INTERNATIONAL STANDARD

ISO 15003

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Agricultural engineering — Electrical and electronic equipment — Testing resistance to environmental conditions

Génie agricole — Matériel électrique et électronique — Essais de résistance aux conditions environnementales

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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.

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 15003 was prepared by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 19, *Agricultural electronics*.

Agricultural engineering — Electrical and electronic equipment — Testing resistance to environmental conditions

1 Scope

This International Standard provides design requirements and guidance for the manufacturers of electrical and electronic equipment for use in all kinds of mobile (including hand-held) agricultural machinery, forestry machinery, landscaping and gardening machinery [referred to hereafter as machine(s)]. It gives tests for specific environmental conditions and defines severity levels for tests which relate to the environmental extremes that can be experienced in practical operation of the equipment.

The standard is intended to be used in determining the suitability of the equipment of the these machines, for use in a specified range of environmental conditions.

NOTE The severity levels given are general guidelines and not guaranteed worst-case exposure levels.

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.

IEC 60068-1:1988, *Environmental testing — Part 1: General and guidance*

IEC 60068-2-5:1975, *Basic environmental testing procedures — Part 2: Tests — Test Sa: Simulated solar radiation at ground level*

IEC 60068-2-6:1995, *Environmental testing — Part 2: Tests — Test Fc: Vibration (sinusoidal)*

IEC 60068-2-9: 1975, *Basic environmental testing procedures — Part 2: Tests — Guidance for solar radiation testing*

IEC 60068-2-11:1981, *Basic environmental testing procedures — Part 2: Tests — Test Ka. Salt mist*

IEC 60068-2-13:1983, *Basic environmental testing procedures — Part 2: Tests — Test M: Low air pressure*

IEC 60068-2-14:1984, *Basic environmental testing procedures — Part 2: Tests — Test N: Change of temperature*

IEC 60068-2-27:1987, *Basic environmental testing procedures — Part 2: Tests — Test Ea and guidance: Shock*

IEC 60068-2-30:1980, *Basic environmental testing procedures — Part 2: Tests — Test Db and guidance: Damp heat, cyclic (12 + 12-hour cycle)*

IEC 60068-2-47:2005, *Environmental testing — Part 2: Tests — Mounting of specimens to vibration, impact and similar dynamic tests*

IEC 60068-2-64:1993, *Environmental testing — Part 2: Test methods — Test Fh: Vibration, broad-band random (digital control) and guidance*

IEC 60068-2-78:2001, *Environmental testing — Part 2-78: Tests — Test Cab: Damp heat, steady state*

IEC 60512-1:2001, *Connectors for electronic equipment — Tests and measurements — Part 1: General*

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*

ISO 14982:1998, *Agricultural and forestry machinery — Electromagnetic compatibility — Test methods and acceptance criteria*

ISO 16750:2003, *Road vehicles — Environmental conditions and testing for electrical and electronic equipment*

3 Terms and definitions

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

3.1
display device
device displaying alpha-numeric characters or graphical symbols designed to be read by operative or service personnel

3.2
equipment
self-contained electronic system containing electric, electronic and mechanical components which is electrically connected to other machinery (including power sources) by means of connectors

3.3
impaired function
state in which one or more of the functions of the equipment as stated by the manufacturer are not operative or do not conform to the manufacturer's specification

3.4
location
position within machines where the equipment will normally be operating

3.5
normal mounting configuration
orientation of the equipment when in normal use

3.6
severity level
severity of the conditions under which an environmental test is undertaken, selected according to the intended location and application of the equipment

3.7
portable equipment
equipment that can be battery operated and that a person can carry

4 General

4.1 General conditions for testing

Except where otherwise specified for a particular test, testing shall be carried out under standard reference conditions as specified in IEC 60068-1:1998, section 5. The severity levels used shall be recorded in the test report. Tests shall be conducted in accordance with IEC 60512-1.

It is desirable to use the same sample of equipment in all tests unless specified otherwise for a particular test.

It is recommended that a functionality check be done before and after each test and that functionality be monitored during a test when practical.

Combined testing is advisable in cases where equipment is subjected in use to extremes of two or more different environmental factors simultaneously (e.g. temperature and vibration) and recorded as such on the test report.

NOTE Combined testing can be used as a means of reducing overall test time.

4.2 Test sequence

The electromagnetic compatibility tests shall be carried out last, since electromagnetic emissions and susceptibility can be affected by prior exposure to other tests. The test sequence shall be recorded in the test report.

The tests should be carried out in progressively increasing order of severity.

4.3 Test report

The test report shall, as a minimum, include the following information:

— description of the equipment;

— model number or other identification;

— manufacturer’s name and address;

— test lab’s name and address;

— test date(s);

— tests to be conducted;

— test equipment used/calibration status and test set up information;

— the order in which the tests were conducted;

— duration of each individual test conducted;

— severity level used for testing;

— test results;

— any additional details regarding the test.

