ABB ELECTRIFICATION – 2022 APR

Low Voltage Switchgear and IEC61439

ABB Electrification Smart Power

Switchgear Design

According to IEC 61439

- IEC 61439 and Main Parameter
- Low-voltage switchgear and controlgear assemblies IEC 61439
- Forms of Internal Separation
- ABB E-design software , OTC Temp-rise assessment tool

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IEC 61439 series

Why do we need Standards?

The purpose of standards

The purpose of standards is to establish
- **Definitions of terms**
- **Environmental Conditions**
- **Features**
- **Performance of Equipment**
- **Testing and Verification Requirements**

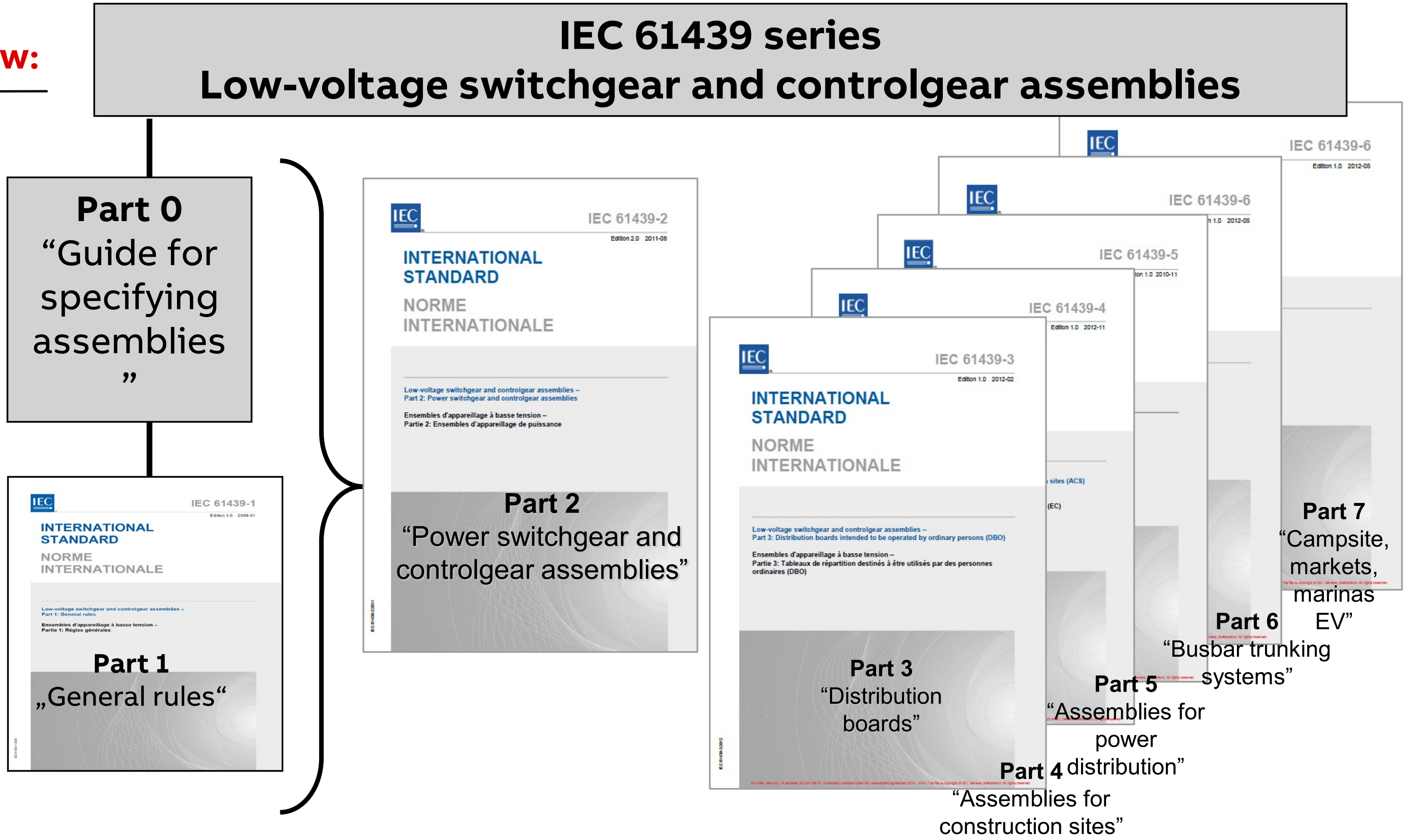
The standards serves important functions for ABB, as well as for the specifier and user guaranteeing :
- Performance
- Safety
- Reliability
- Maintainability

IEC 61439 series

Structure of IEC 61439 series

The standard format was revised as below:

- One document for general rules – IEC 61439-1
- One subsidiary part for each application (product standards) for low voltage switchgear – IEC 61439-2
- For other application (product standards) – IEC 61439-3 to 7



IEC 61439 series

Development of Standard

IEC **60439-1**

- First published in 1985
- Withdrawn in January 2014

IEC **61439-1** and -2 Ed 1.0 was published in January 2009

- From now on it used is to deliver LV switchgear and controlgear assemblies acc. IEC 61439-2.
- All verification testing since 2009 for the ABB MNS® portfolio has been based upon IEC 61439-2.
- IEC 61439-1 and -2 Ed 2.0 was revised & published in August 2011.
- IEC 61439-1 Ed 3.0 was revised & published in May 2020

1985

- IEC 60439 Published

2009

- IEC 61439-1 Edition 1 Published

2020

- Latest IEC 61439-1 Edition 3 Published

35 years

Would you still specify products that were based on 35 year old technology?

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Main Parameter According to IEC 61439

Voltage ratings

Description	Symbol	Detail
Rated voltage	Un	highest nominal voltage of the electrical system, a.c. (r.m.s.) or d.c., declared by the ASSEMBLY manufacturer, to which the main circuit(s) of the ASSEMBLY is (are) designed to be connected
Rated operational voltage	Ue	value of voltage, declared by the ASSEMBLY manufacturer, which combined with the rated current determines its application.
Rated insulation voltage	Ui	r.m.s withstand voltage value, assigned by the ASSEMBLY manufacturer to the equipment or to a part of it, characterising the specified (long-term) withstand capability of the insulation.
Rated impulse withstand voltage	Uimp	impulse withstand voltage value, declared by the ASSEMBLY manufacturer, characterising the specified withstand capability of the insulation against transient overvoltages.

Main Parameter According to IEC 61439

Current Ratings

Description		Detail
Rated current	In	value of current, declared by the ASSEMBLY manufacturer which can be carried without the temperature-rise of various parts of the ASSEMBLY exceeding specified limits under specified conditions
Rated current of the ASSEMBLY	InA	The rated current of the ASSEMBLY is the smaller of: – the sum of the rated currents of the incoming circuits within the ASSEMBLY operated in parallel; – the total current which the main busbar is capable of distributing in the particular ASSEMBLY arrangement. This current shall be carried without the temperature rise of the individual parts exceeding the limits specified.
Rated current of a circuit	Inc	The rated current of a circuit is the value of the current that can be carried by this circuit loaded alone, under normal service conditions. This current shall be carried without the temperature rise of the various parts of the ASSEMBLY exceeding the limits specified.
Rated peak withstand current (Ipk)	Ipk	value of peak short-circuit current, declared by the ASSEMBLY manufacturer, that can be withstood under specified conditions
Rated short-time withstand current (Icw)	Icw	r.m.s value of short-time current, declared by the ASSEMBLY manufacturer, that can be withstood under specified conditions, defined in terms of a current and time
Rated conditional short-circuit current of an ASSEMBLY (Icc)	Icc	value of prospective short-circuit current, declared by the ASSEMBLY manufacturer, that can be withstood for the total operating time (clearing time) of the short-circuit protective device (SCPD) under specified conditions

Main Parameter According to IEC 61439

Other parameter

Rated diversity factor (RDF)		per unit value of the rated current, assigned by the ASSEMBLY manufacturer, to which outgoing circuits of an ASSEMBLY can be continuously and simultaneously loaded taking into account the mutual thermal influences.
Rated frequency (fn)		value of frequency, declared by the ASSEMBLY manufacturer, for which a circuit is designed and to which the operating conditions refer.

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Verification Process

IEC 61439 series

Verification

Testing processes

1. **Type Testing to prove a design is compliant**

2. **Routine Testing to prove that a manufatcured unit is compliant.**

IEC 60439 Type Tests:

Type testing was by :

1. Type Tested Assemblies and
2. Parially Type Tested Assemblies (TTA and PTTA).

IEC 61439 Verification :

1. Verify by testing –

Test made on a sample of an ASSEMBLY or on parts of ASSEMBLIES to verify that the design meets the requirements of the relevant ASSEMBLY standard.

2. Verify by comparison with a reference design -

Structured comparison of a proposed design for an ASSEMBLY, or parts of an ASSEMBLY, with a reference design verified by test.

3. Verify by assessment –

Design verification of strict design rules or calculations applied to a sample of an ASSEMBLY (Reference design, similar variants and comparable function unit) or to parts of ASSEMBLIES to show that the design meets the requirements of the relevant ASSEMBLY standard, including use of appropriate safety margins.

IEC 61439 series

Verification

No.	Characteristic to be verified	Subclauses	Verification options available		
			Testing[a]	Comparison with a reference design	Assessment
1	Strength of material and parts:	10.2			
	Resistance to corrosion	10.2.2	YES	YES	NO
	Properties of insulating materials:	10.2.3			
	Thermal stability	10.2.3.1	YES	YES	NO
	Resistance to abnormal heat and fire due to internal electric effects	10.2.3.2	YES	YES	YES
	Resistance to ultra-violet (UV) radiation	10.2.4	YES	YES	YES
	Lifting	10.2.5	YES	YES	NO
	Mechanical impact (IK)	10.2.6	YES	YES	NO
	Marking	10.2.7	YES	YES	NO
	Mechanical operation	10.2.8	YES	YES	NO
2	Degree of protection of enclosures (IP)	10.3	YES	NO	YES
3	Clearances	10.4	YES	NO	NO
4	Creepage distances	10.4	YES	NO	NO
5	Protection against electric shock and integrity of protective circuits:	10.5			
	Effective continuity between the exposed-conductive-parts of a class I assembly and the protective circuit	10.5.2	YES	NO	NO
	Short-circuit withstand strength of the protective circuit	10.5.3	YES	YES	NO

No.	Characteristic to be verified	Subclauses	Verification options available		
			Testing[a]	Comparison with a reference design	Assessment
6	Incorporation of switching devices and components	10.6	NO	NO	YES
7	Internal electrical circuits and connections	10.7	NO	NO	YES
8	Terminals for external conductors	10.8	NO	NO	YES
9	Dielectric properties:	10.9			
	Power-frequency withstand voltage	10.9.2	YES	NO	NO
	Impulse withstand voltage	10.9.3	YES	NO	YES
	Enclosures made of insulating material	10.9.4	YES	NO	NO
	External operation handles of insulating material	10.9.5	YES	NO	NO
	Conductors covered by insulating material to provide protection against electric shock	10.9.6	YES	NO	NO
10	Temperature-rise limits	10.10	YES	YES	YES
11	Short-circuit withstand strength	10.11	YES	YES	NO
12	Electromagnetic compatibility (EMC)	10.12	YES	NO	YES

[a] Testing may be on representative sample if permitted in the appropriate test clause.

