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Power Switchgear and Controlgear Assemblies and Distribution Boards according to IEC EN 61439

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Table of contents

Author's foreword

This specialist publication concerns *low-voltage switchgear and controlgear assemblies*[1], which are defined in the current issue of the relevant recognised technical regulation IEC EN 61439, as:

Summary of one or several low-voltage switchgears with associated operating equipment for controlling, measuring, reporting, protecting and regulating, with all internal electrical and mechanical connections and structural components.

The overriding objective is to explain to the fullest extent possible within this context, how low-voltage switchgear assemblies[2] can (or must) be introduced legally and safely.

First and foremost the important connections for power switchgear and controlgear assemblies and distribution boards intended to be operated by ordinary persons shall be presented. Detailed requirements for assemblies for construction sites, switchgear and controlgear assemblies in public power distribution grids and busbar systems are not part of this specialist publication, even though they have much in common.

And furthermore in this respect: This specialist publication has neither the intention nor the ability to replace the comprehensive dedication to details of the series of standards IEC EN 61439. This publication is intended as a highly practical introduction to the subject. The aim is to convey that, based on this introduction, any interested party can develop specific, individual involvement in this subject, from an overview down to any level of detail.

The European series of standards EN 61439 has been adopted in member states of the European Union, but only applies as a national standard (i.e. as ÖVE/ÖNORM EN, DIN/VDE EN, BS EN, etc.). Therefore, this publication refers to IEC EN 61439.

This publication went to press on 15 May 2014.

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[1] Definition according to IEC EN 61439-1:2012-07-01, Section 3.1.1

[2] The terms "switchgear and controlgear assembly" and "low-voltage switchgear and controlgear assembly" are used as equivalent terms in this publication.

1 Conformity and recognised technical regulations

1.1 General observations

Low-voltage switchgear and controlgear assemblies are electrical equipment. This equipment is subject to relevant European directives (often referred to as "CE Directives"), which are the absolute prerequisite for lawful circulation within the European Union.

However, low-voltage switchgear and controlgear assemblies consist in turn of electrical equipment. Therefore, the switchgear and controlgear assemblies contain power switches, circuit breakers, residual current circuit breakers, wires, terminals, etc. When talking about equipment in relation to a switchgear and controlgear and controlgear assembly, it must always be observed whether the switchgear and controlgear and controlgear assembly is addressed "as a whole" or only as an individual piece of electrical equipment that is part of the switchgear and controlgear and controlgear assembly.

In accordance with the Austrian Electrotechnical Act [2] electrical equipment used at a low-voltage between 50 V and 1000 V AC and three-phase AC and between 75 V and 1500 V DC (with a few exceptions that need not be discussed further here) must meet the requirements of the *Low-voltage Equipment Regulation* [4] (EU Council Directive concerning low-voltage [3]) Likewise the *Electromagnetic Compatibility Ordinance* [6] (EU EMC Directive [5]) and the provisions of the *Product Liability Act* [8] (EU Product Liability Act[7]).

For electrical equipment i.e. also for low-voltage switchgear and controlgear assemblies, the *manufacturer of the switchgear and controlgear assembly* must perform a corresponding conformity assessment procedure and issue an EC Declaration of Conformity.

With this declaration the *manufacturer of the switchgear and controlgear assembly* confirms that the switchgear and controlgear assembly meets the *Essential Requirements*[3] of all EU directives relevant to the switchgear and controlgear assembly.

1.2 Harmonised standards as a tool for satisfying requirements

The series of standards IEC EN 61439 represents an important tool for satisfying the Essential Requirements of low-voltage switchgear and controlgear assemblies (concerning the low-voltage and EMC directive).

This series of standards is part of the *Harmonised Standards* of the low-voltage and EMC directive. The technical content of the Harmonised Standards must meet the essential requirements of the relevant directive(s). If the Harmonised Standard has been published in the Official Journal *and* the

[3] The term Essential Requirements describes an important element for the legal circulation of productions within the European Union. The *Essential Requirements* are specified in the annexes to the directives and contain everything required to achieve the objective of the directive. Products may only be brought into circulation and put into service if they satisfy the essential requirements. *Essential Requirements* should offer and guarantee a high degree of protection. They are based specific procedures associated with the product (e. g. physical and mechanical strength, flammability, chemical, electrical or biological properties, hygiene, radioactivity, accuracy) or refer to the product and its performance (e. g. provisions regarding materials, design, construction, manufacturing process, instructions issued by the manufacturer) or lay down the most important protection objective (e. g. using an illustrative list). Often it is also a combination of the aforementioned aspects. Therefore, several guidelines can apply at the same time for a given product, as the essential requirements of various directives must be applied at the same time in order to over all relevant public interests [26]. The term "Basic Requirements" is sometimes used instead of the term "Essential Requirements". (Both refer to the term "Essential Requirements“.)

standard has been implemented on a national level, its compliance with the essential requirements is presumed. This therefore also applies for the series of standards IEC EN 61439[4].

If a low-voltage switchgear and controlgear assembly meets all requirements of the relevant sections of the IEC EN 61439, then the manufacturer (and also the user) can assume that the Essential Requirements of the low-voltage and EMC directive have been adhered to. This means that the switchgear and controlgear assembly may be legally brought into circulation in the countries of the European Union.

1.3 The series of standards IEC EN 61439

Part 1 of IEC EN 61439 (sometimes also termed "basic standard") includes general specifications, which are currently[5] defined in sections 2 to 6 (the "specific product standards").

Designation / Issue date	*Title*
IEC EN 62208:2012-07-01	Empty enclosure for low-voltage switchgear and controlgear assemblies – general requirements
IEC/TR 61439-0:2013-04	Low voltage switchgear and controlgear assemblies – Part 0: *Guide* to specifying assemblies [*Planning Guide*]
IEC EN 61439-1:2012-07-01	Low-voltage switchgear and controlgear assemblies - Part 1: General specifications
IEC EN 61439-2:2012-07-01	Low-voltage switchgear and controlgear assemblies - Part 2: Power switchgear and controlgear assemblies (PSC[6])
IEC EN 61439-3:2013-06-01	Low-voltage switchgear and controlgear assemblies - Part 3: Distribution board intended to be operated by ordinary persons (DBO[7])
IEC EN 61439-4:2013-10-01	Low-voltage switchgear and controlgear assemblies - Part 4: Assemblies for Construction Sites (ACS[8])
IEC EN 61439-5:2011-11-01	Low-voltage switchgear and controlgear assemblies - Part 5: Assemblies for power distribution in public networks
IEC EN 61439-6:2013-07-01	Low-voltage switchgear and controlgear assemblies - Part 6: Busbar trunking systems (busways)

Table 1-1 Recognised technical regulations for switchgear and controlgear assemblies and distribution boards; version: 05/2014

A reminder: The series of recognised technical regulations IEC EN 60439 already combined the different types of switchgears and distribution boards in one standard and arranged them into the terms TSK[9] and PTSK[10].

However, in practice this arrangement still caused ambiguities regarding under which circumstances TSK or PTSK switchgears could be used. In this situation it was necessary to fundamentally redefine

[4] The current list of relevant harmonised standards for the low-voltage directive is available at: http://ec.europa.eu/enterprise/policies/european-standards/harmonised-standards/low-voltage/index_en.htm
The current list of relevant harmonised standards for the EMC directive is available at: http://ec.europa.eu/enterprise/policies/european-standards/harmonised-standards/electromagnetic-compatibility/index_en.htm
[5] Part 7 is in preparation.
[6] PSC-Assembly … **P**ower **S**witchgear and **C**ontrolgear Assembly
[7] DBO … **D**istribution **B**oard intended to be operated by **O**rdinary persons
[8] ACS … **A**ssemblies for **C**onstruction ***S***ites
[9] TSK … Type-tested low-voltage switchgear and controlgear assemblies
[10] PTSK … Partially type-tested low-voltage switchgear and controlgear assemblies

the structure and the type of (safety) analysis of conformity. The outcome of this work is that the terms TSK and PTSK are no longer included in the series of standards IEC EN 61439.

Table 1-1 provides an overview of the current recognised technical regulations of the series of standards IEC EN 61439 (along with two further provisions) for the design of low-voltage switchgear and controlgear assemblies. Figure 1-1provides a graphic overview.

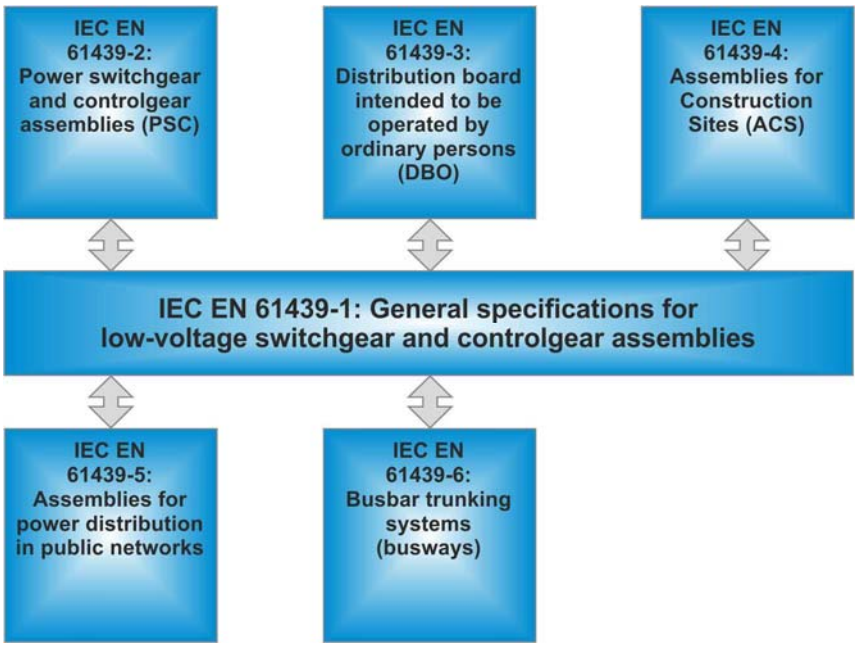

Figure 1-1 overview of the recognised technical regulations IEC EN 61439; version 1/2014

In addition to the individual sections of IEC EN 61439,Table 1-1 includes the harmonised standard IEC EN 62208:2012-07-01 and the internationally applicable Technical Report IEC/TR 61439-0:2013-04.

Therefore, EN 62208 is more significant in practice, because in many cases empty enclosures are used to manufacture a switchgear and controlgear assembly, as these comply with this standard. In these cases there are simplifications for establishing what's known as the design verification according to IEC EN 61439 (see Section 3 of this specialist publication).

The Technical Report IEC/TR 61439-0:2013-04, the original version of which is currently only available in English, contains important fundamentals and also explanations on the series of standards IEC EN 61439, which should support the planning process for switchgear and controlgear assemblies.

In the application of IEC EN 61439 it should be observed that there are nationally recognised technical regulations in the individual member states of the European Union for the establishment of electrical low-voltage installations. This can be found in the prefaces to the corresponding sections of the IEC EN 61439.

In Austria all references to HD 60364 and/or IEC 60364 must be replaced by references to ÖVE-EN 1 and/or ÖVE/ÖNORM E 8001. This means that all relevant sections of ÖVE/ÖNORM E 8001 and (if still applicable) those of ÖVE EN 1 must also be adhered to in conjunction with the application of EN 60439 [27], [28].

1.4 Electromagnetic environment

In principle, every piece of electrical equipment is designed and manufactured for a particular electromagnetic environment. It can only function properly with other electrical equipment in this electromagnetic environment.

There are two types of electromagnetic environments for switchgear and controlgear assemblies. These are environment[11] "A" and environment[12] "B".

Environment A is defined by the EMC generic standards IEC 61000-6-2 and IEC 61000-6-4.

For example: industrial, scientific and medical (ISM[13]-) devices, as defined in CISPR 11[14], are available; large inductive or capacitive loads are often switched; currents and associated magnetic fields are large.

Environment B is defined by the EMC generic standards IEC 61000-6-1 and IEC 61000-6-3.

For example: Domiciles, e. g. houses, apartments; retail e.g. shops, supermarkets; business premises, e. g. offices, banks; public entertainment facilities, e. g. cinemas, public bars, dance clubs; outdoor areas, e. g. petrol stations, car parks, entertainment and sports facilities; small enterprises, e. g. workshops, laboratories, service centres.

In terms of the requirement for electromagnetic compatibility, detailed information is provided in IEC EN 61439-1:2012-07-01[15].

Switchgear and controlgear assemblies (which in many cases are manufactured or assembled as one-off productions and contain one or a few random combinations of equipment) are not subject to EMC interference immunity and emission inspections if the conditions below are present.

- The integral equipment has been designed for the environment stipulated (environment A or environment B) in accordance with the relevant EMC product or generic standards.
- The internal installation and wiring must be performed in accordance with the equipment manufacturer's specifications (layout concerning mutual interference, shielded conductions, grounding, etc.).

1.5 Dates for the application of IEC EN 61439, sections 2 and 3

The application of harmonised standards as evidence of conformity with the Essential Requirements of EU Directives is always related to a specific manufacturing period (area). This means that after the revision of an existing harmonised standard, the previous standard loses its "verification power" after a particular time and thus the status of a harmonised standard. In many cases the revised standard is included in the list of harmonised standards. This also applies for the series of standards IEC EN 61439 as "successor standards" of IEC EN 60439. The corresponding information can be obtained from on-going observation of the publications in the Official Journal of the European Union.

