INTERNATIONAL STANDARD

IEC 62052-11

First edition
2003-02

Electricity metering equipment (AC) – General requirements, tests and test conditions –

Part 11: Metering equipment

*This **English-language** version is derived from the original **bilingual** publication by leaving out all French-language pages. Missing page numbers correspond to the French-language pages.*

Reference number
IEC 62052-11:2003(E)

Publication numbering

As from 1 January 1997 all IEC publications are issued with a designation in the 60000 series. For example, IEC 34-1 is now referred to as IEC 60034-1.

Consolidated editions

The IEC is now publishing consolidated versions of its publications. For example, edition numbers 1.0, 1.1 and 1.2 refer, respectively, to the base publication, the base publication incorporating amendment 1 and the base publication incorporating amendments 1 and 2.

Further information on IEC publications

The technical content of IEC publications is kept under constant review by the IEC, thus ensuring that the content reflects current technology. Information relating to this publication, including its validity, is available in the IEC Catalogue of publications (see below) in addition to new editions, amendments and corrigenda. Information on the subjects under consideration and work in progress undertaken by the technical committee which has prepared this publication, as well as the list of publications issued, is also available from the following:

- **IEC Web Site (www.iec.ch)**

- **Catalogue of IEC publications**

  The on-line catalogue on the IEC web site (www.iec.ch/searchpub) enables you to search by a variety of criteria including text searches, technical committees and date of publication. On-line information is also available on recently issued publications, withdrawn and replaced publications, as well as corrigenda.

- **IEC Just Published**

  This summary of recently issued publications (www.iec.ch/online_news/ justpub) is also available by email. Please contact the Customer Service Centre (see below) for further information.

- **Customer Service Centre**

  If you have any questions regarding this publication or need further assistance, please contact the Customer Service Centre:

  Email: custserv@iec.ch
  Tel: +41 22 919 02 11
  Fax: +41 22 919 03 00

INTERNATIONAL STANDARD

IEC 62052-11

First edition
2003-02

Electricity metering equipment (AC) – General requirements, tests and test conditions –

Part 11: Metering equipment

International Electrotechnical Commission, 3, rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: inmail@iec.ch Web: www.iec.ch

Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

ELECTRICITY METERING EQUIPMENT (AC) – GENERAL REQUIREMENTS, TESTS AND TEST CONDITIONS –

Part 11: Metering equipment

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of the IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested National Committees.
3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical specifications, technical reports or guides and they are accepted by the National Committees in that sense.
4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.
5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.
6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 62052-11 has been prepared by IEC technical committee 13: Equipment for electrical energy measurement and load control.

The text of this standard is based on the following documents:

FDIS	Report on voting
13/1285/FDIS	13/1292/RVD

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

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

The committee has decided that the contents of this publication will remain unchanged until 2012. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

INTRODUCTION

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

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

Replaces particular requirements of IEC 60521:1988 (2nd edition)

IEC 62053-21: 2003, *Electricity metering equipment (a.c.) – Particular requirements – Part 21: Static meters for active energy (classes 1 and 2)*

Replaces particular requirements of IEC 61036: 2000 (2nd edition)

IEC 62053-22:2003, *Electricity metering equipment (a.c.) – Particular requirements – Part 22: Static meters for active energy (classes 0,2 S and 0,5 S)*

Replaces particular requirements of IEC 60687:1992 (2nd edition)

IEC 62053-23:2003, *Electricity metering equipment (a.c.) – Particular requirements – Part 23: Static meters for reactive energy (classes 2 and 3)*

Replaces particular requirements of IEC 61268:1995 (1st edition)

IEC 62053-31:1998, *Electricity metering equipment (a.c.) – Particular requirements – Part 31: Pulse output devices for electromechanical and electronic meters (two wires only)*

IEC 62053-61:1998, *Electricity metering equipment (a.c.) – Particular requirements – Part 61: Power consumption and voltage requirements*

IEC 62059-11:2002, *Electricity metering equipment (a.c.) – Dependability – Part 11: General concepts*

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

This part is a standard for type testing electricity meters. It covers the general requirements for “normal meters”, being used indoors and outdoors in large quantities worldwide. It does not deal with special implementations (such as metering-part and/or displays in separate housings).

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

This standard distinguishes between

– meters intended to be used indoors and outdoors; and

– protective class I and protective class II meters.

The test levels are regarded as minimum values to guarantee the proper functioning of the meter under normal working conditions. For special application, other test levels might be necessary and should be agreed upon between the user and the manufacturer.

ELECTRICITY METERING EQUIPMENT (AC) – GENERAL REQUIREMENTS, TESTS AND TEST CONDITIONS –

Part 11: Metering equipment

1 Scope

This part of IEC 62052 covers type tests for electricity metering equipment for indoor and outdoor application and applies to newly manufactured equipment designed to measure the electrical energy on 50 Hz or 60 Hz networks, with a voltage up to 600 V.

It applies to electromechanical or static meters for indoor and outdoor application consisting of a measuring element and register(s) enclosed together in a meter case. It also applies to operation indicator(s) and test output(s). If the meter has a measuring element for more than one type of energy (multi-energy meters), or when other functional elements, such as maximum demand indicators, electronic tariff registers, time switches, ripple control receivers, data communication interfaces, etc. are enclosed in the meter case, then the relevant standards for these elements apply.

It does not apply to:

a) portable meters;

b) data interfaces to the register of the meter;

c) reference meters.

For rack-mounted meters, the mechanical properties are not covered in this standard.

2 Normative references

The following referenced documents are indispensable for the application 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 60038:1983, *IEC standard voltages*
Amendment 1:1994,
Amendment 2:1997

IEC 60044-1:1996, *Instrument transformers – Part 1: Current transformers*

IEC 60044-2:1997, *Instrument transformers – Part 2: Inductive voltage transformers*

IEC 60050-300:2001, *International Electrotechnical Vocabulary – Electrical and electronic measurements and measuring instruments – Part 311: General terms relating to measurements – Part 312: General terms relating to electrical measurements – Part 313: Types of electrical measuring instruments – Part 314: Specific terms according to the type of instrument*

IEC 60060-1:1989, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60068-2-1:1990, *Environmental testing – Part 2: Tests – Tests A: Cold*
Amendment 1:1993,
Amendment 2:1994

IEC 60068-2-2:1974, *Basic environmental testing procedures – Part 2: Tests – Tests B: Dry heat*
Amendment 1:1993,
Amendment 2:1994

