מכון התקנים הישראלי
The Standards Institution of Israel

תקן ישראלי - ת"י 61347 חלק 2.2

טבת התשס"ג - דצמבר 2002

אבזרי הפעלה ובקרה לנורות: דרישות מיוחדות לממירים אלקטרוניים מורידי מתח לנורות להט המוזנים בזרם ישר או בזרם חילופים

Lamp controlgear: Particular requirements for d.c. or a.c. supplied electronic step-down convertors for filament lamps

תקן זה, למעט השינויים והתוספות המצוינים בו,
זהה לתקן הבין-לאומי IEC 61347-2-2 - 2000

מילות מפתח: ציוד תאורה, ממירים חשמליים, נורות, נורות להט, נורות ליבון, זרם חילופים, זרם ישר, בטיחות חשמל.

Descriptors: lighting equipment, electric convertors, lamps, filament lamps, alternating current, direct current, electrical safety.

תקן זה הוכן על ידי איתן ארז ואיתן רונן.

תקן זה אושר על ידי הוועדה הטכנית 206 - נורות וציוד עזר שלהן ומאור, בהרכב זה:

איגוד הצרכנים בישראל - בלתי תלוי	-	משה ניסנבאום
איגוד התעשייה הקיבוצית	-	דניאל קלינה
איגוד לשכות המסחר בישראל	-	דוד תורג'מן, שלמה פריד
המוסד לבטיחות ולגיהות	-	משה איל
התאחדות המלאכה והתעשייה בישראל	-	מיכאל שינגוט
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מכון התקנים הישראלי	-	צבי אגוזי
משרד הביטחון	-	לריסה מלניק
משרד התשתיות הלאומיות	-	דוד רודיק
רשות ההסתדרות לצרכנות	-	יהודה מינס

איתן רונן ריכז את עבודת הכנת התקן.

הקדמה לתקן הישראלי

תקן ישראלי זה הוא התקן של הנציבות הבין-לאומית לאלקטרוטכניקה IEC 61347-2-2 משנת 2000 (מהדורה ראשונה), שאושר בשפתו האנגלית בלבד כתקן ישראלי בשינויים ובתוספות.

בשפה העברית מובאים:

- סעיף חלות התקן בשינויים ובתוספות
- פירוט השינויים והתוספות לסעיפי התקן הבין-לאומי

התקן הבין-לאומי מובא כלשונו בשפה האנגלית בלבד.

תקן ישראלי זה הוא חלק מסדרת תקנים הדנה באבזרי הפעלה ובקרה לנורות.

חלקי הסדרה הם:

- ת"י 61347 חלק 1 - אבזרי הפעלה ובקרה לנורות: דרישות כלליות ודרישות בטיחות
- ת"י 61347 חלק 2.1 - אבזרי הפעלה ובקרה לנורות: דרישות מיוחדות להתקני הדלקה (למעט מדלקי-להט)
- ת"י 61347 חלק 2.2 - אבזרי הפעלה ובקרה לנורות: דרישות מיוחדות לממירים אלקטרוניים מורידי מתח לנורות להט המוזנים בזרם ישר או בזרם חילופים
- ת"י 61347 חלק 2.3 - אבזרי הפעלה ובקרה לנורות: דרישות מיוחדות לנטלים אלקטרוניים המוזנים בזרם חילופים והמיועדים לשפופרות פלואורניות
- ת"י 61347 חלק 2.4 - אבזרי הפעלה ובקרה לנורות: דרישות מיוחדות לנטלים אלקטרוניים המוזנים בזרם ישר והמיועדים לתאורה כללית
- ת"י 61347 חלק 2.5 - אבזרי הפעלה ובקרה לנורות: דרישות מיוחדות לנטלים אלקטרוניים המוזנים בזרם ישר והמיועדים לתאורה בתחבורה ציבורית
- ת"י 61347 חלק 2.6 - אבזרי הפעלה ובקרה לנורות: דרישות מיוחדות לנטלים אלקטרוניים המוזנים בזרם ישר והמיועדים לתאורה במטוסים
- ת"י 61347 חלק 2.7 - אבזרי הפעלה ובקרה לנורות: דרישות מיוחדות לנטלים אלקטרוניים המוזנים בזרם ישר והמיועדים לתאורת חירום
- ת"י 61347 חלק 2.8 - אבזרי הפעלה ובקרה לנורות: דרישות מיוחדות לנטלים לשפופרות פלואורניות
- ת"י 61347 חלק 2.9 - אבזרי הפעלה ובקרה לנורות: דרישות מיוחדות לנטלים לנורות פריקה (למעט שפופרות פלואורניות)

התקן הבין-לאומי IEC 61347-2-2 הוא חלק מסדרת תקנים בין-לאומיים הדנה באבזרי הפעלה ובקרה לנורות. שמות חלקי סדרת התקנים הבין-לאומיים IEC 61347 מפורטים בהקדמה לתקן הבין-לאומי[א].

[א] סדרת התקנים הבין-לאומיים פורסמה במלואה.

חלות התקן (סעיף 1 של התקן הבין-לאומי בשינויים ובתוספות)

הערה:
השינויים והתוספות בסעיף זה מובאים בגופן שונה.

חלק זה של סדרת התקנים ת"י 61347 מפרט דרישות בטיחות מיוחדות עבור ממירים אלקטרוניים מורידי מתח המיועדים לזינה ממקורות זרם ישר עד 250 וולט או ממקורות זרם חילופים עד 1000 וולט, בתדר 50 הרץ, ואשר מתח המוצא הנקוב שלהם הוא עד 50 וולט בתדר השונה מתדר המקור, או עד $50\sqrt{2}$ וולט בין המוליכים או בין מוליך כלשהו להארקה בזרם ישר פועם, בשילוב עם נורות טונגסטן-הלוגן כמפורט בתקן הישראלי ת"י 1506 ועם נורות להט אחרות.

הערה:
הגבול של 50 וולט מתח מוצא נקוב הוא בהתאם לתחום I של התקן הבין-לאומי IEC 60449.

דרישות מיוחדות עבור ממירים אלקטרוניים מורידי מתח הכוללים אמצעי הגנה מפני חימום יתר מפורטות ב- Annex C.

דרישות מיוחדות עבור ממירים נייחים עצמאיים מטיפוס SELV (מתח בטיחות נמוך מאוד), המהווים חלק מהתיול בהתקנה, מפורטות ב- Annex I.

דרישות ביצועים מפורטות בתקן הבין-לאומי IEC 61047.

על ממירים תקיעים, המהווים חלק מגוף התאורה, חלות הדרישות הנוגעות לממירים מובְנים (build-in) בצירוף הדרישות הנוספות של תקן גוף התאורה.

