Total rated current of the socket-outlets controlled by the switch	Peak surge current
	*
Up to and including 0,5	20
Over 0,5 up to and including 1,0	50
Over 1,0 up to and including 2,5	100
Over 2,5	150

Table 14 DU – Peak surge current

After the test, the switch shall show no damage in the sense of this standard. In particular, it shall show no deterioration of its enclosure, no reduction of clearances and creepage distances and no loosening of electrical connections or mechanical fixings.

Compliance is checked by inspection and by the tests specified in 14.7.3 and/or 14.7.4 in the given order.

14.7.6 DU A MAINS switch provided on audio apparatus intended for household use and on all video apparatus shall comply with (a), (b) or (c), and a switch that controls a MAINS connected receptacle shall comply with (b) below. The contacts of a MAINS relay shall comply with (a), (b) or (d), and the contacts of a relay that controls a MAINS connected receptacle shall comply with (b) or (d) below.

a) Satisfy the following equation for maximum current controlled by a non-TV-rated switch:

 $I_p \leq 1,414 I_{switch}$

<u>Unless $I_{load} \leq 1/2 I_{switch}$ and the switch is double or multi pole, with a minimum of two poles controlling</u> mains current, either in series or switching both mains lines, in which case

 $I_p \le 10 I_{switch}$

in which:

lload is the worst case r.m.s. current drawn by the unit in operation,

Ip is the peak inrush current controlled by the switch or relay, as determined by 14.7.6.1, and

Iswitch is the switch or relay r.m.s. current rating in amperes.

b) Be TV-rated unless it is a keylock MAINS switch used in series with a MAINS on-off switch in a COMMERCIAL APPARATUS.

c) Be located on the back of the apparatus and is not operable from a remote control.

d) Comply with the test in 14.7.6.2.

14.7.6.1 DU The apparatus is to be connected to a rated supply source calibrated to represent a 20-A household branch circuit having a momentary 1 000-A short-circuit current capability.

The controls and switches are to be adjusted as indicated in clause 7 and the thermal state of the apparatus is to maximize the magnitude of the inrush current.

The test circuit to which the apparatus is connected is to be momentarily energized by operating the test-circuit control switch asynchronously for 60 – 100 cycles of closure and opening. The waveforms of these events are to be displayed on a storage oscilloscope connected across a 0.02-ohm, high frequency resistive shunt.

Note: See Annex W for information concerning the 0,02 ohm resistor.

The peak inrush current is to be calculated according to the equation:

 $I_p = E_p / R_s$

in which:

In is the calculated peak inrush current of the apparatus being tested.

 E_p is the maximum value of voltage measured across the 0.02-ohm high-frequency resistive shunt as displayed by the storage oscilloscope, provided that the voltage waveform has a duration of at least 100 microseconds and

R_s is the exact resistance of the high-frequency resistive shunt.

14.7.6.2 DU *A* relay shall be subjected to 25 000 cycles of operation making and breaking the maximum steady-state (r.m.s.) current based on the input current and the marked receptacle rating, as appropriate. *A tungsten load is to be connected to the receptacle for the test.*

During the test, exposed dead metal parts of the apparatus are to be connected to earth through a 1-ampere plug fuse, and the connection is to be such that any single-pole, current-interrupting device is located in the ungrounded conductor of the supply MAINS. When the apparatus is intended for use on direct current, or on direct current as well as alternating current, the exposed dead metal parts of the apparatus are to be connected so as to be positive with regard to a single-pole current-interrupting control device. The device is to be operated at a rate of no more than 10 cycles per minute. Electrical or mechanical breakdown of the control device, undue burning or pitting of the contacts, or opening of the fuse in the earthing connection shall not occur.

14.7.7 DU A double-pole switch controlling two different circuits shall be suitable for the application. The current, frequency, and voltage rating for each pole shall not be less than the maximum steady-state current, frequency, and voltage that it controls.

A double-pole switch controlling one ac circuit and one dc circuit is capable of being used without further tests when:

- a) The dc circuit voltage is 60 V or less.
- b) The dc circuit power capability is 50 W or less, and
- c) The dc current is 10 % or less of the ac current rating of the switch.

14.8 DU SAFETY INTERLOCKS

SAFETY INTERLOCKS shall be provided where access BY HAND is possible to areas presenting hazards in the sense of this standard.

For requirements and test specifications reference is made to 2.8 of IEC 60950-1:2005, Amendment 1:2009 IEC 60950-1:2013 except that the jointed test finger referred to in 9.1.1.3 is used to determine accessibility (2.8.2 of IEC 60950-1:2013) and interlock operation (2.8.3 of IEC 60950-1:2013).

