IEC 60700-3

Edition 1.0 2022-11

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Thyristor valves for high voltage direct current (HVDC) power transmission – Part 3: Essential ratings (limiting values) and characteristics

Valves à thyristors pour le transport d'énergie en courant continu à haute tension (CCHT) – Partie 3: Valeurs assignées (valeurs limites) et caractéristiques essentielles



IEC 60700-3:2022-11(en-fr)



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

ICS 29.200

ISBN 978-2-8322-6121-7

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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THYRISTOR VALVES FOR HIGH VOLTAGE DIRECT CURRENT (HVDC) POWER TRANSMISSION –

Part 3: Essential ratings (limiting values) and characteristics

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IEC 60700-3 has been prepared by subcommittee 22F: Power electronics for electrical transmission and distribution systems, of IEC technical committee 22: Power electronic systems and equipment. It is an International Standard.

The text of this International Standard is based on the following documents:

Draft	Report on voting
22F/667/CDV	22F/686/RVC

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 International Standard 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.

A list of all parts in the IEC 60700 series, published under the general title *Thyristor valves for high voltage direct current (HVDC) power transmission*, can be found on the IEC website.

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THYRISTOR VALVES FOR HIGH VOLTAGE DIRECT CURRENT (HVDC) POWER TRANSMISSION –

Part 3: Essential ratings (limiting values) and characteristics

1 Scope

This part of IEC 60700 specifies the service conditions, the definitions of essential ratings and characteristics of thyristor valves utilized in line commutated converters with three-phase bridge connections to realize the conversion from AC to DC and vice versa for high voltage direct current (HVDC) power transmission applications. It is applicable for air insulated, liquid cooled and indoor thyristor valves.

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 60060-1, *High-voltage test techniques – Part 1: General definitions and test requirements*

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

IEC 60700-1:2015, *Thyristor valves for high voltage direct current (HVDC) power transmission – Part 1: Electrical testing*
IEC 60700-1:2015/AMD1:2021[1]

IEC 60700-2:2016, *Thyristor valves for high voltage direct current (HVDC) power transmission – Part 2: Terminology*

IEC 61803:2020, *Determination of power losses in high-voltage direct current (HVDC) converter stations with line-commutated converters*

3 Terms, definitions, symbols and abbreviated terms

3.1 Terms and definitions

No terms and definitions are listed in this document.

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

[1] There exists a consolidated edition 1.1 (2021) that comprises IEC 60700-1:2015 and its Amendment 1:2021.

3.2 Symbols and abbreviated terms

3.2.1 General

Clause 3.2 covers only the most frequently used symbols and abbreviated terms related to this document. The documents listed in Clause 2 contain additional symbols and abbreviated terms.

3.2.2 Subscripts

0 (zero)	at no load
i	ideal
N	nominal or rated value
d	direct current or voltage
ac	alternating current or voltage
r	resistive or overvoltage
x	inductive
u	undervoltage
j	thyristor junction
v	valve or valve side of converter transformer
m	multiple valve (unit)
vs	valve support
s	switching impulse or stray
l	lightning impulse
st	steep front impulse
PF	protective firing
RP	recovery protection
T	temporary
S	short term
SC	short circuit
max	maximum
min	minimum
RMS	root mean square
av	average
ar	arrester
DRM	off-state repetitive maximum value
DSM	off-state non-repetitive maximum value
RRM	reverse repetitive maximum value
RSM	reverse non-repetitive maximum value

3.2.3 Letter symbols

α	(trigger/firing) delay angle
γ	extinction angle
μ	(commutation) overlap angle
X_t	commutation circuit reactance, including leakage reactance of converter transformer and other reactance in the commutation circuit which influence commutation process

P_{cu} on-load losses of converter transformer and DC smoothing reactor when a six-pulse bridge is operating at rated load

R_{th} equivalent resistance of the voltage drop of the thyristor valve

f_N rated AC system frequency

t_p valve conduction interval

t_G valve hold-off interval

k_{df} uneven voltage distribution factor, defined as the maximum deviation of the peak voltages of thyristor levels in a valve under the specified type of impulses, representing the degree of uneven voltage distribution due to tolerances of the voltage divider components, stray capacitances and differences in recovery charge of thyristors

3.2.4 Abbreviated terms

MVU multiple valve (unit)

SIPL switching impulse protective level

LIPL lightning impulse protective level

STIPL steep front impulse protective level

4 Service conditions

4.1 General

Thyristor valves shall be able to operate continuously and reliably under the specified service conditions throughout their entire service life except for maintenance periods. Such conditions, as the main input parameters for valve design, are essential to define the ratings and characteristics of the thyristor valves, and should be specified by the purchaser or by the system designer or the supplier as recommended in Annex A. The conditions mainly include the environmental conditions of valve halls under which thyristor valves will be required to operate, system conditions directly related to the design and operation of thyristor valves, main technical parameters of six-pulse bridges required by the system design, and any other conditions provided by the purchaser. Some of these conditions cannot be applicable depending upon the HVDC system design.

4.2 Environmental conditions

4.2.1 Site altitude

The altitude of the HVDC substation above sea-level shall be provided for insulation design of thyristor valves.

For external insulation (as defined in 3.1.3 of IEC 60700-1:2015), the insulation level of thyristor valves under standardized reference atmospheric conditions shall be determined in accordance with 4.2 of IEC 60700-1:2015.

For internal insulation (as defined in 3.1.3 of IEC 60700-1:2015), 8.2 of IEC 60700-1:2015 shall be referred to.

4.2.2 Air temperature and humidity range in valve halls

The maximum temperature and minimum relative humidity inside valve halls shall be considered in the atmospheric correction in accordance with 4.2 of IEC 60700-1:2015. In addition, the air temperature and the relative humidity in the valve hall shall be considered to prevent condensation on any surface of components within the valve hall.