[11] Attention! Not to be confused with the term DBO Type A, which is a DBO intended to accommodate unipolar equipment.
[12] Attention! Not to be confused with the term DBO Type B, which is a DBO intended to accommodate multipolar and/or unipolar equipment.
[13] ISM bands … **I**ndustrial, **S**cientific and **M**edical bands
[14] Comité international spécial des perturbations radioélectriques (Special International Committee on Radio Interference; CISPR 11 - Industrial, Scientific and Medical (ISM) Radio-Frequency Equipment -- Electromagnetic Disturbance Characteristics -- Limits and Methods of Measurement
[15] IEC EN 61439-1:2012-07-01, Appendix J.

Figure 1-2 illustrates the introduction of the series of standards IEC EN 61439, sections 1, 2 and 3 and/or the expiry of the previously applicable IEC EN 60439, sections 1, 2 and 3 in Austria. Sections 1, 2 and 3 of IEC EN 60439 lose their evidence function for conformity with essential requirements upon expiry of 31.10.2014 and/or 21.3.2015.

Manufacturers of power switchgear and controlgear assemblies must therefore launch *no later than* from 1.11.2014[16], manufacturers of distribution boards intended to be operated by ordinary persons *no later than* from 22.3.2015[17], based on the harmonised standards IEC EN 61439, Part 2, and/or Part 3. Declarations of Conformity based on IEC EN 61439 must be issued from these dates.

Of course the corresponding sections of IEC EN 61439 can be used at present.

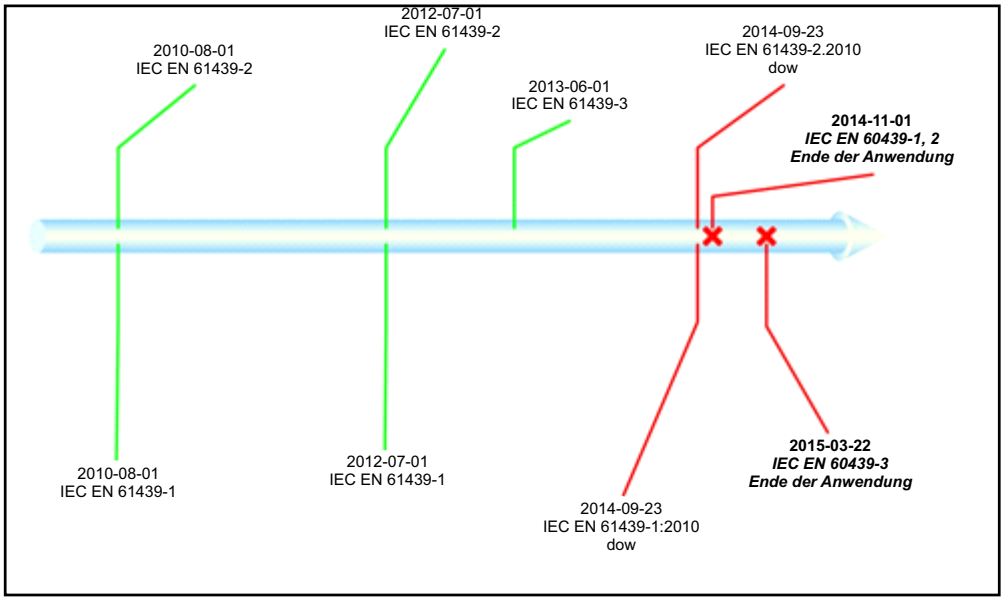

Figure 1-2 Time lapse for the introduction of the series of standards IEC EN 61439, sections 1, 2 and 3 in Austria; dow: latest date for withdrawal of conflicting national standards

2 Manufacture of a switchgear and controlgear assembly

The *basic idea* when manufacturing an EU-directive-compliant switchgear and controlgear assembly is to view it as electrical equipment (see also Section 1.1. of this specialist publication). Low-voltage switchgear and controlgear assemblies are therefore equipment[18] in accordance with the Austrian Electrotechnical Act [2] (see also the remarks in Section 1 of this specialist publication).

A *further idea* is to be able to share the (technical) responsibility for the (internal) construction of this equipment (if necessary) among several persons responsible.

[16] From this date conformity with the essential requirements of the low-voltage and EMC directive of the European Union can no longer be presumed for EN 60439, sections 1 and 2.
[17] From this date conformity with the essential requirements of the low-voltage and EMC directive of the European Union can no longer be presumed for EN 60439, Part 3.

[18] BGBl. 106/1993; Austrian Electrotechnical Act 1992 (ETG-1992), § 1. (1) "Electrical equipment […] are objects that intended as a whole or in individual parts for the generation, conduction or consumption of electrical energy. Operational summaries of several items of electrical equipment that are circulated as constructional units and at least at this point in time as mobile constructional units shall also be deemed electrical equipment."

And a *third idea* is that the certified electrician who connects the equipment along with other equipment to an electrical installation only has to deal with the conformity (the safety) of the equipment to the extent that he/she integrates the switchgear and controlgear assembly into the electrical installation (connects to the electrical installation) in accordance with the manufacturer's specifications.

Now IEC EN 61439-2 for power switchgear and controlgear assemblies and IEC EN 61439-3 for distribution boards intended to be operated by ordinary persons, each together with the provisions of IEC EN 61439-1, help to realise these ideas.

A power switchgear and controlgear assembly[19] is a low-voltage switchgear and controlgear assembly that is used in industrial, commercial and similar applications to distribute and control electrical energy for all types of loads, whereby operation by ordinary persons is not intended[20].

A distribution board intended to be operated by ordinary persons is a switchgear and controlgear assembly for distributing electrical energy for applications in domestic accommodation (homes) and in other locations, whereby operation is performed by ordinary persons[21]. Examples of the operation of distribution boards by ordinary persons are switching operations or changing fuses. These can be performed by anyone for such switchgear and controlgear assemblies.

2.1 Manufacturer and responsibility

Firstly these means that we try to conceive a low-voltage switchgear assembly as a "black box".

If we consider this black box from the perspective of the switchgear and controlgear assembly manufacturer, we see

- The "switchgear and controlgear assembly" equipment with its internal structure,
- Its interfaces and its features for electrical installation (the installation outside the equipment) and
- The user requirements.

This fact is illustrated in Figure 2-1.

[19] Sometimes these switchgear and controlgear assemblies are also termed PSC switchgear and controlgear assemblies (PSC-Assembly … **P**ower **S**witchgear and **C**ontrolgear Assembly).
[20] The *installation* of a power switchgear and controlgear assembly in an area that is accessible to ordinary persons, however, is not ruled out. However, it must be ensured that operation by ordinary persons is effectively prevented.
[21] Sometimes these switchgear and controlgear assemblies are also termed DBOs (DBO … **D**istribution **B**oard intended to be operated by **O**rdinary persons).

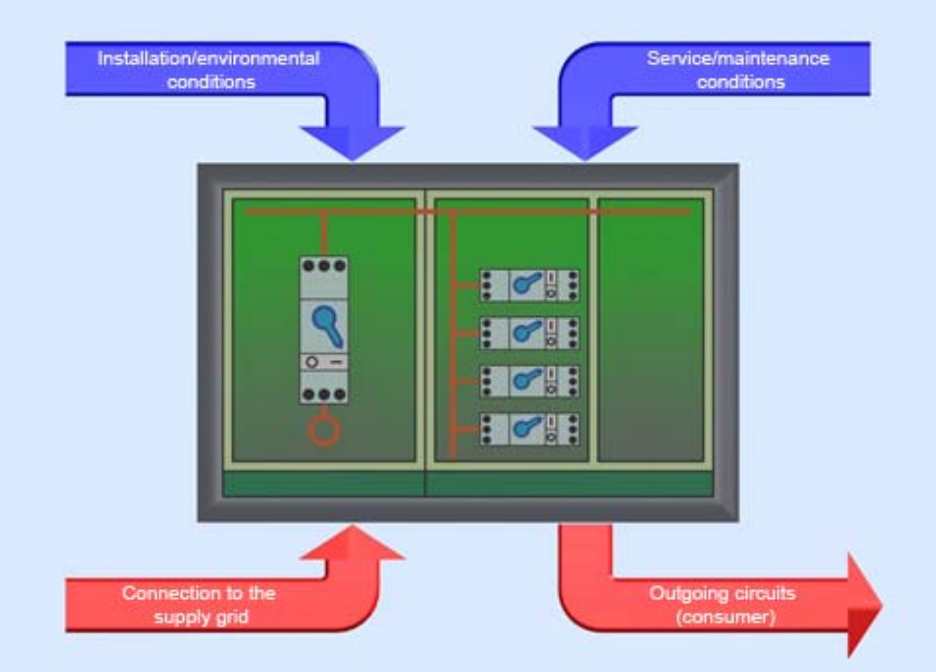

Figure 2-1 Explanation of the "black box" models; idea extracted [9].

In order to discuss and deal with these facts more accurately from a technical and organisational perspective, specific terms with assigned responsibilities are listed in the series of standards IEC EN 61439.

2.1.1 Original manufacturer

The ***original manufacturer***[22] (sometimes also termed *system manufacturer*) is the organisation (or company[23]) that carried out the original design and associated verification of the switchgear and controlgear assembly in accordance with the recognised technical regulations.

The *original manufacturer* is responsible for verifying the design, for establishing what's known as the *design verification*.

To establish the design verification, specific methods applied to switchgear and controlgear assembly patterns or to components of the switchgear and controlgear assembly must technically prove that the design satisfies the relevant parts of IEC EN 61439.

This (technical) verification can be performed in several ways depending on design and rated current of the switchgear and controlgear assembly:

- By inspection,
- By comparison with an inspected reference design
- By assessment, e.g. conformation of the correct application of calculation and design rules, including the application of appropriate excess charge.

[22] Definition according to IEC EN 61439-1:2012-07-01, Section 3.10.1
[23] The recognised technical regulations IEC EN 61439-1:2012-07-01 only refer to "organisation" and not necessarily to a "company" because naturally the requirements for low-voltage switchgear and controlgear assemblies apply regardless of the legal form of the original manufacturer or manufacturer of the switchgear and controlgear assembly.

Some specific verifications can be carried out in several of the ways mentioned[24] (e. g. short-circuit strength, temperature-rise limits). The manufacturer is responsible for choosing the suitable procedure for each individual design. The results of all permissible procedures apply equally.

2.1.2 Manufacturer of the switchgear and controlgear assembly

The ***manufacturer of the switchgear and controlgear assembly***[25] is the organisation (or company) that assumes responsibility for the *finished switchgear and controlgear assembly* (after assembly, possibly further adjustments to the technical requirements for operation, etc.).

The *manufacturer of the switchgear and controlgear assembly* may be (but is not under any obligation) a different organisation from the original manufacturer, e.g. a *system builder, distributor builder or even ("neo-German") assembler or system integrator*.

Figure 2-2provides a schematic overview of the terms "original manufacturer" and "manufacturer of the switchgear and controlgear assembly" and the interaction of these.

The low-voltage switchgear and controlgear assembly can be supplied directly by the original manufacturer (system manufacturer) to the user (blue lettering in Figure 2-2).

Thus it assumes responsibility for the entire switchgear and controlgear assembly as original manufacturer ***and*** as manufacturer of the switchgear and controlgear assembly. In this case the design verification (see Section 3 of this specialist publication) and parts verification (see Section 4 of this specialist publication) are established by the original manufacturer (who in this case is identical to the manufacturer of the switchgear and controlgear assembly).

The second option is that the original manufacturer supplies individual parts ("system parts“) or entire assemblies (e. g. incoming supply section and /or outgoing feeder panel with busbars and circuit breaker) to the manufacturer of the switchgear and controlgear assembly together with instructions and design verification (see Section 3 of this specialist publication).

The manufacturer of the switchgear and controlgear assembly then connects the individual "system parts“ according to the precise instructions of the original manufacturer, establishes the parts verification (see Section 4 of this specialist publication) and supplies the switchgear and controlgear assembly to the user (red lettering in Figure 2-2).

[24] IEC EN 61439-1:2012-07-01, Appendix D.
[25] Definition according to IEC EN 61439-1:2012-07-01, Section 3.10.2

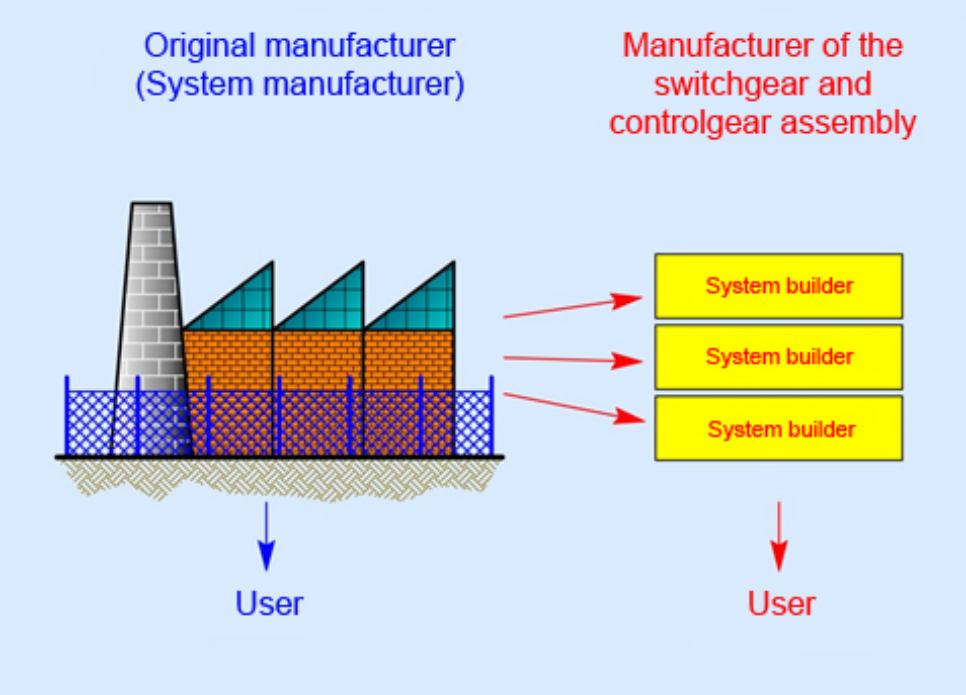

Figure 2-2 Original manufacturer and manufacturer of the switchgear and controlgear assembly in accordance with IEC EN 60439-1; idea extracted [9]

The *manufacturer of the switchgear and controlgear assembly* is responsible for[26]:

- Measuring the switchgear and controlgear assemblies according to the dates agreed with the user
- EC Directive conformity (standard conformity) with the customer
- Compliance with the design verification and instructions of the original manufacturer
- The implementation of parts verifications
- Marking the switchgear and controlgear assembly
- Indicating the distinguishing features of the interfaces (see Sections 7.3 to 7.6) of this specialist publication)
- Handling, installation, operational and maintenance instructions (identifiability of the circuit, …)

If the manufacturer of the switchgear and controlgear assembly fully meets all requirements and instructions stipulated and provided by the original manufacturer, the original design verification does not need to be carried out again.

