IEC: 62052-11
Revised

PAKISTAN STANDARD

ELECTRICITY METERING EQUIPMENT (AC)-GENERAL REQUIREMENTS, TEST AND TEST CONDITIONS- PART-11: METERING EQUIPMENT

PAKISTAN STANDARDS AND QUALITY CONTROL AUTHORITY,
STANDARDS DEVELOPMENT CENTRE,
39 - Garden Road, Saddar,
Karachi – 74400.

ELECTRICITY METERING EQUIPMENT (AC)-GENERAL REQUIREMENTS, TEST AND TEST CONDITIONS- PART-11: METERING EQUIPMENT

0. FOREWORD

0.1 This Pakistan Standard was adopted by the authority of the Board of Directors of Pakistan Standards and Quality Control Authority after the draft prepared by the Technical Committee for "Electrical Measurements (EDC-4)" had been approved & endorsed by the Electro-technical National standard Committee on 31 January 2018.

0.2 This Pakistan Standard was adopted on the basis of revised IEC: 62052-11/2018 since IEC Standard have been revised in 2017, hence it is deemed necessary to adopt the International standard to keep abreast with the latest technology and as per with IEC standard.

0.3 This Pakistan Standard is an adoption of revised IEC: 62052-11/2018 "Electricity Metering Equipment (Ac)-General Requirements, Test and Test Conditions-Part-11: Metering Equipment" and it use hereby acknowledge with thanks.

0.4 This Standard is subject to periodical review in order to keep pace with the changing requirements and latest development in the industry. Any suggestion for improvement will be recorded and placed before the revising committee in due course.

0.5 This Standard covers the technical provisions and it does not purport to include all the necessary provision of a contract.

CONTENTS

INTRODUCTION TO AMENDMENT 1

The purpose of this amendment is to identify and remove all safety related requirements and tests of IEC 62052-11:2003 that are replaced and extended by the complete set of requirements and tests in IEC 62052-31:2015.

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.

The safety aspect is covered by IEC 62052-31:2015.

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

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

NOTE Some standards referenced in IEC 62052-11:2003 have been revised or replaced, but these changes will be considered in the full revision of this standard.

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

See IEC 62052-31:2015, 3.5.11.

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

See IEC 62052-31:2015, 3.2.11.

3.3.2
outdoor meter

See IEC 62052-31:2015, 3.2.12.

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

See IEC 62052-31:2015, 3.2.5.

3.3.6
accessible conductive part

See IEC 62052-31:2015, 3.5.1.

3.3.7
protective earth terminal

See IEC 62052-31:2015, 3.2.8 (protective conductor terminal).

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

See IEC 62052-31:2015, 3.2.6.

3.4 Definitions related to insulation

3.4.1
basic insulation

See IEC 62052-31:2015, 3.6.

3.4.2
supplementary insulation

See IEC 62052-31:2015, 3.6.

3.4.3
double insulation

See IEC 62052-31:2015, 3.6.

3.4.4
reinforced insulation

See IEC 62052-31:2015, 3.6.

3.4.5
insulating encased meter of protective class I

See IEC 62052-31:2015, 3.6.

3.4.6
insulating encased meter of protective class II

See IEC 62052-31:2015, 3.6.

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

---

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

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

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

See also IEC 62052-31:2015, 3.4.1.

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:

- protection against electric shock, see IEC 62052-31:2015, Clause 6;
- protection against mechanical hazards and stresses, see IEC 62052-31:2015, Clauses 7 and 8;
- protection against spread of fire, see IEC 62052-31:2015, Clause 9;
- personal safety against effects of excessive temperature, see IEC 62052-31:2015, Clause 10;
- protection against penetration of dust and water, see IEC 62052-31:2015, Clause 11.
- protection against liberated gases and substances, explosion and implosion, see IEC 62052-31:2015, Clause 12.

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.

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 test shall be performed as part of safety testing as specified in IEC 62052-31:2015, 8.2.