IEC 61439 provides clear and comprehensive verification process

ABB

Specifying to IEC61439

Specifying to IEC 61439

The IEC 61439 contains a template for Specifiers to use to specify the requirements of LV switchgear.

There are many items in the template, we will concentrate on a number of the key items in the template

- Electrical System
- Short Circuit Withstand Capability
- Protection against electric shock
- Installation Environment
- Installation Method
- Storage and Handling
- Operating Arrangements
- Maintenance and Upgrade capabilities
- Current Carrying Capacity

In addition to these IEC61439 tests there is also the requirement in many specifications on Arc Flash Containment as defined in IEC TR 61641.

Table BB.1 – Items subject to agreement between the ASSEMBLY manufacturer and the user

Characteristics	Reference clause or subclause	Default arrangement [b]	Options listed in standard	User requirement [a]
Electrical system				
Earthing system	5.6, 8.4.3.1, 8.4.3.2.3, 8.6.2, 10.5, 11.4	Manufacturer's standard, selected to suit local requirements	TT / TN-C / TN-C-S / IT, TN-S	
Nominal voltage (V)	3.8.9.1, 5.2.1, 8.5.3	Local, according to installation conditions	max 1 000 V a.c. or 1 500 V d.c.	
Transient overvoltages	5.2.4, 8.5.3, 9.1, Annex G	Determined by the electrical system	Overvoltage category I / II / III / IV	
Temporary overvoltages	9.1	Nominal system voltage + 1 200 V	None	
Rated frequency f_n (Hz)	3.8.12, 5.5, 8.5.3, 10.10.2.3, 10.11.5.4	According to local installation conditions	d.c./50 Hz/60 Hz	
Additional on site testing requirements: wiring, operational performance and function	11.10	Manufacturer's standard, according to application	None	
Short-circuit withstand capability				
Prospective short-circuit current at supply terminals I_{cp} (kA)	3.8.7	Determined by the electrical system	None	
Prospective short-circuit current in the neutral	10.11.5.3.5	Max. 60 % of phase values	None	
Prospective short-circuit current in the protective circuit	10.11.5.6	Max. 60 % of phase values	None	
SCPD in the incoming functional unit requirement	9.3.2	According to local installation conditions	Yes / No	
Co-ordination of short-circuit protective devices including external short-circuit protective device details	9.3.4	According to local installation conditions	None	
Data associated with loads likely to contribute to the short-circuit current	9.3.2	No loads likely to make a significant contribution allowed for	None	

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Current Carrying Capacity

Current Carrying Capacity

Overview

The specifying of the current carrying capacity of then assembly is normally done by the specifier using the following documents

- Single Line Diagrams with ratings
- Excel spreadsheets with load lists
- Datasheets

Design Load : I_B = Electrical current intended to be carried by an electric circuit in normal operation. This is the value that the LV switchgear needs to be designed to carry, normally this is in the drawings, load lists , datasheets

The standard has a number of terms that are used to define the current carrying capacity in the specification template

Current carrying capability				
Rated current of the ASSEMBLY I_{nA} (amps)	3.8.9.1, 5.3, 8.4.3.2.3, 8.5.3, 8.8, 10.10.2, 10.10.3, 10.11.5, Annex E	Manufacturer's standard, according to application	None	
Rated current of circuits I_{nc} (amps)	5.3.2	Manufacturer's standard, according to application	None	
Rated diversity factor	5.4, 10.10.2.3, Annex E	As defined within the standard	RDF for groups of circuits / RDF for whole ASSEMBLY	

Current Carrying Capability
Values from Specification Template

Current Carrying Capacity

Circuit Ratings

Rating of Device, I_n

The rating designation by the device manufacturer when tested to the relevant device standard.

For example:

In = 630A is nameplate rating of ABB Tmax XT MCCB, when tested to the relevant standard : IEC 60947

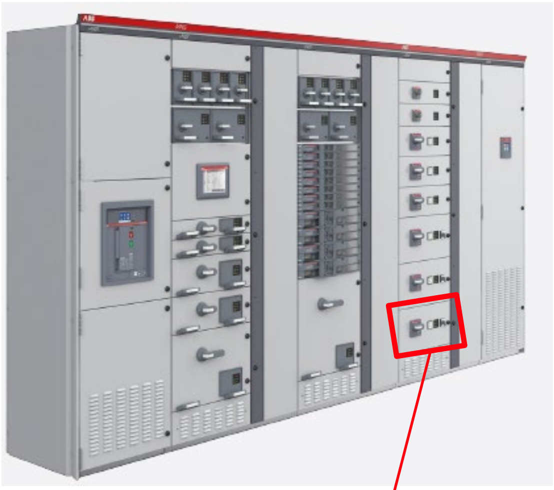
Rated current of a main outgoing circuit, I_{nc}

The rated current of a main outgoing circuit is the current that can be carried by the outgoing circuit when all other outgoing main circuits in the same section are not carrying current This current shall be carried without the temperature-rise of the various parts of the assembly exceeding the limits

For example the

I_n = 630 A MCCB may have :

I_{nc} = 620 A



Energised compartment

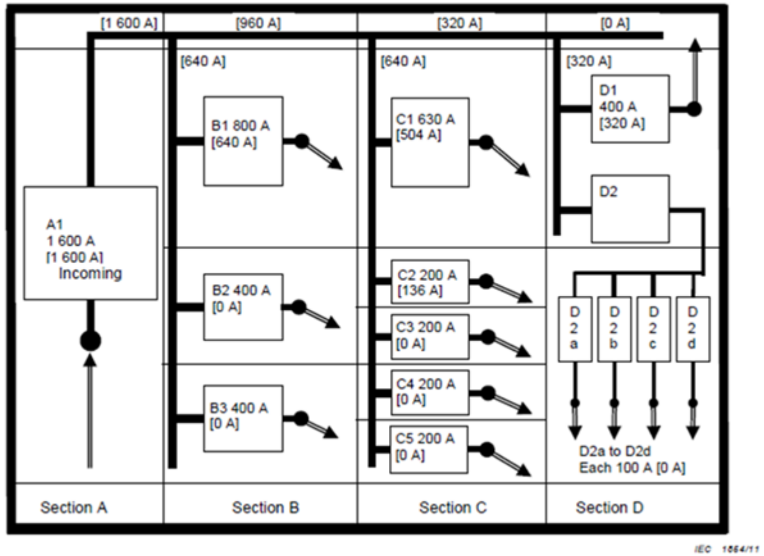
Current Carrying Capacity

Current Ratings

Rated Diversity Factor

By stating a rated diversity factor, the assembly is having the "average“ loading conditions for which the assembly is designed. The rated diversity factor confirms the per unit value of rated current I_{nc} to which all the outgoing circuits, or a group of outgoing circuits, within the assembly can be continuously and simultaneously loaded.

Example



Actual loading is indicated by the figures in brackets e.g. [640 A].
Busbar section loading is indicated by the figure in brackets e.g. [320 A].

Figure E.3 – Example 2: Table E.1 – Functional unit loading for an ASSEMBLY with a rated diversity factor of 0,8

Current Carrying Capacity

Current Ratings

Current Rating of the Assembly, I_{nA}

The current rating of an assembly defines the maximum load current that can be supplied via the incoming circuit(s) and distributed via the main busbars. This rating can be determined by the capacity of the incoming circuit(s) or the main busbars.

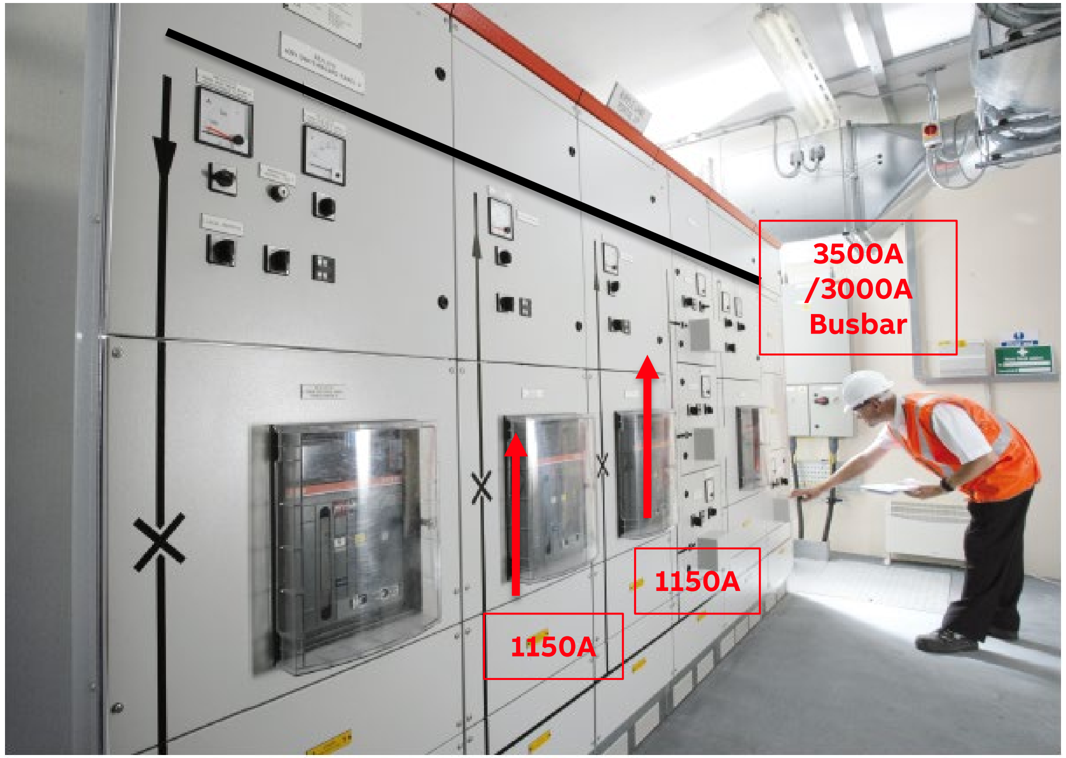
The rated current of the assembly, I_{nA}, is the lower of (i) the sum of the group rated currents of the incoming circuits, and (ii) the group rated current of the main busbars.

