. Compared return stroke and chaotic leader, return stroke more frequently appeared than chaotic leader. Furthermore, return stroke were found to be strong high frequency emitter than chaotic leader compared with their peak value of data. After that, the time duration of return stroke faster strike to ground compared with time duration chaotic leader. During the measurement, the antenna was placed at the top of the building FKE. Beside that, the antenna can detected noise signal from that building so it was disturbed the measurement data.

Based on the result obtained, it shows that chaotic leader had less appeared than return stroke. Chaotic leader was difficult to identify because it pulse irregular in shape. The shape of chaotic leader was not consistently. Furthermore, these result shows that return stroke had fast impulse that transfer charge to the ground. The results were similar with previous research by J.S Mäkelä [3].

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Lightning are one of the phenomenon that difficult to understand until nowadays. Many researchers still work hard do experiment and investigation to know more about lightning. Based on the data that obtained by measurement, it can conclude that the used 3MHz and 30MHz high frequency radiation can detected return stroke and chaotic leader. Basically, it can detected another subsequent lightning flash but for this project it more focus on return stroke process and chaotic leader process. Compared with these two type of lightning, return stroke more appeared than chaotic leader. The result shows that return stroke had fast impulse that transfer charge to the ground than chaotic leader. The results were similar with results by J.S Mäkelä [3]. After that, the research by J.S Mäkelä [3] used 10MHz high frequency radiation. For this project used 3MHz and 30MHz high frequency radiation to detected return stroke and chaotic leader. Three different of these circuits can Weidman [4] reported that chaotic leader had pulses irregular in shape, width and separation. It was similarly with results that obtained from measurement of this project. The chaotic leader obtained from measurement also had irregular in shape, width and separation. The project was conducted at the top of building FKE. The antenna had difficult to detected lightning signal because there had noise signal inside the building that can disturb during measurement activities. The project must conducted at area of open space to avoid any problem and signal noise from environment. Based on the results, the objectives of the project were achieved and had similarly with previous research.

5.2 Recommendation

After finished the project and fulfil requirement of the project objective, there were some improvements need to be done for this project. Therefore, few recommendations should be done to ensure that the result during measurement more precise and accurate compared with previous research.

During conducted the project, there are some problem that give disturbance of the data measurement such as noise signal that come from the building. This noise can effect the data reading display by oscilloscope. So, the project must conducted at area of open space. It can avoid noise signal during measurement.

After that, the circuit that used during measurement must be proper setup because the circuit become hot during measurement. It can effect the component in the circuit. Make sure that always checking the circuit when start measuring to get data more precise and accurate.

Lightning is dangerous natural phenomenon and it is so dangerous either for human or other life because it produces high-current electric discharge. So that, all the equipments or instruments to conduct this project should fulfill the requirement and must be rugged so that it can withstand any input condition that came from the lightning.

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APPENDICES

Process making PCB circuit

Top of parallel plate antenna

Measurement of slow field, fast field and high frequency radiation.

Project Gantt Chart and Key Milestones

Gantt chart													
Main activities of the project based on the month(s).													
	2013							2014					
Project Activities	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mac.	Apr.	May.	June.	July.	Aug	
Analyze and understand the title project													
Literature Review and basic principle													
Do discussion for the project.													
Final Year Project 1 report													
Submission project report FYP 1													
Progress with project system (hardware & software)													
Do analysis and discussion													
Progress final report and presentation for FYP2													

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