פירוט השינויים והתוספות לסעיפי התקן הבין-לאומי

2. Normative references

- ראו סעיף Normative references בתקן הבין-לאומי.
- במקום חלק מהתקנים המפורטים בסעיף Normative references באים תקנים ישראליים, כמפורט כלהלן:

התקן הבין-לאומי המוזכר	התקן הישראלי שבא במקומו	הערות
IEC 60065	ת"י 250 - ציוד אלקטרוני המופעל מרשת החשמל והמיועד לשימוש ביתי ולשימוש כללי דומה: דרישות בטיחות	התקן הישראלי זהה, למעט שינויים ותוספות, למהדורת 1985 של התקן הבין-לאומי (לרבות עדכוניה עד 1992)
IEC 60083	ת"י 32 - תקעים ובתי תקע לשימוש ביתי ולשימושים דומים עד 16 אמפר	התקן הישראלי זהה, למעט שינויים ותוספות, ל- IEC 884-1 משנת 1987
IEC 60127 (all parts)	ת"י 740 על חלקיו - תרמילים לנתיכים זעירים	התקן הישראלי מבוסס על מהדורת 1974 של התקן הבין-לאומי
IEC 60269-2	ת"י 230 חלק 2 - נתיכים למתח נמוך: דרישות מיוחדות לנתיכים לטיפול על ידי חשמלאים מורשים (בעיקר לשימוש תעשייתי)	התקן הישראלי זהה, למעט שינויים ותוספות, למהדורת 1986 של התקן הבין-לאומי המוזכר, יחד עם התקן הבין-לאומי IEC 269-2-1 משנת 1987 ועדכונו מ-1993
IEC 60269-3: 1987	ת"י 230 חלק 3 - נתיכים למתח נמוך: דרישות מיוחדות לנתיכים לשימושם של מי שאינם חשמלאים מורשים (בעיקר נתיכים לשימוש ביתי ולשימושים דומים)	התקן הישראלי זהה, למעט שינויים ותוספות, לתקן הבין-לאומי המוזכר, יחד עם התקן הבין-לאומי IEC 269-3A משנת 1978
IEC 60357	ת"י 1506 - נורות הלוגן בעלות תיל טונגסטן (לא לכלי רכב)	התקן הישראלי זהה, למעט שינויים ותוספות, למהדורת 1982 של התקן הבין-לאומי, לרבות עדכוניו עד 1989

(המשך הטבלה בעמוד הבא)

התקן הבין-לאומי המוזכר	התקן הישראלי שבא במקומו	הערות
IEC 60364-4-41	חוק החשמל התשי"ד-1954 ותקנותיו	[אין זהות]
IEC 60454-3-1	ת"י 840 חלק 1 - סרט דביק בלחיצה לבידוד חשמלי: סרט על בסיס פוליוויניל כלורי	התקן הישראלי הוא מקורי
IEC 60598-2-6	ת"י 20 חלק 2.6 - מנורות: מנורות בעלות שנאי מובנה לנורות עם נימת להט	התקן הישראלי זהה, למעט שינויים ותוספות, למהדורת 1994 של התקן הבין-לאומי, לרבות עדכונו מ-1996
IEC 60742: 1983	ת"י 899 - שנאים מבדלים ושנאי בטיחות מבדלים	התקן הישראלי זהה, למעט שינויים ותוספות, לתקן הבין-לאומי
IEC 61347-1	ת"י 61347 חלק 1 - אבזרי הפעלה ובקרה לנורות: דרישות כלליות ודרישות בטיחות	התקן הישראלי זהה, למעט שינויים ותוספות, לתקן הבין-לאומי

NORME INTERNATIONALE

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Première édition
First edition
2000-10

Appareillages de lampes –

Partie 2-2: Prescriptions particulières pour les convertisseurs abaisseurs électroniques alimentés en courant continu ou alternatif pour lampes à incandescence

Lamp controlgear –

Part 2-2: Particular requirements for d.c. or a.c. supplied electronic step-down convertors for filament lamps

Numéro de référence
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CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

LAMP CONTROLGEAR –

Part 2-2: Particular requirements for d.c. or a.c. supplied electronic step-down convertors for filament lamps

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the 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, the IEC publishes International Standards. 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. The 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 the 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 National Committees.
3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical specifications, technical reports or guides and they are accepted by the National Committees in that sense.
4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.
5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.
6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 61347-2-2 has been prepared by subcommittee 34C: Auxiliaries for lamps, of IEC technical committee 34: Lamps and related equipment.

This first edition of IEC 61347-2-2, together with IEC 61347-1, cancels and replaces the second edition of IEC 61046, published in 1993, and constitutes a minor revision.

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

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 d.c. or a.c. supplied electronic step-down convertors for filament lamps.

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

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

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

FDIS	Report on voting
34C/499/FDIS	34C/513/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.

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

Annex G is for information only.

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[1)]

The committee has decided that the contents of this publication will remain unchanged until 2003. At this date, the publication will be

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

1) To be published.

INTRODUCTION

This first edition of IEC 61347-2-2, published in conjunction with IEC 61347-1, represents an editorial review of IEC 61046. The formatting into separately published parts provides for ease of future amendments and revisions. Additional requirements will be added as and when a need for them is recognized.

This standard, 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.

LAMP CONTROLGEAR –

Part 2-2: Particular requirements for d.c. or a.c. supplied electronic step-down convertors for filament lamps

1 Scope

This part of IEC 61347 specifies particular safety requirements for electronic step-down convertors for use on d.c. supplies up to 250 V or a.c. supplies up to 1 000 V at 50 Hz or 60 Hz and rated output voltage ≤50 V r.m.s. at a frequency deviating from the supply frequency or $\leq 50\sqrt{2}$ V unsmoothed d.c. between conductors or between any conductor and earth, associated with tungsten-halogen lamps as specified in IEC 60357 and other filament lamps.

NOTE The limit of 50 V rated output voltage is in accordance with band I of IEC 60449.

Particular requirements for electronic step-down convertors with means of protection against overheating are given in annex C.

Particular requirements for stationary independent SELV convertors, which are part of the wiring in installations, are given in annex I.

Performance requirements are covered by IEC 61047.

Plug-in convertors, being part of the luminaire, are covered as for built-in convertors by the additional requirements of the luminaire 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 60051 (all parts), *Direct acting indicating analogue electrical measuring instruments and their accessories*

IEC 60065, *Safety requirements for mains operated electronic and related apparatus for household and similar general use*

IEC 60083, *Plugs and socket-outlets for domestic and similar general use standardized in member countries of IEC*

IEC 60085, *Thermal evaluation and classification of electrical insulation*

IEC 60127 (all parts), *Miniature fuses*

IEC 60269-2, *Low-voltage fuses – Part 2: Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application)*

IEC 60269-2-1, *Low-voltage fuses – Part 2-1: Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application) – Sections I to V: Examples of types of standardized fuses*

IEC 60269-3:1987, *Low-voltage fuses – Part 3: Supplementary requirements for fuses for use by unskilled persons (fuses mainly for household and similar applications)*

IEC 60269-3-1, *Low-voltage fuses – Part 3-1: Supplementary requirements for fuses for use by unskilled persons (fuses mainly for household and similar applications) – Sections I to IV*

IEC 60357, *Tungsten-halogen lamps (non-vehicle)*

IEC 60364-4-41, *Electrical installations of buildings – Part 4: Protection for safety – Chapter 41: Protection against electric shock*

IEC 60449, *Voltage bands for electrical installations of buildings*

IEC 60454 (all parts), *Specifications for pressure-sensitive adhesive tapes for electrical purposes*

IEC 60598-2-6, *Luminaires – Part 2: Particular requirements – Section 6: Luminaires with built-in transformers for filament lamps*

IEC 60742:1983, *Isolating transformers and safety isolating transformers – Requirements* Amendment 1 (1992)

IEC 60906 (all parts), *IEC system of plugs and socket-outlets for household and similar purposes*

IEC 60906-1, *IEC system of plugs and socket-outlets for household and similar purposes – Part 1: Plugs and socket-outlets 16 A 250 V a.c.*

IEC 61047, *DC or a.c. supplied electronic step-down convertors for filament lamps – Performance requirements*

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

3 Definitions

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

3.1
electronic step-down convertor (convertor)
unit inserted between the supply and one or more tungsten-halogen or other filament lamps which serves to supply the lamp(s) with its (their) rated voltage, generally at high frequency. The unit may consist of one or more separate components and may include means for dimming, correcting the power factor and suppressing radio interference

3.2
d.c. or a.c. supplied convertor
convertor that includes stabilizing elements for operating one or more filament lamps, generally at high frequency

3.3
safety extra-low voltage (SELV)-equivalent convertor
built-in or associated convertor for operating one or more filament lamps with an output voltage equivalent to a SELV

NOTE For the purposes of this standard, SELV-equivalent convertors, complying with 8.1 and 8.2 are deemed as giving protection against electric shock equivalent to SELV.

