

**TR IEC/TS 62600-100:2023**  
**IEC/TS 62600-100:2012, IDT**  
(ICS 27.140)

**TECHNICAL REFERENCE**

**Marine energy – Wave, tidal and other water  
current converters**

– Part 100: Electricity producing wave energy converters –  
Power performance assessment

**TR IEC/TS 62600-100:2023**  
IEC/TS 62600-100:2012, IDT  
(ICS 27.140)

---

TECHNICAL REFERENCE

**Marine energy – Wave, tidal and other water current  
converters**

– Part 100: Electricity producing wave energy converters – Power  
performance assessment

---

Published by Enterprise Singapore

**Enterprise  
Singapore**



**THIS PUBLICATION IS COPYRIGHT  
PROTECTED**

**Copyright © 2023 Enterprise Singapore  
Copyright © 2012 IEC, Geneva, Switzerland**

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilised in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from Enterprise Singapore, representing the IEC National Committee of Singapore, or the IEC. If you have any questions about the copyrights of Enterprise Singapore or the IEC or have an enquiry about obtaining additional rights to this publication, please contact Enterprise Singapore at: [standards@enterprisesg.gov.sg](mailto:standards@enterprisesg.gov.sg) for further information.

ISBN 978-981-5118-57-5

## National Foreword

This Technical Reference (TR) was prepared by the Working Group on Marine Energy set up by the Technical Committee on Power System and Utilisation under the purview of the Electrical and Electronics Standards Committee.

This TR is an identical adoption of IEC/TS 62600-100:2012, “Marine energy – Wave, tidal and other water current converters – Part 100: Electricity producing wave energy converters – Power performance assessment”, including the corrigendum to this edition, published by the International Electrotechnical Commission.

An informative Annex ZA has been included to:

- let users know the nominal frequency of the grid A.C. power supply in Singapore is at 50 Hz;
- directs users to information on other grid connection parameters;
- alert users on the references used in Singapore (users are advised to refer to prevailing references).

It is presupposed that in the course of their work, users will comply with all relevant regulatory and statutory requirements. An example is listed in the Bibliography. The Singapore Standards Council and Enterprise Singapore shall not be responsible for identifying all of such legal obligations.

This TR is a provisional standard made available for application over a period of three years. The aim is to use the experience gained to update the TR so that it can be adopted as a Singapore Standard. Users of the TR are invited to provide feedback on its technical content, clarity and ease of use. Feedback can be submitted using the form provided in the TR. At the end of the three years, the TR will be reviewed, taking into account any feedback or other considerations, to further its development into a Singapore Standard if found suitable.

Attention is drawn to the possibility that some of the elements of this TR may be the subject of patent rights. Enterprise Singapore shall not be held responsible for identifying any or all of such patent rights.

### NOTE

1. *Singapore Standards (SSs) and Technical References (TRs) are reviewed periodically to keep abreast of technical changes, technological developments and industry practices. The changes are documented through the issue of either amendments or revisions. Where SSs are deemed to be stable, i.e. no foreseeable changes in them, they will be classified as “mature standards”. Mature standards will not be subject to further review, unless there are requests to review such standards.*
2. *An SS or TR is voluntary in nature except when it is made mandatory by a regulatory authority. It can also be cited in contracts making its application a business necessity. Users are advised to assess and determine whether the SS or TR is suitable for their intended use or purpose. If required, they should refer to the relevant professionals or experts for advice on the use of the document. Enterprise Singapore and the Singapore Standards Council shall not be liable for any damages whether directly or indirectly suffered by anyone or any organisation as a result of the use of any SS or TR. Although care has been taken to draft this standard, users are also advised to ensure that they apply the information after due diligence.*
3. *Compliance with a SS or TR does not exempt users from any legal obligations.*



# TECHNICAL SPECIFICATION



---

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





**THIS PUBLICATION IS COPYRIGHT PROTECTED**  
**Copyright © 2012 IEC, Geneva, Switzerland**

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester.

