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Edition 2

SOUTH AFRICAN NATIONAL STANDARD

Electricity metering equipment — General requirements, tests and test conditions

Part 11: Metering equipment

This national standard is the identical implementation of IEC 62052-11:2020, and is adopted with the permission of International Electrotechnical Commission

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This document references other documents normatively.

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Table of changes

Change No.	Date	Scope

National foreword

This South African standard was prepared by National Committee SABS/TC 062, *Electrical energy measurement and control*, in accordance with procedures of the South African Bureau of Standards, in compliance with annex 3 of the WTO/TBT agreement.

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INTERNATIONAL STANDARD

Electricity metering equipment – General requirements, tests and test conditions – Part 11: Metering equipment

IEC 62052-11:2020-06(en)

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INTERNATIONAL STANDARD

Electricity metering equipment – General requirements, tests and test conditions – Part 11: Metering equipment

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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ELECTRICITY METERING EQUIPMENT – GENERAL REQUIREMENTS, TESTS AND TEST CONDITIONS –

Part 11: Metering equipment

FOREWORD

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International Standard IEC 62052-11 has been prepared by IEC technical committee 13: Electrical energy measurement and control.

This second edition cancels and replaces the first edition published in 2003, and its amendment 1:2016. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition: see Annex O.

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

FDIS	Report on voting
13/1808/FDIS	13/1812/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

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

A list of all parts in the IEC 62052 series, published under the general title *Electricity metering equipment – General requirements*, tests and test conditions, 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 "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.

NOTE The attention of National Committees is drawn to the fact that equipment manufacturers and testing organizations may need a transitional period following publication of a new, amended or revised IEC publication in which to make products in accordance with the new requirements and to prepare themselves for conducting new or revised tests.

It is the recommendation of the committee that the content of this publication be adopted for implementation nationally not earlier than two years from the date of publication.

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INTRODUCTION

The general overview and organization of the IEC 6205x series of standards applicable to electricity metering and load control equipment is as follows:

PRODUCT FAMILY STANDARDS – GENERAL REQUIREMENTS	**PRODUCT FAMILIES**				
	AC meters rated up to 1 000 V for direct connection or connection through conventional transformers	**Tariff and load control equipment**	**DC meters rated up to 1 500 V for direct connection**	**AC meters for connection through LPITs (as defined in the IEC 61869 series of standards)**	**DC meters for connection through LPITs (as defined in the IEC 61869 series of standards)**
NOMINAL VALUES, CONSTRUCTION, ELECTRICAL, CLIMATIC AND EMC REQUIREMENTS. TEST METHODS	IEC 62052-11:2020	IEC 62052-21 2004	IEC 62052-11:2020	Planned: IEC 62052-XX general requirements for meters for connection through LPITs.	
SAFETY	IEC 62052-31:2015		Planned: IEC 62052-31 2nd edition including safety requirements for DC meters	Planned: IEC 62052-XX safety requirements for meters for connection through LPITs.	
DEPENDABILITY	IEC 62059-11: 2002, IEC 62059-21:2002, IEC 62059-32-1 2011, IEC 62059-41:2006		Planned: IEC 62059-XX dependability requirements for DC meters	Planned: IEC 62059-XX dependability requirements for meters for connection through LPITs.	
ACCEPTANCE INSPECTION	IEC 62058-11:2008			Planned: IEC 62058-XX acceptance inspection requirements for meters for connection through LPITs.	
EMBEDDED SOFTWARE	Planned: IEC 6205x-xx embedded software (firmware) requirements and test methods for electricity metering and load control equipment				

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PRODUCT FAMILY STANDARDS – PARTICULAR REQUIREMENTS AND ACCURACY CLASSES				
AC meters rated up to 1 000 V for direct connection or connection through conventional transformers	**Tariff and load control equipment**	**DC meters rated up to 1 500 V for direct connection**	**AC meters for connection through LPITs (as defined in the IEC 61869 series of standards)**	**DC meters for connection through LPITs (as defined in the IEC 61869 series of standards)**
Electromechanical, active energy directly connected, classes 0,5, 1, 2 IEC 62053-11:2003, IEC 62058-21:2008	Ripple control receivers IEC 62054-11:2004	Static, DC energy, directly connected, classes 0,5, 1 IEC 62053-41 –	Planned: LPIT operated meters IEC 62053-xx	Planned: LPIT operated meters IEC 62053-xx
Static, active energy directly connected, and transformer operated, classes 1, 2 IEC 62053-21:2020, IEC 62058-31:2008,	Time switches IEC 62054-21:2004	———	———	———
Static, active energy, transformer operated, classes 0,1S, 0,2S, 0,5S IEC 62053-22:2020, IEC 62058-31:2008	———	———	———	———
Static, reactive energy directly connected, and transformer operated, classes 2, 3 IEC 62053-23:2020	———	———	———	———
Static, reactive energy directly connected, and transformer operated, classes 0,5 S, 1S, 1, 2, 3 IEC 62053-24:2020	———	———	———	———
Static, active energy directly connected, prepayment classes 1, 2 IEC 62055-31:2005	———	———	———	———

This part of IEC 62052 is to be used with relevant parts of the IEC 62052, IEC 62053, IEC 62058 and IEC 62059 series:

IEC 62052-31:2015, *Electricity metering equipment (AC) – General requirements, tests and test conditions – Part 31: Product safety requirements and tests*

IEC 62053-11:2003, *Electricity metering equipment (AC) – Particular requirements – Part 11: Electromechanical meters for active energy (classes 0,5, 1 and 2)*

IEC 62053-21:2020, *Electricity metering equipment – Particular requirements – Part 21: Static meters for AC active energy (classes 1 and 2)*

IEC 62053-22:2020, *Electricity metering equipment – Particular requirements – Part 22: Static meters for AC active energy (classes 0,1S, 0,2S and 0,5S)*

IEC 62053-23:2020, *Electricity metering equipment – Particular requirements – Part 23: Static meters for reactive energy (classes 2 and 3)*

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IEC 62053-24:2020, *Electricity metering equipment– Particular requirements – Part 24: Static meters for fundamental component reactive energy (classes 0,5S, 1S, 1, 2 and 3)*

IEC 62053-41: – , *Electricity metering equipment– Particular requirements – Part 41: Static meters for direct current energy (classes 0,5 and 1)*

IEC 62055-31:2005, *Electricity metering – Payment systems – Part 31: Particular requirements – Static payment meters for active energy (classes 1 and 2)*

IEC 62056-6-1:2017, *Electricity metering data exchange – The DLMS/COSEM suite – Part 6-1: Object Identification System (OBIS)*

IEC 62056-6-2:2017, *Electricity metering data exchange – The DLMS/COSEM suite – Part 6-2: COSEM interface classes*

IEC 62057-1: – , *Test equipment, techniques and procedures for electrical energy meters – Part 1: Stationary Meter Test Units (MTU)*

IEC 62058-11:2008, *Electricity metering equipment (AC) – Acceptance inspection – Part 11: General acceptance inspection methods*

IEC 62058-21:2008, *Electricity metering equipment (AC) – Acceptance inspection – Part 21: Particular requirements for electromechanical meters for active energy (classes 0,5, 1 and 2)*

IEC 62058-31:2008, *Electricity metering equipment (AC) – Acceptance inspection – Part 31: Particular requirements for static meters for active energy (classes 0,2 S, 0,5 S, 1 and 2)*

IEC 62059-11:2002, *Electricity metering equipment – Dependability – Part 11: General concepts*

IEC 62059-21:2002, *Electricity metering equipment – Dependability – Part 21: Collection of meter dependability data from the field*

IEC 62059-32-1:2011, *Electricity metering equipment – Dependability – Part 32-1: Durability – Testing of the stability of metrological characteristics by applying elevated temperature*

This document is intended to be used in conjunction with the appropriate part of IEC 62053 for the type of equipment under consideration.

The test levels are regarded as minimum values for the proper functioning of the meter under normal working conditions. For special application, other test levels may be used and are subject to an agreement between the manufacturer and the purchaser.

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ELECTRICITY METERING EQUIPMENT – GENERAL REQUIREMENTS, TESTS AND TEST CONDITIONS –

Part 11: Metering equipment

1 Scope

This part of IEC 62052 specifies requirements and associated tests, with their appropriate conditions for type testing of AC and DC electricity meters. This document details functional, mechanical, electrical and marking requirements, test methods, and test conditions, including immunity to external influences covering electromagnetic and climatic environments.

NOTE 1 For other general requirements, such as safety, dependability, etc., see the relevant IEC 62052 or IEC 62059 standards. For accuracy requirements and other requirements specific to class indices, see the relevant IEC 62053 standards.

This document applies to electricity metering equipment designed to:

- measure and control electrical energy on electrical networks (mains) with voltage up to 1 000 V AC, or 1 500 V DC;

NOTE 2 For AC electricity meters, the voltage mentioned above is the line-to-neutral voltage derived from nominal voltages. See IEC 62052-31:2015, Table 7.

NOTE 3 For meters designed for operation with LPITs, only the metering unit is considered a low voltage device. If the LPITs are rated for voltages exceeding 1 000 V AC, or 1 500 V DC, the combination of the metering unit and LPITs is not a low voltage device.

- have all functional elements, including add-on modules, enclosed in, or forming a single meter case with exception of indicating displays;
- operate with integrated displays (electromechanical or static meters);
- operate with detached indicating displays, or without an indicating display (static meters only);
- be installed in a specified matching sockets or racks;
- optionally, provide additional functions other than those for measurement of electrical energy.

Meters designed for operation with Low Power Instrument Transformers (LPITs as defined in the IEC 61869 series) may be tested for compliance with this document and the relevant IEC 62053 series documents only if such meters and their LPITs are tested together as directly connected meters.

NOTE 4 Modern electricity meters typically contain additional functions such as measurement of voltage magnitude, current magnitude, power, frequency, power factor, etc.; measurement of power quality parameters; load control functions; delivery, time, test, accounting, and recording functions; data communication interfaces and associated data security functions. The relevant standards for these functions may apply in addition to the requirements of this document. However, the requirements for such functions are outside the scope of this document.

NOTE 5 Product requirements for Power Metering and Monitoring Devices (PMDs) and measurement functions such as voltage magnitude, current magnitude, power, frequency, etc., are covered in IEC 61557-12. However, devices compliant with IEC 61557-12 are not intended to be used as billing meters unless they are also compliant with IEC 62052-11 and one or more relevant IEC 62053-xx particular requirements (accuracy class) standard.

NOTE 6 Product requirements for Power Quality Instruments (PQIs) are covered in IEC 62586-1. Requirements for power quality measurement techniques (functions) are covered in IEC 61000-4-30. Requirements for testing of the power quality measurement functions are covered in IEC 62586-2.

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NOTE 7 The IEC TC13 strives to consider EMC phenomena that may occur in practice in meter installations and to amend its standards to ensure that an appropriate level of electromagnetic compatibility is specified for electricity metering equipment. To this end, IEC TC13 cooperates with the relevant IEC technical committees to characterize electromagnetic phenomena, to define emission limits, immunity levels and immunity verification methods based on which the appropriate test methods and requirements can be developed in the TC13 electricity metering equipment standards.

This document is also applicable to auxiliary input and output circuits, operation indicators, and test outputs of equipment for electrical energy measurement.

NOTE 8 Some examples include pulse inputs and outputs, control inputs and outputs, and energy test outputs.

This document also covers the common aspects of accuracy testing such as reference conditions, repeatability and measurement of uncertainty.

This document does not apply to:

- meters for which the voltage line-to-neutral derived from nominal voltages exceeds 1 000 V AC, or 1 500 V DC;
- meters intended for connection with low power instrument transformers (LPITs as defined in the IEC 61869 series of standards) when tested without such transformers;
- metering systems comprising multiple devices (except of LPITs) physically remote from one another;
- portable meters;

NOTE 9 Portable meters are meters that are not permanently connected.

- meters used in rolling stock, vehicles, ships and airplanes;
- laboratory and meter test equipment;
- reference standard meters;

NOTE 10 Nominal values, accuracy classes, requirements and test methods for reference standard meters are specified in IEC 62057-1: –.

- data interfaces to the register of the meter;
- matching sockets or racks used for installation of electricity metering equipment;
- any additional functions provided in electrical energy meters.

This document does not cover measures for the detection and prevention of fraudulent attempts to compromise a meter's performance (tampering).

NOTE 11 Nevertheless, specific tampering detection and prevention requirements, and test methods, as relevant for a particular market are subject to agreement between the manufacturer and the purchaser.

NOTE 12 Specifying requirements and test methods for fraud detection and prevention would be counterproductive, as such specifications would provide guidance for potential fraudsters.

NOTE 13 There are many types of meter tampering reported from various markets; therefore, designing meters to detect and prevent all types of tampering could lead to unjustified increase in costs of meter design, verification and validation.

NOTE 14 Billing systems, such as smart metering systems, are capable of detecting irregular consumption patterns and irregular network losses which enable discovery of suspected meter tampering.

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 60038:2009, *IEC standard voltages*

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IEC 60068-2-1:2007, *Environmental testing – Part 2-1: Tests – Tests A: Cold*

IEC 60068-2-2:2007, *Basic environmental testing procedures – Part 2-2: Tests – Tests B: Dry heat*

IEC 60068-2-5:2018, *Environmental testing – Part 2-5: Tests – Test S: Simulated solar radiation at ground level and guidance for solar radiation testing and weathering*

IEC 60068-2-6:2007, *Environmental testing – Part 2: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60068-2-27:2008, *Environmental testing – Part 2-27: Tests – Test Ea and guidance: Shock*

IEC 60068-2-30:2005, *Environmental testing – Part 2-30: Tests – Test Db: Damp heat, cyclic (12 h + 12 h cycle)*

IEC 60381-1:1982, *Analogue signals for process control systems – Part 1: Direct current signals*

IEC 60404-5:2015, *Magnetic materials – Part 5: Permanent magnet (magnetically hard) materials – Methods of measurement of magnetic properties*

IEC 60404-8-1:2015, *Magnetic materials – Part 8-1: Specifications for individual materials – Magnetically hard materials*

IEC 60404-8-4:2013, *Magnetic materials – Part 8-4: Specifications for individual materials – Cold-rolled non-oriented electrical steel strip and sheet delivered in the fully-processed state*

IEC 60664-1:2007, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

IEC 60721-1:1990, *Classification of environmental conditions – Part 1: Environmental parameters and their severities*

IEC 60947-1:2007, *Low-voltage switchgear and controlgear – Part 1: General rules*
IEC 60947-1:2007/AMD1:2010
IEC 60947-1:2007/AMD2:2014

IEC 61000-4-2:2008, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61000-4-3:2006, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*
IEC 61000-4-3:2006/AMD1:2007
IEC 61000-4-3:2006/AMD2:2010

IEC 61000-4-4:2012, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*

IEC 61000-4-5:2017, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

IEC 61000-4-6:2013, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61000-4-8:2009, *Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test*

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IEC 61000-4-11:2020, *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests for equipment with input current up to 16 A per phase*

IEC 61000-4-12:2017, *Electromagnetic compatibility (EMC) – Part 4-12: Testing and measurement techniques – Ring wave immunity test*

IEC 61000-4-18:2019, *Electromagnetic compatibility (EMC) – Part 4-18: Testing and measurement techniques – Damped oscillatory wave immunity test*

IEC 61000-4-19:2014, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Test for immunity to conducted, differential mode disturbances and signalling in the frequency range 2 kHz to 150 kHz at AC power ports*

IEC 61000-4-20:2010, *Electromagnetic compatibility (EMC) – Part 4-20: Testing and measurement techniques – Emission and immunity testing in transverse electromagnetic (TEM) waveguides*

IEC 61000-4-29:2000, *Electromagnetic compatibility (EMC) – Part 4-29: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations on DC input power port immunity tests*

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

IEC 62052-31:2015, *Electricity metering equipment (AC) – General requirements, tests and test conditions – Part 31: Product safety requirements and tests*

IEC 62054-21:2004, *Electricity metering equipment (AC) – Tariff and load control – Part 21: Particular requirements for time switches*

IEC 62056-6-1:2017, *Electricity metering data exchange – The DLMS/COSEM suite – Part 6-1: Object Identification System (OBIS)*

IEC 62056-6-2:2017, *Electricity metering data exchange – The DLMS/COSEM suite – Part 6-2: COSEM interface classes*

IEC 62057-1:*Test equipment, techniques and procedures for electrical energy meters – Part 1: Stationary Meter Test Units (MTU)*

IEC 62059-32-1:2011, *Electricity metering equipment – Dependability – Part 32-1: Durability – Testing of the stability of metrological characteristics by applying elevated temperature*

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

CISPR 32:2015, *Electromagnetic compatibility of multimedia equipment – Emission requirements*

JCGM 100:2008, *Evaluation of measurement data – Guide to the expression of uncertainty in measurement. (GUM 1995 with minor corrections)*

EN 10027-1:2016, *Designation systems for steels – Part 1: Steel names*

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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 website: http://www.electropedia.org/
- ISO Online Browsing Platform website: http://www.iso.org/obp

NOTE Expression of the performance of electrical and electronic measuring equipment has been taken from IEC 60359.

3.1 General definitions

3.1.1
electromechanical meter
meter in which currents in fixed coils react with the currents induced in the conducting moving element, generally (a) disk(s), which causes their movement proportional to the energy to be measured

3.1.2
static meter
meter in which currents and voltages act on solid state (electronic) elements to produce an output proportional to the energy to be measured

3.1.3
watt-hour meter
active energy meter
instrument intended to measure active energy by integrating active power with respect to time

[SOURCE: IEC 60050-300:2001, 313-06-01]

3.1.4
var-hour meter
reactive energy meter
instrument intended to measure reactive energy by integrating reactive power with respect to time

[SOURCE: IEC 60050-300:2001, 313-06-02]

3.1.5
multi-energy meter
meter which, in a single case, measures two or more types of electrical energy (watt-hour, var-hour, VA-hour)

3.1.6
multi-function meter
meter which, in a single case, incorporates other functions in addition to the energy measurement functions

Note 1 to entry: Multi-function meters may include: maximum demand indicator, time switches, ripple control or radio receivers, pulse output devices, power monitoring functions, power quality functions, input-output control functions, communication function, etc.

3.1.7
multi-rate meter
energy meter provided with multiple registers, each becoming operative as defined by a tariff schedule

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Note 1 to entry: A tariff schedule could be held in the meter, operated on a time basis or a consumption basis, or by external control signals.

[SOURCE: IEC 60050-300:2001, 313-06-09, modified to be better adapted to metering and note added]

3.1.8
directly connected meter
meter intended to be connected directly to the circuit(s) being measured, without use of external instrument transformer(s)

3.1.9
transformer operated meter
meter intended to be connected to the circuit(s) being measured with the use of external instrument transformer(s)

3.1.10
bidirectional meter
meter measuring energy flow in both directions

Note 1 to entry: for instance, energy received at the measuring point (for example import) and energy supplied at the same measuring point (for example, export).

3.1.11
reference standard
reference meter
meter used to measure the unit of electrical energy, designed and operated to obtain the highest accuracy and stability in a controlled laboratory environment and traceable to national or international primary standards

[SOURCE: IEC 62057-1: –, 3.1.7]

3.1.12
meter type for electromechanical meter
meter design, manufactured by one manufacturer, having:

a) similar metrological properties;
b) the same uniform construction of parts determining these properties;
c) the same ratio of the maximum current to the nominal current;
d) the same number of ampere-turns for the current winding at nominal current and the same number of turns per volt for the voltage winding at nominal voltage.

Note 1 to entry: The type may have several values of nominal current and nominal voltage.

Note 2 to entry: Meters are designated by the manufacturer by one or more groups of letters or numbers, or a combination of letters and numbers. Each type has one designation only.

Note 3 to entry: The type is represented by the sample meter(s) intended for the type tests, in which characteristics (nominal current and nominal voltage) are chosen from the values given in the tables proposed by the manufacturer.

Note 4 to entry: Where the number of ampere-turns would lead to a number of turns other than a whole number, the product of the number of turns of the windings by the value of the nominal current may differ from that of the sample meter(s) representative of the type.

It is advisable to choose the next number immediately above or below in order to have whole numbers of turns.

For this reason only, the number of turns per volt of the voltage windings may differ, but by no more than 20 % from that of the sample meters representative of the type.

Note 5 to entry: The ratio of the highest to the lowest basic speed of the rotors of each of the meters of the same type shall not exceed 1,5.

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3.1.13
meter type for static meter
meter design, including the indicating display, if supported, having:

a) similar metrological properties;

b) the same uniform construction of parts determining these properties.

Note 1 to entry: The type may have several values of nominal current and nominal voltage.

Note 2 to entry: Meters are designated by the manufacturer by one or more groups of letters or numbers, or a combination of letters and numbers. Each type has one designation only.

Note 3 to entry: The type is represented by the sample meter(s) intended for the type tests, whose characteristics (nominal current and nominal voltage) are chosen from the values given in the tables proposed by the manufacturer.

3.1.14
active power
active power at any single sinusoidal frequency component of a periodic signal in a single-phase circuit is defined as the product of the RMS values of current and voltage and the cosine of the phase angle between them, where the phase angle is the angle of the voltage signal vector with respect to the current signal vector

Note 1 to entry: Under sinusoidal conditions, the active power is the real part of the complex power.

Note 2 to entry: The active power of a non-sinusoidal periodic signal is the algebraic sum of the active power of the sinusoidal frequency components.

Note 3 to entry: The coherent SI unit for active power is the watt, W.

3.1.15
active energy
time integral of the active power as defined in 3.1.14

Note 1 to entry: The coherent SI unit of active energy is joule, J. Another unit is watt hour. Its multiple, kilowatt hour, kWh, is commonly used for billing consumers of electric energy and is therefore indicated on electric energy meters.

3.1.16
reactive power
var
reactive power at any single sinusoidal frequency component of a periodic signal in a single-phase circuit is defined as the product of the RMS values of current and voltage and the sine of the phase angle between them, where the phase angle is the angle of the voltage signal vector with respect to the current signal vector

Note 1 to entry: In TC 13 standards for reactive energy the reactive power and energy are defined for fundamental frequency only.

Note 2 to entry: The algorithm used for the calculation of reactive power is not specified, however the meter is expected to meet requirements of the relevant accuracy class standard.

Note 3 to entry: The coherent SI unit for reactive power is voltampere, VA. The special unit var and its symbol var are also used.

3.1.17
reactive energy in a single-phase circuit
integral of the reactive power as defined in 3.1.16

Note 1 to entry: The coherent SI unit of reactive energy is var hour.

3.1.18
operator
service person responsible for operation and maintenance of metering equipment and, when applicable, the provision of necessary safety related information to the user

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[SOURCE: IEC 62052-31:2015, 3.5.22]

3.1.19
rated value
value of a quantity used for specification purposes, established for a specified set of operating conditions of a component, device, equipment, or system

[SOURCE: IEC 60050-151:2001, 151-16-08]

3.1.20
nominal value
value of a quantity used to designate and identify a component, device, equipment, or system

Note 1 to entry: The nominal value is generally a rounded value.

[SOURCE: IEC 60050-151:2001, 151-16-09]

3.1.21
reference value
specified value of one influence quantity considered in the reference conditions

[SOURCE: IEC 60050-300:2001, 311-07-01]

3.1.22
polyphase system
m-phase system
set of m interrelated sinusoidal integral quantities of the same kind, where m is an integer greater than one, all quantities having the same period but usually different phases

Note 1 to entry: Polyphase systems of voltages, electric currents and linked fluxes are commonly used.

Note 2 to entry: The qualifiers two-phase, three-phase, four-phase, six-phase and twelve-phase are used for m = 2, 3, 4, 6, 12, respectively.

Note 3 to entry: The concept of polyphase system can, under certain conditions, be extended to non-sinusoidal periodic quantities.

[SOURCE: IEC 60050-141:2004, 141-01-03]

3.1.23
meter connection mode
meter terminal wiring arrangement and configuration of the meter's metrological relevant embedded software (firmware) parameters applicable to the measured service type

3.1.24
service type
number of phases and the number of wires for which the meter is suitable (for example, single-phase two-wire, three-phase three-wire, three-phase four-wire)

3.1.25
power DC
power in DC circuit is defined as the product of the mean value of DC current and the mean value of DC voltage

Note 1 to entry: It is assumed that the DC voltage and current is constant over the integration period.

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3.2 Definitions related to the functional elements

3.2.1
measuring element
part of the meter which produces an output proportional to the energy

3.2.2
test output
output used for testing the meter

Note 1 to entry: A test output may be an optical pulse output, an electrical pulse output or a communication interface.

3.2.3
operation indicator
device which gives a visible signal of the operation of the meter

[SOURCE: IEC 60050-300:2001, 314-07-13]

3.2.4
pulse
wave that departs from an initial level for a limited duration of time and ultimately returns to the original level

3.2.5
pulse output
output for emitting pulses

3.2.6
optical test output
optical pulse output used for testing the meter

3.2.7
receiving head
scanning head
functional unit detecting the marks on the rotor of an electromechanical meter or detecting signals emitted by an optical test output of a static meter

3.2.8
pulse input
pulse input for receiving pulses

3.2.9
memory
element which stores digital information

3.2.10
non-volatile memory
memory which can retain information in the absence of power

3.2.11
indicating display
device that displays the measurement results

Note 1 to entry: An indicating display may also be used to display other relevant information.

[SOURCE: OIML R 46-1 / R46-2:2012, 2.1.12, modified to be better adapted to metering]

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3.2.12
integrated indicating display
indicating display integrated in the meter case

3.2.13
detached indicating display
DID
indicating display housed in its own enclosure (case) separate from the meter case, powered by the meter and specified for use only with (a) designated meter type(s)

Note 1 to entry: A detached indicating display is not a stand-alone generic human machine interface device such as a tablet, a laptop, or a general purpose industrial HMI device.

3.2.14
register
electromechanical or electronic device which stores and displays the information representing the measured energy

Note 1 to entry: In static meters, the register comprises both memory and display.

Note 2 to entry: A single display may be used with multiple electronic memories to form multiple registers.

[SOURCE: IEC 60050-300:2001, 314-07-09]

3.2.15
mains
electrical network supplying the premises

3.2.16
mains circuit
electrical circuit which is conductively connected to and energized directly from the mains

Note 1 to entry: Voltage circuits intended to be connected to the secondary side of measuring voltage transformers are classed also as mains circuits.

3.2.17
non-mains circuit
electrical circuit not energized directly from the mains

Note 1 to entry: This circuit may be isolated by a transformer or supplied by a battery.

Note 2 to entry: In this document the terms "mains circuit" and "non-mains circuit' are used, to avoid confusion with primary and secondary circuits of instrument transformers used with transformer operated meters.

[SOURCE: IEC 62477-1:2012, 3.26, modified to be better adapted to metering and additional information given in the notes.]

3.2.18
current circuit
internal connections of the meter and part of the measuring element through which flows the current of the measured electrical circuit to which the meter is connected

Note 1 to entry: For transformer operated meters, "the measured electrical circuit to which the meter is connected" is the secondary winding of the external current transformer(s).

3.2.19
voltage circuit
internal connections of the meter and part of the measuring element, and in some cases, part of the meter's power supply, energized with the voltage of the measured electrical circuit to which the meter is connected

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Note 1 to entry: For transformer operated meters, "the measured electrical circuit to which the meter is connected" is the secondary winding of the external voltage transformer(s).

3.2.20
auxiliary circuit
circuit other than the voltage circuits, current circuits or the auxiliary power supply circuit, intended to be connected to (an) external device(s)

[SOURCE: IEC 62052-31:2015, 3.5.11, modified to be more precise and coherent with 3.2.18 and 3.2.19.]

3.2.21
meter's auxiliary power supply circuit
internal connections of the meter, separate from the voltage circuits, energized from separate auxiliary supply via dedicated terminals

3.2.22
auxiliary supply
U_s or U_x
electrical power supply source, other than the measured electrical circuit, energizing the meter's internal auxiliary power supply circuit via dedicated terminals

Note 1 to entry: Auxiliary power supply may be necessary if the voltage circuits become de-energized (for example, network outage), but some functions of the meter are expected to operate (for example, communications, registration of power quality events); or to reduce power consumption in the voltage circuits in special applications.

Note 2 to entry: Combinations of supply from voltage circuits and additional auxiliary power supply are also possible. Such applications are common with transformer operated meters in substations or power plants.

[SOURCE: IEC 60688:2012, 3.1.4, modified – definition adapted to metering and notes added.]

3.2.23
auxiliary device
device internal or external to the meter intended to perform a particular function in addition to the energy measurement functions

Note 1 to entry: Some examples include: clock, tariff / load / supply control switch, pulse input / output, data exchange unit.

Note 2 to entry: An auxiliary device may be internal or external to a meter.

3.2.24
supply control switch
SCS
switch internal to the meter intended to control the supply to the premises

Note 1 to entry: SCS comprises the contacts and the parts operating the contacts, and it may include a means for manual operation.

Note 2 to entry: The supply control switch should not be confused with the supply side protection device that is external to the meter and disconnects the supply in the case of an overcurrent fault.

[SOURCE: IEC 62052-31:2015, 3.7.2 modified: "internal to the meter" and "external to the meter" added.]

3.2.25
load control switch
LCS
switch intended to control loads within the premises

Note 1 to entry: LCS comprises the contacts and the parts operating the contacts.

[SOURCE: IEC 62052-31:2015, 3.7.3]

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3.2.26
low-power instrument transformer
LPIT
arrangement, consisting of one or more current or voltage transformer(s) which may be connected to transmitting systems and secondary converters, all intended to transmit a low power analogue or digital output signal to measuring instruments, meters and protective or control devices or similar apparatus

EXAMPLE: An arrangement consisting of three current sensors, three voltage sensors connected to one merging unit delivering one digital output is considered an LPIT.

Note 1 to entry: LPITs are commonly called non-conventional instrument transformers (NCIT).

Note 2 to entry: The output power produced by these devices is typically lower or equal to 1 VA.

[SOURCE: IEC 61869-6:2016, 3.1.601]

3.3 Definitions of meter ports

3.3.1
port
any particular interface of the specific device or system with the external electromagnetic environment

EXAMPLE See Annex E for examples of Equipment Under Test (EUT).

Note 1 to entry: I/O ports are input, output or bi-directional, measurement, control, or data ports.

Note 2 to entry: In this document, ports intended to be connected with earth potential for functional reasons (functional earth ports) are considered as I/O ports.

Note 3 to entry: In this document the protective earth port (if any) is considered as part of the power port.

[SOURCE: IEC 61326-1:2012, 3.11]

3.3.2
enclosure port
physical boundary of the meter through which electromagnetic fields may radiate or impinge

[SOURCE: IEC 61326-1:2012, 2.3.6]

3.3.3
mains port
terminals of current and voltage circuits, including the neutral voltage terminal, of directly connected meters, and terminals of voltage circuits of transformer operated meters

3.3.4
current transformer port
terminals of current circuits of transformer operated meters

3.3.5
auxiliary power supply port
terminals of auxiliary power supply circuits of the meter

Note 1 to entry: The auxiliary power supply circuit of the meter can be a mains or non-mains circuit.

3.3.6
auxiliary port
terminals of a circuit other than the voltage measurement circuits, current measurement circuits or the auxiliary power supply circuit, intended to be connected to (an) external device(s)

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3.3.7
HLV signal port
terminals of auxiliary input or output circuits and other non-mains auxiliary circuits rated for voltages considered to be hazardous live

Note 1 to entry: For example, power line communication (PLC) terminals, tariff (rate) control inputs, control outputs rated for operation with Hazardous Live Voltages (HLV).

3.3.8
ELV signal port
terminals of auxiliary input or output circuits, data communication circuits and other auxiliary circuits rated for voltages that are not considered hazardous live

Note 1 to entry: For the purposes of this document, the ELV (Extra Low Voltage) values are specified in IEC 62052-31:2015 6.3; this definition includes PELV and SELV circuits.

3.3.9
functional earthing
functional grounding (U.S.)
earthing a point or points in a system or in an installation or in equipment for purposes other than electrical safety

[SOURCE: IEC 60050-195:1998/Amd1:2001, 195-01-13]

3.3.10
functional earthing terminal
terminal in equipment for purposes of functional earthing

3.3.11
embedded software firmware identification
sequence of characters that is inextricably linked to the embedded software (firmware)

Note 1 to entry: Software identification is usually realized as a version number, checksum, etc., and is viewable on a meter during use.

[SOURCE: WELMEC Guide 7.2 issue 5, OIML D31:2008, 3.1.42]

3.4 Definitions of mechanical elements

3.4.1
indoor meter
indoor detached indicating display
meter or detached indicating display intended for operation under normal climatic conditions in a building or in a meter cabinet

3.4.2
outdoor meter
outdoor detached indicating display
meter or detached indicating display intended for operation under extended climatic conditions

3.4.3
meter base
back of the meter by which it is generally fixed and to which are attached the measuring elements, the terminals or the terminal block, and the cover

Note 1 to entry: For a flush-mounted meter, the meter base may include the sides of the case.