It is essential to note that the group rating of the incoming circuit(s) may be lower than the nominal rating I_n of the devices used in the incoming circuits.

Example 1
I_{nc1} (incomer 1) = 1150 A
I_{nc2} (incomer 2) = 1150 A
Busbar is rated @ 3500 A
I_{nA} = 1150 A + 1150 A = 3300 A

Example 2
I_{nc1} (incomer 1) = 1150 A
I_{nc2} (incomer 2) = 1150 A
Busbar is rated @ 3000 A
I_{nA} = 3000 A

Example



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Current Carrying Capacity

Climatic Conditions IEC61439-1

Operating Conditions

- **Climatic Conditions**
- Value Load Current
- Duration of Current

Response of the Assembly

- Heating of conductors
- Heating of components
- Heating of enclosure

Results

- Aging of insulation
- Failure of insulation
- Reduced life and failure of the switchgear
- Physical burns
- Damage to personnel and property
- Increase maintenance and downtime

Table 15 – Climatic conditions

Environmental parameter	Unit	Indoor installations		Outdoor installations	
		Lower limit	Upper limit	Lower limit	Upper limit
(1) Ambient air temperature	°C	−5[a]	+40[a] (average over a period of 24 h does not exceed 35 °C)	−25	+40[b] (average over a period of 24 h does not exceed 35 °C)
(2) Relative humidity	%	5[b,c]	95[b, c]	15[b]	100[b]
(3) Rate of change of temperature (average over a period of 5 min)	°C/min	0,5			
(4) Altitude[f]	m	Not specified	2000 (corresponding to an air pressure of the site of installation not less than 80 kPa)[d, e]	Not specified	2000 (corresponding to an air pressure of the site of installation not less than 80 kPa)[d, e]
(5) Condensation		Yes – moderate condensation may occasionally occur due to variations in temperature		Yes	
(6) Wind-driven precipitation (rain, snow, hail, etc.) and/or dust		No		Yes	
(7) Water from sources other than rain		According to user requirement: none / vertically dripping water / water sprayed at an angle up to 60° on either side of the vertical / water splashed from any direction / water projected in jets from any direction / water projected in powerful jets from any direction			
(8) Formation of ice		No		Yes	

[a] Equal to Class AA4 of IEC 60364-5-51:2005.

[b] Relationship between air temperature and humidity is given in IEC 60721-3-3:2019, Figure A.1.

[c] Equal to Class AB4 of IEC 60364-5-51:2005.

[d] See IEC 60664-1:2007, Table A.2. For equipment to be used at higher altitudes, it is necessary to take into account the reduction of the dielectric strength, the switching capability of the devices and of the cooling effect of the air.

[e] Equal to Class AC1 of IEC 60364-5-51:2005.

[f] The majority of the devices are suitable to be used up to 2000 m. For some electronic equipment to be used at altitudes above 1000 m, it may be necessary to take into account the reduction of the cooling effect of the air.

Current Carrying Capacity

Load Current

Operating Conditions

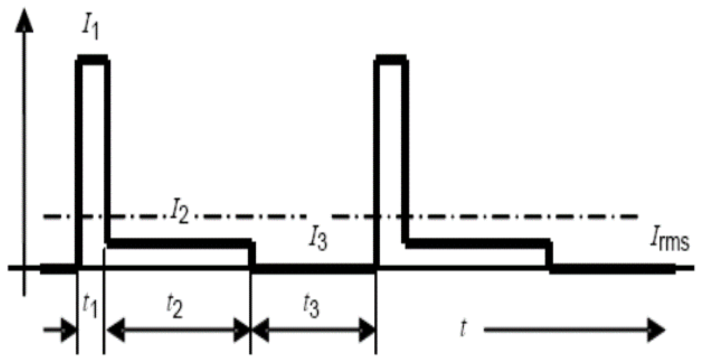
- Climatic Conditions
- **Value Load Current**
- **Duration of Current**

Response of the Assembly

- Heating of conductors
- Heating of components
- Heating of enclosure

Results

- Aging of insulation
- Failure of insulation
- Reduced life and failure of the switchgear
- Physical burns
- Damage to personnel and property
- Increase maintenance and downtime



$$I_{rms} = \sqrt{\frac{I_1^2 \times t_1 + I_2^2 \times t_2 + I_3^2 \times t_3}{t_1 + t_2 + t_3}}$$

t_1 Starting time at current I_1

t_2 Run time at current I_2

t_3 Interval time at $I_3 = 0$

$t_1 + t_2 + t_3$ Cycle time

IEC 1857/11

Intermittent Duty of Load

Current Carrying Capacity

Heating

Operating Conditions
- Climatic Conditions
- Value Load Current
- Duration of Current

Response of the Assembly
- **Heating of conductors**
- **Heating of components**
- **Heating of enclosure**

Results
- Aging of insulation
- Failure of insulation
- Reduced life and failure of the switchgear
- Physical burns
- Damage to personnel and property
- Increase maintenance and downtime

Part of assemblies	Temperature rise (K)
Built-in components [a]	In accordance with the relevant product standard requirements for the individual components or, in accordance with the component manufacturer's instructions [f], taking into consideration the temperature in the assembly.
Terminals for external insulated conductors	70 [b]
Busbars and conductors,	Limited by [f]: • mechanical strength of conducting material [g]; • possible effect on adjacent equipment; • permissible temperature limit of the insulating materials in contact with the conductor; • effect of the temperature of the conductor on apparatus connected to it • for plug-in contacts, nature and surface treatment of the contact material
Manual operating means: • of metal • of insulating material	 15 [c] 25 [c]
Accessible external enclosures and covers • Metal surfaces • Insulating surfaces	 30 [d] 40 [d]
Discrete arrangements of plug and socket-type connections	Determined by the limit for those components of the related equipment of which they form a part [e]

Source : **GAMBICA Technical Guide**
LOW-VOLTAGE POWER SWITCHGEAR AND CONTROLGEAR ASSEMBLIES

Performance requirements

Part: 1, Clause 10.10.4.2 - Verification of temperature rise

Verification shall be made by one or more of the following methods

- a) testing (10.10.2);
- b) derivation (from a tested design) of ratings for similar variants (10.10.3);
- c) calculation for a single compartment ASSEMBLY not exceeding 630 A according to 10.10.4.2 or for ASSEMBLIES not exceeding 1600 A according to 10.10.4.3.

A very simple method of temperature rise verification that requires confirmation that the total power loss of the components and conductors within the ASSEMBLY do not exceed the known power dissipation capability of the enclosure. The scope of this approach is very limited and in order that there are no difficulties with hot spots, **all components must be de-rated to 80 %** of their free air current rating and all conductors shall have a **minimum cross-sectional area based on 125 %** of the permitted current rating of the associated circuit

Total power loss of the components

Power dissipation capability of the enclosure

Short Circuit Capability

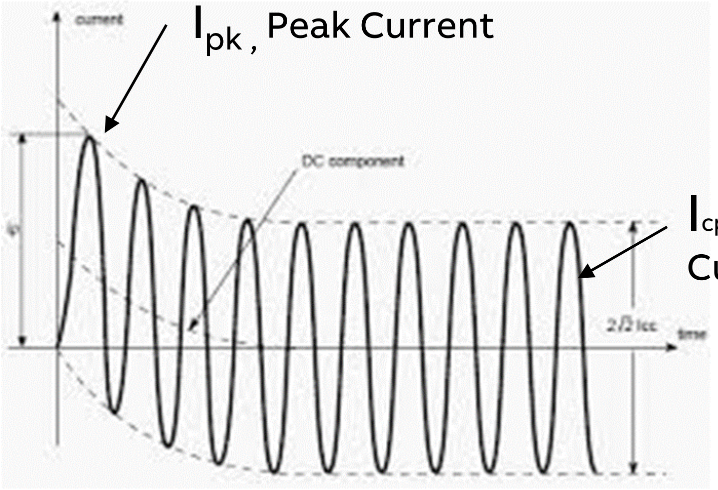
Short Circuit Capability

Mechanical, Electrical and Thermal Strength of the Busbar systems and Protection Earthing to withstand the forces produced by the

- The Prospective Short Circuit current, I_{cp}
- The Peak Short Circuit current , I_{pk}

Once the Peak and Short Circuit current are know along with the maximum duration of the fault (typically 1 sec) we can determine the requirements of the LV assembly.

