भारतीय मानक

Indian Standard

IS 19053 : 2024
IEC TS 63471 : 2023

एचवीडीसी ग्रिड के लिए डीसी वोल्टेज

DC Voltages for HVDC Grids

ICS 29.200; 29.240.01

भारतीय मानक ब्यूरो
BUREAU OF INDIAN STANDARDS
मानक भवन, 9 बहादुर शाह ज़फर मार्ग, नई दिल्ली - 110002
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI - 110002
www.bis.gov.in www.standardsbis.in

October 2024 **Price Group 4**

HVDC Power Systems Sectional Committee, ETD 40

NATIONAL FOREWORD

This Indian Standard which is identical to IEC TS 63471 : 2023 ‘DC voltages for HVDC grids’ issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendation of the HVDC Power Systems Sectional Committee and approval of the Electrotechnical Division Council.

The text of the IEC standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words ‘International Standard’ appears referring to this standard, they should be read as ‘Indian Standard’; and

b) Comma (,) has been used as a decimal marker, while in Indian Standards the current practice is to use a point (.) as the decimal marker.

Only English language text has been retained while adopting it in this Indian Standard, and as such the page numbers given here are not the same as in the International Standard.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test, shall be rounded off in accordance with IS 2 : 2022 ‘Rules for rounding off numerical values (*second revision*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

CONTENTS

INTRODUCTION

While high voltage direct current (HVDC) solutions for bulk power transmission have been developed and implemented commercially since 1954, recent years have seen a strong increase in the number of HVDC projects. There were about 80 commercial projects rated above 50 kV in the five decades until the year 2000. Since then, the use of HVDC technology has rapidly grown to around 200 HVDC systems at the time of writing. This development was accompanied by increasing both the HVDC system voltage and current ratings. While in the 20th century, almost all electrical transmission was performed in AC, at present, network planning activities all over the world are increasingly considering HVDC transmission the technology of choice. This is mainly driven by the response to the climate change and the political commitment, such as European Union's Green Deal and others to reduce the carbon-dioxide footprint of societies.

HVDC power transmission, especially voltage-sourced converter (VSC) HVDC power transmission, provide feasible solutions for the large-scale integration of renewable generation, and electrification of platforms in offshore grids. HVDC systems strengthen the power systems by increasing their power transmission capacity, improving stability and controllability as well as enabling the integration of different electricity markets.

VSC HVDC is put forward as the technology for a DC grid, as it supports multiterminal operation with fixed voltage polarity. The current flow direction in an VSC HVDC transmission line or cable can be easily changed by adjusting the voltage difference between two DC substations without polarity reversal. Utilisation of a standardised DC voltage is useful for DC side equipment manufacturing, DC grid design and operation.

For many stand-alone HVDC projects with a DC voltage above 100 kV (not part of any grid), DC voltage is normally selected by optimising total cost of the project considering cost of initial capital investment and cost of losses over entire lifespan. Considering recommended DC voltage levels for HVDC grids could be very beneficial, for anyone planning HVDC projects, which might potentially become part of a future HVDC grid. However, whilst adopting such standardized DC voltages would facilitate future extensions towards HVDC grids, they would preclude the optimization of DC voltage levels in individual projects, thereby leading to potentially higher investment costs. Thus, the DC voltage series is not mandatory for the DC voltage selection of stand-alone (not forming part of DC Grid) HVDC projects, e.g. a point-to-point HVDC power transmission and distribution system.

Although this DC voltage series is preferable in the conversion of segments of AC grids to DC grids the selected DC voltage should take the ratings of transmission lines or cables into account and thus, should not been limited by levels of this DC voltage series.

Over the last few decades, HVDC technology has matured, and significant work is being done towards development and maturing of the medium voltage DC (MVDC) technology. Modularity, easy compliance with standard voltage and power levels and feasibility of cost reduction indicate high potential for medium voltage DC systems. MVDC collection and distribution grids will be key for the grid integration of renewable energies and the connection of, for example, electrical vehicle charging infrastructure, energy storage systems, data centres, distribution for congested urban areas, city infeed and future smart homes. Interconnected MVDC systems can provide high efficiency, avoid overload conditions, limit short circuit currents, and improve overall system cost. Major cost savings can be realized in DC distribution systems because additional AC/DC conversion steps for home appliances with internal DC use can be eliminated and grid side power factor correction is not needed. In addition, the use of MVDC grids allows power flow control between multiple AC substations. This would enable more stable MVAC grids, increased utilization of the AC infrastructure, higher redundancy, and the support of existing weak AC grids. Considering the aspects summarized above the recommended DC voltage series includes medium DC voltage levels above 1,5 kV. Such medium DC voltage levels could also be considered for the design of the DC neutral, dedicated metallic return (DMR) of HVDC systems taking also other requirements such as the insulation levels into account.

The work should be understood as an initial contribution for standardized DC voltages, to be further elaborated by the respective Technical Committees (e.g. TC 8).

Indian Standard

DC VOLTAGES FOR HVDC GRIDS

1 Scope

This document provides a recommended DC voltage series for HVDC grids with a DC voltage above 1,5 kV. It concerns the selection of a nominal DC voltage of multi-terminal HVDC power transmission and distribution systems and meshed HVDC networks, grids, rather than a rated DC voltage or highest DC voltage.

