

INTERNATIONAL STANDARD



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

<https://standards.iteh.ai>
Document Preview

[IEC 60688:2021](#)

<https://standards.iteh.ai/catalog/standards/iec/72ca1d98-d659-40d8-9deb-9d559382334f/iec-60688-2021>



THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2021 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
info@iec.ch
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 corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables 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 It also gives information on projects, replaced and withdrawn publications.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 online collection - oc.iec.ch

Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

IEC Just Published - webstore.iec.ch/justpublished

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

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 18 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Customer Service Centre - 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: sales@iec.ch.

International Standards
standards.iteh.ai)
Document Preview

[IEC 60688:2021](https://standards.iteh.ai/catalog/standards/iec/72ca1d98-d659-40d8-9deb-9d559382334f/iec-60688-2021)

<https://standards.iteh.ai/catalog/standards/iec/72ca1d98-d659-40d8-9deb-9d559382334f/iec-60688-2021>



IEC 60688

Edition 4.0 2021-09
REDLINE VERSION

INTERNATIONAL STANDARD



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

*iteh Standards
(<https://standards.iteh.ai>)
Document Preview*

[IEC 60688:2021](#)

<https://standards.iteh.ai/catalog/standards/iec/72ca1d98-d659-40d8-9deb-9d559382334f/iec-60688-2021>

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 17.220.20

ISBN 978-2-8322-1029-1

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

CONTENTS

FOREWORD.....	9
INTRODUCTION.....	11
1 Scope.....	12
2 Normative references.....	13
3 Terms and definitions	13
3.1 General terms	14
3.2 Terms describing transducers according to the measurand	17
3.3 Terms describing transducers according to their output load	18
3.4 Nominal values	18
3.5 User adjustment Terms describing transducers with provisions to be adjusted by users.....	19
3.6 Influence quantities and reference conditions.....	20
3.7 Errors and variations	20
3.8 Accuracy, accuracy class, class index	21
4 Class index, permissible limits of intrinsic error, auxiliary supply and reference conditions General.....	21
4.1 Transducer general architecture	21
4.2 Classification of transducers (TRD)	22
5 Requirements for TRD1	22
5.1 Safety requirements: clearances and creepage distances	22
5.2 EMC requirements	22
5.2.1 Immunity.....	22
5.2.2 Emission.....	23
5.3 Class index requirements	23
5.3.1 Class index.....	23
5.3.2 Class index for transducer used with sensors	23
5.3.3 Intrinsic error	23
5.4 Conditions for the determination of intrinsic error	23
5.5 Auxiliary supply.....	25
5.5.1 General	25
5.5.2 DC supply.....	25
5.5.3 AC supply	25
5.6 Input values	26
5.6.1 General	26
5.6.2 Adjustment ranges	26
5.6.3 Preferred nominal values.....	26
5.7 Analogue output signals	26
5.7.1 General	26
5.7.2 Output current.....	26
5.7.3 Compliance voltage.....	26
5.7.4 Maximum output voltage	26
5.7.5 Interference risk of output current.....	27
5.7.6 Output voltage	27
5.8 Output transfer function.....	27
5.9 Digital output signals.....	30
5.10 Ripple (for analogue outputs)	30

5.11	Response time	30
5.12	Variation due to over-range of the measurand.....	30
5.13	Limiting value of the output signal.....	30
5.14	Limiting conditions of operation	31
5.15	Limits of the measuring range.....	31
5.16	Limiting conditions for storage and transport.....	31
5.17	Sealing	31
5.18	Stability	31
6	Tests for TRD1	31
6.1	General.....	31
6.1.1	Determination of variations.....	31
6.1.2	Environmental conditions	32
6.1.3	Computations.....	32
6.2	Variations due to auxiliary supply voltage	32
6.2.1	Application.....	32
6.2.2	Procedure.....	32
6.2.3	Computation	33
	Permissible variations	33
6.3	Variations due to auxiliary supply frequency	33
6.3.1	Application.....	33
6.3.2	Procedure.....	33
6.3.3	Computation	33
6.3.4	Permissible variations	34
6.4	Variations due to ambient temperature	34
6.4.1	Application.....	34
6.4.2	Procedure.....	34
6.4.3	Computation	34
6.4.4	Permissible variations	34
6.5	Variations due to the frequency of the input quantity(ies)	35
6.5.1	Application.....	35
6.5.2	Procedure.....	35
6.5.3	Computation	35
6.5.4	Permissible variations	35
6.6	Variations due to the input voltage.....	35
6.6.1	Application.....	35
6.6.2	Procedure.....	35
6.6.3	Computation	36
6.6.4	Permissible variations	36
6.7	Variations due to the input current.....	36
6.7.1	Application.....	36
6.7.2	Procedure.....	36
6.7.3	Computation	36
6.7.4	Permissible variations	36
6.8	Variations due to power factor	37
6.8.1	Application.....	37
6.8.2	Procedure.....	37
6.8.3	Computation	37
6.8.4	Permissible variations	37
6.9	Variation due to output load.....	38

