BS ISO 10109:2015

BSI Standards Publication

Optics and photonics — Guidance for the selection of environmental tests

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National foreword

This British Standard is the UK implementation of ISO 10109:2015. It supersedes BS ISO 10109:2014 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee CPW/172, Optics and Photonics.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Published by BSI Standards Limited 2015

ISBN 978 0 580 88207 4

ICS 37.020

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 June 2015.

Amendments/corrigenda issued since publication

Date	Text affected

BS ISO 10109:2015

INTERNATIONAL STANDARD

ISO 10109

Second edition
2015-06-01

Optics and photonics — Guidance for the selection of environmental tests

Optiques et photonique — Directives relatives au choix des essais environnementaux

Reference number
ISO 10109:2015(E)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT), see the following URL: Foreword — Supplementary information.

The committee responsible for this document is ISO/TC 172, *Optics and photonics*, SC 1, *Fundamental standards*.

This second edition cancels and replaces the first edition (ISO 10109:2014), of which it constitutes a minor revision.

Introduction

Optical and photonic instruments including additional assemblies from other fields (e.g. mechanical, chemical, and electronic devices) are affected during their use by a number of different environmental and handling parameters, which they are required to resist without significant reduction in performance and to remain within defined specifications. This is what the manufacturer attempts to ensure and the user expects to receive.

This expectation can be assessed by exposure of the instrument to a range of simulated environmental parameters under controlled laboratory conditions. The cumulative combination, degree of severity, and sequence of these conditions can be selected to obtain meaningful results in a relatively short period of time.

Technical requirements as given in the tables of this International Standard are abbreviated and the reader has to consult the referenced standards (i.e. the relevant ISO 9022 part) for the full specification of the technical requirement.

For the purposes of ISO 10109, nominal values for properties or performance characteristics are understood to be the manufacturer's internal technical data and do not directly reflect manufacturer's product specifications.

INTERNATIONAL STANDARD ISO 10109:2015(E)

Optics and photonics — Guidance for the selection of environmental tests

1 Scope

This International Standard contains tables for environmental tests and test parameters which can be used as a guideline for the selection of environmental tests. These include the selection of standardized tests according to ISO 9022 as well as additional parameters not described in ISO 9022 and necessary for the optical or photonic instruments. Ultimately, these tables specify the requirements to be met with regard to the reliability of the optical, mechanical, chemical, and electrical properties or performance characteristics of the instruments when exposed to environmental influences.

Environmental test methods, as specified in ISO 9022 (all parts), can be assigned to the various areas of application for the purpose of ascertaining the suitability of the instruments in the respective area of application.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1
environmental requirements
specific natural and technical environmental influences between the limiting values of which optical instruments and instruments with optical, mechanical, chemical, and electrical components are to be operable

2.2
technical requirement
defined limiting value for the natural and technical environmental influences occurring in the envisaged area of application

Note 1 to entry: In order to verify whether an instrument fulfils a technical requirement, conditioning methods can be stipulated with degrees of severity whose limiting values are either higher or lower than those specified.

2.3
extent of testing
sum of all required tests to ascertain operability as well as product performance within the intended use and time of life

Note 1 to entry: The extent of design verification/testing is subdivided into

— design verification and production process controlling (not addressed by this International Standard), and

— testing of functional models, prototypes, and production series products.

2.4
severity of testing
number of specimens per production batch/series or sample production to be subjected to a specific test

Note 1 to entry: The severity of testing is stipulated in the relevant specification or in the instrument standard.

2.5
area of application
classification of the operability of an instrument within a defined environment and intended application

Note 1 to entry: The manufacturer defines the environment parameters. This can be done, e.g. by using pre-defined 'standardized areas of application' such as in Table 3 to Table 8 in full or in part.

EXAMPLE General application in an office environment with air conditioning; or an outdoor application, non-weather protected in arctic climate.

2.6
conditioning method
individual or combined environmental influence(s) to which the specimen is submitted during the test, e.g. shock or damp heat

2.7
degree of severity
parameter containing all the individual quantities required for the test

Note 1 to entry: See also the specific parts of ISO 9022.

EXAMPLE Temperature, humidity, conditioning time, and others have to be defined for the intended area of application.

2.8
state of operation
code that designates the state of operation of a specimen

Note 1 to entry: Table 1 gives states of operation in accordance with ISO 9022 (all parts).

