



SLOVENSKI STANDARD
SIST EN IEC 61400-12-6:2022

01-december-2022

Sistemi za proizvodnjo energije na veter - 12-6. del: Prenosna funkcija na osnovi meritev za vetrne turbine, ki proizvajajo električno energijo (IEC 61400-12-6:2022)

Wind energy generation systems - Part 12-6: Measurement based nacelle transfer function of electricity producing wind turbines (IEC 61400-12-6:2022)

Windenergieanlagen - Teil 12-6: Messbasierte Gondelübertragungsfunktion von stromerzeugenden Windkraftanlagen (IEC 61400-12-6:2022)

Systèmes de génération d'énergie éolienne - Partie 12-6: Fonction de transfert de la nacelle fondée sur le mesurage des éoliennes de production d'électricité (IEC 61400-12-6:2022)

Ta slovenski standard je istoveten z: EN IEC 61400-12-6:2022

ICS:

27.180 Vetrne elektrarne Wind turbine energy systems

SIST EN IEC 61400-12-6:2022 en

EUROPEAN STANDARD

EN IEC 61400-12-6

NORME EUROPÉENNE

EUROPÄISCHE NORM

October 2022

ICS 27.180

English Version

Wind energy generation systems - Part 12-6: Measurement
based nacelle transfer function of electricity producing wind
turbines
(IEC 61400-12-6:2022)

Systèmes de génération d'énergie éolienne - Partie 12-6:
Fonction de transfert de la nacelle fondée sur le mesurage
des éoliennes de production d'électricité
(IEC 61400-12-6:2022)

Windenergieanlagen - Teil 12-6: Messbasierte
Gondelübertragungsfunktion von stromerzeugenden
Windkraftanlagen
(IEC 61400-12-6:2022)

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European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

EN IEC 61400-12-6:2022 (E)**European foreword**

The text of document 88/826/CDV, future edition 1 of IEC 61400-12-6, prepared by IEC/TC 88 "Wind energy generation systems" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 61400-12-6:2022.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2023-07-04
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2025-10-04

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Any feedback and questions on this document should be directed to the users' national committee. A complete listing of these bodies can be found on the CENELEC website.

Endorsement notice

The text of the International Standard IEC 61400-12-6:2022 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following note has to be added for the standard indicated:

IEC 61400-2 NOTE Harmonized as EN 61400-2

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60688	-	Electrical measuring transducers for converting AC and DC electrical quantities to analogue or digital signals	EN 60688	-
IEC 61400-12-1	-	Wind energy generation systems - Part 12-1: Power performance measurement of electricity producing wind turbines	EN 61400-12-1	-
IEC 61400-12-2	2022	Wind energy generation systems - Part 12-2: Power performance of electricity producing wind turbines based on nacelle anemometry	EN IEC 61400-12-2	2022
IEC 61400-12-3	-	Wind energy generation systems - Part 12-3: Power performance - Measurement based site calibration	EN IEC 61400-12-3	-
IEC 61400-12-5	2022	Wind energy generation systems - Part 12-5: Power performance - Assessment of obstacles and terrain	EN IEC 61400-12-5	2022
IEC 61400-50-1	-	Wind energy generation systems - Part 50-1: Wind Measurement - Application of Meteorological Mast, Nacelle and Spinner Mounted Instruments	EN IEC 61400-50-1 ¹	-
ISO/IEC Guide 98-3 2008		Uncertainty of measurement - Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)	-	-

¹ Under preparation. Stage at the time of publication: FprEN IEC 61400-50-1:2022.



