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colour inside

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

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REDLINE VERSION

colour inside

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)

CONTENTS

FOREWORD 6
1 Scope 8
2 Normative references 9
3 Outline of HVDC transient performance specifications 9
3.1 Transient performance specifications 9
3.2 General comment 10
4 Switching transients without faults 10
4.1 General 10
4.2 Energization and de-energization of a.c. side equipment 10
4.3 Load rejection 12
4.4 Start-up and shut-down of converter units 13
4.5 Operation of d.c. breakers and d.c. switches 13
5 AC system faults 16
5.1 General 16
5.2 Fault categories 16
5.3 Specification matters affecting transient performance 16
5.3.1 Effective a.c. system impedance 16
5.3.2 Power transfer during faults 17
5.3.3 Recovery following fault clearing 17
5.3.4 Reactive power consumption during fault and post-fault recovery periods 18
5.3.5 Load rejection due to a.c. faults 18
5.3.6 Switching of reactive power equipment 19
5.3.7 Effects of harmonic voltages and current during faults 19
5.3.8 Shift in control modes of operation 20
5.3.9 Power modulation on the HVDC system 20
5.3.10 Emergency power reductions 20
5.4 Specification impact on control strategy 20
6 AC filters, reactive power equipment and a.c. bus faults 22
6.1 General 22
6.2 Transient overvoltages in filter banks 22
6.3 Transient overcurrents in filter and capacitor banks 23
6.4 Capacitor unbalance protection 23
6.5 Examples of protection of filters and capacitor banks 24
6.6 Shunt reactor protection 25
6.7 AC bus protection 25
7 Converter unit faults 27
7.1 General 27
7.2 Short circuits 27
7.3 Failure of converter unit to perform its intended function 29
7.3.1 General 29
7.3.2 Rectifier operation 29
7.3.3 Inverter operation 29
7.4 Converter unit protection 30
7.4.1 Converter differential protection 30
7.4.2 Overcurrent protection 30

7.4.3 AC overvoltage protection 30
7.4.4 Protection against large delay angle operation 30
7.4.5 Commutation failure protection 30
7.4.6 Thyristor valve protections 30
7.4.7 Transformer protection 30
7.4.8 Transformer tap-changer unbalance protection 31
7.4.9 AC connection earth fault protection 31
7.5 Additional protection aspects of series connected converter units 31
7.6 Additional protection aspects of parallel connected converter units 31
8 DC reactor, d.c. filter and other d.c. equipment faults 34
8.1 General 34
8.2 Fault types 34
8.3 Protection zones 34
8.4 Neutral protection 35
8.4.1 General 35
8.4.2 Neutral fault detection 35
8.4.3 Neutral bus fault isolation 35
8.4.4 Bipolar neutral bus faults 35
8.5 DC reactor protection 36
8.6 DC harmonic filter protection 36
8.6.1 General 36
8.6.2 Filter bank fault protection 36
8.6.3 DC filter capacitor unit protection 37
8.7 DC harmonic protection 37
8.8 DC overvoltage protection 37
8.9 DC side switching protection 37
9 DC line faults 40
9.1 Overhead line faults 40
9.2 Cable faults 41
9.3 DC fault characteristics 41
9.4 Functional d.c. fault detection requirements 41
9.5 Protective sequence 42
9.5.1 Overhead line faults 42
9.5.2 Faults in cable systems 42
9.5.3 Faults in an overhead line/cable system 42
9.5.4 Faults in one of a system of parallel-connected cables 42
9.5.5 Fault in a system of parallel overhead lines 43
9.6 Fault protection schemes 43
9.7 Open circuit on the d.c. side 43
9.8 Power line cross protection 44
10 Earth electrode line faults 44
10.1 General 44
10.2 Specific requirements – Earth electrode line 44
10.3 Electrode line supervision 45
11 Metallic return conductor faults 45
11.1 Conductor for the return circuit 45
11.2 Metallic return faults 45
11.3 Fault detection – Metallic return 46

11.4 Metallic return fault protection systems 46
12 Insulation co-ordination – HVDC systems 49
12.1 General 49
12.2 Protection schemes using surge arresters 49
12.3 Switching overvoltages and temporary overvoltages on the a.c. side 50
12.4 Switching overvoltages and temporary overvoltages on the d.c. side 50
12.5 Lightning and steep fronted surges 50
12.6 Protective margins 51
12.7 Arrester duties 52
12.7.1 AC bus arresters (A_1, A_2 and A_3) 52
12.7.2 Arrester across filter reactors (FA) 52
12.7.3 Valve arresters (V) 53
12.7.4 Mid-point d.c. bus arrester (M) 53
12.7.5 Converter unit d.c. bus arresters (CB) and converter unit arresters 53
12.7.6 DC bus and d.c. line arresters (DB and DL) 53
12.7.7 Neutral bus arresters (E_1 and E_2) 54
12.7.8 DC reactor arrester (R) 54
12.7.9 DC filter arresters (FD) 54
12.8 Prevention of protective relay action due to arrester currents 54
12.9 Insulation clearances 54
12.10 Creepage distances for the insulation 54
12.10.1 Outdoor insulation 54
12.10.2 Indoor insulation 55
13 Telecommunication requirements 59
13.1 General 59
13.2 Specific requirements - Telecommunication systems 59
13.3 Consequence of telecommunication system outages 60
13.4 Special considerations for power line carrier (PLC) systems 60
14 Auxiliary systems 61
14.1 General 61
14.2 Electrical auxiliary systems 61
14.2.1 General requirements 61
14.2.2 Specific requirements 62
14.3 Mechanical auxiliary systems 63
Bibliography 65

