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INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Computation of waveform parameter uncertainties

Calcul des incertitudes des paramètres des formes d'onde

IEC 62754:2017-05(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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COMPUTATION OF WAVEFORM PARAMETER UNCERTAINTIES

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FDIS	Report on voting
85/585/FDIS	85/X588/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

The terms used throughout this document which have been defined in Clause 3 are in italic type.

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COMPUTATION OF WAVEFORM PARAMETER UNCERTAINTIES

1 Scope

This document specifies methods for the computation of the temporal and amplitude parameters and their associated uncertainty for step-like and impulse-like waveforms. This document is applicable to any and all industries that generate, transmit, detect, receive, measure, and/or analyse these types of pulses.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60469:2013, *Transitions, pulses and related waveforms – Terms, definitions and algorithms*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
aberration region

3.1.1
post-transition aberration region
interval between a user-specified *instant* and a fixed *instant*, where the fixed *instant* is the first sampling *instant* succeeding the 50 % *reference level instant* for which the corresponding *waveform* value is within the *state boundaries* of the *state* succeeding the 50 % *reference level instant*

[SOURCE: IEC 60469:2013, 3.2.1.1, modified – the note 1 to entry has been deleted.]

3.1.2
pre-transition aberration region
interval between a user-specified *instant* and a fixed *instant*, where the fixed *instant* is the first sampling *instant* preceding the 50 % *reference level instant* for which the corresponding *waveform* value is within the *state boundaries* of the *state* preceding the 50 % *reference level instant*

[SOURCE: IEC 60469:2013, 3.2.1.2, modified – the note 1 to entry has been deleted.]

3.2
amplitude

3.2.1
impulse amplitude
difference between the specified *level* corresponding to the *maximum peak* (*minimum peak*) of the positive (negative) *impulse-like waveform* and the *level* of the *state* preceding the first *transition* of that *impulse-like waveform*

[SOURCE: IEC 60469:2013, 3.2.3.1]

3.2.2
waveform amplitude
difference between the *levels* of two different *states* of a *waveform*

SEE Figure 1.

