SIVACON S4

IEC 61439 design verification
SIVACON S4
IEC 61439 design verification

- Overview
- IEC 61439 @SIVACON S4
- Additional tests
- Summary
SIVACON S4
IEC 61439 design verification

- Overview
- IEC 61439 @SIVACON S4
- Additional tests
- Summary
# IEC 61439 History

## Milestones of Switchboard Standards

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1896</td>
<td>First publication of standards, rules and guidelines of the VDE with first security rules for switching and distribution boards.</td>
</tr>
<tr>
<td>1941</td>
<td>VDE 0100 &quot;Regulations on the installation of power circuits with nominal voltages below 1000V&quot;</td>
</tr>
<tr>
<td>1958</td>
<td>VDE 0100 § 29 N Requirements for insulation, short-circuit strength and protection against contact with live parts</td>
</tr>
<tr>
<td>1967 (1973)</td>
<td>VDE 0660 Teil 5 factory assembled switchgear assemblies (EN (IEC) 60439)</td>
</tr>
<tr>
<td>1973</td>
<td>VDE 0100 § 30 b: Construction requirements for not factory assembled switching and distribution boards</td>
</tr>
<tr>
<td>1984 (1985)</td>
<td>VDE 0660 Teil 500 (TTA) type-tested switchgear and controlgear assemblies (EN (IEC) 60439-1) Joint construction requirements</td>
</tr>
<tr>
<td>1984 (1985)</td>
<td>VDE 0660 Teil 500: (PTTA) Partially type-tested switchgear and controlgear assemblies (EN (IEC) 60439-1)</td>
</tr>
<tr>
<td>2009</td>
<td>IEC 61439-1/2 New standard for power switchgear and controlgear assemblies VDE 0660-600-1/2</td>
</tr>
</tbody>
</table>
IEC 60439 problems

Reasons for the new standard series IEC 61439

With the new IEC 61439 the series of standards for low-voltage switchgear and controlgear assemblies was radically revised and restructured. The main reasons for this were the following key points of criticism about the previous IEC 60 439 standard.

- Grey areas leading to subjective interpretations
- Poorly structured content
- TTA / PTTA dilemma
  - Wrongly interpreted categories
  - Limited applicability
  - Classification useless for end customers
- IEC60439 part 1 with double function
  - Product standard and
  - General requirements for all other standards of this series
- Some manufacturers and specific market segments are ignoring the IEC 60439.
IEC 60439 problems

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</thead>
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</tr>
<tr>
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</tr>
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</table>

<table>
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</tr>
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IEC 60439 problems

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</tr>
</thead>
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<td>• Wrongly interpreted categories</td>
<td>• Product standard and</td>
<td>• Limited applicability and classification useless for end customers</td>
</tr>
</tbody>
</table>
Significant Modification IEC 60439

- From empty enclosure standards IEC 62208 additional criteria added in IEC 61439-1 classification 08.x
- Distribution of IEC 61439-1 in general section and product standards -2, -3, ...
- Elimination of the categories TTA and PTTA
- Introduction of design verification
- Shared proof responsibility (panel builder, equipment manufacturer)
- Implementation of „Black Box“ concept for interface definition
- Modified building and conduct requirements
- Verification of switching devices through alternative but equivalent methods
**IEC 61439 architecture**

**Replaced Standards**

<table>
<thead>
<tr>
<th>IEC 61439-1</th>
<th>General rules</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Replaces IEC 60 439-1</td>
</tr>
</tbody>
</table>

- **IEC 61439-2**
  - Power switchgear and controlgear assemblies
  - Replaces IEC 60439-1

- **IEC 61439-3**
  - Distribution boards
  - Replaces EC 60439-3

- **IEC 61439-4**
  - Assemblies for construction sites
  - Replaces IEC 60439-4

- **IEC 61439-5**
  - Assemblies for power distribution
  - Replaces EC 60439-5

- **IEC 61439-6**
  - Busbar trunking systems
  - Replaces IEC 60439-2
IEC 61439 Responsibility of manufacturer