Figure 1 – DC-side switches for an HVDC substation with series-connected converter unit 15
Figure 2 – Example of voltage dependent control characteristics 21
Figure 3 – Example of arrangement of a.c. filters and capacitor and reactor banks for large bipolar HVDC 25
Figure 4 – Example of current transformer arrangements for a.c. filters and a.c. bus differential protections 26
Figure 5 – Example of restricted ground fault protection of filter 26
Figure 6 – Example of current transformers arrangement for capacitor bank unbalance protection and overload protection of double tuned filter arm 27
Figure 7 – Examples of a.c. phase short circuits, pole short circuits and faults in a twelve-pulse converter unit 33

Figure 8 – Protection zones in series-connected converter units 33
Figure 9 – Protection zones in parallel-connected converter units 34
Figure 10 – Example of d.c. protection zones for series-connected converter units 38
Figure 11 – Example of d.c. protection zones for parallel-connected converter pole 40
Figure 12 – Monopolar metallic return system showing metallic return transfer breaker (MRTB) 47
Figure 13 – Monopolar operation of a bipolar system during converter pole outages 47
Figure 14 – DC current flowing into an a.c. system during a fault on a metallic return conductor when the HVDC substation mat is used for grounding of the d.c. circuit 47
Figure 15 – Earth current flowing during line faults 48
Figure 16 – Example of metallic return fault detection system by means of auxiliary a.c. signal 48
Figure 17 – Example of use of MRTB to quench fault to earth on metallic return conductor 49
Figure 18 – Example of an arrester protection schene for an HVDC substation 56
Figure 19 – Example of a d.c. arrester protection scheme for a back to back HVDC substation 57
Figure 20 –Example of an arrester protection arrangement for a capacitor commutated converter HVDC substation 58
Figure 21 – Example of an a.c. arrester protection arrangement for an HVDC substation 58
Figure 22 – Example of an arrester protection scheme in a HVDC substation with series-connected converters 59

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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.

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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Part 2: Faults and switching



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CONTENTS

FOREWORD 6
1 Scope 8
2 Normative references 9
3 Outline of HVDC transient performance specifications 9
3.1 Transient performance specifications 9
3.2 General comment 10
4 Switching transients without faults 10
4.1 General 10
4.2 Energization and de-energization of a.c. side equipment 10
4.3 Load rejection 12
4.4 Start-up and shut-down of converter units 13
4.5 Operation of d.c. breakers and d.c. switches 13
5 AC system faults 15
5.1 General 15
5.2 Fault categories 16
5.3 Specification matters affecting transient performance 16
5.3.1 Effective a.c. system impedance 16
5.3.2 Power transfer during faults 16
5.3.3 Recovery following fault clearing 17
5.3.4 Reactive power consumption during fault and post-fault recovery periods 18
5.3.5 Load rejection due to a.c. faults 18
5.3.6 Switching of reactive power equipment 19
5.3.7 Effects of harmonic voltages and current during faults 19
5.3.8 Shift in control modes of operation 19
5.3.9 Power modulation on the HVDC system 20
5.3.10 Emergency power reductions 20
5.4 Specification impact on control strategy 20
6 AC filters, reactive power equipment and a.c. bus faults 21
6.1 General 21
6.2 Transient overvoltages in filter banks 21
6.3 Transient overcurrents in filter and capacitor banks 22
6.4 Capacitor unbalance protection 22
6.5 Examples of protection of filters and capacitor banks 23
6.6 Shunt reactor protection 24
6.7 AC bus protection 24
7 Converter unit faults 26
7.1 General 26
7.2 Short circuits 27
7.3 Failure of converter unit to perform its intended function 28
7.3.1 General 28
7.3.2 Rectifier operation 28
7.3.3 Inverter operation 29
7.4 Converter unit protection 29
7.4.1 Converter differential protection 29
7.4.2 Overcurrent protection 29

