



BSI Standards Publication

High-voltage direct current (HVDC) systems — Guidance to the specification and design evaluation of AC filters

Part 3: Modelling

National foreword

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TECHNICAL REPORT



**High-voltage direct current (HVDC) systems – Guidance to the specification and design evaluation of AC filters –
Part 3: Modelling**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

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CONTENTS

FOREWORD.....	7
INTRODUCTION.....	9
1 Scope.....	10
2 Normative references.....	10
3 Harmonic interaction across converters.....	10
3.1 General.....	10
3.2 Practical experience of problems	11
3.3 Indicators of where harmonic interaction is significant	13
3.4 Interaction phenomena	14
3.5 Impact on AC filter design	15
3.5.1 General	15
3.5.2 AC side third harmonic.....	15
3.5.3 Direct current on the AC side	16
3.5.4 Characteristic harmonics	16
3.6 General overview of modelling techniques	16
3.6.1 General	16
3.6.2 Time domain AC-DC-AC interaction model	18
3.6.3 Frequency domain AC-DC-AC interaction model	19
3.6.4 Frequency domain AC-DC interaction model.....	19
3.6.5 Frequency domain current source model	19
3.7 Interaction modelling	20
3.7.1 General	20
3.7.2 Coupling between networks.....	20
3.7.3 Driving forces.....	21
3.7.4 System harmonic impedances	22
3.8 Study methods	22
3.8.1 Frequency domain	22
3.8.2 Time domain	22
3.9 Composite resonance.....	23
3.10 Core saturation instability	23
3.11 Particular considerations for back-to-back converters.....	23
3.12 Issues to be considered in the design process	24
3.12.1 General	24
3.12.2 Fundamental frequency and load issues	24
3.12.3 Negative phase sequence	25
3.12.4 Pre-existing harmonic distortion	26
3.12.5 AC network impedance	27
3.12.6 Converter control system.....	28
3.12.7 Combination with "classic" harmonic generation	29
3.12.8 Relative magnitude of pairs of low-order harmonics	29
3.12.9 Superposition of contributions	30
3.13 Parallel AC lines and converter transformer saturation	30
3.14 Possible countermeasures.....	32
3.14.1 AC (and/or DC) filters.....	32
3.14.2 DC control design	32
3.14.3 Operating restrictions and design protections	33

3.15	Recommendations for technical specifications	33
3.15.1	General	33
3.15.2	Specified design data	33
3.15.3	Requirements regarding calculation techniques	34
4	AC network impedance modelling	35
4.1	General	35
4.2	Implications of inaccurate definition of network impedance	36
4.3	Considerations for network modelling	37
4.3.1	General	37
4.3.2	Project life expectancy and robustness of data	37
4.3.3	Network operating conditions	37
4.3.4	Network impedances for performance and rating calculations	38
4.3.5	Modelling of network components	39
4.3.6	Representation of loads at harmonic frequencies	40
4.4	Network harmonic impedance envelopes	40
4.5	Methods of determining envelope characteristics	43
4.5.1	General	43
4.5.2	Low order harmonics	43
4.5.3	Mid-range and higher order harmonics	44
4.5.4	Balancing of risk and benefit	45
4.5.5	Consideration of tolerances on harmonic bands	46
4.5.6	Two separate envelopes for one harmonic band	48
4.5.7	Critical envelope parameters	49
4.5.8	Impedance envelopes for performance and rating conditions	49
4.6	Examples of the impact of different network impedance representations	50
4.6.1	Effect of network envelope parameters on resultant distortion	50
4.6.2	Effect of network minimum resistance on filter rating	53
4.7	Interharmonic impedance assessment	54
4.8	Measurement of network harmonic impedance	56
4.9	Conclusions	57
5	Pre-existing harmonics	57
5.1	General	57
5.2	Modelling and measurement of pre-existing harmonic levels	58
5.3	Harmonic performance evaluation, methods and discussion	60
5.3.1	General	60
5.3.2	"Incremental" harmonic performance evaluation	60
5.3.3	"Aggregate" harmonic performance evaluation	61
5.3.4	Both "incremental" and "aggregate" performance evaluation	62
5.3.5	"Incremental" and "maximum magnification factor" harmonic performance evaluation	63
5.4	Calculation of total harmonic performance indices	63
5.5	Harmonic rating evaluation	64
5.6	Difficulties with the voltage source/worst network model for rating	65
5.6.1	Background	65
5.6.2	Illustration of the voltage source/worst network method	66
5.7	Further possible calculation procedures for rating evaluation	68
5.7.1	Using measured levels of pre-existing distortion	68
5.7.2	Applying compatibility level voltage source at the filter busbar	70

