



BSI Standards Publication

Low-voltage switchgear and controlgear

Part 6-2: Multiple function equipment — Control and protective switching devices (or equipment) (CPS)

National foreword

This British Standard is the UK implementation of EN IEC 60947-6-2:2023. It is identical to IEC 60947-6-2:2020, incorporating corrigendum 1:2024 and corrigendum 2:2023. It supersedes BS EN 60947-6-2:2003, which will be withdrawn on 3 March 2026.

The start and finish of text introduced or altered by corrigendum is indicated in the text by tags. Text altered by IEC corrigendum December 2021 is indicated in the text by AC1 AC1. Text altered by IEC corrigendum June 2023 is indicated in the text by AC2 AC2.

The UK participation in its preparation was entrusted to Technical Committee PEL/121/1, Low voltage switchgear and controlgear.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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English Version

**Low-voltage switchgear and controlgear - Part 6-2: Multiple
function equipment - Control and protective switching devices (or
equipment) (CPS)**

Appareillage à basse tension - Partie 6-2: Matériels à
fonctions multiples - Appareils (ou matériel) de connexion
de commande de protection (ACP)

Niederspannungsschaltgeräte - Teil 6-2: Mehrfunktions-
Schaltgeräte - Steuer- und Schutz-Schaltgeräte (CPS)

This European Standard was approved by CENELEC on 2021-01-19. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

European foreword

The text of document 121A/384/FDIS, future edition 3 of IEC 60947-6-2, prepared by SC 121A "Low-voltage switchgear and controlgear" of IEC/TC 121 "Switchgear and controlgear and their assemblies for low voltage" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 60947-6-2:2023.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2023-12-03
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2026-03-03

This document supersedes EN 60947-6-2:2003 and all of its amendments and corrigenda (if any).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

This document has been prepared under a Standardization Request given to CENELEC by the European Commission and the European Free Trade Association.

Any feedback and questions on this document should be directed to the users' national committee. A complete listing of these bodies can be found on the CENELEC website.

Endorsement notice

The text of the International Standard IEC 60947-6-2:2020 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standard indicated:

- IEC 60034-12:2016 NOTE Approved as EN 60034-12:2017 (not modified)
- IEC 60034-30-1 NOTE Approved as EN 60034-30-1
- IEC 60068-2-2:2007 NOTE Approved as EN 60068-2-2:2007 (not modified)
- IEC 60076-1:2011 NOTE Approved as EN 60076-1:2011 (not modified)
- IEC 60079 (series) NOTE Approved as EN IEC 60079 (series)
- IEC 60269-1:2006 NOTE Approved as EN 60269-1:2007 (not modified)
- IEC 60269-2:2013 NOTE Approved as HD 60269-2:2013
- IEC 60381-1:1982 NOTE Approved as HD 452.1 S1:1984 (not modified)
- IEC 60664-1:2020 NOTE Approved as EN IEC 60664-1:2020 (not modified)
- IEC 60947-4-1:2018 NOTE Approved as EN IEC 60947-4-1:2019 (not modified)
- IEC 60990:2016 NOTE Approved as EN 60990:2016 (not modified)

IEC 61000-6-5	NOTE Approved as EN 61000-6-5
IEC 61032	NOTE Approved as EN 61032
IEC 61439 (series)	NOTE Approved as EN IEC 61439 (series)
IEC 61649:2008	NOTE Approved as EN 61649:2008 (not modified)
IEC 62061	NOTE Approved as EN IEC 62061
IEC 62477-1:2012	NOTE Approved as EN 62477-1:2012 (not modified) +A11:2014
IEC 62683-1	NOTE Approved as EN 62683-1
IEC/TR 63201	NOTE Approved as CLC IEC/TR 63201

Endorsement notice to Corrigendum June 2023

The text of the corrigendum IEC 60947-6-2:2020/COR2:2023 was approved by CENELEC as EN IEC 60947-6-2:2023/AC:2023-07 without any modification.

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60034-1	2017	Rotating electrical machines - Part 1: Rating and performance	-	-
IEC 60085	2007	Electrical insulation - Thermal evaluation and designation	EN 60085	2008
IEC 60417	-	Graphical symbols for use on equipment	-	-
IEC 60617	-	Graphical symbols for diagrams	-	-
IEC 60715	2017	Dimensions of low-voltage switchgear and controlgear - Standardized mounting on rails for mechanical support of switchgear, controlgear and accessories	EN 60715	2017
IEC 60730-1	-	Automatic electrical controls - Part 1: General requirements	EN 60730-1	-
IEC 60947-1	2020	Low-voltage switchgear and controlgear - Part 1: General rules	EN IEC 60947-1	2021
IEC 60947-2	2016	Low-voltage switchgear and controlgear - Part 2: Circuit-breakers	EN 60947-2	2017
+ A1	2019		+ A1	2020
IEC 60947-5-1	2016	Low-voltage switchgear and controlgear - Part 5-1: Control circuit devices and switching elements - Electromechanical control circuit devices	EN 60947-5-1	2017
IEC 61000-6-2	-	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity standard for industrial environments	EN IEC 61000-6-2	-
IEC 61051-2	-	Varistors for use in electronic equipment - Part 2: Sectional specification for surge suppression varistors	EN IEC 61051-2	-
CISPR 11	2015	Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement	EN 55011	2016

+ A1	2016		+ A1	2017
-	-		+ A11	2020
+ A2	2019		+ A2	2021
CISPR 32	-	Electromagnetic compatibility of multimedia equipment - Emission requirements	EN 55032	-
ISO 3864-2	-	Graphical symbols - Safety colours and safety signs - Part 2: Design principles for product safety labels	-	-

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

**Part 6-2: Multiple function equipment –
Control and protective switching devices (or equipment) (CPS)**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 60947-6-2 has been prepared by subcommittee 121A: Low-voltage switchgear and controlgear, of IEC technical committee 121: Switchgear and controlgear and their assemblies for low-voltage.

This third edition cancels and replaces the second edition published in 2002 and its Amendment 1:2007. This edition constitutes a technical revision.

