IEC 61439-6

Edition 1.0 2012-05

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Low-voltage switchgear and controlgear assemblies – Part 6: Busbar trunking systems (busways)

Ensembles d'appareillage à basse tension – Partie 6: Systèmes de canalisation préfabriquée

IEC 61439-6:2012

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LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR ASSEMBLIES –

Part 6: Busbar trunking systems (busways)

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.

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International Standard IEC 61439-6 has been prepared by subcommittee 17D: Low-voltage switchgear and controlgear assemblies, of IEC technical committee 17: Switchgear and controlgear.

This first edition of IEC 61439-6 cancels and replaces the third edition of IEC 60439-2 (2000) and its Amendment 1 (2005), and constitutes a technical revision.

This edition of IEC 61439-6 includes the following significant technical changes with respect to the latest edition of IEC 60439-2:

- alignment on the second edition of IEC 61439-1 (2011) regarding the structure and technical content, as applicable;
- introduction of new verifications, accordingly;
- correction of inconsistencies in resistance, reactance and impedance measurements and calculations;
- numerous editorial improvements.

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

FDIS	Report on voting
17D/452/FDIS	17D/454/RVD

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

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

This standard is to be read in conjunction with the second edition of IEC 61439-1. The provisions of the general rules dealt with in IEC 61439-1 (hereinafter referred to as Part 1) are only applicable to this standard insofar as they are specifically cited. When this standard states “addition”, “modification” or “replacement”, the relevant text in Part 1 is to be adapted accordingly.

Subclauses that are numbered with a 101 (102, 103 etc.) suffix are additional to the same subclause in Part 1.

Tables and figures in this Part 6 that are new are numbered starting with 101.

New annexes in this Part 6 are lettered AA, BB, etc.

The “in some countries” notes regarding differing national practices are contained in the following subclauses:

5.4

A list of all parts of the IEC 61439 series, under the general title *Low-voltage switchgear and controlgear assemblies* can be found on the IEC website.

The committee has decided that the contents of this publication 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

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

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR ASSEMBLIES –

Part 6: Busbar trunking systems (busways)

1 Scope

NOTE 1 Throughout this part, the abbreviation BTS is used for a busbar trunking system. Where reference to Part 1 is made, the term ASSEMBLY therefore reads as "BTS".

This part of IEC 61439 lays down the definitions and states the service conditions, construction requirements, technical characteristics and verification requirements for low voltage BTS (see 3.101) as follows:

- BTS for which the rated voltage does not exceed 1 000 V in case of a.c. or 1 500 V in case of d.c.;
- BTS intended for use in connection with the generation, transmission, distribution and conversion of electric energy, and for the control of electric energy consuming equipment;
- BTS designed for use under special service conditions, for example in ships, in rail vehicles, and for domestic applications (operated by unskilled persons), provided that the relevant specific requirements are complied with;

  NOTE 2 Supplementary requirements for BTS in ships are covered by IEC 60092-302.
- BTS designed for electrical equipment of machines. Supplementary requirements for BTS forming part of a machine are covered by the IEC 60204 series.

This standard applies to all BTS whether they are designed, manufactured and verified on a one-off basis or fully standardized and manufactured in quantity.

The manufacture and/or assembly may be carried out by a manufacturer other than the original manufacturer (see 3.10.1 and 3.10.2 of Part 1).

This standard does not apply to individual devices and self-contained components, such as motor starters, fuse switches, electronic equipment, etc. which will comply with the relevant product standard.

This standard does not apply to the specific types of ASSEMBLIES covered by other parts of the IEC 61439 series, to supply track systems in accordance with IEC 60570, to cable trunking and ducting systems in accordance with the IEC 61084 series, nor to power track systems in accordance with the IEC 61534 series.

2 Normative references

This clause of Part 1 is applicable except as follows.

