

Safety requirements for electronic flash apparatus for photographic purposes

The European Standard EN 60491 : 1995 has the status of a
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ICS 37.040.10

Committees responsible for this British Standard

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- Association of Consulting Scientists
- British Electrotechnical Approvals Board
- British Radio and Electronic Equipment Manufacturers Association
- Consumer Policy Committee of BSI
- Department of Trade and Industry (Consumer Safety Unit)
- Federation of the Electronics Industry
- Institution of Electrical Engineers
- Professional Lighting and Sound Association
- Radio, Electrical and Television Retailers Association

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National foreword

This British Standard has been prepared by Technical Committee EPL/92, and is the English language version of EN 60491 : 1995 *Safety requirements for electronic flash apparatus for photographic purposes*, published by the European Committee for Electrotechnical Standardization (CENELEC). It is derived from IEC 491 : 1994, published by the International Electrotechnical Commission (IEC)

The CENELEC Common Modifications, which are quoted on page 2, have been implemented at the appropriate places in the text and are indicated by a sideline in the margin.

Cross-references

Publication referred to	Corresponding British Standard
IEC 85 : 1984 (HD 566 S1 : 1990)	BS 2757 : 1986 <i>Method for determining the thermal classification of electrical insulation</i>
IEC 536 : 1976 (HD 366 S1 : 1977)	BS 2754 : 1976 <i>Memorandum. Construction of electrical equipment for protection against electric shock</i>
HD 243 S12 : 1995 (IEC 417 : 1973)	BS 6217 : 1981 <i>Guide to graphical symbols for use on electrical equipment</i>
HD 323.2.3 S2 : 1987 (IEC 68-2-3 : 1969)	BS 2011 <i>Environmental testing</i> Part 2.1 <i>Tests</i> Part 2.1Ca : 1997 <i>Test Ca. Damp heat, steady state</i>
EN 60068-2-6 : 1995 (IEC 68-2-6 : 1995)	BS EN 60068 <i>Environmental testing</i> BS EN 60068-2 <i>Test methods</i> BS EN 60068-2-6 : 1996 <i>Test Fc. Vibration (sinusoidal)</i>
HD 568 S1 : 1990 (IEC 167 : 1964)	BS 903 <i>Physical testing of rubber</i>
EN 60068-2-2 : 1993 (IEC 68-2-2 : 1974)	Part C5 : 1992 <i>Determination of insulation resistance</i> BS EN 60068 <i>Environmental testing</i> BS EN 60068-2 <i>Test methods</i> BS EN 60068-2-2 : 1993 <i>Test B. Dry heat</i>
EN 60249-1 : 1993 (IEC 249-1 : 1982)	BS EN 60249 <i>Base materials for printed circuits</i>
EN 60249-2 series (IEC 249-2 series)	BS EN 60249-1 : 1993 <i>Test methods</i> BS EN 60249-2 series <i>Specifications</i>
EN 60317 series (IEC 317 series)	BS EN 60317 series <i>Specifications for particular types of winding wires</i>
EN 60320-1 : 1987 (IEC 320 : 1981)	BS EN 60320-1 : 1987 <i>Appliance couplers for household and similar general purposes</i>
EN 60799 : 1987 (IEC 799 : 1984)	BS EN 60799 : 1995 <i>Cord sets</i>

NOTE. International and European Standards, as well as overseas standards, are available from Customer Services, BSI, 389 Chiswick High Road, London, W4 4AL.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 58, an inside back cover and a back cover.

Descriptors: Electronic equipment, flash apparatus, photography, safety requirements, test methods, marking

English version

**Safety requirements for electronic flash apparatus
for photographic purposes
(IEC 491:1984, modified)**

Règles de sécurité pour les appareils
électroniques à éclairs pour la
photographie
(CEI 491:1984, modifiée)

Sicherheitsbestimmungen für
elektronische Fotoblitzgeräte
(IEC 491:1984, modifiziert)

This European Standard was approved by CENELEC on 1995-09-20. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

The text of the International Standard IEC 491:1984, prepared by IEC SC 12B^{*)}, Safety, of IEC TC 12, Radiocommunications, together with common modifications prepared by Reporting Secretariat SR 12B, was approved by CENELEC as HD 327 S2 on 1988-03-01. Some additional common modifications were approved by CENELEC as amendment A1 to HD 327 S2 on 1990-12-10.

