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Railway application — Communication, signalling and processing system — Test requirements for signalling and telecommunication equipment

National foreword

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European foreword

This document (EN 50736:2025) has been prepared by CLC/SC 9XA “Communication, signalling and processing systems” of CLC/TC 9X “Electrical and electronic applications for railways”.

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withdrawn

This document has been prepared according to Decision 57/5 taken during the SC 9XA meeting.

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Introduction

The environmental conditions for signalling and telecommunication equipment are specified by EN 50125-3:2003, without defining test requirements and their related performance/acceptance criteria.

This document contains test requirements and performance/acceptance criteria for most of the mentioned environmental conditions likely to be experienced in the railway applications and published in EN 50125-3:2003. Furthermore, it clearly indicates for which environmental conditions no test methods are known and therefore no meaningful test requirements can be defined.

Test requirements for the type test defined in this document consider the severity of the environmental parameters provided for by EN 50125-3:2003, but those test requirements remain applicable even if the severity levels requested by the customer differ.

This document has been prepared in the form of a Product Standard.

Where possible, direct references are given to other existing standards to obtain a high degree of acceptance and to reduce additional effort for testing.

1 Scope

This document applies to railway signalling and telecommunication trackside equipment.

This document does not cover signalling and telecommunication equipment mounted in vehicles; these are covered by EN 50155:2021.

This document covers the type testing phases of the equipment for signal and telecommunication (S&T) systems (including power supply systems belonging to S&T), in order to ensure compliance with specified requirements already defined in the customer specifications or by the involved parties.

In particular this document intends to define test requirements with related performance / acceptance criteria, considering only the environmental conditions stated by the EN 50125-3:2003, and considering the severities of the environmental parameters herein defined.

Safety considerations are not covered by this document.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 50121-4, *Railway applications - Electromagnetic compatibility - Part 4: Emission and immunity of the signalling and telecommunications apparatus*

EN 50124-1:2017, *Railway applications - Insulation coordination - Part 1: Basic requirements - Clearances and creepage distances for all electrical and electronic equipment*

EN 50125-3:2003,¹ *Railway applications - Environmental conditions for equipment - Part 3: Equipment for signalling and telecommunications*

EN 60068-2-2, *Environmental testing - Part 2-2: Tests - Test B: Dry heat (IEC 60068-2-2)*

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

EN 60068-2-27, *Environmental testing - Part 2-27: Tests - Test Ea and guidance: Shock (IEC 60068-2-27)*

EN 60068-2-47, *Environmental testing - Part 2-47: Tests - Mounting of specimens for vibration, impact and similar dynamic tests (IEC 60068-2-47)*

EN 60068-2-64:2008,² *Environmental testing - Part 2: Tests - Test Fh: Vibration, broadband random and guidance (IEC 60068-2-64:2008)*

EN 60068-2-75, *Environmental testing - Part 2-75: Tests - Test Eh: Hammer test (IEC 60068-2-75)*

EN 60529, *Degrees of protection provided by enclosures (IP Code) (IEC 60529)*

EN 61180:2016, *High-voltage test techniques for low-voltage equipment - Definitions, test and procedure requirements, test equipment (IEC 61180:2016)*

EN 62262, *Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code) (IEC 62262)*

¹ As impacted by EN 50125-3:2003/corrigendum May 2010.

² As impacted by EN 60068-2-64:2008/A1:2019.

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 50124-1:2017, EN 60068-2-64:2008 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp/>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1.1

enclosure

<for equipment> case, housing, or other part to protect the equipment against certain external influences

Note 1 to entry: The enclosure can offer protection to personnel, e.g. from electric shock.

Note 2 to entry: In this document insulating compound (e.g. potting, encapsulation and vacuum impregnation) used to protect the equipment against external influences is considered as enclosure.

3.1.2

environmental conditions

<for signalling equipment> physical, chemical, electric and biological conditions external to the equipment to which it is subjected in service

[SOURCE: IEC 60050-821:2017, 821-01-53]

3.1.3

environmental factor

physical, chemical or biological influence which, either singly or in combination with other influences, produces an environmental condition (e.g. heat, vibration)

[SOURCE: EN 60721-1:1995, 3.2]

3.1.4

environmental parameter

one or more physical, chemical or biological properties characterizing an environmental factor (e.g. temperature, acceleration)

Note 1 to entry: For example, the environmental factor vibration is characterized by the parameters: type of vibration (sinusoidal, random), acceleration and frequency.

[SOURCE: EN 60721-1:1995, 3.3, modified – The second part of the definition was moved to Note 1 to entry]

3.1.5

equipment

single apparatus or set of devices or apparatuses, or the set of main devices of an installation, or all devices necessary to perform a specific task

EXAMPLES A power transformer, the equipment of a substation, measuring equipment.

[SOURCE: IEC 60050-151:2001, 151-11-25]

3.1.6

operating temperature

<of equipment> temperature range in which the equipment is operating as specified

Note 1 to entry: Outside of the operating temperature range there can be temporary or permanent degradation of the equipment performances.

3.1.7

performance

characteristics defining the ability of an equipment to achieve the intended functions

[SOURCE: IEC 60050-311:2001, 311-06-11, modified – “measuring instrument” has been replaced with “equipment”]

3.1.8

port

<for signalling and telecommunications apparatus> particular interface of the specified apparatus with the external environment

EXAMPLES AC power port, DC power port, I/O (input/output) port, earth port.

