IEC 60947-4-2

Edition 4.1 2024-11
CONSOLIDATED VERSION

INTERNATIONAL STANDARD

Corrected version
2026-03

colour inside

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



IEC 60947-4-2:2020-06+AMD1:2024-11 CSV(en)

THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2024 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, …). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch
Discover our powerful search engine and read freely all the publications previews, graphical symbols and the glossary. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 500 terminological entries in English and French, with equivalent terms in 25 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC 60947-4-2

Edition 4.1 2024-11
CONSOLIDATED VERSION

INTERNATIONAL STANDARD

Corrected version
2026-03

colour inside

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

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ICS 29.130.20

ISBN 978-2-8327-0000-6

Warning! Make sure that you obtained this publication from an authorized distributor.

® Registered trademark of the International Electrotechnical Commission

CONTENTS

FOREWORD 7
INTRODUCTION 9
1 Scope 10
2 Normative references 11
3 Terms, definitions, symbols and abbreviated terms 12
3.1 Terms and definitions 12
3.1.1 Terms and definitions concerning the types of semiconductor motor controllers and starters 12
3.1.2 Terms and definitions concerning semiconductor motor controllers and starters 14
3.1.3 Terms and definitions concerning safety aspects 17
3.1.4 Alphabetical index of terms 18
3.2 Symbols and abbreviated terms 20
4 Classification 20
5 Characteristics of semiconductor motor controllers and starters 20
5.1 Summary of characteristics 20
5.2 Type of equipment 21
5.2.1 Kind of equipment 21
5.2.2 Number of poles 21
5.2.3 Kind of current 21
5.2.4 Interrupting medium (air, vacuum, etc.) 21
5.2.5 Operating conditions of the equipment 21
5.3 Rated and limiting values for main circuits 22
5.3.1 Rated voltages 22
5.3.2 Currents 24
5.3.3 Rated frequency 25
5.3.4 Duty cycle values and sequences 25
5.3.5 Normal load and overload characteristics 25
5.3.6 Rated conditional short-circuit current 27
5.3.7 Semiconductor motor controller power losses 27
5.4 Utilization category 28
5.4.1 General 28
5.4.2 Assignment of ratings based on the results of tests 28
5.5 Control circuits 29
5.6 Auxiliary circuits 29
5.7 Characteristics of relays and releases (overload relays) 29
5.7.1 Summary of characteristics 29
5.7.2 Types of relay or release 30
5.7.3 Characteristic values 30
5.7.4 Designation and current settings of overload relays 31
5.7.5 Time-current characteristics of overload relays 31
5.7.6 Influence of ambient air temperature 32
5.8 Coordination with short-circuit protective devices (SCPD) 32
6 Product information 32
6.1 Nature of information 32
6.2 Marking 34

6.3 Instructions for installation, operation, maintenance, decommissioning and dismantling 34
6.4 Environmental information 34
7 Normal service, mounting and transport conditions 35
7.1 Normal service conditions 35
7.1.1 Ambient air temperature 35
7.1.2 Altitude 35
7.1.3 Atmospheric conditions 35
7.1.4 Shock and vibrations 35
7.2 Conditions during transport and storage 36
7.3 Mounting 36
7.4 Electrical system disturbances and influences 36
8 Constructional and performance requirements 36
8.1 Constructional requirements 36
8.1.1 General 36
8.1.2 Materials 37
8.1.3 Current-carrying parts and their connections 37
8.1.4 Clearances and creepage distances 37
8.1.5 Actuator 37
8.1.6 Indication of the contact position 37
8.1.7 Additional requirements for equipment suitable for isolation 38
8.1.8 Terminals 38
8.1.9 Additional requirements for equipment provided with a neutral pole 38
8.1.10 Provisions for protective earthing 38
8.1.11 Enclosures for equipment 38
8.1.12 Degrees of protection of enclosed equipment 38
8.1.13 Conduit pull-out, torque and bending with metallic conduits 38
8.1.14 Limited energy source 38
8.1.15 Stored charge energy circuit 41
8.1.16 Fault and abnormal conditions 41
8.1.17 Short-circuit and overload protection of ports 42
8.2 Performance requirements 42
8.2.1 Operating conditions 42
8.2.2 Temperature-rise 46
8.2.3 Dielectric properties 48
8.2.4 Normal load and overload performance requirements 49
8.2.5 Coordination with short-circuit protective devices 54
8.3 EMC requirements 54
8.3.1 General 54
8.3.2 Immunity 55
8.3.3 Emission 57
9 Tests 57
9.1 Kinds of tests 57
9.1.1 General 57
9.1.2 Type tests 57
9.1.3 Routine tests 58
9.1.4 Sampling tests 58
9.1.5 Special tests 58
9.2 Compliance with constructional requirements 59