14.9 Voltage setting devices and the like

The apparatus shall be so constructed that changing the setting from one voltage to another or from one nature of supply to another is unlikely to occur accidentally.

Compliance is checked by inspection and by manual test.

Changing of the setting which necessitates consecutive movements BY HAND is considered to comply with this requirement.

14.10 Motors

14.10.1 Motors shall be so constructed as to prevent, in prolonged intended use, any electrical or mechanical failure impairing compliance with this standard. The insulation shall not be affected and contacts and connections shall be such that they do not work loose by heating, vibration, etc.

Compliance is checked by the following tests carried out on the apparatus under normal operating conditions.

a) The apparatus is connected to 1,1 times the RATED SUPPLY VOLTAGE and to 0,9 times the RATED SUPPLY VOLTAGE, each time for 48 h. Motors for short-time or intermittent operation are connected for periods in accordance with the operating time if limited by the construction of the apparatus.

In case of short-time operation, suitable cooling intervals are inserted.

NOTE 1 It can be convenient to carry out this test immediately after the test of 7.1.

b) The motor is started 50 times while the apparatus is connected to 1,1 times the RATED SUPPLY VOLTAGE and 50 times while connected to 0,9 times the RATED SUPPLY VOLTAGE, each period of connection being at least 10 times the period from start to full speed, but not less than 10 s.

The intervals between starts shall be not less than three times the period of connection.

If the apparatus provides for more than one speed, the test is carried out at the most unfavourable speed.

After these tests, the motor shall withstand the dielectric strength of 10.4, no connection shall have loosened and there shall be no deterioration impairing the safety.

NOTE 2 For induction motors with power supplied to the stator only, see also 14.4.3.

14.10.2 Motors shall be so constructed or mounted that wiring, windings, commutators, sliprings, insulations, etc., are not adversely affected by oil, grease or other substances to which they are exposed during intended use.

Compliance is checked by inspection.

14.10.3 Moving parts liable to cause personal injury shall be so arranged or enclosed as to provide adequate protection against this danger during intended use. Protective enclosures, guards and the like shall have adequate mechanical strength. They shall not be removable BY HAND.

Compliance is checked by inspection and by manual test.

14.10.4 In addition, for motors having phase-shifting capacitors, three-phase motors and series motors of IEC 60950-1:2005, Annex B, Clauses B.8, B.9 and B.10 apply.

14.11 Batteries

14.11.1 DC General

Portable secondary sealed cells and batteries (other than button) containing alkaline or other non-acid electrolyte shall comply with <u>IEC 62133 UL 2054</u>.

Batteries shall be so mounted that there is no risk of the accumulation of flammable gases and that the leakage of electrolyte cannot impair any insulation.

Internal rechargeable and non-rechargeable batteries that are replaceable by the USER or a SKILLED PERSON shall additionally comply with 14.11.2 – 14.11.5.

<u>SPECIAL BATTERY packs that are removable by the USER from the apparatus and may be carried by the USER</u> separately from the apparatus are considered transportable and shall additionally comply with the following test requirements detailed in UL 2054:

- Short-circuit test, Section 9;
- Abnormal charging test, Section 10;
- Forced-discharge test, Section 12; and
- 250 N steady force test; Section 19.

NOTE Consumer grade, non-rechargeable carbon-zinc or alkaline batteries are not subjected to the tests specified in 14.11.2 – 14.11.5.

Compliance is checked by inspection and measurement.

14.11.2 User replaceable rechargeable batteries

If it is possible for the USER to replace rechargeable batteries, which can be recharged in the apparatus, by non-rechargeable batteries, special means, such as a separate charging contact on a rechargeable special battery-pack or an electronic protective circuit, shall be provided to avoid any current being supplied into the non-rechargeable batteries.

This requirement does not apply to batteries inside the apparatus, the replacement of which by the USER is not intended, for example batteries for memories.

Compliance is checked by inspection.

NOTE Additional requirements regarding the instructions for use are given in 5.5.2.

14.11.3 Battery use

Under normal operating conditions and under fault conditions,

- for rechargeable batteries, the charging current,
- for lithium batteries, the discharging current and the reverse current,

shall not exceed the permissible values given by the battery manufacturer.

Compliance is checked by measurement.

Lithium batteries shall be removed from the circuit and replaced by a voltage source when measuring discharging currents and by a short circuit when measuring reverse current.