[SOURCE: IEC 60050-821:2017, 821-11-37]

3.1.9

resonance frequency

<in vibration tests> frequency at which resonance exists and the acceleration measured in the response point is more than three times respect the acceleration measured in the reference point

3.1.10

severity of environmental parameter

value of each quantity, characterizing the environmental parameter

EXAMPLE The severity of sinusoidal vibration is defined by values of the acceleration (in m/s^2) and frequency (in Hz).

[SOURCE: EN 60721-1:1995, 3.4]

3.1.11

specified requirement

need or expectation that is stated

Note 1 to entry: Specified requirements can be stated in normative documents such as regulations, standards and technical specifications.

Note 2 to entry: When the severity of an environmental parameter is chosen considering the environment intended for the installation of the equipment, this becomes a specified requirement. This is the target that the equipment has to fulfil. Specified requirements can be defined by generic or product standards. When suitable specifications or standards do not exist, considering the environment intended for the installation of the equipment, customer or supplier can define requirements in their specification (e.g. the value of the environmental high temperature to which equipment can operate has to be 70 °C.).

[SOURCE: IEC 60050-902:2013, 902-02-01, modified – The Note 2 to entry has been added]

3.1.12

system

set of interrelated elements considered in a defined context as a whole and separated from their environment

[SOURCE: IEC 60050-351:2013, 351-42-08, modified – The Notes to entry have been omitted]

3.1.13

test fixture

apparatus to fix the equipment on the test device during testing

[SOURCE: ISO 19594:2017, 3.7, modified – “specimen” has been replaced with “equipment”]

3.1.14

test requirement

prescriptions to be used during the tests

Note 1 to entry: These prescriptions are usually defined in generic or product standards. These prescriptions, that regulate the parameters not properly defined by the basic standards, are necessary to make the test effective to ensure that the specified requirements are met.

Note 2 to entry: E.g. the duration of the dry heat test has to be 10 h.

3.1.15

test procedure

set of instructions in order to obtain a test result

Note 1 to entry: Test procedures are usually defined in basic standards (e.g. the test procedures for dry heat test are described in EN 60068-2-2).

3.1.16

type test

conformity test made on one or more items representative of the production

[SOURCE: IEC 60050-581:2008, 581-21-08]

3.2 Abbreviations

For the purposes of this document, the following abbreviations apply.

AC	Alternating Current
ASD	Acceleration Spectral Density
CCZ	Current Collector Zone
DC	Direct Current
EMC	Electro Magnetic Compatibility
EUT	Equipment Under Test
I/O	Input / Output
IP	Ingress Protection
OCLZ	Overhead Contact Line Zone
PBA	Printed Board Assembly
PCB	Printed Circuit Board
RMS	Root Mean Square
SPD	Surge Protection Device

4 Relation between environmental conditions and test requirements

Clause 4 defines the relation between environmental conditions and the test requirements for type test.

Informative Annex A is added for a better understanding of the document. It shows the analysis of the environmental conditions defined in EN 50125-3:2003 and their influence on the functioning of the EUT, and also the relation with the test requirements for type tests defined in this document.

Table 1 shows the relationship between the environmental conditions considered by EN 50125-3:2003, the preparatory and additional information reported in Annex A, and the test requirements defined in this document.

The structure of Table 1, and also of the informative Annex A, has been deliberately left the same as EN 50125-3:2003, to allow a better readability of the document, even if for some environmental conditions no test requirements have been defined.

Table 1 — List of environmental conditions and related test requirements

Environmental condition	Subclause in EN 50125-3:2003	Preparatory and additional information in Annex A	Test requirements subclause in this document
Pressure	4.2	A.2	5.2 Insulation tests
Temperature	4.3	A.3	5.3 Temperature tests
Humidity	4.4	A.4	5.4 Humidity test
Wind	4.5	A.5	No test requirements defined in this document
Rain	4.6	A.6	5.4 Humidity test 5.8 Test for protection against water ingress
Snow and Hail	4.7	A.7	5.4 Humidity test 5.11 Test for protection against external mechanical impacts
Ice	4.8	A.8	5.4 Humidity test
Solar Radiation	4.9	A.9	5.9 Solar radiation tests
Lightning	4.10	A.10	5.2 Insulation tests 5.7 Surge test
Pollution	4.11	A.11	5.2 Insulation tests 5.10 Test for protection against dust and sand ingress 5.11 Test for protection against external mechanical impacts
Fire Protection	4.12	A.12	No test requirements defined in this document
Vibrations and Shocks	4.13	A.13	5.5 Vibration and shock tests
Electromagnetic compatibility	4.14	A.14	5.6 Electromagnetic compatibility tests
Power supplies	4.15	A.15	No test requirements defined in this document ^a
^a Power supply systems are in the scope of this document and type tests defined in Clause 5 apply. Power supplies itself are not an environmental condition hence no test requirements are given. See Annex A, Clause A.15 for further information.			

As previously explained, Table 1 relates each environmental condition with the relevant tests requirements defined in this document; this is to allow to the user of this document, considering the environmental conditions to be taken into account, to identify which tests shall be performed to the equipment. Due to this approach and the structure of Table 1, some test requirements have been repeated on several rows, because the tested characteristics are related to different environmental conditions.

To directly identify which tests shall be performed on an equipment for a complete execution of the type tests, in order to take into account all environmental conditions stated in EN 50125-3:2003 for which test requirements have been defined in this document, informative Annex D provides a guide.

5 Test requirements for type test

5.1 General test requirements

5.1.1 General

Equipment used for type tests shall be a serial product or an exemplary representative of the final manufactured product.