Table 1 — States of operation

State of operation	Comment
0	Specimen in its normal transport and/or storage container as provided by the manufacturer (transport container, shipping package).
1	Specimen is unprotected, ready for operation, power supply not connected.
2	Specimen is in operation during conditioning for a period to be specified in the relevant specification. The mode of the operating status is specified in the relevant specification. During operation, a check is performed to establish if the specimen is functioning as required.

2.9
status after test
code that designates the outcome of the test as given in Table 2

Table 2 — Status after test

Status after test	Comment
A	All performance criteria are satisfied.
B	All performance criteria are satisfied. Damage to parts not needed for function or reduced life are possible.
C	Not all performance criteria are satisfied. Damage to parts not needed for function or reduced life are possible.
D	Device may not operate anymore; damage is expected.

3 Environmental influences

3.1 General

Table 3 to Table 8 classify and describe standardized environment areas, which constitute a summary of the various environmental parameters with major influences to products during shipping, transport, storage, and operation.

The values for standard environments 1 and 2 have been compiled from excerpts of IEC 60721-2-1 and IEC 60721-3-4.

Standard environment 5 is defined for use in weather-protected locations.

Standard environment 6 is defined as an open-air climate with restricted limiting values for optical precision measurements and for the use of optical consumer products in the open air.

3.2 Standard environment 1

Table 3 — Non-weather-protected locations with cold or extremely cold climates (Arctic or Antarctic climate)

Environmental influence	Value	Comment
Temperature	−65 °C to +35 °C	This range applies for commonly experienced conditions. In extreme geographical conditions, temperatures as low as −75 °C and as high as 40 °C can occur in the location of use. With temporary or permanent storage in enclosed vehicles, sheds, hangars, or attics, temperatures of over 35 °C can be experienced in strong sunshine, and over 70 °C in extreme cases. The specification does not address these conditions.
Relative humidity	up to 100 %	
Air pressure	70 kPa to 106 kPa	50 kPa to 110 kPa in unfavourable conditions.
Total solar irradiance	up to 1,1 kW/m^2	Intensity of global radiation on earth's surface, depending on the latitude.
Amount of precipitation (rain, snow, or hail)	≤15 mm/min	
Dew or ice build-up	yes	

3.3 Standard environment 2

Table 4 — Global locations, non-weather-protected, with the exception of cold and extremely cold climates

Environmental influence	Value	Comment
Temperature	−33 °C to +55 C	This range applies for commonly experienced conditions. In extreme geographical conditions, temperatures as low as −45 °C and over 60 °C can be experienced in the location of use. With temporary or permanent storage in enclosed vehicles, sheds, hangars, or attics, temperatures of over 55 °C can occur in strong sunshine, and over 85 °C in extreme cases. The specification does not address these conditions.
Relative humidity	up to 100 %	
Air pressure	70 kPa to 106 kPa	50 kPa to 110 kPa in unfavourable conditions.
Total solar irradiance	up to 1,1 kW/m^2	Intensity of global radiation on earth's surface, depending on the latitude.

Table 4 *(continued)*

Environmental influence	Value	Comment
Amount of precipitation (rain, snow or hail)	≤15 mm/min	
Dew or ice build-up	yes	

3.4 Standard environment 3

Table 5 — Global locations, non-weather-protected, with maritime and/or coastal climate

Environmental influence	Value	Comment
Temperature	−20 °C to +35 °C	This range applies for commonly experienced conditions. Along coasts with icing, temperatures below −20 °C can be experienced, and above 35 °C along tropical coasts. With temporary or permanent storage in enclosed vehicles, sheds, hangars, or attics, temperatures over 35 °C can be experienced in strong sunshine, and over 85 °C in extreme cases. The specification does not address these conditions.
Relative humidity	up to 100 %	
Air pressure	90 kPa to 106 kPa	50 kPa to 110 kPa in unfavourable conditions.
Total solar irradiance	up to 1,1 kW/m^2	Intensity of global radiation on earth's surface, depending on the latitude.
Amount of precipitation (rain, snow or hail)	≤15 mm/min	
Dew or ice build-up	yes	

