



ABB EGYPT, WEDNESDAY 14TH OF OCTOBER 2020

LV Switchgear Design Verification - IEC 61439

ABB Consultants Talk

Tarek Mahmoud, Technical & Design Promotion Specialist



Training Plan Index

- Low Voltage According to IEC
- IEC 61439 Low-Voltage Switchgear And Controlgear Assemblies
- Design Verifications
- Routine Verifications

Low Voltage According to IEC

Low Voltage According to IEC

IEC 61439 and IEC IEC 60947

IEC 61439

Low-Voltage Switchgear And Controlgear Assemblies

Scope:

Within the IEC 61439 series of standards for low-voltage switchgear and controlgear assemblies (**ASSEMBLIES**), there are system and application details that are specified by the user to enable the manufacturer to produce an ASSEMBLY that meets the needs and expectations of the user.

IEC 60947

Low-Voltage Switchgear and Controlgear

Scope:

This document applies, when required by the relevant product standard, to low-voltage switchgear and controlgear hereinafter referred to as "**equipment**" or “device” and intended to be connected to circuits, the rated voltage of which does not exceed 1000 V AC or 1500 V DC.

Differences

IEC 61439 Low-Voltage Switchgear And Controlgear Assemblies

IEC 61439 Low-Voltage Switchgear And Controlgear Assemblies

Overview

IEC 61439-1 Edition 2.0 2011-08 Part 1: General rules

IEC 61439-2 Edition 2.0 2011-08 Part 2: Power switchgear and controlgear assemblies

IEC 61439-3 Edition 1.0 2012-02 Part 3: Distribution boards intended to be operated by ordinary persons (DBO)

IEC 61439-4 Edition 1.0 2012-11 Part 4: Particular requirements for assemblies for construction sites (ACS)

IEC 61439-5 Edition 2.0 2014-08 Part 5: Assemblies for power distribution in public networks

IEC 61439-6 Edition 1.0 2012-05 Part 6: Busbar trunking systems (busways)

IEC 61439-7 Edition 1.0 2018-12 Part 7: Assemblies for specific applications such as marinas, camping sites, market squares, electric vehicle charging stations

IEC 61439 Low-Voltage Switchgear And Controlgear Assemblies

IEC 61439 Low-Voltage Switchgear And Controlgear Assemblies

IEC 61439 Low-Voltage Switchgear And Controlgear Assemblies

IEC 61439-1 Edition 2.0 2011-08 Part 1: General rules

Within the IEC 61439 series of standards for low-voltage switchgear and controlgear assemblies (ASSEMBLIES), there are system and application details that are specified by the user to enable the manufacturer to produce an **ASSEMBLY** that meets the needs and expectations of the user.

<Assemblies>



IEC 61439 Low-Voltage Switchgear And Controlgear Assemblies

Definitions

Assembly

Combination of one or more low-voltage switching devices together with associated control, measuring, signalling, protective, regulating equipment, with all the internal electrical and mechanical interconnections and structural parts

Assembly System

Full range of mechanical and electrical components (enclosures, busbars, functional units, etc.), as defined by the original manufacturer, which can be assembled in accordance with the original manufacturer's instructions in order to produce various ASSEMBLIES