3.4.4
specified matching meter socket
base with jaws, test block style connectors, or other type of detachable connectors intended for installation of socket-mounted metering equipment

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Note 1 to entry: This includes terminals for connection to the supply and load circuits; also appropriate secure fixing and sealing arrangements.

Note 2 to entry: It may be a single-position socket for one meter or a multiple-position socket for two or more meters.

Note 3 to entry: This term only relates to metering equipment designed as a socket-mounted unit.

Note 4 to entry: Metering equipment can meet the relevant type testing requirements when it is properly installed in any specified matching socket.

3.4.5
specified matching meter rack
mechanical part of the installation for plug-in of one or more meters with rack-mount housing

Note 1 to entry: Racks with plugs for direct plug-in of rack-mount meters are common. Most racks use the standardized 19-inch rack system.

3.4.6
cover of meter, <of detached indicating display>
enclosure on the front of the meter or on the front of the detached indicating display, made either wholly of transparent material or opaque material provided with window(s) through which the operation indicator and the indicating display can be read

3.4.7
case of meter, <of detached indicating display>
comprises the base and the cover

Note 1 to entry: When the case is closed, it provides protection against certain external influences and, in any direction, and protection against direct contact and spread of fire.

3.4.8
terminal block
support made of insulating material on which all or some of the terminals of the meter are grouped together

3.4.9
terminal cover of meter, <of detached indicating display>
cover which conceals meter terminals or terminals of detached indicating display, and, the ends of the external wires or cables connected to the terminals

Note 1 to entry: When the meter is mounted in its normal working position and when the terminal cover is in place, it provides protection in any direction against direct contact with the meter terminals.

3.4.10
metrology seal
specific securing measure which can be applied to an electricity meter to ensure its metrological integrity

3.4.11
installation seal
specific securing measure which can be applied by an installer to ensure the integrity of the meter installation

3.4.12
sealing
means intended to protect the meter against, and provide evidence of, any unauthorized modification, readjustment, removal of parts, embedded software (firmware), etc.

Note 1 to entry: Sealing can be achieved by hardware, embedded software (firmware) or a combination of both.

[SOURCE: OIML D 31:2008, 3.1.18, modified to be better adapted to metering.]

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3.4.13
equipment
device with functions related to electrical energy measurement and control

Note 1 to entry: Some examples include electricity meters, payment meters, tariff and load control equipment. The term "meter" is used in the text sometimes as a synonym of "metering equipment". A meter may include other functions, in addition to the basic energy metering function.

3.4.14
permanently connected equipment
equipment that is electrically connected to a supply by means of a permanent connection which can be detached only using a tool

[SOURCE: IEC 61010-1:2010, 3.1.2]

3.4.15
tool
external device, including keys and coins, used to aid a person to perform a mechanical function

[SOURCE: IEC 61010-1:2010, 3.1.5]

3.4.16
terminal
conductive part of a device, electric circuit or electric network, provided for connecting that device, electric circuit or electric network to one or more external conductors

[SOURCE: IEC 60050-151:2001, 151-12-12, modified – Note omitted.]

3.4.17
meter cabinet
enclosure for housing metering equipment and affording protection suitable for the intended application

Note 1 to entry: It may be fixed on a wall, built in a wall recess or it may be free-standing and self-supporting. It may also accommodate elements of the electrical installation, such as fuses, circuit breakers, or residual current devices.

3.4.18
packaging
products used for the containment, protection, handling, delivery and preservation of the meter from the manufacturer to the user or consumer

[SOURCE: IEC 62052-31:2015, 3.2.16]

3.5 Definitions related to measurements

3.5.1
measurand
quantity subject to measurement

[SOURCE: IEC 60050-300:2001, 311-01-03]

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3.5.2
starting current
I_{st}
for AC meters, the value of current at which the meter is required to start and continue to register active electrical energy at cos(φ) = 1 (and in case of polyphase meters, with balanced load) or reactive electrical energy at sin(φ) = 1 (inductive or capacitive, and in case of polyphase meters, with balanced load);for DC meters, the value of current at which the meter is required to start and continue to register electrical energy

Note 1 to entry: The term "current" indicates RMS values unless otherwise specified.

3.5.3
minimum current
I_{min}
lowest current at which the meter accuracy requirements are specified

Note 1 to entry: The term "current" indicates RMS values unless otherwise specified.

[SOURCE: OIML R 46-1 / R46-2:2012, 2.2.3, modified to be better adapted to metering.]

3.5.4
nominal current
I_n
current in accordance with which the relevant performance of the meter is fixed

Note 1 to entry: The term "current" indicates RMS values unless otherwise specified.

3.5.5
maximum current
I_{max}
highest current the meter can carry continuously and remain safe, and at which it purports to meet the accuracy requirements of the relevant standard

Note 1 to entry: The term "current" indicates RMS values unless otherwise specified.

[SOURCE: OIML R 46-1 / R46-2:2012, 2.2.5, modified to be better adapted to metering.]

3.5.6
nominal voltage
U_n
voltage in accordance with which the relevant performance of the meter is fixed

Note 1 to entry: The term "voltage" indicates RMS values unless otherwise specified.

3.5.7
nominal frequency
f_n
frequency in accordance with which the relevant performance of the meter is fixed

3.5.8
specified measuring range
set of values of a measured quantity for which the error of a meter is intended to lie within specified limits

3.5.9
accuracy
quality which characterizes the ability of a measuring instrument (meter) to provide an indicated value close to a true value of the measurand

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Note 1 to entry: This term is used in the "true value" approach.

Note 2 to entry: Accuracy is better when the indicated value is closer to the corresponding true value.

[SOURCE: IEC 60050-300:2001, 311-06-08]

3.5.10
accuracy class
category of measuring instruments, all of which are intended to comply with a set of specifications regarding accuracy

Note 1 to entry: In this document, the approximated measure of accuracy is the percentage error defined in 3.5.12.

[SOURCE: IEC 60050-300:2001, 311-06-09, modified: "uncertainty" replaced by "accuracy" and note added.]

3.5.11
accuracy class index
conventional designation of the nominal accuracy class of the meter identifying the intrinsic error limits

Note 1 to entry: The limits of percentage error are defined for the various kinds of meters in the particular requirement (accuracy class) standards.

Note 2 to entry: The reference conditions are defined in 7.1 in this document.

Note 3 to entry: The designation of meter "class" implies compliance with the accuracy requirements at reference conditions and in the presence of influence quantities, as defined in the relevant particular requirements (accuracy class) standards.

3.5.12
percentage error
percentage error is given by the following formula:

$$\varepsilon = \frac{E_m - E_t}{E_t} \times 100\ \%$$

where

ε is the percentage error;

E_m is the energy registered by the meter under test (EUT);

E_t is the true energy.

Note 1 to entry: Since the true value cannot be determined, it is approximated by a value with a stated uncertainty that can be traced to (reference) standard meters subject to an agreement between the manufacturer and the purchaser or to national standards.

3.5.13
repeatability
difference between the maximum measured percentage error value and the minimum measured percentage error value of a number of test results, where the tests have been performed under the same conditions of measurement, i.e.:

a) by the same measurement procedure;
b) by the same observer;
c) with the same measuring instruments, used under the same conditions;
d) in the same laboratory;
e) at relatively short intervals of time.

Note 1 to entry: These conditions are called repeatability conditions.

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Note 2 to entry: For example, the following three percentage errors are measured, under the above-mentioned conditions: +0,08 %; +0,02 %; -0,13 %. The repeatability for those error measurements is equal to +0,08 % – (– 0,13 %) = 0,21 %.

[SOURCE: IEC 60050-300:2001, 311-06-06, modified: note modified.]

3.5.14
uncertainty of measurement
parameter, associated with the result of a measurement, that characterizes the relative dispersion of the values, expressed as a percentage, that could reasonably be attributed to the measurand

Note 1 to entry: The parameter can be, for example, a standard deviation (or a given multiple of it), or a half width of an interval having a stated level of confidence. Various ways of obtaining uncertainty are defined in the IEC Guide 98-3 (GUM:1995 / JCGM 100: 2008).

Note 2 to entry: Uncertainty of measurement comprises, in general, many components. Some of these components can be evaluated from the statistical distribution of the results of a series of measurements and can be characterized by experimental standard deviations. The other components, which can also be characterized by standard deviations, are evaluated from the assumed probability distributions based on experience or other information.

[SOURCE: IEC 60050-300:2001, 311-01-02, modified: Note 1 omitted]

3.5.15
durability of accuracy
ability of a meter to perform energy measurement functions as specified in the relevant accuracy class standards under given conditions of use and maintenance, until the end of its useful life

Note 1 to entry: A limiting state of an item may be characterized by end of useful life, unsuitability or any economic or technological reasons or other relevant factors.

[SOURCE: IEC 60050-192:2015/Amd. 1 2016, 192-01-21, modified to be better adapted to metering.]

3.5.16
meter start-up time
$t_{\text{start-up}}$
specified time, after which the meter starts to register energy following the energization of its voltage, current and, when applicable, its auxiliary power supply circuits

3.5.17
normal use
operation, including stand-by, according to the instructions for use or for the obvious intended purpose

Note 1 to entry: Normal use of electrical energy meters assumes correct installation of all meter connections, meter cover, terminal covers, and metrology seals. Normal use does not include meter servicing, installation and commissioning operations, when the meter connections, covers and metrology seals may not yet be installed, or may be temporarily removed.

[SOURCE: IEC 61010-1:2010, 3.5.8]

3.6 Definitions related to external influences

3.6.1
influence quantity
any quantity of long duration which is not subject of the measurement and whose change affects the metrological performance of the meter

Note 1 to entry: Influence quantities can originate from the measured system, the meter or the environment.

Note 2 to entry: For the purpose of this definition the term "meter" means a meter with its detached indicating display, if specified.

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Note 3 to entry: The electromagnetic "influence quantities" and "disturbances" defined in this document are considered together as "electromagnetic disturbances" in the context of the EU EMC Directive, which defines "electromagnetic disturbance" as any electromagnetic phenomenon which may degrade the performance of equipment. In addition, the EU MID Directive defines influence quantities and disturbances differently than in this document.

Note 4 to entry: Current is a normal variation of the operating conditions of meters in the electrical distribution system and not considered as an influence quantity.

[SOURCE: IEC 60050-300:2001, 311-06-01, modified to be better adapted to metering and to make a distinction between short duration and long duration effects, see also the definition of disturbance.]

3.6.2
disturbance
any quantity of short (transient) duration, which may affect the metrological performance of the meter

Note 1 to entry: Disturbances can originate from the measured system, the meter or the environment.

Note 2 to entry: For the purpose of this definition the term "meter" means a meter with its detached indicating display, if specified.

3.6.3
critical change value
maximum amount of change allowed in the meter's energy registers during disturbance tests without any current flowing in the meter's current circuits.

The critical change value (x) is derived from the following formula:

$$x = 10^{-6} \times m \times U_{\mathrm{n}} \times I_{\mathrm{max}}$$

where

x is the critical change value, in kWh or kvarh;

m is the number of measuring elements;

U_{n} is the nominal voltage, in volts;

I_{max} is the maximum current, in amperes.

3.6.4
reference conditions
appropriate set of influence quantities and performance characteristics, with reference values, their tolerances and ranges, with respect to which the intrinsic error is specified

[SOURCE: IEC 60050-300:2001, 311-06-02, modified to be better adapted to metering]

3.6.5
intrinsic error
percentage error of a measuring instrument when used under reference conditions

[SOURCE: IEC 60050-300:2001, 311-03-08, modified to be better adapted to metering and note omitted.]

3.6.6
variation of error due to an influence quantity
difference between the percentage errors of the meter when only one influence quantity assumes successively two specified values, one of them being the reference value

Note 1 to entry: The variation due to an influence quantity is relative to the intrinsic error.

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3.6.7
total distortion factor
ratio of the RMS value of the total distortion content to the RMS value of an alternating quantity

Note 1 to entry: The total distortion factor depends on the choice of the fundamental component. If it is not clear from the context which one is used an indication should be given.

Note 2 to entry: The distortion factor is usually expressed as a percentage.

[SOURCE: IEC 60050-551:2001/Amd. 1:2017, 551-20-16]

3.6.8
reference temperature
ambient temperature specified for reference conditions

3.6.9
mean temperature coefficient
ratio of the variation of the percentage error to the change of temperature which produces this variation

3.6.10
rated operating conditions
set of specified measuring ranges for performance characteristics and specified operating ranges for influence quantities, within which the variations of operating percentage errors of a meter are specified and determined

3.6.11
specified operating range
range of values of a single influence quantity which forms a part of the rated operating conditions

3.6.12
limit range of operation
extreme conditions which an operating meter can withstand without damage and without degradation of its metrological characteristics when it is subsequently operated under its rated operating conditions

3.6.13
storage and transport conditions
extreme conditions which a non-operating meter can withstand without damage and without degradation of its metrological characteristics when it is subsequently operated under its rated operating conditions

3.6.14
normal working position
position of the meter defined by the manufacturer for normal service

3.6.15
thermal stability
thermal stability is reached when the change in percentage error as a consequence of thermal effects during 20 min is less than 0,1 times the intrinsic error limit, corresponding to the relevant accuracy class, for the measurement under consideration

3.6.16
common mode
simultaneous coupling to all lines versus the ground reference plane

[SOURCE: IEC 61000-4-4:2012, 3.1.5]

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3.6.17
interharmonic frequency
frequency which is a non-integer multiple of the reference fundamental frequency

Note 1 to entry: By extension from harmonic order, the interharmonic order is the ratio of an interharmonic frequency to the fundamental frequency. This ratio is not an integer. (Recommended notation m).

Note 2 to entry: The term "interharmonics" replaces the term "sub-harmonics" used in previous edition of this standard.

[SOURCE: IEC 60050-551:2001/Amd. 1:2017, 551-20-06, modified: notes added]

3.7 Definition of tests

3.7.1
type test
procedure according to which the series of tests is carried out on one meter or on a small number of meters of the same type having identical characteristics, to verify that the respective type of meter complies with all the requirements of the relevant standards

3.8 Definitions related to electromechanical meters

3.8.1
rotor
moving element of the meter upon which the magnetic fluxes of fixed windings and of braking elements act and which operates the register

3.8.2
driving element
working part of the meter which produces a torque by the action of its magnetic fluxes on the currents induced in the moving element. It generally comprises electromagnets with their control devices

3.8.3
braking element
part of the meter which produces a braking torque by the action of its magnetic flux on the currents induced in the moving element. It comprises one or more magnets and their adjusting devices

3.8.4
frame
part to which are affixed the driving elements, the rotor bearings, the register, usually the braking element, and sometimes the adjusting devices

3.8.5
basic speed
nominal speed of rotation of the rotor expressed in revolutions per minute when the meter is under reference conditions and carries nominal current at unity power-factor

3.8.6
basic torque
nominal value of the torque to apply to the rotor to keep it from moving, when the meter is under reference conditions and carries nominal current at unity power factor

3.8.7
vertical working position
position of the meter in which the shaft of the rotor is vertical

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3.9 Definitions related to meter marking and symbols

3.9.1
primary register
register of an instrument transformer-operated meter which takes into account the ratios of all the transformers (voltage and current transformers) to which the meter is connected

Note 1 to entry: The value of the energy on the primary side of the transformers is obtainable from the direct reading of the register.

3.9.2
half-primary register
register of an instrument transformer-operated meter which takes into account either the ratio(s) of the current transformer(s) or the ratio(s) of the voltage transformer(s), but not both

Note 1 to entry: The value of the energy on the primary side of the transformer(s) is obtainable from the reading of the register multiplied by an appropriate factor.

3.9.3
secondary register
register of an instrument transformer-operated meter which does not take into account the transformer ratio(s)

Note 1 to entry: The value of the energy on the primary side of the transformer(s) is obtainable from the reading of the register multiplied by an appropriate factor.

3.9.4
nameplate information
information for the identification and installation of the meter and for the interpretation of the measurement results

Note 1 to entry: Nameplate data may be carried by a nameplate placed inside or outside of the meter case or may be printed on the meter case.

Note 2 to entry: In the case of static meters, some nameplate data may be shown on the display.

3.9.5
dial
part of the indicating device carrying the scale or scales

Note 1 to entry: In general, the dial also carries other information characterizing the instrument.

[SOURCE: IEC 60050-311:2001, 314-01-03]

3.9.6
constant C
reading factor for displays or registers of transformer operated meters, which is a product of voltage transformer ratio and current transformer ratio

Note 1 to entry: Constant C represents the factor to calculate primary energy value from energy value, which is shown in meter display. The measured energy value must be multiplied by the constant C to get primary energy value. Constant K (see 3.9.9) is the factor, considered already in displayed value; display shows primary value.

Note 2 to entry: Examples are shown in table below:

Line	U primary	U secondary	I primary	I secondary	C
1	1 000 V	100 V	1 A	1 A	10
2	100 V	100 V	600 A	1 A	600
3	1 000 V	100 V	600 A	1 A	6 000
4	100 V	100 V	1 A	1 A	1

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Note 3 to entry: Values for C placed on the meter nameplate, a separate label or in meter display

3.9.7
meter constant X for electromechanical meter
value expressing the relation between the energy registered by the meter and the corresponding number of revolutions of the rotor

Note 1 to entry: The constant is expressed in either revolutions per kilowatt-hour (imp/kWh) resp. per kilovar-hour (imp/kvarh) or watt-hours (Wh/imp) resp. var-hours (varh/imp) per revolution .

3.9.8
meter constant R for static watt-hour meters
value expressing the relation between the energy registered by the meter and the corresponding value of the test output

Note 1 to entry: The constant is expressed either impulses per kilowatt-hour (imp/kWh) resp. per kilovar-hour (imp/kvarh) or watt-hours (Wh/imp) resp. var-hours (varh/imp) per impulse.

3.9.9
transformer ratio
K
ratio between the primary and secondary voltage multiplied by the primary and secondary current of the instrument transformer to which the meter is connected

$$K = \frac{Up}{Us} \times \frac{Ip}{Is}$$

where

U_p is the primary voltage of the voltage transformer;

U_s is the secondary voltage of the voltage transformer;

I_p is the primary current of the current transformer;

I_s is the secondary current of the current transformer.

4 Nominal electrical values

4.1 Voltages

4.1.1 Nominal voltages

The nominal voltage(s) of a meter shall be equal to one or more of the nominal voltages listed in Table 1.

Table 1 – Nominal voltages

Meters for	Nominal values U_n for AC meters V	Nominal values U_n for DC meters V
Direct connection	100 – 110 – 120 – 208 – 220 – 230 – 240 – 277 – 347 – 380 – 400 – 415 – 480 – 600 – 690 – 1 000 (IEC 60038: 2009)	5 – 9 – 12 – 24 – 36 – 48 – 60 – 96 – 100 – 110 – 120 – 150 – 200 – 220 – 240 – 300 – 400 – 500 – 600 – 750 – 800 – 1000 – 1500 Preferred values; other values may be chosen (IEC 60038: 2009)
Connection through voltage transformer(s)	57,7-63,5-100-110-115-120-200-230 (IEC 61869-3: 2011)	n/a

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4.1.2 Voltage ranges

The voltage ranges of a meter shall be at least equal to the voltage ranges listed in Table 2.

Table 2 – Voltage ranges

Specified operating range	From 0,9 to 1,1 U_n
Limit range of operation	From 0,0 to 1,15 U_n [a]

[a] For AC meters, the maximum voltages under earth-fault conditions are specified in 9.4.13; these voltages are considered as fault conditions (not normal operating conditions).

NOTE 1 U_n refers to each nominal voltage specified by the manufacturer and selected from Table 1.

NOTE 2 In some countries, the limit range of operation could be extended beyond the values shown in this Table, which are regarded as minimum values to guarantee the proper functioning of the meter under normal working conditions. For special applications, extended ranges of operation might be necessary and be subject to an agreement between the manufacturer and the purchaser.

4.2 Currents

4.2.1 Nominal currents

The preferred nominal current(s) of a meter shall be equal to one or more of the nominal current values listed in Table 3.

Table 3 – Preferred values of nominal currents

Meters for	Nominal current values I_n for AC meters [a] A	Nominal current values I_n for DC meters A
Direct connection	1 – 2 – 5 – 10 – 15 – 20 – 30 – 40 – 50 – 63 – 80 – 100 – 125	5 – 10 – 15 – 20 – 30 – 40 – 50 – 80 – 90 – 125 – 300 – 500 Preferred values; other values may be chosen
Connection through current transformer(s)	1 – 2 – 5	n/a

[a] The values of 1A, 2A for directly connected meters are for special applications.

For meters intended for operation with LPITs, the values in Table 3 for direct connection apply to the primary ratings of the LPITs used with the meter.

NOTE Meters operating with external LPITs are sometimes specified for nominal current values greater than the values in Table 3, e.g. common values to be considered are 160 A, 200 A, 250 A, 400 A, 500 A, 600 A, 630 A.

4.2.2 Starting current

The meter shall start and continue to register electrical energy at current value equal to the starting current (I_{st}) value specified in the relevant accuracy class standard. Registration of energy at current values lower than the starting current is permitted.

4.2.3 Minimum current

The meter shall meet its accuracy requirements at the minimum current (I_{min}) value as specified for the relevant accuracy class standard.

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There are no specified accuracy requirements for energy registration at current values lower than the minimum current (I_{min}) value specified in the relevant accuracy class standard.

NOTE For special applications, the accuracy requirements between I_{st} and I_{min} are subject to an agreement between manufacturer and user.

4.2.4 Maximum current

The maximum current (I_{max}) for directly connected meters should be an integral multiple of the nominal current (for example four times the nominal current).

When the meter is operated from (a) current transformer(s), attention is drawn to the need to match the current range of the meter in relation to that of the secondary of the current transformer(s). The maximum current (I_{max}) of the meter shall be at least 1,2 I_n or 1,5 I_n. Maximum currents above 1,5 I_n should be integer multiples of the nominal current I_n.

4.2.5 Current ranges

The current range of a meter shall be at least equal to the current ranges listed in Table 4.

Table 4 – Current ranges

Specified operating range	I_{min} to I_{max}
Limit range of operation	0 to I_{max}
NOTE Maximum short-term overcurrent conditions are specified in 9.4.10; these currents are considered as fault conditions (not normal operating conditions);	

4.3 Frequencies

4.3.1 Nominal frequencies

The nominal frequencies for AC meters (f_n) shall be equal to at least one of the nominal frequencies of 50 Hz or 60 Hz.

4.3.2 Frequency ranges

The frequency range(s) of AC meters shall be at least equal to the frequency ranges listed in Table 5.

Table 5 – Frequency ranges

Frequency range	f_n = 50 Hz	f_n = 60 Hz
Specified operating range (f_n ±2 %)	From 49,0 Hz to 51,0 Hz	From 58,8 Hz to 61,2 Hz
Other frequency ranges	Extended frequency ranges are subject to an agreement between the manufacturer and the purchaser.	

4.4 Power consumption

The power consumption requirements in 4.4. apply to AC meters.

The power consumption requirements for DC meters are given in the relevant particular accuracy class standards.

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The power consumption of a meter shall be determined at reference conditions given in 7.1 by any suitable method. The maximum uncertainty of the measurement of the power consumption shall not exceed 5 %.

The active and apparent power consumption for each voltage and current circuit measured at nominal frequency and reference temperature shall not exceed the values shown in Table 6.

In case of meters specified for multiple values of nominal frequency, voltage or current, the measurements shall be conducted using nominal values resulting in the worst case (highest) power consumption of the meter.

Table 6 – Maximum power consumption

Meter circuit	Single-phase[b, c]	Two-phase per phase[a, b, c]	Three-phase per phase[a, b, c]
Voltage circuit of single-function energy meters measured at nominal voltage with meter's power supply circuit connected to the voltage circuits;	2 W 10 VA	2 W 10 VA	2 W 10 VA
Voltage circuit of multi-energy meters measured at nominal voltage with meter's power supply circuit connected to the voltage circuits;	3 W 15 VA	2,5 W 12,5 VA	2 W 10 VA
Voltage circuit of multi-function meters without auxiliary devices, measured at nominal voltage with meter's power supply circuit connected to the voltage circuits;	5 W 25 VA	3,5 W 17,5 VA	3 W 15 VA
Voltage circuits of multi-function meters with auxiliary devices, measured at nominal voltage with meter's power supply circuit connected to the voltage circuits; Auxiliary devices may include communication devices (such as telephone and radio transceivers, PLC), devices performing functions not related to energy metering and billing (such as supply or load control devices, network analysis, harmonic analysis, power quality analysis), detached indicating displays, input-output modules, or other accessories;	Not specified [2]		
Voltage circuits measured at nominal voltage with meter powered by auxiliary power supply;	Not specified [3]		
Auxiliary power supply measured at nominal voltage of the auxiliary power supply;	Not specified [4]		
Current circuit of electromechanical meters, when measured at nominal current;	Class 0,5: 6 VA per phase; Class 1: 4 VA per phase; Class 2: 2,5 VA per phase.		
Current circuit of static meters, when measured at nominal current.	For all classes: 1 VA per phase.		

[a] For polyphase meters, the burden is supposed to be evenly shared between the two or three phases supplied. Should a phase voltage be missing, it is permitted that the maximum consumption per phase is higher than specified but in no case shall exceed three times the allowed limit for individual phase. However, the meter shall continue to operate correctly.

[b] In order to match voltage and current transformers to meters, the meter manufacturer shall state whether the burden is inductive or capacitive (for transformer operated meters only).

[c] Switching power supplies with peak power values higher than these specified values are permitted; the meter manufacturer shall state whether the power supply burden is inductive or capacitive.

NOTE 1 The figures in Table 6 are mean values.

NOTE 2 The total power required is subject to an agreement between the manufacturer and the purchaser;

NOTE 3 The power consumption is subject to an agreement between the manufacturer and the purchaser. To reduce the burden of voltage transformers, a common value is 0,5 VA per phase;

NOTE 4 The total power required is subject to an agreement between the manufacturer and the purchaser. A common value is 10 VA per phase;

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5 Construction requirements

5.1 General

The meter shall comply with the safety requirements covered in IEC 62052-31:2015.

The construction safety requirements for detached indicating displays are covered in IEC 62052-31:2015, 13.1 c).

All parts which are subject to corrosion under normal working conditions shall be protected effectively. Any protective coating shall not be liable to damage by ordinary handling nor damage due to exposure to air, under normal working conditions.

The meter case shall be so constructed and arranged that any non-permanent deformation cannot prevent the satisfactory operation of the meter. In case of meters with detached indicating displays, this requirement applies also to the enclosure of the detached indicating display.

The meter cover shall not be removable without the use of a tool.

The mechanical strength of the meter shall be tested with the tests specified in 5.2.

NOTE 1 For meters for special use in corrosive atmospheres, additional mechanical requirements are subject to an agreement between the manufacturer and the purchaser (for example salt mist test according to IEC 60068-2-11).

If an electricity meter is designed to be installed in a specified matching socket or a rack, then the mechanical requirements apply to, and the mechanical tests shall be performed on, the meter installed in its specified matching socket or rack, as per the manufacturer's instructions.

If an electricity meter is designed to be installed with a specified detached indicating display, then the mechanical requirements apply to, and the mechanical tests shall be performed on, the meter and its specified detached indicating display.

If an electricity meter is designed to be installed with specified LPITs, then the mechanical requirements apply to, and the mechanical tests shall be performed on, the meter with its specified LPITs connected.

Electricity meters designed to operate only with data communication interfaces and without any indicating display may be also evaluated using this document. However, requirements specified for indicating displays, integrated or detached, shall not apply to such meters.

NOTE 2 National or regional requirements often require an indicating display on meters intended for legal metrology applications.

5.2 Mechanical tests

5.2.1 Shock test

The test shall be carried out according to IEC 60068-2-27: 2008, under the following conditions:

a) meter in non-operating condition, without the packing;

b) half-sine pulse;

c) peak acceleration: 30 g_n (300 m/s^2);

d) duration of the pulse: 18 ms.

After the test, the meter shall show no damage or change of the information and shall operate correctly in accordance with the requirements of the relevant standard.

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5.2.2 Vibration test

The test shall be carried out according to IEC 60068-2-6: 2007, under the following conditions:

a) meter in non-operating condition, without the packing;
b) frequency range: 10 Hz to 150 Hz;
c) transition frequency: 60 Hz;
d) $f < 60$ Hz, constant amplitude of movement 0,075 mm;
e) $f > 60$ Hz, constant acceleration 9,8 m/s^2 (1 g);
f) single point control;
g) number of sweep cycles per axis: 10.

NOTE 10 sweep cycles = 75 min.

After the test, the meter shall show no damage or change of the information and shall operate correctly in accordance with the requirements of the relevant standard.

5.3 Window

If the cover is not transparent, one or more windows shall be provided for reading the indicating display and observation of the operation indicator.

These windows shall be of transparent material which cannot be removed undamaged without breaking the seal(s). This requirement also applies to detached indicating displays.

5.4 Terminals – Terminal block(s) – Protective conductor terminal

The material of which the terminal block is made shall be capable of passing the tests given in 10.5.2 of IEC 62052-31:2015. This requirement applies to terminals of combined current and voltage circuits of directly connected meters, terminals of voltage circuits of transformer operated meters, terminals of current circuits of transformer operated meters, and terminals of auxiliary power supply circuits.

The protective conductor terminal, if present, shall meet the requirements given in 6.5.2.3 of IEC 62052-31:2015.

5.5 Sealing provisions

5.5.1 General

The meter shall be designed in a way that allows sealing of the meter case, the meter terminal covers, and the relevant metrological configuration parameters which influence the measurement results.

If the meter is installed in a meter cabinet that is sealed, the terminal covers do not need to be sealed (see 5.5.3.1).

When the meter has been installed according to the installation instructions, regardless of the solution used to implement sealing, it shall be visually evident if the sealing has been tampered with.

5.5.2 Meter case

The meter case shall have a means for applying a metrology seal in such a way that the internal parts of the meter are accessible only after breaking the sealing mechanism.

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The meter case may be designed in such a way that it cannot be opened after the meter is manufactured. A seal is not required if the meter case cannot be opened without damaging it to such an extent that the attempt is clearly visible, and the meter case cannot be reused.

5.5.3 Meter terminals

5.5.3.1 General

The terminals of a meter shall be protected against tampering using sealable terminal covers, or by installing the meter in a sealable electrical cabinet.

5.5.3.2 Sealing of installation cabinet

Meters specified by the manufacturer for installation in sealable electrical cabinets are considered to meet the requirement for terminal sealing provisions without sealable terminal covers.

NOTE The terminals of a meter installed in a sealed electrical cabinet are protected against tampering by the cabinet and its seal. In this case, the access to the meter terminals is not possible without breaking the installation seal of the electrical cabinet.

5.5.3.3 Sealing of terminal covers

The terminals of meters specified for installation without a sealable electrical cabinet shall have a terminal cover(s) which can be sealed independently of the meter case and the meter cover.

Access to the meter terminals shall not be possible without breaking the seal(s) of the terminal cover(s).

This requirement applies to the terminal cover(s) for the terminals of current and voltage measuring circuits, and the terminals of auxiliary power supply circuits.

NOTE 1 Local metrological regulations may require additional seals to be provided for other terminals (e.g. detached display terminals) or covers (for example covers protecting access to configuration switches).

NOTE 2 Terminal covers are sometimes applied for reasons of electrical safety, however in this case they need not be sealed.

The terminal cover shall enclose the meter terminals, the conductor fixing screws and, a suitable length of the external conductors and their insulation. No conductive material shall be exposed when the terminal cover is installed.

5.5.4 Sealing of detached indicating displays

The enclosure (case) of a detached indicating display shall have means for applying a metrology seal in such a way that the internal parts of the detached indicating display are accessible only after breaking the sealing mechanism.

All seals are not required if the enclosure of the detached indicating display cannot be opened without damaging it to such an extent that the attempt is clearly visible, and the enclosure cannot be reused.

The connection terminals of the detached indicating display cable, both at the meter and at the detached indicating display, shall have means for being sealed with an installation seal.

5.5.5 Sealing of LPIT connections

The connection terminals of the LPIT cables, both at the meter and at the LPIT end, shall have means for being sealed with a metrology seal.

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5.5.6 Sealing of meter configuration

The meter and its detached indicating display, if present, shall have means for securing of all metrologically relevant parameters by means of (a) metrology seal(s). The securing means may comprise a hardware seal capable of providing sufficient evidence of unauthorized intervention, or an embedded software (firmware) cryptographic seal, or both.