3.4
independent SELV convertor
convertor providing a SELV output isolated from the supply mains by means such as a safety isolating transformer, as specified in IEC 60742

3.5
associated convertor
convertor designed to supply specific appliances or equipment, incorporated or not incorporated, but specially designed to be used only with the specific appliance(s) or equipment

3.6
stationary convertor
either a fixed convertor or one which cannot be easily moved from one place to another

3.7
plug-in convertor
convertor incorporated in an enclosure provided with an integral plug as the means of connection of the electrical supply

3.8
rated output voltage
output voltage, at rated supply voltage, rated frequency and at unity power factor, assigned to the convertor

3.9
half-resistance effect
effect which can occur at the end of lamp life due to filament deformation or crystallization effects resulting in a partial short-circuit of the lamp filament, which can cause overloading of the convertor

3.10
arcing
effect which can occur in lamps at a voltage of ≥20 V and which can cause overloading of the convertor

4 General requirements

The requirements of clause 4 of IEC 61347-1 apply, together with the following additional requirement:

Independent SELV convertors shall comply with the requirements of annex I. This includes insulation resistance, electric strength, creepage distances and clearances of the outer case.

5 General notes on tests

The requirements of clause 5 of IEC 61347-1 apply, with the following additional requirement:

Number of specimens

The following number of specimens shall be submitted for testing:

– one unit for the tests of clauses 6 to 12 and 15 to 21;
– one unit for the tests of clause 14 (additional units or components, where necessary, may be required in consultation with the manufacturer).

6 Classification

Convertors are classified according to the method of installation given in clause 6 of IEC 61347-1 and according to:

Protection against electric shock

– SELV-equivalent or isolating convertors (this type of convertor can be used instead of double-wound transformers with reinforced insulation; see IEC 60598-2-6);
– auto-wound convertors;
– independent SELV convertors.

7 Marking

7.1 Mandatory marking

Convertors, other than integral convertors, shall be clearly and durably marked, in accordance with the requirements of 7.2 of IEC 61347-1, with the following mandatory markings:

– items a), b), c), d), e), f), k), l), m) of 7.1 of IEC 61347-1 together with
– rated output voltage.

7.2 Information to be provided if applicable

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

– items h), i), and j) of 7.1 of IEC 61347-1 together with
– mention whether the convertor has mains-connected windings,
– mention that they are SELV-equivalent convertors, if applicable.

8 Protection against accidental contact with live parts

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

8.1

For SELV-equivalent convertors, the accessible parts shall be insulated from live parts by double or reinforced insulation.

Subclauses 9.3.4 and 9.3.5 of IEC 60065 shall apply.

8.2

Output circuits of SELV-equivalent convertors may have exposed terminals if

– the rated output voltage under load does not exceed 25 V r.m.s.;

– the no-load output voltage does not exceed 33 V r.m.s. or $33\sqrt{2}$ V peak or $33\sqrt{2}$ V unsmoothed d.c.

Compliance is checked by measuring the output voltage when steady conditions are established, the convertor being connected to rated supply voltage and rated frequency. For the test under load, the convertor is loaded with a resistance which would give rated output at rated output voltage.

For convertors with more than one rated supply voltage, the requirement is applicable for each of the rated supply voltages.

NOTE The limit of 25 V r.m.s. is based on IEC 60364-4-41.

Convertors with a rated output voltage above 25 V shall have insulated terminals.

In the case of capacitors which are connected between SELV-equivalent output and primary circuits, two capacitors in series with the same value according to 9.3.4 of IEC 60065 shall be used.

Each capacitor shall comply with the requirements of 14.2 of IEC 60065.

In the case of resistors which are connected to SELV-equivalent output and primary circuits, two resistors in series with the same value shall be used.

If other components are necessary for bridging the separating transformer, for example resistors, clause 14 of IEC 60065 shall apply.

8.3

Convertors incorporating capacitors of a total capacitance exceeding 0,5 µF shall be constructed so that the voltage at the convertor terminations does not exceed 50 V, 1 min after disconnection of the convertor from a source of supply at rated voltage.

9 Terminals

The requirements of clause 8 of IEC 61347-1 apply.

10 Provisions for earthing

The requirements of clause 9 of IEC 61347-1 apply.

11 Moisture resistance and insulation

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

For SELV-equivalent convertors, the insulation between input and output terminals not bonded together shall be adequate.

With double or reinforced insulation, the resistance shall be not less than 4 MΩ.

12 Electric strength

The requirements of clause 12 of IEC 61347-1 apply, together with the following additional requirement.

Insulation conditions of windings of separating transformers in SELV-equivalent convertors shall apply according to 14.3.2 of IEC 60065.

13 Thermal endurance test for windings

The requirements of clause 13 of IEC 61347-1 are not applicable.

14 Fault conditions

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

In the case of convertors provided with the marking ▽, the requirements specified in annex C shall be fulfilled.

In addition, the output voltage of the convertor, when operated under fault conditions, shall not exceed 115 % of the rated output voltage.

15 Transformer heating

In SELV-equivalent convertors, windings of separating transformers shall be tested according to 7.1 of IEC 60065.

15.1 Normal operation

For normal operation the values in column I of table 3 of IEC 60065 shall apply.

15.2 Abnormal operation

For operation under abnormal conditions according to clause 16 and fault conditions according to clause 14 of this standard, the values in column II of table 3 of IEC 60065 shall apply.

The values of the temperature rise in table 3 of IEC 60065, columns I and II, are based on a maximum ambient temperature of 35 °C. Because the test will be made with the case temperature at t_c, the relevant ambient temperature shall be measured and the values in table 3 changed respectively. If these temperature rises are higher than those allowed by the class of the relevant insulating material, the nature of the material is the governing factor. The permissible temperature rises are based on the recommendations in IEC 60085. The materials quoted in table 3 of IEC 60065 are shown only as examples. If materials other than those listed in IEC 60085 are used, the maximum temperatures shall not exceed those which have proved to be satisfactory.

Tests shall be made under conditions such that the convertor is brought to t_c as reached under normal operation.

NOTE The test can be carried out in such a way that the convertor is operated at thermal equilibrium under normal conditions in the test enclosure described in annex F, in an ambient temperature such that a case temperature of $t_{c\,-5}^{+0}$ °C is obtained.

For moulded-in transformers specially prepared samples provided with thermocouples shall be submitted for testing.

16 Abnormal conditions

The convertor shall not impair safety when operated under abnormal conditions.

In addition, the output voltage of the convertor when operated under fault conditions shall not exceed 115 % of the rated output voltage.

Compliance is checked by the following test at any voltage between 90 % and 110 % of the rated supply voltage.

Each of the following conditions shall be applied with the convertor operating according to the manufacturer's instructions (including heatsinks, if specified) for 1 h.

a) No lamp is inserted.

b) Double the number of lamps of the type for which the convertor is designed are connected in parallel to the output terminals.

c) The output terminals of the convertor shall be short-circuited. If the convertor is designed for operation of more than one lamp, each pair of output terminals for connecting a lamp shall be short-circuited in turn.