IEC 61439 Low-Voltage Switchgear And Controlgear Assemblies

Design Verifications

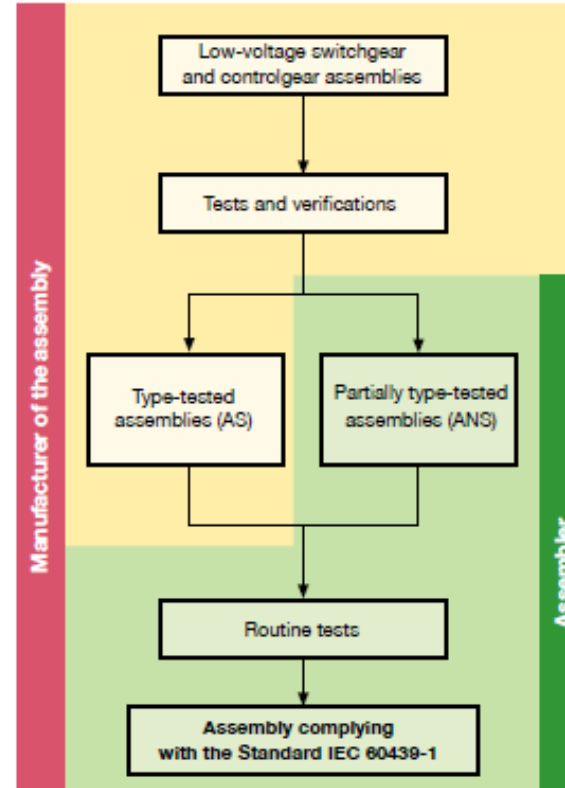
From IEC 60439-1 to 61439-1



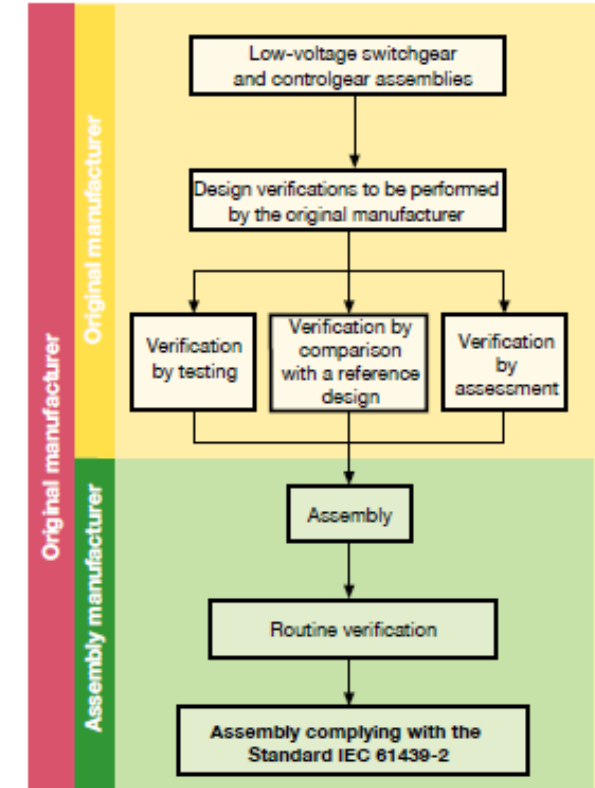
Work book
The standard IEC 61439 in practice

Power and productivity
for a better world™ **ABB**

Standard IEC 60439-1

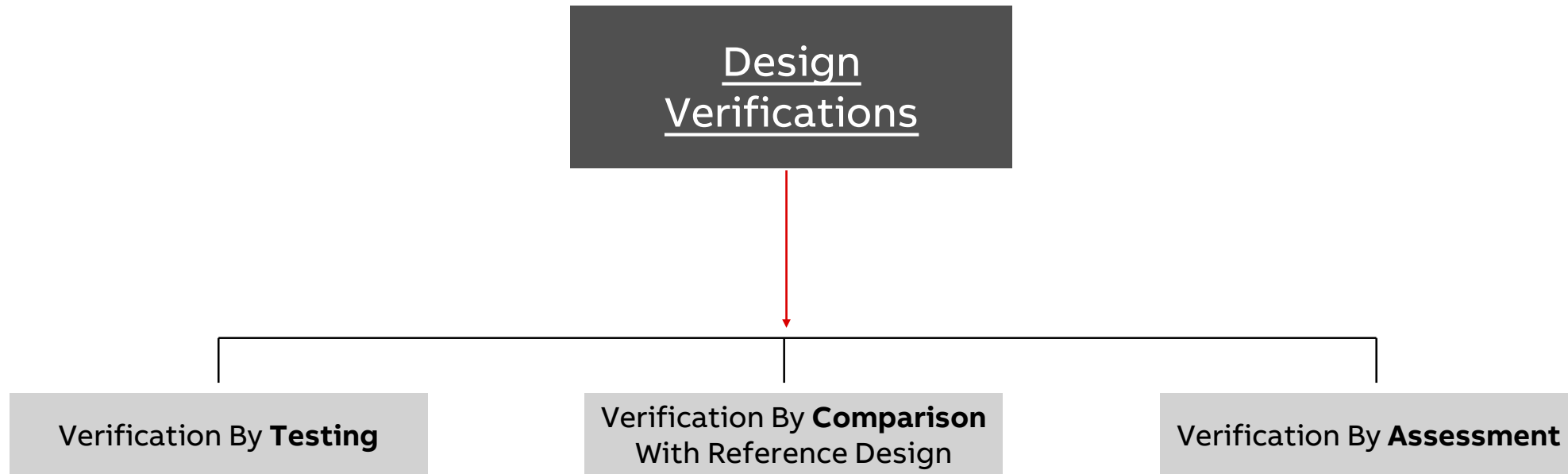


Standard IEC 61439-1-2



Design Verifications

Ways of Verifications



IEC 61439 Low-Voltage Switchgear And Controlgear Assemblies

Definitions

Design Verification

Verification made on a sample of an ASSEMBLY or on parts of ASSEMBLIES to show that the design meets the requirements of the relevant ASSEMBLY standard

Verification Test

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

IEC 61439 Low-Voltage Switchgear And Controlgear Assemblies



IEC 61439 Low-Voltage Switchgear And Controlgear Assemblies

Definitions

Verification Comparison

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

Verification Assessment

Design verification of strict design rules or calculations applied to a sample of an ASSEMBLY or to parts of ASSEMBLIES to show that the design meets the requirements of the relevant ASSEMBLY standard

IEC 61439 Low-Voltage Switchgear And Controlgear Assemblies

Definitions

Routine Verification

Verification of each ASSEMBLY performed during and/or after manufacture to confirm whether it complies with the requirements of the relevant ASSEMBLY standard



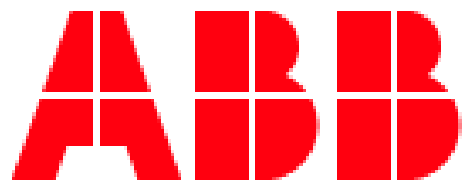
IEC 61439 Low-Voltage Switchgear And Controlgear
Assemblies

IEC 61439 Low-Voltage Switchgear And Controlgear Assemblies

Definitions

Original Manufacturer

Organization that has carried out the original design and the associated verification of an ASSEMBLY in accordance with the relevant ASSEMBLY standard