Addition:

IEC 60332-3-10:2000, *Tests on electric and optical fibre cables under fire conditions – Part 3-10: Test for vertical flame spread of vertically-mounted bunched wires or cables – Apparatus*

IEC 60439-2:2000, *Low-voltage switchgear and controlgear assemblies – Part 2: Particular requirements for busbar trunking systems (busways)*

IEC 61439-1:2011, *Low-voltage switchgear and controlgear assemblies – Part 1: General rules*

IEC 61786:1998, *Measurement of low-frequency magnetic and electric fields with regard to exposure of human beings – Special requirements for instruments and guidance for measurements*

ISO 834-1:1999, *Fire-resistance tests – Elements of building construction – Part 1: General requirements*

3 Terms and definitions

This clause of Part 1 is applicable except as follows.

Additional definitions:

3.101
busbar trunking system
BTS
busway
enclosed ASSEMBLY used to distribute and control electrical energy for all types of loads, intended for industrial, commercial and similar applications, in the form of a conductor system comprising busbars which are spaced and supported by insulating material in a duct, trough or similar enclosure

[SOURCE: IEC 60050-441:1984, 441-12-07 modified]

Note 1 to entry: See 3.1.1 of Part 1 for the definition of ASSEMBLY.

Note 2 to entry: The BTS may consist of a full range of mechanical and electrical components such as:

– busbar trunking units with or without tap-off facilities;
– phase transposition, expansion, flexible, feeder and adapter units;
– tap-off units;
– additional conductors for communication and/or control.

Note 3 to entry: The term "busbar" does not presuppose the geometrical shape, size and dimensions of the conductor.

3.102
busbar trunking unit
BTU
unit of a BTS complete with busbars, their supports and insulation, external enclosure and any fixing and connecting means to other units, with or without tap-off facilities

Note 1 to entry: BTUs may have different geometrical shapes such as straight length, elbow, tee or cross.

3.103
busbar trunking run
BT run
number of BTUs connected together to form the BTS, excluding the tap-off units

3.104
busbar trunking unit with tap-off facilities
BTU with tap-off facilities
BTU designed to enable tap-off units to be installed at one or more points as predetermined by the original manufacturer

3.105
busbar trunking unit with trolley-type tap-off facilities
BTU with trolley-type tap-off facilities
BTU designed to permit the use of roller- or brush-type tap-off units

3.106
busbar trunking adapter unit
adapter BTU
BTU intended to connect two units of the same system but of different type or of different rated current

3.107
busbar trunking thermal expansion unit
thermal expansion BTU
BTU intended to permit a certain movement in the axial direction of the BT run due to thermal expansion of the system

Note 1 to entry: This term does not presuppose which elements permit movement, e.g. the conductors within the enclosure or both conductors and enclosure

3.108
busbar trunking phase transposition unit
phase transposition BTU
BTU intended to change the relative positions of the phase conductors in order to balance the inductive reactances or to transpose the phases (such as L1-L2-L3-N to N-L3-L2-L1)

3.109
flexible busbar trunking unit
flexible BTU
BTU having conductors and enclosures designed to allow a specified change of direction during installation

3.110
busbar trunking feeder unit
feeder BTU
BTU serving as an incoming unit

Note 1 to entry: See 3.1.9 of Part 1 for the definition of incoming unit.

3.111
tap-off unit
outgoing unit, either fixed or removable, for tapping-off power from the BTU

Note 1 to entry: See 3.1.10, 3.2.1 and 3.2.2 of Part 1 for the definition of outgoing unit, fixed part and removable part.

Note 2 to entry: A plug-in tap-off unit is a removable tap-off unit (see 8.5.2) which can be connected or disconnected by manual operation

3.112
busbar trunking unit for building movements
BTU for building movements
BTU intended to allow for building movements due to thermal expansion, contraction and/or flexing of the building

3.113
busbar trunking fire barrier unit
fire barrier BTU
BTU or a part of, intended to prevent the propagation of fire through building divisions for a specified time under fire conditions

4 Symbols and abbreviations

This clause of Part 1 is applicable except as follows.

