IEC 62823

Edition 1.0 2019-12

INTERNATIONAL STANDARD

NORME INTERNATIONALE

AMENDMENT 1
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Thyristor valves for thyristor controlled series capacitors (TCSC) – Electrical testing

Valves à thyristors pour condensateurs série commandés par thyristors (CSCT) – Essai électrique

IEC 62823:2015-08/AMD1:2019-12(en-fr)

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Thyristor valves for thyristor controlled series capacitors (TCSC) – Electrical testing

Valves à thyristors pour condensateurs série commandés par thyristors (CSCT) – Essai électrique

INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

ICS 29.240.99

ISBN 978-2-8322-7599-3

FOREWORD

This amendment has been prepared by subcommittee 22F: Power electronics for electrical transmission and distribution systems, of IEC technical committee 22: Power electronic systems and equipment.

The text of this amendment is based on the following documents:

CDV	Report on voting
22F/518/CDV	22F/532/RVC

Full information on the voting for the approval of this amendment can be found in the report on voting indicated in the above table.

The committee has decided that the contents of this amendment and the base publication will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

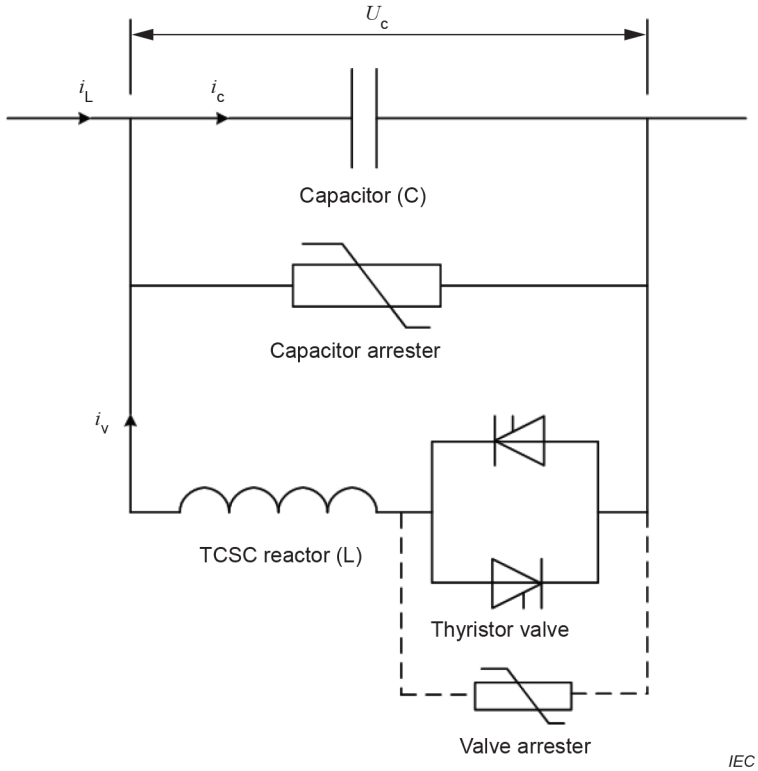
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

3.23
boost factor

Replace the words "divided by" by the word "and".

Figure 2 – TCSC subsegment

Replace the existing Figure 2 by the following new figure:



NOTE Valve arrester is optional.

Figure 2 – TCSC subsegment

Figure 4 – Thyristor valve voltage in a TCSC

Replace the existing Figure 4 by the following new figure:

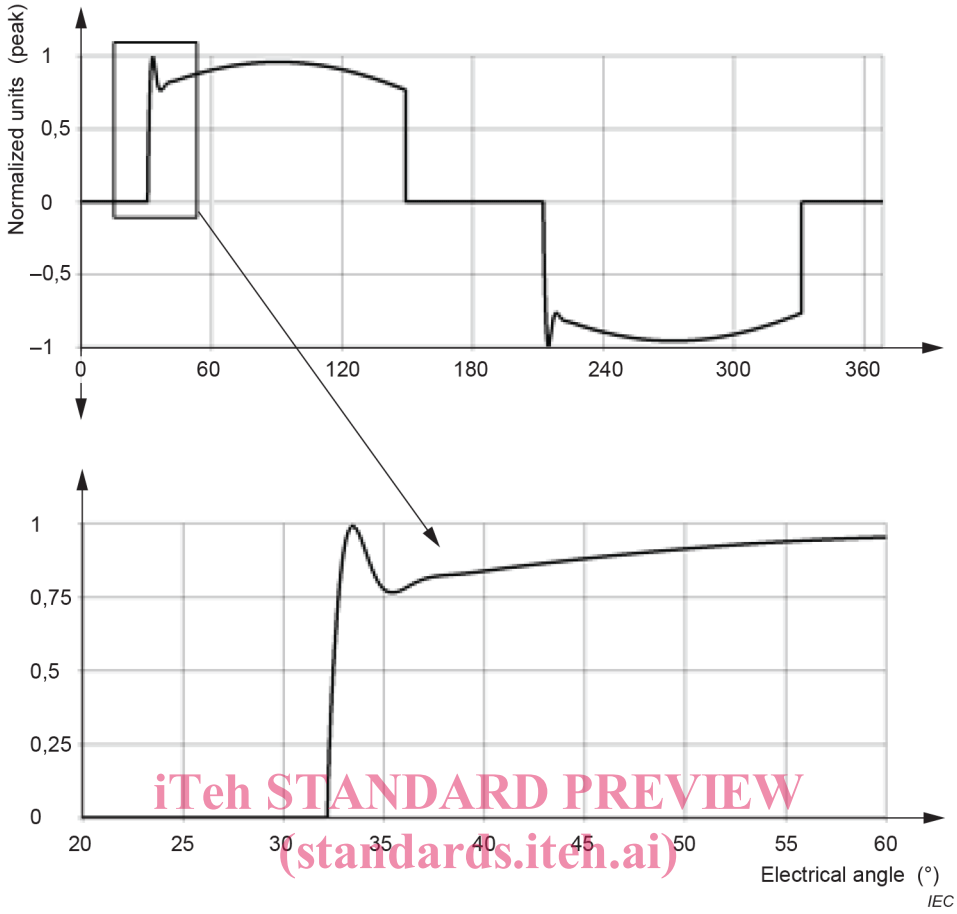


Figure 4 – Thyristor valve voltage in a TCSC

4.2.3.1 Capacitive boost operation mode

Replace the existing text by the following new text:

In TCSC capacitive boost operation mode, the TCSC valve current follows the formulation below:

$$i_v = (-1)^n \cdot \frac{\lambda^2 \cdot I_{L\_peak}}{\lambda^2 - 1} \cdot \left(\cos(\omega_N \cdot t) - \frac{\cos\beta}{\cos(\lambda \cdot \beta)} \cdot \cos(\lambda \cdot \omega_N \cdot t) \right), \qquad n \cdot \pi - \beta \le (\omega_N \cdot t) \le n \cdot \pi + \beta$$

$$i_v = 0 \qquad n \cdot \pi + \beta < (\omega_N \cdot t) < (n+1) \cdot \pi - \beta$$

$$n = 0, 1, 2, 3, \ldots$$

where

λ is the ratio of TCSC subsegment LC branch natural frequency and AC system power frequency, $\lambda = \dfrac{1}{\omega_N \cdot \sqrt{L \cdot C}}$;

I_{L_peak} is the AC system line current;

ω_N nominal angle frequency of AC system;

β is half of the maximum conduction angle of TCSC valves in one direction for capacitive boost at I_{L_peak}.

The rate of current change, di_v/dt, at thyristor turn-on and turn-off derives as follows:

$$\left.\frac{di_v}{dt}\right|_{\omega_N \cdot t=\frac{\pi}{2}+\beta} = \frac{\lambda^2 \cdot I_{L\_peak}}{\lambda^2 - 1} \cdot \left[\omega_N \cdot \sin\beta - \omega_N \cdot \frac{\cos\beta}{\cos(\lambda \cdot \beta)} \cdot \sin(\lambda \cdot \beta)\right]$$

The peak current through the TCSC valve is equal to:

$$i_{v\_peak} = \frac{\lambda^2 \cdot I_{L\_peak}}{\lambda^2 - 1} \cdot \left[1 - \frac{\cos\beta}{\cos(\lambda \cdot \beta)}\right]$$

The capacitor voltage, U_{C_N}, at thyristor turn-on and turn-off instants is equal to:

$$U_{C\_N} = \frac{\lambda \cdot I_{L\_peak}}{\lambda^2 - 1} \cdot X_0 \cdot [\sin\beta - \lambda \cdot \cos\beta \cdot \tan(\lambda \cdot \beta)]$$

where

X_0 is the TCSC subsegment LC branch impedance:

$$X_0 = \sqrt{\frac{L}{C}}$$

where

L is the inductance of TCSC subsegment LC branch (Figure 2);

C is the capacitance of TCSC subsegment LC branch (Figure 2).