Assembly Manufacturer

Organization taking the responsibility for the completed ASSEMBLY

Low Voltage Panel Builders

Egypt

Nigeria

Ghana

+2(010) 0175 6725
Arab Tech for Electrical Industries

+2(012) 2236 4673
Eliaco - El Eman Electric Industrial Company

+2(010) 1237 5666
ELSEWEDY for Engineering Industries

+2(012) 2310 3329
GMS - Engineering Company for Manufacturing

+2(0100) 166 0892
EMEC - Electro Mechanical Contractors

+2(012) 2222 1209
Inco Tech - Inco Tech for Electrical Industries

+2(011) 1005 2345
Lectro - Egypt for Electrical Products & Contracting

+2(0100) 504 1436
Miratech

+2(010) 9636 6783
OMEGA - Electrical & Mechanical Consultation & Contracting

+2(0100) 000 2147
PowerLine for Contracting and Supplying

+2(012) 2314 8105
Smart Industries

+2(010) 0103 5804
Synchro Mizr

+2(02) 25747070
AGEC

+2(02) 27324945
HCH Supply Co

Design Verifications

Design Verifications

According to IEC 61439-1

Construction

1. Strength of materials and parts
2. Degree of protection of enclosures
3. Clearances
4. Creepage distances
5. Protection against electric shock and integrity of protective circuits
6. Incorporation of switching devices and components
7. Internal electrical circuits and connections
8. Terminals for external conductors

Performance

1. Dielectric properties
2. Verification of temperature rise
3. Short-circuit withstand strength
4. Electromagnetic compatibility
5. Mechanical operation

Design Verifications According to IEC 61439-1

Design Verifications Construction

IEC 61439 Low-Voltage Switchgear And Controlgear Assemblies

Construction - Design Verification According to IEC 61439-1

1. Strength of Materials and Parts

1. Resistance to corrosion
2. Properties of insulating materials
3. Resistance to ultra-violet (UV) radiation
4. Lifting provision
5. Mechanical strength
6. Marking

Design Verifications According to IEC 61439-1

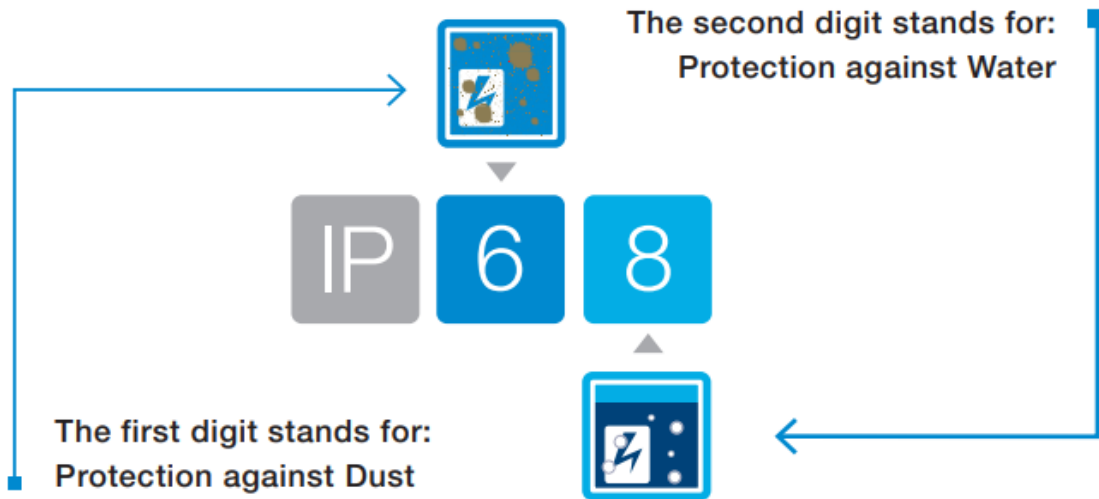


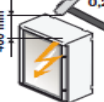
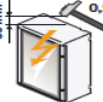
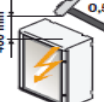
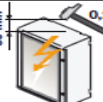
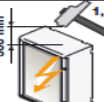
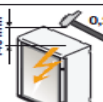
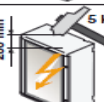
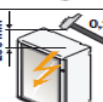
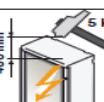
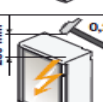
IEC 61439 Low-Voltage Switchgear And Controlgear Assemblies

Construction - Design Verification According to IEC 61439-1

2. Degree of Protection

- Degrees of protection provided by enclosures (IP Code)
- Degree of Protection provided by enclosures for electrical equipment against external mechanical impacts (IK Code)