If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Central Office  
3, rue de Varembe  
CH-1211 Geneva 20  
Switzerland

Tel.: +41 22 919 02 11  
Fax: +41 22 919 03 00  
[info@iec.ch](mailto:info@iec.ch)  
[www.iec.ch](http://www.iec.ch)

### **About the IEC**

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

### **About IEC publications**

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

#### **Useful links:**

IEC publications search - [www.iec.ch/searchpub](http://www.iec.ch/searchpub)

The advanced search enables you to find IEC publications by a variety of criteria (reference number, text, technical committee,...).

It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)

Stay up to date on all new IEC publications. Just Published details all new publications released. Available on-line and also once a month by email.

Electropedia - [www.electropedia.org](http://www.electropedia.org)

The world's leading online dictionary of electronic and electrical terms containing more than 30 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary (IEV) on-line.

Customer Service Centre - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: [csc@iec.ch](mailto:csc@iec.ch).



# TECHNICAL SPECIFICATION



---

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

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

---

ICS 27.140

ISBN 978-2-83220-330-9

**Warning! Make sure that you obtained this publication from an authorized distributor.**

## CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope.....	7
2 Normative references .....	7
3 Symbols and units .....	8
4 Sequence of work.....	10
5 Test site characterization .....	10
5.1 General.....	10
5.2 Measurements.....	10
5.2.1 Wave measurement for wave power .....	10
5.2.2 Current measurement.....	11
5.2.3 Tidal measurement.....	11
5.2.4 Bathymetric survey.....	11
5.2.5 Calculation of wave spatial transfer model.....	11
5.2.6 Modelling of the test site.....	11
6 Methodology.....	12
6.1 General.....	12
6.2 Sample duration and frequency .....	12
6.3 Simultaneity .....	13
6.4 Data recording.....	13
6.4.1 Amount of data to be recorded .....	13
6.4.2 Data format and retaining .....	13
7 Measurement and data collection for wave data .....	13
7.1 General.....	13
7.2 WMI and calibration.....	13
7.3 Instrumentation location .....	13
7.3.1 General .....	13
7.3.2 Direct measurement .....	13
7.3.3 Measures with spatial transfer model.....	14
7.3.4 Correction for WEC interference .....	14
7.4 Metocean data .....	14
7.5 Procedure for the calculation of derived parameters .....	14
8 WEC power output measurements.....	15
8.1 WEC output terminals.....	15
8.2 Power measurement point.....	15
8.3 Power measurements.....	16
8.3.1 General .....	16
8.3.2 Limitations on power production .....	16
8.4 Instruments and calibration .....	16
9 Determination of power performance .....	17
9.1 General.....	17
9.2 Structure of the normalized power matrix .....	17
9.2.1 Core structure .....	17
9.2.2 Sub-division of the normalized power matrix.....	17
9.2.3 Calculation of the capture length .....	17

9.2.4	Representation of the capture length matrix.....	18
9.3	Calculation of power matrix .....	19
10	Calculation of mean annual energy production (MAEP) .....	19
10.1	General .....	19
10.2	Standard methodology.....	19
10.3	Alternative methodology .....	20
10.4	Completeness of the capture length matrix for MAEP .....	20
Annex A (informative)	Example production of a normalized power matrix .....	21
Annex B (normative)	Method for power loss compensation where the measurement point is located on shore .....	29
Annex C (normative)	Evaluation of uncertainty .....	32
Annex D (normative)	Error analysis of the wave spatial transfer model .....	34
Annex ZA (informative)	Additional information for Clause 8 WEC power output measurements .....	35
Bibliography	.....	36
Figure 1	– Timeline of assessment.....	11
Figure 2	– Data flow diagram .....	13
Figure A.1	– Power scatter.....	22
Figure B.1	– Location options for metering equipment.....	29
Figure B.2	– Positive sequence cable model.....	30
Table 1	– Symbols and units .....	9
Table A.1	– Sample data.....	21
Table A.2	– Average capture length .....	23
Table A.3	– Standard deviation of capture length .....	24
Table A.4	– Maximum capture length .....	25
Table A.5	– Minimum capture length .....	26
Table A.6	– Number of data samples .....	27
Table A.7	– Power matrix.....	28
Table C.1	– List of uncertainty components .....	32