9.2.1 General 59
9.2.2 Electrical performance of screwless-type clamping units 59
9.2.3 Ageing test for screwless-type clamping units 60
9.2.4 Limited energy source test 60
9.2.5 Breakdown of components 60
9.2.6 Wire flexing test 61
9.2.7 Abnormal operating tests 61
9.3 Compliance with performance requirements 63
9.3.1 Test sequences 63
9.3.2 General test conditions 64
9.3.3 Performance under no load, normal load, and overload conditions 64
9.3.4 Performance under short-circuit conditions 74
9.4 EMC tests 77
9.4.1 General 77
9.4.2 EMC immunity tests 78
9.4.3 EMC emission tests 79
9.5 Routine and sampling tests 82
9.5.1 General 82
9.5.2 Operation and operating limits 82
9.5.3 Dielectric tests 82
Annex A (normative) Marking and identification of terminals 84
A.1 General 84
A.2 Marking and identification of terminals of semiconductor controllers and starters 84
A.2.1 Marking and identification of terminals of main circuits 84
A.2.2 Marking and identification of terminals of control circuits 84
A.3 Marking and identification of terminals of overload relays 84
Annex B (xxx) 85
Annex C (normative) Coordination at the crossover current between the starter and associated SCPD 86
C.1 General and definitions 86
C.1.1 General 86
C.1.2 Terms and definitions 86
C.2 Condition for the test for the verification of coordination at the crossover current by a direct method 86
C.3 Test currents and test circuits 86
C.4 Test procedure and results to be obtained 87
C.4.1 Test procedure 87
C.4.2 Results to be obtained 87
C.5 Verification of coordination at the crossover current by an indirect method for type "2" coordination 87
C.5.1 General 87
C.5.2 Test for I_{cd} 87
C.5.3 Time-current characteristic withstand capability of controllers/starters 88
Annex D (xxx) 90
Annex E (xxx) 91
Annex F (informative) Operating capability 92
Annex G (informative) Rated operational currents and rated operational powers of switching devices for electrical motors 96

G.1 General 96
G.2 Rated operational powers and rated operational currents 96
Annex H (xxx) 100
Annex I (normative) Modified test circuit for short-circuit testing of semiconductor motor controllers and starters 101
Annex J (xxx) 103
Annex K (xxx) 104
Annex L (normative) Examples of overvoltage category reduction 105
L.1 General 105
L.2 Insulation to the surroundings 105
L.2.1 Circuits connected directly to the supply mains 105
L.2.2 Insulation between circuits 106
Annex M (xxx) 110
Annex N (normative) Additional requirements and tests for equipment with protective separation 111
N.1 General 111
N.2 Definitions 111
N.3 Requirements 111
N.3.1 Test method for implementing protective impedance 111
N.3.2 Touch current measurement 112
Bibliography 114

Figure 1 – Semiconductor motor control devices 13
Figure 2 – Connecting methods 24
Figure 3 – Thermal memory test 44
Figure 4 – Multiple of current setting limits for ambient air temperature compensated time-delay overload relays 74
Figure C.1 – Examples of time-current withstand characteristic 89
Figure F.1 – Thermal stability test profile 93
Figure F.2 – Overload capability test profile 94
Figure F.3 – Blocking and commutating capability test profile 95
Figure I.1 – Modified circuit for short-circuit testing of semiconductor devices 101
Figure I.2 – Time line for the short-circuit test of 9.3.4.1.6 102
Figure L.1 – Basic insulation evaluation for circuits connected directly to the origin of the installation mains supply 105
Figure L.2 – Basic insulation evaluation for circuits connected directly to the mains supply 106
Figure L.3 – Basic insulation evaluation for equipment not permanently connected to the mains supply 106
Figure L.4 – Basic insulation evaluation for insulation between circuits connected directly to the origin of the installation mains supply and that are declared galvanically separated 107
Figure L.5 – Basic insulation evaluation for insulation between circuits connected directly to the mains supply and that are declared galvanically separated 107
Figure L.6 – Basic insulation evaluation for insulation between circuits not permanently connected directly to the mains supply and that are declared galvanically separated 108