An example test report is given in Annex A.

4.4 ISO 16750 compliance

Electrical and electronic equipment in accordance with ISO 16750 that corresponds to the requirements of this International Standard is in compliance with this International Standard.

5 Tests

5.1 General

5.1.1 Monitoring for impaired function

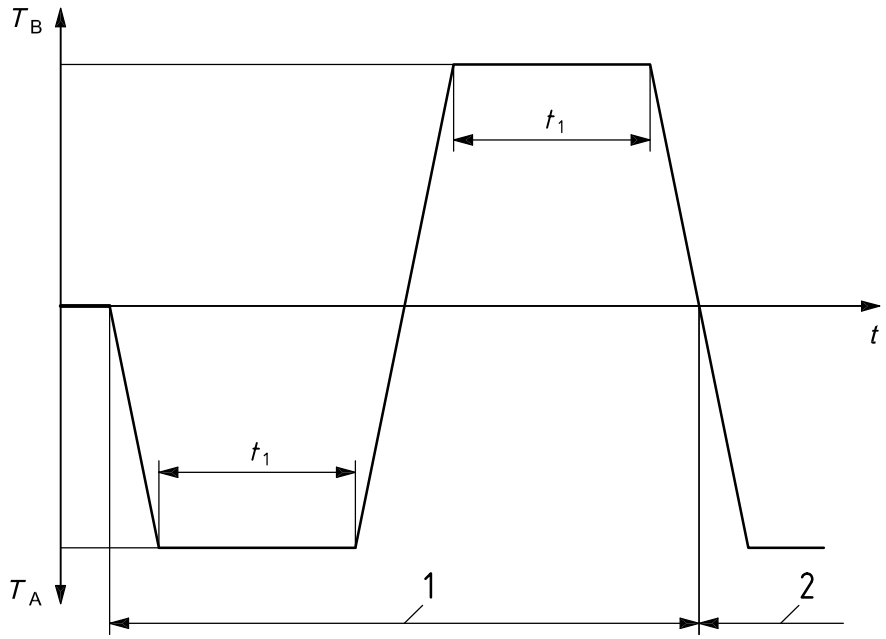
Where equipment is to be monitored for impaired function during or after a test, the equipment shall be connected to power and signal input and output lines in accordance with the manufacturer's instructions.

5.2 Cold and dry heat

5.2.1 Changes of temperature with specified rate of change

5.2.1.1 Test method

A cold and dry heat test shall be conducted in accordance with IEC 60068-2-14:1984, Test Nb, with the exception that testing can be done using one test chamber. The temperature cycle is shown in Figure 1. The steady state time shall be 3 h; the transition times shall be adjusted to yield three cycles in 24 h.



Key

T_A minimum temperature

T_B maximum temperature

t time

t_1 steady state time = 3 h

1 first cycle

2 second cycle

Figure 1 — Temperature cycle for cold and dry heat test

5.2.1.2 Test limits

See Table 1.

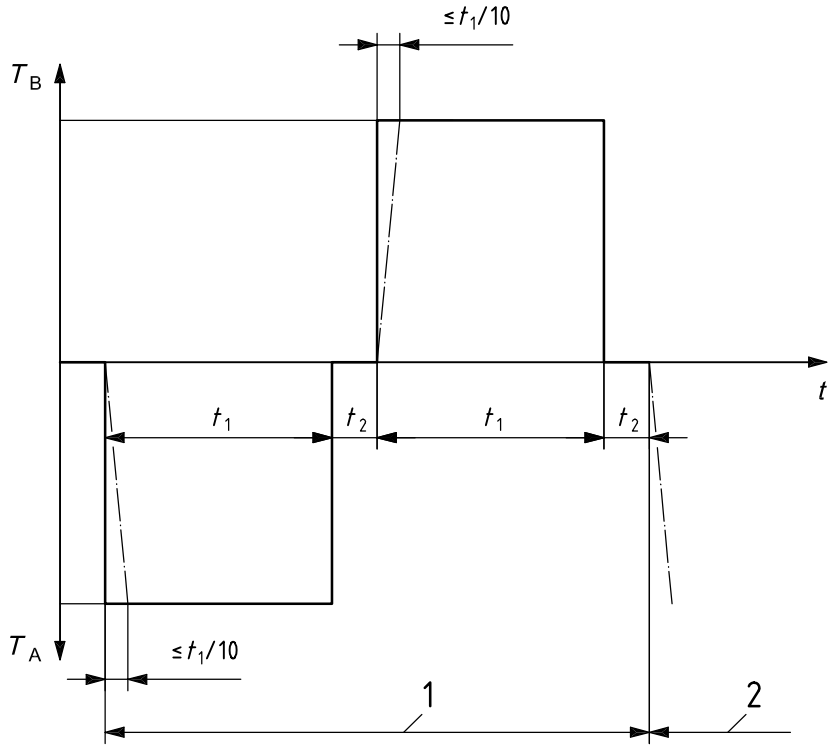
Table 1 — Test levels for temperatures

Level	T_A °C	T_B °C
1	0	70
2	−20	70
3	−40	85
4	−40	105
5	−40	125
Refer to B.2 for examples of severity levels.		

