

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Wearable electronic devices and technologies –
Part 406-1: Test method for measuring surface temperature of wrist-worn
wearable electronic devices while in contact with human skin**

**Technologies et dispositifs électroniques prêts-à-porter –
Partie 406-1: Méthode d'essai pour le mesurage de la température de surface
des dispositifs électroniques prêts-à-porter placés au poignet au contact de la
peau humaine**

<https://www.iec.ch/catalog/standards/iec/fec6063b-a4ca-49de-85c3-7b1f342b0a2f/iec-63203-406-1-2021>



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2021 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.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

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

Tel.: +41 22 919 02 11
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 corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

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 online collection - oc.iec.ch

Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

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 once a month by email.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 18 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

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: sales@iec.ch.

A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC -

webstore.iec.ch/advsearchform

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études, ...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC online collection - oc.iec.ch

Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

IEC Just Published - webstore.iec.ch/justpublished

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Electropedia - www.electropedia.org

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 000 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 16 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

Service Clients - webstore.iec.ch/csc

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.



INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Wearable electronic devices and technologies –
Part 406-1: Test method for measuring surface temperature of wrist-worn
wearable electronic devices while in contact with human skin**

**Technologies et dispositifs électroniques prêts-à-porter –
Partie 406-1: Méthode d'essai pour le mesurage de la température de surface
des dispositifs électroniques prêts-à-porter placés au poignet au contact de la
peau humaine**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 31.020

ISBN 978-2-8322-1061-5

**Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

CONTENTS

FOREWORD.....	3
1 Scope.....	5
2 Normative references	5
3 Terms and definitions	5
4 Test conditions and test setup	7
4.1 Environmental conditions	7
4.2 Human skin-imitating fixture.....	7
4.2.1 General	7
4.2.2 Structure of the human skin-imitating fixture	7
4.2.3 Monitoring skin-imitating temperature and heater control	7
4.3 Stabilization time	7
4.4 Test setup.....	8
4.4.1 General	8
4.4.2 Placement of device under test (DUT)	8
4.4.3 Thermocouple placement.....	9
4.4.4 Device operating conditions.....	9
5 Test method	9
6 Test report.....	10
Annex A (informative) Low-temperature burn caused by wearable electronic devices.....	11
A.1 General.....	11
A.2 Low-temperature burn threshold	11
Annex B (informative) Human skin-imitating fixture	12
B.1 General structure	12
B.2 Heater for imitating skin temperature	12
Annex C (informative) Device operation scenario for the temperature test	14
C.1 Normal operating condition scenario	14
C.2 Abnormal operating condition scenario	14
Bibliography.....	15

Figure 1 – Test setup for evaluating the contact-surface temperature of a wearable electronic device.....	8
Figure B.1 – Structure of human skin-imitating fixture	12
Figure B.2 – Minimum size of cover, heater, and the position of thermocouple to monitor skin-imitating temperature	13
Figure C.1 – Working period and duty cycle under device operating conditions.....	14

INTERNATIONAL ELECTROTECHNICAL COMMISSION

WEARABLE ELECTRONIC DEVICES AND TECHNOLOGIES –**Part 406-1: Test method for measuring surface temperature of wrist-worn wearable electronic devices while in contact with human skin**

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.

IEC 63203-406-1 has been prepared by technical committee 124: Wearable electronic devices and technologies. It is an International Standard.

