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Road vehicles — Airbag components —

Part 3: **Testing of inflator assemblies**

Véhicules routiers — Composants des sacs gonflables —

Partie 3: Essais des générateurs de gaz

Reference number
ISO 12097-3:2002(E)

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Contents

Page

Foreword ... iv
1 Scope ... 1
2 Normative references ... 1
3 Terms and definitions ... 1
4 General requirements ... 1
5 General test conditions ... 2
5.1 Purpose of environmental testing ... 2
5.2 Test sequence ... 3
5.3 Measurements and test report ... 4
5.4 Test programme ... 4
6 Environmental testing ... 5
6.1 General ... 5
6.2 Drop test ... 5
6.3 Mechanical impact test ... 6
6.4 Vacuum test ... 9
6.5 Simultaneous vibration and temperature test ... 10
6.6 Thermal humidity cycling ... 12
7 Performance testing ... 14
7.1 Electrostatic discharge (ESD) test ... 14
7.2 Electromagnetic compatibility (EMC) test ... 17
7.3 Tank test ... 18
7.4 Bonfire test ... 20
7.5 Trigger device testing ... 22
7.6 Burst test ... 22
Annex A (normative) **Definition of temperature build-up time, t_e** ... 23
Annex B (informative) **Survey of origin of environmental test procedures** ... 25
Bibliography ... 26

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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 part of ISO 12097 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 12097-3 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 12, *Passive safety crash protection systems*.

ISO 12097 consists of the following parts, under the general title *Road vehicles — Airbag components*:

— *Part 1: Vocabulary*

— *Part 2: Testing of airbag modules*

— *Part 3: Testing of inflator assemblies*

Annex A forms a normative part of this part of ISO 12097. Annex B is for information only.

Road vehicles — Airbag components —

Part 3:
Testing of inflator assemblies

CAUTION — There is a possibility of accidental firing of the airbag during any of the tests described in this part of ISO 12097. Appropriate precautions should therefore be taken both in terms of handling the inflator assembly and in terms of the design of test equipment.

1 Scope

This part of ISO 12097 establishes uniform test methods and specifies environmental procedures and requirements for the inflator assemblies of airbag modules in road vehicles.

NOTE For testing of the inflator assembly as part of the airbag module, see ISO 12097-2.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 12097. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 12097 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 12097-1, *Road vehicles — Airbag components — Part 1: Vocabulary*

ISO 6487, *Road vehicles — Measurement techniques in impact tests — Instrumentation*

ISO 11452 (all parts), *Road vehicles — Component test methods for electrical disturbances from narrowband radiated electromagnetic energy*

IEC 60068-2, *Environmental testing — Part 2: Tests*

3 Terms and definitions

For the purposes of this part of ISO 12097, the terms and definitions given in ISO 12097-1 and the following, apply.

3.1
trigger device
device that activates the inflator assembly (IA)

4 General requirements

The IA shall be designed such that, when handled appropriately, no dangers arise for persons or objects. The IA manufacturer shall produce and make available appropriate handling instructions.

The gas concentrations and the amount of particles measured immediately after the ignition of an IA (or complete module) shall not occur in concentrations that, with the current state of knowledge, can be considered as toxic to humans within 30 min of exposure in an enclosed room having a volume of 2,5 m^3.

The gas and particulates arising from the ignition of an IA (or complete module) shall not have a strong irritating effect on a person.

The IA, complete with squib, if applicable, shall not be ignited by electromagnetic coupling or interference voltages.

5 General test conditions

5.1 Purpose of environmental testing

Environmental tests simulate the effects of environmental loads on the IA with respect to its

— functional behaviour, and

— service life.

They are based on the typical life-cycle of an IA covering shipping, storage, mounting on the module, operation, maintenance and repair of the vehicle.

The complete environmental test programme is composed of individual test methods which simulate automobile-related influences such as mechanical shocks and vibration, heat, cold and humidity.

Simulating the total service life may require more severe test levels than those seen in real world conditions to accelerate ageing and degradation processes.

The environmental test programme for IAs as specified in this part of ISO 12097 shall be a minimum requirement to ensure the verification of its environmental robustness.

Table 1 gives an overview of the complete test programme applied to three identical test samples.

Table 2 lists the performance tests which shall be applied to three exposed samples and nine (or ten, see 7.4.4) unexposed samples.

The supplementary performance tests given in Table 3 shall be performed on the trigger device and the IA housing.

Table 1 — Inflator assembly environmental test programme

Test sequence	Test	Subclause	Sample number												
			Exposed samples			Unexposed samples									
			1	2	3	4	5	6	7	8	9	10	11	12	13
1	Drop test	6.2	**X**	**X**	**X**										
2	Mechanical impact test	6.3	**X**	**X**	**X**										
3	Vacuum test	6.4	**X**	**X**	**X**										
4	Simultaneous vibration temperature test	6.5	**X**	**X**	**X**										
5	Thermal humidity cycling	6.6	**X**	**X**	**X**										

Table 2 — Performance test programme

Test Sequence	Test	Subclause	Sample number												
			Exposed samples			Unexposed samples									
			1	2	3	4	5	6	7	8	9	10	11	12	13
1	ESD test	7.1							**X**	**X**	**X**				
2	EMC test	7.2											**X**	**X**	**X**
3	Tank test at	7.3													
	— (− 35 ± 2,5) °C		**X**			**X**									
	— (23 ± 5) °C			**X**			**X**								
	— (85 ± 2,5) °C				**X**			**X**							
4	Gas and solid analyses	7.3.5.6 7.3.5.7	**x**	**x**	**x**	**x**	**x**	**x**							
5	Bonfire test	7.4							**X**	**X**	**X**	**(X)**			

Table 3 — Supplementary performance tests

Test sequence	Test	Subclause	
1	Trigger device testing	7.5	Statistical procedures
2	Burst test	7.6	

5.2 Test sequence

The test purpose and sequence are based on life-cycle considerations and on possible failure mechanisms.

— The drop test and the mechanical impact test reflect handling, transportation and mounting conditions that occur mainly during an early stage of the life cycle.

— The vacuum test simulates transportation in partially pressurized aircraft and driving at high altitudes.

— The simultaneous vibration temperature test simulates the combined action of vibration and temperature that occurs during the life cycle in a vehicle. Dynamic loads during driving can be typically described as broadband random vibrations with increased vibration levels at several characteristic frequency ranges. Such loads may cause friction, abrasion, fatigue and other damaging effects. It is important to apply vibrations to the test sample at various temperatures, as many of the materials, especially polymers, vary their mechanical behaviour with temperature. A simultaneous vibration/temperature regime therefore simulates appropriately the real vehicle environment.

— The thermal humidity test simulates changing climatic influences with special emphasis on the penetration of water into the IA during periods when the IA temperature is below the dew point temperature of the surrounding air. This test can cause electrical failures as well as material swelling, shrinking and corrosion, and can also promote biodeterioration such as fouling.

5.3 Measurements and test report

The following items shall be measured and recorded on a data sheet before or during, or both before and during, each test of Table 1:

- test number, sample number, test temperature and date;
- visual inspection of the samples and, if necessary, photographic documentation;
- definition of the three main axes (see example in Figure 1);
- ambient temperature during test, in degrees Celsius (°C);
- squib resistance of the inflator assembly, if applicable.

All relevant observations and unusual events shall be noted and included in the test report.