5.2.2 Temperature shock

5.2.2.1 Test method

The temperature shock test shall be conducted in accordance with IEC 60068-2-14:1984, Test Na, with the cycle shown in Figure 2. The steady state time t_1 shall be 0,5 h, and the transition time $t_2 \leqslant 1$ min; the number of cycles shall be 10.



Key

T_A minimum temperature
T_B maximum temperature
t time
t_1 steady state time = 0,5 h
t_2 transition time ⩽ 1 min

1 first cycle
2 second cycle

Figure 2 — Cycle for temperature shock test

5.2.2.2 Test limits

See Table 2.

Table 2 — Test levels for temperatures

Level	T_A °C	T_B °C
1	0	70
2	–20	70
3	–40	85
4	–40	105
5	–40	125
Refer to B.2 for examples of severity levels.		

5.3 Damp heat, steady state

5.3.1 Test method

The steady state damp heat test shall be conducted in accordance with IEC 60068-2-78.

5.3.2 Test limits

Expose the equipment under test to $93\,^{+2}_{-3}$ % relative humidity at 40 ± 2 °C for the lengths of time (durations) according to Table 3.

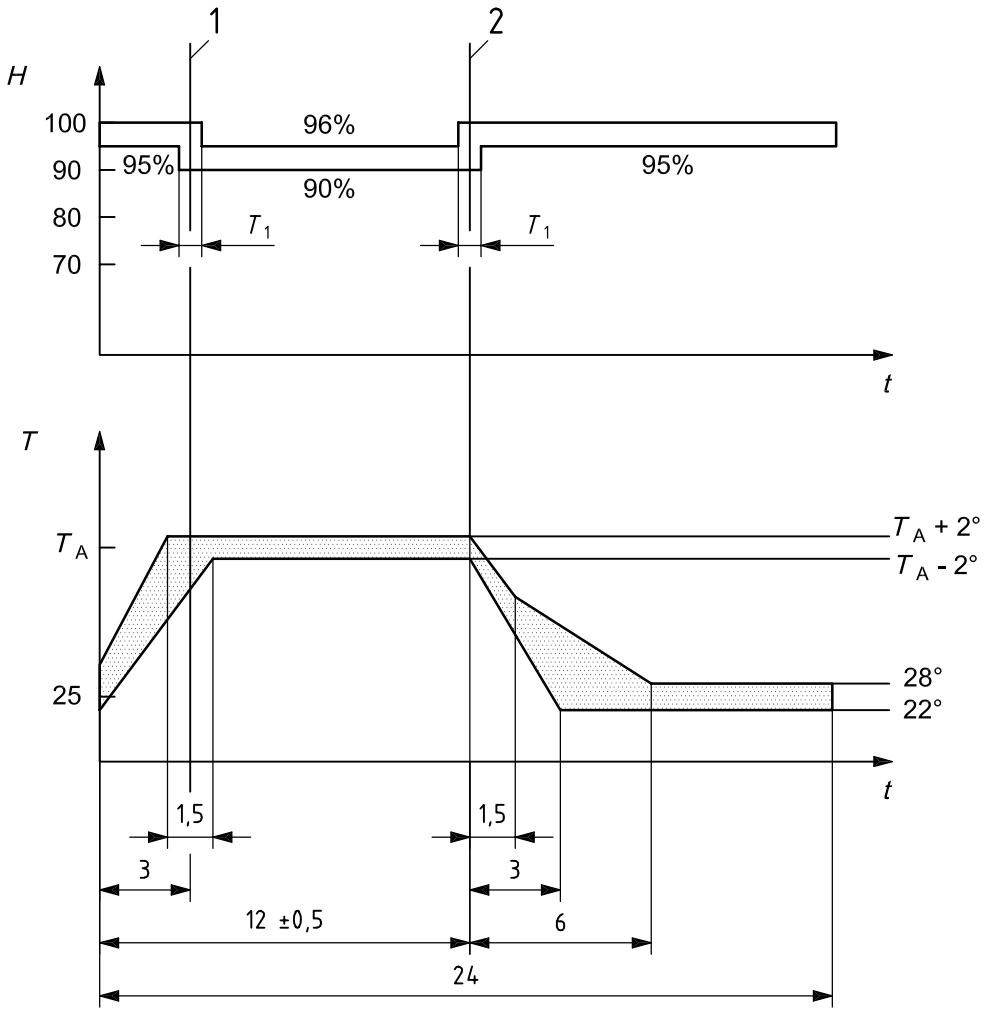
Table 3 — Test levels for durations

Level	Duration days
1	4
2	10
3	21
Refer to B.3 for examples of severity levels.	