5.7.3	Limiting the filter bus harmonic voltage to a maximum level for filter rating (MLFR)	72
5.7.4	Limiting total source distortion to the defined THD	73
5.7.5	Limiting harmonic order of pre-existing distortion	75
5.8	Conclusions	75
Annex A (informative)	Location of worst-case network impedance	76
Annex B (informative)	Accuracy of network component modelling at harmonic frequencies	79
B.1	General	79
B.2	Loads	79
B.3	Transformers	82
B.3.1	Transformer reactance	82
B.3.2	Transformer resistance	82
B.4	Transmission lines	85
B.5	Synchronous machines	87
B.6	Modelling of resistance in harmonic analysis software	88
Annex C (informative)	Further guidance for the measurement of harmonic voltage distortion	91
Annex D (informative)	Project experience of pre-existing harmonic issues	93
D.1	General	93
D.2	Third harmonic overload of filters in a back-to-back system	93
D.3	Third and fifth harmonic overload of filters in a line transmission	94
D.4	Overload of a DC side 6 th harmonic filter	94
Annex E (informative)	Worked examples showing impact of pre-existing distortion	96
E.1	General	96
E.2	Pre-existing distortions	97
E.2.1	Example 1 – Illustration of magnification	97
E.2.2	Impact of network impedance parameters	101
Annex F (informative)	Comparison of calculation methods	103
F.1	General	103
F.2	Reference case – Converter generated harmonics only	106
F.3	Method 1 – Source voltages behind impedance sector	106
F.4	Method 2 – Source voltages at filter bus (see 5.7.2)	106
F.5	Method 3 – Limiting the filter bus harmonic voltage to a maximum level for filter rating (MLFR) (see 5.7.3)	107
F.6	Method 4 – Limiting total source distortion to the THD level (see 5.7.4)	107
F.7	Method 5 – Pre-existing harmonics considered only up to the 10 th , with 10 % margin on converter generation for remainder (see 5.7.5)	110
Bibliography		111
Figure 1	– Key elements of a complete AC-DC-AC harmonic interaction model	17
Figure 2	– Equivalent circuit for evaluation of harmonic interaction with DC side interaction frequency greater than AC side fundamental frequency	21
Figure 3	– DC side 6 th harmonic voltage due to AC side 5 th harmonic (fixed angle) and 7 th harmonic (varying angle)	27
Figure 4	– Simple circuit used to represent AC network impedance at 5 th and 7 th harmonics	28
Figure 5	– Example of a single impedance locus for harmonic orders 2 to 49	41

