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TECHNICAL REPORT

colour inside

High-voltage direct current (HVDC) power transmission using voltage sourced converters (VSC)

IEC TR 62543:2011-03+AMD1:2013-07+AMD2:2017-05 CSV(en)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

HIGH-VOLTAGE DIRECT CURRENT (HVDC) POWER TRANSMISSION USING VOLTAGE SOURCED CONVERTERS (VSC)

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In this Redline version, a vertical line in the margin shows where the technical content is modified by amendments 1 and 2. Additions are in green text, deletions are in strikethrough red text. A separate Final version with all changes accepted is available in this publication.

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This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of the base publication and its amendments 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

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- replaced by a revised edition, or
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HIGH-VOLTAGE DIRECT CURRENT (HVDC) POWER TRANSMISSION USING VOLTAGE SOURCED CONVERTERS (VSC)

1 Scope

This technical report gives general guidance on the subject of voltage-sourced converters used for transmission of power by high voltage direct current (HVDC). It describes converters that are not only voltage-sourced (containing a capacitive energy storage medium and where the polarity of d.c. voltage remains fixed) but also self-commutated, using semiconductor devices which can both be turned on and turned off by control action. The scope includes 2-level and 3-level converters with pulse-width modulation (PWM), along with multi-level converters, modular multi-level converters and cascaded two-level converters, but excludes 2-level and 3-level converters operated without PWM, in square-wave output mode.

HVDC power transmission using voltage sourced converters is known as "VSC transmission".

The various types of circuit that can be used for VSC transmission are described in the report, along with their principal operational characteristics and typical applications. The overall aim is to provide a guide for purchasers to assist with the task of specifying a VSC transmission scheme.

Line-commutated and current-sourced converters are specifically excluded from this report.

2 Normative references

The following referenced documents are indispensable for the application 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, *Terminology for high-voltage direct-current (HVDC) transmission*~~

IEC 61975, *High-voltage direct current (HVDC) installations – System tests*

IEC 62501, *Voltage sourced converter (VSC) valves for high-voltage direct current (HVDC) power transmission – Electrical testing*

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

IEC 62751 (all parts), *Power losses in voltage sourced converter (VSC) valves for high voltage direct current (HVDC) systems*

3 Terms and definitions

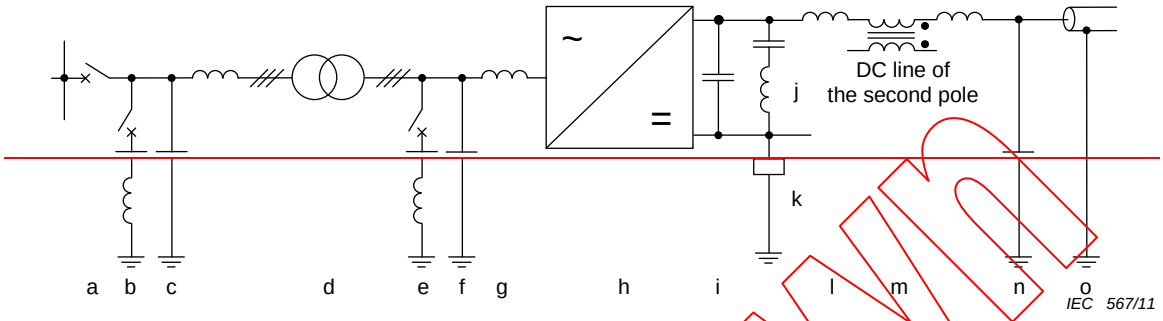
For the purposes of this document, the terms and definitions given in IEC 62747, IEC 62501 and the following apply.

3.1 General

Basic terms and definitions for voltage sourced converters used for HVDC transmission are given in IEC 62747. Terminology on electrical testing of VSC valves for HVDC transmission is given in IEC 62501.

NOTE This report uses the terminology established by IEC 60633 and IEC 61803 for line-commutated HVDC. Only terms which are specific to HVDC transmission using voltage sourced converters are defined in this clause. Those terms that are either identical to or obvious extensions of IEC 60633 or IEC 61803 terminology have not been defined.

To support the explanations, Figure 1 presents the basic diagram of a VSC system. Dependent on the converter topology and the requirements in the project, some components can be omitted or can differ.



