

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Low-voltage switchgear and controlgear –
Part 4-2: Contactors and motor-starters – AC semiconductor motor controllers
and starters

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



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IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

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CONTENTS

FOREWORD.....	6
INTRODUCTION.....	8
1 Scope.....	9
2 Normative references	10
3 Terms, definitions, symbols and abbreviations.....	10
3.1 General.....	10
3.2 Alphabetical index of terms	10
3.3 Terms and definitions concerning a.c. semiconductor motor controllers and starters.....	12
3.4 Terms and definitions concerning hybrid motor controllers and starters.....	14
3.5 Terms and definitions concerning EMC definitions.....	18
3.6 Symbols and abbreviations.....	19
4 Classification.....	19
5 Characteristics of a.c. semiconductor motor controllers and starters.....	20
5.1 Summary of characteristics	20
5.2 Type of equipment.....	20
5.2.1 Form of equipment	20
5.2.2 Number of poles.....	20
5.2.3 Kind of current.....	20
5.2.4 Interrupting medium (air, vacuum, etc.).....	20
5.2.5 Operating conditions of the equipment.....	20
5.3 Rated and limiting values for main circuits.....	21
5.3.1 Rated voltages	21
5.3.2 Currents	23
5.3.3 Rated frequency	23
5.3.4 Rated duty.....	23
5.3.5 Normal load and overload characteristics	24
5.3.6 Rated conditional short-circuit current	25
5.4 Utilization category.....	25
5.4.1 General	25
5.4.2 Assignment of ratings based on the results of tests	26
5.5 Control circuits	27
5.6 Auxiliary circuits	27
5.7 Characteristics of relays and releases (overload relays).....	27
5.7.1 Summary of characteristics.....	28
5.7.2 Types of relay or release	28
5.7.3 Characteristic values	28
5.7.4 Designation and current settings of overload relays.....	29
5.7.5 Time-current characteristics of overload relays.....	29
5.7.6 Influence of ambient air temperature	30
5.8 Co-ordination with short-circuit protective devices (SCPD)	30
6 Product information	30
6.1 Nature of information.....	30
6.2 Marking.....	31
6.3 Instructions for installation, operation, and maintenance	31
7 Normal service, mounting and transport conditions.....	32

IEC STANDARD PREVIEW
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IEC 60947-4-2:2011
<https://standards.iteh.ai/catalog/standards/sist/a3ab5ee1-143f-4168-adf1-f70555d0e637/iec-60947-4-2-2011>

7.1	Normal service conditions	32
7.1.1	Ambient air temperature	32
7.1.2	Altitude	32
7.1.3	Atmospheric conditions	32
7.1.4	Shock and vibrations	32
7.2	Conditions during transport and storage	32
7.3	Mounting	32
7.4	Electrical system disturbances and influences	32
8	Constructional and performance requirements	33
8.1	Constructional requirements	33
8.1.1	General	33
8.1.2	Materials	33
8.1.3	Current-carrying parts and their connections	33
8.1.4	Clearances and creepage distances	33
8.1.5	Actuator	33
8.1.6	Indication of the contact position	33
8.1.7	Additional requirements for equipment suitable for isolation	33
8.1.8	Terminals	33
8.1.9	Additional requirements for equipment provided with a neutral pole	34
8.1.10	Provisions for protective earthing	34
8.1.11	Enclosures for equipment	34
8.1.12	Degrees of protection of enclosed equipment	34
8.1.13	Conduit pull-out, torque and bending with metallic conduits	34
8.2	Performance requirements	34
8.2.1	Operating conditions	34
8.2.2	Temperature rise	38
8.2.3	Dielectric properties	41
8.2.4	Normal load and overload performance requirements	42
8.2.5	Co-ordination with short-circuit protective devices	47
8.3	EMC requirements	47
8.3.1	General	47
8.3.2	Emission	48
8.3.3	Immunity	48
9	Tests	50
9.1	Kinds of tests	50
9.1.1	General	50
9.1.2	Type tests	50
9.1.3	Routine tests	50
9.1.4	Sampling tests	50
9.1.5	Special tests	51
9.2	Compliance with constructional requirements	51
9.3	Compliance with performance requirements	51
9.3.1	Test sequences	51
9.3.2	General test conditions	52
9.3.3	Performance under no load, normal load, and overload conditions	52
9.3.4	Performance under short-circuit conditions	62
9.3.5	EMC tests	65
9.3.6	Routine and sampling tests	68
Annex A	(normative) Marking and identification of terminals	70