This Harmonization Document and its amendment were submitted to the formal vote for conversion into a European Standard and were approved by CENELEC as EN 60491 on 1995-09-20.

The following date was fixed:

- latest date by which the EN has to be implemented
at national level by publication of an identical
national standard or by endorsement (dop) 1996-09-01

Annexes designated "normative" are part of the body of the standard.
In this standard, annex ZA is normative.
Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 491:1984 was approved by CENELEC as a European Standard with agreed common modifications as given below.

COMMON MODIFICATIONS

5.2 Add to the first paragraph:

c) Apparatus of Class II construction shall be marked with the double square symbol  (417-IEC-5172).

Delete the first line of the explanation.

Replace the second line of the explanation by:

The symbol specified under c) shall be so placed that it will be obvious that it is a part of the technical information and is unlikely to be confused with the maker's name or trade mark.

8.3.4 Add after the fourth paragraph:

A capacitor manufactured and approved according to the CECC system complies with the condition for use of a single capacitor.

15.1 Add after the first paragraph:

Mains cords of Class II apparatus shall be of the sheathed type.

^{*)} IEC SC 12B has been replaced by IEC TC 92, Safety of audio, video and similar electronic equipment.

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Note. — In this standard, the requirements proper are printed in roman type.

Test specifications are printed in italic type.

Explanatory matter is printed in smaller roman type.

SAFETY REQUIREMENTS FOR ELECTRONIC FLASH APPARATUS FOR PHOTOGRAPHIC PURPOSES

1. Scope

- 1.1 This standard applies to the following electronic flash apparatus for photographic purposes, having a stored energy not exceeding 2 000 J, together with associated apparatus and not intended to be subjected to dripping or splashing:
- apparatus of the single-flash type which can have more than one flash head operating at the same time;
 - apparatus for the illumination of sequential photographic exposures;
 - battery chargers and supply units to be used in connection with electronic flash apparatus for photographic purposes. These auxiliary units may form a part of the mains plug;
 - accessories, such as light regulators and slave units, specified in the instruction leaflet.

This standard does not apply to stroboscopes.

As long as no appropriate requirements exist for apparatus having a stored energy exceeding 2 000 J, this standard may be used, in so far as it is applicable.

Additional requirements may be necessary, e.g. for explosion and thermal radiation.

With regard to the supply, the following categories are covered:

- mains-operated apparatus;
- battery-operated apparatus;
- apparatus having a combination of mains and battery supply.

This standard is intended to cover apparatus which can be used both in moderate and tropical climates.

For the modelling lamps combined with electronic flash apparatus for photographic purposes, additional requirements may be taken from IEC Publication 598-2-9: Luminaires, Section Nine — Photo and Film Luminaires (Non-professional), as far as applicable.

- 1.2 This standard does not apply to apparatus designed for a rated supply voltage exceeding 250 V (r.m.s.) against earth.
- 1.3 This standard is concerned with safety only and not with the other properties of the apparatus (see Clause 3).

2. Definitions

The following definitions apply for the purpose of this standard:

- 2.1 The *type test* of a product is the complete series of tests to be carried out on a number of specimens representative of the type, with the object of determining whether a particular manufacturer can be considered to be able to produce products meeting the standard.
- 2.2 *By hand* denotes that the operation does not require the use of a tool, coin or any other object.