14.11.4 DC Battery mould stress relief

A SPECIAL BATTERY not covered by IEC 62133, in which containment of the electrolyte is dependent upon a thermoplastic material, shall not release electrolyte due to stresses caused by the moulding process if the electrolyte can contact insulation or enter a USER-serviceable compartment.

Compliance is checked by the following test.

The battery is to be placed in an air-circulating oven, maintained at a temperature of 70 °C, for a period of 7 h. Following the oven conditioning, the battery shall be examined for electrolyte that has been released.

14.11.5 DC DU Battery drop test

A USER-serviceable SPECIAL BATTERY not covered by IEC 62133 shall not release electrolyte as a result of being dropped.

Compliance is checked by the following test.

Three samples are each to be subjected to a single drop<u>, or one sample is to be subjected to three drops</u>, through a distance of 1 m to strike a hardwood surface as described in 15.4.3. Following the drop test, each battery is to be examined for electrolyte that has been released.

14.11.6 DU External battery

An apparatus intended for use with an external battery shall be provided with an overcurrent protective device in the battery-supply circuit.

Alternatively, the overcurrent protective device in the apparatus battery-supply circuit is not required if the apparatus is intended to be connected to a vehicle power outlet using a vehicle battery adapter.

Vehicle battery adapters supplied with or specified for use in the user instruction manual shall comply with the requirements of UL 2089.

14.12 DC Optocouplers

<u>Component power supplies and their optocouplers complying with the construction and test requirements of UL 1310, UL 60950-1, or UL 62368-1 are considered to fulfill the construction and test requirements of this sub-clause.</u>

Optocouplers shall comply with the constructional requirements of Clause 8 requirements in UL 1577.

CLEARANCES and CREEPAGE DISTANCES external to the optocoupler shall comply with 13.1.

For optocouplers with an internal insulating compound completely filling the casing of the optocoupler, no internal CLEARANCES and CREEPAGE DISTANCES are required.

For all other optocouplers, the internal CLEARANCES and CREEPAGE DISTANCES shall comply with 13.1.

There is no minimum distance through insulation for SUPPLEMENTARY INSULATION OF REINFORCED INSULATION consisting of an insulating compound completely filling the casing of an optocoupler, provided that the component:

a) passes

- the TYPE TESTS and inspection criteria of 13.6; and

- ROUTINE TESTS for dielectric strength during manufacturing according to N.3.2, using the appropriate value of the test voltage in 10.4.2 applied for 1 s; or

b) complies with the requirements of IEC 60747-5-5, where the test voltages specified in 5.2.7 of IEC 60747-5-5:2007, including Amendment 1:2013, shall be at least the appropriate test voltage in 10.4.2 of this standard:

- the voltage V_{ini,a} for TYPE TESTING; and

- the voltage V_{ini,b} for ROUTINE TESTING applied for 1 s; or

c) complies with 13.8, if applicable.

14.13 DC Surge suppression varistors

Surge suppression variators used in order to prevent MAINS overvoltages coming into the apparatus shall comply with IEC 61051-2 UL 1449.

Such components shall not be connected between parts connected to the MAINS and ACCESSIBLE conductive parts or parts connected to them, except for earthed parts of PERMANENTLY CONNECTED APPARATUS.

Where a varistor in series with a Gas Discharge Tube (GDT) is used to bridge BASIC INSULATION, the following applies:

- the varistor has to comply with IEC 61051-2 as indicated below UL 1449; and
- the GDT has to comply with:
 - the electric strength test for BASIC INSULATION; and
 - the external clearance and creepage distance requirements for basic insulation.

Reference is made to IEC 61051-2 where the following requirements apply:

preferred climatic categories (2.1.1 of IEC 61051-2:1991)

- maximum lower temperature: –10 °C
- minimum upper temperature: +85 °C
- minimum duration of climatic tests: 21 days
- maximum continuous voltages (2.1.2 of IEC 61051-2:1991)

The minimum value of the maximum continuous a.c. voltage shall be 1,2 times the RATED SUPPLY VOLTAGE of the apparatus.

- current pulse rating (2.1.2 of IEC 61051-2:1991)

Surge suppression variators shall withstand a combination pulse of 6 kV/3 kA with voltage waveform of 1,2/50 μ s and current waveform of 8/20 μ s.

As an alternative, the combination pulse test of IEC 61051-2:1991, Amendment 1:2009 (2.3.6, Table I, group 1 and Annex A), or nominal discharge current (I_n) test with the current values in accordance with Table 8.2 of UL 840, including consideration of the nominal MAINS voltage and overvoltage category, is acceptable.

