

INTERNATIONAL STANDARD



**Plasma display panels –
Part 4-1: Environmental testing methods – Climatic and mechanical**

IECNORM.COM : Click to view the full PDF of IEC 61988-4-1:2015



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2015 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

IEC Catalogue - webstore.iec.ch/catalogue

The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

IEC publications search - www.iec.ch/searchpub

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and also once a month by email.

Electropedia - www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing more than 30 000 terms and definitions in English and French, with equivalent terms in 15 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary

More than 60 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: csc@iec.ch.

IECNORM.COM : Click to view the full text of IEC 60384-41:2015

INTERNATIONAL STANDARD



**Plasma display panels –
Part 4-1: Environmental testing methods – Climatic and mechanical**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 31.260

ISBN 978-2-8322-2392-5

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD.....	5
1 Scope.....	7
2 Normative references.....	7
3 Terms, definitions and letter symbols	8
4 Environmental tests	8
4.1 General.....	8
4.2 Test items	8
4.3 Structure of testing equipment	8
5 Standard conditions	8
5.1 Standard reference atmosphere.....	8
5.2 Standard atmospheric conditions for reference measurements and tests	9
5.3 Standard atmospheric conditions for measurements and tests.....	9
5.4 Standard atmospheric conditions for assisted drying	9
5.5 Recovery conditions	9
5.6 Standard installation conditions	10
5.7 Standard measuring conditions.....	10
5.8 PDP module state	10
5.9 Operating conditions	10
6 Measurements.....	10
6.1 General.....	10
6.2 Measurement item.....	10
6.3 Initial measurements	10
6.4 Intermediate measurements	10
6.5 Final measurements	11
6.6 Information to be given in the relevant specification	11
7 Report.....	11
8 Temperature and humidity testing methods (operation and storage).....	11
8.1 High temperature (storage).....	11
8.1.1 Purpose.....	11
8.1.2 Test conditions	11
8.1.3 Testing equipment	12
8.1.4 Testing procedures	12
8.1.5 Recovery	12
8.1.6 Measurements	12
8.1.7 Information to be given in the relevant specification	12
8.2 Low temperature (operation).....	13
8.2.1 Purpose	13
8.2.2 Test conditions	13
8.2.3 Testing equipment	13
8.2.4 Testing procedures	13
8.2.5 Recovery	14
8.2.6 Measurements	14
8.2.7 Information to be given in the relevant specification	15
8.3 Low temperature (storage)	15
8.3.1 Purpose	15
8.3.2 Test conditions	15

8.3.3	Testing equipment	15
8.3.4	Testing procedures	15
8.3.5	Recovery	16
8.3.6	Measurements	16
8.3.7	Information to be given in the relevant specification	16
8.4	Damp heat at steady state (operation)	16
8.4.1	Purpose	16
8.4.2	Test conditions	16
8.4.3	Testing equipment	17
8.4.4	Testing procedures	17
8.4.5	Recovery	17
8.4.6	Measurements	17
8.4.7	Information to be given in the relevant specification	17
8.5	Damp heat at steady state (storage)	17
8.5.1	Purpose	17
8.5.2	Test conditions	17
8.5.3	Testing equipment	18
8.5.4	Testing procedures	18
8.5.5	Recovery	18
8.5.6	Measurements	18
8.5.7	Information to be given in the relevant specification	18
8.6	Damp heat, cyclic	19
8.6.1	Purpose	19
8.6.2	Test conditions	19
8.6.3	Testing equipment	19
8.6.4	Testing procedure	19
8.6.5	Recovery	19
8.6.6	Measurements	19
8.6.7	Information to be given in the relevant specification	19
8.7	Rapid change of temperature with prescribed time of transition	20
8.7.1	Purpose	20
8.7.2	Test conditions	20
8.7.3	Testing equipment	20
8.7.4	Testing procedures	20
8.7.5	Recovery	20
8.7.6	Measurements	20
8.7.7	Information to be given in the relevant specification	21
8.8	Change of temperature with specified rate of change	21
8.8.1	Purpose	21
8.8.2	Test condition	21
8.8.3	Testing equipment	21
8.8.4	Testing procedures	21
8.8.5	Recovery	21
8.8.6	Measurements	21
8.8.7	Information to be given in the relevant specification	22
9	Air pressure testing methods	22
9.1	Low air pressure (operation)	22
9.1.1	Purpose	22
9.1.2	Test conditions	22

9.1.3	Testing equipment	22
9.1.4	Testing procedures	22
9.1.5	Recovery	23
9.1.6	Measurements	23
9.1.7	Information to be given in the relevant specification	23
9.2	Low air pressure (storage).....	23
9.2.1	Purpose	23
9.2.2	Test conditions	23
9.2.3	Testing equipment	24
9.2.4	Testing procedures	24
9.2.5	Recovery	24
9.2.6	Measurements	24
9.2.7	Information to be given in the relevant specification	24
10	Mechanical testing methods.....	24
10.1	Vibration (sinusoidal)	24
10.1.1	Purpose	24
10.1.2	Equipment	25
10.1.3	Test conditions	25
10.2	Shock	25
10.2.1	Purpose	25
10.2.2	Equipment	25
10.2.3	Test conditions	26
10.3	Transportation drop.....	27
10.4	Toppling.....	27
	Figure 1 – Testing procedure at low temperature (operation)	14
	Figure 2 – Configuration of PDP module directions	25
	Figure 3 – Example of PDP shock testing equipment	26
	Table 1 – Standard conditions for reference measurements and tests	9
	Table 2 – Peak value and duration	26