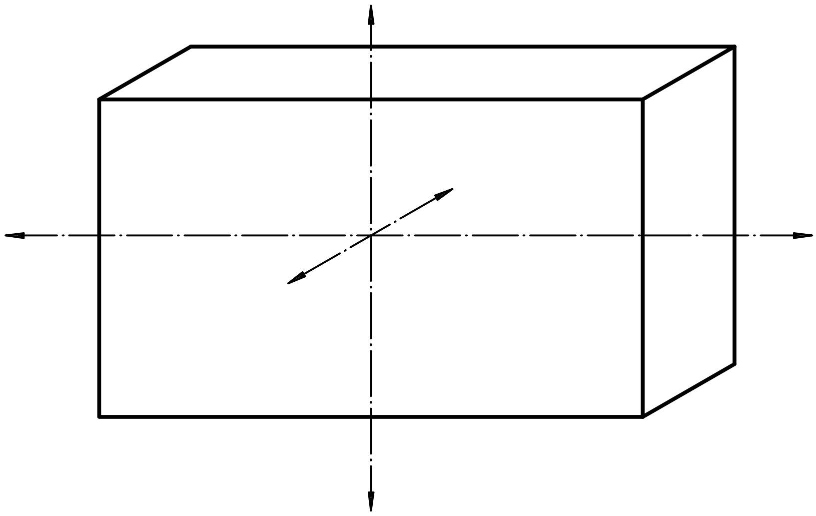


Figure 1 — Definition of IA main axes

5.4 Test programme

This part of ISO 12097 specifies a test programme with 12 identical samples of an inflator assembly (possibly 13 in the case of the bonfire test, see 7.4.3), numbered in accordance with Table 1 and Table 2:

- three IAs are subjected to the environmental test programme (multiple exposure);
- nine (or ten) IAs are unexposed samples.

The plug and the ignition cable shall be connected, if applicable; a test current (see Figure 2 for an example) shall be applied according to the system used (with the exception of the mechanical impact test, the drop test and the vacuum test). After each test, measure and record the squib resistance, where applicable.

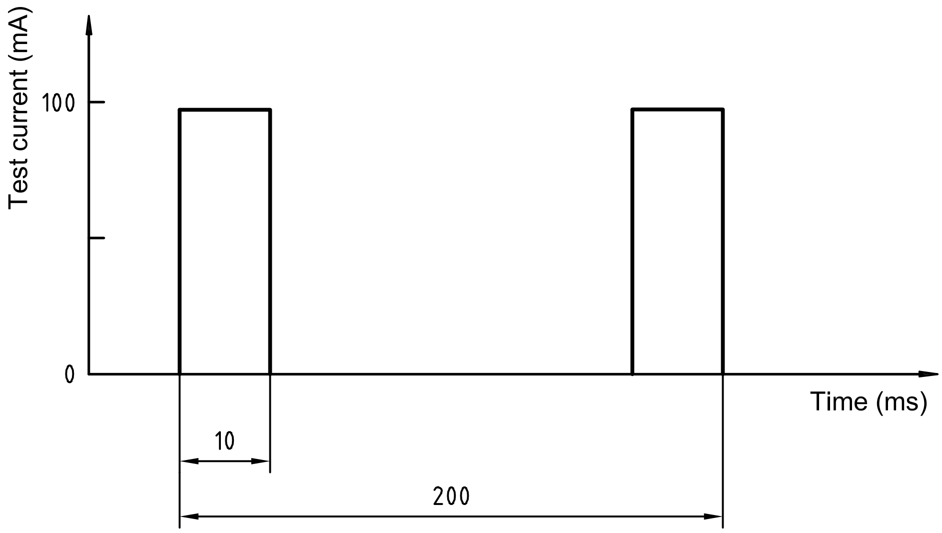


Figure 2 — Example of a test current for environmental simulation

6 Environmental testing

6.1 General

The following test procedures are based mainly on those of IEC 60068-2 (see the Bibliography). Certain modifications to that basic standard were adopted for this part of ISO 12097 in order to recognize vehicle-specific conditions.

6.2 Drop test

6.2.1 Purpose

The purpose of this test is to determine whether the IA experiences any detrimental effect when dropped from a specified height and at specified orientations.

6.2.2 Equipment

A steel impact plate of a minimum of 1 m × 1 m with at least 10 mm thickness, resting on a solid floor, with a fixture that supports the sample at the specified height, shall be used.

6.2.3 Test samples

Three IAs shall be tested under the conditions specified in 6.2.4 and in accordance with Table 1.

6.2.4 Test conditions

The drop height shall be $1^{+0,2}_{0}$ m.

The ambient temperature shall be (23 ± 5) °C.

6.2.5 Test procedure

Mount test sample No. 1 onto the support fixture at the specified height above the impact plate and oriented such that it will fall in one of the six directions indicated in Figure 1. Disarm the trigger device, if included in the IA.

Release the IA, allowing it to free fall onto the impact plate. Repeat the test using the same sample oriented to fall in the opposite direction.

Repeat the test twice more, once using sample No. 2 and once using sample No. 3, each time along one of the remaining directions indicated in Figure 1.

6.2.6 Requirements

On completion of the test, the IA shall be intact.

Any visible damage shall be noted. The unit under test shall continue to be made to undergo the test programme in accordance with Table 1, even if there is visible damage.

It is permissible to repair any IA damage that prevents mounting, in order that the test can proceed.

6.3 Mechanical impact test

6.3.1 Purpose

The purpose of this test is to determine whether the complete IA experiences any detrimental effect when subjected to a series of shock impacts at normal and extreme temperatures.

6.3.2 Equipment

A climatic chamber capable of controlling the test conditions according to 6.3.4 shall be used.

A shock testing machine that allows fastening of an IA to its fixture or table shall be used.

The characteristics of the shock testing machine shall be such that it can be determined whether the true value of the actual pulse as measured in the intended direction at the check point is within the tolerances required by Figure 3.

The check point is a fixing point of the IA nearest the centre of the table surface at the shock testing machine, unless there is a fixing point with a more rigid connection to the table, in which case this latter point shall be used. The frequency response of the overall shock testing machine, which includes the accelerometer, can have a significant effect on the accuracy, and shall be within the limits shown in Figure 4 and given in Table 4.

6.3.3 Test samples

Three IAs shall be tested under the conditions specified in 6.3.4 and in accordance with Table 1.

6.3.4 Test conditions

Each IA is subject to two successive shocks, which shall be applied in each direction of three mutually perpendicular axes of the IA (see Figure 1) at the following test temperatures (12 shocks at each test temperature for a total of 36 shocks):

— (− 35 ± 2,5) °C;

— (23 ± 5,0) °C;

— (85 ± 2,5) °C.

