IEC 60947-4-2

Edition 4.0 2020-06

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Low-voltage switchgear and controlgear –
Part 4-2: Contactors and motor-starters – Semiconductor motor controllers, starters and soft-starters

Appareillage à basse tension –
Partie 4-2: Contacteurs et démarreurs de moteurs – Gradateurs, démarreurs et démarreurs progressifs à semiconducteurs de moteurs

IEC 60947-4-2:2020-06(en-fr)

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LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

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FOREWORD

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International Standard IEC 60947-4-2 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 fourth edition cancels and replaces the third edition published in 2011. This edition constitutes a technical revision.

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

- scope exclusions;
- editorial correction of notes and hanging paragraphs;
- reference to IEC 62683-1;

- safety aspects related to:
  - general aspects;
  - limited energy circuits;
  - electronic circuits;
- mention of dedicated wiring accessories;
- power consumption measurement;
- alignment to IEC 60947-1:2020.

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 standard is based on the following documents:

FDIS	Report on voting
121A/353/FDIS	121A/360/RVD

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

This publication 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.

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

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- withdrawn,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

INTRODUCTION

This document covers low-voltage semiconductor motor controllers, starters and soft-starters that have many capabilities and features beyond the simple starting and stopping of an induction motor, such as controlled starting and stopping, manoeuvring and controlled running.

The generic term “controller” is used in this document wherever reference is made to elements of power semiconductor switching devices.

The generic term “starter” is used in this document wherever reference is made to the elements of power semiconductor switching devices together with suitable overload protective devices.

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 4-2: Contactors and motor-starters – Semiconductor motor controllers, starters and soft-starters

1 Scope

This part of IEC 60947 applies to semiconductor motor controllers, starters and soft-starters which can include a series mechanical switching device, intended to be connected to circuits the rated voltage of which does not exceed 1 000 V AC.

This document characterizes semiconductor motor controllers and starters with and without bypass means.

This document does not apply to:

– semiconductor motor controllers and starters used for continuous operation of AC motors at motor speeds other than the normal speed[1];

– electromechanical contactors and external overload relays (see IEC 60947-4-1);

– short-circuit protective device associated with semiconductor motor controllers and starters (see IEC 60947-4-1 (MPSD), IEC 60947-2 and IEC 60947-3);

– semiconductor equipment, including semiconductor contactors (3.4.13 of IEC 60947-1:2020) controlling non-motor loads (see IEC 60947-4-3);

– semiconductor motor controllers and starters used for rotor circuits[1];

– adjustable speed electrical power drive systems (see IEC 61800 series);

– use of the product within explosive atmospheres (see IEC 60079 series);

– software and firmware requirements[1];

NOTE 1 Guidance on embedded software is given in IEC TR 63201.

– cyber security aspects (see IEC TS 63208).

Contactors, overload relays and control circuit devices used in semiconductor motor controllers and starters 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 motor controllers, starters and soft-starters and associated equipment;

– the conditions with which semiconductor motor controllers, starters and soft-starters 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;

[1] For this subject, the manufacturer is responsible for taking additional safety measures.

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.

NOTE 2 For the purpose of this document, the term "controller" is used instead of "semiconductor motor controller".

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

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 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 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*

3 Terms, definitions, symbols and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in 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:

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

3.1.1 Terms and definitions concerning the types of semiconductor motor controllers and starters

3.1.1.1
semiconductor switching device
switching device designed to make and/or break the current in an electric circuit by means of the controlled conductivity of a semiconductor

Note 1 to entry: This definition differs from IEC 60050-441:1984, 441-14-03 since a semiconductor switching device is also designed for breaking the current.

[SOURCE: IEC 60947-1:2020, 3.4.3, modified – Note 1 to entry added.]

3.1.1.2
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 (3.1.2.12) exist in a semiconductor controller, the load terminals should be 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.

Note 4 to entry: This device can include internal electromechanical switching device(s) bypassing or in series with the semiconductor at the manufacturer's discretion.