INTERNATIONAL ELECTROTECHNICAL COMMISSION

PLASMA DISPLAY PANELS –**Part 4-1: Environmental testing methods –
Climatic and mechanical**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 61988-4-1 has been prepared by IEC technical committee 110: Electronic display devices.

The text of this standard is based on the following documents:

FDIS	Report on voting
110/637/FDIS	110/653/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all the parts in the IEC 61988 series, under the general title *Plasma display panels*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

IECNORM.COM : Click to view the full PDF of IEC 61988-4-1:2015

PLASMA DISPLAY PANELS –

Part 4-1: Environmental testing methods – Climatic and mechanical

1 Scope

This part of IEC 61988 defines the following test methods for evaluating the climatic and mechanical endurance characteristics of plasma display modules (PDP modules):

- a) temperature and humidity tests
- b) air pressure tests
- c) mechanical tests

2 Normative references

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

IEC 60068-1:2013, *Environmental testing – Part 1: General and guidance*

IEC 60068-2-1:2007, *Environmental testing – Part 2: Tests – Test A: Cold*

IEC 60068-2-2:2007, *Environmental testing – Part 2: Tests – Test B: Dry heat*

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

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

IEC 60068-2-14:2009, *Environmental testing – Part 2-14: Tests – Test N: Change of temperature*

IEC 60068-2-27:2008, *Environmental testing – Part 2-27: Tests – Test Ea and guidance: Shock*

IEC 60068-2-30:2005, *Environmental testing – Part 2-30: Tests – Test Db: Damp heat, cyclic (12 h + 12 h cycle)*

IEC 60068-2-78:2012, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

IEC 61747-5:1998, *Liquid crystal and solid-state display devices – Part 5: Environmental, endurance and mechanical test methods*

IEC 61988-1, *Plasma display panels – Part 1: Terminology and letter symbols*

IEC 61988-2-1, *Plasma display panels – Part 2-1: Measuring methods – Optical and optoelectrical*

IEC 61988-2-5, *Plasma display panels – Part 2-5: Measuring methods – Acoustic noise*

ISO 2248, *Packaging – Complete, filled transport packages – Vertical impact test by dropping*

ISO 4180, *Packaging – Complete, filled transport packages – General rules for the compilation of performance test schedules – Part 1: General principles*

ISO 10531, *Packaging – Complete, filled transport packages – Stability testing of unit loads*

3 Terms, definitions and letter symbols

For the purposes of this document, the terms, definitions and letter symbols given in IEC 60068-1 and IEC 61988-1, as well as the following apply.

3.1

P_{op}

air pressure at which the PDP module is operated during the tests

3.2

P_{st}

air pressure at which the PDP module is stored in a non-operating state during the tests

4 Environmental tests

4.1 General

In this document, tests mean storage or operation tests at high or low temperature, high humidity, low pressure, or combinations thereof, and vibration tests or shock tests, while measurements mean the characteristic evaluations, i.e. initial, intermediate and final measurements.

4.2 Test items

This document describes the following test items:

- a) temperature and humidity tests (operation);
- b) temperature and humidity tests (storage);
- c) air pressure tests;
- d) mechanical tests.

4.3 Structure of testing equipment

The system diagrams and/or driving conditions of the testing equipment shall comply with the structure specified in each item.

5 Standard conditions

5.1 Standard reference atmosphere

Temperature: 25 °C

Air pressure: 101,3 kPa

NOTE No requirement for relative humidity is given because correction by calculation is generally not possible.

If the parameters to be measured depend on temperature and/or pressure, and the law of dependence is known, the values shall be measured in the conditions specified in 5.3 and, if

necessary, be corrected by calculation to the standard reference atmospheric conditions above.

5.2 Standard atmospheric conditions for reference measurements and tests

If the parameters to be measured depend on temperature, pressure and humidity and the law of dependence is unknown, the atmospheric conditions to be specified shall be selected from the following values, as shown in Table 1.

Table 1 – Standard conditions for reference measurements and tests

Temperature	Relative humidity ^a	Air pressure ^a
°C	% RH	kPa
20 ± 3	45 to 75	86 to 106
25 ± 3		
30 ± 3		
35 ± 3		
^a Inclusive values.		

5.3 Standard atmospheric conditions for measurements and tests

Unless otherwise specified, all tests and measurements shall be carried out under standard atmospheric conditions:

temperature: 15 °C to 35 °C;
 relative humidity: 25 % to 85 %, where appropriate;
 air pressure: 86 kPa to 106 kPa.