6.3.5 Test procedure

6.3.5.1 General

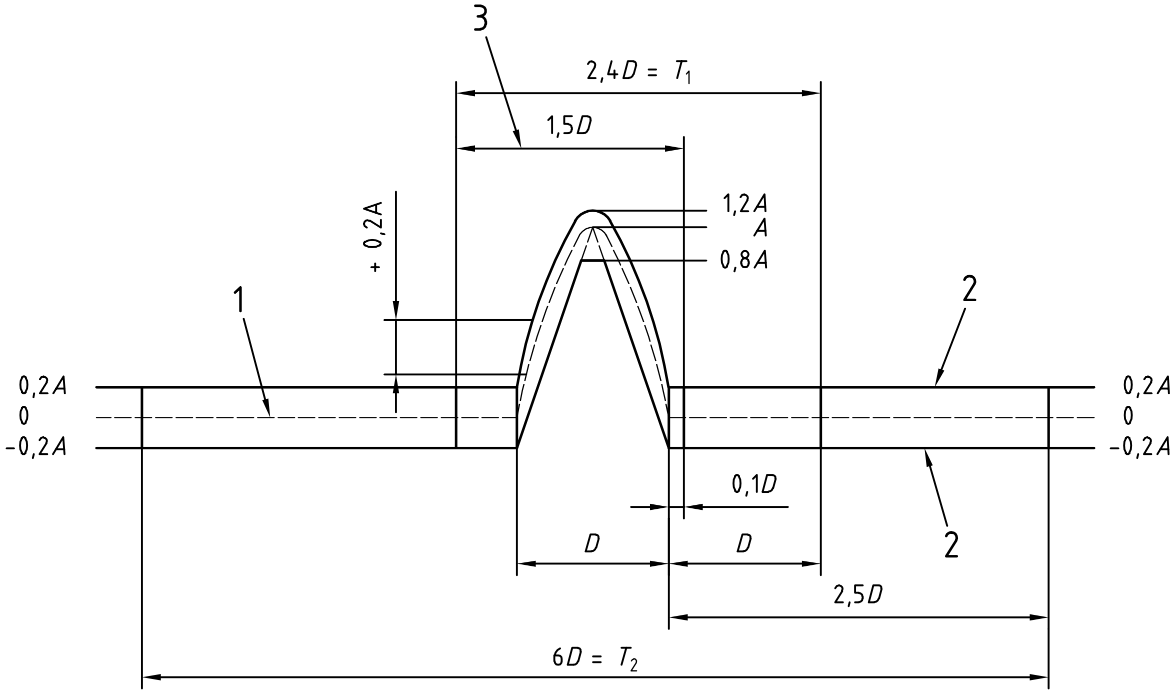
Mount the IA on the test rig and subject it to the test conditions given in 6.3.4.

IAs that include a trigger device shall be tested in the disarmed condition.

Before mounting, condition each sample in the climatic chamber at the required temperature for at least 4 h or, alternatively, for the temperature build-up time, t_e, determined in accordance with the procedure specified in annex A.

Consecutive impact tests may be conducted outside the climatic chamber. After 5 min, recondition the IA for 10 min or, alternatively, for t_e in accordance with annex A.

NOTE The reference point for t_e is within the propelling media.



Key

1 Nominal pulse

2 Limits of tolerance

3 Integration time

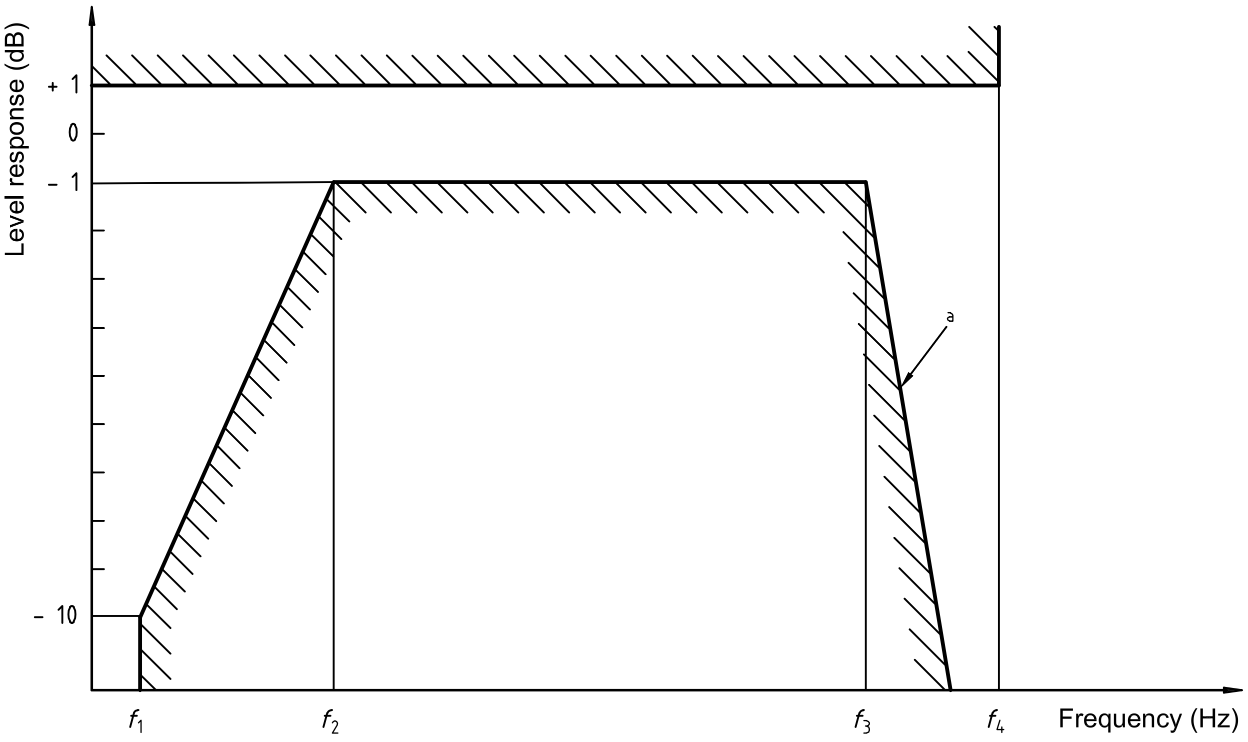
D Duration of nominal pulse.

A Peak acceleration of nominal pulse.

T_1 Minimum time during which the pulse shall be monitored for shocks produced using a conventional shock testing machine.

T_2 Minimum time during which the pulse shall be monitored for shocks produced using a vibration generator.

Figure 3 — Half-sine pulse



[a] 24 dB/octave

Figure 4 — Frequency response of the measuring system

Table 4 — Frequency characteristics of the measuring system

Duration of pulse ms	**Low-frequency cut-off** Hz		**High frequency cut-off** kHz	**Frequency beyond which response may rise above + 1 dB** kHz
	f_1	f_2	f_3	f_4
0,2	20	120	20	40
0,5	10	50	15	30
1	4	20	10	20
3	2	10	5	10
6	1	4	2	4
11	0,5	2	1	2
18 and 30	0,2	1	1	2
For shocks of duration $\leqslant$ 0,5 ms, the indicated values of f_3 and f_4 could be unnecessarily high. In such instances, the relevant specification should state the alternative values to be adopted.				

6.3.5.2 Basic pulse shape

The applied pulse shall be a half-sine (see Figure 3). The true value of the actual pulse shall be within the limits of tolerance shown by the solid line.

6.3.5.3 Velocity change tolerance

The actual velocity change at the pulse shall be within ± 15 % of the value corresponding to the nominal pulse. Where the velocity change is determined by integration of the actual pulse, this shall be done from 0,4 D before the pulse to 0,1 D beyond the pulse, where D is the duration of the nominal pulse.

6.3.5.4 Transverse motion

The positive or negative peak acceleration at the check point, perpendicular to the intended shock direction, shall not exceed 30 % of the value of the peak acceleration at the nominal pulse in the intended direction, when determined with a measuring system in accordance with 6.3.2.

6.3.5.5 Severity

The shock severity shall correspond to the values of Table 5.

Table 5 — Shock severity

	IA		
	for driver module	**for passenger module**	**for other modules**
Peak acceleration A	100 g[a]	40 g	Specific values to be determined
Duration of nominal pulse D	6 ms	6 ms	

[a] Depending on the steering column type, lower g-levels (minimum 40 g) may be appropriate.

6.3.6 Requirements

On completion of the test, the IA shall be intact.

Any visible damage shall be noted. The unit under test shall continue to be made to undergo the test programme in accordance with Table 1, even if there is visible damage.

It is permissible to repair any IA damage that prevents mounting, in order that the test can proceed.