- 2.3 *Accessible part* denotes a part which can be touched by the standard test finger (see Sub-clause 8.1.1).
- Any accessible area of a non-conducting part is considered as being covered with a conductive layer (see Sub-clause 4.3.1).
- 2.4 *Live part* denotes a part, contact with which may cause a significant electric shock (see Sub-clause 8.1.1).
- 2.5 *Creepage distance* denotes the shortest distance along the surface of an insulation material between two conductive parts. (According to IEC Publication 664: Insulation Co-ordination within Low-voltage Systems Including Clearances and Creepage Distances for Equipment.)
- 2.6 *Clearance* denotes the shortest distance in air between two conductive parts.
- 2.7 *Supply mains* denotes any power source with an operating voltage of more than 34 V (peak) which is not used solely to supply the equipment specified in Sub-clause 1.1.
- 2.8 *Rated supply voltage* denotes the mains voltage for which the manufacturer has designed the apparatus.
- 2.9 *Part directly connected to the supply mains* denotes a part of an apparatus which is in electrical connection with the supply mains in such a way that a connection between the part and either pole of the supply mains causes in that connection a current equal to or greater than 9 A.
- A current of 9 A is chosen as the minimum rupturing current of a 6 A fuse.
- In tests to determine which parts are directly connected to the supply mains, fuses in the apparatus are not short-circuited.
- 2.10 *Part conductively connected to the supply mains* denotes a part of an apparatus which is in electrical connection with the supply mains in such a way that a connection through a resistance of 2000 Ω between the part and either pole of the supply mains causes in that resistance a current greater than 0.7 mA (peak), the apparatus not being connected to earth.
- 2.11 *Supply unit* denotes an apparatus which takes energy from the mains and from which one or more other apparatus are fed.
- 2.12 *Battery charger* denotes an apparatus which is directly fed from the supply mains and which provides energy in the form necessary to charge a battery.
- 2.13 *Terminal device* denotes a part of an apparatus by which connection is made to external conductors or other apparatus; it may contain several terminal contacts.
- 2.14 *Thermal release* denotes a device which prevents the maintenance of excessively high temperatures in certain parts of the apparatus by disconnecting those parts from their supply.
- 2.15 *Safety switch* denotes a device which interrupts the supply when a cover is opened.
- 2.16 *Printed board* denotes a base material cut to size, containing all holes and bearing at least one conductive pattern.

- 2.17 *Conductive pattern* denotes a configuration formed by electrically conductive material of a printed board.
- 2.18 *Class I apparatus* denotes an equipment in which protection against electric shock does not rely on basic insulation only, but which includes an additional safety precaution in such a way that means are provided for the connection of accessible conductive parts to the protective (earthing) conductor in the fixed wiring of the installation in such a way that accessible conductive parts cannot become live in the event of a failure of the basic insulation.
- Such apparatus may have parts consisting of Class II construction.
- 2.19 *Class II apparatus* denotes an equipment in which protection against electric shock does not rely on basic insulation only, but in which additional safety precautions, such as double insulation or reinforced insulation, are provided, there being no provision for protective earthing or reliance upon installation conditions.
- 2.20 *Basic insulation* denotes an insulation applied to live parts to provide basic protection against electric shock.
- 2.21 *Supplementary insulation* denotes an independent insulation applied in addition to basic insulation in order to provide protection against electric shock in the event of a failure of the basic insulation.
- 2.22 *Double insulation* denotes an insulation comprising both basic insulation and supplementary insulation.
- 2.23 *Reinforced insulation* denotes a single insulation system applied to live parts which provides a degree of protection against electric shock equivalent to double insulation under the conditions specified in this standard.

The term "insulation system" does not imply that the insulation should be one homogeneous piece. It may comprise several layers which cannot be tested singly as supplementary or basic insulation.

The definitions given in Sub-clauses 2.18 to 2.23 are according to IEC Publication 536: Classification of Electrical and Electronic Equipment with Regard to Protection against Electric Shock.

3. General requirements

The apparatus shall be so designed and constructed as to present no danger, either in normal use or under fault conditions, providing particularly:

- personal protection against electric shock;
- personal protection against the effects of excessive temperature;
- protection against fire.

In general, compliance is checked under normal operating conditions and under fault conditions specified in Sub-clauses 4.2 and 4.3, by carrying out all the tests indicated.

4. General conditions for tests

4.1 Conduct of tests

4.1.1 Tests according to this standard are type tests.

4.1.2 All tests are carried out on one and the same apparatus and in the order of the clauses as far as this is possible.

4.1.3 Unless otherwise specified, tests are made under normal operating conditions at an ambient temperature within the range of 15 °C to 35 °C, a relative humidity of 45% to 75% and an air pressure of 860 mbar to 1060 mbar.

4.1.4 Unless otherwise specified:

- waveforms are substantially sinusoidal;
- measurements of voltages and currents are carried out with instruments which do not appreciably affect the values to be measured.

4.1.5 Test requirements are based on the use of fully charged rechargeable batteries or dry batteries in a fresh condition.

4.2 Normal operating conditions

Normal operating conditions are considered to consist of the most unfavourable combination of the following conditions:

4.2.1 Any position of normal use of the apparatus.

4.2.2 A supply voltage of 0.9 times or 1.1 times any rated supply voltage for which the apparatus is set.

For apparatus having a rated supply voltage range not requiring the adjustment of a voltage setting device, a supply voltage of 0.9 times the lower limit or 1.1 times the upper limit of the rated supply voltage range; if considered necessary, a supply voltage of 0.9 times or 1.1 times a nominal supply voltage within the range marked on the apparatus.