6.9.1	Application.....	38
6.9.2	Procedure.....	38
6.9.3	Computation.....	38
6.9.4	Permissible variations.....	38
6.10	Variations due to distortion of the input quantity(ies).....	38
6.10.1	Application.....	38
6.10.2	Procedure.....	38
6.10.3	Computation.....	39
6.10.4	Permissible variations.....	39
6.11	Variation due to magnetic field of external origin.....	39
6.11.1	Application.....	39
6.11.2	Procedure.....	39
6.11.3	Computation.....	39
6.11.4	Permissible variations.....	40
6.12	Variation due to unbalanced currents.....	40
6.12.1	Application.....	40
6.12.2	Procedure.....	40
6.12.3	Computation.....	40
6.12.4	Permissible variations.....	40
6.13	Variation due to interaction between measuring elements.....	40
6.13.1	Application.....	40
6.13.2	Procedure.....	41
6.13.3	Computation.....	41
6.13.4	Permissible variations.....	41
6.14	Variation due to self-heating.....	41
6.14.1	Application.....	41
6.14.2	Method.....	41
6.14.3	Computation.....	41
6.14.4	Permissible variations.....	41
6.15	Variation due to continuous operation.....	42
6.15.1	Application.....	42
6.15.2	Procedure.....	42
6.15.3	Computation.....	42
6.15.4	Permissible variation.....	42
6.16	Variation due to common mode interference.....	42
6.16.1	Application.....	42
6.16.2	Procedure.....	42
6.16.3	Computation.....	42
6.16.4	Permissible variations.....	42
6.17	Variation due to series mode interference.....	43
6.17.1	Application.....	43
6.17.2	Procedure.....	43
6.17.3	Computation.....	43
6.17.4	Permissible variations.....	43
6.18	Permissible excessive inputs.....	43
6.18.1	General.....	43
6.18.2	Continuous excessive inputs.....	43
6.18.3	Excessive inputs of short duration.....	44
6.19	Voltage test, insulation tests and other safety requirements.....	44

6.20	Impulse voltage tests	44
6.21	High frequency disturbance test	44
6.22	Test for temperature rise	44
6.23	Other tests	45
7	Marking and information for TRD1	45
7.1	Marking on the case	45
7.2	Markings relating to the reference conditions and nominal ranges of use for transducers	46
7.3	Identification of connections and terminals	46
7.4	Information to be given in a separate document	46
Annex A (normative)	Requirements for TRD2	50
A.0	General	50
A.1	Scope	50
A.2	Normative references	50
A.3	Terms and definitions	50
A.4	Environmental conditions	50
A.4.1	General	50
A.4.2	Normal environmental conditions	50
A.4.3	Special environmental conditions	50
A.5	Ratings for TRD2	50
A.5.1	General	50
A.5.2	Input ratings	51
A.5.3	Output ratings	52
A.5.4	General ratings	53
A.6	Requirements for design of TRD2	54
A.6.1	General	54
A.6.2	Safety requirements	54
A.6.3	EMC requirements	57
A.6.4	Climatic requirements	59
A.6.5	Mechanical requirements	59
A.6.6	Interface requirements	60
A.6.7	Accuracy requirements	60
A.6.8	Marking requirements	64
A.6.9	Documentation requirements	65
A.7	Tests for TRD2	66
A.7.1	Type tests	66
A.7.2	Routine tests	75
Annex B (normative)	Interface coding	77
B.1	General	77
B.2	Characteristics of interface connection	77
B.3	Coding of rated output values for transducers	77
B.4	Coding of auxiliary power supply for transducers	79
B.5	Coding of transfer function curves for transducers	80
B.6	Interface full coding for output of transducers	80
B.6.1	General	80
B.6.2	Examples of interface codes and most common interface codes	81
Annex C (informative)	Anti-aliasing requirements	83
Annex D (informative)	Requirements for the measurement of harmonics and low frequencies	85