6.4 Vacuum test

6.4.1 Purpose

The purpose of this test is to prove the ability of an IA to withstand high-altitude use and transportation.

6.4.2 Equipment

A high-altitude simulation chamber shall be used.

6.4.3 Test samples

Three IAs shall be tested under the conditions specified in 6.4.4 and in accordance with Table 1.

6.4.4 Test conditions

The chamber pressure shall be $61{,}6\,_{-1}^{\;0}$ kPa [0, 616 $_{-0{,}01}^{\;0}$ bar][1];

The conditioning temperature shall be 23 ± 5 °C (ambient temperature).

NOTE This pressure condition represents an altitude of 4 000 m to 4 200 m above sea level.

6.4.5 Test procedure

Place the IA in a high-altitude simulation chamber and condition it 1 h in accordance with 6.4.4.

6.4.6 Requirements

On completion of the test, the IA shall be intact.

Any visible damage shall be noted. The unit under test shall continue to be made to undergo the test programme in accordance with Table 1, even if there is visible damage.

It is permissible to repair any IA damage that prevents mounting, in order that the test can proceed.

6.5 Simultaneous vibration and temperature test

6.5.1 Purpose

The purpose of this test is to determine the ability of the IA to withstand combined vibration and temperature conditions.

6.5.2 Equipment

This shall consist of a vibration table mounted within a climatic chamber capable of controlling the temperature during the test in accordance with Figure 6. The table shall be capable of producing the vibration of loads as characterized in Figure 5.

6.5.3 Test samples

Three IAs shall be tested under the conditions specified in 6.5.4 and in accordance with Table 1.

6.5.4 Test conditions

6.5.4.1 Vibration load

Random vibration shall be applied in accordance with Table 6 and Figure 5. Alternatively, a vehicle-specific or driving-condition-specific vibration load more severe (e.g. RMS > 1,34 g) than that specified in Figure 5 may be used, subject to agreement between IA supplier and client.

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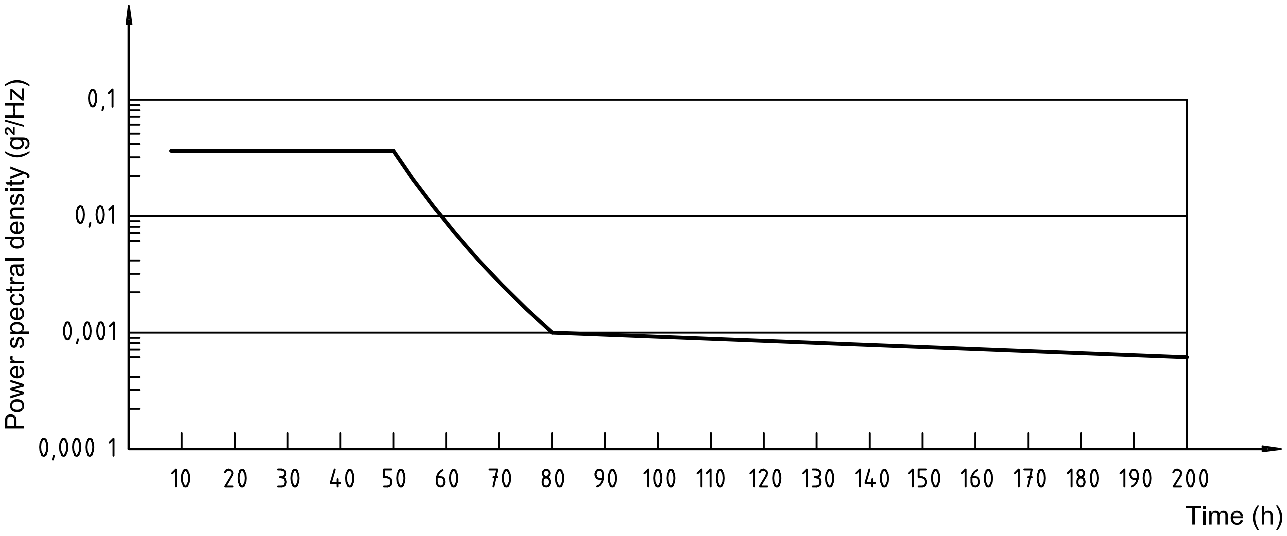
1) 1 bar = 0,1 MPa = 10^5 Pa = 100 kPa; 1 mbar = 100 Pa

Table 6 — Frequency characteristics at RMS of 1,34 g

Frequency Hz	Power spectral density g^2/Hz
8	0,035
50	0,035
80	0,001
200	0,0005



Number of lines: 400

Range of analysis (filter bandwidth 1,25 Hz): 500 Hz

Degrees of freedom (DOF): 154

Abort limits lines: ± 5 dB

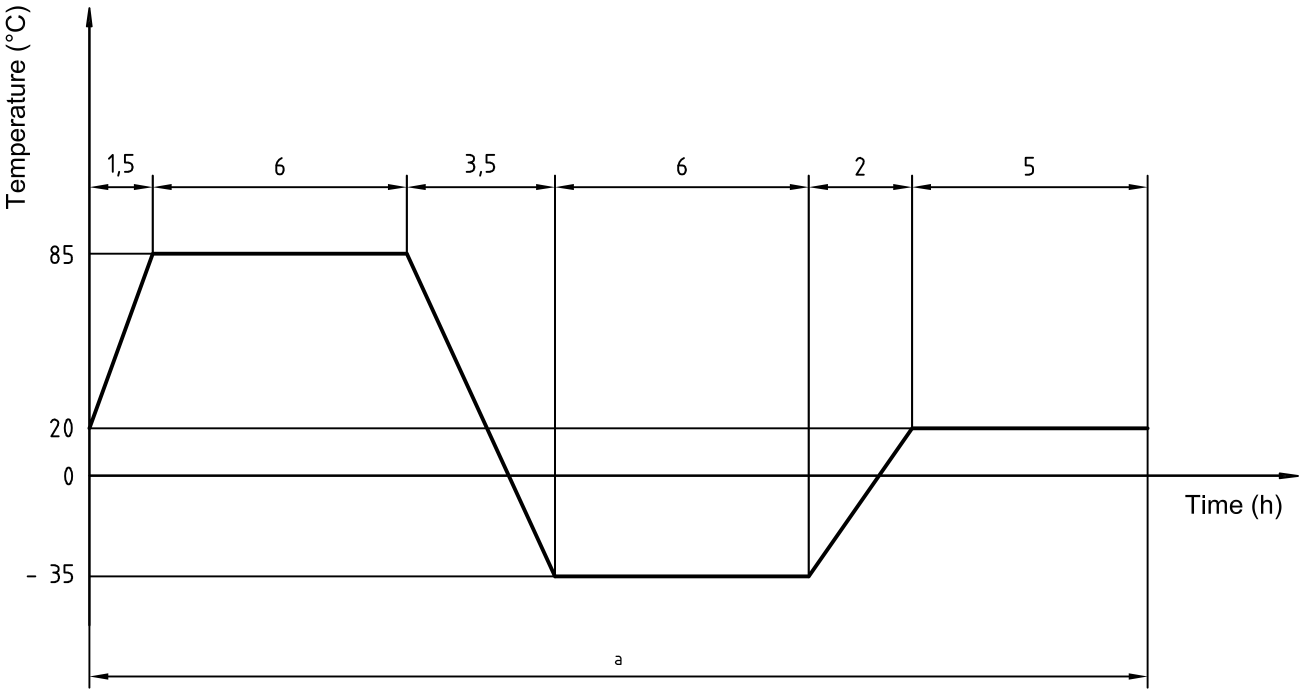
Abort limits g RMS: ± 5 dB

Figure 5 — Vibration load

6.5.4.2 Temperature cycle

The temperature shall be changed in accordance with Figure 6.