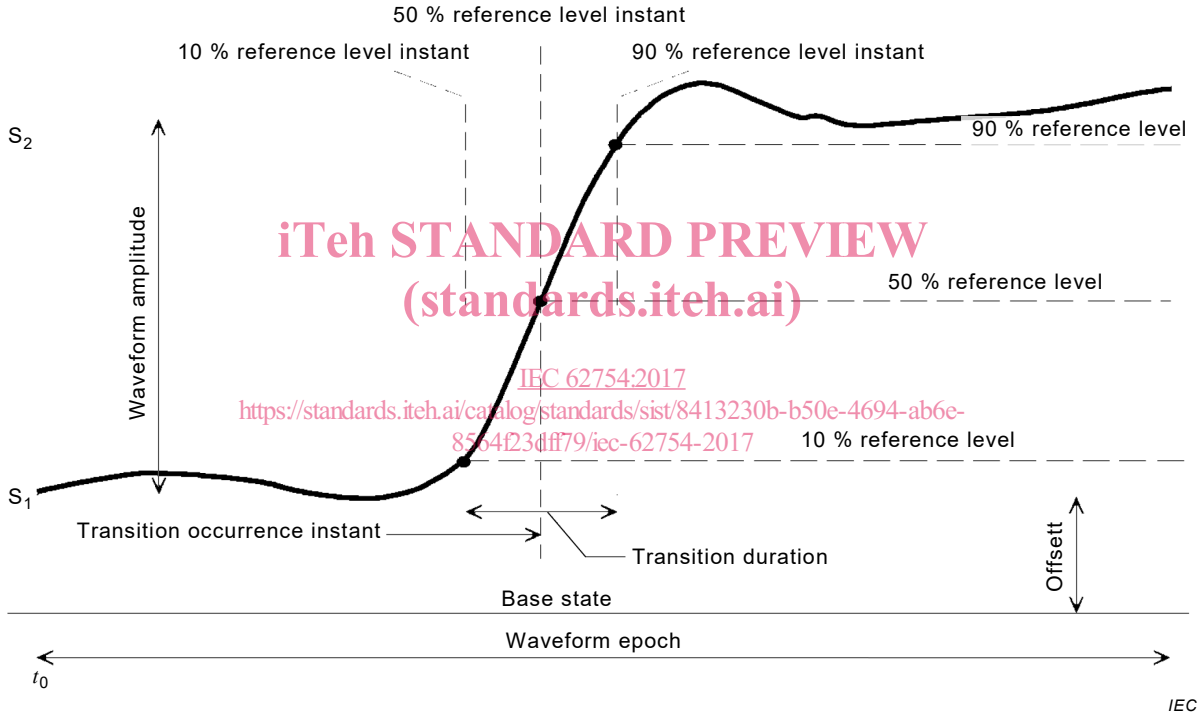

Figure 1 – Reference levels, reference level instants, waveform amplitude, and transition duration for a single positive-going transition

[SOURCE: IEC 60469:2013, 3.2.3.2, modified – the Note 1 to entry has been deleted and the reference to Figure 1 has been added.]

3.3
correction
operation that combines the results of the conversion operation with the transfer function information to yield a *waveform* that is a more accurate representation of the *signal*

Note 1 to entry Correction may be effected by a manual process by an operator, a computational process, or a compensating device or apparatus. Correction shall be performed to an accuracy that is consistent with the overall accuracy desired in the *waveform measurement process*.

[SOURCE: IEC 60469:2013, 3.2.4]

3.4
coverage factor
numerical factor used as a multiplier of the combined standard uncertainty in order to obtain an expanded uncertainty

Note 1 to entry: A coverage factor, k, is typically in the range 2 to 3.

Note 2 to entry: Coverage factor is also defined as a "number larger than or equal to one by which a *combined standard measurement uncertainty* is multiplied to obtain an *expanded measurement uncertainty*," (See ISO/IEC Guide 99:2007, 2.38).

[SOURCE: ISO/IEC Guide 98-3:2008, 2.3.6, modified – the Note 2 to entry has been added.]

3.5
degrees of freedom
in general, the number of terms in a sum minus the number of constraints on the terms of the sum

[SOURCE: ISO/IEC Guide 98-3:2008, C.2.31]

3.6
impulse response
output *signal* from an instrument, device, or system that is the result of an input *signal*, where this input *signal* can be described by a unit impulse function, $\delta(t)$:

$$\begin{aligned} \delta(t=0) &= 1 \\ \delta(t\neq 0) &= 0 \end{aligned} \tag{1}$$

3.7
instant
particular time value within a *waveform epoch* that, unless otherwise specified, is referenced relative to the *initial instant* of that *waveform epoch*

[SOURCE: IEC 60469:2013, 3.2.13]

3.7.1
initial instant
first sample *instant* in the *waveform*

[SOURCE: IEC 60469:2013, 3.2.13.3]

3.7.2
impulse center instant
instant at which a user-specified approximation to the *maximum peak* (*minimum peak*) of the positive (negative) *impulse-like waveform* occurs

[SOURCE: IEC 60496:2013, 3.2.13.2]

3.7.3
reference level instant
instant at which the *waveform* intersects a specified *reference level*

SEE Figure 1.

[SOURCE: IEC 60469:2013, 3.2.13.5, modified – the reference to Figure 1 has been added.]

3.8
interval

set of all values of time between a first *instant* and a second *instant*, where the second *instant* is later in time than the first

Note 1 to entry: These first and second *instants* are called the endpoints of the *interval*. The endpoints, unless otherwise specified, are assumed to be part of the *interval*.

[SOURCE: IEC 60469:2013, 3.2.15]

3.9
level

constant value having the same units as y

SEE Figure 1.

Note 1 to entry: y is the *signal*.

[SOURCE: IEC 60469:2013, 3.2.17, modified – the reference to Figure 1 has been added as well as the note 1 to entry.]