IEC 61400-12-6

Edition 1.0 2022-08

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Wind energy generation systems –
Part 12-6: Measurement based nacelle transfer function of electricity producing
wind turbines**

**Systèmes de génération d'énergie éolienne –
Partie 12-6: Fonction de transfert de la nacelle fondée sur le mesurage des
éoliennes de production d'électricité**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

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INTERNATIONALE

ICS 27.180

ISBN 978-2-8322-5604-6

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CONTENTS

FOREWORD.....	5
INTRODUCTION.....	7
1 Scope.....	8
2 Normative references.....	8
3 Terms and definitions.....	9
4 Symbols, units and abbreviated terms.....	11
5 Overview of test method.....	15
6 Preparation for measurement of nacelle transfer function.....	15
6.1 General.....	15
6.2 Wind turbine.....	15
6.3 Test site.....	16
6.3.1 General.....	16
6.3.2 Terrain classification.....	17
6.4 Test plan.....	17
7 Test equipment.....	17
7.1 General.....	17
7.2 Data acquisition.....	18
8 Measurement procedure.....	19
8.1 General.....	19
8.2 Data system(s) synchronisation.....	19
8.3 Data collection.....	20
8.4 Data quality check.....	20
8.4.1 General.....	20
8.4.2 Measured signals are in range and available.....	20
8.4.3 Sensors are operating properly.....	20
8.4.4 Ensure data acquisition system(s) is(are) operating properly.....	21
8.4.5 Sector self-consistency check.....	21
8.5 Data rejection.....	21
8.6 Data correction.....	21
8.7 Database.....	22
9 Derived results.....	22
9.1 Overview of derived results.....	22
9.2 Determination of measured nacelle transfer function.....	23
9.3 Data quality check.....	24
9.3.1 General.....	24
9.3.2 Directional stability check.....	24
9.3.3 Self-consistency check for NTF, using the NPC.....	25
9.4 Uncertainty analysis.....	25
10 Reporting format.....	25
Annex A (informative) Nacelle instrument mounting.....	29
A.1 General.....	29
A.2 Preferred method of anemometer's mounting.....	29
A.3 Preferred position of anemometer.....	29
Annex B (normative) Evaluation of uncertainty in measurement.....	31
B.1 General.....	31

B.2	The measurands	31
B.3	Uncertainty components	31
B.4	Wind direction uncertainty	33
Annex C (normative) Theoretical basis for determining the uncertainty of measurement using the method of bins		34
C.1	General	34
C.2	Propagation of uncertainty through the stages of NTF/NPC measurement	35
C.3	Category A uncertainties	38
C.3.1	General	38
C.3.2	Category A uncertainty in electric power	38
C.4	Category B uncertainties	39
C.4.1	General	39
C.4.2	Category B uncertainties in climatic variations	40
C.5	Expanded uncertainty	40
Annex D (normative) NTF uncertainty estimates and calculation		41
D.1	Methods and assumptions	41
D.1.1	General	41
D.1.2	Site calibration	41
D.1.3	Nacelle transfer function uncertainty component estimates	43
D.1.4	Nacelle power curve uncertainty component estimates	45
D.1.5	Wind direction uncertainty	45
D.1.6	Contribution factors	47
D.2	Uncertainty example calculations	48
D.2.1	Example description	48
D.2.2	Example case – NTF uncertainty	49
D.2.3	Example case – NPC uncertainty	49
Annex E (normative) Allowable anemometry instrument types		51
E.1	General	51
E.2	Recalibration of sonic anemometers	51
E.3	Uncertainty of sonic and propeller anemometers	51
Annex F (informative) Organisation of test, safety and communication		52
F.1	General	52
F.2	Responsibility for test	52
F.3	Safety during test	52
F.4	Communication	52
F.5	Prior to test	52
F.6	During test	52
F.7	After test	53
Annex G (informative) NTF flowchart		54
Bibliography		55
Figure 1 – Presentation of example data: measured transfer function		27
Figure A.1 – Mounting of anemometer on top of nacelle		30
Figure G.1 – NTF flowchart		54
Table 1 – Example of presentation of a measured power curve based on data from the meteorological mast, for consistency check		28
Table B.1 – Uncertainty components in nacelle transfer function evaluation		32

Table B.2 – Uncertainty components in nacelle based absolute wind direction	33
Table C.1 – Example cancellation sources	36
Table C.2 – List of category A and B uncertainties for NTF	39
Table C.3 – Expanded uncertainties	40
Table D.1 – Estimates for uncertainty components from site calibration	42
Table D.2 – Estimates for uncertainty components from NTF measurement	44
Table D.3 – Estimates for uncertainty components for wind direction	46
Table D.4 – Estimates for contribution factors for site calibration	47
Table D.5 – Estimates for contribution factors for NTF	48

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

WIND ENERGY GENERATION SYSTEMS –**Part 12-6: Measurement based nacelle transfer
function of electricity producing wind turbines**

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.
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- 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.