During and at the end of the tests specified under a) to c), the convertor shall show no defect impairing safety, nor shall any smoke or flammable gases be produced.

17 Construction

The requirements of clause 15 of IEC 61347-1 apply, together with the following additional requirement.

Socket-outlets in the output circuit shall not accept plugs complying with IEC 60083 and IEC 60906; neither shall it be possible to engage plugs accepted by socket-outlets in the output circuit with socket-outlets complying with IEC 60083 and IEC 60906.

Compliance is checked by inspection and by manual test.

18 Creepage distances and clearances

Unless otherwise specified in clause 14, the requirements of clause 16 of IEC 61347-1 apply.

19 Screws, current-carrying parts and connections

The requirements of clause 17 of IEC 61347-1 apply.

20 Resistance to heat, fire and tracking

The requirements of clause 18 of IEC 61347-1 apply.

21 Resistance to corrosion

The requirements of clause 19 of IEC 61347-1 apply.

Annex A
(normative)

Test to establish whether a conductive part is a live part which may cause an electric shock

The requirements of annex A of IEC 61347-1 apply.

Annex B
(normative)

Particular requirements for thermally protected lamp controlgear

The requirements of annex B of IEC 61347-1 are not applicable.

Annex C
(normative)

Particular requirements for electronic lamp controlgear with means of protection against overheating

The requirements of annex C of IEC 61347-1 apply.

Annex D
(normative)

Requirements for carrying out the heating tests of thermally protected lamp controlgear

The requirements of annex D of IEC 61347-1 apply.

Annex E
(normative)

Use of constant *S* other than 4 500 in t_w tests

The requirements of annex E of IEC 61347-1 apply only for windings of 50/60 Hz.

Annex F
(normative)

Draught-proof enclosure

The requirements of annex F of IEC 61347-1 apply.

Annex G
(informative)

Explanation of the derivation of the values of pulse voltages

The requirements of annex G of IEC 61347-1 are not applicable.

Annex H
(normative)

Tests

The requirements of annex H of IEC 61347-1 apply.

Annex I
(normative)

Particular additional requirements for independent SELV d.c. or a.c. supplied electronic step-down convertors for filament lamps

NOTE The text of this annex is partially taken from IEC 60742 and its amendment 1.

I.1 Scope

This annex applies to independent convertors for use as the SELV supply for class III luminaires of 25 A maximum. It consists of the relevant requirements of IEC 60742 according to 4.12 of that standard for associated transformers.

I.2 Definitions

I.2.1
short-circuit proof convertor
convertor in which the temperature rise does not exceed the specified limits when the convertor is overloaded or short-circuited and which remains capable of functioning after the overload is removed

I.2.2
non-inherently short-circuit proof convertor
short-circuit proof convertor which incorporates a protective device which opens the circuit or reduces the current in the input circuit or the output circuit when the convertor is overloaded or short-circuited

NOTE Examples of protective devices are fuses, overload releases, thermal fuses, thermal links, thermal cut-outs, PTC resistors and automatic break-off mechanical devices.

I.2.3
inherently short-circuit proof convertor
short-circuit proof convertor in which the temperature, in the case of overload or short circuit and in the absence of a protective device, does not exceed the specified limits, and which continues to function after the overload or short circuit is removed

I.2.4
fail-safe convertor
convertor which, after abnormal use, fails to function but presents no danger to the user or surroundings

I.2.5
non-short-circuit proof convertor
convertor designed to be protected against excessive temperature by means of a protective device which is not incorporated in the convertor

I.2.6
HF transformer
component part of the convertor operating with frequency deviating from the supply frequency

I.3 Classification

Independent convertors are classified as follows:

I.3.1 According to their protection against electric shock

– class I convertors;
– class II convertors.

I.3.2 According to the short-circuit protection or protection against abnormal use

– non-inherently short-circuit proof convertors;
– inherently short-circuit proof convertors;
– fail-safe convertors;
– non-short-circuit proof convertors.

I.4 Marking

When symbols are used, they shall be as follows:

PRI	Input
SEC	Output
⎓	Direct current
N	Neutral
∼	Single phase
	Fuse link (add symbol for time-current characteristic)
t_a	Rated maximum ambient temperature
	Frame or core terminal
	Safety isolating convertor
F or F	Fail-safe convertor
or	Non-short-circuit proof convertor
or	Short-circuit proof convertor (inherently or non-inherently)

The last three symbols may be arranged with symbols for isolating convertors or for safety isolating convertors.

EXAMPLE The dimensions of the symbol for class II construction shall be such that the length of the sides of the outer square is about twice the length of the sides of the inner square. The length of the sides of the outer square shall be not less than 5 mm, unless the largest dimension of the convertor does not exceed 15 cm, in which case the dimension of the symbol may be reduced, but the length of the sides of the outer square shall be not less than 3 mm.

I.5 Protection against electric shock

I.5.1 There shall be no connection between the output circuit and the body or the protective earthing circuit, if any, unless this is allowed under the conditions specified in 8.2.

Compliance is checked by inspection.

I.5.2 The input and output circuits shall be electrically separated from each other, and the construction shall be such that there is no possibility of any connection between these circuits, either directly or indirectly, through other metal parts.

The expression ‘circuits’ also covers windings of the internal HF transformer of the convertor, if any.

In particular, precautions shall be taken to prevent

– undue displacement of input or output windings or the turns of the HF transformer thereof;
– undue displacement of internal circuits or wires for external connections;
– undue displacement of parts of circuits, or of internal wiring, in the event of rupture of wires or loosening of connections;
– wires, screws, washers and the like from bridging any part of the insulation between the input and output circuits, including the connections of windings of the HF transformer, should they loosen or become free.

It is not to be expected that two independent fixings will become loose at the same time.

Compliance is checked for the convertor by inspection, taking I.5.2.1 up to and including I.5.2.5 into consideration, and, for the convertor enclosure, by the tests of 4.13 of IEC 60598-1.

I.5.2.1 The insulation between the input and output winding(s) of the HF transformer shall consist of double or reinforced insulation, unless the requirements of I.5.2.4 are complied with.

In addition, the following requirements apply:

– for class II convertors, the insulation between the input circuits and the body, and between the output circuits and the body shall consist of double or reinforced insulation;
– for class I convertors, the insulation between the input circuits and the body shall consist of basic insulation, and the insulation between the output circuits and the body shall consist of supplementary insulation.

I.5.2.2 Where an intermediate metal part (for example, the magnetic core of the HF transformer) not connected to the body is located between the input and output windings of the HF transformer, the insulation between the input and output windings via the intermediate metal part shall consist of double or reinforced insulation, and, for class II convertors, the insulation between the input windings and the body and between the output windings and the body via the intermediate metal part of the HF transformer shall consist of double or reinforced insulation.

The insulation between the intermediate metal part and the input or output windings of the HF transformer shall, in both cases, consist of at least basic insulation rated for the relevant circuit voltage.

An intermediate part which is separated from one of the windings by double or reinforced insulation is considered as being connected to the other winding of the HF transformer.

I.5.2.3 Where serrated tape is used as insulation, at least one additional layer shall be applied to reduce the risk of serration of two adjacent layers.

I.5.2.4 For class I convertors for fixed connection, the insulation between the input and output windings of the HF transformer may consist of basic insulation plus protective screening instead of double or reinforced insulation, provided the following conditions are complied with.