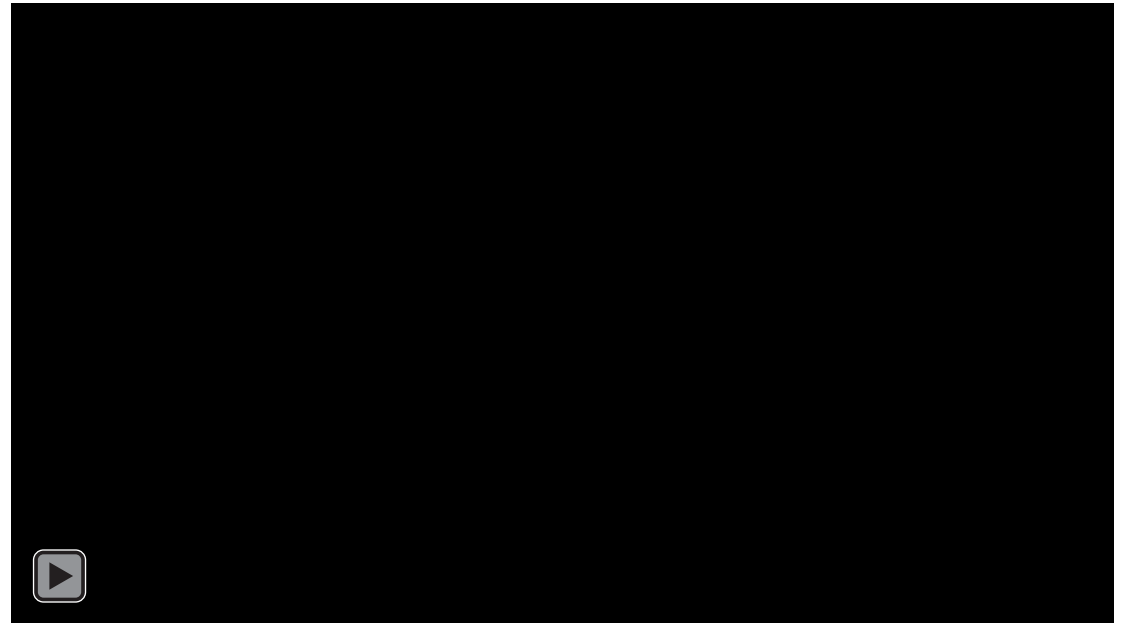
IK 0		No protection against impacts	IK 06		Resistance to impacts with impact energy up to 1,00 J
IK 01		Resistance to impacts with impact energy up to 0,150 J	IK 07		Resistance to impacts with impact energy up to 2,00 J
IK 02		Resistance to impacts with impact energy up to 0,200 J	IK 08		Resistance to impacts with impact energy up to 5,00 J
IK 03		Resistance to impacts with impact energy up to 0,350 J	IK 09		Resistance to impacts with impact energy up to 10,00 J
IK 04		Resistance to impacts with impact energy up to 0,500 J	IK 10		Resistance to impacts with impact energy up to 20,00 J
IK 05		Resistance to impacts with impact energy up to 0,700 J			

IEC 61439 Low-Voltage Switchgear And Controlgear Assemblies

Construction - Design Verification According to IEC 61439-1

IP Code According To IEC 60529

IK Code According To IEC 62202



2. Degree of Protection of ASSEMBLIES

IEC 61439 Low-Voltage Switchgear And Controlgear Assemblies

Construction - Design Verification According to IEC 61439-1

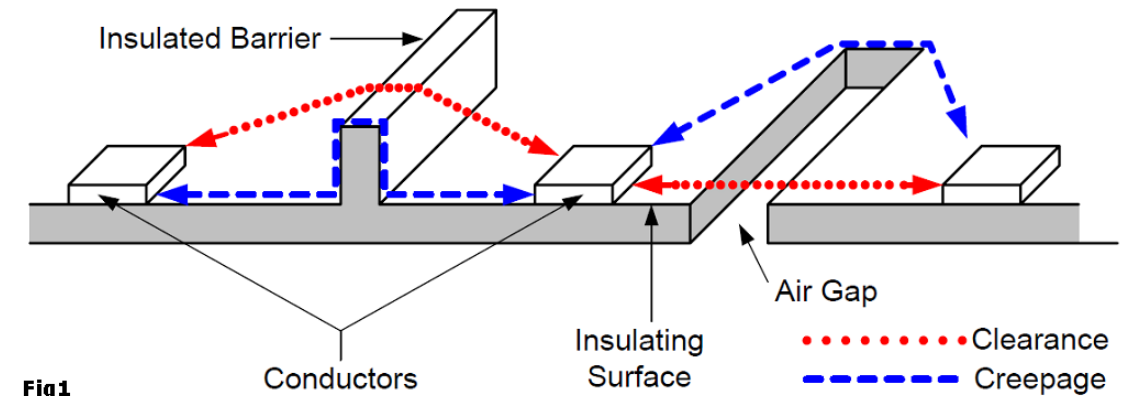
3 & 4 Clearances and Creepage Distances

1. Clearances

The distance between two conductive parts along a string stretched the shortest way between these conductive parts.

2. Creepage Distances

The shortest distance along the surface of a solid insulating material between two conductive parts



IEC 61439 Low-Voltage Switchgear And Controlgear
Assemblies

IEC 61439 Low-Voltage Switchgear And Controlgear Assemblies

Construction - Design Verification According to IEC 61439-1

5. Protection Against Electric Shock

1. Effectiveness of the protective circuit
2. Effective earth continuity between the exposed conductive parts of the ASSEMBLY and the protective circuit
3. Short-circuit withstand strength of the protective circuit



IEC 61439 Low-Voltage Switchgear And Controlgear Assemblies

IEC 61439 Low-Voltage Switchgear And Controlgear Assemblies

Construction - Design Verification According to IEC 61439-1

6. Incorporation of Switching Devices and Components

1. Fixed parts
2. Incorporation of switching devices and components
3. Selection of switching devices and components
4. Installation of switching devices and components
5. Accessibility
6. Barriers
7. Direction of operation and indication of switching positions
8. Indicator lights and push-buttons