Annex B Vacant	73
Annex C (normative) Co-ordination at the crossover current between the starter and associated SCPD	74
Annex D Vacant	78
Annex E Vacant	79
Annex F (informative) Operating capability	80
Annex G (informative) Examples of control circuit configurations	83
Annex H Vacant	85
Annex I (normative) Modified test circuit for short-circuit testing of semiconductor motor controllers and starters	86
Annex J (informative) Flowchart for constructing bypassed semiconductor controllers tests	88
Annex K (normative) Extended functions within electronic overload relays	89
Bibliography	94
Figure 1 – Semiconductor motor control devices	13
Figure 2 – Connecting methods	22
Figure 3 – Thermal memory test	36
Figure 4 – Multiple of current setting limits for ambient air temperature compensated time-delay overload relays	62
Figure C.1 – Examples of time-current withstand characteristic	77
Figure F.1 – Thermal stability test profile	80
Figure F.2 – Overload capability test profile	81
Figure F.3 – Blocking and commutating capability test profile	82
Figure G.1 – Diagrammatic representation of an ECD	83
Figure G.2 – Single supply and control input	83
Figure G.3 – Single supply and control input	84
Figure G.4 – Controllers with an internal control supply and control input only	84
Figure I.1 – Modified circuit for short-circuit testing of semiconductor devices	86
Figure I.2 – Time line for the short-circuit test of 9.3.4.1.6	87
Figure K.1 – Test circuit for the verification of the operating characteristic of a residual current electronic overload relay	93
Table 1 – Functional possibilities of semiconductor motor control devices	14
Table 2 – Utilization categories	26
Table 3 – Relative levels of severity	27
Table 4 – Trip classes of overload relays	29
Table 5 – Limits of operation of time-delay overload relays when energized on all poles	35
Table 6 – Limits of operation of three-pole time-delay overload relays when energized on two poles only	37
Table 7 – Temperature rise limits for insulated coils in air and in oil	40
Table 8 – Intermittent duty test cycle data	40
Table 9 – Minimum overload current withstand time (T_x) in relation to overload current ratio (X) and corresponding to overload relay trip class (see Table 19)	43
Table 10 – Minimum requirements for thermal stability test conditions ^a	43

Table 11 – Minimum requirements for overload capability test conditions.....	44
Table 12 – Minimum requirements and conditions for performance testing with an induction motor load	44
Table 13 – Making and breaking capacity test; making and breaking conditions according to utilization categories for the mechanical switching device of hybrid motor controllers H1, H2, H3 and for certain forms of bypassed controllers	46
Table 14 – Conventional operational performance making and breaking conditions according to utilization categories for the mechanical switching device of hybrid motor controllers H1B, H2B, H3B and for certain forms of bypassed controllers.....	46
Table 15 – Specific acceptance or performance criteria when EM disturbances are present	49
Table 16 – Thermal stability test specifications	57
Table 17 – Initial case temperature requirements.....	57
Table 18 – Blocking and commutating capability test specifications	59
Table 19 – Terminal disturbance voltage limits for conducted radio-frequency emission	67
Table 20 – Radiated emissions test limits	67
Table A.1 – Main circuit terminal markings.....	70
Table C.1 – Test conditions	76
Table K.1 – Operating time of residual current electronic overload relays	90

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[IEC 60947-4-2:2011](https://standards.iteh.ai/catalog/standards/sist/a3ab5ee1-143f-4168-adf1-f70bbbd0e637/iec-60947-4-2-2011)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

**Part 4-2: Contactors and motor-starters –
AC semiconductor motor controllers and starters**

FOREWORD

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International Standard IEC 60947-4-2 has been prepared by subcommittee 17B: Low-voltage switchgear and controlgear, of IEC technical committee 17: Switchgear and controlgear.