However, if the manufacturer of the switchgear and controlgear assembly carries out changes that are not included in the verifications of the original manufacturer, the manufacturer of the switchgear and controlgear assembly shall be deemed *original manufacturer* for these changes.

The manufacturer of the switchgear and controlgear assembly becomes the original manufacturer for these changes and must ensure the necessary (design) verifications. In this case execution of the parts verification alone is insufficient.

A reminder: Both the *original manufacturer* and the *manufacturer of the switchgear and controlgear assembly* in accordance with IEC EN 61439 must be distinguished from the manufacturer of the

[26] See also: IEC EN 61439-1:2012-07-01, Section 6.

equipment ("the component") from which the switchgear and controlgear assembly is constructed (e.g. the manufacturers of power switches, residual current circuit breakers, circuit breakers).

2.1.3 User

In general the IEC EN 61439 deems the ***User***[27] to be any party that will specify, purchase, use or operate the switchgear and controlgear assembly or any party that acts on its behalf.

The user, who can also be a planner designing the system, but also the system constructor responsible for integrating the low-voltage switchgear and controlgear assembly into an existing installation (as instructed by the system builder), or simply the (future) operator of the switchgear and controlgear assembly is extremely important in the manufacture of low-voltage switchgear and controlgear assemblies.

At the time of ordering or advertising for tender, the user must indicate the recognised technical regulations [standard(s)] that must be adhered to for the corresponding switchgear and controlgear assembly.

Such indication e.g. for a power switchgear and controlgear assembly would be[28]:

> *Power switchgear and controlgear assembly (PSC[29]) according to IEC EN 61439-2:2012-07-01 and IEC EN 61439-1:2012-07-01*

or e.g. for a distribution board intended to be operated by ordinary persons

> *Distribution board intended to be operated by ordinary persons (DBO[30]) Type A[31] (or Type B[32]) according to IEC EN 61439-3:2013-06-01 and IEC EN 61439-1:2012-07-01*

The user is also obligated to provide the manufacturer of the switchgear and controlgear assembly with "interface data" (see Section 7, 11.1 and 11.2 of this specialist publication), which includes e. g.:

- Conditions for connection to the mains supply
- Information on outgoing circuits and consumers
- Installation and environmental conditions
- Further details on operation and maintenance

"Check lists" are available in the relevant sections of IEC EN 61439 for detailed agreements between manufacturer of the switchgear and controlgear assembly and user. Every type of switchgear and controlgear assembly has its "own" checklist. The corresponding agreement for power switchgear and controlgear assemblies is available in IEC EN 61439-2:2012-07-01, Appendix BB (see also Section 11.1 of this specialist publication); for distribution boards intended to be operated by ordinary

[27] Definition according to IEC EN 61439-1:2012-07-01, Section 3.10.3
[28] Power switchgear and controlgear assembly according to IEC EN 61439-2:2012-07-01, Section 3.1.101: Low-voltage switchgear and controlgear assembly, which is used to distribute and control electrical energy for all types of load in industrial, commercial and similar applications, whereby *operation by ordinary persons is not intended.*
[29] PSC-Assembly … **P**ower **S**witchgear and **C**ontrolgear Assembly
[30] DBO … **D**istribution **B**oard intended to be operated by **O**rdinary persons
[31] DBO Type A … DBO, which is intended to accommodate unipolar equipment. Attention! Not to be confused with EMC environment A and/or B!!
[32] DBO Type B … DBO, which is intended to accommodate multipolar and/or unipolar equipment. Attention! Not to be confused with EMC environment A and/or B!!

persons in IEC EN 61439-3:2012-06-01, Appendix AA (see also Section 11.2 of this specialist publication).

Although these are both designated as "informative appendices" in the standards, the use of these resources is strongly advised. This prevents many ambiguities arising between the manufacturer and user in the first place. These "check lists" also include individual sections on the stipulation of requirements for operation, maintenance and also for potential expansions.

Co-operation, responsibilities and tasks of the "original manufacturer", "manufacturer of the switchgear and controlgear assembly" and "user" are illustrated once again in Figure 2-3 .

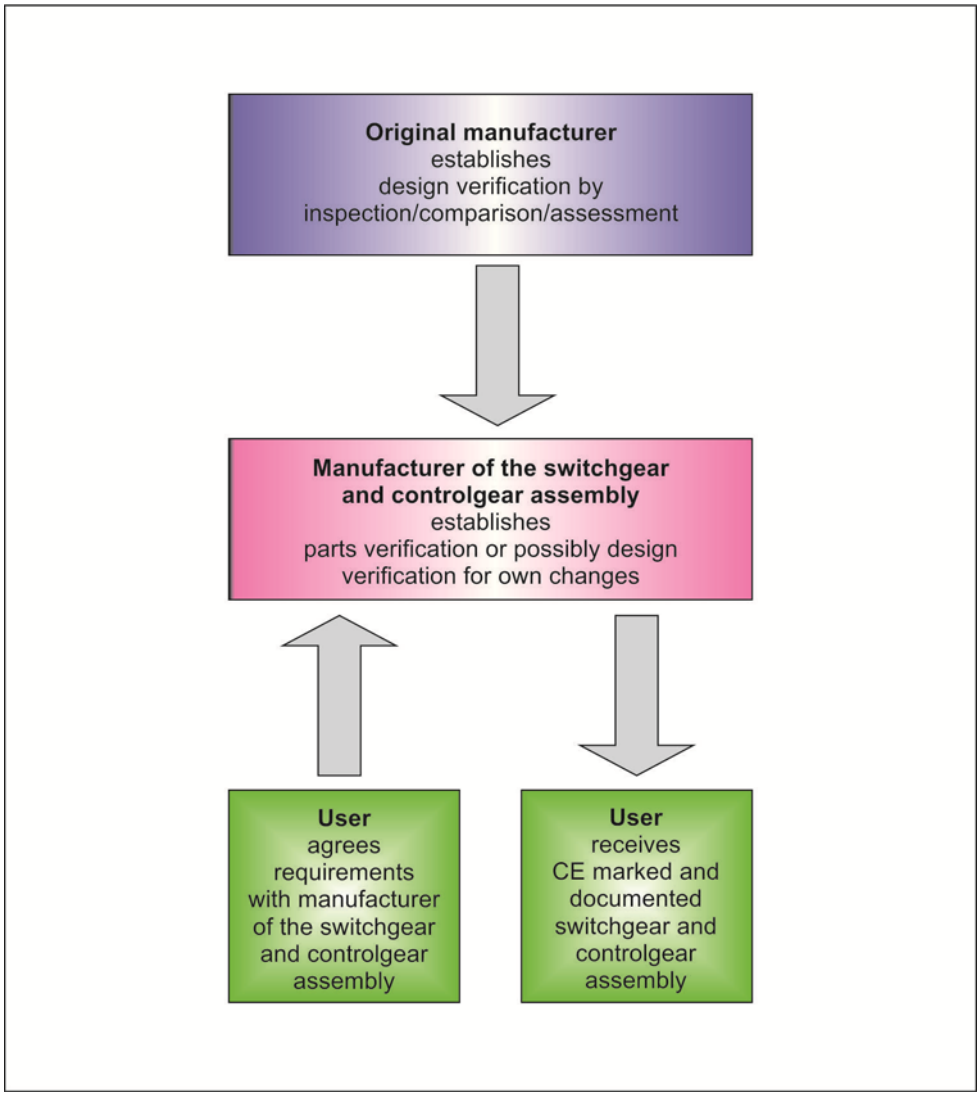

Figure 2-3 Co-operation, responsibilities and tasks of original manufacturer, manufacturer of the switchgear and controlgear assembly and user (illustrative)

At this point it should be highlighted once again that the functions presented here: original manufacturer, manufacturer of the switchgear and controlgear assembly and user does imply that these must be perceived as three different companies or persons etc.

It is quite possible that the manufacturer of a switchgear and controlgear assembly manufacturers a switchgear and controlgear assembly without using "system parts". In this case it must also observe

the obligations of the original manufacture and establish the design verification in addition to the parts verification.

Similarly it is also possible that the on-site electrical engineer (as representative of the user) manufactures the switchgear and controlgear assembly; naturally this also concerns the obligations of the switchgear and controlgear assembly manufacturer to establish the design and parts verification and issue the declaration of conformity.

2.2 The "5+1 points programme"

An application-specific, system-specific ("project-specific") low-voltage switchgear and controlgear assembly is manufactured, in simple terms, according to a "5+1 point programme".

More accurately this is a four-point comprehensive process. The necessity to regard "marking and documentation" as an individual point comes from the practical experience of the author. Remember that the switchgear and controlgear assembly documentation must be established *before the declaration of conformity is drawn up* (and before the switchgear and controlgear assembly is connected to the electrical system). This also applies for marking. Table 2-1provides an overview of this process.

Point	*Designation*	*Task*
1	**Gathering**	Specification or selection of influences, operating conditions, interface parameters by the ***manufacturer of the switchgear and controlgear assembly*** and the user using the forms in ▪ Appendix BB of IEC EN 61439-2 for power switchgear and controlgear assemblies, etc. ▪ Appendix AA of IEC EN 61439-3 for distribution boards intended to be operated by ordinary persons
2	**Planning**	Drafting of the low-voltage switchgear and controlgear assembly by the ***manufacturer of the switchgear and controlgear assembly*** according to the agreements made in point 1. The design verifications of the parts used (assemblies, configured functional units) are supplied by the *original manufacturer*. If none of these types of assemblies are used by an original manufacturer, the *manufacturer of the switchgear and controlgear assembly* must furnish the design verification.
3	**Manufacture (Production)**	The low-voltage switchgear and controlgear assembly is manufactured ("produced"). The instructions of the device manufacturer (devices such as: residual current circuit breakers, contactors, MCBs, …) and the information of the original manufacturer (manufacturing instructions) are adhered to.
4	**Verification**	The parts verification is established by the ***manufacturer of the switchgear and controlgear assembly*** for each individual low-voltage switchgear and controlgear assembly.
+1	**Marking and documentation**[33]	Mark the switchgear and controlgear assembly and prepare documentation.
5	**Declare conformity**	Perform conformity assessment, the manufacturer of the switchgear and

[33] Strictly speaking this step is part of point 5. For practical reasons ("so as not to forget"), this obligation of the switchgear and controlgear assembly manufacturer is provided in another point.

		controlgear assembly issues the EC Declaration of Conformity and the CE mark is affixed.

Table 2-1 "5+1 point programme" for planning and "production" of an application-specific low-voltage switchgear and controlgear assembly

3 Design verification

Switchgear and controlgear assemblies must meet design requirements. These are stipulated in sections 8 and 9 of IEC EN 61439.

This section provides the important explanations regarding the character and content of the *design verification* for switchgear and controlgear assemblies (PSCs and DBOs).

The design verification must prove the fulfilment of these building and "performance requirements".

3.1 General observations

The obligation to establish the design verification concerns the *original manufacturer* and/or the manufacturer of the switchgear and controlgear assembly in respect of any changes that are not included in the design verification of the original manufacturer.

If no "system parts" are used by the original manufacturer, the manufacturer of the switchgear and controlgear assembly must establish the design verification.

The design verification concerns the design and the performance of the switchgear and controlgear assembly as piece of equipment. The implementation of the design verification establishes the compliance of the switchgear and controlgear assembly design or the switchgear and controlgear assembly system design with the requirements of the relevant sections of the series of standards IEC EN 61439[34].

The devices, terminals, contactors, circuit breakers, etc. integrated in the switchgear and controlgear assembly that were tested by the manufacturer of these components in accordance with applicable EN or IEC stipulations (product standards) and satisfy these, do not have to be tested (and verified) again[35].

However, it is important that these integral devices are installed in the switchgear and controlgear assembly *precisely* according to the manufacturer's instructions. For example, if the switchgear and controlgear installation instructions state that no other switchgears may be installed within 5 cm of the device, the manufacturer of the switchgear and controlgear assembly must act accordingly.

The design verification must include the points indicated in Table 3-1. All data used, calculations and comparisons made for the verification must be documented in an inspection report.

[34] If inspections according to the previously applicable series of standards IEC EN 60439 have already been performed on a switchgear and controlgear assembly and the results of the inspection meet the requirements of the relevant section of IEC EN 61439, it is not necessary to repeat the verification of these requirements. (Avoidance of recent inspections regarding pre-inspected requirements according to the previously applicable series of standards)

[35] However, inspections of individual equipment according to relevant product standards are not an alternative to the design verification for switchgear and controlgear assemblies. This means that a switchgear and controlgear assembly constructed from individually tested equipment does *not* "automatically" meet the requirements of the series of standards IEC EN 61439.

