



IEC TR 63179

Edition 1.0 2026-01

TECHNICAL REPORT

Planning of HVDC systems



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2026 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search -

webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, ...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch

Discover our powerful search engine and read freely all the publications previews, graphical symbols and the glossary. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 500 terminological entries in English and French, with equivalent terms in 25 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD.....	3
1 Scope.....	5
2 Normative references.....	5
3 Terms and definitions.....	5
4 General	5
5 Selection between HVDC and AC	7
5.1 Consideration of overall network planning	7
5.1.1 Overall network planning	7
5.1.2 Connection topologies.....	7
5.2 Consideration of transmission capacity	8
5.3 Consideration of operation requirements	8
5.3.1 System fault and stability	8
5.3.2 Voltage regulation and reactive power compensation.....	8
5.4 Consideration of costs.....	9
5.5 Consideration of other aspects.....	9
6 HVDC solutions	10
6.1 Main circuit topologies.....	10
6.1.1 Asymmetrical monopolar HVDC transmission system.....	10
6.1.2 Symmetrical monopole HVDC transmission system	11
6.1.3 Bipolar HVDC transmission system	11
6.2 Key DC rating parameters	13
6.2.1 Nominal DC power	13
6.2.2 Nominal DC voltage	13
6.2.3 Nominal DC current.....	14
6.3 Converters	14
6.3.1 General.....	14
6.3.2 LCC.....	15
6.3.3 VSC	15
6.3.4 Comparisons between LCC and VSC	16
6.3.5 Applicable scenarios of LCC and VSC.....	19
6.3.6 Converter connection and combination in a project.....	19
6.3.7 Converter/interface transformer	20
6.4 Other main equipment.....	21
6.4.1 General.....	21
6.4.2 AC filtering equipment	21
6.4.3 Dynamic braking system	22
6.4.4 DC circuit breakers	22
6.5 Line conductor	22
6.6 Station sites and transmission line routes.....	23
6.6.1 HVDC converter station sites	23
6.6.2 Overhead line route.....	24
6.6.3 Electrode station sites	24
6.6.4 Submarine cable route.....	25
6.6.5 Land cable route	25
7 Interconnection system scheme and stability analysis.....	25
7.1 Scheme for HVDC access to AC system	25

7.2	Interface requirements between AC network and converter station	26
7.3	Requirements of HVDC control systems.....	27
7.3.1	LCC control.....	27
7.3.2	VSC control.....	27
7.4	Stability analysis.....	28
7.4.1	Static analysis	28
7.4.2	Transient analysis.....	31
7.4.3	Dynamic analysis	31
8	Economic comparison of the alternatives	33
8.1	General	33
8.2	Main factors to be considered	33
8.3	Indexes to be considered.....	33
8.4	Sensitivity analysis	34
8.5	Economic conclusion for recommended solution	34
9	Study conclusions and recommended solution.....	34
Annex A (informative)	Introduction to three of the broadband oscillation analysis methods	35
A.1	Electromagnetic transient simulation method	35
A.2	Eigenvalue modelling method	35
A.3	impedance modelling method.....	36
Bibliography.....		37
Figure 1 – Phases during integration of a new HVDC system into the electrical power network		6
Figure 2 – Procedure for planning an HVDC system.....		7
Figure 3 – Asymmetrical monopolar HVDC transmission system with earth return		10
Figure 4 – Asymmetrical monopolar HVDC transmission system with dedicated metallic return.....		10
Figure 5 – Symmetrical monopolar HVDC transmission system. with AC side ground impedance.....		11
Figure 6 – Bipolar HVDC transmission system with earth return		12
Figure 7 – Bipolar HVDC transmission system with dedicated metallic return.....		12
Figure 8 – Rigid bipolar HVDC transmission system.....		13
Figure 9 – Different MMC submodule topologies		15
Figure 10 – Bipolar configuration of the Baihetan-Jiangsu UHVDC project with LCC and VSC in the inverter station		20
Table 1 – Comparison between LCC and VSC HVDC system on technical items		16

INTERNATIONAL ELECTROTECHNICAL COMMISSION

Planning of HVDC 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.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch>. IEC shall not be held responsible for identifying any or all such patent rights.

IEC TR 63179 has been prepared by IEC technical committee 115: High Voltage Direct Current (HVDC) transmission for DC voltages above 100 kV. It is a Technical Report.

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

Draft	Report on voting
115/418/DTR	115/427/RVDTR

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 Report 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.

1 Scope

This document provides technical information for planning high-voltage direct current (HVDC) systems with line-commutated converters (LCC), voltage sourced converters (VSC), or both. It provides general principles for deciding between HVDC and AC transmission systems, as well as processes and methods for preliminarily defining the HVDC transmission scheme, including selection of converter type and key parameters, grid stability analysis, and technical-economic comparison among various solutions. In addition, this document gives the objectives to be achieved in the planning phase.

This document is applicable for planning a point-to-point or a back-to-back HVDC system.

This document can also be used for DC grid systems (including multi-terminal HVDC systems) as a reference.

This document is not exhaustive. It is possible that there are other specific aspects, that are particularly important for a specific HVDC project.

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*

Bibliography

IEC 60050-601, *International Electrotechnical Vocabulary (IEV) - Part 601: Generation, transmission and distribution of electricity - General*

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

IEC TR 62001 (all parts), *High-voltage direct current (HVDC) systems - Guidance to the specification and design evaluation of AC filters*

IEC TS 62344, *Design of earth electrode stations for high-voltage direct current (HVDC) links - General guidelines*

IEC TR 62672, *Reliability and availability evaluation of HVDC systems*

IEC TR 62681, *Electromagnetic performance of high voltage direct current (HVDC) overhead transmission lines*

IEC TR 63127, *Guideline for the system design of HVDC converter stations with line-commutated converters*

IEC TS 63471, *DC voltages for HVDC grids*

CIGRE Technical Brochure No. 068, *Guide for planning DC links terminating at AC locations having low short-circuit capacities. Part 1. AC/DC interaction phenomena*

CIGRE Technical Brochure No. 115, *Guide for planning DC links terminating at AC system locations having low short-circuit capacities. Part II: Planning guidelines*

CIGRE Technical Brochure No. 186, *Economic assessment of HVDC links*

CIGRE Technical Brochure No. 269, *VSC Transmission*

CIGRE Technical Brochure No. 352, *Capacitor commutated converted (CCC) HVDC interconnections - Digital modeling and benchmark circuit*

CIGRE Technical Brochure No. 364, *Systems with multiple DC infeed*

CIGRE Technical Brochure No. 388, *Impacts of HVDC lines on the economics of HVDC projects*

CIGRE Technical Brochure No. 417, *Technological assessment of 800kV HVDC applications*

CIGRE Technical Brochure No. 492, *Voltage source converter (VSC) HVDC for power transmission – Economic aspects and comparison with other AC and DC technologies*

CIGRE Technical Brochure No. 508, *HVDC environmental planning guidelines*

CIGRE Technical Brochure No. 950, *Hybrid LCC/VSC HVDC systems*

EPRI Report, *HVDC system control for damping of subsynchronous oscillations, EPRI EL-2708, Final Report, October 1982*

IEEE Std 1204-1997, *IEEE guide for planning DC links terminating at AC locations having low short-circuit capacities*