IEC 60439

LV switchgear and controlgear ASSEMBLY

Type tests to verify the conformity

TSK type-tested SK

Type-tested device

Not type-tested device

PTTA Partially type-tested switchgear

Routine verification

Ready-to-use ASSEMBLY

IEC 61439

valid as of Nov. 2014

LV switchgear and controlgear ASSEMBLY

Design Verification from original manufacturer

Test

Derivation

Assessment

ASSEMBLY (original system)

Manufacturer of assembly can:
- perform the installation according to the rules of the original manufacturer
- In case of modification, the manufacturer of the assembly will become original manufacturer for the customized system

Routine verification

Ready-to-use ASSEMBLY
Overview
Allowed Test methods

Design Verification

Table D.1 – List of design verifications to be performed

<table>
<thead>
<tr>
<th>No.</th>
<th>Characteristic to be verified</th>
<th>Clauses or subclauses</th>
<th>Verification options available</th>
<th>Testing</th>
<th>Comparison with a reference design</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Strength of material and parts</td>
<td>10.2, 10.2.2, 10.2.3</td>
<td>Testing</td>
<td>YES</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td></td>
<td>Resistance to corrosion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Properties of insulating</td>
<td>10.2.3.1, 10.2.3.2</td>
<td></td>
<td>YES</td>
<td>NO</td>
<td>YES</td>
</tr>
<tr>
<td></td>
<td>materials</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Thermal stability</td>
<td></td>
<td></td>
<td>YES</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td></td>
<td>Resistance to abnormal heat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>and fire due to internal electric effects</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Test

Comparison with reference design

„Worst case“ scenario will be tested and covers the rest of the system.

Assessment
Responsibility of the original manufacturer
IEC 61439@SIVACON S4

LV switchgear and controlgear ASSEMBLY

Design Verification from original manufacturer

Test Derivation Assessment

ASSEMBLY (original system)

Manufacturer of assembly can:
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Routine Verification

Ready-to-use ASSEMBLY
| 10.1  | General introduction                          |
| 10.2  | Strength of materials and parts              |
| 10.3  | Degrees of protection of enclosures          |
| 10.4  | Clearances and creepage distances            |
| 10.5  | Protection against electric shock and continuity of PE circuits |
| 10.6  | Incorporation of switching devices and components |
| 10.7  | Internal electrical circuits and connections |
| 10.8  | Terminal connections for external conductors |
| 10.9  | Dielectric properties                        |
| 10.10 | Verification of temperature rise             |
| 10.11 | Short-circuit resistance                     |
| 10.12 | Electromagnetic compatibility (EMC)          |
| 10.13 | Mechanical function                          |
10.2 Verification of materials and parts

Resistance to corrosion

- Test of the corrosion resistance according to IEC 61439-1 (Resistance to corrosion, security level A (clause A 10.2.2.2))
- Visual evaluation
10.2 Verification of materials and parts

**Resistance to corrosion**

**In case of door cut-outs**

- Corrosion protection at cutting edges needs to be recovered
- Suitable systems are available at specialist shops e.g.: BRILLUX painting systems
10.2 Verification of materials and parts

- Resistance of insulating materials to exceeding heat and fire due to internal electric effects
- UV test required by outdoor plastic parts

- Made of steel metal sheets
- S4 is designed for indoor applications
- not relevant for SIVACON S4
10.2 Verification of materials and parts

<table>
<thead>
<tr>
<th>MLFB</th>
<th>Width (mm)</th>
<th>Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8PQ3 000-1BA03</td>
<td>1200</td>
<td>1300</td>
</tr>
<tr>
<td>8PQ3 000-1BA02</td>
<td>1000</td>
<td>1350</td>
</tr>
<tr>
<td>8PQ3 000-1BA01</td>
<td>800</td>
<td>1400</td>
</tr>
</tbody>
</table>