Figure 6 – Example of simple circle envelope encompassing all scatter points for harmonic orders 2 to 49	42
Figure 7 – Example of an impedance envelope for 7 th to 13 th harmonic with associated scatter plots	44
Figure 8 – Example of an impedance envelope for 13 th to 19 th harmonic with associated scatter plots	45
Figure 9 – Example of an impedance envelope for 19 th to 25 th harmonic with associated scatter plots	45
Figure 10 – Example of the need to extend the band of harmonics to allow for resonance effects	47
Figure 11 – Application of tolerance range in percentage of the harmonic number	48
Figure 12 – Application of tolerance range in percentage of the harmonic number, zoomed to show 11 th and 13 th harmonics	48
Figure 13 – Example showing two impedance envelopes for a particular band.....	49
Figure 14 – Example of impedance envelopes under "performance" and "rating" conditions for harmonic orders 4 th to 7 th	50
Figure 15 – Example of impedance envelopes "performance" and "rating" conditions for harmonic orders 25 th to 31 st	50
Figure 16 – Discrete envelopes for different groups of harmonics.....	51
Figure 17 – Example showing a distributed generation causing about 15 % attenuation of ripple control signal at the PCC	55
Figure 18 – Generic circuit model for calculation of harmonic performance or rating	59
Figure 19 – Illustration of basic voltage quality concepts with time/location statistics covering the whole system	60
Figure 20 – Circuit model for calculation of incremental performance	61
Figure 21 – Equivalent circuit of a network for the h^{th} harmonic	66
Figure 22 – Typical voltage magnification factor	67
Figure 23 – Pre-existing distortion set to measured levels (plus margin).....	68
Figure 24 – Pre-existing distortion applied directly at the filter bus	70
Figure 25 – Harmonic voltage stress on a shunt capacitor with IEC planning levels applied	72
Figure A.1 – Equivalent circuit model for demonstration of worst-case resonance between AC filters and the network	76
Figure A.2 – Diagram indicating vectors Z_F , Z_N and Z_H	77
Figure B.1 – Typical equivalent load network.....	80
Figure B.2 – Relative error of equivalent load loss resistance R_n of using [28] compared with Electra 167 [27] model.....	83
Figure B.3 – Effect of temperature on transformer load loss	84
Figure B.4 – Ratio between harmonic and fundamental frequency resistance as calculated for balanced mode components and calculated from averages of reduced Z matrix resistance values	86
Figure B.5 – Ratio between harmonic and fundamental frequency resistance as calculated for balanced mode components and calculated from averages of reduced Z matrix resistance values, for varying earth resistivity	87
Figure B.6 – Comparison of synchronous machine reactance between [4-1] recommendation and test measurements for a salient pole hydro generator of 370 MVA	87
Figure B.7 – Comparison of synchronous machine resistance between [17] recommendation and test measurements for a salient pole hydro generator of 370 MVA	88
Figure B.8 – Comparison of different approximations for resistance variations.....	89

Figure B.9 – Network impedance for Araraquara substation	90
Figure E.1 – Harmonic models for converter and for pre-existing distortion	97
Figure E.2 – Geometrical visualisation of selecting worst-case impedance for converter harmonics.....	97
Figure E.3 – Simple filter scheme to illustrate magnification.....	98
Figure E.4 – Plots illustrating magnification of various pre-existing harmonics.....	101
Figure F.1 – Network impedance sector used in example.....	103
Figure F.2 – Assumed filter scheme for examples of different methods of calculation	104
Figure F.3 – IEC planning levels used for source voltages in the study.....	105
Table 1 – Dominant frequencies in AC–DC harmonic interaction	15
Table 2 – Comparison of calculated harmonic voltage distortion between two methods of representing network harmonic impedance	52
Table 3 – Comparison of calculated harmonic voltage distortion considering the variation of network impedance angle.....	53
Table 4 – Comparison of calculated filter harmonic current considering the variation of network minimum resistance and filter detuning.....	54
Table 5 – Amplification factor $\tan \phi$ at different network impedance angles.....	66
Table 6 – Variation of calculated filter harmonic current as a function of detuning	71
Table B.1 – Constants for resistance adjustment – five parameter equations.....	89
Table E.1 – Parameters of elements of a simplified filter scheme shown in Figure E.3.....	98
Table E.2 – Voltage and current distortion for $Z_{\min} = 1 \Omega$ and varying ϕ	101
Table E.3 – Voltage and current distortion for $\phi = \pm 85^\circ$ and varying $Z_{\min}$	102
Table F.1 – Table F.1 – Parameters of components of filters shown in Figure F.2.....	104
Table F.2 – Component rating calculated using different calculation methods.....	106
Table F.3 – Rating calculations using Method 3 – for BP1113 C1.....	107
Table F.4 – Rating calculations using Method 3 – for HP24 R1	109
Table F.5 – Rating calculations using Method 4 – for BP1113 C1.....	110