IEC 61400-12-6 has been prepared by IEC technical committee 88: Wind energy generation systems. It is an International Standard.

This first edition of IEC 61400-12-6 is part of a structural revision that cancels and replaces the performance standards IEC 61400-12-1:2017 and IEC 61400-12-2:2013. The structural revision contains no technical changes with respect to IEC 61400-12-1:2017 and IEC 61400-12-2:2013, but the parts that relate to wind measurements, measurement of site calibration and assessment of obstacle and terrain have been extracted into separate standards.

The purpose of the re-structure was to allow the future management and revision of the power performance standards to be carried out more efficiently in terms of time and cost and to provide a more logical division of the wind measurement requirements into a series of separate standards which could be referred to by other use case standards in the IEC 61400 series and subsequently maintained and developed by appropriate experts.

The text of this International Standard is based on the following documents:

Draft	Report on voting
88/826/CDV	88/871/RVC

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 International Standard 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 www.iec.ch/standardsdev/publications.

A list of all parts in the IEC 61400 series, published under the general title *Wind energy generation systems*, 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,
- replaced by a revised edition, or
- amended.

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INTRODUCTION

The IEC 61400-12 series consists of the following parts, under the general title Wind energy generation systems:

IEC 61400-12:	<i>Power performance measurements of electricity producing wind turbines – Overview</i>
IEC 61400-12-1:	<i>Power performance measurement of electricity producing wind turbines</i>
IEC 61400-12-2:	<i>Power performance of electricity producing wind turbines based on nacelle anemometry</i>
IEC 61400-12-3:	<i>Power performance – Measurement based site calibration</i>
IEC 61400-12-4:	<i>Numerical site calibration</i>
IEC 61400-12-5:	<i>Power performance – Assessment of obstacles and terrain</i>
IEC 61400-12-6:	<i>Measurement based nacelle transfer function of electricity producing wind turbines</i>

The purpose of this document is to provide a uniform methodology of measurement, analysis, and reporting for the determination of a nacelle transfer function of electricity producing wind turbines utilising nacelle-anemometry methods. This document is intended to be applied only to horizontal axis wind turbines of sufficient size that the nacelle-mounted anemometer does not significantly affect the flow through the turbine's rotor and around the nacelle and hence does not affect the wind turbine's performance. The intent of this document is that the methods presented herein be utilised when applying the methodology described in IEC 61400-12-2 to determine the power performance of individual wind turbines. This will ensure that the results are as consistent, accurate, and reproducible as possible within the current state of the art for instrumentation and measurement techniques.

This procedure describes how to characterise a wind turbine's nacelle transfer function in terms of wind speeds measured on a meteorological mast as well as a wind speed measured on the hub or nacelle of a wind turbine. The anemometer that is placed on the turbine is measuring a wind speed that is strongly affected by the test turbine's rotor. This procedure includes methods for determining and applying appropriate corrections for this interference. Such a correction is termed a nacelle transfer function which relates the wind speed measured on the turbine to a free-stream wind speed as measured on a meteorological mast. The procedure also provides guidance on determination of measurement uncertainty including assessment of uncertainty sources and recommendations for combining them into uncertainties.

Even when anemometers are carefully calibrated in a quality wind tunnel, fluctuations in magnitude and direction of the wind vector can cause different anemometers to perform differently in the field. Further, the flow conditions close to a turbine nacelle are complex and variable. Therefore, special care should be taken in the selection and installation of the anemometer. These issues are addressed in this document.