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

- editorial changes according to ISO/IEC directives Part 2,
- alignments with IEC 60947-1:2020:
 - markings ("s", "sol", "r" or "f");
 - constructional requirements including material requirements;
 - requirements for screwless terminals;

- measurement method of the pole impedance;
- EMC requirement and testing;
- procedure to determine data for electromechanical CPS's used in functional safety applications;
- harmonisation with IEC 60947-2:2016:
 - operation tests of under-voltage relays and shunt releases;
 - CPS for IT systems (Annex G);
 - coordination with other short-circuit protective devices;
- alignments with IEC 60947-4-1:2018:
 - test at the rated conditional short-circuit current I_q of protected switching devices;
 - short-circuit tests harmonisation with North America;
 - reliability data for functional safety applications (new Annex K);
 - safety aspects related to electronic circuits and protective impedance (new Annex N);
 - introduction of provisions covering the impact of higher locked rotor current to achieve high efficiency class;
 - mention of dedicated wiring accessories;
 - definitions and measurement method of the power consumption of the control circuit during holding and pick-up operations;
 - load monitoring indicators (new Annex M).

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

FDIS	Report on voting
121A/384/FDIS	121A/392/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.

A list of all the parts in the IEC 60947 series, under the general title *Low-voltage switchgear and controlgear*, can be found on the IEC website.

This document shall be read in conjunction with IEC 60947-1, *Low voltage switchgear and controlgear – Part 1: General rules*.

The provisions of the general rules are applicable to this part of IEC 60947-6, where specifically called for. General rules clauses and subclauses thus applicable as well as tables, figures and annexes are identified by reference to IEC 60947-1, for example, 1.2.3, Table 4, or Annex A of IEC 60947-1:2020.

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

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

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

The contents of the corrigendum of December 2021 have been included in this copy.

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 6-2: Multiple function equipment – Control and protective switching devices (or equipment) (CPS)

1 Scope

This document applies to control and protective switching devices (or equipment) (CPS), the main contacts of which are intended to be connected to circuits of rated voltage not exceeding 1 000 V AC or 1 500 V DC.

It covers control and protective switching device (CPS):

- which provides protective and control functions for circuits and motors;
- where its control function is operated exclusively otherwise than by hand;
- which provides continuity of service after over-current conditions; and
- which can have additional functions, such as isolation or communication.

This document does not apply to:

- auxiliary contacts, covered by IEC 60947-5-1;
- CPS used downstream to frequency drive¹;

NOTE Additional requirements for CPS used downstream to frequency drive are under consideration for the next maintenance cycle.

- the use of the product with additional measure within explosive atmospheres, covered by IEC 60079 (all parts);
- embedded software design rules, covered by IEC TR 63201;
- cyber security aspects, covered by IEC TS 63208.

The object of this document is to state:

- the characteristics of CPS's;
- the conditions with which CPS's are complying with reference to their operation and behaviour, their dielectric properties, the degree of protection provided by their enclosure where applicable, its construction including safety measures against electric shock, fire hazard and mechanical hazard;
- the tests intended to verify that these conditions have been met, and the methods to be adopted for these tests;
- the information to be marked on or given with the CPS's.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

¹ For this subject, the manufacturer is responsible to take additional safety measures.

IEC 60034-1:2017, *Rotating electrical machines – Part 1: Rating and performance*

IEC 60085:2007, *Electrical insulation – Thermal evaluation and designation*

IEC 60417, *Graphical symbols for use on equipment* (available at <http://www.graphical-symbols.info/equipment>)

IEC 60617, *Graphical symbols for diagrams* (available at <http://std.iec.ch/iec60617>)

IEC 60715:2017, *Dimensions of low-voltage switchgear and controlgear – Standardized mounting on rails for mechanical support of switchgear, controlgear and accessories*

IEC 60730-1, *Automatic electrical controls – Part 1: General requirements*

IEC 60947-1:2020, *Low-voltage switchgear and controlgear – Part 1: General rules*

IEC 60947-2:2016, *Low-voltage switchgear and controlgear – Part 2: Circuit-breakers*
IEC 60947-2:2016/AMD1:2019

IEC 60947-5-1:2016, *Low-voltage switchgear and controlgear – Part 5-1: Control circuit devices and switching elements – Electromechanical control circuit devices*

IEC 61000-6-2, *Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity standard for industrial environments*

IEC 61051-2, *Varistors for use in electronic equipment – Part 2: Sectional specification for surge suppression varistors*

CISPR 11:2015, *Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement*

CISPR 11:2015/AMD1:2016

CISPR 11:2015/AMD2:2019

CISPR 32, *Electromagnetic compatibility of multimedia equipment – Emission requirements*

ISO 3864-2, *Graphical symbols – Safety colours and safety signs – Part 2: Design principles for product safety labels*

3 Terms and definitions

3.1 General

For the purposes of this document, the terms and definitions of Clause 3 of IEC 60947-1:2020, as well as the following terms, definitions, symbol and abbreviations apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.2 Terms and definitions related to the equipment

3.2.1

control and protective switching device

CPS

mechanical switching device with a control function operated otherwise than by hand capable of:

- making, carrying and breaking currents under normal conditions;
- making, carrying for a specified time in overload condition;
- breaking currents under specified abnormal operating condition such as those of short-circuits;
- continuity of service,

with or without local manual operating means

Note 1 to entry The term "with a control function operated otherwise than by hand" means that the device is intended to be controlled and kept in working position from one or more external controls.

Note 2 to entry: A CPS can consist of a single device but is always rated as a unit. Coordination can be either inherent or obtained by correct selection of releases in accordance with the manufacturer's instructions.

3.2.2

direct-on-line CPS

CPS which connects the line voltage across the motor terminals in one step

3.2.3

reversing CPS

CPS for starting a motor, intended to cause a motor to reverse the direction of rotation by reversing the motor primary connections when the motor is not running

Note 1 to entry An application where reversing the motor primary connections while the motor is running is called plugging.

3.2.4

electronically controlled electromagnet

electromagnet in which the coil is controlled by a circuit with active electronic elements

[SOURCE IEC 60947-4-1:2018, 3.3.8]

3.2.5

dedicated wiring accessory

prefabricated connection wiring system specifically intended for identified switchgear or controlgear

Note 1 to entry A dedicated wiring accessory can be integrated in the switchgear or controlgear or delivered separately.

Note 2 to entry A typical dedicated wiring accessory is for example a connection link.