Section in IEC EN 61439-1	*Design verification - Contents*
10.2	*Strength of materials and parts* If an empty enclosure according to IEC EN 62208 is used and no changes have been made that could influence the suitability of the enclosure, further inspection of the enclosure according to 10.2 is not necessary.
10.3	*Enclosure protection class* If an empty enclosure according to IEC EN 62208 is used, verification by assessment must be performed to ensure that every external change made does not affect the protection class. In this case no further inspection is necessary.
10.4	Clearance and creepage distance
10.5	Protection against electric shock and patency of earth conductor circuits
10.6	Installation of equipment
10.7	Internal circuits and connections
10.8	Connections for conductors inserted from outside
10.9	Insulation properties
10:10	Evidence of temperature-rise
10:11	Short-circuit strength
10:12	Electromagnetic compatibility
10:13	Mechanical function

Table 3-1 Content of the design verification, general overview according to IEC EN 61439-1:2012-07-01

For the design of power switchgear and controlgear assemblies and/or distribution boards intended to be operated by ordinary persons, requirements for the building verification deviating from the general requirements in Table 3-1 shall also apply (see also Section 3.5 and 3.6 of this specialist publication).

In contrast to the previously applicable series of standards IEC EN 60439, in addition to verification through inspection other (equivalent) verification methods are possible for specific properties of switchgear and controlgear assemblies in the series of standards IEC EN 61439. The original manufacturer can choose between several verification options, within the scope specified in the corresponding section of the standard. If several methods are permitted, the original manufacturer is responsible for selecting the appropriate method.

The verification procedures are:

- Verification by inspection;
- Verification by comparison with an inspected reference design;
- Verification by assessment, e.g. conformation of the correct application of calculation and design rules, including the application of appropriate excess charge.

Table 3-2[36] provides an overview of options for verifying the individual features (inspection, comparison with reference designs, assessment).

No.	**Symptom**	**Available selection for verification by**		
		Inspection	Comparison with	Assessment

[36] IEC EN 61439-1:2012-07-01, Appendix D, Table D.1.

			reference design	
1	Strength of materials and parts			
	Corrosion resistance	+	-	-
	Properties of insulation material			
	Thermal stability	+	-	-
	Resilience to extreme heat and fire due to internal electrical effects	+	-	+
	Resistance to UV radiation	+	-	+
	Lifting	+	-	-
	Impact test	+	-	-
	Inscriptions	+	-	-
2	Enclosure protection class	+	-	+
3	Clearance	+	-	-
4	Creepage distance	+	-	-
5	Protection against electric shock and patency of earth conductor circuits			
	Patency of the connection between bodies of the switchgear and controlgear assembly and the protective earth circuit	+	-	-
	Short-circuit strength of the protective earth circuit	+	+	-
6	Installation of equipment	-	-	+
7	Internal electrical circuits and connections	-	-	+
8	Connections for conductors inserted from outside	-	-	+
9	Insulation properties			
	Operating frequency dielectric strength	+	-	-
	Surge voltage strength	+	-	+
10	Temperature-rise limits	+	+	+
11	Short-circuit strength	+	+	-
12	Electromagnetic compatibility (EMC)	+	-	+
13	Mechanical function	+	-	-
+ … Permissible as proof; - … Impermissible as proof				

Table 3-2 Design verification – overview of possibilities for verifying individual features of a low-voltage switchgear and controlgear assembly according to IEC EN 61439-1:2012-07-01, Appendix D, Table D.1.

3.1.1 Changes to switchgear and controlgear assemblies

If changes are made to a switchgear and controlgear assembly or parts thereof that are subject to a design verification, it must be established whether these changes impair the performance of the switchgear and controlgear assembly based on the specification of Section 10 Part 1 (including the additional requirements for the corresponding type of switchgear and controlgear assembly from Part 2 or Part 3). The design verification (or one part thereof) must be performed on the amended switchgear and controlgear assembly if impairment is likely.

3.1.2 Assembly of switchgear and controlgear assemblies with design verification

In practice it is (often) the case that a switchgear and controlgear assembly for which the original manufacturer established a design verification is assembled by the manufacturer of the switchgear and controlgear assembly according to the assembly instructions[37] of the original manufacturer.

In this case the original design verification does not need to be repeated. The switchgear and controlgear assembly is assembled unchanged.

However, if the manufacturer of the switchgear and controlgear assembly performs changes that are not included in the verifications of the original manufacturer, the manufacturer of the switchgear and controlgear assembly shall be deemed original manufacturer for these changes. The design verification must be repeated for the changes and for any features that are affected by the change.

If the original manufacturer of the switchgear and controlgear assembly decides to perform the verification of a specific feature using the "inspection" method, then the inspections must be performed on a representative, new test specimen of a switchgear and controlgear assembly.

The verification by inspection (e.g. short-circuit inspection) can however impair the performance of a switchgear and controlgear assembly; i.e. these inspections should not be performed on a switchgear and controlgear assembly that is then scheduled to be put into operation[38].

3.2 Protection against electric shock

The protective earth circuit of the switchgear and controlgear assembly is an important element of the protection system against electric shock (particularly when using the protective measures of protective earthing and residual current protective circuit). This ensures the automatic shut-off of the power supply in the event of a fault.

The effectiveness of the protective earth circuit must be verified as part of the design verification for the following functions:

- Protection against the consequences of a fault in the switchgear and controlgear assembly (internal faults) and
- Protection against the consequences of a fault in external power circuits that are supply by the switchgear and controlgear assembly (external fault).

In terms of protection against the consequences of an internal error, it must be verified that

- The various bodies of the switchgear and controlgear assembly are effectively coupled to the connection of the incoming external protective conductor and that
- The resistance of the power circuit does not exceed 0.1 Ω.

An ohmmeter that can supply power of at least 10 A (AC or DC) must be used for the verification. As such the power flows from each body inside the switchgear and controlgear assembly to the connection for the external protective conductor. The resistance may not exceed 0.1 Ω. Observe test

[37] The manufacturing instructions of the original manufacturer must be **fully** adhered to!
[38] The wish sometimes expressed by users that the switchgear and controlgear assembly that is actually installed should also be fully inspected in accordance with IEC EN 61439 is thus impractical!

duration! The test duration must be limited if the equipment suitable for low currents is impaired by a long test duration.

The verification as regards protection against the consequences of external faults is stipulated in IEC EN 61439:2012-07-01, Section 10.5.3. This largely concerns verifying the rated short-circuit strength of the protective earth circuit. No further details are required here.

However, the verification of the short-circuit strength of the protective earth may be omitted under *special circumstance*s.

If a standard-compliant, separate protective earth[39] is available, a short-circuit test is not necessary for

1. Switchgear and controlgear assemblies with a rated short-circuit strength[40] (I_{cw}) or a conditional rated short-circuit current[41] (I_{cc}) of maximum 10 kA effective value.
2. Switchgear and controlgear assemblies or circuits of switchgear and controlgear assemblies, protected by current-limited devices, whose conducting state current at the highest permitted uninfluenced short-circuit current (I_{cp}) at the supply connections of the switchgear and controlgear assembly does not exceed 17 kA.
3. Auxiliary circuits of switchgear and controlgear assemblies that are intended to be connected to transformers of switchgear and controlgear assemblies, whose rated output
   - is maximum 10 kVA with a rated voltage on the secondary side of at least 110 V or
   - 1.6 kVA with a rated voltage on the secondary side of less than 110 V

   and whose short-circuit impedance in both cases is at least 4 %.

3.3 Short-circuit strength

Every switchgear and controlgear assembly and/or its individual circuits are rated for particular values of the short-circuit current[42]. The verification of these rated values must be performed by the original manufacturer of the switchgear and controlgear assembly through comparison with a reference design or by inspection[43].

The details of performing the verification should not be addressed any further here[44]; however, it practice it is important that is some cases (similar to verifying the short-circuit strength of the protective earth) the verification of the short-circuit strength may be omitted. This is particularly important for the verification of distribution boards intended to be operated by ordinary persons, whereby in many cases the conditions listed below are actually satisfied.

The verification of the short-circuit strength is not necessary in the following cases:

1. For switchgear and controlgear assemblies with a rated short-circuit strength[45] (I_{cw}) or a conditional rated short-circuit current[46] (I_{cc}) of maximum 10 kA effective value.

[39] Protective conductor in accordance with IEC EN 61439-1:2012-07-01, Section 8.4.3.2.3
[40] IEC EN 61439-1:2012-07-01, Section 5.3.4
[41] IEC EN 61439-1:2012-07-01, Section 5.3.5
[42] A short-circuit current (I_c) is an overcurrent that occurs with a short-circuit as a result of a fault or an incorrect (defective) connection to an electrical circuit.
[43] IEC EN 61439-1:2012-07-01, Section 10.11
[44] See IEC EN 61439-1:2012-07-01, Section 10.5
[45] IEC EN 61439-1:2012-07-01, Section 5.3.4
[46] IEC EN 61439-1:2012-07-01, Section 5.3.5

2. For switchgear and controlgear assemblies or circuits of switchgear and controlgear assemblies, protected by current-limited devices, whose conducting state current at the highest permitted uninfluenced short-circuit current (I_{cp}) at the supply connections of the switchgear and controlgear assembly does not exceed 17 kA.
3. For auxiliary circuits of switchgear and controlgear assemblies that are intended to be connected to transformers of switchgear and controlgear assemblies, whose rated output
    - is maximum 10 kVA with a rated voltage on the secondary side of at least 110 V or
    - 1.6 kVA with a rated voltage on the secondary side of less than 110 V

   and whose short-circuit impedance in both cases is at least 4 %.

The corresponding data for the current-limiting devices (fuses, circuit breakers, residual current circuit breakers, …) is available in the data sheets provided by the manufacturers of these devices. The data sheets are part of the switchgear and controlgear assembly documentation[47], which must always be archived by the original manufacturer.

3.4 Verification of temperature-rise

3.4.1 General observations

The ***verification of temperature-rise*** is particularly important for dimensioning a switchgear and controlgear assembly, and/or also for the design verification.

In principle, the stipulated[48] temperature-rise limits, which refer to the ambient temperature in the switchgear and controlgear assembly, may not be exceeded. This requirement also concerns operating elements made of metal or insulation material, connections for conductors inserted from outside, etc.

This means that the original manufacturer must verify that the heat generated in the switchgear and controlgear assembly only leads to temperature-rises at the installation location of the integral equipment that do not exceed the upper limits at the rated current (or a part thereof used as a basis for dimensioning).

This verification means that no temperatures should arise that result in:

- Significant impairment or ageing of the switchgear and controlgear assembly or
- Excessive heat being emitted to the external conductor so that the operational availability of the external conductor and the connected equipment is impaired or
- Operating personnel, other persons or animals in close proximity to the switchgear and controlgear assembly suffering burns during normal operation.

The original manufacturer is responsible for selecting the verification method; in principle the methods "verification by calculation" and "verification by inspection/derivation“ are available.

[47] This refers to the "Technical Documentation" according to the EU Directive relating to Low-Voltage. Under the Low-Voltage and EMC Directive the manufacturer of the switchgear and controlgear assembly is obligated to produce technical documentation, which contains information that is required to verify the conformity of the product with the valid requirements. These documents must be retained for at least ten years after product manufacture. This Technical Documentation is required in cases where the relevant authority (not the user!) requires the manufacturer to provide verification of compliance with the aforementioned directives. This must not be confused with the Documentation (service and operating instructions, ...), which must be transferred to the user of the switchgear and controlgear assembly.

[48] IEC EN 61439-1:2012-07-01, Section 9.2 and Table 6

For switchgear and controlgear assemblies with a (total) rated current I_{nA} of more than 1600 A, only the "verification by inspection/derivation" method is available. For switchgear and controlgear assemblies with $I_{nA} \leq 1600$ A, verification by calculation is also possible for particular designs in compliance with defined conditions within the switchgear and controlgear assembly. An overview is provided[49] in Table 3-3.

In principle, it is permissible to use one or a combination of the verification methods specified in the standard in order to verify the temperature rise of the switchgear and controlgear assembly.

This allows the original manufacturer to choose the most suitable method for the switchgear and controlgear assembly or a part of the switchgear and controlgear assembly, taking into account the volumes, design, flexibility of the structure, ampacity and size of the switchgear and controlgear assembly.

3.4.2 Basic assumptions for the limiting values of the temperature rise

All limiting values for the temperature -rise (temperature-rise limits) indicated in IEC EN 61439-1:2012-07-01 are specified under the assumption that the switchgear and controlgear assembly is located in an environment where the daily mean value (24 h) of the ambient temperature is 35 °C and the daily maximum value of the ambient temperature does not exceed 40 °C.

If the daily mean value (24 h) of the ambient temperature is larger than 35 °C, the temperature-rise limits must be adapted to these special operating conditions accordingly so that the overall ambient temperature and respective temperature-rise limit remains the same. If the mean ambient temperature is lower than 35 °C, then the same adjustment of the temperature-rise limit is permitted subject to an agreement between user and manufacturer of the switchgear and controlgear assembly[50].

There is also the basic assumption that not all outgoing circuits within the switchgear and controlgear assembly are operated at the same time with its rated current. This consideration of the practical situation is defined by the rated diversity factor (RDF[51], see also Section 7.2 of this specialist publication).

With the verification of the temperature-rise, the original manufacturer of the switchgear and controlgear assembly confirms that:

- Each type of circuit, if installed in the switchgear and controlgear assembly, is in the position to conduct its rated current. This considers how the circuit is connected and integrated into the switchgear and controlgear assembly, but excludes each heat effect that may emanate from adjacent conductive circuits.

[49] A flow chart intended as a tool for selecting the suitable verification method is provided in IEC EN 61439-1:2012-07-01, Appendix O, Figure O.1.

