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TECHNICAL SPECIFICATION

colour inside

Power quality management –
Part 3: User characteristics modelling

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POWER QUALITY MANAGEMENT –

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IEC 63222-3 has been prepared by IEC technical committee 8: System aspects of electrical energy supply. It is a Technical Specification.

The text of this Technical Specification is based on the following documents:

Draft	Report on voting
8/1690/DTS	8/1702/RVDTS

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this Technical Specification is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at http://www.iec.ch/standardsdev/publications.

A list of all parts in the IEC 63222 series, published under the general title *Power quality management*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

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POWER QUALITY MANAGEMENT –

Part 3: User characteristics modelling

1 Scope

This part of IEC 63222 is intended to provide provisions regarding recognized engineering practices applicable to assess the user's characteristics in power quality predicted assessment. It summarizes the best practice in non-linear, unbalanced, impact and fluctuating loads or generations modelling for power quality disturbance anticipation in public power systems at the planning stage.

This document focuses on frequency-domain modelling for AC power quality analysis in electric power networks, typically in the range up to the 50th harmonic (2,5 kHz in 50 Hz systems or 3 kHz in 60 Hz systems). Unbalance is analyzed in three-phase systems and only negative sequence component is considered. The approach and modelling guidelines provided are valid on the representation of user installations connected to power systems acting as sources of disturbance. Modelling of the network elements is out of the scope of the document.

These guidelines will be valuable in the definition of power quality performance specifications for user equipment. They will also assist users when modelling their installation to assess or demonstrate compliance with the emission limits provided by the system owner/operator and to investigate and specify mitigation measures.

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 TR 61000-3-6, *Electromagnetic compatibility (EMC) – Part 3-6: Limits – Assessment of emission limits for the connection of distorting installations to MV, HV and EHV power systems*

IEC TR 61000-3-7, *Electromagnetic compatibility (EMC) – Part 3-7: Limits – Assessment of emission limits for the connection of fluctuating installations to MV, HV and EHV power systems*

IEC TR 61000-3-13, *Electromagnetic compatibility (EMC) – Part 3-13: Limits – Assessment of emission limits for the connection of unbalanced installations to MV, HV and EHV power systems*

IEC 61000-4-30, *Electromagnetic compatibility (EMC) – Part 4-30: Testing and measurement techniques – Power quality measurement methods*

3 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

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

3.1
power quality
characteristics of the electric current, voltage and frequency at a given point in an electric power system, evaluated against a set of reference technical parameters

[SOURCE: IEC 60050-614:2016, 614-01-01 − The note to entry has been deleted.]

3.2
point of common coupling
PCC
point in an electric power system, electrically nearest to a particular load, at which other loads are, or may be, connected

Note 1 to entry: These loads can be either devices, equipment or systems, or distinct network users' installations.

[SOURCE: IEC 60050-614:2016, 614-01-12]

3.3
point of connection
POC
reference point on the electric power system where the user’s electrical facility is connected

[SOURCE: IEC 60050-617: 2009, 617-04-01]

3.4
system impedance
impedance of the electric power system as viewed from a designated point (e.g. point of common coupling or point of supply)

[SOURCE: IEC 60050-614:2016, 614-01-13]

3.5
short-circuit power
product of the current in the short circuit at a point of a system and a conventional voltage, generally the operating voltage

[SOURCE: IEC 60050-601:1985, 601-01-14]

3.6
RMS value
root-mean-square value
effective value
for a time-dependent quantity, positive square root of the mean value of the square of the quantity taken over a given time interval

[SOURCE: IEC 60050-103:2017, 103-02-03, modified – The notes to entry have been deleted.]

3.7
voltage deviation
difference between the supply voltage at a given instant and the declared supply voltage

[SOURCE: IEC 60050-614:2016, 614-01-04]

3.8
voltage fluctuation
series of voltage changes or a continuous variation of the RMS or peak value of the voltage

Note 1 to entry: Whether the RMS or peak value is chosen depends upon the application, and which is used should be specified.

[SOURCE: IEC 60050-161:1990, 161-08-05]

3.9
flicker
impression of unsteadiness of visual sensation induced by a light stimulus whose luminance or spectral distribution fluctuates with time

[SOURCE: IEC 60050-614:2016, 614-01-28]

3.10
voltage unbalance
condition in a polyphase system in which the RMS values of the phase element voltages (fundamental component), or the phase angles between consecutive phase element voltages, are not all equal

[SOURCE: IEC 60050-614:2016, 614-01-32]

3.11
unbalance factor
in a three-phase system, degree of unbalance expressed by the ratio (in per cent) of the RMS values of the negative sequence component (or the zero sequence component) to the positive sequence component of the fundamental component of the voltage or the electric current

[SOURCE: IEC 60050-614:2016, 614-01-33]