IEC 61439 Low-Voltage Switchgear And Controlgear Assemblies



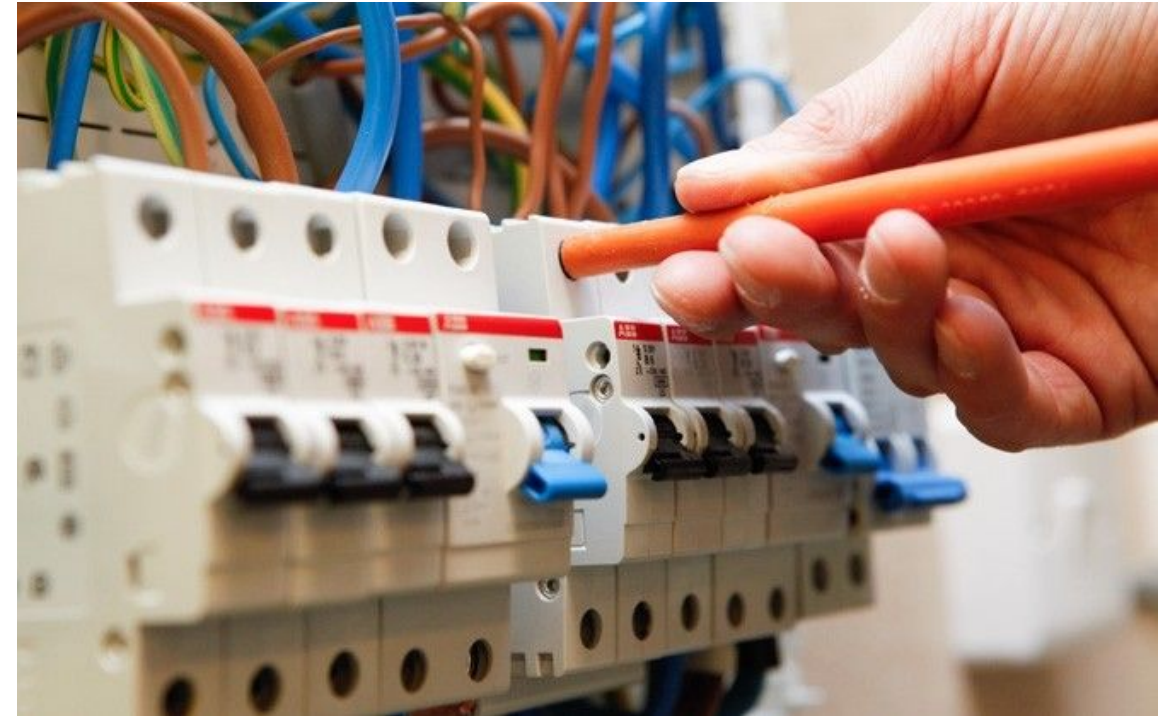
IEC 61439 Low-Voltage Switchgear And Controlgear Assemblies

Construction - Design Verification According to IEC 61439-1

7. Internal Electrical Circuits and Connections

1. Main circuits
2. Auxiliary circuits
3. Bare and insulated conductors
4. Selection and installation of non-protected live conductors to reduce the possibility of short-circuits
5. Identification of the conductors of main and auxiliary circuits
6. Identification of the protective conductor (PE, PEN) and of the neutral conductor (N) of the main circuits

IEC 61439 Low-Voltage Switchgear And Controlgear Assemblies

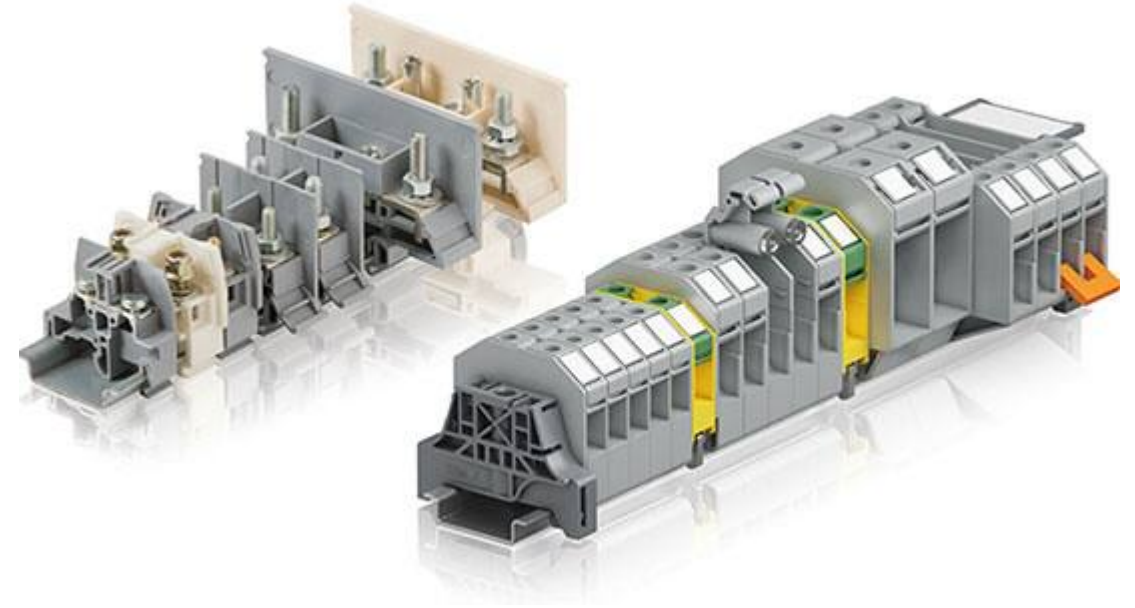


IEC 61439 Low-Voltage Switchgear And Controlgear Assemblies

Construction - Design Verification According to IEC 61439-1

8. Terminals For External Conductors

The number, type and identification of terminals shall be checked in accordance with the ASSEMBLY manufacturing instructions.