# INTERNATIONAL ELECTROTECHNICAL COMMISSION

---

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

### Part 100: Electricity producing wave energy converters – Power performance assessment

#### FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

The main task of IEC technical committees is to prepare International Standards. In exceptional circumstances, a technical committee may propose the publication of a Technical Specification when

- the required support cannot be obtained for the publication of an International Standard, despite repeated efforts, or
- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

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

IEC 62600-100, 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
114/87/DTS	114/95/RVC

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

A list of all parts in the IEC 62600 series, published 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 web site 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.

The contents of the corrigendum of April 2017 have been included in this copy.

**IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.**

## INTRODUCTION

This part of IEC 62600, which is a Technical Specification, provides performance assessment methods for Wave Energy Conversion Systems (WECS). A Wave Energy Converter (WEC) is a device which generates electricity using the action of water waves and delivers electricity to an electrical load.

Wave energy industry development is transitioning from preliminary stages to commercial production stages. Validated data gathering and processing techniques are important to improve existing technologies. This technical specification will be subject to changes as data are collected and processed from testing of WECS.

The expected users of the specification include:

- device developers who want to validate the performance of their WEC;
- investors who want to assess the performance of a device developer's WEC;
- project developers who want to assess the performance of their project against manufacturer's claims;
- surveyors contracted to carry out the assessment.

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

### **Part 100: Electricity producing wave energy converters – Power performance assessment**

#### **1 Scope**

This part of IEC 62600, which is a Technical Specification, provides a method for assessing the electrical power production performance of a Wave Energy Converter (WEC), based on the performance at a testing site.

The scope of this Technical Specification includes:

- a) all WECs that produce electrical power from wave energy;
- b) all sea resource zones (near and offshore, deep and shallow water);
- c) the specification applies to commercial scale WECs that are:
  - 1) compliantly moored,
  - 2) tautly moored,
  - 3) bottom mounted,
  - 4) shore mounted.

The scope of this Technical Specification does not include:

- a) WECs that produce other forms of energy unless this energy is converted into electrical energy;
- b) resource assessment;
- c) scaled devices in test facilities (tank or scaled sea conditions) where any scaling would need to be carried out to extrapolate results for a full scale device;
- d) power quality issues;
- e) environmental issues;
- f) power matrix transposition from one location to another.

This Technical Specification provides a systematic method which includes:

- measurement of WEC power output in a range of sea states;
- WEC power matrix development;
- an agreed framework for reporting the results of power and wave measurements.

#### **2 Normative references**

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60044-1, *Instrument transformers – Part 1: Current transformers*

IEC 60688, *Electrical measuring transducers for converting a.c. electrical quantities to analogue or digital signals*

IEC 61000-3 (all parts), *Electromagnetic compatibility (EMC) – Part 3: Limits*

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

ISO/IEC Guide 98-1:2009, *Uncertainty of measurement – Part 1: Introduction to the expression of uncertainty in measurement*

ISO/IEC Guide 98-3:2008, *Uncertainty of measurement – Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

ISO 8601, *Data elements and interchange formats – Information interchange – Representation of dates and times*

*EquiMar: Protocols for the equitable assessment of marine energy converters, Part II, Chapters I.A.1 through I.A.5., Editors: David Ingram, George Smith, Claudio Bittencourt Ferreira, Helen Smith. European Commission 7th framework programme grant agreement number 213380, First Edition 2011*

NDBC:2009, Technical Document 09-02, *Handbook of automated data quality control checks and procedures*. National Data Buoy Center, August 2009