STATISTICAL ASSESSMENT OF POSITIVE NARROW BIPOLAR PULSE UNDER THE INFLUENCE OF SOUTHWEST MONSOON

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ABSTRACT: This paper presents an improvement of the statistical information on Positive Narrow Bipolar Pulse (+NBP) during Southwest Monsoon. From 260 samples, only 149 samples are available for the analysis work. 14.8 % observed as isolated +NBP and 54.4 % found to be associated with the negative ground flash (-CG) and 30.9 % associated with cloud flashes. 66 out of 81 samples (81.5 %) observed as the feature of +NBP preceded the Preliminary Breakdown Pulse of -CG flash, while 15 out of 81 samples (18.5 %) exhibit as the feature of +NBP appear after the first return stroke (or in the strokes intervals).

Keywords: *Positive Narrow Bipolar Pulse; +NBP; -CG.*

1. INTRODUCTION

The recent study by [1,2] reported that NBP also associated with the cloud-to-ground flash either before initial breakdown pulse or appear in the intervals of the return strokes. This study specifically only examines the +NBP under the influence of Southwest monsoon season. This study also presenting the results of Rising Time 0-100%, Rising Time 10-90%, Peak Amplitude (V), Duration NBP Pulse (µs), Zero Crossing Time (ZCT (µs)), and Full Width Half Maximum (FWHM (µs)).

2. METHODOLOGY

The overall of methodology of measurement and analysis work is illustrated in Figure 1 and the measurement concept is similar with [3]. The length of the recording was 2 seconds, while the sampling rate was adjusted to 12.5 MS/s. The trigger voltage of the oscilloscope was set to -200 mV to ensure only +NBP could be captured. The pre-trigger mode was set at 200 milliseconds. The measurements were conducted in Universiti Teknikal Malaysia Melaka (UTeM) in May 26, 2018, during the rainstorm monsoon period in the southern part of Peninsular Malaysia near equator. The station in UTeM located at the latitude: 2°16'39.8586''N, longitude: 102°16'30.72" E.

3. RESULT AND DISCUSSION

The profile of the NBP for this analysis work is shown in Figure 2 and Figure 3. From Table 1, 22 out of the total of 262 samples are characterize as isolated +NBP. Figure 4 illustrates the histograms of four lightning parameters interest for Power Engineer and Lightning Protection for the case of isolated NBP.
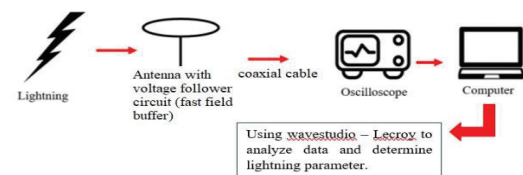

Figure 1 Overall methodology featuring the electric field measurement, recording and analysis.
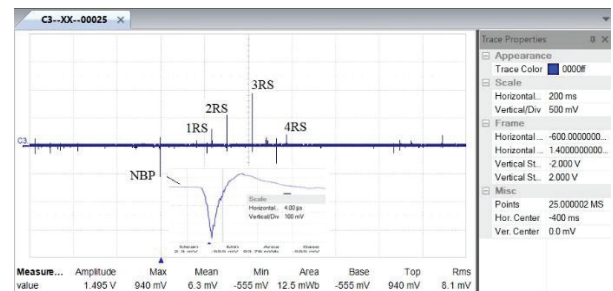

Figure 2 +NBP appear before the initial breakdown or return stroke (RS-Return Stroke).
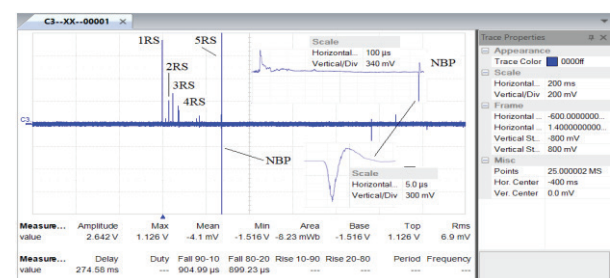

Figure 3 +NBP appear after fifth Return Stroke.

Table 1 Statistical result of Isolated +NBP (P_a: Peak Amplitude; O_s: Overshoot)