The temperature tolerance shall be ± 2,5 °C.



a Duration of one cycle: 24 h

Figure 6 — Temperature cycle

6.5.5 Test procedure

Apply the specified vibration load along each of the three main axes (see Figure 1) of each IA for 24 h. Change the temperature simultaneously.

6.5.6 Requirements

On completion of the test, the IA shall be intact.

Any visible damage shall be noted. The unit under test shall continue to be made to undergo the test programme in accordance with Table 1, even if there is visible damage.

It is permissible to repair any IA damage that prevents mounting, in order that the test can proceed.

6.6 Thermal humidity cycling

6.6.1 Purpose

The purpose of this test is to determine the ability of an IA to withstand high humidity and temperature variations.

6.6.2 Equipment

A climatic chamber with recirculating air shall be used.

6.6.3 Test samples

Three IAs shall be tested under the conditions specified in 6.6.4 and in accordance with Table 1.

6.6.4 Test conditions

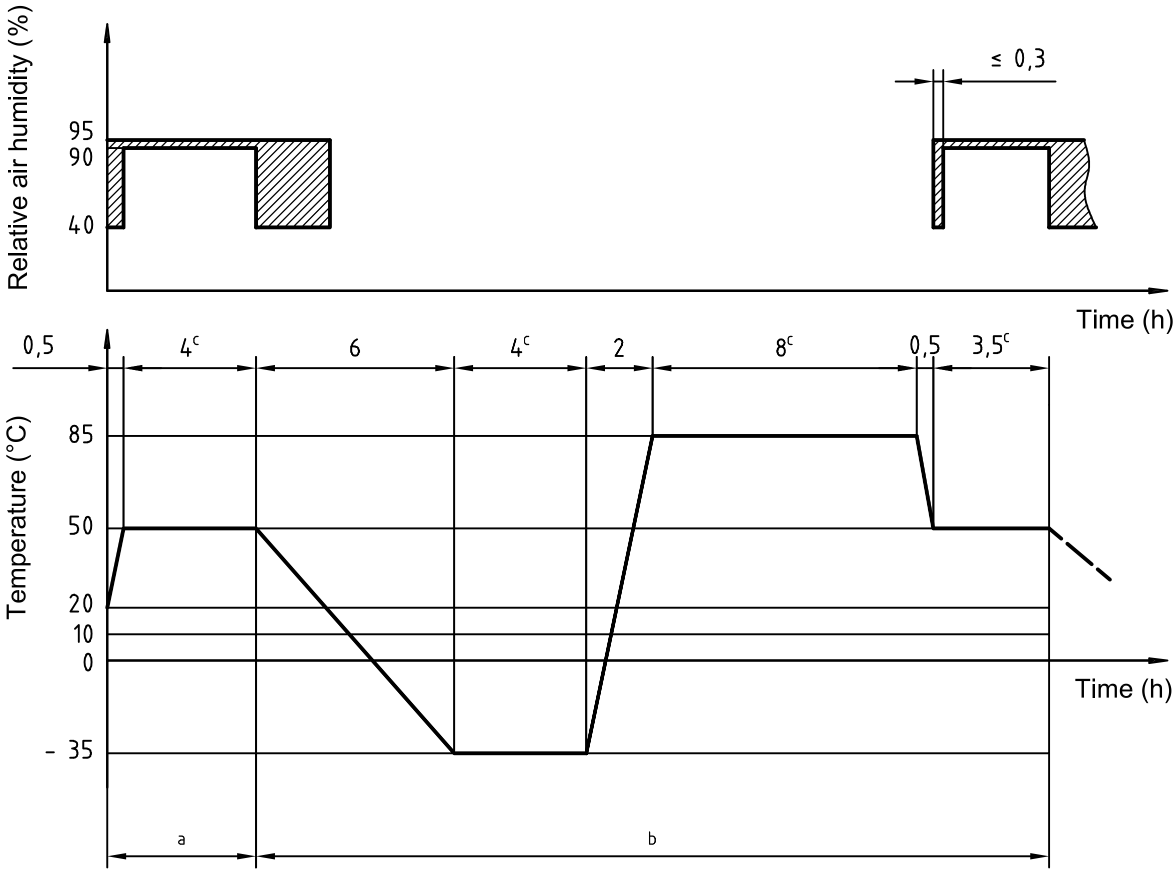
Temperature and relative humidity shall be applied in accordance with Figure 7.

The temperature tolerance shall be ± 2,5 °C.

6.6.5 Test procedure

Place the IAs in the climatic chamber and subject them to 30 thermal humidity cycles in accordance with Figure 7.

NOTE The reference point is within the propelling media.



a Lead time

b Duration of one cycle: 24 h, or less using t_e

c Or reference temperature build-up time, t_e

The relevant temperature build-up times, t_e, may be used instead of the given hours; this shall be determined prior to the test (see annex A).

Figure 7 — Thermal humidity cycle

6.6.6 Requirements

On completion of the test, the IA shall be intact.

Any visible damage shall be noted. The unit under test shall continue to be made to undergo the test programme in accordance with Table 1, even if there is visible damage.

It is permissible to repair any IA damage that prevents mounting, in order that the test can proceed.

7 Performance testing

7.1 Electrostatic discharge (ESD) test

7.1.1 Purpose

The purpose of this test is to prove the avoidance of ignition by electrostatic discharges.

7.1.2 ESD generator

7.1.2.1 General

An ESD generator capable of producing the test pulse, adjustable within the limits given in 7.1.4, shall be used. The test generator shall, in its main parts, consist of the following:

— charging resistor (Rch);

— energy-storage capacitor (Cs);

— hand capacitor (Ch);

— distributed capacitance (Cd);

— discharge resistor (Rd);

— voltage indicator;

— discharge switch;

— discharge return cable;

— power supply unit.

Figure 8 presents a simplified diagram of the ESD generator. Construction details are not given.

7.1.2.2 ESD generator requirements

The ESD generator shall meet the following requirements.

— Energy storage capacitance (Cs + Cd): 150 pF ± 10 %.

— Hand capacitance (Ch): 10 pF ± 10 %.

— Discharge resistance (Rd): 330 Ω ± 10 %.

— Charging resistance (Rch): between 50 MΩ and 100 MΩ.

— Output voltage (see note 1) up to 8 kV (nominal) for contact discharge.

— Tolerance of the output voltage indication: ± 5 %.

— Polarity of the output voltage: positive and negative.

— Holding time: at least 5 s.

