IEC 60695-11-11

Edition 1.0 2021-05

INTERNATIONAL STANDARD

NORME INTERNATIONALE

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BASIC SAFETY PUBLICATION

PUBLICATION FONDAMENTALE DE SÉCURITÉ

Fire hazard testing – Part 11-11: Test flames – Determination of the characteristic heat flux for ignition from a non-contacting flame source

Essais relatifs aux risques du feu – Partie 11-11: Flammes d'essai – Détermination de la densité de flux de chaleur caractéristique pour l'allumage à partir d'une flamme source sans contact

IEC 60695-11-11:2021-05(en-fr)

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

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

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FIRE HAZARD TESTING –

**Part 11-11: Test flames –
Determination of the characteristic heat flux
for ignition from a non-contacting flame source**

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.
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IEC 60695-11-11 has been prepared by IEC technical committee 89: Fire hazard testing.

It has the status of a basic safety publication in accordance with IEC Guide 104 and ISO/IEC Guide 51.

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

CDV	Report on voting
89/1482/CDV	89/1507/RVC

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.

This international standard is to be used in conjunction with IEC 60695-11-4.

A list of all the parts in the IEC 60695 series, under the general title *Fire hazard testing*, can be found on the IEC website.

Part 11 consists of the following parts:

Part 11-2: Test flames – 1 kW nominal pre-mixed flame – Apparatus, confirmatory test arrangement and guidance

Part 11-3: Test flames – 500 W flames – Apparatus and confirmational test methods

Part 11-4: Test flames – 50 W flame – Apparatus and confirmational test method

Part 11-5: Test flames – Needle-flame test method – Apparatus, confirmatory test arrangement and guidance

Part 11-10: Test flames – 50 W horizontal and vertical flame test methods

Part 11-11: Test flames – Determination of the characteristic heat flux for ignition from non-contacting flame source

Part 11-20: Test flames – 500 W flame test methods

Part 11-30: Test flames – History and development from 1979 to 1999

Part 11-40: Test flames – Confirmatory tests – Guidance

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.

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INTRODUCTION

In the design of any electrotechnical product, the risk of fire and the potential hazards associated with fire need to be considered. In this respect the objective of component, circuit and equipment design as well as the choice of materials is to reduce, to acceptable levels, the potential risks of fire even in the event of foreseeable abnormal use, malfunction or failure. IEC 60695-1-10, IEC 60695-1-11 and IEC 60695-1-12 provide guidance on how this is to be accomplished.

Fires involving electrotechnical products can be initiated from external non-electrical sources. Considerations of this nature are dealt with in an overall fire hazard assessment.

The aim of the IEC 60695 series of standards is to save lives and property by reducing the number of fires or reducing the consequences of the fire. This can be accomplished by

– trying to prevent ignition caused by an electrically energised component part and, in the event of ignition, to confine any resulting fire within the bounds of the enclosure of the electrotechnical product.
– trying to minimise flame spread beyond the product's enclosure and to minimise the harmful effects of fire effluents including heat, smoke and toxic or corrosive combustion products.

This international standard is to be used to measure and describe the properties of materials used for electrotechnical products and sub-assemblies in response to heat from a non-contacting flame source or heat source under controlled laboratory conditions which is characterized by quantitative heat input (heat flux) to the materials. Results of this test may be used as elements of a fire risk assessment which takes into account all of the factors which are pertinent to an assessment of the fire hazard of a particular end use. A test specimen cut from an end-product or sub-assembly can be tested by this test method.

This international standard may involve hazardous materials, operations, and equipment. It does not purport to address all of the safety problems associated with its use. It is the responsibility of the user to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

Test methods to determine flammability by contact of flame have been developed and standardized already, such as IEC 60695-11-5 [1][1], IEC 60695-11-10 [2], IEC 60695-11-20 [3] and ISO 4589-2 [4].

This is the first test method to determine the characteristic heat flux for ignition (CHFI) of materials used for electrotechnical products, sub-assemblies or parts from a non-contacting flame source. CHFI characterizes ignition behaviour in terms of incident heat flux. This test method simulates the fire behaviour of materials used for electrotechnical products where a flame source or heat source exists close to, but does not contact with, these items. An example is a candle flame near an electrotechnical product.

1 Numbers in square brackets refer to the bibliography.

FIRE HAZARD TESTING –

Part 11-11: Test flames – Determination of the characteristic heat flux for ignition from a non-contacting flame source

1 Scope

This part of IEC 60695 describes a test method used to determine the characteristic heat flux for ignition (CHFI) from a non-contacting flame source for materials used in electrotechnical products, sub-assemblies or their parts. It provides a relationship between ignition time and incident heat flux. A test specimen cut from an end-product or sub-assembly can be tested by this test method.