The text of this International Standard is based on the following documents:

Draft	Report on voting
124/161/FDIS	124/168/RVD

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

A list of all parts in the IEC 63203 series, published under the general title *Wearable electronic devices and technologies*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

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

iTeh Standards
(<https://standards.itih.ai>)
Document Preview

[IEC 63203-406-1:2021](#)

<https://standards.itih.ai/catalog/standards/iec/fec6063b-a4ca-49de-85c3-7b1f342b0a2f/iec-63203-406-1-2021>

WEARABLE ELECTRONIC DEVICES AND TECHNOLOGIES –

Part 406-1: Test method for measuring surface temperature of wrist-worn wearable electronic devices while in contact with human skin

1 Scope

This part of IEC 63203 defines the terms, definitions, symbols, configurations, and test methods to be used to specify the standard measurement conditions and methods for determining the contact-surface temperature of wrist-worn wearable electronic devices intended to be worn directly on a human wrist and that can be worn continuously during use. The conditions of the test do not consider perfusion and results are therefore considered conservatively. The temperature increase is induced by the thermal energy of wearable electronic devices during operation. This document gives the general procedure for the test method applicable to various wrist-worn wearable electronic devices for use by ordinary persons which in the context of this document is a healthy human adult.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 62368-1:2018, *Audio/video, information and communication technology equipment – Part 1: Safety requirements*

3 Terms and definitions

For the purpose of this document, the following terms and definitions apply:

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: Available at <http://www.iso.org/obp>
- IEC Electropedia: Available at <http://www.electropedia.org/>

3.1

ambient temperature

average temperature of air or another medium in the vicinity of a wearable electronic device

Note 1 to entry: During the measurement of the ambient temperature the measuring instrument/probe should be shielded from draughts and radiant heating.

[SOURCE: IEC 60050-816:2004, 826-10-03, modified – In the definition, "the equipment" has been replaced with "a wearable electronic device".]

3.2

human skin-imitating fixture

test fixture with thermal conductivity similar to that of human skin including internal heater to imitate the temperature of human skin and its thermal conduction properties, as well as providing a surface on which the device is placed during the measurement

Note 1 to entry: The human skin-imitating fixture consists of a support equipped with a heater and cover material.

3.3

skin-imitating temperature

temperature on the surface of a human skin-imitating fixture that is controlled by heater to emulate the skin temperature of the human body

3.4

skin-contact surface

surface of the wearable electronic device that is physically in contact with the skin of the human body

3.5

contact-surface temperature

temperature of the skin-contact surface of the wearable electronic device

Note 1 to entry: Only that part of the device which may have an elevated temperature and is in contact with the skin shall be considered. It may not be necessary to measure the temperature of passive fixing devices, for example non-metallic wrist bands, outside the thermal footprint of the electronic device.

3.6

normal operating condition

mode of operation that represents as closely as possible the range of normal use that can reasonably be expected

[SOURCE: IEC 62368-1:2018, 3.3.7.4, modified – Notes to entry have been omitted.]

3.7

abnormal operating condition

temporary operating condition that is not a normal operating condition and is not a single fault condition of the equipment itself

[SOURCE: IEC 62368-1:2018, 3.3.7.1, modified – Notes to entry have been omitted.]

3.8

single fault condition

condition of equipment with a fault under normal operating condition of a single safeguard (but not a reinforced safeguard) or of a single component or a device

[SOURCE: IEC 62368-1:2018, 3.3.7.9, modified – Note to entry has been omitted.]

3.9

burn threshold

surface temperature defining the boundary between no burn and a superficial partial thickness burn caused by contact of the skin with a hot surface for a specified contact period

[SOURCE: IEC GUIDE 117:2010, 3.3]

4 Test conditions and test setup

4.1 Environmental conditions

The measurements shall be carried out under the following normal environmental conditions.

- Ambient temperature: $25\text{ °C} \pm 5\text{ °C}$,
- Relative humidity: 25 % RH to 85 % RH,
- Atmospheric pressure: 86 kPa to 106 kPa.

4.2 Human skin-imitating fixture

4.2.1 General

A human skin-imitating fixture shall be used when measuring the contact surface temperature of a wearable electronic device. This fixture shall imitate the thermal conduction property of the human skin and the temperature of the surface of the human skin.

4.2.2 Structure of the human skin-imitating fixture

The human skin-imitating fixture shall be equipped with a heater, and the skin temperature shall be imitated by the operation of the heater. The heater shall be covered with a material which imitates the thickness and thermal conductivity of human skin. The wearable electronic device shall be attached to the cover by the method specified by the manufacturer. All of the skin-contact surfaces shall be in contact with the heated area of the fixture. Other detailed descriptions about the structure can be defined as described in Annex B.

