

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE

Lamp controlgear **STANDARD PREVIEW**  
Part 2-10: Particular requirements for electronic invertors and convertors for  
high-frequency operation of cold start tubular discharge lamps (neon tubes)

Appareillages de lampes **IEC 61347-2-10:2000+AMD1:2008 CSV**  
Partie 2-10: Prescriptions particulières pour onduleurs et convertisseurs  
électroniques destinés à l'alimentation en haute fréquence des lampes  
tubulaires à décharge à démarrage à froid (tubes néon)



## THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2009 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 la CEI ou du Comité national de la CEI du pays du demandeur.

Si vous avez des questions sur le copyright de la CEI ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de la CEI de votre pays de résidence.

IEC Central Office  
3, rue de Varembe  
CH-1211 Geneva 20  
Switzerland  
Email: [inmail@iec.ch](mailto:inmail@iec.ch)  
Web: [www.iec.ch](http://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.

- Catalogue of IEC publications: [www.iec.ch/searchpub](http://www.iec.ch/searchpub)

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 It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: [www.iec.ch/online\\_news/justpub](http://www.iec.ch/online_news/justpub)

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

- Electropedia: [www.electropedia.org](http://www.electropedia.org)

The world's leading online dictionary of electronic and electrical terms containing more than 20 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary online.

- Customer Service Centre: [www.iec.ch/webstore/custserv](http://www.iec.ch/webstore/custserv)

If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:

Email: [csc@iec.ch](mailto:csc@iec.ch)  
Tel.: +41 22 919 02 11  
Fax: +41 22 919 03 00

### A propos de la CEI

La Commission Electrotechnique Internationale (CEI) 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 CEI

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

- Catalogue des publications de la CEI: [www.iec.ch/searchpub/cur\\_fut-f.htm](http://www.iec.ch/searchpub/cur_fut-f.htm)

Le Catalogue en-ligne de la CEI vous permet d'effectuer des recherches en utilisant différents critères (numéro de référence, texte, comité d'études,...). Il donne aussi des informations sur les projets et les publications retirées ou remplacées.

- Just Published CEI: [www.iec.ch/online\\_news/justpub](http://www.iec.ch/online_news/justpub)

Restez informé sur les nouvelles publications de la CEI. Just Published détaille deux fois par mois les nouvelles publications parues. Disponible en-ligne et aussi par email.

- Electropedia: [www.electropedia.org](http://www.electropedia.org)

Le premier dictionnaire en ligne au monde de termes électroniques et électriques. Il contient plus de 20 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans les langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International en ligne.

- Service Clients: [www.iec.ch/webstore/custserv/custserv\\_entry-f.htm](http://www.iec.ch/webstore/custserv/custserv_entry-f.htm)

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions, visitez le FAQ du Service clients ou contactez-nous:

Email: [csc@iec.ch](mailto:csc@iec.ch)  
Tél.: +41 22 919 02 11  
Fax: +41 22 919 03 00

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE

---

Lamp controlgear – **STANDARD PREVIEW**  
Part 2-10: Particular requirements for electronic invertors and convertors for  
high-frequency operation of cold start tubular discharge lamps (neon tubes)

IEC 61347-2-10:2000+AMD1:2008 CSV  
Appareillages de lampes –  
Partie 2-10: Prescriptions particulières pour onduleurs et convertisseurs  
électroniques destinés à l'alimentation en haute fréquence des lampes  
tubulaires à décharge à démarrage à froid (tubes néon)

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

COMMISSION  
ELECTROTECHNIQUE  
INTERNATIONALE

## CONTENTS

FOREWORD.....	3
INTRODUCTION.....	5
1 Scope.....	6
2 Normative references .....	6
3 Definitions .....	7
4 General requirements .....	8
5 General notes on tests .....	8
6 Classification.....	8
7 Marking .....	8
7.1 Items to be marked.....	8
7.2 Durability and legibility of marking .....	8
8 Terminals .....	9
9 Provisions for earthing.....	9
10 Protection against accidental contact with live parts .....	9
11 Moisture resistance and insulation.....	10
12 Electric strength .....	10
13 Thermal endurance test for windings .....	10
14 Normal conditions.....	10
15 Abnormal conditions .....	11
16 Fault conditions .....	11
17 Construction.....	12
18 Creepage distances and clearances .....	12
19 Protective circuits .....	12
20 Screws, current-carrying parts and connections.....	14
21 Resistance to heat, fire and tracking.....	14
22 Resistance to corrosion .....	14
23 No-load rated output voltage and rated output current .....	14
23.1 No-load rated output voltage .....	14
23.2 Rated output current.....	14
23.3 Compliance .....	14
Annexes .....	15

iTeh STANDARD PREVIEW  
(standards.iteh.ai)