5.6 Display of measured values

5.6.1 General

These requirements are applicable to meters with or without indicating displays.

The principal unit for the measured values shall be the watt-hour (Wh), var-hour (varh), volt-ampere-hour (VAh), kilowatt-hour (kWh), kilovar-hour (kvarh), kilovolt-ampere-hour (kVAh) or the megawatt-hour (MWh), megavar-hour (Mvarh), megavolt-ampere-hour (MVAh).

Each register shall be able to record starting from zero, for a minimum of 4 000 h, the energy corresponding to maximum current at nominal voltage and unity power factor for active energy, or zero power factor for reactive energy. In meters intended for applications in power plants and substations, the value of 1 500 h may be used, and is subject to an agreement between the manufacturer and the purchaser.

It shall be impossible to reset the register of the cumulative total for each electrical energy type during normal use.

NOTE The regular rollover of the register is not considered as a reset.

For electromechanical registers, register markings shall be indelible and easily readable. When continuously rotating, the lowest values of the drums shall be graduated and numbered in ten divisions, each division being subdivided into ten parts, or any other arrangement ensuring the same reading accuracy. The drums which indicate a decimal fraction of the unit shall be marked differently when they are visible.

The update rate of the energy register shall be documented in the user manual.

5.6.2 Meters without indicating displays

The measurement results (value of the register) shall be available via a data communication interface(s).

5.6.3 Meters with indicating displays

5.6.3.1 General

The measurement results shall be shown on an indicating display either continuously or on demand.

When the meter is not energized, an electronic indicating display does not need to be readable.

In the case of multiple values presented by a single indicating display it shall be possible to display the content of all relevant registers.

When displaying the register content, the identification of each measured quantity and the applicable tariff shall be possible.

NOTE For example, IEC 62056-6-1: 2017 specifies appropriate OBIS codes for this purpose.

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For indicating displays with automatic sequencing, each register content used for billing purposes shall be displayed for a minimum of 5 s.

An electronic indicating display shall be provided with a test function for the purpose of determining whether it is functioning correctly. This function shall be accessible during normal use of the meter.

Every numerical element of an electronic indicating display shall be able to show all the numbers from "zero" to "nine".

For testing purposes only, it shall be possible to increase the resolution in order to enable the critical change value to be seen.

5.6.3.2 Detached indicating display

A detached indicating display shall provide information sufficient to identify the meter to which it is connected, in particular, the type and serial number of the meter.

The detached indicating display shall be capable of showing the status of its data communication connection with the meter. If the data communication connection between the meter and the detached indicating display is lost, the detached indicating display shall not show values which may be considered as valid and up-to-date measurement results. An indication of an invalid meter reading may be used, such as "error" or "n/a". Such indication of an invalid meter reading, if used, shall be described in the user manual.

NOTE The IEC 62056 DLMS/COSEM suite specifies appropriate standards for the data exchange between the meter and the detached indication display. However, the use of other standardized or proprietary communication protocols is also acceptable.

5.7 Storage of measured values

Following the disconnection of all external power sources to the meter, the amounts of electrical energy measured shall remain stored in the meter’s memory for a period of at least 12 months while the meter is powered down and shall be available for reading once the meter power is restored.

The measured values shall be stored in the meter.

Conformity to 5.7 shall be verified by a design examination.

NOTE National or regional requirements may contain provisions to guarantee access to the data stored in the meter’s memory.

5.8 Pulse outputs

5.8.1 General

Pulse outputs shall be designed in such a way that electromagnetic influence quantities and disturbances do not damage or substantially influence its operation.

Pulse outputs may be configurable to represent different measured quantities (for example such as those listed in 5.6.1, or any other time-integrated quantities) if an indication is provided to identify the quantity represented by the output pulses.

5.8.2 Optical test output

5.8.2.1 General characteristics

Static meters shall have an optical test output capable of being monitored with suitable testing equipment.

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The optical test output shall be located on the meter.

In case of meters designed to operate with a detached indicating display, a second optical test output may be also located on the detached indicating display.

An optical test output shall be accessible when the meter is installed for normal operation.

NOTE In case of meters intended to be installed as completely enclosed within an electrical cabinet, the access to the optical test output may be possible after opening of the electrical cabinet.

The test output pulses shall represent the total energy measured by the meter on all phases of the electrical system. In addition, it may be configurable to represent per-phase energy values.

The optical test output shall generate a number of pulses proportional to the measured energy.

Pulse outputs generally may not produce periodic pulse sequences. Therefore, the manufacturer shall state the necessary number of pulses to ensure a measuring accuracy of at least ± 1/10th of the class of the meter at the different test points.

The maximum pulse frequency shall not exceed 2,5 kHz.

The unmodulated output pulses shall have the shape shown in Figure A.2.

The pulse transition time (rise time or fall time) is the time of transition from one state to the other state, including transient effects. The transition time shall not exceed 20 μs (see Figure A.2).

5.8.2.2 Optical characteristics

The wavelength of the radiated signals for emitting systems shall be between 550 nm and 1 000 nm.

The optical output in the meter shall generate a signal with a radiation strength E_T over a defined reference surface (optically active area) at a distance of a_1 = 10 mm ± 1 mm from the surface of the meter, with the following limiting values:

ON-condition: $50\ \mu W/cm^2 \leq E_T \leq 1\ 000\ \mu W/cm^2$

OFF-condition: $E_T \leq 2\ \mu W/cm^2$

See also Figure A.1.

5.8.2.3 Functional tests

The optical pulse output shall operate correctly with regards to the number of pulses emitted, and the times t_{ON} and t_{OFF} shall remain within their specified range. The functional tests of the optical test output shall be carried out under reference conditions given in 7.1. The test arrangement shall be according to Annex A.

An optimum pulse transmission is achieved when, under test conditions, the receiving head is aligned with its optical axis on the optical pulse output.

The transition time given in Annex A, Figure A.2 shall be verified by a reference receiver diode with $t_r \leq 0{,}2$ μs.

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5.8.3 Electrical pulse output

5.8.3.1 General characteristics

The meter may be equipped with electrical pulse outputs.

The meter may have a passive, externally powered pulse output(s). Such pulse outputs may be used as meter test outputs, or to transmit pulses representing a finite energy quantity, to a remote receiver (e.g. a tariff device).

Three types of pulse outputs are defined:

a) pulse outputs class A for long range transmission (See Annex B);
b) pulse outputs class B for short range transmission (See Annex B);
c) pulse outputs for long distances according to IEC 60381-1:1982 (See Annex C).

The pulse output shall generate a number of pulses proportional to the measured energy.

The output pulse is characterized by two states: ON-state and OFF-state, as defined in Table B.1 and Table B.2. Each ON-state and each OFF-state is followed by a transient state before reaching the other state.

When the meter is equipped with several pulse outputs that have a common terminal this common terminal shall be negative.

5.8.3.2 Electrical characteristics

The main electrical characteristics of class A and class B electrical pulse outputs are summarized in Annex B, Table B.1.

The main electrical characteristics of pulse outputs for long distances according to IEC 60381-1: 1982 are summarized in Annex C, Table C.1.

5.8.3.3 Functional tests

The pulse output shall operate correctly with regards to the number of pulses emitted, and the times t_{ON} and t_{OFF} shall remain within their specified range. The functional tests of the electrical pulse outputs shall be carried out under reference conditions given in 7.1.

Class A and B electrical pulse outputs shall fulfil the requirements of Annex B, Table B.2. The arrangement shall be according to Annex B, Figure B.3.

Electrical pulse outputs for long distances according to IEC 60381-1:1982 shall fulfil the requirements of Annex C, Table C.2. The arrangement shall be according to Annex C, Figure C.2.

5.8.4 Operation indicator

Electromechanical meters do not need to be equipped with an operation indicator.

Solid state meters shall have an operation indicator.

The operation indicator is intended to show that the meter's power supply circuit is energized.

An operation indicator shall be visible when the meter is installed for normal use.

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The operation indicator shall be located on the meter and on the detached indicating display, if present.

NOTE In case of meters intended to be installed as completely enclosed within an electrical cabinet, the operation indicator located on the meter is not visible when the electrical cabinet is closed. The operation indicator on the detached indicating display (if present) remains visible.

The optical output may be configurable to operate as the operation indicator or as the test output if an indication is provided to identify the active function of the optical output.

Alternatively, the indicating display may be used to provide (or be considered as) an indication of meter operation.

5.9 Electrical pulse inputs

5.9.1 General characteristics

The meter may have a passive or active two-wire, pulse input(s). Such pulse inputs may be used to receive pulses, representing a finite energy quantity.

Inputs shall be designed in such a way that electromagnetic influence quantities and disturbances do not damage or substantially influence their operation.

5.9.2 Functional tests of electrical pulse inputs

The functional tests of the electrical pulse inputs shall be carried out under reference conditions given in 7.1.

Pulse inputs compatible with class A or class B outputs shall fulfil the requirements given in Annex B, Table B.3. The test arrangement shall be according to Annex B, Figure B.4.

Pulse inputs compatible with pulse outputs for long distances according to IEC 60381-1:1982 shall fulfil the requirements given in Annex C, Table C.3. The test arrangement shall be according to Annex C, Figure C.3.

5.10 Auxiliary power supply

In special applications meters may be powered either exclusively from an auxiliary power supply, or from both the voltage circuits (measured mains) and from the auxiliary power supply.

NOTE 1 The source of auxiliary power depends on the local installation, e.g. 24 V DC to 48 V DC is often used in panel meters integrated in power distribution switchboards; 48 V DC to 220 V DC is used in substation installations where a substation battery or an uninterruptible power supply (UPS) is available as the power source for automation, protection and monitoring equipment.

Where a three-phase meter powered exclusively from the auxiliary power supply is intended to be used in billing applications, the manufacturer shall specify the auxiliary power supply connection method(s) which ensure the meter operation when any one or two of its voltage circuits (phases of the measured mains) are de-energized.

In addition, auxiliary power supply terminals of such meters shall be marked with symbol 14 from IEC 62052-31:2015, Table 3 and shall be accompanied by appropriate information in the installation instructions, such as "for billing operation: auxiliary power supply shall be permanently energized" (see 9.4.5).

NOTE 2 In some countries, due to the national legal metrology regulations, an electricity meter used for billing is always powered from its voltage circuits.

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Meters powered both from their voltage circuits and from the auxiliary power supply shall automatically switch between these power sources in case either one becomes de-energized. The manufacturer and the purchaser may agree which of the power sources becomes the default supply when both are energized, and which one is considered the backup one. When operating from the backup supply, the meter shall maintain its primary functions defined in 9.2; however, the manufacturer and the purchaser may agree which of the other meter functions, if any, should be maintained.

6 Meter marking and documentation

6.1 Meter accuracy class marking

A meter shall not be marked with an accuracy class index unless it meets all applicable accuracy and performance requirements specified in the relevant accuracy class standard(s).

6.2 Meter marking

A meter shall bear all of the markings required by local regulations. In addition, and if not already required by the local regulations, the meter shall also bear the following information as applicable:

a) manufacturer's name or trademark;

b) designation of type (see e.g. 3.1.2, 3.1.13);

NOTE 1 Examples are "kWh meter", "kvarh meter", "energy meter", "smart meter", "time switch", "ripple control receiver".

c) space for approval mark;

d) the meter serial number and year of manufacture.

   If the meter serial number is marked on a plate fixed to the cover, the number shall also be marked on the meter base.

   In addition, for static meters, the serial number shall be stored in the meter's non-volatile memory, viewable on the indicating display (if present) and accessible via communication ports (if present).

   The serial number of the detached indicating display shall be marked on a case of the detached indicating display, stored in its non-volatile memory, viewable on the indicating display and accessible via communication ports (if present on meter or on the detached indicating display);

e) service type: these markings may be replaced by the graphical symbols given in 6.4.1, Annex D, Table D.2. Meters which are configurable to support multiple service types, or meters capable of automatic detection and configuration of service type shall be marked with all possible service types and shall indicate the configured (operating) service type on the indicating display;

f) the nominal voltage or the range of voltage, in one of the following forms:

   - the number of elements if more than one, and the nominal voltage, or the range of voltage, at the meter terminals of the voltage circuit(s);
   - the nominal voltage of the system or the nominal secondary voltage of the instrument transformer to which the meter is intended to be connected. Examples of markings are shown in Annex D, Table D.1;

g) the minimum current, nominal current and the maximum current for directly connected meters: $I_{min} – I_n (I_{max})$;

NOTE for example, 0,5 – 10(40) A, for a meter having a minimum current of 0,5 A, nominal current of 10 A and a maximum current of 40 A.

h) the rated secondary current of transformer(s) to which a transformer-operated meter should be connected, for example: /5 A or /1 A. The nominal current(s) and the maximum current(s) of the meter may be included in the type designation.;

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i) the nominal frequency in Hz for AC meters; for DC meters "DC" shall be marked;

j) the meter constants; see examples given in Annex D, Table D.4. Meter constants for both active and reactive energy shall be marked, if the meter measures both types of energy;

k) the ratio(s) of external instrument transformers, if taken into account in the meter constant;

l) the accuracy class index of the meter; see examples given in Annex D, Table D.4. Classes for both active and reactive energy shall be marked, if the meter measures both types of energy;

m) the specified operating temperature range (see Table 12);

n) if the meter is of a special type (for example in the case of a multi-rate meter, if the voltage of the tariff control device differs from the nominal voltage), this shall be marked on the meter or on a separate plate;

o) the nominal value and the operating range of the auxiliary supply voltage and frequency, if the meter requires an auxiliary power supply;

p) the identification of the embedded software (firmware); the identification of the meter's embedded software (firmware) shall be stored in the meter's non-volatile memory; the identification of the embedded software (firmware) of the detached indicating display (DID) shall be stored in the DID's non-volatile memory; in both cases, the identification of the embedded software (firmware), shall be viewable on the indicating display (if present), and shall be accessible through communication ports (if no display is present).

The location of the meter marking shall be as specified in Table 7 columns C ("Case" i.e. meter enclosure) and D ("Display" i.e. indicating display of the meter, integrated or detached).

Other information shall be provided on meter packaging and in documentation as specified in the remaining columns in Table 7.

The external nameplate shall be permanently attached to the meter case.

The marking on an external nameplate shall be indelible, distinct and legible from outside the meter.

Markings shall remain clear and legible under conditions of normal use and resist the effects of cleaning agents specified by the manufacturer. Meter markings shall be tested for their durability in accordance with IEC 62052-31:2015, 5.2.2.

Standard symbols may be used (see 6.4).

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Table 7 – Marking and documentation requirements

Information	Subclause reference	Location [b, 1]						
		C[a]	D	P	IM	UM	MM	DID-C[a]
General information								
Manufacturer's name or trademark	IEC 62052-11:2020, 6.2a) IEC 62052-31:2015, 5.3.2	M	O	M	M	M	M	M
Designation of function	IEC 62052-11:2020, 6.2 IEC 62052-31:2015, 5.3.2	O	O	O	O	O	O	
Type	IEC 62052-11:2020, 6.2b) IEC 62052-31:2015, 5.3.2	M	M	M	M	M	M	M
Space for approval mark	IEC 62052-11:2020, 6.2c) IEC 62052-31:2015, 5.3.2	M						O
Meter serial number and year of manufacture	IEC 62052-11:2020, 6.2d) IEC 62052-31:2015, 5.3.2	M	M	O				M
Detached indicating display serial number	IEC 62052-11:2020, 6.2d) IEC 62052-31:2015, 5.3.2		M	O				M
Embedded software (firmware) identification	IEC 62052-11:2020, 6.2p)		M					
Protective class	IEC 62052-31:2015, 5.3.2	M		M	M		M	M
Rated impulse voltage U_{imp} [5]	IEC 62052-31:2015, 5.3.2	M		M	M		M	
Utilization category (UC) for directly connected meters only with SCS	IEC 62052-31:2015, 5.3.2	M		M	M		M	
Environmental conditions, storage				O	M		M	
Environmental conditions, operation, including				O	M		M	
• mechanical conditions				O	O		O	
• climatic conditions				O	O		O	
• altitude				O	O		O	
• location (dry or wet)				O	O		O	
IP rating		O		M	M		M	O
Reference to standards [7]		M		M	M	M	M	O
Reference to instructions		O	O					O
Nominal value and the operating range of the auxiliary power supply voltage	IEC 62052-11:2020, 6.2o) IEC 62052-31:2015, 5.4.3	M	O		M	M	M	
Nominal value and the operating range of the auxiliary power supply frequency	IEC 62052-11:2020, 6.2o) IEC 62052-31: 2015, 5.4.3	M	O		M	M	M	
General information for installation and commissioning								
Handling and mounting	IEC 62052-31: 2015, 5.4.2			O	M		M	
Enclosure	IEC 62052-31: 2015, 5.4.3				M			
Connection requirements	IEC 62052-31: 2015, 5.4.4				M		M	
Connection and wiring diagrams	IEC 62052-31: 2015, 5.4.4.2	M			M		M	
Mains terminals	IEC 62052-31: 2015, 5.4.4.3	M			M		M	
Auxiliary terminals	IEC 62052-31: 2015, 5.4.4.4	M			M		M	
Connecting cables	IEC 62052-31: 2015, 5.4.4.5				M		M	
Isolation from the supply	IEC 62052-31: 2015, 5.4.4.6				M		M	

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Information	Subclause reference	Location [b, 1]						
		C [a]	D	P	IM	UM	MM	DID-C [a]
Protection requirements	IEC 62052-31: 2015, 5.4.5				M		M	
Protective class and earthing (grounding)	IEC 62052-31: 2015, 5.4.5.1	M			M		M	
External protection devices	IEC 62052-31: 2015, 5.4.5.2				M		M	
Supply for external devices	IEC 62052-31: 2015, 5.4.7				M		M	
Self-consumption	IEC 62052-31: 2015, 5.4.9				M		M	
Commissioning	IEC 62052-31: 2015, 5.4.10				M		M	
General information for use								
General	IEC 62052-31: 2015, 5.5.1					M		
Display, push buttons and other controls	IEC 62052-31: 2015, 5.5.2					M		
Switches	IEC 62052-31: 2015, 5.5.3	M	M			M		
Connection to user's equipment	IEC 62052-31: 2015, 5.5.4					M		
External protection devices	IEC 62052-31: 2015, 5.5.5					M		
CISPR emissions class A product warning	IEC 62052-11:2020, 9.3.14				M	M	M	
General information for maintenance								
Maintenance instructions	IEC 62052-31: 2015, 5.5.6						M	
Cleaning	IEC 62052-31: 2015, 5.5.6				O	M	M	
Batteries	IEC 62052-31: 2015, 5.4.8	M		M	O	O	M	M
Information specific for meters								
Nominal voltage(s) or voltage range	IEC 62052-11:2020, 6.2f) IEC 62052-31: 2015, 5.3.3	M	O		M	M	M	
Service type	IEC 62052-11:2020, 6.2e)	M	O	M	M	M	M	
Nominal current and current range	IEC 62052-11:2020, 6.2g) IEC 62052-11:2020, 6.2h) IEC 62052-31: 2015, 5.3.3	M	O		M	M	M	
Nominal frequency	IEC 62052-11:2020, 6.2i)	M	O		M	M	M	
Meter constant	IEC 62052-11:2020, 6.2j)	O/M[3]	O/M[2,3]		M	M	M	
Accuracy class index	IEC 62052-11:2020, 6.2l)	M	O		M	M	M	
Specified operating temperature range	IEC 62052-11:2020, 6.2m)	M	O		M	M	M	M[4]
Instrument transformer ratio	IEC 62052-11:2020, 6.2k)	O/M[6]	O/M[6]		M	M	M	
Special type information	IEC 62052-11:2020, 6.2n)	M	O		M	M	M	O
Information specific for stand-alone tariff and load control equipment								
Rated Supply voltage(s)		M			M	M	M	
Supply control switches	IEC 62052-31: 2015							
The rated operating voltage: U_e;		M		M	M	M	M	
Load control switches								
The rated operating voltage: U_e;		M		M	M	M	M	
The rated operating current: I_e;		M		M	M	M	M	
The maximum total current of the load control switches: I_{tot};		M		M	M	M	M	

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[a] If there is not enough space for the markings on the meter case or on the case of the detached indicating display, the symbol 14 from IEC 62052-31:2015, Table 3 shall be marked and shall be accompanied by appropriate information in the technical documentation.

[b] The installation, user and maintenance manuals may be combined as appropriate and, if acceptable to the purchaser, may be supplied in electronic format. When more than one of any products is supplied to a single purchaser, it is not necessary to supply a manual with each unit, if acceptable to the purchaser

NOTE 1 Location

C = Case. These markings may appear on an external nameplate(s) or may be carried by the meter cover(s) in a permanent manner. Connection diagrams may be marked on the underside of the terminal cover(s).

D = screen of integrated indicating display or screen of a detached indicating display.

P = Packaging.

IM = Installation manual.

UM = User manual.

MM = Maintenance manual.

DID-C = Case of a detached indicating display. These markings may appear on an external nameplate(s) or the case of a detached indicating display.

M = Mandatory.

O = Optional.

NOTE 2 If the meter constant is programmable

NOTE 3 M on either C or D if the meter constant is not programmable

NOTE 4 If different than the operating temperature range of the meter.

NOTE 5 Normally, the rated impulse voltage of the meter is determined by the meter's nominal voltage and the installation category as per IEC 60664-1:2007, Table B.1. and IEC 62052-31:2015, Table 7. However, in some countries, due to local conditions, the impulse voltage requirements may be higher. In such cases the rated impulse voltage of the meter is subject to an agreement between the manufacturer and the purchaser. U_{imp} is the term used in IEC 60947-1:2007/AMD1:2010/AMD2:2014.

NOTE 6 M on either C or D.

NOTE 7 Only standards for particular requirements of meters.

6.3 Connection diagrams and terminal marking

Every meter shall preferably be indelibly marked with a diagram of connections. If this is not possible, reference shall be made to a connection diagram. For polyphase meters, this diagram shall also show the phase sequence for which the meter is intended. It is permissible to indicate the connection diagram by an identification figure in accordance with national standards.

If the meter terminals are marked, this marking shall appear on the diagram.

6.4 Symbols

6.4.1 General

This subclause applies to letter and graphical symbols intended for marking and identifying the function of electromechanical or static electricity meters and their auxiliary devices.

This section also applies to letter and graphical symbols intended for identifying the information displayed by electromechanical or static electricity meters and their auxiliary devices.

The applicable symbols specified in this subclause shall be marked on the meter case, an external nameplate, dial plate, external labels or accessories, or shown on the indicating display as appropriate.

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6.4.2 Symbols for the measuring elements

In the symbols, which are given as examples in Annex D, Table D.2, each voltage circuit is represented by a line and each current circuit by a small circle.

At the end of each line representing a voltage circuit, (a) circle(s) is (are) placed to represent (a) current circuit(s), arranged to have a point of common connection with that voltage circuit.

If a current circuit and a voltage circuit having such a common point of connection are not part of the same measuring element, the circle representing the current circuit is joined to the mid-point of the line representing the voltage circuit by means of a guideline not more than half the thickness of the first line.

The angle between two lines of a symbol represents the phase angle between the corresponding voltages provided the positive direction be accepted as that going towards the common point in two-line symbols.

In order to distinguish the direction of the voltage acting on each current, a current influenced by a positive direction of voltage shall be indicated by a black circle, and a current influenced by a negative direction of voltage shall be indicated by a white circle.

6.4.3 Symbols for transformer-operated meters

For transformer operated meters, the ratios of the external transformers shall be marked as follows.

The transformer ratios, which are taken into account in the energy registers values shall be shown on the indicating display (if present) and optionally marked on the name-plate or on the dial of the meter; for primary registers, the ratios of all the transformers shall be marked; and for half-primary registers, that ratios which are taken into account in the energy registers values shall be marked.

The transformer ratios which are not taken into account in the energy register values shall be marked on a supplementary plate located on the cover of meters fitted with half-primary or secondary registers; for secondary registers, the ratios of all the transformers shall be marked; and for half-primary registers that ratios which are not taken into account in the energy register values shall be marked.

The transformer symbol as shown in Annex D, Table D.5, shall be marked on the meter case, nameplate or on the dial of the meter fitted with half-primary or secondary registers. This symbol means that the meter is intended to be operated in assembly with instrument transformer(s) the ratio(s) of which is (are) not taken into account by the register. The value of the energy on the primary side of the transformer(s) is in such cases obtainable from the reading of the register multiplied by an appropriate factor.

That factor by which the reading of the register is to be multiplied to obtain the value of the energy on the primary side of the transformers shall be marked on the supplementary plate of meters fitted with half-primary or secondary registers.

See examples in Annex D, Table D.5.

6.4.4 Identification of the displayed information

All information displayed, for example, various identifiers, parameters, energy and demand register readings for import, export or per quadrant active and reactive energy, instantaneous values, per tariff values, historical values, prices, credits, charges, (the list is not exhaustive) shall be identified by appropriate symbols or identifiers. These symbols or identifiers shall be placed close to the information that is to be identified.

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The identifiers to be used in conjunction with COSEM objects specified in IEC 62056-6-2: 2017 are specified in IEC 62056-6-1: 2017.

See examples given in Annex D, Table D.6 and Table D.7.

6.4.5 Marking of the measured quantity

The symbols of principal units in accordance with 6.4.6, together with the applicable SI unit prefixes (for example, k, M, G) shall be marked conspicuously on the meter case, external nameplate or the dial of the meter. If the meter is capable of measuring several different quantities, then the units with the appropriate scalers shall be shown on the indicating display. Other appropriate symbols may be marked on the meter case, an external nameplate, the dial or shown on the indicating display, provided that they do not hinder the clear reading of the measured quantity(ies).

When the meter is intended only for special conditions and/or for a different power-factor range, the appropriate symbol shall be used.

If an electromechanical meter for reactive energy is adjusted to measure under leading power-factor conditions only, or lagging power-factor conditions only, the direction of normal rotation of the rotor, viewed from the front of the meter, shall be from left to right, and the register shall be marked with  or as appropriate. If the meter is adjusted to measure under both leading and lagging power-factor conditions, the direction of rotation of the rotor, viewed from the front of the meter, under lagging conditions shall be from left to right. The two registers shall be marked with or  respectively, close to each register.

If the meter is intended to measure apparent energy with determined limiting values of power factor, these values shall be marked in brackets after the symbol for the measuring unit.

See examples in Annex D, Table D.3.

6.4.6 Symbols of principal units used for meters (see Table 8)

Table 8 – Symbols of principal units used for meters

Designation	Symbol
Ampere	A
Volt	V
Watt	W
Watt-hour	Wh
Var	var
Var-hour	varh
Volt-ampere	VA
Volt-ampere-hour	VAh
Hertz	Hz
Volt squared hour	V^2h
Ampere squared hour	A^2h
Hour	h
Minute	min
Second	s
Degree Celsius	°C

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6.4.7 Symbols for auxiliary devices

See examples given in Annex D, Table D.8.

6.4.8 Symbols for details of the suspension of the moving element

See examples given in Annex D, Table D.9. Applicable only to electromechanical meters.

6.4.9 Symbols for communication ports

See examples given in Annex D, Table D.10.

6.5 Documentation

6.5.1 Installation manuals

For three-phase meters powered exclusively from an auxiliary power supply and intended to be used in billing applications, the manufacturer shall document the auxiliary power supply connection method which ensures meter operation during phase voltage interruptions (see 5.10. and 9.4.5).

The manufacturer shall clearly state if the meter is, or is not, suitable for use on impedance grounded networks (see 9.4.13).

6.5.2 Instruction for use

The meter’s technical documentation shall not reference an accuracy class index unless the meter meets all applicable accuracy and performance requirements specified in the relevant accuracy class standard(s).

If a meter complies only with class A emission limits (see 9.3.14), the following warning shall be included in the instructions for use:

Warning: This equipment is compliant with Class A of CISPR 32: 2015. In a residential environment, this equipment may cause radio interference.

[SOURCE: CISPR 32:2015]

7 Metrological performance requirements and tests

7.1 General test conditions

The following test conditions shall be maintained during the testing of accuracy requirements:

a) The meter shall be tested in its case with the cover in place.

b) All parts intended to be earthed (grounded) shall be earthed (grounded).

c) Before any test is made, the circuits shall have been energized for a time sufficient to reach thermal stability; the length of the warming-up period shall be as specified by the manufacturer. During the test, the meter shall be allowed to stabilize at each current level before measurements for a period specified by the manufacturer, but no longer than 5 min.

d) In addition, for polyphase meters:
   - the phase sequence shall be as marked on the diagram of connections;
   - the voltages and currents shall be substantially balanced (see Table 9).

e) The reference conditions are given in Table 10.

f) For requirements regarding test stations, see IEC 62057-1:–.

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g) If an electricity meter is designed to be installed in a specified matching socket or a rack, then the requirements apply to, and the tests shall be performed on, the meter installed in its specified matching socket or rack (as per manufacturer's instructions), unless specified otherwise.

h) If an electricity meter is designed to be installed with a detached indicating display, then the requirements apply to, and the tests shall be performed on, the meter with its detached indicating display connected.

i) If an electricity meter is designed for operation with external LPITs, then the requirements apply to, and the tests shall be performed on, the meter with its LPITs connected.

If an electricity meter has more than one current circuit per phase, then the requirements of this document shall apply to all current circuits in the meter case.

Table 9 – Voltage and current balance

Polyphase meters	Permissible tolerances
Each of the voltages between phase and neutral and between any two phases shall not differ from the average corresponding voltage by more than	±1 %
Each of the currents in the conductors shall not differ from the average current by more than	±1 %
The phase displacements of each of these currents from the corresponding phase-to-neutral voltage, irrespective of the phase angle, shall not differ from each other by more than	2°

Table 10 – Reference conditions

Influence quantity	Reference value	Permissible tolerances
Ambient temperature	Reference temperature or, in its absence, 23 °C[a]	±2 °C
Ambient relative humidity[b]	45 % to 75 %	–
Air pressure	86 kPa to 106 kPa	–
Voltage	Nominal voltage	±1,0 %
Frequency[c]	Nominal frequency	±0,3 %
Phase sequence[c]	L1 – L2 – L3 [d]	–
Voltage unbalance[d]	All phases connected	–
Waveform[c]	Sinusoidal voltages and currents	Total distortion factor < 2 %
Continuous magnetic induction of external origin	Equal to zero	–
Power frequency magnetic field	Magnetic field equal to zero	Induction value which causes a variation of percentage error not greater than: ±0,1 %, but should in any case be smaller than 0,05 mT [e, f]
Electromagnetic radio-frequency fields, 30 kHz to 6 GHz	Equal to zero	< 1 V/m
Operation of accessories	No operation of accessories	–
Conducted disturbances, induced by radio-frequency fields, 150 kHz to 80 MHz	Equal to zero	< 1 V
Conducted, differential mode disturbances and signalling in the frequency range 2 kHz to 150 kHz at AC power ports	Equal to zero	< 0,1 A
DC voltage and current ripple [c]	Equal to zero	±1,0 %

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Earth resistance	Equal to zero	< 2 Ω

[a] If the tests are made at a temperature other than the reference temperature, including permissible tolerances, the results shall be corrected by applying the appropriate temperature coefficient of the meter.

[b] No condensation, dew, formation of ice, hoar-frost, percolating water, rain, etc., shall be present.

[c] Applicable only to AC meters.

[d] Applicable only to polyphase AC systems.

[e] For a single-phase meter, the test consists of determining the percentage errors first with the meter normally connected to the mains and then after inverting the connections to the current circuits as well as to the voltage circuits. Half of the difference between the two percentage errors is the value of the variation of percentage error. Because of the unknown phase of the magnetic field, the test should be made at 0,05 I_n at unity power factor and 0,1 I_n at 0,5 power factor.

[f] For a three-phase meter, the test consists of making three measurements at 0,05 I_n at unity power factor, after each of which the connection to the current circuits and to the voltage circuits are changed over 120° while the phase sequence is not altered. The greatest difference between each of the percentage errors so determined and their average value is the value of the variation of percentage error.

NOTE The current is not considered an influence quantity, and its value is not specified at reference conditions, because the meter energy accuracy is characterized with respect to the changing load current, while keeping the influence quantities at their reference values.

7.2 Methods of accuracy verification

The verification of accuracy may be performed using any of the meter test methods specified in IEC 62057-1: –, or alternatively by reading the meter's energy registers. The content of the meter's energy registers may be verified by reading the energy registers through the meter's communication ports using the communication protocols specified by the manufacturer.

The manufacturer shall provide to the testing laboratory any software tools which may be required to read the meter's energy register via communication ports.

For testing purposes, the energy registers of the electricity meter shall have a resolution sufficient to observe the critical change value.