IEC 60068-2-5:1975, *Basic environmental testing procedures – Part 2: Tests – Test Sa: Simulated solar radiation at ground level*

IEC 60068-2-6:1995, *Environmental testing – Part 2: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60068-2-11:1981, *Basic environmental testing procedures – Part 2: Tests – Test Ka: Salt mist*

IEC 60068-2-27:1987, *Basic environmental testing procedures – Part 2: Tests – Test Ea and guidance: Shock*

IEC 60068-2-30:1980, *Basic environmental testing procedures – Part 2: Tests – Test Db and guidance: Damp heat, cyclic (12 + 12-hour cycle)*

IEC 60068-2-75:1997, *Environmental testing – Part 2-75: Tests – Test Eh: Hammer tests*

IEC 60085:1984, *Thermal evaluation and classification of electrical insulation*

IEC 60359:2001, *Electrical and electronic measurement equipment – Expression of performance*

IEC 60387:1992, *Symbols for alternating-current electricity meters*

IEC 60417-2:1998, *Graphical symbols for use on equipment – Part 2: Symbols originals*

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*
Amendment 1:1999

IEC 60695-2-11:2000, *Fire hazard testing – Part 2-11: Glowing/hot-wire based test methods – Glow-wire flammability test method for end-products*

IEC 60721-3-3:1994, *Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities – Section 3: Stationary use at weatherprotected locations*
Amendment 1:1995,
Amendment 2:1996

IEC 61000-4-2:1995, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 2: Electrostatic discharge immunity test.* Basic EMC publication

IEC 61000-4-3:2002, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-4:1995, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 4: Electrical fast transient/burst immunity test.* Basic EMC publication

IEC 61000-4-5:1995, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 5: Surge immunity test*

IEC 61000-4-6:1996, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 6: Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61000-4-12:1995, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 12: Oscillatory waves immunity test.* Basic EMC publication

IEC 62053-31:1998, *Electricity metering equipment (a.c.) – Particular requirements – Part 31: Pulse output devices for electromechanical and electronic meters (two wires only)*

CISPR 22:1997, *Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement*
Amendment 1:2000

ISO 75-2:1993, *Plastics – Determination of temperature of deflection under load – Part 2: Plastic and ebonite*

3 Terms and definitions

For the purposes of this International Standard, the following definitions apply.

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

Where there is a difference between the definitions in the glossary and those contained in product standards produced by TC 13, then the latter shall take precedence in applications of the relevant standard.

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 current and voltage act on solid state (electronic) elements to produce an output proportional to the energy to be measured

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

[IEV 301-06-01]

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

[IEV 301-06-02]

3.1.5
reactive power (var)
reactive power for sinusoidal waveforms of any single frequency in a single phase circuit is defined as the product of the r.m.s. values of current and voltage and the sine of the phase angle between them.

NOTE Standards for reactive power apply for sinusoidal currents and voltages containing the fundamental frequency only.

3.1.6
reactive energy (var-hour)

3.1.6.1
reactive energy in a single-phase circuit
the reactive energy in a single-phase circuit is the time integral of the reactive power as defined under 3.1.5

3.1.6.2
reactive energy in a polyphase circuit
the algebraic sum of the reactive energies of the phases

NOTE The specification is based on reactive energy derived from sinusoidal current and voltage of fundamental frequencies, the inductive or capacitive state of a circuit in these recommendations is given by the factor “sin φ”.

3.1.7
multi-rate meter
energy meter provided with a number of registers, each becoming operative for specified time intervals corresponding to different tariff rates

[IEV 313-06-09 modified]

3.1.8
meter type

3.1.8.1
meter type (for electromechanical meter)

term used to define a particular design of meter, 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 reference current;

d) the same number of ampere-turns for the current winding at reference current and the same number of turns per volt for the voltage winding at reference voltage.

The type may have several values of reference current and reference voltage.

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 1 The type is represented by the sample meter(s) intended for the type tests, whose characteristics (reference current and reference voltage) are chosen from the values given in the tables proposed by the manufacturer.

NOTE 2 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 basic 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 may the number of turns per volt of the voltage windings differ, but by not more than 20 % from that of the sample meters representative of the type.

NOTE 3 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.

3.1.8.2
meter type (for static meter)
term used to define a particular design of meter, 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 reference current.

The type may have several values of reference current and reference voltage.

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

3.1.9
reference meter
a meter used to measure the unit of electric energy. It is usually designed and operated to obtain the highest accuracy and stability in a controlled laboratory environment

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
output devices

3.2.2.1
test output
device which can be used for testing the meter

3.2.2.2
operation indicator
device which gives a visible signal of the operation of the meter

3.2.2.3
pulse
wave that departs from an initial level for a limited duration of time and ultimately returns to the original level

3.2.2.4
pulse device (for electricity metering)
functional unit for emitting, transmitting, retransmitting or receiving electric pulses, representing finite quantities, such as energy normally transmitted from some form of electricity meter to a receiver unit

3.2.2.5
pulse output device (pulse output)
pulse device for emitting pulses

3.2.2.6
optical test output
optical pulse output device that is used for testing the meter

3.2.2.7
electrical test output
electrical pulse output device that is used for testing the meter

3.2.2.8
receiving head
functional unit for receiving pulses emitted by an optical pulse output

3.2.3
memory
element which stores digital information

3.2.3.1
non-volatile memory
memory which can retain information in the absence of power

3.2.4
display
device which displays the content(s) of the memory(ies)

3.2.5
register
the part of the meter which enables the measured value to be determined

[IEC 314-07-09 modified]

It can be an electromechanical device or an electronic device comprising both memory and display which stores and displays information. A single electronic display may be used with multiple electronic memories to form multiple electronic registers.

3.2.6
current circuit
internal connections of the meter and part of the measuring element through which flows the current of the circuit to which the meter is connected

3.2.7
voltage circuit
internal connections of the meter, part of the measuring element and in the case of static meters, part of the power supply, supplied with the voltage of the circuit to which the meter is connected

3.2.8
auxiliary circuit
elements (lamps, contacts, etc.) and connections of an auxiliary device within the meter case intended to be connected to an external device, for example clock, relay, impulse counter

3.2.9
constant

3.2.9.1
constant (for electromechanical meter)
value expressing the relation between the energy registered by the meter and the corresponding number of revolutions of the rotor for example, either in revolutions per kilowatt-hour (rev/kWh) or watt-hours per revolution (Wh/rev)

3.2.9.2
constant (for static watt-hour meters)
value expressing the relation between the energy registered by the meter and the corresponding value of the test output. If this value is a number of pulses for example, the constant should be either pulses per kilowatt-hour (imp/kWh) or watt-hours per pulse (Wh/imp)

3.3 Definitions of mechanical elements

3.3.1
indoor meter
meter which can only be used with additional protection against environmental influences (mounted in a house, in a cabinet)

3.3.2
outdoor meter
meter which can be used without additional protection in an exposed environment

3.3.3
base
back of the meter by which it is generally fixed and to which are attached the measuring element, the terminals or the terminal block, and the cover.

