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Performance of high-voltage direct current (HVDC) systems with linecommutated converters - Part 2: Faults and switching (IEC/TR 60919-2:2008)

Betriebsverhalten netzgeführter Stromrichter in Hochspannungsgleichstrom (HGÜ)-Systemen - Teil 2: Fehler und Schalten (IEC/TR 60919-2:2008)

Fonctionnement des systèmes à courant continu haute tension (CCHT) munis de convertisseurs commutés par le réseau - Partie 2: Défaits et manoeuvres (CEI/TR 60919-2:2008)

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TECHNICAL REPORT
RAPPORT TECHNIQUE
TECHNISCHER BERICHT

CLC/TR 60919-2

October 2010

ICS 29.200; 29.240.99

English version

**Performance of high-voltage direct current (HVDC) systems with line-commutated converters -
Part 2: Faults and switching**
(IEC/TR 60919-2:2008)

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This Technical Report was approved by CENELEC on 2010-09-17.

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CENELEC

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

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Foreword

This Technical Report consists of the text of the International Technical Report IEC/TR 60919-2:2008 prepared by SC 22F, Power electronics for electrical transmission and distribution systems, of IEC TC 22, Power electronic systems and equipment.

It was circulated for voting in accordance with the Internal Regulations, Part 2, Subclause 11.4.3.3 (simple majority) and was accepted by CENELEC as CLC/TR 60919-2 on 2010-09-17.

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.

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the Technical Report IEC/TR 60919-2:2008 was approved by CENELEC as a Technical Report without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60071-1:2006	NOTE	Harmonized as EN 60071-1:2006 (not modified).
IEC 60071-2:1996	NOTE	Harmonized as EN 60071-2:1997 (not modified).
IEC 60076 series	NOTE	Harmonized in EN 60076 series (partially modified).
IEC 60044-5:2004	NOTE	Harmonized as EN 60044-5:2004 (not modified).
IEC 60076-6:2007	NOTE	Harmonized as EN 60076-6:2008 (not modified).
IEC 60505:2004	NOTE	Harmonized as EN 60505:2004 (not modified).

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 Where 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 60071-1	-	Insulation co-ordination - Part 1: Terms, definitions, principles and rules	-	-
IEC 60146-1-1 + A1	1991 1996	Semiconductor convertors - General requirements and line commutated convertors - Part 1-1: Specifications of basic requirements	EN 60146-1-1 + A1	1993 1997
IEC/TR 60146-1-2	-	Semiconductor convertors - General requirements and line commutated convertors - Part 1-2: Application guide	-	-
IEC 60146-1-3	-	Semiconductor convertors - General requirements and line commutated convertors - Part 1-3: Transformers and reactors	EN 60146-1-3	-
IEC 60633	-	Terminology for high-voltage direct current (HVDC) transmission	EN 60633	-
IEC 60700-1	-	Thyristor valves for high voltage direct current (HVDC) power transmission - Part 1: Electrical testing	EN 60700-1	-
IEC/TR 60919-1	2005	Performance of high-voltage direct current (HVDC) systems with line-commutated convertors - Part 1: Steady-state conditions	CLC/TR 6091-1	2005
IEC 60919-3	-	Performance of high-voltage direct current (HVDC) systems - Part 3: Dynamic conditions	-	-

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TECHNICAL REPORT

RAPPORT TECHNIQUE

Performance of high-voltage direct current (HVDC) systems with line-commutated converters – (standards.iteh.ai)
Part 2: Faults and switching

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Partie 2: Défaits et manœuvres

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**PERFORMANCE OF HIGH-VOLTAGE DIRECT CURRENT
(HVDC) SYSTEMS WITH LINE-COMMUTATED CONVERTERS –**

Part 2: Faults and switching

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.
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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 60919-2, which is a technical report, has been prepared by subcommittee 22F: Power electronics for electrical transmission and distribution systems, of IEC technical committee 22: Power electronic systems and equipment.

This second edition cancels and replaces the first edition, published in 1991, and constitutes a technical revision.

This edition includes the following main changes with respect to the previous edition:

- a) this report concerns only line-commutated converters;
- b) significant changes have been made to the control system technology;

- c) some environmental constraints, for example audible noise limits, have been added;
- d) the capacitor coupled converters (CCC) and controlled series capacitor converters (CSCC) have been included.

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

Enquiry draft	Report on voting
22F/160/DTR	22F/165/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 the IEC 60919 series, under the general title: *Performance of high-voltage direct current (HVDC) systems with line-commutated converters*, 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.