[IEC 61347-2-10:2000+AMD1:2008.CSV](https://standards.iteh.ai/catalog/standards/sist/36aeb46c-9521-4409-b0fb-e7a997fca56d/iec-61347-2-10-2000amd1-2008-csv)

<https://standards.iteh.ai/catalog/standards/sist/36aeb46c-9521-4409-b0fb-e7a997fca56d/iec-61347-2-10-2000amd1-2008-csv>

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

## LAMP CONTROLGEAR –

**Part 2-10: Particular requirements for electronic invertors  
and convertors for high-frequency operation of cold start  
tubular discharge lamps (neon tubes)**

## 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 provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
- 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 61347-2-10 has been prepared by subcommittee 34C: Auxiliaries for lamps, of IEC technical committee 34: Lamps and related equipment.

This consolidated version of IEC 61347-2-10 consists of the first edition (2000) [documents 34C/507/FDIS and 34C/521/RVD] and its amendment 1 (2008) [documents 34C/849/FDIS and 34C/859/RVD].

The technical content is therefore identical to the base edition and its amendment and has been prepared for user convenience.

It bears the edition number 1.1.

A vertical line in the margin shows where the base publication has been modified by amendment 1.

This standard shall be used in conjunction with IEC 61347-1. It was established on the basis of the first edition (2000) of that standard.

This part 2 supplements or modifies the corresponding clauses in IEC 61347-1, so as to convert that publication into the IEC Standard: Particular requirements for electronic invertors and convertors for high-frequency operation of cold start tubular discharge lamps (neon tubes)

NOTE In this standard, the following print types are used:

- Requirements proper: in roman type.
- *Test specifications: in italic type.*
- NOTES: Explanatory matter: in smaller roman type.

Annexes A, B, C, D, E, F, H and I form an integral part of this standard.

IEC 61347 consists of the following parts, under the general title: *Lamp controlgear*:

- Part 1: General and safety requirements
- Part 2-1: Particular requirements for starting devices (other than glow starters)
- Part 2-2: Particular requirements for d.c. or a.c. supplied electronic step-down convertors for filament lamps
- Part 2-3: Particular requirements for a.c. supplied electronic ballasts for fluorescent lamps
- Part 2-4: Particular requirements for d.c. electronic ballasts for general lighting
- Part 2-5: Particular requirements for d.c. supplied electronic ballasts for public transport lighting
- Part 2-6: Particular requirements for d.c. supplied electronic ballasts for aircraft lighting
- Part 2-7: Particular requirements for d.c. supplied electronic ballasts for emergency lighting
- Part 2-8: Particular requirements for ballasts for fluorescent lamps
- Part 2-9: Particular requirements for ballasts for discharge lamps (excluding fluorescent lamps)
- Part 2-10: Particular requirements for electronic invertors and convertors for high frequency operation of cold start tubular discharge lamps (neon tubes)
- Part 2-11: Particular requirements for miscellaneous electronic circuits used with luminaires

The committee has decided that the contents of the base publication and its amendments will remain unchanged until the maintenance result 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.

## INTRODUCTION

This part of IEC 61347, and the parts which make up IEC 61347-2, in referring to any of the clauses of IEC 61347-1, specify the extent to which such a clause is applicable and the order in which the tests are to be performed; they also include additional requirements, as necessary. All parts which make up IEC 61347-2 are self-contained and, therefore, do not include references to each other.

Where the requirements of any of the clauses of IEC 61347-1 are referred to in this standard by the phrase "The requirements of clause n of IEC 61347-1 apply", this phrase is interpreted as meaning that all requirements of the clause in question of part 1 apply, except any which are clearly inapplicable to the specific type of lamp controlgear covered by this particular part of IEC 61347-2.

## **iTeh STANDARD PREVIEW** **(standards.iteh.ai)**

[IEC 61347-2-10:2000+AMD1:2008 CSV](https://standards.iteh.ai/catalog/standards/sist/36aeb46c-9521-4409-b0fb-e7a997fca56d/iec-61347-2-10-2000amd1-2008-csv)

<https://standards.iteh.ai/catalog/standards/sist/36aeb46c-9521-4409-b0fb-e7a997fca56d/iec-61347-2-10-2000amd1-2008-csv>

## LAMP CONTROLGEAR –

### Part 2-10: Particular requirements for electronic invertors and convertors for high-frequency operation of cold start tubular discharge lamps (neon tubes)

#### 1 Scope

This part of IEC 61347 specifies particular requirements for electronic invertors and convertors for high-frequency operation of tubular cold-cathode discharge lamps used in signs and luminous discharge tube installations and operating with an output voltage exceeding 1 000 V but not exceeding 10 000 V for direct connection to supply voltages not exceeding 1 000 V at 50 Hz or 60 Hz or 1 000 V d.c.