3.2.6

phase-loss sensitive relay or release

<motor protection> multipole relay or release for motor protection which operates in case of loss of phase in accordance with specified requirements

3.2.7

under-current relay or release

relay or release which operates automatically when the current through it is reduced below a predetermined value

3.2.8**under-voltage relay or release**

relay or release which operates automatically when the voltage applied to it is reduced below a predetermined value

3.2.9**stall relay or release**

electronic overload relay or release which operates when the current has not decreased below a predetermined value for a specific period of time during start-up or when the relay or the release receives the input indicating there is no rotation of the motor after a predetermined time in accordance with specified requirements

Note 1 to entry Explanation of stall: rotor locked during start.

Note 2 to entry With appropriate adjustment of the current and starting time settings, such relay or release can be used to detect starts requiring longer than specified times.

3.2.10**jam relay or release**

electronic overload relay or release which operates in the case of overload and also when the current has increased above a predetermined value for a specific period of time during operation in accordance with specified requirements

Note 1 to entry A jam is a high overload occurring after the completion of starting which causes the current to reach the locked rotor current value of the motor being controlled.

3.2.11**inhibit time**

time-delay period during which the tripping function of the relay is inhibited (may be adjustable)

3.3 Terms and definitions concerning characteristic quantities**3.3.1****continuity of service**

<of a control and protective switching device> capability to return into service after occurrence of an over-current fault in the circuit under control at all current up to the rated service short-circuit breaking capacity I_{CS} of the control and protective switching device

3.3.2**holding power**

power needed to maintain the operation of the electromagnet

[SOURCE: IEC 60947-4-1:2018, 3.3.9, modified – Without “(of a contactor)”.]

3.3.3**pick-up power**

power needed to operate the device from the de-energized state

[SOURCE: IEC 60947-4-1:2018, 3.3.10, modified – Deletion of “(of a contactor)” in the term and of “to the energized state” in the definition.]

3.3.4**O**

<operation> breaking operation by the device under short-circuit current

3.3.5**CO**

<operation> making operation under short-circuit current followed, after the appropriate opening time, by a breaking operation

3.3.6

rCO

<operation> remote controlled CO operation

3.3.7

galvanic separation

prevention of electric conduction between two electric circuits intended to exchange power and/or signals

Note 1 to entry Galvanic separation can be provided e.g. by an isolating transformer or an opto-coupler.

[SOURCE: IEC 60050-151:2001, 151-12-26]

3.3.8

conventional prospective current “r”

specified value of prospective short-circuit current for which the switching device is tested under specified conditions

3.3.9

conventional prospective current I_{cr}

specified values of prospective short-circuit current for which the switching device is tested under specified conditions followed by operational performance tests

3.4 Terms and definitions concerning safety aspects

3.4.1

abnormal operating condition

temporary operating condition that is not a normal operating condition and is not a single fault condition of the equipment itself

Note 1 to entry An abnormal operating condition is a temporary condition which can be introduced by the equipment or by a person and can result in a failure of a component, a device or a safeguard

Note 2 to entry This definition is used in the context of component failure risk analysis.

3.4.2

accessible part

part which can be touched by means of the standard test finger

[SOURCE: IEC 60050-442:1998, 442-01-15]

3.4.3

hazardous-live-part

live part which, under certain conditions, can give a harmful electric shock

[SOURCE: IEC 60050-195:1998, 195-06-05]

3.4.4

limited energy source

source that is designed and protected that, under both normal operating conditions and single fault conditions, the current that can be delivered is not hazardous with respect to fire hazard

3.4.5

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, is limited to a safe value, and which is so constructed that its ability is maintained throughout the life of the equipment

[SOURCE: IEC 62477-1:2012, 3.42]

3.4.6

reasonably foreseeable misuse

use of a product or system in a way not intended by the supplier, but which can result from readily predictable human behaviour

[SOURCE: ISO/IEC Guide 51:2014, 3.7, modified – Notes to entry have been deleted]

3.4.7

single fault condition

condition in which there is a fault of a single protection (but not a reinforced protection) or of a single component or a device

Note 1 to entry If a single fault condition results in one or more other fault conditions, all are considered as one single fault condition.

Note 2 to entry: Reinforced protection is defined in IEC 60050-903:2013, 903-02-08.

[SOURCE: IEC Guide 104:2019, 3.8]

4 Classification

Data which may be used as criteria for classification are given in 5.2.

5 Characteristics

5.1 Summary of characteristics

The characteristics of a CPS shall be stated in terms of the following, as applicable:

- type of CPS (5.2);
- rated and limiting values of the main circuit (5.3);
- utilization categories (5.4);
- control circuits (5.5);
- auxiliary circuits (5.6);
- relays and releases (5.7);
- items subject to agreement between manufacturer and user (see Annex D).

NOTE In the context of this document, the term "manufacturer" means any person, company or organization with ultimate responsibility as follows:

- to verify compliance with this document;
- to provide the product information according to Clause 6 (marking, identification, characteristics).

For information exchange in electronic format, e.g. electronic catalogue, IEC 62683-1 gives the data format of the essential characteristics of motor-starter combination and their accessories.

5.2 Type of equipment

5.2.1 Number of poles

5.2.2 Kind of current (alternating current or direct current)

5.2.3 Method of operation

For example: electromagnetic, manual, motor operated.

5.2.4 Method of control

For example:

- automatic (by pilot switch or sequence control);
- non-automatic (such as by handle or by push-buttons).

5.2.5 Method of resetting after overload

The following types are recognized:

- self resetting;
- local manual resetting;
- remote resetting.

5.2.6 Method of rearming after short-circuit

The following types are recognized:

- CPS capable of remote re-arming after operation;
- CPS incapable of remote re-arming after operation:
 - those not requiring replacement of a renewable short-circuit protective element, for example a normally operated circuit-breaker;
 - those requiring replacement of a renewable short-circuit protective element, for example a fuse-link.

5.3 Rated and limiting values of the main circuit

5.3.1 Rated voltages

Subclause 5.3.1 of IEC 60947-1:2020 applies with the following addition.

CPS's for unearthed or impedance earthed systems (IT) require additional tests according to Annex G.

5.3.2 Currents and powers

A CPS is defined by the following currents and powers:

- conventional free air thermal current (I_{th}): 5.3.2.1 of IEC 60947-1:2020 applies;
- conventional enclosed thermal current (I_{the}): 5.3.2.2 of IEC 60947-1:2020 applies;
- rated operational current (I_e) or, if applicable, rated operational power: 5.3.2.3 of IEC 60947-1:2020 applies.