IEC 61439 Low-Voltage Switchgear And Controlgear
Assemblies

Empty Enclosures



IEC 61439 Low-Voltage Switchgear And Controlgear Assemblies

IEC 62208 Edition 2.0 2011-08 Empty enclosures for low-voltage switchgear and controlgear assemblies

Empty Enclosures For Low Voltage Switchgear and Control Gear Assemblies

Table 1 – Number of samples to be tested and order of test per sample

Subclause	Test	Sample 1	Sample 2	Sample 3	Representative sample (see 9.12)
9.3	Marking	8			
9.4	Static loads	1			
9.5	Lifting	2			
9.6	Axial loads of metal inserts	3			
9.7	Degree of protection against external mechanical impacts (IK code)	4			
9.8	Degree of protection against access to hazardous parts and against ingress of solid objects and/or water (IP code)	5			
9.9.1	Thermal stability		1		
9.9.2	Resistance to heat		2		
9.9.3	Resistance to abnormal heat and fire		3		
9.10	Dielectric strength	6			
9.11	Continuity of the protective circuit	7		3	
9.12	Resistance to ultra-violet (UV) radiation				*
9.13	Resistance to corrosion			2	
9.14	Thermal power dissipation capability			1 ^b	
* Tests carried out on representative sample only.					
^b Only applicable if verified by test.					

Guaranteed Construction



IEC 62208

Edition 2.0 2011-08

INTERNATIONAL
STANDARD
NORME
INTERNATIONALE

Empty enclosures for low-voltage switchgear and controlgear assemblies –
General requirements
Enveloppes vides destinées aux ensembles d'appareillage à basse tension –
Exigences générales

IEC 62208:2011

For ABB use only. Publication provided under IEC subscription agreement 2010 - 2019. This file is copyright of IEC, Geneva, Switzerland. All rights reserved.



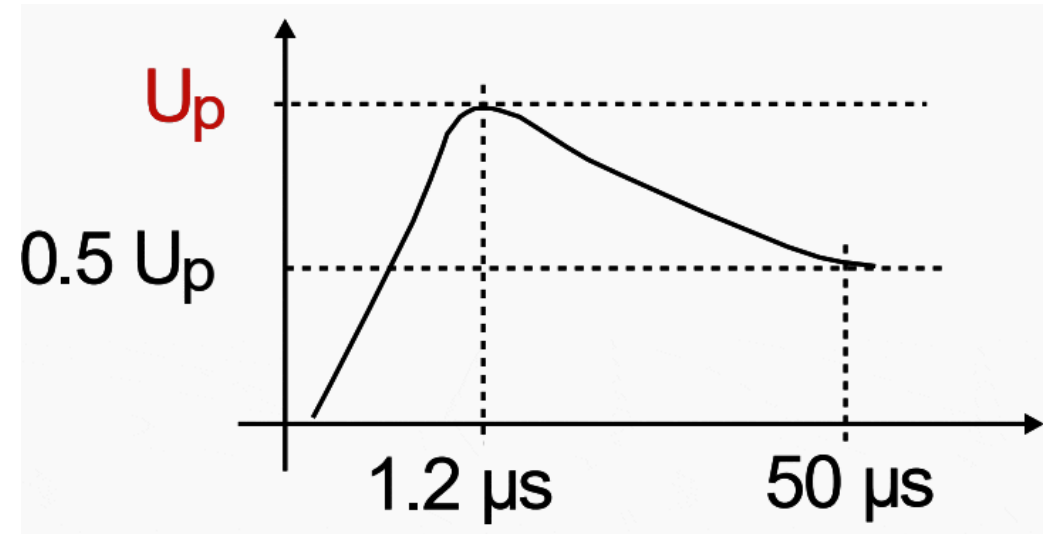
Design Verifications Performance

IEC 61439 Low-Voltage Switchgear And Controlgear Assemblies

Performance Requirements - Design Verification According to IEC 61439-1

1. Dielectric Properties

1. Power-frequency withstand voltage
2. Impulse withstand voltage
3. Testing of enclosures made of insulating material
4. External operating handles of insulating material



