

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Switches for household and similar fixed electrical installations –
Part 2-1: Particular requirements – Electronic control devices**

**Interrupteurs pour installations électriques fixes domestiques et analogues –
Partie 2-1: Exigences particulières – Dispositifs de commande électronique**



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CONTENTS

FOREWORD	6
1 Scope	8
2 Normative references	9
3 Terms and definitions	11
4 General requirements	15
5 General remarks on tests	15
6 Ratings	18
7 Classification	18
8 Marking	20
9 Checking of dimensions	23
10 Protection against electrical shock	23
11 Provision for earthing	26
12 Terminals	26
13 Constructional requirements	27
14 Mechanism	29
15 Resistance to ageing, protection provided by enclosures of switches and resistance to humidity	29
16 Insulation resistance and electric strength	29
17 Temperature rise	31
18 Making and breaking capacity	35
19 Normal operation	37
20 Mechanical strength	44
21 Resistance to heat	45
22 Screws, current-carrying parts and connections	45
23 Creepage distances, clearances and distances through sealing compound	45
24 Resistance of insulating material to abnormal heat, to fire and to tracking	52
25 Resistance to rusting	52
26 EMC requirements	52
101 Abnormal conditions	62
102 Components	67
103 Electromagnetic fields (EMF)	71
Annex A (normative) <i>Replacement of title to Annex A as follows:</i> Additional requirements for electronic control devices having facilities for the outlet and retention of flexible cables	76
Annex B (informative) Changes planned for the future in order to align IEC 60669-1 with the requirements of IEC 60998 (all parts), IEC 60999 (all parts) and IEC 60228	77
Annex C (informative) Circuit development (19.3)	78
Annex D (informative) Additional requirements for insulation-piercing terminals	79
Annex E (informative) Additional requirements and tests for switches intended to be used at a temperature lower than –5 °C	80
Annex AA (informative) Examples of types of electronic switches or HBES/BACS switches and their functions	85
Annex BB (informative) Circuit development: 19.106 explained	86

Annex CC (normative) Additional requirements for electronic control devices using DLT-technology in accordance with IEC 62756-1	91
Annex DD (informative) Test set-ups	93
Annex EE (informative) Electrical interface specification for phase-cut dimmer in phase-cut dimmed lighting systems.....	100
Annex FF (normative) Requirements for electronic RCS and electronic TDS that provide the function, markings and connection configuration in accordance with IEC 60669-2-2 and IEC 60669-2-3	131
Bibliography.....	136
Figure 101 – Protective separation between circuits	47
Figure 102 – Current path tested in the looping through circuit	72
Figure 103 – Circuit diagram for testing electronic switches and HBES/BACS switches according to 17.101 and 101.4.....	72
Figure 104 – Minimum creepage and clearances on printed circuit boards	73
Figure 105 – Surge test	74
Figure BB.1 – 120 V 15 W (LT spice model).....	87
Figure BB.2 – 230 V 15 W (LT spice model).....	88
Figure BB.3 – Model for multiple lamp loads	89
Figure BB.4 – I_{peak} and I^2t for multiple lamp loads	90
Figure DD.1 – Test setup for AC mains connection according to IEC 61000-4-4.....	93
Figure DD.2 – Test setup for bus and DC mains connection according to IEC 61000-4-4	94
Figure DD.3 – Test setup for AC mains connection according to IEC 61000-4-5.....	95
Figure DD.4 – Test setup for bus and DC mains connection according to IEC 61000-4-5	96
Figure DD.5 – Test setup for the ESD according to IEC 61000-4-2	97
Figure DD.6 – Test setup for AC mains connection according to IEC 61000-4-6.....	98
Figure DD.7 – Test setup for bus and DC mains connection according to IEC 61000-4-6	99
Figure EE.1 – Example of wiring diagram.....	103
Figure EE.2 – Timing leading edge dimming method	106
Figure EE.3 – Timing trailing edge dimming method	111
Figure EE.4 – Circuit to test the properties of the phase-cut dimmer during the non-conducting phase (Method 1).....	117
Figure EE.5 – Circuit to test the properties of the phase-cut dimmer during the non-conducting phase (Method 2).....	118
Figure EE.6 – Circuit to test the properties of the phase-cut dimmer during the transition from the non-conducting to the conducting phase	119
Figure EE.7 – Circuit to test the properties of the phase-cut dimmer during the electronic off-state	121
Figure EE.8 – Waveform of AC voltage source – Leading edge.....	122
Figure EE.9 – Waveform of AC voltage source – Trailing edge	122
Figure EE.10 – Equivalent circuit for controlgear in the on state to be used during dimmer tests	123
Figure EE.11 – Equivalent circuit for controlgear being in off state.....	124
Figure EE.12 – Test enclosure.....	127

Figure EE.13 – Geometry of microphone placement in regard to device under test	127
Figure EE.14 – Test circuit to test stability of phase angle	128
Figure EE.15 – Possibilities for proper triggering	129
Figure EE.16 – Equivalent circuit EC_CG2	130
Table 1 – Number of specimens needed for the tests	16
Table 15 – Test voltage, points of application and minimum values of insulating resistance for the verification of electric strength	29
Table 101 – Permissible temperature rise values	33
Table 102 – Application of tests for making and breaking capacity and normal operation for electronic switches and HBES/BACS switches according to 7.102.2	36
Table 103 – Relationship between rated current and capacitance	40
Table 104 – Values for I_{peak} and I^2t depending on the type of distribution system	42
Table 105 – Calculated circuit parameters	43
Table 106 – Test loads for HBES/BACS switches for heating installations	44
Table 23 – Creepage distances, clearances and distances through insulating sealing compound	45
Table 107 – Relation between the rated voltage of the HBES/BACS switch, the rated insulation voltage and the rated impulse voltage	48
Table 108 – Minimum clearances without verification test	49
Table 109 – Test voltages and corresponding altitudes	50
Table 110 – Minimum clearances with verification test	50
Table 111 – Minimum creepage distances of basic, supplementary and reinforced insulation without verification test for clearances	51
Table 112 – Minimum creepage distances of basic, supplementary and reinforced insulation with verification test for clearances	51
Table 113 – Immunity tests (overview)	54
Table 114 – Voltage dip and short-interruption test values	55
Table 115 – Surge immunity test voltages	56
Table 116 – Fast transient test values	57
Table 117 – Values for radiated electromagnetic field test of IEC 61000-4-3 ^a	59
Table 118 – Measurement methods	62
Table 119 – Protection methods and test conditions	64
Table 120 – Capacitors	68
Table A.101 – Maximum current and minimum cross-sectional area	76
Table E.101 – Energy for impact tests	83
Table AA.1 – Functions overview	85
Table BB.1 – Lamp	86
Table EE.1 – Nominal mains voltage 100 V – Frequency 50 Hz or 60 Hz	107
Table EE.2 – Nominal mains voltage 120 V – Frequency 50 Hz or 60 Hz	107
Table EE.3 – Nominal mains voltage 200 V – Frequency 50 Hz or 60 Hz	107
Table EE.4 – Nominal mains voltage 230 V – Frequency 50 Hz or 60 Hz	107
Table EE.5 – Nominal mains voltage 277 V – Frequency 50 Hz or 60 Hz	107
Table EE.6 – Slew rate for voltage decrease across the phase-cut dimmer	108

Table EE.7 – Nominal mains voltage 100 V – Frequency 50 Hz or 60 Hz	109
Table EE.8 – Nominal mains voltage 120 V – Frequency 50 Hz or 60 Hz	109
Table EE.9 – Nominal mains voltage 200 V – Frequency 50 Hz or 60 Hz	109
Table EE.10 – Nominal mains voltage 230 V – Frequency 50 Hz or 60 Hz	109
Table EE.11 – Nominal mains voltage 277 V – Frequency 50 Hz or 60 Hz	110
Table EE.12 – Nominal mains voltage from 100 V to 277 V – Frequency 50 Hz or 60 Hz	112
Table EE.13 – Nominal mains voltage 100 V – Frequency 50 Hz or 60 Hz	113
Table EE.14 – Nominal mains voltage 120 V – Frequency 50 Hz or 60 Hz	113
Table EE.15 – Nominal mains voltage 200 V – Frequency 50 Hz or 60 Hz	113
Table EE.16 – Nominal mains voltage 230 V – Frequency 50 Hz or 60 Hz	114
Table EE.17 – Nominal mains voltage 277 V – Frequency 50 Hz or 60 Hz	114
Table EE.18 – Currents and voltages for controlgear during the electronic off state	115
Table EE.19 – Parameters for testing purposes	116
Table EE.20 – Parameters for testing purposes	125

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SIMILAR FIXED ELECTRICAL INSTALLATIONS –****Part 2-1: Particular requirements – Electronic control devices****FOREWORD**

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International Standard IEC 60669-2-1 has been prepared by subcommittee 23B: Plugs, socket-outlets and switches, of IEC technical committee 23: Electrical accessories.

This fifth edition cancels and replaces the fourth edition published in 2002, Amendment 1:2008 and Amendment 2:2015. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) incorporation of the requirements for HBES switches, previously included in IEC 60669-2-5;
- b) modification of 19.106, test and requirements for switches for LEDs;
- c) general indication to cover electronic control devices;
- d) test for looping through.

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

FDIS	Report on voting
23B/1326/FDIS	23B/1342/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

This part of IEC 60669 is to be used in conjunction with IEC 60669-1:2017, hereinafter referred to as Part 1. It lists the changes necessary to convert that standard into a specific standard for electronic control devices.

In this document, the following print types are used:

- requirements proper: in roman type;
- *test specifications: in italic type;*
- notes: in smaller roman type.

Subclauses, figures, tables or notes which are additional to those in Part 1 are numbered starting from 101.

A list of all the parts in the IEC 60669 series, published under the general title *Switches for household and similar fixed electrical installations*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

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- withdrawn,
- replaced by a revised edition, or
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SWITCHES FOR HOUSEHOLD AND SIMILAR FIXED ELECTRICAL INSTALLATIONS –

Part 2-1: Particular requirements – Electronic control devices

1 Scope

This clause of Part 1 is completely replaced by the following:

This part of IEC 60669 applies to electronic control devices, a general term to cover electronic switches, home and building electronic systems (HBES) / building automation and control systems (BACS) switches and electronic extension units.

It applies to electronic switches and to HBES/BACS switches, for alternating current (AC) only with a rated switching voltage not exceeding 250 V and a rated current not exceeding 16 A, intended for household and similar fixed electrical installations, either indoors or outdoors.

It also applies to electronic extension units with a rated supply voltage not exceeding 250 V AC and 120 V DC, such as sensors and push buttons.

This document also applies to electronic remote control switches (RCS) and electronic time delay switches (TDS). Particular requirements are given in Annex FF.

Switches including only passive components such as resistors, capacitors, inductors, positive temperature coefficient (PTC) and negative temperature coefficient (NTC) components, varistors, printed wiring boards and connectors are not considered as electronic control devices.

This document also applies to electronic switches and HBES/BACS switches for the operation of lighting equipment circuits and the control of the brightness of lighting equipment (dimmers) as well as the control of the speed of motors (for example, those used in ventilating fans) and for other purposes (for example, heating controls).

The operation and/or control as mentioned above can be transmitted by an electronic signal via several media, for example, powerline (mains), twisted pair, optical fibre, radio frequency, infrared, etc. and are performed:

- intentionally by a person via an actuating member, a key, a card, etc., via a sensing surface or a sensing unit, by means of touch, proximity, turn, optical, acoustic, thermal;
- by physical means, for example, light, temperature, humidity, time, wind velocity, presence of people;
- by any other influence.

This document also applies to electronic control devices which include integrated radio receivers and transmitters.

This document covers only those requirements for mounting boxes which are necessary for the tests on the electronic control devices.

Requirements for general purpose mounting boxes are given in the relevant part, if any, of IEC 60670.

Electronic control devices complying with this document are suitable for use at ambient temperature not normally exceeding 25 °C but occasionally reaching 35 °C with a lower limit of the ambient air temperature of –5 °C.

NOTE 1 For lower temperatures, see Annex E.