5.3.3 Rated frequency

Subclause 5.3.3 of IEC 60947-1:2020 applies.

5.3.4 Rated duties

Subclause 5.3.4 of IEC 60947-1:2020 applies with the following addition to 5.3.4.3 of IEC 60947-1:2020 (intermittent periodic duty or intermittent duty).

In case of utilization categories AC-2, AC-3 and AC-3e, an operating cycle comprises starting, running to full speed and switching off the supply to the motor.

NOTE In the case of a CPS controlling a motor for intermittent duty, the difference between the thermal time-constant of the overload relay and that of the motor can render a thermal relay unsuitable for overload protection. For installations intended for intermittent duty, the question of overload protection is subject to an agreement between manufacturer and user.

5.3.5 Normal load and overload characteristics – Rated making and breaking capacities

Subclauses 5.3.5.2 and 5.3.5.3 of IEC 60947-1:2020 apply with the following additions.

Requirements for the various utilization categories (5.4) are given in 8.2.4.1.

The rated making and breaking capacities are only valid when the CPS is operated in accordance with the requirements of 8.2.1.1 and 8.2.1.2.

5.3.6 Short circuit characteristics – Rated service short-circuit breaking capacity (I_{cs})

Subclause 5.3.6.3 of IEC 60947-1:2020 applies with the following additions.

A rated short-circuit breaking capacity requires that the CPS shall be able to break any value of short-circuit current up to and including the value corresponding to the rated capacity at a power-frequency recovery voltage corresponding to the prescribed test voltage values and,

- for alternating current, at any power-factor not less than that of Table 16 of IEC 60947-1:2020;
- for direct current, with a time-constant up to that of Table 16 of IEC 60947-1:2020.

The rated service short-circuit breaking capacity of a CPS is the value of service short-circuit breaking capacity assigned to that CPS by the manufacturer for the corresponding rated operational voltage, under the conditions specified in 9.5.3.3. It is expressed as a value of prospective breaking current. I_{cs} shall be equal to or greater than the conventional prospective current I_{cr} (see 8.2.5 a)).

For alternating current, the short-circuit making capacity of a CPS shall be not less than its rated service short-circuit breaking capacity, multiplied by the factor n of Table 16 of IEC 60947-1:2020.

For direct current, the short-circuit making capacity of a CPS shall be not less than its rated service short-circuit breaking capacity.

5.3.7 Pole impedance of a CPS (Z)

Subclause 5.3.7 of IEC 60947-1:2020 applies.

5.4 Utilization categories

5.4.1 General

Subclause 5.4 of IEC 60947-1:2020 applies with the following additions.

Utilization categories given in Table 1 are considered as standard. Any other type of utilization shall be based on an agreement between manufacturer and user, but information given in the manufacturer's catalogue or a tender may constitute such an agreement.

Each utilization category is characterized by the values of currents (including prospective conventional test current, see 8.2.5 a)), voltages, power factors, or time-constants and other data in Table 9, Table 10, Table 11, Table 12 and Table 13 and by the test conditions specified in this document.

For CPS's defined by their utilization categories, it is therefore unnecessary to specify separately the rated making and breaking capacities as these values depend directly on the utilization category as shown in Table 9.

The voltage for all utilization categories is the rated operational voltage of the CPS.

Table 1 – Utilization categories

Specific utilization categories	Harmonised utilization categories ^d	Typical load
AC-40		Distribution circuits comprising mixed resistive and reactive loads having a resultant inductive reactance
AC-41	AC-1	Non-inductive or slightly inductive loads
AC-42	AC-2	Slip-ring motors or mixed resistive and inductive loads, including moderate overloads
AC-43	AC-3	Squirrel-cage motors ^{a, b}
	AC-3e	Squirrel-cage motors with higher locked rotor current ^{a, c}
AC-44	AC-4	Squirrel-cage motors ^b plugging, inching
AC-45a	AC-5a	Discharge lamp controls
AC-45b	AC-5b	Incandescent lamps
DC-40		Distribution circuits comprising mixed resistive and reactive loads having a resultant inductive reactance
DC-41	DC-1	Non-inductive or slightly inductive loads
DC-43	DC-3	Shunt-motors
DC-45	DC-5	Series-motors
DC-46	DC-6	DC incandescent lamps

^a AC-3 category may be used for occasional inching (jogging) or plugging for limited time periods such as machine set up; during such limited time periods the number of operations should not exceed five per minute nor 10 in a 10-min period.

^b Asynchronous motor of design N and H according to IEC 60034-12:2016.

^c Asynchronous motor of design NE and HE, according to IEC 60034-12:2016, having extended/higher locked rotor apparent power and current than design N and H respectively, to achieve a higher efficiency class according to IEC 60034-30-1.

^d The new utilization categories according to Annex A of IEC 60947-1:2020 are proposed to replace the specific ones but the specific utilization categories are remaining valid.

5.4.2 Assignment of utilization categories based on the results of tests

- a) A CPS which has been tested for one utilization category or at any combination of parameters (such as highest operational voltage and current, etc.) can be assigned other utilization categories without additional testing provided that the values of test current, voltages, power-factors or time-constants, number of operating cycles, the ON-times and OFF-times given in Table 9 and Table 10 and the test circuit for the assigned utilization categories are not more severe than those at which the equipment has been tested and temperature-rise has been verified at a current not less than the highest assigned rated operational current in continuous duty.

For example, when tested for utilization category AC-4, a CPS may be assigned utilization category AC-3 provided that I_e for AC-3 is not higher than 1,2 times I_e for AC-4 at the same rated operational voltage.

- b) DC-3 or DC-5 CPS is assumed to be capable of opening and closing loads other than those on which they have been tested provided that:

– the voltage and current do not exceed the specified values of U_e and I_e ;

- the energy J stored in the actual load is equal to or less than the energy J_c stored in the load with which the CPS has been tested. The values of the energy stored in the test circuit are as follows:
 - For DC-3: $J_c = 0,005\,25 \times U_e \times I_e$
 - For DC-5: $J_c = 0,031\,5 \times U_e \times I_e$

The values of the constants 0,005 25 and 0,031 5 are derived from: $I_c = \frac{1}{2} LI^2$ where the time-constant has been replaced by $2,5 \times 10^{-3}$ s for DC-3 and 15×10^{-3} s for DC-5 and where $U = 1,05 U_e$ and $I = 4 I_e$ (see Table 9).