The absolute humidity of the atmosphere shall not exceed 22 g/m³.

5.4 Standard atmospheric conditions for assisted drying

Where assisted drying is required before commencing a series of measurements, the conditions listed below shall be used on the PDP module for at least 2 h, unless otherwise prescribed by the relevant specification:

temperature: (55 ± 3) °C;
 relative humidity: not exceeding 20 %;
 air pressure: 86 kPa to 106 kPa.

When the specified temperature for the dry heat test is lower than 55 °C, assisted drying shall be carried out at that lower temperature.

5.5 Recovery conditions

The recovery shall be carried out in the conditions specified in IEC 60068-1:2013, 5.3:

temperature: 15 °C to 35 °C;
 relative humidity: 25 % to 75 %;
 air pressure: 86 kPa to 106 kPa.

5.6 Standard installation conditions

Unless otherwise specified in the relevant specification, stand the PDP module keeping adequate clearance to avoid airflow disturbance. The mounting structure of the PDP module shall be specified in the relevant specification.

5.7 Standard measuring conditions

The standard measuring conditions described in IEC 61988-2-1 shall be applied.

5.8 PDP module state

For the non-operating test, the PDP module shall be either unpacked and turned off, or as otherwise specified in the relevant specification.

For the operating test, the PDP module shall be either in the unpacked, turned off and ready-for-use state, or as otherwise specified in the relevant specification. In the operating test, the module shall be turned on in each test procedure.

5.9 Operating conditions

Full screen: The signal input sets at (15 ± 1) % of white level without gamma correction or an equivalent input level when gamma correction is used.

In case a different signal input is used, it shall be noted in the report.

NOTE The 15 % signal input level is a typical value for video.

6 Measurements

6.1 General

Measurement items are defined in each testing method. An initial measurement is required before each test, and a final measurement is required after the test. If necessary, intermediate measurements can be carried out during the test. If necessary, recovery conditioning defined in each test shall be applied before final and intermediate measurements.

6.2 Measurement item

The following items shall be evaluated on initial, intermediate and final measurements:

- a) visual and optical performance (refer to IEC 61988-2-1);
- b) electrical performance (refer to IEC 61988-2-1);
- c) acoustic noise (refer to IEC 61988-2-5);
- d) mechanical performance.

If additional measurements are carried out, they shall be noted in the report. Data about initial, intermediate and final measurements shall be recorded in the report.

6.3 Initial measurements

Initial measurements shall be carried out as specified under the standard atmospheric conditions for the reference measurements and tests.

6.4 Intermediate measurements

The relevant specification may require functional tests during the conditioning programme. When intermediate measurements are required, the relevant specification shall define the

measuring items and the period(s) during the conditioning, and the results shall be noted in the report.

6.5 Final measurements

Final measurements shall be carried out in the same way as specified for the initial measurements.

6.6 Information to be given in the relevant specification

When any test is included in the relevant specification, at least, the following details shall be given, if applicable:

- a) initial measurements;
- b) final measurements.

Measurement requirements, for example intermediate measurements, etc., are added in each test. Other details, which shall be given in the relevant specification, are described in each clause or subclause.

7 Report

The test conditions shall be noted in the report.

The measurement items, measuring conditions and the results shall be noted in the report.

8 Temperature and humidity testing methods (operation and storage)

8.1 High temperature (storage)

8.1.1 Purpose

The purpose of this test is to evaluate the performance of the PDP module after high temperature storage.

8.1.2 Test conditions

Test Bb of IEC 60068-2-2 shall be applied with the following specific conditions.

NOTE Test Bb: Dry heat for non heat-dissipating specimen with gradual change of temperature.

a) Temperature

The temperature shall be selected from the values given below:

(80 ± 3) °C

(70 ± 3) °C

(60 ± 3) °C

The temperature selected shall be noted in the report.

b) Duration

The duration shall be selected from the values given below:

24 h, 48 h, 72 h, 96 h, 120 h, 240 h and 500 h.

The duration selected shall be noted in the report.

c) Humidity

The absolute humidity of the atmosphere should not exceed 20 g/m³ (corresponding approximately to 50 % relative humidity at 35 °C).

8.1.3 Testing equipment

The specifications of the testing chamber are as follows:

- a) The chamber shall be capable of maintaining the specified temperature in the working space within the tolerances given in IEC 60068-2-2:2007, Clause 4, taking into account the effect of the PDP module under test on chamber conditions. Forced air circulation may be used to maintain homogeneous conditions.
- b) In order to limit radiation problems, the temperature of the walls of the chamber, after temperature stability has been reached, shall not differ by more than 8 % of the specified ambient temperature of the test, expressed in K. This requirement applies to all parts of the chamber walls, and the PDP modules shall be unable to “see” any heating or cooling elements which do not comply with this requirement.
- c) The temperature tolerances given in IEC 60068-2-2:2007, 5.1, are intended to take account of absolute errors in measurements and slow changes of temperature.