[50] If the temperature-rise limits are changed to adapt to deviating ambient temperatures, it may be necessary to change the rated currents of all busbars, functional units, etc. accordingly. The original manufacturer must specify the measures that are necessary to ensure adherence with the temperature-rise limits. For ambient temperatures up to 50 °C, this can be calculated on the assumption that the temperature-rise of any equipment is proportionate to the power loss generated in this equipment. There are devices whose power loss is largely proportional to I^2, devices with linear gradient to I and others with largely constant power loss regardless of I. See also [31], page 252f.

[51] RDF … **R**ated **D**iversity **F**actor

- The switchgear and controlgear assembly as a whole is loaded with its rated current and each assembly of outgoing currents is simultaneously and permanently loaded with its rated currents multiplied by the rated diversity factor. This takes the maximum supply current into account.

The manufacturer is responsible for the temperature-rise limits within the switchgear and controlgear assembly. Essentially these are determined to ensure that the operating temperature does not exceed the long-term limits used in the switchgear and controlgear assembly. At the interfaces between the switchgear and controlgear assembly and the environment, for example at cable connections and actuating caps, the permissible temperature-rise limits are stipulated in IEC EN 61439-1:2012-07-01, Table 6.

Embodiment of the switchgear and controlgear assembly	***Calculation of results***	***Evaluation of results***
Rated current (supply current) not over 630 A Maximum 60 Hz Only one single division	**Determining the temperature-rise** within the switchgear and controlgear assembly: Calculate *power loss of all circuits* including the internal conductor on the basis of the rated current. *Power loss of conductors* is determined by calculation[52]. *Power loss of the switchgear and controlgear assembly* is calculated by adding up the power losses of the circuits (total load current is limited to the rated current of the switchgear and controlgear assembly). Use of information regarding the temperature-rise depending on the power loss generated in the enclosure for the various permissible installation methods (e. g. in-wall, on-wall). These can: ▪ be provided by the manufacturer of the enclosure, ▪ be determined by[53] inspection ▪ if active cooling[54] is used, in accordance with the performance features and installation criteria of the cooling device manufacturer.	The switchgear and controlgear assembly is verified if the air pressure determined using the calculated power loss does not exceed the permissible air temperature stipulated by the equipment manufacturer during operation. For switchgears or electrical equipment in the main circuits, this means that the continuous load does not exceed the permissible load at the calculated air temperature and that all components are loaded with no more than 80 % of their rated current in outdoor installation[55].
Rated current (total supply current) not over 1600 A Maximum 60 Hz Several divisions possible	**Calculating the temperature-rise** within the switchgear and controlgear assembly: Calculate *power loss of all circuits* including the internal conductor on the basis of the rated current. *Power loss of the switchgear and controlgear assembly* is calculated by adding up the power losses of the circuits (total load current is limited to the rated current of the switchgear and controlgear assembly). Power loss of conductors is determined by calculation[56].	The switchgear and controlgear assembly is verified if the calculated air temperature **at the installation height of each piece of equipment** does not exceed the permissible ambient temperature stipulated by the equipment manufacturer in operation. For switchgears or electrical equipment in the main circuits, this means that the continuous load does not exceed the permissible load at the

[52] IEC EN 61439-1:2012-07-01, Appendix H
[53] IEC EN 61439-1:2012-07-01, Section 10.10.4.2.2
[54] e. g. forced cool-down, internal air conditioner, heat exchanger, …,
[55] IEC EN 61439-1:2012-07-01, Section 10.10.4.2.1c
[56] IEC EN 61439-1:2012-07-01, Appendix H

	Determining the temperature-rise characteristic curve within the switchgear and controlgear assembly: From the entire power loss using the procedure mentioned in IEC 60890.	calculated local air temperature and come to no more than 80 % of their rated current in outdoor installation[57].

Table 3-3 Verification of the temperature-rise by calculation (overview)

The very simple procedure, for switchgear and controlgear assemblies with one single division and a rated current of no more than 630 A, requires confirmation that the entire power loss of the components and conductors in the switchgear and controlgear assembly does not exceed the known value of the heat dissipation capacity of the enclosure.

The scope of application of this approach is extremely limited[58]. To avoid problems with hotspots, the rated currents of all components must be reduced to 80% of the rated currents in open air.

Another method for verifying the temperature-rise is calculation according to IEC/TR 60890 [19], [20], [21], [22] with some additional limitations[59]. The scope of application is limited to rated currents of 1600 A. The rated currents of the components are reduced to 80 % of the rated currents in outdoor installation, and must contribute at least 50 % to the ventilation cross-section of each horizontal subdivision.

3.4.3 Principles for calculating the temperature curve in switchgear and controlgear assemblies

The calculation method in accordance with IEC/TR 60890[60] is based on a number of basic assumptions[61], which should be presented as an overview.

The calculation method had already been developed for the prior standard IEC EN 61439. For particular designs of low-voltage switchgear and controlgear assemblies, for which the temperature-rise inspection is either infeasible or does not apply for economic reasons, it should be possible to calculate the temperature-rise by extrapolating data that was determined by inspecting other assemblies. At that time these assemblies were referred to as partially type-tested switchgear and controlgear assemblies (PTSK).

The calculation method is applicable to closed switchgear and controlgear assemblies or switchgear and controlgear assemblies divided by partitions. The influence of materials and wall thickness that are normally used for enclosures is negligible for the equilibrium of temperatures. Therefore, the method applies to enclosures made of sheet steel, aluminium sheet, cast iron, insulation material and the like.

The temperature-rise curve (the vertical distribution of temperature-rises, also known as heating characteristic[62]) in a switchgear and controlgear assembly, depending on the height of the covering

[57] IEC EN 61439-1:2012-07-01, Section 10.10.4.3.1c

[58] For limitations see IEC EN 61439-1:2012-07-01, Section 10.10.4.2.1

[59] For limitations see IEC EN 61439-1:2012-07-01, Section 10.10.4.3.1

[60] IEC/TR 60890 was revised in recent years and adapted to the series of standards IEC 61439 and is anticipated to be published in May 2014.

[61] These assumptions are based on physical principles and predominantly on the experience of international experts who compile IEC/TR 60890.

[62] The temperature-rise of a component or part thereof is the difference between the measured temperature of this part and the ambient temperature outside the switchgear and controlgear assembly.

enclosure, can be calculated on the assumption of particular conditions[63] regarding air within the enclosure. Under these assumptions, the air temperature at different heights over the entire cross-section of the enclosure (over an entire enclosure plane) is practically constant.

When applying the generally accepted calculation method[64], depending on the effective cooling surface A_e, two principal temperature distributions[65] are assumed.

Temperature-rise curve for enclosures with an effective cooling surface A_e > 1,25 m²

The temperature-rise curve is defined in sufficient detail by a straight line through the points ($\Delta t_{1.0}$ /1.0·n) and ($\Delta t_{0.5}$ /0,5·n) (Figure 3-1). The corresponding points $\Delta t_{1.0}$ and $\Delta t_{0.5}$ must be determined with the calculation method according to [21].

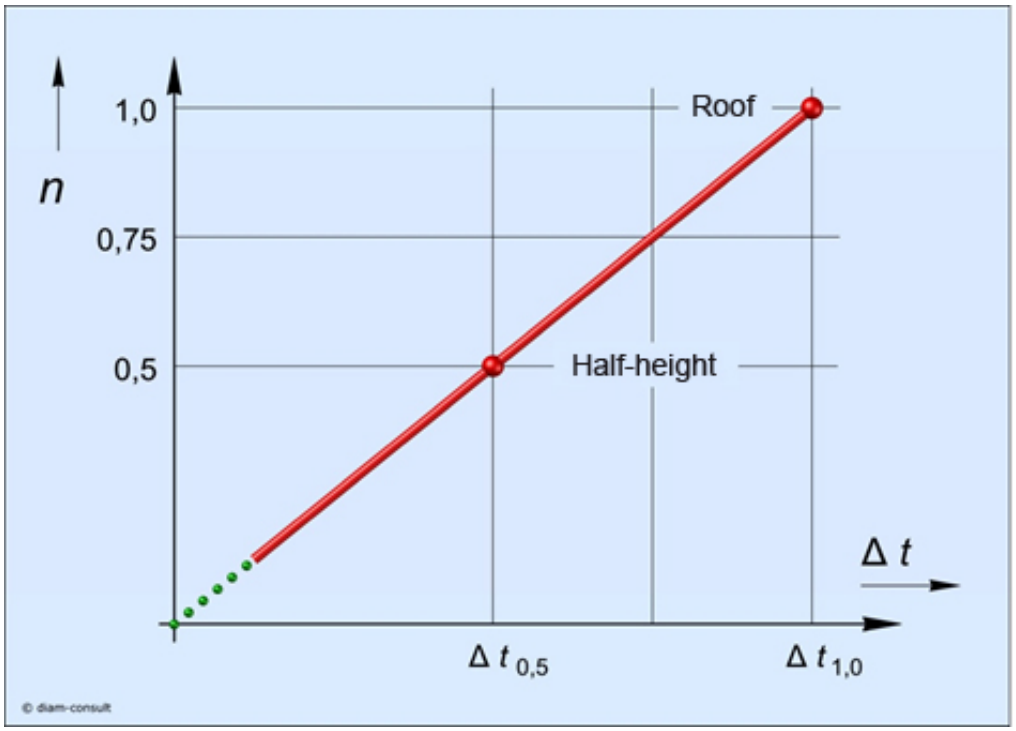

Figure 3-1 Vertical temperature distribution (temperature-rise curve), effective cooling surface A_e > 1.25 m² schematic diagram; Δt … Temperature-rise in the enclosure; n … Multiple of the enclosure height

The temperature-rise inside the base of the enclosure is close to zero i.e. the temperature-rise characteristic begins at zero. (In practice the dashed part of the characteristic curve is not important.)

[63] See IEC EN 61439-1:2012-07-01, Section 10.10.4.2, 10.10.4.3
[64] HD 528 S2:1997-01; see also [21]
[65] Important: Significant local temperature-rises in the switchgear and controlgear assembly, known as hotspots, are not taken into account in these considerations.

Temperature-rise curve for enclosures with an effective cooling surface A_e > 1.25 m²

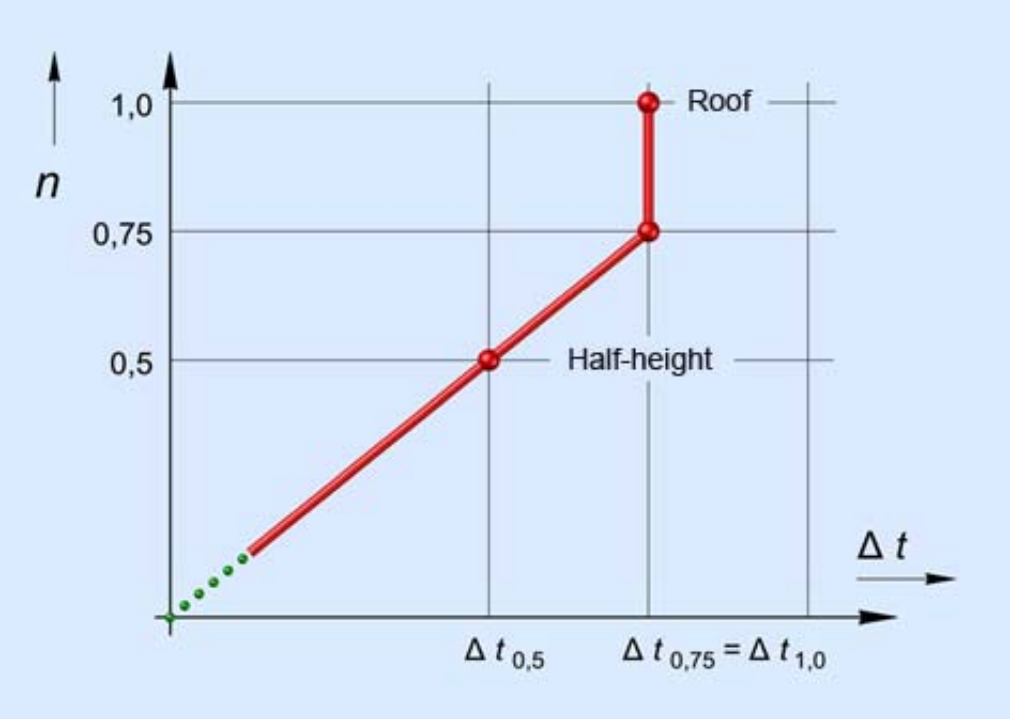

Figure 3-2 Vertical temperature distribution (temperature-rise curve), effective cooling surface A_e > 1.25 m² schematic diagram; Δt … Temperature-rise in the enclosure; n … Multiple of the enclosure height

In these types of enclosures the largest temperature-rise is constant in the upper quarter. Therefore the temperature-rise values $\Delta t_{1.0}$ and $\Delta t_{0.75}$ are identical (Figure 3-2). The temperature-rise curve is generated by combining the temperature-rise values at the values 0.75 and 0.5 of the enclosure height.

3.5 Design verification for power switchgear and controlgear assemblies (PSC)

A power switchgear and controlgear assembly[66] is a low-voltage switchgear and controlgear assembly that is used in industrial, commercial and similar applications to distribute and control electrical energy for all types of loads, whereby operation by ordinary persons is not intended[67].

For power switchgear assemblies the additional/deviating specifications according to IEC EN 61439-2 apply with respect to the general requirements: 2012-07-01, Section 10. First and foremost they comprise the additional requirements for inserts in switchgear and controlgear assemblies. These are included in Table 3-4 at the respective points in the text.