Compliance is checked by applying the test of IEC 61051-2, group 1 <u>UL 1449</u>. After the test, the varistor voltage V_{p} (as defined in IEC 61051 <u>UL 1449</u>) shall not have changed by more than 10 % when measured with the manufacturer's specified current.

- fire hazard (IEC 61051-2, Table I, group 6)

The coating of surge suppression varistors shall have a flammability category V-0 or better according to IEC 60695-11-10 or UL 94.

Compliance is checked according to IEC 60695-11-10 or according to G.1.1 of Annex G UL 94.

thermal stress

For apparatus with nominal MAINS voltage of < 150 V, the apparatus and a test resistor connected in series with the apparatus shall be energised from an a.c. source of 250 V.

The voltage source shall be applied for 4 h or until the circuit path through the varistor opens for each of the test series resistance values: 2 000 Ω , 500 Ω , 250 <u>100</u> Ω , 50 Ω . A separate apparatus shall be used for each resistor value, unless damage from the previous test has been repaired.

At the end of each test, the apparatus shall comply with Clause 11.

15 TERMINALS

15.1 Plugs and sockets

15.1.1 DC DR DU Plugs and appliance couplers for the connection of the apparatus to the MAINS and socket-outlets and interconnection couplers for providing MAINS power to other apparatus shall comply with the relevant IEC standards for plugs and socket-outlets, appliance couplers or interconnection couplers. The attachment plug shall have a current rating no lower than 125 % of the current drawn by the apparatus under normal operating conditions and a voltage rating appropriate for the rated voltage for the

apparatus. When the apparatus is capable of being adapted for use on two or more different supply voltages by means of an input selector, the attachment plug provided with the apparatus shall be rated for the voltage for which the apparatus is intended to be connected when it is shipped from the factory.

The attachment plug cap shall be a polarized type when the apparatus is provided with a manually operated, line connected, single-pole switch for apparatus on-off operation; an Edison-base lampholder; or a 15- or 20-ampere socket-outlet.

The identified grounded circuit conductor (neutral) shall be connected to the screw shell of the lampholder and/or to the wide blade of a socket outlet. A manually operated. MAINS connected, single-pole on-off switch shall not be connected to the identified grounded circuit conductor.

Examples of the relevant IEC publications are: IEC 60083, IEC 60320, IEC 60884 and IEC 60906.

NOTE 1 In Australia, Denmark, Israel, Japan, New Zealand, South Africa, Switzerland and the United Kingdom, special national conditions are valid for plugs and socket-outlets.

NOTE 2 In South Africa, where a cordset is used as the means of connection to the supply MAINS, this cordset may be provided with a rewirable plug, provided that the plug complies with the national regulations.

MAINS socket-outlets and interconnection couplers mounted on CLASS II apparatus shall only permit connection of other CLASS II apparatus.

MAINS socket-outlets and interconnection couplers mounted on CLASS I apparatus shall either allow connection of CLASS II apparatus only or shall be provided with protective earthing contacts which are reliably connected to the PROTECTIVE EARTHING TERMINAL or contact of the apparatus.

For CLASS I apparatus, provision for both kinds of socket-outlets and interconnection couplers is allowed on the same apparatus.

NOTE 3 Socket-outlets allowing only the connection of CLASS II apparatus can be designed, for instance, similar to IEC 60906-1:2009, standard sheets 3-1 or 3-2, or according to IEC 60320-2-2:1998, standard sheets D or H.

For apparatus with socket-outlets providing MAINS power to other apparatus, measures shall be taken to ensure that plugs or appliance inlets for the connection of the apparatus to the MAINS cannot be overloaded, if the rated current of the plug or appliance connector is less than 16 A.

NOTE 4 For marking of the socket-outlets, see 5.3 c).

Conductors of internal wiring of socket-outlets providing MAINS power to other apparatus either directly or via a MAINS SWITCH shall have a nominal cross-sectional area as specified in 16.2 for external flexible cords based upon the marked rating of the socket-outlet, but not less than 18 AWG, except where the apparatus complies with Clause 11 when 4.3.10 is applied.

Compliance is checked according to the relevant standards, by inspection and according to 16.2.

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15.1.2 DU Connectors other than for connecting MAINS power shall be so designed that the plug or socket has such a shape that connection to a mains socket outlet, appliance coupler or mains connector is unlikely to occur.

This requirement does not apply to connectors forming part of a non-detachable cord which are not CONDUCTIVELY CONNECTED TO THE MAINS, UNless ACCESSIBLE CONDUCTIVE parts become HAZARDOUS LIVE during or after insertion of the connector into the MAINS socket-outlet.