8.1.4 Testing procedures

The initial and final measurements shall be applied before and after the test respectively.

The following testing procedure shall be applied:

- a) The chamber shall be at the temperature of the laboratory. The PDP module, while being at the ambient temperature of the laboratory, shall be introduced into the chamber in accordance with 5.6 or as otherwise defined.
- b) The temperature in the chamber shall then be adjusted to the temperature appropriate to the degree of severity and time shall be allowed for the chamber to reach temperature stability. (Temperature stability is defined in IEC 60068-1:2013, 4.8.) The rate of change of temperature in the chamber shall not exceed 3 °C/min, averaged over a period of not more than 5 min. The test temperature shall be measured in accordance with IEC 60068-1:2013, 4.6.
- c) The PDP module shall then be exposed to the high temperature conditions for the duration as specified in the relevant specification. The duration shall be measured from the moment temperature stability has been reached.
- d) At the end of this period, the PDP module shall remain in the chamber and the temperature shall be gradually lowered to a value lying within the limits of standard atmospheric conditions for testing. The rate of change of temperature in the chamber shall not exceed 3 °C/min, averaged over a period of not more than 5 min. At the end of this period, the PDP module shall be subject to the recovery procedure in the chamber or otherwise as appropriate.

8.1.5 Recovery

The following recovery is added to the procedure:

- a) The PDP module shall then remain under standard atmospheric conditions for recovery for a period adequate for the attainment of temperature stability.
- b) If required by the relevant specification, the PDP module shall be measured during the recovery period.

8.1.6 Measurements

The initial and final measurements shall be applied, where the measuring items shall be defined in the relevant specification (see Clause 6). If these are required by the relevant specification, intermediate measurements shall be performed during the procedure c) and d) in 8.1.4.

8.1.7 Information to be given in the relevant specification

In addition to 6.6, the information below shall be given, if applicable:

- a) time duration;
- b) room temperature and PDP module temperature;
- c) if required, intermediate measurements, time and temperature.

8.2 Low temperature (operation)

8.2.1 Purpose

The purpose of this test is to evaluate the performance of the PDP module at low temperature operating conditions.

8.2.2 Test conditions

Test Ad of IEC 60068-2-1 shall be applied with the following specific conditions.

NOTE Test Ad: Cold for heat-dissipating specimens with gradual change of temperature that are powered after initial temperature stabilization.

a) Temperature

The temperature shall be selected from the values given below:

(-20 ± 3) °C

(-10 ± 3) °C

(-5 ± 3) °C

The temperature selected shall be noted in the report.

b) Time before PDP module power-on

After the specified temperature has been reached, the time before the PDP module power-on shall be selected from the values given below:

2 h, 4 h, 8 h, 12 h and 24 h.

The selected time before the PDP module power-on shall be noted in the report.

c) Duration

The duration shall be 4 h as shown in Figure 1 or longer. In case it is longer it shall be noted in the report.

8.2.3 Testing equipment

The specifications of the testing chamber are as follows:

- a) The chamber shall be capable of maintaining the specified temperature in the working space within the tolerances given in IEC 60068-2-1:2013, Clause 4, taking into account the effect of the PDP module under test on chamber conditions. Forced air circulation may be used to maintain homogeneous conditions.
- b) In order to limit radiation problems, the temperature of the walls of the chamber, after temperature stability has been reached, shall not differ by more than 8 % of the specified ambient temperature of the test, expressed in K. This requirement applies to all parts of the chamber walls and the PDP modules shall be unable to “see” any heating or cooling elements which do not comply with this requirement.
- c) The temperature tolerances given in IEC 60068-2-1:2013, 5.1, are intended to take account of absolute errors in measurements and slow changes of temperature. For heat-dissipating PDP modules, the temperature near the PDP module is influenced by the effect of heat dissipation of the PDP module itself and can be different from the values measured in the positions defined in IEC 60068-1.

8.2.4 Testing procedures

The initial and final measurements shall be applied before and after the test respectively.

The following testing procedure shall be applied:

- a) The PDP module shall be introduced into the chamber in the ready-for-use state.
- b) Adjust the temperature in the chamber to the prescribed temperature and maintain at the temperature for the prescribed duration. The temperature and time before the PDP module power-on shall be selected from the values given in 8.2.2.
- c) Operate the PDP module. See 5.9 for the operating conditions.
- d) Measure the PDP module 5 min after the PDP module has been turned on (low temperature, first measurement on Figure 1).
- e) Keep the PDP modules operating for 4 h or longer.
- f) Measure the PDP module (low temperature, second measurement on Figure 1).
- g) Turn off the PDP module and adjust the chamber to the standard atmospheric conditions. The PDP module shall not show condensation.

Figure 1 shows the testing procedure at the low temperature operation mentioned above.