The capacitor voltage peak, appearing on the TCSC valve, is equal to:

$$U_P = \lambda \cdot I_{L\_peak} \cdot X_0 \cdot \left[1 + \frac{\lambda \cdot (\cos\beta \cdot \tan(\lambda \cdot \beta) - \lambda \cdot \sin\beta)}{\lambda^2 - 1}\right]$$

The capacitive boost factor of the TCSC subsegment is equal to:

$$k_B = 1 + \frac{2}{\pi} \cdot \frac{\lambda^2}{\lambda^2 - 1} \cdot \left\{\frac{2 \cdot \cos^2\beta}{\lambda^2 - 1} \cdot [\lambda \cdot \tan(\lambda \cdot \beta) - \tan\beta] - \beta - \frac{\sin(2 \cdot \beta)}{\beta}\right\}$$

5.1.1.2 Test object

Replace, in the second sentence of the existing first paragraph, the words "valve interface electronics units" *by* "valve base electronics units"*.*

5.2.3 Atmospheric correction factor

Replace, in the existing second and third dash items, the two occurrences of the word "hall" by "enclosure"*.*

Table 2 – List of tests

Delete, in the second row, the word "earth".

Replace, in the third row, second column, the reference "7.2" by "7.3.1".

Replace, in the fourth row, second column, the reference "7.3" by "7.3.2".

Replace, in the sixth row, second column, the reference "8.2" *by* "8.3.1".

Replace, in the seventh row, second column, the reference "8.3" *by* "8.3.2".

Replace, in the 16th row, the existing title "Test for valve insensitivity to electromagnetic disturbance" *by the new title* "Test for valve insensitivity to electromagnetic disturbance (type test)".

Replace, in the 17th row, second column, the reference "11.3" by "11".

Replace, in the 17th row, third column, the word "valve" *by* "valve or valve section".

7.3.1.1 Test values and waveshapes

Replace, in the key U_{s1} to the equation in item a), the existing brackets by the following new brackets:

(typically derived from the lower of the protective levels of the valve arrester, if any, and the capacitor arrester)

Replace, in the key U_{s2} to the equation in item b), the existing brackets by the following new brackets:

(typically derived from operation with maximum continuous capacitive boost mode operating point A2 in Figure 5 for TCSC intended for application of power flow control or from the peak voltage of maximum continuous voltage across the series capacitor for TCSC intended for application of power oscillations damping or elimination of the risk of sub-synchronous resonance)

7.3.2 Lightning impulse test

Replace the existing text by the following text:

The test shall comprise three applications of positive polarity and three applications of negative polarity lightning impulse voltages between the main terminals, which are in common, and valve enclosure.

A standard lightning impulse voltage waveshape in accordance with IEC 60060-1 shall be used.

The test voltage shall be selected in accordance with the insulation co-ordination of the TCSC installation.

NOTE To use standard lightning impulse withstand voltage according to IEC 60071-1, based on the rated TCSC voltage, U_N, for testing is an alternative. However, this alternative does not take the TCSC capacitor surge arrester or TCSC valve surge arrester, if any, protection into consideration and applies an unrealistic higher voltage on the supporting structure. The choice of this alternative is subjected to agreement of the valve supplier.

8.3.1.1 Test values and waveshapes

Replace, in the existing first paragraph, the words "1 min" *by* "15 s".

Replace, in the key U_{v1} to the first equation, the existing brackets by the following new brackets:

(typically derived from the lower of the protective levels of the valve arrester, if any, and the capacitor arrester)

Delete, in the paragraph immediately preceding the second equation, the second existing sentence starting with "Where this is the case".

Replace, in the second equation, the existing letter symbol "k_{tv2}" *by* "k_3", as follows:

$$U_{tv2} = \frac{U_{v2}}{\sqrt{2}} \cdot k_3$$

Replace, in the key U_{v2} *to the second equation, the existing brackets by the following new brackets:*

(typically derived from operation with maximum continuous capacitive boost mode operating point A2 in Figure 5 for TCSC intended for application of power flow control or from the peak voltage of maximum continuous voltage across the series capacitor for TCSC intended for application of power oscillations damping or elimination of the risk of sub-synchronous resonance)

8.3.2.1 Test values and waveshapes

Add, at the end of the subclause, the following new note:

NOTE If the valve impulse withstand levels are equal to or less than the valve AC test level, it is deemed that the valve AC test can cover the impulse tests and consequently the impulse tests can be omitted.

9.3.5.1.2 Test values and waveshapes

Replace the existing third paragraph by the following new paragraph:

The test duration shall be 1,2 times the specified time at maximum temporary current bypass mode.

11.1 Purpose of tests

Replace, in the second bullet of the second existing paragraph, the word "converter" *by* "valve".

Replace the existing last paragraph by the following new paragraph:

The valve insensitivity to electromagnetic disturbance can be checked by monitoring the valve during other type tests. Of these, the switching impulse test of valve (8.3.2) is the most important.

11.3 Test requirements

Replace, in the third sentence of the existing paragraph, the words "valve interface electronics units" *by* "valve base electronics units".

A.2 TCSC characteristics

Delete, at the end of the formula for λ, *the comma.*

A.4 Reactive power rating

Replace, in the last paragraph, the words "with nominal boost and nominal line current" *by* "with the nominal boost factor and the rated line current".