This part of IEC 60695 can be used in the fire hazard assessment and fire safety engineering procedures described in IEC 60695-1-10, IEC 60695-1-11 and IEC 60695-1-12.

This basic safety publication is intended for use by technical committees in the preparation of standards in accordance with the principles laid down in IEC Guide 104 and ISO/IEC Guide 51.

One of the responsibilities of a technical committee is, wherever applicable, to make use of basic safety publications in the preparation of its publications. The requirements, test methods or test conditions of this basic safety publication will not apply unless specifically referred to or included in the relevant publications.

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 60695-1-10, *Fire hazard testing – Part 1-10: Guidance for assessing the fire hazard of electrotechnical products – General guidelines*

IEC 60695-1-11, *Fire hazard testing – Part 1-11: Guidance for assessing the fire hazard of electrotechnical products – Fire hazard assessment*

IEC 60695-1-12, *Fire hazard testing – Part 1-12: Guidance for assessing the fire hazard of electrotechnical products – Fire safety engineering*

IEC 60695-4, *Fire hazard testing – Part 4: Terminology concerning fire tests for electrotechnical products*

IEC 60695-11-4, *Fire hazard testing – Part 11-4: Test flames – 50 W flame – Apparatus and confirmational test method*

IEC GUIDE 104, *The preparation of safety publications and the use of basic safety publications and group safety publications*

ISO/IEC Guide 51, *Safety aspects – Guidelines for their inclusion in standards*

ISO 13943:2017, *Fire safety – Vocabulary*

ISO 291, *Plastics – Standard atmospheres for conditioning and testing*

ISO/TS 14934-4, *Fire tests – Calibration of heat flux meters – Part 4: Guidance on the use of heat flux meters in fire tests*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13943:2017 and IEC 60695-4, some of which are reproduced below for the user's convenience, as well as the following apply.

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

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

3.1
average ignition time, $\bar{t}_{ig}$
arithmetic mean of three ignition times measured at a given heat flux

3.2
characteristic heat flux for ignition
CHFI
maximum incident heat flux which is a multiple of 5 kW/m^2 and at which $\bar{t}_{ig}$ is greater than 120 s

3.3
draught-free environment
space in which the results of experiments are not significantly affected by the local air speed

Note 1 to entry: A quantitative example is a space in which a wax candle flame remains essentially undisturbed. Quantitative examples are small-scale fire tests in which a maximum air speed of 0,1 m/s or 0,2 m/s is sometimes specified

[SOURCE ISO 13943:2017, 3.83]

3.4
heat flux
amount of thermal energy emitted, transmitted or received per unit area and per unit of time

Note 1 to entry: the typical unit is W/m^2

[SOURCE ISO 13943:2017, 3.201]

3.5
ignition
initiation of combustion which results in a sustained flaming combustion for at least 5 s

Note 1 to entry: The term "ignition" in French has a very different meaning [state of body combustion].

3.6
incident heat flux
heat flux received by the surface of a test specimen

[SOURCE: ISO 13943:2017, 3.226]