This third edition replaces the second edition published in 1999 and its Amendments 1 (2001) and 2 (2006). It is a technical revision.

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

- updated EMC normative references and associated requirements,
- new references to IEC 60947-1,
- marking of electronic relays without thermal memory,
- marking of tripping time at 0 °C ambient or below,
- new test requirements for limits of operation of time-delay overload relays,

- new classes of overload current withstand time,
- damp heat, salt mist, vibration and shock tests,
- short-circuit test in the smallest enclosure,
- update of the routine and sampling tests.

This standard shall be read in conjunction with IEC 60947-1:2007, *Low-voltage switchgear and controlgear – Part 1: General rules*. The provisions of the general rules are applicable to this standard, where specifically called for.

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

FDIS	Report on voting
17B/1734/FDIS	17B/1741/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

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

The contents of the corrigendum of July 2012 have been included in this copy.

INTRODUCTION

This standard covers low-voltage a.c. semiconductor motor controllers and 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 standard wherever the unique features of the power semiconductor switching elements are the most significant points of interest. The generic term “starter” is used wherever the consequences of operating the power semiconductor switching elements, together with suitable overload protective means, are the most significant points of interest. Specific designations (for example form 1, form HxB, etc.) are used wherever the unique features of various configurations comprise significant points of interest.

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LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 4-2: Contactors and motor-starters – AC semiconductor motor controllers and starters

1 Scope

This standard applies to a.c. semiconductor motor controllers and starters, which may include a series mechanical switching device, intended to be connected to circuits, the rated voltage of which does not exceed 1 000 V a.c.

This standard characterizes a.c. semiconductor motor controllers and starters with and without bypass means.

AC semiconductor motor controllers and starters dealt with in this standard are not normally designed to interrupt short-circuit currents. Therefore, suitable short-circuit protection (see 8.2.5) should form part of the installation, but not necessarily of the a.c. semiconductor motor controller or starter.

In this context, this standard gives requirements for a.c. semiconductor motor controllers and starters associated with separate short-circuit protective devices.

This standard does not apply to

- continuous operation of a.c. motors at motor speeds other than the normal speed;
- semiconductor equipment, including semiconductor contactors (see 2.2.13 of IEC 60947-1:2007) controlling non-motor loads;
- electronic a.c. power controllers covered by IEC 60146 series.

Contactors, overload relays and control circuit devices used in a.c. semiconductor motor controllers and starters should comply with the requirements of their relevant product standard. Where mechanical switching devices are used, they should meet the requirements of their own IEC product standard, and the additional requirements of this standard.

The object of this standard is to state as follows:

- the characteristics of a.c. semiconductor motor controllers and starters and associated equipment;
- the conditions with which a.c. semiconductor motor controllers and starters comply with reference to
 - a) their operation and behaviour;
 - b) their dielectric properties;
 - c) the degrees of protection provided by their enclosures where applicable;
 - d) their construction;
- 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 For the purpose of this standard, the term "controller" may be used instead of "a.c. semiconductor motor controller".