5.4.3 Application of utilization categories for motor control duty

Typical service conditions are:

- rotation in one direction, the motor being switched off while running under normal service conditions (utilization categories AC-2, AC-3 and AC-3e);
- rotation in two directions, but running of the motor in the second direction being started only after the CPS has been switched off and the motor completely stopped (utilization categories AC-2, AC-3 and AC-3e);
- rotation in one direction, or in two directions as in the previous paragraph, but with the possibility of infrequent inching. For this service condition, a direct-on-line CPS is generally used (utilization category AC-3 and AC-3e);
- rotation in one direction with frequent inching (jogging); a direct-on-line CPS is generally used (utilization category AC-4);
- rotation in one or two directions but with the possibility of infrequent plugging in order to stop the motor, the plugging being associated with rotor resistor braking if this is provided. In this case a CPS may be used in the stator circuit (utilization category AC-2);
- rotation in two directions but with the possibility of reversing the supply connections to the motor while it is running in the first direction (plugging), in order to obtain its rotation in the other direction while switching off the motor running under normal service conditions. A direct-on-line reversing CPS with plugging capability is generally used for this service condition (utilization category AC-4).

Unless otherwise stated, CPS's used as starters are designed on the basis of the starting characteristics of the motors compatible with the making capacities of Table 9. When the starting current of a motor exceeds these values, a CPS having a suitably higher rated operational current should be used.

5.5 Control circuits

Subclause 5.5 of IEC 60947-1:2020 applies with the following additions.

The list of characteristics given in 5.5.1 of IEC 60947-1:2020 shall be completed by:

- limited energy (if the source is in accordance with 8.1.14);
- SELV (PELV) supply (in accordance with Annex N of IEC 60947-1:2020).

NOTE In the USA and Canada, control circuits can be characterised as Class 2 sources as defined in NFPA 70, National Electrical Code and CSA C22.1, Canadian Electrical Code in lieu of or in addition to SELV (PELV) sources.

- the power consumption of the electromagnet of a CPS, necessary for determining the characteristics of the power supply of the control circuit, is given by:
 - holding power;
 - pick-up power.

5.6 Auxiliary circuits

Subclause 5.6 of IEC 60947-1:2020 applies.

Digital inputs and/or digital outputs contained in CPS, and intended to be compatible with PLC's, shall fulfil the requirements of Annex S of IEC 60947-1:2020.

Annex F applies for CPS equipped with mirror contact.

5.7 Relays or releases

5.7.1 Summary of characteristics

The characteristics of relays and releases shall be stated in the following terms, whenever applicable:

- types of relay or release (see 5.7.2);
- characteristic values (see 5.7.3);
- designation and current settings of overload relays (see 5.7.4);
- time-current characteristics of overload relays (see 5.7.5);
- influence of ambient air temperature (see 5.7.6);
- extended functions as given in Annex T of IEC 60947-1:2020;
- load monitoring indicator as given in Annex M.

5.7.2 Types of relays or releases

5.7.2.1 Shunt release (3.6.34 of IEC 60947-1:2020)

5.7.2.2 Under-voltage relay or release (for opening) (3.6.35 of IEC 60947-1:2020).

5.7.2.3 Over-current relays or releases

5.7.2.3.1 Overload relays or releases

- a) Instantaneous overload relay or release (e.g. jam sensitive, 3.2.10);
- b) Definite time-delay overcurrent relay or release (3.6.27 of IEC 60947-1:2020);
- c) Inverse time-delay overcurrent relay or release (3.6.28 of IEC 60947-1:2020):
 - i) substantially independent of previous load;
 - ii) dependent on previous load;
 - iii) dependent on previous load and also sensitive to phase-loss (see 3.2.6).
- d) Stall relay or release (see 3.2.9).

5.7.2.3.2 Short-circuit relays or releases

- a) Instantaneous short-circuit relay or release;
- b) Definite time-delay overcurrent relay or release (3.6.27 of IEC 60947-1:2020).

NOTE A CPS has a combination of relays or releases from 5.7.2.3.1 and 5.7.2.3.2 above.

5.7.2.4 Other relays and releases (e.g. phase failure relay, control relay associated with devices for motor thermal protection, residual current relay)

Types referred to under 5.7.2.4 require consultation between manufacturer and user according to the particular application.

5.7.3 Characteristic values

Shunt, under-voltage (under-current), over-voltage (instantaneous over current), current or voltage asymmetry and phase reversal opening relay or release:

- rated voltage (current);
- rated frequency;
- operating voltage (current);
- operating time (when applicable);
- inhibit time (when applicable).

Over-current relay or release:

- designation and current settings (see 5.7.4);
- rated frequency, when necessary (for example, in the case of a current transformer operated overload relay);
- time-current characteristics (or range of characteristics), when necessary;
- trip class according to classification in Table 3, or the value of the maximum tripping time, in seconds, under the conditions specified in Table 2, column D, when this time exceeds 40 s;
- nature of the relay: thermal, magnetic, electronic or electronic without thermal memory;
- nature of the reset: in case of manual and/or automatic, the position shall be indicated;
- tripping time of overload relays class 10 A if longer than 2 min at -5°C or below (see 8.2.1.5.1.1).

Release with residual current sensing relay:

- rated current;
- operating current;
- operating time or time-current characteristic according to Table T.1 of IEC 60947-1:2020;
- inhibit time (when applicable);
- type designation (see Annex T of IEC 60947-1:2020).

5.7.4 Designation and current setting of overload relays or releases

Overload relays or releases are designated by their current setting (or the upper and lower limits of current setting range, if adjustable) and their trip class, where applicable. The current setting (or current setting range) shall be marked on the relay or release.