IEC 61439 Low-Voltage Switchgear And Controlgear
Assemblies

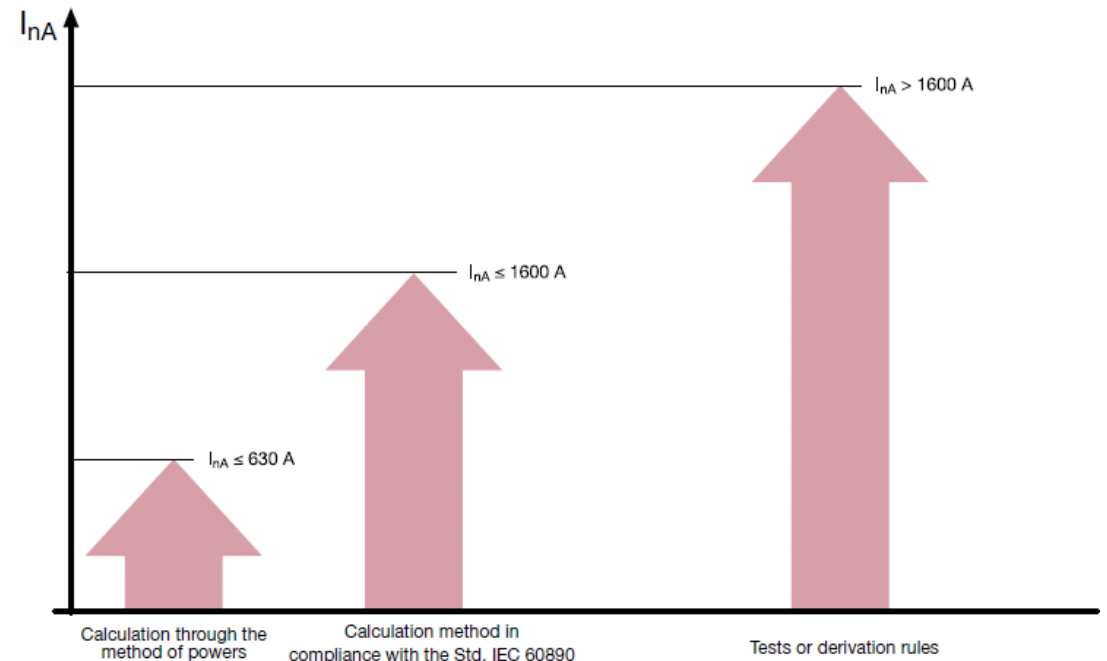
IEC 61439 Low-Voltage Switchgear And Controlgear Assemblies

Performance Requirements - Design Verification According to IEC 61439-1

2. Temperature Rise Limits

- a) Verification by testing
- b) Derivation of ratings for similar variants
- c) Verification assessment

IEC 61439 Low-Voltage Switchgear And Controlgear Assemblies



IEC 61439 Low-Voltage Switchgear And Controlgear Assemblies

Performance Requirements - Design Verification According to IEC 61439-1

3. Short-Circuit Protection And Short-Circuit Withstand Strength

ASSEMBLIES shall be capable of withstanding the thermal and dynamic stresses resulting from short-circuit currents not exceeding the rated values.

ASSEMBLIES shall be protected against short-circuit currents by means of, for example, circuitbreakers, fuses or combinations of both, which may either be incorporated in the ASSEMBLY or arranged outside it.

IEC 61439 Low-Voltage Switchgear And Controlgear Assemblies

Table 13 – Short-circuit verification by comparison with a reference design: check list (10.5.3.3, 10.11.3 and 10.11.4)

Item No.	Requirements to be considered	YES	NO
1	Is the short-circuit withstand rating of each circuit of the ASSEMBLY to be assessed, less than or equal to, that of the reference design?		
2	Is the cross-sectional dimensions of the busbars and connections of each circuit of the ASSEMBLY to be assessed, greater than or equal to, those of the reference design?		
3	Is the center line spacing of the busbars and connections of each circuit of the ASSEMBLY to be assessed, greater than or equal to, those of the reference design?		
4	Are the busbar supports of each circuit of the ASSEMBLY to be assessed of the same type, shape and material and have, the same or smaller center line spacing, along the length of the busbar as the reference design? And is the mounting structure for the busbar supports of the same design and mechanical strength?		
5	Are the material and the material properties of the conductors of each circuit of the ASSEMBLY to be assessed the same as those of the reference design?		
6	Are the short-circuit protective devices of each circuit of the ASSEMBLY to be assessed equivalent, that is of the same make and series ^a with the same or better limitation characteristics (I^2t , I_{lim}) based on the device manufacturer's data, and with the same arrangement as the reference design?		
7	Is the length of unprotected live conductors, in accordance with 8.6.4, of each non-protected circuit of the ASSEMBLY to be assessed less than or equal to those of the reference design?		
8	If the ASSEMBLY to be assessed includes an enclosure, did the reference design include an enclosure when verified by test?		

IEC 61439 Low-Voltage Switchgear And Controlgear Assemblies

Performance Requirements - Design Verification According to IEC 61439-1

4. Electromagnetic Compatibility (EMC)

Under normal service conditions, ASSEMBLIES not incorporating electronic circuits are not sensitive to electromagnetic disturbances and therefore no immunity tests are required.

IEC 61439 Low-Voltage Switchgear And Controlgear
Assemblies



IEC 61439 Low-Voltage Switchgear And Controlgear Assemblies

Performance Requirements – Design Verification According to IEC 61439-1

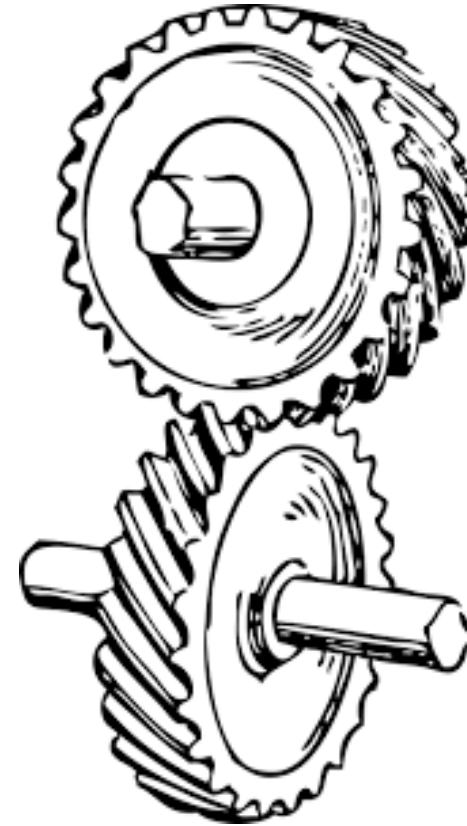
5. Mechanical Operation

This verification test shall not be made on such devices (e.g. withdrawable circuit breaker) of the ASSEMBLY which have already been type tested according to their relevant product standard unless their mechanical operation has been modified by their mounting.