3.1.1.3
semiconductor motor controller
semiconductor controller that provides the starting function for an AC motor and an OFF-state

Note 1 to entry: This device can include any starting method specified by the manufacturer, control functions which can have any combination of manoeuvring, controlled acceleration, running or controlled deceleration of an AC motor. A FULL-ON state can also be provided.

Note 2 to entry: See Figure 1.

3.1.1.4
direct-on-line semiconductor motor controller
DOL semiconductor motor controller
semiconductor motor controller, in which the starting function is limited to a full-voltage, unramped starting method only, and where the additional control function is limited to providing FULL-ON

Note 1 to entry: This device can include a very short controlled ramp time of a few cycles which contribute to limit the inrush current of the motor to the level of Table 9.

Note 2 to entry: See Figure 1.

3.1.1.5
semiconductor motor-starter
soft-starter
semiconductor motor controller with suitable overload protection, rated as a unit

Note 1 to entry: The term “soft-starter” is often used on the market to designate a semiconductor motor controller with or without overload protection but, in this document, it is a type of starter which by definition includes an overload protection.

3.1.1.6
direct-on-line semiconductor motor-starter
DOL semiconductor motor-starter
direct-on-line semiconductor motor controller with suitable overload protection, rated as a unit

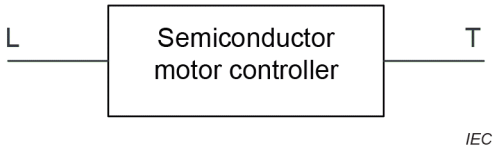
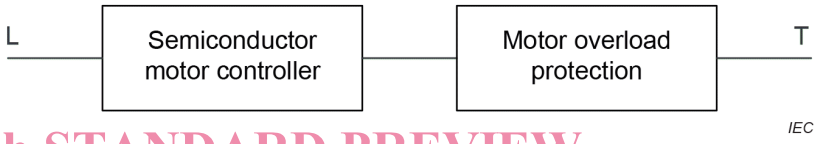
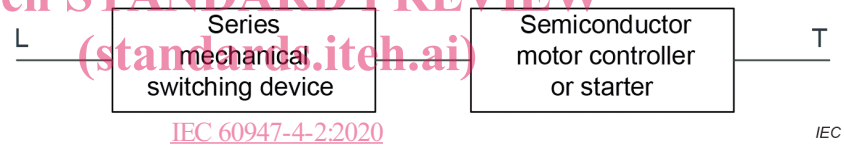
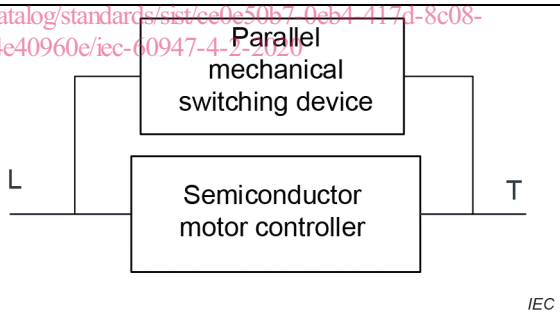
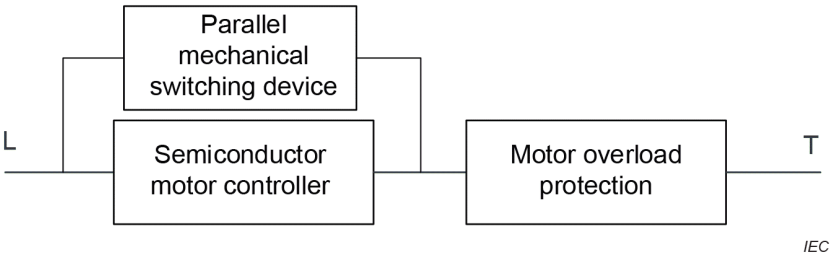
Device	Functional unit diagram
Semiconductor motor controller	
Semiconductor motor-starter	
Semiconductor motor controller or starter in series with a mechanical switching device	
Bypassed semiconductor motor controller	
Bypassed semiconductor motor-starter	

Figure 1 – Semiconductor motor control devices