3.5 Standard environment 4

Table 6 — High altitudes of up to 30 000 m

Environmental influence	Value	Comment
Temperature	−65 °C to +55 °C	This range applies for commonly experienced conditions. Above polar zones, temperatures below −65 °C have to be expected. With temporary or permanent storage in enclosed vehicles, sheds, hangars, or attics, temperatures over 55 °C can be experienced in strong sunshine, and over 85 °C in extreme cases. The specification does not address these conditions.
Relative humidity	up to 100 %	
Air pressure	1 kPa to 106 kPa	
Total solar irradiance	up to 1,4kW/m^2	Intensity of radiation at altitude of 30 000 m.
Amount of precipitation (rain, snow or hail)	≤15 mm/min	
Dew or ice build-up	yes	

3.6 Standard environment 5

Table 7 — Technical climate in weather-protected locations

Environmental influence	Value	Comment
Temperature	+15 °C to +35 °C	This range applies for commonly experienced conditions. In unfavourable conditions, temperatures below 15 °C and over 35 °C may occur. The specification does not address these conditions.
Relative humidity	up to 85 %	
Air pressure	70 kPa to 106 kPa	50 kPa to 110 kPa in unfavourable conditions.
Total solar irradiance	up to 0,9 kW/m^2	Without protection from sunshine, depending on the latitude.

3.7 Standard environment 6

Table 8 — Non-weather-protected locations with restricted limiting values

Environmental influence	Value	Comment
Temperature	−20 °C to +50 °C	The restricted temperature range applies for state of operation 2. The values of standard environment 2 apply for the states of operation 0 and 1.
Relative humidity	up to 100 %	
Air pressure	70 kPa to 106 kPa	50 kPa to 110 kPa in unfavourable conditions.
Total solar irradiance	up to 1,1 kW/m^2	The total solar irradiance depends on the latitude. Beware of critical values in and on the instruments when combining heat and solar irradiance.
Amount of precipitation (rain, snow or hail)	≤6 mm/min	
Dew or ice build-up	yes	

4 Table for environmental tests and test parameters

The wide range of technologies applied in complex instruments often requires specific and individually selected test parameters, test sequences, and combined tests. Table 9 is a collection of mainly climatic and mechanical tests.

The user of this International Standard, e.g. a manufacturer, selects the tests and adapts the parameters to his specific equipment. A specific area of application has to be defined for every item of equipment and both the tests and the degree of severity also have to be adapted to the intended climatic and operating environment and to the customer expectations. It is up to the manufacturer to carefully select the appropriate tests, the combination of the tests, the required technical parameters, the degree of severity, the status of operation and other parameters. An example is given in Annex A.

As a general test result, the status after the test can be shown in the table for each specific test-run.

Note that in Table 9, the combination of the three columns “Conditioning method”, “Degree of severity”, and “State of operation” provide the full specification using the coded format as defined in ISO 9022-1. The column labelled “Technical requirement” is only a short description and does not reproduce the full requirement. For a full description, it is necessary to consult the referenced standards.

Table 9 — List of international environmental and handling tests for optical and photonics equipment (the tests may be selected and combined as required)

Test number	Test description	In accordance with standard (leave blank if no accordance)	Conditioning method	Area of application: (e.g. Outdoor)			
				Description of application:			
				Degree of severity	State of operation	Technical requirement	Status after test
1	**Climate**					Select the test and fill in the required parameters	
1.1	**Cold**	ISO 9022-2	10				
1.2	**Heat (dry heat)**	ISO 9022-2	11				
1.3	**Damp heat**	ISO 9022-2	12				
1.4	**Condensation**	ISO 9022-2	13				
1.5	**Slow temperature change**	ISO 9022-2	14				
1.6	**Temperature shock, rapid temperature change**	ISO 9022-2	15				
1.7	**Damp heat, cyclic**	ISO 9022-2	16				
1.8	**Cold, dry heat or temperature change with bump or random vibration**	ISO 9022-22	22				
….	**….**						
2	**Atmosphere**					Select the test and fill in the required parameters	
2.1	**Combined low pressure and ambient temperature**	ISO 9022-23	45				
2.2	**Combined low pressure and dry heat**	ISO 9022-23	46				
2.3	**Damp heat and** low internal pressure, pressure difference low	ISO 9022-23	47				
2.4	**Damp heat** and low internal pressure, pressure difference medium	ISO 9022-23	48				
2.5	**Damp heat** and low internal pressure, pressure difference high	ISO 9022-23	49				
2.6	**Combined cold, low pressure including hoarfrost and dew**	ISO 9022-23	50				
2.7	**Combined cold, low pressure without hoarfrost and dew**	ISO 9022-23	51				
2.8	**Excess pressure**						