Figure L.7 – Basic insulation evaluation for insulation between circuits connected directly to the origin of the installation mains supply and that are declared galvanically separated where internal SPDs are used 108

Figure L.8 – Basic insulation evaluation for insulation between circuits connected directly to the mains supply and that are declared galvanically separated where internal SPDs are used 109

Figure L.9 – Basic insulation evaluation for insulation between circuits connected directly to the mains supply and that are declared galvanically separated 109

Figure N.1 – Protection by means of protective impedance 112

Figure N.2 – Measuring instrument 113

Table 1 – Utilization categories 28

Table 2 – Relative levels of severity 29

Table 3 – Trip classes of overload relays 31

Table 19 – Limits for limited energy sources without an over-current protective device 39

Table 20 – Limits for limited energy sources with an over-current protective device 40

Table 21 – Limits for limited energy source with current limiting impedance 40

Table 4 – Limits of operation of time-delay overload relays when energized on all poles 44

Table 5 – Limits of operation of three-pole time-delay overload relays when energized on two poles only 45

Table 6 – Temperature-rise limits for insulated coils in air and in oil 47

Table 7 – Minimum overload current withstand time (T_X) in relation to overload current ratio (X) and corresponding to overload relay trip class (see Table 3) 49

Table 8 – Minimum requirements for thermal stability test conditions 50

Table 9 – Prospective locked rotor current by utilization categories 51

Table 10 – Minimum requirements for overload capability test conditions 51

Table 11 – Making and breaking capacity test; making and breaking conditions according to utilization categories for the mechanical switching device 53

Table 12 – Conventional operational performance making and breaking conditions according to utilization categories for the mechanical switching device 53

Table 13 – Specific performance criteria when EM disturbances are present 56

Table 14 – Thermal stability test specifications 68

Table 15 – Initial case temperature requirements 69

Table 16 – Minimum requirements and conditions for performance testing with an induction motor load 71

Table 17 – Terminal disturbance voltage limits for conducted radio-frequency emission (AC mains power port) 81

Table 18 – Radiated emissions test limits 82

Table A.1 – Main circuit terminal markings 84

Table C.1 – Test conditions 88

Table G.1 – Rated operational powers and rated operational currents of motors 97

Table L.1 – Drawing keys 105

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

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

AMENDMENT 1

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.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at https://patents.iec.ch [and/or] www.iso.org/patents. IEC shall not be held responsible for identifying any or all such patent rights.

This consolidated version of the official IEC Standard and its amendment has been prepared for user convenience.

IEC 60947-4-2 edition 4.1 contains the fourth edition (2020-06) [documents 121A/353/FDIS and 121A/360/RVD], its amendment 1 (2024-11) [documents 121A/615/FDIS and 121A/626/RVD] and its corrigendum 1 (2026-03).

In this Redline version, a vertical line in the margin shows where the technical content is modified by amendment 1. Additions are in green text, deletions are in strikethrough

red text. A separate Final version with all changes accepted is available in this publication.

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.

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 document and its amendment will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

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.

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 60445:2021, *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*

IEC 63404:2024, *Switchgear and controlgear and their assemblies for low voltage – Integration of radiocommunication device above 380 MHz into an equipment*

IEC TS 63058, *Environmental aspects for low-voltage switchgear and controlgear and their assemblies*