3.9.1
percent reference level

reference level specified by:

$$y_{x\%} = y_{0\%} + \frac{x}{100\%}\left(y_{100\%} - y_{0\%}\right) \quad (2)$$

where

$0\ \% < x < 100\ \%$

$y_{0\%}$ = *level* of *low state*

$y_{100\%}$ = *level* of *high state*

$y_{0\%}$, $y_{100\%}$, and $y_{x\%}$ are all in the same unit of measurement

SEE Figure 1.

Note 1 to entry: Commonly used *reference levels* are: 0 %, 10 % , 50 %, 90 %, and 100 %.

[SOURCE: IEC 60469:2013, 3.2.17.3, modified – the reference to Figure 1 has been added.]

3.10
measurand

quantity intended to be measured

[SOURCE: ISO/IEC Guide 99:2007, 2.3, modified – the notes have been deleted.]

3.11
measurement model
model of measurement
model

mathematical relation among all quantities known to be involved in a measurement

[SOURCE: ISO/IEC Guide 99:2007, 2.48, modified – the notes have been deleted.]

3.12
measurement uncertainty
uncertainty of measurement
uncertainty
non-negative parameter characterizing the dispersion of the quantity values being attributed to a *measurand*, based on the information used

Note 1 to entry Measurement uncertainty is also defined as a "parameter, associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the *measurand*," (See ISO/IEC Guide 98-3:2008, 2.2.3).

[SOURCE: ISO/IEC Guide 99:2007, 2.26, modified – the notes have been deleted and the note 1 to entry has been added.]

3.12.1
standard measurement uncertainty
standard uncertainty of measurement
standard uncertainty
measurement uncertainty expressed as a standard deviation

Note 1 to entry: *Standard measurement uncertainty* is also defined as an *"uncertainty* of the results of measurement expressed as a standard deviation," (See ISO/IEC Guide 98-3:2008, 2.3.1).

[SOURCE: ISO/IEC Guide 99:2007, 2.30, modified – the note 1 to entry has been added.]

3.12.2
combined standard measurement uncertainty
combined standard uncertainty
standard *measurement uncertainty* that is obtained using the individual standard measurement uncertainties associated with the input quantities in a measurement model

Note 1 to entry: Combined standard uncertainty is also defined as a "standard uncertainty of the result of a measurement when that result is obtained from the values of a number of other quantities, equal to the positive square root of a sum of terms, the terms being the variances or covariances of these other quantities weighted according to how the measurement result varies with changes in these quantities," (See ISO/IEC Guide 98-3:2008, 2.3.4).

[ISO/IEC Guide 99:2007, 2.31, modified – the note has been deleted and the note 1 to entry has been added.]

3.12.3
expanded measurement uncertainty
expanded uncertainty
product of a *combined standard measurement uncertainty* and a factor larger than the number one

[SOURCE: ISO/IEC Guide 99:2007, 2.35]

Note 1 to entry: Expanded uncertainty is also defined as a "quantity defining an interval about the result of a measurement that may be expected to encompass a large fraction of the distribution values that could reasonably be attributed to the *measurand*," (See ISO/IEC Guide 98-3:2008,2.3.5).

[SOURCE: ISO/IEC Guide 99:2007, 2.35, modified – the notes have been deleted and the note 1 to entry has been added.]

3.12.4
instrumental measurement uncertainty
instrumental uncertainty
component of *measurement uncertainty* arising from a measuring instrument or measuring system in use

[SOURCE: ISO/IEC Guide 99:2007, 4.24, modified – the term "instrumental uncertainty" has been added as a synonym and the notes have been deleted.]

3.12.4.1
intrinsic (instrumental) uncertainty
uncertainty of a measuring instrument when used under reference conditions

[SOURCE: IEC 60359:2001, 3.2.10]

3.12.4.2
operating instrumental uncertainty
instrumental uncertainty under the rated operating conditions

[SOURCE: IEC 60359:2001, 3.2.11]

3.13
overshoot
waveform aberration within a post-transition aberration region or pre-transition aberration region that is greater than the upper state boundary for the associated state level

SEE Figure 2.