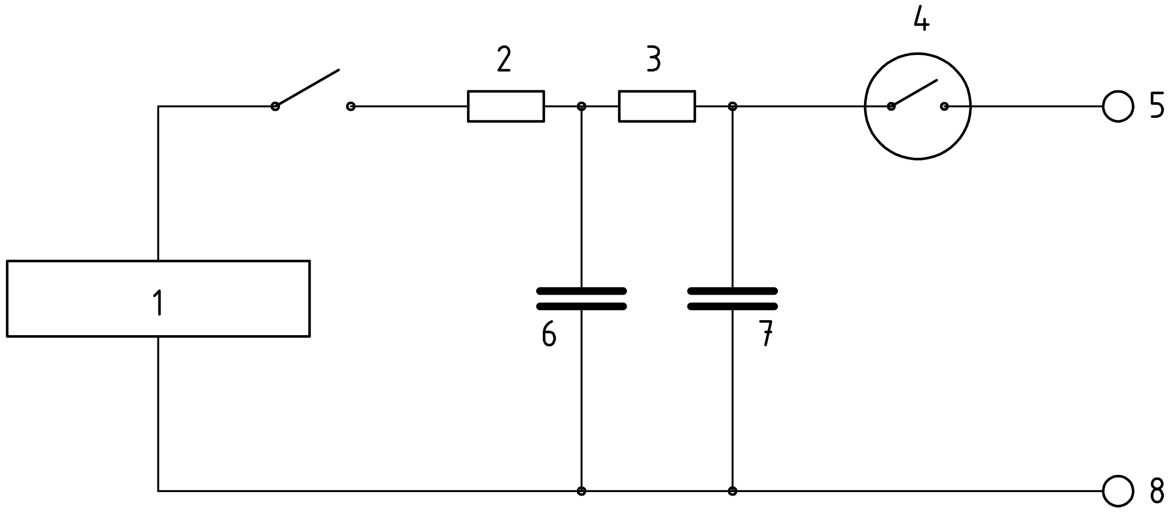
— Discharge, mode of operation: single discharge; the generator should be able to generate at a rate of at least 20 discharges per second for exploratory purposes only.

— Time between successive discharges: at least 1 s.

NOTE Open circuit voltage is measured at the energy storage capacitor.

The generator shall be provided with a means of preventing unintended radiated or conducted emissions, of either pulse or continuous type, so that the IA and auxiliary test equipment are not disturbed by parasitic effects.

The discharge return cable of the test generator shall be in general 2 m long, constructed to allow the generator to meet the waveform specification. It shall be sufficiently insulated to prevent the flow, during the ESD test, of the discharge current to personnel or conducting surfaces other than via its termination.



Key

1 DC HV supply
2 Charging resistor, Rch
3 Discharge resistor, Rd
4 Discharge switch
5 Discharge contact
6 Energy-storage capacitor, Cs
7 Hand capacitor, Ch
8 Discharge return connection

NOTE 1 Cd, omitted from the figure, is a distributed capacitance existing between generator and IA, ground reference plane and coupling planes.

NOTE 2 Because the capacitance is distributed over the whole generator, it is not possible to show this in the circuit.

Figure 8 — Simplified diagram of the ESD generator

7.1.3 Test samples

Three unexposed, fully assembled IA samples shall be tested under the conditions specified in 7.1.4 and in accordance with Table 2.

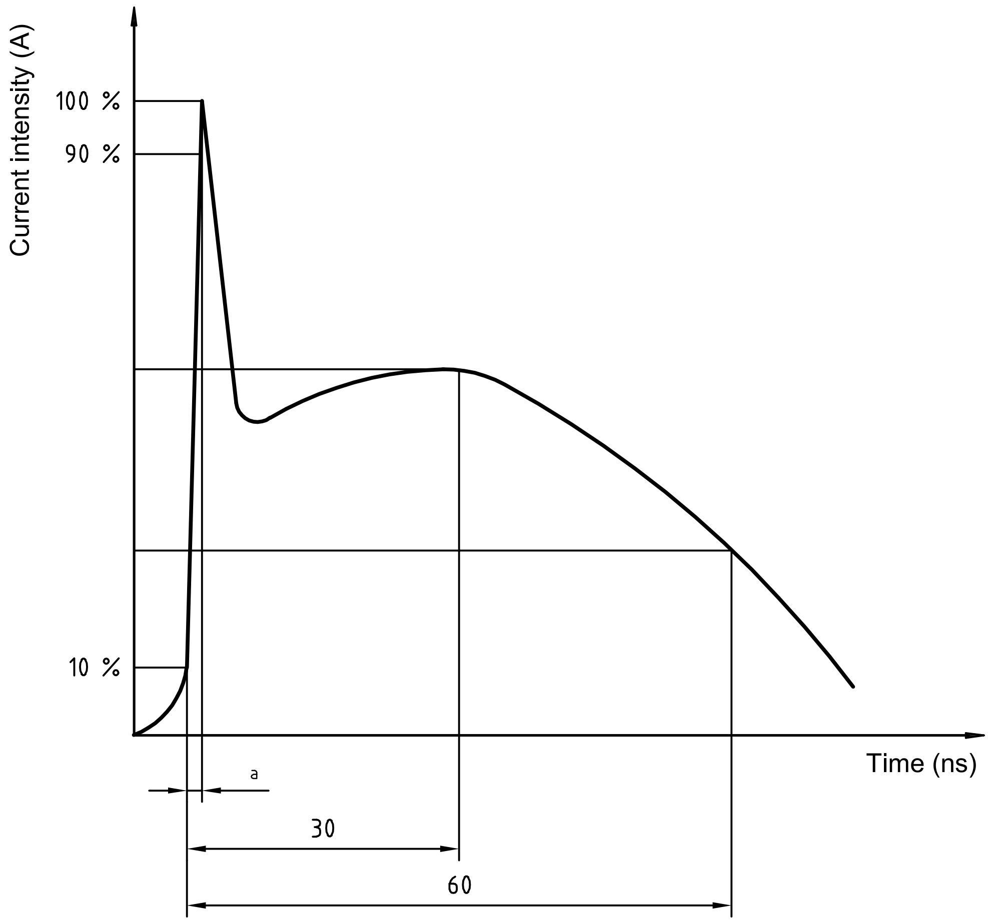
Shorting devices, if applicable, shall not be disturbed.

7.1.4 Test conditions

7.1.4.1 General

Electrostatic discharge shall be applied in accordance with Figure 9.

The IA shall be at ambient temperature.



a Risetime, t_r, with discharge switch

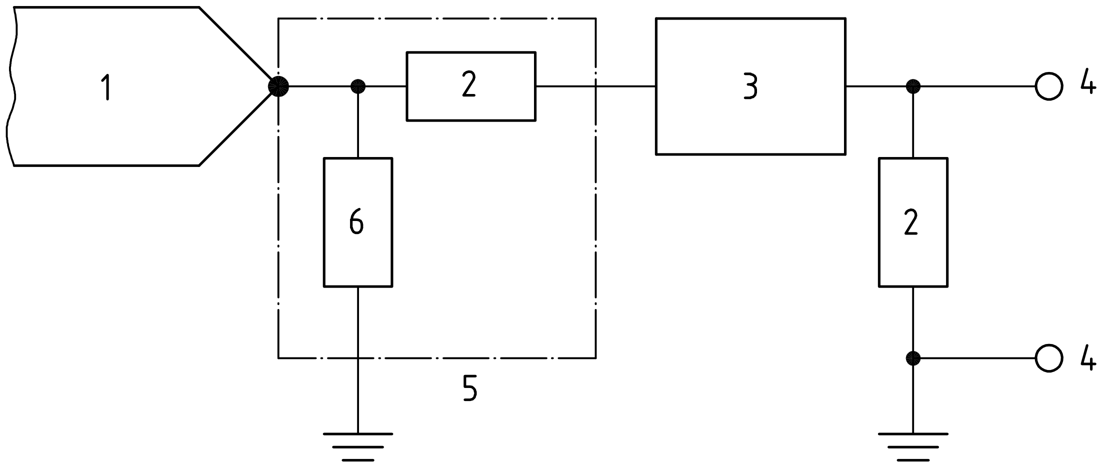
Figure 9 — Typical waveform of the output current of the ESD generator

7.1.4.2 Calibration of the test set-up for contact discharge

The calibration shall be done in such a way that the impulse shown in Figure 9 and given in Table 7 is measured by a suitable device connected to the ESD-simulator in accordance with the wiring diagram in Figure 10.