For the purpose of this subclause, the expression "windings" does not include internal circuits.

a) The insulation between the input winding and the protective screen shall comply with the requirements for basic insulation (rated for the input voltage).
b) The insulation between the protective screen and the output winding shall comply with the requirements for basic insulation (rated for the output voltage).
c) The metal screen shall, unless otherwise specified, consist of a metal foil or of a wire-wound screen extending at least the full width of one of the windings adjacent to the screen; a wire-wound screen shall be wound tight without space between the turns.
d) The metal screen shall, in order to prevent eddy current losses due to creation of a shorted turn, be so arranged that both edges cannot simultaneously touch a magnetic core.
e) The metal screen and its lead-out wire shall have a cross-section sufficient to ensure that, if a breakdown of insulation should occur, an overload device will open the circuit before the screen is destroyed.
f) The lead-out wire shall be soldered to the metal screen or fixed in an equally reliable manner.

I.5.2.5 The last turn of each winding of the HF transformer shall be retained by suitable means, for example, by tape or a suitable bonding agent.

Where cheekless bobbins are used, the end turns of each layer shall be retained by suitable means. Each layer can, for example, be interleaved with adequate insulation material projecting beyond the end turns of each layer and, moreover

either

– the winding(s) shall be impregnated with hard-baking or cold-setting material, substantially filling the intervening spaces and effectively sealing off the end turns;

or

– the winding(s) shall be held together by means of insulating material.

It is not expected that two independent fixings will become loose at the same time.

Compliance is checked for the convertor by inspection, taking I.5.2.1 up to and including I.5.2.5 into consideration and clauses 11, 12 and I.8 of this standard, and, for the convertor enclosure, by the tests of 4.13 of IEC 60598-1.

I.5.3 The input and output circuits are permitted to be bridged by components, such as capacitors, resistors and opto-couplers.

I.5.3.1 Capacitors and resistors shall comply with 8.2 of this standard.

I.5.3.2 Opto-couplers

Under consideration.

I.6 Heating

I.6.1 Convertors and their supports shall not attain excessive temperature in normal use.

Compliance is checked by the test of I.6.2. Moreover, the following requirements apply to the windings.

I.6.1.1 If the manufacturer has neither stated which classified material has been used, nor stated any value of t_a and the measured temperature rise does not exceed the value given in table I.1 for class A material, the tests of I.6.3 are not made.

However, if the measured temperature rise exceeds the value given in table I.1 for class A material, the active parts of convertors (magnetic core and windings) are submitted to the tests of I.6.3. The temperature of the heating cabinet is chosen according to table I.2. The temperature rise value to be chosen in table I.2 is the next higher value to the measured temperature rise value.

I.6.1.2 If the manufacturer has not stated which classified material has been used but has stated a value of t_a, and the measured temperature rise does not exceed the value given in table I.1 for class A material, taking the value of t_a into account (see I.6.2), the tests of I.6.3 are not made.

However, if the measured temperature rise, taking the value of t_a into account, exceeds the value given in table I.1 for class A material, the active parts of convertors (magnetic core and windings) are submitted to the tests of I.6.3. The temperature of the heating cabinet is chosen according to table I.2, taking the value of t_a into account. The temperature rise value to be chosen in table I.2 is the next higher value to the calculated temperature rise value.

I.6.1.3 If the manufacturer has stated which classified material has been used, but has not stated any value of t_a and the measured temperature rise does not exceed the relevant value given in table I.1, the tests of I.6.3 are not made.

However, if the measured temperature rise exceeds the value given in table I.1, the convertor is deemed not to comply with the requirements of this clause.

I.6.1.4 If the manufacturer has stated which classified material has been used and has stated a value of t_a, and the measured temperature rise does not exceed the relevant value given in table I.1, taking the value of t_a into account, the tests of I.6.3 are not made.

However, if the measured temperature rise, taking the value of t_a into account, exceeds the value given in table I.1, the convertor is deemed not to comply with the requirements of this clause.

I.6.2 Temperature rises are determined under the following conditions when steady state is established.

The test and the measurements are made in a draught-free location having dimensions such that the test results are not influenced. If the t_a rating of the convertor exceeds 50 °C, the room temperature during the test shall be within 5 °C of the t_a rating and shall preferably be at the t_a rating.

Portable convertors are placed on a dull, black painted plywood support, stationary convertors are mounted as in normal use, also on a dull, black painted plywood support. The support is approximately 20 mm thick and has dimensions which are at least 200 mm in excess of those of the orthogonal projection of the specimen on the support.

Convertors are connected to rated supply voltage and loaded with a resistance which would give rated output at rated output voltage and, for a.c. current, at rated power factor.

No adjustments are made, except that the supply voltage is increased by 6 %.

Associated convertors are operated under the conditions occurring when the appliances or other equipment is operated under the conditions of normal use indicated in the specification for the relevant appliance or equipment. If the design of the appliance or other equipment is such that the convertor can be operated without load, the test is repeated under no-load conditions.

Temperature rises of windings are determined by the resistance method or by means of thermocouples so chosen and positioned that they have the minimum effect on the temperature of the part under test. In this case, specially prepared samples need to be submitted.

When determining the temperature rise of windings, the ambient temperature is measured at such a distance from the specimen that it does not influence the temperature reading. At this point, the temperature of the air shall not vary by more than 10 K during the test.

During the test,

– for convertors without a t_a marking, the temperature rise shall not exceed the values shown in table I.1;
– for convertors with a t_a marking, the sum of the temperature rise and t_a shall not exceed the sum of the values shown in table I.1 and 25 °C.

EXAMPLE – Allowed temperature rise of windings for

a) convertor t_a = +35 °C, class A material

$\Delta t + 35 \leq 75 + 25$

$\Delta t \leq 65$ K

b) convertor t_a = –10 °C, class E material

$\Delta t + (-10) \leq 90 + 25$

$\Delta t \leq 125$ K

Also, the electrical connections shall not work loose, creepage distances and clearances shall not be reduced to less than the values specified in I.11. Sealing compound shall not flow out and overload protection devices shall not operate.

Table I.1 – Values of temperature rises in normal use

Parts	Temperature rise K
Windings (with which bobbins and laminations have contact), if the winding insulation is	
– of class A material [a]	75
– of class E material	90
– of class B material	95
– of class F material	115
– of class H material	140
– of other material [b]	
[a] The material classification is in accordance with IEC 60085 or IEC 60317-0-1 or equivalent standards. [b] If materials other than those specified in IEC 60085 under classes A, E, B, F and H are used, they shall withstand the tests of I.6.3	

NOTE In the future, this classification will be replaced by t_w marking (requirements are under consideration).

The values in the table are based on an ambient temperature not normally exceeding 25 °C, but occasionally reaching 35 °C.

The winding temperatures are based on IEC 60085, but have been adjusted to take into account the fact that, in these tests, the temperatures are mean and not hot-spot values.

Immediately after this test, the sample shall withstand an electric strength test as specified in I.8.3, the test voltage being applied between input and output windings only.

For class I convertors, care is taken that other insulation is not stressed by a voltage exceeding the relevant value specified in I.8.3.

It is recommended that the measurement be made on each winding separately, and that the resistance of windings at the end of the test be determined by taking resistance measurements as soon as possible after switching off, and then at short intervals, so that a curve of resistance against time can be plotted to ascertain the resistance at the instant of switching off.

For convertors with more than one output winding or a tapped output winding, the results to be considered are those showing the greatest temperature rise.

For convertors having other than continuous working conditions, the test conditions may be found in the relevant clauses.