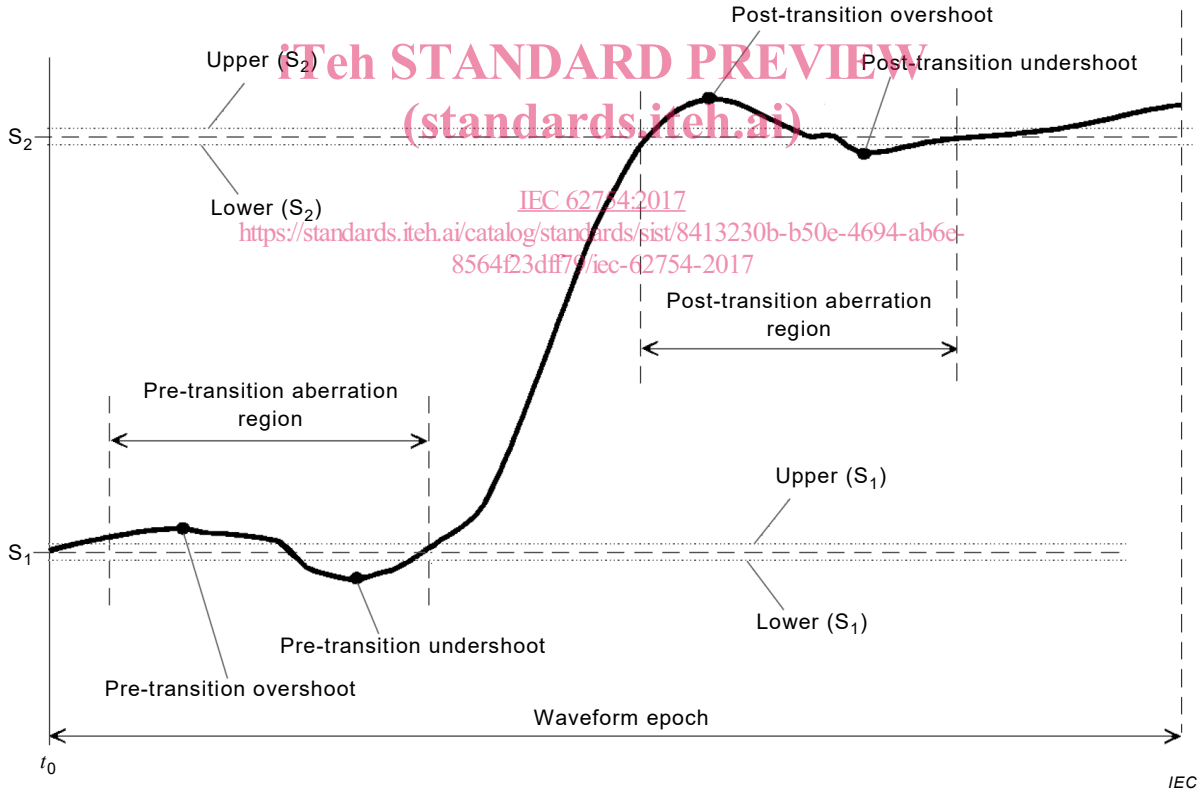

Figure 2 – Overshoot, undershoot, state levels, and state boundaries for a single positive-going transition

[SOURCE: IEC 60469:2013, 3.2.19, modified – the reference to Figures 5 and 6 in the source definition has been replaced by the reference to Figure 2.]

3.14
parameter
any value (number multiplied by a unit of measure) that can be calculated from a *waveform*

[SOURCE: IEC 60469:2013, 3.2.20]

3.15
maximum peak
pertaining to the greatest value of the *waveform*

[SOURCE: IEC 60469:2013, 3.2.21]

3.16
minimum peak
pertaining to the least value of the *waveform*

[SOURCE: IEC 60469:2013, 3.2.22]

3.17
pulse duration
difference between the first and second *transition occurrence instants*

[SOURCE: IEC 60469:2013, 3.2.27, modified – the note has been deleted.]

