



# UL 60947-4-1

## **STANDARD FOR SAFETY**

Low-Voltage Switchgear and Controlgear – Part  
4-1: Contactors and Motor-Starters –  
Electromechanical Contactors and Motor-Starters



UL Standard for Safety for Low-Voltage Switchgear and Controlgear – Part 4-1: Contactors and Motor-Starters – Electromechanical Contactors and Motor-Starters, UL 60947-4-1

Third edition, Dated April 4, 2014

### **Summary of Topics**

***This revision of ANSI/UL 60947-4-1 includes the following changes to “US only” requirements:***

***1. Harmonization of endurance test cycle rates for contactors, starters, manual motor controllers, manual motor controllers used as a disconnecting means and manual motor controllers used as tap conductor protection as a U.S. only national difference.***

***2. Harmonization of endurance test cycle rates for manual motor controller and manual self-protected combination motor controller as a U.S. only difference.***

***As noted in the Commitment for Amendments statement located on the back side of the title page, UL and CSA are committed to updating this harmonized standard jointly. However, the revision pages dated October 17, 2017 will not be jointly issued by UL and CSA as these revision pages only address UL 60947-4-1 ANSI approval dates.***

The new/revised requirements are substantially in accordance with Proposal(s) on this subject dated August 25, 2017.

Text that has been changed in any manner or impacted by UL’s electronic publishing system is marked with a vertical line in the margin.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form by any means, electronic, mechanical photocopying, recording, or otherwise without prior permission of UL.

UL provides this Standard “as is” without warranty of any kind, either expressed or implied, including but not limited to, the implied warranties of merchantability or fitness for any purpose.

In no event will UL be liable for any special, incidental, consequential, indirect or similar damages, including loss of profits, lost savings, loss of data, or any other damages arising out of the use of or the inability to use this Standard, even if UL or an authorized UL representative has been advised of the possibility of such damage. In no event shall UL’s liability for any damage ever exceed the price paid for this Standard, regardless of the form of the claim.

Users of the electronic versions of UL’s Standards for Safety agree to defend, indemnify, and hold UL harmless from and against any loss, expense, liability, damage, claim, or judgment (including reasonable attorney’s fees) resulting from any error or deviation introduced while purchaser is storing an electronic Standard on the purchaser’s computer system.

No Text on This Page



CSA Group  
CAN/CSA-C22.2 No. 60947-4-1-14  
Second Edition (IEC 60947-4-1:2009, MOD)



Underwriters Laboratories Inc.  
UL 60947-4-1  
Third Edition

## Low-Voltage Switchgear and Controlgear – Part 4-1: Contactors and Motor-Starters – Electromechanical Contactors and Motor-Starters

April 4, 2014

(Title Page Reprinted: October 17, 2017)

This standard is based on IEC 60947-4-1, edition 3.0 (2009).



ANSI/UL 60947-4-1-2017

*Approved by*



Standards Council of Canada  
Conseil canadien des normes

This is a preview. [Click here to purchase the full publication.](#)

## **Commitment for Amendments**

This standard is issued jointly by the Canadian Standards Association (operating as “CSA Group”) and Underwriters Laboratories Inc. (UL). Comments or proposals for revisions on any part of the standard may be submitted to CSA Group or UL at anytime. Revisions to this standard will be made only after processing according to the standards development procedures of CSA Group and UL. CSA Group and UL will issue revisions to this standard by means of a new edition or revised or additional pages bearing their date of issue.

---

## **ISBN 978-1-77139-217-4 © 2014 CSA Group**

All rights reserved. No part of this publication may be reproduced in any form whatsoever without the prior permission of the publisher.

This Standard is subject to review within five years from the date of publication, and suggestions for its improvement will be referred to the appropriate committee. To submit a proposal for change, please send the following information to [inquires@csagroup.org](mailto:inquires@csagroup.org) and include “Proposal for change” in the subject line: Standard designation (number); relevant clause, table, and/or figure number; wording of the proposed change; and rationale for the change.

To purchase CSA Group Standards and related publications, visit CSA Group’s Online Store at [shop.csa.ca](http://shop.csa.ca) or call toll-free 1-800-463-6727 or 416-747-4044.