The verification of accuracy may be performed using the methods described above or by other suitable means; however, the applied method shall be described in the test report.

In order to determine if the meter has not suffered degradation of its metrological performance after exposure to an external influence or disturbance, it is sufficient to verify the accuracy of the meter at reference conditions.

These methods of accuracy verification apply to the tests specified in 7.4 to 7.11, 8.4, 9.3.2 to 9.3.13, and 9.4.2 to 9.4.13, unless therein specified otherwise.

7.3 Measurement uncertainty

An expanded uncertainty (U) shall be estimated according to IEC Guide 98-3 (GUM:1995/ JCGM 100:2008) with a level of confidence of approximately 95 %.

An expanded uncertainty U shall not be greater than 1/5th of the error limit for the relevant accuracy class, for all accuracy classes except class 0,1S, unless otherwise specified in the relevant test description.

For the accuracy class 0,1S, an expanded uncertainty U shall not be greater than 1/3rd of the error limit, unless otherwise specified in the relevant test description.

If these requirements are met, the test results may be evaluated by comparing the measured percentage error values with the percentage error limit.

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NOTE This decision rule is known as simple acceptance or shared risk (ISO/IEC Guide 98-4:2012 (JCGM 106), 8.2). The probability of a false acceptance or false rejection is not always negligible, but the chances of incorrect decisions are kept to an acceptable level.

However, if the above-mentioned expanded uncertainty requirements cannot be met, the test results (the measured percentage error values) may be evaluated against the percentage error limits reduced by the obtained value of expanded uncertainty U. In this case, the following acceptance criteria shall be used:

For all accuracy classes, except class 0,1S:

$$\varepsilon_{\text{reduced}} = \pm\left(\frac{6}{5} \times |\varepsilon| - |U|\right)$$

For accuracy class 0,1S:

$$\varepsilon_{\text{reduced}} = \pm\left(\frac{4}{3} \times |\varepsilon| - |U|\right)$$

where

$\varepsilon_{\text{reduced}}$ is the reduced percentage error limit;

ε is the percentage error limit specified in the relevant accuracy class standard for the corresponding test;

U is the obtained value of expanded uncertainty.

EXAMPLE When assuming that during testing for type evaluation of a class 1 meter, the test result has an expanded uncertainty U = 0,3 % (k = 2), the test result can be accepted if the percentage error is between ± (6/5 × 1,0 – 0,3) % = ± 0,9 %.

7.4 Meter constant

The relationship between the test output and the indication on the indicating display, if present, and/or the meter energy register content read through the communications interface, shall comply with the value of the meter constant.

The difference between the value determined (or calculated) from the test output and the value on the indicating display, or the register content read via data communications port shall not exceed ±1/10$^{\text{th}}$ of the intrinsic error limit for the relevant accuracy class, except for meters with accuracy class 0,1S.

For meters with accuracy of class 0,1S this difference may be larger, but shall not exceed ± 0,02 %.

The manufacturer documentation and the test report shall state the number of pulses required to verify this requirement. Conformity shall be checked by measuring a sufficient amount of energy, observing the test output and reading the display.

7.5 Initial start-up of the meter

The meter shall start to register energy after the start-up time $t_{\text{start-up}}$ specified by the manufacturer. Generally, the start-up time of the meter shall be not more than 10 s, except for multi-function meters.

In the case of multi-function meters with a real-time operating system and complex embedded firmware, or in the case of meters with SCS that open during power down and close again once the meter is energized, 10 s may not be achievable or economically justifiable. In such cases, the manufacturer and the purchaser may agree on a larger value for $t_{\text{start-up}}$.

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NOTE A documented meter start-up time allows the users to decide if this is acceptable in their application.

Conformity is verified by the following test:

a) The test conditions shall be as specified in 7.1. Initially, the voltage circuits and the auxiliary power supply circuits, if present, shall not be energized; the current circuits shall be carrying the meter's maximum current I_{max}.

b) Subsequently, the voltage circuits and, where applicable, the auxiliary power supply circuits shall be energized with their nominal voltages U_n and cos φ = 1 (for active energy meters) or sin φ = 1 (for reactive energy meters). If the meter is rated for more than one nominal voltage, the lowest nominal voltage shall be used.

c) $t_{start\text{-}up}$ is the time measured from the moment of energizing the voltage circuits and, where applicable, the auxiliary power supply circuits, until the moment the test output produces the first pulse.

If the meter has a SCS that cannot be closed without energizing the voltage circuits, the power supply for the current circuits needs to increase the current to I_{max} after the meter has closed the SCS. This additional delay shall be documented and considered for the determination of $t_{start\text{-}up}$.

7.6 Test of no-load condition

The purpose of this test is to make sure that the energy accumulation, which may occur in the meter's registers due to effects other than the flow of load current, is sufficiently lower than the energy accumulation at the specified starting current I_{st}.

When the voltage is applied to the voltage circuits and if present, to the auxiliary power supply circuit, with no current flowing in the current circuits, the test output of the meter shall not produce more than one pulse. For an electromechanical meter, the rotor of the meter shall not make a complete revolution.

For this test, the SCS if fitted, shall be closed, the current circuit shall be open-circuit and a voltage of 1,1 U_n (110 % of the nominal voltage, i.e. the maximum specified operating voltage) shall be applied to the mains port. For meters rated for multiple nominal voltages, the highest rated nominal voltage shall be used.

The minimum test time Δt, in minutes, is calculated according to the formula given below:

$$\Delta t \geq \frac{240 \times 10^3}{k \times m \times U_{test} \times I_{start}}$$

where

Δt is the minimum required test time,

U_{test} is maximum specified operating voltage, 1,1 U_n, in Volts,

k is the meter constant R (see 3.9.8) for static meters, in impulses per kWh or impulses per kvarh, or the meter constant X (see 3.9.7) for electromechanical meters, in revolutions per kWh or revolutions per kvarh,

m is the number of elements; for DC meters, assume m = 1,

I_{st} is the meter starting current, in Amperes.

7.7 Starting current test

For this test, the conditions shall be as stated in 7.1.

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The lowest specified nominal voltage of the meter shall be used.

The meter shall start and continue to register at the starting current values specified for the accuracy class in the relevant particular requirements (accuracy class) standards.

If the meter is designed for the measurement of energy in both directions, then the starting current test shall be applied with energy flowing in each direction.

7.8 Repeatability test

The application of the same signal to be measured, under the same conditions of measurement, shall result in the close agreement of successive measurements.

At any test point given in Table 11, the repeatability shall be less than, or equal to 1/5th of the absolute intrinsic error limit for the relevant accuracy class, except for meters with accuracy class 0,1S.

For meters with accuracy class 0,1S the repeatability shall not exceed 0,04 %.

NOTE For example, for a class 1 meter the repeatability at I_n shall be better or equal to 1/5th of ± 1,0 %, i.e. 0,2 %.

The methods of accuracy verification described in 7.2 shall apply. The test shall be conducted at reference conditions as specified in 7.1. The manufacturer shall state the necessary number of pulses, or the minimum test duration.

At least three measurements shall be done at each of the test points in Table 11, at the same test conditions and in close succession, after the meter under test has achieved thermal stability.

The lowest specified nominal voltage of the meter shall be used.

Table 11 – Repeatability test points

Value of current		Power factor
for directly connected meters	for transformer operated meters	active energy meters: cos(φ), reactive energy meters: sin(φ), DC energy meters:not applicable
I_{min}	I_{min}	1
0,1 I_n	0,05 I_n	1 0,5 0,8
I_n	I_n	1 0,5 0,8
I_{max}	I_{max}	1 0,5 0,8

7.9 Limits of error due to variation of the current

The limits of percentage error due to variation of the current are specified in the relevant particular requirements (accuracy class) standards.

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7.10 Limits of error due to influence quantities

The limits of variation in percentage error due to influence quantities are specified in the relevant particular requirements (accuracy class) standards.

7.11 Time-keeping accuracy

Meter clock(s), if fitted, shall meet the relevant timekeeping accuracy requirements specified in IEC 62054-21:2004, 7.5.

8 Climatic requirements

8.1 General

The environmental conditions and tests for electricity meters and their accessories are defined assuming that the meters are mounted for stationary use at weather protected locations under use conditions, including periods of erection work, down time, maintenance and repair.

Meters shall be designed to operate and to be stored and transported in the climatic conditions determined by the climatic classes shown in Table 12.

8.2 Environmental conditions

The rated temperature range of meters shall be as shown in Table 12.

The rated humidity conditions shall be as specified in the IEC 60721-1:1990 environmental classes corresponding to the temperature ranges shown in Table 12, but without condensation, dew, formation of ice, hoar-frost, percolating water, rain, etc.

Table 12 – Environmental conditions

	Indoor use	Outdoor use
Specified operating range	-10 °C to 45 °C	-25 °C to 55 °C
Limit range of operation	-25 °C to 55 °C	-40 °C to 70 °C
Limit range for storage and transport	-25 °C to 70 °C	-40 °C to 70 °C

For special applications, other temperature values can be used according to purchase contract, for example, for cold environment for indoor meters, -40 °C to +40 °C.

The exposure to the extremes of temperature in each category is 72 h, as specified in the dry heat test and in the cold test.

The specified operating range and the limit range of operation for the indicating display may be different than that of the meter. The indicating display should function correctly once the temperature returns to its specified operating range.

8.3 Tests of the effects of the climatic environments

8.3.1 General test requirements

If an electricity meter is designed to be installed with a detached indicating display, then the climatic requirements apply to, and the tests shall be performed on, the meter with its detached indicating display connected, unless specified otherwise.

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If an electricity meter is designed to be installed with specified LPITs, then the climatic requirements apply to, and the tests shall be performed on, the meter with its specified LPITs connected.

8.3.2 Acceptance criteria

After each of the climatic tests in 8.3.3, 8.3.4, 8.3.5, 8.3.6, and after the specified recovery time in reference temperature and humidity conditions, the acceptance criteria B defined in 9.2, Table 15 shall be applied.

In addition, after each of the climatic tests the meter shall be visually inspected.

The appearance and, in particular, the legibility of markings shall not be altered.

8.3.3 Dry heat test

The test shall be carried out according to IEC 60068-2-2: 2007, under the following conditions:

a) meter in non-operating condition;
b) temperature: +70 °C ± 2 °C;
c) duration of the test: 72 h;
d) recovery time: 2 h.

8.3.4 Cold test

The test shall be carried out according to IEC 60068-2-1: 2007, under the following conditions:

a) meter in non-operating condition;
b) temperature: –25 °C ± 3 °C for indoor meters;
   –40 °C ± 3 °C for outdoor meters;
c) duration of the test: 72 h;
d) recovery time: 2 h.

8.3.5 Damp heat cyclic test

The test shall be carried out according to IEC 60068-2-30: 2005, under the following conditions:

a) voltage and auxiliary power circuits energized with nominal voltage; if a meter is rated for more than one value of nominal voltage, the highest value shall be used;
b) without any current in the current circuits;
c) variant 1;
d) upper temperature: +40 °C ± 2 °C for indoor meters;
   +55 °C ± 2 °C for outdoor meters;
e) no special precautions shall be taken regarding the removal of surface moisture;
f) duration of the test: 6 cycles;
g) recovery time: 24 h.

In addition to the acceptance criteria in 8.3.2, the meter shall pass the insulation test according to IEC 62052-31:2015, 6.10.4.3.3 and 6.10.4.3.4, except that the impulse voltage shall be multiplied by a factor of 0,8; if the test on complete equipment is not possible, the test on sub-assemblies may be performed according to IEC 62052-31:2015, 6.10.4.4.2.1 and 6.10.4.4.2.2.

During visual inspection, no traces of corrosion likely to affect the functional properties of the meter shall be apparent.

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8.3.6 Protection against solar radiation

Meters for outdoor use shall withstand solar radiation.

The test shall be carried out according to IEC 60068-2-5: 2018, under the following conditions:

a) meter in non-operating condition;
b) test procedure A (8 h irradiation and 16 h darkness);
c) upper temperature: +55 °C;
d) duration of the test: 3 cycles or 3 days.

8.4 Durability

The meter shall be subjected to the metrological stability testing as per IEC 62059-32-1: 2011 and meet the limits of change in percentage error specified therein.

NOTE Metrological stability is considered to be an aspect of meter durability.

9 The effects of external influence quantities and disturbances

9.1 General

These general test conditions apply to all tests specified in 9.3 and 9.4, unless therein specified otherwise.

For the electromagnetic compatibility tests, the meter – including its detached indicating display and LPITs, if applicable – shall be tested as table top equipment, in its normal working position with the meter cover and terminal covers in place.

If an electricity meter is designed to be installed in a specified matching socket or a rack, then the requirements apply to, and the tests shall be performed on, the meter installed in its specified matching socket or rack, as per the manufacturer's instructions.

If an electricity meter is designed to operate with a detached indicating display, then the effects of external influences apply to, and the tests shall be performed on, the meter with its detached indicating display connected, unless specified otherwise.

The meter port(s) intended for connection of a detached indicating display(s) shall be treated as ELV port(s).

If an electricity meter is designed to be installed with specified LPITs, then the external influence requirements apply to, and the tests shall be performed on, the meter with its specified LPITs connected.

The meter port(s) intended for connection of LPIT(s) shall be treated as ELV port(s).

Accessories (e.g. communication modules, I/O modules, etc.) shall be installed to create a test configuration representative of the typical meter configuration in service.

All cables shall be connected according to the manufacturer's instructions (e.g. voltage and current measurement cables, communication cables, auxiliary power supply cables, I/O cables, accessory cables, etc.).

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The length of the cables, connection of signal ports or termination loads shall be as specified in the referenced basic electromagnetic compatibility standards, unless otherwise specified in a test clause. An effort shall be made to maximize emissions and/or susceptibility effects, by varying cabling lay-out and rotation of the set-up, as permitted by the relevant basic electromagnetic compatibility standards.

The temperature and humidity during the electromagnetic compatibility test shall be as per the basic electromagnetic compatibility standards; all other reference conditions shall be as specified in 7.1.

If a meter is rated for more than one nominal voltage, a test at one nominal voltage is deemed sufficient, as specified in the relevant test description.

All meter parts intended to be earthed shall be earthed.

Table 13 – Summary of the tests of immunity to influence quantities

Continuous (long duration) phenomena: influence quantities	**Basic standard**	**Acceptance criteria as per 9.2**
Radiated, radio-frequency, electromagnetic field immunity test – test with current	IEC 61000-4-3: 2006 or IEC 61000-4-20: 2010	A
Immunity to conducted disturbances, induced by radio-frequency fields	IEC 61000-4-6: 2013	A
Test for immunity to conducted, differential mode disturbances and signalling in the frequency range 2 kHz to 150 kHz at AC power ports	IEC 61000-4-19: 2014	A
Power frequency magnetic field immunity test	IEC 61000-4-8: 2009	A
External static magnetic fields	n/a	A
Harmonics in the current and voltage circuits	n/a	A
Interharmonics in the current circuit – burst fired waveform test	n/a	A
Odd harmonics in the current circuit	n/a	A
DC and even harmonics	n/a	A
Voltage variation	n/a	A
Frequency variation	n/a	A
Ambient temperature variation	n/a	A
Interruption of phase voltage	n/a	A
Reversed phase sequence	n/a	A
Auxiliary voltage variation	n/a	A
Operation of auxiliary devices	n/a	A
Self-heating	n/a	A
Fast load current variations	n/a	A

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Table 14 – Summary of the tests of immunity to disturbances

Transient (short duration) phenomena with high occurrence: disturbances	Basic standard	Acceptance criteria as per 9.2
Electrostatic discharge immunity test	IEC 61000-4-2:2008	B [1]
Voltage dips, short interruptions and voltage variations immunity tests	IEC 61000-4-11:2020	B [1]
Voltage dips, short interruptions and voltage variations on DC input power port immunity tests	IEC 61000-4-29:2000	B [1]
Electrical fast transient/burst immunity test	IEC 61000-4-4:2012	A [2]
Damped oscillatory wave immunity test	IEC 61000-4-18:2019	A [2]
Transient (short duration) phenomena with low occurrence: disturbances	**Basic standard**	**Acceptance criteria as per 9.2**
Radiated, radio-frequency, electromagnetic field immunity test – test without current	IEC 61000-4-3:2006 or IEC 61000-4-20:2010	B [1]
Surge immunity test	IEC 61000-4-5:2017	B [1]
Ring wave immunity test	IEC 61000-4-12:2017	B [1]
Short-time overcurrents	n/a	B [2, 3]
Earth fault	n/a	B [2, 3]

[1] Test without current in the current circuits.

[2] Test with current in the current circuits.

[3] Criteria A apply for energy registration after recovery time.

9.2 Acceptance criteria

The acceptance criteria in Table 15 shall apply to the tests described in 9.3 and 9.4, unless therein specified otherwise.

Primary functions of electricity meters include:

a) energy registration;
b) indicating display;
c) operation of the supply control and load control switches.

These primary functions shall be observed during testing.

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Table 15 – Acceptance criteria

Acceptance criteria	Description
Criteria A	During the test, a temporary degradation of primary functions is acceptable only within defined limits: **a) energy registration:** the variation in percentage error due to an influence quantity or a disturbance shall not exceed the limits specified in the relevant particular requirements (accuracy class) standards; **b) indicating display:** degradation of display quality (colour, brightness, contrast, sharpness, geometry, etc.) during the test is acceptable; the indication of the content of energy registers shall remain unambiguously readable during the test; **c) supply and load control switches:** unexpected operation of the switch during the test shall not occur. During the test a temporary degradation or loss of other meter functions within the scope of this document is acceptable, except for a reset of embedded software (firmware); After the test, when the influence quantity or disturbance is removed, and the reference test conditions are restored, the meter shall show no damage and shall operate with no degradation of its metrological performance. All meter functions within the scope of this document shall be restored without any intervention of the operator, and without removal of the mains supply or the auxiliary power supply.
Criteria B	During the test, a temporary degradation or loss of primary functions is acceptable: **a) energy registration:** at any time during the test, and immediately after, the value of energy registers shall not change by more than the critical change value; **b) indicating display**: degradation of display quality (colour, brightness, contrast, sharpness, geometry, etc.) during the test is acceptable; the indication of the content of energy registers may become unreadable during the test; **c) supply and load control switches:** unexpected operation of the switch during the test shall not occur. During the test, a temporary degradation or loss of other meter functions within the scope of this document is acceptable, including a self-recovering reset of embedded software (firmware). After the test when the disturbance is removed, and the reference test conditions are restored, the meter shall show no damage and shall operate with additional percentage error not exceeding the limits specified in the relevant particular requirements (accuracy class) standards. All meter functions within the scope of this document shall be restored without any intervention of the operator, and without removal of the mains supply or the auxiliary power supply.

NOTE For tests of effects of external influence quantities or disturbances (9.3 and 9.4), constant monitoring of the indicating display during the whole duration of a test is not always feasible. In such cases it is sufficient to monitor the indicating display only when there is a reasonable doubt that the indicating display of the EUT may be susceptible to a particular influence quantity. The determination of such conditions is left to the expertise of the testing laboratory.

9.3 Electromagnetic compatibility (EMC)

9.3.1 General

9.3.1.1 Electromagnetic phenomena covered by EMC tests

Meters (electromechanical with electronic functional devices or fully static meters) shall be designed in a way that prevents external electromagnetic phenomena from damaging the meter, corrupting the meter's energy registers or substantially influencing the result of measurements.

The meter under test (EUT) shall be subjected to two types of electromagnetic phenomena:

a) Continuous or long duration electromagnetic phenomena, which are considered as influence quantities in accordance with 3.6.1; generally, acceptance criteria A apply to these tests, see Table 13.

b) Short duration electromagnetic phenomena, which are considered as electromagnetic disturbances in accordance with 3.6.2; generally, acceptance criteria B apply to these tests, see Table 14.

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The meter under test (EUT) shall be subjected to the tests of influence quantities summarized in Table 13 and disturbances summarized in Table 14. However, not all electromagnetic phenomena are covered in this document, but only those considered as relevant for the electricity metering equipment operated under normal conditions of use.

The electromagnetic compatibility requirements specified in this document do not cover extreme cases, which may occur with a very low probability in some installations. In unlikely situations where the levels of electromagnetic disturbances or influences may exceed the levels given in this document, special precautions and procedures may have to be employed by the installer or the operator.

NOTE 1 Any immunity levels higher than those given in this document, intended to provide additional protection (e.g. for specific anti-tampering requirements) are negotiated between the manufacturer and the purchaser.

NOTE 2 It is the responsibility of the installer or the operator to ensure electromagnetic compatibility of the meter installation, and to mitigate against phenomena for which no immunity requirements are specified in this document.

9.3.1.2 Dwell time for EMC tests with frequency sweeping

9.3.1.2.1 General

The dwell time is the period during which a disturbance or an influence quantity is applied at a specific frequency. When the EUT is exposed to the electromagnetic influences or disturbances by sweeping through the frequency band, the dwell time at each frequency step shall not be less than 3 s.

9.3.1.2.2 Dwell time for EMC tests with current

The dwell time shall be extended as necessary to perform a stable verification of the meter accuracy. The manufacturer shall specify the number of test pulses necessary for the verification of accuracy, or an alternative and equivalent method of verification of accuracy.

During dwell times the percentage error of the meter is determined at each frequency step, while using the specified number of test pulses from the test optical output. If necessary, further investigation may be conducted by exposing the meter to the disturbance or influence quantity for a longer dwell time per frequency step at frequencies where indication of susceptibility is discovered.

NOTE Alternative and equivalent methods of accuracy verification include, for example, using electrical pulse outputs or reading meter’s energy registers via data communication ports. See 7.2.

9.3.1.2.3 Dwell time for EMC tests without current

During tests without current no pulses should be generated on the test outputs and no change which is more than the critical change value, should occur in the corresponding register. Consequently, the meter’s accuracy cannot be verified at each frequency step. Therefore, the frequency sweep shall be completed with the dwell time of 3 s. The content of the meter’s energy registers shall be examined before and after the frequency sweep to determine if any change has occurred.

At the frequency steps where indication of susceptibility is discovered, further investigation may be conducted by exposing the meter to the disturbance or influence quantity for a minimum of 1 min per frequency step and determining the change in the energy registers. This change, extrapolated over a period of one hour, shall not exceed the critical change value.

NOTE 1 The critical change value induced by short duration / low occurrence disturbances corresponds to an energy register change deemed to be acceptable after the occurrence of similar disturbances in the field. During field operation of meters, however, the exposure to such frequencies may be longer; 1 h is a reasonably practical value (e.g. equipment operated nearby occasionally). Also, there are physical phenomena caused by such disturbances that may lead to an energy register change, depending on the exposure time (e.g. influence on analogue circuit elements such as a bandgap references). Therefore, at frequencies, where there exists a susceptibility, the dwell time is extended, and the measured register change is further extrapolated to closer approximate field conditions.

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NOTE 2 For example, a polyphase meter, with 3x230/400 V and 100 A maximum current, has a critical change value of 3x230x100x10e-6 = 0,069 kWh. At a certain frequency during 1 min an energy registration of 0,004 kWh is recorded, which is equal to 0,004 x 60 = 0,24 kWh for a period of 1 h. This exceeds the critical change value and therefore the requirements are not fulfilled.

NOTE 3 A method of "discovering indication of susceptibility" is left to the expertise of the testing laboratory. Generally, it is not necessary to know the exact frequency where the susceptibility occurs; it is sufficient to identify the range of frequencies. It is assumed that the test is stopped at the first failure.

9.3.2 Voltage dips and short interruptions

9.3.2.1 Voltage dips, short interruptions and voltage variations immunity tests

The intent of these tests is to ensure that the meter is not susceptible to dips and short interruptions that commonly occur on the mains or auxiliary AC power supply. This test applies to meters for AC energy, powered from AC mains supply either via voltage circuits or auxiliary supply circuits, or both; also applies to meters for DC energy, powered from AC mains supply via auxiliary supply circuit.

The test shall be carried out according to IEC 61000-4-11: 2020, under the conditions specified in 7.1, and the following conditions:

The meter shall be in operating condition:

a) Voltage circuits and auxiliary power supply circuits energized with their lowest specified nominal voltages.
b) Without any current in the current circuits; the SCS if fitted shall be closed; the external current circuit shall be open-circuit.

The voltage shall be interrupted for either the auxiliary power port, or the mains port, or both in sequence, depending on which one is used to power the meter.

For meters powered from 3-phase power supplies:

c) Voltage interruption tests shall be applied to all three phases simultaneously.
d) Voltage dips test for three-phase systems with neutral shall be applied to each individual phase-to-neutral voltage, one at a time, leaving the other phases connected to the supply voltage.
e) Voltage dips test for three-phase systems without neutral shall be applied to each individual phase-to-phase voltage, one at a time, leaving the other phases connected to the supply voltage.

Table 16 – Voltage dips, short interruptions and voltage variations immunity tests

Event	ΔU (voltage reduction) %	Duration cycles 1	Number of events	Inception angle °	Time between events cycles 1
Voltage interruption Test 1	100	5/6	3	0	3/3
Voltage interruption Test 2	100	50/60	3	0	3/3
Voltage interruption Test 3	100	1/1	1	0	n/a
Voltage interruption Test 4	95	250/300	3	0	500/600
Voltage dip Test 5	60	5/6	3	0	500/600
Voltage dip Test 6	60	50/60	3	0	500/600

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Event	ΔU (voltage reduction) %	Duration cycles 1	Number of events	Inception angle °	Time between events cycles 1
Voltage dip Test 7	30	0,5/0,5	3 3	0 180	500/600
Voltage dip Test 8	30	1/1	3	0	500/600
Voltage dip Test 9	50	3 000/3 600	1	0	n/a
NOTE "Cycles" means a number of nominal power line frequency cycles at either 50 Hz or 60 Hz, e.g. "50/60" means "50 cycles for 50 Hz test" and "60 cycles for 60 Hz test".					

Acceptance criteria: B, applied separately to each test in Table 16.

9.3.2.2 Voltage dips, short interruptions and voltage variations on DC input power port immunity tests

The intent of these tests is to ensure the meter is not susceptible to common dips and short interruptions on the mains or auxiliary DC power supply. This test applies to meters for DC energy, powered from DC mains supply either via voltage circuits or auxiliary supply circuits, or both; also applies to meters for AC energy, powered from DC mains supply via auxiliary supply circuit.

The test shall be carried out according to IEC 61000-4-29: 2000, under the conditions specified in 7.1, and the following conditions:

The meter shall be in operating condition:

a) Voltage circuits and auxiliary power supply circuits energized with their lowest specified nominal voltages.
b) Without any current in the current circuits and the current terminals shall be open circuit.
c) The voltage shall be interrupted for either the auxiliary power port, or the mains port, or both in sequence, depending on which one is used to power the meter.

Table 17 – Voltage dips, short interruptions and voltage variations on DC input power port immunity tests

Event	ΔU (voltage reduction) [%]	Duration [s]	Number of events	Time between events [s]
Voltage interruptions Test 1	100	1	3	10
Voltage interruptions Test 2	100	0,01	3	10
Voltage interruptions Test 3	100	0,001	3	10
Voltage dip Test 4	60	0,3	3	10
Voltage dip Test 5	60	0,03	3	10
Voltage dip Test 6	30	0,3	3	10
Voltage dip Test 7	30	0,03	3	10

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Acceptance criteria: B, applied separately to each test in Table 17.

9.3.3 Electrostatic discharge immunity test

The test shall be carried out according to IEC 61000-4-2: 2008, under the conditions specified in 7.1, and the following conditions:

The meter shall be in operating condition:

a) Voltage circuits and auxiliary power supply circuits energized with their highest specified nominal voltages;

b) Without any current in the current circuits and the current terminals shall be open circuit;

The following tests shall be applied to the meter's enclosure port:

c) Indirect discharge: the test voltage of 8 kV shall be applied to both vertical and horizontal coupling planes in contact mode. In both vertical and horizontal plane, all faces of meter shall be exposed to the discharge;

d) Contact discharge: the test voltage of 8 kV shall be applied to metallic parts accessible in normal operation;

e) Air discharge: the test voltage of 15 kV shall be applied to non-metallic parts accessible in normal operation;

f) Number of discharges: 10 discharges at each test point and in the most sensitive polarity; if sensitivity is not known then 10 shall be applied in both polarities with at least 1s between discharges, unless a longer interval is necessary to determine whether the EUT failure has occurred.

Acceptance criteria: B applied separately to each test c) to e).

9.3.4 Radiated, radio-frequency, electromagnetic field immunity test – test without current

This test is intended to verify meter's immunity to electromagnetic radio-frequency fields in various frequency bands. The test shall be carried out according to IEC 61000-4-3: 2006, or according to IEC 61000-4-20: 2010, under conditions specified in 7.1, and the following conditions, using TEM cells that allow cable lengths of at least 1 m. The meter shall be deemed to comply with the requirements if it meets the acceptance criteria when tested using one of the two test methods.

NOTE This consideration is supported by IEC TR 61000-4-1: 2016 (prepared by IEC technical committee TC77). IEC TR 61000-4-1: 2016 gives information about and guidance on the application of the EMC basic standards and other basic EMC documents published as the IEC 61000-4 series.

The meter shall be in operating condition:

a) Voltage circuits and auxiliary power supply circuits energized with their highest specified nominal voltage;

b) Without any current in the current circuits and the current terminals shall be open circuit;

c) The length of cables exposed to the electromagnetic field shall be 1 m, arranged according to IEC 61000-4-3:2006, 7.3, or according to IEC 61000-4-20: 2010 Annex B;

This test shall be applied to the enclosure port:

d) Frequency band: 80 MHz to 2,0 GHz; carrier modulated with 80 % AM at 1 kHz sine wave; unmodulated field strength of 30 V/m;

e) Frequency band: 2,0 GHz MHz to 6,0 GHz; carrier modulated with 80 % AM at 1 kHz sine wave; unmodulated field strength of 10 V/m;

f) The frequency step shall be 1 %;

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g) The dwell time shall be as specified in 9.3.1.2.3.

Acceptance criteria: B.

9.3.5 Radiated, radio-frequency, electromagnetic field immunity test – test with current

This test is intended to verify meter's immunity to electromagnetic radio-frequency fields in various frequency bands. The test shall be carried out according to IEC 61000-4-3:2006, or according to IEC 61000-4-20:2010, under conditions specified in 7.1, and the following conditions, using TEM cells that allow cable lengths of at least 1 m. The meter shall be deemed to comply with the requirements if it meets the acceptance criteria when tested using one of the two test methods.

NOTE This consideration is supported by IEC TR 61000-4-1: 2016 (prepared by IEC technical committee TC77). IEC TR 61000-4-1: 2016 gives information about and guidance on the application of the EMC basic standards and other basic EMC documents published as the IEC 61000-4 series.

The meter shall be in operating condition:

a) Voltage circuits and auxiliary power supply circuits energized with their highest specified nominal voltages;

b) The current circuits shall be carrying the value of the current given in the relevant particular requirements (accuracy class) standards;

c) For AC meters, the power factor (cosφ or sinφ) of the measured test signal shall be according to the values given in the relevant accuracy class standard;

d) The length of cables exposed to the electromagnetic field shall be 1 m, arranged according to IEC 61000-4-3:2006, 7.3, or according to IEC 61000-4-20:2010, Annex B;

This test shall be applied to the enclosure port:

e) Frequency band: 80 MHz-2,0 GHz: carrier modulated with 80 % AM, at 1 kHz sine wave; unmodulated field strength 10 V/m;

f) Frequency band: 2,0 GHz – 6,0 GHz: carrier modulated with 80 % AM, at 1 kHz sine wave; unmodulated field strength 3 V/m.

g) The frequency step shall be 1 %;

h) The dwell time shall be as specified in 9.3.1.2.2.

Acceptance criteria: A.

9.3.6 Electrical fast transient/burst immunity test

The test shall be carried out according to IEC 61000-4-4: 2012, under the conditions specified in 7.1, and the following conditions:

The meter shall be in operating condition:

a) Voltage circuits and auxiliary power supply circuits energized with their highest specified nominal voltages; if a meter is rated for more than one value of nominal voltage, the highest value shall be used;

b) The current circuits shall be carrying the value of the current given in the relevant particular requirements (accuracy class) standards;

c) For AC meters, the power factor (cosφ or sinφ) of the measured test signal shall be according to the values given in the relevant accuracy class standard;

d) The length of cables between the coupling device and the EUT shall be (0,5 − 0/+0,1) m, arranged according to IEC 61000-4-4:2012, 7.3.

The transients shall be applied in common mode to each port at a time:

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e) Mains port and the current transformer port: ±4 kV;

f) HLV auxiliary power supply port: ±2 kV;

g) HLV signal ports: ±2 kV (all terminals tested together as signal groups);

h) ELV signal ports and ELV auxiliary power supply ports: ±1 kV (all terminals tested together as signal groups);

i) Duration of the test: 60 s at each polarity;

j) Repetition rate: 100 kHz.