Any rated frequency of the supply voltage.

For battery-operated apparatus, the specified battery in a fully charged state or in fresh condition.

The apparatus operated on each type of supply for which it is designed.

4.2.3 Any position of controls which are accessible to the user for adjustments by hand, except voltage setting devices complying with Sub-clause 13.6.

4.2.4 Connection or not of flash heads, capacitors and other accessories.

4.2.5 Apparatus which can be used either while connected to the mains or with its own supply connected to the mains or not.

4.2.6 Any protective earth terminal being connected to earth or not, and either pole of the isolated supply source, used during the test, being earthed.

4.3 Fault conditions

Operation under fault conditions denotes that, in addition to the normal operating conditions mentioned in Sub-clause 4.2, each of the following conditions is applied in turn and, associated with it, those other fault conditions which are a logical consequence.

Examination of the apparatus and its circuit diagram will generally show the fault conditions which should be applied. These are applied in sequence in the order which is most convenient.

4.3.1 Short-circuit across creepage distances and clearances if they are less than the values indicated by curve A in Table I.

If an insulating part contains a groove of less than 1 mm width, the creepage distance is not measured over the surface of the groove but only across its width.

If a clearance consists of two or more air gaps in series separated by conductive parts, any gap of less than 1 mm width is ignored in computing the total distance unless the total distance as required in Table I is less than 1 mm. However, individual gaps of less than 0.5 mm are ignored.

This does not imply that dimensional requirements of insulations specified in Sub-clauses 8.3.7 and 8.3.8 can be ignored.

If an insulating barrier consists of two parts separated by a capillary slit, the path along the slit should be taken into account when measuring creepage distances and clearances.

The specified creepage distances and clearances are the minimum actual separations taken into account tolerances in assemblies and piece parts.

Guidance for the determination of creepage distances and clearances involving enamelled wires is given in Sub-clause 4.3.3.

In the determination of creepage distances and clearances between accessible parts and live parts, when using the standard test finger, any accessible zone of a non-conductive part is considered as being covered with a conductive layer (see Figure 1, page 90, as an example).

The voltages mentioned in Table I are determined with the apparatus connected to the rated supply voltage after the steady state has been reached.

Creepage distances and clearances are measured with conductors and plugs in their normal positions.

Between conductors, one of which may be directly or conductively connected to one pole of the supply mains, which are on a printed board complying with the pull-off and peel strength requirements specified in IEC Publication 249-1: Base Materials for Printed Circuits, Part 1: Test methods and IEC Publication 249-2: Part 2: Specifications, the requirements for creepage distances and clearances are modified.

The dimensions of Table I are replaced by the values calculated from the formula:

$$\log d = 0.78 \log \frac{\hat{U}}{300}, \text{ with a minimum of 0.5 mm,}$$

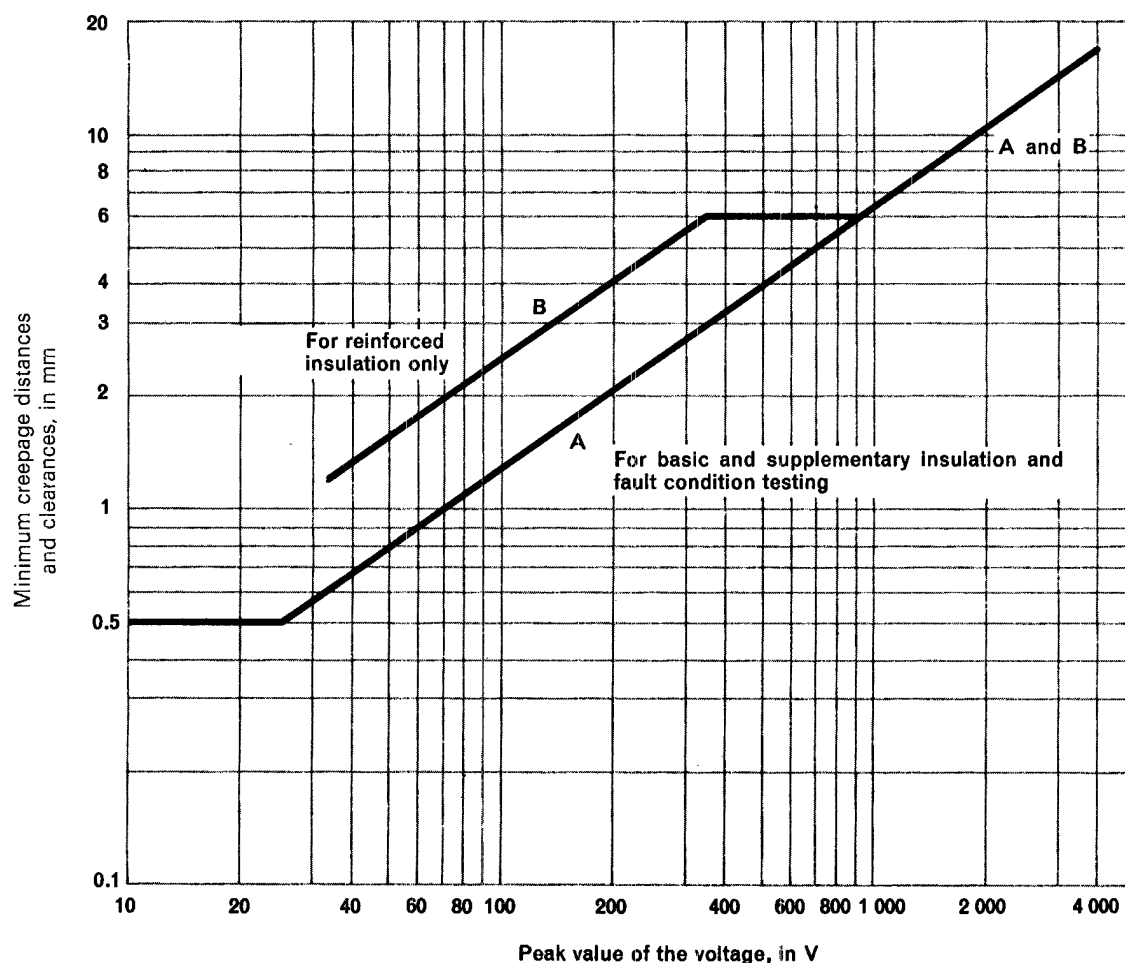
where d is the distance in millimetres and $\hat{U}$ the peak value of the voltage in volts. These distances can be determined by reference to Figure 7, page 97.

This reduction in creepage distances and clearances is permitted only as far as overheating is concerned (see Sub-clause 10.2).

The reduced values above apply to the conductors themselves, but not to mounted components or associated soldering terminals.

Coverings of lacquer or the like on printed boards are ignored when calculating the distances.

TABLE I



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For parts conductively connected to the supply mains with voltages in the range of 220 V to 250 V (r.m.s.), the dimensions are equal to those related to 354 V peak.

For voltages over 4000 V peak, the voltage test is used to determine whether the creepage distances or clearances shall be short-circuited or not (see Sub-clause 9.2).

A voltage across the basic insulation is determined by short-circuiting the supplementary insulation and vice versa.

The graphs of Table I are defined by the following:

- Curve A: 34 V corresponds to 0.6 mm
354 V corresponds to 3.0 mm
- Curve B: 34 V corresponds to 1.2 mm
354 V corresponds to 6.0 mm

Under certain conditions, the distances may be reduced as given in Sub-clauses 4.3.3 and 8.3.5.

4.3.2 *Short-circuit across or, if applicable, interruption of semiconductor devices and interruption of filaments of lamps.*

Short and open circuiting of glow-discharge lamps (used for indication or regulation).

4.3.3 *Short-circuit across insulation consisting of covering of lacquer, enamel or textile. Such coverings are ignored in assessing the creepage distances and clearances specified in Table I. However, if enamel forms the insulation of a wire and withstands the voltage test prescribed for Grade 2 in Clause 13 of IEC Publication 317: Specifications for Particular Types of Winding Wires, it is considered as contributing 1 mm to those creepage distances and clearances.*

This sub-clause does not imply a need to short-circuit the insulation between turns of coils, insulating sleeves or tubings.