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

See IEC 62052-31:2015, 6.5.2, 6.9.5 and 6.9.7.

5.5 Terminal cover(s)

See IEC 62052-31:2015, 6.9.4.

5.6 Clearance and creepage distances

See IEC 62052-31:2015, 6.7.

5.7 Insulating encased meter of protective class II

See IEC 62052-31:2015:

- 3.6.8, (Protective) class II equipment;
- 5.4.5.1, Protective class and earthing;
- 6.5.2, Protective bonding;
- 6.8, Insulation requirements between circuits and parts, and Annex B, Examples for insulation between parts;
- 6.9.2, Insulating materials.

5.8 Resistance to heat and fire

See IEC 62052-31:2015, Clause 9.

5.9 Protection against penetration of dust and water

See IEC 62052-31:2015, Clause 11.

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

This subclause shall be read together with IEC 62052-31:2015, Clause 5.

For metrology related markings, the existing text applies. For safety related markings, IEC 62052-31:2015, Clause, 5 applies.

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;

---

[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).

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;

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

This subclause shall be read together with IEC 62052-31:2015, 1.4.1, 1.4.2 and 1.4.3.

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 specified in IEC 62052-31:2015, 1.4.1 c), 1.4.2 c) and 1.4.3. For combined temperature and humidity test, see 6.3.3 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.

6.2.1 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.

6.2.2 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.

6.2.3 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.

6.2.4 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.

For equipment temperature limits and resistance to heat, see IEC 62052-31:2015, Clause 10.

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 meet the requirements and shall pass the tests specified in IEC 62052-31:2015, 6.7, 6.8 and 6.10.

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.

See also IEC 62052-31:2015, 6.10.3.2.

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 $\cos\varphi$ resp. $\sin\varphi$ 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.

Annex A
(normative)

Relationship between ambient air temperature and relative humidity

See IEC 62052-31:2015, 1.4.1 c) and 1.4.2 c).

Annex B
(normative)

Voltage wave-form for the tests of the effect of voltage dips and short interruptions

