INTERNATIONAL STANDARD

ISO 10109-8

Second edition
2005-11-15

Optics and photonics — Environmental requirements —

Part 8: Test requirements for extreme conditions of use

Optique et photonique — Exigences environnementales —

Partie 8: Exigences d'essai pour conditions d'utilisation extrêmes

Reference number
ISO 10109-8:2005(E)

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Published in Switzerland

Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 10109-8 was prepared by Technical Committee ISO/TC 172, *Optics and photonics*, Subcommittee SC 1, *Fundamental standards*.

This second edition cancels and replaces the first edition (ISO 10109-8:1994), which has been technically revised.

ISO 10109 consists of the following parts, under the general title *Optics and photonics — Environmental requirements*:

— *Part 1: General overview, terms and definitions, climatic zones and their parameters*

— *Part 4: Test requirements for telescopic systems*

— *Part 6: Test requirements for medical optical instruments*

— *Part 7: Test requirements for optical measuring instruments*

— *Part 8: Test requirements for extreme conditions of use*

— *Part 11: Optical instruments for outdoor conditions of use*

— *Part 12: Conditions of transport for optical instruments*

Optics and photonics — Environmental requirements —

Part 8:
Test requirements for extreme conditions of use

1 Scope

This part of ISO 10109 is applicable to optical instruments and instruments with optical assemblies in extreme conditions of use.

It specifies requirements to be met with regard to the resistance of the optical, mechanical, chemical and electrical properties or performance data of instruments to environmental influences and hence determines geographical and technical areas of application. Environmental test methods, as specified in ISO 9022 (all parts), are assigned to the various areas of application for the purpose of ascertaining the suitability of the instruments in their respective area of application.

This part of ISO 10109 is the basis for the specification of environmental requirements and environmental tests in instrument standards. If necessary, these requirements and tests can be amended in the instrument standards.

This part of ISO 10109 does not deal with the requirements to be met by the packaging of the instrument during transport from the manufacturer to the user.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 9022-1:1994, *Optics and optical instruments — Environmental test methods — Part 1: Definitions, extent of testing*

ISO 9022-2:2002, *Optics and optical instruments — Environmental test methods — Part 2: Cold, heat and humidity*

ISO 9022-3:1998, *Optics and optical instruments — Environmental test methods — Part 3: Mechanical stress*

ISO 9022-4:2002, *Optics and optical instruments — Environmental test methods — Part 4: Salt mist*

ISO 9022-5:1994, *Optics and optical instruments — Environmental test methods — Part 5: Combined cold, low air pressure*

ISO 9022-6:1994, *Optics and optical instruments — Environmental test methods — Part 6: Dust*

ISO 9022-7:2005, *Optics and photonics — Environmental test methods — Part 7: Resistance to drip or rain*

ISO 9022-8:1994, *Optics and optical instruments — Environmental test methods — Part 8: High pressure, low pressure, immersion*

ISO 9022-9:1994, *Optics and optical instruments — Environmental test methods — Part 9: Solar radiation*

ISO 9022-10:1998, *Optics and optical instruments — Environmental test methods — Part 10: Combined sinusoidal vibration and dry heat or cold*

ISO 9022-11:1994, *Optics and optical instruments — Environmental test methods — Part 11: Mould growth*

ISO 9022-12:1994, *Optics and optical instruments — Environmental test methods — Part 12: Contamination*

ISO 9022-13:1998, *Optics and optical instruments — Environmental test methods — Part 13: Combined shock, bump or free fall and dry heat or cold*

ISO 9022-14:1994, *Optics and optical instruments — Environmental test methods — Part 14: Dew, hoarfrost, ice*

ISO 9022-16:1998, *Optics and optical instruments — Environmental test methods — Part 16: Combined bounce or steady-state acceleration and dry heat or cold*

ISO 9022-17:1994, *Optics and optical instruments — Environmental test methods — Part 17: Combined contamination, solar radiation*

ISO 9022-18:1994, *Optics and optical instruments — Environmental test methods — Part 18: Combined damp heat and low internal pressure*

ISO 10109-1:2005, *Optics and photonics — Environmental requirements — Part 1: General overview, terms and definitions, climatic zones and their parameters*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 9022-1 and ISO 10109-1 apply.