[66] Sometimes these switchgear and controlgear assemblies are also termed PSC switchgear and controlgear assemblies (PSC-Assembly … **P**ower **switchgear and controlgear** and **C**ontrolgear Assembly).

[67] The *installation* of a power switchgear and controlgear assembly in an area that is accessible to ordinary persons, however, is not ruled out. However, it must be ensured that operation by ordinary persons is effectively prevented.

Section in IEC EN 61439-1	*Design verification - Contents and additional/deviating requirements in accordance with IEC EN 61439-2*
10.2	Strength of materials and parts If an empty enclosure according to IEC EN 62208 is used and no changes have been made that could influence the suitability of the enclosure, further inspection of the enclosure according to 10.2 is not necessary. Supplement to IEC EN 61439-1: If an impact test is performed, it must be performed according to IEC EN 62208:2002 and not IEC EN 62262.
10.3	Enclosure protection class If an empty enclosure according to IEC EN 62208 is used, verification by assessment must be performed to ensure that every external change made does not affect the protection class. In this case no further inspection is necessary. Contrary to IEC EN 61439-1: The protection class of inserts according to IEC EN 61439-1, Section 8.2.101 and the internal subdivision according to 8.101 must be verified in accordance with IEC EN 60529.
10.4	Clearance and creepage distance
10.5	Protection against electric shock and patency of earth conductor circuits
10.6	Installation of equipment
10.7	Internal circuits and connections
10.8	Connections for conductors inserted from outside
10.9	Insulation properties Supplement to IEC EN 61439-1: When inspecting the surge voltage strength, the surge voltage strength of the separate sections between the main contacts of inserts and the assigned fixed contacts must be verified in accordance with 8.3.2.
10:10	Evidence of temperature-rise
10:11	Short-circuit strength
10:12	Electromagnetic compatibility
10:13	Mechanical function Supplement to IEC EN 61439-1: For inserts the cycle includes all physical movements from operating position to isolation position and back to operating position.

Table 3-4 Content of the design verification, general overview according to IEC EN 61439-1:2012-07-01 supplemented by the additional specifications from IEC EN 61439-2:2012-07-01 applicable for power switchgear and controlgear assemblies.

3.6 Design verification for distribution boards intended to be operated by ordinary persons (DBO)

A distribution board intended to be operated by ordinary persons is a switchgear and controlgear assembly for distributing electrical energy for applications in domestic accommodation (homes) and in other locations, whereby operation is performed by ordinary persons[68]. Examples of the operation of distribution boards by ordinary persons are switching operations or changing fuses. These can be performed by anyone for such switchgear and controlgear assemblies.

Similar to power switchgear assemblies, the additional/deviating requirements according to IEC EN 61439-3 also apply for distribution boards intended to be operated by ordinary persons: 2012-07-01, Section 10. First and foremost they include a number of material requirements and verification of the temperature-rise. These are included in Table 3-5 at the respective points in the text.

[68] Sometimes these switchgear and controlgear assemblies are also termed DBOs (DBO … **D**istribution **B**oard intended to be operated by **O**rdinary persons).

Section in IEC EN 61439-1	*Design verification - Contents and additional/deviating requirements in accordance with IEC EN 61439-3*
10.2	Strength of materials and parts If an empty enclosure according to IEC EN 62208 is used and no changes have been made that could influence the suitability of the enclosure, further inspection of the enclosure according to 10.2 is not necessary. Contrary to IEC N 61439-1: For the implementation of a corrosion-resistance inspection, an alternative inspection procedure is provided for inspection according to sharpness A. Likewise a change concerning the evaluation for this alternative inspection method. When inspecting the resilience of insulation material against extreme heat and fire due to internal electrical effects of enclosures designed to be installed in cavity walls, the glow wire temperature of 850 °C parts of the enclosure (e.g. cladding and doors) does not apply. The alternative, whereby the original manufacturer can provide supplier data about the suitability of the insulating material to verify the compliance of the material with the general requirements related to resistance properties (see IEC EN 61439-1, Section 8.1.3.2.3), is not permitted for DBOs. The specifications relating to the impact test according to IEC EN 62262 are supplemented by detailed information concerning the test implementation (test chamber facility, temperature of the sample…). The stipulated inspection of inscriptions only applies to distribution boards installed outdoors, not for those installed indoors.
10.3	Enclosure protection class If an empty enclosure according to IEC EN 62208 is used, verification by assessment must be performed to ensure that every external change made does not affect the protection class. In this case no further inspection is necessary.
10.4	Clearance and creepage distance
10.5	Protection against electric shock and patency of earth conductor circuits
10.6	Installation of equipment
10.7	Internal circuits and connections
10.8	Connections for conductors inserted from outside
10.9	Insulation properties
10:10	Evidence of temperature-rise Supplement to IEC EN 61439-1: Concerning the implementation of the temperature-rise inspection, if there are no manufacturer's instructions in this respect, the torque applied to the equipment connections must correspond to the value for the temperature-rise inspection defined in the product standard assigned to the equipment (e. g. in EN 60898 for circuit breakers). The selection of the most unfavourable group represents a significant task when inspecting the temperature-rise of the switchgear and controlgear assembly. Thus there are special instructions for distribution boards intended to be operated by ordinary persons. For DBOs whereby the temperature-rise is performed by "derivation through a similar tested design", special relations apply between DBOs with enclosures made of plastic and those made of metal. DBOs with enclosures made of plastic are representative of DBOs with metal enclosures if the highest air temperature-rise on the inside of the plastic enclosure does not exceed the maximum temperature-rise for surfaces of touchable, external metal parts[69]. Instructions are provided for evaluating the results of the temperature-rise verification. Conclusions regarding the permissible continuous load can be drawn from information provided by the equipment manufacturer regarding I_{th}.

[69] Temperature rise limits according to IEC EN 61439-1:2012-07-01, Table 6. The surfaces of touchable, external metals parts are marked there as "Touchable external surfaces of enclosures or cladding".

10:11	Short-circuit strength Supplement to IEC EN 61439-1: Under special circumstances a conditional rated short-circuit current[70] (I_{cc}) can be assigned to the DBO.
10:12	Electromagnetic compatibility
10:13	Mechanical function Supplement to IEC EN 61439-1: switchgear and controlgear assemblies must be subject to a mechanical inspection. The number of operating cycles is reduced to 50 cycles for DBOs (compared with 200 cycles in IEC EN 61439-1).

Table 3-5 Content of the design verification, general overview according to IEC EN 61439-1:2012-07-01 supplemented by the additional specifications from IEC EN 61439-3:2013-06-01 applicable for DBOs.

For distribution boards intended to be operated by ordinary person, it is made clear, as with the establishment of the design verification for power switchgear and controlgear assemblies, that the use of enclosures tested by the manufacturer in accordance with IEC EN 62208 simplifies things considerably. The verification of the enclosure manufacturer must be attached to the Technical Documentation of the original manufacturer of the switchgear and controlgear assembly.

3.7 Design verification and possible verification methods

Various verification methods can be consulted for the verification of individual requirements. A general overview is provided in Table 3-1. A detailed overview intended as a tool for the practical implementation of the verification is provided in Table 3-6. This is also printed again in Section 11.3, implemented as a master copy for daily use.

Section in IEC EN 61439-1	***Design verification - Features to be verified***	***Possible verification through[71]***	✓
10.2	Strength of materials and parts		
		Empty enclosure according to IEC EN 62208	
10.2.1 to 10.2.7.	General remarks for the verification: mechanical, electrical and thermal suitability in accordance with 10.2.1 to 10.2.7 (Document test results of the individual points 10.2.1 to 10.2.7)	Inspection	
		Assessment	
10.3	Protection class of enclosures [IP protection class:……..]	Inspection	
		Assessment	
10.4	Clearance and creepage distance	Inspection	
10.5	Protection against electric shock and patency of earth conductor circuits		
	Patency of the connection between bodies of the switchgear and controlgear assembly and the protective earth circuit Maximum resistance 0.1 Ω with a test current of at least 10 A (AC or DC)	Inspection	

[70] Rated conditional short-circuit current I_{cc} according to IEC EN 61439-1:2012-07-01, Section 3.8.10.4 refers to the uninfluenced short-circuit current indicated by the manufacturer of the switchgear and controlgear assembly that a circuit protected by a short-circuit protective device (SCPD) can withstand for the entire break time (period of current flow) of the protective device under specific conditions.

[71] Inspection and calculation results are attached to this verification

Section in IEC EN 61439-1	*Design verification - Features to be verified*	*Possible verification through*[71]	✔
	Short-circuit strength of the protective earth circuit	Inspection	
		Comparison with reference design	
10.6	Installation of equipment	Assessment	
10.7	Internal circuits and connections	Assessment	
10.8	Connections for conductors inserted from outside	Assessment	
10.9	Insulation properties		
	Operating frequency dielectric strength	Inspection	
	Surge voltage strength	Inspection	
		Assessment	
10:10	Temperature-rise limits (proof of temperature-rise)	Inspection	
		Comparison with reference design	
		Assessment	
10:11	Short-circuit strength	Inspection	
		Comparison with reference design	
10:12	Electromagnetic compatibility	Inspection	
		Assessment	
10:13	Mechanical function	Inspection	

Table 3-6 Practical implementation of the design verification, check list

4 Parts verification

4.1 General observations

The purpose of the parts verification (to be performed by the **manufacturer** of the switchgear and controlgear assembly) is to determine any potential material and manufacturing faults and to ensure the proper functioning of the completed switchgear and controlgear assembly.

It must be performed for *each individual switchgear and controlgear assembly* and must include the points indicated in Table 4-1 [72]. The manufacturer of the switchgear and controlgear assembly must specify whether the parts verification must be performed during and/or after manufacture.

Parts verifications do not need to be performed on equipment installed in the switchgear and controlgear assembly and on assemblies to be used on their own if they are selected according to the selection regulations stated in Section 8.5.3 of IEC EN 61439-1:2012-07-01 and are installed according to the instructions of the equipment manufacturer. The main concern is the suitability of

[72] Requirements from Section 11 of IEC EN 61439-1:2012-07-01

the devices for the special switchgear and controlgear assembly, adherence to the IEC (and/or EN) specifications of the integral devices and the coordination thereof.

The verification must contain all content from Table 4-1.

Section in IEC EN 61439-1	***Part verification - Contents***
11.2	Enclosure protection class
11.3	Clearance and creepage distance
11.4	Protection against electric shock and patency of earth conductor circuits
11.5	Installation of equipment
11.6	Internal electrical circuits and connections
11.7	Connections for conductors inserted from outside
11.8	Mechanical function
11.9	Insulation properties
11:10	Wiring, performance and function

Table 4-1 Content of the parts verification, overview

4.2 Parts verification and possible verification methods

A detailed overview intended as a tool for the practical implementation of the parts verification is provided in Table 4-2. This is also printed again in Section 11.4, implemented as a master copy for daily use.

Section in IEC EN 61439-1	***Parts verification - Features to be verified***	***Possible verification through[73]***	✔
11.2	Enclosure protection class	Visual inspection	
11.3	Creepage distance	Visual inspection	
		Measurement	
11.3	Clearance		
	Smaller than in Table 1 of IEC EN 61439-1	Inspect	
	Not obviously larger than in Table 1 of IEC EN 61439-1	Measurement/Inspection	
	Larger than in Table 1 of IEC EN 61439-1	Visual inspection	
11.4	Protection against electric shock and patency of earth conductor circuits		
	Basic protection, fault protection, additional protection	Visual inspection	
	Screwed connections of earth conductor circuits	Sampling inspection	
11.5	Installation of equipment	Visual inspection	
11.6	Internal electrical circuits and connections		
	Connections of electrical circuits tightened properly	Sampling inspection	

[73] Inspection and calculation results are attached to this verification

Section in IEC EN 61439-1	*Parts verification - Features to be verified*	*Possible verification through*[73]	✔
	Wiring complies with manufacturing instructions (assembly instructions)	Visual inspection	
11.7	Compliance of connections for cables inserted from outside with assembly documents	Visual inspection	
11.8	Mechanical function	Inspect	
11.9	Insulation properties		
	Inspection of operating frequency dielectric strength	Inspection	
	Insulation measurement (only for switchgear and controlgear assemblies with overcurrent protection device up to 250 A in the supply)	Inspection	
11:10	Wiring, performance and function		
	Completeness of markings and documentation	Visual inspection	
	Functional testing in complex switchgear and controlgear assemblies	Inspection	

Table 4-2 Practical implementation of the parts verification, check list

5 Marking and documentation

5.1 Marking

Before the declaration of conformity is issued and no later than before commissioning (connection of the switchgear and controlgear assembly to the electrical system) the marking of the switchgear and controlgear assembly, the documentation and the identification requirements of the equipment and/or components must be performed by the *manufacturer of the switchgear and controlgear assembly*[74].

Current designation	Information	OK
a	Name of the manufacturer of the switchgear and controlgear assembly or trademark; this is the organisation that assumes responsibility for the assembled switchgear and controlgear assembly	
b	Type designation or identification number or another mark on the basis of which the necessary information can be requested from the manufacturer of the switchgear assembly.	
c	Mark for establishing the manufacturing date	
d	Information regarding which parts of the IEC EN 61439 the switchgear and controlgear assembly corresponds to. For power switchgear and controlgear assemblies must be indicated here: IEC EN 61439-2 For distribution boards intended to be operated by ordinary persons must be indicated here: IEC EN 61439-3	
e	Possible further designations if required in the corresponding section of the series of standards IEC EN 61439. No further designations are stipulated for power switchgear and controlgear assemblies. For distribution boards intended to be operated by ordinary persons the rated current (in this	

[74] See also IEC EN 61439-1:2012-07-01, Section 6

	example the rated current is I_{nA} =125 A) must be indicated in the following form: I_{nA} 125 A For distribution boards intended to be operated by ordinary persons, the protection class of the switchgear and controlgear assembly must be indicated if it exceeds IP 2XC: e.g. IP 22C	

Table 5-1 Designation of the switchgear and controlgear assembly on identification plate ("identification plate"); check list

The manufacturer of the switchgear and controlgear assembly must permanently furnish each switchgear and controlgear assembly with one or more inscriptions so that these are legible when the connected switchgear and controlgear assembly is in operation.