The value of the temperature rise of a winding is calculated from the formula with

x = 234,5 for copper;

x = 229 for aluminium;

$$\Delta t = \frac{R_2 - R_1}{R_1}(x + t_1) - (t_2 - t_1)$$

and where

Δt is the temperature rise above t_2, in kelvins;

R_1 is the resistance at the beginning of the test, at temperature t_1, in ohms;

R_2 is the resistance at the end of the test, when steady conditions have been established, in ohms;

t_1 is the room temperature at the beginning of the test, in degrees Celsius;

t_2 is the room temperature at the end of the test, in degrees Celsius.

At the beginning of the test, the windings shall be at room temperature.

I.6.3 Tests

When applicable (see I.6.1), the active parts of the convertors (magnetic core and windings) are subjected to the following cycling test, each cycle consisting of a heat run, a moisture treatment and a vibration test. Measurements are made after each cycle.

The number of specimens shall be as indicated in clause 5 (three additional specimens). The specimens shall be subjected to 10 test cycles.

I.6.3.1 Heat run

Dependent on the type of insulation, the specimens are kept in a heating cabinet for the time and the temperature specified in table I.2.

The temperature in the heating cabinet shall be maintained to within a tolerance of ±3 °C.

Table I.2 – Test temperature and testing time (in days) per cycle

Test temperature °C	Temperature rise for insulation systems* K				
	75	**90**	**95**	**115**	**140**
220	–	–	–	–	4
210	–	–	–	–	7
200	–	–	–	4	14
190	–	–	–	7	–
180	–	–	–	14	–
170	–	–	4	–	–
160	–	–	7	–	–
150	–	4	–	–	–
140	–	7	–	–	–
130	4	–	–	–	–
120	7	–	–	–	–
Temporary classification assigned for the tests of clause I.7 only	A	E	B	F	H
* Based on an ambient temperature of 25 °C, occasionally reaching 35 °C.					

I.6.3.2 Moisture treatment

The specimens are submitted for two days (48 h) to a moisture treatment according to clause 11 of IEC 61347-1.

I.6.3.3 Vibration test

With the axis of the windings vertical, the specimens are submitted for 1 h to a vibration test, exerting a maximum acceleration of 1,5 *g* at rated supply frequency.

I.6.3.4 Measurements

After each cycle the insulation resistance and electric strength are measured according to I.8.1. After the heat runs, the specimens are allowed to cool down to ambient temperature before the moisture treatment is made.

The values of the test voltage for the dielectric test according to clause I.8 are, however, reduced to 35 % of the specified values and the testing time shall be doubled, except that the windings test according to I.8.3 shall be made with a test voltage of at least 1,2 times rated supply voltage. A specimen is considered not to comply with the windings test if the no-load current or the ohmic component of the no-load input deviates from the corresponding value, obtained during the first measurement, by more than 30 %. If, after completion of all 10 cycles, one or more specimens have failed, the convertor is considered as not complying with the endurance test.

In the case of one specimen failing due to breakdown between the turns of a winding, this is not considered to be a failure of the endurance test. The test can be continued with the remaining two specimens.

I.7 Short-circuit and overload protection

I.7.1 Convertors shall not become unsafe due to short circuits and overloads which may occur in normal use.

Compliance is checked by inspection and by the following tests which are made immediately after the test according to I.6.2 without the position of the convertor being changed at 1,06 times rated supply voltage, or, for non-inherently short-circuit proof transformers, at any value of the supply voltage between 0,94 and 1,06 times rated supply voltage:

- *for inherently short-circuit proof convertors, by the tests of I.7.2;*
- *for non-inherently short-circuit proof convertors, by the tests of I.7.3;*
- *for convertors provided with non-self-resetting thermal cut-outs which can neither be reset nor replaced, by the tests of I.7.5 as if they were of the fail-safe type;*
- *for non-short-circuit proof convertors, by the tests of I.7.4;*
- *for fail-safe convertors, by the tests of I.7.5;*
- *for convertors combined with a rectifier, the tests of I.7.2 or I.7.3 are made twice, once with the short circuit applied on one side of the rectifier and again with the short circuit applied at the other side of the rectifier;*
- *for high-frequency transformers with more than one output winding or a tapped output winding, the results to be considered are those showing the greatest temperature rise. All windings which are intended to be loaded at the same time are loaded at rated output and then the short circuit or overload, as specified, is made on the chosen output winding.*

For the tests of I.7.2, I.7.3 and I.7.4, temperature rise shall not exceed the values given in table I.3.

Table I.3 – Maximum values of temperature rises under short circuit or overload conditions

Insulation classification	A	E	B	F	H
	Maximum temperature rise K				
Type of protection:					
Winding protected inherently	125	140	150	165	185
Winding protected by protective device:					
– during first hour or, for fuses having a rated current exceeding 63 A, during the first two hours [a]	175	190	200	215	235
– after first hour, peak value [b]	150	165	175	190	210
– after first hour, arithmetic mean value [b]	125	140	150	165	185
External enclosures (which may be touched with the standard test finger)	80				
Rubber insulation of wiring	60				
PVC insulation of wiring	60				
Supports (i.e. any area on the pine plywood surface covered by convertor)	80				

[a] After the test of I.7.3.3, these values may be exceeded due to the thermal inertia of the convertor.

[b] Does not apply to the test of I.7.3.3.

I.7.2 Inherently short-circuit proof convertors are tested by short-circuiting the output windings until steady-state conditions are reached.

I.7.3 Non-inherently short-circuit proof convertors are tested as indicated in I.7.3.1 to I.7.3.5.

I.7.3.1 The output terminals are short-circuited. The incorporated overload protection device shall operate before the temperature rise exceeds the values shown in table I.3 for any value of the supply voltage between 0,94 and 1,06 times rated supply voltage.

I.7.3.2 If protected by a fuse in accordance with either IEC 60269-2 or IEC 60269-3, or a technically equivalent fuse, the convertor is loaded for a time *T* and with a current equal to *k* times the current marked on the convertor as the rated current of the protection fuse-link, where *k* and *T* have the values shown in table I.4.

Table I.4 – Rated current of the protection fuse-link

Values marked as rated current of protection fuse-link I_n for gG A	***T*** **h**	***k***
$I_n \leq 4$	1	2,1
$4 < I_n < 16$	1	1,9
$16 \leq I_n \leq 63$	1	1,6
$63 < I_n \leq 160$	2	1,6
$160 < I_n \leq 200$	3	1,6
For cylindric fuses gG type B for use by unskilled persons (IEC 60269-3-1) and for fuses for use by authorized persons with fuse-links for bolted connections (IEC 60269-2-1), the value of *k* is 1,6 for I_n < 16 A. For D-type fuses for use by unskilled persons (IEC 60269-3-1) for a rated current of 16 A, the value of *k* is 1,9.		

I.7.3.3 If protected by miniature fuses in accordance with IEC 60127 or by a technically equivalent fuse, the convertor is loaded for 30 min with a current equal to 2,1 times the value of the rated current of the fuse.

I.7.3.4 If protected by an overload protection device other than a fuse, the convertor is loaded by a current equal to 0,95 times the value of the lowest current which causes the device to operate, until steady-state conditions are reached.

I.7.3.5 For the tests of I.7.3.2 and I.7.3.3, the fuse-link is replaced by a link of negligible impedance.

For the tests of I.7.3.4, the test current is obtained at ambient temperature, commencing at 1,1 times the rated tripping current, which is slowly decreased in steps of 2 % until the current value is obtained for which the overload protection device does not operate.

If thermal fuses are used, the test current of one specimen shall be increased in steps of 5 %. After each step, the convertor shall reach steady-state conditions. This is continued until the thermal fuse-link fails. This current value is noted. The test is repeated with the other specimen using 0,95 times the noted value.