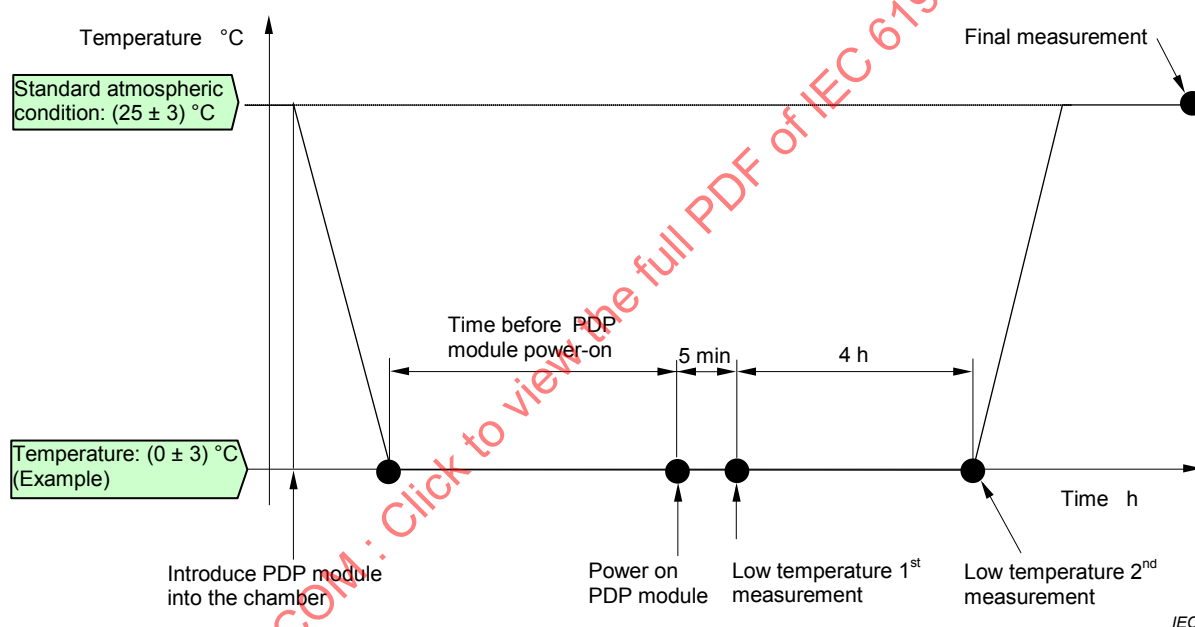


Figure 1 – Testing procedure at low temperature (operation)

8.2.5 Recovery

The following recovery shall be applied:

- a) The droplets of water may be removed.
- b) The PDP module shall then remain under standard atmospheric conditions for recovery for a period until the dew condensation is removed, with a minimum of 5 h.
- c) If required by the relevant specification, the PDP module shall be measured during the recovery period.

8.2.6 Measurements

The initial and final measurements shall be applied, where the measuring items shall be defined in the relevant specification (see Clause 6).

8.2.7 Information to be given in the relevant specification

In addition to 6.6, the information below shall be given, if applicable:

- a) temperature and time before PDP module power-on;
- b) low temperature 1st and 2nd measurements.

8.3 Low temperature (storage)

8.3.1 Purpose

The purpose of this test is to evaluate the performance of the PDP module after low temperature storage.

8.3.2 Test conditions

Test Ab of IEC 60068-2-1 shall be applied with the following specific conditions.

NOTE Test Ab: Cold for non heat-dissipating specimen with gradual change of temperature.

a) Temperature

The temperature shall be selected from the values given below:

(–40 ± 3) °C

(–30 ± 3) °C

(–20 ± 3) °C

(–10 ± 3) °C

(–5 ± 3) °C

(0 ± 3) °C

The temperature selected shall be noted in the report.

b) Duration

The duration shall be selected from the values given below:

24 h, 48 h, 72 h, 96 h, 120 h and 240 h.

The duration selected shall be noted in the report.

8.3.3 Testing equipment

The testing chamber is specified in 8.2.3.

8.3.4 Testing procedures

The initial and final measurements shall be applied before and after the test respectively.

The following testing procedure shall be applied:

- a) The chamber shall be at the temperature of the laboratory. The PDP module, while being at the ambient temperature of the laboratory, shall be introduced into the chamber in accordance with 5.6, or as otherwise specified.
- b) The temperature in the chamber shall then be adjusted to the temperature appropriate to the degree of severity and time shall be allowed for the chamber to reach temperature stability. (Temperature stability is defined in IEC 60068-1:2013, 4.8.) The rate of change of the temperature in the chamber shall not exceed 3 °C/min, averaged over a period of not more than 5 min. The test temperature shall be measured in accordance with IEC 60068-1:2013, 4.6.
- c) The PDP module shall then be exposed to the low temperature conditions for the duration as specified in the relevant specification. The duration shall be measured from the moment temperature stability has been reached.

- d) At the end of this period, the PDP module shall remain in the chamber and the temperature shall be gradually raised to a value lying within the limits of standard atmospheric conditions for testing. The rate of change of the temperature in the chamber shall not exceed 3 °C/min, averaged over a period of not more than 5 min. At the end of this period, the PDP module shall be subject to the recovery procedure in the chamber, or otherwise as appropriate.