5.4 Damp heat, cyclic

5.4.1 Test method

The cyclic damp heat test shall be conducted in accordance with IEC 60068-2-30 and Figure 3.



Key

T temperature, °C
T_A minimum temperature
t time
H humidity, %
1 end of temperature rise
2 start of temperature fall

Figure 3 — Damp heat test cycle

5.4.2 Test limits

See Table 4.

Table 4 — Test levels for number of cycles

Level	Number of cycles	T_A °C
1	2	40
2	2	55
3	6	55
Refer to B.4 for examples of severity levels.		

5.5 Impact

5.5.1 Particle impact

5.5.1.1 Test method

Use gravel, 0,5 l (approx. 250 to 300 stones), of a size that will pass through a 15 mm mesh screen and be retained on a 10 mm mesh screen.

Use equipment for producing an air blast, devices for measuring air blast pressure and equipment for injecting gravel into the air blast, in a tube with 50 mm diameter bore, through a 7 mm diameter nozzle in the tube, where the nozzle is 20 mm from the end of the tube from which the stones are to be ejected.

Use protective screens to protect personnel and monitoring equipment.

Mount the equipment under test in its normal mounting configuration, positioned so that the distance from the outlet of the air blast equipment to the nearest point on the equipment under test is 350 mm.

If desired, this test may be performed after the equipment has been heated or cooled.

5.5.1.2 Test limits

Turn on the air blast equipment and adjust it to give an air blast pressure at the point of gravel injection of 500 kPa $\pm$ 20 kPa. Inject the gravel into the air blast over a period of 5 s to 10 s. Carry out the test 10 times.

Refer to B.5 for test applicability.

5.5.2 Mechanical shock

5.5.2.1 Test method

Operational mechanical shock shall be tested in accordance with IEC 60068-2-27.

5.5.2.2 Test limits

Subject the equipment to three sinusoidal impulses of a duration and acceleration according to Table 5, in each of three mutually perpendicular axes. The normal mounting configuration shall be one of these axes. Monitor the equipment under test for impaired function and examine for loose parts or visible cracks at the conclusion of the tests.

Table 5 — Test levels for peak acceleration

Level	Peak acceleration m/s^2	Duration ms
1	150	11
2	300	18
3	500	11
Refer to B.6 for examples of severity levels.		

5.6 Vibration

5.6.1 Random vibration test

5.6.1.1 Test method

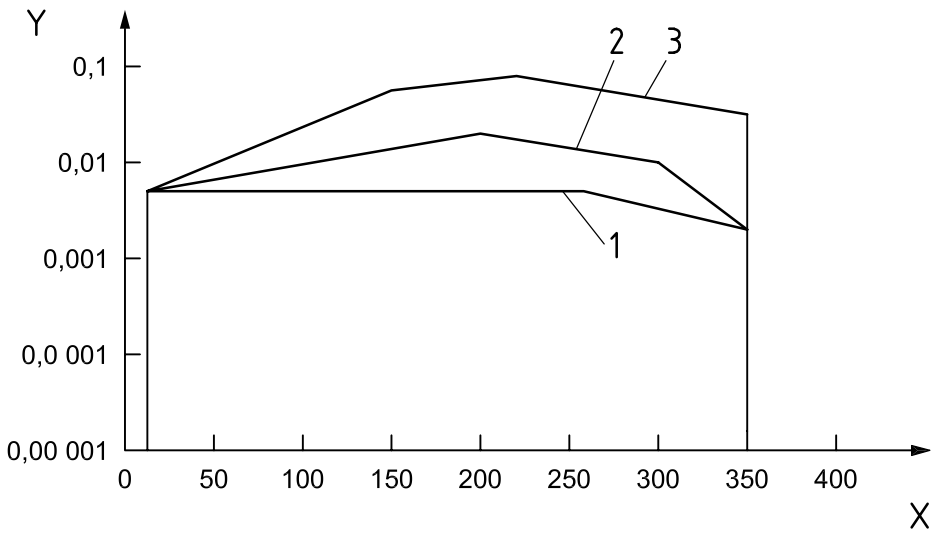
The vibration tests shall be carried out in accordance with IEC 60068-2-64 and IEC 60068-2-6, except for as follows.