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

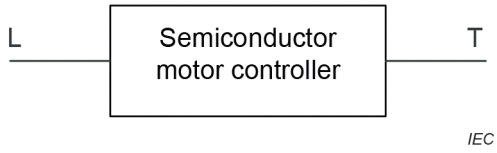
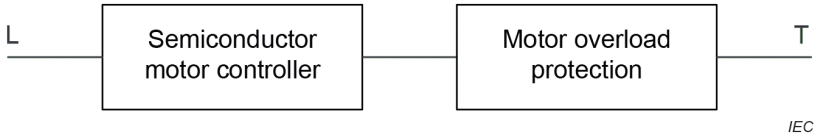
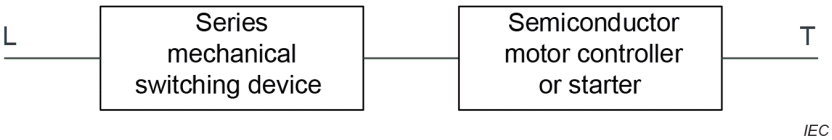
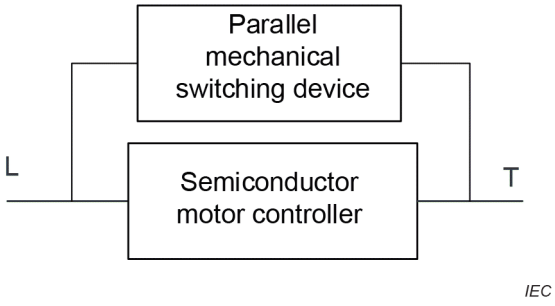
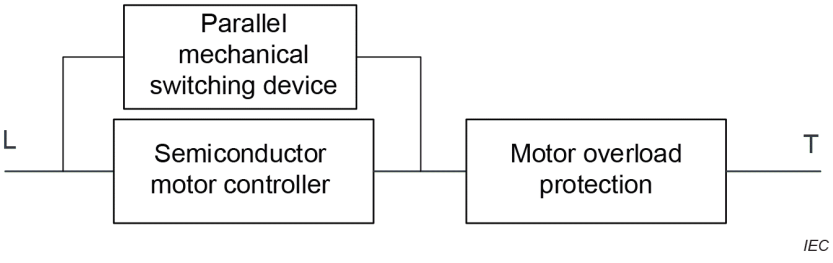
Device	Functional unit diagram
Semiconductor motor controller	
Semiconductor motor-starter	
Semiconductor motor controller or starter in series with a mechanical switching device	
Bypassed semiconductor motor controller	
Bypassed semiconductor motor-starter	

Figure 1 – Semiconductor motor control devices

3.1.2 Terms and definitions concerning semiconductor motor controllers and starters

3.1.2.1
current-limit function
ability of the controller to limit the motor current to a specified value

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

3.1.2.2
manoeuvre
any deliberate operation that causes current changes which shall be characterized and controlled (for example jogging, braking)

Note 1 to entry: Starting is a mandatory manoeuvre that is recognized separately.

Note 2 to entry: Braking operations performed by the semiconductor motor controller or starter are considered to be a manoeuvre within the scope of this document.

3.1.2.3
controlled acceleration
control of motor performance while increasing motor speed by acting on the motor supply

3.1.2.4
controlled deceleration
control of motor performance while decreasing motor speed by acting on the motor supply

3.1.2.5
controlled running
control of motor performance by acting on the motor supply while the motor is running at normal speed (for example, energy saving)

3.1.2.6
prospective current
<circuit with respect to a switching device or a fuse> current that would flow in the circuit if each pole of the switching device or the fuse were replaced by a conductor of negligible impedance

Note 1 to entry: The method to be used to evaluate and to express the prospective current is to be specified in the relevant product standard.

[SOURCE: IEC 60947-1:2020, 3.7.5]

3.1.2.7
prospective locked rotor current
I_{LRP}
prospective current that would flow when the rated voltage is applied to the motor with a locked rotor

Note 1 to entry: The test current of I_{LRP} for overload capability is given by Table 9.

3.1.2.8
ON-state
the condition of a controller when the conduction current can flow through its main circuit

3.1.2.9
FULL-ON
<state of controllers> condition of a controller when the controlling functions are set to provide normal full voltage excitation to the load

3.1.2.10
minimum load current
minimum operational current in the main circuit which is necessary for correct action of a controller in the ON-state

Note 1 to entry: The minimum load current is given as the RMS value.

3.1.2.11
OFF-state
the condition of a controller when no control signal is applied, and no current exceeding the OFF-state current flows through the main circuit

3.1.2.12
OFF-state current
the current which flows through the main circuit of a controller in the OFF-state

3.1.2.13
operation
<controller> transition from the ON-state to the OFF-state, or the reverse

3.1.2.14
operating cycle
<controller> succession of operations from one state to the other and back to the first state

Note 1 to entry: A succession of operations not forming an operating cycle is referred to as an operating series.