---

## **Copyright © 2017 Underwriters Laboratories Inc.**

UL’s Standards for Safety are copyrighted by UL. Neither a printed nor electronic copy of a Standard should be altered in any way. All of UL’s Standards and all copyrights, ownerships, and rights regarding those Standards shall remain the sole and exclusive property of UL.

This ANSI/UL Standard for Safety consists of the Third Edition, including revisions through October 17, 2017. The most recent designation of ANSI/UL 60947-4-1 as an American National Standard (ANSI) occurred on October 17, 2017. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page (front and back), or the Preface. The National Difference Page and IEC Foreword are also excluded from the ANSI approval of IEC-based standards.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL’s On-Line Collaborative Standards Development System (CSDS) at <https://csds.ul.com>.

To purchase UL Standards, visit UL’s Standards Sales Site at <http://www.shopulstandards.com/HowToOrder.aspx> or call toll-free 1-888-853-3503.

---

## CONTENTS

<b>Preface .....</b>	<b>7</b>
<b>NATIONAL DIFFERENCES .....</b>	<b>9</b>
<b>FOREWORD .....</b>	<b>11</b>
1 Scope and object .....	14
1.1 Scope .....	14
1.1.2 AC motor-starters .....	15
1.2 Exclusions .....	17
1.3 Object .....	18
2 Normative references .....	18
3 Terms, definitions, symbols and abbreviations .....	20
3.1 General .....	20
3.2 Alphabetical index of terms .....	20
3.3 Terms and definitions concerning contactors .....	22
3.4 Terms and definitions concerning starters .....	23
3.5 Terms and definitions concerning characteristic quantities .....	26
3.6 Symbols and abbreviations .....	27
4 Classification .....	27
5 Characteristics of contactors and starters .....	27
5.1 Summary of characteristics .....	27
5.2 Type of equipment .....	28
5.3 Rated and limiting values for main circuits .....	29
5.4 Utilization category .....	38
5.5 Control circuits .....	41
5.6 Auxiliary circuits .....	42
5.7 Characteristics of relays and releases (overload relays) .....	42
5.8 Co-ordination with short-circuit protective devices .....	46
5.9 Void .....	46
5.10 Types and characteristics of automatic change-over devices and automatic acceleration control devices .....	46
5.11 Types and characteristics of auto-transformers for two-step auto-transformer starters .....	47
5.12 Types and characteristics of starting resistors for rheostatic rotor starters .....	48
6 Product information .....	48
6.1 Nature of information .....	48
6.2 Marking .....	51
6.3 Instructions for installation, operation and maintenance .....	54
7 Normal service, mounting and transport conditions .....	54
8 Constructional and performance requirements .....	54
8.1 Constructional requirements .....	54
8.2 Performance requirements .....	58
8.3 Electromagnetic compatibility (EMC) .....	79
9 Tests .....	81
9.1 Kinds of test .....	81
9.2 Compliance with constructional requirements .....	84
9.3 Compliance with performance requirements .....	84
9.4 EMC Tests .....	114

## **Annex A (normative) Marking and identification of terminals of contactors and associated overload relays**

A.1 General .....	126
A.2 Marking and identification of terminals of contactors .....	126
A.2.1 Marking and identification of terminals of coils .....	126
A.2.2 Marking and identification of terminals of main circuits .....	128
A.2.3 Marking and identification of terminals of auxiliary circuits .....	129
A.3 Marking and identification of terminals of overload relays .....	136

## **Annex B (normative) Special tests**

B.1 General .....	138
B.2 Mechanical durability .....	138
B.2.1 General .....	138
B.2.2 Verification of mechanical durability .....	138
B.3 Electrical durability .....	141
B.3.1 General .....	141
B.3.2 Results to be obtained .....	142
B.3.3 Statistical analysis of test results for contactors or starters .....	143
B.4 Co-ordination at the crossover current between the starter and associated SCPD .....	143
B.4.1 General and definitions .....	143
B.4.2 Condition for the test for the verification of co-ordination at the crossover current by a direct method .....	144
B.4.3 Test currents and test circuits .....	144
B.4.4 Test procedure and results to be obtained .....	145