I_{cw} = Short Circuit Withstand RMS value of AC current, declared by the assembly manufacturer, that can be withstood under specified conditions, defined in terms of current and time



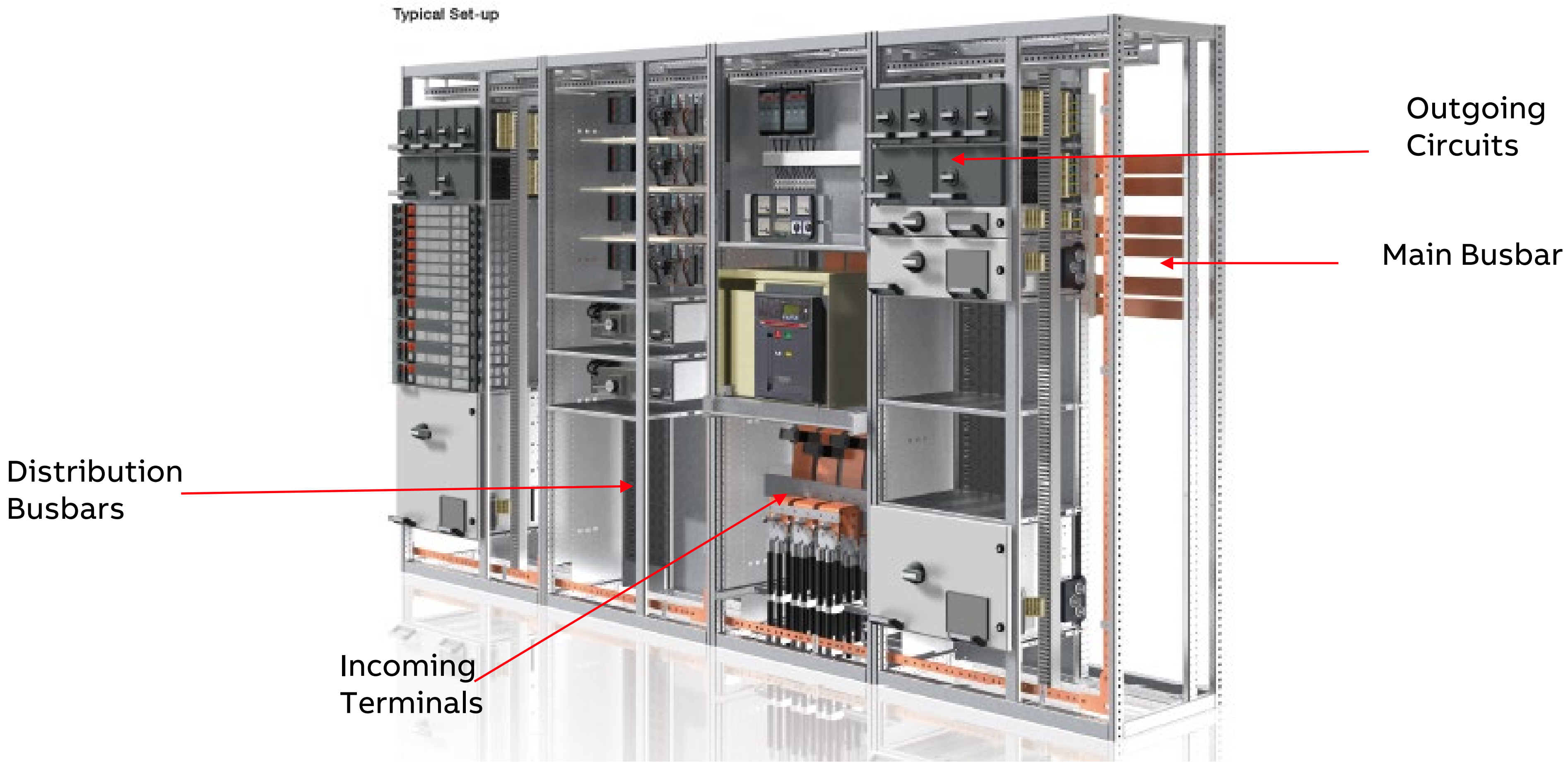
RMS value of the short-circuit current kA	cos φ	n
$I \le 5$	0,7	1,5
$5 < I \le 10$	0,5	1,7
$10 < I \le 20$	0,3	2,0
$20 < I \le 50$	0,25	2,1
$50 < I$	0,2	2,2

[a] Values of this table represent the majority of applications. In special locations, for example in the vicinity of transformers or generators, lower values of power factor may be found, whereby the maximum prospective peak current may become the limiting value instead of the RMS value of the short-circuit current.

Rated short-time withstand current is not the same as an internal arc fault rating as given in IEC TR 61641

Short Circuit Capability

Verification



Arc Fault Containment

Arc Fault Containment

Overview

Relevant Standard : IEC/TR 61641 Ed3 published in 2019

Specification requires the nomination by manufacturer of :

a. Arcing Classification

b. Permissible Arcing Current*

c. Permissible Arc Duration

*** The permissible current under arcing conditions can be lower than the rated short time withstand current (*I*cw).**

4.1 Classification with regard to the protection characteristic

According to their characteristics under arcing conditions ASSEMBLIES can be classified by the manufacturer into:

Arcing class A – ASSEMBLY providing personnel protection under arcing condition by arc tested zones conforming to arcing conditions in 8.7, criteria 1 to 5, and by arc ignition protected zones, if any;

Arcing class B – ASSEMBLY providing personnel and ASSEMBLY protection under arcing conditions by arc tested zones conforming to arcing conditions to 8.7, criteria 1 to 6, and by arc ignition protected zones, if any;

Arcing class C – ASSEMBLY providing personnel and ASSEMBLY protection under arcing conditions by arc tested zones conforming to arcing conditions with limited operation in 8.7, criteria 1 to 7, and by arc ignition protected zones, if any;

Arcing class I – ASSEMBLY providing a reduced risk of arcing faults solely by means of arc ignition protected zones.

Criteria

Following the Arc Fault…..

Class A

1. Doors stay closed
2. Parts do not fly off the enclosure
3. No holes in the enclosure
4. The fire indicators do not burn
5. Earthing is still effective

Class B

Class A + Arc is limited to the ignition areas

Class C

Class B + able to remove damaged module and replace with spare.

Forms of Separation (Form 1,2,3,4) is not associated with Arc Fault Containment

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Arc Flash Containment

Verification

Verification Requirements

- Testing carried out on all functional unit
  - Busbars
  - Incomers
  - Outgoing Units
- Doors and covers closed
- Vertical ignition panels

ABB Verification

- **Complies to IEC TR 61641 for all MNS 3.0 ratings**
- **Tested with doors open / modules removed**
- **Addition of horizontal ignition panels at 2 m high**

ROUTINE VERIFICATION

ROUTINE VERIFICATION

Part: 1, Clause 11 – Routine verification

Verification shall comprise the following categories:

a) Construction (see 11.2 to 11.8):

- 1) degree of protection of enclosures;
- 2) clearances and creepage distances;
- 3) protection against electric shock and integrity of protective circuits;
- 4) incorporation of built-in components;
- 5) internal electrical circuits and connections;
- 6) terminals for external conductors;
- 7) mechanical operation.

b) Performance (see 11.9 to 11.10):

- 1) dielectric properties;
- 2) wiring, operational performance and function.

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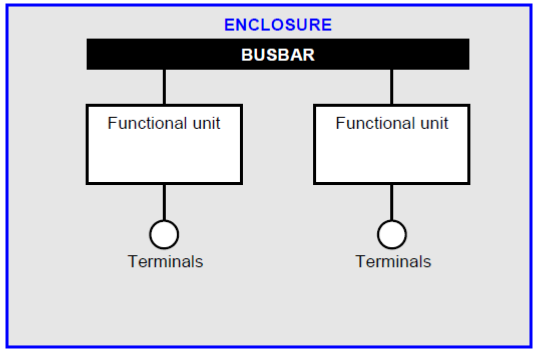
FORMS OF INTERNAL SEPARATION : FORM 1

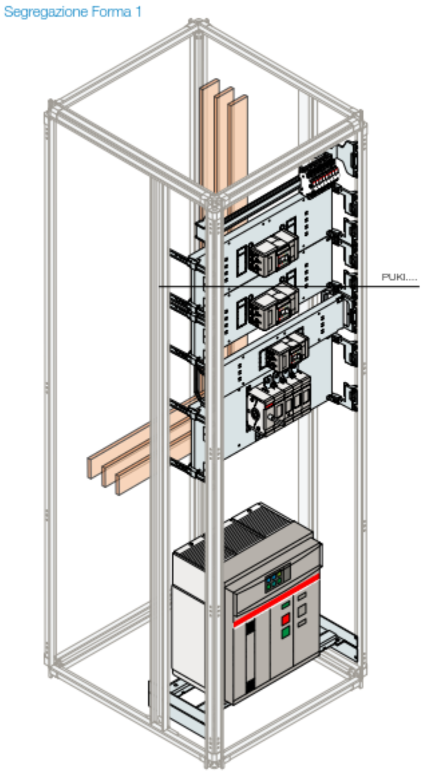
Forms of separation/Types of construction

The Forms of internal separation and the associated Types of construction are illustrated



Form 1

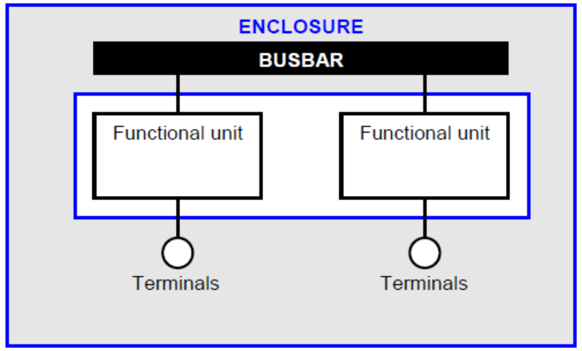
No internal separation



FORMS OF INTERNAL SEPARATION : FORM 2A, 3A

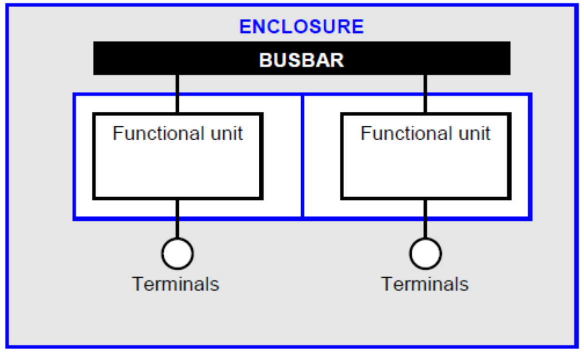
Forms of separation/Types of construction

The Forms of internal separation and the associated Types of construction are illustrated