Done by Siemens
10.2 Verification of materials and parts

Mechanical impact

IK 10
$W_k = 20 \text{ J}$

IK 09
$W_k = 10 \text{ J}$

IK 08
$W_k = 5 \text{ J}$

Done by Siemens
10.2 Verification of materials and parts

Marking

Delivered with every rack

Supported by Siemens
## 10.3 Degree of protection

### Solid particles

<table>
<thead>
<tr>
<th>Code</th>
<th>Solid particles</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>50 mm</td>
</tr>
<tr>
<td>2</td>
<td>12 mm</td>
</tr>
<tr>
<td>3</td>
<td>2,5 mm</td>
</tr>
<tr>
<td>4</td>
<td>1,0 mm</td>
</tr>
<tr>
<td>5</td>
<td>Dust, no dangerous amount inside housing</td>
</tr>
<tr>
<td>6</td>
<td>No dust inside</td>
</tr>
</tbody>
</table>

### Liquid protection

<table>
<thead>
<tr>
<th>Code</th>
<th>Liquid protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dripping water</td>
</tr>
<tr>
<td>2</td>
<td>Dripping water up to 15° angle</td>
</tr>
<tr>
<td>3</td>
<td>Spraying water</td>
</tr>
<tr>
<td>4</td>
<td>Splashing of water</td>
</tr>
<tr>
<td>5</td>
<td>Water jets</td>
</tr>
<tr>
<td>6</td>
<td>Strong water jets</td>
</tr>
</tbody>
</table>
### 10.3 Degree of protection

<table>
<thead>
<tr>
<th>Degree of Protection</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP 40</td>
<td>ventilated</td>
</tr>
<tr>
<td>IP x1</td>
<td>extension</td>
</tr>
<tr>
<td>IP 55</td>
<td>cable entry</td>
</tr>
</tbody>
</table>

If standard parts are not modified, no further actions are required!
10.3 Degree of protection

When using devices with tested IP degree of protection under assembled conditions

IP degree is **higher** or **equal** to SIVACON S4
→ Follow up instructions given by device supplier

IP degree of protection is **lower** than SIVACON S4
→ IP degree of the system in total is reduced to device level
10.4 Clearances and creepage distances

Clearances: shortest distance between two conductors
IEC 61439@SIVACON S4
Clearances and creepage distances

Table 1 – Minimum clearances in air\(^1\) (8.3.2)

<table>
<thead>
<tr>
<th>Rated impulse withstand voltage (U_{\text{imp}})</th>
<th>Minimum clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>\text{kV}</td>
<td>\text{mm}</td>
</tr>
<tr>
<td>\leq 2,5</td>
<td>1,5</td>
</tr>
<tr>
<td>4,0</td>
<td>3,0</td>
</tr>
<tr>
<td>6,0</td>
<td>5,5</td>
</tr>
<tr>
<td>8,0</td>
<td>8,0</td>
</tr>
<tr>
<td>12,0</td>
<td>14,0</td>
</tr>
</tbody>
</table>

1) Based on inhomogeneous field conditions and pollution degree 3

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Creepage distance: shortest distance along surface between two conductors

Conductor

Channel

Partition
10.4 Clearances and creepage distances

<table>
<thead>
<tr>
<th>Rated insulation voltage $U_i$</th>
<th>Minimum creepage distance (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>I</td>
</tr>
<tr>
<td>All material groups</td>
<td>1.5</td>
</tr>
<tr>
<td>Material group 1</td>
<td>1.5</td>
</tr>
<tr>
<td>Material group 2</td>
<td>1.5</td>
</tr>
<tr>
<td>Material group 3</td>
<td>1.5</td>
</tr>
<tr>
<td>Material group 4</td>
<td>1.5</td>
</tr>
<tr>
<td>Material group 5</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Pollution degree

- I: Normal pollution
- II: Heavy pollution
- IIIa: Medium pollution
- IIIb: Very heavy pollution