Functional safety aspects are not covered by this document. Functional safety requirements are covered by the standards of the controlled devices.

In locations where special conditions prevail, such as in ships, vehicles and the like and in hazardous locations, for example where explosions are liable to occur, special construction and/or additional requirements may be required.

This document is not intended to cover devices which are designed to be incorporated in appliances or are intended to be delivered together with a specific appliance and which are within the scope of IEC 60730 (all parts) or IEC 61058-1.

Examples of designs of electronic switches and HBES/BACS switches and functions are shown in Annex AA.

Additional requirements for electronic control devices using DLT-technology in accordance with IEC 62756-1 are given in Annex CC.

Electrical interface specification for phase-cut dimmer used in phase-cut dimmed lighting systems are given for information only in Annex EE.

NOTE 2 Electronic switches and HBES/BACS switches without a mechanical switch in the main circuit do not provide a "full off-state". Therefore, the circuit on the load side are to be considered to be live.

2 Normative references

This clause of Part 1 applies except as follows.

Addition:

IEC 60050-845, *International Electrotechnical Vocabulary (IEV) – Part 845: Lighting* (available at www.electropedia.org)

IEC 60068-2-78, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

IEC 60127 (all parts), *Miniature fuses*

IEC 60317 (all parts), *Specifications for particular types of winding wires*

IEC 60317-0-1:2013, *Specifications for particular types of winding wires – Part 0-1: General requirements – Enamelled round copper wire*

IEC 60384-14:2013, *Fixed capacitors for use in electronic equipment – Part 14: Sectional specification – Fixed capacitors for electromagnetic interference suppression and connection to the supply mains*

IEC 60384-14:2013/AMD1:2016

IEC 60664-1:2020, *Insulation coordination for equipment within low-voltage supply systems – Part 1: Principles, requirements and tests*

IEC 60669-1:2017, *Switches for household and similar fixed electrical installations – Part 1: General requirements*

IEC 60669-2-2:2006, *Switches for household and similar fixed electrical installations – Part 2-2: Particular requirements – Electromagnetic remote-control switches (RCS)*

IEC 60669-2-3:2006, *Switches for household and similar fixed electrical installations – Part 2-3: Particular requirements – Time-delay switches (TDS)*

IEC 60670 (all parts), *Boxes and enclosures for electrical accessories for household and similar fixed electrical installations*

IEC 60704-1, *Household and similar electrical appliances – Test code for the determination of airborne acoustical noise – Part 1: General requirements*

IEC 60715, *Dimensions of low-voltage switchgear and controlgear – Standardized mounting on rails for mechanical support of switchgear, controlgear and accessories*

IEC 60730 (all parts), *Automatic electrical controls*

IEC 60990, *Methods of measurement of touch current and protective conductor current*

IEC 60999-1, *Connecting devices – Electrical copper conductors – Safety requirements for screw-type and screwless-type clamping units – Part 1: General requirements and particular requirements for clamping units for conductors from 0,2 mm² up to 35 mm² (included)*

IEC 61000-2-2, *Electromagnetic compatibility (EMC) – Part 2-2: Environment – Compatibility levels for low-frequency conducted disturbances and signaling in public low-voltage power supply systems*

IEC 61000-3-2:2018, *Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)*

IEC 61000-3-3:2013, *Electromagnetic compatibility (EMC) – Part 3-3: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection*
IEC 61000-3-3:2013/AMD1:2017

IEC 61000-4-2, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61000-4-3, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-4, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*

IEC 61000-4-5, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

IEC 61000-4-6, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61000-4-8, *Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test*

IEC 61000-4-11, *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests for equipment with input current up to 16 A per phase*

IEC 61000-4-20:2010, *Electromagnetic compatibility (EMC) – Part 4-20: Testing and measurement techniques – Emission and immunity testing in transverse electromagnetic (TEM) waveguides*

IEC 61558-2-6, *Safety of transformers, reactors, power supply units and similar products for supply voltages up to 1 100 V – Part 2-6: Particular requirements and tests for safety isolating transformers and power supply units incorporating safety isolating transformers*

IEC 61558-2-16, *Safety of transformers, reactors, power supply units and similar products for supply voltages up to 1 100 V – Part 2-16: Particular requirements and tests for switch mode power supply units and transformers for switch mode power supply units*

IEC 62504, *General lighting – Light emitting diode (LED) products and related equipment – Terms and definitions*

IEC 62756-1, *Digital load side transmission lighting control (DLT) – Part 1: Basic requirements*

IEC/TR 63037:2019, *Electrical interface specifications for self ballasted lamps and controlgear in phase-cut dimmed lighting systems*

IEC 63044-3:2017, *Home and Building Electronic Systems (HBES) and Building Automation and Control Systems (BACS) – Part 3: Electrical safety requirements*

CISPR 14-1:2016, *Electromagnetic compatibility – Requirements for household appliances, electric tools and similar apparatus – Part 1: Emission*

CISPR 15:2018, *Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment*

CISPR 32:2015, *Electromagnetic compatibility of multimedia equipment – Emission requirements*
CISPR 32:2015/AMD1:2019

ISO 306:2013, *Plastics – Thermoplastic materials – Determination of Vicat softening temperature (VST)*

ISO 3741, *Acoustics – Determination of sound power levels and sound energy levels of noise sources using sound pressure – Precision methods for reverberation test rooms*

ISO 3744, *Acoustics – Determination of sound power levels and sound energy levels of noise sources using sound pressure – Engineering methods for an essentially free field over a reflecting plane*

3 Terms and definitions

This clause of Part 1 applies except as follows.

Add the terms and definitions in IEC 63044-3:2017 and the following:

3.101

electronic switch

stand-alone device designed to make or break and/or control directly the current in one or more electric circuits either through mechanical switching element(s) via an electronic control circuit, or through an electronic switching element via a mechanical/electronic control circuit

Note 1 to entry: A stand-alone device can still be controlled remotely via RF, IR or a dedicated electronic extension unit.

Note 2 to entry: To make or break and/or to control directly means that an actuator makes or breaks the current and/or controls the current.

3.102

HBES/BACS

combination of HBES/BACS products (including their separate connected/detachable devices) linked together via one or more HBES/BACS networks

Note 1 to entry: Other names used such as "home control network", "home control systems", "home and building electronic systems", "building systems", "building automation system", etc. describe types of HBES/BACS system.

Note 2 to entry: HBES is the abbreviated term for "home and building electronic systems" and BACS is the abbreviated term for "building automation and control systems".

[SOURCE: IEC 63044-1:2017, 3.1.3, modified – Note 2 added.]

3.103

HBES/BACS switch

network operated electronic device intended to be used in an HBES/BACS, using two-way communication and designed to make or break and/or to control directly the current in one or more electric circuits

Note 1 to entry: The communication can use different media, for example twisted pair (TP), power line (PL), infrared (IR) and radio frequency (RF).

Note 2 to entry: To make or break and/or to control directly means that an actuator makes or breaks the current and/or controls the current.

3.104

electronic extension unit

device connected to an electronic switch, an HBES/BACS switch, and to lighting products used in lighting systems in the building environment in order to remotely control and/or to monitor the electronic switch, the HBES/BACS switch, and lighting products used in lighting systems in the building environment

Note 1 to entry: The electronic extension unit does not control directly the current in one or more circuits (e.g. sensors, HBES/BACS push buttons, status display).

3.105

ELV

extra low voltage

nominal voltage in the electrical installation of buildings according to the voltage band I specified in IEC 61140:2016

Note 1 to entry: Voltage band I according to IEC 61140 is a voltage below or equal to 50 V AC or 120 V DC.

[SOURCE: IEC 63044-3:2017, 3.1.7, modified – The publication IEC 61140 has been dated.]

3.106

FELV

functional extra low voltage

electrical circuit in which the nominal voltage cannot exceed ELV under normal conditions

Note 1 to entry: FELV has simple separation from mains.

Note 2 to entry: A FELV circuit is not safe to touch and may be connected to protective earth.

[SOURCE: IEC 63044-3:2017, 3.1.9, modified – The word "circuit" has been omitted from both terms.]

3.107**SELV circuit****safety extra low voltage circuit**

electrical circuit in which the nominal voltage cannot exceed ELV

- under normal conditions,
- under single fault conditions, including earth fault in other circuits

Note 1 to entry: SELV has simple separation from PELV and other SELV systems, and earth and protective separation from all other circuits.

Note 2 to entry: Under normal conditions and single-fault conditions in a dry location inside a building, a SELV circuit with a voltage not higher than 25 V AC or 60 V DC is safe to touch.

[SOURCE: IEC 63044-3:2017, 3.1.10]

3.108**PELV circuit****protective extra low voltage circuit**

electrical circuit in which the nominal voltage cannot exceed ELV

- under normal conditions,
- under single-fault conditions, except earth fault in other circuits

Note 1 to entry: PELV has protective separation from all circuits other than PELV, SELV or earth.

Note 2 to entry: PELV circuit is safe to touch within the same equipotential bonding area inside a building under the following conditions: under normal and single-fault conditions in dry locations and with no large contact area with a voltage not higher than 25 V AC or 60 V DC; otherwise not higher than 12 V AC or 30 V DC.

[SOURCE: IEC 63044-3:2017, 3.1.11]

3.109**simple separation**

separation between circuits or between a circuit and earth by means of basic insulation

[SOURCE: IEC 63044-3:2017, 3.1.12]

3.110**protective separation**

separation of one electric circuit from another by means of

- double insulation, or
- basic insulation and protective screening (shielding), or
- reinforced insulation

[SOURCE: IEC 63044-3:2017, 3.1.13]

3.111**basic insulation**

insulation of hazardous-live-parts which provides basic protection

Note 1 to entry: This concept does not apply to insulation used exclusively for functional purposes.

[SOURCE: IEC 63044-3:2017, 3.1.14, modified – The note has been added.]

3.112**supplementary insulation**

independent insulation applied in addition to basic insulation for fault protection

[SOURCE: IEC 63044-3:2017, 3.1.16]

3.113

double insulation

insulation comprising both basic insulation and supplementary insulation

[SOURCE: IEC 63044-3:2017, 3.1.15]

3.114

reinforced insulation

insulation of hazardous-live-parts which provides a degree of protection against electric shock equivalent to double insulation

Note 1 to entry: Reinforced insulation may comprise several layers which cannot be tested singly as basic insulation or supplementary insulation.

[SOURCE: IEC 63044-3:2017, 3.1.18, modified – The note has been added.]

3.115

rated load

load assigned by the manufacturer to the electronic switch, HBES/BACS switch, electronic TDS switch or electronic RCS switch

3.116

minimum load

lowest load at which the electronic switch, HBES/BACS switch, electronic TDS switch or electronic RCS switch still operates correctly

3.117

minimum current

lowest current at which the electronic switch, HBES/BACS switch, electronic TDS switch or electronic RCS switch still operates correctly

3.118

electromechanically operated contact mechanism

component which operates the parts used to open and close the circuit electromechanically

3.119

semiconductor switching device

switching device designed to make or break the current in an electric circuit by means of the controlled conductivity of a semiconductor in that circuit

Note 1 to entry: In a circuit where the current passes through zero (periodically or otherwise), the effect of "not making" the current following such a zero value is equivalent to breaking the current.

Note 2 to entry: Typical examples of semiconductor switching devices are:

- electronic switching devices using the phase-cut-on principle to control the load by electronic switching on the current at any phase angle at or after zero crossing in each half-wave, for example, by a thyristor;
- electronic switches or HBES/BACS switches using the phase-cut-off principle to control the load by switching off the current at any phase angle after zero crossing in each half-wave, for example, by a transistor in a diode bridge.

3.120

phase-cut dimmer

electronic switch or HBES/BACS switch that is connected in series with a load and changes the supply voltage waveform applied to the load from the pure mains voltage waveform to a leading edge (forward phase) or a trailing edge (reverse phase) AC voltage waveform or is capable of switching between both waveforms

Note 1 to entry: The output voltage waveform of a phase-cut dimmer is applied to one or more loads.

Note 2 to entry: The conduction angle of the voltage waveform is adjustable.

