

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Low-voltage switchgear and controlgear –
Part 4-3: Contactors and motor-starters – Semiconductor controllers and
semiconductor contactors for non-motor loads**

**Appareillage à basse tension –
Partie 4-3 : Contacteurs et démarreurs de moteurs – Gradateurs à
semiconducteurs et contacteurs à semiconducteurs pour charges non moteurs**



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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 29.130.20, 31.180

ISBN 978-2-8327-0251-2

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR –**Part 4-3: Contactors and motor-starters –
Semiconductor controllers and semiconductor
contactors for non-motor loads**

FOREWORD

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International Standard IEC 60947-4-3 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 2014. This edition constitutes a technical revision.

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

- a) scope exclusions;
- b) editorial correction of notes and hanging paragraphs;

- c) safety aspects related to:
 - general aspects;
 - limited energy circuits;
 - electronic circuits;
- d) mention of dedicated wiring accessories;
- e) power consumption measurement;
- f) alignment to IEC 60947-1:2020;
- g) alignment with IEC 60947-4-2 when appropriate.

The provisions of the general rules dealt with IEC 60947-1 are applicable to this part of IEC 60947 series where specifically called for. Clauses and subclauses, tables, figures and annexes of the general rules thus applicable are identified by reference to IEC 60947-1:2020.

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

FDIS	Report on voting
121A/357/FDIS	121A/368/RVD

Full information on the voting for the approval of this document 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 parts in the IEC 60947 series, published under the general title *Low-voltage switchgear and controlgear*, can be found on the IEC website.

The following differing practices of a less permanent nature exist in the countries indicated below.

5.5 USA and Canada

8.1.14.1 Canada

Table 14 USA

Table 15 USA

9.4.3.2 USA

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- amended.

INTRODUCTION

This document covers low-voltage semiconductor controllers and semiconductor contactors (solid-state contactors) intended for the use with non-motor loads. As semiconductor controllers, they have many capabilities beyond the simple switching on and off of non-motor loads. As semiconductor contactors, they perform the same functions as mechanical contactors, but utilize one or more semiconductor switching devices in their main poles.

The devices may be single-pole or multi-pole (see 3.5.1 of IEC 60947-1:2020). This document refers to complete devices rated as a unit incorporating all necessary heat-sinking material and terminals. It includes devices with all necessary terminals, which are supplied with or without heat-sink in knocked-down form for combination by the users, when the manufacturer gives with the device detailed information about choosing the heat-sink and mounting the device on the heat-sink.

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LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 4-3: Contactors and motor-starters – Semiconductor controllers and semiconductor contactors for non-motor loads

1 Scope

This document applies to semiconductor controllers and semiconductor contactors for non-motor load intended to be connected to circuits, the rated voltage of which does not exceed 1 000 V AC.

It covers their use:

- for operations of changing the state of AC electric circuits between the ON-state and the OFF-state;
- with or without bypass switching devices;
- as controller, for reducing the amplitude of the RMS AC voltage.

This document does not apply to:

- electromechanical contactors (see IEC 60947-4-1);
- short-circuit protective device associated with semiconductor controllers and semiconductor contactors (see IEC 60947-4-1 (MPSD), IEC 60947-2 and IEC 60947-3);
- semiconductor motor controller or soft-starter equipment (see IEC 60947-4-2);
- semiconductor converters (see IEC 60146 (all parts));
- solid-state relays (see IEC 62314);
- use of the product within explosive atmospheres (see IEC 60079 (all parts));
- software and firmware requirements (see IEC TR 63201);
- cyber security aspects (see IEC TS 63208).

Contactors and control-circuit devices used in semiconductor controllers and contactors are considered compliant with the requirements of their relevant product standard. Where mechanical switching devices are used, they are considered meeting the requirements of their own IEC product standard and the additional requirements of this document.

The object of this document is to state as follows:

- the characteristics of semiconductor controllers and semiconductor contactors;
- the conditions with which semiconductor controllers and semiconductor contactors comply with reference to:
 - a) their operation and behaviour in normal and abnormal operating conditions including overcurrent operating conditions;
 - b) their dielectric properties;
 - c) the degrees of protection provided by their enclosures, where applicable;
 - d) their construction including safety measures against electric shock, fire hazard and mechanical hazard;
- the tests intended for confirming that these conditions have been met, and the methods to be adopted for these tests;
- the information to be given with the equipment or in the manufacturer's literature.

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.

IEC 60445, *Basic and safety principles for man-machine interface, marking and identification – Identification of equipment terminals, conductor terminations and conductors*

IEC 60715, *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 60947-4-1, *Low-voltage switchgear and controlgear – Part 4-1: Contactors and motor-starters – Electromechanical contactors and motor-starters*

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

IEC 61000-3-3, *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 61000-3-11, *Electromagnetic compatibility (EMC) – Part 3-11: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems – Equipment with rated current ≤ 75 A and subject to conditional connection*

IEC 61000-3-12, *Electromagnetic compatibility (EMC) – Part 3-12: Limits – Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current > 16 A and ≤ 75 A per phase*

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

IEC 61140:2016, *Protection against electric shock – Common aspects for installation and equipment*

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

CISPR 11:2015/AMD1:2016

ISO 2859-1:1999, *Sampling procedures for inspection by attributes – Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*