8.3.5 Recovery

The following recovery shall be applied:

- a) The droplets of water may be removed.
- b) The PDP module shall then remain under standard atmospheric conditions for recovery for a period until the dew condensation is removed, with a minimum of 5 h.
- c) If required by the relevant specification, the PDP module shall be measured during the recovery period.

8.3.6 Measurements

The initial and final measurements shall be applied, where the measuring items shall be defined in the relevant specification (see Clause 6). If these are required by the relevant specification, intermediate measurements shall be performed during the procedure c) and d) in 8.3.4.

8.3.7 Information to be given in the relevant specification

In addition to 6.6, the information below shall be given, if applicable:

- a) time duration;
- b) room temperature and PDP module temperature;
- c) if required, intermediate measurements, time and temperature.

8.4 Damp heat at steady state (operation)

8.4.1 Purpose

The purpose of this test is to evaluate the performance of the PDP module after exposure to damp heat operating conditions.

8.4.2 Test conditions

This test shall be executed in a chamber or a room in which constant temperature and humidity can be maintained. Water drop condensation should be avoided.

Test Cab of IEC 60068-2-78 shall be applied with the following specific conditions.

NOTE Test Cab: Damp heat, steady state.

a) Temperature and humidity

The temperature and humidity shall be selected from the values given below:

Temperature: (40 ± 3) °C

(50 ± 3) °C

(60 ± 3) °C

Humidity: (85 ± 3) %RH

(93 ± 3) %RH

The temperature and humidity selected shall be noted in the report.

b) Time before PDP module power-on

After the specified temperature and humidity have been reached, the time before the PDP module power-on shall be selected from the values given below:

2 h, 4 h, 8 h, 12 h and 24 h.

The time before the PDP module power-on selected shall be noted in the report.

c) **Duration**

The duration shall be selected from the values given below:

24 h, 48 h, 72 h, 96 h, 120 h, 240 h, 500 h and 1 000 h.

The duration selected shall be noted in the report.

8.4.3 Testing equipment

The testing chamber is specified in IEC 60068-2-78:2012, 4.1.

8.4.4 Testing procedures

The initial and final measurements shall be applied before and after the test respectively.

For testing procedures other than those described above, refer to IEC 60068-2-78:2012, Clause 7.

8.4.5 Recovery

The PDP module shall be placed under the standard atmospheric conditions for assisted drying, or shall remain under standard atmospheric conditions for recovery for a period until the dew condensation is removed, with a minimum of 5 h.

When the PDP module is placed under the standard atmospheric conditions for assisted drying, placing the PDP module under the standard atmospheric conditions (at least 2 h) shall follow.

8.4.6 Measurements

The initial and final measurements shall be applied, where the measuring items shall be defined in the relevant specification (see Clause 6). If these are required by the relevant specification, intermediate measurements shall be performed during the procedure. Intermediate measurements are specified in IEC 60068-2-78:2012, 5.2.

8.4.7 Information to be given in the relevant specification

In addition to 6.6, the information below shall be given, if applicable:

- a) time duration;
- b) room temperature, humidity and PDP module temperature;
- c) if required, intermediate measurements, time and temperature, humidity.

8.5 Damp heat at steady state (storage)

8.5.1 Purpose

The purpose of this test is to evaluate the performance of the PDP module after exposure to damp heat storage.

8.5.2 Test conditions

This test shall be executed in a chamber or a room in which constant temperature and humidity can be maintained. Water drop condensation should be avoided.

Test Cab of IEC 60068-2-78 shall be applied with the following specific conditions.

NOTE Test Cab: Damp heat, steady state.

a) Temperature and humidity

The temperature and humidity shall be selected from the values given below:

Temperature: $(40 \pm 3) ^\circ\text{C}$
 $(50 \pm 3) ^\circ\text{C}$
 $(60 \pm 3) ^\circ\text{C}$
 Humidity: $(85 \pm 3) \% \text{RH}$
 $(93 \pm 3) \% \text{RH}$

The temperature and humidity selected shall be noted in the report.

b) Duration

The duration shall be selected from the values given below:

24 h, 48 h, 72 h, 96 h, 120 h and 240 h

The duration selected shall be noted in the report.

8.5.3 Testing equipment

The testing chamber is specified in IEC 60068-2-78:2012, 4.1

8.5.4 Testing procedures

The initial and final measurements shall be applied before and after the test respectively.

For testing procedures other than described above, refer to IEC 60068-2-78:2012, Clause 7.

8.5.5 Recovery

The PDP module shall be placed under the standard atmospheric conditions for assisted drying, or shall remain under standard atmospheric conditions for recovery for a period until the dew condensation is removed, with a minimum of 5 h.

When the PDP module is placed under the standard atmospheric conditions for assisted drying, placing the PDP module under the standard atmospheric conditions (at least 2 h) shall follow.