4 Principle of the test

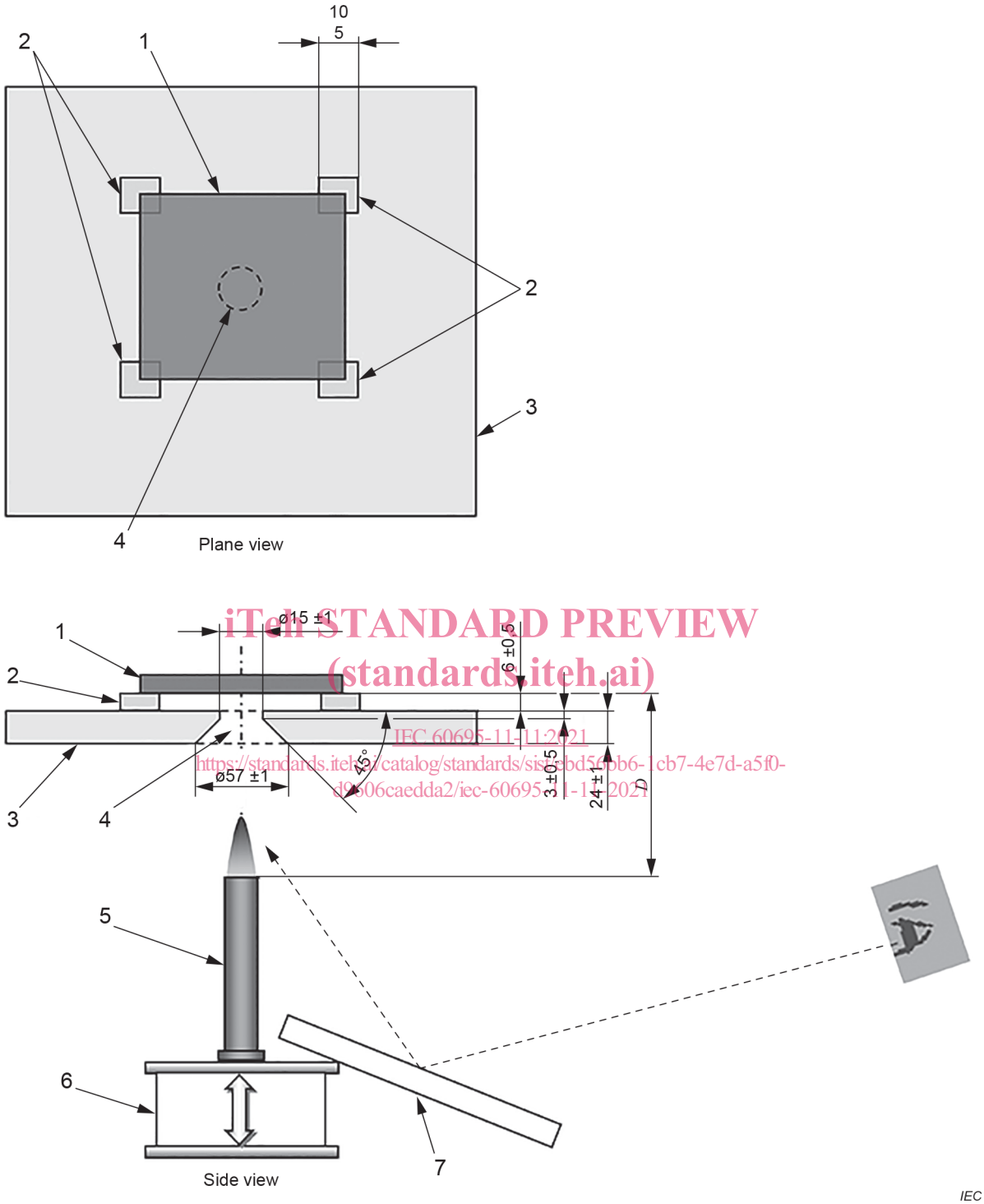
The incident heat flux, Q, is measured using the apparatus described in 5.3 and 5.4. The incident heat flux is controlled by the distance, D, between the top of the burner tube and the lower surface of the test specimen and by the flow rate of fuel gas to the burner (See Annex A). The time required to ignite the test specimen is measured as a function of the incident heat flux. The tests are performed at different levels of incident heat flux until the maximum heat flux, at which the average ignition time $\bar{t}_{ig}$ is greater than 120 s, is obtained. This maximum heat flux is defined as the characteristic heat flux for ignition (CHFI). The incident heat flux values at which the tests are carried out are chosen within the range of 30 kW/m^2 to 75 kW/m^2 and shall be integral multiples of 5 kW/m^2.

5 Apparatus

5.1 Test arrangement

The arrangement of the apparatus and the position of the test specimen and burner are shown in Figure 1. The test specimen and masking board shall be mounted horizontally. The burner tube shall be mounted vertically. The centre of the test specimen, the burner tube, the sensor of the heat flux meter and the conical hole in the masking board shall all be aligned vertically. The sensor of the heat flux meter shall be placed horizontally 6 mm above the upper surface of the masking board with its sensing surface facing down, i.e. the sensing surface of the heat flux meter is placed in the horizontal plane where the lower surface of the test specimen is placed.

Dimensions in millimetres



Key

1 Test specimen
2 Test specimen support
3 Masking board
4 Conical hole (diameter at the top side 15 mm)
5 Burner tube and test flame (inner diameter 9,5 mm)
6 Burner support (adjustable vertically)
7 Mirror
D Distance between the top of the burner tube and the lower surface of the test specimen

Figure 1 – Arrangement and position of test specimen and burner

5.2 Burner and test flame

The burner shall conform to IEC 60695-11-4. The flame size and the gas flow rate will differ from that specified in IEC 60695-11-4 in order to obtain the heat flux necessary for the test. The test flame used for each test shall be kept unchanged throughout the test. The fuel gas shall be methane gas having a purity of 98 % or greater.