5.1.2 Test levels

EN 50125-3:2003 specifies the environmental conditions, with the related severity of environmental parameters, encountered within Europe for railway signalling and telecommunication trackside equipment.

The test levels defined in this document are derived from the severity of the environmental parameters defined in EN 50125-3:2003.

5.1.3 Standard atmospheric conditions

As defined in EN 60068-1:2014, 4.3, the standard range of atmospheric conditions for carrying out measurements and tests are (inclusive values):

Temperature:	15 °C to 35 °C
Relative humidity:	from 25 % to 75 %
Air pressure:	86 kPa to 106 kPa

These standard atmospheric conditions shall be maintained during the execution of all tests defined in this document, unless specifically defined in the respective basic standard. If it is impracticable to carry out measurements in standard atmospheric conditions, a note stating the actual conditions shall be added to the test report.

5.1.4 Performance criteria

5.1.4.1 General

The expected performance (i.e. the equipment is functioning as specified), from the equipment under test, shall be specified for all operational conditions.

No damage to any connected equipment is allowed when the equipment does not operate as intended during or after the test.

5.1.4.2 Performance criterion A

The EUT shall continue to operate as intended. No change of operational state is allowed. No loss or unintentional change in stored data shall occur.

5.1.4.3 Performance criterion B

Degradation of the performance below the level described in criterion A is permitted, provided the EUT self-recovers to the condition established prior to the application of the test. No loss of stored data are allowed.

5.1.4.4 Performance criterion C

Degradation of performance as described in criteria A and B is permitted provided that the EUT self-recovers to the condition established prior to the application of the test within a maximum defined time, or can be restored after the test by the operator.

5.1.5 Visual Inspection

The visual inspection verifies the mechanical, dimensional and appearance conformance of the equipment with the requirements defined by the manufacturer in its specifications.

5.1.6 Performance test

The performance test verifies that the functional requirements of the equipment are met; consists of a comprehensive series of measurements of the functional characteristics to verify that the equipment operates as specified.

The performance test shall be well defined in the type test specification.

5.2 Insulation tests

5.2.1 General

The insulation tests herein defined are based on the provisions of EN 50124-1:2017, using the same terminology and acronyms.

The insulation tests, defined below, verify that the design of the equipment (mounted components, metal connections and enclosures, routing of printed circuit board tracks and wire) meets the requirements for galvanic isolation necessary for proper operation in the railway environment.

The tests should be carried out on fully assembled equipment and no alteration of the original settings is permitted (e.g. component removal). If components have to be removed during the tests, that specific test configuration shall be agreed between the involved parties and defined in the type test specification.

The manufacturer shall define in the type test specifications the maximum altitude at which the equipment can operate and all ports interfacing the EUT with other equipment or in general with the railway signalling and telecommunication system. For each port shall be defined, in accordance with EN 50124-1:2017:

- nominal voltage U_n ;
- rated insulation voltage U_{Nm} ;
- rated impulse voltage U_{Ni} ;
- insulation type (see EN 50124-1:2017, 3.6).

Earth connection, if present, and the enclosure of the equipment shall be considered as ports in order to verify the insulation barrier. For these ports the information written above (U_n , U_{Nm} , etc.) cannot be defined.

Ports related to the same equipotential section (see EN 50124-1:2017, 3.3) shall be considered as a single port for the scope of these tests and all their terminals shall be short-circuited together during all the insulation tests (e.g. metallic enclosure connected to the earth connection, and the earth port shall be considered as a single port). In these cases, the U_{Ni} of the port is the highest U_{Ni} of the ports directly connected to the same equipotential section.

EXAMPLE If an equipment has two ports connected to the same equipotential section, and the two ports have different values of rated impulse voltage U_{Ni} , the rated impulse voltage U_{Ni} of the equipotential section (therefore of the single port for the scope of these tests) is the highest U_{Ni} considering the two ports.

The insulation tests consist in four parts that shall be done in sequence:

- initial insulation resistance test (see 5.2.2);
- impulse test (see 5.2.3);
- voltage withstand test (see 5.2.4);
- final insulation resistance test (see 5.2.2).

Impulse test (5.2.3) and voltage withstand test (5.2.4) may be replaced by a single test with the test requirements defined in 5.2.5.

During the tests the equipment shall be switched OFF. After the insulation tests the equipment shall work as intended and within its specified limits. All measured values shall be recorded in the test report.

Tests shall be performed for all isolated ports of the EUT in order to verify the isolation with the other ports.

NOTE If the insulation type from the port under test to the other ports is the same (all with basic insulation or all with reinforced insulation), the other ports, which are not subjected to test, can be connected together and to the reference of the test instrument in order to reduce the number of the tests. With this strategy it is possible to verify multiple insulations during the same test.

If an equipment has an insulating enclosure, this shall be covered with a metal foil in contact with the insulating surface so that it can be electrically connected for the purpose of the insulation tests.

The insulation tests specified in 5.2 do not consider the fault conditions of the overhead contact line or current collector, and the consequent risk related to the hazardous transferred potentials, as these are beyond the scope of EN 50124-1:2017. This topic is treated by EN 50122-1:2022 and information is given in informative Annex F.

5.2.2 Insulation resistance test

5.2.2.1 General

The insulation resistance test shall be carried out at DC 500 V, with a tolerance of $\pm 10\%$ if U_{Ni} defined for the port is more, or equal, than 0,8 kV, otherwise at DC 250 V, with a tolerance of $\pm 10\%$, between each isolated port and all the other ports connected together and to the reference of the test instrument.