Table 7 — Characteristics of output current of ESD generator

Indicated voltage	First peak current of discharge ± 10 %	Risetime, t_r, with discharge switch	Current (± 30 %) at 30 ns	Current (± 30 %) at 60 ns
8 kV	30 A	0,7 to 1 ns	16 A	8 A



Key

1 ESD simulator (330 Ω)
2 50 Ω
3 20 dB attenuator
4 Purpose input
5 Coaxial target
6 2 Ω

Figure 10 — Simulator calibration set-up schematic

The values of the parameters of the discharge current shall be verified with 1 000 MHz bandwidth-measuring instrumentation.

A lower bandwidth implies limitations in the measurement of rise time and amplitude of the first current peak.

7.1.5 Test procedure

Place the IA under test on a conductive bench and mount it in a tank (see 7.3).

The bench ESD simulator and power source shall be grounded to earth.

Identify specific test points on the IA prior to conducting the test.

If a squib is present, apply the discharge to the squib from pin to pin and from each pin to all those other areas of the housing accessible to personnel in normal use.

Perform the test with positive and negative voltages. Subject each discharge point to a minimum of three positive and three negative discharges at the voltage level as shown in Figure 9. The time duration between discharges shall be a minimum of 5 s.

7.1.6 Requirement

The IA shall not be ignited by the electrostatic discharges.

7.2 Electromagnetic compatibility (EMC) test

7.2.1 Purpose

The purpose of this test is to prove the avoidance of ignition by electromagnetic effects.

7.2.2 Equipment

Depending on the size of the test sample and the selected test frequencies, the equipment shall be in accordance with the corresponding part or parts of ISO 11452.

7.2.3 Test samples

Three unexposed, fully assembled IAs shall be tested under the conditions specified in 7.2.4 and in accordance with Table 2.

7.2.4 Test conditions

The tests shall be in accordance with one or more parts of ISO 11452, selected, together with test conditions, test set-ups and severity levels, by agreement between the IA supplier and client.

NOTE For testing for the provision of airbag system immunity in a vehicle, see ISO 11451-1 to ISO 11451-4.

7.2.5 Test procedure

The test procedure shall be performed in accordance with the selected part or parts of ISO 11452.

7.2.6 Requirement

The IA shall not be induced to ignite by electromagnetic effect.

7.3 Tank test

7.3.1 Purpose

The purpose of this test is to assess the performance of an IA by firing it into a closed volume container at a given temperature level.

7.3.2 Equipment

An appropriate tank for testing an IA shall be used.

7.3.3 Test samples

Three unexposed and three exposed IA samples shall be tested under the conditions specified in 7.3.4 and in accordance with Table 2.

7.3.4 Test conditions

Each sample shall be conditioned so that the required test temperature of Table 2 is reached.

NOTE The point of reference for the temperature is the propelling media of the IA.

7.3.5 Test procedure

7.3.5.1 General

Fix the IA tightly to the appropriate tank so that gases and solid particles are captured in the tank during ignition.

The IA fixed to the tank shall be, if applicable, ignited with a defined nominal current pulse (amplitude and duration).

Alternatively, for analysis concentration and residue analysis and amount, the test may be carried out with the airbag module or modules, including the IA, in an appropriate chamber of 2,5 m^3 volume. In this case, three additional exposed and three unexposed samples are required.

Perform the following measurements, where applicable.

a) Prior to ignition:

— squib resistance (see 7.3.5.2);

— tank temperature (see 7.3.5.3).

b) During ignition/firing:

— ignition current versus time (see 7.3.5.4);

— tank pressure versus time (see 7.3.5.5).

c) Immediately after firing:

— gas analysis and concentration (see 7.3.5.6);

— residue analysis and amount (see 7.3.5.7).

7.3.5.2 Squib resistance

Measure the squib resistance before ignition of the IA.

7.3.5.3 Tank temperature

Measure the tank temperature at the mounting area of the IA. It shall be at ambient for the time prior to the test.

7.3.5.4 Ignition current

Measure the ignition current versus time in accordance with ISO 6487:2000, CFC 1 000 (channel frequency class).

7.3.5.5 Tank pressure

Measure the tank pressure versus time, using a transducer for absolute pressure, to the following specifications:

— appropriate calibration range;

— usable frequency range from 0 Hz to 2 000 Hz;

— linearity and hysteresis error $\leqslant$ 1 %;

— CAC (channel amplitude class): 0 kPA [0 bar] to 500 kPa [5 bar];

— CFC 1 000 according to ISO 6487:2000, error $\leqslant$ 2,5 %.

Do not place the pressure transducer in the direct gas flow from the exit ports of the inflator.

7.3.5.6 Gas analysis and concentration

Immediately after the test, remove a gas sample from the test tank and analyse this sample to identify species and concentrations, in particular with respect to harmful substances.

7.3.5.7 Residue analysis and amount

Capture airborne residues during the opening of the tank. Wash remaining solid and liquid residues from the inner walls of the tank with distilled water.

Determine the amount (by mass) of all residues and analyse species, in particular with respect to harmful substances. Further analysis may be carried out, if necessary.

7.3.6 Requirements

The results of the measurements of 7.3.5.2. to 7.3.5.7 shall be within the defined nominal values and tolerances for the particular type of IA tested (nominal values and tolerances are to be defined by supplier and client).

If gas composition and concentration, as well as residue amount and composition, indicate irritating or harmful effects on human beings or on the proper functioning of the airbag system, further investigations shall be carried out.

The evaluation of such measurements shall be made by appropriate experts or institutions and shall be recorded.

7.4 Bonfire test

7.4.1 Purpose

The purpose of this test is to ensure that no fragmentation of the IA occurs as a result of the heat from a fire.

7.4.2 Equipment

7.4.2.1 Gas cylinder containing, for example, propane gas, with gas-cylinder valve and hose assembly.

7.4.2.2 Gas burner or burners with handle (high-power warm-up burner, 60 mm in diameter).

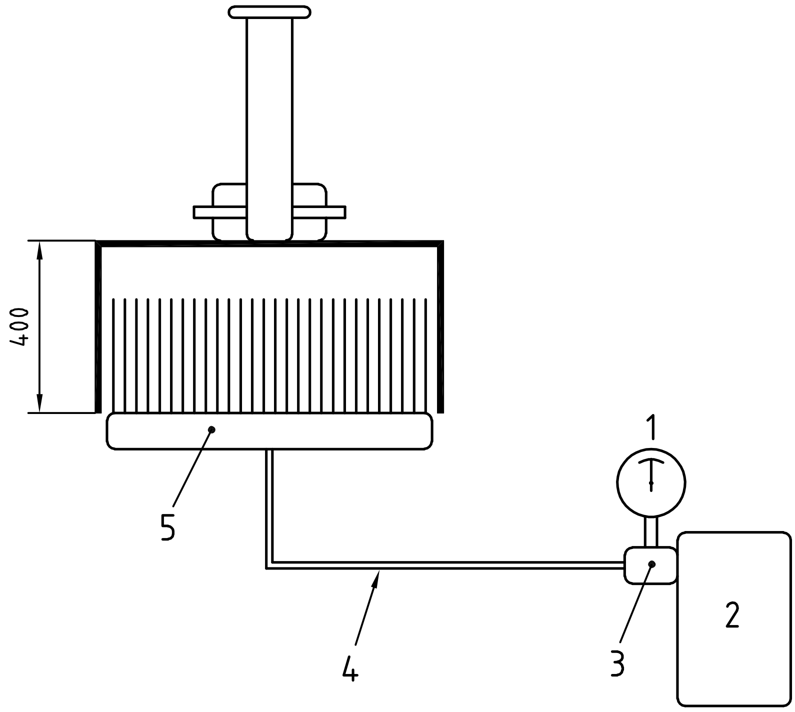
7.4.2.3 Specimen holder.