Addition:

Symbol / Abbreviation	Term	Subclause
k_{1A}	temperature factor of the BTS	5.3.1
k_{1c}	temperature factor of a circuit	5.3.2
k_{2c}	mounting factor of a circuit	5.3.2
R, X, Z	phase conductor and fault-loop characteristics	5.101

5 Interface characteristics

This clause of Part 1 is applicable except as follows.

5.1 General

Replacement:

The characteristics of the BTS shall ensure compatibility with the ratings of the circuits to which it is connected and the installation conditions and shall be declared by the BTS manufacturer using the criteria identified in 5.2 to 5.6 and 5.101 to 5.102.

The specification schedule according to informative Annex C is intended to help the user and the BTS manufacturer to meet this objective, whether the user:

- select catalogue products the characteristics of which meet their needs, and the requirements of this standard,
- and/or make a specific agreement with the manufacturer.

NOTE Annex C also relates to the topics dealt with in Clauses 6 and 7.

In some cases information provided by the BTS manufacturer may take the place of an agreement.

5.2.4 Rated impulse withstand voltage (U_{imp}) (of the ASSEMBLY)

Replacement of the NOTE:

NOTE Unless otherwise specified, the rated impulse withstand voltage is selected according to overvoltage category IV (origin of installation level) or III (distribution circuit level) as given in Table G.1 of Part 1.

5.3.1 Rated current of the ASSEMBLY (I_{nA})

Addition:

NOTE 4 Where the BTS is not equipped with a single incoming unit at one end of the BT run, (e.g. incoming unit not installed at one end of the BTS, or more than one incoming unit), the rated currents will be subject to agreement between the user and the manufacturer.

The rated current shall apply for a specified mounting orientation (see 5.3.2). However the influence of the mounting orientation may be ignored for short (e.g. less than 3 m long) vertical sections in a horizontal BTS.

The BTS manufacturer may state the rated currents of the BTS for different ambient temperatures for example by means of the following formula:

$I'_{nA} = k_{1A}\, I_{nA}$

where k_{1A} is a temperature factor, equal to 1 at an ambient air temperature of 35 °C.

In case of significant harmonic currents, special agreement shall be made for a reduction factor, if necessary.

5.3.2 Rated current of a circuit (I_{nc})

Addition:

The rated current (I_{nc}) of each circuit (i.e. incoming unit, BTU, tap-off unit, outgoing circuit) shall be equal to or higher than its assumed loading. For tap-off units provided with more than one main outgoing circuit, see also 5.4.

The rated current shall apply for specified mounting conditions. Mounting conditions may include orientation and position, as follows:

a) orientation

Orientation may be horizontal or vertical.

Unless otherwise specified, the reference orientation is horizontal.

b) position

Position may be for example edgewise or flatwise for a BT run, and/or below or on top of the BTU for a tap-off unit.

The BTS manufacturer may state different rated currents for different ambient temperatures and/or mounting conditions, where applicable, for example by means of the following formula:

$I'_{nc} = k_{1c}\, k_{2c}\, I_{nc}$

where

k_{1c} is a temperature factor, equal to 1 at an ambient air temperature of 35 °C;

k_{2c} is a mounting factor, equal to 1 in the reference mounting conditions.

In case of significant harmonic currents, special agreement shall be made for a reduction factor, if necessary.

5.4 Rated diversity factor (RDF)

Replacement:

For the whole BTS, unless otherwise specified, the RDF (see 3.8.11 of Part 1) shall be equal to 1, i.e. all tap-off units can be continuously and simultaneously loaded with their full rated current, within the limit of the rated current of the BT run(s) and feeder BTU(s)

NOTE 1 This is because thermal influence between tap-off units is considered negligible.

For tap-off units provided with more than one main outgoing circuit, these circuits shall be able to be continuously and simultaneously loaded at their rated current multiplied by the RDF, within the limit of the rated current of the tap-off unit. Unless otherwise specified, the RDF of such tap-off units shall be equal to the values given in Table 101.