This document will benefit those parties interested in power performance testing of wind turbines using IEC 61400-12-2 as well as parties involved in the installation, planning and execution of such tests. When and where appropriate, the technically accurate measurement and analysis techniques recommended in this document should be applied by all parties to ensure that continuing development and operation of wind turbines is carried out in an atmosphere of consistent and accurate communication relative to environmental concerns. This document presents measurement and reporting procedures expected to provide accurate results that can be replicated by others.

Meanwhile, a user of this document should be aware of differences that arise from large variations in wind shear and turbulence intensity, and from the chosen criteria for data selection. Therefore, a user should consider the influence of these differences and the data selection criteria in relation to the purpose of the test before engaging in nacelle transfer function measurements.

WIND ENERGY GENERATION SYSTEMS –

Part 12-6: Measurement based nacelle transfer function of electricity producing wind turbines

1 Scope

This part of IEC 61400-12 specifies a procedure for measuring the nacelle transfer function of a single electricity-producing, horizontal axis wind turbine, which is not considered to be a small wind turbine in accordance with IEC 61400-2. It is expected that this document be used when a valid nacelle transfer function is needed to execute a power performance measurement according to IEC 61400-12-2.

A wind speed measured on the nacelle or hub of a wind turbine is affected by the turbine rotor (i.e. speeded up or slowed down wind speed). In IEC 61400-12-1, an anemometer is located on a meteorological tower that is located between two and four rotor diameters upwind of the test turbine. This location allows direct measurement of the "free" wind with minimum interference from the test turbine's rotor. In the procedure of this document, the anemometer is located on or near the test turbine's nacelle. In this location, the anemometer is measuring a wind speed that is strongly affected by the test turbine's rotor and the nacelle. The procedure in this document includes methods for determining and applying appropriate corrections for this interference. However, note that these corrections inherently increase the measurement uncertainty compared to a properly configured test conducted in accordance with IEC 61400-12-1.

This document specifies how to characterise a wind turbine's nacelle transfer function. The nacelle transfer function is determined by collecting simultaneous measurements of nacelle-measured wind speed and free stream wind speed (as measured on a meteorological mast) for a period that is long enough to establish a statistically significant database over a range of wind speeds and under varying wind and atmospheric conditions. The procedure also provides guidance on determination of measurement uncertainty including assessment of uncertainty sources and recommendations for combining them.

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 60688, *Electrical measuring transducers for converting AC and DC electrical quantities to analogue or digital signals*

IEC 61400-12-1, *Wind energy generation systems – Part 12-1: Power performance measurement of electricity producing wind turbines*

IEC 61400-12-2:2022, *Wind energy generation systems – Part 12-2: Power performance of electricity producing wind turbines based on nacelle anemometry*

IEC 61400-12-3, *Wind energy generation systems – Part 12-3: Power performance – Measurement based site calibration*

IEC 61400-12-5:2022, *Wind energy generation systems – Part 12-5: Power performance – Assessment of obstacles and terrain*

IEC 61400-50-1, *Wind energy generation systems – Part 50-1: Wind measurement – Application of meteorological mast, nacelle and spinner mounted instruments*

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

3 Terms and definitions

For the 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

accuracy

closeness of the agreement between the result of a measurement and a true value of the measurand

3.2

complex terrain

terrain surrounding the test site that features significant variations in topography and terrain obstacles that may cause flow distortion

3.3

data set

collection of data sampled over a contiguous period

3.4

documentation

any information regarding the test which is kept in files or data, or both, but which is not necessarily presented in the final report

3.5

flow distortion

change in air flow caused by obstacles, topographical variations, turbine's rotor, turbine's nacelle or other wind turbines that results in a significant deviation of the measured wind speed from the free stream wind speed

3.6

free stream wind speed

horizontal wind speed measured upstream of the rotor of the wind turbine generator that is unaffected by rotor aerodynamics

3.7

turbulence intensity

ratio of the wind speed standard deviation to the mean wind speed, determined from the same set of measured data samples of horizontal wind speed, and taken over a specific period of time

3.8

hub height

<wind turbine> height of the centre of the swept area of the wind turbine rotor above the ground level at the tower base