4 Subdivision of instruments for extreme conditions of use

Instruments for extreme conditions of use are subdivided into instrument types with the type numbers given in Table 1.

NOTE Previously, instruments for extreme conditions of use were designated as instrument group number 07, however, the use of group numbers is no longer recommended.

Table 1 — Subdivision of instruments for extreme conditions of use

Type number	Instrument type
01	Mainly instruments for ground use, except when used in extreme polar conditions
02	Mainly instruments exposed to maritime climatic conditions
03	Mainly instruments for use in aircraft and instruments in global use

5 Designation of environmental requirements and of environmental tests

The relevant specification and other technical documents shall indicate the environmental requirements required by this standard using the designation as per ISO 10109-1.

EXAMPLE An example of the designation for the environmental requirements for instruments for extreme conditions of use of instrument Type 02, and requiring the extent "T" (type or sample testing) is:

Environmental requirements ISO 10109-P08-02-T

In relevant specifications and other technical documentation, tests carried out in accordance with the environmental requirements given in this part of ISO 10109 shall be the environmental test code as specified in ISO 9022-1.

6 Type of testing on the basis of technical requirements

Table 2 specifies the technical requirements and the conditioning methods for the extent of testing T (type or sample testing). Table 3 shows a summary of the tests given in Table 2 as specified in the appropriate part of ISO 9022.

Table 4 specifies the technical requirements and the conditioning methods for the extent of testing S (series testing). Table 5 shows a summary of the tests given in Table 4 as specified in the appropriate part of ISO 9022.

Further technical requirements to be met by instruments for extreme conditions of use which are not contained in Tables 2 and 4 may be selected from Table 6, if required, and shall be agreed separately between the customer and manufacturer. Table 7 shows a summary of the tests given in Table 6 as specified in the appropriate part of ISO 9022.

For each of the conditioning methods given in Tables 2, 4 and 6, the instrument is suitable for the technical requirement specified if it is operative without restriction after conditioning.

For the purposes of this part of ISO 10109, the value of g_n is rounded up to the next highest integer, that is 10 m/s^2.

All tests shall be performed as specified in the appropriate part of ISO 9022. The tests may be performed in any order, if not specified otherwise.

Table 2 — Technical requirements and conditioning methods for extent of testing T