For a flush-mounted meter, the meter base may include the sides of the case.

3.3.3.1
socket
base with jaws to accommodate terminals of a detachable meter and which has terminals for connection to the supply line. It may be a single-position socket for one meter or a multiple-position socket for two or more meters

3.3.4
cover
enclosure on the front of the meter, made either wholly of transparent material or opaque material provided with window(s) through which the operation indicator (if fitted) and the display can be read

3.3.5
case
comprises the base and the cover

3.3.6
accessible conductive part
conductive part which can be touched by the standard test finger, when the meter is installed and ready for use

3.3.7
protective earth terminal
terminal connected to accessible conductive parts of a meter for safety purposes

3.3.8
terminal block
support made of insulating material on which all or some of the terminals of the meter are grouped together

3.3.9
terminal cover
cover which covers the meter terminals and, generally, the ends of the external wires or cables connected to the terminals

3.3.10
clearance
shortest distance measured in air between conductive parts

3.3.11
creepage distance

shortest distance measured over the surface of insulation between conductive parts

3.4 Definitions related to insulation

3.4.1
basic insulation
insulation applied to live parts to provide basic protection against electric shock

NOTE Basic insulation does not necessarily include insulation used exclusively for functional purposes.

3.4.2
supplementary insulation
independent insulation applied in addition to the basic insulation, in order to provide protection against electric shock in the event of a failure of the basic insulation

3.4.3
double insulation
insulation comprising both basic insulation and supplementary insulation

3.4.4
reinforced insulation
single insulation system applied to live parts, which provides a degree of protection against electric shock equivalent to double insulation

NOTE The term “insulation system” does not imply that the insulation should be one homogeneous piece. It may comprise several layers which cannot be tested singly as supplementary or basic insulation.

3.4.5
insulating encased meter of protective class I
meter in which protection against electric shock does not rely on basic insulation only but which includes an additional safety precaution in that conductive accessible parts are connected to the protective earthing conductor in the fixed wiring of the installation in such a way that conductive accessible parts cannot become live in the event of a failure of the basic insulation

NOTE This provision includes a protective earth terminal.

3.4.6
insulating encased meter of protective class II
meter with a case of insulating material in which protection against electric shock does not rely on basic insulation only, but in which additional safety precautions, such as double insulation or reinforced insulation, are provided, there being no provision for protective earthing or reliance upon installation conditions

3.5 Definitions of meter quantities

3.5.1 Reference current

3.5.1.1
starting current[1] (I_{st})
the lowest value of the current at which the meter starts and continues to register

3.5.1.2
basic current[1] (I_b)
value of current in accordance with which the relevant performance of a direct connected meter are fixed

3.5.1.3
rated current[1] (I_n)
value of current in accordance with which the relevant performance of a transformer operated meter are fixed

3.5.2
maximum current[1] (I_{max})
highest value of current at which the meter purports to meet the accuracy requirements of this standard

3.5.3
reference voltage[1] (U_n)
value of the voltage in accordance with which the relevant performance of the meter are fixed

3.5.4
reference frequency
value of the frequency in accordance with which the relevant performance of the meter is fixed

3.5.5
specified measuring range
set of values of a measured quantity for which the error of a meter is intended to lie within specified limits

3.5.6
class index
number which gives the limits of the permissible percentage error, for all values of current between 0,1 I_b and I_{max}, or between 0,05 I_n and I_{max}, for the unity power factor (and in the case of polyphase meters with balanced loads) when the meter is tested under reference conditions (including permitted tolerances on the reference values) as defined in the parts defining particular requirements

---

[1] "The terms "voltage" and "current" indicate r.m.s. values unless otherwise specified.

3.5.7
percentage error
percentage error is given by the following formula:

$$\text{Percentage error} = \frac{\text{energy registered by the meter - true energy}}{\text{true energy}} \text{ x100}$$

NOTE Since the true value cannot be determined, it is approximated by a value with a stated uncertainty that can be traced to standards agreed upon between manufacturer and user or to national standards.

3.6 Definitions of influence quantities

3.6.1
influence quantity
any quantity, generally external to the meter, which may affect its working performance

[IEV 311-06-01 modified]

3.6.2
reference conditions
appropriate set of influence quantities and performance characteristics, with reference values, their tolerances and reference ranges, with respect to which the intrinsic error is specified

[IEV 311-06-02 modified]

3.6.3
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

3.6.4
distortion factor
ratio of the r.m.s. value of the harmonic content (obtained by subtracting from a non-sinusoidal alternating quantity its fundamental term) to the r.m.s. value of the non-sinusoidal quantity. The distortion factor is usually expressed as a percentage

3.6.5
electromagnetic disturbance
conducted or radiated electromagnetic interferences which may functionally or metrologically affect the operation of the meter

3.6.6
reference temperature
ambient temperature specified for reference conditions

3.6.6.1
mean temperature coefficient
ratio of the variation of the percentage error to the change of temperature which produces this variation

3.6.7
rated operating conditions
set of specified measuring ranges for performance characteristics and specified operating ranges for influence quantities, within which the variations of operating errors of a meter are specified and determined

3.6.8
specified operating range
range of values of a single influence quantity which forms a part of the rated operating conditions

3.6.9
extended operating range
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. For this range, relaxed accuracy requirements may be specified

3.6.10
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

3.6.11
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

3.6.12
normal working position
position of the meter defined by the manufacturer for normal service

3.6.13
thermal stability
thermal stability is considered to be reached when the change in error as a consequence of thermal effects during 20 min is less than 0,1 times the maximum permissible error for the measurement under consideration

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, selected by the manufacturer, to verify that the respective type of meter complies with all the requirements of this standard for the relevant class of meters

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 upon 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 upon 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 basic current resp. rated 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 basic current resp. rated current at unity power factor

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

4 Standard electrical values

4.1 Standard reference voltages

Table 1 – Standard reference voltages

Meters for	Standard values V	Exceptional values V
Direct connection	120-230-277-400-480 (IEC 60038)	100-127-200-220 240-380-415
Connection through voltage transformer(s)	57,7-63,5-100-110-115-120-200 (IEC 60044-2)	173-190-220

4.2 Standard currents

Table 2 – Standard reference currents

Meters for	Standard values A	Exceptional values A
Direct connection (I_b)	5-10-15-20-30-40-50	80
Connection through current transformer(s) (I_n)	1 – 2 – 5 (IEC 60044-1)	1,5 – 2,5

4.2.1 Maximum current

The maximum current for direct connected meters is preferably an integral multiple of the basic current (for example four times the basic 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 of the meter is 1,2 I_n, 1,5 I_n or 2 I_n.