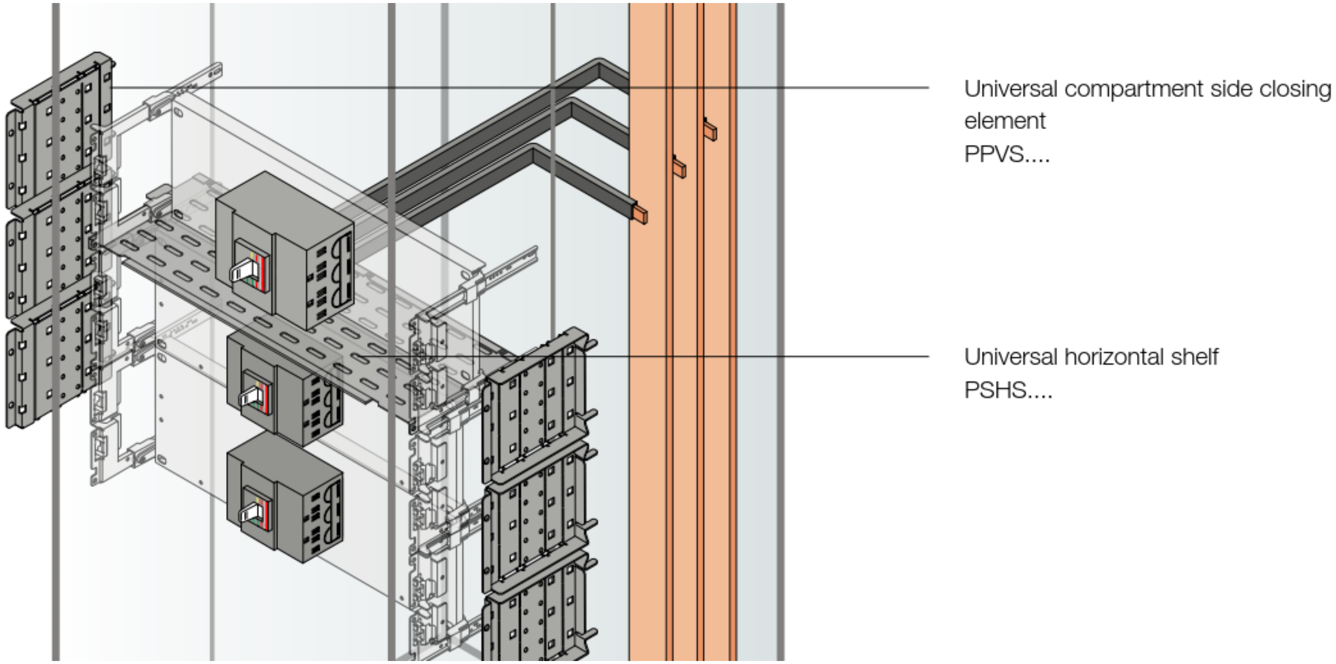
Form 2A

Terminals not separated from busbars



Form 3A

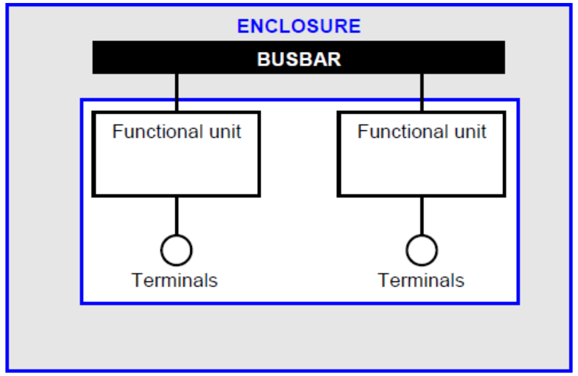
Terminals not separated from busbars



FORMS OF INTERNAL SEPARATION : FORM 2B

Forms of separation/Types of construction

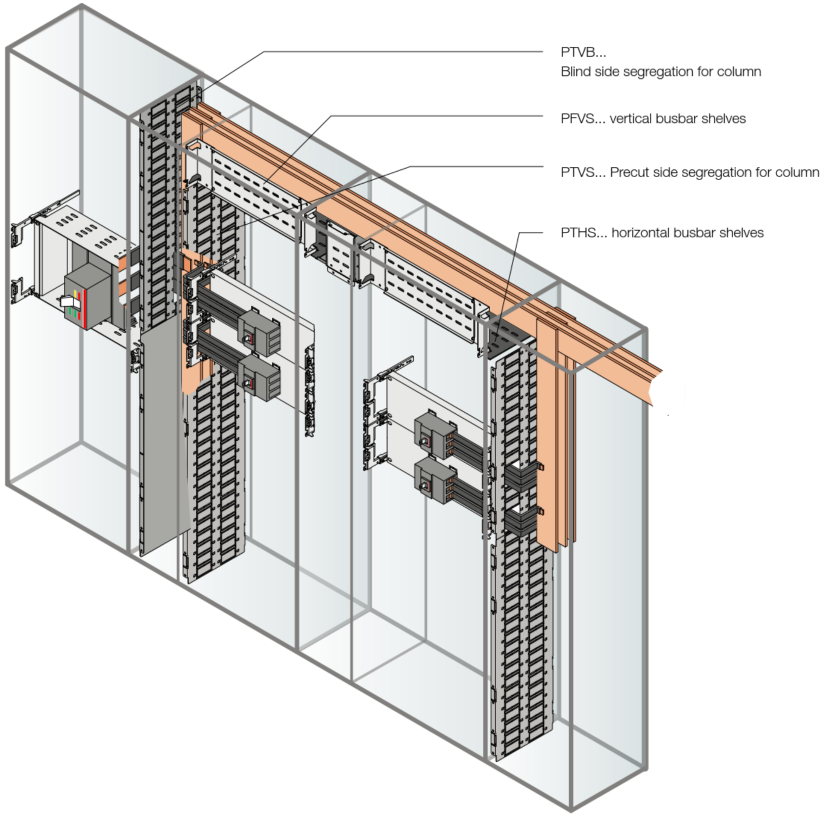
The Forms of internal separation and the associated Types of construction are illustrated



Form 2B

Terminals separated from busbars

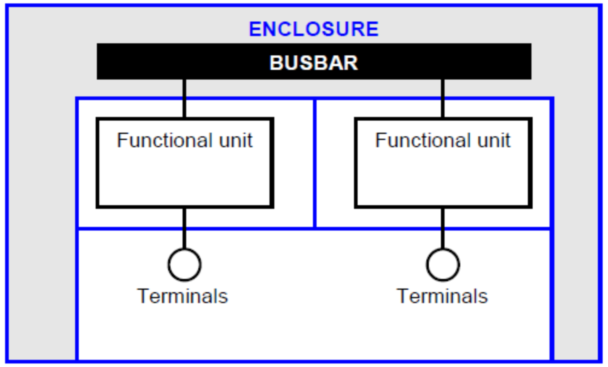
Segregation Form 2b



FORMS OF INTERNAL SEPARATION : FORM3B

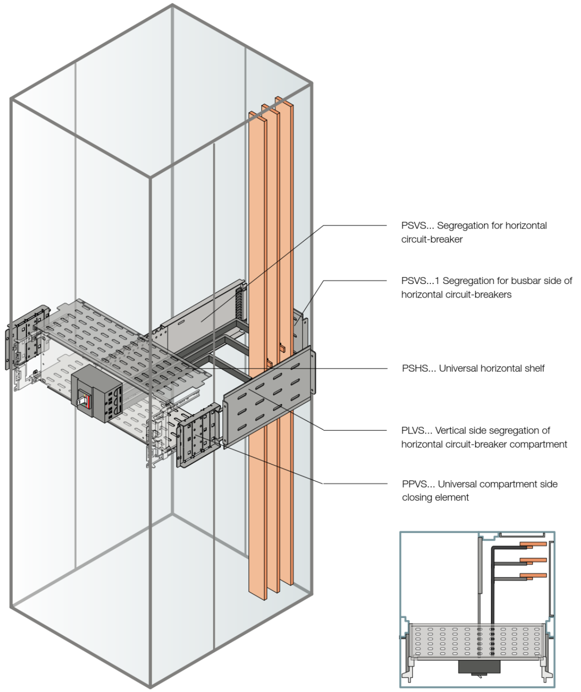
Forms of separation/Types of construction

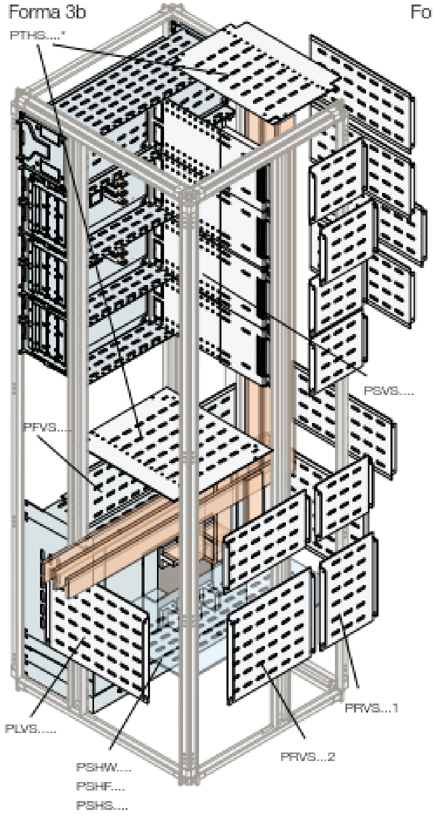
The Forms of internal separation and the associated Types of construction are illustrated



Form 3B

Terminals and external conductors separated from busbars



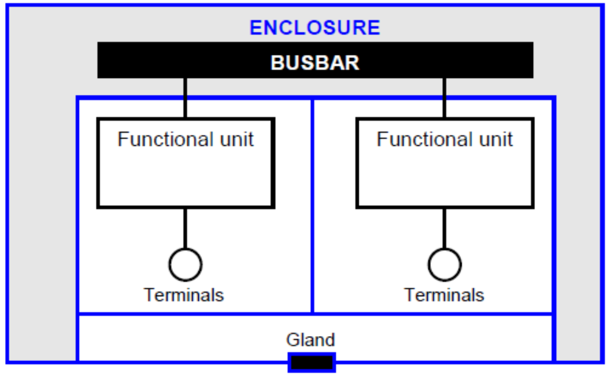


Arc fault containment certification for the Fixed portfolio utilising the TVOC – 2 shall available early 2019.