The test shall be performed by connecting the test generator directly to the two measuring points without interposing networks or coupling devices.

The test voltage shall be applied for at least 5 s to have a stabilized value of the insulation resistance. The resistance values measured, for each port, shall be recorded in the test report.

Any suitable test equipment can be used. The measuring device shall be capable of determining the insulation resistance with an overall accuracy of at least $\pm 10\%$.

AC voltage components, possibly present in the DC output voltage of the test equipment, should be reduced in order to minimize the influence that high value capacitors, installed between the test circuits, can have on the insulation resistance measurement. The test defined in EN IEC 61557-2:2021, 6.8 should be used to validate the measuring device.

NOTE The aim of this test is not only to verify the insulation resistance value, but also to identify insulation degradation due to the test sequence.

5.2.2.2 Test acceptance criteria for initial insulation resistance test

For each measurement, the value of the insulation resistance between ports shall be higher than 10 M Ω . Different values of the minimum insulation resistance may be used by agreement between the involved parties.

NOTE The minimum value of 10 M Ω is related to the highest leakage current that can be produced in worst case conditions, so as it cannot produce any significant functional (e.g. transistor unexpected polarization) or physical (e.g. electrolysis between PCB tracks) effects and considering requirements given in other product standards.

If high impedance bleeder resistors, inserted between ports, are required for measuring or clamping purposes, the effect of these resistors shall be considered for acceptance criteria and shall be defined in the type test specification. In this case the minimum value of the insulation resistance test shall be higher than the theoretical value of the parallel circuit between 10 M Ω and the value of the bleeder resistors.

EXAMPLE The bleeder resistor has a value of 5 M Ω . The parallel circuit with the required insulation resistance of at least 10 M Ω results in a minimum value of 3,33 M Ω . Thus, the measured value shall be 3,33 M Ω or higher.

5.2.2.3 Test acceptance criteria for final insulation resistance test

For each measurement, the value of the insulation resistance between ports shall be compliant with the acceptance criteria defined in 5.2.2.2.

Differences between the results obtained during the initial and the final insulation resistance tests shall be analysed and justified in the test report (engineering judgment is required).

5.2.3 Impulse test

5.2.3.1 General

The impulse test shall be carried out with a voltage having a front time of 1,2 μ s, with a tolerance of ± 30 % and a time to half-value of 50 μ s, with a tolerance of ± 20 % and described as a 1,2/50 μ s impulse (see EN 61180:2016, Figure 6), and is intended to simulate overvoltages of atmospheric origin. It also covers overvoltages due to switching of low-voltage equipment.

The pulse test generator, shall comply with the following parameters:

- source output impedance: no higher than 500 Ω ;
- test impulse voltage level U_i : derived from the rated impulse voltage U_{Ni} defined for each port;
- test voltage tolerance (voltage peak value): ± 10 %.

For each isolation barrier that has to be verified, the test impulse voltage level U_i shall be equal to the multiplication of the following factors:

- the rated impulse voltage U_{Ni} of the port that shall be tested;
- the altitude correction factor k_d defined in EN 50124-1:2017, Table A.9;
- the constant value equal to 1,6 (160 %) if the insulation type to be tested is reinforced or double (considering what is defined in EN 50124-1:2017, 5.2.3).

EXAMPLE 1 For an equipment that can be installed up to 2 500 m above sea level, the test impulse voltage level between two ports with reinforced insulation is $U_i = U_{Ni} \times 1,07 \times 1,6$.

EXAMPLE 2 For an equipment that can be installed up to 2 000 m above sea level, the test impulse voltage level between two ports with basic insulation is $U_i = U_{Ni}$.

NOTE A single port can be tested, with respect to one port rather than another, with two different impulse voltage level U_i , depending on the insulation type (basic, reinforced or double) between the equipotential sections.

The test impulse voltage level U_i shall be the open-circuit voltage of the generator before connection to the ports of the equipment.

For each isolation barrier that has to be verified, five impulses of the specified shape and of each polarity shall be applied at the test impulse voltage level U_i . The test shall be performed by connecting the test generator directly to the two testing points without interposing networks or coupling devices.

The result of the impulse test, for each isolation barrier, shall be recorded in the test report.

5.2.3.2 Test acceptance criteria

There shall be no disruptive discharge (spark-over, flashover or puncture) during test.

The impulse voltage and its waveform shall be monitored during the test to identify discharges.

5.2.4 Voltage withstand test

5.2.4.1 General

The voltage withstand test shall be carried out with an alternating voltage with a frequency in the range 45 Hz to 65 Hz, normally referred to as power-frequency of the equipment.

For each isolation barrier that has to be verified (the same tested with the impulse test defined in 5.2.3), the test voltage value U_{ac} is derived from the test impulse voltage level U_i of the impulse test (see 5.2.3), according to EN 50124-1:2017, Table A.8. Interpolation between adjacent values is permitted.

EXAMPLE The test impulse voltage level U_i between two ports is 4 kV. According to EN 50124-1:2017, Table A.8, interpolating between adjacent values, the test voltage value U_{ac} is approximately 2,17 kV.

Testing with alternating voltage is generally preferable, but if some ports under test have high capacitance values to other ports, such that cause a current draw by the test generator equal to or greater than 20 mA at the test voltage value U_{ac} , the test can be performed by applying a continuous voltage with a value equal to the rms value of the alternating voltage test multiplied by $\sqrt{2}$. In that case, both polarities shall be tested.