Mount the equipment under test in its normal mounting configuration on the vibration test equipment in accordance with IEC 60068-2-47, with power applied and subject to random vibration within the relevant vibration envelope according to 5.5.1.2. Perform the test in three orthogonal axes sequentially for a period of 8 h in each axis.

Monitor the equipment under test for impaired function, during and at the conclusion of each test phase, and examine for loose parts and visible cracks at the conclusion of each phase.

5.6.1.2 Test limits

See Figure 4 and Table 6.



Key

X frequency, f

Y power spectral density

1 level 1

2 level 2

3 level 3

Figure 4 — Random vibration test limits

Table 6 — Test levels for frequency

Level	Frequency, f Hz	Power spectral density G^2/Hz
1	10	0,005
	260	0,005
	350	0,002
2	10	0,005
	200	0,02
	300	0,01
	350	0,002
3	10	0,005
	150	0,060
	220	0,080
	350	0,040
Refer to B.7 for examples of severity levels.		

5.6.2 Sinusoidal (resonance) test

5.6.2.1 Test method

The sinusoidal vibration test shall be performed in accordance with IEC 60068-2-6 with the equipment under test mounted on the vibration test equipment in accordance with IEC 60068-2-47 except as indicated in the following.

Mount the equipment under test on the vibration test equipment in its normal mounting configuration and subject to a resonance search — without power applied to the equipment — followed by a period of vibration at each resonance frequency detected (dwell periods). For the purposes of this International Standard, a resonance frequency is one where the acceleration, as indicated by the reference accelerometer, would increase to at least twice the reference level were it not for the effect of the closed loop acceleration control system. Perform the test in three orthogonal axes sequentially.

The equipment under test shall be checked for impaired function and examined for loose parts and visible cracks at the conclusion of each test phase.

5.6.2.2 Test limits/dwell times

The resonance searches, and dwell periods, shall be conducted at an acceleration of 20 m/s^2, with the frequency being swept from 10 Hz to 2 000 Hz to 10 Hz at a sweep rate of 1 octave/min.

Table 7 — Test levels for dwell times

Level	Dwell time min
1	10
2	30
3	90
Refer to B.8 for examples of severity levels.	

5.7 Corrosive atmosphere

5.7.1 Test method

The corrosive atmosphere test shall be conducted in accordance with IEC 60068-2-11.

Mount the equipment under test in its normal mounting configuration in the test chamber and expose to the corrosive atmosphere for the durations according to Table 8.

Inspect the equipment for corrosion, without rinsing, immediately after the test and, again, 100 h after the test, also without rinsing, and monitor the equipment for impaired function at these same times. During the 100 h duration the equipment shall be in an environment of 25 °C and < 50 % relative humidity.

5.7.2 Test limits

The test shall be performed using a sodium chloride, 5 % aqueous solution at a temperature 35 °C and a pH of 6.5 to 7.2.

See Table 8.

Table 8 — Test levels for duration

Level	Duration h
1	16
2	48
Refer to B.9 for examples of severity levels.	

5.8 Degrees of protection provided by enclosures (IP Code)

5.8.1 Dust

5.8.1.1 Test method/test limits

The dust test shall be conducted in accordance with IEC 60529.

Refer to B.10 for examples of IP codes related to machine type and location.

5.8.2 Water spray

5.8.2.1 Test method/test limits

The water spray test shall be conducted in accordance with IEC 60529.

Refer to B.10 for examples of IP codes related to machine type and location.

5.9 Air pressure (altitude)

5.9.1 Test method

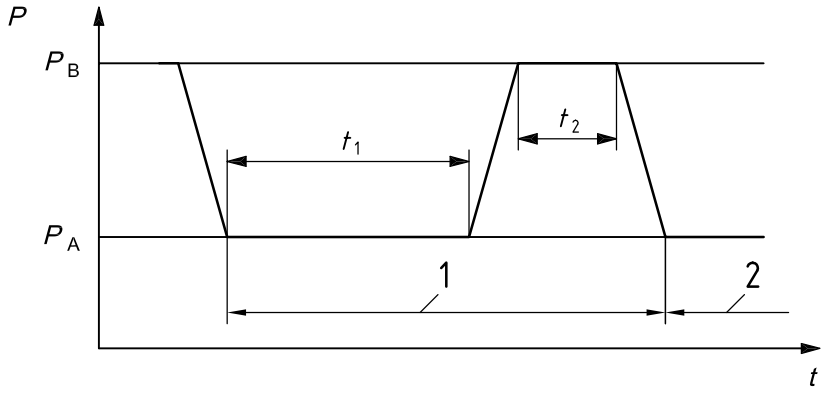
The air pressure test shall be performed in accordance with IEC 60068-2-13, except as indicated in the following.