For examples of the test set-up, see Annex F, Figures F.1 to F.4. The geometrical arrangement shall be according to IEC 61000-4-4: 2012.

Acceptance criteria: A applied separately to each test e) to j), except for the indicating display function, which shall be evaluated according to criteria B.

9.3.7 Immunity to conducted disturbances, induced by radio-frequency fields

The test shall be carried out according to IEC 61000-4-6: 2013, under the conditions specified in 7.1, and the following conditions:

The meter shall be in operating condition:

a) Voltage circuits and auxiliary power supply circuits energized with their lowest specified nominal voltages;

b) The current circuits shall be carrying the value of the current given in the relevant particular requirements (accuracy class) standards;

c) For AC meters, the power factor (cosφ or sinφ) of the measured test signal shall be according to the values given in the relevant accuracy class standard;

d) A polyphase meter shall be connected to a balanced voltage system with polyphase load.

This test shall be applied to all terminals (tested together as signal groups) of each port at a time:

e) Mains port, current transformer port, auxiliary power supply port, HLV signal ports, ELV signal ports;

f) Frequency range: 150 kHz to 80 MHz;

g) Voltage level: 10 V:

h) The dwell time shall be as specified in 9.3.1.2.

NOTE The choice of cable terminations representative of the real-life use cases is left to the expertise of the test labs.

Acceptance criteria: A, except for the indicating display function, which shall be evaluated according to criteria B.

9.3.8 Test for immunity to conducted, differential mode disturbances and signalling in the frequency range 2 kHz to 150 kHz at AC power ports

These tests are intended to verify meter's immunity against disturbing differential currents in the 2 kHz-150 kHz originating from power electronics and power line communication systems (see Annex G). This test does not apply to DC meters.

The test is performed with disturbances in the current only; the test with voltage disturbances is not required.

The test shall be carried out according to the IEC 61000-4-19: 2014, under the conditions specified in 7.1, and the following additional conditions:

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The meter shall be in operating condition:

a) Voltage circuits and auxiliary power supply circuits energized with their lowest specified nominal voltages;

b) The current circuits shall be carrying the value of the current given in the relevant particular requirements (accuracy class) standards;

c) The power factor (cosφ or sinφ) of the measured test signal shall be according to the values given in the relevant accuracy class standard;

d) A polyphase meter shall be connected to a balanced voltage system with single-phase load. If the meter metrology design is identical in all three phases, testing of one phase is sufficient; otherwise each phase shall be tested one by one.

The differential test current I_{diff} shall be applied to:

e) Mains port of directly connected meters:

   1) 2 kHz to 30 kHz: I_{diff} = 3 A,

   2) 30 kHz to 150 kHz: I_{diff} = 1,5 A.

f) Current transformer port of transformer operated meters:

   1) 2 kHz to 30 kHz: I_{diff} = 0,03 x I_{max};

   2) 30 kHz to 150 kHz: I_{diff} = 0,015 x I_{max};

g) The test waves profiles "CW (Continuous Wave) pulses with pause" and "rectangular modulated pulses" shall be used (IEC 61000-4-19:2014, 5.2.2 and 5.2.3):

h) I_{diff} shall be generated with a tolerance of ± 5 % of the selected level during the test;

i) Frequency step shall be 1 %;

j) The dwell time shall be as specified in 9.3.1.2.2.

Acceptance criteria: A, except for the indicating display function, which shall be evaluated according to criteria B.

9.3.9 Surge immunity test

The test shall be carried out according to IEC 61000-4-5: 2017, under the conditions specified in 7.1, and the following conditions:

The meter shall be in operating condition:

a) Voltage circuits and auxiliary power supply circuits energized with their highest specified nominal voltages;

b) Without any current in the current circuits and the current terminals shall be open circuit;

c) Cable lengths between the surge generator and the EUT shall be 1 m, arranged according to the IEC 61000-4-5: 2017, Clause 7;

The surge test signal shall be applied to:

d) Mains port:

   1) each line to line, and each line to neutral, per Table 18;

   2) with generator source impedance of 2 Ω;

e) Current transformer port (this test is only applicable for meters with direct voltage connection, the test can be carried out together with the mains port test d):

   1) the current transformer port shall be tested with one terminal (line) of each current transformer port floating (unconnected, open circuit).

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2) each current transformer terminal (line) to neutral and between any two current transformer terminals (lines), per Table 18;
3) with generator source impedance of 2 Ω;

f) HLV auxiliary power supply port and HLV signal ports rated for direct connection to mains:
1) each line-to-line: 2 kV with generator source impedance of 2 Ω;
2) each line-to-ground: 4 kV with generator source impedance of 12 Ω; (if applicable, see l)

g) HLV auxiliary ports rated for connection to circuits other than HLV mains networks:
1) each line-to-line: 1 kV;
2) each line-to-ground: 2 kV; (if applicable, see l)
3) with generator impedance of 42 Ω.

NOTE An auxiliary control switch is defined in IEC 6205-31:2015, 3.7.4. as a "switch intended to control auxiliary devices". This means that an auxiliary control switch is not rated for a direct connection to mains or for a direct switching of high load currents. However, such auxiliary control switches may operate at HLV levels, and are therefore considered as "HLV auxiliary ports rated for connection to circuits other than HLV mains networks".

h) ELV auxiliary power supply port:
1) each line-to-line: 0,5 kV;
2) each line-to-ground: 1 kV; (if applicable, see l)
3) with generator source impedance: 42 Ω.

i) ELV signal ports (if applicable, see l):
1) Unshielded or shield connected at one end to ground, unsymmetrical lines: each line-to-ground: 1 kV;
2) Unshielded or shield connected at one end to ground, symmetrical lines: in common mode, 1 kV;
3) Lines with shield connected at both ends to ground: 1 kV (applied to shield or metallic device case);
4) with generator source impedance: 42 Ω.

Table 18 – Surge immunity test voltage

Voltage line to neutral derived from nominal system voltage (see IEC 62052-31:2015, Table 7), V AC or DC	**Open-circuit peak voltage of the surge test waveform, ± 10 %,** V
100	1 500
150	2 500
300	4 000
600	6 000
1 000	8 000
1 500 (DC only)	8 000

j) The surges on AC ports (mains port, current transformer port, HLV auxiliary power supply port, HLV signal ports) shall be applied at phase angles of 0°, 90°, 180° and 270° of the fundamental AC voltage waveform; five positive and five negative surges shall be applied at a rate of one surge per minute, at each specified phase angle;

k) On DC ports (mains port, auxiliary power supply port, signal port), five positive and five negative surges shall be applied at a rate of one surge per minute;

l) Line-to-ground and common mode tests are only applicable to meters with functional or any other connection to ground.

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Acceptance criteria: B.

9.3.10 Ring wave immunity test

The test shall be carried out according to IEC 61000-4-12: 2017, under the conditions specified in 7.1, and the following conditions. This test does not apply to DC meters.

The meter shall be in operating condition:

a) Voltage circuits and auxiliary power supply circuits energized with their highest specified nominal voltages;
b) Without any current in the current circuits and the current terminals shall be open circuit;
c) Cable length between the coupling device and the EUT shall be 1 m, arranged according to the IEC 61000-4-12: 2017 clauses 7.5;

The ring wave test waveform shall be applied to:

d) Mains port:
    1) between each line, including neutral, and ground: 4 kV,
    2) in differential mode (each line to line, each line to neutral): 2 kV,
    3) with generator source impedance of 12 Ω;
e) Current transformer port:
    1) the current transformer port shall be tested with one terminal of each current transformer port floating (unconnected, open circuit).
    2) between each current transformer port and ground: 4 kV,
    3) between any two current transformer ports: 2 kV,
    4) with generator source impedance of 12 Ω;
f) HLV auxiliary power supply port and HLV signal ports:
    1) between each line and ground: 2 kV,
    2) in differential mode (each line to line): 1 kV;
    3) with generator source impedance of 12 Ω;
g) ELV auxiliary power supply port and the ELV signal ports:
    1) in common mode: 0,5kV;
    2) with generator source impedance of 30 Ω;
    3) communication ports and signal ports shall be tested as a signal group.
h) The transients on mains port, current transformer port, HLV auxiliary power supply port, and HLV signal port shall be applied at phase angles of 0°, 90°, 180° and 270°of the fundamental AC voltage waveform; five positive and five negative transients shall be applied at a rate of one transient per minute, at each specified phase angle;
i) On DC ports (auxiliary power supply port, signal port), five positive and five negative transients shall be applied at a rate of one transient per minute.

Acceptance criteria: B.

9.3.11 Damped oscillatory wave immunity test

This test is applicable only to voltage transformer operated AC meters and does not apply to DC meters. This test shall be carried out according to IEC 61000-4-18: 2019, under the conditions specified in 7.1, and the following conditions.

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The meter shall be in operating condition:

a) Voltage circuits and auxiliary power circuits energized with their highest specified nominal voltages;

b) The current circuits shall be carrying the value of the current given in the relevant particular requirements (accuracy class) standards;

c) The power factor (cosφ or sinφ) of the measured test signal shall be according to the values given in the relevant accuracy class standard;

d) Cable length between the coupling device and the EUT shall be 1 m, arranged according to the IEC 61000-4-18: 2019, 7.3;

This test voltage shall be applied to each port at a time:

e) Mains port, HLV auxiliary power supply port and HLV signal ports:

   1) In common mode: 2,5 kV;

   2) In differential mode: 1,0 kV;

f) Test frequencies shall be:

   1) 100 kHz, repetition rate: 40 Hz;

   2) 1 MHz, repetition rate: 400 Hz;

g) Test duration: 60 s (15 cycles with 2 s on, 2 s off, for each frequency).

Acceptance criteria: A, except for the indicating display function, which shall be evaluated according to criteria B.

9.3.12 External static magnetic fields

This test is intended to verify the meter's immunity to continuous magnetic fields that may be present in its operating environment.

Immunity levels higher than specified in this subclause may be negotiated between the manufacturer and the purchaser to provide additional protection (e.g. for specific anti-tampering requirements).

This test shall be conducted under the conditions specified in 7.1, and the following conditions:

The meter shall be in operating condition:

a) Voltage circuits and auxiliary power circuits energized with their lowest specified nominal voltages;

b) The current circuits shall be carrying the value of the current given in the relevant particular requirements (accuracy class) standards;

c) For AC meters, the power factor (cosφ or sinφ) of the measured test signal shall be according to the values given in the relevant accuracy class standard;

This test shall be applied to the enclosure port.

d) The magnetic field shall act on all accessible surfaces of the meter under normal operating conditions;

e) Meter enclosure surfaces in contact with a mounting board or butting up against a supporting structure are regarded as not accessible and do not need to be exposed to the magnetic field. In cases where the mounting arrangements may vary or cannot be guaranteed, all exposed surfaces shall be tested;

f) The value of the magneto-motive force shall be 1 000 At (ampere-turns); the static magnetic induction may be generated by using the electromagnet according to Clause K.2, energized with a DC current;

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g) Static meters intended for installation in locations with normally open access (e.g. residential or commercial locations), shall also pass the test of static magnetic induction generated with a permanent magnet according to Clause K.1. The test magnet shall remain stationary during the application of the magnetic field to any particular location on the surface of the meter. Surfaces which are deemed inaccessible when the meter is installed as per manufacturer's instructions, are not subject to this test. This test is not applicable to electromechanical (Ferraris) meters.

NOTE Restricted access areas (i.e. areas accessible only to electrically skilled persons and electrically instructed persons with the proper authorization) may include, but are not limited to: industrial areas, substations, power generation stations, other large consumers (such as manufacturing plants, mining or drilling operations, wastewater and sewage treatment plants).

h) The application of the field shall be long enough to obtain a stable percentage error measurement.

Acceptance criteria: A.

Meters which contain construction elements susceptible to external static magnetic fields, shall log the exposure to magnetic field in all cases when primary functions are affected, and acceptance criteria A cannot be met. The indication of exposure on the meter display is not necessary if the log of exposure is accessible through the communication ports.

9.3.13 Power frequency magnetic field immunity test

This test shall be carried out according to IEC 61000-4-8: 2009, under the conditions specified in 7.1, and the following conditions:

The meter shall be in operating condition:

a) Voltage circuits and auxiliary power circuits energized with their lowest specified nominal voltages;

b) The current circuits shall be carrying the value of the current given in the relevant particular requirements (accuracy class) standards;

c) For AC meters, the power factor (cosφ or sinφ) of the measured test signal shall be according to the values given in the relevant particular requirements (accuracy class) standards;

d) Cable length exposed to the magnetic field shall be 1 m, arranged according to the IEC 61000-4-8: 2009, 7.3.

This test shall be applied to the meter's enclosure port:

e) A magnetic induction produced by a current of the same frequency as that of the voltage applied to the meter voltage circuits and flowing through the inductive coil shall be applied in the most unfavorable conditions of phase and direction compared to the voltage(s) energizing the meter;

f) Frequency equal to nominal meter frequency;

g) The inductive coil as per 6.3.3a) of IEC 61000-4-8:2009;

h) Immersion test method, continuous magnetic field applied in three perpendicular planes, field strength 0,5 mT (400 A/m);

i) After the test position of the EUT has been determined, the test duration shall be 1 min.

Acceptance criteria: A.

9.3.14 Emission requirements

This test shall be carried out according to CISPR 32: 2015, under the conditions specified in 7.1, and the following conditions:

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The meter shall be tested as table top equipment and shall be in operating condition:

a) Voltage and auxiliary power circuits energized with their highest specified nominal voltages;
b) The current circuits shall be carrying a current between 0,1 I_n and 0,2 I_n drawn by linear load;
c) For connection to the voltage circuits, the auxiliary circuits, and the current circuits an unshielded cable length of 1 m to each terminal shall be used;
d) If a detached indicating display is specified for installation far from the meter (where the distance exceeds 1 m), or outside of the metal metering cabinet, the meter may be tested with the detached indicating display placed outside of the measurement area or below the reference ground plane; however, in this case the detached indicating display shall also be tested with the meter placed outside of the measurement area or below the reference ground plane; in either case the meter and its specified detached indicating display shall meet the acceptance criteria;
e) Indicating display shall be exercised during the test with a test image constructed and provided by the manufacturer according to the CISPR 32: 2015, Clause B.2.

Acceptance criteria: the test results shall comply with the limits given in CISPR 32: 2015 for class B equipment; the limits given in CISPR 32: 2015 for class A equipment are acceptable for meter types intended to be installed only in industrial locations.

NOTE Examples of industrial locations (environments) include, but are not limited to: manufacturing plants, mining or drilling operations, wastewater and sewage treatment plants, substations, power generation stations.

9.4 Tests of immunity to other influence quantities

9.4.1 General

The additional percentage error due to the change of influence quantities with respect to reference conditions, shall not exceed the limits specified in the relevant particular requirements (accuracy class) standards.

The meter shall be tested in operating condition:

a) The conditions specified in 7.1 apply, unless specified otherwise;
b) The current circuits shall be carrying the value of the current given in the relevant particular requirements (accuracy class) standards, unless specified otherwise;
c) For AC meters, the power factor (cosφ or sinφ) of the measured test signal shall be according to the values given in the relevant particular requirements (accuracy class) standards, unless specified otherwise.

9.4.2 Harmonics in the current and voltage circuits

9.4.2.1 General

These tests are intended to verify meter's accuracy when measuring various non-sinusoidal current and voltage signals. These tests do not apply to DC meters.

These tests shall be applied to the mains port, and the current transformer port, unless specified otherwise.

If the meter is specified for operation with a detached indicating display, such device may be connected or not connected.

Voltage circuits shall be energized with their highest specified nominal voltages.

The distortion factor of the voltage waveform shall be as specified in Table 10.

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9.4.2.2 Harmonics in the current and voltage circuits – 5th harmonic test

Test conditions:

a) Fundamental frequency current: I_1 = 0,5 I_{max};

b) Fundamental frequency voltage: U_1 = U_n;

c) Fundamental frequency power factor for active energy meters: such that cos φ_1 = 1;

d) Fundamental frequency power factor for reactive energy meters: such that sin φ_1 = 1;

e) Content of 5th harmonic voltage: U_5 = 10 % of U_n;

f) Content of 5th harmonic current: I_5 = 40 % of fundamental current;

g) Harmonic power factor for active energy meters: such that cos φ_5 = 1;

NOTE 1 Resulting harmonic active power due to the 5th harmonic is P_5 = 0,1 U_1 × 0,4 I_1 = 0,04 P_1 or total active power = 1,04 P_1 (fundamental + harmonics).

Harmonic power factor for reactive energy meters such that sin φ_5 = 1;

NOTE 2 Harmonic power factor: such that sin φ_5 = 1; means that the phase angle of the fifth order current harmonic is lagging the fifth order voltage harmonic by 90 degrees (or 1 ms for a 50 Hz signal or 0,833 ms for a 60 Hz signal).

h) Fundamental and harmonic voltages are in phase, at positive zero crossing.

Acceptance criteria: A.

9.4.2.3 Interharmonics in the current circuit – burst fired waveform test

The tests of the influence of interharmonics shall be made with the circuit shown in Figure H.1 or with other equipment able to generate the current waveforms as shown Figure H.2.

Acceptance criteria: A.

9.4.2.4 Odd harmonics in the current circuit

The tests of the influence of odd harmonics shall include test with a 45°, 90° and 135° phase fired waveforms.

This test shall be made with the circuit shown in Figure H.1 or with other equipment able to generate the current waveforms as shown Figure H.4, Figure H.6 and Figure H.7.

Acceptance criteria: A.

9.4.2.5 DC and even harmonics – half-wave rectified waveform test

This shall be applied to the mains port of directly connected meters.

This test does not apply to the transformer operated meters.

The tests of the influence of direct current and even harmonics shall be made with the circuit shown in Figure H.8 or with other equipment able to generate the current waveforms as shown in Figure H.9.

Acceptance criteria: A.

9.4.3 Voltage variation

This test shall be applied to the mains port.

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The primary meter functions shall be evaluated as per Table 19.

Table 19 – Evaluation of primary meter functions under influence of voltage variation

	Primary meter functions		
Voltage variation [a]	**Energy registration**	**Indicating display**	**Operation of switches** [e]
0,9 $U_{\text{n-min}} \leq U \leq$ 1,1 $U_{\text{n-max}}$	Criteria A	Criteria A	Criteria A
0,8 $U_{\text{n-min}} \leq U <$ 0,9 $U_{\text{n-min}}$ 1,1 $U_{\text{n-max}} < U \leq$ 1,15 $U_{\text{n-max}}$	3x percentage error limit for Criteria A	Criteria A	Criteria A
0,0 $\leq U <$ 0,8 $U_{\text{n-min}}$	+10 % .. -100 % [b, d] Criteria B [c]	Criteria A [b, d]	Criteria A [b, d]
1,15 $U_{\text{n-max}} < U \leq$ 1,9 $U_{\text{n-max}}$ [f]	See 9.4.13		

[a] $U_{\text{n-min}}$ and $U_{\text{n-max}}$ refer respectively to the lowest nominal voltage and to the highest nominal voltage specified by the manufacturer; In three-phase three-wire meters, $U_{\text{n-min}}$ and $U_{\text{n-max}}$ refer respectively to the lowest nominal line-to-line voltage and to the highest nominal line-to-line voltage specified by the manufacturer.

[b] For meters powered only from the measured circuits (mains port), criteria apply for voltages above the lowest power supply voltage specified by the manufacturer.

[c] For meters powered only from the measured circuits (mains port), criteria apply for voltages below the lowest power supply voltage specified by the manufacturer.

[d] For meters powered from an auxiliary power supply, criteria apply in the whole voltage variation range, as the auxiliary supply is independent of the measured mains network.

[e] Applicable to Load Control Switches and to Supply Control Switches.

[f] These values represent fault conditions applied as per 9.4.13; applicable for transformer operated meters only.

9.4.4 Ambient temperature variation

The temperature coefficient shall be determined for the specified operating temperature range. The specified operating temperature range shall be divided into 20 K wide sub-ranges, unless specified otherwise in the relevant accuracy class standard. The temperature coefficient shall then be determined for each of these sub-ranges by taking measurements 10 K above and 10 K below the middle of each sub-range. During the test, the temperature shall be in no case outside the specified operating temperature range.

Voltage circuits and auxiliary power circuits shall be energized with their highest specified nominal voltages.

Acceptance criteria: A, except for the indicating display function, which shall be evaluated according to criteria B for temperatures outside the specified range of display operation.

9.4.5 Interruption of phase voltage

This test does not apply to DC meters.

Test conditions:

a) Voltage circuits and auxiliary power circuits energized with their lowest specified nominal voltages;
b) For transformer operated meters, no current shall be flowing in the current circuits of phases whose voltage is interrupted during this test;
c) During interruptions of the mains voltage, three-phase meters shall measure and register energy on the phases which remain energized;

This test shall be applied to:

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d) the mains port of three-phase meters powered from the measured mains (measurand); in this case the measured mains is connected to the voltage circuits and to the power supply circuits of the meter, which share the same terminals;

e) the mains port of three-phase meters powered from the measured mains (measurand) and from an auxiliary power supply; the auxiliary power supply shall not be interrupted during this test;

f) the mains port of three-phase meters powered exclusively from an auxiliary power supply; in this case the measured mains is connected only to the voltage circuits of the meter; the meter's auxiliary power supply circuit is connected via its own dedicated terminals, which are separate from the voltage circuit terminals; the auxiliary power supply shall not be interrupted during this test;

During this test, the phase voltages are interrupted as follows:

g) in a three-phase, four wire networks: any single and any two phases (in all combinations, six tests in total);

h) in a three-phase, three-wire network (if the meter is designed for this service): any one of the three phases (three tests in total).

Acceptance criteria: A.

NOTE For directly connected meters, this test covers the case of tripping of a fuse, and for transformer operated meters the case of tripping of a breaker (disconnection of voltage and current).

9.4.6 Frequency variation

This test shall be applied to the mains port of AC meters.

This test does not apply to DC meters.

Voltage circuits shall be energized with their highest specified nominal voltage.

For this test the measured frequency shall vary within the range specified by the manufacturer, but no less than from -2 % to +2 % of nominal frequency. For meters rated to operate at multiple nominal frequencies, this test shall apply to each of the nominal frequencies of the meter.

Acceptance criteria: A.

9.4.7 Reversed phase sequence

This test shall be applied to the mains port of three-phase meters AC meters.

This test does not apply to DC meters.

For this test, any two of the three phases shall be interchanged.

Voltage circuits shall be energized with their highest specified nominal voltage.

Acceptance criteria: A.

9.4.8 Auxiliary voltage variation

This test shall be applied to AC or DC auxiliary power supply port.

For auxiliary power supply voltage variation between -20 % of the lowest specified nominal auxiliary supply voltage, and +15 % of the highest specified nominal auxiliary supply voltage, the variation in percentage error shall not exceed the limits specified in the relevant particular requirements (accuracy class) standards.

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Voltage circuits shall be energized with the lowest specified nominal voltage.

Acceptance criteria: A.

9.4.9 Operation of auxiliary devices

The installation and operation of any accessories, or combination of accessories, shall not influence the meter accuracy. This test shall be conducted with accessories connected to create a test configuration representative of the typical meter configuration in service.

NOTE For example, an electromagnet of a multi rate register or an accessory for external communication (GSM, PLC, Zigbee ®, etc.).

It is preferable that the connection to the auxiliary device(s) is marked to indicate the correct method of connection. If these connections are made by means of plugs and sockets, they should be irreversible.

However, in the absence of those markings or irreversible connections, the variations of percentage errors shall not exceed those specified in the relevant standards if the meter is tested with the connections giving the most unfavourable condition.

The meter voltage and auxiliary power circuit shall be energized with their lowest specified nominal voltages.

All cables shall be connected according to the manufacturer's instructions (e.g. voltage and current measurement cables, communication cables, auxiliary power supply cables, I/O cables, accessory cables, etc.) The manufacturer shall provide the test equipment enabling the operation of accessories during this test.

Acceptance criteria: A.

9.4.10 Short-time overcurrents

This test is intended to verify the influence of short term overcurrents on meter accuracy.

This test shall be applied to the mains port, or the current transformer port.

Voltage circuits and auxiliary power circuits shall be energized with their highest specified nominal voltages.

Short-time overcurrents shall not damage the meter.

The test circuit shall be practically non-inductive.

For polyphase meters this test shall be performed on each phase, one phase at a time. The other phases where the overcurrent is not applied shall remain at reference conditions as specified in 7.1.

Directly connected AC meters shall be tested with an overcurrent equal to 30 I_{max} with a relative tolerance of +0 % to –10 % for one half-cycle at nominal rated frequency. See Annex I.

Transformer operated AC meters shall be tested with an overcurrent equal to 20 I_{max} with a relative tolerance of +0 % to –10 % for 0,5 s.

Directly connected DC meters shall be tested with an overcurrent equal to 30 I_{max} with a relative tolerance of +0 % to –10 % for 10 ms.

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The meter shall be allowed at least 1 h of recovery time before the energy measurement percentage error is checked.

Acceptance criteria: B, except for energy registration after recovery time, for which acceptance criteria A apply.

9.4.11 Self-heating

This test shall be carried out as follows: after the voltage circuits and auxiliary power supply circuits have been energized with the highest specified nominal voltage for at least 1 h, without any current in the current circuits, the maximum current shall be applied to the current circuits.

The cable used for energizing the meter during the test shall be selected according to the IEC 62052-31:2015, 4.3.2.11.

The meter percentage error shall be measured immediately after the current is applied and then at intervals short enough to allow a correct drawing to be made of the curve of percentage error variation as a function of time. The test shall be carried out for at least 1 h.

NOTE For electromechanical (Ferraris) meters a longer warm-up time of up to 2 h is acceptable.

The current and the power factor (cosφ or sinφ) shall be according to the values given in the relevant particular requirements (accuracy class) standards.

Acceptance criteria: A.

9.4.12 Fast load current variations

The intent of this test is to ensure that the accuracy of the meter is not susceptible to fast load current variations occurring over an extended time period (see Annex J).

The test shall be carried out under the conditions specified in 7.1.

Voltage circuits and auxiliary power circuits energized with their highest specified nominal voltages;

The test shall be applied to the mains port of directly connected meters and to the current transformer port of transformer operated meters:

a) the test current shall be repeatedly switched between on and off states;
b) during the t_{on} period, the value of the test current shall be as given in the relevant particular requirements (accuracy class) standards;
c) during the t_{off} period, the value of the test current shall be equal to zero;
d) the duration of the t_{on} and t_{off} periods shall be according to the following test profiles:
   1) t_{on} = 10 s t_{off} = 10 s, total test duration 4 h;
   2) t_{on} = 5 s t_{off} = 5 s, total test duration 4 h;
   3) t_{on} = 5 s t_{off} = 0,5 s, total test duration 4 h;
e) For AC meters, the turn-off times and the turn-on times do not need to be synchronized with the zero crossings of the mains frequency. The switching between on and off states shall occur within one cycle at nominal mains frequency. The tolerance for t_{on} and t_{off} shall be +/- one cycle at nominal mains frequency;
f) For DC meters, the switching between on and off states shall occur within 20 ms. The tolerance for t_{on} and t_{off} is +/- 20 ms.

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The recommended method to verify the measured energy is using the energy register of the meter.

Acceptance criteria: A, applied separately to each test d)1), d)2), and d)3).

9.4.13 Earth fault

This test applies to three-phase four-wire transformer operated AC meters, connected to distribution networks which are equipped with earth fault neutralizers or in which the star point is isolated.

This test does not apply to DC meters.

In the case of an earth fault and with 10 % overvoltage, the line-to-earth voltages of the two lines which are not affected by the earth fault will rise to 1,9 times the nominal voltage. This overvoltage condition is considered as an influence quantity of long duration.

The test shall be conducted under the conditions specified in 7.1, and the following conditions:

a) The meter shall be in operating condition:
b) Voltage circuits and auxiliary power circuits energized with their highest specified nominal voltages;
c) The current circuits shall be carrying the value of the current given in the relevant standards;

This test shall be applied to the mains port.

d) For a test under a simulated earth fault condition in one of the three lines, all voltages are increased to 1,1 times the highest specified nominal voltages. The neutral terminal of the meter under test is connected to the line terminal at which the earth fault has to be simulated (see Annex L);
e) The simulated earth fault shall be applied to any two phases and neutral with a phase angle of 60° between two phase voltages. A total of three tests are required to cover the pairs of phases;
f) In every configuration (test) described above, the maximum withstand voltage of 1,9 Un shall be applied for 4 h, with a cooling period of 1 h between the test runs.

NOTE See IEC 62052-31:2015: 6.10.3.2.

The energy measurement percentage error is checked after a recovery time necessary for the meter to return to the reference conditions and its normal operating temperature after the test.

Acceptance criteria: B, except for energy registration after recovery time, for which criteria A apply.

10 Type test

10.1 Test conditions

All tests shall be carried out under the reference conditions given in 7.1, unless otherwise stated in the relevant clause.

In order to verify that the meter type complies with all the requirements of this standard and with the relevant requirements of the particular (accuracy class) standards, the tests shall be carried out on a limited number of meters of the same type having identical and representative characteristics of the type, and configuration(s) representative of the worst-case meter configuration(s) in relation to a test.

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Testing this representative configuration is deemed to be sufficient to verify compliance of identical sample(s), all possible configurations, and all possible combinations of functions and accessories. There is no specific need to perform all listed tests on the same sample(s).

A recommended test sequence is given in Annex P.

Accessories (e.g. communication modules, I/O modules, etc.) shall be installed to create a test configuration representative of the typical meter configuration in service.

In case of modifications to parts of the meter made after the type test, only those tests with results possibly influenced by said modifications are deemed to be necessary.

10.2 Type test report

The type test shall be documented in a test report, which shall include all the information necessary to reproduce the type test. In particular, the following shall be recorded:

a) Commercial identification of the tested meter type and all the configurations covered by the type test;

b) Name and address of the manufacturer;

c) Name and address of the testing laboratory and its accreditation information;

d) Identification of the representative meter model(s) and configuration(s) tested, including serial number(s) and year(s) of manufacture, embedded software (firmware) identification;

e) Identification of the detached indicating displays, LPITs, and all meter accessories used during the type test, including serial number(s), year(s) of manufacture and embedded software (firmware) revision number(s);

f) For accredited test laboratories: proof of accreditation; for other laboratories: identification of the reference meter, and other test equipment used: brand name, product type, model and serial number; calibration dates of test equipment;

For each test:

g) Identification of the type, configuration, serial number and the firmware version number(s) of the tested meter;

h) Description of the test method applied, where this standard allows the choice of the test methods;

i) The test results (test data) shown vs. the acceptance criteria and rationale for the pass/fail decision;

j) Any specific conditions necessary to enable the test to be performed and reproduced;

k) Any specific conditions of use, for example cable length or type, shielding or grounding, or meter operating conditions, which are required to achieve compliance;

l) A photograph of the test setup where the test setup may affect the results;

In addition to the above, for testing conducted subsequent to modifications made to the meter after the original type test:

m) Technical description of the modifications;

n) Rationale for selection of the limited tests necessary to verify the compliance of the modified meter.

If a meter complies only with class A emission limits (see 9.3.14), this shall be clearly stated in the meter's type test report.