For special inscriptions an inspection ("wipe test") is included in the standard[75]. Inscriptions that are produced by shaping, pressing, engraving or similar, including labels with laminated plastic surface, do not have to be inspected separately. The visual inspection is sufficient. The "wipe test" only has to be performed for DBOs if the DBO is designed for outdoor installation.

The necessary switchgear and controlgear assembly information on the designation plates are compiled in the checklist (Table 5-1). Further information may be required depending on the type of switchgear and controlgear assembly. Thus for distribution boards intended to be operated by ordinary persons the rated current I_{nA} (e. g. I_{nA} 125 A) and the protection class must still be indicated if it exceeds IP 2XC.

5.2 Documentation

All distinguishing features of interfaces[76] (see Section 7 of this specialist publication) must be available in the technical documentation of the switchgear and controlgear assembly manufacturer supplied with the switchgear and controlgear assembly.

The handling, installation, operation and maintenance conditions of the switchgear and controlgear assembly and the equipment contained therein must be included in the documentation.

Similarly the instructions, where necessary, must describe any measures that are important for faultless transportation, handling, installation and operation of the switchgear and controlgear assembly. This also includes information about recommended scope and frequency of maintenance.

The indication of weight details is particularly important in relation to the transportation and handling of switchgear and controlgear assemblies. The correct position and mounting of lifting devices and the thread dimensions of lifting devices must, if necessary, be indicated in the technical documentation for the switchgear and controlgear assembly or in the transportation instructions.

If installation, operation and maintenance measures are necessary in terms of electromagnetic compatibility, these must also be indicated[77].

Particular attention should be paid to the documentation obligation in any cases where a switchgear and controlgear assembly, which is designed specifically for the (EMC) environment A, is used in (EMC) environment B.

In these cases the following information must be included in the documentation:

[75] Inspection according to IEC EN 61439-1:2012-07-01, Section 10.2.7
[76] Distinguishing features of interfaces according to IEC EN 61439-1:2012-07-01, Section 5 and/or the information required in Parts 2 to 6, provided they are relevant to the respective switchgear and controlgear assembly.
[77] IEC EN 61439-1:2012-07-01, Appendix J.

"Note: This is a product for environment A[78]. This product may cause undesirable electromagnetic interference in environment B[79]; in this case the user may be obligated to take appropriate action".

If the circuit is not clear from the structural arrangement of the integral devices, documentation must be provided e.g. circuit diagrams or terminal diagrams. It must be possible to identify particular circuits and the protection devices of these within the switchgear and controlgear assembly.

Markings must be legible, permanent and suitable for the physical environment. All markings used must comply with IEC 81346-1 and IEC 81346-2[80] and identical to those in the circuit diagram, which must comply with IEC 61082-1[81].

6 Declaration of Conformity

In principle, with the declaration of conformity the manufacturer of a switchgear and controlgear assembly declares that it has observed the specifications of the recognised technical regulations cited in the declaration of conformity during manufacture and designates a number and issue date for this.

The EC (or more recent EU) Declaration of Conformity represents a special form of declaration of conformity. The issuance of the EU Declaration of Conformity is mandatory for manufacturers that intend to market the switchgear and controlgear assembly in an EU Member State.

Low-voltage switchgear and controlgear assemblies as equipment must satisfy the Directive relating to Low-voltage [3] and the EMC Directive [5] (see also Section 1 of this specialist publication). Both of these directives stipulate that the following points must be included in the EC Declaration of Conformity:

- Name and address of the manufacturer and if necessary, its representative in the Community.
- Information to clearly identify the switchgear and controlgear assembly
- Description of the electrical equipment
- Reference to the Directive relating to Low-voltage and/or the EMC Directive [3], [5]
- Reference to the harmonised standards that were applied during manufacture
- If necessary, reference to (further) specification that were consulted for the declaration of conformity
- The last to figures of the year in which the CE mark was applied.
- Date of declaration
- Name and signature of the authorised signatory for the manufacturer or its representatives

[78] Examples of environment A: Industrial, scientific and medical (ISM-) devices, as defined in CISPR 11, are available; large inductive or capacitive loads are often switched; currents and associated magnetic fields are large. Environment A is defined by the EMC generic standards IEC 61000-6-2 and IEC 61000-6-4.

[79] Examples of environment B: Domiciles, e. g. houses, apartments; retail e.g. shops, supermarkets; business premises, e. g. offices, banks; public entertainment facilities, e. g. cinemas, public bars, dance clubs; outdoor areas, e. g. petrol stations, car parks, entertainment and sports facilities; small enterprises, e. g. workshops, laboratories, service centres. Environment B is defined by the EMC generic standards IEC 61000-6-1 and IEC 61000-6-3.

[80] The standard EN 81346 and/or IEC 81346, Industrial systems, Installations and Equipment and Industrial Products — Structuring Principles and Reference Designations records ways of structuring information via systems and establishing reference designations (previously: equipment designation)

[81] IEC 61082, current issue; Preparation of documents used in electrotechnology

The EC Directives [3], [5] do not provide any special procedural requirement for the EC Declaration of Conformity. It is important that the EC Declaration of Conformity can be clearly assigned to the switchgear and controlgear assembly. This is normally through a clear identification number, which is marked on the switchgear and controlgear assembly itself (on the identification plate). This identification number must be legible on the connected switchgear and controlgear assembly when in operation (in terms of designation see also Section 5.1 of this specialist publication).

Each individual switchgear and controlgear assembly is manufactured for a specific installation environment. The conformity statement of the switchgear and controlgear assembly manufacturer is always (only) related to the specific installation environment for which it is produced. Furthermore, for this reason it is very important (particularly for potential liability claims) that the manufacturer can accurately correlate the declaration of conformity and switchgear and controlgear assembly.

7 Interfaces and the distinguishing features of these

7.1 General observations

The switchgear and controlgear assembly comes into contact with the installation environment via interfaces (rated values for voltages and currents, rated diversity factor, requirements for operation, maintenance and expansion ...), which are determined by "distinguishing features".

The *distinguishing features*[82] are technical properties of the switchgear and controlgear assembly that are determined by the installation environment.

Thus for example, as a feature of the supply the uninfluenced effective value of the short-circuit current (I_{cp}) determines the conditional rated short-circuit current (I_{cc}) of the switchgear and controlgear assembly. The installation conditions e.g. indoor or outdoor installation determine the properties of the switchgear and controlgear assembly in terms of IP class, IK class and/or UV resistance.

7.2 Rated Diversity Factor (RDF)

As a distinguishing feature of a low-voltage switchgear and controlgear assembly, the rated diversity factor[83]is particularly important for safe operation. For this reason, from the author's perspective, a number of important remarks should be made.

Provided that the supply load does not exceed its rated current, the load factor represents the proportion of the respective rated currents that each assembly of outgoing circuits can simultaneously and permanently conduct, without overloading the switchgear and controlgear assembly. The load factor (assumed load, rated diversity factor, RDF) is normally defined for the entire switchgear and controlgear assembly. However, the original manufacturer can also specify the load factor for groups of circuits, for example, for the circuits in one field.

The rated diversity factor may be indicated:

- for groups of circuits;
- for the entire switchgear and controlgear assembly.

[82] Distinguishing features of interfaces according to IEC EN 61439-1:2012-07-01, Section 5
[83] RDF … **R**ated **D**iversity **F**actor

The rated current of the circuit multiplied with the rated diversity factor must be larger than or equal to the assumed load of the outflows, whereby the assumed load of the outputs can be a constant, continuous load or the thermal equivalent of a fluctuating current (e.g. for intermittent service of equipment to one or more outflows).

The rated diversity factor applies for operation of the switchgear and controlgear assembly with rated current. The RDF takes into account the fact that in practice several functional units are intermittently loaded or not fully loaded at the same time[84].

In principle all circuits within a switchgear and controlgear assembly must be dimensioned to ensure that each individual circuit can permanently conduct its rated current. However, the ampacity of a circuit can be influenced by adjacent circuits. The heat is transported from or to adjacent circuits through such thermal interaction. Naturally these processes also influence the temperature of the cooling air available to a circuit. This may already lie above the permissible ambient temperature due to the influence of other circuits.

In practice in many cases not all circuits within a switchgear and controlgear assembly are required to be able to permanently conduct the rated current at the same time. A number of circuits can be heavily loaded, while others are less so or are not in operation.

It is therefore economic and also from the perspective of an efficient use of materials and resources not practical to design switchgear and controlgear assemblies so that all circuits can permanently conduct the rated current. The indication of a rated diversity factor takes these circumstances into account. Therefore by indicating a rated diversity load the manufacturer of the switchgear and controlgear assembly specifies which "mean" load conditions the switchgear and controlgear assembly is designed for.

In switchgear and controlgear assemblies where sum of the rated currents of the outflows (taking into account the rated diversity factor) exceeds the capacity of the supply current, this rated diversity factor ("only") applies to each assembly of output circuits that are used to distribute the input current.

7.2.1 RDF in power switchgear and controlgear assemblies (PSC)

If *no agreement* exists for power switchgear and controlgear assemblies between the manufacturer of the switchgear and controlgear assembly and the user regarding the actual load currents, the values for the assumed load of the outgoing circuits or a group of outgoing circuits of the switchgear and controlgear assembly may be taken from Table 7-1.

Type of load / Number of outgoing circuits	Assumed load factor
Energy distribution: 2 and 3	0.9
Energy distribution: 4 and 5	0.8
Energy distribution: 6 up to and including 9	0.7
Energy distribution: 10 (and more)	0.6
Actuator	0.2
Engines ≤ 100 kW	0.1
Engines > 100 kW	1.0

Table 7-1 Values for the assumed load; extracted IEC EN 60439-2:2012-07-01, Table 101

[84] See IEC EN 61439-1:2012-07-01, Appendix E

7.2.2 RDF in distribution boards intended to be operated by ordinary persons (DBO)

If *no agreement* exists for distribution boards intended to be operated by ordinary persons between the manufacturer of the switchgear and controlgear assembly and the user regarding the actual load currents, the values for the assumed load of the outgoing circuits or a group of outgoing circuits of the switchgear and controlgear assembly may be taken from Table 7-1.

Number of outgoing circuits	Assumed load factor
2 and 3	0.8
4 and 5	0.7
6 up to and including 9	0.6
10 (and more)	0.5

Table 7-2 Values for the assumed load; extracted IEC EN 60439-3:2013-06-01, Table 101

7.3 Distinguishing features - Overview

The distinguishing features of the switchgear and controlgear assembly must be indicated by the *manufacturer of the switchgear and controlgear assembly*. These features must be compatible with the rating of the circuits to which the switchgear and controlgear assembly is connected and with the installation conditions.

Table 7-3 provides a summary of these distinguishing features. Each standard-compliant definition of the individual features can be found in sections 3 and 5 in IEC EN 62439:2012-07-01[85].

Section in IEC EN 61439-1	Symbol	Designation
5.2	**Rated values for voltages**	
5.2.1	U_n	Rated voltage of the switchgear and controlgear assembly
5.2.2	U_e	Rated supply voltage of a circuit of a switchgear and controlgear assembly
5.2.3	U_i	Rated insulation voltage of a circuit of a switchgear and controlgear assembly
5.2.4	U_{imp}	Rated surge voltage strength of the switchgear and controlgear assembly
5.3	**Rated values for currents**	
5.3.1	I_{nA}	Rated current of the switchgear and controlgear assembly
5.3.2	I_{nc}	Rated current of a circuit
5.3.3	I_{pk}	Rated surge current strength
5.3.4	I_{cw}	Rated short-time current strength of a circuit of a switchgear and controlgear assembly
5.3.5	I_{cc}	Conditional rated short-circuit current of a switchgear and controlgear assembly
5.4	**RDF**	**Rated Diversity Factor**
5.5	**f_n**	**Rated frequency**
5.6	**Other distinguishing features**	
5.6 a)		Additional requirements depending on the special operating conditions

[85] Unfortunately a literal reproduction of the text of the definitions is not possible due to copyright.

		of a functional unit (e.g. type of coordination, overload properties)
5.6 b)		Pollution level
5.6 c)		The grid system according to type of ground connection for which the switchgear and controlgear assembly is designed
5.6. d)		Indoor and/or outdoor installation
5.6 e)		Stationary or portable
5.6 f)		Protection class
5.6 g)		Intended for use by qualified electricians or ordinary persons
5.6 h)		Classification according to electromagnetic compatibility (EMC)
5.6 i)		Special operating conditions (if applicable)
5.6 j)		External dimensions
5.6 k)		Protection against mechanical stress (if applicable)
5.6 l)		Type of structure - inserts or removable parts
5.6 m		Type of short-circuit protection
5.6 n)		Measures to protect against electric shock
5.6 o)		Total dimensions, including existing parts e.g. handles, cladding, doors (if necessary)
5.6 p)		Mass (if necessary)

Table 7-3 Distinguishing features of interfaces of low-voltage switchgear and controlgear assemblies; general overview according to IEC EN 61439-1:2012-07-01

7.4 Distinguishing features for power switchgear and controlgear assemblies (PSC)

In addition to the distinguishing features to be observed for all low-voltage switchgear and controlgear assemblies (see Table 7-3), the additional/deviating stipulations according to IEC EN 61439-2 apply for power switchgear and controlgear assemblies in respect of the general requirements: 2012-07-01, Section 5.