4.3 Standard reference frequencies

Standard values for reference frequencies are 50 Hz and 60 Hz.

5 Mechanical requirements and tests

5.1 General mechanical requirements

Meters shall be designed and constructed in such a way as to avoid introducing any danger in normal use and under normal conditions, so as to ensure especially:

– personal safety against electric shock;
– personal safety against effects of excessive temperature;
– protection against spread of fire;
– protection against penetration of solid objects, dust and water.

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. Outdoor meters shall withstand solar radiation.

NOTE For meters for special use in corrosive atmospheres, additional requirements shall be fixed in the purchase contract (for example salt mist test according to IEC 60068-2-11).

5.2 Case

5.2.1 Requirements

The meter shall have a case which can be sealed in such a way that the internal parts of the meter are accessible only after breaking the seal(s).

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

The case shall be so constructed and arranged that any non-permanent deformation cannot prevent the satisfactory operation of the meter.

Unless otherwise specified, meters intended to be connected to a supply mains where the voltage under reference conditions exceeds 250 V to earth, and whose case is wholly or partially made of metal, shall be provided with a protective earth terminal.

The mechanical strength of the meter case shall be tested with the following tests:

5.2.2 Mechanical tests

5.2.2.1 Spring hammer test

The mechanical strength of the meter case shall be tested with a spring hammer (see IEC 60068-2-75).

The meter shall be mounted in its normal working position and the spring hammer shall act on the outer surfaces of the meter cover (including windows) and on the terminal cover with a kinetic energy of 0,2 J ± 0,02 J.

The result of the test is satisfactory if the meter case and terminal cover do not sustain damage which could affect the function of the meter and if it is not possible to touch live parts. Slight damage which does not impair the protection against indirect contact or the penetration of solid objects, dust and water is acceptable.

5.2.2.2 Shock test

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

– meter in non-operating condition, without the packing;
– half-sine pulse;
– peak acceleration: 30 g_n (300 m/s^2);
– 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.

5.2.2.3 Vibration test

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

– meter in non-operating condition, without the packing;
– frequency range: 10 Hz to 150 Hz;
– transition frequency: 60 Hz;
– f < 60 Hz, constant amplitude of movement 0,075 mm;
– f > 60 Hz, constant acceleration 9,8 m/s^2 (1 g);
– single point control;
– 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 display and observation of the operation indicator, if fitted. These windows shall be of transparent material which cannot be removed undamaged without breaking the seal(s).

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

Terminals may be grouped in (a) terminal block(s) having adequate insulating properties and mechanical strength. In order to satisfy such requirements when choosing insulating materials for the terminal block(s), adequate testing of materials shall be taken into account.

The material of which the terminal block is made shall be capable of passing the tests given in ISO 75-2 for a temperature of 135 °C and a pressure of 1,8 MPa (method A).

The holes in the insulating material which form an extension of the terminal holes shall be of sufficient size to also accommodate the insulation of the conductors.

The manner of fixing the conductors to the terminals shall ensure adequate and durable contact such that there is no risk of loosening or undue heating. Screw connections transmitting contact force and screw fixings which may be loosened and tightened several times during the life of the meter shall screw into a metal nut.

All parts of each terminal shall be such that the risk of corrosion resulting from contact with any other metal part is minimized.

Electrical connections shall be so designed that contact pressure is not transmitted through insulating material.

For current circuits, the voltage is considered to be the same as for the related voltage circuit.

Terminals with different potentials which are grouped close together shall be protected against accidental short-circuiting. Protection may be obtained by insulating barriers. Terminals of one current circuit are considered to be at the same potential.

The terminals, the conductor fixing screws, or the external or internal conductors shall not be liable to come into contact with metal terminal covers.

The protective earth terminal, if any:

a) shall be electrically bonded to the accessible metal parts;

b) should, if possible, form part of the meter base;

c) should preferably be located adjacent to its terminal block;

d) shall accommodate a conductor having a cross-section at least equivalent to the main current conductors but with a lower limit of 6 mm^2 and an upper limit of 16 mm^2 (these dimensions apply only when copper conductors are used);

e) shall be clearly identified by the graphical symbol IEC 60417-5019: Protective earth (ground).

After installation, it shall not be possible to loosen the protective earth terminal without the use of a tool.

5.5 Terminal cover(s)

The terminals of a meter, if grouped in a terminal block and if not protected by any other means, shall have a separate cover which can be sealed independently of the meter cover. The terminal cover shall enclose the actual terminals, the conductor fixing screws and, unless otherwise specified, a suitable length of the external conductors and their insulation.

When the meter is panel-mounted, no access to the terminals shall be possible without breaking the seal(s) of the terminal cover(s).

5.6 Clearance and creepage distances

The clearance and creepage distances between

a) any terminal of a circuit with a reference voltage over 40 V and

b) earth, together with terminals of auxiliary circuits with reference voltages below or equal to 40 V

shall not be less than stated in

– Table 3a for meters of protective class I;

– Table 3b for meters of protective class II.

The clearance and creepage distances between terminals of circuits with reference voltages over 40 V shall not be less than stated in Table 3a.

The clearance between the terminal cover, if made of metal, and the upper surface of the screws when screwed down to the maximum applicable conductor fitted shall be not less than the relevant values indicated in Tables 3a and 3b.