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Annex A
(normative)

Optical test output

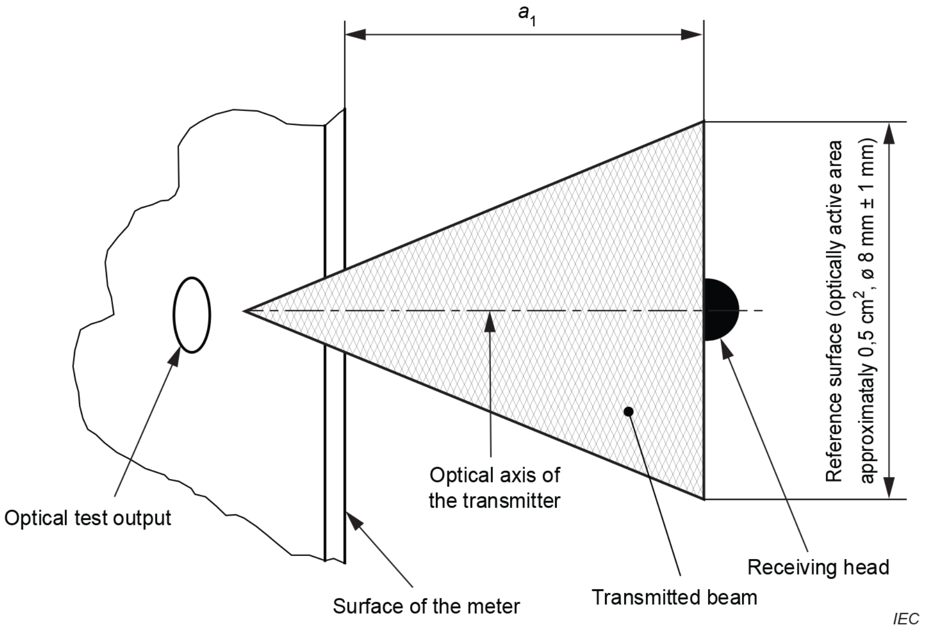
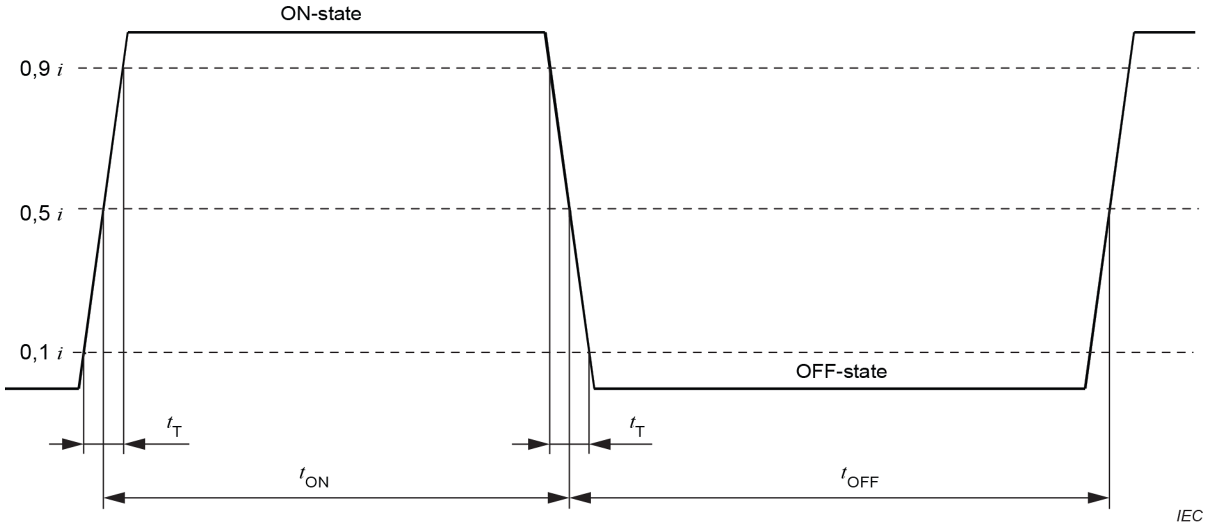


Figure A.1 – Test arrangement for the test output



Requirements

t_{ON} ≥ 0,2 ms

t_{OFF} ≥ 0,2 ms

t_T < 20 µs

Figure A.2 – Waveform of the optical test output

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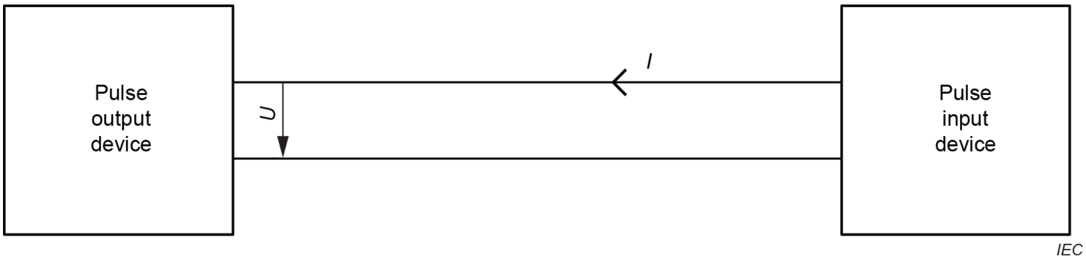
Annex B
(normative)

Class A and class B electrical pulse outputs

B.1 Electrical characteristics of pulse output



Key

U voltage across the terminals of the output

I current flowing in the pulse output

Figure B.1 – Physical interface of the electrical pulse output

Table B.1 – Specified operating conditions

Parameters	Class A pulse device	Class B pulse device
Maximum voltage (U_{max})	27 V DC	15 V DC
Maximum current in ON-state	27 mA	15 mA
Minimum current in ON-state	10 mA	2 mA
Maximum current in OFF-state	2 mA	0,15 mA
NOTE 1 The maximum distance of transmission is dependent on the environment and the quality of the cable, and shall be defined specifically. NOTE 2 If other functions like detection of fraud, short circuit or open circuit in the transmission line, etc. are required, a solution with the values specified in Annex C may be used.		

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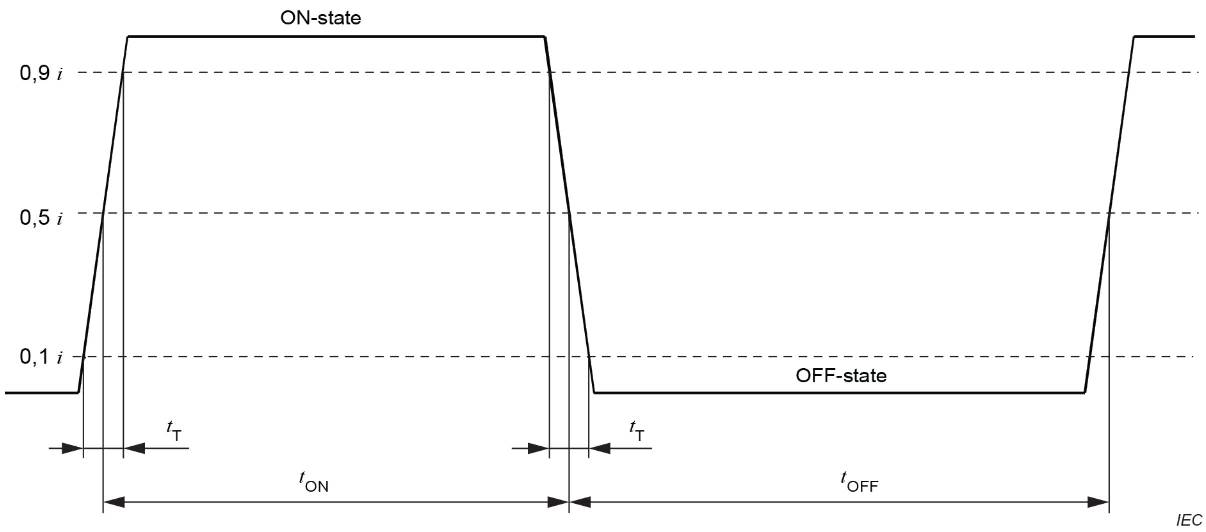
B.2 Electrical output pulse waveform



Requirements: t_{ON} ≥ 30 ms, t_{OFF} ≥ 30 ms, t_T ≤ 5 ms.

Figure B.2 – Electrical output pulse waveform

B.3 Test of electrical pulse output

The test set-up is according to Figure B.3.

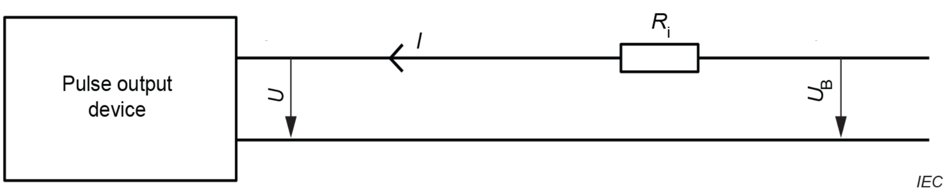


Figure B.3 – Pulse output test set-up

Pulse output shall fulfil the requirements of the Table B.2.

Table B.2 – Test of pulse output

State of pulse output	Test conditions				Test results			
	Power supply voltage (U_B) V		Power supply internal resistance (R_i) kΩ		Loop current (I) mA		Voltage (U) V	
	Class A	Class B	Class A	Class B	Class A	Class B	Class A	Class B
ON	18	3	1		≥ 10	≥ 2	≤ 8	≤ 1
OFF	27	15	1		≤ 2	≤ 0,15	≥ 25	≥ 14

B.4 Test of pulse input

The test set-up is according to Figure B.4.

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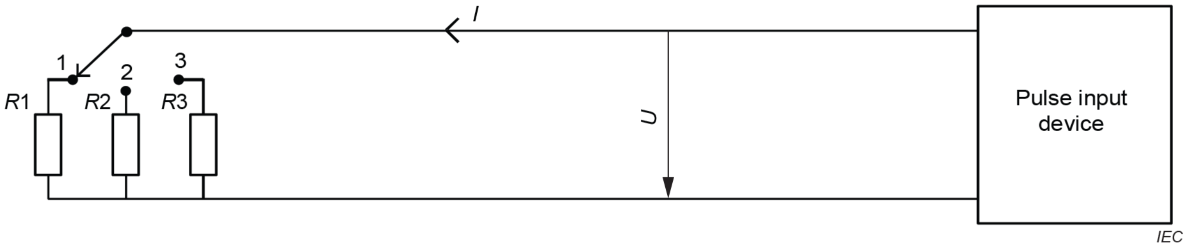

Figure B.4 – Pulse input test set-up

Pulse inputs shall fulfil the requirements given in Table B.3. The test arrangement shall be according to Figure B.4.

Table B.3 – Test of pulse input device

Switch position	Resistance value	Remarks	Test results; loop current or voltage	
			Class A	**Class B**
1	R_1 = 800 Ω	Pulse input power supply	$I \geq$ 10 mA	$I \geq$ 2 mA
2	$R_2 \leq$ 1 Ω	Short-circuit current of pulse input device	$I <$ 27 mA	$I <$ 15 mA
3	$R_3 >$ 1 MΩ	Open-circuit voltage of pulse input device	$U \leq$ 27 V	$U \leq$ 15 V

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Annex C
(normative)

Electrical pulse output for special applications and long distances according to IEC 60381-1:1982

C.1 Specified operating conditions and output pulse waveform

The main electrical characteristics are summarized in Table C.1.

Table C.1 – Specified operating conditions

Parameters	Minimum	Maximum
Open circuit (I_o)	0 mA	<4 mA
Rest (OFF) (I_r)	4 mA	<6,5 mA
Defraudation (I_d)	6,5 mA	<8,9 mA
Measure pulse (ON) (I_p)	8,9 mA	<11,4 mA
Defraudation + Measure pulse (I_{dp})	11,4 mA	<14 mA
Short circuit (I_s)	14 mA	20 mA
Power supply voltage	20 V	30 V
Pulse duration (t_{ON})	30 ms	120 ms
Rise time and fall time (t_T)	–	≤5 ms
Load impedance (R_i)	–	≤300 Ω
Distance		100 m

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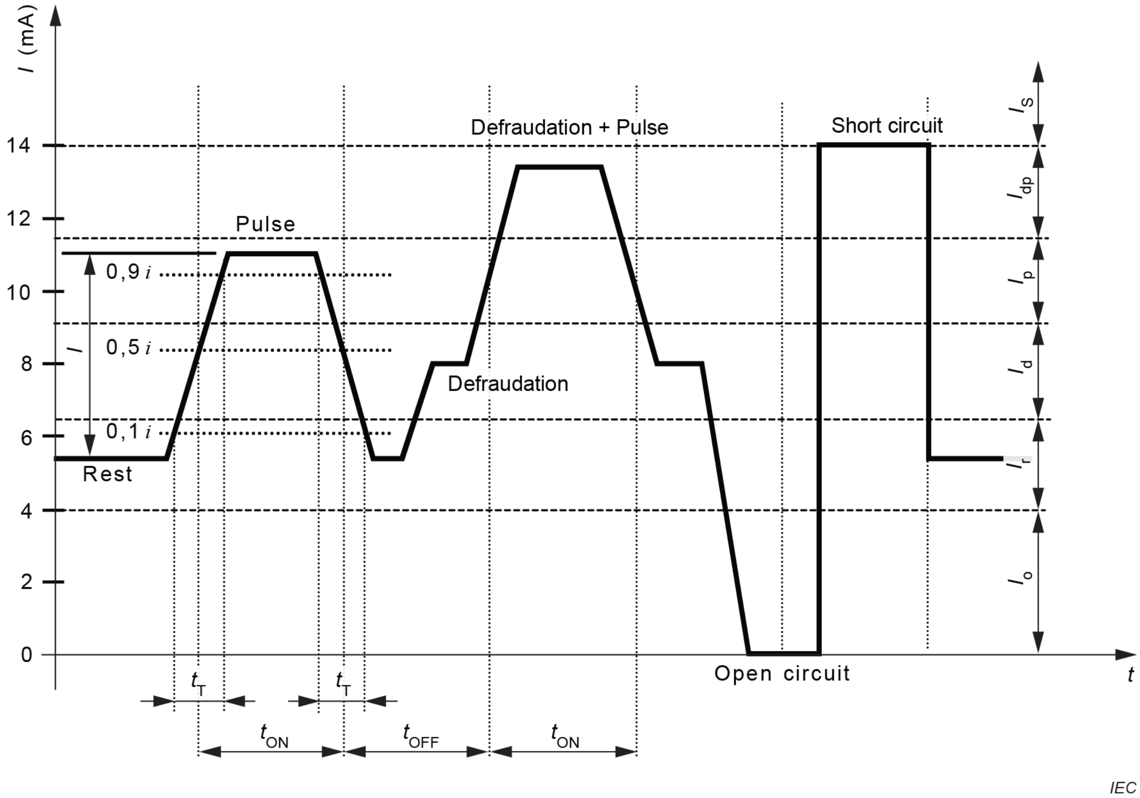

Requirements: 30 ms ≤ t_{ON} ≤ 120 ms
t_{OFF} ≥ 30 ms, t_T ≤ 5 ms

Figure C.1 – Output pulse waveform

C.2 Test of pulse output

The test set-up is according to Figure C.2.

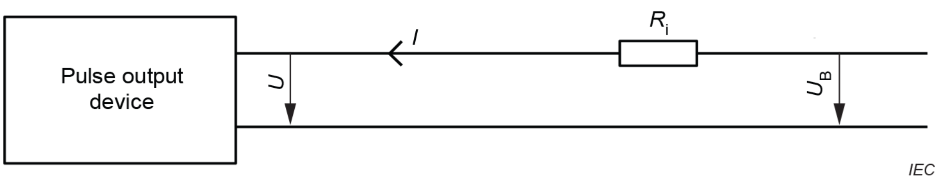

Figure C.2 – Pulse output test set-up

The pulse output shall fulfil the requirements of Table C.2.

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Table C.2 – Test of pulse output device

State of pulse output	Test conditions		Test results
	Power supply voltage (U_B) V	Power supply internal resistance (R_i) Ω	Loop current (I) mA
Open circuit	20 to 30	226	$0 \leq I < 4$
Rest (OFF)	20 to 30	226	$4 \leq I < 6,5$
Defraudation	20 to 30	226	$6,5 \leq I < 8,9$
Measure pulse (ON)	20 to 30	226	$8,9 \leq I < 11,4$
Defraudation + Measure pulse	20 to 30	226	$11,4 \leq I < 14$
Short circuit	20 to 30	226	$14 \leq I < 20$

C.3 Test of pulse input

The test set-up is according to Figure C.3.

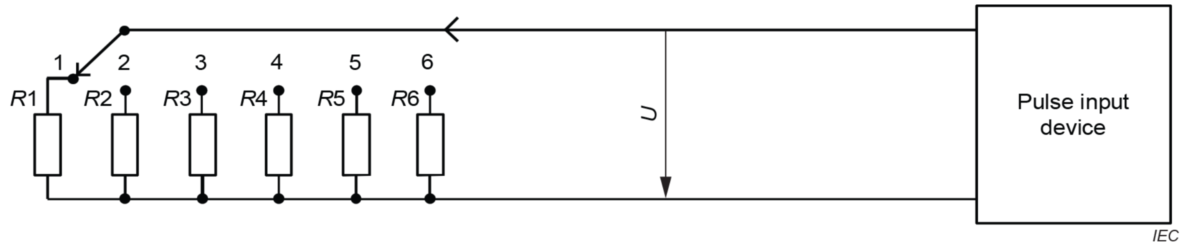

Figure C.3 – Pulse input test set-up

The pulse input shall fulfil the requirements of Table C.3.

Table C.3 – Test of pulse input device

Switch position	Resistance value	Remarks	Test results; loop current or voltage
1	R_1 = 2 kΩ	Pulse	$8,9 \leq I_p < 11,4$ mA
2	$R_2 \leq 1$ Ω	Short circuit	$14 \leq I_s < 20$ mA
3	$R_3 > 1$ MΩ	Open circuit	$0 \leq I_o < 4$ mA $U < 30$ V DC
4	R_4 = 4 kΩ	Rest	$4 \leq I_r < 6,5$ mA
5	R_5 = 3 kΩ	Defraudation	$6,5 \leq I_d < 8,9$ mA
6	R_6 = 1,7 kΩ	Pulse + Defraudation	$11,4 \leq I_{dp} < 14$ mA

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Annex D
(informative)

Meter symbols and markings

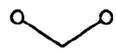
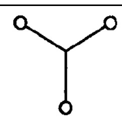
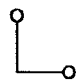
See IEC 60417.

NOTE Specific National regulations can override these meter symbol recommendations.

Table D.1 – Examples of voltage marking according to network voltage

Meter	Rated system voltage V
Single-phase two-wire 120 V	120
Single-phase three-wire 120 V (120 V to the mid-wire)	240
Three-phase three-wire two-element (230 V between phases)	3 × 230 3 × 230/400 [a]
Three-phase four-wire three-element (230 V phase to neutral)	3 × 230 (400) 3 × 230 / 400
[a] Voltage marking on the meter according to network voltage.	

Table D.2 – Symbols for measuring elements

Designation	Symbol
Watt-hour or var-hour meter with one measuring element, having one current circuit and one voltage circuit (for one-phase two-wire circuits)	
Watt-hour or var-hour meter with one measuring element, having one voltage circuit and two current circuits (for one-phase, two- or three-wire circuits, when the voltage circuit is connected across the outer conductors)	
Watt-hour or var-hour meter with two measuring elements, each having a voltage circuit and a current circuit, each of which is connected in the outers of a one-phase three-wire circuit, the corresponding voltage circuits being connected between the outers and the mid-wire	
Watt-hour or var-hour meter with two measuring elements, each having a voltage circuit and a current circuit, the latter being inserted in a phase conductor of a three-phase circuit, the voltage circuit of each measuring element being connected between the neutral and the phase conductor in which its current circuit is inserted	
Watt-hour or var-hour meter with two measuring elements, each having a voltage circuit and a current circuit, and connected for the two-wattmeter method (for three-phase three-wire circuits)	
Watt-hour or var-hour meter with three measuring elements, each having a voltage circuit and a current circuit, and connected for the three-wattmeter method (for three-phase four-wire circuits)	
Watt-hour or var-hour meter with two measuring elements, each having a voltage circuit and a current circuit, and connected in the two-phase conductors of a two-phase three-wire circuit	

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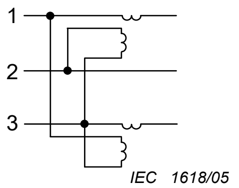
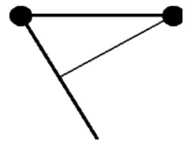
Designation	Symbol
Var-hour meter with two measuring elements, each having a voltage circuit and a current circuit, one of the current circuits having a common point with the voltage circuit of the other measuring element, whilst the current circuit of the latter has a common point with the voltage circuits of the two measuring elements As can be seen, this symbol corresponds to the figure below and is applicable to three-phase three-wire circuits  Figure – Cross-phase connection of a var-hour meter with two measuring elements in three-phase three-wire circuits	

Table D.3 – Marking of the measured quantity (examples)

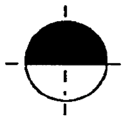
Designation	Symbol
Watt-hour meter	kWh
Var-hour meter	kvarh
Inductive and capacitive var-hour meter with two registers	kvarh 
Volt-ampere-hour meter	kVAh
Working range of var-hour meter	
NOTE Instead of black shaded or crosshatched possible.	

Table D.4 – Inscriptions indicating the accuracy class and the meter constant (examples)

Designation	Symbol
Accuracy class Example*:* class 1 Example*:* class 0,1 S	**Cl. 1** **Cl. 0,1 S**
Meter constant for electromechanical meters Example: 500 revolutions per kilowatt-hour, or 2 Wh per revolution	500 r/kWh or 2 Wh/r
Meter constant for static meters Example: 500 pulses per kilowatt-hour, or 2 Wh per pulse Example: R = 500 imp / kWh, kvarh	500 imp / kWh or 2 Wh / imp

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Table D.5 – Symbols for transformer-operated meters (examples)

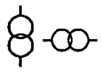
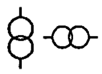
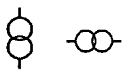
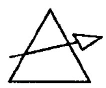
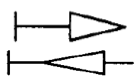
Designation	Marking to be placed on		
	Meter case		a supplementary plate or label under seal
Meter with secondary register (the nominal value of both the primary current and the primary voltage is variable)		5 A 100 V	50/5 A 10 000/100 V or Reading factor C = 1 000 if meter with secondary data Transformer ratio K = 1000
Meter with half-primary register (the nominal value of the primary current is variable)		10 000 / 100 V, 5 A	500/5 A Reading factor C = 100
Meter with primary register Meter with primary data		10 000 / 100 V 50 / 5 A	Transformer ratio K = 1000
Meter with half-primary register and direct connected for voltage (the nominal value of the primary current is variable)		3 × 230 / 400 V 5 A	500 / 5 A Reading factor C = 100

Table D.6 – Tariff function symbols (examples)

I	day	
II	night	
III	peak	
NOTE Marking of more than three-rate registers is subject of the purchase contract.		

Table D.7 – Symbols for tariff function (examples)

Designation	Symbol
Excess energy meter in which the excess level is adjustable	
Bidirectional meter Energy received at the measuring point (for example, import) Energy supplied at the measuring point (for example, export)	
The instantaneous (actual) value of the average demand value	P_{inst}
The highest average demand value for the present cumulation (billing) period	P_{max}
The cumulated maximum demand value	P_{cum}
Integration period	t_{m}

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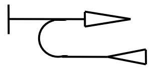
Designation	Symbol
Detent time	t_o
Bidirectional meter with always positive register (the meter always counts the energy as import energy, irrespective of the real energy direction)	

Table D.8 – Symbols for auxiliary devices (examples)

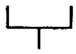
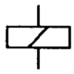
Designation	Symbol
Meter supplied with pulse transmitter The marking gives the number of pulses per kWh or the number of Wh per pulse Example: 10 imp/kWh or 100 Wh/imp	10 imp/kWh or 100 Wh/imp
Meter supplied with rotor clamp	
Auxiliary supply voltage for a static energy meter (when separated from the measuring voltage) Example: U_s = 100 V AC	U_s = 100 V 50 Hz
Nature and value of auxiliary voltage of the relay of a multi-rate meter (shown on the connection diagram) Example: U_d = 60 V DC	 60 V —
Reversal preventing metering	

Table D.9 – Symbols for details of the suspension of the moving element (examples)

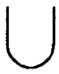
Designation	Symbol
Double jewel lower bearing	
Magnet for partial relief of the pressure of the rotor against the bottom bearing	
Moving element with magnetic suspension or support	

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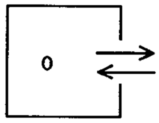
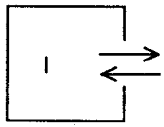
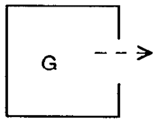
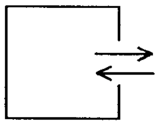
Table D.10 – Symbols for communication ports (examples)

Designation	Symbol
Optical port, bidirectional	
Inductive port, bidirectional	
Galvanical port, unidirectional	
Port in accordance with a specific standard, for example, IEC 62056-21, Mode C, IEC 62056 DLMS/COSEM, etc.	
NOTE Directions of communication: ⟶ output (for example, reading) ⟵ input (for example, programming) ——— continuous connection -------- connection on demand only (for example, password, switch)	

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Annex E
(informative)

Meter ports

For the purpose of defining the EMC requirements in the document, the following ports are defined for electricity meters, see Figure E.1, Figure E.2 and Figure E.3.

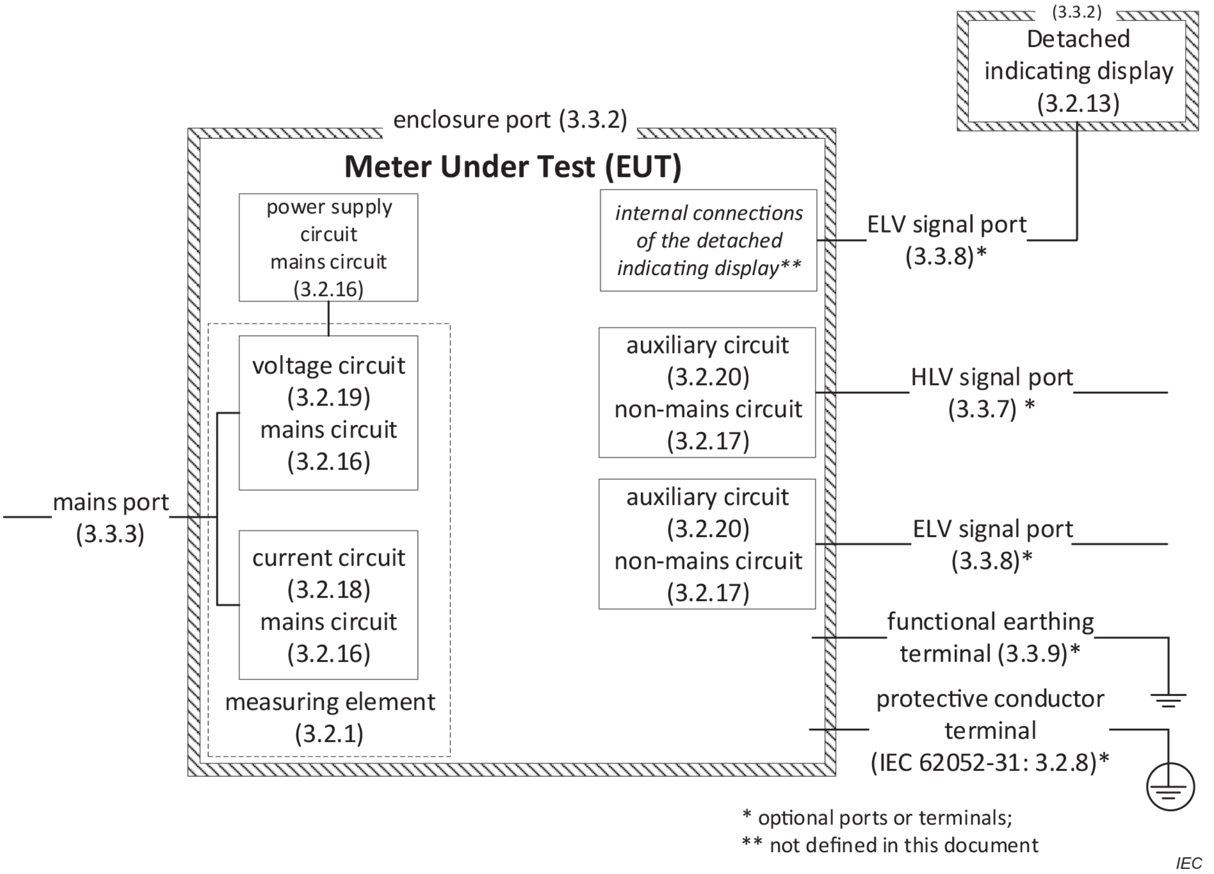

Figure E.1 – Typical port configuration of a directly connected meter (example)

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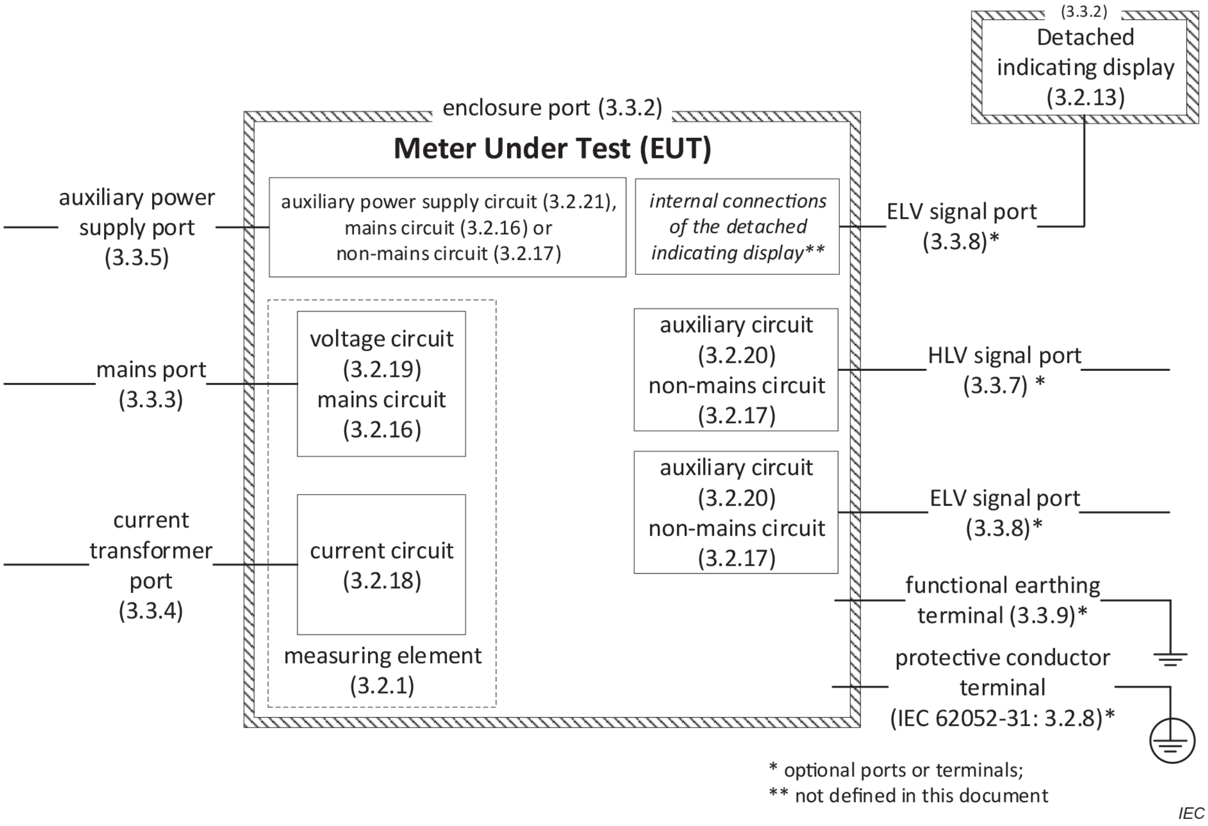

Figure E.2 – Typical port configuration of a transformer operated meter (example)

Other port configurations are possible for both directly connected and transformer operated meters.