4.3.4 *Short-circuit across electrolytic capacitors.*

4.3.5 *Short-circuit across insulating parts, the short-circuiting of which might cause an infringement of the requirements regarding protection against electric shock or overheating, with the exception of insulating parts which comply with the requirements of Sub-clause 9.2.*

4.3.6 *Short-circuit or disconnection, whichever is more unfavourable, of capacitors, resistors or inductors other than transformers and motors, the short-circuiting or disconnection of which might cause an infringement of the requirements regarding protection against electric shock or overheating.*

These fault conditions do not apply to:

- a) resistors complying with the requirements of Sub-clauses 10.2 and 13.1*
- b) inductors complying with the requirements of Sub-clause 13.8.1*
- c) capacitors complying with the requirements of Sub-clause 13.2, provided that the voltage at their terminals does not exceed 354 V (peak)*

Requirements for capacitors which need not be short-circuited or disconnected when checking the protection against overheating are under consideration.

- d) self-healing capacitors (e.g. of the metallized paper type) as far as overheating is concerned.*

In order to determine which are the insulating parts and the components (see Sub-clauses 4.3.5 and 4.3.6), the short-circuiting or disconnection of which might cause an infringement of the requirements regarding protection against electric shock or overheating, the apparatus is inspected and its circuit diagram is studied.

4.3.7 *Loosening, by a quarter of a turn, unlocked screws or similar devices which are used for fixing covers over live parts.*

4.3.8 *For battery chargers and supply units: connection of the most unfavourable load impedance to the output terminals, including short circuit.*

4.3.9 *For battery chargers and supply units: connection to a supply voltage of 250 V a.c., independent of the rated supply voltage or voltages of the charger or unit and with the voltage setting device, if any, set at the most unfavourable position.*

4.3.10 *Stopping of forced cooling.*

4.3.11 *Locking of moving parts of apparatus provided with:*

- *motors having a locked rotor torque smaller than the full load torque;*
- *motors with moving parts which can be jammed by mechanical failures or by handling of the equipment, if such a failure or handling is probable.*

4.3.12 *Continuous operation of motors, relay coils or the like, intended for short-time or intermittent operation, if continuous operation may occur accidentally.*

5. Marking

5.1 General

The apparatus shall be marked in accordance with the requirements of Sub-clauses 5.2 and 5.3.

The marking shall be:

- easily discernible on the apparatus when ready for use, in such a way that there can be no misunderstanding;
- indelible and legible.

Compliance is checked by inspection and by the following test.

The marking shall not be removed when rubbed lightly with a piece of cloth soaked with petroleum spirit or water.

The information should preferably be put on the exterior of the apparatus. It is, however, permissible to put it on another place that is easily accessible by hand, provided that the location of the marking is given in the instructions for use.

Letter symbols for quantities and units shall be in accordance with IEC Publication 27: Letter Symbols to be Used in Electrical Technology.

Graphical symbols shall be in accordance with IEC Publication 417: Graphical Symbols for Use on Equipment. Index, Survey and Compilation of the Single Sheets.

Fuse holders shall be marked in accordance with Sub-clause 13.3.2.

Mains switches shall be marked in accordance with Sub-clause 13.4.3.

Compliance is checked by inspection.

5.2 Identification

The apparatus shall be identified by:

- a) manufacturer's name or registered trade mark;
- b) model number or name.

Compliance is checked by inspection.

- c) apparatus of Class II construction shall be marked with the double square symbol  (417-IEC-5172).

The symbol specified under c) shall be so placed that it will be obvious that it is a part of the technical information and is unlikely to be confused with the maker's name or trade mark.

5.3 Supply

The apparatus shall be marked with the following information:

a) Nature of supply:

- a.c. only with the symbol $\sim$;
- d.c. only with the symbol — or === (for battery apparatus only).

b) Rated supply voltage or range of the rated supply voltages which can be applied without operating a voltage setting device, unless the apparatus is supplied from a separate supply unit only.

c) Apparatus which can be set to different rated supply voltages shall be so constructed that the indication of the voltage to which the apparatus is set is discernible on the apparatus when ready for use. If the apparatus is so constructed that the user can alter the supply voltage setting, the action of changing the setting shall change also the indication.

For battery chargers and supply units which form part of a mains plug, it is permitted that the indication of the voltage to which the apparatus is set is on the engagement face of the plug.

d) Rated mains frequency (or range of frequencies) in hertz, if safety is dependent on the use of the correct mains frequency.

Compliance is checked by inspection.

5.4 Instructions for use

5.4.1 Battery chargers and supply units shall be accompanied by an instruction leaflet in which shall be indicated the type of flash apparatus with which it is to be used.

The flash apparatus shall be accompanied by an instruction leaflet in which shall be indicated the type of supply unit or battery charger with which it is to be used.

It is also permitted to give this information on the devices themselves.

