

TECHNICAL SPECIFICATION

DC side harmonics & filtering in HVDC transmission systems

CONTENTS

FOREWORD.....	13
INTRODUCTION.....	15
0.1 Introduction.....	15
0.2 Continuing relevance	15
1 Scope.....	16
2 Normative references	16
3 Terms, definitions, symbols and abbreviated terms.....	16
3.1 General terms	17
3.2 Specific terms	18
3.3 Symbols.....	21
3.4 Abbreviated terms.....	21
4 Overview of this document.....	22
4.1 General.....	22
4.2 Experience.....	22
4.3 Literature	22
4.4 Harmonic generation.....	23
4.5 Modelling	23
4.6 Inductive coupling to telecommunication systems	23
4.7 Mitigation measures.....	23
4.8 Elimination or reduction of DC filters	24
4.9 DC side low-order resonance	24
4.10 Various other issues	24
4.11 Specification and design	24
4.12 Illustrative example.....	24
4.13 Reference material	24
5 DC side harmonic generation – LCC technology	25
5.1 General.....	25
5.2 DC side harmonic generation – basic concepts.....	25
5.2.1 Idealized assumptions	25
5.2.2 Influence of non-idealities.....	26
5.3 Stray capacitance and the three-pulse model.....	28
5.4 Influence of non-idealities	28
5.5 Harmonic cross-modulation from AC side.....	28
6 DC side harmonic generation – VSC technology.....	30
6.1 General.....	30
6.2 Harmonic generation from VSC using switch type valves	31
6.2.1 Overview	31
6.2.2 Two-level converter with carrier-based PWM	31
6.2.3 Two-level converter with optimized PWM (OPWM).....	34
6.3 Harmonic generation from multilevel VSC	36
6.3.1 Overview	36
6.3.2 Harmonic generation from a CTL converter.....	37
6.3.3 Harmonic generation from MMC type converters.....	38
6.4 Harmonic cross-modulation from AC side.....	41
6.5 Influence of non-idealities	41
6.6 Ground mode harmonics	42

6.7	Converter impedance.....	43
6.7.1	Overview	43
6.7.2	Passive impedance.....	44
6.7.3	Active impedance	44
7	Modelling and analysis	45
7.1	General.....	45
7.2	Frequency domain, time domain and other techniques	45
7.3	HVDC converter modelling for LCC technology	46
7.4	HVDC converter modelling for VSC technology	47
7.5	DC line modelling.....	48
7.6	HVDC cable modelling	49
7.7	DC switchyard equipment modelling	49
7.8	Detuning due to frequency and component deviations.....	50
7.8.1	Overview	50
7.8.2	Individual consideration of filter component detuning and AC frequency variation	51
7.8.3	Equivalent frequency detuning.....	52
7.9	Harmonic current calculation.....	53
7.10	Frequency dependent modelling	54
7.11	Detailed aspects to be considered in studies for LCC.....	54
7.12	Transfer of disturbances between AC systems.....	55
8	Inductive coupling to telecommunication lines	56
8.1	General.....	56
8.2	Analytical method	57
8.3	Analysis of harmonic currents in the DC system.....	58
8.4	Mutual impedance between power lines and telephone lines.....	58
8.4.1	Overview	58
8.4.2	Calculations of mutual impedance	58
8.4.3	Variation of mutual impedance with frequency, resistivity and separation	63
8.4.4	Influence of earth resistivity	66
8.4.5	Crossings and angled exposures	67
8.5	Induced voltages on telephone lines	67
8.5.1	Overview	67
8.5.2	Longitudinal induced voltages.....	68
8.5.3	HVDC transmission line shield wires.....	68
8.5.4	Telephone circuit shielding factor (K_n).....	69
8.5.5	Telephone circuit balance factor (B_n).....	70
8.5.6	Psophometric weighting.....	70
8.5.7	Calculation of differential (metallic mode) weighted induced voltage	71
8.6	Equivalent disturbing current method (I_{eq}).....	73
8.6.1	Methodology	73
8.6.2	Determination of H_n factor	74
8.6.3	Differences between a 50 Hz and a 60 Hz system	78
8.7	Modal analysis	78
8.7.1	General	78
8.7.2	Modal analysis of HVDC conductor currents	78
8.7.3	Modal analysis of mutual impedance	79
8.7.4	Modal analysis of coupling between HVDC and communication lines.....	81