Table 9 *(continued)*

Test number	Test description	In accordance with standard (leave blank if no accordance)	Conditioning method	Area of application: (e.g. Outdoor)			
				Description of application:			
				Degree of severity	State of operation	Technical requirement	Status after test
2.9	**High internal pressure**	ISO 9022-8	80				
2.10	**Low internal pressure**	ISO 9022-8	81				
2.11	**Immersion**	ISO 9022-8	82				
2.12	**Dust**	ISO 9022-6	52				
2.13	**Drip**	ISO 9022-7	72				
2.14	**Steady rain**	ISO 9022-7	73				
2.15	**Driving rain**	ISO 9022-7	74				
2.16	**Dew**	ISO 9022-14	75				
2.17	**Hoarfrost, followed by process of thawing**	ISO 9022-14	76				
2.18	**Ice covering, followed by process of thawing**	ISO 9022-14	77				
2.19	**Precipitation:**						
	— Rain	IEC 60529					
	— Snow	IEC 60529					
	— Hail	IEC 60529					
	— Fog	IEC 60529					
	— Freezing fog	IEC 60529					
	— Hoarfrost	IEC 60529					
2.20	**Icing**						
2.21	**Solar radiation**	ISO 9022-9	20				
2.22	**Warming due to one-sided sun exposure**						
2.23	**Wind**						
2.24	**Dust**	IEC 60529					
2.25	**Sand**						
2.26	Polluted atmosphere — **salt**	IEC 60068–2-11					
2.27	Polluted atmosphere — **marine environment**	IEC 60068–2-52					
2.28	Polluted atmosphere — **H_2S**	IEC 60068–2-43					
2.29	Polluted atmosphere — **SO_2**	IEC 60068–2-42					
2.30	Polluted atmosphere — **NH_3**						
2.31	Polluted atmosphere — **Ozone**						

Table 9 *(continued)*

Test number	Test description	In accordance with standard (leave blank if no accordance)	Conditioning method	Area of application: (e.g. Outdoor)			
				Description of application:			
				Degree of severity	State of operation	Technical requirement	Status after test
....	....						
3	**Mechanical**					Select the test and fill in the required parameters	
3.1	**Shock**	ISO 9022-3	30				
3.2	**Handling shock**	ISO 9022-3	30/33				
3.3	**Bump**	ISO 9022-3	31				
3.4	**Drop and topple**	ISO 9022-3	32				
3.5	**Drop in transportation case**	ISO 9022-3	33				
3.6	**Drop in package for shipping**	ISO 9022-3	33				
3.7	**Free fall**	ISO 9022-3	33				
3.8	**Bounce**	ISO 9022-3	34				
3.9	**Steady-state acceleration, centrifugal**	ISO 9022-3	35				
3.10	**Sinusoidal vibration**	ISO 9022-3	36				
3.11	**Vibration in transportation case**	ISO 9022-3	36/37				
3.12	**Random vibration (wide-band) digitally controlled**	ISO 9022-3	37				
....	**....**						
4	**Chemical**					Select the test and fill in the required parameters	
4.1	**Salt mist**	ISO 9022-4	40				
4.2	**Humid atmosphere containing sulfur dioxide (SO_2)**	ISO 9022-20	41				
4.3	**Humid atmosphere containing hydrogen sulfide (H_2S)**	ISO 9022-20	42				
4.4	**Mould growth**	ISO 9022-11	85				
4.5	**Contamination:** Basic cosmetic substances and artificial hand sweat	ISO 9022-12	86				
4.6	**Contamination:** Laboratory agents	ISO 9022-12	87				
4.7	**Contamination:** Production plant resources	ISO 9022-12	88				

Table 9 *(continued)*

Test number	Test description	In accordance with standard (leave blank if no accordance)	Conditioning method	Area of application: (e.g. Outdoor)			
				Description of application:			
				Degree of severity	State of operation	Technical requirement	Status after test
4.8	**Contamination:** Fuels and resources for aircraft, naval vessels and land vehicles	ISO 9022-12	89				
….	**….**						
5	**Optional tests**					individual technical requirements	
….	**….**						
….	**….**						

Annex A
(informative)

Example of selection of environmental tests

As an example, an area of application has been defined in Table A.1 for a typical "Outdoor use". If necessary, more "Area of application" columns can be added.