For parts, which need verification by test (see 8.1.5), satisfactory mechanical operation shall be verified after installation in the ASSEMBLY. The number of operating cycles shall be 200.

At the same time, the operation of the mechanical interlocks associated with these movements shall be checked. The test is passed if the operating conditions of the apparatus, interlocks, specified degree of protection etc., have not been impaired and if the effort required for operation is practically the same as before the test.

IEC 61439 Low-Voltage Switchgear And Controlgear Assemblies

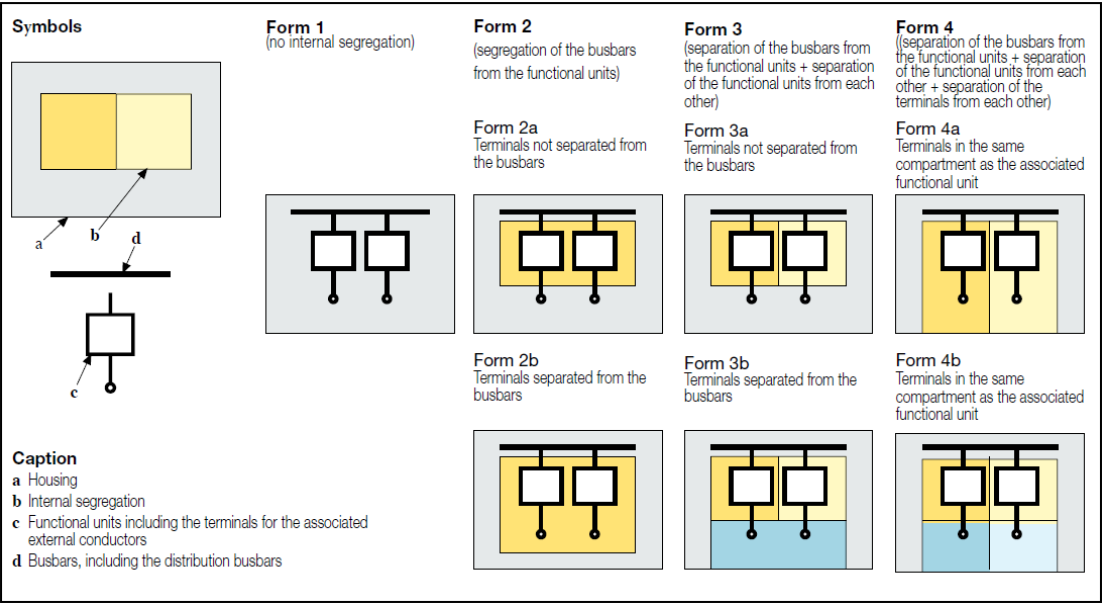


Annex AA

IEC 61439 Low-Voltage Switchgear And Controlgear Assemblies

Guide to Forms of Internal Separation

Annex AA - Form Of Segregation



IEC 61439-2 Low-Voltage Switchgear And Controlgear Assemblies

Table 104 – Forms of internal separation

Main criteria	Subcriteria	Form
No internal separation.		Form 1
Separation of busbars from all functional units.	Terminals for external conductors not separated from busbars	Form 2a
	Terminals for external conductors separated from busbars	Form 2b
- Separation of busbars from all functional units. - Separation of all functional units from one another. - Separation of terminals for external conductors and the external conductors from the functional units, but not from the terminals of other functional units.	Terminals for external conductors not separated from busbars	Form 3a
	Terminals for external conductors and external conductors separated from busbars	Form 3b
- Separation of busbars from all functional units - Separation of all functional units from one another. - Separation of terminals for external conductors associated with a functional unit from the terminals of any other functional unit and the busbars. - Separation of the external conductors from the busbars. - Separation of the external conductors associated with a functional unit from other functional units and their terminals. - External conductors need not be separated from each other.	Terminals for external conductors in the same compartment as the associated functional unit	Form 4a
	Terminals for external conductors not in the same compartment as the associated functional unit, but in individual, separate, enclosed protected spaces or compartments	Form 4b

Routine Verifications

IEC 61439 Low-Voltage Switchgear And Controlgear Assemblies

Routine Verification According to IEC 61439-1

Routine Verifications

1. Degree of protection of enclosures -> **Visual Inspection**
2. Clearances and creepage distances -> **Visual Inspection**
3. Protection against electric shock and integrity of protective circuits -> **Visual Inspection**
4. Incorporation of built-in components -> **In accordance with the ASSEMBLY manufacturing instructions**
5. Internal electrical circuits and connections -> **In accordance with the ASSEMBLY manufacturing instructions**
6. Terminals for external conductors -> **In accordance with the ASSEMBLY manufacturing instructions**
7. Mechanical operation -> **By Test**
8. Dielectric properties -> **By Test**
9. Wiring, operational performance and function -> **By Test (may be necessary to be repeated at site also)**

IEC 61439 Low-Voltage Switchgear And Controlgear Assemblies



ABB