



TECHNICAL REPORT



**Wind energy generation systems –
Part 21-3: Measurement and assessment of electrical characteristics – Wind
turbine harmonic model and its application**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

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CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope.....	7
2 Normative references	8
3 Terms, definitions and abbreviations	8
3.1 Terms and definitions.....	8
3.2 Abbreviations.....	12
4 General description	13
4.1 Overview.....	13
4.2 Background.....	14
5 Recommendations of minimal requirements.....	17
5.1 General.....	17
5.2 Application	18
5.3 Input parameters.....	18
5.4 Harmonic model terminal	18
5.5 Output variables.....	19
5.6 Structure.....	19
6 Interfaces to other IEC documents.....	20
6.1 IEC 61400-21-1:2019, Annex D – Harmonic evaluation	20
6.2 IEC 61400-21-1:2019, Annex E – Assessment of power quality of wind turbines and wind power plants	21
7 Harmonic model	21
7.1 General.....	21
7.2 Thévenin/Norton equivalent circuit	22
7.3 Equivalent harmonic voltage/current sources	22
7.3.1 General	22
7.3.2 Harmonic equivalent impedance	23
7.4 Wind turbine types	24
7.4.1 General	24
7.4.2 Type 1 and Type 2.....	24
7.4.3 Type 3	25
7.4.4 Type 4	26
8 Validation	28
8.1 General.....	28
8.2 Overview.....	28
8.3 Model validation.....	29
8.4 Fictitious grid	30
9 Limitations.....	30
Bibliography.....	32

Figure 1 – Example of a phase angle between the harmonic current and the harmonic voltage component as well as the fundamental voltage..... 9

Figure 2 – Example of wind power plant typical components relevant for the harmonic studies and potential challenges in harmonic performance..... 14

Figure 3 – Example of a WPP complex structure..... 15

Figure 4 – Example of a WPP complex electrical infrastructure with many WTs 16

Figure 5 – Harmonic impedance estimated at the point of connection specified in Figure 4	17
Figure 6 – Generic harmonic model structure represented as Norton/Thévenin equivalent circuit.....	20
Figure 7 – Main electrical and mechanical components of Type 3 WTs [6]	25
Figure 8 – Example of a structure of a DFAG harmonic model (from [13])	26
Figure 9 – Main electrical and mechanical components of Type 4 WTs [6]	26
Figure 10 – Example of a converter harmonic model as Thévenin equivalent circuit together with an example of a WT power circuit (from [9])	27
Figure 11 – Harmonic voltage comparison for respective power bins	28
Table 1 – Example of a representation/template of the harmonic voltage source	23
Table 2 – Example of a representation/template of the harmonic current source	23
Table 3 – Example of a representation/template of the harmonic equivalent impedance.....	24

INTERNATIONAL ELECTROTECHNICAL COMMISSION

WIND ENERGY GENERATION SYSTEMS –

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IEC TR 61400-21-3, which is a Technical Report, has been prepared by IEC Technical Committee 88: Wind energy generation systems.

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

DTR	Report on voting
88/698/DTR	88/717/RVDTR

Full information on the voting for the approval of this Technical Report 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 in the IEC 61400 series, published under the general title *Wind energy generation systems*, can be found on the IEC website.

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the next edition.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "<http://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.

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

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INTRODUCTION

The purpose of this IEC Technical Report (TR) is to provide a methodology that will ensure understanding, consistency and accuracy in application, structure and validation of the harmonic model of grid connected wind turbines (WTs).

There is an understandable requirement from wind power industry shareholders, e.g. transmission system operators (TSOs) and distribution system operators (DSOs), wind power plant (WPP) developers, WT manufacturers, WT component suppliers, academic units, research institutions, certifying bodies and standardization groups (e.g. TC88 MT21), for having a standardized WT harmonic model.

The standardized harmonic model would find a broad application in many areas of electrical engineering related to design, analysis, and optimisation of electrical infrastructure of onshore as well as offshore WPPs. Among others, this could be the evaluation of the WT harmonic performance, system-level harmonic studies, electrical infrastructure design and proposal of harmonic mitigation measures.

Standardized WT harmonic models as a performance measure starts to be important in such multi stakeholder systems as large offshore WPPs where TSOs, WPP developers and operators as well as WT manufacturers need to have a common understanding about harmonic modelling of WTs and harmonic studies in WPPs.

WIND ENERGY GENERATION SYSTEMS –

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1 Scope

This part of IEC 61400 provides guidance on principles which can be used as the basis for determining the application, structure and recommendations for the WT harmonic model. For the purpose of this Technical Report, a harmonic model means a model that represents harmonic emissions of different WT types interacting with the connected network.

This document is focused on providing technical guidance concerning the WT harmonic model. It describes the harmonic model in detail, covering such aspects as application, structure, as well as validation. By introducing a common understanding of the WT representation from a harmonic performance perspective, this document aims to bring the overall concept of the harmonic model closer to the industry (e.g. suppliers, developers, system operators, academia, etc.).

A standardized approach of WT harmonic model representation is presented in this document. The harmonic model will find a broad application in many areas of electrical engineering related to design, analysis, and optimisation of electrical infrastructure of onshore as well as offshore WPPs.

The structure of the harmonic model presented in this document will find an application in the following potential areas:

- evaluation of the WT harmonic performance during the design of electrical infrastructure and grid-connection studies;
- harmonic studies/analysis of modern power systems incorporating a number of WTs with line side converters;
- active or passive harmonic filter design to optimize electrical infrastructure (e.g. resonance characteristic shaping) as well as meet requirements in various grid codes;
- sizing of electrical components (e.g. harmonic losses, static reactive power compensation, noise emission, harmonic compatibility levels, etc.) within WPP electrical infrastructure;
- evaluation of external network background distortion impact on WT harmonic assessment;
- standardised communication interfaces in relation to WT harmonic data exchange between different stakeholders (e.g. system operators, generators, developers, etc.);
- universal interface for harmonic studies for engineering software developers;
- possible benchmark of WT introduced to the academia and the industry.

The advantage of having standardized WT harmonic performance assessment by means of the harmonic model is getting more and more crucial in case of large systems with different types of WTs connected to them, e.g. multi-cluster wind power plants incorporating different types of WTs connected to the same offshore or onshore substation.

The WT harmonic model can cover the integer harmonic range up to the 40th, 50th, or 100th. And can be expanded, depending on requirements and application, to higher harmonic range as well as can also cover interharmonic components.

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 60050-415:1999, *International Electrotechnical Vocabulary – Part 415: Wind turbine generator systems* (available at <<http://www.electropedia.org/>>)

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 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 61400-21-1:2019, *Wind energy generation systems – Part 21-1: Measurement and assessment of electrical characteristics – Part 1 – Wind turbines*