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IEC TR 60919-2

Edition 2.2 2020-04
CONSOLIDATED VERSION

TECHNICAL REPORT

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

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

IEC TR 60919-2:2008-11+AMD1:2015-06+AMD2:2020-04 CSV(en)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

Part 2: Faults and switching

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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.

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.

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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.

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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~~2010, *Performance of high-voltage direct current (HVDC) systems with line-commutated converters – Part 1: Steady-state conditions*
Amendment 1:2013

IEC TR 60919-3:2009, *Performance of high-voltage direct current (HVDC) systems with line-commutated converters – Part 3: Dynamic conditions*

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

Part 2: Faults and switching

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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.

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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 60919-1:2010, *Performance of high-voltage direct current (HVDC) systems with line-commutated converters – Part 1: Steady-state conditions*
Amendment 1:2013

IEC TR 60919-3:2009, *Performance of high-voltage direct current (HVDC) systems with line-commutated converters – Part 3: Dynamic conditions*