I.7.4 Non-short-circuit proof convertors are loaded as indicated in I.7.3. The protective device specified by the manufacturer is fitted to the relevant input or output circuit.

Associated non-short-circuit-proof convertors are tested under the most unfavourable conditions of normal use, with the correct protective device specified by the manufacturer fitted in the input or output circuit, and in the most unfavourable load conditions for the type of equipment or circuit for which the convertor is designed. Examples of unfavourable load conditions may be continuous, intermittent or temporary use.

I.7.5 Fail-safe convertors

I.7.5.1 *Three additional specimens are used only for the following test. Convertors used in the other tests are not subjected to this test.*

Each of the three specimens is mounted as for normal use on a 20 mm thick, dull black painted plywood surface. Each convertor is operated at 1,06 times the rated primary voltage, the output winding which produced the highest temperature rise during the test of I.6.2 being initially loaded with 1,5 times rated output current (or, if this is not possible, the maximum value of the output current obtainable) until steady-state conditions are reached or the convertor fails (whichever occurs first).

If the convertor fails, it shall comply, during and after the tests, with the criteria in I.7.5.2.

If the convertor does not fail, the time to reach steady-state conditions is noted and the chosen output winding is then short-circuited. The test is continued until the convertor fails. For this part of the test, each specimen shall do so within a time not longer than that necessary to attain steady-state conditions, but not exceeding 5 h.

The convertors shall fail safely and comply during and after the tests with the criteria given in I.7.5.2.

I.7.5.2 *At any time, during the tests of I.7.5.1,*

– the temperature rise of any part of the enclosure of the convertors which may be touched with the standard test finger shall not exceed 150 K;
– the temperature rise of the plywood support shall nowhere exceed 100 K;
– the convertors shall not emit flames, molten material, glowing particles or burning drops of insulating material.

After the tests of I.7.5.1 and after cooling down to ambient temperature,

– the convertors shall withstand a dielectric strength test, the test voltage being 35 % of the values given in table I.6, for primary-to-secondary and primary-to-body only;
– enclosures, if any, shall show no holes allowing the standard test finger (see IEC 60529) to touch bare live parts. In case of doubt, contact with life parts is shown by means of an electrical contact indicator, the voltage being not less than 40 V.

If one specimen does not pass the test, the complete test is considered as having failed.

I.8 Insulation resistance and electric strength

I.8.1 The insulation resistance and the electric strength of convertors shall be adequate.

Compliance is checked by the tests of clauses 11 and 12 and subclauses I.8.2 and I.8.3, which are made immediately after the test of clause 11 in the humidity or in the room in which the specimen was brought to the prescribed temperature, after reassembly of those parts which may have been removed.

I.8.2 Insulation resistance is measured with a d.c. voltage of approximately 500 V applied, the measurement being made 1 min after application of the voltage.

The insulation resistance shall be not less than that shown in table I.5.

Table I.5 – Values of insulation resistances

Insulation to be tested	Insulation resistance MΩ
Between live parts and the body:	
– for basic insulation	2
– for reinforced insulation	4
Between input circuits and output circuits	5
Between metal parts of class II convertors which are separated from live parts by basic insulation only and the body	5
Between metal foil in contact with the inner and outer surfaces of enclosures of insulating material	2

I.8.3 Immediately after the test of I.8.2, the insulation is subjected for 1 min to a voltage of substantially sine-wave form at rated frequency. The value of the test voltage and the points of application are given in table I.6.

Table I.6 – Test voltages

Application of test voltage	Working voltage [a] V				
	≤50	**200**	**<200 ≤450**	**700**	**1 000**
Between live parts of input circuits and live parts of output circuits [b]	500	2 000	3 750	5 000	5 500
Over basic or supplementary insulation between a) live parts which are or may become of different polarity (for example, by the action of a fuse); b) live parts and the body if intended to be connected to protective earth; c) accessible metal parts and a metal rod of the same diameter as the flexible cable or cord (or metallic foil wrapped round the cable cord) inserted inside inlet bushings, cord guards and anchorages and the like; d) live parts and an intermediate metal part; e) intermediate metal parts and the body.	250	1 000	1 875	2 500	2 750
Over reinforced insulation between the body and live parts	500	2 000	3 750	5 000	5 500

[a] Values of test voltage for intermediate values of working voltage are found by interpolation between tabulated values, except in the column <200 ≤450, where the values apply without interpolation.

[b] These requirements do not apply to circuits separated by an earthed metal screen as described in I.5.2.4.

Initially, not more than half the prescribed voltage is applied; then, it is raised rapidly to the full value.

No flashover or breakdown shall occur during the test, corona effects and similar phenomena being disregarded.

The high-voltage transformer used for the test shall be capable of supplying a current of at least 200 mA when the output terminals are short-circuited. The overload releases of the circuit shall not operate for any current less than 100 mA. The voltmeter used to measure the r.m.s value of the test voltage shall be of class 2,5 according to IEC 60051.

Care shall be taken that the voltage applied for test between input and output circuits does not overstress other insulations. If it is stated by the manufacturer that a double insulation system exists between primary and secondary windings, such as from primary winding to magnetic core and from magnetic core to secondary winding, each insulation is then tested separately. The same applies to a double insulation between primary and the body.

For class II constructions incorporating both reinforced insulation and double insulation, care shall be taken that the voltage applied to the reinforced insulation does not overstress the basic or supplementary insulation.

I.9 Construction

I.9.1 The construction of convertors shall be such that they comply with all the requirements of specified applications and be resistant to heat, moisture, water and shock (mechanical and magnetic).

Compliance is checked by the relevant test.

I.9.2 The input and output terminals for the connection of external wiring shall be so located that the distance between the clamping units of these terminals is not less than 25 mm. If the distance is achieved by a barrier, this barrier shall be of insulating material and be permanently fixed to the convertor.

Compliance is checked by inspection and by measurement disregarding intermediate metal parts.

I.10 Components

I.10.1 Sockets-outlets in the output circuit shall not accept plugs complying with IEC 60083, and IEC 60906-1, neither shall it be possible to engage plugs accepted by socket-outlets in the output circuit with socket-outlets complying with IEC 60083 and IEC 60906-1.

Compliance is checked by inspection and by manual test.

I.10.2 Self-resetting devices shall not be used unless it is certain that there will be no hazards.

Compliance is checked by inspection and by connecting the convertor for 48 h (two days) at 1,06 times the rated input voltage with the output terminals short-circuited.

During these tests, no sustained arcing shall occur and there shall be no damage from other causes. The device shall also operate satisfactorily.

I.11 Creepage distances and clearances

Creepage distances and clearances shall be not less than the values shown in clause 16, table 3, of IEC 61347-1 and table I.7.

Creepage distances and clearances in table I.7 replace the relevant requirements of IEC 60598-1, including the illustration of creepage distance and clearance measurements at a supply terminal as shown in figure 24 of that standard.

The required distances in table I.7 apply to the terminal without conductors inserted.