8.8	Induced voltage in a test line	84
8.9	Electrode lines	84
8.10	Inductive coupling from HVDC underground cables	85
8.11	Frequency range	86
8.12	Digital telecommunications systems	87
8.13	Railway signal interference	87
9	Harmonic performance limits	88
9.1	General	88
9.2	Procedure to determine limits	89
9.3	Standard limits for induced noise	90
9.3.1	Overview	90
9.3.2	IEEE and Canadian standards	90
9.3.3	ITU-T standard	92
9.3.4	Comparison between standards	92
9.3.5	Allowance for other noise sources	92
9.4	Derivation of equivalent disturbing current (I_{eq}) limit	93
9.5	Rapid estimation of permissible disturbing current limit	94
9.5.1	Overview	94
9.5.2	Using IEEE recommendations	95
9.5.3	Using ITU-T recommendations	96
9.6	Considerations for definition of limits	97
9.6.1	Overview	97
9.6.2	Variation of performance limits along the transmission corridor	97
9.6.3	Variation of harmonic limits with time duration	99
9.6.4	Unbalanced bipolar operation	99
9.6.5	Consideration of pole mode contribution	100
9.6.6	Combination of harmonic current contributions from converter stations	100
9.7	Limits for induced voltage criterion	101
9.8	Experience from existing projects	101
9.9	Harmonic performance limits for HVDC cables	102
9.10	Harmonic rating limits for HVDC cables	104
9.11	Safety aspects	105
10	Harmonic performance verification and measurements	105
10.1	General	105
10.2	Compliance verification	106
10.3	Measurements on DC conductors	106
10.4	Measurements of external induction	108
10.4.1	Overview	108
10.4.2	Measurements to indirectly assess disturbing current	108
10.4.3	Verification by magnetic field measurements	110
10.4.4	Measurements to assess disturbance to an actual telephone line	111
10.5	Monitoring equipment and analytical software	112
10.6	Influence of mutual impedance and earth resistivity	112
10.7	Duration and analysis of measurements	114
11	Mitigation of adverse effects of DC side harmonics	114
11.1	General	114
11.2	Objectives of mitigation measures	115
11.3	Optimization of cost of mitigation measures	115

11.4	Mitigation measures in the HVDC system.....	115
11.4.1	Overview	115
11.4.2	Mitigation measures for LCC HVDC	116
11.4.3	Mitigation measures for VSC HVDC	117
11.5	Mitigation measures in telecommunication systems	118
12	DC filter design.....	118
12.1	General.....	118
12.2	DC filter fundamentals	119
12.3	Filtering mechanisms for LCCs	120
12.4	DC filter design process	123
12.5	Possible DC filter configurations	125
12.5.1	Single-tuned filters	125
12.5.2	Multiple-tuned filters	127
12.5.3	Damping resistors in shunt filters	133
12.6	Arrangement and switching of filter banks	135
12.6.1	Overview	135
12.6.2	Choice of switchable filter units	136
12.6.3	Capability and speed of switches	136
12.6.4	Switching of additional filters in monopolar mode.....	136
12.6.5	Use of out-of-service pole filters in monopolar mode.....	137
12.7	Neutral side smoothing reactors and impact on DC side harmonic flow	138
12.8	Pole to earth filters	139
12.9	Series filters	140
12.10	Active filters	141
12.11	Paralleling of DC lines and DC filters	142
12.12	Equipment rating for harmonic stresses	144
12.12.1	General	144
12.12.2	Calculation principles	144
12.12.3	Calculation considerations	145
12.12.4	Derivation of rating parameters.....	145
12.12.5	Outage contingencies	146
12.12.6	Short-time rating.....	147
12.12.7	Re-evaluation of critical cases	147
12.13	Rating for abnormal operation conditions	148
12.14	Transient rating.....	148
12.15	Protection aspects	151
12.16	Reliability and availability.....	152
12.16.1	Overview	152
12.16.2	Outage management	153
12.17	Audible noise	153
12.18	Losses	154
12.19	Mechanical and visual design	155
12.20	Economic aspects.....	157
12.20.1	General	157
12.20.2	Equipment costs	157
12.20.3	Other costs.....	158
12.21	Safety aspects related to harmonic currents.....	158
12.21.1	HVDC substations	158
12.21.2	HVDC transmission lines	158