Note 3 to entry: Within this document, where the term "dimmer" is used the term "phase-cut dimmer" is meant.

3.121**mechanical control unit**

unit directly adjustable by mechanical means (for example, potentiometer) which controls the output via electronic components

3.122**electronic output control unit**

unit adjustable by other than mechanical means (for example, sensing unit), containing electronic components and controlling the output via electronic components

3.123**protective impedance**

impedance connected between hazardous live parts and accessible conductive parts, of such value that the current, in normal use and under likely fault conditions in the electronic switch, is limited to a safe value, and which is so constructed that the reliability is maintained throughout the life of the electronic switch or HBES/BACS switch

3.124**external flexible cable**

cable, a part of which is external to the electronic output control unit

Note 1 to entry: Such a cable may either be a supply cable or a connecting cable between separate parts of an accessory.

3.125**live part**

conductive part intended to be energized in normal operation

3.126**hazardous live part**

live part with a voltage higher than 25 V AC or 60 V DC ripple free in dry conditions or 12 V AC or 30 V DC in wet conditions

Note 1 to entry: Ripple free is conventionally an RMS ripple voltage not more than 10 % of the DC component.

3.127**looping through function**

means on the line or both line and neutral terminals to power other devices in the circuit of the installation

4 General requirements

This clause of Part 1 applies, as far as applicable.

5 General remarks on tests

This clause of Part 1 applies, as far as applicable, except as follows.

Replace Table 1 by the following Table 1:

Table 1 – Number of specimens needed for the tests

	Clauses and subclauses	Number of specimens	Notes
6	Ratings	A	
7	Classification	A	
8	Marking	A	
9	Checking of dimensions	ABC	
10	Protection against electric shock	ABC	a
11	Provision for earthing	ABC	b
12	Terminals	ABC	c, d, e
13	Constructional requirements	ABC	f, g
14	Mechanism	ABC	
15	Resistance to ageing, protection provided by enclosures of switches, and resistance to humidity	ABC	t
16	Insulation resistance and electric strength	ABC	h
17	Temperature rise	ABC	
18	Making and breaking capacity	ABC	i, j
19	Normal operation	ABC	i, j
20	Mechanical strength	ABC	k, l
21	Resistance to heat	ABC	m
22	Screws, current-carrying parts and connections	ABC	
23	Creepage distances, clearances and distances through sealing compound	ABC	
24	Resistance of insulating material to abnormal heat, to fire and to tracking	DEF	n, o
25	Resistance to rusting	DEF	
26	EMC requirements	G	
101	Abnormal conditions	HIJ	p, q, r
102	Components	HIJ	s
	TOTAL	10	

- a) One extra set of specimens of touch sensitive electronic control devices with a protective impedance may be used for the tests of 10.2.
- b) One extra set of specimens of electronic control devices with printed conductors used to provide protective earthing continuity is needed for the tests of 11.101.
- c) Five extra screwless terminals are used for the test of 12.3.11 and one extra set of specimens is used for the test of 12.3.12.
- d) Two extra sets of specimens of terminals suitable for rigid and flexible conductors are required for 12.2.5, 12.2.6 and 12.2.7.
- e) Number of specimens required for insulation-piercing terminals (IPTs) are shown in Table D.1.
- f) An extra set of membranes are needed for each of the tests of 13.15.1 and 13.15.2.
- g) For switches with pilot light units if the electronic circuitry is so enclosed that the short-circuiting or disconnecting of components is impossible or difficult, the manufacturer shall provide additional prepared test specimens.
- h) One extra set of specimens of switches fitted with pilot light may be used for the tests of Clause 16.
- i) Only the complete contact mechanism may be submitted.
- j) For electronic switches and HBES/BACS switches with mechanical and electromechanical switching devices, one extra set of specimens is needed for each additional type of load (see also Table 102).
- k) One extra set of specimens of cord-operated switches is needed for the test of 20.10.
- l) Extra sets of specimens are needed for the tests of 20.5.2 and 20.5.3.
- m) One extra set of specimens may be used for the tests of 21.2 and 21.3. In this case the specimens shall be subjected first to the tests of 15.1.
- n) The test is made on one specimen (D). In case of doubt, the test shall be repeated on two further specimens (E and F).
- o) For electronic control devices with an IP code higher than IPX0, one extra set of specimens may be used for the test of 24.2.
- p) It may be necessary to provide 3 additional specimens for the test of 101.2.4
- q) It may be necessary to provide 6 additional sets of 3 specimens for the test of 101.4.
- r) It may be necessary to provide 3 additional specimens for the test of 101.5.
- s) For electronic control devices with a cut-out, one extra set of specimens may be used for the tests of 102.5.2.2 or 102.5.2.3.
- t) Two extra sets of specimens may be used for IP test IP > 20 according to 15.2.2 and 15.2.3. The specimens shall be preliminarily submitted to the ageing test of 15.1.

5.101 Particular requirements

All measurements shall be carried out by methods which are suitable for the purpose, which do not appreciably affect the values to be measured and which are not affected by factors such as waveform.

Care should be taken to use instruments giving true RMS indications.

If the electronic circuitry is so enclosed that the short-circuiting or disconnecting of components is impossible or difficult, the manufacturer shall provide one additional test specimen with leads connected for measurements, short-circuiting, etc.

It is not necessary to connect leads to the interior of hybrid and monolith integrated circuits.

It may be necessary to disconnect electronic components for tests.

For electronic switches and HBES/BACS switches equipped with cut-outs, it may be necessary to provide three additional specimens for the test of 102.5.2.

6 Ratings

This clause of Part 1 applies, as far as applicable, except as follows.

6.1 Rated voltage

Replace the first paragraph by:

Preferred rated voltages of the load circuits are 110 V, 120 V, 130 V, 220 V, 230 V and 240 V.

NOTE For electronic extension units, other AC or DC voltages are common for the power supply and communication.

6.2 Rated current

Replace the entire text of Subclause 6.2 by:

There are no preferred values.

6.3 Preferred combinations of number of poles and ratings

Replace the entire text of Subclause 6.3 by:

There are no preferred combinations of number of poles and ratings.

6.101 Preferred rated supply frequency

The preferred rated supply frequencies are 50 Hz and/or 60 Hz.

7 Classification

This clause of Part 1 applies, as far as applicable, except as follows.

7.5 according to the method of actuating the switch:

Addition:

- touch;
- proximity;
- optical;
- acoustic;
- other external influences.

7.6 according to the method of mounting the switch:

Addition:

- electronic control devices only intended to be mounted at a height greater than 1,7 m.

7.7 according to the method of installation, as a consequence of the design of the switch:

Addition:

NOTE This classification is not applicable for SELV electronic control devices

7.8 according to the type of terminal:

Addition:

- electronic control devices without terminals equipped with connecting leads.

7.9 according to the suitability to accept conductors:

Add the following note at the end:

NOTE 101 This classification does not apply to terminals used for communication purpose only.

7.101 according to the type of product:

- electronic control devices classified as an electronic switch;
- electronic control devices classified as an HBES/BACS switch;
- electronic control devices classified as an electronic extension unit.

7.102 according to the kind of load intended to be controlled by the electronic switch or HBES/BACS switch:

7.102.1 for general purpose use according to Part 1 up to and including 16 A;

7.102.2 for dedicated loads:

- incandescent lamps;
- externally ballasted light sources (e.g. fluorescent lamps, CFL, LED lamps, LED modules);
- motors;
- self-ballasted lamps (e.g. CFLi, LEDi);
- load for heating installations (e.g. resistive load, a motor load with a power factor not less than 0,6 or a combination of both);
- declared load.

7.103 according to the presence of SELV, PELV or FELV parts:

- electronic control devices with SELV, PELV or FELV parts only;
- electronic control devices without SELV, PELV or FELV parts;
- electronic control devices having a combination of parts connected to the mains and SELV, PELV or FELV parts.

7.104 according to the installation environment:

- electronic control devices intended to be used in a SELV/PELV environment only;
- electronic control devices intended to be used in a FELV environment only;
- electronic control devices intended to be used in a SELV/PELV, FELV and/or mains environment.

7.105 according to the connection to the network port based on SELV/PELV:

- a) connected to a network which is installed wholly within the same equipotential earthing system;
- e) connected to a network which is not installed wholly within the same equipotential earthing system.

8 Marking

This clause of Part 1 applies except as follows.

8.1 General

Replacement:

Electronic switches and HBES/BACS switches shall be marked with:

- rated voltage(s) in volts;
- for switches classified according to 7.102.1, the rated current(s)
 - in amperes (A) if the switch is tested according to 19.1 of Part 1 only, or
 - in amperes (A) if the switch is tested according to 19.1 and 19.3 of Part 1 only, or
 - in amperes (AX) if the switch is tested according to 19.1, 19.2 and 19.3 of Part 1 when the rated currents in amperes (A) and (AX) are equal, or
 - in amperes (A and AX) if the switch is tested according to 19.1, 19.2 and 19.3 of Part 1 when the rated currents in amperes (A) and (AX) are not equal;
- for switches classified according to 7.102.2, the rated current(s) in amperes or rated load(s) in volt-amperes or watts;
- symbol for nature of supply;
- manufacturer's or responsible vendor's name, trade mark or identification mark;
- type reference, which may be a catalogue number;
- symbol for mini-gap construction, if applicable;
- symbol for micro-gap construction, if applicable;
- symbol for semiconductor switching device, if applicable;
- first characteristic numeral for the degree of protection against access to hazardous live parts and against harmful effects due to ingress of solid objects, if declared higher than 4, in which case the second characteristic numeral shall also be marked;
- second characteristic numeral for the degree of protection against harmful effects due to ingress of water, if declared higher than 2, in which case the first characteristic numeral shall also be marked;
- length of insulation to be removed before the insertion of the conductor into the screwless type terminal.

Marking of the pattern number given in 7.1 is recommended if the connections are not clear from an inspection of the electronic switches and HBES/BACS switches; this pattern number may be part of the type reference.

If a base carries two or more electronic switches and HBES/BACS switches with separate operating devices, marking with the pattern numbers is recommended, for example 1 + 6 or 1 + 1 + 1.

NOTE 1 For electronic switches and HBES/BACS switches suitable for more than one type of rated load, see 8.3.

NOTE 2 In the following country, the marking of the type reference is not used: UK.

NOTE 3 In the following countries, the symbol that electrotechnical expertise is required (see IEC 60417-6182:2013-09) is to be placed on the packaging: DE.

In addition, electronic switches and HBES/BACS switches shall be marked with

- rated frequency in hertz, unless the electronic switch and HBES/BACS switch is designed for both 50 Hz and 60 Hz;

- rating and type of any fuse incorporated in the electronic switch and HBES/BACS switch, if intended to be replaceable;
- symbols for the kind of load (see 8.2); except for electronic switches and HBES/BACS switches classified according to 7.102.1 for general purpose use for which Part 1 applies;
- the minimum height for mounting the electronic switch and the HBES/BACS switch shall be indicated in the installation instruction of the manufacturer if there is a restriction (see 10.1).

In addition, electronic switches and HBES/BACS switches with screwless terminals shall be marked with an indication of the suitability to accept rigid conductors only, for those electronic switches and HBES/BACS switches having this restriction. This information may be put on the electronic switch and/or on the packaging unit.

For electronic switches and HBES/BACS switches with included automatic function if the manufacturer's declared number of operations is higher than that indicated in 19.101, 19.102, 19.104, 19.106 and 19.107 then this shall be stated in the accompanying instruction sheet.

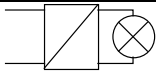
Electronic extension units are marked as for electronic switches and HBES/BACS switches but electronic extension units which are supplied by the network do not need to be marked with:

- rated voltage in volts;
- rated current in amperes or rated load in volt-amperes or watts;
- symbol for nature of supply.

The method for the correct installation of the product shall be provided in the manufacturer's instructions.