2 Normative references

The following referenced documents are indispensable for the application 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 60034-1:2010, *Rotating electrical machines – Part 1: Rating and performance*

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

IEC 60269-1:2006, *Low-voltage fuses – Part 1: General requirements*
Amendment 1 (2009)

IEC 60410:1973, *Sampling plans and procedures for inspection by attributes*

IEC 60664 (all parts), *Insulation coordination for equipment within low-voltage systems*

IEC 60947-1:2007, *Low-voltage switchgear and controlgear – Part 1: General rules*

IEC 61000-4 (all parts), *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques*

CISPR 11:2009, *Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement*
Amendment 1 (2010)

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3 Terms, definitions, symbols and abbreviations

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3.1 General

For the purposes of this document, the terms and definitions of Clause 2 of IEC 60947-1:2007, as well as the following terms, definitions, symbol and abbreviations apply.

3.2 Alphabetical index of terms

	Reference
A	
a.c. semiconductor motor controller	3.3.2
B	
burst (of pulses or oscillations)	3.5.7
bypassed controller.....	3.4.31
C	
CO operation	3.4.32
controlled acceleration	3.4.6
controlled deceleration.....	3.4.7
controlled running	3.4.8
current-limit function	3.4.4
E	
electromagnetic compatibility [EMC]	3.5.1
electromagnetic disturbance	3.5.3
electromagnetic emission.....	3.5.2

F	
FULL-ON (state of controllers)	3.4.12
H	
hybrid motor controller or starter, form HxA (where x = 1, 2 or 3)	3.4.1
hybrid motor controller or starter, form HxB	3.4.2
I	
inhibit time	3.4.28
J	
jam sensitive electronic overload relay	3.4.27
M	
manoeuvre	3.4.5
minimum load current	3.4.13
O	
O operation	3.4.33
OFF-state	3.4.14
OFF-state leakage current [I_L]	3.4.15
OFF-time	3.4.30
ON-state	3.4.11
ON-time	3.4.29
OPEN position	3.4.3
operating capability	3.4.18
operating cycle (of a controller)	3.4.17
operation (of a controller)	3.4.16
overload current profile	3.4.19
R	
phase loss sensitive overload relay or release	3.4.23
prospective current (of a circuit and with respect to a switching device or a fuse)	3.4.9
prospective locked rotor current [I_{LRP}]	3.4.10
S	
semiconductor direct on line (DOL) motor controller (form 3)	3.3.5
semiconductor motor controller (form 1)	3.3.3
semiconductor motor starter (form 1, form 2, form 3)	3.3.6
semiconductor soft-start motor controller (form 2)	3.3.4
semiconductor switching device	3.3.1
stall sensitive electronic overload relay	3.4.26
T	
transient (adjective and noun)	3.5.6
trip-free controller or starter	3.4.22
tripping operation (of a controller or starter)	3.4.21
U	
under-current relay or release	3.4.24
under-voltage relay or release	3.4.25

V

voltage surge 3.5.8

3.3 Terms and definitions concerning a.c. semiconductor motor controllers and starters

3.3.1

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

[IEC 60947-1:2007, 2.2.3]

3.3.2

a.c. semiconductor motor controller

semiconductor switching device that provides the starting function for an a.c. motor and an OFF-state

NOTE 1 Because dangerous levels of leakage currents can exist in a semiconductor motor controller in the OFF-state, the load terminals should be considered as live parts at all times.

NOTE 2 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.

3.3.3

semiconductor motor controller (form 1)

a.c. semiconductor motor controller, in which the starting function may comprise any starting method specified by the manufacturer, and that provides control functions which may include any combination of manoeuvring, controlled acceleration, running or controlled deceleration of an a.c. motor. A FULL-ON state may also be provided

NOTE See Figure 1 and Table 1.

3.3.4

semiconductor soft-start motor controller (form 2)

special form of a.c. semiconductor motor controller, in which the starting function is limited to a voltage and/or current ramp which may include controlled acceleration, and where the additional control function is limited to providing FULL-ON

NOTE See Figure 1 and Table 1.

3.3.5

semiconductor direct on line (DOL) motor controller (form 3)

special form of a.c. 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 See Figure 1 and Table 1.