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**HIGH-VOLTAGE DIRECT CURRENT (HVDC) SYSTEMS –
GUIDANCE TO THE SPECIFICATION AND
DESIGN EVALUATION OF AC FILTERS –****Part 3: Modelling****FOREWORD**

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IEC TR 62001-3, 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 first edition of IEC TR 62001-3, together with IEC TR 62001-1, IEC TR 62001-2 and IEC TR 62001-4, cancels and replaces IEC TR 62001 published in 2009. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to IEC TR 62001:

- a) expanded and supplemented Clause 6;
- b) new Clause 4;
- c) new Clause 5;
- d) new annexes on the location of worst case network impedance;
- e) accuracy of network component modelling at harmonic frequencies;
- f) further guidance for the measurement of harmonic voltage distortion;
- g) project experience of pre-existing harmonic issues;
- h) worked examples showing impact of pre-existing distortion;
- i) comparison of calculation methods.

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

Enquiry draft	Report on voting
22F/411/DTR	22F/415/RVC

Full information on the voting for the approval of this document 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 in the IEC 62001 series, published under the general title *High-voltage direct current (HVDC) systems – Guidance to the specification and design evaluation of AC filters*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability 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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

The IEC TR 62001 series is structured in four parts:

Part 1 – Overview

This part concerns specifications of AC filters for high-voltage direct current (HVDC) systems with line-commutated converters, permissible distortion limits, harmonic generation, filter arrangements, filter performance calculation, filter switching and reactive power management and customer specified parameters and requirements.

Part 2 – Performance

This part deals with current-based interference criteria, design issues and special applications, field measurements and verification.

Part 3 – Modelling

This part addresses the harmonic interaction across converters, pre-existing harmonics, AC network impedance modelling, simulation of AC filter performance.

Part 4 – Equipment

This part concerns steady-state and transient ratings of AC filters and their components, power losses, audible noise, design issues and special applications, filter protection, seismic requirements, equipment design and test parameters.

HIGH-VOLTAGE DIRECT CURRENT (HVDC) SYSTEMS – GUIDANCE TO THE SPECIFICATION AND DESIGN EVALUATION OF AC FILTERS –

Part 3: Modelling

1 Scope

This part of IEC TR 62001, which is a Technical Report, provides guidance on the harmonic interaction across converters, pre-existing harmonics, AC network impedance modelling and simulation of AC filter performance.

The scope of this document covers AC side filtering for the frequency range of interest in terms of harmonic distortion and audible frequency disturbances. It excludes filters designed to be effective in the PLC and radio interference spectra.

This document concerns the "conventional" AC filter technology and line-commutated high-voltage direct current (HVDC) converters.

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 TR 61000-3-6:2008, *Electromagnetic compatibility (EMC) – Part 3-6: Limits – Assessment of emission limits for the connection of distorting installations to MV, HV and EHV power systems*

IEC 61000-4-30, *Electromagnetic compatibility (EMC) – Part 4-30: Testing and measurement techniques – Power quality measurement methods*

3 Harmonic interaction across converters

3.1 General

In order to facilitate the analysis of harmonic generation by an HVDC converter, simplifying assumptions are often made. Typically, the HVDC converter is regarded as a generator of harmonic currents, with an infinite internal impedance. Such an assumption is reasonably valid for practical purposes for most harmonics, and is the basis of the calculation methods described in IEC TR 62001-1.

The customer should be aware, however, that such a simplified approach has limitations, and can lead to incorrect analysis and design in some circumstances. In practice, the converter is a link between the AC and DC side harmonic systems, and the AC side harmonic currents may be strongly influenced by the harmonic impedance and harmonic current flows on the DC side.

This is particularly true for low-order harmonics, and it is strongly recommended that the analysis of third harmonic distortion and filtering requirements should take into account the AC/DC side harmonic interaction. At the 11th and 13th harmonics, the interaction effect can