3.12
harmonic order
harmonic number
the integral number given by the ratio of the frequency of a harmonic to the fundamental frequency

[SOURCE: IEC 60050-161:1990, 161-02-19]

3.13
harmonic content
the quantity obtained by subtracting the fundamental component from an alternating quantity

[SOURCE: IEC 60050-161:1990, 161-02-21]

3.14
nth harmonic ratio
ratio of the RMS value of the nth harmonic to that of the fundamental component

[SOURCE: IEC 60050-161:1990, 161-02-20]

3.15
total harmonic ratio
THD
total harmonic distortion
ratio of the RMS value of the harmonic content to the RMS value of the fundamental component or the reference fundamental component of an alternating quantity

Note 1 to entry: The total harmonic ratio depends on the choice of the fundamental component. If it is not clear from the context which one is used an indication should be given.

Note 2 to entry: The total harmonic ratio can be restricted to a certain harmonic order. This is to be stated.

[SOURCE: IEC 60050-551:2001, 551-20-13, modified – In the term, "factor" has been changed to "ratio", an equivalent term and an admitted term have been added; in the definition, "of an alternating quantity" has been replaced by "value of the fundamental component or the reference fundamental component of an alternating quantity" and note 2 to entry has been added.]

3.16
interharmonic frequency
frequency which is a non-integer multiple of the reference fundamental frequency

[SOURCE: IEC 60050-551:2001, 551-20-06]

3.17
voltage dip
sudden voltage reduction at a point in an electric power system, followed by voltage recovery after a short time interval, from a few periods of the sinusoidal wave of the voltage to a few seconds

[SOURCE: IEC 60050-614:2016, 614-01-08]

4 Model category and modelling methodology

4.1 Model category used for power quality assessment of distorting installations

Power quality predictive evaluation procedure follows three stages (IEC TR 61000-3-6, IEC TR 61000-3-7, IEC TR 61000-3-13). User characteristics modelling differs with three stages of power quality assessment. For stage 1, no power quality evaluation or modelling is necessary. For stage 2, the simplified calculation method is used to evaluate the impact of equipment. For stage 3, assessment is generally carried out by power system simulation software. Three types of modelling methods are involved in stage 3, including:

– frequency-domain modelling, with respect to simulations for analysis of harmonics, interharmonics and unbalance.
– electromechanical time-domain modelling, with respect to electromechanical transient simulations for analysis of voltage dip/surge, fast voltage variation and flicker.
– electromagnetic time-domain modelling of equipment such as power electronic converter, with respect to electromagnetic transient (EMT) simulations for analysis of harmonics and interharmonics.

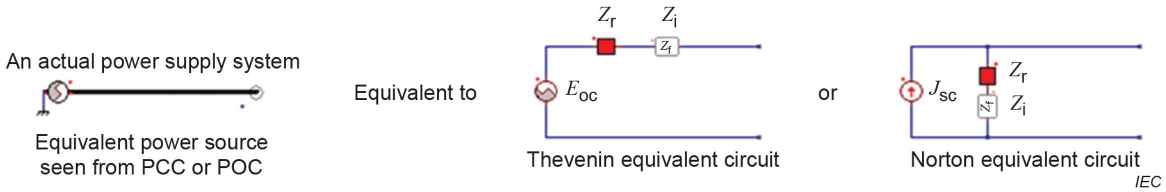
NOTE power quality simulations can be carried out based on load flow results in two ways:

– "fast RMS time domain modelling method" for analysis of voltage dip/swell, fluctuation, flicker, etc.
– "frequency domain modelling method" for analysis of harmonics, interharmonics and disturbances > 2 kHz, where all harmonic components are synchronized to fundamental voltages.

4.2 Model structure

4.2.1 Power supply model

To analyze voltage deviation, voltage fluctuation, flicker, and voltage dip, an equivalent power source model is recommended, as in Figure 1. The parameters in the equivalent Thevenin or Norton source circuit is recommended in Table 1. This model can be used to represent background voltage disturbances at point of common coupling (PCC) or point of connection (POC).



Key

E_{oc} equivalent open-circuit voltage source (case Thevenin)

J_{sc} equivalent short-circuit current source (case Norton)

Z_r, Z_i source impedance in complex values

Figure 1 – Equivalent power source model

Table 1 – Example of representation/Template of the equivalent power source

Case Thevenin equivalent circuit:			
Phase	**Open circuit voltage E_{oc}** V	**Short-circuit impedance real part Z_r** Ω	**Short-circuit impedance image part Z_i** Ω
A			
B			
C			
Case Norton equivalent circuit:			
Phase	**Short-circuit current J_{sc}** A	**Source impedance real part Z_r** Ω	**Source impedance image part Z_i** Ω
A			
B			
C			