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TECHNICAL REPORT

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

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

Part 2: Selectivity under over-current conditions

FOREWORD

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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- withdrawn,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

3.2 Terms and definitions

3.2.1
coordination of over-current protective devices
coordination of two or more over-current protective devices in series to ensure over-current discrimination (selectivity) and/or back-up protection

NOTE This report deals with selectivity. Guidance on back-up protection is given in IEC/TR 61912-1.

3.2.2
over-current discrimination
coordination of the operating characteristics of two or more over-current protective devices such that, on the incidence of over-currents within stated limits, the device intended to operate within these limits does so, while the other(s) does (do) not

NOTE Distinction is made between series discrimination, involving different over-current protective devices passing substantially the same over-current, and network discrimination involving identical protective devices passing different proportions of the over-current.

[IEV 441-17-15]

3.2.3
selectivity of protection
ability of a protection to identify the faulty section and/or phase(s) of a power system

[IEV 448-11-06]

NOTE Whereas the terms “selectivity” and “discrimination” have a similar meaning according to the IEV definitions, this report prefers and uses the term “selectivity” to express the ability of one over-current device to operate in preference to another over-current device in series, over a given range of over-current. The effect of standing load current on selectivity in the overload zone is also considered.

3.2.4
selectivity limit current
current coordinate (Is) of the intersection between the maximum break time-current characteristic of the downstream over-current protective device and the pre-arcing (for fuses) or tripping (for circuit-breakers) time-current characteristic of the upstream over-current protective device

[IEV 442-05-60 modified]

NOTE 1 In the case of a combination of circuit-breakers without intentional time-delay, in the short-circuit zone the selectivity limit-current is not a simple function of time and must be established from test data.

NOTE 2 In the case of a combination of fuses, in the short-circuit zone the selectivity limit-current is a function of energy let-through I^2t.

3.2.5
over-current protective device
OCPD
device provided to interrupt an electric circuit in the case of the current in the circuit exceeding a predetermined value for a specified duration

[IEV 826-14-14 modified]

NOTE The term OCPD includes the use of an over-current protective relay in combination with a separate switching device.

3.2.6
back-up protection
over-current coordination of two over-current protective devices in series where the protective device, generally but not necessarily on the supply side, effects the over-current protection with or without the assistance of the other protective device and prevents any excessive stress on the latter

[IEC 60947-1, definition 2.5.24]

NOTE When referred to particular devices in combination, back-up protection is sometimes known as "series rating".

3.2.7
upstream device
UD
in considering selectivity between two OCPDs, the OCPD connected in the circuit nearest to the source of supply

3.2.8
downstream device
DD
in considering selectivity between two OCPDs, the OCPD connected in the circuit immediately following the upstream device, on the load side

3.2.9
overload zone (of over-current)
range of current, exceeding the rated current of the OCPD, produced by the circuit loading in the absence of a fault in the circuit

NOTE 1 The overload zone operation of the OCPD is in the range from a few seconds, up to four hours, following an inverse time/current characteristic.

NOTE 2 In the case of a distribution circuit, the overload zone is not strictly defined since it depends on the capability of the load to draw excessive current. It may be defined by the characteristics of the OCPD as follows:

– in the case of a circuit-breaker, this is the point when the tripping characteristic changes from inverse time dependent to virtually instantaneous, at which level the operation will be in less than 0,2 s. Typically, this occurs in the region of 10 times the nominal full-load current, dependent on the setting.

MCBs to IEC 60898-1 have defined limits of instantaneous tripping given, in Table 7 of the standard, as three types B, C and D;

– in the case of a fuse, the overload zone may be considered as values of over-current that result in operation in more than 0,1 s, typically below 10-20 times rated current.

NOTE 3 In the case of a circuit supplying an individual motor, the overload zone is limited to the stalled current of the motor, typically 6-15 times motor full-load current (I_e), exceptionally higher values are found.

NOTE 4 Within the overload zone, transitory conditions may occur, for example transformer inrush currents, of only a few milliseconds duration.

3.2.10
fault current zone (of over-current)
range of current exceeding the overload current, produced by a fault in the circuit

NOTE 1 In the fault current zone, operation of a circuit-breaker as OCPD is typically in the range from a few milliseconds (instantaneous), up to three seconds with a definite short-time delay function.

Below 50 ms the time/current characteristic is no longer useful. Reference should be made to current limitation and/or energy let-through characteristics.

NOTE 2 In the case of a fuse, the fault current zone may be considered as values of over-current that result in operation in less than 0,1 s.

The time current characteristic of a fuse uses the pre-arcing time, i.e. the time after which the fuse will operate. Above 0,1 s pre-arcing time, on an a.c. supply, the arcing time of the fuse is not considered significant. However below 0,1 s pre-arcing time, the arcing time is a significant portion of the total time and hence the time/current characteristic is no longer useful and the I^2t characteristic is used.

NOTE 3 The fault current zone is also referred to as the short-circuit zone.

3.3 Abbreviated terms

ACB Air circuit-breaker