The combination of the three columns "Conditioning method", "Degree of severity", and "State of operation" provide the full specification using the coded format as defined in ISO 9022-1. The column labelled "Technical requirement" is only a short description and does not reproduce the full requirement. For a full description, it is necessary to consult the referenced standards.

Table A.1 — Example of selection of environmental tests for an outdoor application in non-weather-protected locations in temperate climate

Test number	Test description	In accordance with standard	Conditioning method	Area of application: Outdoor			
				Non-weather-protected locations in temperate climate			
				Degree of severity	State of operation	Technical requirement	Status after test
1	Climate					Select the tests and fill in the required parameters	
1.1	Cold	ISO 9022-2	10	04	2	–20 °C, 16 h	A
1.2	**Heat (dry heat)**	ISO 9022-2	11	03	0 and 1	+55 °C	A
1.3	**Damp heat**	ISO 9022-2	12	06	2	+55 °C and r.h. 90 % to 95 %	C
1.4	**Condensation**	ISO 9022-2	13	03	1	2d, +40°C, 100 % rel. humidity	C
1.5	**Slow temperature change**	ISO 9022-2	14	02	0 and 1	from +55 °C to –25 °C	A
1.6	**Temperature shock, rapid temperature change**	ISO 9022-2	15	02	0 and 1	from +40 °C to –25 °C	A
1.7	**Damp heat, cyclic**	ISO 9022-2	16	04	2	+23 °C/83 % to 55 °C/95 %	A
1.8	**Cold, dry heat or temperature change with bump or random vibration**	ISO 9022-22	22	---	2	Dry heat, 55 °C (ISO 9022-11–03-2) [a] Vibration 20 Hz to 150 Hz, 0,02 g_n^2/Hz (ISO 9022-37–01-2) [a]	A

[a] These are environmental test codes for the methods selected for this combination test. See ISO 9022-1 for the numbering system and ISO 9022-22 for further details.

[b] Note that it is permissible in a practical case to have more than one table row for one single test criterion.

[c] "x" is a placeholder for the protection against ingress of objects; see IEC 60529 for more detail.

[d] "x" is a placeholder for the protection against water ingress; see IEC 60529 for more detail.

Table A.1 *(continued)*

Test number	Test description	In accordance with standard	Conditioning method	Area of application: Outdoor			
				Non-weather-protected locations in temperate climate			
				Degree of severity	State of operation	Technical requirement	Status after test
2	**Atmosphere**					Select the tests and fill in the required parameters	
2.1	**Combined low pressure and ambient temperature**	ISO 9022-23	45	01	2	23 °C, 800 hPa	A
2.2	**Combined low pressure and dry heat**	ISO 9022-23	46	03	2	55 °C, 100 hPa, exposure 24 h	A
2.3	**Damp heat** and low internal pressure, pressure difference low	ISO 9022-23	47	02	2	55 °C, <40 % r.h., 12 cycles, etc.	A
2.4	**Damp heat** and low internal pressure, pressure difference medium	ISO 9022-23	48	02	2	40 °C, 800 hPa, 90 % r.h., Cond.2: –10 °C, Cond.3: 40 °C	A
2.5	**Damp heat** and low internal pressure, pressure difference high	ISO 9022-23	49	02	2	40 °C, 90 % r.h., etc.	A
2.6	**Combined cold, low pressure including hoarfrost and dew**	ISO 9022-23	50	02	1	–40 °C, 600 hPa, 4 h	A
2.7 a)[b]	**Combined cold, low pressure without hoarfrost and dew**	ISO 9022-23	51	02	1	–40 °C, 600 hPa, 4 h	A
2.7 b)[b]	**Combined cold, low pressure without hoarfrost and dew**	ISO 9022-23	51	01	0 and 2	altitude up to 8 500 m	A
2.8	**Excess pressure**				0 and 2	–1 000 m NOTE Only if used in mines (with or without firedamp).	A
2.9	**High internal pressure**	ISO 9022-8	80	03	2	40 °C, press diff: 100 hPa, drop: 20 hPa, exposure 10 min	A

[a] These are environmental test codes for the methods selected for this combination test. See ISO 9022-1 for the numbering system and ISO 9022-22 for further details.