3.3.6

semiconductor motor starter (form 1, form 2, form 3)

a.c. semiconductor motor controller with suitable overload protection, rated as a unit

NOTE See Figure 1 and Table 1.

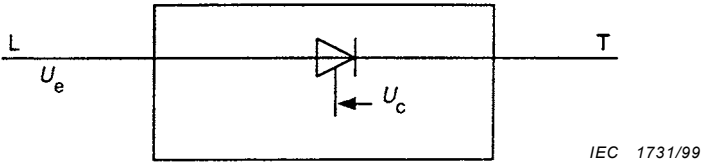
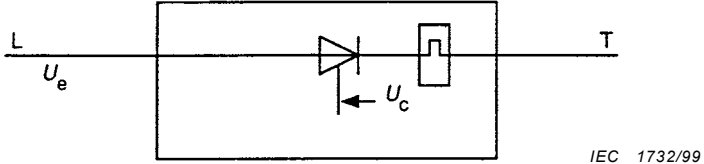
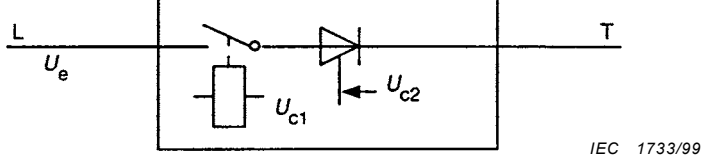
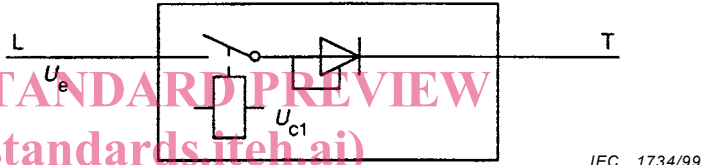
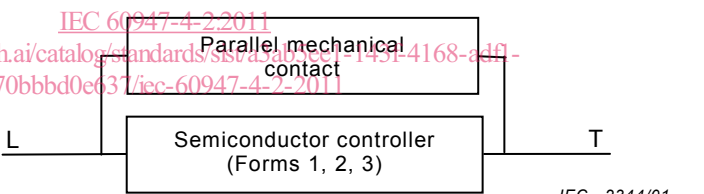
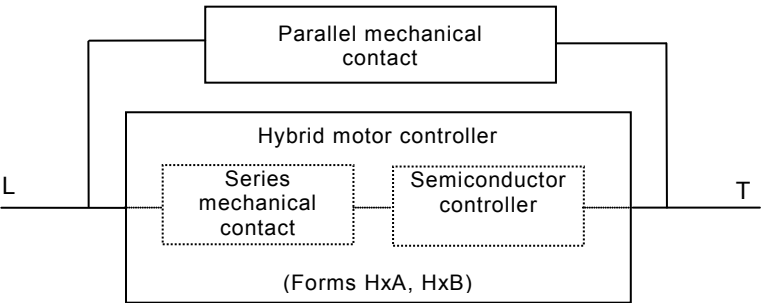
<p>Device</p>			
<p>Semiconductor motor controller (forms 1, 2, 3)</p>			
<p>Semiconductor motor starter (forms 1, 2, 3)</p>			
<p>Hybrid motor controller HxA^a where x = 1, 2 or 3</p>			
<p>Hybrid motor controller HxB^b</p>			
<p>Bypassed controller</p>			
<p>Bypassed hybrid motor controller^c</p>			
<p>Hybrid motor starter</p>	<p>Form H1A or H1B with motor overload protection</p>	<p>Form H2A or H2B with motor overload protection</p>	<p>Form H3A or H3B with motor overload protection</p>
<p>^a Two separate controls for the controller and the series mechanical switching device. ^b One control only for the series mechanical switching device. ^c For other configurations, tests may be suitably adapted by agreement between the user and the manufacturer.</p>			

Figure 1 – Semiconductor motor control devices