NOTE 1 In Japan, the output voltage of 15 000 V is acceptable.

The requirements for two types of invertors and convertors, types A and B, are specified as follows:

- Type A unit: an invertor or convertor operating within the frequency range 20 kHz to 50 kHz, and having an output voltage (between terminals) not exceeding 5 000 V peak, a maximum output current limited to 35 mA (r.m.s.) and 50 mA (peak value). The supply voltage does not exceed 250 V at 50 Hz or 60 Hz or 250 V d.c.

NOTE 2 The output current of a type A unit may be considered as not presenting an electric shock hazard due to the limits on the current and frequency range.

NOTE 3 In Japan, the output voltage of 15 000 V is acceptable.

- Type B unit: an invertor or convertor having a no-load output voltage not exceeding 5 000 V to earth or 10 000 V between terminals, operating within the frequency range 10 kHz to 100 kHz with a maximum output current limited to 200 mA (r.m.s.) and 400 mA (peak value).

NOTE 4 Type B units require additional protection in the output circuit.

NOTE 5 In Japan, a type B unit exceeding 50 mA and/or the secondary grounded is not acceptable.

In order to check the safety of invertors or convertors, it is necessary to check their performance. However, since no standardization of the characteristics of neon tubes exists, reference loads are specified in this standard to ensure reproducible test results.

The rated maximum operating temperature of the winding,  $t_w$ , is not applicable to this standard.

#### 2 Normative references

For the purpose of this part of IEC 61347, the normative references given in clause 2 of IEC 61347-1 which are mentioned in this standard apply, together with the following normative references:

IEC 61347-1, *Lamp controlgear – Part 1: General and safety requirements*

ISO 3864:1984, *Safety colours and safety signs*



### 3 Definitions

For the purpose of this part of IEC 61347, the definitions given in clause 3 of IEC 61347-1, with the exception of definitions 3.14, 3.16 and 3.17 apply, together with the following:

#### 3.1

##### **tubular cold cathode discharge lamp (neon tube)**

discharge tube having cathodes which may be coated with an electron emitting material and which, during the starting process without external heating, emits electrons by field emission. These lamps have a low-pressure filling of a rare gas (or a mixture of rare gases) and possibly mercury vapour. They can have an inside coating of fluorescent materials

#### 3.2

##### **no-load rated output voltage**

$U_0$

maximum rated voltage between the output terminals or the ends of the integral connecting leads of the inverter or convertor connected to the rated supply voltage at rated frequency with no load on the output circuit

NOTE For sinusoidal wave forms, it is the r.m.s. value or the peak value divided by square root of 2. For other waveforms, it is the r.m.s. value or the equivalent value deduced from the peak value, obtained by mathematical calculation.

#### 3.3

##### **inverter**

electric energy transducer that converts direct current to alternating current

#### 3.4

##### **convertor**

unit for the electronic conversion of a.c. supply at one frequency to an a.c. supply at another frequency

#### 3.5

##### **earth-leakage protective device**

device which removes the output power from an inverter or convertor in the event of an earth fault current flowing between any part of the output high-voltage circuit and earth

#### 3.6

##### **open-circuit protective device**

device which removes the output power from an inverter or convertor in the event of non-operation of the tube load or an interruption in the output high-voltage circuit

NOTE An open-circuit protective device may operate by detecting an increase in the output voltage or by other suitable means.

#### 3.7

##### **upper shut-down limit**

output voltage of an inverter or convertor at which an open-circuit protective device operates

#### 3.8

##### **output high-voltage circuit**

that part of the circuit consisting of

- cables between the output terminals of the convertor or inverter and the discharge tubes;
- discharge tubes;
- any series connections between the discharge tubes.

It does not include any internal components or wiring of the inverter or convertor.

iTeh STANDARD PREVIEW  
(standards.iteh.ai)

IEC 61347-2-10:2000+AMD1:2008 CSV

<https://standards.iteh.ai/catalog/standards/sist/36aeb46c-9521-4409-b0fb->

<https://standards.iteh.ai/catalog/standards/sist/36aeb46c-9521-4409-b0fb->

## 4 General requirements

The general requirements of clause 4 of IEC 61347-1 apply.