Mount the equipment under test in its normal mounting configuration in an enclosure connected to a supply of compressed air free from all impurities such as oil and dust. Subject the equipment under test to two air pressure cycles as shown in Figure 5, where P_A = 80 kPa (equivalent to 1 700 m above sea level) and P_B = 100 kPa (equivalent to sea level); t_1 shall be 7 h to 8 h and t_2 shall be 3 h to 4 h, with transition times such that two cycles shall be 24 h.

NOTE Testing at lower pressures may be required for equipment which operates above 1 700 m.

5.9.2 Test limits

See Figure 5.



Key

P pressure, kPa

P_A minimum pressure = 80 kPa

P_B maximum pressure = 100 kPa

t time

t_1 steady state time = 7 h to 8 h

t_2 transition time = 3 h to 4 h

1 first cycle

2 second cycle

NOTE Refer to Annex B.11 for examples of severity levels.

Figure 5 — Air pressure cycle

5.10 Chemical brush or spray

SAFETY PRECAUTIONS — For safety reasons, brushing should be used except in cases where adequate coverage is only possible with a spray — for example, on connector mating surfaces. Whether brush or spray is used, adequate personnel safety procedures should be followed.

5.10.1 Test method

Select chemicals to be applied from Table 9. If more than one chemical is used, apply each chemical to a different sample of the equipment.

— **Brush**

Apply the specified chemical solution with a brush evenly over the exposed surface area. Repeat once a day for three days.

— **Spray**

Subject the equipment under test, in its normal mounting configuration, on its normally exposed surfaces, to the relevant chemicals sprayed at a pressure not exceeding 30 kPa at an angle of 45° to the surfaces for 2 min each day for 5 days.

Inspect the equipment for corrosion, without rinsing, immediately after the test and at 100 h after the test, also without rinsing, and monitor the equipment for impaired function at the same times. During the 100 h, the equipment shall be in an environment of 25 °C and < 50 % relative humidity.

Table 9 — Chemicals for brush and spray tests

Chemical	Concentration
Urea nitrogen	Saturated solution
Liquid lime	10 %
NPK fertiliser (7,5 % N, 7,5 % P, 7,5 % K compound fertiliser)	Saturated solution
Ammonium hydroxide	20 % aqueous solution
Diesel fuel	100 %
Petrol	100 %
Hydraulic oil	100 %
Ethylene glycol	50 % aqueous solution
Agro-chemicals	a
It is recommended that plastic parts be mechanically stressed, as when installed, when exposed to chemicals. NOTE The chemical names given here are the names used in agriculture.	
a For each agrochemical, use the strongest solution recommended by the agrochemical manufacturer.	

5.10.2 Test limits

Refer to B.12 for examples of severity levels.

5.11 Solar radiation (ultraviolet)

5.11.1 Test method

The solar radiation test shall be performed in accordance with IEC 60068-2-5, and IEC 60068-2-9 except as indicated herein.

Subject the equipment under test to alternating UV exposure and humidity exposure for 1 500 h.

The UV exposure time shall be 8 h $\pm$ 6 min at (60 $\pm$ 5) °C with ambient humidity, and the humidity exposure time shall be 4 h $\pm$ 6 min with condensing humidity at (50 $\pm$ 5) °C.

Check the equipment for impaired function and visually examine for ultraviolet-induced degradation after the test.

UV radiation in the wavelength range of 280 nm to 400 nm at a power density of 60 $W \cdot m^2$ squared 15 $W \cdot m^2$ shall be applied.

NOTE Only equipment which is exposed to sunlight in use need be tested.

5.11.2 Test limits

Refer to B.13 for examples of severity levels

5.12 Readability of displays

5.12.1 Test Method

The readability of displays test shall be performed with a radiation source with spectral energy distribution shown in of IEC 60068-2-5:1975, Table 1, and in accordance with IEC 60068-2-5 and IEC 60068-2-9, except as indicated in the following.

Subject the display under test, in its normal operating configuration, to radiation from the solar radiation source such that the light levels at the centre of the display and at four locations around the perimeter of the display are within 5 % of the relevant severity level specified in Annex B.

Monitor the display for readability as defined by the user.

5.12.2 Test limits

See Table 10.

Table 10 — Test levels for ambient light level

Level	Ambient light level cd
1	108
2	36
3	0

5.13 Electromagnetic compatibility

5.13.1 Susceptibility and emissions

5.13.1.1 Test method/limits

These tests shall be conducted as specified in ISO 14982.

5.14 Electrical environment

5.14.1 Operating voltage

5.14.1.1 Test method

Subject the equipment to a 24 h voltage cycle consisting of three 8 h periods at supply voltages of V_L, V_{nom} and V_U, in sequence.

This test may be combined with test 5.2.1 (changes of temperature with specified rate of change) in a synchronised cycle temperature/voltage test.

5.14.1.2 Test limits

See Table 11.