Table 101 – Rated diversity factor for a tap-off unit

Number of main outgoing circuits	Rated diversity factor
2 and 3	0,9
4 and 5	0,8
6 to 9 inclusive	0,7
10 (and above)	0,6

The RDF is applicable with the BTS operating at rated current (I_{nA})

NOTE 2 The RDF recognizes that multiple functional units are in practice not fully loaded simultaneously or are intermittently loaded.

NOTE 3 The assumed loading of the outgoing circuits can be a steady continuous current or the thermal equivalent of a varying current.

NOTE 4 In Norway, the overload protection of conductors is not solely based on the use of diversity factors of the downstream circuits.

5.6 Other characteristics

Modification of item e):

e) stationary BTS ;

Modification of item j):

j) enclosed BTS;

Addition:

aa) ability to withstand mechanical loads, either normal or heavy (see 8.1.101);

bb) resistance to flame propagation, if applicable (see 9.101);

cc) fire resistance in building penetration, if applicable (see 9.102).

Additional subclauses:

5.101 Phase conductor and fault-loop characteristics

NOTE 1 For BTS rated below 100 A, the reactances are deemed negligible.

R and X according to Table 102 are intended to be used to calculate voltage drops (see informative Annex AA).

Table 102 – Phase conductor characteristics

Mean phase conductor characteristics at rated current I_{nc}, and rated frequency f_n Ω per-metre length	
Resistance, - at an ambient air temperature of 35 °C - at a conductor temperature of 20 °C	R R_{20}
Reactance (independent from temperature)	X
Positive-sequence and negative-sequence impedances - at an ambient air temperature of 35 °C - at a conductor temperature of 20 °C	$Z = Z_{(1)} = Z_{(2)}$ $Z_{20} = Z_{(1)20} = Z_{(2)20}$
All phase conductor characteristics may be determined according to Annex BB.	

R_{20} and X according to Table 102, and fault-loop resistances and reactances according to Table 103, i.e. the total resistances and reactances of the phase conductor(s) and return path, are intended to be used to calculate fault currents according to the method of impedances (see Table 104).

Z and Z_{20} according to Table 102, and fault-loop zero-sequence impedances according to Table 103, i.e. the total zero-sequence impedances of the phase conductor(s) and return path, are intended to be used to calculate fault currents according to the method of symmetrical components (see Table 104).

NOTE 2 Fault currents reach their lowest value for the highest impedance values; this is deemed to happen when the BTUs are operating at I_{nc} at the maximum normal ambient air temperature i.e. 35 °C, resulting in a conductor temperature of (35 + $\Delta\theta$) °C, where $\Delta\theta$ is the mean stabilized temperature rise measured according to 10.10.

Conversely fault currents reach their highest value for the lowest impedance values; this is deemed to happen when the BTUs are not operating, resulting in a conductor temperature of 20 °C, and the circuit is closed while a short-circuit is present.

Table 103 – Fault-loop characteristics

Mean fault-loop characteristics at rated frequency f_n Ω per-metre length	**Phase-to-phase**	**Phase-to-neutral**	**Phase-to-PEN**	**Phase-to-PE**
Zero-sequence impedances - at an ambient air temperature of 35 °C - at a conductor temperature of 20 °C		$Z_{(0)bphN}$ $Z_{(0)b20phN}$	$Z_{(0)bphPEN}$ $Z_{(0)b20phPEN}$	$Z_{(0)bphPE}$ $Z_{(0)b20phPE}$
Resistances - at an ambient air temperature of 35 °C - at a conductor temperature of 20 °C	R_{bphph} $R_{b20phph}$	R_{bphN} R_{b20phN}	R_{bphPEN} $R_{b20phPEN}$	R_{bphPE} $R_{b20phPE}$
Reactances (independent from temperature)	X_{bphph}	X_{bphN}	X_{bphPEN}	X_{bphPE}
Fault-loop zero-sequence impedances may be determined according to Annex CC. Fault-loop resistances and impedances may be determined according to Annex DD.				