Serial No.	ISO 9022 Part	ISO 9022 Conditioning method	Instrument type		Mainly instruments for ground use, except when used in extreme polar conditions			Mainly instruments exposed to maritime climatic conditions			Mainly instruments for use in aircraft and instruments in global use		
			Type No.		01			02			03		
			State of operation[a]		0	1	2	0	1	2	0	1	2
1	2	10 Cold	Technical requirement	Temperature °C	–55	–40	–35	–35	–25	–25	–65	–65[b] –40	–65[b] –40
			Degree of severity[a]		09	08	07	07	05	05	10	10[b] 08	10[b] 08
2	2	11 Dry heat	Technical requirement	Temperature °C	70	63	63	70	55	55	70	63	63
			Degree of severity[a]		05	04	04	05	03	03	05	04	04
3	2	14 Slow temperature change	Technical requirement	Temperature °C t_2	—	63	55	—	55	40	—	70	70
				Temperature °C t_1	—	–35	–25	—	–25	–10	—	–65[b]	–65[b]
			Degree of severity[a]		—	05	02	—	02	01	—	08[b]	08[b]
4	2	15 Rapid temperature change	Technical requirement	Temperature °C t_2	—	40	—	—	40	—	—	55	55
				Temperature °C t_1	—	–25	—	—	–25	—	—	–40	–40
			Degree of severity[a]		—	02	—	—	02	—	—	03	03
5	2	16 Damp heat cyclic	Technical requirement	Temperature °C/ Relative humidity %	—	40/92	40/92	—	40/ 92	40/92	—	40/92	40/92
					—	23/83	23/83	—	23/ 83	23/83	—	23/83	23/83
			Degree of severity[a]		—	02	01	—	02	01	—	02	01
6	3	30 Shock	Technical requirement	Acceleration g	—	500	30	—	30	15	—	500	50
				Duration ms	—	1	6	—	18	11	—	1	3
			Degree of severity[a]		—	08[c]	03	—	04	02	—	08[c, d]	05
7	3	31 Bump	Technical requirement	Acceleration g	—	10	10	—	10	10	—	10	10
				Duration ms	—	6	6	—	6	6	—	6	6
			Degree of severity[a]		—	01	01	—	01	01	—	01	01
8	3	32 Drop and topple	Technical requirement	Height of overturn	—	100	—	—	100	—	—	100	—
			Degree of severity[a]		—	03[e]	—	—	03[e]	—	—	03[e]	—
9	3	33 Free fall	Technical requirement	Height of fall	Mass-dependent								
			Degree of severity[a]		f	f, g	—	f	f, g	—	g	f, g	—
10	3	34 Bounce	Technical requirement		Mechanical stresses during transport								
			Degree of severity[a]		03	—	—	03	—	—	03	—	—
11	3	36 Sinusoidal vibration	Technical requirement	Displacement mm	—	—	—	—	1	1	—	—	—
				Acceleration g	—	1	1	—	—	—	—	5	2
				Frequency range Hz	—	10 to 2 000	10 to 2 000	—	10 to 55	10 to 55	—	10 to 2 000	10 to 2 000
			Degree of severity[a]		—	02	02	—	10[h]	10[h]	—	09	06

Table 2 (*continued*)

Serial No.	ISO 9022 Part	ISO 9022 Conditioning method	Instrument type		Mainly instruments for ground use, except when used in extreme polar conditions			Mainly instruments exposed to maritime climatic conditions			Mainly instruments for use in aircraft and instruments in global use		
			Type No.		01			02			03		
			State of operation[a]		0	1	2	0	1	2	0	1	2
12	4	40 Salt mist	Technical requirement		Corrosion resistance[i]								
			Degree of severity[a]		—	05	—	—	06	—	—	05	—
13	7	74 Driving rain	Technical requirement	Wind velocity m/s	up to 21								
				Rain rate mm/min	up to 10								
			Degree of severity[a]		—	02	02	—	02	02	—	02	02
14	8	80 High internal pressure	Technical requirement	Difference from ambient pressure hPa	—	—	—	—	—	—	—	400	—
			Degree of severity[a]		—	—	—	—	—	—	—	10	—
15	8	81 Low internal pressure	Technical requirement	Difference from ambient pressure hPa	—	—	—	—	—	—	—	400	—
			Degree of severity[a]		—	—	—	—	—	—	—	10	—
16	11	85[j] Mould growth	Technical requirement		Ability to be operated for > 3 years in humid tropical locations in compliance with stipulated instructions regarding maintenance and care.								
			Degree of severity[a]		—	02	—	—	02	—	—	02	—
17	12	86[k] Basic cosmetic substances and artificial hand sweat	Technical requirement		Ability to be operated for ⩾ 5 years in compliance with stipulated instructions regarding maintenance and care.								
			Degree of severity[a]		—	02	—	—	02	—	—	02	—

[a] See the appropriate part of ISO 9022.

[b] Only for aerotechnical equipment mounted outside the aircraft and for instruments in global use.

[c] Applies to the testing of components and assemblies; complete optical instruments are tested with acceleration of 500g and a shock duration of 0,5 ms.

[d] Aerotechnical equipment shall be tested with degree of severity 03.

[e] Degree of severity 04 drop and topple shall be used for specimens at risk of toppling.

[f] The degree of severity shall be taken from ISO 9022-3 according to the mass of the specimen.