Table 11 — Test levels for 12 V and 24 V systems

Level	**12 V** (13,6 V nom.)		**24 V** (27,2 V nom.)	
	V_L	V_U	V_L	V_U
	V			
1	10,5	16	21	36
2	9		18	
3	5,3		10,6	

5.14.2 Over-voltage

5.14.2.1 Test method/limits

Operate the equipment for 5 min at 26 V d.c. for 12 V systems or 48 V d.c. for 24 V systems, with applicable protection systems in place.

Check for impaired function during the test (temporary impaired function) and impaired function following the test (permanent impaired function).

5.14.3 Reverse polarity

5.14.3.1 Test method/limits

Subject the equipment to a reversed polarity supply of −26 V d.c. for 12 V systems or −48 V d.c. for 24 V systems for a period of 5 min, with applicable protection systems in place.

5.14.4 Short circuit

5.14.4.1 Test method/limits

With the equipment under power, sequentially short each external connection to ground for 5 min and then to 16 V d.c. for 12 V systems or 36 V d.c. for 24 V systems for 5 min. Applicable protection systems shall be in place and the power source shall be capable of providing the expected inrush current.

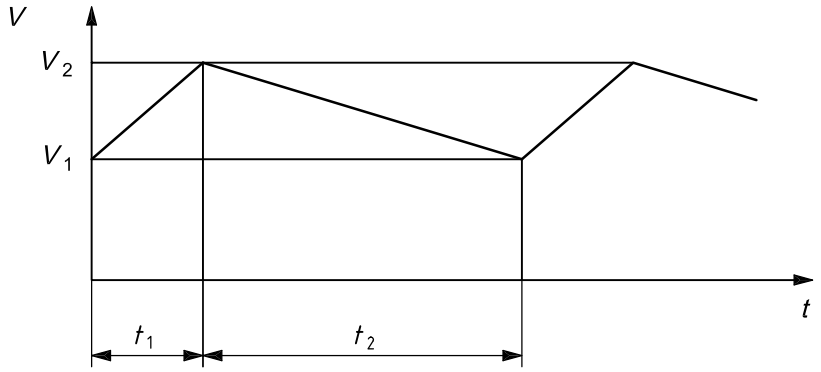
At the option of the user, this test may be performed by connecting all connections together, or in groups, then to ground for 5 min, and then to 16 V d.c. for 12 V systems or 36 V d.c. for 24 V systems for 5 min.

5.14.5 Battery-less operation

5.14.5.1 Test method/limits

Apply the waveform shown in Figure 6, with the voltage levels as specified for either 12 V systems or 24 V systems, to the power supply connection of the equipment, where t is time in seconds, and sweep period t_2 is from 100 ms to 10 ms over an elapsed time of 5 min. The source impedance should be 0,5 Ω.

Monitor the equipment for impaired function during the test. Essential machine functions (e.g. engine control, safety critical functions) shall not be impaired during this test.



Key

t time, s
V voltage, V
V_1 12 V systems = 10 V
24 V systems = 20 V
V_2 12 V systems = 18 V
24 V systems = 38 V
t_1 sweep period ~ 8 ms
t_2 sweep period 10 ms $\leqslant t_2 \geqslant$100 ms

Figure 6 — Batteryless operation voltage waveform

5.14.6 Transient supply

5.14.6.1 Test method/limits

The transient tests shall be conducted in accordance with ISO 14982.

5.14.7 Electrostatic discharge

5.14.7.1 Test method/limits

Subject the equipment to an electrostatic discharge test in accordance with ISO 14982

Annex A
(informative)

Example test report

This annex specifies an example of suitable presentation for the test report. See 4.3.

Testing of equipment for conformity to ISO 15003, *Agricultural engineering — Electrical and electronical equipment — Testing resistance to environmental conditions*

Manufacturer's name and address:.....

.....

Description of equipment:.....

Tests to be conducted:.....

Model no./identifying marks:.....

Equipment list with calibration status:.....

Details of test set-up:.....

Date of test	Severity level	Test result [a]	Test details [b]

[a] Indicate that the equipment has met ("P") or has not met ("F"), the requirement of the relevant test.

[b] Indicate more specific details of the test (e.g. agrochemical type, see 5.10).

Annex B
(informative)

Machinery/equipment codes and guidance for use of severity levels

B.1 General

B.1.1 Type of machinery

The type of the machinery shall be classified using a two-letter code according to Table B.1.

Table B.1 — Type of machinery

Code	Type
MA	Gardening machinery
MB	Harvesting/tilling machinery
MC	Forest machinery
MD	Tractors and attachments

B.1.2 Location of equipment

The location of the equipment on an agricultural machine enterprise shall be classified using a two-letter according to Table B.2.