D.1	General.....	85
D.2	Measuring accuracy classes with harmonics	85
D.3	Accuracy class extensions of transducers for high bandwidth applications	86
Annex E (normative) Markings terminals of TRD2		87
E.1	Marking of terminals for TRD2 monitoring AC current.....	87
E.2	Marking of terminals for TRD2 monitoring voltage	87
Annex F (informative) Guidance related to cables, busbars and bare conductors within an installation		89
F.1	Insulation of cables	89
F.2	Temperature of cables and busbars.....	89
F.2.1	Cables	89
F.2.2	Busbars	89
Annex G (informative) Guidance related to overvoltage categories and measurement categories		90
G.1	Concept of overvoltage category	90
G.2	Approach of IEC 60664-1 for primary circuits of TRD2	90
G.2.1	General	90
G.2.2	Examples with IEC 60664-1:2020, for primary measuring circuits, OVC III, PD 2, altitude under 2 000 m, inhomogeneous field.....	90
G.3	Approach of IEC 61010 for primary circuits of TRD2.....	91
G.3.1	General	91
G.3.2	Example with IEC 61010-2-030:2017, for primary measuring circuits, OVC III, PD 2, altitude under 2 000 m, inhomogeneous field	91
G.4	Approach for secondary circuits of TRD2	92
Bibliography		93
Figure 1 – Transducer (TRD) architecture.....		22
Figure 2 – Transfer function curve A.....		27
Figure 3 – Transfer function curve B.....		28
Figure 4 – Transfer function curve C		28
Figure 5 – Transfer function curve D		29
Figure 6 – Transfer function curve E.....		29
Figure A.1 – Relationship between ambient air temperature and relative humidity		54
Figure A.2 – Accuracy limits of a TRD2-IDC		62
Figure A.3 – Measurement of the step response time.....		70
Figure A.4 – Temperature cycle accuracy test		72
Figure C.1 – Digital data acquisition system example		83
Figure C.2 – Frequency response mask for metering accuracy class 1 ($f_r = 60$ Hz, $f_s = 4\ 800$ Hz).....		84
Table 1 – Functional classification of transducers with minimal required functions		22
Table 2 – Relationship between the limits of intrinsic error, expressed as a percentage of the fiducial value, and the class index		23
Table 3 – Pre-conditioning		24
Table 4 – Reference conditions of the influence quantities and tolerances or testing purposes		24
Table 5 – Reference conditions relative to the measurand		25

Table 6 – Usage groups	32
Table 7 – Permissible variations due to AC auxiliary supply	33
Table 8 – Permissible variations due to DC auxiliary supply	33
Table 9 – Permissible variations due to auxiliary supply frequency	34
Table 10 – Permissible variations due to ambient temperature	34
Table 11 – Permissible variations due to the frequency of input quantity	35
Table 12 – Permissible variations due to the input voltage	36
Table 13 – Permissible variations due to the input current	37
Table 14 – Permissible variations due to power factor	37
Table 15 – Permissible variations due to output load	38
Table 16 – Permissible variations due to distortion of input quantities	39
Table 17 – Permissible variations due to magnetic field of external origin	40
Table 18 – Permissible variations due to unbalance currents	40
Table 19 – Permissible variations due to interactions between measuring elements	41
Table 20 – Permissible variations due to self-heating	42
Table 21 – Permissible variations due to continuous operation	43
Table 22 – Permissible variations due to series mode interference	43
Table 23 – Examples of marking relating to the reference conditions and nominal range of use for temperature	46
Table 24 – Symbols for marking transducers	47
Table A.1 – Rated burden for TRD2 with an AC or DC voltage output, or a frequency output	52
Table A.2 – Rated burden for TRD2 with an AC or DC current output	53
Table A.3 – Rated temperatures for TRD2	53
Table A.4 – Rated humidity classes	54
Table A.5 – Definition of ports	58
Table A.6 – Performance criteria for EMC immunity tests	59
Table A.7 – RJ45 connector pinout	60
Table A.8 – Limits for error and phase error for TRD2-IAC	61
Table A.9 – Limits of ratio error for TRD2-IDC	62
Table A.10 – Limits of ratio error for TRD2-UAC	63
Table A.11 – Limits of ratio error for TRD2-UDC	63
Table A.12 – Burden values for basic accuracy tests	68
Table B.1 – Coding of interface connection	77
Table B.2 – Rated AC RMS voltage output	78
Table B.3 – Rated DC voltage output	78
Table B.4 – Rated range of DC voltage output	78
Table B.5 – Rated AC RMS current output less than 1A	78
Table B.6 – Rated range of DC current output	79
Table B.7 – Rated frequency output	79
Table B.8 – Rated pulse density output	79
Table B.9 – Coding of power supply for transducers supplied from measuring instrument via the connector	80
Table B.10 – Coding of external power supply for transducers	80

Table B.11 – Coding of transfer function curves for transducers.....	80
Table B.12 – Interface full coding for output of transducers.....	81
Table B.13 – Examples of interface codes and most common interface codes.....	81
Table C.1 – Anti-aliasing filter.....	83
Table D.1 – Limits of error for harmonics – Accuracy classes.....	85
Table D.2 – Limits of error for harmonics – Accuracy class extensions WB1 and WB2.....	86
Table E.1 – Marking of terminals for TRD2 monitoring current.....	87
Table E.2 – Marking of terminals for TRD2 monitoring voltage.....	88
Table G.1 – Clearances according to IEC 60664-1:2020.....	90
Table G.2 – Creepage distances according to IEC 60664-1:2020.....	91
Table G.3 – Clearances according to IEC 61010-2-030:2017.....	92
Table G.4 – Creepage distances according to IEC 61010-2-030:2017.....	92

iTeh Standards
(<https://standards.iteh.ai>)
Document Preview

[IEC 60688:2021](#)