[g] For specially armoured instruments constructed for free fall.

[h] For use on ships only, otherwise degree of severity 02.

[i] To be performed primarily on representative samples.

[j] Testing of representative samples and components only. The test is not required if tests of identical materials and/or the structure of identical finish coatings have been performed on other instrument types using the same conditioning or if the fungus-resistant properties have been verified.

Long-term storage in high relative humidity (> 75 %) and in packaging which is not humidity-proof can also lead to mould contamination in fungus-resistant materials (caused by minor contamination, e.g. fingerprints, on the surface of the material which serves as a culture-medium for fungus spores).

[k] Testing representative samples only. The test is not required if tests of identical materials and/or the structure of identical finish coatings have been performed on other instrument types using the same or more severe conditioning.

Table 3 — Test summary

Environmental requirement ISO 10109-P08-01-T	Environmental requirement ISO 101019-P08-02-T	Environmental requirement ISO 10109-P08-03-T	Part of ISO 9022
Environmental test ISO 9022			
10-09-0	10-07-0	10-10-0	2
10-08-1	10-05-1	10-10-1	
10-07-2	10-05-2	10-10-2	
11-05-0	11-05-0	11-05-0	
11-04-1	11-03-1	11-04-1	
11-04-2	11-03-2	11-04-2	
14-05-1	14-02-1	14-08-1	
14-02-2	14-01-2	14-08-2	
15-02-1	15-02-1	15-03-1	
		15-03-2	
16-02-1	16-02-1	16-02-1	
16-01-2	16-01-2	16-01-2	
30-08-1	30-04-1	30-08-1	3
30-03-2	30-02-2	30-05-2	
31-01-1	31-01-1	31-01-1	
31-01-2	31-01-2	31-01-2	
32-03-1	32-03-1	32-03-1	
33-x-0	33-x-0	33-x-0	
33-x-1	33-x-1	33-x-1	
34-03-0	34-03-0	34-03-0	
36-02-1	36-10-1	36-09-1	
36-02-2	36-10-2	36-06-2	
40-05-1	40-06-1	40-05-1	4
74-02-1	74-02-1	74-02-1	7
74-02-2	74-02-2	74-02-2	
—	—	80-10-1	8
		81-10-1	
85-02-1	85-02-1	85-02-1	11
86-02-1	86-02-1	86-02-1	12

Table 4 — Technical requirements and conditioning methods for extent of testing S

Serial No.	ISO 9022		Instrument type		Mainly instruments for ground use, except when used in extreme polar conditions			Mainly instruments exposed to maritime climatic conditions			Mainly instruments for use in aircraft and instruments in global use		
	Part	Conditioning method	Type No.		01			02			03		
			State of operation[a]		0	1	2	0	1	2	0	1	2
1	2	10 Cold	Technical requirement	Temperature °C	–55	–40	–35	–35	–25	–25	–65	–65[b] –40	–65[b] –40
			Degree of severity[a]		09	08	07	07	05	05	10	10[b] 08	10[b] 08
2	2	11 Dry heat	Technical requirement	Temperature °C	70	63	63	70	55	55	70	63	63
			Degree of severity[a]		05	04	04	05	03	03	05	04	04
3	3	30 Shock	Technical requirement	Acceleration g	—	500	30	—	30	15	—	500	50
				Duration ms	—	1	6	—	18	11	—	1	3
			Degree of severity[a]		—	08[c]	03	—	04	02	—	08[c, d]	05
4	3	31 Bump	Technical requirement	Acceleration g	—	10	10	—	10	10	—	10	10
				Duration ms	—	6	6	—	6	6	—	6	6
			Degree of severity[a]		—	01	01	—	01	01	—	01	01
5	3	36 Sinusoidal vibration	Technical requirement	Displacement mm	—	—	—	—	1	1	—	—	—
				Acceleration g	—	1	1	—	—	—	—	5	2
				Frequency range Hz	—	10 to 2 000	10 to 2 000	—	10 to 55	10 to 55	—	10 to 2 000	10 to 2 000
			Degree of severity[a]		—	02	02	—	10[e]	10[e]	—	09	06
6	8	80 High internal pressure	Technical requirement	Difference from ambient pressure hPa	—	—	—	—	—	—	—	400	—
			Degree of severity[a]		—	—	—	—	—	—	—	10	—
7	8	81 Low internal pressure	Technical requirement	Difference from ambient pressure hPa	—	—	—	—	—	—	—	400	—
			Degree of severity[a]		—	—	—	—	—	—	—	10	—

[a] See the appropriate part of ISO 9022.