12.22	Seismic requirements	159
13	Elimination or reduction of DC filters.....	160
13.1	General.....	160
13.2	Refurbishment of existing LCC HVDC schemes	161
13.3	Overhead line and cable transmissions	161
13.4	DC filters in a hybrid LCC-VSC system	162
13.4.1	General	162
13.4.2	Assessment of vulnerability of the VSC to DC side harmonic currents	163
13.4.3	With limitations due to telecommunication interference	163
13.4.4	No limitations due to telecommunication interference	163
13.5	Back-to-back systems	164
14	DC side low order resonance	164
14.1	General.....	164
14.2	Parameters affecting low-order resonance	165
14.2.1	Overhead line transmission	165
14.2.2	Cable transmissions	168
14.3	Low order harmonic voltage sources	170
14.4	Impact of high values of 2 nd harmonic currents and voltages.....	171
14.5	Core saturation instability	173
14.6	Mitigation measures.....	174
14.7	Study and assessment.....	176
15	Coupling between DC line and parallel AC lines	177
15.1	General.....	177
15.2	Deleterious effects of fundamental frequency induction.....	178
15.3	Factors affecting significance.....	179
15.4	Study methods.....	181
15.5	Modes and impacts of induced currents	181
15.6	AC line configuration, loading and phase sequences	183
15.7	Effect of earth resistivity	184
15.8	Location along line route.....	185
15.9	Multiple AC line exposures.....	185
15.10	AC and DC lines sharing a tower	187
15.11	Transpositions	188
15.11.1	Overview	188
15.11.2	DC line transpositions.....	188
15.11.3	AC line transpositions.....	189
15.12	Cross modulation in LCC and VSC.....	190
15.13	Mitigation measures.....	190
15.13.1	General	190
15.13.2	Transposition of DC and/or AC lines	191
15.13.3	Fundamental frequency filters.....	191
15.13.4	Control actions	192
15.14	Interaction between nearby HVDC links	193
16	Harmonics in HVDC grids	193
16.1	General.....	193
16.2	Similarities with AC networks	194
16.3	Harmonic emissions in an HVDC grid.....	196
16.4	Network harmonic impedance of an HVDC grid.....	196