## 5 General notes on tests

The general requirements of clause 5 of IEC 61347-1 apply.

## 6 Classification

The requirements of clause 6 of IEC 61347-1 apply, together with the following:

Invertors and convertors shall be classified according to their no-load output voltage, the rating of the operating frequency and output current range, as follows:

- a) type A invertor or convertor;
- b) type B invertor or convertor.

Type B invertors or convertors may have more than one output. In this case, each output shall comply with the above.

## 7 Marking

iTeh STANDARD PREVIEW

### 7.1 Items to be marked (standards.iteh.ai)

Electronic invertors and convertors for high-frequency operation of cold start tubular discharge lamps shall be clearly and durably marked, in accordance with the requirements of 7.2 of IEC 61347-1, with the following markings:

- items a), b), c), d), e) and f) of 7.1 of IEC 61347-1, together with
- on independent electronic invertors and convertors, a warning notice for high voltage, e.g. "HIGH VOLTAGE" and a symbol in the form of an arrow in accordance with IEC 60417 and figure 1 of ISO 3864.

This marking shall be placed on the outside of the enclosure of the electronic invertor or convertor so that it is clearly visible.

NOTE It is not necessary to mark integral invertors or convertors separately as their marking is the subject of relevant sign or luminaire standards.

- type A or type B as applicable.

### 7.2 Durability and legibility of marking

In addition to the above mandatory marking, the following information, if applicable, shall be given on the electronic invertor or convertor, or be made available in the manufacturer's catalogue or similar:

- items h), k), m), n) and o) of 7.1 of IEC 61347-1, together with
- if the electronic invertor or convertor consists of more than one separate unit, the units providing the output shall be marked with necessary information about other associated units such as d.c power supplies or capacitors;
- the range and number of tube types, diameters and lengths recommended for the invertor or convertor;
- where the invertor or convertor is not supplied with integral leads, (tails) details of the recommended cable types and maximum cable lengths;
- details of suitable types of mounting surfaces and recommended mounting arrangements;

- details of earthing arrangements, including connections to the inverter or converter output winding, where appropriate;
- details of any protective circuits incorporated in the inverter or converter;
- the following nominal electrical characteristics:

1) output no-load voltage. This marking shall be in the following terms:

- if the output terminal is not connected to an earthing terminal:  
“...kV” (e.g. 4 kV),
- if one output terminal is connected to an earthing terminal:  
“E -...kV” (e.g. E – 4 kV),
- if the centre point of the output winding is referred to an earthing terminal:  
“... - E -...kV” (e.g. 3 – E – 3 kV);

NOTE In Japan, E - .kV and - E - kV are not used.

For type A units, this will be the peak value. For type B units, it will be the r.m.s. value or 0,5 times the peak value, whichever is the greater.

- 2) output current with rated load;
- 3) output frequency.

Where appropriate, the details in items 1) and 2) above shall be marked for each independent output circuit of an inverter or converter.

## 8 Terminals

iTeh STANDARD PREVIEW

The requirements of clause 8 of IEC 61347-1 apply, together with the following:

Inverters or converters provided with tails shall comply with the relevant requirements of IEC 60598-1.

<https://standards.iteh.ai/catalog/standards/sist/36aeb46c-9521-4409-b0fb-e7a997fca56d/iec-61347-2-10-2000amd1-2008-csv>

## 9 Provisions for earthing

The requirements of clause 9 of IEC 61347-1 apply, together with the following:

For type B inverters or converters, the earthing terminal shall be connected to a part of the output circuit except where

- the earthing terminal is connected to a part of the output circuit through means to detect earth-fault currents, or
- there is no direct connection between any part of the output circuit and the earth terminal, and for example, part(s) of that output circuit are referenced to earth potential by means of the internal circuits.

*Compliance is checked by inspection.*

NOTE In Japan, this clause is not applicable.

## 10 Protection against accidental contact with live parts

The requirements of clause 10 of IEC 61347-1 apply, together with the following:

**10.1** The remaining charge between terminals in the output circuit of an inverter or converter following a worst case of disconnection shall not exceed 45  $\mu\text{C}$ .

*Compliance is checked by measurement.*

**10.2** Where part(s) of the output circuit of an inverter or converter is(are) not connected to earth, or is(are) not referenced to earth by means of internal circuits, the insulation barrier between the input and output circuits shall consist of double or reinforced insulation (see clause 12, test voltages).