FORMS OF INTERNAL SEPARATION : FORM4A

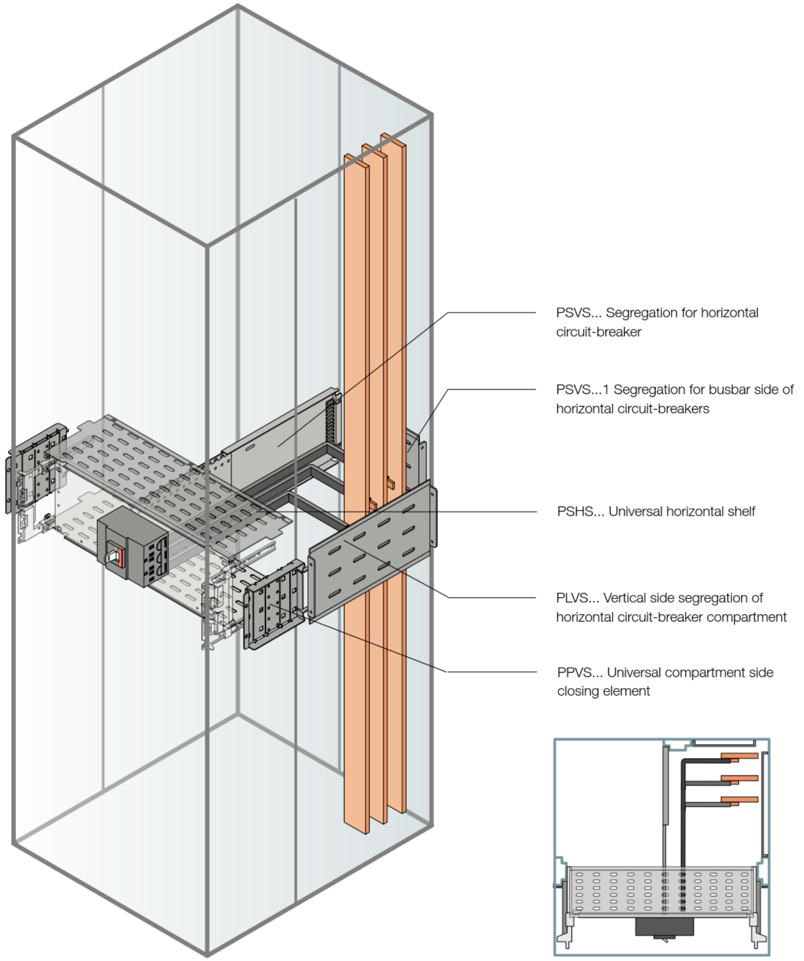
Forms of separation/Types of construction

The Forms of internal separation and the associated Types of construction are illustrated



Form 4A

Terminals in same compartment as associated functional unit (common glanding)

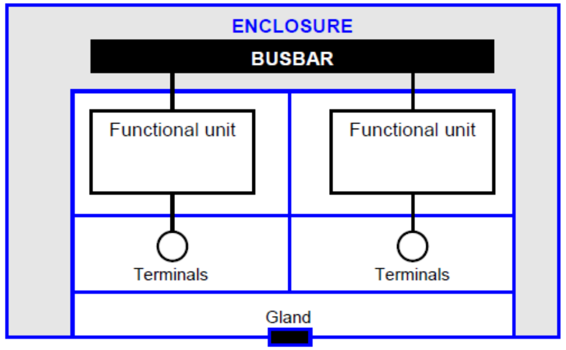


Arc fault containment certification for the Fixed portfolio utilising the TVOC – 2 shall available early 2019.

FORMS OF INTERNAL SEPARATION : FORM4B

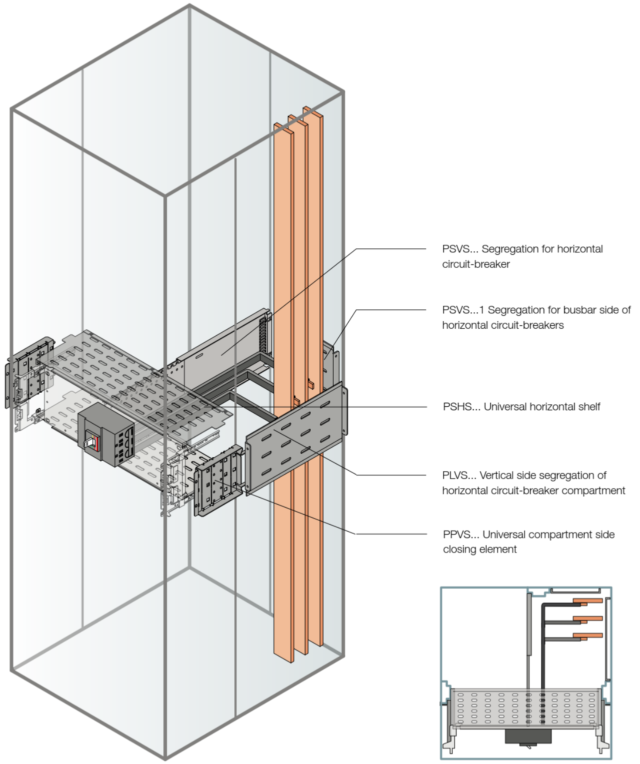
Forms of separation/Types of construction

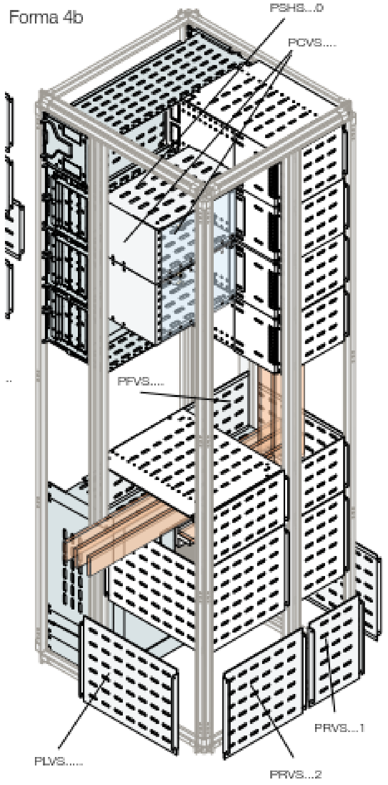
The Forms of internal separation and the associated Types of construction are illustrated



Form 4B

Terminals for external conductors NOT in the same compartment as associated functional unit (common glanding)

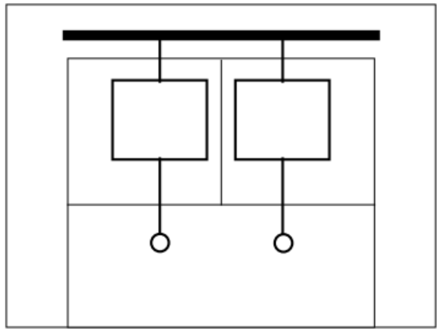




FORMS OF INTERNAL SEPARATION
The differences IEC and BS EN 61439-2

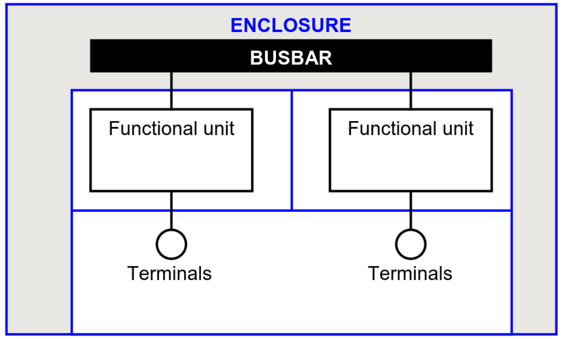
Form 3B

IEC 61439



Form 3b:
Terminals and external conductors separated from busbars

BS EN 61439



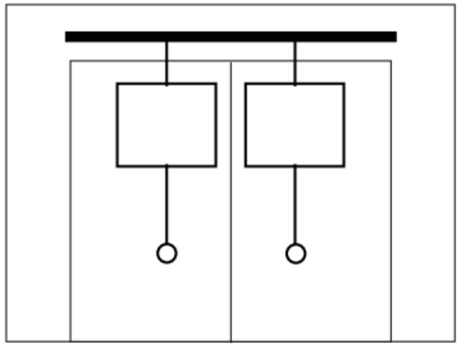
Type 1: Busbar separation is achieved using an insulated covering e.g. Sleeving or wrapping
Type 2: Busbar separation is achieved using metallic or non-metallic rigid barriers or partitions.

FORMS OF INTERNAL SEPARATION

The differences IEC and BS EN 61439-2

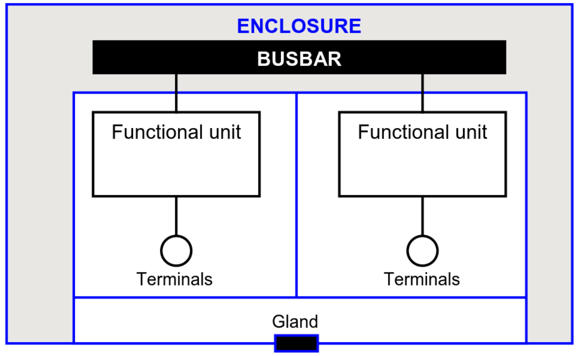
Form 4a

IEC 61439



Form 4a:
Terminals in same compartment
as associated functional unit

BS EN 61439



Type 1: Busbar separation is achieved using an insulated covering e.g. Sleeving or wrapping. Cables may be glanded elsewhere.
Type 2: Busbar separation is achieved using metallic or non-metallic rigid barriers or partitions. Cables may be glanded elsewhere.

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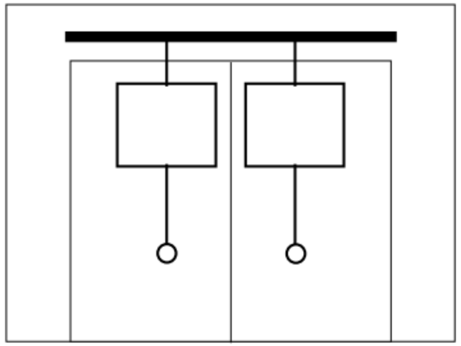
FORMS OF INTERNAL SEPARATION

The differences IEC and BS EN 61439-2

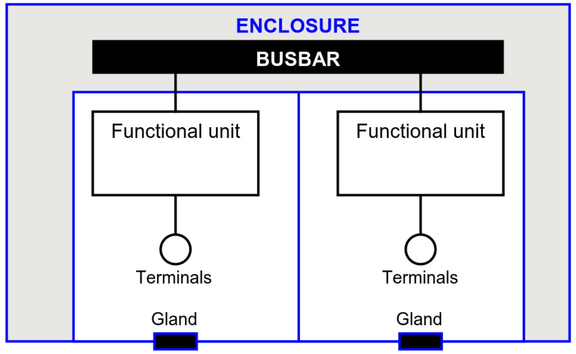
Form 4a

IEC 61439



Form 4a:
Terminals in same compartment
as associated functional unit

BS EN 61439



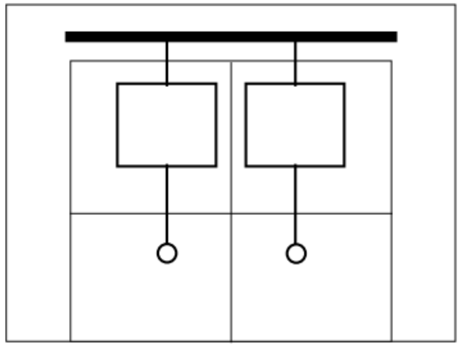
Type 3: Busbar separation is achieved using metallic or non-metallic rigid barriers or partitions. The termination for each functional unit has its own integral glanding facility.