The voltage withstand test generator (AC or DC), and the test voltage, shall comply with the provisions defined in EN 61180:2016, 5.2 and 6.1.

The test shall be performed by connecting the test generator directly to the two testing points without interposing networks or coupling devices.

For each isolation barrier that has to be verified, the test voltage shall be raised uniformly from 0 V to the test voltage value U_{ac} within not more than 5 s, and then maintained at this level for 60 s.

The value of the leakage current measured by the test generator, for each isolation barrier, shall be recorded in the test report.

5.2.4.2 Test acceptance criteria

During the test, no breakdown or flashover shall occur. Partial internal discharges (e.g. caused by floating circuits inside the equipment) which do not cause breakdown, shall be disregarded.

5.2.5 Alternatives to impulse test

Considering what is stated in EN IEC 60664-1:2020, 6.2.2.1.3.1, impulse test defined in 5.2.3 and voltage withstand test defined in 5.2.4 may be replaced by a single voltage withstand test with the test requirements specified in 5.2.4.1, except for the definition of the test voltage values U_{ac} .

For each isolation barrier that has to be verified, the test voltage values U_{ac} shall be equal to the peak value of the test impulse voltage levels U_i as specified in 5.2.3.1.

EXAMPLE If, for an isolation barrier that has to be verified, the test impulse voltage level U_i , is 4 kV, the test voltage value U_{ac} is $4 \text{ kV} / \sqrt{2} = 2,83 \text{ kV}$.

NOTE The application of this test can overload and damage certain solid insulations.

For the test acceptance criteria refer to 5.2.4.2.

5.3 Temperature tests

5.3.1 General

In 5.3 the test requirements are defined for verifying that the equipment is able to withstand the temperature extremes to which it can be subjected during operation.

No temperature tests are required, and no test requirements are defined, for equipment with an operating temperature range specified from 15 °C to 35 °C and intended to be used only in environments with continuous thermal or climatic control.

The test level values shall be chosen in Table 2 and clearly defined in type test specification.

Table 2 — Test level values for temperature tests

Test levels	Acronyms	Value
$T_{O_MAX_test}$ = High temperature for dry heat test	HT1	45 °C
	HT2	55 °C
	HT3	70 °C
	HT4	85 °C
$T_{O_min_test}$ = Low temperature for cold test	LT1	-5 °C
	LT2	-25 °C
	LT3	-40 °C
	LT4	-55 °C
NOTE Test level values are derived from environmental parameters defined in EN 50125-3:2003.		

Tests passed with the test levels defined above, and the test requirements defined below, ensure that the equipment is able to operate, as specified, in a temperature range between low and high test levels.

To verify that the equipment can be stored and transported within the storage and transport temperature range defined by the manufacturer, see informative Annex C, Clause C.2 for additional information.

It is not recommended to use test level values other than those defined in Table 2. However, considering special technological arrangements used in the equipment (i.e. LCD screen) or particular installation environments, different values may be used by prior agreement between the involved parties.

The application of the test is defined in 5.3.2 and in 5.3.3.

5.3.2 Dry heat test

5.3.2.1 General

Dry heat test shall be carried out for equipment not directly exposed to sun rays or when the enclosure is not a part of the equipment, designed or chosen by the manufacturer.

Dry heat test doesn't cover the heating effects due to solar radiation.

NOTE For equipment directly exposed to sun rays and when the enclosure is a part of the equipment, designed or chosen by the manufacturer, dry heat test can be performed in order to verify the functioning of the equipment in an environment with a defined temperature.

This test is based on the provisions and tolerances of EN 60068-2-2 (test Be). The climatic chamber, used for the test, shall maintain a low-air velocity circulation around the equipment. The test shall be performed with the test requirements defined in this document.

5.3.2.2 Test setup

The EUT shall be placed in the climatic chamber with the same orientation as at which it will be installed. If forced ventilation, or any other type of equipment cooling other than natural convection, is used in the normal installation, this shall be replicated inside the climatic chamber. The Ancillary Equipment (AE), needed to execute the performance tests, shall be placed outside of the climatic chamber and connected to the equipment through the technical panel of the chamber.

5.3.2.3 Test requirements

The test requirements are defined in Table 3 and the test cycle is shown graphically in Figure 1.

Table 3 — Test requirements for dry heat test

Initial measurement
The performance test and the visual inspection shall be executed before the test at the standard atmospheric conditions; then the equipment shall be left switched ON for all the duration of the test.
Preconditioning
The environmental condition inside the test chamber shall be set to 25 °C of temperature with 50 % of relative humidity and shall remain at these values for 1 h.
Test cycle
The temperature of the climatic chamber shall reach the $T_{O_MAX_test}$ value with a temperature change rate between 0,5 K/min and 1 K/min.
When the temperature of the climatic chamber has reached the $T_{O_MAX_test}$ value, the temperature shall remain at this value for 16 h; during this time period the absolute humidity shall not exceed 20 g/m ³ .
During the period at $T_{O_MAX_test}$ the functionality of the equipment shall be monitored as specified in type test specification.
At the end of the period at $T_{O_MAX_test}$ value a performance test shall be executed.
The temperature of the climatic chamber shall reach 25 °C with a temperature change rate between 0,5 K/min and 1 K/min.
Recovery
Reached the target temperature the test chamber shall remain to 25 °C of temperature with 50 % of relative humidity for 1 h.
Final measurement
After the test, at the standard atmospheric conditions, the performance test and the visual inspection shall be executed.
Additional information for the test execution
With test temperatures higher than 70 °C the climatic chamber needs to maintain a relative humidity below 10 % in order to fulfil the required absolute humidity below 20 g/m³; this can be difficult for the majority of the climatic chambers present in the market. Therefore, the following precautions should be used to execute the test easily: — Pay particular attention to sealing the technical panels of the climatic chamber, so as not to let in air and humidity from the outside. — Deactivate the humidity control of the climatic chamber at the end of the preconditioning phase, and keep it off until the recovery phase. With these precautions it is guaranteed that the absolute humidity, set during the preconditioning phase at approximately 11,5 g/m³, does not increase because there are no sources of water or steam in the climatic chamber. During the cycle the absolute humidity can only decrease due to the effect of condensation on refrigerated coil, installed inside the chamber, that is controlled at a temperature very close to the freezing point. Moisture in the chamber is attracted to the cold surface and condense, but not freeze. The accumulated water is drained out of the chamber thereby lowering the humidity. The above is certainly valid for climatic chambers that use humidity systems as boiler/steam generators or atomizing systems, but remain valid for climatic chambers that use humidity systems with water bath if the water container is automatically emptied when the humidity control is switched off.