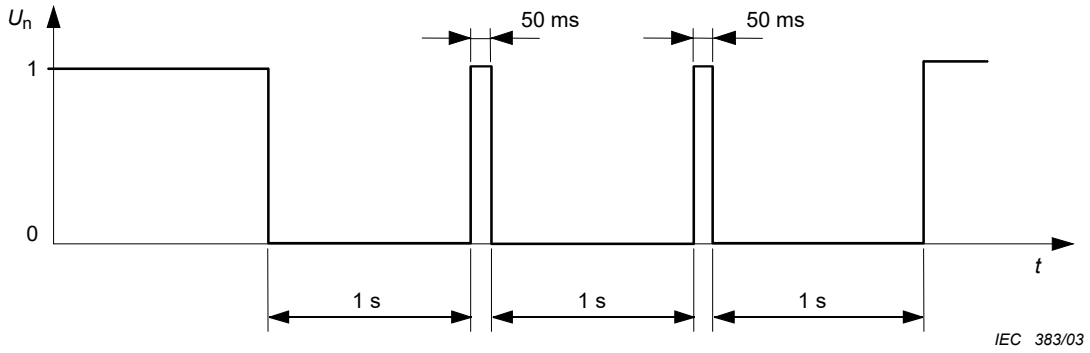


Figure B.1 – Voltage interruptions of ΔU = 100 %, 1 s

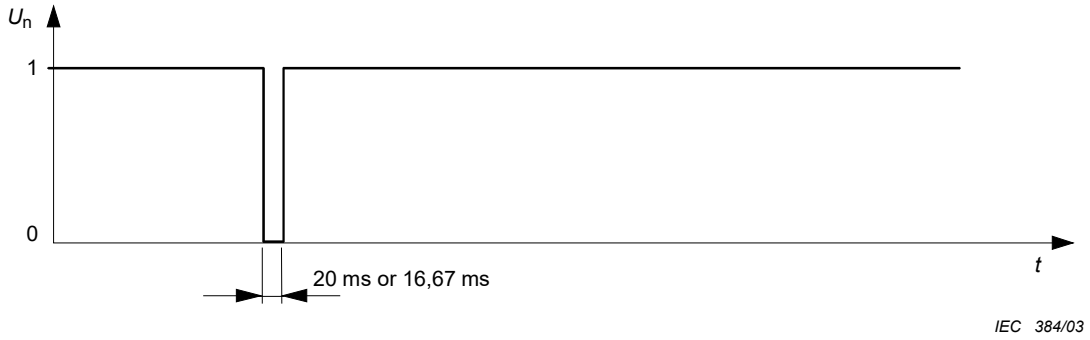


Figure B.2 – Voltage interruptions of ΔU = 100 %, one cycle at rated frequency

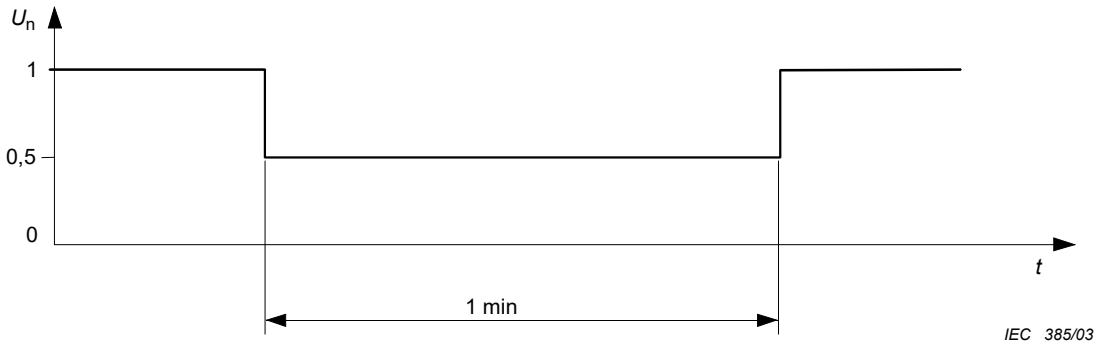


Figure B.3 – Voltage dips of ΔU = 50 %

Annex C
(normative)