Table 3a – Clearances and creepage distances for insulating encased meter of protective class I

Voltage phase to earth derived from rated system voltage	Rated impulse voltage	Minimum clearances		Minimum creepage distance	
		Indoor meter	Outdoor meter	Indoor meter	Outdoor meter
V	V	mm	mm	mm	mm
≤100	1 500	0,5	1,0	1,4	2,2
≤150	2 500	1,5	1,5	1,6	2,5
≤300	4 000	3,0	3,0	3,2	5,0
≤600	6 000	5,5	5,5	6,3	10,0

Table 3b – Clearances and creepage distances for insulating encased meter of protective class II

Voltage phase to earth derived from rated system voltage	Rated impulse voltage	Minimum clearances		Minimum creepage distance	
		Indoor meter	Outdoor meter	Indoor meter	Outdoor meter
V	V	mm	mm	mm	mm
≤100	2 500	1,5	1,5	2,0	3,2
≤150	4 000	3,0	3,0	3,2	5,0
≤300	6 000	5,5	5,5	6,3	10,0
≤600	8 000	8,0	8,0	12,5	20,0

The requirement of the impulse voltage test shall also be met (see 7.3.2).

5.7 Insulating encased meter of protective class II

A meter of protective class II shall have a durable and substantially continuous enclosure made wholly of insulating material, including the terminal cover, which envelopes all metal parts, with the exception of small parts, for example, name-plate, screws, suspensions and rivets. If such small parts are accessible by the standard test finger (as specified in IEC 60529) from outside the case, then they shall be additionally isolated from live parts by supplementary insulation against failure of basic insulation or loosening of live parts. The insulating properties of laquer, enamel, ordinary paper, cotton, oxide film on metal parts, adhesive film and sealing compound, or similar unsure materials, shall not be regarded as sufficient for supplementary insulation.

For the terminal block and terminal cover of such a meter, reinforced insulation is sufficient.

5.8 Resistance to heat and fire

The terminal block, the terminal cover and the meter case shall ensure reasonable safety against spread of fire. They should not be ignited by thermal overload of live parts in contact with them. To comply therewith they shall fulfil the following test.

The test shall be carried out according to IEC 60695-2-11, with the following temperatures:

– terminal block: 960 °C ± 15 °C;

– terminal cover and meter case: 650 °C ± 10 °C;

– duration of application: 30 s ± 1 s.

The contact with the glow wire may occur at any random location. If the terminal block is integral with the meter base, it is sufficient to carry out the test only on the terminal block.

5.9 Protection against penetration of dust and water

The meter shall conform to the degree of protection given in IEC 60529.

Indoor meter: IP51, but without suction in the meter.

Outdoor meter: IP54.

The tests shall be carried out according to IEC 60529, under the following conditions:

a) Protection against penetration of dust

– meter in non-operating condition and mounted on an artificial wall;

– the test should be conducted with sample lengths of cable (exposed ends sealed) of the types specified by the manufacturer and terminal cover in place;

– for indoor meters only, the same atmospheric pressure is maintained inside the meter as outside (neither under- nor over-pressure);

– first characteristic digit: 5 (IP5X)

Any ingress of dust shall be only in a quantity not impairing the operation of the meter. An insulation test according to 7.3 shall be passed.

b) Protection against penetration of water

– meter in non-operating condition;

– second characteristic digit: 1 (IPX1) for indoor meters;
4 (IPX4) for outdoor meters.

Any ingress of water shall be only in a quantity not impairing the operation of the meter. An insulation test according to 7.3 shall be passed.

5.10 Display of measured values

The information can be shown either by an electromechanical register or an electronic display. In the case of an electronic display the corresponding non-volatile memory shall have a minimum retention time of four months.

NOTE 1 Longer retention time of the non-volatile memory should be the subject of a purchase contract.

In the case of multiple values presented by a single display it shall be possible to display the content of all relevant memories. When displaying the memory, the identification of each tariff applied shall be possible and, for automatic sequencing displays, each display of register for billing purposes shall be retained for a minimum of 5 s.

The active tariff rate shall be indicated.

When the meter is not energized, the electronic display need not be visible.

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

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.

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

The register shall be able to record and display, starting from zero, for a minimum of 1 500 h, the energy corresponding to maximum current at reference voltage and unity power factor.

NOTE 2 Values higher than 1 500 h should be the subject of purchase contract.

It shall be impossible to reset the indication of the cumulative total of electrical energy during use.

NOTE 3 The regular roll over of the display is not considered as a reset.

5.11 Output device

The meter shall have a test output device capable of being monitored with suitable testing equipment.

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

For electrical test output see, IEC 62053-31.

If the test output is an optical test output, then it shall fulfil the requirements according 5.11.1 and 5.11.2.

The operation indicator, if fitted, shall be visible from the front.

5.11.1 Mechanical and electrical characteristics

An optical test output shall be accessible from the front.

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

Modulated and unmodulated output pulses are permitted. The unmodulated output pulses shall have the shape shown in Figure D.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 D.2).

The distance of the optical pulse output from further adjacent ones or from an optical status display shall be sufficiently long that the transmission is not affected.

An optimum pulse transmission[2] is achieved when, under test conditions, the receiving head is aligned with its optical axis on the optical pulse output.

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

5.11.2 Optical characteristics

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

The output device 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 D.1.

5.12 Marking of meter

5.12.1 Name-plates

Every meter shall bear the following information as applicable:

a) manufacturer's name or trade mark and, if required, the place of manufacture;

b) designation of type (see 3.1.8) and, if required, space for approval mark;

c) the number of phases and the number of wires for which the meter is suitable (for example, single-phase 2-wire, three-phase 3-wire, three-phase 4-wire); these markings may be replaced by the graphical symbols given in IEC 60387;

d) the serial number and year of manufacture. If the serial number is marked on a plate fixed to the cover, the number shall also be marked on the meter base or stored in the meter's non-volatile memory;

---

[2] The optical path (pulse transmission) should not be affected by surrounding light with an intensity of up to 16 000 lx (light composition comparable with daylight, including fluorescent light).

e) the reference voltage in one of the following forms:
   - the number of elements if more than one, and the voltage at the meter terminals of the voltage circuit(s);
   - the rated voltage of the system or the secondary voltage of the instrument transformer to which the meter is intended to be connected.

Examples of markings are shown in Table 4.

Table 4 – Voltage marking

Meter	Voltage at the terminals of the voltage circuit(s) V	Rated system voltage V
Single-phase 2-wire 120 V	120	120
Single-phase 3-wire 120 V (120 V to the mid-wire)	240	240
Three-phase 3-wire 2-element (230 V between phases)	2 × 230	3 × 230
Three-phase 4-wire 3-element (230 V phase to neutral)	3 × 230 (400)	3 × 230/400

f) for direct connected meters, the basic current and the maximum current expressed, for example: 10-40 A or 10(40) A for a meter having a basic current of 10 A and a maximum current of 40 A;

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

g) the reference frequency in Hz;

h) the meter constant;

i) the class index of the meter;

j) the reference temperature if different from 23 °C;

k) the sign of the double square ⧈ for insulating encased meters of protective class II.

