International Telecommunication Union

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TELECOMMUNICATION
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K.96

Amendment 1
(12/2014)

SERIES K: PROTECTION AGAINST INTERFERENCE

Surge protective components: Overview of surge mitigation functions and technologies

Amendment 1: New Appendix II – Alternative duration measurement method for 1.2/50-8/20 and 10/700 surge generator impulses

Recommendation ITU-T K.96 (2014) – Amendment 1

ITU-T

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New Appendix II – Alternative duration measurement method for 1.2/50-8/20 and 10/700 surge generator impulses

Summary

The time to half value of a double exponential surge, simulating a lightning impulse, is traditionally measured from a virtual zero point to the 50% amplitude decay point of the waveform, as explained in clause I.3. The time duration of electrostatic discharge (ESD) and electrical fast transient (EFT) impulses is measured as the time for which the impulse exceeds the 50% amplitude level. The time measured from virtual zero will always be longer than the time between the two waveform 50% points. Edition 3 of IEC 61000-4-5 (2014) departs from the traditional lightning surge time to half value measurement by specifying the use of the time between the two waveform 50% points for the 1.2/50-8/20 and 10/700 surge generator waveforms. Amendment 1 to Recommendation ITU-T K.96 introduces Appendix II, which discusses the time value changes caused by the Edition 3 approach and how other standards can be referenced to maintain the tradition measurement method.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T K.96	2014-02-13	5	11.1002/1000/12129
1.1	ITU-T K.96 (2014) Amd. 1	2014-12-19	5	11.1002/1000/12442

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

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1) New Appendix II

Add the following appendix after Appendix I:

Appendix II

Alternative duration measurement method for 1.2/50-8/20 and 10/700 surge generator impulses

(This appendix does not form an integral part of this Recommendation.)

II.1 Introduction

IEC 61000-4-5 ed3, [b-IEC 61000-4-5 ed3], changes the established method of surge waveshape *time to half value* and names the parameter as *duration*. An explanation of the changed approach is given in [b-Carobbi]. This appendix explains the change and possible consequences.

II.2 Time to half value measurement

Many standards define double exponential waveshape time to half-value for voltage or current or both. [b-IEC 60099-9] has a definition covering both voltage and current.

virtual time to half-value on the tail of an impulse, T_2: time interval between the virtual origin and the instant when the voltage or current has decreased to half its peak value, expressed in microseconds.

II.3 Duration measurement

[b-IEC 61000-4-5 ed3] has three definitions for the term "duration"; one for voltage and two for current.

1) **duration (surge voltage) T_d**: time interval between the instant at which the surge voltage rises to 0.5 of its peak value, and then falls to 0.5 of its peak value (T_W).

   $T_d = T_W$

2) **duration (surge current for 5/320 µs) T_d**: time interval between the instant at which the surge current rises to 0.5 of its peak value, and then falls to 0.5 of its peak value (T_W).

   $T_d = T_W$

3) **duration (surge current for 8/20 µs) T_d**: time interval between the instant at which the surge current rises to 0.5 of its peak value, and then falls to 0.5 of its peak value (T_W), multiplied by 1.18.

$T_d = 1.18 \times T_W$

NOTE – For this measurement, an 18 µF capacitor is connected in series with the generator output.

II.4 Comparison of time to half value and duration

[b-IEC 61000-4-5 ed3] only covers two generator types; the 1.2/50-8/20 combination wave generator and the 10/700 generator.

II.4.1 Durations type 1 and type 2

When the waveshape front time is 2.5% or less of the time to half value, there is only a small difference between the time to half value and the duration. This condition applies to the 1.2/50 and 10/700 open-circuit voltage waveshapes and the type 1 duration is used. Similarly for the 10/700 generator 5/320 short-circuit current waveshape the type 2 duration is used. As an error example, a 1.2/50 waveshape would have a 50 µs time to half value (T_2) and a duration (T_d) of 49.4 µs. This is a 1.2% time difference, which will only be significant for generators close to the minimum value of T_2.

II.4.1 Duration type 3

As the 8/20 short-circuit current waveshape has a front time that is 40% of the time to half value, serious discrepancies would arise if just 50% amplitude time (T_W) was used. For example a 8/20 waveshape would have a T_W value of about 17 µs. This is why the type 3 duration multiples the T_W value by factor of 1.18. Figure II.1 shows this condition.

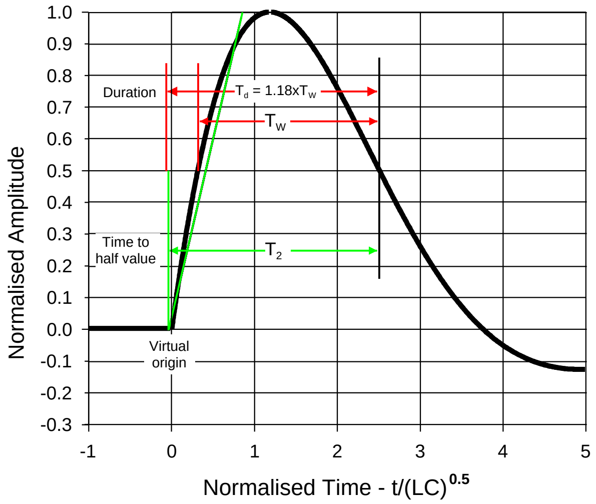

Figure II.1 – Comparison of time to half value, T_2, and duration, T_d

Figure II.1 uses a timescale of $t/(LC)^{0.5}$, where L is the series inductance and C is the energy storage capacitor of a simple RLC combination wave generator circuit. The actual current waveshape will depend on the resistive damping factor, k, of the LC circuit, see Figure II.2.