<table>
<thead>
<tr>
<th>Pollution degree</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated voltage category</td>
<td>1000 V</td>
<td>600 V</td>
<td></td>
</tr>
<tr>
<td>Rated impulse withstand voltage $U_{lim}$</td>
<td>8 kV</td>
<td>6 kV</td>
<td></td>
</tr>
<tr>
<td>Maximum clearance (other than pollution, 1x/s)</td>
<td>6.3</td>
<td>6.3</td>
<td></td>
</tr>
<tr>
<td>Comparative tracking index</td>
<td>400</td>
<td>400</td>
<td></td>
</tr>
<tr>
<td>Maximum creepage distance</td>
<td>14.0 mm</td>
<td>14.0 mm</td>
<td></td>
</tr>
</tbody>
</table>

Done by Siemens
### 10.4 Clearances and creepage distances

<table>
<thead>
<tr>
<th>Assembly kits are already designed according to this design rule</th>
<th>For mounting plate installations, these design rules need to be respected</th>
</tr>
</thead>
</table>

- Clearances and creepage distances

IEC 61439 @ SIVACON S4

For Siemens assembly kits
IEC 61439@SIVACON S4
Effective earth continuity between the exposed conductive parts of the assembly & the protective circuit

10.5 Effective earth continuity between the exposed conductive parts of the assembly and the protective circuit (1/3)

Protection class I
- measuring current: 10 A
- not > 0,1 Ω

Done by Siemens

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10.5 Effective earth continuity between the exposed conductive parts of the assembly and the protective circuit (2/3)

For door assemblies

<table>
<thead>
<tr>
<th>Bemessungsbetriebsstrom $I_e$</th>
<th>Mindestquerschnitt für Schutzleiter $S$ mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_e \leq 20$</td>
<td>$S^a$</td>
</tr>
<tr>
<td>$20 &lt; I_e \leq 25$</td>
<td>$2,5$</td>
</tr>
<tr>
<td>$25 &lt; I_e \leq 32$</td>
<td>$4$</td>
</tr>
<tr>
<td>$32 &lt; I_e \leq 63$</td>
<td>$6$</td>
</tr>
<tr>
<td>$63 &lt; I_e$</td>
<td>$10$</td>
</tr>
</tbody>
</table>

$^a$ $S$ ist der Querschnitt des Außenleiters (mm²).

8PQ9400-0BA15 6mm²
10.5 Effective earth continuity between the exposed conductive parts of the assembly and the protective circuit (3/3)

For connection to split PE busbars

**Screw connection**
With spring washer according to DIN 6796

**Connection clamp**
## 10.6 Incorporation of switching devices and components

### For SIVACON assembly kits
- Already prepared for the installation of specific devices
- Using device accessories (e.g. clamping covers) defined within device manual

### For mounting plate installations
Follow installation and mounting instructions given by the device manufacturer
10.7 Internal electric circuits and connections

1. Follow up fixed construction rules
2. Conductor material
   - Copper, aluminium
   - Cross section
   - Marking
   - Mechanical strength
3. Cable entrance
   - IP degree of protection
4. Connection points
10.7 Internal electric circuits and connections

Copper drawings available through Industry mall

Using type tested materials according to IEC 61439

Done by Siemens
10.8 Terminals for external conductors
10.9 Dielectric properties

10.9.1 power frequency voltage
10.9.2 impulse voltage

12 kV for main busbars
10.10 Verification of temperature rise

- Proof of temperature rise is provided by Siemens via testing.
- Based on our test results different variants can be generated via the power loss calculation from SIMARIS configuration.
- For exact power loss calculation it is mandatory that the exact environment parameters are entered (outside temperature, inner temperature, etc.).
- The temperature rise verification is done field by field.