<https://standards.iteh.ai/catalog/standards/iec/72ca1d98-d659-40d8-9deb-9d559382334f/iec-60688-2021>

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTRICAL MEASURING TRANSDUCERS FOR CONVERTING AC AND DC ELECTRICAL QUANTITIES TO ANALOGUE OR DIGITAL SIGNALS

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.

This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 60688:2012. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

IEC 60688 has been prepared by IEC technical committee 85: Measuring equipment for electrical and electromagnetic quantities. It is an International Standard.

This fourth edition cancels and replaces the third edition published in 2012. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) updating normative references;
- b) additional requirements for specific transducers used for LV monitoring applications;
- c) creation of interface coding to ease selection by the end-user.

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

CDV	Report on voting
85/748/CDV	85/781/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.

In this document, the following print types are used:

- requirements and definitions: in roman type;
- NOTES: in smaller roman type;
- *compliance*: in italic type.

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.

IMPORTANT – The "colour inside" logo on the cover page of this document 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

New transducers can now be equipped with microprocessors that utilise digital data processing, communication methods and auxiliary sensors. This makes them more complex than conventional analogue transducers and gives them considerable added value.

The class index system of classification used in this document is based upon IEC 60051 (all parts). Under this system, the permitted variations of the output signal due to varying influence quantities – ambient temperature, voltage, frequency, etc. – are implicit in the classification.

For those unfamiliar with the class index system, a word of warning is necessary. If, for example, a transducer is classified as class 1, it does not mean that the error under practical conditions of use will be within ± 1 % of the actual value of the output or ± 1 % of the full output value. It means that the error should not exceed ± 1 % of the fiducial value under closely specified conditions. If the influence quantities are varied between the limits specified by the nominal ranges of use, a variation of amount comparable with the value of the class index may be incurred for each influence quantity.

The permissible error of a transducer under working conditions is the sum of the permissible intrinsic error and of the permissible variations due to each of the influence quantities. However, the actual error is likely to be much smaller because not all of the influence quantities are likely to be simultaneously at their most unfavourable values and some of the variations may cancel one another. It is important that these facts be taken into consideration when specifying transducers for a particular purpose.

Furthermore, some of the terms used in this document are different from those used in IEC 60051 (all parts) due to the fundamental differences between indicating instruments and measuring transducers.

All statements of performance are related to the output which is governed by two basic terms:

– "the nominal value", which may have a positive or a negative sign or both;

– "the span", which is the range of values of the output signal from maximum positive to maximum negative, if appropriate.

ELECTRICAL MEASURING TRANSDUCERS FOR CONVERTING AC AND DC ELECTRICAL QUANTITIES TO ANALOGUE OR DIGITAL SIGNALS

1 Scope

This document applies to transducers with electrical inputs and outputs for making measurements of AC or DC electrical quantities. The output signal ~~may~~ can be in the form of an analogue direct current, an analog direct voltage or in digital form. ~~In this case, that part of the transducer utilized for communication purposes will need to be compatible with the external system.~~

This document applies to measuring transducers used for converting electrical quantities such as

- current,
- voltage,
- active power,
- reactive power,
- power factor,
- phase angle,
- frequency,
- harmonics or total harmonic distortion, and
- apparent power

to an output signal.

IEC 60688:2021

<http://www.iteh.ai/standards/iec/72ca1d98-d659-40d8-9deb-9d559382334f/iec-60688-2021>

- instrument transformers that comply with ~~IEC 60044 series~~ IEC 61869 (all parts);
- transmitters for use in industrial process application that comply with IEC 60770 (all parts), and
- performance measuring and monitoring devices (PMD) that comply with IEC 61557-12:2018.

Within the measuring range, the output signal is a function of the measurand. An auxiliary supply ~~may~~ can be needed.

This document applies

- a) if the nominal frequency of the input(s) lies between 0 Hz and 1 500 Hz,
- b) ~~if a measuring transducer is part of a system for the measurement of a non-electrical quantity, this standard may be applied to the electrical measuring transducer, if it otherwise falls within the scope of this standard~~
to the electrical measuring transducer if it is part of a system for the measurement of a non-electrical quantity, and if it otherwise falls within the scope of this document, and
- c) to transducers for use in a variety of applications such as telemetry and process control and in one of a number of defined environments.

This document is intended:

- to specify the terminology and definitions relating to transducers whose main application is in industry,