5.3 Heat flux meter

The heat flux meter shall be of a water-cooled thermopile type (see ISO/TS 14934-4) which determines the incident heat flux, Q, applied to the test specimen.

When incident heat flux measurements are made, the heat flux meter shall be placed in the centre of a heat flux meter mounting board, and the heat flux meter shall not have any optical filter in-line with the sensor.

NOTE 1 The incident heat flux measurement is of critical importance to the test results. ISO 14934-3 [5] provides the calibration method for the heat flux meter.

NOTE 2 A heat flux meter of Schmidt-Boelter type with a thermopile, which has a measurement range of up to 100 kW/m^2 and a target diameter of approximately 12,5 mm, has been found to be suitable for the purpose of this international standard.

5.4 Data acquisition system

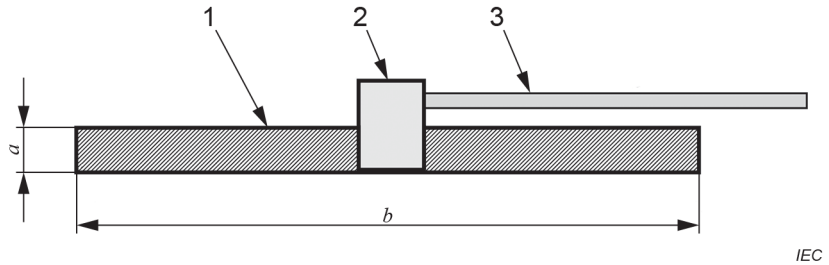
The voltmeter for measuring the output of the heat flux meter shall have a resolution of 0,01 % or better for the maximum output range.

NOTE The usual output level of the heat flux meter is several tens of millivolts.

5.5 Heat flux meter mounting board

The heat flux meter mounting board shall be approximately 75 mm × 75 mm × 12 mm with a centrally located hole whose diameter is slightly larger than the outside diameter of the heat flux meter. The board shall be made from a heat-resistant non-combustible rigid board. The heat flux meter mounting board is used, together with the heat flux meter (see Figure 2), for the determination of incident heat flux, Q (see 8.1).

NOTE A calcium silicate board of approximately 12 mm thickness having a dry density of approximately (850 ± 50) kg/m^3 has been found suitable for the heat flux meter mounting board.



Key

1 Heat flux meter mounting board

2 Heat flux meter

3 Cooling water pipe

a Approximately 12 mm

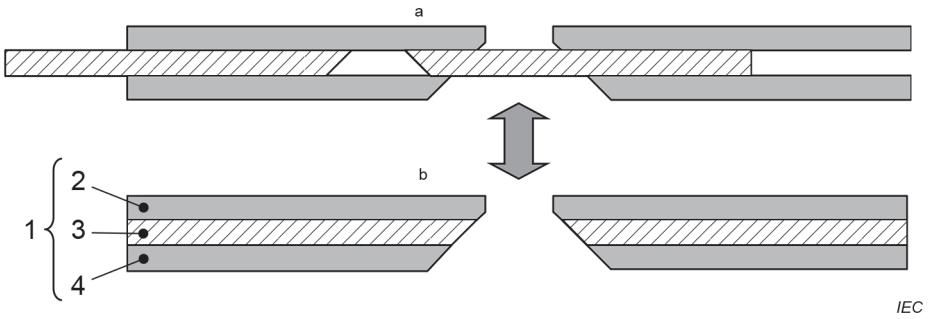
b Approximately 75 mm

Figure 2 – Heat flux meter mounting board

5.6 Masking board

The masking board shall consist of three heat-resistant non-combustible rigid boards, each having a dry density of (850 ± 50) kg/m^3 and a thickness of (8 ± 0,5) mm. The total thickness of the three non-combustible boards shall be (24 ± 1,5) mm. One board is inserted between the upper and lower boards and shall be made moveable. This moveable board works as a radiant heat shield which protects the test specimen from the heat source before the commencement of the test. There shall be a conically shaped opening at the centre of the masking board. The diameter of the opening on the upper surface shall be (15 ± 1) mm and (57 ± 1) mm on the lower surface. An illustration of the masking board and its operation is shown in Figure 3.

NOTE A calcium silicate board of the required density has a thermal conductivity of 0,14 W·m^{-1}·K^{-1} at 200 °C, 0,15 W·m^{-1}·K^{-1} at 400 °C, and 0,17 W·m^{-1}·K^{-1} at 600 °C.



Key

1 Masking board

2 Upper board

3 Moveable board (Radiant heat shield)

4 Lower board

a Position of the moveable masking board prior to a test

b Position of the moveable masking board during a test

Figure 3 – Structure of the masking board

5.7 Timing device

The timing device shall have a resolution of 0,5 s or better.