*Compliance is checked by the test of clause 12, test voltages.*

## 11 Moisture resistance and insulation

The requirements of clause 11 of IEC 61347-1 apply, together with the following:

For type A units the capacitance between the output terminals and the metal foil of not less than 100 cm<sup>2</sup> area placed anywhere on the surface of the enclosure of the inverter or converter shall not exceed 50 pF. During the test the converter shall not operate.

## 12 Electric strength

The requirements of clause 12 of IEC 61347-1 apply, together with the following:

Test voltages

The test voltages for all inverters and converters are:

- twice the rated input voltage plus 1 000 V on the input side, with the output circuits connected to external metal parts;
- twice the no-load rated output voltage on the output side, the input circuits being connected to external metal parts.

NOTE In Japan, 1,5 times the test voltage is approved.

Table 10.2 of IEC 60598-1 applies for independent inverters or converters.

## 13 Thermal endurance test for windings

An inverter or converter or its support shall not, under normal or abnormal conditions, have too high a temperature or impair safety.

*Compliance is checked by the tests specified in clauses 14, 15 and 16.*

## 14 Normal conditions

**14.1** The inverter or converter shall be installed in its normal operating position arranged in accordance with the manufacturer's instructions and mounted as shown in figure H.1 of IEC 61347-1. The test shall be carried out in a draught-free enclosure as specified in annex F of IEC 61347-1.

**14.2** The inverter or converter shall be operated with the tube load replaced by the specified load resistor  $R_1$  (see annex I) and with nominal supply voltage.

- In the case of inverters or converters which provide near constant current output, the supply voltage shall be maintained at the nominal value until steady-state temperatures are obtained.
- In the case of inverters or converters which do not provide near constant current output, adjustments shall be made to the supply voltage until the output current is the same as the nominal value specified on the label of the inverter or converter. The output current is then maintained at this value until steady-state temperatures are obtained.

**14.3** *If the inverter or convertor has more than one output, the appropriate load resistors ( $R_1$ ) shall be connected to each pair of output terminals.*

**14.4** *During the test, the temperature on the relevant parts shall not exceed the values specified in tables 12.1 and 12.2 of IEC 60598-1.*

## 15 Abnormal conditions

**15.1** The inverter or convertor shall be operated under the test conditions specified in 15.2, and according to the manufacturer's instructions (including heatsinks and spacers, if specified) at the most onerous voltage between 90 % and 110 % of the rated supply voltage for a period of 1 h. The test shall be carried out in a draught-free enclosure as specified in annex F of IEC 61347-1.

**15.2** The test shall be carried out with one of the following combination of conditions, whichever is the most onerous. The time interval between tests shall not exceed 15 min.

- a) *Conditions 1) to 3) applied sequentially.*
- b) *Conditions 2) and 3) applied simultaneously.*

- 1) *The output circuit(s) shall be short-circuited.*

*If there is more than one output circuit, all circuits shall be short-circuited at the same time.*

NOTE 1 If the inverter or convertor includes means to remove the output power in the event of a short-circuit of the output load, this test may be omitted.

- 2) *The abnormal load resistor  $R_2$  (see annex I) shall be connected across the output terminals. If the inverter or convertor has more than one output, the appropriate abnormal resistors  $R_2$  shall be connected to each pair of output terminals at the same time.*

- 3) *The inverter or convertor shall be mounted on a 1 mm thick metal sheet, whose material shall be specified by the manufacturer.*

*If not specified, then either steel or aluminium (whichever provides the worst condition) shall be used.*

NOTE 2 In addition, other materials may be taken into consideration.

**15.3** During and at the end of the tests specified in 15.2, the inverter or convertor shall show no defect impairing safety, nor shall any smoke be produced.

The temperature of any part of the outer surface of an independent inverter or convertor shall not exceed 90 °C. In addition, the output current and voltage shall not exceed the values specified in clause 23.

## 16 Fault conditions

The requirements of clause 14 of IEC 61347-1 apply, together with the following:

**16.1** The output current shall not exceed 1,5 times the nominal value specified by the manufacturer under the following conditions:

- a) with the output short-circuited, or in the case of an inverter or convertor having short-circuit protection, with the output connected to resistor  $R_3$  as described in annex I;
- b) with an earth fault of negligible impedance applied on one or both of the output terminals.

NOTE The test of 16.1 b) need not be applied if there is no earth connection to any part of the output circuit; or if the inverter or convertor includes means to remove the output power in the event of a short-circuit between one of the output terminals and earth, in accordance with clause 19.