**Power loss calculation**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emitable power loss [W]</td>
<td>389.1</td>
</tr>
<tr>
<td>Power loss busbar system [W]</td>
<td>261</td>
</tr>
<tr>
<td>Power loss feeders [W]</td>
<td>102.4</td>
</tr>
<tr>
<td>Power loss addition [W]</td>
<td>5.1</td>
</tr>
</tbody>
</table>

RDF = 80%
Simultaneous factor = 1

Done by Siemens
**10.11 Short-circuit strength**

**Main busbar systems**
- Tested by Siemens

**Follow up instruction rules**
- Number of reinforcements are contained in the catalogue
- SIMARIS configuration gives you the right quantity as well
- In addition, they are published in the mounting instructions

<table>
<thead>
<tr>
<th>Busbar size</th>
<th>Dimensions</th>
<th>Section width</th>
<th>Number of reinforcements as a function of $I_{pk}, I_{cw}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of bars per phase</td>
<td>mm</td>
<td>mm</td>
<td>$I_{cw} = 25$ kA</td>
</tr>
<tr>
<td>2</td>
<td>20 x 10</td>
<td>350</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>400</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>600</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>650</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1000</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1200</td>
<td>2</td>
</tr>
</tbody>
</table>

**Done by Siemens**
10.11 Short-circuit strength

Device installation

- Tested for SIVACON assembly kits

Follow up instruction rules

- Follow up mounting instructions and manual
10.12 Electromagnetic compatibility

Installed devices must be designed according to environmental conditions.
10.13 Mechanical operation

Test requirement

- All movable parts need to be checked 200 times
- Approved by Siemens
Assembly manufacturer responsibility
IEC 61439@SIVACON S4

LV switchgear and controlgear ASSEMBLY

Design Verification from original manufacturer

Test
Derivation
Assessment

ASSEMBLY (original system)

Manufacturer of assembly can:
• perform the installation according to the rules of the original manufacturer
• In case of modification, the manufacturer of the assembly will become original manufacturer of the customized system

Routine Verification

Ready-to-use ASSEMBLY
IEC 61439@SIVACON S4
Customizing

- when modification affects one of these 12 tests
- Assembly manufacturer is original manufacturer for customized area

LV switchgear and controlgear ASSEMBLY

Design Verification from original manufacture

Test \[\rightarrow\] Derivation \[\rightarrow\] Assessment

ASSEMBLY (original system)

Manufacturer of assembly can:
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Routine Verification

Ready to use ASSEMBLY
IEC 61439@SIVACON S4
Routine verification

Checking constructional requirements
• Degree of protection
• Clearances and creepage distance
• Protection against electric shock and integrity of protective circuits
• Internal circuits and connections
• Terminals for external conductors
• Mechanical function

Checking performance
• Electric properties
• Wiring, operating performance and function

Follow up our step by step check list

Supported by Siemens
SIVACON S4
IEC 61439 design verification

- Overview
- IEC 61439 @SIVACON S4
- Additional tests
- Summary
Additional tests
IEC61641 – arc fault

Arc fault protection

In order to increase personal safety
Controlled pressure relief through:
• flapping roof
• spring lock

http://www.youtube.com/watch?v=KHyh3nyTgK4
Quality standards fulfilled by our production site

ISO 9001

ALPHA Verteilertechnik GmbH
Ringstr. 60
93413 Cham-Altenmarkt
Germany
SIVACON S4
IEC 61439 design verification

- Overview
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Summary
Industry mall

Industry Mall

www.siemens.com/industrymall

Catalogue
LV 56

Information and Training
IEC 61439

Software
• SIMARIS design
• SIMARIS project
• SIMARIS configuration

Certifications
• IEC 61439
• ISO 9001
• etc.

Manuals

Copper drawings
Summary Certificate
Summary
Customer benefits

- The “make it easy” solution to fulfill IEC 61439
- SIVACON S4 offers more than standard requirements
  - Arc fault protection
  - Quality certification
- One partner for housing and devices
- We have the best knowledge on our own devices
- Deep integration level of devices and accessories