Table I.7 – Creepage distances (cr) and clearances (cl) and distances through insulation (dti)

Dimensions in millimetres

Type of insulation		Measurement				Working voltage [a] V											
		Through winding enamel [b]		Other than through winding enamel		≤50		150		250		440		690		1 000	
		NP[c]	SP [d]	NP	SP	cl	cr	cl	cr	cl	cr	cl	cr	cl	cr	cl	cr
1) Insulation between input and output circuits	a) Creepage distances and clearances between live parts of input circuits and live parts of output circuits [e]			X		1,5	1,5	4,0	4,0	6,0	6,0	8,0	8,0	10,0	10,0	11,0	11,0
					X	1,5	2,0	4,0	5,0	6,0	7,0	8,0	9,7	10,0	13,2	11,0	15,4
		X				1,0	1,2	2,7	3,2	4,0	4,8	5,4	6,4	6,6	8,0	7,4	8,8
			X			1,0	1,6	2,7	4,0	4,0	5,2	5,4	7,8	6,6	10,6	7,4	12,4
						dti		**dti**		**dti**		**dti**		**dti**		**dti**	
	b) Distances through insulation between input or output circuits and an earthed metal screen (see note 2, except that at least two layers are required)	X	X	X	X	0,1 (0,05)		0,25 (0,08)		0,5 (0,15)		0,65 (0,18)		0,75 (0,20)		1,0 (0,25)	
	c) Distances through insulation between input and output circuits (see note 2)	X	X	X	X	0,2 (0,1)		0,5 (0,15)		1,0 (0,3)		1,3 (0,35)		1,5 (0,4)		2,0 (0,5)	
						cl	**cr**	**cl**	**cr**	**cl**	**cr**	**cl**	**cr**	**cl**	**cr**	**cl**	**cr**
2) Insulation between adjacent input circuits or insulation between adjacent output circuits (see note 3)	Creepage distance and clearances			X	X	0,5	0,9	1,0	1,5	1,5	2,0	2,0	2,5	2,5	3,0	3,0	3,5
		X	X			0,5	0,5	0,7	1,0	1,0	1,4	1,4	1,7	1,7	2,0	2,0	2,4

Table I.7 *(continued)*

Dimensions in millimetres

Type of insulation		Measurement				Working voltage [a] V											
		Through winding enamel [b]		Other than through winding enamel		≤50		150		250		440		690		1 000	
		NP [c]	SP [d]	NP	SP	cl	cr	cl	cr	cl	cr	cl	cr	cl	cr	cl	cr
3) Creepage distances and clearances between terminals for the connection of external cables and cords excluding those between terminals for input and for output circuits	a) Up to and including 6 A	X	X	X	X	3,0		4,0		6,0		8,0		10,0		12,0	
	b) Over 6 A up to and including 16 A	X	X	X	X	5,0		7,0		10,0		12,0		14,0		16,0	
	c) Over 16 A	X	X	X	X	10,0		12,0		14,0		16,0		18,0		20,0	
4) Basic or supplementary insulation	Between a) Live parts which are or may become of different polarity (for example by the action or a fuse)					0,8	1,0	2,0	2,0	3,0	3,0	4,0	4,0	5,0	5,0	5,5	5,5
	b) Live parts and the body if intended to be connected to protective earth				X	0,8	1,0	2,0	2,5	3,0	3,5	4,0	4,9	5,0	6,6	5,5	7,7
	c) Accessible metal parts and a metal rod of the same diameter as the flexible cable or cord (or metal foil wrapped around the cable or cord) inserted inside inlet bushings, anchorages and the like					0,5	1,0	1,4	1,6	2,0	2,4	2,7	3,2	3,3	4,0	3,7	4,4

Table I.7 *(continued)*

Dimensions in millimetres

Type of insulation		Measurement				Working voltage [a] V											
		Through winding enamel [b]		Other than through winding enamel		≤50		150		250		440		690		1 000	
		NP [c]	SP [d]	NP	SP	cl	cr	cl	cr	cl	cr	cl	cr	cl	cr	cl	cr
	d) Live parts and an intermediate metal part																
	e) An intermediate metal part and the body		X			0,5	1,0	1,4	2,0	2,0	2,6	2,7	3,9	3,3	5,8	3,7	6,2
5) Reinforced insulation	Between the body and live parts			X	X	1,5	1,5	4,0	4,0	6,0	6,0	8,0	8,0	10,0	10,0	11,0	11,0
						1,5	2,0	4,0	5,0	6,0	7,0	8,0	9,8	10,0	13,2	11,0	15,4
		X				1,0	1,2	2,7	1,2	4,0	4,8	5,4	6,4	6,6	8,0	7,4	8,8
			X			1,0	1,6	2,7	4,0	4,0	5,2	5,4	7,8	6,6	10,0	7,4	12,4
						dti		dti		dti		dti		dti		dti	
6) Distance through insulation (excluding insulation between input and output circuits) [f]	a) Between metal parts separated by supplementary insulation	X	X	X	X	0,5		0,6		0,8		1,0		1,2		1,5	
	b) Between metal parts separated by reinforced insulation	X	X	X	X	0,7		0,8		1,0		1,5		2,0		2,5	
	c) Supplementary insulation where there are no metal parts adjacent to one of the surfaces [e]	X	X	X	X	0,3		0,4		0,5		0,6		0,8		0,9	
	d) Reinforced insulation where there are no metal parts adjacent to one of the surfaces [e]	X	X	X	X	0,5		0,6		0,8		1,0		1,2		1,5	

Table I.7 *(continued)*

NOTE 1 Values for printed wiring where failure may cause a hazard in the sense of this standard, must be the same as values for live parts as in the table. Where printed wiring circuits are for operational purposes only, the values of IEC 60065 for basic insulation (curve A of figure 9) may be used.

NOTE 2 The distance through insulation shown in brackets in item 1 of this table may be used provided that the insulation is in thin sheet form and consists of at least three layers and that, with one layer removed, the remaining layer(s) withstand the prescribed electric strength test of I.8.3.

Additional layers may be required if serrated tape is used (see I.5.2.3).

For transformers having a rated output greater than 100 VA, the figures in brackets apply.

For transformers having a rated output of 25 VA up to and including 100 VA, the figures in brackets may be reduced to two-thirds of their value.

For transformers having a rated output less than 25 VA, the figure in brackets may be reduced to one-third of their value.

Smaller distances through insulation may be used if it can be shown by the tests of I.6.3 that the materials have adequate mechanical strength and are resistant to ageing.

NOTE 3 These values do not apply inside each winding and do not apply inside each winding intended to be connected together; they do apply, however, if the windings are intended to be connected in a series-or-parallel arrangement (for example 110/220 V inputs).

NOTE 4 If the pollution generates high and persistent conductivity, caused, for instance, by conductive dust or by rain or snow, the creepage distances and clearances, as given for severe pollution, must be further increased with a minimum clearance of 1,6 mm and a value of *X* in appendix ID of IEC 60742 of 4,0 mm.

NOTE 5 Windings which are sealed by means such as impregnation or are covered with adhesive bonding tape which adheres to the flanges of a coil former, are considered to have no creepage distances or clearances at these places, provided that all insulating materials are classified according to IEC 60085.

NOTE 6 The requirements concerning distance through insulation do not imply that the prescribed distance shall be through solid insulation only. It may consist of a thickness of solid insulation plus one or more air layers.

NOTE 7 Where an insulation barrier consisting of an uncemented, pushed-on partition wall is used, creepage distances are measured through the joint. If the joint is covered by an adhesive bonding tape in accordance with IEC 60454, one layer of adhesive bonding tape is required on each side of the wall in order to reduce the risk of tape folding over during production.

NOTE 8 Transformers having a reasonably tight enclosure are considered to have a normal degree of pollution and hermetic sealing is not required.

[a] Values of creepage distances, clearances and distances through insulation may be found for intermediate values of working voltages by interpolation between tabulated values.

[b] Measurement through winding wire enamel if the winding wire complies with grade 1 of IEC 60317-0-1.

[c] NP = Normal pollution.

[d] SP = Severe pollution.

[e] This requirement does not apply to windings separated by an earthed metal screen, as described in I.5.2.4

[f] This requirement does not apply to supplementary insulation consisting of three layers.

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