[b] Note that it is permissible in a practical case to have more than one table row for one single test criterion.

[c] "x" is a placeholder for the protection against ingress of objects; see IEC 60529 for more detail.

[d] "x" is a placeholder for the protection against water ingress; see IEC 60529 for more detail.

Table A.1 *(continued)*

Test number	Test description	In accordance with standard	Conditioning method	Area of application: Outdoor			
				Non-weather-protected locations in temperate climate			
				Degree of severity	State of operation	Technical requirement	Status after test
2.10	**Low internal pressure**	ISO 9022-8	81	03	2	40 °C, press diff: 100 hPa, rise: 20 hPa, exposure: 10 min	
2.11	**Immersion**	ISO 9022-8	82	02	2	immersion depth, 4 m, exposure 2 h	A
2.12	**Blowing dust**	ISO 9022-6	52	02	1	18 °C to 28 °C, <25 % r.h., 8 m/s to 10 m/s	A
2.13	**Drip**	ISO 9022-7	72	04	1	Drip rate: 3,5 mm/min, exposure: 5 min	A
2.14	**Steady rain**	ISO 9022-7	73	02	1	Rain rate: 20 mm/min, exposure: 30 min	A
2.15	**Driving rain**	ISO 9022-7	74	04	1	Rain rate: 10 mm/min, wind 18 m/s, exposure: 30 min	A
2.16	**Dew**	ISO 9022-14	75	01	2	10 °C, heat up to 30 °C, 85 % r.h.	A
2.17	**Hoarfrost, followed by process of thawing**	ISO 9022-14	76	02	2	–25 °C heat up to 30 °C, 90 % r.h.	A
2.18	**Ice covering, followed by process of thawing**	ISO 9022-14	77	02	2	–15 °C, 5 mm to 7 mm ice, heat up to 30 °C, 90 % r.h.	A
2.19	**Precipitation:**						
	— Rain	IEC 60529			0 and 2	IP x4[c]	A
	— Snow	IEC 60529					
	— Hail	IEC 60529					
	— Fog	IEC 60529					
	— Freezing fog	IEC 60529					
	— Hoarfrost	IEC 60529					
2.20	**Icing**						
2.21	**Solar radiation**	ISO 9022-9	20	03	0 and 2	1 000 W/m^2, +40 °C	A
2.22	**Warming due to one-sided sun exposure**				2	drift, hysteresis	A
2.23	**Wind**						

[a] These are environmental test codes for the methods selected for this combination test. See ISO 9022-1 for the numbering system and ISO 9022-22 for further details.

[b] Note that it is permissible in a practical case to have more than one table row for one single test criterion.

[c] "x" is a placeholder for the protection against ingress of objects; see IEC 60529 for more detail.

[d] "x" is a placeholder for the protection against water ingress; see IEC 60529 for more detail.

Table A.1 *(continued)*

Test number	Test description	In accordance with standard	Conditioning method	Area of application: Outdoor			
				Non-weather-protected locations in temperate climate			
				Degree of severity	State of operation	Technical requirement	Status after test
2.24	**Dust**	IEC 60529			0 and 2	IP 5x [d]	B
2.25	**Sand**					see 2.24, Dust	
2.26	Polluted atmosphere **— salt**	IEC 60068–2-11				5 %, +35 °C, 24 h	
2.27	Polluted atmosphere **— marine environment**	IEC 60068–2-52				cyclic: 5 %, severity 2	
2.28	Polluted atmosphere **— H_2S**	IEC 60068–2-43				21 d; 1 ppm (special)	
2.29	Polluted atmosphere **— SO_2**	IEC 60068–2-42				21 d; 10 ppm (special)	
2.30	Polluted atmosphere **— NH_3**						
2.31	Polluted atmosphere **— Ozone**						
3	**Mechanical**					Select the tests and fill in the required parameters	
3.1	**Shock**	ISO 9022-3	30	02	1	Acceleration 150 m/s^2	A
3.2	**Handling shock**				1	9 bumps from handling position (1 m) onto hard wood (50 mm) over concrete floor.	B
3.3	**Bump**	ISO 9022-3	31	02	1	Acceleration 100 m/s^2	A
3.4	**Drop and topple**	ISO 9022-3	32	02	0	Height of overturn: 50 mm	A
3.5	**Drop in transportation case**	ISO 9022-3	33	05	0	0,5 m drop height, once to all surfaces onto hardwood (50 mm) over concrete floor.	B

[a] These are environmental test codes for the methods selected for this combination test. See ISO 9022-1 for the numbering system and ISO 9022-22 for further details.