8.2 Symbols

Addition:

Volt-ampere	VA
Hertz	Hz
Terminal for regulated load (IEC 60417-6165:2012-06)	
Type of load:	
LED light sources	LED
Incandescent lamps (IEC 60417-5012:2002-10)	
Externally ballasted fluorescent lamps (IEC 60417-6153:2012-04)	
Motors (ISO 7000-0147:2004-01)	
Electronic step-down converter for extra-low-voltage incandescent lamps (for example, halogen)	
Iron core transformer for extra-low-voltage incandescent lamps (for example, halogen)	

For electronic switches or HBES/BACS switches intended for heating installations suitable for resistive load and for motor load, the rated current for motor load is placed between round brackets and immediately follows the rated current for resistive load.

Example: 16(3), where 16 A is the rated current for resistive load and 3 A is the rated current for motor load.

NOTE 101 The rating and type of any fuse can be marked with symbols (see IEC 60127 (all parts)).

If other symbols are used, they shall be explained in the installation instructions.

Additional markings according to IEC 61140 can only be used if the protection class is not dependent on the installation conditions.

8.3 Visibility of markings

Replacement of the second paragraph with the following:

The following marking shall be placed on the main part of the electronic switch and HBES/BACS switch:

- the rated current or rated load, rated voltage, symbol for nature of supply, rated frequency (if required by 8.1), at least one type of load if the electronic switch and HBES/BACS switch is not classified for general purpose use, the rating and type of any incorporated fuse (this shall be marked on the fuse-holder or in the proximity of the fuse),
- either the name, trade mark or identification mark of the manufacturer or of the responsible vendor,
- length of insulation to be removed before the insertion of the conductor into the screwless terminal, if any,
- symbol for mini-gap construction, micro-gap construction or semiconductor device, if applicable,
- the type reference.

NOTE The type reference can be the series reference only.

Where an electronic switch or HBES/BACS switch is suitable for more than one type of load if not already marked on the electronic switch or HBES/BACS switch, the information concerning these shall be stated in the accompanying instruction sheet. In addition, the minimum, if any, and the maximum current or the minimum, if any, and the maximum load in volt-ampere or watt shall be stated for each type of load.

If a phase-cut dimmer is intended to be used together with an iron core transformer, information shall be given in the manufacturer's instructions that only a transformer intended to be used with a phase-cut dimmer shall be used.

8.4 Marking on terminals for phase conductors

Addition:

If there are more than two terminals, the load terminal shall be marked with an arrow pointing away from the terminal or with one of the symbols mentioned in 8.2 and any other terminals shall be marked in accordance with the installation instructions.

Unless the installation of the electronic control device is made clear by the markings of the terminals, a wiring diagram shall be provided with each electronic control device.

If switched circuits cannot be used in SELV/PELV circuits, the relevant information shall be provided in the manufacturer's instructions.

If a product is classified according to 7.105 a), this shall be stated in the manufacturer's instructions.

8.6 Marking of the switch position

Addition:

The off-state shall not be marked with an "O" if the circuit on the load side is considered as live, in accordance with Clause 10.

8.6.101 It is recommended that the actual state of the electronic switch and HBES/BACS switch intended to control the brightness of lighting products shall be indicated when used as intended. This can be achieved by one of the following:

- with marking of the on-/off-state position, or
- with an indicator lamp, or
- by adjusting the lamp dimmer so that at the lowest control state and at rated voltage minus 10 %, the light is still visible.

Adjustment is to be made by the installer using an appropriate load specified by the manufacturer.

NOTE 101 A test to verify that the light is still visible is under consideration.

8.7 Additional requirements for marking

Addition after the second paragraph:

If an electronic control device containing a viewing window (lens) for a sensing device is intended to be mounted at a height greater than 1,7 m, this information shall be stated in the instruction sheet.

If the electronic control device provides a looping through function on the input terminals through other components inside the electronic switch, such as PCBs, then the maximum rated current of the upstream fuse/circuit breaker to be installed shall be declared by the manufacturer in the instruction sheets.

Addition to NOTE 2:

- information concerning external, directly associated fuses/current limiting devices, where applicable.

9 Checking of dimensions

This clause of Part 1 applies except as follows.

Addition:

Electronic control devices may be of dimensions other than those specified in the standard sheets (if any) provided they are supplied with suitable boxes.

10 Protection against electrical shock

This clause of Part 1 applies except as follows.

10.1 Prevention of access to live parts

Addition after the second paragraph:

NOTE 101 For the purpose of this document, metal sensing surfaces which are connected to hazardous live parts by means of protective impedances (see 10.2) are not considered to be hazardous live parts.

Add before the last paragraph:

Viewing windows or the like on electronic control devices intended to be mounted at a height greater than 1,7 m are subjected to a force of 30 N.

10.2 Requirements for operating parts

Addition:

For touch sensitive electronic control devices, the associated protective impedance does not have to comply with the requirements of Clause 16 and Clause 23.

For electronic control devices with a protection degree of IPX0, accessible parts which are needed for the operation of electronic control devices (for example, sensing surfaces) may be connected to hazardous live parts. If they are connected to hazardous live parts, it shall be by means of a protective impedance.

The protective impedance shall consist of at least two resistors or independent capacitors in series, of the same nominal value or a combination of both. The resistors shall comply with the requirements given in 102.4, and the capacitors shall comply with the requirements given in 102.3.

The removal of protective impedance shall only be possible by destruction of the electronic control device or by rendering it unusable.

Compliance is checked by inspection and by the following test.

The measurements are carried out between either a single accessible metal part or any combination of accessible metal parts and earth, through a non-inductive resistor of 2 kΩ at rated voltage (and rated load in on-state), in on- and off-state, and/or at lowest and highest setting values. During the measurements, each one of the resistors and all other components, if any, in the protective impedance, are alternatively short-circuited.

The current shall not exceed, in any measurement, 0,7 mA (peak value) for AC up to 1 kHz or 2 mA for DC.

For frequencies above 1 kHz, the limit of 0,7 mA is multiplied by the value of the frequency in kilohertz, but shall not exceed 70 mA.

10.101 Requirements for fuse replacement or adjustment of control setting

Replacement of fuses or adjustment of control shall not involve risk of electric shock.

If a cover or cover-plate or a fuse can be removed without the use of a tool, or if the manufacturer's instructions indicate that for the purpose of maintenance, fuse replacement or adjustment of control settings, covers and cover-plates fastened by means of a tool have to be removed, the protection against contact with hazardous live parts shall be assured even after removal of the covers or cover-plates.

This requirement does not apply when the electronic control device is to be dismantled from its supporting means for the replacement of the fuse-link and adjustment.

The conditions for the safe replacement of the fuse and the safe adjustment of the setting(s) shall be specified in the manufacturer's instructions, if relevant.

Compliance is checked by applying test probe B according to IEC 61032:1997 with a force not exceeding 10 N. The test probe shall not touch hazardous live parts.

If an electronic control device is provided with a hole for adjusting the setting of the electronic control device and this hole is indicated as such, the adjustment shall not involve the risk of an electric shock.

Compliance is checked by applying a test pin according to Figure 106 through that hole only. The pin shall not touch hazardous live parts.

10.102 Ventilation openings

Ventilation openings over hazardous live parts shall be so designed that a foreign body introduced into these openings shall not come into contact with any hazardous live parts with the electronic control device installed as in normal use.

Compliance is checked by applying the test probe 13 of IEC 61032:1997 through the openings. The pin of the test probe shall not touch hazardous live parts.

10.103 SELV, PELV or FELV circuits

Live parts of SELV, PELV or FELV circuits shall be electrically separated from each other and from other circuits by simple or protective separation as given in Clause 23.

If the SELV / PELV is higher than 25 V AC or 60 V DC in dry conditions or 12 V AC or 30 V DC in wet conditions, protection against direct contact shall be provided by:

- barriers or enclosures giving at least the degree of protection IP2X or IPXXB, or
- insulation capable of withstanding a test voltage of 500 V AC for 1 min.

Compliance is checked by inspection and the tests of Clause 16 and Clause 23.

10.104 Protection from touch current

10.104.1 General

For an explanation on touch current, see IEC 63044-3.

10.104.2 Permissible touch current when touching accessible parts of HBES/BACS switches

The touch current of HBES/BACS switches shall not be higher than 0,5 mA RMS (0,7 mA peak) even during single fault condition.

Compliance is checked by inspection and, if necessary, by tests in accordance with IEC 60990.

10.104.3 Limitation of the touch current from the device to the dedicated HBES/BACS network

The touch current to the HBES/BACS network from HBES/BACS switches supplied from the mains supply, or from interfaces to other networks, shall be limited to 0,25 mA RMS.

Compliance is checked by measurement in accordance with IEC 60990.

This test does not apply to HBES/BACS switches where the circuit to be connected to the HBES/BACS network is connected to the protective or functional earthing terminal in the HBES/BACS switch. In this case the touch current from the HBES/BACS switch to the network is considered to be zero.

NOTE When it is possible to touch the HBES/BACS network during maintenance, the limitation of the summation of touch current can be considered to be in accordance with IEC 63044-3.

11 Provision for earthing

This clause of Part 1 applies except as follows.

Clause 11 does not apply to SELV electronic switches or to SELV HBES/BACS switches.

11.101 Protective earthing continuity via printed circuit boards

The printed conductors of printed circuit boards may be used to provide protective earthing continuity under the following conditions only:

- at least two tracks are used each having independent soldering points which will withstand a single short circuit test according to 101.4 ensuring that the current goes through the track and immediately after the switch shall fulfill the requirements of 11.4, or
- a single track is used with two independent means of connection on each end which will withstand a single short circuit test according to 101.4 ensuring that the current goes through the track and immediately after the switch shall fulfill the requirements of 11.4.

In addition,

- the material of the printed circuit board shall consist of epoxide woven glass fabric copper-clad laminated sheet and
- the printed circuit board shall comply with the overload test according to 101.2.4.

Three new specimens are submitted to the test.

12 Terminals

This clause of Part 1 applies except as follows.

12.1 General

Addition after the last paragraph:

Terminals having screw clamping complying with IEC 60998-2-1 are considered to be in compliance with the requirements and tests of 12.2, except those of 12.2.6 and 12.2.7 and 12.2.8, provided they are chosen according to Table 4.

Terminals for other than the main circuit (load circuit) may have different connecting capability in relation to this circuit. This means that these terminals need not necessarily have the same connecting capability as the mains terminals. Terminals for conductors smaller than 0,5 mm² shall fulfil the requirements of IEC 60999-1.

Terminals having screwless clamping complying with IEC 60998-2-2 are considered to be in compliance with the requirements and tests of 12.3 provided they are chosen according to Table 8, except for the requirements of 12.3.7 and 12.3.9. The tests of 12.3.7 and 12.3.9 shall be carried out in addition.

12.2 Terminals with screw clamping for external copper conductors

Addition to footnote b) of Table 4:

This requirement may be achieved using terminal(s) with two separate clamping units.

13 Constructional requirements

This clause of Part 1 applies except as follows.

13.3.3

Replacement of the text in Table 12 of the last row of the first column with "To insulating parts, earthed metal parts, the live parts of SELV or metal parts separated from hazardous live parts by creepage distances and by clearances twice those according to 23.1".

13.4 Openings in normal use

Addition after the first paragraph:

Free openings according to 10.101 and 10.102 are accepted.

13.5 Attachment of knobs

Replacement:

Knobs of electronic control devices shall be securely fixed in a reliable manner so that they will not work loose in normal use, if loosening may result in a hazard.

If knobs are used to indicate the position of electronic control devices, it shall not be possible to fix them in a wrong position, if this may result in a hazard.

Compliance is checked by inspection and by the following tests.

Where it is possible to apply an axial pull in normal use, an axial pull shall be applied for 1 min to try to pull off the knob.

The pull force to be applied is normally 15 N, but if the knob is intended to be pulled in normal use this is increased to 30 N.

An axial push of 30 N for 1 min is then applied to all knobs.

During and after these tests, the electronic control device shall show no damage, nor shall a knob have moved so as to impair compliance with this document.

NOTE Sealing compound and the like, other than self-hardening resins are not considered to be adequate to prevent loosening.

13.9 Surface-type switches having an IP code higher than IP20

Replace the second paragraph by:

Wall mounted surface-type switches that have degrees of protection IPX4, IPX5 and IPX6 shall have provisions for opening a drain hole.

