

## TECHNICAL REPORT

---

### Low-voltage switchgear and controlgear – Over-current protective devices – Part 2: Selectivity under over-current conditions



## **THIS PUBLICATION IS COPYRIGHT PROTECTED**

**Copyright © 2009 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.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de la CEI ou du Comité national de la CEI du pays du demandeur.

Si vous avez des questions sur le copyright de la CEI ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de la CEI de votre pays de résidence.

IEC Central Office  
3, rue de Varembe  
CH-1211 Geneva 20  
Switzerland  
Email: [inmail@iec.ch](mailto:inmail@iec.ch)  
Web: [www.iec.ch](http://www.iec.ch)

### **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 corrigenda or an amendment might have been published.

- Catalogue of IEC publications: [www.iec.ch/searchpub](http://www.iec.ch/searchpub)

The IEC on-line Catalogue enables you to search by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: [www.iec.ch/online\\_news/justpub](http://www.iec.ch/online_news/justpub)

Stay up to date on all new IEC publications. Just Published details twice a month all new publications released. Available on-line and also by email.

- Electropedia: [www.electropedia.org](http://www.electropedia.org)

The world's leading online dictionary of electronic and electrical terms containing more than 20 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary online.

- Customer Service Centre: [www.iec.ch/webstore/custserv](http://www.iec.ch/webstore/custserv)

If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:

Email: [csc@iec.ch](mailto:csc@iec.ch)  
Tel.: +41 22 919 02 11  
Fax: +41 22 919 03 00

# TECHNICAL REPORT

---

## Low-voltage switchgear and controlgear – Over-current protective devices – Part 2: Selectivity under over-current conditions

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

PRICE CODE

ICS 29.130

ISBN 2-8318-1042-0

## CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope.....	7
2 Normative references .....	7
3 Terms, definitions and abbreviated terms .....	8
3.1 Alphabetical index of terms .....	8
3.2 Terms and definitions .....	9
3.3 Abbreviated terms .....	10
4 Scope of selectivity requirements .....	11
4.1 General.....	11
4.2 Motor protection circuit-breaker / Manual motor starter.....	12
5 Selectivity determination .....	12
5.1 Circuit-breaker as UD.....	12
5.1.1 Selectivity between circuit-breakers.....	12
5.1.2 Selectivity between a circuit-breaker (UD) and a fuse to IEC 60269-1 (DD) .....	15
5.1.3 CB/CPS – Selectivity between a circuit-breaker to IEC 60947-2 (UD) and a CPS to IEC 60947-6-2 (DD) .....	16
5.1.4 Circuit-breaker/MOR – Selectivity between a circuit-breaker (UD) and a motor protection overload relay to IEC 60947-4-1 or IEC 60947-4-2 (DD) .....	17
5.2 Fuse(s) to IEC 60269-1 as UD.....	18
5.2.1 Fuse/circuit-breaker – Selectivity between a fuse to IEC 60269-1 (UD) and a circuit-breaker (DD) .....	18
5.2.2 FU/FU – Selectivity between fuses to IEC 60269-1 (UD and DD) .....	20
5.2.3 FU/CPS – Selectivity between fuse(s) to IEC 60269-1 (UD) and a CPS to IEC 60947-6-2 (DD).....	21
5.2.4 FU/MOR – Selectivity between fuse(s) to IEC 60269-1 (UD) and a motor overload protection relay to IEC 60947-4-1 or IEC 60947-4-2 (DD) .....	21
6 Residual current devices (RCDs).....	21
6.1 General.....	21
6.2 Selectivity – RCD/RCD .....	22
6.2.1 Selectivity between RCDs in the case of earth-leakage current.....	22
6.2.2 Selectivity between RCDs in the case of earth-fault (ground-fault) current.....	23
7 Zone Selective Interlocking (ZSI).....	24
7.1 General.....	24
7.2 Operating principle .....	24
7.3 Example .....	25
8 Over-current protection relay (OCR) – Single input energizing quantity measuring relays with dependent or independent time.....	26
Annex A (informative) Examples of selectivity between over-current protection devices Examples of the grades of selectivity applicable to circuit-breakers .....	27
Annex B (informative) Standing loads – Effect of standing loads on selectivity in the overload zone .....	30
Bibliography.....	33

Figure 1 – Comparison of the operating characteristics of circuit-breakers in the overload zone .....	13
Figure 2 – Example of selectivity in the fault current zone with time-delay short-circuit release .....	14
Figure 3 – Selectivity in the overload zone between a circuit-breaker (UD) and a fuse (DD).....	16
Figure 4 – Circuit-breaker/MOR – Circuit-breaker selectivity with motor overload relay .....	17
Figure 5 – ICB/MOR – ICB selectivity with motor overload relay .....	18
Figure 6 – Fuse/circuit -breaker - Verification of selectivity between fuse and circuit-breaker for operating time in the overload zone ( $t \geq 0,1$ s for the fuse).....	19
Figure 7 – FU/CB – Verification of selectivity between fuse and circuit-breaker for operating time $t < 0,1$ s .....	19
Figure 8 – FU/FU – Verification of selectivity between fuses for operating time $t \geq 0,1$ s .....	20
Figure 9 – RCD characteristics showing selectivity on earth-leakage – time-delay Type S versus non-time delay .....	23
Figure 10 – Schematic diagram of an installation designed for multiple supplies with zone selective interlocking .....	25
Figure 11 – Schematic diagram of mains distribution system with OCR protection .....	26
Figure A.1 – Circuit-breaker coordination example – 50 kA/9 kA fault levels .....	27
Figure A.2 – Time-current curves (examples 1 and 2) .....	28
Figure A.3 – Operation in the fault current zone (examples 1 and 2) .....	28
Figure A.4 – Circuit-breaker coordination example – 50 kA/20 kA fault levels .....	29
Figure B.1 – Overload and short-circuit zones.....	30
Figure B.2 – OCPDs in series .....	31
Table 1 – Type of selectivity and corresponding subclause number .....	12