Test circuit diagram for the test of immunity to earth fault

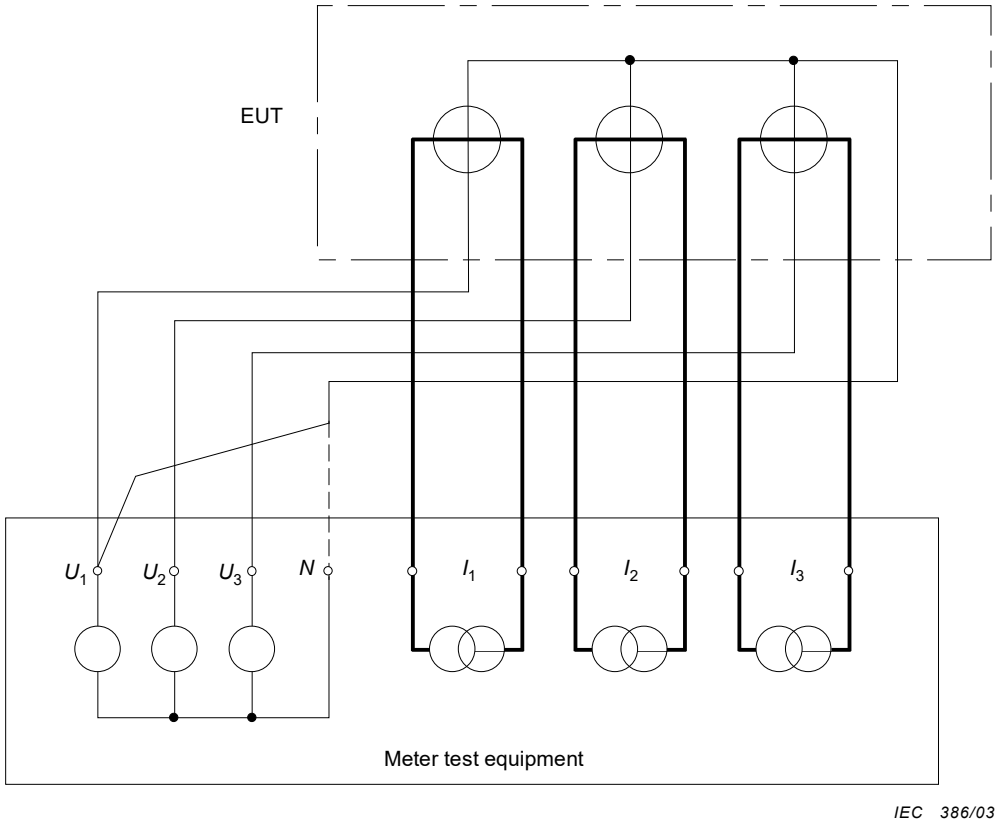


Figure C.1 – Circuit to simulate earth fault condition in phase 1

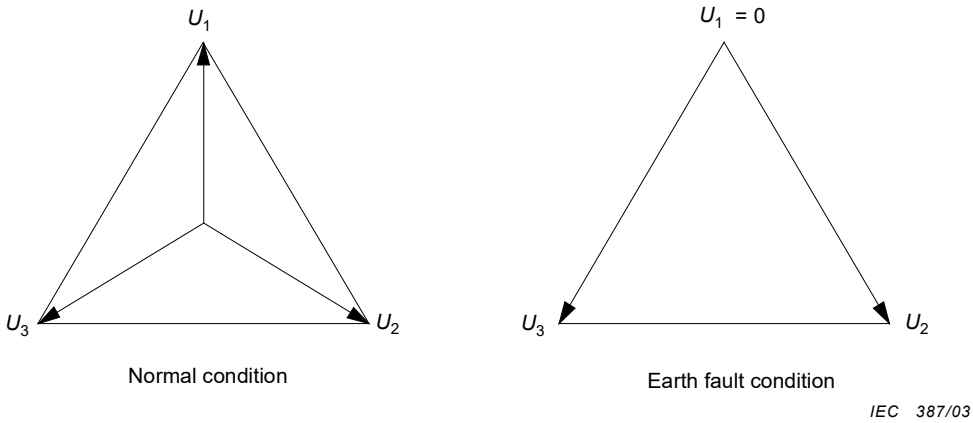


Figure C.2 – Voltages at the meter under test

Annex D
(normative)