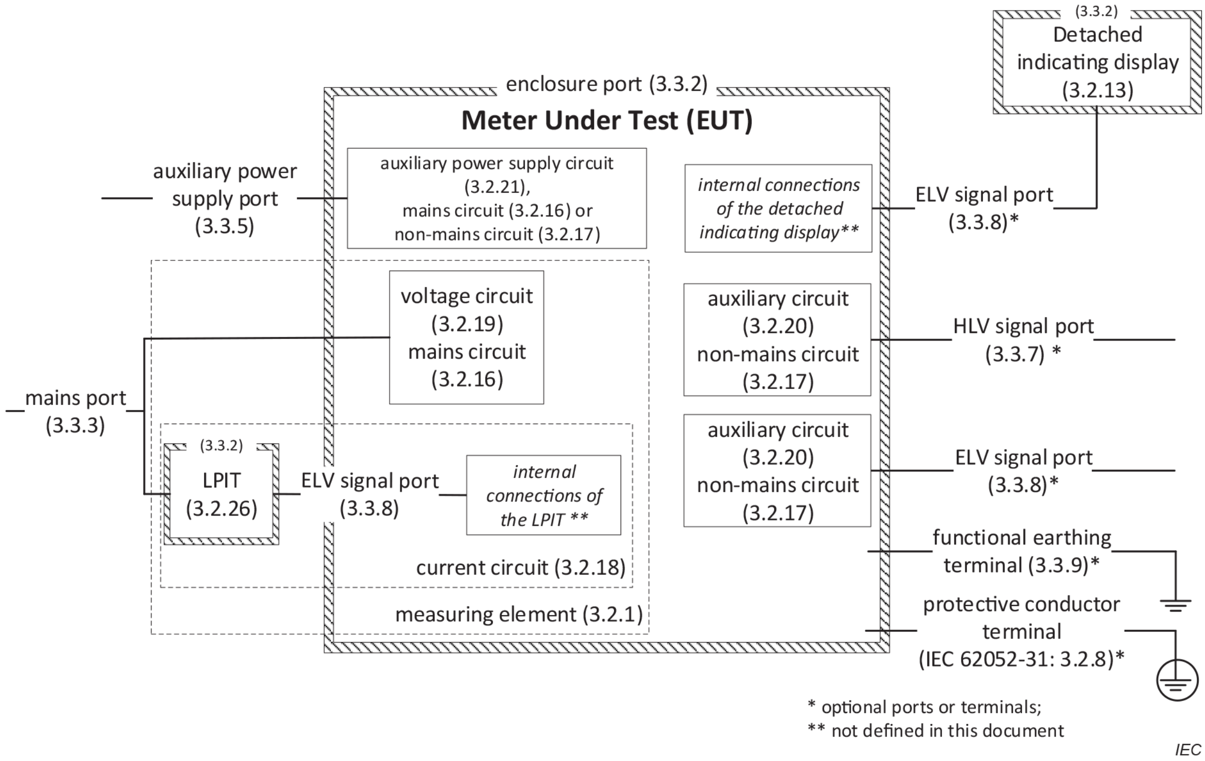

Figure E.3 – Typical port configuration of a LPIT operated meter with a detached indicating display (example)

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The following rationale should be considered when testing meters operating with LPITs:

a) In the particular accuracy class requirements, the meter performance is specified with respect to the load current in case of directly connected meters, or the secondary current of external conventional CTs in case of transformer operated meters. The meter performance is not specified with respect to a low power analogue or digital output signal of LPITs, therefore meters operating with LPITs may be evaluated for compliance to this document, and the particular accuracy class documents, only as directly connected meters;
b) When testing meters with LPITs as directly connected meters, the external LPITs are considered part of the meter's current circuit, and part of the meter's measuring element;
c) Meters operating with LPITs may have very high specified nominal current values, which may result in practical limitations of how this document may be applied to such meters;
d) In all EMC tests, where the electromagnetic fields impinge on or radiate from the meter enclosure, they should be considered to equally impinge on or radiate from the external LPITs, and the connecting cables;
e) External influences and disturbances normally applied to the mains port of directly connected meters, such as influence of differential mode currents, damped oscillatory wave immunity test, harmonics in the current circuits, are applied to the primary of the LPITs;
f) Generally, as stated in 9.1, the meter ports intended for connections to LPITs are considered to be ELV signal ports;
g) For electrical fast transient/burst immunity test, immunity to conducted disturbances, induced by radio-frequency fields, surge immunity test and ring wave immunity test the disturbances can be coupled to the LPIT secondary side cable (LPIT port) with the test levels specified for ELV ports;
h) Environmental tests are applied to the meter and the connected LPITs;
i) The specification of meter performance with respect to LPIT output signals, test conditions and methods may be addressed in future documents.

The following rationale should be considered when testing meters operating with detached indicating displays (DIDs):

j) In all EMC tests, where the electromagnetic fields impinge on or radiate from the meter enclosure, they should be considered to equally impinge on or radiate from the DID and the connecting cables. However, if long cables are specified between the meter and the DID, a superposition of emitted electromagnetic fields is unlikely. Consequently, when the meter emissions are tested, the DID may be removed from the test area, but should remain connected to the meter during the test. Similarly, when testing the DID emissions, the meter may be removed from the test area, See 9.3.14.
k) Generally, as stated in 9.1, the meter ports intended for connections to a DID are considered to be ELV signal ports;
l) External influences and disturbances normally applied to the meter ELV ports are also applied to the meter DID port. It is recommended that the meter and the DID are connected during the test.
m) Environmental tests are applied to the meter and the connected DID. However due to the limitations of LCD technology, DIDs using this technology may be acceptable with a smaller operating range of temperatures than the meter.

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Annex F
(informative)

Test set-up for EMC tests

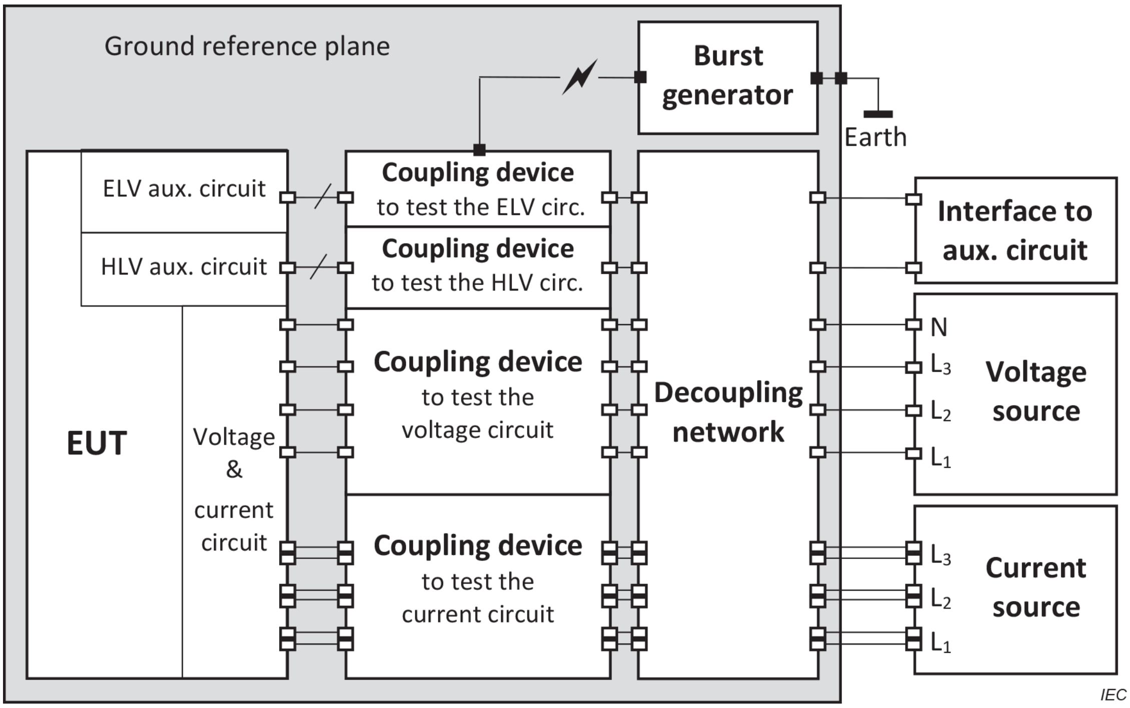

Figure F.1 – Test set-up for the electrical fast transient/burst immunity test for transformer operated meters: each port (Mains, CT, HLV, ELV) is tested separately by adding the coupling device to the respective port

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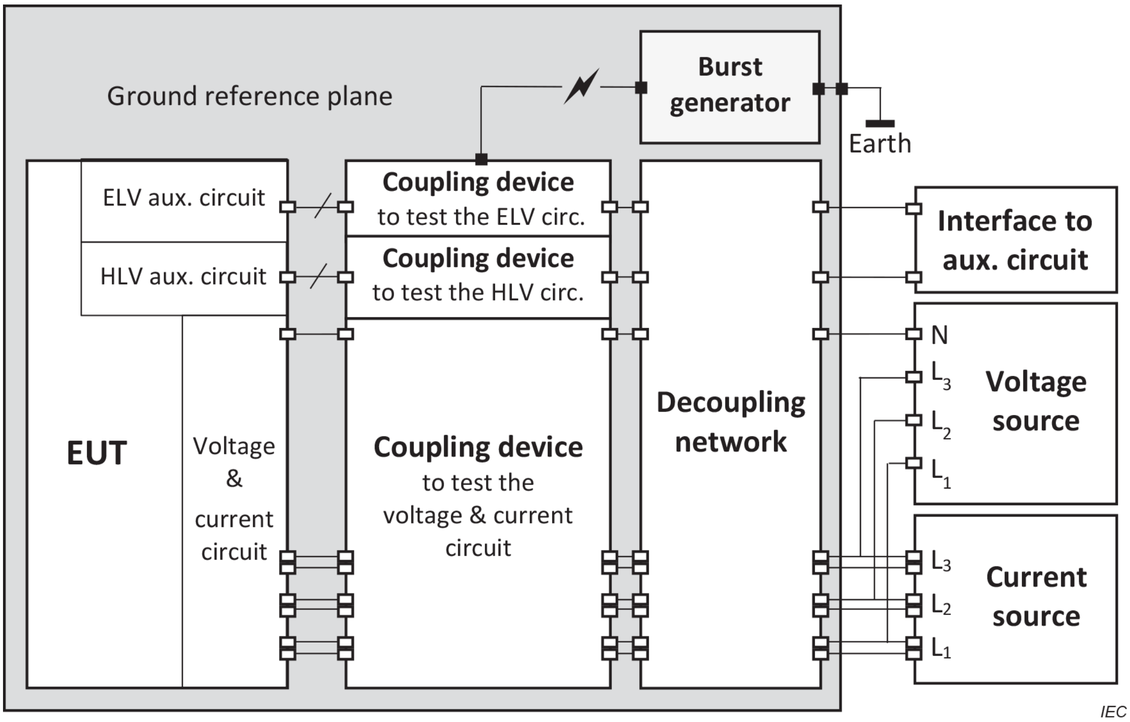

Figure F.2 – Test set-up for the electrical fast transient/burst immunity test for directly connected meters: each port (Mains, HLV, ELV) is tested separately by adding the coupling device to the respective port

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Annex G
(informative)

Test for immunity to conducted, differential mode disturbances and signalling in the frequency range 2 kHz to 150 kHz at AC power ports

Differential mode current disturbances in the range 2 kHz to 150 kHz are generated by equipment such as power electronics, inverters and mains communication systems.

Differential mode current disturbance levels in this range can reach levels not negligible as compared to the levels of the current at mains frequency. The disturbing current can heavily distort the current signal at mains frequency used for energy registration and cause problems such as overloading of the meter current measurement circuits or current transformers.

In order to identify and exclude meter designs susceptible to differential mode current disturbances, the levels of disturbing current are applied as they can be found in the field, considering an adequate margin. The test method is according to the test for immunity to conducted, differential mode disturbances and signaling in the frequency range 2 kHz to 150 kHz at AC power ports in IEC 61000-4-19: 2014.

Conversely, due to the low impedances in the field wiring for frequencies from 2 kHz to 150 kHz, these current disturbances are associated with only small voltage disturbances, typically below 1 % of the voltage at mains frequency used for energy registration. Therefore, no issues with energy registration due to differential mode voltage disturbances in the range 2 kHz to 150 kHz are observed, and no immunity test for such disturbances is required. In particular, the test for differential mode voltage disturbances according to IEC 61000-4-19: 2014 is not applied.

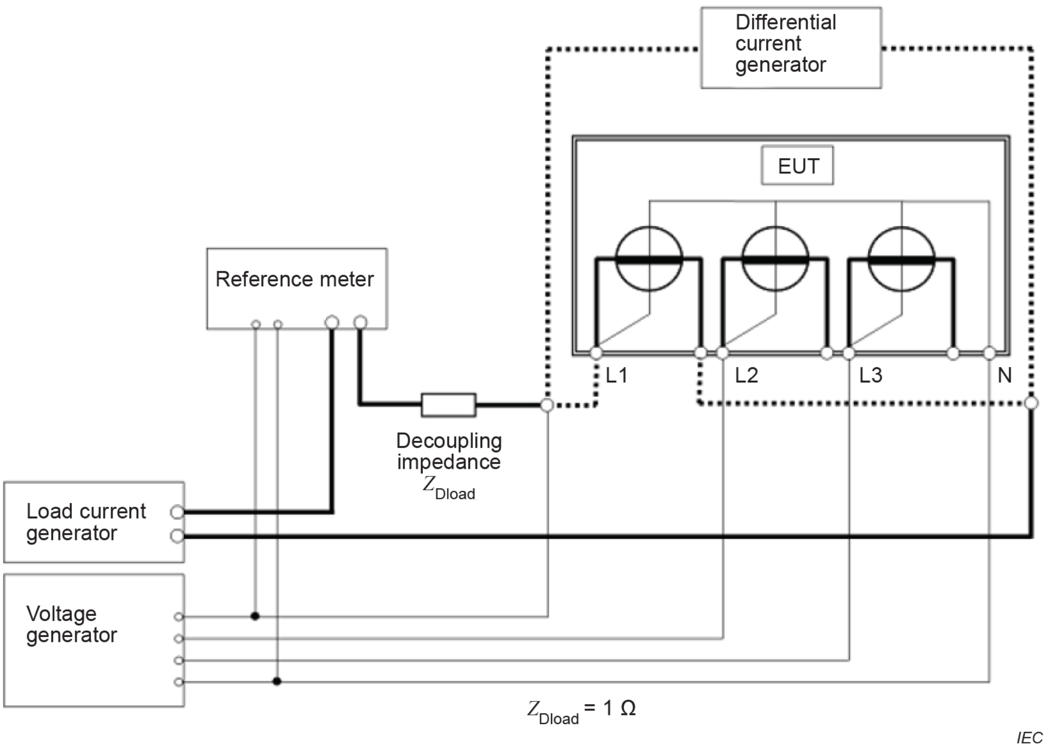

Figure G.1 – Example of a test set-up for immunity to conducted, differential mode disturbances and signalling in the frequency range 2 kHz to 150 kHz at AC power ports (from IEC 61000-4-19: 2014)

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Annex H
(normative)

Test circuit diagrams for testing influence of harmonics and interharmonics

The values given in Figure H.2, Figure H.3, Figure H.4, Figure H.5, Figure H.6, Figure H.7, Figure H.9 and Figure H.10 are for 50 Hz only. For other frequencies the values should be adapted accordingly.

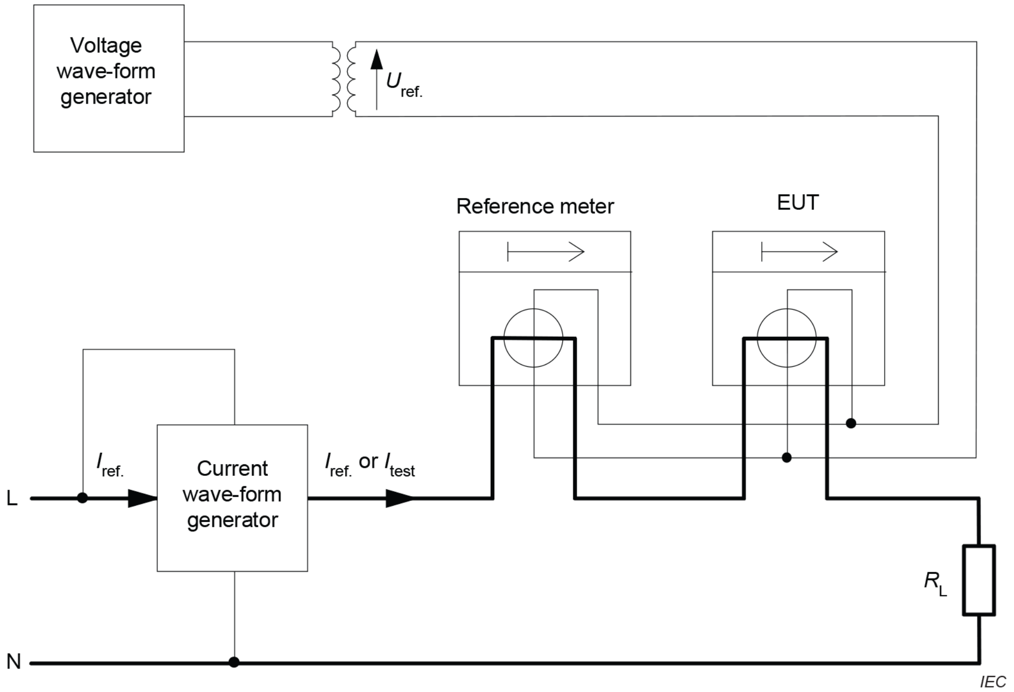

Figure H.1 – Test circuit diagram (informative, test of influence of interharmonics and odd harmonics)

The reference meter shall measure the total active energy (fundamental + harmonics) in the presence of harmonics.

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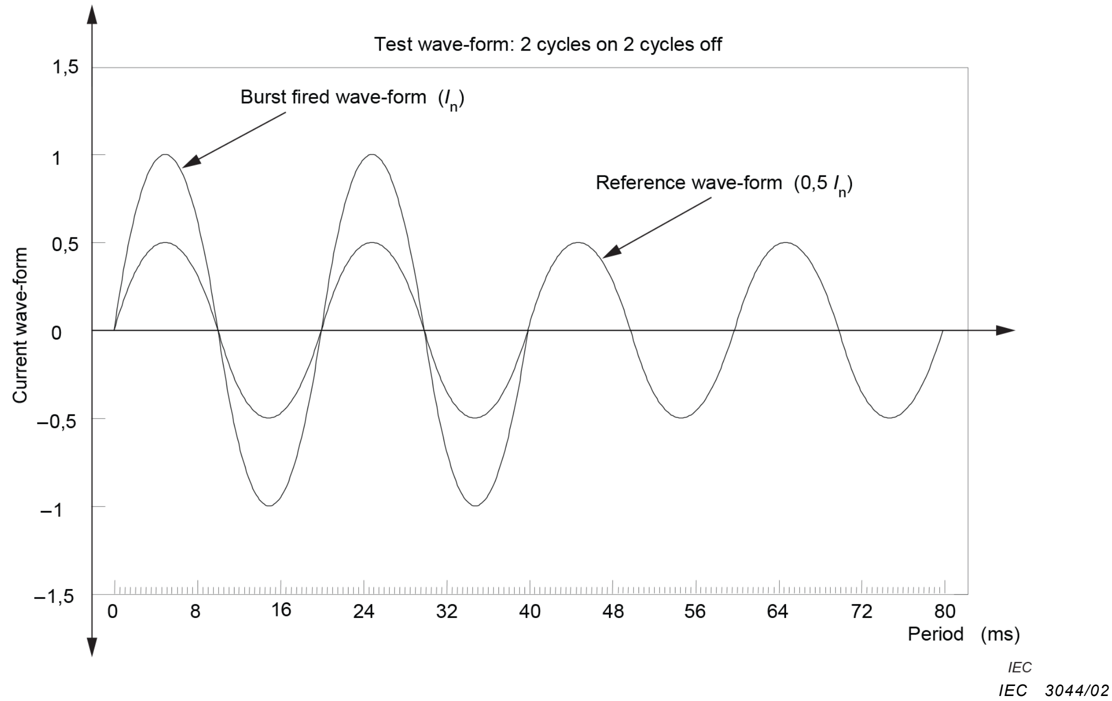

Figure H.2 – Burst fired wave-form (interharmonics)

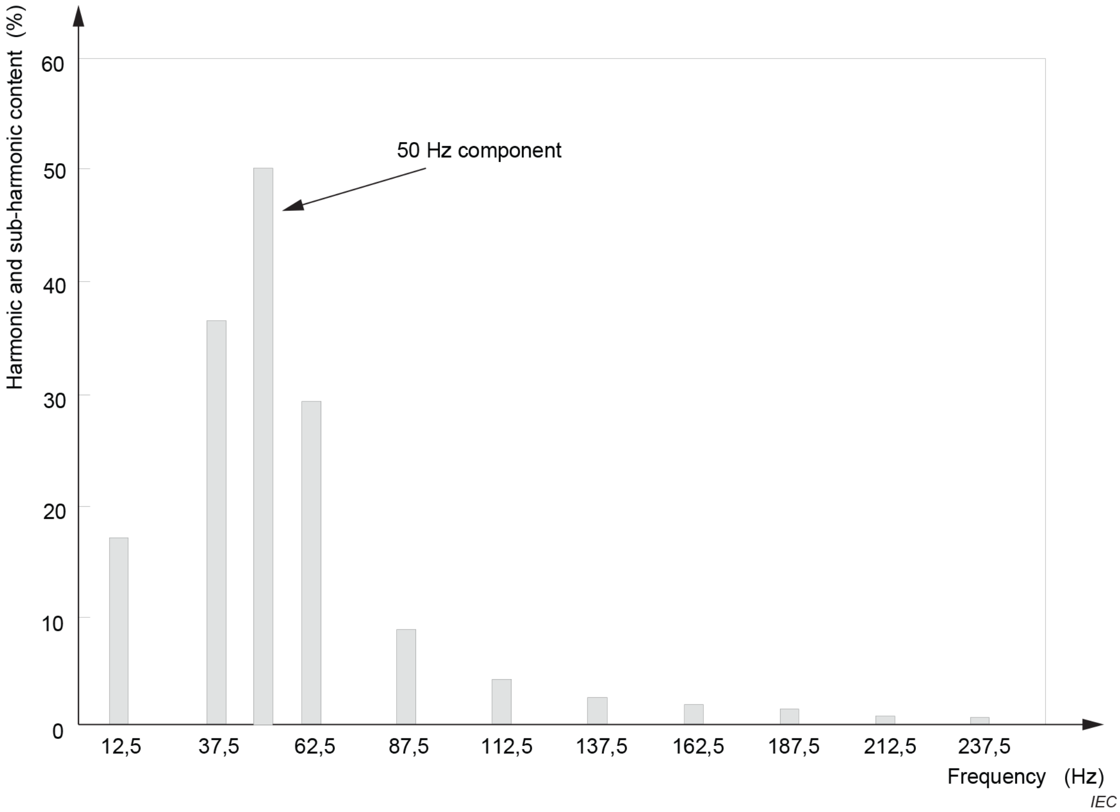

Figure H.3 – Informative distribution of interharmonic content of burst-fired waveform (the Fourier analysis is not complete)

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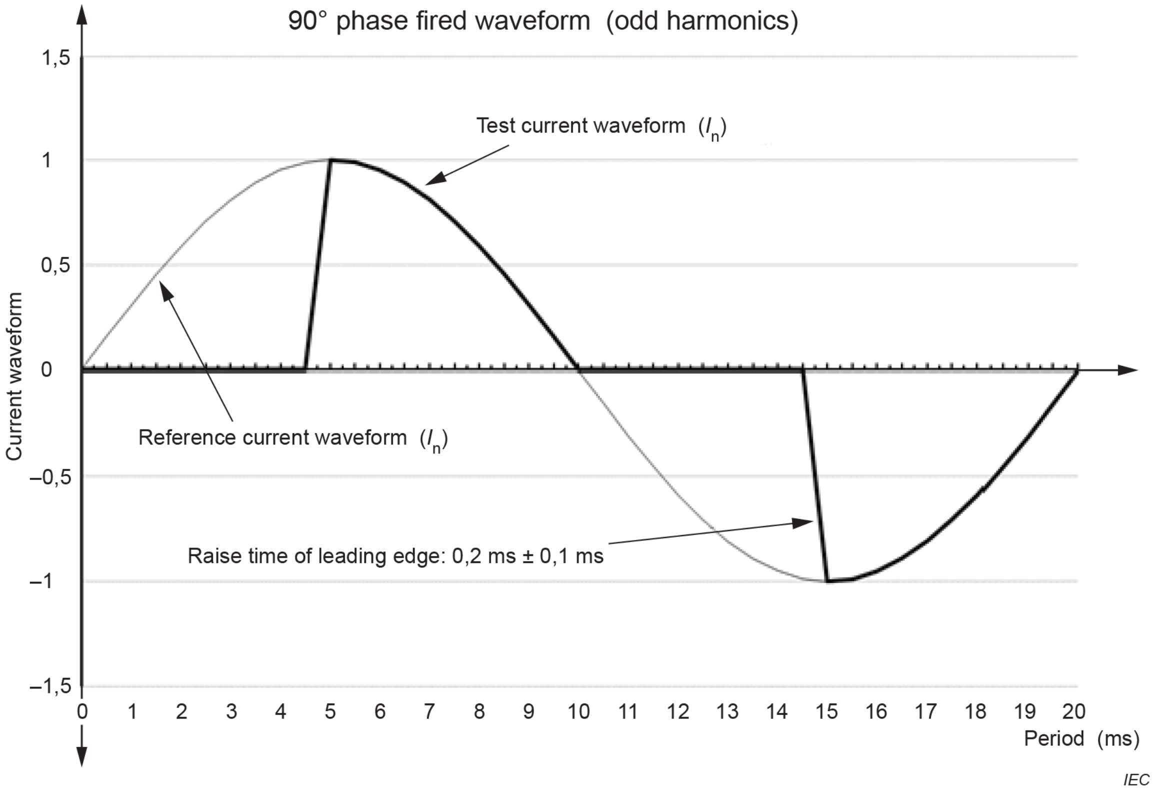

Figure H.4 – Phase fired waveform (odd harmonics) – 90° fired waveform

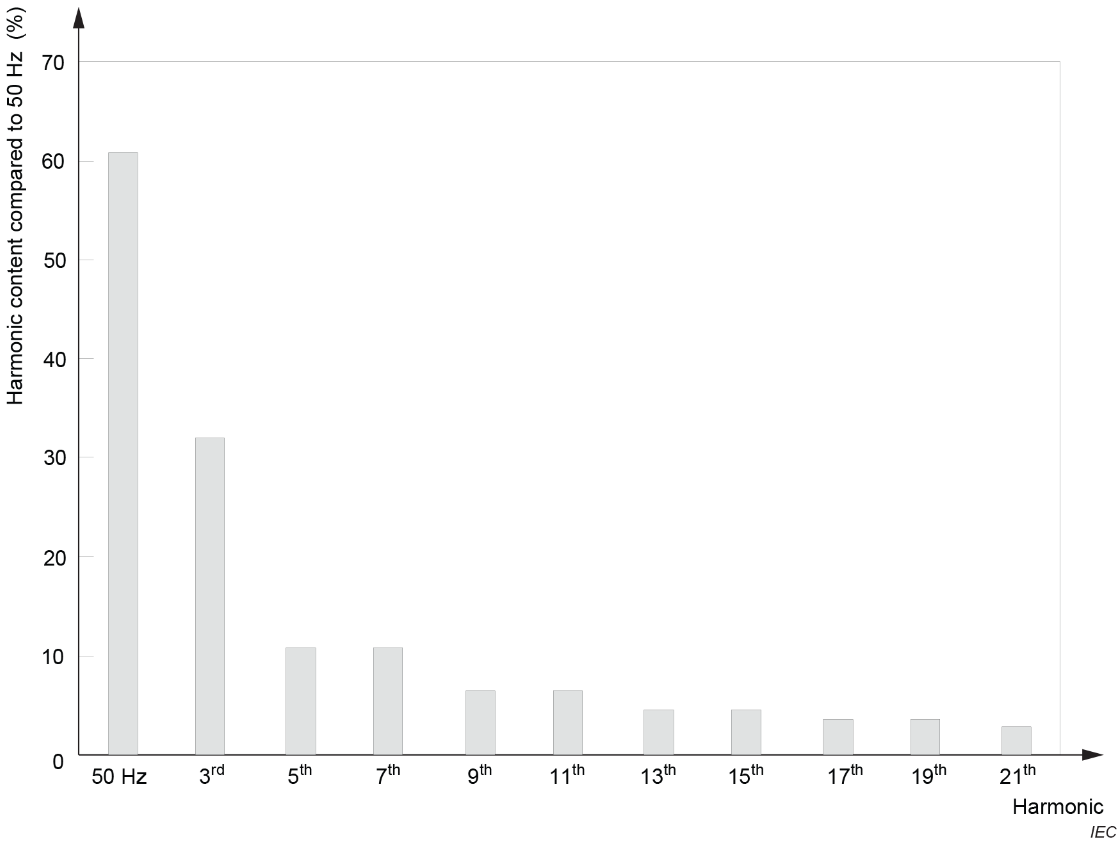

Figure H.5 – Informative distribution of harmonic content of 90° phase fired waveform (the Fourier analysis is not complete)

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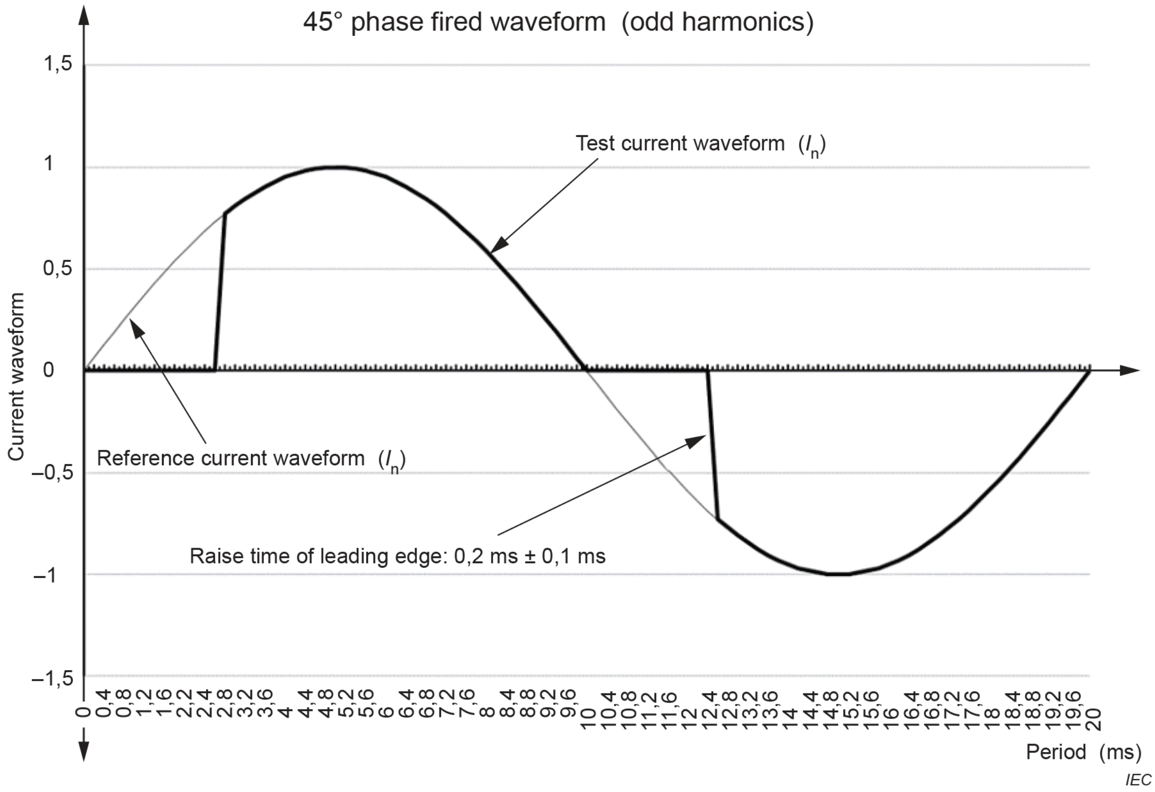

Figure H.6 – Phase fired waveform (odd harmonics) – 45° fired waveform

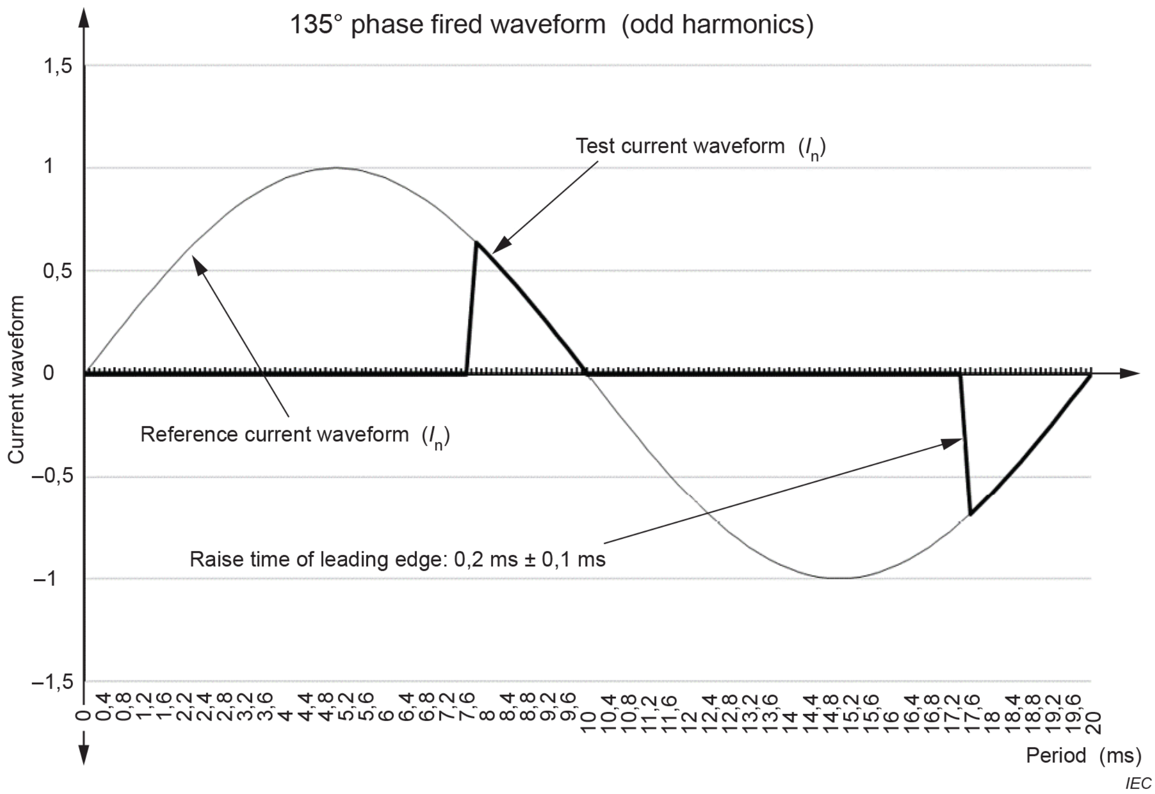

Figure H.7 – Phase fired waveform (odd harmonics) – 135° fired waveform

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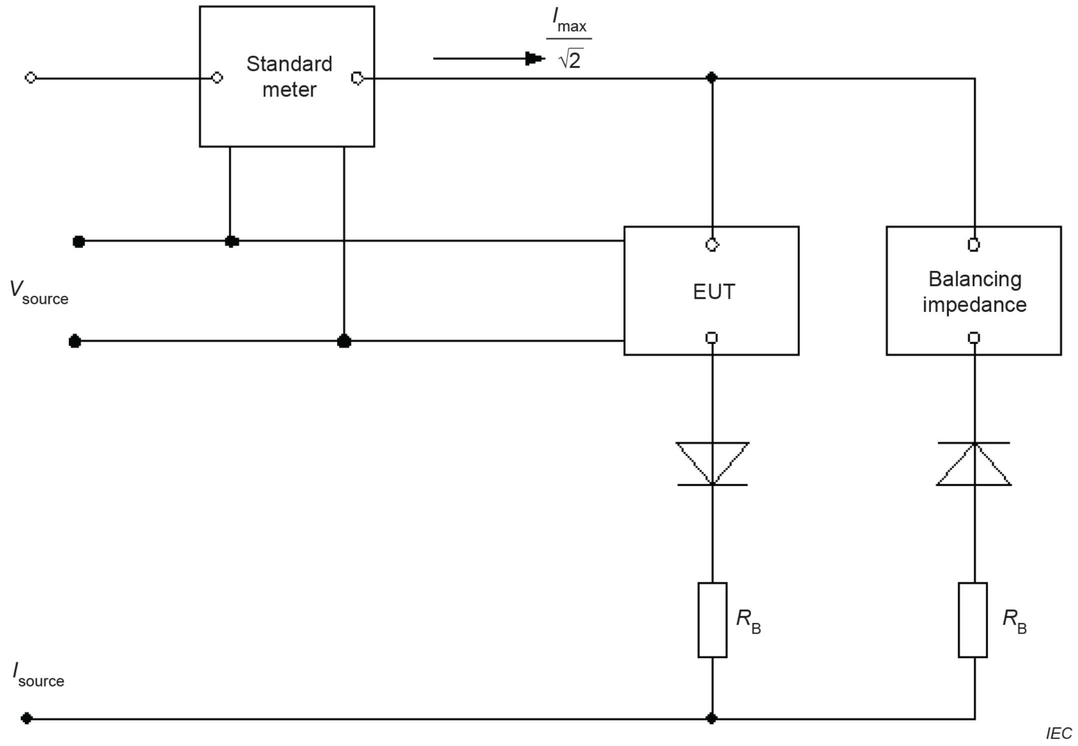

Figure H.8 – Test circuit diagram for half-wave rectification (DC and even harmonics)

The balancing impedance shall be equal to the impedance of the equipment under test (EUT) to ensure the measurement accuracy. The balancing impedance could most conveniently be a meter of the same type as the EUT. The rectifier diodes shall be of the same type. To improve the balancing condition, an additional resistor RB can be introduced in both paths. Its value should be approximately 10 times the value of the EUT.