Information under points a), b) and c) may be marked on an external plate permanently attached to the meter cover.

Information under points d) to k) shall be marked on a name-plate preferably placed within the meter. The marking shall be indelible, distinct and legible from outside the meter.

If the meter is of a special type (for example in the case of a multi-rate meter, if the voltage of the changeover device differs from the reference voltage), this shall be specified on the name-plate or on a separate plate.

If the instrument transformers are taken into account in the meter constant, the transformer ratio(s) shall be marked.

Standard symbols may also be used (see IEC 60387).

5.12.2 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 Climatic conditions

6.1 Temperature range

The temperature range of the meter shall be as shown in Table 5. The values are based on IEC 60721-3-3, Table 1, with the exception of m) Condensation and p) Formation of ice.

Table 5 – Temperature range

	Indoor meter	Outdoor meter
Specified operating range	–10 °C to 45 °C (class 3K5 mod.)	–25 °C to 55 °C (class 3K6)
Limit range of operation	–25 °C to 55 °C (class 3K6)	–40 °C to 70 °C (class 3K7)
Limit range for storage and transport	–25 °C to 70 °C (class 3K8H)	–40 °C to 70 °C (class 3K7)
NOTE 1 For special applications, other temperature values can be used according to purchaser contract, for example, for cold environment for indoor meters, class 3K7. NOTE 2 Operation and storage and transport of the meter at the extremes of this temperature range (class 3K7) should only be for a maximum period of 6 h.		

6.2 Relative humidity

The meter shall be designed to withstand the climatic conditions defined in Table 6. For combined temperature and humidity test, see 6.3.3.

Table 6 – Relative humidity

Annual mean	<75 %
For 30 days, these days being spread in a natural manner over one year	95 %
Occasionally on other days	85 %

The limits of relative humidity as a function of ambient temperature are shown in Annex A.

6.3 Tests of the effect of the climatic environments

After each of the climatic tests, the meter shall show no damage or change of the information and shall operate correctly.

6.3.1 Dry heat test

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

– meter in non-operating condition;
– temperature: +70 °C ± 2 °C;
– duration of the test: 72 h.

6.3.2 Cold test

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

– meter in non-operating condition;
– temperature: –25 °C ± 3 °C for indoor meters;
–40 °C ± 3 °C for outdoor meters;
– duration of the test: 72 h for indoor meters;
16 h for outdoor meters.

6.3.3 Damp heat cyclic test

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

– voltage and auxiliary circuits energized with reference voltage;
– without any current in the current circuits;
– variant 1;
– upper temperature: +40 °C ± 2 °C for indoor meters;
+55 °C ± 2 °C for outdoor meters;
– no special precautions shall be taken regarding the removal of surface moisture;
– duration of the test: 6 cycles.

24 h after the end of this test, the meter shall be submitted to the following tests:

a) an insulation test according to 7.3, except that the impulse voltage shall be multiplied by a factor of 0,8;
b) a functional test. The meter shall show no damage or change of information and shall operate correctly.

The damp heat test also serves as a corrosion test. The result is judged visually. No trace of corrosion likely to affect the functional properties of the meter shall be apparent.

6.3.4 Protection against solar radiation

The meter for outdoor use shall withstand solar radiation.

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

– for outdoor meters only;
– meter in non-operating condition;
– test procedure A (8 h irradiation and 16 h darkness);
– upper temperature: +55 °C;
– duration of the test: 3 cycles or 3 days.

After the test the meter shall be visually inspected. The appearance and, in particular, the legibility of markings shall not be altered. The function of the meter shall not be impaired.

7 Electrical requirements

7.1 Influence of supply voltage

7.1.1 Voltage range

Table 7 – Voltage range

Specified operating range	From 0,9 to 1,1 U_n
Extended operating range	From 0,8 to 1,15 U_n
Limit range of operation	From 0,0 to 1,15 U_n

NOTE For maximum voltages under earth-fault conditions see 7.4.

7.1.2 Voltage dips and short interruptions

Voltage dips and short interruptions shall not produce a change in the register of more than x units and the test output shall not produce a signal equivalent of more than x units. The value x is derived from the following formula:

$$x = 10^{-6}\, m\, U_n\, I_{max}$$

where

m is the number of measuring elements;

U_n is the reference voltage in volts;

I_{max} is the maximum current in amperes.

When the voltage is restored, the meter shall not have suffered degradation of its metrological characteristics.

For testing purposes, the register of the electricity meter shall have a resolution of at least 0,01 units.

The tests shall be carried out under the following conditions:

– voltage and auxiliary circuits energized with reference voltage;
– without any current in the current circuits.

a) voltage interruptions of ΔU = 100 %
   – interruption time: 1 s;
   – number of interruptions: 3;
   – restoring time between interruptions: 50 ms. See also Annex B, Figure B.1.

b) voltage interruptions of ΔU = 100 %
   – interruption time: one cycle at rated frequency;
   – number of interruptions: 1. See also Annex B, Figure B.2.

c) voltage dips of ΔU = 50 %
   – dip time: 1 min;
   – number of dips: 1. See also Annex B, Figure B.3.

7.2 Heating

Under rated operating conditions, electrical circuits and insulation shall not reach a temperature which might adversely affect the operation of the meter.

The insulation materials shall comply with the appropriate requirements of IEC 60085.

With each current circuit of the meter carrying rated maximum current and with each voltage circuit (and with those auxiliary voltage circuits which are energized for periods of longer duration than their thermal time constants) carrying 1,15 times the reference voltage, the temperature rise of the external surface shall not exceed 25 K, with an ambient temperature of 40 °C.

During the test, the duration of which shall be 2 h, the meter shall be exposed neither to draught nor to direct solar radiation.

After the test, the meter shall show no damage and shall comply with the dielectric strength tests of 7.3.

7.3 Insulation

The meter and its incorporated auxiliary devices, if any, shall be such that they retain adequate dielectric qualities under normal conditions of use, taking into account the effects of the climatic environment and different voltages to which they are subjected under normal conditions of use.

The meter shall withstand the impulse voltage test and the a.c. voltage test as specified in 7.3.1 to 7.3.3.

7.3.1 General test conditions

The tests shall be carried out only on a complete meter, with its cover (except when indicated hereinafter) and terminal cover, the terminal screws being screwed down to the maximum applicable conductor fitted in the terminals.