NOTE Examples of connectors meeting this requirement are those constructed according to IEC 60130-2, IEC 60130-9, IEC 60169-2 or IEC 60169-3, when used as prescribed. An example of a connector not meeting the requirements is the so-called "banana" plug.

Sockets for audio and video circuits of LOAD TRANSDUCERS indicated with the symbol of 5.3 b) shall be so designed, that a plug for antenna and earth, for audio and video circuits of LOAD TRANSDUCERS and SOURCE TRANSDUCERS and for data and similar circuits which are not indicated with the symbol of 5.3 b), cannot be inserted into them.

Compliance is checked by inspection.

15.1.3 TERMINALS and connectors used in output circuits of SUPPLY APPARATUS, whose output voltage is not a standard nominal MAINS voltage according to IEC 60038:2009, Table I, shall not be compatible with those specified for household and similar general purposes, for example those described in IEC 60083, IEC 60320, IEC 60884, IEC 60906.

Compliance is checked by inspection and by manual tests.

The TERMINAL or connector shall be designed for the loading which may appear under normal operating conditions and during intended use.

Compliance is checked according to the IEC 60320 series as far as safety is concerned, for instance with regard to shock hazard and heating.

15.1.3.1 DR An AUDIO AMPLIFIER having an open-circuit audio output voltage not limited to 120 V that is permanently connected to the MAINS shall be provided with a means for connection complying with U.21.1.1 - U.21.1.7, and wire-binding screws, No. 6-32 (3,5 mm diameter) or larger, guick-connect TERMINALS, or leads. When wire-binding screws are provided, the screws shall comply with the requirements in U.21.3.1 - U.21.3.5.

When guick-connect TERMINALS are provided, the TERMINALS shall comply with the following requirements:

a) Male tabs shall be firmly mounted in place.

b) Mating female connectors shall be provided with the apparatus.

c) Strain relief that complies with 16.5, and associated installation instructions, shall be provided to prevent stress being transmitted to the TERMINALS when a disconnected TERMINAL can contact a HAZARDOUS LIVE part or an accessible dead metal part.

d) The installation instructions shall include information for assembly of a TERMINAL to a conductor, and the utilization of strain relief as follows:

1) the tool designation, if a tool is to be used during the assembly,

2) instruction for the preparation of conductors, such as twisting strands of conductors together before assembly.

3) the size and type of wire (solid or stranded), and

<u>4)</u> identification of the strain relief means and instruction for its use if required by c) above, and

e) The quick connect TERMINALS shall be appropriate for the use with the size and type (solid or stranded) of wire specified.

15.1.3.2 DR An AUDIO AMPLIFIER having an open-circuit audio output voltage not limited to 120 V that is connected to the MAINS by means of a flexible cord shall be provided with one of the following:

a) A length of permanently attached Type SPT-2, NISPT-2, SV, SJ flexible cord or the equivalent, and an appliance coupler. The cord shall be provided with strain relief and a bushing complying with the requirements in 16.3 – 16.5, or

b) An opening that permits the field installation of a flexible cord and wire-binding screws, quick connect TERMINALS or leads as described in 15.1.3.1. Such an opening shall be provided with an insulating bushing as described in 16.5, or

c) A receptacle for plug-in connections.

15.2 DR Provisions for protective earthing

ACCESSIBLE conductive parts of CLASS I apparatus, which might assume a hazardous voltage in the event of a single insulation fault in BASIC INSULATION, and the protective earthing contacts of socket-outlets shall be reliably connected to a PROTECTIVE EARTHING TERMINAL within the apparatus.

Solder alone shall not serve as the sole means to provide mechanical securement of the protective conductor.

The protective conductor termination shall be made such that it is not likely to be loosened during servicing, other than servicing of the conductor itself. The protective earthing conductor termination shall not serve as a means to fix any other component.

Protective earthing circuits shall not contain switches or fuses.

The earthing conductor in a supply cord, or in an interconnecting cable shall have an equivalent or larger cross-sectional area than the current-carrying conductors in the supply cord or cable.

Protective earthing conductors may be bare or insulated. If insulated, the insulation shall be green or green/yellow except in the following two cases:

a) for earthing braids, the insulation shall be either green or green/yellow or transparent;

b) for internal protective conductors in assemblies such as ribbon cables, busbars, flexible printed wiring, etc., any colour may be used provided that no misinterpretation of the use of the conductor is likely to arise.

Wires identified by the colour <u>green or combination green/yellow shall</u> be used only for protective earthing connections.

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