[b] Note that it is permissible in a practical case to have more than one table row for one single test criterion.

[c] "x" is a placeholder for the protection against ingress of objects; see IEC 60529 for more detail.

[d] "x" is a placeholder for the protection against water ingress; see IEC 60529 for more detail.

Table A.1 *(continued)*

Test number	Test description	In accordance with standard	Conditioning method	Area of application: Outdoor			
				Non-weather-protected locations in temperate climate			
				Degree of severity	State of operation	Technical requirement	Status after test
3.6	**Drop in package for shipping**	ISO 9022-3	33	–-	0	0,8 m (0 kg to 10 kg); 0,6 m (10 kg to 20 kg); 0,5 m (20 kg to 30 kg); 0,4 m (30 kg to 40 kg); 0,3 m (40 kg to 50 kg); 0,2 m (50 kg to 100 kg) Once to all surfaces onto hardwood (50 mm) over concrete floor.	B
3.7	**Free fall**	ISO 9022-3	33	05	0	Height of fall: 500 mm	A
3.8	**Bounce**	ISO 9022-3	34	02	0	Exposure time: 60 min	A
3.9	**Steady-state acceleration, centrifugal**	ISO 9022-3	35	02	1	Acceleration 100 m/s^2	A
3.10	**Sinusoidal vibration**	ISO 9022-3	36	04	2	10 Hz to 500 Hz, 20 m/s^2 Exposure time: 30 min	B
3.11	**Vibration in transportation case**				0	10 Hz to 150 Hz; 2 g_n; ±0,15 mm	B
3.12	**Random vibration (wide-band) digitally controlled**	ISO 9022-3	37	02	1	20 Hz to 150 Hz, 0,05 g_n^2/Hz	A
4	**Chemical**					Select the tests and fill in the required parameters	
4.1	**Salt mist**	ISO 9022-4	40	02	1	Exposure time: 4 h	A
4.2	**Humid atmosphere containing sulfur dioxide (SO_2)**	ISO 9022-20	41	02	2	1 cm^3/m^3 to 2 cm^3/m^3 SO_2	A
4.3	**Humid atmosphere containing hydrogen sulfide (H_2S)**	ISO 9022-20	42	02	2	0,5 cm^3/m^3 to 1 cm^3/m^3 H_2S	A

a These are environmental test codes for the methods selected for this combination test. See ISO 9022-1 for the numbering system and ISO 9022-22 for further details.

b Note that it is permissible in a practical case to have more than one table row for one single test criterion.

c "x" is a placeholder for the protection against ingress of objects; see IEC 60529 for more detail.

d "x" is a placeholder for the protection against water ingress; see IEC 60529 for more detail.

Table A.1 *(continued)*

Test number	Test description	In accordance with standard	Conditioning method	Area of application: Outdoor			
				Non-weather-protected locations in temperate climate			
				Degree of severity	State of operation	Technical requirement	Status after test
4.4	**Mould growth**	ISO 9022-11	85	01	1	29 °C, 96 % r.h., 28 d	A
4.5	**Contamination:** Basic cosmetic substances and artificial hand sweat	ISO 9022-12	86	01	1	exposure: 1 d	A
4.6	**Contamination:** Laboratory agents	ISO 9022-12	87	01	1	1:20 test agent/distilled water, 120 min exposure	A
4.7	**Contamination:** Production plant resources	ISO 9022-12	88	01	1	Exposure: 2 h	A
4.8	**Contamination:** Fuels and resources for aircraft, naval vessels and land vehicles	ISO 9022-12	89	01	1	Exposure: 2 h	A
5	**Optional tests**					individual technical requirements	
….	**….**						
….	**….**						

[a] These are environmental test codes for the methods selected for this combination test. See ISO 9022-1 for the numbering system and ISO 9022-22 for further details.

[b] Note that it is permissible in a practical case to have more than one table row for one single test criterion.

[c] "x" is a placeholder for the protection against ingress of objects; see IEC 60529 for more detail.

[d] "x" is a placeholder for the protection against water ingress; see IEC 60529 for more detail.

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