[b] Only for aerotechnical equipment mounted outside the aircraft and for instruments in global use.

[c] Applies to specimens of components and assemblies; complete optical instruments shall be tested with an acceleration of 500g an a shock duration of 0,5 ms.

[d] Aerotechnical equipment shall be tested with degree of severity 03.

[e] For use on ships only, otherwise degree of severity 02.

Table 5 — Test summary

Environmental requirement ISO 10109-P08-01-S	Environmental requirement ISO 10109-P08-02-S	Environmental requirement ISO 10109-P08-03-S	Part of ISO 9022
Environmental test ISO 9022			
10-09-0	10-07-0	10-10-0	2
10-08-1	10-05-1	10-10-1	
10-07-2	10-05-2	10-10-2	
11-05-0	11-05-0	11-05-0	
11-04-1	11-03-1	11-04-1	
11-04-2	11-03-2	11-04-2	
30-08-1	30-04-1	30-08-1	3
30-03-2	30-02-2	30-05-2	
31-01-1	31-01-1	31-01-1	
31-01-2	31-01-2	31-01-2	
36-02-1	36-10-1	36-09-1	
36-02-2	36-10-2	36-06-2	
—	—	80-10-1	8
		81-10-1	

Table 6 — Technical requirements and conditioning methods not included in Tables 2 and 4

Serial No.	ISO 9022		Instrument type		Mainly instruments for ground use, except when used in extreme polar conditions			Mainly instruments exposed to maritime climatic conditions			Mainly instruments for use in aircraft and instruments in global use		
	Part	Condition-ing method	Type No.		01			02			03		
			State of operation[a]		0	1	2	0	1	2	0	1	2
1	2	12 Damp heat	Technical requirement	Temperature °C	—	55[b]	—	—	55[b]	—	—	55[b]	—
				Rel. humidity %	—	92[b]	—	—	92[b]	—	—	92[b]	—
			Degree of severity[a]		—	06	—	—	06	—	—	06	—
2	2	13 Condensed water	Technical requirement	Temperature °C	40	—	—	40	—	—	40	—	—
				Rel. humidity %	100	—	—	100	—	—	100	—	—
			Degree of severity[a]		02	—	—	02	—	—	02	—	—
3	9	20 Solar radiation	Technical requirement	Irradiance kW/m^2	up to 1								
			Degree of severity[a]		—	02	—	—	02	—	—	02	—
4	3	35 Steady state acceleration, centrifugal	Technical requirement	Acceleration *g*	—	—	5	—	—	—	—	20	10
			Degree of severity[a]		—	—	01	—	—	—	—	03[c]	02[c]

Table 6 (*continued*)