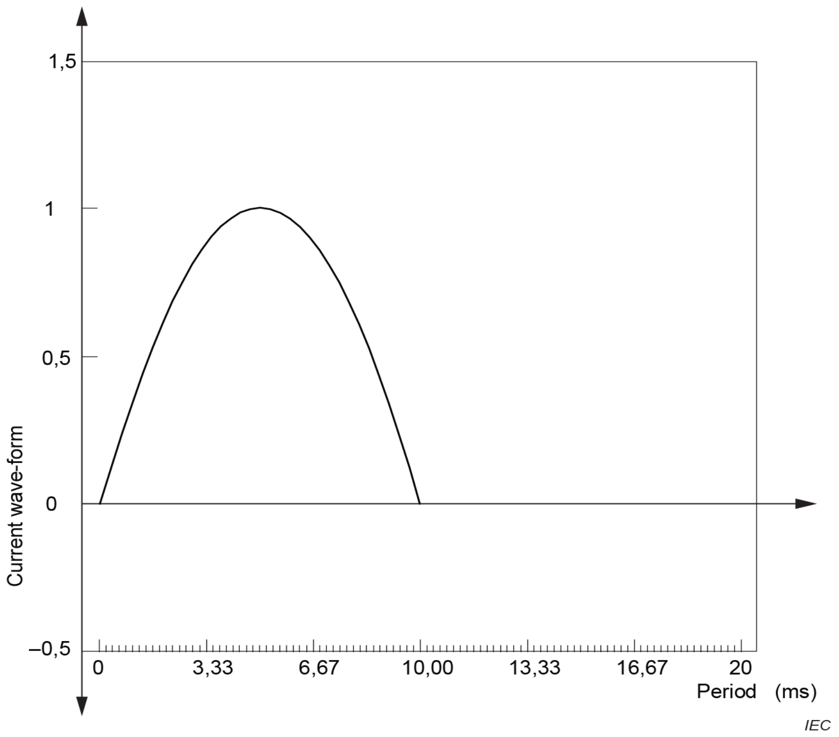

Figure H.9 – Half-wave rectified waveform (DC and even harmonics)

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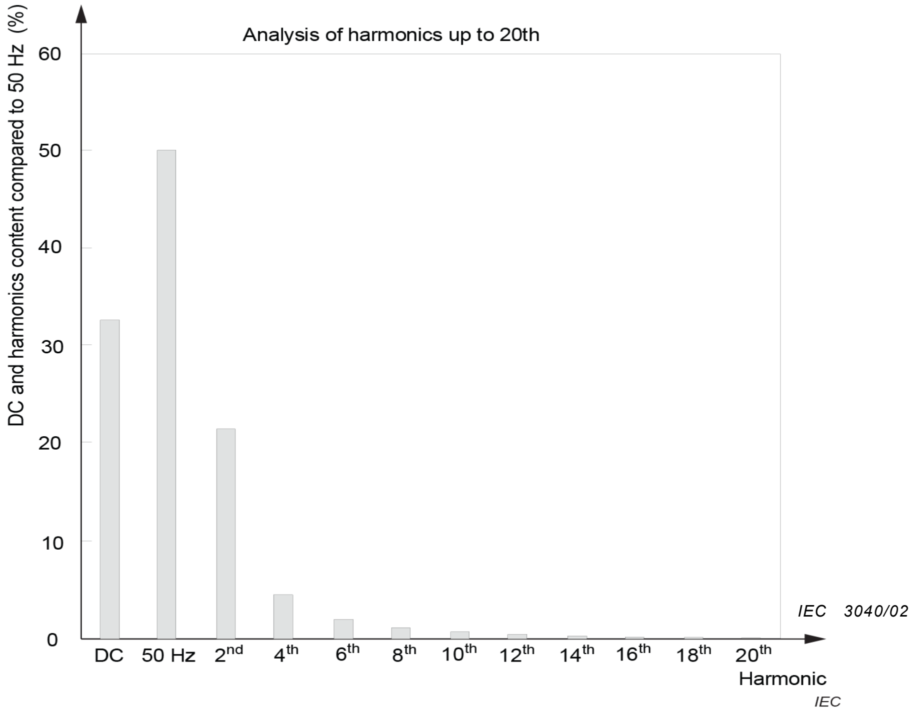

Figure H.10 – Informative distribution of harmonic content of half-wave rectified waveform (the Fourier analysis is not complete)

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Annex I
(informative)

Short time overcurrent test waveform

Annex I provides explanation for determining test values for the short time overcurrent test.

This test shall prove the meter's ability to withstand a short-circuit current; this current will be limited by fuse or line protection devices; the I^2t-Integral of a sine-half-wave should be the measure if an exact sine half-wave cannot be achieved.

A sinusoidal half-rectified waveform has an amplitude of

$$I = 30 \times I_{max} \times \sqrt{2} = 42{,}43 \times I_{max}.$$

A sinusoidal half-rectified waveform of amplitude I has generally an I^2t value of

$$E = I^2 \int_0^{T/2} (\sin \omega t)^2 \, dt = \frac{I^2}{\omega} \int_0^{\pi} (\sin \varphi)^2 \, d\varphi \, ,$$

therefore with $\omega = \frac{2\pi}{T}$

$$E = I^2 \times \frac{T}{4}$$

with T = 20 ms, the I^2t value

$$E = (42{,}43 \times I_{max})^2 \times 5\times 10^{-3} \text{ s} = 9 \text{ s} \times I_{max}^2$$

Example:

I_{max} = 60 A,

E = (2 545 A)^2 × 5 ms = 32 400 [A^{2}s].

If the waveform of the short-time overcurrent cannot be exactly sine-half-wave then the I^2t-value of the current pulse should be the same as for the correct half-wave.

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Annex J
(informative)

Fast load current variation test

Annex J gives the rationale for introducing the fast load current variation test.

The accuracy of electricity meters is normally defined and verified only for stationary conditions. However, in practical situations the load current can vary frequently with high amplitude. Examples are temperature regulated heaters, air conditioners, arc welding systems, etc. Some meter designs have exhibited significant accuracy errors under such conditions, mainly due to incorrectly implemented current range gain switching algorithms. This test (9.4.12) is intended to verify accuracy under varying load conditions using different duty cycles. As the load switching and the meter internal gain switching are not synchronized, the accuracy error may vary over time depending on how the load switching transients are timed with respect to gain switching. If the test time is sufficiently long, in this case 4 h, the timing conditions will vary similarly to practical situations and accuracy problems can be revealed.

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Annex K
(normative)

Electromagnet for testing the influence of externally produced magnetic fields

K.1 Permanent magnet for testing the influence of external static magnetic field

Specification for NdFeB-magnet (test magnet):

a) The magnetic material is the neodymium-iron-boron alloy Nd2Fe14B 280/167 in accordance with IEC 60404-8-1:2015.

b) The remanence (residual flux density) of the material is 1 200 mT.

c) The determination of the remanence is done in accordance with IEC 60404-5: 2015.

d) The dimensions of the magnet are 50 × 50 × 25 mm, the pole surface is 50 × 50 mm. The flux density measured at the center of the pole surface is 400 mT ± 10 mT.

K.2 Electromagnet for testing the influence of external static magnetic field with magneto-motive force of 1 000 At (ampere-turns) (see Figure K.1)

Specification of the electromagnet core material:

a) The magnetic material is made by cold-rolled, non-oriented electrical steel sheets.

b) In accordance with IEC 60404-8-4:2013.

c) The steel shall be M270-35 A5 according to EN 10027-1:2016, Table 1.

d) The surface shall be weldable coated.

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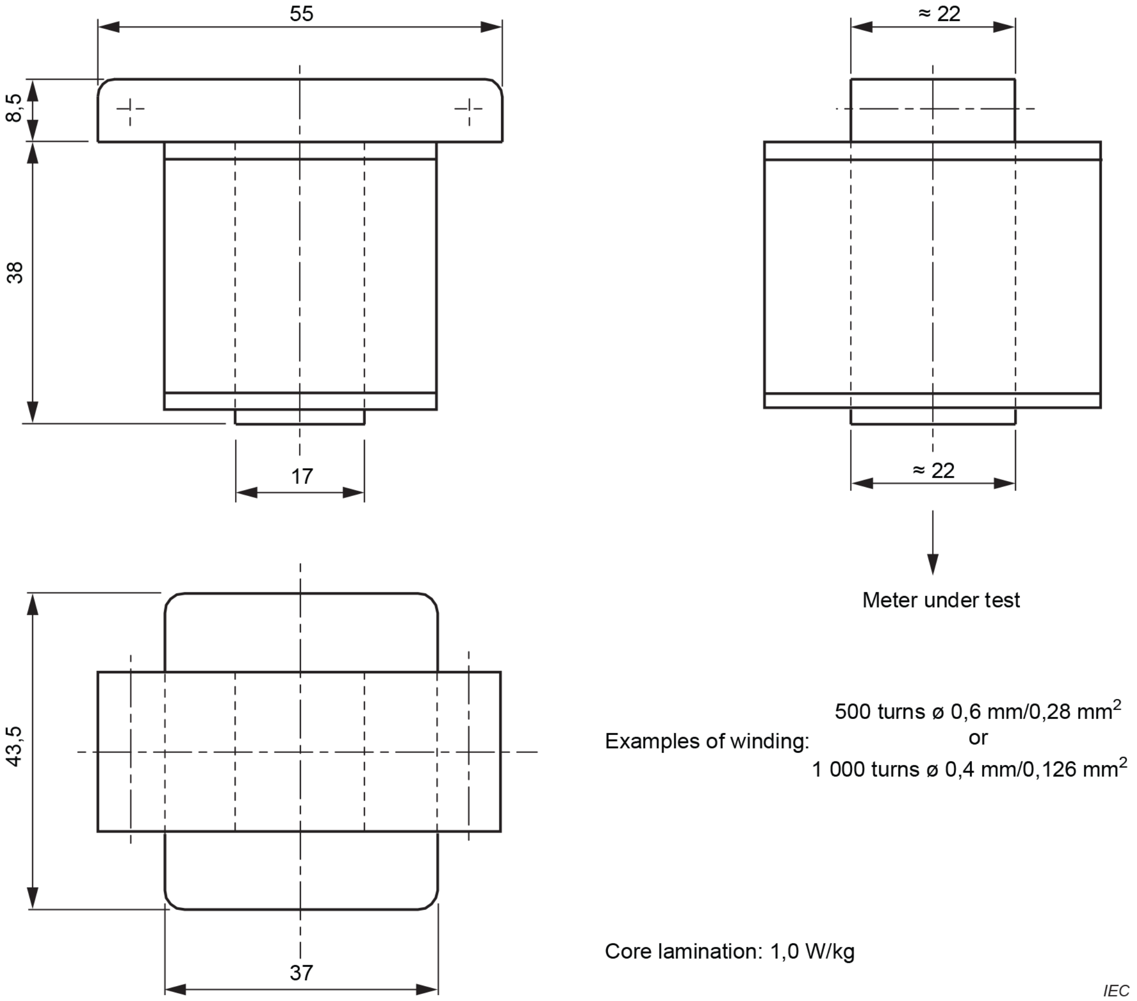

Figure K.1 – Electromagnet for testing the influence of external static magnetic field with magneto-motive force of 1 000 At (ampere-turns)

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Annex L
(normative)

Test circuit diagram for the test of immunity to earth fault

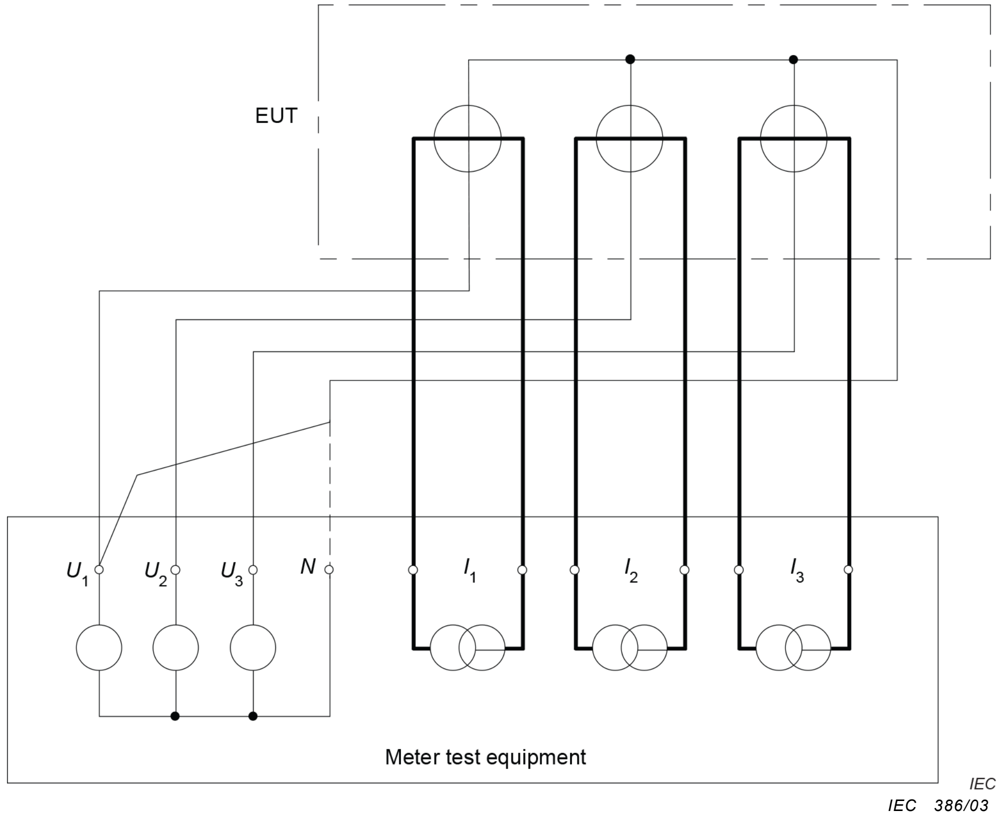

Figure L.1 – Circuit to simulate earth fault condition in phase 1

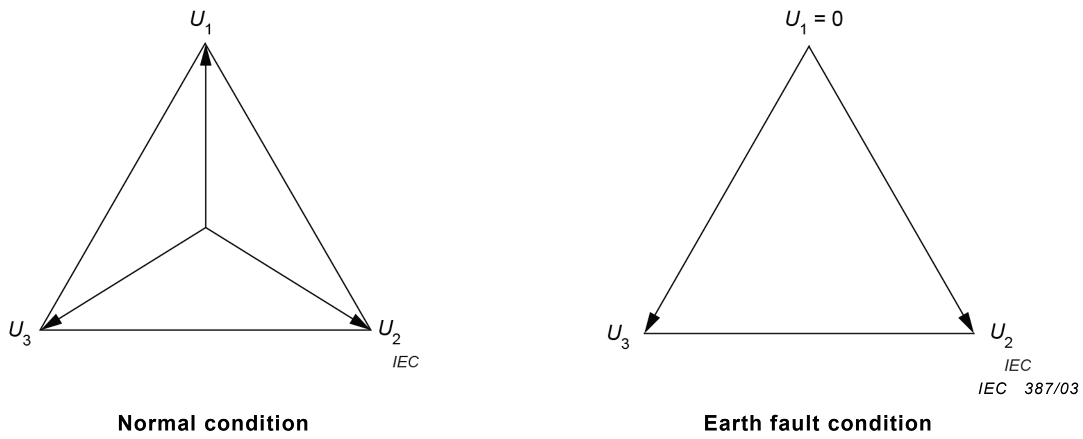

Figure L.2 – Voltages at the meter under test

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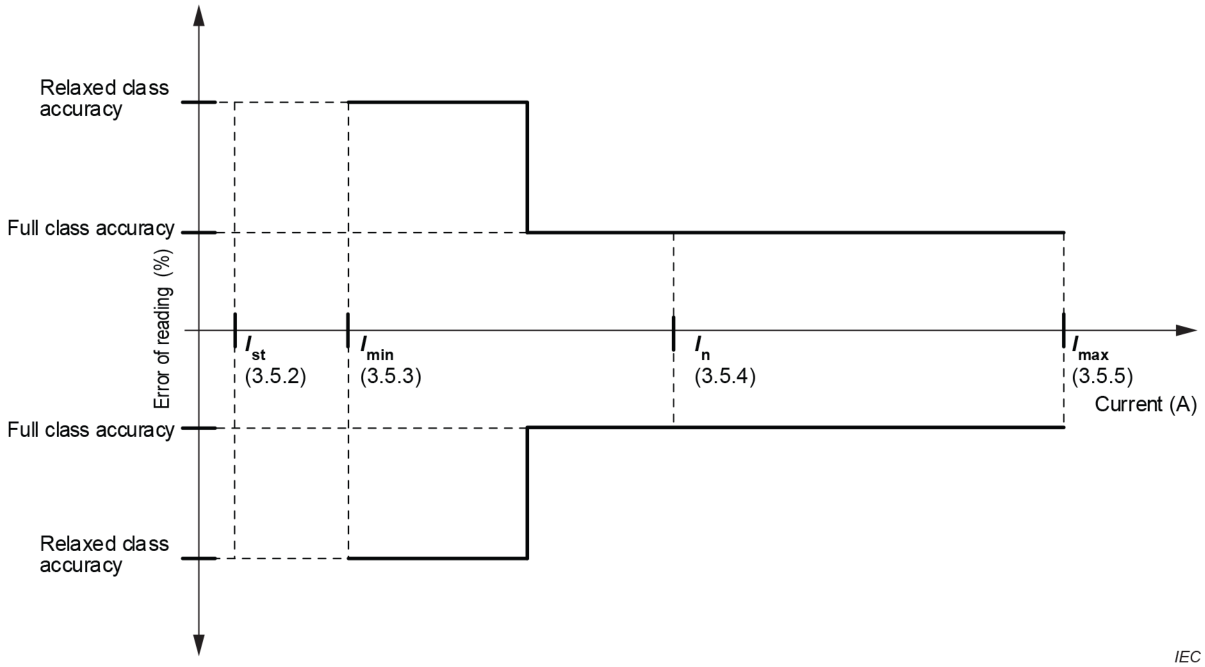
Annex M
(informative)

Meter current range



I_{st} starting current (see 3.5.2, 4.2.2)

I_{min} minimum current (see 3.5.3, 4.2.3)

I_n nominal current (see 3.5.4, 4.2.1)

I_{max} maximum current (see 3.5.5, 4.2.4)

Figure M.1 – Meter current range

Percentage error limits for accuracy class – see the relevant particular requirements (accuracy class) standards.

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Annex N
(informative)

Application to Branch Circuit Power Meters

N.1 Overview

This annex contains additional test methods and requirements that may be applied to type test Branch Circuit Energy meters. The intention of this annex is only to give guidance. Applying these additional test methods does not constitute compliance with this document.

N.2 Definitions

multi-branch meter
meter designed to measure energy on multiple branch circuits of electrical distribution network

Note 1 to entry: Multi-branch meters are typically connected via LPITs, and may have a large number of measuring channels, one for each branch circuit in the distribution panelboard or switchboard.

channel
analogue or digital input in a multi-branch meter associated with one connected circuit or phase

N.3 General

The following requirements are applicable for the type approval of multi-branch meters.

a) Meters shall be designed so that every channel is identical.
b) For testing purposes only, every branch includes an individual pulse output or the registers have sufficient resolution to detect a single pulse, with a minimum resolution of 1 Wh.
c) If the meter is designed to measure single phase connections, the meter shall comply with the limits of percentage error for the accuracy class on the single-phase connection. This shall be assessed by testing one or more single phase channel (randomly selected).
d) If the meter is designed to measure three phase connections, the meters shall comply with the limits of percentage error for the accuracy class for all three connections. This shall be assessed by testing one group of three channels (randomly selected).
e) The meter shall be tested for cross-channel influences (see cross-channel influences).
f) For all other requirements for type approval, the meter shall meet the requirements in each configuration. In order to verify that the meter type complies with all the requirements, the tests shall be carried out on a limited number of branches, representative of the worst-case configuration in relation to a test, and is subject to an agreement between the manufacturer and the test laboratory. Testing these representative branches is sufficient to verify compliance of the whole system.
g) Requirements for self-heating shall be met applying maximum current and voltage to all branches.
h) If the meter is designed to operate with a family of LPITs, with identical characteristics, but different primary current values, the following tests shall be performed on the additional types of LPITs within the family:
    1) Accuracy due to variation in current;
    2) Starting;
    3) No load.

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N.4 Cross-channel influences

The purpose of this test is to determine whether the performance of the meter on one channel is affected by the presence of signals in other channels. It is only applicable for multi-branch meters.

The meter shall be fully connected. That is, energy shall be flowing in every channel. The accuracy of the meter on one channel shall comply with the limits of percentage error for the accuracy class under the following conditions, see Table N.1.

Table N.1 – Cross-channel influence test conditions for multi-circuit meters

Test channel		Other channels	
Current	**Power factor**	**Current**	**Power factor**
No current	No load, see 7.6	Maximum current	Cos phi 1, 0,5 ind. and 0,5 cap. Sin phi 1, 0,5 ind. and 0,5 cap.
Minimum current	1		
Minimum current	0,5 inductive		
Minimum current	0,8 capacitive		

For example: when the test channel is loaded with nominal current, power factor 1, testing is performed with the other channels loaded with power factors 1, 0,5 inductive and 0,8 capacitive.

N.5 Channel configuration and sealing for multi-branch meters

The configuration of the channels for multi-branch meters is considered to be a metrologically relevant parameter. The configuration of the channels includes which channels are grouped together to measure poly-phase circuits.

For multi-branch meters, the metrological seal(s) shall also secure the meter along with the connected LPITs.

N.6 Verification for multi-branch meters

The following requirements are applicable for verification of multi-branch meters:

a) If the meter is intended to measure single phase connections, the verification tests shall be performed on every single-phase channel on the meter.

b) If the meter is intended to measure three phase connections, the verification tests shall be performed on every group of three phase channels on the meter. Note, if the meter is designed to allow flexibility in how to group three channels, this could result in a very large number of combinations. For example, there are 59 640 combinations of three channels for a 72 channels meter. In this case, it is sufficient to tests a subset of the combinations – typically each set of sequential groups of three channels (1, 2, 3), (4, 5, 6) and so on.

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Annex O
(informative)

Overview of the technical changes

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

a) Removed all meter safety requirements; the meter safety requirements are covered in IEC 62052-31:2015;

b) Included requirements for meter power consumption and voltage requirements from IEC 62053-61; IEC 62053-61 is withdrawn;

c) Included requirements for meter symbols from IEC 62053-52; IEC 62053-52 is withdrawn;

d) Included requirements for meter pulse output devices from IEC 62053-31; IEC 62053-31 is withdrawn;

e) Moved the descriptions of all general requirements and test methods from IEC 62053-21:2020, IEC 62053-22:2020, IEC 62053-23:2020, IEC 62053-24:2020 to IEC 62052-11; IEC 62053-21:2020, IEC 62053-22:2020, IEC 62053-23:2020, IEC 62053-24:2020 contain only accuracy class specific requirements;

f) Added new requirements and tests concerning:

   1) meters with detached indicating displays, and meters without indicating displays (clause 1);
   2) meter sealing provisions (5.5);
   3) measurement uncertainty and repeatability (7.8);
   4) measurement of meter initial start-up time (7.5);
   5) time-keeping accuracy (7.11);
   6) durability (8.4);
   7) influence of fast load current variations (9.4.12);
   8) immunity to conducted differential current disturbances in the 2 kHz-150 kHz frequency range (9.3.8);
   9) ring wave immunity test (9.3.10);
   10) voltage dips, short interruptions and voltage variations on DC input power port immunity tests (9.3.2.2);
   11) type test report (10.2).

g) Updated and clarified acceptance criteria for testing of external influences;

h) Revised and updated tests for immunity to electromagnetic influences and disturbances as per the latest editions of the basic EMC publications.

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Annex P
(informative)

Test schedule – Recommended test sequences

No	Tests	General requirements IEC 62052-11 clause	Electro-mechanical AC meters	Electronic (static) AC meters	Electronic (static) DC meters
1	Test of safety requirements	5			
1.1	Tests related to safety	5.1	IEC 62052-31: 2015	IEC 62052-31: 2015	IEC 62052-31: 2015
2	Tests of mechanical requirements	5.2			
2.1	Shock test	5.2.1	X	X	X
2.2	Vibration test	5.2.2	X	X	X
2.3	Terminals – Terminal block(s)	5.4	IEC 62052-31: 2015	IEC 62052-31: 2015	IEC 62052-31: 2015
3	Tests of general requirements	4, 5, 6			
3.1	Power consumption	4.4	X	X	IEC 62053-41: –
3.1	Optical test output	5.8.2.2	X	X	X
3.2	Electrical pulse output	5.8.3.2	X	X	X
3.3	Electrical pulse input	5.9.2	X	X	X
3.4	Meter marking	6.2	IEC 62052-31: 2015	IEC 62052-31: 2015	IEC 62052-31: 2015
4	Tests of accuracy requirements	7			
4.1	Meter constant	7.4	X	X	X
4.2	Initial start-up of the meter	7.5	X	X	X
4.3	Test of no-load condition	7.6	X	X	X
4.4	Starting current test	7.7	X	X	X
4.5	Repeatability test	7.8	X	X	X
4.6	Limits of error due to variation of the current	7.9	IEC 62053-11: 2003	IEC 62053-21: 2020 IEC 62053-22: 2020 IEC 62053-23: 2020 IEC 62053-24: 2020	IEC 62053-41: –
4.7	Test of time keeping accuracy	7.11	X	X	X
5	Tests for electromagnetic compatibility (EMC) and limits of error due to influence quantities	9.3, 7.10			
5.1	Limits of percentage error due to influence quantities	7.10		IEC 62053-21: 2020 IEC 62053-22: 2020 IEC 62053-23: 2020 IEC 62053-24: 2020	IEC 62053-41: –
5.2	Voltage dips and short interruptions	9.3.2		X	X
5.3	Electrostatic discharge immunity test	9.3.3		X	X
5.4	Radiated, radio-frequency, electromagnetic field immunity test	9.3.4, 9.3.5		X	X
5.5	Electrical fast transient/burst immunity test	9.3.6		X	X

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No	Tests	General requirements IEC 62052-11 clause	Electro-mechanical AC meters	Electronic (static) AC meters	Electronic (static) DC meters
5.6	Immunity to conducted disturbances, induced by radio-frequency fields	9.3.7		X	X
5.7	Test for immunity to conducted, differential mode disturbances and signalling in the frequency range 2 kHz to 150 kHz at AC power ports	9.3.8		X	X
5.8	Surge immunity test	9.3.9		X	X
5.9	Ring wave immunity test	9.3.10		X	X
5.10	Damped oscillatory wave immunity test	9.3.11		X	X
5.11	External static magnetic fields	9.3.12		X	X
5.12	Power frequency magnetic field immunity test	9.3.13		X	X
5.13	Emission requirements	9.3.14		X	X
6	Tests of immunity to other influence quantities	9.4, 7.10			
6.1	Limits of error due to influence quantities	7.10	IEC 62053-11: 2003	IEC 62053-21: 2020 IEC 62053-22: 2020 IEC 62053-23: 2020 IEC 62053-24: 2020	IEC 62053-41: –
6.2	Harmonics in the current and voltage circuits 5th harmonic test	9.4.2.2	X	X	
6.3	Interharmonics in the current circuit – burst fired waveform test	9.4.2.3	X	X	
6.4	Odd harmonics in the current circuit	9.4.2.4	X	X	
6.5	DC and even harmonics – half wave rectified waveform test	9.4.2.5	X	X	
6.6	Voltage variation	9.4.3	X	X	X
6.7	Ambient temperature variation	9.4.4	X	X	X
6.8	Interruption of phase voltage	9.4.5	X	X	
6.9	Frequency variation	9.4.6	X	X	
6.10	Reversed phase sequence	9.4.7	X	X	
6.11	Auxiliary voltage variation	9.4.8		X	X
6.12	Operation of auxiliary devices	9.4.9	X	X	X
6.13	Short time overcurrents	9.4.10	X	X	X
6.14	Self-heating	9.4.11	X	X	X
6.15	Fast load current variations	9.4.12	X	X	X
6.16	Earth fault	9.4.13	X	X	
7	Tests of the effect of the climatic environments	8.3, 8.4			
7.1	Dry heat test	8.3.3	X	X	X
7.2	Cold test	8.3.4	X	X	X
7.3	Damp heat, cyclic test	8.3.5	X	X	X
7.4	Protection against solar radiation	8.3.6	X	X	X
7.5	Durability	8.4	X	X	X

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