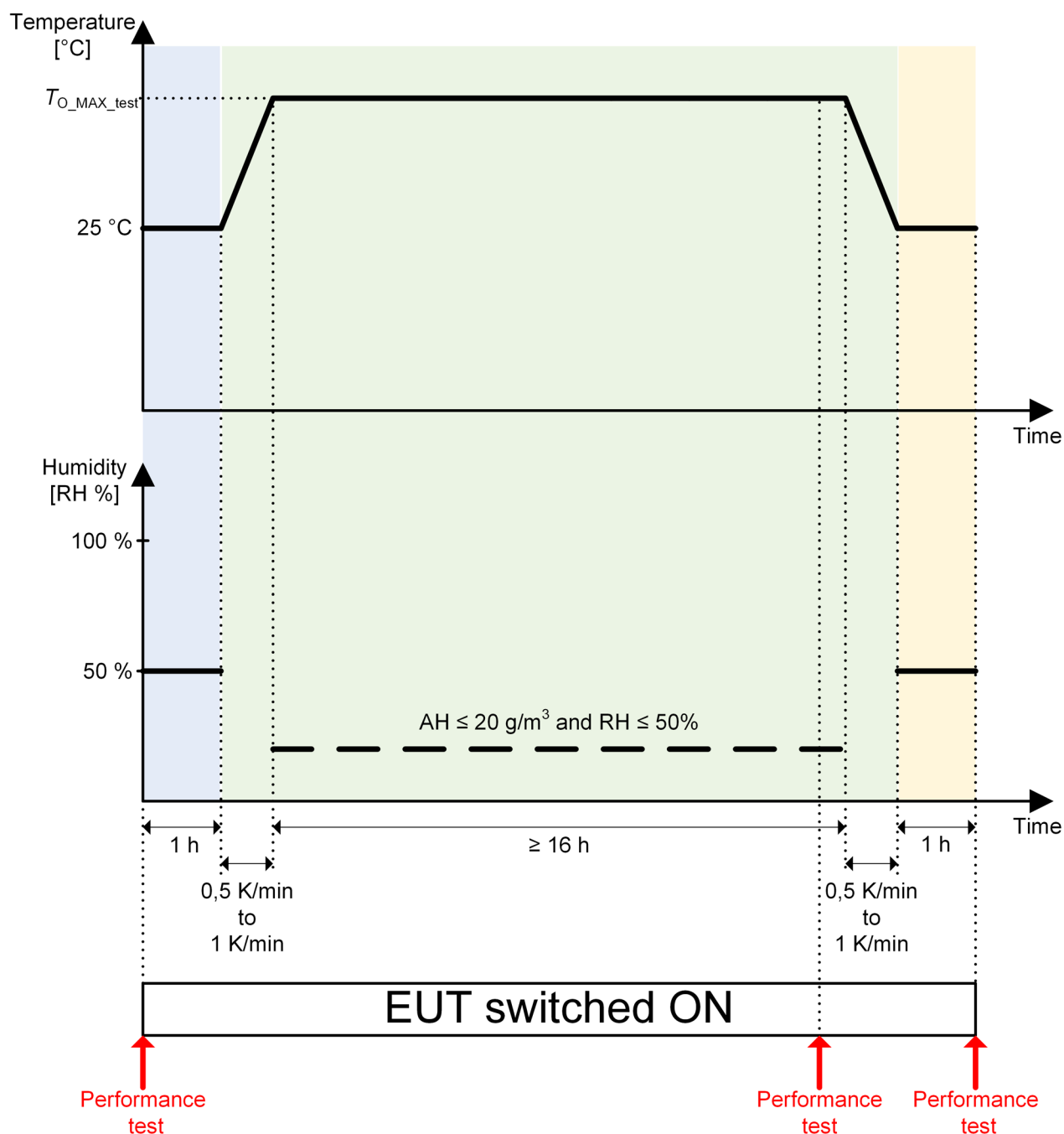


Figure 1 — Dry heat test cycle

5.3.2.4 Test acceptance criteria

During the test and after the recovery period, the equipment shall work as intended within its specified limits (performance criterion A), and the visual inspection, executed at the end of the test, shall not reveal any anomalies.

5.3.3 Cold test

5.3.3.1 General

This test is based on the provisions and tolerances of EN 60068-2-1 (test Ad). The test shall be performed with the test requirements defined in this document.

