

**Madalpingelised lülitus- ja juhtimisaparaadid. Osa 4-2:
Kontaktorid ja mootorikäivited. Vahelduvvoolu pooljuht-
mootorikontrollerid ja -käivited**

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

EESTI STANDARDI EESSÕNA

NATIONAL FOREWORD

See Eesti standard EVS-EN 60947-4-2:2012 sisaldab Euroopa standardi EN 60947-4-2:2012 ingliskeelset teksti.	This Estonian standard EVS-EN 60947-4-2:2012 consists of the English text of the European standard EN 60947-4-2:2012.
Standard on jõustunud sellekohase teate avaldamisega EVS Teatajas.	This standard has been endorsed with a notification published in the official bulletin of the Estonian Centre for Standardisation.
Euroopa standardimisorganisatsioonid on teinud Euroopa standardi rahvuslikele liikmetele kättesaadavaks 29.06.2012.	Date of Availability of the European standard is 29.06.2012.
Standard on kättesaadav Eesti Standardikeskusest.	The standard is available from the Estonian Centre for Standardisation.

Tagasisidet standardi sisu kohta on võimalik edastada, kasutades EVS-i veebilehel asuvat tagasiside vormi või saates e-kirja meiliaadressile standardiosakond@evs.ee.

ICS 29.130.20

Võtmesõnad: contactors and motor-starters, low-voltage switchgear and controlgear, semiconductor motor controllers and starters,

Standardite reprodutseerimise ja levitamise õigus kuulub Eesti Standardikeskusele

Andmete paljundamine, taastekitamine, kopeerimine, salvestamine elektroonsesse süsteemi või edastamine ükskõik millises vormis või millisel teel ilma Eesti Standardikeskuse kirjaliku loata on keelatud.

Kui Teil on küsimusi standardite autorikaitse kohta, võtke palun ühendust Eesti Standardikeskusega:
Aru 10, 10317 Tallinn, Eesti; www.evs.ee; telefon 605 5050; e-post info@evs.ee

The right to reproduce and distribute standards belongs to the Estonian Centre for Standardisation

No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying, without a written permission from the Estonian Centre for Standardisation.

If you have any questions about copyright, please contact Estonian Centre for Standardisation:
Aru 10, 10317 Tallinn, Estonia; www.evs.ee; phone 605 5050; e-mail info@evs.ee

English version

**Low-voltage switchgear and controlgear -
Part 4-2: Contactors and motor-starters -
AC semiconductor motor controllers and starters
(IEC 60947-4-2:2011)**

Appareillage à basse tension -
Partie 4-2: Contacteurs et démarreurs de
moteurs -
Gradateurs et démarreurs à
semiconducteurs de moteurs à courant
alternatif
(CEI 60947-4-2:2011)

Niederspannungsschaltgeräte -
Teil 4-2: Schütze und Motorstarter -
Halbleiter-Motor-Steuergeräte und -Starter
für Wechselspannungen
(IEC 60947-4-2:2011)

This European Standard was approved by CENELEC on 2011-06-22. 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.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

CENELEC

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

Management Centre: Avenue Marnix 17, B - 1000 Brussels

Foreword

The text of document (17B/1734/FDIS), future edition 3 of IEC 60947-4-2, prepared by SC 17B, "Low-voltage switchgear and controlgear", of IEC TC 17, "Switchgear and controlgear", was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 60947-4-2:2012.

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) 2012-12-29
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2014-06-22

This European Standard supersedes EN 60947-4-2:2000 + A1:2002 + A2:2006.

EN 60947-4-2:2012 includes the following significant technical changes with respect to EN 60947-4-2:2000 + A1:2002 + A2:2006:

- updated EMC normative references and associated requirements,
- new references to EN 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.

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

This standard shall be read in conjunction with EN 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.

This standard covers the Principle Elements of the Safety Objectives for Electrical Equipment Designed for Use within Certain Voltage Limits (LVD - 2006/95/EC).

This document has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For the relationship with EU Directive(s) see informative Annex ZZ, which is an integral part of this document.

Endorsement notice

The text of the International Standard IEC 60947-4-2:2011 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 standards indicated:

IEC 60146 series	NOTE Harmonized in EN 60146 series (not modified).
IEC 60255 series	NOTE Harmonized in EN 60255 series (partially modified).
IEC 60947-5 series	NOTE Harmonized in EN 60947-5 series (partially modified).
IEC 61000-3-2:2005 + A1: 2008 + A2: 2009	NOTE Harmonized as EN 61000-3-2:2006 + A1:2009 + A2:2009 (not modified).
IEC 61000-4-2:2008	NOTE Harmonized as EN 61000-4-2:2009 (not modified).
IEC 61000-4-3:2006 + A1: 2007 + A2: 2010	NOTE Harmonized as EN 61000-4-3:2006 + A1:2008 + A2:2010 (not modified).
IEC 61000-4-4:2004 + A1: 2010	NOTE Harmonized as EN 61000-4-4:2004 + A1:2010 (not modified).
IEC 61000-4-5:2005	NOTE Harmonized as EN 61000-4-5:2006 (not modified).
IEC 61000-4-6:2008	NOTE Harmonized as EN 61000-4-6:2009 (not modified).
IEC 61000-4-11:2004	NOTE Harmonized as EN 61000-4-11:2004 (not modified).
IEC 61131-2:2007	NOTE Harmonized as EN 61131-2:2007 (not modified).

Preview generated by EVS

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60034-1 (mod)	2010	Rotating electrical machines - Part 1: Rating and performance	EN 60034-1 + corr. October	2010 2010
IEC 60085	2007	Electrical insulation - Thermal evaluation and designation	EN 60085	2008
IEC 60269-1 + A1	2006 2009	Low-voltage fuses - Part 1: General requirements	EN 60269-1 + A1	2007 2009
IEC 60410	1973	Sampling plans and procedures for inspection by attributes	-	-
IEC 60664	Series	Insulation coordination for equipment within low-voltage systems	EN 60664	Series
IEC 60947-1	2007	Low-voltage switchgear and controlgear - Part 1: General rules	EN 60947-1	2007
IEC 61000-4	Series	Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques -	EN 61000-4	Series
CISPR 11 (mod) + A1	2009 2010	Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement	EN 55011 + A1	2009 2010

Annex ZZ
(informative)

Coverage of Essential Requirements of EU Directives

This European Standard has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association and within its scope the standard covers all relevant essential requirements as given in Article 1 of Annex I of the Directive 2004/108/EC.

Compliance with this standard provides one means of conformity with the specified essential requirements of the Directive concerned.

WARNING - Other requirements and other EU Directives may be applicable to the products falling within the scope of this standard.

This document is a preview generated by EVS

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

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

preview generated by EVS

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.

This document is a preview generated by EVS

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)

3 Terms, definitions, symbols and abbreviations

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