IEC TS 62600-30

Edition 1.0 2018-08

TECHNICAL SPECIFICATION

colour inside

Marine energy – Wave, tidal and other water current converters – Part 30: Electrical power quality requirements

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MARINE ENERGY – WAVE, TIDAL AND OTHER WATER CURRENT CONVERTERS –

Part 30: Electrical power quality requirements

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Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC TS 62600-30, which is a technical specification, has been prepared by IEC technical committee 114: Marine energy – Wave, tidal and other water current converters.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
114/238/DTS	114/253A/RVDTS

Full information on the voting for the approval of this technical specification 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.

A list of all parts of the IEC 62600 series, under the general title *Marine energy – Wave, tidal and other water current converters*, can be found on the IEC website.

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

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

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INTRODUCTION

Marine energy conversion systems, as viable electric power sources for utility and community-based applications, require close attention to the quality of the power produced. Poor power quality has negative impacts on both the electrical power source and the load. Therefore, guidance is needed for the manufacturer, developer and user on how to mitigate power quality issues during the design of the device. Electrical system planners also need to identify the requirements for grid integration of such variable and intermittent energy sources, while maintaining high reliability and power quality standards.

Conceptually, except for wave energy convertors, many marine energy converter unit devices operate in a manner similar to wind turbines. As power quality is a mature topic within other renewable and conventional power generation schemes, there are numerous standards, codes, and guidelines in existence. In contrast, there are no standards or technical specifications for marine power generation systems that deal with the power quality issues and the associated integration needs. Therefore, this knowledge-gap needs to be addressed through incremental, detailed and collaborative standards development.

This technical specification aims at:

- identifying power quality issues and parameters (non-device specific and non-prescriptive) for single/three-phase, grid-connected/off-grid (including micro-mini grid) marine wave, tidal and other water current converter-based power systems;
- establishing the measurement methods, application techniques and result-interpretation guidelines.

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In addition to containing the associated definitions, normative references, symbols and units, forms, annexes, as well as other supporting material, the core of this technical specification would contain the following key items:

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- identify characteristic parameters, define and specify the quantities required to characterize the power quality impacts of marine energy conversion devices,
- develop measurement procedures as pertains to marine energy devices,
- outline standardized procedures for measuring the characteristic parameters, including test and measurement conditions, and test equipment requirements.

It is expected that this technical specification will provide evaluation guidelines for device developers and applied researchers.

Assessment of power quality for utilities will be part of a separate, future technical specification that is currently being developed under IEC TC 8 SC 8A.

MARINE ENERGY –
WAVE, TIDAL AND OTHER WATER CURRENT CONVERTERS –

Part 30: Electrical power quality requirements

1 Scope

This part of IEC 62600 includes:

- definition and specification of the quantities to be determined for characterizing the power quality of a marine energy (wave, tidal and other water current) converter unit;
- measurement procedures for quantifying the characteristics of a marine energy (wave, tidal and other water current) converter.

The measurement procedures are valid for a single marine energy converter (MEC) unit (or farm) with three-phase grid or an off-grid connection. The measurement procedures are valid for any size of MEC unit, though this document only requires MEC unit types intended for PCC (Point of Common Coupling) at Medium Voltage (MV) or High Voltage (HV) to be tested and characterized. In addition, a simplified measurement and reporting procedure is outlined for MEC units connected at Low Voltage (LV) networks. MV–connected and LV-connected devices are defined as:

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- MV connected units – typically multiple three-phase MEC units operating as a marine power farm and delivering power through a HV or MV network;
- LV connected units – typically single-phase or three-phase units deployed in isolated, hybrid or micro-grid type systems supplying small-scale loads.

Considering the nascent status of the marine energy sector, the following limitations of this document are to be recognized:

- voltage fluctuations under switching operation – the current revision only considers voltage fluctuations under continuous operation;
- resource classifications – to categorize the measured flicker quantities, various resource classes are suggested only as guidelines. The user is advised to use these resource classes judiciously.

The measurement procedures are designed to be as non-site-specific as possible so that power quality characteristics measured at a test site, for example, can be considered valid at other sites also providing the same MEC unit configuration and operation modes (for example control parameters). If the configuration or operation mode is changed in any way that might cause the MEC unit to behave differently with respect to power quality, the power quality measurement procedures must be repeated.

This document is for testing of wave, tidal and other water current energy converter units, though it contains information that may also be useful for testing of MEC farms. The cases described are not intended for Ocean Thermal Energy Conversion (OTEC) systems.

NOTE This document uses the following terms for system voltage:

– low voltage (LV) refers to U_n <= 1 kV;

– medium voltage (MV) refers to 1 kV < U_n <= 35 kV;

– high voltage (HV) refers to U_n > 35 kV.