5.7.5 Time-current characteristics of over current relays or releases

Time-delay relay or release:

- definite time-delay: the time-delay of such relays or releases is independent of the over-current. The tripping time setting shall be stated as the duration in seconds of the opening time of the CPS if the time-delay is not adjustable, or the minimum and maximum values of the opening time, if the time-delay is adjustable.
- inverse time-delay: the time-current characteristics shall be given in the form of curves supplied by the manufacturer. These shall indicate how the opening time, starting from the cold state, varies with current within the range of operation of the relay or release. The manufacturer shall indicate, by suitable means, the tolerances applicable to these curves. These curves shall be given for the minimum and maximum values of the current setting and, if the time setting for a given current setting is adjustable, it is recommended that they be given in addition for each minimum and maximum values of the time setting.
- opening time: subclause 3.7.39 of IEC 60947-1:2020 applies, with the following additions:

- in the case of a CPS tripped by an over-current relay or release, the instant of initiation of the opening time is the instant when the current reaches a value large enough to cause the CPS to operate;
- in the case of a CPS operated by any form of auxiliary power, the instant of initiation of the opening time is the instant of application of the auxiliary power to or its removal from the opening release.

NOTE 1 For CPS's "opening time" is commonly referred to as "tripping time", although strictly speaking, tripping time applies to the time between the instant of initiation of the opening time and the instant when the opening command becomes irreversible.

NOTE 2 The current is plotted as abscissa and the time as ordinates, using logarithmic scales. The current is plotted as multiples of the setting current I_r and the time in seconds on the standard graph sheet detailed in 5.6.1 and Figure 1 of IEC 60269-1:2006 and in Figure 104, Figure 504 and Figure 505 of IEC 60269-2:2013.

5.7.6 Influence of ambient air temperature

Unless otherwise specified, the operating value of over-current relays or releases other than those of the thermal type is independent of the ambient air temperature within the limits of -5 °C to $+40\text{ °C}$.

For relays or releases of the thermal type:

The time-current characteristics refer to a stated value of ambient air temperature and are based on no previous loading of the overload relay (i.e. from an initial cold state).

This value of the ambient air temperature shall be clearly given on the time curves; the preferred values are $+20\text{ °C}$ or $+40\text{ °C}$.

The overload-relays or releases shall be able to operate within the ambient air temperature range of -5 °C to $+40\text{ °C}$ and the manufacturer shall be prepared to state the effect of variation in ambient air temperature on the characteristics of overload relays or releases.

6 Product information

6.1 Nature of information

6.1.1 Identification

- The manufacturer's name or trademark;
- Type designation or serial number;
- Number of this part, if the manufacturer claims compliance.

6.1.2 Characteristics

- Rated operational voltages U_e (see 5.3.1 and, where applicable, Annex G);
- Utilization category and rated operational currents (or, where applicable, rated powers) at the rated-operational voltages;
- Either the rated frequency (e.g.: 50 Hz, 50 Hz/60 Hz) and/or the indication "d.c." (or the symbol — — — (IEC 60417-5031:2002-10));
- Rated duty with the indication of the class of intermittent duty, if any;
- Pole impedance of the switching device (Z);
- i1) Rated service short-circuit breaking capacity (I_{cs}) (see 5.3.6);
- i2) Rated insulation voltage according to 5.3.1.2 of IEC 60947-1:2020;
- j) Rated impulse withstand voltage (U_{imp});
- k) Indication of the open and closed positions (according to 8.1.6);

- l) Pollution degree (see Clause 7);
- m) Rated control circuit voltage (U_c), nature of current and rated frequency (if alternating current).

NOTE 1 Other information such as the holding or pick-up power could be given e.g. in the product literature.

- n) IP code according to Annex C of IEC 60947-1:2020;

NOTE 2 In the USA and Canada this protection is defined by NFPA 70, National Electrical Code and CSA C22.1, Canadian Electrical Code as the Enclosure Environmental Type Ratings.

- o) If necessary, nature of current, rated frequency and rated control circuit supply voltage (U_s);

In the case of electronically controlled electromagnets, other information may also be necessary, for example control circuit configuration (see 5.5 of this document and Annex U of IEC 60947-1:2020).

- p) Ratings of auxiliary circuits;
- q1) Maximum permissible altitude of the site of installation, if greater than 2 000 m;
- q2) Minimum enclosure size and ventilation data (if any) to which marked ratings apply;
- q3) Details of minimum distance between CPS and earthed metal parts for CPS's intended for use without enclosures;
- r) Current setting and identification of time-current characteristic of over current relays or releases, specifying, according to 5.7, if the electronic overload relay does not contain thermal memory;
- s) Other characteristics of over-current relays or releases according to 5.7;
- t) In the case of renewable short-circuit protective elements (see 5.2) current rating, type and characteristics in accordance with relevant standard;
- u1) Suitability for isolation where applicable (see 6.2 of IEC 60947-1:2020);
- u2) Suitability for IT systems according to Annex G;
- v) Environment A or environment B (see 8.3.1 of IEC 60947-1:2020);
- w1) Length of insulation to be removed before insertion of the conductor into the terminal;
- w2) Maximum number of conductors which may be clamped;
- w3) For non-universal screwless terminals:
 - "s" or "sol" for terminals declared for rigid-solid conductors;
 - "r" for terminals declared for rigid (solid and stranded) conductors;
 - "f" for terminals declared for flexible conductors.
- w4) Special requirements, if applicable, for example shielded or twisted conductors;

NOTE 3 Unshielded or untwisted conductors are considered as normal installation conditions.

- x) Minimum cable cross-section, if different from Table 9 of IEC 60947-1:2020, for ratings ≤ 20 A according to rated ultimate short-circuit breaking capacity I_{cu} ;
- y) Values of tightening torque for the CPS terminals;
- z1) Reference of dedicated wiring accessories which can be used for wiring the CPS;
- z2) Material declaration according to Annex W of IEC 60947-1:2020.

6.2 Marking

Subclause 6.2 of IEC 60947-1:2020 applies with the following additions related to 6.1.1 and 6.1.2 above:

- data under items c) and n) (if the degree of protection is different than IP00) shall be marked on the equipment;
- data under items d) to g), i) to m), o) to q), s) and v) to z2) shall be included on the nameplate or on the equipment or in the manufacturer's published literature;

- data under items h) and t) and relevant operational data under items d), e) and f) shall be marked on the CPS;
- data under item r) shall be marked on the relay or release;

- data under u) shall be marked on the CPS, the global symbol being:
(IEC 60417-6410:2018-11);



- terminals shall be marked so as to clearly identify line and load terminals (see 8.1.8.2).