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PERFORMANCE OF HIGH-VOLTAGE DIRECT CURRENT (HVDC) SYSTEMS WITH LINE-COMMUTATED CONVERTERS –

Part 2: Faults and switching

1 Scope

This part of IEC 60919 which is a technical report provides guidance on the transient performance and fault protection requirements of high voltage direct current (HVDC) systems. It concerns the transient performance related to faults and switching for two-terminal HVDC systems utilizing 12-pulse converter units comprised of three-phase bridge (double way) connections but it does not cover multi-terminal HVDC transmission systems. However, certain aspects of parallel converters and parallel lines, if part of a two-terminal system, are discussed. The converters are assumed to use thyristor valves as the bridge arms, with gapless metal oxide arresters for insulation co-ordination and to have power flow capability in both directions. Diode valves are not considered in this report.

Only line-commutated converters are covered in this report, which includes capacitor commutated converter circuit configurations. General requirements for semiconductor line-commutated converters are given in IEC 60146-1-1, IEC 60146-1-2 and IEC 60146-1-3. Voltage-sourced converters are not considered.

The report is comprised of three parts. IEC 60919-2, which covers transient performance, will be accompanied by companion documents, IEC 60919-1 for steady-state performance and IEC 60919-3 for dynamic performance. An effort has been made to avoid duplication in the three parts. Consequently users of this report are urged to consider all three parts when preparing a specification for purchase of a two-terminal HVDC system.

Readers are cautioned to be aware of the difference between system performance specifications and equipment design specifications for individual components of a system. While equipment specifications and testing requirements are not defined herein, attention is drawn to those which could affect performance specifications for a system. Note that detailed seismic performance requirements are excluded from this technical report. In addition, because of the many possible variations between different HVDC systems, these are not considered in detail. Consequently this report should not be used directly as a specification for a specific project, but rather to provide the basis for an appropriate specification tailored to fit actual system requirements for a particular electric power transmission scheme. This report does not intend to discriminate the responsibility of users and manufacturers for the work specified.

Terms and definitions for high-voltage direct current (HVDC) transmission used in this report are given in IEC 60633.

Since the equipment items are usually separately specified and purchased, the HVDC transmission line, earth electrode line and earth electrode are included only because of their influence on the HVDC system performance.

For the purpose of this report, an HVDC substation is assumed to consist of one or more converter units installed in a single location together with buildings, reactors, filters, reactive power supply, control, monitoring, protective, measuring and auxiliary equipment. While there is no discussion of a.c. switching substations in this report, a.c. filters and reactive power sources are included, although they may be connected to an a.c. bus separate from the HVDC substation.

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 60146-1-1, *Semiconductor converters – General requirements and line commutated converters – Part 1-1: Specifications of basic requirements*
Amendment 1 (1996)

IEC 60146-1-2, *Semiconductor converters – General requirements and line commutated converters – Part 1-2: Application guide*

IEC 60146-1-3, *Semiconductor converters – General requirements and line commutated converters – Part 1-3: Transformers and reactors*

IEC 60633, *Terminology for high-voltage direct current (HVDC) transmission*

IEC 60071-1, *Insulation co-ordination – Part 1: Terms, definitions, principles and rules*

IEC 60700-1, *Thyristor valves for high-voltage direct current (HVDC) power transmission – Part 1: Electrical testing*

IEC/TR 60919-1:2005, *Performance of high-voltage direct current (HVDC) systems with line-commutated converters – Part 1: Steady-state conditions*

IEC 60919-3, *Performance of high-voltage direct current (HVDC) systems with line-commutated converters – Part 3: Dynamic conditions*

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3 Outline of HVDC transient performance specifications

3.1 Transient performance specifications

A complete performance specification related to transient performance of an HVDC system during faults and switching should also include fault protection requirements.

These concepts are introduced at the appropriate locations in the following transient performance and related clauses:

- Clause 4 – Switching transients without faults
- Clause 5 – AC system faults
- Clause 6 – AC filter, reactive power equipment and a.c. bus faults
- Clause 7 – Converter unit faults
- Clause 8 – DC reactor, d.c. filter and other d.c. equipment faults
- Clause 9 – DC line faults
- Clause 10 – Earth electrode line faults
- Clause 11 – Metallic return conductor faults
- Clause 12 – Insulation co-ordination - HVDC systems
- Clause 13 – Telecommunication requirements
- Clause 14 – Auxiliary systems