5.8 Conditioning chamber

The conditioning chamber shall have a capability of maintaining the temperature at (23 ± 2) ºC, and the relative humidity within (50 ± 10) % (see ISO 291).

5.9 Test specimen support

The test specimen support shall maintain a distance of (6 ± 0,5) mm between the lower surface of the test specimen and the upper surface of the masking board.

5.10 Burner support

The burner shall be located on a support which can adjust the position of the burner in the vertical direction. The distance, D, between the top of the burner tube and the lower surface of the test specimen shall be determined using a suitable measuring device which has a resolution of 1 mm or better.

5.11 Observation mirror

To observe the ignition behaviour of the test specimen, an observation mirror approximately 100 mm × 100 mm shall be positioned underneath the masking board (See Figure 1).

5.12 Flow controller

The fuel gas flow controller shall have a control range of between 100 ml/min and 200 ml/min, and have a resolution of 5 ml/min or better.

5.13 Heat flux meter supporting device

In order to correctly place the heat flux meter at the measurement position, the heat flux meter supporting device as shown in Figure 4 shall be used.

Dimensions in millimetres

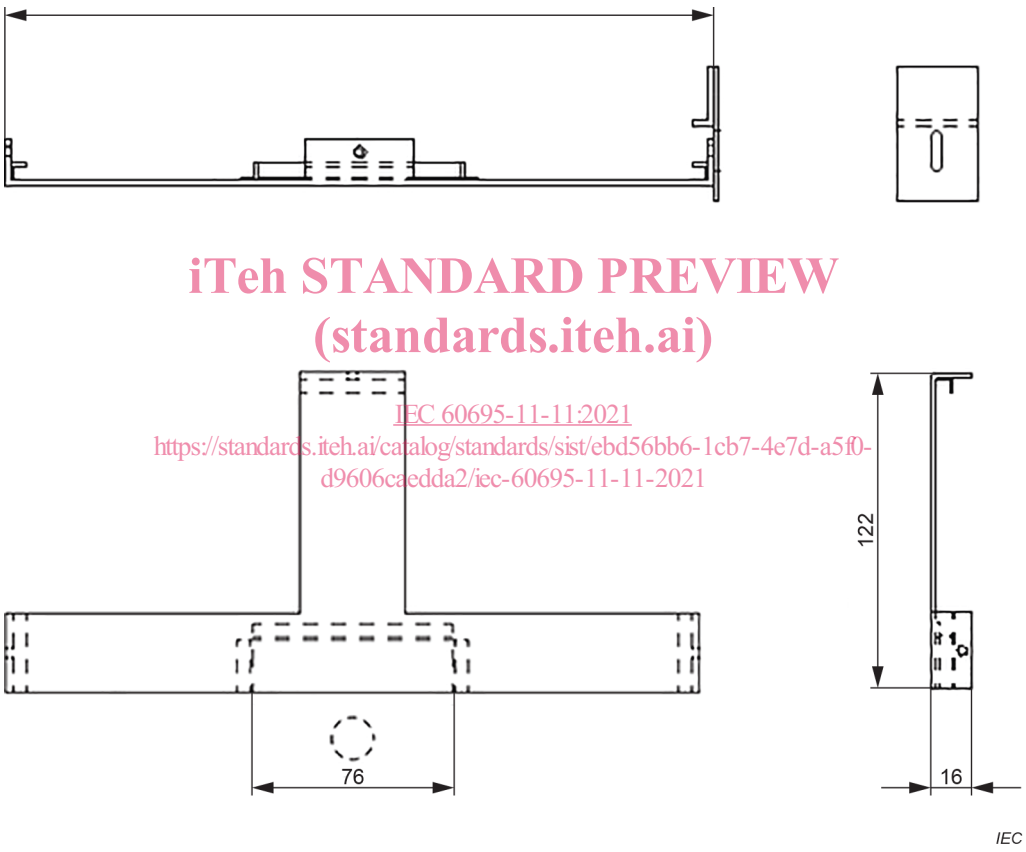


Figure 4 – Heat flux meter supporting device

6 Test specimen

6.1 Dimensions of test specimen

The test specimen shall be a flat plate. Each test specimen shall be at least (77,5 ± 2,5) mm in length and width and at the thickness under consideration. The preferred thicknesses for the presentation of comparative data include (0,4 ± 0,05) mm, (0,75 ± 0,1) mm, (1,5 ± 0,1) mm, (3,0 ± 0,2) mm and (6,0 ± 0,4) mm.