4.2.3 Monitoring skin-imitating temperature and heater control

A surface-mount-type thermocouple (TC 1) with adhesive tape made from a low-thermal-conductivity material ($\lambda < 0,5\text{ W/m K}$) shall be attached to the surface of the cover of the fixture, a small distance away from the device under test (DUT). The thermocouple wire shall be no more than 0,26 mm in diameter and the measurement accuracy shall be within $\pm 1,0\text{ °C}$. The position of the thermocouple is shown in Figure 1 and Figure B.2. By monitoring the temperature with TC 1, the heater shall be controlled to maintain a skin-imitating temperature of $32,5\text{ °C} \pm 0,5\text{ °C}$ in normal environmental conditions. This is to ensure that the test is conducted under the appropriate operating conditions. A proportional-integral-derivative (PID) controller can be used to control the heater.

NOTE The temperature of human skin can vary with the ambient temperature, the part of the human body and the condition of the skin. The temperature of human skin is normally in the range of 30 °C to 35 °C .

Considerations should be given to the thermal mass and the heat flux of the device under test with respect to the applicability of the human skin-imitating fixture. It should be noted that the human skin-imitating fixture is considered as a conservative method in assessing thermal burn injuries as it does not consider perfusion/sweating or blood circulation of the body.

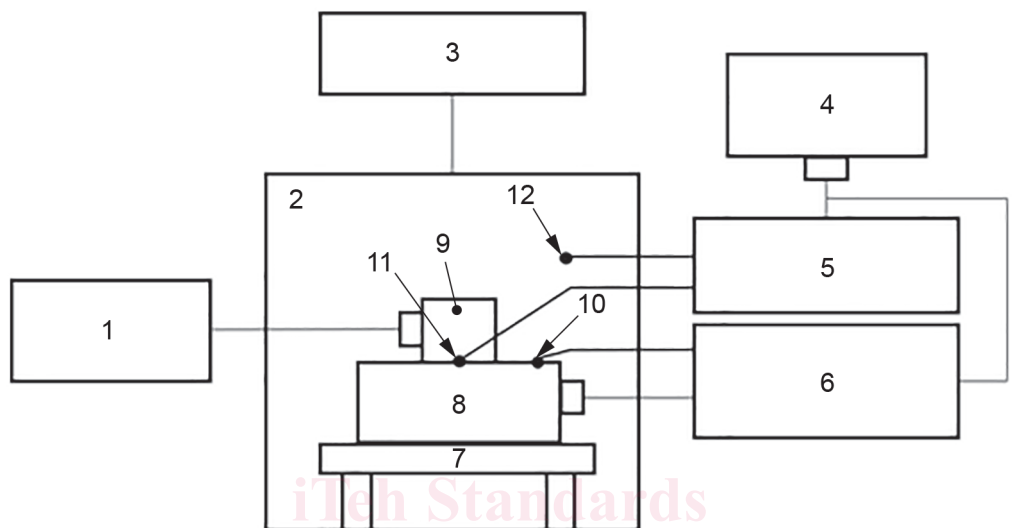
4.3 Stabilization time

The measurements shall be carried out after a sufficient stabilization time has elapsed. The first state stabilization time (step in Clause 5, list item c)) is defined as the time taken for the test chamber temperature to stabilize at the required ambient temperature $\pm 1,0\text{ °C}$. The second state stabilization time (step in Clause 5, list item e)) is defined as the time taken for the fixture surface to stabilize at the required contact-surface temperature $\pm 1,0\text{ °C}$.

4.4 Test setup

4.4.1 General

Figure 1 shows the test setup for measuring the electrical characteristics of a device being tested. To measure the contact surface temperature of a wearable electronic device and the ambient temperature, the device shall be mounted on a human skin-imitating fixture and thermocouples for temperature measurements shall be set at appropriate positions.