FORMS OF INTERNAL SEPARATION

The differences IEC and BS EN 61439-2

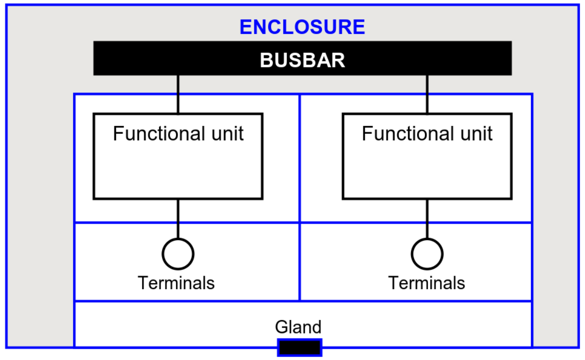
Form 4b

IEC 61439



Form 4b:
Terminals not in same compartment
as associated functional unit

BS EN 61439



Type 4: Busbar separation is achieved using an insulated covering e.g. Sleeving or wrapping. Cables may be glanded elsewhere.
Type 5: Busbar separation is achieved using metallic or non-metallic rigid barriers or partitions. Terminals may be separated by insulated coverings. Cables may be glanded in common cabling chambers.
Type 6: All separation requirements are achieved using metallic or non-metallic rigid barriers or partitions. Cables are glanded in common cabling chambers.

Switchgear Design

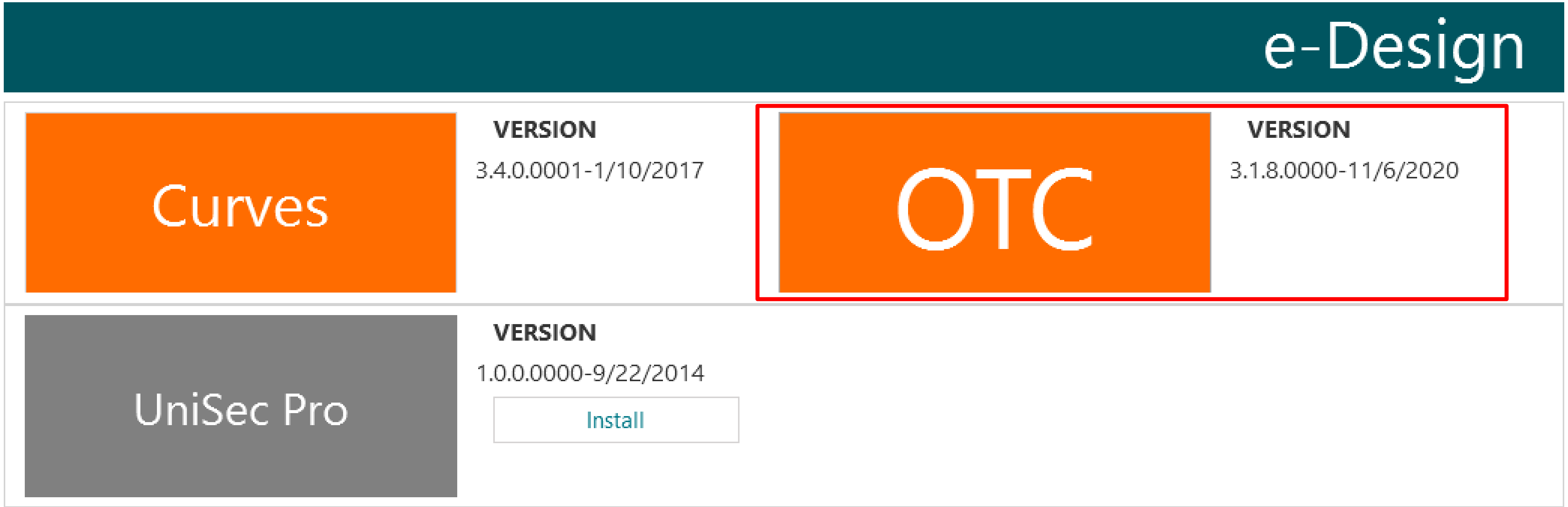
According to IEC 61439

- IEC 61439 and Main Parameter
- Low-voltage switchgear and controlgear assemblies IEC 61439
- Forms of Internal Separation
- ABB E-design software , OTC Temp-rise assessment tool

ABB E-design software , OTC Temp-rise assessment tool

OTC Temperature-Rise Assessment tool

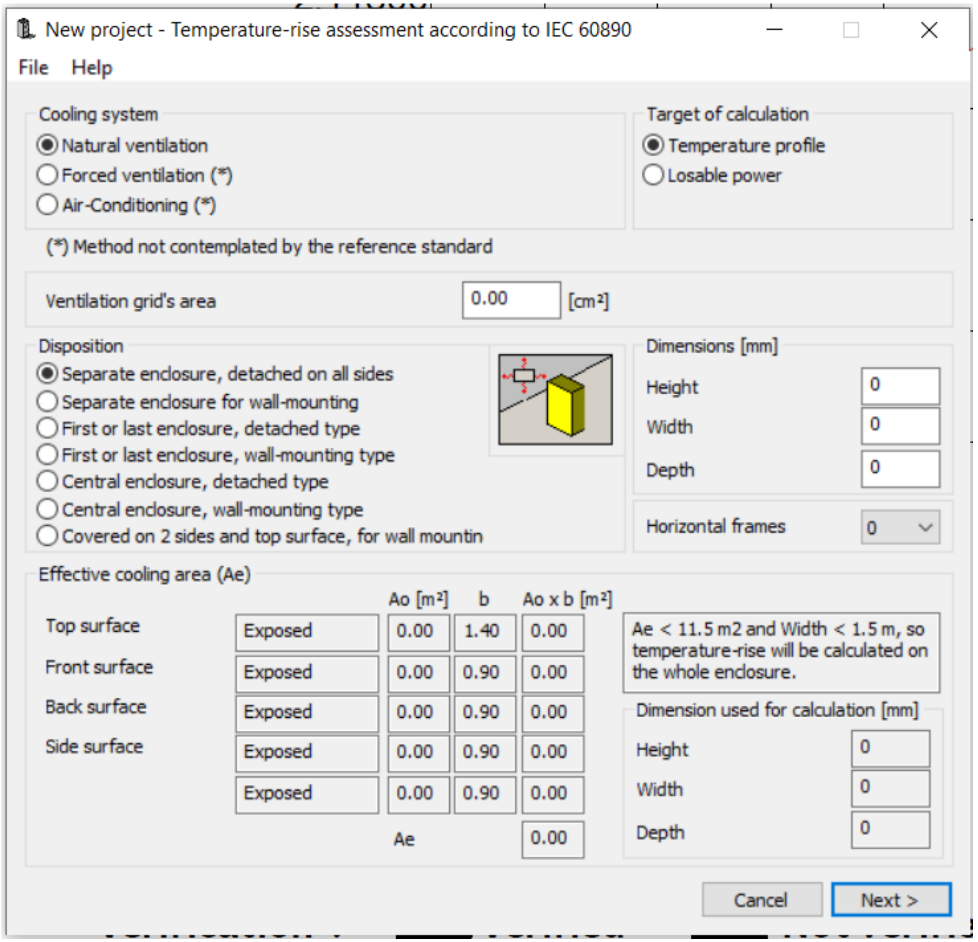
ABB e-Design software (Freeware available to download at ABB.com)



OTC Temperature-Rise Assessment tool
Introduction

The thermal calculation module makes it possible to evaluate the thermal behavior of ABB boards and – if desired – to dimension the fans and air-conditioning units to be installed in the board. I ca also be sued on sets of boards obtained by installing several units side by side.

The algorithms used by the software are as described in Standard IEC 60890. If the use of air-conditioning of fans is specified (a situation no considered in the Standard 60890), the program still uses computation algorithms that are compatible with Standard on low-voltage boards.