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR –  
OVER-CURRENT PROTECTIVE DEVICES –****Part 2: Selectivity under over-current conditions**

## 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 provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
- 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) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

The main task of IEC technical committees is to prepare International Standards. However, a technical committee may propose the publication of a technical report when it has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

IEC 61912-2, which is a technical report, has been prepared by subcommittee 17B: Low-voltage switchgear and controlgear, of IEC technical committee 17: Switchgear and controlgear.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
17B/1606/DTR	17B/1666/RVC

Full information on the voting for the approval of this technical report 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 parts of IEC 61912 series, published under the general title *Low-voltage switchgear and controlgear – Over-current protective devices*, can be found on the IEC website.

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

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

A bilingual version of this publication may be issued at a later date.

## INTRODUCTION

Low-voltage equipment standards IEC 60947, IEC 60269, IEC 60898-1 and IEC 61009-1 currently include operating characteristics for over-current protective devices, defined in terms of the ability of the equipment to operate at levels of over-current up to their maximum short-circuit current ratings. In practice, the installation of such devices in series requires consideration of the relationship between the device characteristics to achieve the optimum in supply availability in the event of an over-current causing operation of any device. The ability of an over-current device to perform selectively in combination with other such devices needs to be fully understood by the circuit designer to avoid leaving a circuit vulnerable to unnecessary loss of supply, particularly where critical supplies are concerned. It is also useful to take full advantage of the capability of devices and systems to avoid over-engineering, with the consequent unnecessary additional cost. Selectivity over the whole range of fault current up to the prospective fault current at the point of installation is not always possible or necessary. A more economic solution may be found in many cases by accepting a limited selectivity, particularly taking into account the low probability of a high short-circuit fault current.

Where a short-circuit protective device is used to provide back-up protection to a downstream device, guidance on the application is provided in IEC/TR 61912-1.



## LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR – OVER-CURRENT PROTECTIVE DEVICES –

### Part 2: Selectivity under over-current conditions

#### 1 Scope

This technical report, which serves as an application guide for the determination of selectivity between over-current protective devices of low-voltage switchgear and controlgear, summarises the definitions of the terminology and provides examples of application.

The following standards for devices are considered in this technical report:

- IEC 60255-3; IEC 60255-6; IEC 60255-8, IEC 60255-12
- IEC 60269-1, IEC 60269-2, IEC 60269-3; IEC 60269-4;
- IEC 60898-1;
- IEC 60947 series;
- IEC 61008-1;
- IEC 61009-1.

This report does not deal with other forms of protection, such as power-reversal protection, directional protection and arc-protection systems.

#### 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 60255 (all parts), *Electrical relays*

IEC 60269-1, *Low-voltage fuses – Part 1: General requirements*

IEC 60269-2, *Low-voltage fuses – Part 2: Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application) – Examples of standardized systems of fuses A to I*

IEC 60269-3, *Low-voltage fuses – Part 3: Supplementary requirements for fuses for use by unskilled persons (fuses mainly for household and similar applications)*

IEC 60269-4, *Low-voltage fuses – Part 4: Supplementary requirements for fuse-links for the protection of semiconductor devices*

IEC 60898-1, *Electrical accessories – Circuit-breakers for over-current protection for household and similar installations – Part 1: Circuit-breakers for a.c. operation*

IEC 60947-2, *Low-voltage switchgear and controlgear – Part 2: Circuit-breakers*

IEC 60947-4-1, *Low-voltage switchgear and controlgear – Part 4-1: Contactors and motor-starters – Electromechanical contactors and motor-starters*

IEC 60947-4-2, *Low-voltage switchgear and controlgear – Part 4-2: Contactors and motor-starters – AC semiconductor motor controllers and starters*

IEC 60947-6-2, *Low-voltage switchgear and controlgear – Part 6-2: Multiple function equipment – Control and protective switching devices (or equipment) (CPS)*

IEC 61008-1, *Residual current operated circuit-breakers without integral over-current protection for household and similar uses (RCCBs) – Part 1: General rules*

IEC 61009-1, *Residual current operated circuit-breakers with integral over-current protection for household and similar uses (RCBOs) – Part 1: General rules*

IEC/TR 61459, *Coordination between fuses and contactors/motor-starters – Application guide*

IEC/TR 61818, *Application guide for low-voltage fuses*

IEC/TR 61912-1, *Low-voltage switchgear and controlgear – Overcurrent protective devices – Part 1: Application of short-circuit ratings*

### 3 Terms, definitions and abbreviated terms

For the purposes of this document, the following terms, definitions and abbreviated terms apply.

#### 3.1 Alphabetical index of terms

	Reference
B	
back-up protection .....	3.2.6
C	
coordination of over-current protective devices .....	3.2.1
D	
downstream device (DD) .....	3.2.8
F	
fault current zone (of over-current) .....	3.2.10
O	
over-current discrimination .....	3.2.2
over-current protective device (OCPD) .....	3.2.5
overload zone (of over-current) .....	3.2.9
S	
selectivity of protection .....	3.2.3
selectivity limit current .....	3.2.4
U	
upstream device (UD) .....	3.2.7