3.18
pulse separation
duration between the 50 % *reference level instant*, unless otherwise specified, of the second *transition* of one *pulse* in a *pulse train* and that of the first *transition* of the immediately following *pulse* in the same *pulse train*

[SOURCE: IEC 60469:2013, 3.2.28]

3.19
waveform reconstruction deconvolution
process of removing the effect of the measurement instrument, connectors, cables, and jitter on the measured *waveform*

Note 1 to entry: This process deconvolves the impulse response of the measurement instrument from the measured *waveform*.

3.20
sample
element of a *sampled waveform,* given in units of the amplitude of the *signal* at a given time

3.21
signal
physical phenomenon, one or more of whose characteristics may vary to represent information

Note 1 to entry: This phenomenon is a function of time.

[SOURCE: IEC 60469:2013, 3.2.38]

3.22
state
particular *level* or, when applicable, a particular *level* and upper and lower limits (the upper and lower *state boundaries*) that are referenced to or associated with that *level*

Note 1 to entry Unless otherwise specified, multiple *states* are ordered from the most negative *level* to the most positive *level*, and the *state levels* are not allowed to overlap. The most negative *state* is called *state* 1. The most positive *state* is called *state* n. The *states* are denoted by s_1, s_2, ..., s_n; the *state levels* are denoted by *level*(s_1),

level(s_2), ..., *level*(s_n); the upper *state boundaries* are denoted by upper(s_1), upper(s_2), ..., upper(s_n); and the lower *state boundaries* are denoted by lower(s_1), lower(s_2), ..., lower(s_n).

SEE Figure 2.

[SOURCE: IEC 60469:2013, 3.2.40, modified – the reference to Figure 2 has been added and note 2 of the original definition has been deleted.]

3.23
state boundaries
upper and lower limits of the states of a *waveform*

SEE Figure 2.

Note 1 to entry: All values of a *waveform* that are within the boundaries of a given *state* are said to be in that *state*. The *state boundaries* are defined by the user.

[SOURCE: IEC 60469:2013, 3.2.41, modified – the reference to Figure 2 has been added.]

3.24
state occurrence
contiguous region of a *waveform* that is bounded by the upper and lower *state boundaries* of a *state*, and whose *duration* equals or exceeds the specified minimum *duration* for *state* attainment. The state occurrence consists of the entire portion of the waveform that remains within the state boundaries of that state.

Note 1 to entry *State occurrences* are numbered as ordered pairs (s_i,n), where s_i refers to the i^{th} state, and n is the number of the occurrence of that particular *state* within the *waveform epoch*. In a given *waveform epoch*, when the *waveform* first enters a *state* s_1, that state occurrence is (s_1, 1). If and when the *waveform* exits that *state*, that *state occurrence* is over. If and when the *waveform* next enters and remains in state s_1, that *state occurrence* would be labelled (s_1, 2); and so on.

[SOURCE: IEC 60469:2013, 3.2.42, modified – the note has been shortened so that it does not discuss figures that are not contained in this document]

3.25
timebase
that component of a measurement instrument that provides the unique *instant* for each sample in a *sampled waveform*

Note 1 to entry: The *timebase* provides a vector of sampling instants where each *instant* corresponds to a unique sample in the *waveform*. Often the interval between sample *instants* is not uniform and exhibits both systematic and random errors.

3.26
transition
contiguous region of a *waveform* that connects, either directly or via intervening *transients*, two *state occurrences* that are consecutive in time but are occurrences of different *states*

[SOURCE: IEC 60469:2013, 3.2.47]

3.26.1
negative-going transition
transition whose terminating *state* is more negative than its originating *state*

Note 1 to entry: The endpoints of the *negative-going transition* are the last exit of the *waveform* from the higher *state boundary* and the first entry of the *waveform* into the lower *state boundary*.

[SOURCE: IEC 60469:2013, 3.2.47.1, modified – note 2 has been deleted.]