8.5.6 Measurements

The initial and final measurements shall be applied, where the measuring items shall be defined in the relevant specification (see Clause 6). If these are required by the relevant specification, intermediate measurements shall be performed during the procedure. Intermediate measurements are specified in IEC 60068-2-78:2012, 5.2

8.5.7 Information to be given in the relevant specification

In addition to 6.6, the information below shall be given if applicable:

- a) time duration;
- b) room temperature, humidity and PDP module temperature;
- c) if required intermediate measurements, time and temperature, humidity.

8.6 Damp heat, cyclic

8.6.1 Purpose

The purpose of this test is to evaluate the performance of the PDP module after a damp heat, cyclic test.

8.6.2 Test conditions

Test Db of IEC 60068-2-30 shall be applied with the following specific conditions.

NOTE Test Db: Damp heat, cyclic.

Test conditions shall be selected from the values given in IEC 60068-2-30:2005, Clause 5.

8.6.3 Testing equipment

The testing chamber is specified in IEC 60068-2-30:2005, Clause 4.

8.6.4 Testing procedure

The initial and final measurements shall be applied before and after the test respectively.

The following testing procedure shall be applied:

- a) The PDP module shall be introduced into the chamber in accordance with 5.6 or as otherwise specified in the relevant specification.
- b) The damp heat conditions (12 h + 12 h cycle) defined in IEC 60068-2-30:2005, Clause 7 shall be applied.
- c) The relevant specification may require functional tests during the conditioning programme.
- d) When intermediate measurements are required, the relevant specification shall define the measuring items and the period(s) during the conditioning, and the results shall be noted in the report.

8.6.5 Recovery

The PDP module shall be placed under the standard atmospheric conditions for assisted drying, or shall remain under standard atmospheric conditions for recovery for a period until the dew condensation is removed, with a minimum of 5 h.

When the PDP module is placed under the standard atmospheric conditions for assisted drying, placing the PDP module under the standard atmospheric conditions (at least 2 h) shall follow.

8.6.6 Measurements

The initial and final measurements shall be applied, where the measuring items shall be defined in the relevant specification (see Clause 6.). If these are required by the relevant specification, intermediate measurements shall be performed during the procedure. Intermediate measurements are specified in IEC 60068-2-30:2005, Clause 8.

8.6.7 Information to be given in the relevant specification

In addition to 6.6, the information below shall be given, if applicable:

- a) time duration;
- b) room temperature, humidity and PDP module temperature;
- c) if required, intermediate measurements, time and temperature, humidity.

8.7 Rapid change of temperature with prescribed time of transition

8.7.1 Purpose

The purpose of this test is to determine the ability of the PDP module to withstand rapid changes of ambient temperature.

8.7.2 Test conditions

Test Na of IEC 60068-2-14 shall be applied with the following specific conditions.

NOTE 1 Test Na: Rapid change of temperature with prescribed time of transition.

a) Temperature

The lower temperature shall be specified in the relevant specification and should be chosen from the temperatures of 8.2.2.

The higher temperature shall be specified in the relevant specification and should be chosen from the temperatures of 8.1.2.

b) Transition time

The transition time should be:

2 min to 3 min;

20 s to 30 s;

less than 10 s.

NOTE 2 The choice of transition time depends on the thermal time constant of the PDP module and the most severe change of temperature conditions it will be subjected to in use.

NOTE 3 The shorter transition times can be applicable by the use of automatic transfer testing equipment.

NOTE 4 In an automatic test equipment of a single chamber system, the transition period means the change over time from cut-off of the control at a test temperature to the commencement of the control at another test temperature. If the chamber temperature is maintained at the temperature of the test place on the way to the transition, such a period is considered as "the PDP module being taken out of the chamber."

8.7.3 Testing equipment

Two separate chambers shall be provided, one for the low temperature and one for the high temperature. Also one single chamber may be used for both low and high temperature exposure.

The air in the chamber shall satisfy the condition described in IEC 60068-2-14:2009, Clause 5.

8.7.4 Testing procedures

The initial and final measurements shall be applied before and after the test respectively.

The PDP module shall be removed from the cold chamber and transferred to the hot chamber.

The transition time consists of the time of removal from one chamber and of the insertion into the second chamber, and possibly the dwell time at the ambient temperature of the laboratory.

8.7.5 Recovery

The recovery shall be carried out in the conditions specified in IEC 60068-1:2013, 5.3, if necessary.

8.7.6 Measurements

Evaluation is performed under the standard measuring conditions as described in 5.7.

- a) The image performance shall be compared to the relevant specification.
- b) The electrical performance shall be compared to the relevant specification.
- c) The visual appearance shall be judged visually.

8.7.7 Information to be given in the relevant specification

In addition to 6.6, the information below shall be given, if applicable:

- a) time duration;
- b) room temperature, humidity and PDP module temperature;
- c) if required, intermediate measurements, time and temperature, humidity.

8.8 Change of temperature with specified rate of change

8.8.1 Purpose

The purpose of this test is to determine the ability of the PDP module to withstand and/or function during changes of ambient temperatures.