7.4.3 AC overvoltage protection 29
7.4.4 Protection against large delay angle operation 29
7.4.5 Commutation failure protection 29
7.4.6 Thyristor valve protections 30
7.4.7 Transformer protection 30
7.4.8 Transformer tap-changer unbalance protection 30
7.4.9 AC connection earth fault protection 30
7.5 Additional protection aspects of series connected converter units 30
7.6 Additional protection aspects of parallel connected converter units 31
8 DC reactor, d.c. filter and other d.c. equipment faults 33
8.1 General 33
8.2 Fault types 34
8.3 Protection zones 34
8.4 Neutral protection 34
8.4.1 General 34
8.4.2 Neutral fault detection 34
8.4.3 Neutral bus fault isolation 35
8.4.4 Bipolar neutral bus faults 35
8.5 DC reactor protection 35
8.6 DC harmonic filter protection 35
8.6.1 General 35
8.6.2 Filter bank fault protection 36
8.6.3 DC filter capacitor unit protection 36
8.7 DC harmonic protection 36
8.8 DC overvoltage protection 36
8.9 DC side switching protection 37
9 DC line faults 38
9.1 Overhead line faults 38
9.2 Cable faults 39
9.3 DC fault characteristics 39
9.4 Functional d.c. fault detection requirements 39
9.5 Protective sequence 40
9.5.1 Overhead line faults 40
9.5.2 Faults in cable systems 40
9.5.3 Faults in an overhead line/cable system 40
9.5.4 Faults in one of a system of parallel-connected cables 40
9.5.5 Fault in a system of parallel overhead lines 41
9.6 Fault protection schemes 41
9.7 Open circuit on the d.c. side 41
9.8 Power line cross protection 42
10 Earth electrode line faults 42
10.1 General 42
10.2 Specific requirements – Earth electrode line 42
10.3 Electrode line supervision 43
11 Metallic return conductor faults 43
11.1 Conductor for the return circuit 43
11.2 Metallic return faults 43
11.3 Fault detection – Metallic return 44

11.4 Metallic return fault protection systems 44
12 Insulation co-ordination – HVDC systems 47
12.1 General 47
12.2 Protection schemes using surge arresters 47
12.3 Switching overvoltages and temporary overvoltages on the a.c. side 48
12.4 Switching overvoltages and temporary overvoltages on the d.c. side 48
12.5 Lightning and steep fronted surges 48
12.6 Protective margins 49
12.7 Arrester duties 50
12.7.1 AC bus arresters (A_1, A_2 and A_3) 50
12.7.2 Arrester across filter reactors (FA) 50
12.7.3 Valve arresters (V) 51
12.7.4 Mid-point d.c. bus arrester (M) 51
12.7.5 Converter unit d.c. bus arresters (CB) and converter unit arresters 51
12.7.6 DC bus and d.c. line arresters (DB and DL) 51
12.7.7 Neutral bus arresters (E_1 and E_2) 52
12.7.8 DC reactor arrester (R) 52
12.7.9 DC filter arresters (FD) 52
12.8 Prevention of protective relay action due to arrester currents 52
12.9 Insulation clearances 52
12.10 Creepage distances for the insulation 52
12.10.1 Outdoor insulation 52
12.10.2 Indoor insulation 53
13 Telecommunication requirements 57
13.1 General 57
13.2 Specific requirements - Telecommunication systems 57
13.3 Consequence of telecommunication system outages 58
13.4 Special considerations for power line carrier (PLC) systems 58
14 Auxiliary systems 59
14.1 General 59
14.2 Electrical auxiliary systems 59
14.2.1 General requirements 59
14.2.2 Specific requirements 60
14.3 Mechanical auxiliary systems 61
Bibliography 63

Figure 1 – DC-side switches for an HVDC substation with series-connected converter unit 15
Figure 2 – Example of voltage dependent control characteristics 21
Figure 3 – Example of arrangement of a.c. filters and capacitor and reactor banks for large bipolar HVDC 25
Figure 4 – Example of current transformer arrangements for a.c. filters and a.c. bus differential protections 25
Figure 5 – Example of restricted ground fault protection of filter 26
Figure 6 – Example of current transformers arrangement for capacitor bank unbalance protection and overload protection of double tuned filter arm 26
Figure 7 – Examples of a.c. phase short circuits, pole short circuits and faults in a twelve-pulse converter unit 32

Figure 8 – Protection zones in series-connected converter units 33
Figure 9 – Protection zones in parallel-connected converter units 33
Figure 10 – Example of d.c. protection zones for series-connected converter units 37
Figure 11 – Example of d.c. protection zones for parallel-connected converter pole 38
Figure 12 – Monopolar metallic return system showing metallic return transfer breaker (MRTB) 45
Figure 13 – Monopolar operation of a bipolar system during converter pole outages 45
Figure 14 – DC current flowing into an a.c. system during a fault on a metallic return conductor when the HVDC substation mat is used for grounding of the d.c. circuit 45
Figure 15 – Earth current flowing during line faults 46
Figure 16 – Example of metallic return fault detection system by means of auxiliary a.c. signal 46
Figure 17 – Example of use of MRTB to quench fault to earth on metallic return conductor 47
Figure 18 – Example of an arrester protection schene for an HVDC substation 54
Figure 19 – Example of a d.c. arrester protection scheme for a back to back HVDC substation 55
Figure 20 –Example of an arrester protection arrangement for a capacitor commutated converter HVDC substation 56
Figure 21 – Example of an a.c. arrester protection arrangement for an HVDC substation 56
Figure 22 – Example of an arrester protection scheme in a HVDC substation with series-connected converters 57

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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Part 2: Faults and switching

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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 60919-1:2010, *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*