5.3.3.2 Test setup

The EUT shall be placed in the climatic chamber with the same orientation as at which it will be installed. The Ancillary Equipment (AE), needed to execute the performance tests, shall be placed outside of the climatic chamber, and connected to the equipment through the technical panel of the chamber.

5.3.3.3 Test requirements

The test requirements are defined in Table 4 and the test cycle is shown graphically in Figure 2.

Table 4 — Test requirements for cold test

Initial measurement
The performance test and the visual inspection shall be executed before the test at the standard atmospheric conditions; then the equipment shall be switched OFF.
Preconditioning
The environmental condition inside the test chamber shall be set to 25 °C of temperature with 50 % of relative humidity and shall remain at these values for 1 h.
Test cycle
The temperature of the climatic chamber shall reach the $T_{O_min_test}$ value with a temperature change rate between 0,5 K/min and 1 K/min.
When the temperature of the climatic chamber has reached the $T_{O_min_test}$ value, the temperature shall remain at this value for 16 h.
At the end of the period at $T_{O_min_test}$ the equipment shall be switched ON for the time required to execute a performance test (minimum 5 min). Then the equipment shall be switched OFF.
The temperature of the climatic chamber shall reach 25 °C with a temperature change rate between 0,5 K/min and 1 K/min.
Recovery
Reached the target temperature the test chamber shall remain to 25 °C of temperature with 50 % of relative humidity for 1 h.
Final measurement
After the test, at the standard atmospheric conditions, the performance test and the visual inspection shall be executed
Additional information for the test execution
Deactivate the humidity control of the climatic chamber at the end of the preconditioning phase, and keep it off until the recovery phase.

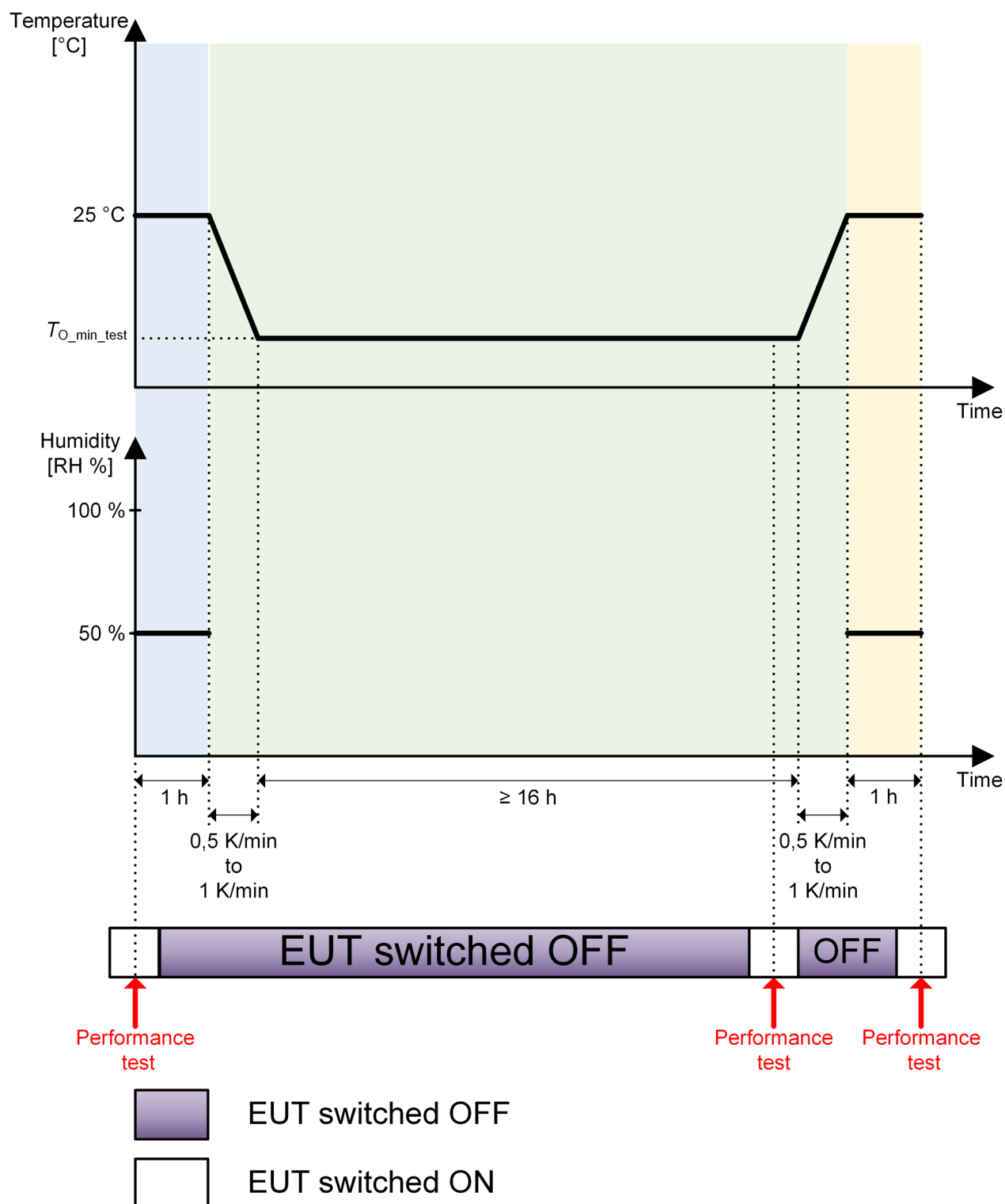


Figure 2 — Cold test cycle

5.3.3.4 Test acceptance criteria

During the test (when the equipment is switched ON) and after the recovery period, the equipment shall work as intended within its specified limits (performance criterion A), and the visual inspection, executed at the end of the test, shall not reveal any anomalies.