ISO 2859-1:1999/AMD1:2011

3 Terms, definitions, symbols and abbreviated terms

3.1 General

For the purposes of this document, the terms and definitions given in Clause 3 of IEC 60947-1:2020, as well as the following terms, definitions, symbols and abbreviated terms 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 Alphabetical index of terms

Term		Reference
A	Abnormal operating condition	3.5.1
	Accessible part	3.5.2
B	Bypassed semiconductor controller	3.4.18
C	Current-limit function	3.4.1
F	FULL-ON	3.4.6
G	Galvanic opening	3.4.20
	Galvanic separation	3.4.21
H	Hazardous-live-part	3.5.3
I	Instantaneous switching	3.4.9
L	Limited energy source	3.5.4
	Load control	3.4.2
O	OFF-state	3.4.7
	OFF-state current	3.4.8
	OFF-time	3.4.17
	ON-state	3.4.5
	ON-time	3.4.16
	Operating capability	3.4.11
	Operating cycle	3.4.10
	Overcurrent protective means OCPM	3.4.15
Overload current profile	3.4.12	
P	Protective impedance	3.5.5
R	Ramp-down	3.4.4
	Ramp-up	3.4.3
	Rating index	3.4.13
	Reasonably foreseeable misuse	3.5.6
S	Semiconductor controller	3.3.1
	Semiconductor contactor	3.3.2
	Semiconductor controller power losses	3.4.19
	Single fault condition	3.5.7
T	Trip-free semiconductor controller	3.4.14

3.3 Terms and definitions concerning the types of semiconductor controllers and semiconductor contactors (see Figure 1)

3.3.1

semiconductor controller

semiconductor switching device that provides a switching function for an AC electrical load and an OFF-state

Note 1 to entry: Because hazardous levels of the OFF-state current (3.4.8) exist in a semiconductor controller, the load terminals are considered as live parts at all times.

Note 2 to entry: In a circuit where the current passes through zero (alternately or otherwise), the effect of "not making" the current following such a zero value is equivalent to breaking the current.

Note 3 to entry: See 3.4.3 of IEC 60947-1:2020 for the definition of semiconductor switching device.

3.3.2

semiconductor contactor

<solid-state contactor> semiconductor controller, in which the switching function is limited to FULL-ON

Note 1 to entry: A semiconductor contactor can also contain mechanical switching devices.

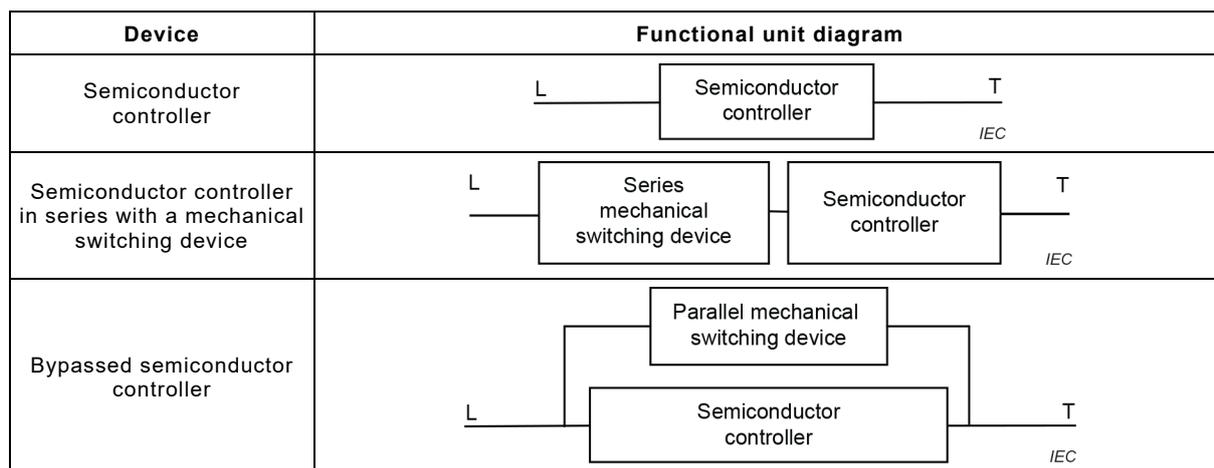


Figure 1 – Semiconductor control devices

3.4 Terms and definitions concerning characteristics of semiconductor controllers and semiconductor contactors

3.4.1

current-limit function

ability of the semiconductor controller to limit the load current to a specified value

Note 1 to entry: It does not include the ability to limit the instantaneous current under conditions of short circuit.

3.4.2

load control

any deliberate operation which causes changes in the effective power available to the load through variation of either

- an imposed operating cycle (i.e. variation of the cyclic duration factor F and/or the number of operating cycles per hour S , see 5.3.4
- or
- the load terminal voltage (for example, through phase-angle control)
- or
- a combination of these

Note 1 to entry: Switch-on is a mandatory form of load control that is recognized separately.

Note 2 to entry: Load control can be performed by semiconductor contactor, if an external switching device or control circuit causes the cyclic transition from the OFF-state to the FULL-ON state and back again (i.e. load control by operating cycle).

3.4.3

ramp-up

switching (switch-on) function which causes the transition from the OFF-state (or from the open state, in the case of a semiconductor controller in series with a mechanical switching device) to the ON-state (i.e. to the FULL-ON state or to a load control operation) over a defined period of time (the ramp-up time)