Table 104 – Characteristics to be used for fault currents calculations

Fault currents	Method of impedances	Method of symmetrical components
Maximum short-circuit current		
- 3-phase	R_{20}, X	Z_{20}
- phase-to-phase	$R_{b20phph}$, X_{bphph}	Z_{20}
- phase-to-neutral	R_{b20phN}, X_{bphN}	Z_{20} and $Z_{(0)20phN}$
Minimum short-circuit current		
- phase-to-phase	R_{bphph}, X_{bphph}	Z
- phase-to-neutral	R_{bphN}, X_{bphN}	Z and $Z_{(0)phN}$
Earth fault current (phase-to-PE(N))	$R_{bphPE(N)}$, $X_{bphPE(N)}$	Z and $Z_{(0)phPE(N)}$

NOTE 3 The method of symmetrical components is based on respectively summing the modulus of the fault-loop positive-, negative- and zero-sequence impedances (see IEC 60909-0). Similarly the method of impedance is based on respectively summing the modulus of the fault-loop resistances and reactances.

5.102 Electromagnetic field

The strength of the power frequency magnetic field in the vicinity of the BT run may be stated by the BTS manufacturer.

NOTE The magnetic field is a fast-decreasing function of the distance.

A method for measurement and calculation of the modulus of the magnetic field around the BTS is given in Annex EE.

6 Information

This clause of Part 1 is applicable except as follows.

6.1 ASSEMBLY designation marking

Addition after the first paragraph:

One nameplate shall be located near one end of each BTU and one on each tap-off unit.

Replacement:

d) IEC 61439-6.

7 Service conditions

This clause of Part 1 is applicable except as follows.

7.2 Special service conditions

Addition:

aa) exposure to special mechanical loads, such as lighting apparatus, additional cables, ladder supports, etc.;

bb) applications with high repetitive overcurrent, for example resistance welding;

cc) installation near highly sensitive IT equipment, such as high-speed data networks, radiology apparatus, workstation monitors, etc.;

dd) applications requiring defined performance under fire conditions, e.g. circuit integrity for a definite time.

8 Constructional requirements

This clause of Part 1 is applicable except as follows.

8.1.5 Mechanical strength

Addition after the last paragraph:

BTS with trolley-type tap-off facilities shall be able to carry out successfully 10 000 cycles of to-and-fro movements along the conductors of the BT run, with the sliding contacts carrying their rated current at rated voltage. In the case of a.c., the power factor of the load shall be between 0,75 and 0,8.

Compliance to this requirement is checked by the test of 10.13.

Additional subclauses:

8.1.101 Ability to withstand mechanical loads

BTS intended for horizontal installation shall be able to withstand in use normal or heavy mechanical loads as specified according to 5.6 aa).

Normal mechanical loads include the weight of the feeder unit, if not supported by its own separate fixings, and tap-off units, in addition to the weight of the BTUs.

Heavy mechanical loads include additional loads such as the weight of a person.

NOTE This statement does not imply that a BTS is a walkway.

The necessary mechanical properties may be obtained by the choice of material, its thickness, its shape, and/or by the number of and position of fixing points as indicated by the original manufacturer.

Compliance to this requirement is checked by test according to 10.2.101.

8.1.102 Ability of plug-in tap-off units to withstand thermal variations

Plug-in tap-off units in which the contact force is developed by the deflection of a spring member shall be able to withstand the mechanical constraints due to temperature variations when subjected to intermittent duty.

NOTE For the purpose of this requirement, a disc spring is not considered to be a spring member.

Compliance is checked by test according to 10.2.102.

8.2.1 Protection against mechanical impact

Replacement:

Where a degree of protection against mechanical impact according to IEC 62262 IK code is declared by the original manufacturer, the BTS shall be so designed that it is capable of withstanding the test according to IEC 62262 IK code (see 10.2.6).