NOTE Data under items a) and b) of 6.1.1 are already covered by 6.2 of IEC 60947-1:2020.

If the manufacturer declares an electronic overload relay without thermal memory, this shall be marked on the device.

For dedicated accessories used for wiring the CPS, data under 6.1.1 c), 6.1.2 i2) and the current I_{th} , if applicable, shall be provided in the manufacturer's published literature.

6.3 Instructions for installation, operation and maintenance

Subclause 6.3 of IEC 60947-1:2020 applies with the following addition.

The instructions shall also cover the dedicated wiring accessories.

Additional information for the decommissioning and dismantling of the device shall be maintained available to the user in case of foreseeable hazardous condition of the device, for example due to stored energy, instability or falling of objects, etc.

The manufacturer of a CPS incorporating an automatic reset overload relay capable of being connected to enable automatic restarting shall provide, with the CPS, that information necessary to alert the user to the possibility of automatic restarting.

If the construction requires energization by an external source that is not a limited energy source as defined in 8.1.14, the manufacturer shall provide the appropriate information for short-circuit and overcurrent protection of the ports.

For each relevant potential hazard, the manufacturer shall provide safety signs, graphical symbols or safety notes of the hazard for example by using e.g. IEC 60417-5036:2002-10. Signal words shall be defined according to ISO 3864-2.

NOTE ISO/IEC 82079-1 provide guidance for developing safety instructions.

6.4 Environmental information

Subclause 6.4 of IEC 60947-1:2020 applies with the following addition.

NOTE Future publication IEC TS 63058² will give the method for assessing the environmental impact of switchgear and controlgear.

7 Normal service, mounting and transport conditions

Clause 7 of IEC 60947-1:2020 applies with the following additions.

² Under preparation. Stage at the time of publication: IEC TS APUB 63058:2020.

Unless otherwise stated by the manufacturer's, a CPS is for use in pollution degree 3 environmental conditions, as defined in 7.1.3.2 of IEC 60947-1:2020. However, other pollution degrees may be considered to apply depending upon the micro-environment.

Rail mounting shall be specified according to IEC 60715:2017, when relevant.

Standard conditions of vibration and shock are defined in footnotes ^b of Table Q.1 of IEC 60947-1:2020.

8 Constructional and performance requirements

8.1 Constructional requirements

8.1.1 General

Subclause 8.1.1 of IEC 60947-1:2020 applies with the following addition.

Measures shall be provided to reduce the likelihood of injury or, in case of fire, property damage, under installation, maintenance, normal operation conditions, abnormal operation conditions and reasonably foreseeable misuses. The requirements of this document are generically providing these measures.

Protection against hazards caused by the electronic circuits shall be maintained under normal and single fault conditions, as specified in this document.

Components used in the construction of the equipment, compliant with a relevant IEC product standard do not require separate evaluation. Components or assemblies of components, for which no relevant product standard exists, shall be tested according to the requirements of this document.

Where the product is intended to be used together with specific auxiliary equipment and dedicated wiring accessories, the safety evaluation and test shall include this auxiliary equipment and accessories unless it can be shown that it does not affect the safety of any equipment.

The accessible part of the device and especially the operating means shall not present sharp edges and corners which can injure the operator.

The user manual shall give details of all safety-relevant measures intended for the user. Clear warning shall be provided in the user manual where adjustments or settings could lead to a hazardous situation.

The setting of the automatic reset of the overload release needs to be identified in the user manual as a specific safety relevant warning.

Annex O of IEC 60947-1:2020 should be considered carefully especially for substitution or reduction in use of hazardous substances or if not possible for providing measures to prevent emission and contact with them.

8.1.2 Materials

8.1.2.1 General materials requirements

Subclause 8.1.2.1 of IEC 60947-1:2020 applies with the following addition.

NOTE Fire hazard aspects are detailed in IEC TR 63054.

Parts of insulating materials located in electrical circuits sourced from limited energy sources according to 8.1.14 are not required to comply with the requirements of this subclause.

8.1.2.2 Glow wire testing

Subclause 8.1.2.2 of IEC 60947-1:2020 applies with the following addition.

When tests on the equipment or on sections taken from the equipment are used, parts of insulating materials necessary to retain current-carrying parts in position shall conform to the glow-wire tests of 9.2.2.1 of IEC 60947-1:2020 at a test temperature of 960 °C.

8.1.2.3 Test based on flammability category

Subclause 8.1.2.3 of IEC 60947-1:2020 applies.

8.1.3 Current-carrying parts and their connections

Subclause 8.1.3 of IEC 60947-1:2020 applies.

8.1.4 Clearances and creepage distances

Subclause 8.1.4 of IEC 60947-1:2020 applies with the following addition.

Creepage and clearance distances within the circuits sourced from limited energy sources as defined in 8.1.14 are not required to comply with the requirements of this subclause.

Clearance and creepage distances on printed wiring boards (PWBs) including components mounted on PWBs, for functional, basic, supplementary and reinforced insulation, designed according to 8.1.14, are considered to meet these requirements and do not need any further investigation.

Where SELV and PELV circuits are accessible, they shall be separated from other hazardous-live-part according to the requirements of Annex N for protective impedance in addition to Annex N of IEC 60947-1:2020.

NOTE If some circuits are only accessible under maintenance or similar conditions, they can, depending on the risk level (severity of harm and the probability of occurrence), be considered under normal service conditions (see 6.1), and use only basic insulation. Accessible parts can be determined using test probes according to IEC 61032.

8.1.5 Actuator

8.1.5.1 Insulation

Subclause 8.1.5.1 of IEC 60947-1:2020 applies.

8.1.5.2 Direction of movement

Subclause 8.1.5.2 of IEC 60947-1:2020 applies.

8.1.5.3 Mounting

Actuators mounted on removable panels or opening doors shall be so designed that, when the panels are replaced or the doors closed, the actuator will engage correctly with the associated mechanism.

8.1.5.4 Protection

There shall be no path or opening which allows incandescent particles to be discharged from the area of the manual operating means.

8.1.6 Indication of the contact position

8.1.6.1 Indicating means

Subclause 8.1.6.1 of IEC 60947-1:2020 applies.

8.1.6.2 Indication by the actuator

Subclause 8.1.6.2 of IEC 60947-1:2020 applies.