16.5	Harmonic distortion limits for HVDC grids	196
16.6	Allocation of headroom	197
16.7	Use of DC filters	198
16.8	DC side harmonic stability	198
17	Impact of geomagnetic storms	199
17.1	General.....	199
17.2	Impact on DC side harmonics	199
18	Guidelines for requirement specifications	200
18.1	General.....	200
18.2	Environmental licencing considerations.....	200
18.3	Vulnerable infrastructure.....	201
18.4	Circuit configurations and operating conditions	201
18.4.1	General	201
18.4.2	Circuit configurations	201
18.4.3	Operating modes	202
18.4.4	Special operating conditions	202
18.4.5	Range of operating parameters	202
18.4.6	Environmental parameters	203
18.5	Basic data to be considered for harmonic calculation	203
18.5.1	DC transmission line data.....	203
18.5.2	AC system data	203
18.5.3	Deviation of parameters and tolerances to be considered	204
18.5.4	DC filter outage and redundancy requirements	204
18.6	Methods for harmonic calculation.....	204
18.7	Performance requirements regarding telecommunication interference.....	205
18.8	Requirements regarding danger from induced voltages.....	205
18.9	Ripple voltage on cables and overhead lines	206
18.10	Other criteria for filter design	206
18.10.1	Additional requirements	206
18.10.2	Standards and test requirements	206
18.10.3	Filter component rating.....	206
18.10.4	Insulation levels.....	206
18.10.5	Availability, reliability and switching.....	206
18.10.6	Protection and safety.....	206
18.11	DC side harmonic field measurements	207
19	Equipment design and test requirements	207
19.1	General.....	207
19.2	General requirements	207
19.2.1	Structural.....	207
19.2.2	Failure rate.....	208
19.2.3	Quality assurance.....	208
19.2.4	Equipment test requirements	209
19.2.5	Technical information submitted by the contractor	209
19.2.6	Filter component ratings	210
19.3	Capacitors	210
19.3.1	Capacitors general	210
19.3.2	Capacitor design aspects.....	211
19.3.3	Capacitor electrical data.....	213
19.3.4	Capacitor tests	214

19.4	Reactors	215
19.4.1	Reactors general	215
19.4.2	Reactor design aspects	216
19.4.3	Reactor electrical data	217
19.4.4	Reactor tests	218
19.5	Resistors	218
19.5.1	Resistors general	218
19.5.2	Resistor design aspects	218
19.5.3	Resistor electrical data	219
19.5.4	Resistor tests	220
19.6	Arresters	222
19.6.1	Arresters general	222
19.6.2	Arrester design aspects	222
19.6.3	Arrester electrical data	223
19.6.4	Arrester tests	223
19.7	Current transformers	224
19.7.1	Current transformers general	224
19.7.2	Current transformer design aspects	224
19.7.3	Current transformer electrical data	224
19.7.4	Current transformer tests	225
19.8	Filter switching equipment	226
19.8.1	Filter switching equipment general	226
19.8.2	Filter switching equipment design aspects	226
19.8.3	Filter switching equipment electrical data	226
19.8.4	Filter switching equipment tests	227
Annex A (normative)	Stray capacitances and the three pulse model	228
A.1	Overview	228
A.2	Calculation of three-pulse harmonic driving voltages	228
A.3	Phase angles of triplen order harmonic generation	232
A.4	Return path for ground mode currents	233
A.5	Triplen order harmonic current flow through stray capacitances	234
A.5.1	General	234
A.5.2	Odd order triplens	235
A.5.3	Even order triplens	238
A.5.4	Odd and even harmonic flow in bipolar mode	240
A.6	Complete harmonic current paths	241
A.7	Stray capacitive paths in converter transformer	244
A.8	Influence of non-idealities	247
Annex B (informative)	Illustrative calculations	251
B.1	General	251
B.2	Data	251
B.3	Results	252
B.4	Mechanisms of harmonic current flow	252
B.4.1	Studies for current flow	252
B.4.2	Case A	252
B.4.3	Case B	252
B.4.4	Case C	252
B.4.5	Case D	253
B.4.6	Case E	253