7.4.2.4 Gas lighter.

7.4.2.5 Stop watch.

The test rig shall be in accordance with that shown in Figure 11.

Dimensions in millimetres



Key

1 Pressure gauge

2 Gas cylinder

3 Pressure valve

4 Hose assembly

5 High-power burner

Figure 11 — Bonfire test rig

7.4.3 Test samples

Three (or four, see 7.4.4) unexposed samples shall be tested under the conditions specified in 7.4.4 and in accordance with Table 2.

7.4.4 Test conditions

The test shall be performed with the inflator at ambient temperature. Three standard positions of the IA shall be considered:

— position 1, igniter towards fire;

— position 2, igniter away from fire;

— position 3, right-angled to position 1 or position 2.

Should the design of the inflator show a test position more critical than that of positions 1 to 3, then the position shall be tested additionally.

The number and orientation of the burner or burners shall be chosen such that the whole cross-section (projection to the test rig) is surrounded by the flames.

Calibration as described below shall be ensured over the whole cross-section.

For calibration of the test installation, the warm-up rate shall be defined with a steel cube of 125 cm^3 of 5 cm side length and a mass of 1 kg. The cube shall be positioned in the mounting rig instead of the IA. An appropriate thermocouple shall be fixed in the centre of the cube and connected to an appropriate temperature recorder.

The warm-up rate of the cube is affected by the change of the gas pressure as related to the gas flow rate. The gas pressure recorded at a warm-up rate of 80 °C/min ± 5 °C/min from 20 °C to 200 °C shall be considered as calibration pressure.

Appropriate methods for pointing out the reproducibility of the test shall be used.

7.4.5 Test procedure

Position the IA in the intended path of the fire before lighting. Heat the IA until activated.

7.4.6 Requirement

No fragmentation of the IA housing shall be allowed.

7.5 Trigger device testing

The purpose of this test is to establish the function and reliability of the trigger device using appropriate statistical tests.

For an electrical igniter, the Probit Bayes test or the Bruceton test shall be used.

The test procedure proves the all-fire and no-fire values. These values, together with reliability and confidence levels, shall be specified.

7.6 Burst test

7.6.1 Purpose

The purpose of this test is to prove the strength of an IA housing.

7.6.2 Equipment

Unless otherwise specified, a hydraulic device or suitable pyrotechnic shall be used.

7.6.3 Test sample

Unexposed IA housings shall be tested under conditions in accordance with a statistical procedure.

7.6.4 Test conditions

The test shall be carried out at an ambient temperature of (23 ± 5) °C.

7.6.5 Test procedure

7.6.5.1 Hydraulic test

Close the gas exhaust openings of the IA from the inside using suitable inserts. Assemble the IA without propellant. By suitable connection to the IA housing, place the combustion chamber under load hydraulically.

7.6.5.2 Pyrotechnic test

Alternatively, the test may be carried out with pyrotechnic media and ignited.

7.6.6 Requirement

Burst safety (burst pressure divided by maximum combustion chamber pressure from the tank test at 85 °C) shall be greater than a defined value. The burst safety depends on the test procedure used.

Annex A
(normative)

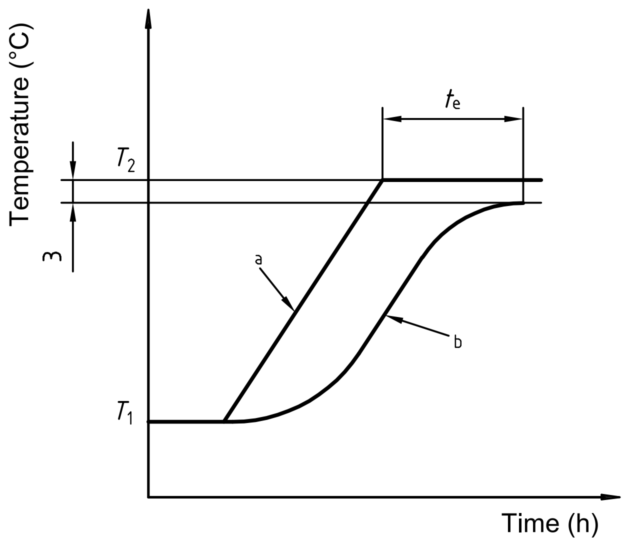
Definition of temperature build-up time, t_e

The temperature build-up time t_e is the time required, after a change in the surrounding temperature from T_1 to T_2, for a defined reference point of the test sample to reach the temperature T_2.

— within 3 °C, in the case of $|T_2 - T_1| \geqslant 60\,°C$;

— within 5 % of the temperature difference $|T_2 - T_1|$, in the case of $|T_2 - T_1| < 60\,°C$.

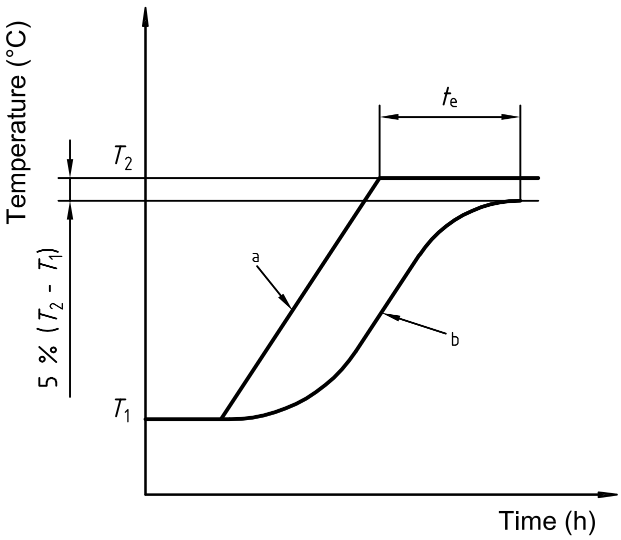
The temperature build-up time begins at the point where the desired target value curve reaches the surrounding temperature T_2 (see Figures A.1 and A.2). The temperature build-up times shall be determined in the apparatus for the relevant test. The test sample temperature shall be measured at the prescribed reference point.



a Target temperature, T_{targ}

b Actual temperature, T_{act}

Figure A.1 — Temperature build-up time t_e for $|T_2 - T_1| \geqslant 60\,°C$



a Target temperature, T_{targ}

b Actual temperature, T_{act}

Figure A.2 — Temperature build-up time t_e for $|T_2 - T_1| < 60\,°C$

Annex B
(informative)

Survey of origin of environmental test procedures

See Table 1.

Table B.1 — Origin of tests used in this part of ISO 12097

Subclause	Test	Origin
6.2	Drop test	IEC 60068-2-32
6.3	Mechanical impact test	IEC 60068-2-27
6.5	Simultaneous vibration and temperature test	IEC 60068-2-53
6.6	Thermal humidity cycling	IEC 60068-2-38

Bibliography

[1] IEC 60068-2-27, *Environmental testing — Part 2: Tests. Test Ea and guidance: Shock*

[2] IEC 60068-2-32, *Environmental testing — Part 2: Tests. Test Ed: Free fall*

[3] IEC 60068-2-38, *Environmental testing — Part 2: Tests. Test Z/AD: Composite temperature/humidity cycle test*

[4] IEC 60068-2-53, *Environmental testing — Part 2: Tests. Guidance to tests Z/AFc and Z/BFc: Combined temperature (cold and dry heat) and vibration (sinusoidal) tests*

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