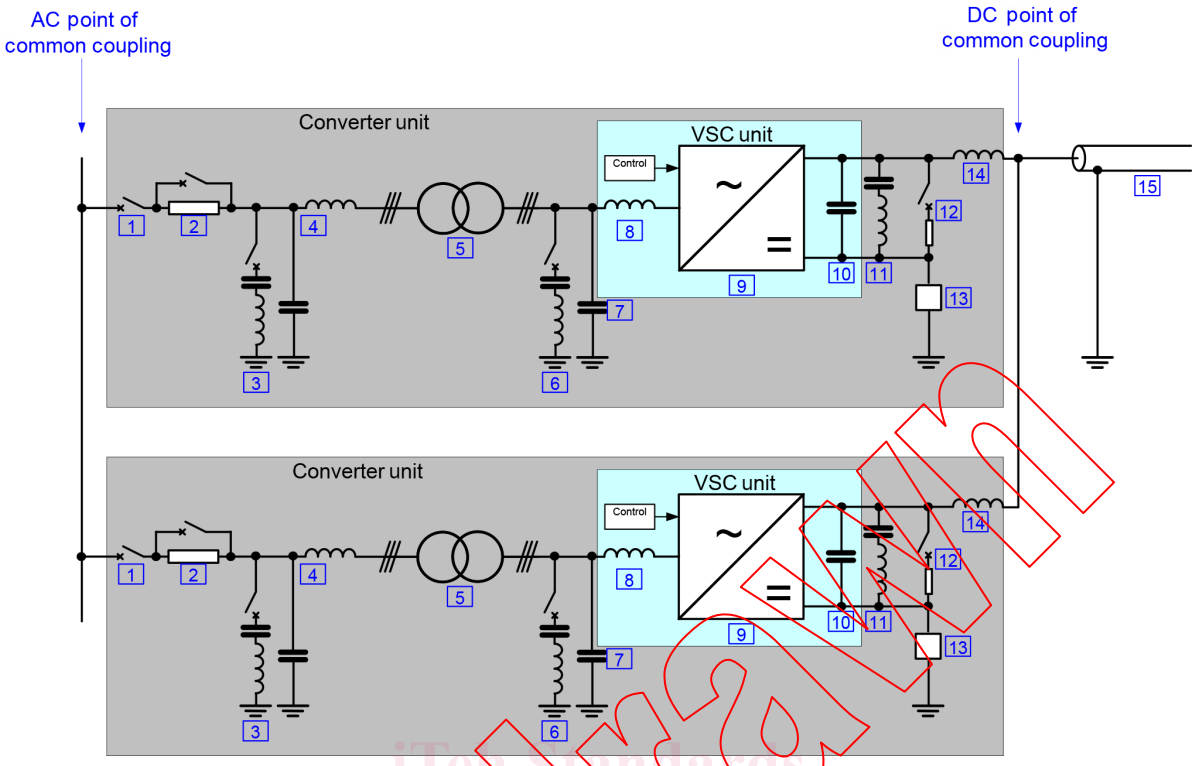
a	circuit breaker	i	VSC d.c. capacitor [b]
b	line side harmonic filter	j	d.c. harmonic filter
c	line side high frequency filter	k	neutral point grounding branch [c]
d	interface transformer	l	d.c. reactor [d]
e	converter side harmonic filter	m	common mode blocking reactor [d]
f + g	converter side high frequency filter [a]	n	d.c. side high frequency filter [d]
g	phase reactor [a]	o	d.c. cable or overhead transmission line [b]
h	VSC unit		

[a] In some designs of VSC, the phase reactor may fulfil part of the function of the converter-side high frequency filter. In addition, in some designs of VSC, part of or all of the phase reactor may be built into the three "Phase units" of the VSC unit, as "Valve reactors".

[b] In some designs of VSC, the VSC d.c. capacitor may be partly or entirely distributed amongst the three phase units of the VSC unit, where it is referred to as the d.c. submodule capacitors.

[c] The location of the neutral point grounding branch may be different depending on the design of the VSC unit.

[d] Not normally required for back-to-back systems.



1	circuit breaker	9	VSC unit [3]
2	pre-Insertion Resistor	10	VSC d.c. capacitor [4]
3	line side harmonic filter[1]	11	d.c. harmonic filter[1]
4	line side high frequency filter[6]	12	dynamic braking system[7]
5	interface transformer	13	neutral point grounding branch [5]
6	converter side harmonic filter[1]	14	d.c. reactor[8]
7 + 8	converter side high frequency filter[2]	15	d.c. cable or overhead transmission line
8	phase reactor [2]		

1) In some designs of VSC based on "controllable voltage source" valves, the harmonic filters may not be required.

2) In some designs of VSC, the phase reactor may fulfill part of the function of the converter-side high frequency filter.

3) In some VSC topologies, each valve of the VSC unit may include a "valve reactor", which may be built into the valve or provided as a separate component.

4) In some designs of VSC, the VSC d.c. capacitor may be partly or entirely distributed amongst the three phase units of the VSC Unit, where it is referred to as the d.c. submodule capacitors.

5) The philosophy and location of the neutral point grounding branch may be different depending on the design of the VSC unit.

6) In some designs of VSC, the interface transformer may fulfill part of the function of the line-side high frequency filter.

7) Optional.

8) Optional, if phase reactors are located on the d.c. side of the converter.

Figure 1 – Major components that may be found in a VSC substation