B.5	Filter solutions for different target disturbance limits	253
B.5.1	Studies for filter solutions	253
B.5.2	Case F	253
B.5.3	Case G	253
B.5.4	Case H	254
B.5.5	Case I	254
B.5.6	Case J	254
B.5.7	Case K	254
B.5.8	Case L	254
B.6	General conclusions	254
B.7	Connection of filters from pole to earth	255
B.7.1	Case M	255
B.7.2	Case N	255
B.8	Smoothing reactor sizing	255
B.9	Electrode line harmonic disturbing current	255
B.10	Other operation modes	256
Bibliography		258
Figure 1 – DC-voltage for 12-pulse operation		26
Figure 2 – References and carrier for a two-level converter using PWM with pulse number 9		32
Figure 3 – Resulting modulation waveform for one phase of a two-level converter using PWM with pulse number 9		32
Figure 4 – AC current is directed through the positive path when the modulation signal is positive and the negative path when the signal is negative		33
Figure 5 – Source current from the converter on the DC side (before the pole capacitor)		33
Figure 6 – Current harmonic spectrum for a two-level converter with pulse number 39		34
Figure 7 – Current harmonic spectrum for a two-level converter with pulse number 39 (extended frequency range)		34
Figure 8 – Modulation waveform and fundamental voltage on AC side for OPWM		35
Figure 9 – DC side current waveform contribution from one phase		35
Figure 10 – DC current harmonic spectrum for a two-level converter with OPWM		36
Figure 11 – DC current harmonic spectrum for a two-level converter with OPWM (extended frequency range)		36
Figure 12 – Voltage source representation of the MMC or CTL ([28] [29])		37
Figure 13 – Example of the DC voltage harmonic spectrum from a CTL converter		38
Figure 14 – Example of the DC voltage harmonic spectrum from a CTL converter (extended frequency range)		38
Figure 15 – Valve voltage generation [28] [29]		39
Figure 16 – Harmonic spectrum of the DC voltage U_{DC}		39
Figure 17 – Harmonic spectrum of the DC voltage U_{DC} (extended frequency range)		40
Figure 18 – Harmonic spectrum for one arm of the MMC converter (extended frequency range)		40
Figure 19 – Pole mode current paths for MMC symmetrical monopole		42
Figure 20 – Ground mode current paths for MMC symmetrical monopole		42
Figure 21 – Active and passive impedance elements		43

Figure 22 – Energy balancing	44
Figure 23 – Illustration of converter active impedance seen from the DC side	45
Figure 24 – Coupling between an HVDC overhead line and a parallel telecommunication line	56
Figure 25 – Complex earth return plane	61
Figure 26 – Absolute depth of earth return plane as a function of frequency and resistivity	61
Figure 27 – Complex earth return plane and image conductor.....	62
Figure 28 – Difference between Carson’s and Dubanton’s equations for 100 m separation and 1 000 Ω-m earth resistivity	63
Figure 29 – Real part of the mutual impedance for different separation distances (for 100 Ω-m).....	64
Figure 30 – Imaginary part of the mutual impedance for different separation distances (for 100 Ω-m).....	64
Figure 31 – Absolute value of the mutual impedance for different separation distances (for 100 Ω-m).....	65
Figure 32 – Real part of the mutual impedance for different earth resistivities (for 100 m separation)	65
Figure 33 – Imaginary part of the mutual impedance for different earth resistivities (for 100 m separation)	66
Figure 34 – Absolute value of the mutual impedance for different earth resistivities (for 100 m separation)	66
Figure 35 – Comparison of C-message and ITU-T (formerly-CCITT) weighting curves	71
Figure 36 – Mutual impedances for varying separation at resistivity 100 Ω-m (linear frequency scale)	76
Figure 37 – Modal impedances as function of earth resistivity, for separation distance 100 m	80
Figure 38 – Modal impedances as function of separation for earth resistivity 100 Ω-m.....	80
Figure 39 – Example of HVDC cable route (red) and nearby telephone cable beside a road (blue).....	86
Figure 40 – Relationship between induced voltage and telephone noise in dBrn	91
Figure 41 – Mutual impedance magnitude at 800 Hz versus separation distance	93
Figure 42 – Mutual impedance magnitude at 1 000 Hz vs. separation distance	94
Figure 43 – Permissible I_{eq} versus earth resistivity for varying separations (IEEE criteria).....	95
Figure 44 – Permissible I_{eq} versus separation for varying earth resistivities (IEEE criteria).....	96
Figure 45 – Permissible I_{eq} versus earth resistivity for varying separations (ITU-T criteria).....	96
Figure 46 – Permissible I_{eq} versus separation for varying earth resistivities (ITU-T criteria).....	97
Figure 47 – Variation along a DC line of total I_{eq} and harmonics emitted by one converter station.....	98
Figure 48 – Variation along a DC line of total I_{eq} and harmonics emitted by both converter stations	98
Figure 49 – Maximum exposure distances for two different VSC converter types	104
Figure 50 – Measurement of cable core current only.....	107