13.15 Requirements for membranes in inlet openings

Replace the title by:

13.15 Requirements for membranes in inlet opening and lenses

13.15.1

Replacement:

Membranes, lenses and the like shall be reliably fixed and shall not be displaced by the mechanical and thermal stresses occurring in normal use.

Compliance is checked by the following tests.

Membranes, lenses and the like are tested when assembled in the electronic control devices.

First, the electronic control devices are fitted with the membranes, lenses and the like which have been subjected to the treatment specified in 15.1.

The electronic control devices are then placed for 2 h in a heating cabinet as described in 15.1, the temperature being maintained at $(40 \pm 2) ^\circ\text{C}$.

Immediately after this period, a force of 30 N is applied for 5 s to various parts of the membranes, lenses and the like, by means of the tip of test probe 11 according to IEC 61032.

During these tests, the membranes, lenses and the like shall not deform to such an extent that hazardous live parts become accessible.

For membranes, lenses and the like likely to be subjected to an axial pull in normal use, an axial pull of 30 N is applied for 5 s.

During this test, the membranes, lenses and the like shall not come out.

The test is then repeated with membranes, lenses and the like which have not been subjected to any treatment.

13.101 Cut-outs

Cut-outs in electronic switches and HBES/BACS switches for motor control circuits shall be non-self-resetting.

Compliance is checked by inspection.

13.102 Electronic switches and HBES/BACS switches for the control of the voltage of iron core transformers for extra-low-voltage incandescent lamps

Electronic switches and HBES/BACS switches for the control of the voltage of iron core transformers for extra-low-voltage incandescent lamps (for example, halogen) shall have a maximum tolerance of the phase-control angle between the positive and negative half-wave of $\pm 2^\circ$.

NOTE 1 Higher tolerances will generate a DC current influencing the temperature rise in the windings of the iron core transformer.

NOTE 2 The maximum tolerance between the phase-control angle of the positive and negative half-wave can be measured directly or as DC voltage as a percentage of the rated voltage. This corresponds at 90° to 1,1 % of the peak value of the rated voltage.

Compliance is checked by measurement.

13.103 Free ends of leads

Free ends of leads of electronic switches and HBES/BACS switches, if any, may be prepared but pre-soldering shall not be used.

Compliance is checked by inspection.

14 Mechanism

This clause of Part 1 only applies to electronic switches and HBES/BACS switches provided with mechanical switching devices.

15 Resistance to ageing, protection provided by enclosures of switches and resistance to humidity

This clause of Part 1 applies.

16 Insulation resistance and electric strength

This clause of Part 1 applies except as follows.

16.1 General

Addition after the first paragraph:

Insulation resistance and electric strength are measured with the protective impedances disconnected as described in 10.2.

Replace Table 15 by the following new Table 15:

Table 15 – Test voltage, points of application and minimum values of insulating resistance for the verification of electric strength

Insulation to be tested	Minimum value of insulation resistance MΩ	Test voltage V	
		Switches having a rated voltage not exceeding 130 V	Switches having a rated voltage exceeding 130 V
1 Between all poles connected together and the body, with the switch in the "on" position.	5	1 250	2 000
2 Between each pole in turn and all other poles connected to the body, with the switch in the "on" position.	2	1 250	2 000
3 Between the terminals which are electrically connected together when the switch is in the "on" position, the switch being in the "off" position:			
– normal/mini-gap construction;	2	1 250	2 000
– micro-gap construction;	2	500 ^a	1 250 (NOTE 1)
– semiconductor switching devices.	(NOTE 2)	(NOTE 2)	(NOTE 2)
4 Between metal parts of the mechanism, when insulated from hazardous live parts, and			
– hazardous live parts;	5	1 250	2 000
– metal foil in contact with the surface of the knob or a similar actuating member;	5	1 250	2 000

Insulation to be tested	Minimum value of insulation resistance MΩ	Test voltage V	
		Switches having a rated voltage not exceeding 130 V	Switches having a rated voltage exceeding 130 V
– the key of key-operated switches, if insulation is required (see 10.6);	5	1 250	2 000
– the point of anchorage of the cord, chain or rod of switches operated by such means, if insulation is required (see 10.6);	5	1 250	2 000
– accessible metal parts, including fixing screws, of the main part, if insulation is required (see 10.5).	5	1 250	2 000
5 Between any metal enclosure and metal foil in contact with the inner surface of its insulating linings, if any (Note 3).	5	1 250	2 000
6 Between hazardous live parts and accessible metal parts, if the metal parts of the mechanism are not insulated from hazardous live parts.	–	2 000	3 000
7 Between hazardous live parts and parts of the mechanism			
– if the latter parts are not insulated from accessible metal parts (see 10.5);	–	2 000	3 000
– if the latter parts are not insulated from the point of contact with a removable key or operating cord, chain or rod (see 10.6).	–	2 000	3 000
8 Between hazardous live parts and metal knobs, push-buttons and the like (see 10.2).	–	2 500	4 000
9 Between LV (mains) circuit(s) and FELV circuit(s)	5	1 500	1 500
10 Between SELV/PELV circuits and other circuit(s) having a higher voltage than SELV/PELV	7	3 000	3 750
11 Between a SELV or PELV circuit below 25 V AC or 60 V DC and a SELV or PELV circuit above 25 V AC or 60 V DC	5	500	500
12 Between a SELV or PELV circuit above 25 V AC or 60 V DC and accessible surfaces (see Clause 10)	5	500	500
13 Between a SELV and PELV circuits or between different SELV or different PELV circuits from different sources	5	500	500
14 Between switching circuit(s) and control circuit(s) if they are electrically separated	5	2 000	3 000
^a This value also applies for the electric strength test after normal operation. NOTE 1 For switches having a rated voltage up to and including 250 V, this value is reduced to – 750 V for the electric strength test after resistance to humidity; – 500 V for the electric strength test after normal operation. NOTE 2 Tests for the verification of the off-position of semiconductor switching devices according to item 3 are under consideration. NOTE 3 This test is carried out only if any insulation is necessary. NOTE 4 In the following country the test of item 8 is conducted between hazardous live parts and metal knobs, push-buttons and metal foil in contact with the outer surface of accessible external parts and operating keys of insulating material. The test voltage for switches with a rating voltage exceeding 130 V is to be 3000 V: AU. NOTE 101 The test according to item 3 is carried out only on electronic switches and HBES/BACS switches combined with mechanical switches. NOTE 102 Only items 10, 11, 12 and 13 are applicable to SELV or PELV parts of electronic control devices. NOTE 103 Items 1 to 9 are not applicable to SELV or PELV parts of electronic control devices.			

17 Temperature rise

This clause of Part 1 is completely replaced by the following:

17.1 General

Electronic switches and HBES/BACS switches shall be so constructed that the temperature rise in normal use is not excessive.

The metal and the design of the contacts, if any, shall be such that the operation of the electronic switches and HBES/BACS switches is not adversely affected by oxidation or any other deterioration.

The design and the material of the electronic switch and HBES/BACS switch shall be such that the material and the components in the electronic switch and HBES/BACS switch are not adversely affected by the temperature rise in normal use.

Compliance is checked by the following test, where applicable.

The electronic switches and HBES/BACS switches shall be connected as for normal use with the fuses, circuit breakers or other current-limiting means, if any, specified by the manufacturers in their instruction sheets.

The electronic switches and HBES/BACS switches are fitted with the conductors as specified in Table 16, the cross-sectional area being not less than 1,5 mm²; the terminal screws or nuts, if any, are tightened with a torque equal to two-thirds of that specified in 12.2.8.

Electronic switches and HBES/BACS switches with mechanical switching mechanism, e.g. relais, shall be loaded with the maximum rated current.

For other electronic switches and other HBES/BACS switches which can be loaded with incandescent lamps (lamps rated for the supply voltage, including halogen lamps) the following applies:

- *If the rated power of some of the loads is expressed in W and is higher than or equal to the rated power of other loads expressed in VA, electronic switches and HBES/BACS switches shall be loaded with halogen lamps or tungsten filament lamps so that, at the rated voltage of the load, the rated load will be obtained.*

NOTE 1 As the characteristics of halogen lamps of different power are equivalent, lamps of any power can be used to reach the rated load.

- *If the rated power of some of the loads is expressed in W and is lower than the rated power of other loads expressed in VA, electronic switches and HBES/BACS switches shall be loaded with all types of load in accordance with the manufacturer's instructions.*
- *If the rated power of the self-ballasted lamps, or externally ballasted lamps, expressed in W is higher than 25 % of the rated power of the incandescent lamps the test shall be done with all types of load.*

For electronic switches and HBES/BACS switches which are designed for lamps other than incandescent lamps the following applies:

- *Electronic switches and HBES/BACS switches for self-ballasted lamps (e.g. LEDi, CFLi) are loaded with one type of load as specified by the manufacturer for this test so that, at the rated voltage of the load, the rated load will be obtained. Dimmers shall be loaded with dimmable self-ballasted lamps as specified by the manufacturer for this test. If for these types of electronic switches and HBES/BACS switches, the maximum number of self-ballasted lamps and the rating of the lamp are given by the manufacturer, the electronic switch and HBES/BACS switch is loaded accordingly.*

- *Electronic switches and HBES/BACS switches for other types of lamp are tested in accordance with the manufacturer's instructions.*

Other electronic switches and HBES/BACS switches shall be loaded with the type of load as stated in the manufacturer's instructions.

NOTE 2 The rated loads are verified with the electronic switch or HBES/BACS switch short-circuited.

If the electronic switch provides a looping through function to power other devices in the circuit via the input terminals and where the circuit current is transferred not only via the terminals but through other components inside the electronic switch, then this looping through circuit is loaded in addition to the rated current of the upstream fuse/circuit breaker declared by the manufacturer minus the rated load already connected to the switch.

The electronic switches and HBES/BACS switches are loaded until steady-state temperature is reached or for 4 h, whichever is the shorter time, at a voltage between 0,9 and 1,1 times rated voltage, whichever is the more unfavourable. In practice, steady-state value is reached when the variation of the temperature rise does not exceed 1 K/h.

Phase-cut dimmers operating with leading and trailing edge shall be tested in both modes with the relevant load.

In lamp phase-cut dimmers and speed controllers, the setting is adjusted such that the highest temperature rise will occur.

Flush-mounted electronic switches and HBES/BACS switches are mounted in flush-mounted boxes. The box is placed in a block of wood filled around the box with plaster, so that the front edge of the box does not protrude and is not more than 5 mm below the front surface of the wood block.

The test assembly shall be allowed to dry for not less than seven days when first made.

The size of the pinewood block, which may be fabricated from more than one piece, shall be such that there is at least 25 mm of wood surrounding the plaster, the plaster having a thickness between 10 mm and 15 mm around the maximum dimensions of the sides and rear of the box.

NOTE 3 The sides of the cavity in the pinewood block can have a cylindrical shape.

The cables connected to the electronic switch shall enter through the top of the box, the point(s) of entry being sealed to prevent the circulation of air. The length of each conductor within the box shall be (80 ± 10) mm.

Surface-type electronic switches and HBES/BACS switches shall be mounted as in normal use, centrally on the surface of a wooden block, which shall be at least 20 mm thick, 500 mm wide and 500 mm high.

The other types of electronic switches and HBES/BACS switches shall be mounted according to the manufacturer's instructions or, in the absence of such instructions, in the position of normal use considered to give the most onerous conditions.

The test assembly shall be placed in a draught-free environment for the test.

The temperature is determined by thermocouples, so chosen and positioned that they have negligible effect on the temperature being determined.

During the test, the state of the electronic switches and HBES/BACS switches shall not change, fuses and other protective devices shall not operate and the permissible temperature rises determined in Table 101, column concerning Clause 17, shall not be exceeded.

After this test, the electronic switches and HBES/BACS switches shall be in operating condition.

If sealing compounds are used, they shall not have flowed to such an extent that hazardous live parts are exposed.

Compliance is checked by inspection.

NOTE 4 For the purpose of the test of 21.3, the temperature rise of external parts of insulating material not necessary to retain current-carrying parts and parts of the earthing circuit in position, even though they are in contact with them, is also determined.