5.4 Humidity test

5.4.1 General

In 5.4 the test requirements are defined for verifying that the equipment is able to withstand the high humidity levels to which it can be subjected during operation.

No humidity tests are required, and no test requirements are defined, for equipment intended to be used only in enclosed locations, as shelters or buildings, with a maximum expected value of relative humidity less than 85 % where can be considerate negligible the phenomenon of condensation.

No test requirements are specified in this document for equipment with a maximum operating temperature less than 40°C and intended to be used in environment with expected values of relative humidity more than 85 % and with possible condensation. In this case test requirements shall be agreed between the involved parties. See informative Annex A, Clause A.4 for further information.

Considering the operating temperature range of the EUT (in particular the maximum operating temperature), the test level values shall be chosen in Table 5 and clearly defined in type test specification.

Table 5 — Test level values for humidity test

Maximum operating temperature of the equipment T_{O_MAX}	Test levels	Acronyms	Temperature test value for humidity test
$40\text{ °C} \leq T_{O_MAX} < 55\text{ °C}$	$T_{RH_MAX_test}$ = High temperature for damp heat test	RHT1	40 °C
$T_{O_MAX} \geq 55\text{ °C}$		RHT2	55 °C

The test level shall be selected in accordance with the maximum operating temperature of the equipment as shown in Table 5.

NOTE 1 E.g. for an equipment with a maximum operating temperature of 45 °C the test value is RHT1; for an equipment with a maximum operating temperature of 55 °C the test value is RHT2.

NOTE 2 E.g. for equipment intended to be used in areas not weather protected and directly exposed to the sun rays, the test level is RHT2 (the maximum operating temperature of the equipment is considered to be more or equal than 55 °C, see 5.9.3).

Tests passed with the test levels defined above and the test requirements defined below ensure that the equipment is able to operate, as specified, in an environment with high values of relative humidity and with the possibility of condensation.

5.4.2 Damp heat test

5.4.2.1 General

This test is based on the provisions and tolerances of EN 60068-2-30 (test Db variant 2) performing 2 damp heat 24 h cycles. The test shall be performed with the test requirements defined in this document.

5.4.2.2 Test setup

The EUT shall be placed in the climatic chamber with the same orientation as at which it will be installed. The Ancillary Equipment (AE), needed to execute the performance tests, shall be placed outside of the climatic chamber, and connected to the equipment through the technical panel of the chamber.

Special attention shall be given to allow humidity to reach all the parts of the equipment that in the normal installation can be exposed to air humidity (directly or due to breathing effects). See informative Annex A, Clause A.4 for further information.

5.4.2.3 Test requirements

The test requirements are defined in Table 6 and the test cycle is shown graphically in Figure 3, Figure 4 and Figure 5.

Table 6 — Test requirements for damp heat test

Initial measurement
The performance test and the visual inspection shall be executed before the test at the standard atmospheric conditions; then the equipment shall be switched OFF.
Preconditioning
The environmental condition inside the test chamber shall be set to $25\text{ °C} \pm 3\text{ K}$ of temperature with $60\% \pm 15\%$ of relative humidity and shall remain at these values for at least 1 h.
In less than 1 h, the relative humidity shall be increased to not less than 95 %.
Test cycle – 1 st 24 h cycle
The temperature of the chamber shall be raised to the $T_{RH_MAX_test}$ value. The upper temperature shall be achieved in a period of $3\text{ h} \pm 30\text{ min}$. During this period, the relative humidity shall not be less than 95 %. During the last 15 min it shall not be less than 90 %. Condensation can occur on the specimen during this temperature rise period
The temperature shall then be maintained within $T_{RH_MAX_test} \pm 2\text{ K}$ until $12\text{ h} \pm 30\text{ min}$ from the start of the cycle. During this period, the relative humidity shall be $93\% \pm 3\%$. During the first and last 15 min it shall be between 90 % and 100 %.
The temperature shall then be lowered to $25\text{ °C} \pm 3\text{ K}$ within 3 h to 6 h. During this temperature fall period and during the last 15 min the relative humidity shall be not less than 80 %.
The temperature shall then be maintained at $25\text{ °C} \pm 3\text{ K}$ with a relative humidity of not less than 95 % until the 24 h cycle is completed.
Test cycle – 2 nd 24 h cycle
Shall be followed the same test requirements defined for the 1 st 24 h cycle, with the exception that during the temperature rise period, at 35 °C of temperature (during the possible condensation), the EUT shall be switched ON for the time required to execute a performance test (minimum 5 min). Then the EUT shall be switched OFF.
Recovery
After the 2 nd 24 h cycle, the relative humidity shall be decreased at $60\% \pm 15\%$ in less than 1 h.
The environmental condition inside the test chamber shall be maintain to $25\text{ °C} \pm 3\text{ K}$ of temperature with $60\% \pm 15\%$ of relative humidity for a time of 1 h to 2 h.
With the same environmental condition of the last period, the equipment shall be switched ON (for maximum 30 min) and a performance test shall be executed. Then the equipment shall be switched OFF.
Final measurement
The EUT shall be removed from the chamber and one single insulation resistance test shall be executed (see 5.2.2 for test requirements) on dry equipment at the standard atmospheric conditions.
After the insulation resistance tests the equipment shall be switched ON and a performance test shall be executed.