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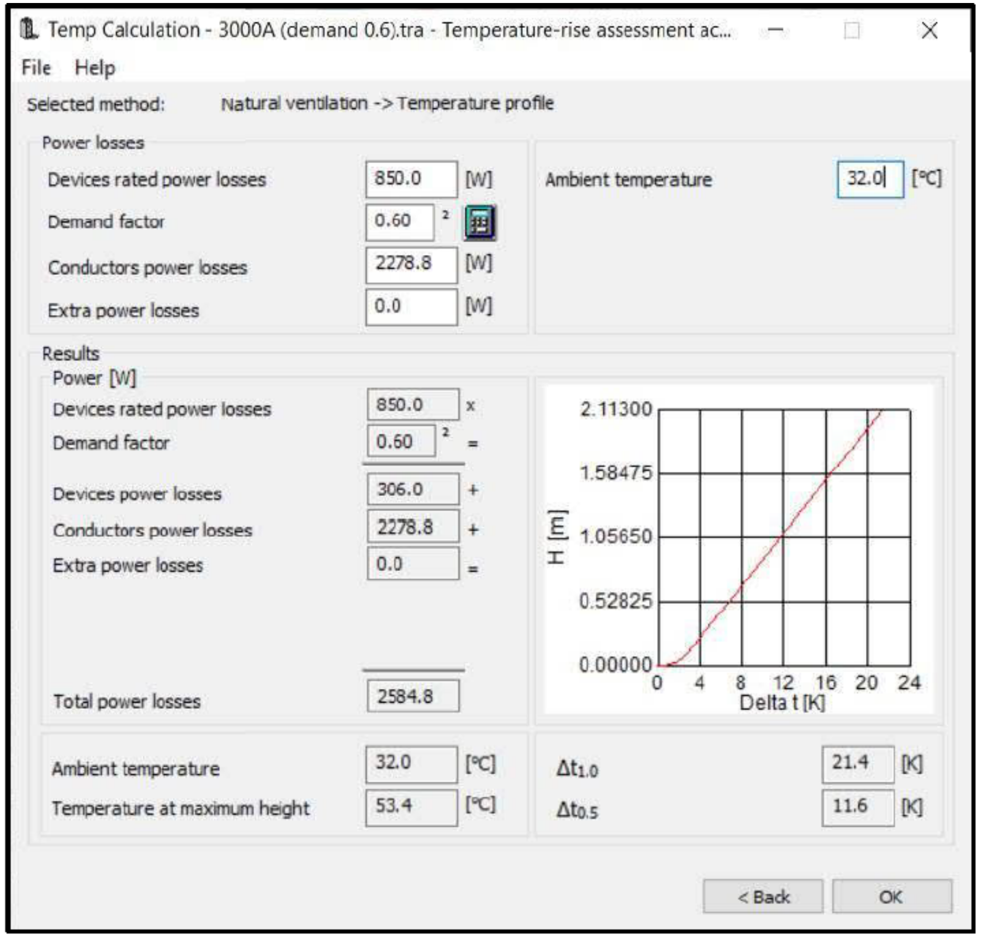
OTC Temperature-Rise Assessment tool
Introduction

The proposed method makes it possible to determine the overtemperatures. or the air temperatures , inside the enclosure, but is unable to determines the temperatures of individual equipment, devices and cables contained in it.

The temperatures of the air inside the board is the same as that of the ambient air outside the enclosure plus the overtemperatures of the air inside the board due to power dissipated by the devices installed.



OTC Temperature-Rise Assessment tool

Introduction

Cooling system	Target of calculation	Results
Natural ventilation	Temperature profile	Temperatures at the top of the enclosure Overtemperature at the middle of the enclosure Overtemperature at the top of the enclosure
	Losable power	Maximum losable power Maximum losable power still available (residual) Overtemperature at the middle of the enclosure Overtemperatures at the top of the enclosure
Forced ventilation	Temperature profile	Temperatures at the top of the enclosure Overtemperature at the middle of the enclosure Overtemperature at the top of the enclosure
	Losable power	Maximum losable power Maximum losable power still available (residual) Overtemperature at the middle of the enclosure Overtemperatures at the top of the enclosure
	Fan capacity	Power losses extracted by the fan Fan capacity Overtemperature at the middle of the enclosure Overtemperatures at the top of the enclosure
Air-conditioning	Temperature profile	Average temperature inside the enclosure
	Losable power	Maximum losable power Maximum losable power still available (residual)
	Conditioning power	Power losses extracted by the air-conditioning Air-conditioning power

The value assumed by the calculation target selected.

The table shows an overview of the parameters calculated by the software depending on type of colling system and the calculation target selected by the user.

Reference – Table 6 Temperature Rise Limits

Table 6 – Temperature-rise limits (9.2)

Parts of assemblies	Temperature-rise K
Built-in components [a]	In accordance with the relevant product standard requirements for the individual components or, in accordance with the component manufacturer's instructions[f], taking into consideration the temperature in the assembly
Terminals for external insulated conductors	70[b]
Busbars and conductors	Limited by[f]: – mechanical strength of conducting material[g]; – possible effect on adjacent equipment; – permissible temperature limit of the insulating materials in contact with the conductor; – effect of the temperature of the conductor on the apparatus connected to it; – for plug-in contacts, nature and surface treatment of the contact material
Manual operating means: – of metal – of insulating material	 15[c,h] 25[c,h]
Accessible external enclosures and covers: – metal surfaces – insulating surfaces	 30[d,h] 40[d,h]

Reference – Table 6 Temperature Rise Limits

The temperature-rise limits given in this table apply for a daily average ambient air temperature up to 35 °C under service conditions (see 7.1). During verification a different ambient air temperature is permissible (see 10.10.2.3.4).

[a] The term "built-in components" means:

– conventional switchgear and controlgear;

– electronic sub-assemblies (e.g. rectifier bridge, printed circuit);

– parts of the equipment (e.g. regulator, stabilized power supply unit, operational amplifier).

[b] The temperature-rise limit of 70 K is a value based on the conventional test of 10.10. An assembly used or tested under installation conditions may have connections, the type, nature and disposition of which will not be the same as those adopted for the test, and a different temperature-rise of terminals may result and may be required or accepted. Where the terminals of the built-in component are also the terminals for external insulated conductors, the lower of the corresponding temperature-rise limits shall be applied. The temperature-rise limit is the lower of the maximum temperature-rise specified by the component manufacturer and 70 K. In the absence of manufacturer's instructions, it is the limit specified by the built-in component product standard but not exceeding 70 K. For terminals of the built-in component that are terminals for external insulated conductors, the thermocouple for the temperature-rise test shall not be placed on the test conductor insulation.

[c] Manual operating means within assemblies which are only accessible after the assembly has been opened, for example draw-out handles which are not operated while the assembly is in normal service, are permitted to sustain a 25 K increase on these temperature-rise limits.

[d] Unless otherwise specified, in the case of covers and enclosures, which are accessible but need not be touched during normal operation, a 10 K increase on these temperature-rise limits is permissible. External surfaces and parts over 2 m from the base of the assembly are considered inaccessible.

[e] This allows a degree of flexibility in respect of equipment (e.g. electronic devices) which is subject to temperature-rise limits different from those normally associated with switchgear and controlgear.

[f] For temperature-rise tests according to 10.10, the temperature-rise limits have to be specified by the original manufacturer. It is the responsibility of the original manufacturer to take into account any additional measuring points and limits imposed by the component manufacturer.

[g] Assuming all other criteria listed are met, a maximum temperature-rise of 105 K for copper busbars and conductors shall not be exceeded. The 105 K relates to the temperature above which annealing of copper is likely to occur. In the absence of a declaration from the original manufacturer, regarding the reliability and stability of the ageing behaviour of the electrical contact or joint, a maximum temperature-rise of 55 K for bare (uncoated) aluminium busbars and conductors is applicable.

[h] Where an assembly is installed in an ambient air temperature exceeding a daily average of 35 °C, a higher absolute temperature (°C) may be permitted. Temperature-rise (K) shall not exceed the values given in this table. See also 9.2. In such a case warning label according to ISO 7010 W017 shall be provided.

Reference – Annex K Operating current and power loss of bare copper bars

Annex K
(normative)

Operating current and power loss of bare copper bars

Table K.1 and Table K.2 provide values for conductor operating currents and power losses under ideal conditions within an assembly (see 10.10.2.2.3, 10.10.4.2.1 and 10.10.4.3.1). Annex K does not apply to conductors verified by testing.

The calculation methods used to establish these values are given to enable values to be calculated for other conditions.

Table K.1 – Operating current and power loss of bare copper bars with rectangular cross-section, run horizontally and arranged with their largest face vertical, frequency 50 Hz to 60 Hz (ambient air temperature inside the assembly: 55 °C, temperature of the conductor 70 °C)

Height × thickness of bars	Cross-sectional area of bar	One bar per line			Two bars per line (space between the two bars is equal to the thickness of one bar)		
		k_3	Operating current	Power-losses per line conductor, P_v	k_3	Operating current	Power-losses per line conductor, P_v
mm × mm	mm²		A	W/m		A	W/m
12 × 2	23,5	1,00	70	4,5	1,01	118	6,4
15 × 2	29,5	1,00	83	5,0	1,01	138	7,0
15 × 3	44,5	1,01	105	5,4	1,02	183	8,3
20 × 2	39,5	1,01	105	6,1	1,01	172	8,1
20 × 3	59,5	1,01	133	6,4	1,02	226	9,4
20 × 5	99,1	1,02	178	7,0	1,04	325	11,9
20 × 10	199	1,03	278	8,5	1,07	536	16,6
25 × 5	124	1,02	213	8,0	1,05	381	13,2
30 × 5	149	1,03	246	9,0	1,06	437	14,5
30 × 10	299	1,05	372	10,4	1,11	689	18,9
40 × 5	199	1,03	313	10,9	1,07	543	17,0

Example - ABB Air circuit Breaker Emax2 Power Losses

Power losses

Circuit-breaker type		Iu	630A	800A	1000A	1250A	1600A	2000A	2500A	3200A	4000A	5000A	6300A
Fixed	E1.2 B/C/N	[W]	31	50	78	122	201	-	-	-	-	-	-
	E2.2 B/N/S/H	[W]	-	34	53	83	136	212	267	-	-	-	-
	E4.2 N/S/H/V	[W]	-	-	-	-	-	-	-	425	465	-	-
	E6.2 H/V/X	[W]	-	-	-	-	-	-	-	-	309	483	767
Withdrawable	E1.2 B/C/N	[W]	62	100	156	244	400	-	-	-	-	-	-
	E2.2 B/N/S/H	[W]	-	72	113	176	288	450	550	-	-	-	-
	E4.2 N/S/H/V	[W]	-	-	-	-	-	-	-	743	900	-	-
	E6.2 H/V/X	[W]	-	-	-	-	-	-	-	-	544	850	1550

Example - ABB MCCB Tmax Power Losses

Power losses

Power [W/pole]	In [A]	T1/T1 1P	T2		T3		T4		T5		T6		T7 S,H,L		T7 V	
		F	F	P	F	P	F	P/W	F	P/W	F	W	F	W	F	W
TMD	320								13.6	20.9						
TMA	400								19.5	31						
TMG	500								28.8	36.7						
MF	630										30.6	30				
MA	800										31	39.6				
PR22..	10		0.5	0.6												
PR23..	25		1	1.2												
PR33..	63		3.5	4												
	100		8	9.2			1.7	2.3								
	160		17	20			4.4	6								
	250						10.7	14.6								
	320						17.6	24	10.6	17.9						
	400								16.5	28			5	9	8	12
	630								41	53.6	30	38.5	12	22	20	30
	800										32	41.6	19.3	35.3	32	48

ABB