Figure 51 – Additive and subtractive connection of Rogowski coils	107
Figure 52 – Practical arrangements for test line measurements	108
Figure 53 – Alternative measurement locations to eliminate pole mode influence.....	109
Figure 54 – Convenient location of test vehicle	110
Figure 55 – Measurement of I_{eq} by magnetic loop antenna	111
Figure 56 – Possible test arrangement for telephone line partially parallel to DC cables	112
Figure 57 – Double test line method.....	113
Figure 58 – Overview of DC filtering configuration	120
Figure 59 – Additional line reactors.....	121
Figure 60 – Typical single-frequency filter configuration and sample impedance plot	125
Figure 61 – Single-frequency filter with bypass capacitor connection and sample impedance plot	126
Figure 62 – Typical double-tuned filter configuration and sample impedance plot.....	127
Figure 63 – Typical double-tuned filter configuration with bypass capacitor and sample impedance plot	130
Figure 64 – Typical triple-tuned filter configuration.....	131
Figure 65 – Impedance plot for a 12th/24th/36th triple tuned filter.....	131
Figure 66 – Double-tuned filters with optional resistor locations	133
Figure 67 – Double tuned filter impedance characteristic without resistors	133
Figure 68 – Impedance characteristic with $R_2 = 300 \Omega$	134
Figure 69 – Impedance characteristic with $R_1 = 500 \Omega$	134
Figure 70 – Impedance characteristic with $R_{hp} = 500 \Omega$	135
Figure 71 – Common additional monopolar filter	137
Figure 72 – Smoothing reactance split between pole and neutral	139
Figure 73 – Impedance plot for one particular pole-earth filter	140
Figure 74 – Possible series “blocking” filter configurations.....	140
Figure 75 – Paralleling of converters and DC lines.....	143
Figure 76 – Equivalent circuit for transient analysis of earth faults on pole line	149
Figure 77 – Equivalent circuit for transient analysis of switching surges.....	150
Figure 78 – 800 kV DC filter HV capacitor.....	156
Figure 79 – Comparison of the design response spectra of different seismic codes	159
Figure 80 – Impedance of overhead DC line for different line lengths (remote end short-circuited).....	165
Figure 81 – Circuit components affecting DC side resonance.....	166
Figure 82 – Influence of converter station components on 1 500 km DC side impedance	167
Figure 83 – Total impedance seen from inside the converter for an LCC HVDC cable system example.....	168
Figure 84 – Pole mode impedances of 300 km XLPE cable pair	169
Figure 85 – Pole mode impedances of 150 km XLPE cable pair	170
Figure 86 – Ground mode impedances of 300 km XLPE cable pair	170
Figure 87 – Direct current (in kA) response to AC 1-ph fault (time scale 10 ms/div)	173
Figure 88 – Additional line reactor	175
Figure 89 – Currents in DC line caused by inductive and capacitive coupling.....	178