Optical test output

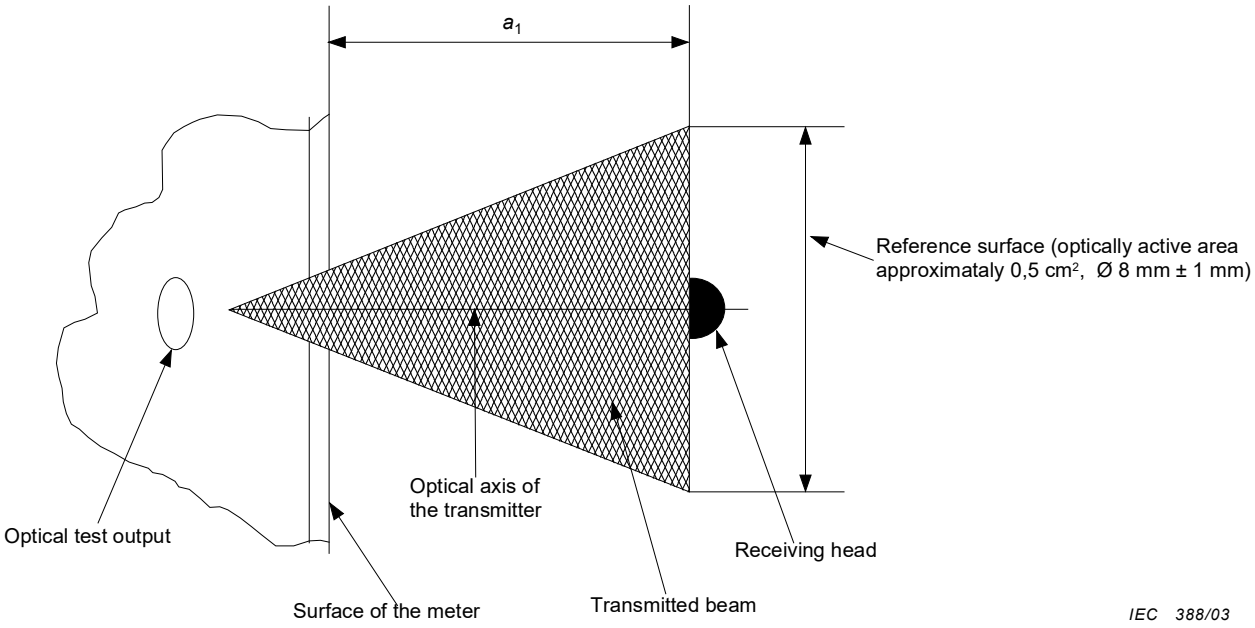
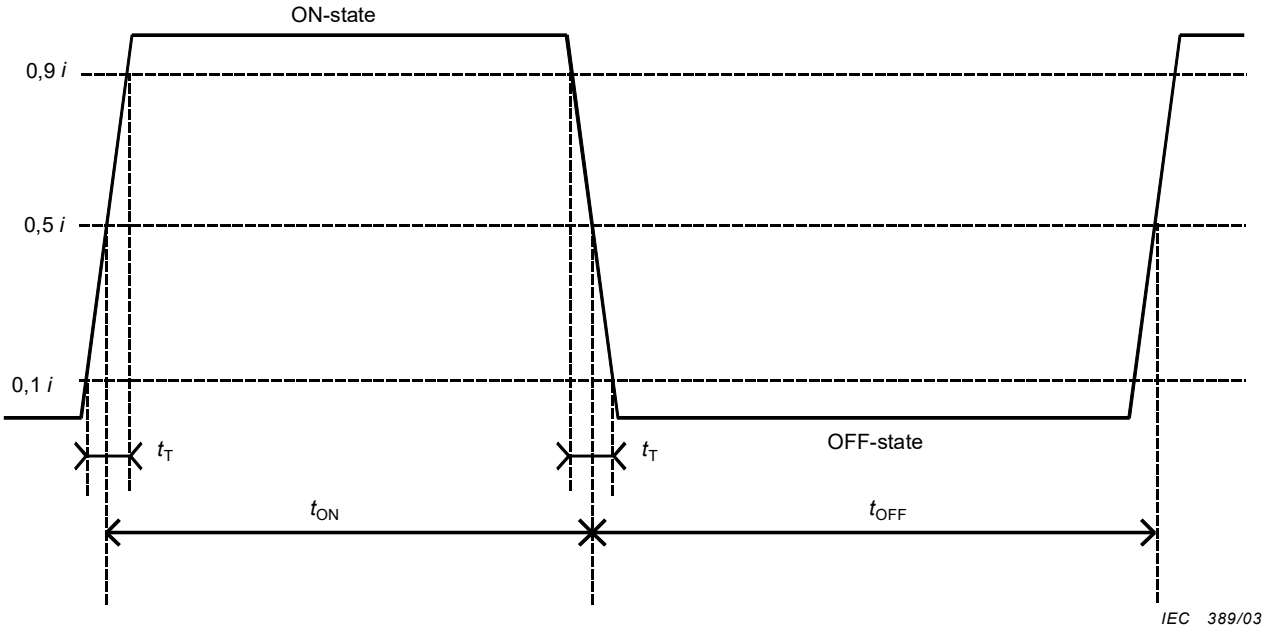