Test procedure in accordance with IEC 60060-1.

The impulse voltage tests shall be carried out first and the a.c. voltage tests afterwards.

During type tests, the dielectric strength tests are considered to be valid only for the terminal arrangement of the meter which has undergone the tests. When the terminal arrangements differ, all the dielectric strength tests shall be carried out for each arrangement.

For the purpose of these tests, the term “earth” has the following meaning:

a) when the meter case is made of metal, the “earth” is the case itself, placed on a flat conducting surface;

b) when the meter case or only a part of it is made of insulating material, the “earth” is a conductive foil wrapped around the meter touching all accessible conductive parts and connected to the flat conducting surface on which the meter base is placed. Where the terminal cover makes it possible, the conductive foil shall approach the terminals and the holes for the conductors within a distance of not more than 2 cm.

During the impulse and the a.c. voltage tests, the circuits which are not under test are connected to the earth as indicated hereinafter.

After these tests, there shall be no change at reference conditions in the percentage error of the meter greater than the uncertainty of the measurement and no mechanical damage to the equipment.

In this subclause, the expression “all the terminals” means the whole set of terminals of the current circuits, voltage circuits and, if any, auxiliary circuits having a reference voltage over 40 V.

These tests shall be made in normal conditions of use. During the test, the quality of the insulation shall not be impaired by dust or abnormal humidity.

Unless otherwise specified, the normal conditions for insulation tests are:

– ambient temperature: 15 °C to 25 °C;
– relative humidity: 45 % to 75 %;
– atmospheric pressure: 86 kPa to 106 kPa.

If for any reason the insulation tests have to be repeated, then they may be performed on a new specimen.

7.3.2 Impulse voltage test

The test shall be carried out under the following conditions:

– impulse waveform: 1,2/50 impulse specified in IEC 60060-1;
– voltage rise time: ±30 %;
– voltage fall time: ±20 %;
– source impedance: 500 Ω ± 50 Ω;
– source energy: 0,5 J ± 0,05 J;
– test voltage: in accordance with Table 3a or 3 b;
– test voltage tolerance: +0 – 10 %.

For each test, the impulse voltage is applied ten times with one polarity and then repeated with the other polarity. The minimum time between the impulses shall be 3 s.

NOTE For areas where overhead supply networks are predominant, a higher peak value than given in Tables 3a and 3b of the test voltage may be required.

7.3.2.1 Impulse voltage tests for circuits and between the circuits

The test shall be made independently on each circuit (or assembly of circuits) which is insulated from the other circuits of the meter in normal use. The terminals of the circuits which are not subjected to impulse voltage shall be connected to earth.

Thus, when the voltage and the current circuits of a measuring element are connected together in normal use, the test shall be made on the whole. The other end of the voltage circuit shall be connected to earth and the impulse voltage shall be applied between the terminal of the current circuit and earth. When several voltage circuits of a meter have a common point, this point shall be connected to earth and the impulse voltage successively applied between each of the free ends of the connections (or the current circuit connected to it) and earth. The other terminal of this current circuit shall be open.

When the voltage and the current circuits of the same measuring element are separated and appropriately insulated in normal use (for example each circuit connected to measuring transformer), the test shall be made separately on each circuit.

During the test of a current circuit, the terminals of the other circuits shall be connected to earth and the impulse voltage shall be applied between one of the terminals of the current circuit and earth. During the test of a voltage circuit, the terminals of the other circuits and one of the terminals of the voltage circuit under test shall be connected to earth and the impulse voltage shall be applied between the other terminal of the voltage circuit and earth.

The auxiliary circuits intended to be connected either directly to the mains or to the same voltage transformers as the meter circuits, and with a reference voltage over 40 V, shall be subjected to the impulse voltage test in the same conditions as those already given for voltage circuits. The other auxiliary circuits shall not be tested.

7.3.2.2 Impulse voltage test of electric circuits relative to earth

All the terminals of the electric circuits of the meter, including those of the auxiliary circuits with a reference voltage over 40 V, shall be connected together.

The auxiliary circuits with a reference voltage below or equal to 40 V shall be connected to earth. The impulse voltage shall be applied between all the electric circuits and earth. During this test no flashover, disruptive discharge or puncture shall occur.

7.3.3 AC voltage test

See relevant standard for particular requirements.

7.4 Immunity to earth fault

(Only for meters to be used in networks equipped with earth fault neutralizers)

For three-phase four-wire transformer-operated meters, connected to distribution networks which are equipped with earth fault neutralizers or in which the star point is isolated (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), the following requirements apply:

For a test under a simulated earth fault condition in one of the three lines, all voltages are increased to 1,1 times the nominal voltages during 4 h. The neutral terminal of the meter under test is disconnected from the ground terminal of the meter test equipment (MTE) and is connected to the MTE's line terminal at which the earth fault has to be simulated (see Annex C). In this way, the two voltage terminals of the meter under test which are not affected by the earth fault are connected to 1,9 times the nominal phase voltages. For this test the current circuits are set to 50 % of the rated current I_n, power factor 1 and symmetrical load. After the test, the meter shall show no damage and shall operate correctly.

The change of error measured when the meter is back at nominal working temperature shall not exceed the limits given in Table 8.

Table 8 – Change of error due to earth fault

Value of current	Power factor	Limits of variation in percentage error for meters of class				
		0,2	0,5	1	2	3
I_n	1	0,1	0,3	0,7	1,0	1,5

For test diagram see Annex C.

7.5 Electromagnetic compatibility (EMC)

Meters (electromechanical with electronic functional devices or fully static meters) shall be designed in such a way that conducted or radiated electromagnetic phenomena and electrostatic discharge neither damage nor substantially influence the result of measurement.

Continuous and long duration electromagnetic phenomena are considered as influence quantities and the accuracy requirements are given in the relevant standard.

Short duration electromagnetic phenomena are considered as disturbance according to the definition given in 3.6.5.

NOTE Considering the electromagnetic environment of electricity metering equipment, the following phenomena are relevant:

– electrostatic discharges;
– electromagnetic RF fields;
– fast transient burst;
– conducted voltages induced by radio-frequency fields;
– surges;
– oscillatory waves;
– radio interference.

For testing, see 7.5.1 to 7.5.8.

7.5.1 General test conditions

Unless otherwise specified for all these tests, the meter shall be in its normal working position with the cover and terminal covers in place. All parts intended to be earthed shall be earthed.

After these tests, the meter shall show no damage and operate as specified in the relevant standards.