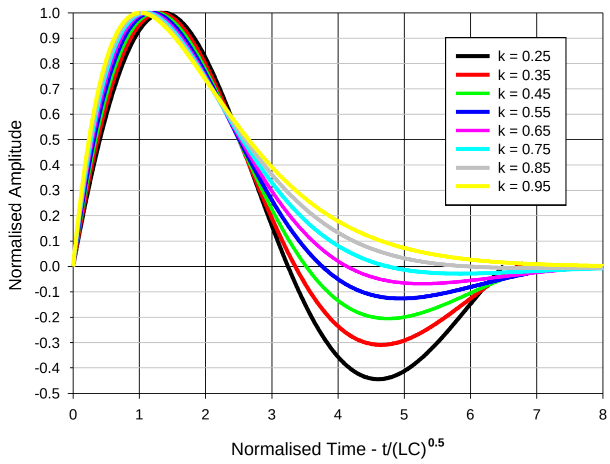

Figure II.2– Short-circuit current waveshape variation with damping factor k

To meet the requirements of an 8/20 waveshape, the k value needs to be between 0.35 (30% undershoot condition) and 0.95 (no undershoot). The T_2/T_d factor varies with k as shown in Figure II.3.

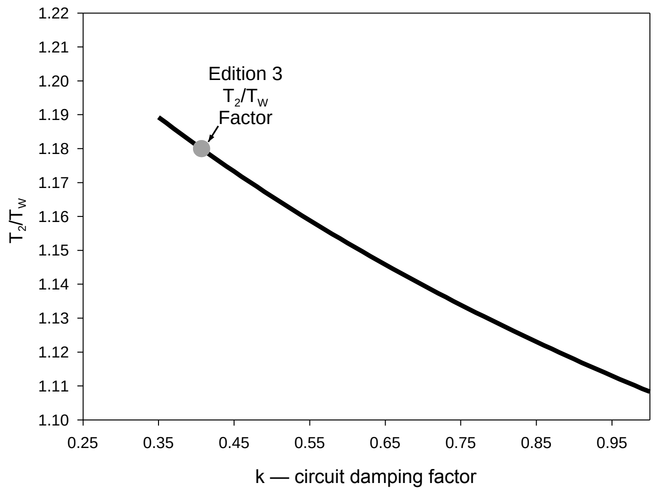

Figure II.3 – T_2/T_W ratio versus the damping factor k

Figure II.3 shows that the 1.18 factor is optimized for a k value of 0.4 which results in a time to half value to front time ratio of 2.6 (impulse shape range of 6.4/16.4 to 9.2/24). At k values of 0.5 or above and front times less than 8.4 µs, the 1.18 factor can give durations (T_d) longer than T_2 and the 24 µs limit of the 8/20 waveshape. This could cause some generator compliant to IEC 61000-4-5 ed2 to be non-compliant to [b-IEC 61000-4-5 ed3].

IEC 61000-4-5 ed2 has been withdrawn, those wishing to continue to measure in the established way, as embodied in ed2, could reference back to the components that established the combination wave generator; the 1.2/50 insulation voltage test impulse and the 8/20 arrester current impulse. Three elements are needed to create a 1.2/50-8/20 combination generator definition.

1 The 1.2/50 open-circuit voltage waveshape shall be according to [b-IEC 60060-1] having a front time of 1.2 µs ± 30% and a time to half value of 50 µs ± 20%.

2 The 8/20 short-circuit current waveshape shall be according to [b-IEC 62475] having a front time of 8 µs ± 20% and a time to half value of 20 µs ± 20%. The opposite polarity current undershoot shall not exceed 30% of the peak current.

3 The ratio of peak open-circuit voltage to short-circuit current shall be 2 Ω ± 10%.

2) Bibliography

Add the following entries to the Bibliography:

[b-IEC 60099-9] IEC 60099-9 (2014-06), *Surge arresters – Part 4: Metal-oxide surge arresters without gaps for a.c. systems*.

[b-IEC 61000-4-5 ed3] IEC 61000-4-5 ed3.0 (2014-05), *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques - Surge immunity test*.

[b-Carobbi] C. F. M. Carobbi and A. Bonci, *Elementary and Ideal Equivalent Circuit Model of the 1.2/50 – 8/20 μs Combination Wave Generator*, IEEE Electromagnetic Compatibility Magazine, Volume 2, Quarter 4, 2013.

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