8.8.2 Test condition

Test Nb of IEC 60068-2-14 shall be applied with the following specific temperature conditions.

NOTE Test Nb: Change of temperature with specified rate of change.

The lower temperature shall be specified in the relevant specification and should be chosen from the temperatures of 8.2.2.

The higher temperature shall be specified in the relevant specification and should be chosen from the temperatures of 8.1.2.

8.8.3 Testing equipment

The air in the chamber shall satisfy the condition described in IEC 60068-2-14:2009, Clause 5.

8.8.4 Testing procedures

The initial and final measurements shall be applied before and after the test respectively.

The PDP module shall be removed from the cold chamber and transferred to the hot chamber.

The transition time consists of the time of removal from one chamber and of the insertion into the second chamber, and possibly the dwell time at the ambient temperature of the laboratory.

8.8.5 Recovery

The recovery shall be carried out in the conditions specified in IEC 60068-1:2013, 5.3, if necessary.

8.8.6 Measurements

Evaluation is performed under the standard measuring conditions as described in 5.7.

- a) The image performance shall be compared to the relevant specification.
- b) The electrical performance shall be compared to the relevant specification.
- c) The visual appearance shall be judged visually.

8.8.7 Information to be given in the relevant specification

In addition to 6.6, the information below shall be given, if applicable:

- a) time duration;
- b) room temperature, humidity and PDP module temperature;
- c) if required, intermediate measurements, time and temperature, humidity.

9 Air pressure testing methods

9.1 Low air pressure (operation)

9.1.1 Purpose

The purpose of this test is to evaluate the influence of air pressure on the assumption that the PDP module is used at high altitude areas.

9.1.2 Test conditions

Test M of IEC 60068-2-13 shall be applied with the following specific conditions.

NOTE Test M: low air pressure.

a) Air pressure

This test starts at ambient conditions.

Air pressure shall be reduced to 1 kPa/min or slower, starting from atmospheric pressure (86 kPa to 106 kPa) down to P_{op} .

Air pressure, P_{op} , shall be selected from the values given below:

(60 ± 5) kPa

(70 ± 5) kPa

(80 ± 5) kPa

The pressure selected shall be noted in the report.

b) Duration

The duration shall be selected from the values given below:

5 min, 30 min and 2 h.

The duration selected shall be noted in the report.

9.1.3 Testing equipment

The testing chamber is specified in IEC 60068-2-13:1983, Clause 3.

9.1.4 Testing procedures

The initial and final measurements shall be applied before and after the test respectively.

The following testing procedure shall be applied:

- a) The chamber shall be within the temperature range specified by the standard atmospheric conditions for testing. For non-operating tests, the PDP module shall be introduced into the chamber in accordance with 5.6 or as otherwise specified.
- b) The pressure in the chamber shall then be reduced to the value appropriate to the severity.
- c) When operating tests are required, the PDP module shall be switched on or be electrically loaded. Checks shall be made to ascertain whether the PDP module is capable of functioning in accordance with the relevant specification. The PDP module may remain under operating conditions for the specified duration, or be switched off as prescribed in

the relevant specification. For heat-dissipating PDP modules, the relevant specification may require that the PDP module is switched on and adequate time allowed for it to reach thermal stability before or after the air pressure is reduced and functional tests and/or measurements are made.

- d) The air pressure shall be maintained for the specified duration.
- e) The air pressure shall be restored to the standard atmospheric conditions at the end of the tests and measurements. Even if required by the relevant specification, the rate of change of air pressure shall not exceed 10 kPa/min.

9.1.5 Recovery

The following recovery shall be applied:

- a) The droplets of water may be removed.
- b) The PDP module shall then remain under standard atmospheric conditions for recovery for a period until the dew condensation is removed.

9.1.6 Measurements

The initial and final measurements shall be applied, where the measuring items shall be defined in the relevant specification (see Clause 6). If required by the relevant specification, intermediate measurements shall be performed during the procedure.

9.1.7 Information to be given in the relevant specification

In addition to 6.6, the information below shall be given, if applicable:

- a) time duration;
- b) room temperature, air pressure;
- c) if required intermediate measurements, time and temperature, air pressure.

9.2 Low air pressure (storage)

9.2.1 Purpose

The purpose of this test is to evaluate the influence of air pressure on the assumption that the PDP module is stored or transported at high altitude areas.

9.2.2 Test conditions

Test M of IEC 60068-2-13 shall be applied with the following specific conditions.

NOTE Test M: low air pressure.

a) Air pressure

Air pressure shall be reduced to 4 kPa/min or slower, starting from atmospheric pressure (86 kPa to 106 kPa) down to P_{st} .

Air pressure, P_{st} , shall be selected from the values given below:

(30 ± 5) kPa

(40 ± 5) kPa

(50 ± 5) kPa

The pressure selected shall be noted in the report.

b) Duration

The duration shall be selected from the values given below:

5 min, 30 min and 2 h.

The duration selected shall be noted in the report.