Figure D.1 – Test arrangement for the test output



Requirements

t_{ON} ≥ 0,2 ms

t_{OFF} ≥ 0,2 ms

t_T < 20 µs

Figure D.2 – Waveform of the optical test output

Annex E
(informative)

Test set-up for EMC tests

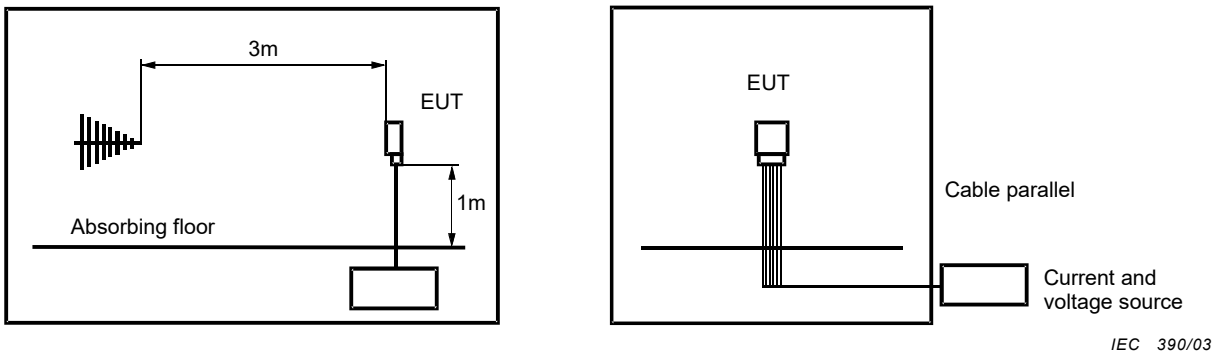
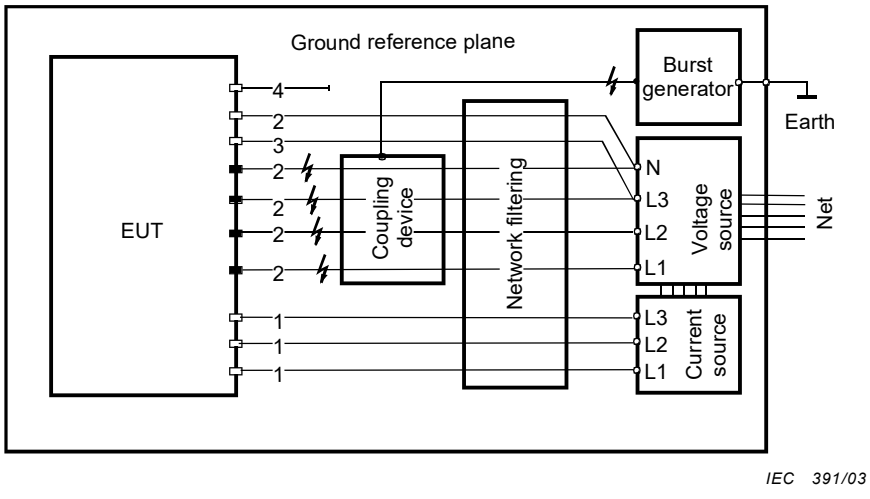


Figure E.1 – Test set-up for the test of immunity to electromagnetic RF fields

NOTE To obtain the test field strength of 30 V/m it is possible to reduce the distance between antenna and EUT down to 1,5 m. In this case, the adjustment of the amplifier must be controlled by a field sensor.