Figure 90 – Half-cycle saturation due to DC offset	179
Figure 91 – Typical harmonic content of magnetizing current for half-cycle saturation.....	179
Figure 92 – Factors affecting fundamental frequency induction	180
Figure 93 – Induced modal voltages for different separations between AC and DC lines	182
Figure 94 – Alternative paths through symmetrical monopole for induced ground mode fundamental frequency current.....	183
Figure 95 – Induction in one DC conductor for close and distant AC-DC line separations.....	184
Figure 96 – Several parallel AC lines	185
Figure 97 – Second AC line acts partially as a load on the DC circuit.....	186
Figure 98 – Second AC line in same location acts as shield wires.....	187
Figure 99 – Capacitive coupling on a hybrid AC-DC transmission line.....	188
Figure 100 – Effect of transposing the DC line on induced fundamental frequency.....	189
Figure 101 – Effect of perfect AC line transposition on induced fundamental frequency in DC line.....	190
Figure 102 – Fundamental frequency blocking filters (with alternative resistor locations).....	191
Figure 103 – Fundamental frequency blocking filter locations for a symmetrical monopole.....	192
Figure 104 – Example of a hypothetical HVDC grid [149]	193
Figure 105 – Concept of Planning Levels and Compatibility Levels ([108]).....	195
Figure 106 – Planning level and headroom	195
Figure 107 – Geomagnetic induction in the DC circuit.....	199
Figure A.1 – Decomposition of 6-pulse waveform into three-pulse waveforms.....	229
Figure A.2 – Six-pulse converter modelled as series connection of two three-pulse converters.....	229
Figure A.3 – Twelve-pulse converter modelled as series connection of four three-pulse converters.....	230
Figure A.4 – 6 th harmonic driving voltage per three-pulse bridge.....	231
Figure A.5 – 12 th harmonic driving voltage per three-pulse bridge	231
Figure A.6 – Relative phase displacement of three-pulse sources (balanced bipolar operation).....	233
Figure A.7 – Pole and neutral path equivalents for triplen harmonics	234
Figure A.8 – Odd triplen harmonic generation and current flow (part 1).....	235
Figure A.9 – Odd order triplen harmonic generation and current flow (part 2).....	237
Figure A.10 – Even order triplen harmonic generation and current flow.....	240
Figure A.11 – Triplen harmonic flow in bipolar mode.....	241
Figure A.12 – Harmonic current flow – monopolar operation (as generated by left-hand converter)	242
Figure A.13 – Harmonic current flow – bipolar operation (as generated by left-hand converter)	243
Figure A.14 – Example of converter transformer stray capacitance paths.....	245
Figure A.15 – Distributed element model of converter transformer winding	246
Figure A.16 – Characteristic harmonic voltage generation for a notional 800 kV converter at rated power	248
Figure A.17 – Harmonic voltage generation due to 1 % AC negative sequence voltage.....	248

Figure A.18 – Harmonic voltage generation due to voltage difference between Y and D windings	249
Figure A.19 – Harmonic voltage generation due to difference in reactance between Y and D windings	249
Figure A.20 – Harmonic voltage generation due to random variation in dx among phases	249
Figure A.21 – Harmonic voltage generation due to valve firing jitter	250
Figure A.22 – Harmonic voltage generation due to all sources simultaneously	250
Table 1 – Some of the more significant cross-modulation relationships	29
Table 2 – Earth penetration depth as a function of frequency and earth resistivity (Carson-Clem)	60
Table 3 – IEEE recommended noise and balance thresholds [87]	91
Table 4 – Recommended ITU-T limits for telephone noise	92
Table 5 – Comparison of seismic fortification goals and levels	160
Table 6 – Capacitor design parameters	213
Table 7 – Reactor design parameters	217
Table 8 – Resistor design parameters	219
Table 9 – Arrester design parameters	223
Table 10 – Current transformer design parameters	224
Table 11 – Filter switching equipment design parameters	227
Table B.1 – C-message weighted harmonic currents results for numerical example	257

INTERNATIONAL ELECTROTECHNICAL COMMISSION

DC side harmonics & filtering in HVDC transmission systems

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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IEC TS 63529 has been prepared by IEC technical committee 115: High Voltage Direct Current (HVDC) transmission for DC voltages above 100 kV. It is a Technical Specification.

CIGRE Technical Brochure 811 served as a basis for the elaboration of this document.