7.5.2 Test of immunity to electrostatic discharges

The test shall be carried out according to IEC 61000-4-2, under the following conditions:

- tested as table-top equipment;
- meter in operating condition:
  – voltage and auxiliary circuits energized with reference voltage;
  – without any current in the current circuits (open circuit);
- contact discharge;
- test voltage: 8 kV;
- number of discharges: 10 (in the most sensitive polarity).

If contact discharge is not applicable because no metallic parts are outside, then apply air discharge with a 15 kV test voltage.

The application of the electrostatic discharge shall not produce a change in the register of more than *x* units and the test output shall not produce a signal equivalent to more than *x* units. Formula for *x*: see 7.1.2

During the test, a temporary degradation or loss of function or performance is acceptable.

7.5.3 Test of immunity to electromagnetic RF fields

The test shall be carried out according to IEC 61000-4-3, under the following conditions:

- tested as table top equipment;
- cable length, exposed to the field: 1 m;
- frequency band: 80 MHz to 2 000 MHz;
- carrier modulated with 80 % AM at 1 kHz sine wave.

Example of test set-up, see Annex E, Figure E.1

a) Test with current
   - meter in operating condition:
     – voltage and auxiliary circuits energized with reference voltage;
     – basic current I_b resp. rated current I_n, and cosφ resp. sinφ according to the value given in the relevant standard.
   - unmodulated test field strength: 10 V/m.

   During the test, the behaviour of the equipment shall not be perturbed and the variation of error shall be within the limits as specified in the relevant standards.

b) Test without any current
   - meter in operating condition:
     – voltage and auxiliary circuits energized with reference voltage;
     – without any current in the current circuits and the current terminals shall be open circuit.
   - unmodulated test field strength: 30 V/m.

     The application of the RF field shall not produce a change in the register of more than *x* units and the test output shall not produce a signal equivalent to more than *x* units. Formula for *x*: see 7.1.2.

   During the test, a temporary degradation or loss of function or performance is acceptable.

7.5.4 Fast transient burst test

The test shall be carried out according to IEC 61000-4-4, under the following conditions:

- tested as table-top equipment;
- meter in operating condition:
  – voltage and auxiliary circuits energized with reference voltage;
  – with basic current I_b resp. rated current I_n, and cosφ resp. sinφ according to the value given in the relevant standard;

- cable length between coupling device and EUT: 1 m;
- the test voltage shall be applied in common mode (line to earth) to:
  - the voltage circuits;
  - the current circuits, if separated from the voltage circuits in normal operation;
  - the auxiliary circuits, if separated from the voltage circuits in normal operation;
- test voltage on the current and voltage circuit: 4 kV;
- test voltage on the auxiliary circuits with a reference voltage over 40 V: 2 kV;
- duration of the test: 60 s at each polarity.

NOTE The accuracy may be determined by the registration method or other suitable means.

During the test, a temporary degradation or loss of function or performance is acceptable, nevertheless the variation of the error shall be within the limits as specified in the relevant standard.

For examples of the test set-up, see Annex E, Figures E.2 and E.3.

7.5.5 Test of immunity to conducted disturbances, induced by radio-frequency fields

The test shall be carried out according to IEC 61000-4-6, under the following conditions:

- tested as table-top equipment;
- meter in operating condition;
  - voltage and auxiliary circuits energized with reference voltage;
  - with basic current I_b resp. rated current I_n and cosφ resp. sinφ according to the value given in the relevant standard;
- frequency range: 150 kHz to 80 MHz;
- voltage level: 10 V.

During the test, the behaviour of the equipment shall not be perturbed and the variation of the error shall be within the limits as specified in the relevant standards.

7.5.6 Surge immunity test

The test shall be carried out according to IEC 61000-4-5, under the following conditions:

- meter in operating condition:
  - voltage and auxiliary circuits energized with reference voltage;
  - without any current in the current circuits and the current terminals shall be open circuit;
- cable length between surge generator and meter: 1 m;
- tested in differential mode (line to line);
- phase angle: pulses to be applied at 60° and 240° relative to zero crossing of AC supply;
- test voltage on the current and voltage circuits (mains lines): 4 kV, generator source impedance: 2 Ω;
- test voltage on auxiliary circuits with a reference voltage over 40 V: 1 kV; generator source impedance: 42 Ω;
- number of tests: 5 positive and 5 negative;
- repetition rate: maximum 1/min.

The application of the surge immunity test voltage shall not produce a change in the register of more than *x* units and the test output shall not produce a signal equivalent to more than *x* units. Formula for *x*: see 7.1.2.

During the test, a temporary degradation or loss of function or performance is acceptable.

7.5.7 Damped oscillatory waves immunity test

The test shall be carried out according to IEC 61000-4-12, under the following conditions:

- only for transformer operated meters;
- tested as table top equipment;
- meter in operating condition:
  - voltage and auxiliary circuits energized with reference voltage;
  - with rated current I_n and cosφ resp. sinφ according to the value given in the relevant standard;
- test voltage on voltage circuits and auxiliary circuits with a reference voltage > 40 V:
  - common mode: 2,5 kV;
  - differential mode: 1,0 kV;
- test frequencies:
  - 100 kHz, repetition rate: 40 Hz;
  - 1 MHz, repetition rate: 400 Hz;
- test duration: 60 s (15 cycles with 2 s on, 2 s off, for each frequency)

During the test the behaviour of the equipment shall not be perturbed and the variation in error shall be within the limits as specified in the relevant standards.

7.5.8 Radio interference suppression

The test shall be carried out according to CISPR 22, under the following conditions:

- for class B equipment;
- tested as table-top equipment;
- for connection to the voltage circuits, an unshielded cable length of 1 m to each connector shall be used;
- meter in operating condition:
  - voltage and auxiliary circuits energised with reference voltage;
  - with a current between 0,1 I_b and 0,2 I_b resp. 0,1 I_n and 0,2 I_n (drawn by linear load and connected by unshielded cable length of 1 m).

The test results shall comply with the requirements given in CISPR 22.

8 Type test

8.1 Test conditions

All tests are carried out under reference conditions unless otherwise stated in the relevant clause.

The type test defined in 3.7.1 shall be made on one or more specimens of the meter, selected by the manufacturer, to establish its specific characteristics and to prove its conformity with the requirements of this standard.

A recommended test sequence is given in Annex F.

In the case of modifications to the meter made after the type test and affecting only part of the meter, it will be sufficient to perform limited tests on the characteristics that may be affected by the modifications.