Legend

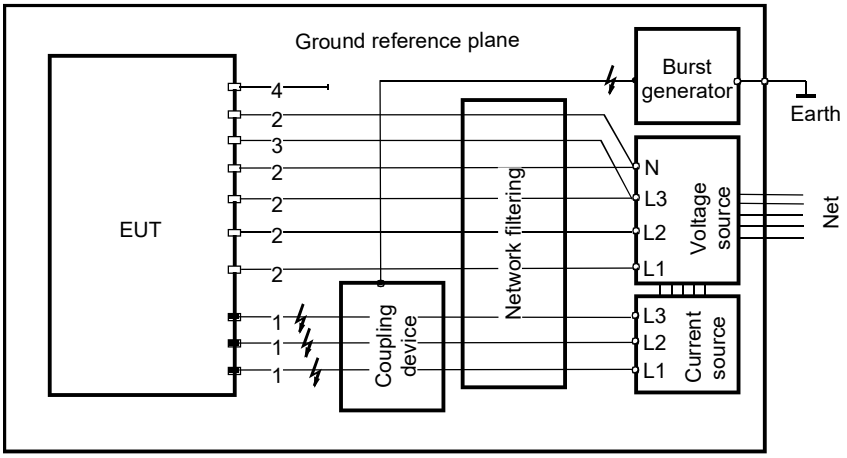
1 Current circuits

2 Voltage circuits

3 Auxiliary circuits with a reference voltage over 40 V

4 Auxiliary circuits with a reference voltage below 40 V

Figure E.2 – Test set-up for the fast transient burst test: Voltage circuits



IEC 392/03

Legend

1 Current circuits

2 Voltage circuits

3 Auxiliary circuits with a reference voltage over 40 V

4 Auxiliary circuits with a reference voltage below 40 V

Figure E.3 – Test set-up for the fast transient burst test: Current circuits

Annex F
(informative)

Test schedule –
Recommended test sequences

Nr.	Tests	Subclause	Electro-mechanical meters	Electronic meters
1	Tests of insulation properties			
1.1	To be performed as part of safety testing, as specified in IEC 62052-31:2015, 6.10.	7.3	X	X
2	Tests of accuracy requirements			
2.1	Test of meter constant		X	X
2.2	Test of starting condition		X	X
2.3	Test of no-load condition		X	X
2.4	Test of influence quantities		X	X
3	Tests of electrical requirements			
3.1	Test of power consumption		X	X
3.2	Test of influence of supply voltage	7.1.2		X
3.3	Test of influence of short-time overcurrents: See the relevant standards specifying particular requirements		X	X
3.4	Test of influence of self-heating: See the relevant standards specifying particular requirements		X	X
3.5	Test of influence of heating: To be performed as part of safety testing, as specified in IEC 62052-31:2015, Clause 10.	7.2	X	X
3.6	Test of immunity to earth fault	7.4	X	X
4	Tests for electromagnetic compatibility (EMC)			
4.1	Radio interference suppression	7.5.8		X
4.2	Fast transient burst test	7.5.4		X
4.3	Damped oscillatory waves immunity test	7.5.7		X
4.4	Test of immunity to electromagnetic RF fields	7.5.3		X
4.5	Test of immunity to conducted disturbances, induced by radio-frequency fields	7.5.5		X
4.6	Test of immunity to electrostatic discharges	7.5.2		X
4.7	Surge immunity test	7.5.6		X
5	Tests of the effect of the climatic environments			
5.1	Dry heat test	6.3.1	X	X
5.2	Cold test	6.3.2	X	X
5.3	Damp heat, cyclic test	6.3.3	X	X
5.4	Solar radiation test	6.3.4	X	X
6	Mechanical tests			
6.1	Vibration test	5.2.2.3	X	X
6.2	Shock test	5.2.2.2	X	X
6.3	Spring hammer test: To be performed as part of safety testing, as specified in IEC 62052-31:2015, 8.2.	5.2.2.1	X	X
6.4	Tests of protection against penetration of dust and water: To be performed as part of safety testing, as specified in IEC 62052-31:2015, Clause 11.	5.9	X	X

6.5	Test of resistance to heat and fire: To be performed as part of safety testing, as specified in IEC 62052-31:2015, Clause 9.	5.8	X	X