The text of this Technical Specification is based on the following documents:

Draft	Report on voting
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Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this Technical Specification is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

INTRODUCTION

0.1 Introduction

This document is intended as guidelines to all aspects of DC side harmonic behaviour and filters for HVDC transmission systems. It is based on CIGRE Technical Brochure 811 [1]¹ developed by CIGRE Working Group B4.68. CIGRE sought to bring together the experience, and consider the interests, of different sectors of the HVDC community to produce a Brochure [1] of interest to all parties concerned, including utilities, suppliers and consultants.

The objective of this document is to provide information to enable informed and intelligent decisions to be made by those concerned. Where there are different possible approaches to some aspect of design, the relative merits are discussed.

0.2 Continuing relevance

Two major technological changes have transformed the subject area of Technical Brochure 811 [1] since publication of the original CIGRE Technical Brochure 92 [2] on the same topic:

- a) The replacement of analogue telephone systems by digital and optical and mobile (cell phone) technologies has reduced the relevance of inductive interference from HVDC lines, although there remain areas where local analogue telephone connections can still be affected.
- b) The introduction of VSC HVDC converters with inherently lower harmonic generation, and often with underground cable transmission, has largely removed the need for DC side filters in HVDC projects using such technology.

The question might therefore be asked – if it is not useful to have DC filters in many future projects, is there a need for this document dealing with DC side harmonics and filtering? Strong justifications are given below.

- c) National or international regulations governing electro-magnetic compatibility (EMC) often demand that no interference be caused to third parties, and this is an element to consider for third parties or regulators before an HVDC project can obtain planning permission or enter operation. Definitions of such interference include the frequency range addressed in this Technical Specification. Studies can be required to reduce the risk to all parties involved in an HVDC project, even if the conclusion is that no special mitigation measures are required.
- d) There can be a telephone interference issue in regions where analogue technology is still used for the final connection from an exchange to the consumer's premises, especially where telephone cables and HVDC cables are laid in, or alongside, the same road.
- e) Some digital communication can be subject to interference or safety hazard from induction, even if not affected directly at audible frequencies.
- f) Possible resonance of the DC transmission system at harmonic frequencies should always be considered and studied.
- g) Coupling with parallel AC transmission lines in the same corridor, or even on the same tower, is becoming increasingly topical due to restrictions on the construction of new overhead lines.
- h) The owners of older HVDC projects undergoing refurbishment might wish to consider whether their DC filters are still required, and this will necessitate studies.
- i) As DC filters and DC side harmonic issues become less common, the expertise in this field will diminish, and therefore the comprehensive record of knowledge encapsulated in this document will be a valuable reference.

¹ Numbers in square brackets refer to the Bibliography.

1 Scope

This document is intended to inform and guide the harmonic design of the DC side of HVDC projects. It considers all aspects of AC current and voltage occurring on the DC circuit and also the interaction with adjacent systems.

The switching action in HVDC converters results in a wide spectrum of harmonics. These range from the fundamental frequency to the radio frequency range. Traditionally the specification of DC side harmonic performance has been limited to the frequency range of interest for induced audible noise on nearby telephone systems. Often a limit of 50th harmonic has been applied, corresponding to 2 500 Hz or 3 000 Hz on 50 Hz and 60 Hz systems respectively. Occasionally the range has been extended to 5 000 Hz. This frequency range has corresponded to the spectrum of characteristic harmonic generation from thyristor line-commutated converters (LCC).

The introduction of HVDC voltage sourced converters (VSC) has meant that although the magnitude of DC side harmonic generation from these converters is generally lower, the generated spectrum of interest extends to higher frequencies.

The scope of this document therefore covers the frequency range up to approximately 5 000 Hz. Higher frequencies are mentioned only when relevant. The scope excludes the much higher frequency ranges appropriate to PLC communication and the radio interference spectra.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60633, *High-voltage direct current (HVDC) transmission - Vocabulary*

IEC 62747, *Terminology for voltage-sourced converters (VSC) for high-voltage direct-current (HVDC) systems*

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