Compliance is checked by inspection.

5.4.2 The instructions for use shall state that the apparatus shall not be exposed to dripping or splashing.

Compliance is checked by inspection.

5.4.3 The instructions for use shall contain a warning to the effect that:

- batteries shall not be exposed to excessive heat such as sunshine, fire or the like,
- dry batteries shall not be subjected to charging.

Compliance is checked by inspection.

5.5 Terminal devices

Terminal devices shall be marked with the following symbols:

a) protective earth terminal, if any: $\oplus$ (417-IEC-5019).

- b) terminal devices which are live under normal operating conditions, with the exception of terminals for mains supply and mains socket-outlets:  (417-IEC-5036).

The flash shall point to the terminal device.

This symbol may only be used to indicate the existence of a live terminal and may not be used to label non-live terminals for the purpose of avoiding more stringent insulation requirements.

Compliance is checked by inspection. The marking of a protective earth terminal need not be discernible from the outside (see Sub-clause 14.4).

For information purposes, it may be useful to mark apparatus suitable for both a.c. and d.c. with the symbol:  (417-IEC-5033).

6. Heating under normal operating conditions

- 6.1 In normal use, no part of the apparatus shall attain an unsafe temperature.

Compliance is checked by monitoring the temperatures under the conditions specified below and immediately after they have been applied.

If the apparatus can be mains-operated, it is switched on for a period of 4 h without flashing; if only battery or rechargeable battery is supplied, it is switched on for 30 s.

Thereupon as many consecutive flashes as can be produced, with a maximum of 40, are made as quickly as possible. The rate of flashing is determined by the indicator or, if no indicator, by the measured voltage on the flash capacitors, which should be 85% of the maximum peak voltage. The apparatus is supplied at its rated voltage.

A battery charger is connected for 4 h to a fully discharged rechargeable battery for which the charger has been designed.

Temperatures are determined:

- in the case of windings, by the resistance method;*
- in other cases, by any other suitable method.*

Care should be taken that during the measurement of the resistance of windings, the influence of circuits or loads connected to these windings is negligible.

Temperature rises shall not exceed the values given in column I of Table II.

- 6.2 Insulating material supporting parts conductively connected to the supply mains shall be resistant to heat if, in normal use, these parts carry a current exceeding 0.5 A and might dissipate substantial heat due to imperfect contact.

In those cases where two groups of conductors, each supported by insulation parts, can be rigidly connected or joined together (e.g. by plug and socket), one only of the insulating parts shall meet the test. Where one of the insulating parts is fixed in the apparatus, this part shall meet the test.

Compliance is checked by subjecting the insulating material to the test specified under a) in Note 6 to Table II.

The softening temperature of the insulating material shall be at least 150 °C.

Examples of parts which might dissipate substantial heat in normal use are contacts of switches and of voltage adaptors, screw terminals and fuse holders.

TABLE II

Parts of the apparatus	Permissible temperature rise K	
	Normal operating conditions I	Fault conditions II
External parts		
Metal parts knobs, handles, etc. enclosure (note 1)	30 40	65 65
Non-metallic parts knobs, handles, etc. (note 2) enclosures (note 1, note 2)	50 60	65 65
Inside of enclosures of insulating material	(note 3)	(note 3)
Windings (note 4)		
Wires insulated with non-impregnated silk, cotton, etc.	55	75
Wires insulated with impregnated silk, cotton, etc.	70	100
Oleoresinous enamelled wires	70	135
Wires enamelled with polyvinylformaldehyde or polyurethane resins	85	150
Core laminations	As for the relevant windings	
Supply cords and wiring		
Insulated with ordinary polyvinyl chloride (note 8) not under mechanical stress	60	100
under mechanical stress	45	100
Insulated with natural rubber	45	100
Other insulations (note 4, note 7) except thermoplastic		
Non-impregnated paper	55	70
Non-impregnated cardboard	60	80
Impregnated cotton, silk, paper and textile, urea resins	70	90
Laminates, bonded with phenolformaldehyde resins, phenolformaldehyde mouldings with cellulose fillers	85	110
Phenolformaldehyde mouldings with mineral fillers	95	130
Laminates bonded with epoxy resins	120	150
Natural rubber	45	100
Thermoplastic materials (note 5)	(note 6)	

The values of the temperature rises are based upon a maximum ambient temperature of 35°C, but the measurements are made under normal operating conditions.