NOTE 5 Undue oxidation of contacts can be prevented by sliding action or by the use of silver or silver-faced contacts.

NOTE 6 In the case of combination of electronic switches, the test is carried out separately on each electronic switch.

For the purposes of the tests of 102.3, 102.4 and 102.5.2, the reference temperature surrounding a component in an electronic switch and HBES/BACS switch is the maximum temperature rise measured on the component during the test plus 25 °C.

Table 101 – Permissible temperature rise values

Parts of the electronic switch	Permissible temperature rise K	
	Clause 17	Clause 101
External accessible parts when installed during normal use		
Metal parts Knobs, handles, sensing surfaces, etc.	40	75
Enclosure ^a	50	75
Non-metallic parts Knobs, handles, sensing surfaces, etc. ^b	60	75
Enclosure ^{a,b}	70	75
Inside of enclosures of insulating material	c	c
Windings ^d		
Class A	75	115
Class E	90	130
Class B	95	140
Class F	115	155
Class H	140	175
Class 200	160	195
Class 220	180	215
Class 250	210	245
Core laminations	As for relevant windings	
Supply cable and wiring:		
Insulated with ordinary polyvinyl chloride ^h		
– not under mechanical stress	70	110
– under mechanical stress	55	110
– insulated with natural rubber	55	110

Parts of the electronic switch	Permissible temperature rise K	
	Clause 17	Clause 101
Other insulations ^(d, g) except thermoplastic		
Non-impregnated paper	65	80
Non-impregnated cardboard	70	90
Impregnated cotton, silk, paper and textile, urea resins	80	100
Laminates bonded with phenol-formaldehyde resins, phenol-formaldehyde mouldings with cellulose fillers	95	120
Phenol-formaldehyde mouldings with mineral fillers	105	140
Laminates bonded with epoxy resins	130 ^j	160 ⁱ
Natural rubber	55	110
Thermoplastic materials ^e	f	
Terminals and parts which may come into contact with cable insulation when installed	55	110
The values of the permissible temperature rises are based on an ambient temperature of 25 °C, but the measurements are made under normal conditions. ^a For areas not exceeding 5 cm² and which are not likely to be touched in normal use, temperature rises up to 75 K are allowed under normal operating conditions. ^b 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. ^c The permissible temperature rises for the inside of enclosures of insulating material are those indicated for the relevant materials. ^d For the purpose of this document, the permissible temperature rises are based on the recommendations in IEC 60085. The materials quoted above 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 been proved to be satisfactory. ^e Natural and synthetic rubbers are not considered as being thermoplastic materials. ^f Owing 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: 1) <i>The softening temperature of the material is determined on a separate specimen, under the conditions specified in ISO 306, modified as follows:</i> <i>the depth of penetration is 0,1 mm;</i> <i>the total thrust of 10 N is applied before the dial gauge is set to zero or its initial reading noted.</i> 2) <i>The temperature limits to be considered for determining the temperature rises are:</i> <i>under normal operating conditions, a temperature 10 °C lower than the softening temperature as obtained under 1);</i> <i>under fault conditions, the softening temperature itself.</i> ^g Table 101 does not apply to components which comply with relevant IEC standards. ^h The possibility of raising the values for wires and cables insulated with heat-resistant polyvinyl chloride is under consideration. ⁱ The temperature rise may exceed the above value (160 K, for Clause 101)) by not more than 100 K for a maximum period of 1 min. ^j For the test of Clause 17 the temperature rise shall not exceed the typical value of the maximum operational temperature (MOT) of the printed circuit board as given in the data sheets.		

17.101 Looping through circuit

Electronic control devices connected to the mains providing means for the continuation of the circuit current, and where the circuit current is transferred not only via the terminals but through other components inside the electronic switch, such as PCBs, shall be submitted to the following test.

The electronic switch and the HBES/BACS switch are mounted according to Clause 17 and connected with conductors with the maximum accepted cross-sectional area being not less than 1,5 mm².

The looping through function of the electronic switch is loaded for 1 h with the rated current of the upstream fuse/circuit breaker declared by the manufacturer.

During this test no current is transferred through the switch contacts as given in Figure 102.

The temperature is determined by means of thermocouples, so chosen and positioned that they have negligible effect on the temperature being determined.

The temperature rise of the terminals shall not exceed 55 K.

The temperature rise of the PCB shall not exceed the maximum operational temperature (MOT) of the printed circuit board as given in the data sheets of this component.

After the test the looping through circuit shall in addition be tested according to 101.4 with the following modifications:

The short circuit is applied one time by the auxiliary switch A without any synchronization with respect to the voltage as given in Figure 103.

18 Making and breaking capacity

This clause of Part 1 applies except as follows.

Replacement:

18.1 General

Electronic switches and HBES/BACS switches shall have adequate making and breaking capacity.

NOTE 1 Where the term "switch" is used in Part 1, this term is replaced by "contact mechanism" as appropriate.

NOTE 2 In the case of electronic switches and HBES/BACS switches using relays, the relay is operated at the specified rate of operation with the appropriate load(s) as in normal use.

This test is carried out only on electronic switches and HBES/BACS switches provided with mechanically or electro-mechanically operated contact mechanisms in the load circuit.

Electronic switches and HBES/BACS switches classified for general purpose use according to 7.102.1, shall be tested according to Clause 18 of Part 1.

Electronic switches and HBES/BACS switches classified for dedicated loads according to 7.102.2 shall be tested according to Part 1 except as follows.

Contact mechanisms shall have adequate making and breaking capacity.

The test is made on three separate specimens of the complete contact mechanism.

Compliance is checked by the relevant tests, as reported in Table 102:

Table 102 – Application of tests for making and breaking capacity and normal operation for electronic switches and HBES/BACS switches according to 7.102.2

Electronic switches and HBES/BACS switches for the control of:	Tests of Clause 18				Tests of Clause 19				
	18.2	18.3	18.101	18.102	19.101 (incandescent lamp circuits with or without step-down converters)	19.102 (externally ballasted lamps)	19.106 (self-ballasted lamps)	19.107 Heating installations	19.108 (motor control circuits)
Fluorescent lamps loads	X					X			
Voltage of iron core transformers for extra-low-voltage incandescent lamps	X	X		X	X				
Voltage of electronic step-down converters for extra-low-voltage incandescent lamps		X			X				
Self-ballasted lamps	X						X		
Motor control circuits	X		X						X
Heating installations	X		X					X	
X = applicable									
NOTE For electronic switches and HBES/BACS switches whose cycle of operation is limited by their application (for example, passive infrared, time delay electronic switches), the rate of operation during the tests can be specified by the manufacturer.									

The tests are made by means of an apparatus.

The connections are as shown in Figure 11.

Electronic switches and HBES/BACS switches are fitted with conductors as for the test of Clause 17.

18.2 Overload

Addition after the second paragraph:

For electronic switches and HBES/BACS switches whose rate of operation is limited by their application (for example, heat or light sensors), the rate of operation is as follows. The electronic switch is set to the shortest cycle time possible. The electronic switch and HBES/BACS switches are re-activated at the end of each cycle within a time of (2 ± 0.5) s.

18.101 Contact mechanism for motor control circuits

The contact mechanism is subjected to tests of 50 cycles of operation, each at rated voltage and at the rate of operations specified in 18.1:

- a) *the contact mechanism closes a circuit through which a current of $9 I_n$ ($\cos \varphi = 0,8 \pm 0,05$) passes, this current being interrupted by means of an auxiliary switch 50 ms to 100 ms after each closure;*
- b) *the circuit through which a current of $6 I_n$ ($\cos \varphi = 0,6 \pm 0,05$) passes is closed by an auxiliary switch and opened by the contact mechanism 300 ms to 500 ms after each closure.*

NOTE 101 I_n is the rated current of the electronic switch.

If the electronic switch and HBES/BACS switch has a rated load instead of a rated current, I_n is calculated under the assumption that the power factor ($\cos \varphi$) of the motor load is 0,6.

During the tests, no sustained arcing shall occur.

After these tests, the specimens shall show no damage impairing their further use.

18.102 Electronic switches and HBES/BACS switches for control of the voltage of iron core transformers for extra-low-voltage incandescent lamps

Electronic switches and HBES/BACS switches for control of the voltage of iron core transformers for extra-low-voltage incandescent lamps (for example, halogen) shall be subjected to the following test.

The test is made on three specimens.

The contact mechanism is subjected to 50 making operations, each at rated voltage and at the rate of operation as specified in 18.1.

To simulate making, the test circuit shall be adjusted to a test current 10 times the rated current of the electronic switch for one half-cycle of the power supply frequency.

During the tests, no sustained arcing shall occur.

After the tests, the specimens shall show no damage impairing their further use.

19 Normal operation

This clause of Part 1 applies except as follows.

Replacement:

19.1 General

Electronic switches and HBES/BACS switches classified for general purpose use according to 7.102.1, shall be tested according to Clause 19 of Part 1.

Electronic switches and HBES/BACS switches classified for dedicated loads according to 7.102.2 shall be tested as follows.

Electronic switches and HBES/BACS switches shall withstand, without excessive wear or other harmful effect, the mechanical, electrical and thermal stresses occurring in normal use.

Compliance is checked by the tests of 19.101, 19.102, 19.103, 19.104, 19.105, 19.106, 19.107 and 19.108, during which the electronic switches and HBES/BACS switches are tested at their rated voltage and loaded as specified in Clause 17, unless otherwise specified.

For HBES/BACS switches, the tests according to 19.101 and 19.108 are conducted on the complete HBES/BACS switch which shall be controlled by the electronic extension units as described by the manufacturer of the system.

The electronic extension units are tested when installed according to the manufacturer's instructions so as to verify that they are capable of controlling the electronic switch or the HBES/BACS switch in accordance with this Clause 19.

For electronic switches and HBES/BACS switches with included automatic function the number of operations for tests of 19.101, 19.102, 19.104, 19.106 and 19.108 is that specified in the relevant subclause. If a manufacturer declares a number of operations higher than those indicated in the relevant subclause, the tests shall be made according to the declared value.

NOTE 1 The correlation between the tests of 19.102 and 19.106 is under consideration.

Sticking of the contacts, which does not prevent the next operation of the switch, is not regarded as welding.

Sticking of contacts is permitted for maximum 5 times if the contacts can be separated with a force applied to the actuator of a value which does not damage the switch mechanically.

Electronic switches and HBES/BACS switches including electronic circuits which close the contact of the contact mechanism always at zero-crossing $\pm 20^\circ$ phase angle, shall be tested together with their electronic circuit.

NOTE 2 For the purpose of this test, the manufacturer can provide the specimens with a special circuit that simulates the automatic operations.

NOTE 3 For electronic switches and HBES/BACS switches whose cycle of operation is limited by their applications (for example, passive infrared, time delay electronic switches, etc.), the rate of operation during the tests can be specified by the manufacturer.

During the test, the specimens shall function correctly.

After the tests, except for 19.103, the specimen shall withstand the following:

- *an electric strength test as specified in Clause 16, the test voltage of 4 000 V being, however, reduced by 1 000 V and the other test voltages by 500 V, except for the specimens tested in 19.102 where no electric strength test is performed;*
- *a temperature rise test as specified in Clause 17.*

The specimens shall then not show:

- *wear impairing their further use;*
- *discrepancy between the position of the actuating member and that of the moving contacts, if any, if the position of the actuating member is indicated;*
- *deterioration of enclosures, insulating linings or barriers to such an extent that the electronic switch cannot be further operated or that the requirements of Clause 10 are no longer complied with;*
- *loosening of electrical or mechanical connections;*
- *seepage of sealing compound;*
- *relative displacement of the moving contacts of electronic switches of pattern number 2.*

The humidity treatment according to 15.3 is not repeated before the electric strength test of this Subclause 19.1.

During the test, the specimens are not lubricated.

19.101 Contact mechanisms incorporated in electronic switches and HBES/BACS switches intended for incandescent lamp circuits

Contact mechanisms incorporated in electronic switches and HBES/BACS switches intended for incandescent lamp circuits with or without step-down converters are subjected to the following test.