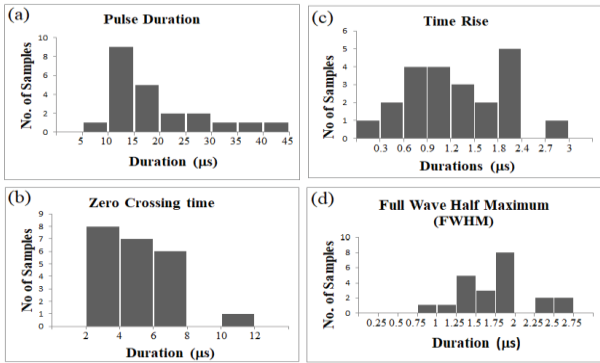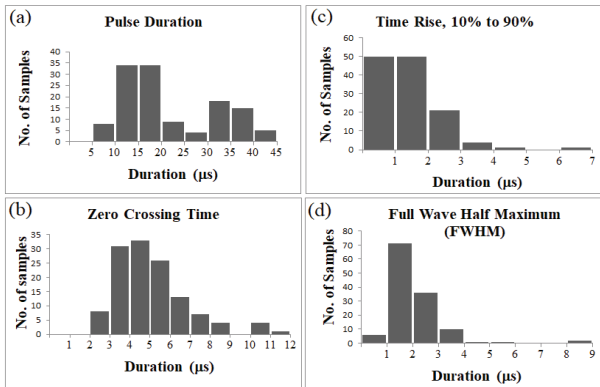| Features	NBP Duration (µs)	ZCT (µs)	Time Rise (µs) 0-100%	Rising Time (µs) 10%-90%	FWHM (µs)	Ratio Pa/Os
no of sample	22	22	22	22	22	22
min	6.32	2.65	0.83	0.29	0.92	1
max	43.6	10.14	5.17	2.87	2.6	13.23
Arith. mean	19.28	5.10	2.46	1.33	1.78	4.72
Geo. mean	17.46	4.84	2.18	1.14	1.73	4.20
median	16.46	4.94	2.05	1.22	1.85	3.99
Std. dev	9.18	1.74	1.23	0.7	0.45	2.54

Figure 4 Isolated +NBP

Figure 5 +NBP associated with mixed flashes

Table 2 summarized 127 samples of +NBP associated with the -CG and the cloud flashes with the samples of 81 and 46, respectively. From 81 samples of +NBP associated with the -CG, 66 samples appeared before Preliminary Breakdown Pulse (PBP) and 15 samples after the first return strokes. Figure 5 shows the histograms for the case of +NBP associated with -CG and cloud flashes.

Table 2: +NBP associated with mixed flashes

Features	NBP Duration (µs)	ZCT (µs)	Time Rise (µs) 0-100%	Rising Time (µs) 10%-90%	FWHM (µs)	Ratio Pa/Os
no of sample	127	127	127	127	127	127
min	6.88	2.16	0.61	0.3	0.53	2.15
max	41.72	11.21	7.97	6.67	8.82	30.19
Arith. mean	21.62	5.11	2.45	1.42	2.04	5.88
Geo. mean	19.38	4.84	2.13	1.17	1.85	4.67
median	16.92	4.76	2.14	1.17	1.82	3.81
Std. dev	13.15	1.80	1.31	0.93	1.12	5.16

Table 3: +NBP associated with the -CG appear before the preliminary breakdown pulse

Features	NBP Duration (µs)	ZCT (µs)	Time Rise (µs) 0-100%	Rising Time (µs) 10%-90%	FWHM (µs)	Ratio Pa/Os
No. of sample	66	66	66	66	66	66
Min	7.23	2.16	0.69	0.31	0.68	2.15
max	37.73	10.99	5.94	4.56	8.82	24.71
Arith. mean	20.46	4.93	2.37	1.38	2.06	5.60
Geo. mean	18.58	4.68	2.09	1.16	1.83	4.54
Median	16.72	4.65	2.90	1.15	1.79	3.91
Std. dev	9.15	1.74	1.20	0.84	1.34	4.71

Next, the results in Table 2, were separated as +NBP associated with -CG appear before the PBP (as depicted Table 3) and +NBP associated with -CG appear after the first return (as depicted in Table 4). Based on this analysis work, it is important to separate between the data of Isolated NBP and NBP associated the cloud flashes since the parameters of FWHM and the ratio of Pa/Os have given a big different compared to the case of the NBP associated with the negative ground flash. Interestingly, NBP can also appear following the return stroke and this result is consistent with the report by [1,2].

Table 4: +NBP associated with the -CG appear after the first return stroke

Features	NBP Duration (µs)	ZCT (µs)	Time Rise (µs) 0-100%	Rising Time (µs) 10%-90%	FWHM (µs)	Ratio Pa/Os
no of sample	15	15	15	15	15	15
min	9.62	2.98	0.7	0.3	0.96	2.40
max	33.17	7.74	4.77	2.97	3.78	17.92
Arith. mean	18.93	4.32	2.15	1.27	1.82	5.78
Geo. mean	17.82	4.17	1.93	1.10	1.73	4.57
median	15.84	3.99	2.07	1.14	1.73	3.70
Std. dev	7.03	1.27	1.03	0.69	0.65	5.06

4. CONCLUSION

14.8 % (Case 1) observed as isolated positive Narrow Bipolar Pulse and 54.4 % (Case 2) found to be associated with the negative ground flash and 30.9 % (Case 3) associated with cloud flashes. 66 out of 81 samples (81.5 %) observed as the feature of Narrow Bipolar Pulse preceded the negative ground flash, while 15 out of 90 samples (18.5 %) exhibit as the feature of Narrow Bipolar Pulse appear after the first return stroke. It is necessary to separate between the cases in order to analyze a sub-microsecond structure then one can perform a clear statistical information of the Narrow Bipolar Pulse.

5. ACKNOWLEDGEMENT

6. REFERENCES

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