Table B.2 — Location of equipment

Code	Location
LE	Protected from weather (e.g. in a cab)
LF	Unprotected from weather
LG	In an engine compartment
LI	Built-in/attached to an engine or transmission

B.2 Cold and dry heat (5.2)

See Table B.3.

Table B.3 — Cold and dry heat

Level	T_A °C	T_B °C	Location	Type of machinery
1	0	70	LE	MA, MB
2	–20	70	LF	MA, MB, MC
3	–40	85	LF	MC, MD
4	–40	105	LG	MA, MB, MC, MD
5	–40	125	LI	MA, MB, MC, MD

B.3 Damp heat, steady state (5.3)

See Table B.4.

Table B.4 — Damp heat, steady state

Level	Duration days	Location	Type of machinery
1	4	LE	MA, MB, MC, MD
2	10	LF, LI	MA, MB, MC, MD
3	21	LG	MA, MB, MC, MD

B.4 Damp heat, cyclic (5.4)

See Table B.5.

Table B.5 — Damp heat, cyclic

Level	Number of cycles	T_A °C	Location	Type of machinery
1	2	40	LE	MA, MB, MC, MD
3	2	55	LF	MB, MC, MD
4	6	55	LG, LI	MB, MC, MD

B.5 Particle impact (5.5.1)

This test is applicable to all components with location LF or LG on all types of machines.

B.6 Mechanical shock (5.5.2)

See Table B.6.

Table B.6 — Mechanical shock

Level	Peak acceleration m/s^2	Duration ms	Location	Type of machinery
1	150	11	LE, LH	MA, MB, MC, MD
2	300	18	LF	MA, MB, MC, MD
3	500	11	LG, LI	MA, MB, MC, MD

B.7 Random vibration (5.6.1)

See Table B.7.

Table B.7 — Random vibration

Level	Frequency Hz	Power spectral density G^2/Hz	Location	Type of machinery
1	10 260 350	0,005 0,005 0,002	LE	MA, MB, MC, MD
2	10 200 300 350	0,005 0,02 0,01 0,002	LF	MA, MB, MC, MD
3	10 150 220 350	0,005 0,060 0,080 0,040	LG, LI	MA, MB, MC, MD

B.8 Sinusoidal (resonance) vibration (5.6.3)

See Table B.8.

Table B.8 — Sinusoidal (resonance) vibration

Level	Dwell time min
1	10
2	30
3	90

B.9 Corrosive atmosphere (5.7)

See Table B.9.

Table B.9 — Corrosive atmosphere

Level	Duration h	Location	Type of machinery
1	16	LE	MA, MB, MC, MD
2	48	LF, LG	MA, MB, MC, MD

B.10 Degrees of protection provided by enclosures (IP Code) (5.8)

See Table B.10.

Table B.10 — Degrees of protection provided by enclosures (IP Code)

IP Code	Location
54	LE
67	LF
66	LG
68	LI

B.11 Air pressure (altitude) (5.9)

This test is applicable to all components.

B.12 Chemical brush or spray (5.10)

See Table B.11.

B.13 Solar radiation (5.11)

This test is applicable for all components that are exposed to sunlight.

B.14 Readability of displays (5.12)

See Table 10.

B.15 Operating voltage (5.14.1)

See Table 11.

Table B.11 — Chemical brush or spray

Chemical	Concentration	Location	Machinery	Applicable
Urea nitrogen	Saturated solution	LE	MA, MB, MC, MD	No
		LF, LG, LI	MD	Yes
Liquid lime	10 %	LE	MA, MB, MC, MD	No
		LF, LG, LI	MD, MC	Yes
NPK fertiliser (7.5 % N, 7.5 % P, 7.5 % K compound fertiliser)	Saturated solution	LE	MA, MB, MC, MD	No
		LF, LG, LI	MD	Yes
Ammonium hydroxide	20 % Aqueous solution	LE	MA, MB, MC, MD	No
		LF, LG, LI	MD	Yes
Diesel fuel	100 %	LE	MA, MB, MC, MD	No
		LF, LG, LI	MA, MB, MC, MD	Yes
Petrol	100 %	LE	MA, MB, MC, MD	No
		LF, LG, LI	MA	Yes
Hydraulic oil	100 %	LE	MA, MB, MC, MD	No
		LF, LG, LI	MA, MB, MC, MD with hydraulic	Yes
Ethylene glycol	50 % aqueous solution	LE	MA, MB, MC, MD	No
		LF, LG, LI	MA, MB, MC, MD	Yes
Agro-chemicals	[a]	LE	MA, MB, MC, MD	No
		LF, LG, LI	MD	Yes

[a] For each agrochemical, use the strongest solution recommended by the agrochemical manufacturer.

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[1] IEC 60068-2-3:1969, *Basic environmental testing procedures — Part 2: Tests — Tests Ca: Damp heat, steady state*

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