Earth resistance	Equal to zero	< 2 Ω
[a] If the tests are made at a temperature other than the reference temperature, including permissible tolerances, the results shall be corrected by applying the appropriate temperature coefficient of the meter.		
[b] No condensation, dew, formation of ice, hoar-frost, percolating water, rain, etc., shall be present.		
[c] Applicable only to AC meters.		
[d] Applicable only to polyphase AC systems.		
[e] For a single-phase meter, the test consists of determining the percentage errors first with the meter normally connected to the mains and then after inverting the connections to the current circuits as well as to the voltage circuits. Half of the difference between the two percentage errors is the value of the variation of percentage error. Because of the unknown phase of the magnetic field, the test should be made at 0,05 I_n at unity power factor and 0,1 I_n at 0,5 power factor.		
[f] For a three-phase meter, the test consists of making three measurements at 0,05 I_n at unity power factor, after each of which the connection to the current circuits and to the voltage circuits are changed over 120° while the phase sequence is not altered. The greatest difference between each of the percentage errors so determined and their average value is the value of the variation of percentage error.		
NOTE The current is not considered an influence quantity, and its value is not specified at reference conditions, because the meter energy accuracy is characterized with respect to the changing load current, while keeping the influence quantities at their reference values.		

7.2   Methods of accuracy verification

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

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

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

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

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

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

7.3   Measurement uncertainty

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

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

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

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

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

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

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

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

For accuracy class 0,1S:

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

where

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

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

U is the obtained value of expanded uncertainty.

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

7.4   Meter constant

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

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

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

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

7.5   Initial start-up of the meter

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

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

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

Conformity is verified by the following test:

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

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

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

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

7.6   Test of no-load condition

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

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

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

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

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

where

Δt is the minimum required test time,

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

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

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

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

7.7   Starting current test

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

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

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

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

7.8 Repeatability test

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

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

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

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

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

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

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

Table 11 – Repeatability test points

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

7.9 Limits of error due to variation of the current

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

7.10 Limits of error due to influence quantities

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

7.11 Time-keeping accuracy

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

8 Climatic requirements

8.1 General

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

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

8.2 Environmental conditions

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

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

Table 12 – Environmental conditions

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

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

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

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

8.3 Tests of the effects of the climatic environments

8.3.1 General test requirements

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

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

8.3.2   Acceptance criteria

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

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

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

8.3.3   Dry heat test

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

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

8.3.4   Cold test

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

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

8.3.5   Damp heat cyclic test

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

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

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

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

8.3.6   Protection against solar radiation

Meters for outdoor use shall withstand solar radiation.

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

    a) meter in non-operating condition;

    b) test procedure A (8 h irradiation and 16 h darkness);

    c) upper temperature: +55 °C;

    d) duration of the test: 3 cycles or 3 days.

8.4   Durability

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

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

9   The effects of external influence quantities and disturbances

9.1   General

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

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

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

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

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

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

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

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

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

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

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

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

All meter parts intended to be earthed shall be earthed.

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

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

Table 14 – Summary of the tests of immunity to disturbances

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

9.2   Acceptance criteria

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

Primary functions of electricity meters include:

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

These primary functions shall be observed during testing.

Table 15 – Acceptance criteria

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

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

9.3   Electromagnetic compatibility (EMC)

9.3.1   General

9.3.1.1   Electromagnetic phenomena covered by EMC tests

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

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

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

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