Serial No.	ISO 9022		Instrument type			Mainly instruments for ground use, except when used in extreme polar conditions			Mainly instruments exposed to maritime climatic conditions			Mainly instruments for use in aircraft and instruments in global use		
	Part	Conditioning method	Type No.			01			02			03		
			State of operation[a]			0	1	2	0	1	2	0	1	2
5	3	37 Random vibration	Technical requirement	Frequency range Hz		—	20 to 500	—	—	—	—	—	20 to 2 000	—
				Acceleration power spectral density g^2/Hz		—	0,01	—	—	—	—	—	0,02	—
			Degree of severity[a]			—	12	—	—	—	—	—	25[d]	—
6	18	48 Damp heat and low internal pressure, pressure difference medium	Technical requirement	Temperature	°C	—	—	—	—	—	—	—	40	—
				Rel. humidity	%	—	—	—	—	—	—	—	95	—
				Pressure	kPa		—	—		—	—	—	65	—
			Degree of severity[a]			—	—	—	—	—	—	—	04	—
7	5	50 Combined cold, low air pressure including hoarfrost and dew	Technical requirement	Temperature °C		—	–40	—	—	—	—	—	–65	–65
				Altitude m		—	3 500	—	—	—	—	—	31 000	16 000
			Degree of severity[a]			—	02[e]	—	—	—	—	—	08[f]	05[f]
8	6	52 Blowing dust	Technical requirement	Air velocity m/s		⩽ 10								
				Sand concentration g/m^3		5 to 15								
			Degree of severity[a]			02	01	—	02	—	—	02[g]	02[g]	—
9	16	57 Combined bounce, dry heat	Technical requirement	During mechanical stresses, temperature °C		63	—	—	63	—	—	63	—	—
			Degree of severity[a]			02	—	—	02	—	—	02	—	—
10	16	58 Combined bounce, cold	Technical requirement	During mechanical stresses, temperature °C		–25	—	—	–25	—	—	–55	—	—
			Degree of severity[a]			02	—	—	02	—	—	07[h]	—	—

Table 6 (*continued*)

Serial No.	ISO 9022		Instrument type		Mainly instruments for ground use, except when used in extreme polar conditions			Mainly instruments exposed to maritime climatic conditions			Mainly instruments for use in aircraft and instruments in global use		
	Part	Conditioning method	Type No.		01			02			03		
			State of operation[a]		0	1	2	0	1	2	0	1	2
11	10	61 Combined sinusoidal vibration, dry heat	Technical requirement	Temperature °C	—	55	55	—	63	63	—	63	63
				Displacement mm	—	—	—	—	1,0	1,0	—	—	—
				Acceleration *g*	—	1	1	—	—	—	—	5	2
				Frequency range Hz	—	10 to 2 000	10 to 2 000	—	10 to 55	10 to 55	—	10 to 2 000	10 to 2 000
			Degree of severity[a]		—	03	03	—	13[j]	13[j]	—	12	10
12	10	62 Combined sinusoidal vibration, cold	Technical requirement	Temperature °C	—	–35	–25	—	–25	–25	—	–55	–35
				Displacement mm	—	0,075	0,075	—	0,15	0,15	—	0,35	0,35
				Acceleration *g*	—	1	1	—	—	—	—	5	2
				Frequency range Hz	—	10 to 2 000	10 to 2 000	—	10 to 55	10 to 55	—	10 to 2 000	10 to 2 000
			Degree of severity[a]		—	09	05	—	07[j]	07[j]	—	15	11
13	13	64 Combined shock, dry heat	Technical requirement	Temperature °C	—	40	40	—	40	40	—	55	40
				Acceleration *g*	—	500	30	—	30	15	—	30	30
				Duration ms	—	1	6	—	6	11	—	6	6
			Degree of severity[a]		—	04[k]	02	—	02	01	—	06	02
14	13	66 Combined shock, cold	Technical requirement	Temperature °C	—	–25	–20	—	–20	–10	—	–35	–25
				Acceleration *g*	—	500	30	—	30	15	—	30	30
				Duration ms	—	1	6	—	6	11	—	6	6
			Degree of severity[a]		—	13[k]	06	—	06	01	—	15	10
15	13	68 Combined free fall, dry heat	Technical requirement	Temperature °C	63	63	—	63	63	—	63	63	—
				Height of fall	Depending on the mass								
			Degree of severity[a]		I	I, m	—	I	I, m	—	I	I, m	—
16	13	69 Combined free fall, cold	Technical requirement	Temperature °C	–35	–35	—	–25	–25	—	–40	–40	—
				Height of fall	Depending on the mass								
			Degree of severity[a]		I	I	—	I	I	—	I	I	—