8.1.7 Additional requirements for equipment suitable for isolation

Subclause 8.1.7 of IEC 60947-1:2020 applies with the following addition.

If the tripped position of the CPS is not the indicated open position, it should be clearly visible that it is not the open position. The verification of the main contact position suitable for isolation shall be tested according to 9.5.2.6.

CPS's suitable for isolation shall be provided with means for locking in the open position.

8.1.8 Terminals

8.1.8.1 General

Subclause 8.1.8 of IEC 60947-1:2020 applies with the following additional requirements.

8.1.8.2 Terminal identification and marking

Subclause 8.1.8.4 of IEC 60947-1:2020 applies with additional requirements as given in Annex C with the following addition.

Line and load terminals of CPS for utilization categories AC-40 and DC-40 having trip units which are not removable or sealed against removal may not be identified, in which case control circuits shall not be internally connected to the main circuit.

8.1.9 Additional requirements for equipment provided with a neutral pole

Subclause 8.1.9 of IEC 60947-1:2020 applies.

8.1.10 Provisions for protective earthing

Subclause 8.1.10 of IEC 60947-1:2020 applies.

8.1.11 Enclosures for equipment

8.1.11.1 Design

Subclause 8.1.11.1 of IEC 60947-1:2020 applies with the following addition.

In the case of enclosed CPS's provided with an externally manually operated actuator, the door or cover shall be interlocked so that they cannot be opened without the CPS being in the open position. However, provision may be made to open the door or cover with the CPS in the ON position by the use of a tool.

8.1.11.2 Insulation

Subclause 8.1.11.2 of IEC 60947-1:2020 applies.

8.1.12 Degrees of protection of enclosed equipment

Subclause 8.1.12 of IEC 60947-1:2020 applies.

8.1.13 Conduit pull-out, torque and bending with metallic conduits

Subclause 8.1.13 of IEC 60947-1:2020 applies.

8.1.14 Limited energy source

8.1.14.1 General

A limited energy source can be implemented as a secondary circuit derived from circuits connected to the hazardous-live-part with the following separation means:

- a) galvanic separation;
- b) current limiting impedance.

NOTE Class 2 sources as defined in NFPA 70, National Electrical Code and CSA C22.1 Canadian Electrical Code (CE Code) have the same electrical output characteristics as limited energy sources with galvanic separation.

8.1.14.2 Limited energy source with galvanic separation

A limited energy source with galvanic separation incorporates an isolating component such as a transformer between the primary circuit and the limited energy output. It shall comply with one of the following requirements:

- a) the output is inherently limited in compliance with Table 20; or
- b) a linear or non-linear impedance limits the output in compliance with Table 20. If a positive temperature coefficient device (e.g. PTC) is used, it shall pass the applicable tests specified in IEC 60730-1; or
- c) a regulating network limits the output in compliance with Table 20, both with and without a single fault in the regulating network; or
- d) an over-current protective device is used and the output is limited in compliance with Table 21.

Where an over-current protective device is used, it shall be a fuse or non-adjustable electromechanical device.

Compliance to determine the maximum available power is checked by test of 9.2.4.

In case of external power supply without overcurrent protective devices, it shall not exceed the values given in Table 20. In case of external power supply with over-current protective, it shall not exceed the values given in Table 21.

Table 20 – Limits for limited energy sources without an over-current protective device

Output voltage ^a U_{oc}		Output current ^{b, d} I_{sc}	Maximum power ^c S
V AC	V DC	A	VA
≤ 30 RMS	≤ 30 V DC	≤ 8	100
-	$30 < U_{oc} \leq 60$ ^e	$\leq \frac{150}{U_{oc}}$	100

NOTE This table will be moved into the future revision of IEC 60947-1 and is therefore numbered differently to the other tables in this document.

AC1 a. U_{oc} : Output voltage measured in accordance with all load circuits disconnected. Voltages are for substantially sinusoidal AC and ripple-free DC. For non-sinusoidal AC and DC with ripple greater than 10 % of the peak, its peak value shall not exceed 42,4 V.

b. I_{sc} : Maximum output current with any non-capacitive load, including a short circuit.

c. S (VA): Maximum output apparent power with any non-capacitive load as determined by 9.2.4.

d. Measurement of I_{sc} is made 5 s after application of the load if protection is by an electronic circuit or a positive temperature coefficient device (e.g. PTC), and 60 s in other cases.

e. In the USA, the limit is 60 V DC continuous or DC switching outside of 10 Hz to 200 Hz, 24,8 V DC switching at 10 Hz to 200 Hz. **AC1**

Table 21 – Limits for limited energy sources with an over-current protective device

Output voltage ^a U_{oc}		Output current ^{b, d} I_{sc}	Maximum power ^{c, d} S	Current rating of over-current protective device ^e
V AC	V DC	A	VA	A
≤ 20	≤ 20	$\leq \frac{100}{U_{oc}}$	250	≤ 5,0
$20 < U_{oc} \leq 30$	$20 < U_{oc} \leq 30$ ^f			$\leq \frac{100}{U_{oc}}$
-	$30 < U_{oc} \leq 60$ ^f			$\leq \frac{100}{U_{oc}}$

NOTE 1 The reason for making measurements with over-current protective devices bypassed is to determine the amount of energy that is available to cause possible overheating during the operating time of the over-current protective devices.

NOTE 2 This table will be moved into the future revision of IEC 60947-1 and is therefore numbered differently to the other tables in this document.

a. U_{oc} : Output voltage measured with all load circuits disconnected. Voltages are for substantially sinusoidal AC and ripple free DC. For non-sinusoidal AC and for DC with ripple greater than 10 % of the peak, its peak value shall not exceed 42,4 V.

b. I_{sc} : Maximum output current with any non-capacitive load, including a short circuit, measured 60 s after application of the load.

c. S (VA): Maximum output apparent power with any non-capacitive load measured 60 s after application of the load as determined by 9.2.4.

d. Current limiting impedances remain in the circuit during measurement, but over-current protective devices are bypassed.

e. The current ratings of over-current protective devices that break the circuit within 120 s with a current equal to 210 % of the current rating specified in the table.

f. In the USA, the limit is 60 V DC continuous or DC switching outside of 10 Hz to 200 Hz, 24,8 V DC switching at 10 Hz to 200 Hz.