There is no stringent requirement to consider this DC voltage series for the DC voltage selection for any stand-alone (not forming part of DC Grid) HVDC projects, e.g. a point-to-point HVDC power transmission and distribution system. However, in order to facilitate the later progression towards larger HVDC systems in the future the use of standardized DC voltages is very useful. At later stages, with multi-terminal systems and meshed HVDC grids, the use of harmonized voltages will indeed become essential in order to optimize both capital and operational costs. Also, for entirely new projects, system planning should include this outlook and can benefit from the use of the recommended DC voltage series.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1
HVDC grid
high voltage direct current transmission and distribution network connecting more than two AC/DC converter stations transferring energy in the form of high voltage direct current, including related transmission lines, switching stations, DC/DC converter stations, if any, as well as other equipment and sub-systems needed for operation

3.2
nominal DC voltage
value of DC voltage used to designate or identify a system or grid

Note 1 to entry: In HVDC grids, the nominal DC voltage is defined as pole-to-earth or pole-to-neutral. The nominal value is generally a rounded value.

3.3
highest DC voltage
highest value of DC voltage for which the equipment and system is designed to operate continuously, in respect of its insulation as well as other characteristics

Note 1 to entry: Rated DC voltage is defined elsewhere for equipment design purposes.

4 Recommended DC voltages for HVDC grids

The DC voltages for a DC grid with a DC voltage above 1,5 kV are recommended to be selected from the values in Table 1.

Table 1 – Recommended nominal DC voltages for HVDC grids with a DC voltage above 1,5 kV

Pole-to-earth voltage (kV)
3
6
10 [a]
20
35
50
100
160 [a]
200
250
320 [a]
400
500 / 525 [a]
600
800
1 100 [b]

[a] Preferred values.

[b] Economic feasibility of this voltage level needs to be evaluated.

Bibliography

IEC 60071-1, *Insulation co-ordination – Part 1: Definitions, principles and rules*

IEC 60071-11, *Insulation co-ordination – Part 11: Definitions, principles and rules for HVDC systems*

IEC 60038, *IEC standard voltages*

IEC/TR 62543, *High-voltage direct current (HVDC) power transmission using voltage sourced converters (VSC)*

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

IEC 60633, *High-voltage direct current (HVDC) transmission – Vocabulary*

IEC/TS 63291-1, *High-voltage direct current (HVDC) grid systems and connected converter stations – Guideline and parameter lists for functional specifications – Part 1: Guideline*

CIGRE Technical Brochure No. 533, *HVDC grid feasibility study*

CIGRE Technical Brochure No. 657, *Guidelines for the preparation of "connection agreements" or "grid codes" for multi-terminal schemes and DC grids*

CIGRE Technical Brochure No. 684, *Recommended voltages for HVDC grids*

CIGRE Technical Brochure No. 793, *Medium voltage direct current (MVDC) grid feasibility study*

CIGRE B4 DC Grid Test System, ELECTRA, No. 270 October 2015

Technical Guidelines for Radial HVDC Networks, CLC/TR 50609

J. K. Steinke, P. Maibach, G. Ortiz, F. Canales and P. Steimer, "MVDC Applications and Technology," PCIM Europe 2019, Nuremberg, May 2019

B. Grainger and R. W. De Doncker, Medium Voltage DC System Architectures, 1st ed. The Institution of Engineering and Technology, London, United Kingdom, 2022

“German Standardization Roadmap – Low Voltage DC,” Version 1, Feb. 2016. This DKE Roadmap for developing DC guidelines can be downloaded from the DKE webpages: www.dke.de/Gleichstrom-Roadmap

ETSI standards and guidelines can be found at www.etsi.org/standards

____

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act*, 2016 to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Copyright

Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the website-www.bis.gov.in or www.standardsbis.in.

This Indian Standard has been developed from Doc No.: ETD 40 (25564).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones: 2323 0131, 2323 3375, 2323 9402 *Website*: www.bis.gov.in

Regional Offices:		*Telephones*
Central	: 601/A, Konnectus Tower -1, 6th Floor, DMRC Building, Bhavbhuti Marg, New Delhi 110002	2323 7617
Eastern	: 8th Floor, Plot No 7/7 & 7/8, CP Block, Sector V, Salt Lake, Kolkata, West Bengal 700091	2367 0012 2320 9474
Northern	: Plot No. 4-A, Sector 27-B, Madhya Marg, Chandigarh 160019	265 9930
Southern	: C.I.T. Campus, IV Cross Road, Taramani, Chennai 600113	2254 1442 2254 1216
Western	: 5th Floor/MTNL CETTM, Technology Street, Hiranandani Gardens, Powai Mumbai 400076	2570 0030 2570 2715

Branches : AHMEDABAD, BENGALURU, BHOPAL, BHUBANESHWAR, CHANDIGARH, CHENNAI, COIMBATORE, DEHRADUN, DELHI, FARIDABAD, GHAZIABAD, GUWAHATI, HARYANA (CHANDIGARH), HUBLI, HYDERABAD, JAIPUR, JAMMU, JAMSHEDPUR, KOCHI, KOLKATA, LUCKNOW, MADURAI, MUMBAI, NAGPUR, NOIDA, PARWANOO, PATNA, PUNE, RAIPUR, RAJKOT, SURAT, VIJAYAWADA.

Published by BIS, New Delhi