IEC

Key

- 1 controller/driver
- 2 temperature controlled environment chamber
- 3 temperature/humidity controller
- 4 computer for recording
- 5 thermometer
- 6 heater controller
- 7 support table
- 8 human skin-imitating fixture
- 9 device under test
- 10 thermocouple 1 (TC 1)
- 11 thermocouple 2 (TC 2)
- 12 thermocouple 3 (TC 3)

Figure 1 – Test setup for evaluating the contact-surface temperature of a wearable electronic device

4.4.2 Placement of device under test (DUT)

The device being tested shall be positioned on the human skin-imitating fixture in the geometric centre of the chamber by adjusting the position of the human skin-imitating fixture. The human skin-imitating fixture may be placed on a support table to adjust the position of the device under test. Any support table shall be made from a low thermal conductivity material ($\lambda < 0,5 \text{ W/mK}$). The positioning of the device on the human skin-imitating fixture shall follow, where provided, the method specified by the manufacturer to attach the device on the human body. The device shall be attached to ensure firm contact with no significant separation from the human skin-imitating fixture. There shall be no structures above the device being tested which may disturb the convection air flow. There shall be no significant external air movement sources affecting the device being tested, such as fan-forced air movement or ambient air movement.

4.4.3 Thermocouple placement

Thermocouple TC 2 for measuring the contact-surface temperature shall be positioned at the hottest point of the skin-contact surface. The hottest point is defined as the region with the highest temperature on the skin-contact surface of the wearable electronic device. This point has the shortest thermal path from the heat source inside the wearable electronic device to the contact-surface and can be determined by obtaining a thermographic mapping image of the skin-contact surface using infrared imaging by operating the wearable electronic device before placement on the human skin-imitating fixture. Thermocouple TC 3 for measuring the ambient temperature shall be positioned inside the test chamber such that disturbance of the convection air flow is avoided.

4.4.4 Device operating conditions

The normal operating conditions, abnormal operating conditions, and single fault conditions shall be set according to methods defined in IEC 62368-1:2018, Annex B when measuring the contact-surface temperature during device operation. The device operating mode may be set according to its functions. Further guidance is given in Annex C. An external power source to operate the DUT may be used instead of an internal power source such as a battery inside the device if the heat from the internal power source is negligible.

NOTE IEC 62368-1 defines only the test temperature and thermal criteria for skin burn without providing detailed test conditions. In this document, test conditions considering human skin and detailed measurement setup for the precise temperature measurement are defined to prevent low-temperature skin burn during long periods of contact with wearable electronic devices. See Annex A.

5 Test method

The procedure for testing a wearable electronic device is performed as follows.

- a) The human skin-imitating fixture is placed inside the test chamber.
- b) Thermocouples are placed:
 - inside the test chamber for ambient temperature measurement (TC 3);
 - on the surface of the human skin-imitating fixture as indicated in Figure B.2 and connected to the heater controller for skin-imitating temperature control (TC 1); and
 - on the DUT for contact-surface temperature measurement (TC 2).
- c) The test chamber ambient temperature and humidity shall reach stabilization before continuing (first state stabilization time). The chamber temperature should be set at 25,0 °C +0 °C, –5 °C according to IEC GUIDE 117:2010, 3.7.
- d) The heater of the human skin-imitating fixture is set such that the skin-imitating temperature is maintained within the designated temperature range.
- e) The human skin-imitating fixture shall reach stabilization before continuing (second state stabilization time).
- f) The DUT with the attached thermocouple is placed on the human skin-imitating fixture.
- g) The operating conditions of the DUT are set. The device may be using an internal or external power source.
- h) The contact-surface temperature measurements start by operating the DUT.
- i) The measurements end when the contact-surface temperature reaches its maximum stable value within 1,0 °C in 20 min.
- j) Repeat steps from list items g) to i) according to each operating condition.