The test is made on three separate specimens of the complete contact mechanism.

The circuit details and the manner of operation of the selector switch S are as described in 18.1, unless otherwise specified.

The number of operations is 40 000.

The rate of operation is as specified in 18.1.

For rotary electronic switches and HBES/BACS switches intended to be operated in either direction, the actuating member is turned in one direction for half the total number of operations and in the reverse direction for the remainder.

While testing one part, the other part is in the "off" position. The test is followed by the test of 14.3, if applicable.

19.102 Contact mechanisms for externally ballasted lamps

Contact mechanisms incorporated in electronic switches and HBES/BACS switches, intended for externally ballasted lamps (e.g. fluorescent lamps, CFL, LED) are checked by the test circuit indicated in Figure 12 Load A with the following test conditions.

NOTE The test with Load B is not applicable.

The prospective short-circuit current (RMS) of the supply shall be between 3 kA and 4 kA at $\cos \varphi = 0,9 \pm 0,05$ (lagging). F is a copper-wire fuse of 0,1 mm nominal diameter having a length not less than 50 mm.

R_1 is a resistor limiting the current to approximately 100 A.

The twin-core cable shall have a suitable length to give a resistance R_3 equal to 0,25 Ω in the test circuit to the load. It shall have a cross-sectional area of 1,5 mm² when switches with rated current up to and including 10 A are being tested and 2,5 mm² when switches with rated current over 10 A up to and including 16 A are being tested.

The load shall consist of:

- *a capacitor bank C_1 , giving a capacitance according to Table 103. The capacitors shall be connected with 2,5 mm² conductors having the shortest possible length;*
- *an inductor L_1 and a resistor R_2 , adjusted to give the power factor $0,9 \pm 0,05$ (lagging) and the test current $I_n^{+5}_0$ % through the specimen.*

Table 103 – Relationship between rated current and capacitance

Rated current A	Capacitance μF
Up to and including 1	12
Up to and including 2	24
Up to and including 3	35
Up to and including 4	48
Up to and including 5	58
Up to and including 6	70
Up to and including 7	77
Up to and including 8	96
Up to and including 9	105
Up to and including 10	140
Up to and including 16	140
NOTE The circuit parameters have been chosen to represent the lamp loads used in the most practical applications.	

For the test, new specimens are used if the electronic switch and HBES/BACS switch is not for externally ballasted lamps only.

The tolerance of the test voltage is $\pm 5\%$. The circuit details and the manner of operation of the selector switch S are as described in 18.1.

The number of operations is as follows.

For electronic switches and HBES/BACS switches with a rated current up to and including 10 A: 10 000 operations with 30 operations per minute.

For electronic switches and HBES/BACS switches with rated current above 10 A up to and including 16 A: 5 000 operations with 15 operations per minute.

The test specimens shall be connected to the test circuit with cables of length $(1 \pm 0,1)$ m so that the temperature rise measurement can be made without disturbing the terminals.

The metal support of the switch, if any, on which the switch is mounted, and the accessible metal parts of the switch, if any, shall be earthed through a wire fuse which shall not blow during the test. The fuse element shall consist of a copper wire of 0,1 mm diameter and not less than 50 mm in length.

During this test, the switch shall be operated so that the test apparatus does not interfere with the normal action of the switch mechanism and the free movement of the actuating member.

There shall be no forced actuation. The on-period shall be $25 \left(\begin{smallmatrix} +5 \\ 0 \end{smallmatrix} \right) \%$ of the total cycle and the off-period $75 \left(\begin{smallmatrix} 0 \\ -5 \end{smallmatrix} \right) \%$.

19.103 Semiconductor switching devices and/or electronic regulating units incorporated in electronic switches and HBES/BACS switches

Semiconductor switching devices and/or electronic regulating units incorporated in electronic switches and HBES/BACS switches are subjected to the following tests.

NOTE Examples of electronic regulating units are controls used for the adjustment of time, light level, sensitivity, etc., of the device.

The electronic switches and HBES/BACS switches are loaded with rated load until steady-state temperature at 1,1 times rated voltage is reached.

The switch state of the electronic switches and HBES/BACS switches is changed 10 times, and/or the setting value is altered 10 times over the whole range from minimum to maximum and back to minimum by means of the sensing surface or unit.

Additionally, where appropriate, the switch state of the electronic switches and HBES/BACS switches is changed 10 times, and/or the setting value is altered 10 times over the whole range from minimum to maximum and back to minimum by means of an electronic extension unit.

19.104 Mechanical control units incorporated in electronic switches and HBES/BACS switches

Mechanical control units are push buttons, potentiometers, etc, requiring a manual operation.

Mechanical control units incorporated in electronic switches and HBES/BACS switches are subjected to the following test.

The electronic switches and HBES/BACS switches are loaded with their rated load and the voltage is then increased to 1,1 times the rated voltage, the setting is altered 10 000 times over the whole range from minimum to maximum and back to minimum by means of its control unit, the rate of operation being between 10 and 15 operations per minute.

19.105 Electronic switches and HBES/BACS switches for which a minimum load or current is specified by the manufacturer

For electronic switches and HBES/BACS switches for which a minimum load or current is specified by the manufacturer, the characteristic is additionally tested with the specified minimum load or current at 0,9 times rated voltage.

The switch state of the electronic switches and HBES/BACS switches is changed 10 times, and/or the setting value is altered 10 times over the whole range from minimum to maximum and back to minimum.

In addition, where appropriate, the switch state of the electronic switch and HBES/BACS switch is changed 10 times, and/or the setting value is altered 10 times over the whole range from minimum to maximum and back to minimum by means of an electronic extension unit.

19.106 Contact mechanisms incorporated in electronic switches and HBES/BACS switches intended for self-ballasted lamps

Contact mechanisms incorporated in electronic switches and HBES/BACS switches intended for self-ballasted lamps shall withstand, without excessive wear or other harmful effect, the electrical and thermal stresses occurring when controlling self-ballasted lamps circuits.

Compliance is checked by connecting the test circuit, including Load B, as given in Figure 12b via the electronic switches and HBES/BACS switches under test to a power supply with the following test conditions.

The test circuit, including the cables for connecting the test specimen and the Load B, shall be adjusted to reach, downstream the switch under test, the I_{peak} and I^2t values of Table 104.

Indicative values for C and R_2 of Load B are given in Table 105 which is given for information only.

NOTE 101 The values for C and R_2 in Table 105 are calculated to have the required values for inrush current and I^2t and considering:

- a prospective short-circuit current (RMS) of the supply of 3 kA at $\cos \varphi = 0,9$ (lagging).
- a resistance R_3 equal to $0,25 \Omega$ and an inductance L equal to $20 \mu\text{H}$ simulating the twin-core cable in the test circuit.

For the test, new specimens are used in case the electronic switch and HBES/BACS switch is not for self-ballasted lamps only.

The tolerance of the test voltage is $\pm 5\%$. The circuit details and the manner of operation of the selector switch S are as described in 18.1.

For electronic switches and HBES/BACS switches with rated power for self-ballasted lamps up to and including 250 W: 40 000 operations with 30 operations per minute.

For electronic switches and HBES/BACS switches with rated power for self-ballasted lamps higher than 250 W: 40 000 operations with 15 operations per minute.

NOTE 102 R_1 is the total series resistance in the lamp circuit including the ESR (equivalent series resistance) value of the capacitor.

The values of R_2 and C in load B shall be chosen in order to reach the values ($\pm 5\%$) for I_{peak} and I^2t as given in Table 104 when the switching contact closes at $(90 \pm 5)^\circ$ phase-angle. The value of R_4 shall be chosen to reach the rated power in W ($\pm 5\%$).

Table 104 – Values for I_{peak} and I^2t depending on the type of distribution system

Rated power (W)	I_{peak} A	I^2t A ² s	I_{peak} A	I^2t A ² s
	Distribution system: 220/380, 230/400 240/415	Distribution system: 220/380, 230/400 240/415	Distribution system: 120/208 127/220	Distribution system: 120/208 127/220
15	22	0,08	69	0,56
30	41	0,3	109	1,9
60	73	1,2	162	5,9
100	108	2,8	200	11,5
150	142	5,5	231	18,5
200	170	9	248	24,5
250	192	13	255	30
300	209	16,5	260	35
350	223	20,5	262	39
400	235	24,5	263	43
NOTE 1 For values not given in this Table 104 the test values are determined by interpolation.				
NOTE 2 The values of I_{peak} and I^2t were determined based on the models given in Annex BB.				

Table 105 – Calculated circuit parameters

Rated power (W)	$R_2(\Omega)$ 230 V	C (μ F) 230 V	$R_2(\Omega)$ 120 V	C (μ F) 120 V
15	13	20	1,36	70
30	6,5	40	0,65	140
60	3,25	80	0,28	280
100	1,9	125	0,17	445
150	1,25	180	0,11	640
200	0,95	240	0,10	830
250	0,8	310	0,10	1 000
300	0,7	355	0,11	1 250
350	0,64	420	0,13	1 500
400	0,59	480	0,135	1 660

The test specimens shall be connected to the test circuit with cables of length $(1 \pm 0,1)$ m so that the temperature rise measurement can be made without disturbing the terminals.

The metal support of the electronic switch and HBES/BACS switch, if any, on which the electronic switch and HBES/BACS switch is mounted, and the accessible metal parts of the electronic switch and HBES/BACS switch, if any, shall be earthed through a wire fuse which shall not blow during the test. The fuse element shall consist of a copper wire of 0,1 mm diameter and not less than 50 mm in length.

During this test, the electronic switch and HBES/BACS switch shall be operated so that the test apparatus does not interfere with the normal action of the switch mechanism and the free movement of the actuating member.

There shall be no forced actuation. The on-period shall be $25 \left(\begin{smallmatrix} +5 \\ 0 \end{smallmatrix} \right)$ % of the total cycle and the off-period $75 \left(\begin{smallmatrix} 0 \\ -5 \end{smallmatrix} \right)$ %.

19.107 Electronic switches and HBES/BACS switches designed for heating installations

For electronic switches and HBES/BACS switches designed for heating installations the number of operations shall be 200 000.

Contact mechanisms incorporated in electronic switches and HBES/BACS switches intended for heating installations are subjected to the test described in 19.101 but with the electrical conditions specified in Table 106.

Table 106 – Test loads for HBES/BACS switches for heating installations

Type of load as classified in 7.1.101	Operation of contacts	Test voltage	Test current RMS	Power factor ^c
Resistive and motor	Making ^b	Rated voltage	$6 \times I\text{-M}$ or $I\text{-R}$ ^a	0,60 (+0,05) $\geq 0,9$
	Breaking	Rated voltage	$I\text{-R}$ or $I\text{-M}$ ^a	$\geq 0,9$
NOTE $I\text{-M}$: motor-load current, and $I\text{-R}$: resistive-load current. ^a Whichever is arithmetically greater or whichever is the most unfavourable value in case of equal values. ^b The specified making conditions are maintained for a period between 50 ms and 100 ms, and are then reduced by an auxiliary switch to the specified breaking conditions. The reduction to the break current should be achieved without any open circuiting of the simulated inductive loads circuit to ensure that no abnormal voltage transients are generated. A typical method of achieving this is shown in Figure 16 of IEC 61058-1:2016. ^c Resistors and inductors are not connected in parallel except that if any air-core inductor is used, a resistor taking approximately 1 % of the current through the inductor is connected in parallel with it. Iron-core inductors may be used provided that the current has a substantially sine-wave form.				

19.108 Contact mechanisms for motor control circuits

Contact mechanisms incorporated in electronic switches and HBES/BACS switches intended for motor control circuits are tested as in 19.101, but they close a circuit through which a current of $6 \times I_n$ ($\cos \varphi = 0,65 \pm 0,05$) passes and open a circuit through which a current of I_n ($\cos \varphi = 0,65 \pm 0,05$) passes, the ratio of recovery voltage U_s and rated operational voltage U_e being 1,00 ($\pm 10\%$).

20 Mechanical strength

This clause of Part 1 applies with the following modifications:

Replace in 20.2 the last 7 paragraphs by:

After the test, hazardous live parts shall not become accessible.

