The Definition of the Rise Time of Impulse Signals

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Abstract—We present in this paper an example of the numerous contributions made by Dr. Dave Giri in the field of high power electromagnetics that have found applications in other fields. Specifically, we discuss how his definition of the risetime has been applied to lightning-originated waveforms.

Keywords-lightning; signal risetime.

I. INTRODUCTION

The risetime of the lightning current and of electromagnetic fields is an important parameter in the context of electromagnetic compatibility since it responsible for induced voltages and thus for disturbance and damage to circuits and systems. However, the definition of the risetime is not unique and difference methods to measure it are used in different fields. In this abstract, we describe two of the methods. One of them, commonly used in the Nuclear Electromagnetic Pulse and the High-Power Electromagnetics research fields, was proposed by Carl Baum and Dave Giri ([1-3]). The other is widely used in the lightning field and in standards and it is defined based on the instants at which the waveform in question crosses thresholds defined as percentages of the peak value.

II. Risetime definitions

A. *The 10% to 90% risetime or $t_{10\text{-}90}$ risetime*

The $t_{10\text{-}90}$ risetime is defined as the time between the instant at which a waveform reaches 10% of its peak and the time at which it reaches 90% of its peak (see [4]). In spite of its simplicity, the $t_{10\text{-}90}$ risetime is not generally applicable since some waveforms exhibit an oscillatory behavior during the rising part that makes the 10% and 90% thresholds be crossed more than once.

B. *The rate-of-rise risetime*

An alternative definition of the risetime was proposed by Carlo Baum and Dave Giri and it is commonly used in the Nuclear Electromagnetic Pulse and the High-Power Electromagnetics research fields [1-3]. The definition is given in terms of the maximum rate of rise of the waveform. It is given in Eq. (1).

$$t_{mr} = \frac{i_{peak}}{\left(\frac{di}{dt}\right)_{peak}} \qquad (1)$$

Fig. 1 shows an example of a measured lightning current waveform at the Säntis tower characterized by a complex early-time behaviour to which the two definitions for the risetime were Applied. The application of Eq. (1) results in a risetime of 0.3 µs, while the use of the $t_{10\text{-}90}$ definition yields a risetime of 0.7 µs.

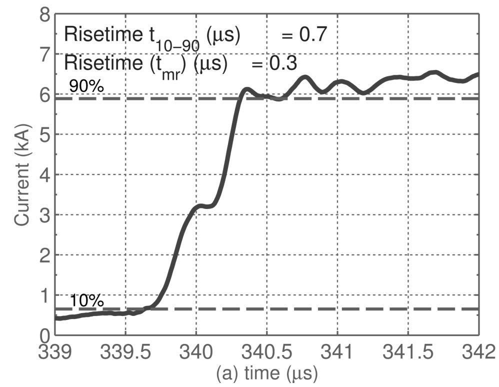

Fig. 1. The use of the two definitions for the determination of the risetime: application to a measured lightning current waveform at the Säntis tower (adapted from [5]).

It was observed [5] that the t_{mr} risetime is in general more consistent with the maximum frequency content of the signals and the probability distributions are more consistent with the expected lognormal distributions.

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