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 61000-3-6:2008, *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 61000-3-7:2008, *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 61000-4-7:2002, *Electromagnetic compatibility (EMC) – Part 4-7: Testing and measurement techniques – General guide on harmonics and interharmonics measurements and instrumentation, for power supply systems and equipment connected thereto*
IEC 61000-4-7:2002/AMD1:2008

IEC 61000-4-15:2010, *Electromagnetic compatibility (EMC) – Part 4-15: Testing and measurement techniques – Flickermeter – Functional and design specifications*

IEC 61400-21, *Wind turbines – Part 21: Measurement and assessment of power quality characteristics of grid connected wind turbines*

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IEC 61800-3:2017, *Adjustable speed electrical power drive systems – Part 3: EMC requirements and specific test methods*

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IEC 61869-1:2007, *Instrument transformers – Part 1: General requirements*

IEC 61869-2:2012, *Instrument transformers – Part 2: Additional requirements for current transformers*

IEC 61869-3:2011, *Instrument transformers – Part 3: Additional requirements for inductive voltage transformers*

IEC 62008:2005, *Performance characteristics and calibration methods for digital data acquisition systems and relevant software*

IEC TS 62600-100:2012, *Marine energy – Wave, tidal and other water current converters – Part 100: Electricity producing wave energy converters – Power performance assessment*

IEC TS 62600-101:2015, *Marine energy – Wave, tidal and other water current converters – Part 101: Wave energy resource assessment and characterization*

IEC TS 62600-201:2015, *Marine energy – Wave, tidal and other water current converters – Part 201: Tidal energy resource assessment and characterization*

3 Terms and definitions

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

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

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

3.1
flicker
impression of unsteadiness of visual sensation induced by a light stimulus whose luminance or spectral distribution fluctuates with time

Note 1 to entry: Flicker is caused by rapid, regular changes to the voltage level of the electrical supply caused by devices connected to the electrical system. The voltage variations are caused by fluctuating power consumed or generated by a load or particularly renewable generator, more severely for reactive power fluctuations.

[SOURCE: IEC 60050-161:1990,161-08-13, modified – The note to entry has been added]

3.2
network impedance phase angle
phase angle of network short-circuit impedance:

$$\psi_k = \arctan(X_k / R_k)$$

where

X_k is the network short-circuit reactance;

R_k is the network short-circuit resistance.

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3.3
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

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

[SOURCE: IEC 60050-161:1990,161-07-15, modified – " Power supply network" has been replaced by "electric power system"; in note 1 to entry, "customer" has been replaced by "user" and note 2 to entry has been deleted]

3.4
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

[SOURCE: IEC 60050-551:1998,551-20-13, modified – Notes to entry have been deleted]

4 Symbols and units

α_o is the electrical angle at t = 0

β exponent with a numerical value to be selected to determine $I_{h\Sigma}$

$\alpha_m(t)$ electrical angle of the fundamental component of the measured voltage (°)

ψ_k network impedance phase angle (°)

Δd_{dyn} fractional change in voltage

$c(\psi_k)$ flicker coefficient for continuous operation

$c_i(\psi_k)$ flicker coefficient of an individual marine energy converter

$c(\psi_k)(t)$	time-series data of flicker coefficient (synthesized)
d	relative voltage change (%)
E_{plti}	long-term flicker emission limits for the PCC under consideration
E_{psti}	short-term flicker emission limits for the PCC under consideration
f_g	supply/grid frequency (Hz)
$f(t)$	time-varying frequency
$f(V_{MEC})$	device flicker characteristics (graphical, tabular/look-up or best-fit formula)
H_{m0}	significant wave height (m)
I_h	subgrouped RMS current harmonic of harmonic order h
$I_{h\Sigma}$	h^{th} order harmonic current distortion at the PCC
$I_{h,i}$	h^{th} order harmonic current distortion of the i^{th} converter
$i_m(t)$	measured instantaneous current (A)
I_r	rated phase current (A)
L_{fic}	inductance of fictitious grid (H)
n_i	ratio of the transformer at the i^{th} converter
N_{mec}	number of marine energy converters connected to the PCC
P_{600}	600 s average value of maximum measured active power of the marine energy converter
P_{60}	60 s average value of maximum measured active power of the marine energy converter
$P_{0,2}$	0,2 s average value of maximum measured active power of the marine energy converter
P_{lt}	long-term flicker disturbance factor
$P_{lt\Sigma}$	long-term flicker emission from the sum of marine energy converters
P_r	rated active power of marine energy converter (W)
P_{st}	short-term flicker disturbance factor
$P_{st,fic}$	flicker emission from the marine energy converter unit on the fictitious grid
$P_{st,i}$	flicker disturbance factor of an individual marine energy converter
$P_{st}(t)$	time-series data of flicker disturbance factor (synthesized)
$P_{st\Sigma}$	short-term flicker emission from the sum of marine energy converters
Q	reactive power
Q_{max}	maximum reactive power
Q_{min}	minimum reactive power
R_{fic}	resistance of fictitious grid (Ω)
R_k	network short-circuit resistance (Ω)
S_k	short-circuit apparent power of the grid under specified conditions (VA)
$S_{k,fic}$	short-circuit apparent power of the fictitious grid (VA)

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