## **Annex C Void**

## **Annex D (informative) Items subject to agreement between manufacturer and user**

## **Annex E (informative) Examples of control circuit configurations**

E.1 External control device (ECD) .....	151
E.1.1 Definition of an ECD .....	151
E.1.2 Diagrammatic representation of an ECD .....	151
E.1.3 Parameters of an ECD .....	151
E.2 Control circuit configurations .....	152
E.2.1 Contactor or starter with external control supply .....	152
E.2.2 Contactor or starter with an internal control supply and control input only .....	153
E.2.3 Contactor or starter with several external control supplies .....	154
E.2.4 Contactor or starter with bus interface (may be combined with other circuit configurations) .....	155



**Annex F (normative) Requirements for auxiliary contact linked with power contact (mirror contact)**

F.1 Scope and object .....	157
F.1.1 Scope .....	157
F.1.2 Object .....	157
F.2 Terms and definitions .....	157
F.3 Characteristics .....	157
F.4 Product information .....	157
F.5 Normal service, mounting and transport conditions .....	158
F.6 Constructional and performance requirements .....	158
F.7 Tests .....	158
F.7.1 General .....	158
F.7.2 Tests on products in a new condition .....	159
F.7.3 Test after conventional operational performance (defined under Table 10) .....	159

**Annex G (informative) Rated operational currents and rated operational powers of switching devices for electrical motors**

G.1 General .....	160
G.2 Rated operational powers and rated operational currents .....	160

**Annex H (normative) Extended functions within electronic overload relays**

H.1 Scope .....	165
H.1.1 General .....	165
H.1.2 Ground/earth fault detection function .....	165
H.2 Terms and definitions .....	165
H.3 Classification of electronic overload relays .....	166
H.4 Type of relays .....	166
H.5 Performance requirements .....	166
H.5.1 Limits of operation of ground/earth fault relays .....	166
H.5.2 Limits of operation of ground/earth fault relays type CII(-A and -B) .....	167
H.5.3 Limits of operation of voltage imbalance relays .....	167
H.5.4 Limits of operation of phase reversal relays .....	168
H.5.5 Limits of operation of current imbalance relays .....	168
H.5.6 Limits of operation of over-voltage relays .....	168
H.5.7 Limits of operation of under-power relays .....	169
H.6 Tests .....	169
H.6.1 Limits of operation of ground/earth fault relays type CI and CII (-A and -B) .....	169
H.6.2 Verification of inhibit function of ground/earth fault relays type CII (-A and -B) .....	169
H.6.3 Current imbalance relays .....	170
H.6.4 Voltage imbalance relays .....	170
H.6.5 Phase reversal relays .....	170
H.6.6 Over-voltage relays .....	170
H.6.7 Under-power relays .....	170
H.7 Routine and sampling tests .....	170

## **Annex I (informative) AC1 contactors for use with semiconductor controlled motor loads**

## **Annex J Void**

## **Annex K (normative) Procedure to determine data for electromechanical contactors used in functional safety applications**

K.1	General	174
K.1.1	Introduction	174
	K.1.2 Scope and object	174
	K.1.3 General requirements	174
K.2	Terms, definitions and symbols	174
K.2.1	Terms and definitions	175
	K.2.2 Symbols	176
K.3	Method based on durability test results	176
K.3.1	General method	176
	K.3.2 Test requirements	176
	K.3.3 Characterization of a failure mode	177
	K.3.4 Weibull modelling	177
	K.3.5 Useful life and upper limit of failure rate	179
	K.3.6 Reliability data	181
K.4	Method based on experience of returns from the field	181
K.5	Data to be provided	181
K.6	Example	182
K.6.1	Test results	182
	K.6.2 Weibull distribution and median rank regression	183
	K.6.3 Useful life and failure rate	184

## **Annex DVA (normative) Reference Standards**

## **Annex DVB (informative) Standards for Components**

## **Annex DVC (normative) Combination Controllers, Combination Motor Controllers and Manual Motor Controllers**

DVC.1	Scope	190
DVC.2	Definitions	190
DVC.3	Markings	191
DVC.4	Constructional and performance requirements	195
DVC.5	Tests	199

## **Annex DVD (normative) Clearance and creepage distances for low voltage contactors and starters**

DVD.2	Spacings within an enclosure	213
-------	------------------------------	-----

## **Bibliography**