Notes 1. — For areas having no dimension exceeding 5 cm and which are not likely to be touched in normal use, temperature rises up to 65 K are allowed under normal operating conditions.

2. — 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.

3. — The permissible temperature rises for the inside of enclosures of insulating material are those indicated for the relevant materials.

4. — *For the purpose of this standard, the permissible temperature rises are based on the recommendations in IEC Publication 85: Thermal Evaluation and Classification of Electrical Insulation. The materials quoted above are shown only as examples. If materials other than those listed in IEC Publication 85 are used, the maximum temperatures should not exceed those which have been proved to be satisfactory.*
5. — *Natural and synthetic rubbers are not considered as being thermoplastic materials.*
6. — *Due to their wide variety, it is not possible to specify permissible temperature rises for thermoplastic materials. While the matter is under consideration, the following method shall be used:*
 - a) *a softening temperature of the material is determined on a separate specimen, under the conditions specified in ISO Standard 306, modified as follows:*
 - the depth of penetration is 0.1 mm;*
 - the total thrust of 10 N (1 kgf) is applied before the dial gauge is set to zero or its initial reading noted.*
 - b) *the temperature limits to be considered for determining the temperature rises are:*
 - under normal operating conditions, a temperature 10 °C lower than the softening temperature as obtained under a);*
 - under fault conditions, the softening temperature itself.*
7. — *The table does not apply to materials used in the construction of resistors.*
8. — *The possibility of raising the values for wires and cables insulated with heat-resistant polyvinyl chloride is under consideration.*

7. Resistance to deformation at elevated ambient temperatures

The enclosure of the apparatus shall be sufficiently resistant to deformation at elevated temperatures.

Compliance is checked by the following test.

The apparatus is subjected for a period of two days (48 h) to the test prescribed in IEC Publication 68-2-2: Basic Environmental Testing Procedures, Part 2, Tests — Tests B: Dry heat, Test Bb, at a temperature of $70 \pm 2^\circ\text{C}$.

After this treatment, the apparatus shall show no damage in the sense of this standard.

8. Shock hazard under normal operating conditions

8.1 Testing on the outside

8.1.1 General

Accessible parts and terminals for the connection to the synchronizer of the camera shall not be live.

In order to determine whether a part is accessible (see Sub-clause 2.3), the jointed test finger according to Figure 2a, page 91, or the rigid test finger according to Figure 2b, page 91, is applied in every possible position, in case of doubt with a maximum force of 30 N (3 kgf). The test is carried out on all outer surfaces.

The force shall be so exerted by the tip of the test finger as to avoid wedge or lever action.

A rigid test finger loaded as above should be applied around any opening, or at any place where deformation could cause an opening. At the same time, a jointed test finger is applied without force to determine if live parts have become accessible.

During the tests, the distances between accessible metal parts and live parts shall become not less than the values given in Table I, live parts shall not become accessible.

An electrical contact indication with a voltage of approximately 40 V is recommended to show contact with conductive parts.

In order to verify that a part or terminal contact is not live, the following measurements are carried out between any two parts or contacts, then between any part on terminal contact and either pole of the supply source.

The measurements are also carried out 2 s after withdrawal of plugs and/or connectors from the corresponding socket-outlets or connector sockets.

If possible, flashing is made during the measurements.

*The part or terminal contact is not live if:
from each part or contact, the current measured through a non-inductive resistance of 50 000 Ω does not exceed 0.7 mA (peak) a.c. or 2 mA d.c. and moreover:*

— *for voltages between 34 V (peak) and 450 V (peak), the capacitance does not exceed 0.1 μ F,*

— *for voltages between 450 V (peak) and 15 kV (peak), the discharge does not exceed 45 μ C.*

For frequencies above 1 kHz, the limit of 0.7 mA (peak) is multiplied by the value of the frequency in kilohertz, but shall not exceed 70 mA (peak).

The values indicated for the capacitances are rated values.

The test establishes that if the voltage at the part exceeds 34 V (peak) a.c. or 100 V d.c., the source impedance is such that a current greater than 0.7 mA (peak) a.c. or 2 mA d.c. cannot be drawn through a resistance of 50 000 Ω .

8.1.2 Operating shafts

Operating shafts shall not be live.

Compliance is checked by measurement.

8.1.3 Ventilation holes

Ventilation and other holes over live parts shall be so designed that a suspended foreign body (for example a necklace) introduced into the apparatus shall not come into contact with any live part.