After the test on a lens (window for pilot lights or a viewing window for a sensing device), the lens may be cracked and/or dislodged, but it shall not be possible to touch hazardous live parts with

- *the test probe B of IEC 61032 under the conditions stated in 10.1;*
- *the test probe 11 of IEC 61032 under the conditions stated in 10.1, but with a force of 10 N.*

In case of doubt, it shall be verified that it is possible to remove and to replace external parts, such as boxes, enclosures, covers and cover plates, without these parts or their insulating lining being broken.

If, however, a cover plate, backed by an inner cover, is broken, the test is repeated on the inner cover, which shall remain unbroken.

Damage to the finish, small dents which do not reduce creepage distances or clearances below the value specified in 23.1 and small chips which do not adversely affect the protection against electric shock are neglected.

Cracks not visible with normal or corrected vision without magnification and surface cracks in fibre-reinforced mouldings and the like are ignored.

Cracks or holes in the outer surface of any part of the switch are ignored if the switch complies with this document even if this part is omitted. If a decorative cover is backed by an inner cover, fracture of the decorative cover is neglected if the inner cover withstands the test after removal of the decorative cover.

21 Resistance to heat

This clause of Part 1 applies with the following modifications:

21.2 Basic heating test

Replace the second paragraph by:

During the test, the mechanical parts of the specimens shall not undergo any change impairing their further use, and sealing compound, if any, shall not flow to such an extent that hazardous live parts are exposed.

22 Screws, current-carrying parts and connections

This clause of Part 1 applies.

23 Creepage distances, clearances and distances through sealing compound

This clause of Part 1 applies except as follows.

23.1 General

Add the following rows at the end of Table 23:

Table 23 – Creepage distances, clearances and distances through insulating sealing compound

For electronic control devices the following applies:

The values given in items 2 and 7 of Table 23 apply:

- to terminals for external wiring except terminals in SELV circuits,
- to printed circuit boards with material group below IIIa,
- to all hazardous live parts which are not protected by a directly associated fuse, circuit breaker or other current-limiting means with adequate breaking capacity.

For printed circuit boards, the creepage values shall not be less than the values given in Table F.5 of IEC 60664-1:2020 for pollution degree 2.

The values given in items 1 and 6 of Table 23 apply to terminals for external wiring except terminals in SELV circuits.

For functional separation within the same circuit, recommended creepage and clearance values are given in IEC 60664-1:2020, Table F.2 and Table F.5.

For the purpose of this document, the following applies:

- Pollution degree 2,
- Overvoltage category III for the mains circuit.

NOTE 1 Directly associated fuses and current-limiting means are devices inserted in the circuit whose primary function is to protect the electronic switch and HBES/BACS switch.

NOTE 2 A directly associated fuse and/or current-limiting means need not necessarily be incorporated in the electronic switch and HBES/BACS switch.

23.101 Use of enamel wires

If the enamel of the wire is at least grade 1 in accordance with IEC 60317 (all parts), the clearances between the wire of the control coil, the hazardous live parts of different polarity and exposed conductive parts may be reduced to a value equal to two-thirds of the clearances required in the absence of enamel.

23.102 Separation between circuits

23.102.1 General

Arrangements shall ensure protective separation between mains (and other hazardous voltages) and SELV/PELV circuit.

For this separation, creepage and clearance distance can be split in 2 parts with intermediate conductive part (e.g. metallic shielding). In this case each separate creepage and clearance distance shall not be less than 3,0 mm.

The protective separation can be achieved by one of the methods given in Figure 101.

Control devices containing hazardous voltages and SELV/PELV circuits shall provide double or reinforced insulation for the rated insulation voltage and the rated impulse withstand voltage externally (between control devices and other circuits outside the control device) and internally (between the different circuits inside the control device).

NOTE 101 Figure 101 a) addresses the SELV/PELV part within HBES switches which are intended to be used either in SELV/PELV installations or in mains installations where basic insulation of mains hazardous live parts can be expected. Figure 101 b) addresses the SELV/PELV part within single mains HBES switches which are intended to be used in installations where hazardous voltages appear (including mains installations).

A SELV HBES/BACS switch circuit and a SELV network circuit of the same rated insulation voltage and the same rated impulse withstand voltage can be considered as the same circuit and therefore no separation is needed.

A PELV HBES/BACS switch circuit and a PELV network circuit of the same rated insulation voltage and the same rated impulse withstand voltage can be considered as the same circuit and therefore no separation is needed.

Control devices containing only SELV/PELV circuits shall provide double or reinforced insulation for the rated insulation voltage and the rated impulse withstand voltage (between SELV/PELV circuit of the control device and other circuits outside the control device (see Figure 101 c)) according to the 230/400 V mains environment unless the usage in another environment is made clearly visible either by marking, an instruction sheet or similar means (see Figure 101 d)).

When connecting a control device based on SELV/PELV circuits to a network based on SELV/PELV circuits the simple separation is required based on the rated insulation voltage of 50 V and the highest rated impulse withstand voltage of the circuits.

NOTE 102 Figure 101 c) addresses SELV/PELV control devices which are intended to be used in installations where hazardous voltages appear (including mains installations). Figure 101 d) addresses SELV/PELV control devices which are intended to be used as standalone in SELV/PELV installations. Figure 101 e) addresses SELV/PELV control devices which are intended to be used as standalone in mains installation where basic insulation of mains hazardous live parts can be expected.

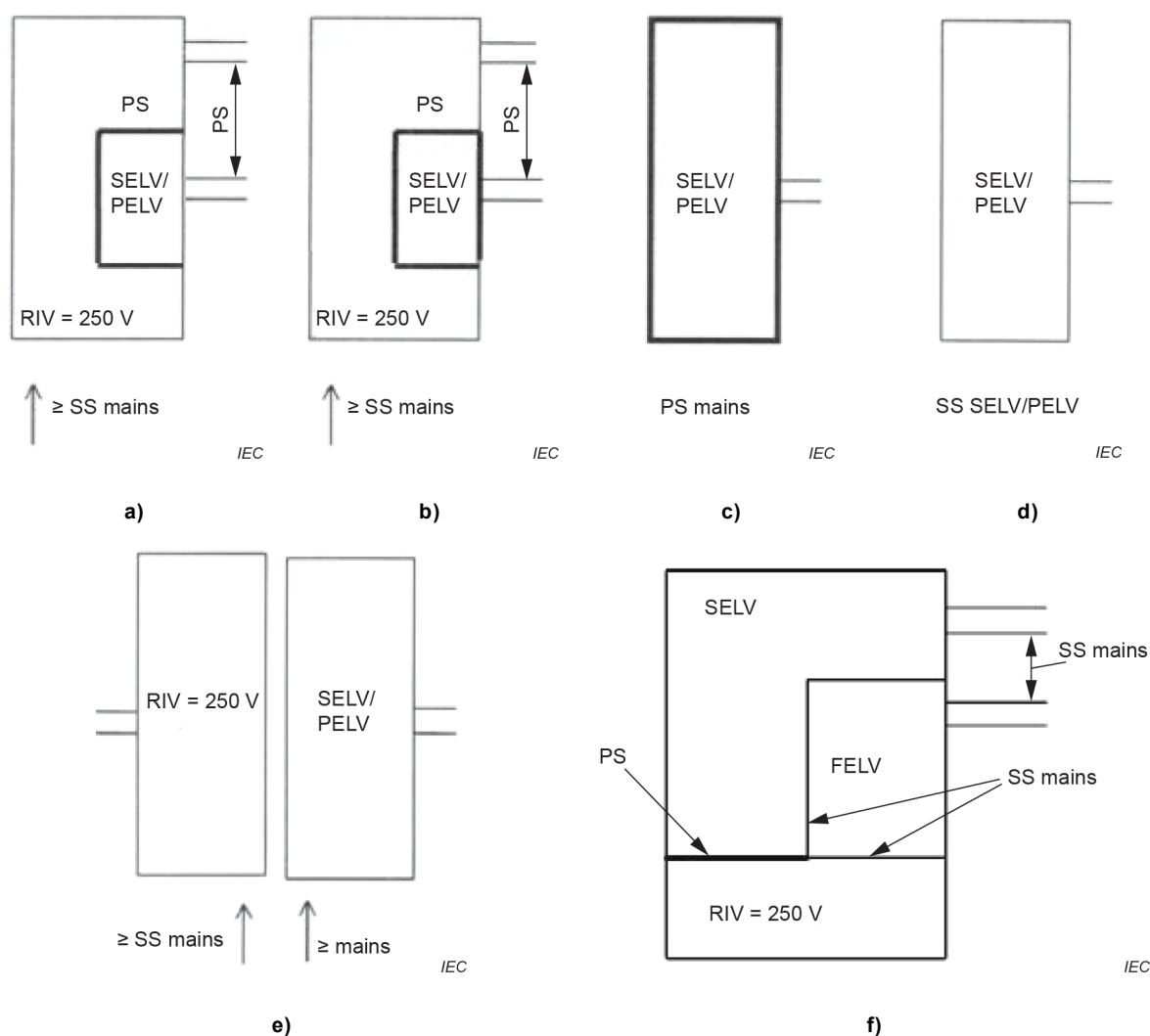
SELV circuits shall be insulated from FELV circuits by simple separation (see Figure 101 f)).

FELV circuits shall be insulated from the mains by at least basic insulation (based upon a working voltage equal to mains voltage) (see Figure 101 f)).

It is not required that FELV circuits be insulated from other FELV circuits except for functional purpose.

It is not required that FELV circuits be insulated from the protective earth circuit except for functional purpose.

FELV circuits shall be insulated from non-earthed accessible metal parts by simple separation (based upon a working voltage equal to mains voltage).



Methods to achieve protective separation:

SS mains = simple separation

SS SELV/PELV = simple separation

PS mains = protective separation

RIV = rated insulation voltage

= Basic insulation for rated insulation voltage and for rated impulse withstand voltage in mains environment according to Table 107

= Basic insulation for rated insulation voltage and for rated impulse withstand voltage in SELV/PELV environment according to Table 107

= Double insulation or reinforced insulation for rated insulation voltage and for rated impulse withstand voltage in mains environment according to Table 107

Figure 101 – Protective separation between circuits

23.102.2 Specifications of insulation

The following parameters apply:

- a) Overvoltage category: III
- f) Pollution degree: 2
- g) Material class: min. IIIa

Table 107 – Relation between the rated voltage of the HBES/BACS switch, the rated insulation voltage and the rated impulse voltage

Rated voltage of control device (RMS)	Rated insulation voltage	Rated impulse withstand voltage
Up to and including 50 V	50 V	2 500 V ^a
Above 50 V up to and including 100 V	100 V	2 500 V ^b
Above 100 V up to and including 150 V	150 V	2 500 V
Above 150 V up to and including 250 V	250 V	4 000 V
230/400 V (three phase)	250 V	4 000 V
^a When the control device is classified according to 7.105 a) the value can be reduced to 800 V. NOTE For clarification see IEC 60664-1:2007.		
^b If the control device is classified according to 7.105 a) the value can be reduced to 1 500 V.		

23.102.3 Dimensioning of clearances of basic, double or reinforced insulation between circuits

If no verification test is carried out, clearances of basic insulation shall be dimensioned as specified in Table 107 taking into account that the required impulse withstand voltage is equal to the rated impulse withstand voltage of the control device (as defined in Table 107).

Clearances through openings in enclosures of insulating material shall not be less than those specified for inhomogeneous field conditions since the configuration is not controlled, which may have an adverse effect on the homogeneity of the electric field (5.2.3.2 of IEC 60664-1:2020).

NOTE 101 The values for inhomogeneous field conditions are the values given in Table 107 without verification test.

Double insulation consists of basic insulation and supplementary insulation. Each shall be dimensioned as specified in Table 108 if no verification test is carried out.

For control devices provided with double insulation where basic insulation and supplementary insulation cannot be tested separately, the insulation system is considered as reinforced insulation.

Clearances of reinforced insulation shall be dimensioned as specified in Table 108 taking into account that the required impulse withstand voltage is one step higher than the rated impulse withstand voltage of the control device.