3.1.2.15
operating capability
under prescribed conditions, the ability to perform a series of operating cycles without failure

3.1.2.16
overload current profile
current-time co-ordinate specifying the requirement to accommodate overload currents for a period of time

Note 1 to entry: See 5.3.5.2.

3.1.2.17
rating index
rating information organized in a prescribed format, unifying rated operational current and the corresponding utilization category, overload current profile, and the duty cycle or OFF-time

Note 1 to entry: See 6.1 e).

3.1.2.18
tripping operation
<of a motor controller or starter> operation to establish and maintain an OFF-state (or open position in the case of series mechanical switching device) initiated by a control signal

3.1.2.19
phase loss sensitive overload relay or release
multipole overload relay or release which operates in case of overload and also in case of loss of phase in accordance with specified requirements

3.1.2.20
under-current relay or release
measuring relay or release which operates automatically when the current through it is reduced below a predetermined value

3.1.2.21
under-voltage relay or release
measuring relay or release which operates automatically when the voltage applied to it is reduced below a predetermined value

3.1.2.22
stall sensitive electronic overload relay
electronic overload relay 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 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.

3.1.2.23
jam sensitive electronic overload relay
electronic overload relay 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 run in accordance with specified requirements

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

3.1.2.24
inhibit time
time-delay period during which the tripping function of the relay is inhibited (may be adjustable)

3.1.2.25
ON-time
period of time during which the controller is on-load

Note 1 to entry: See the example in Figure F.1.

3.1.2.26
OFF-time
period of time during which the controller is off-load

Note 1 to entry: See the example in Figure F.1.

3.1.2.27
bypassed semiconductor motor controller
bypassed semiconductor motor-starter
equipment wherein the main circuit contacts of a mechanical switching device are connected in parallel with the main circuit terminals of a semiconductor switching device, and wherein the operating means of the two switching devices are co-ordinated, tested and rated as a unit

Note 1 to entry: See rows 4 and 5 of Figure 1.

3.1.2.28
CO operation
breaking of the circuit by the SCPD resulting from closing the circuit by the equipment under test

3.1.2.29
O operation
breaking of the circuit by the SCPD resulting from closing the circuit on the equipment under test which is in the closed position

3.1.2.30
semiconductor motor controller power losses
power consumed by the semiconductor motor controller or starter at FULL-ON at the maximum power rating

3.1.2.31
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 a opto-coupler.

[SOURCE: IEC 60050-151:2001-07, 151-12-26]

3.1.3 Terms and definitions concerning safety aspects

3.1.3.1
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.

3.1.3.2
accessible part
part which can be touched by means of the standard test finger

[SOURCE: IEC 60050-442:1998-11, 442-01-15, modified – removal of “a” at the beginning]

3.1.3.3
hazardous-live-part
live part which, under certain conditions, can give a harmful electric shock

[SOURCE: IEC 60050-195:1998-08, 195-06-05]

3.1.3.4
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

3.1.3.5
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]

3.1.3.6
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 – Deletion of Notes to entry]

3.1.3.7
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 104:2019-07, 3.8]

3.1.4 Alphabetical index of terms

Reference

A

abnormal operating condition 3.1.3.1
accessible part 3.1.3.2

B

bypassed semiconductor motor controller 3.1.2.27
bypassed semiconductor motor-starter 3.1.2.27

C

CO operation 3.1.2.28
controlled acceleration 3.1.2.3
controlled deceleration 3.1.2.4
controlled running 3.1.2.5
current-limit function 3.1.2.1

D

direct-on-line semiconductor motor controller 3.1.1.4
DOL semiconductor motor controller 3.1.1.4
direct-on-line semiconductor motor-starter 3.1.1.6
DOL semiconductor motor-starter 3.1.1.6

F

FULL-ON 3.1.2.9

G

galvanic separation 3.1.2.31

H

hazardous-live part 3.1.3.3

I

inhibit time 3.1.2.24

J

jam sensitive electronic overload relay 3.1.2.23

L

limited energy source 3.1.3.4

M

manoeuvre 3.1.2.2
minimum load current 3.1.2.10