As well as the options to specify the rated diversity factor based on the type of load (if no other relevant agreements exist between the manufacturer and the user) (see Section 7.2.1 of this specialist publication), these concern the design, type of internal subdivision and electrical connection methods of functional units. These are included in Table 7-4 at the respective points in the text.

Section in IEC EN 61439-1	**Symbol**	**Designation** ***and additional/deviating requirements in accordance with IEC EN 61439-2***
5.2	**Rated values for voltages**	
5.2.1	U_n	Rated voltage of the switchgear and controlgear assembly
5.2.2	U_e	Rated supply voltage of a circuit of a switchgear and controlgear assembly
5.2.3	U_i	Rated insulation voltage of a circuit of a switchgear and controlgear assembly
5.2.4	U_{imp}	Rated surge voltage strength of the switchgear and controlgear assembly
5.3	**Rated values for currents**	

5.3.1	I_{nA}	Rated current of the switchgear and controlgear assembly
5.3.2	I_{nc}	Rated current of a circuit
5.3.3	I_{pk}	Rated surge current strength
5.3.4	I_{cw}	Rated short-time current strength of a circuit of a switchgear and controlgear assembly
5.3.5	I_{cc}	Conditional rated short-circuit current of a switchgear and controlgear assembly
5.4	**RDF**	**Rated Diversity Factor** Supplement to IEC EN 61439-1: In particular cases the assumed load of the outgoing circuits may be read from a table (see Section 7.2.1 of this specialist publication)
5.5	**f_n**	**Rated frequency**
5.6	**Other distinguishing features**	
5.6 a)		Additional requirements depending on the special operating conditions of a functional unit (e.g. type of coordination, overload properties)
5.6 b)		Pollution level
5.6 c)		The grid system according to type of ground connection for which the switchgear and controlgear assembly is designed
5.6. d)		Indoor and/or outdoor installation
5.6 e)		Stationary or portable
5.6 f)		Protection class
5.6 g)		Intended for use by qualified electricians or ordinary persons
5.6 h)		Classification according to electromagnetic compatibility (EMC)
5.6 i)		Special operating conditions (if applicable)
5.6 j)		External dimensions
5.6 k)		Protection against mechanical stress (if applicable)
5.6 l)		Change to IEC EN 61439-1: Design - fixed, removable parts or inserts
5.6 m)		Type of short-circuit protection
5.6 n)		Measures to protect against electric shock
5.6 o)		Total dimensions, including existing parts e.g. handles, cladding, doors (if necessary)
5.6 p)		Mass (if necessary)
5.6 q)		Supplement to IEC EN 61439-1: shape of the internal division
5.6 r)		Supplement to IEC EN 61439-1: types of electrical connection of functional units

Table 7-4 Distinguishing features of interface of low-voltage switchgear and controlgear assemblies; general overview according to IEC EN 61439-1:2012-07-01, supplemented by the additional specification from IEC EN 61439-2:2012-07-01 applicable to power switchgear and controlgear assemblies

7.5 Notes for practical use of PSCs

Requirements for power switchgear and controlgear assemblies (PSCs) are specified according to the operational requirements of the user and/or planner. A few, select points that concern the structural design of the switchgear and controlgear assembly, particularly the choice and design of the switchgear and controlgear, should be highlighted here.

A detailed representation is available in IEC EN 61439, Part 1 and/or Part 2, Section 8.4.6.

7.5.1 Availability of power switchgear and controlgear assemblies

The option to activate a power switchgear and controlgear assembly in part or in full largely depends on the type of consumer to be supplied and the utilisation of the buildings and/or infrastructure.

For example, in some cases it is not possible to interrupt the operation of IT systems, data processing centres, intensive care units, industrial processes, etc. for maintenance.

Category	Availability of the switchgear and controlgear	Normal operation Operation, configuration, completion, locking	Maintenance Inspection, cleaning, replacement, maintenance	Expansion Addition of control panels, conversion of existing equipment, replacement of equipment
1	Unnecessary	Release of the complete switchgear and controlgear	Release of the complete switchgear and controlgear	Release of the complete switchgear and controlgear
2	Partially desired	Disconnection of affected functional unit (power and auxiliary circuits)	Power disconnection of affected functional unit (loosening the outgoing connections)	Power disconnection of affected functional unit (vacant positions are predefined and mounted)
3	Necessary	Power disconnection of affected functional unit; functional testing possible in test position	Power disconnection of affected functional unit (no loosening the outgoing connections necessary)	Power disconnection of affected functional unit Retrofitting of vacant positions possible

Table 7-5 Assignment of operating modes (normal operation, maintenance, expansion) for activities and for availability of the low-voltage switchgear and controlgear assembly

Therefore, in practice it is important to know the precise requirements of the user (operator) when designing a switchgear and controlgear assembly.

Table 7-5 assigns the three categories of availability (not necessary, partially desired, and necessary) to the intervention options for the different operating modes (normal operation, maintenance, expansion. On the other hand, the required category throws up consequences for the mechanical and electrical design of the switchgear and controlgear assembly and for the type of switchgear and controlgear used (see Table 7-6).

	Operation	Maintenance	Expansion	Suggestions for structural design
Category	2	1	1	**Fixed installation** Switchgear and controlgear installed on assembly plate
	2	2	3	**Plug-in technology** Input side
	2	3	3	**Plug-in technology** Input and output side
	3	3	2	**Slot technology** Switchgear and controlgear with own hard-wired slot enclosure
	3	3	3	**Slot technology** with operating, test and isolation position

Table 7-6 Structural design of the low-voltage switchgear and controlgear assembly depending on the availability categories

7.5.2 Requirements related to accessibility for authorised persons during operation

Type and scope of accessibility for authorised persons during operation must be agreed between the manufacturer of the switchgear and controlgear assembly and the user/planner.

The design implementation by the manufacturer of the switchgear and controlgear assembly must satisfy requirements *in addition to basic protection*.

Generally speaking, the requirements and working methods for work performed in zero potential condition, for live working and/or for working in close proximity to live parts must be observed for all work performed on low-voltage switchgear and controlgear assemblies in operation[86]. In general the application of these provisions is not overridden by special precautions taken when designing the switchgear and controlgear assembly.

If for operating reasons the switchgear and controlgear assembly is set-up to allow authorised persons access to active parts while the equipment is live (e.g. by bypassing a lock or using a tool), the lock must *reactivate automatically* after the door(s) is/are closed.

7.5.2.1 Accessibility requirements for monitoring and similar actions

The switchgear and controlgear assembly must be constructed to ensure that operations agreed between the manufacturer of the switchgear and controlgear assembly and the user can be performed while the switchgear and controlgear assembly is in operation and live.

For example, such operations include visual inspections of

- switchgears and other equipment,
- settings and indicators for relays and triggers,
- conductor connections and designations

7.5.2.2 Accessibility requirements for maintenance work

Design precautions must be taken for maintenance work agreed between the manufacturer of the switchgear and controlgear assembly and the user to be performed on separate functional units or separate groups of functional units while adjacent functional units or functional groups are live.

The scope of precautions depends on factors such as operating conditions, frequency of maintenance, expert knowledge of authorised persons.

An example of such a precaution is the use of covers or barriers that are designed and installed to protect against the direct contact of equipment in adjacent functional units or groups.

7.5.2.3 Accessibility requirements for expansions when live

Should a switchgear and controlgear assembly require subsequent expansion by way of additional, live functional units or groups while the remaining switchgear and controlgear assembly is live, the same requirements as those for accessibility for maintenance work shall apply (see Section 7.5.2.2 of this specialist publication). Naturally this must also be agreed in detail between the manufacturer of the switchgear and controlgear assembly and the user[87].

[86] Provisions according to IEC EN 50110-1:2008-09-01

[87] Here the operator shall also be obligated to observe the requirements and working methods for live work according to IEC EN 50110-1:2008-09-01 for all work performed on live low-voltage switchgear and controlgear assemblies while in operation.

7.6 Distinguishing features for distribution boards intended to be operated by ordinary persons (DBO)

In addition to the distinguishing features to be observed for all low-voltage switchgear and controlgear assemblies (see Table 7-3), both the general requirements and the additional/deviating stipulations according to IEC EN 61439-3 apply for distribution boards intended to be operated by ordinary persons: 2013-06-01, Section 5.

The distinguishing features must be specified by the manufacturer and must be compatible with the rating of the circuits to which the DBO is connected and with the installation conditions.

Particularly for DBOs this can be achieved in two ways:

The user

- chooses either a product whose characteristic values meet its requirements from the manufacturer's catalogue; i.e. the manufacturer of the switchgear and controlgear assembly specifies the characteristic values

or

- it makes a special agreement with the manufacture.

The table provided in Section 11.2 of this specialist publication is helpful for both cases. In practice the manufacturer's indication of the DBO can replace a formal "*Agreement*".

These specific provisions concern, in addition to options for determining the rated diversity factor simply on the basis of standardised table values (see Section 7.2.2 of this specialist publication), the specification of a minimum value for the overvoltage category and specifying whether a DBO is Type A or Type B.

These are included in Table 7-7 at the respective points in the text.

Section in IEC EN 61439-1	Symbol	Designation
5.2	**Rated values for voltages**	
5.2.1	U_n	Rated voltage of the switchgear and controlgear assembly
5.2.2	U_e	Rated supply voltage of a circuit of a switchgear and controlgear assembly
5.2.3	U_i	Rated insulation voltage of a circuit of a switchgear and controlgear assembly
5.2.4	U_{imp}	Change to IEC EN 61439-1: The rated surge voltage strength must be larger than or equal to the stated values for transient overvoltages that may occur in the electrical system(s) to which the circuit is intended to be connected. Distribution boards must correspond in the very least to overvoltage category III[88] .
5.3	**Rated values for currents**	
5.3.1	I_{nA}	Rated current of the switchgear and controlgear assembly

[88] According to Table G.1 in Appendix G of IEC EN 61439-1:2012-07-01

5.3.2	I_{nc}	Rated current of a circuit
5.3.3	I_{pk}	Rated surge current strength
5.3.4	I_{cw}	Rated short-time current strength of a circuit of a switchgear and controlgear assembly
5.3.5	I_{cc}	Conditional rated short-circuit current of a switchgear and controlgear assembly
5.4	**RDF**	**Rated Diversity Factor** Supplement to IEC EN 61439-1: In particular cases the assumed load of the outgoing circuits may be read from a table (see Section 7.2.2 of this specialist publication)
5.5	**f_n**	**Rated frequency**
5.6	**Other distinguishing features**	
5.6 a)		Additional requirements depending on the special operating conditions of a functional unit (e.g. type of coordination, overload properties)
5.6 b)		Pollution level
5.6 c)		The grid system according to type of ground connection for which the switchgear and controlgear assembly is designed
5.6. d)		Indoor and/or outdoor installation
5.6 e)		Stationary or portable
5.6 f)		Protection class
5.6 g)		Intended for use by qualified electricians or ordinary persons
5.6 h)		Classification according to electromagnetic compatibility (EMC)
5.6 i)		Special operating conditions (if applicable)
5.6 j)		External dimensions
5.6 k)		Protection against mechanical stress (if applicable)
5.6 l)		Type of structure - inserts or removable parts
5.6 m)		Type of short-circuit protection
5.6 n)		Measures to protect against electric shock
5.6 o)		Total dimensions, including existing parts e.g. handles, cladding, doors (if necessary)
5.6 p)		Mass (if necessary)
5.6 q)		Supplement to IEC EN 61439-1: Type A or Type B DBO

Table 7-7 Distinguishing features of interface of low-voltage switchgear and controlgear assemblies; general overview according to IEC EN 61439-1:2012-07-01, supplemented by the additional specification from IEC EN 61439-3:2013-06-01 applicable to DBOs

7.7 Notes for practical use of DBOs

7.7.1 Description of a DBO

Part 3 of IEC EN 61439 published 1 June 2013 entitled: "Distribution board intended to be operated by ordinary persons (DBO[89])" is particularly important because it applies to a large number of distribution boards. In Austria this standard is currently in the transitional period, which lasts until 22.3.2015 (see Figure 1-2).

[89] DBO … **D**istribution **B**oard intended to be operated by **O**rdinary persons

A distribution board intended to be operated by ordinary persons is a switchgear and controlgear assembly for distributing electrical energy for applications in domestic accommodation (homes) and in other locations, whereby operation is performed by ordinary persons.

The standard recognises a further two categories of distribution boards, namely:

Distribution boards (DBO) of *Type A*, which are (only) designed to accommodated unipolar equipment and those of *Type B*, which are designed to accommodate multipolar and/or unipolar equipment[90].

Part 3 must also be read in conjunction with Part 1. The general requirements from Part 1 *only apply if specifically referred to in Part 3*. If the terms "supplement", "amendment" or "replace" are used in Part 3, the text concerned in Part 1 must be adjusted accordingly.

IEC EN 61439-3:2013-06-01[91] applies to all DBOs, regardless of whether they are designed, manufactured and verified as individual parts, or manufactured in large quantities as series productions. DBOs may only be assembled off the premises of the original manufacturer (e.g. on the construction site).

It is important that this Part 3 of the standard does not apply to the switchgear and controlgear assemblies that are handled in the other parts of IEC EN 61439. Thus for example there are no power switchgear and controlgear assemblies according to Part 2, which are also simultaneously distribution boards intended to be operated by ordinary persons (according to Part 3).

Distribution boards intended to be operated by ordinary persons are defined by the features listed below:

- They are designed to be operated by ordinary persons (e. g. switching operations and replacing fuse links), e. g. for use in residential accommodation;
- The output circuits include short-circuit protective devices that are intended to be operated by ordinary persons in accordance with e. g. EN 60898-1, EN 61008, EN 61009, EN 62423 and EN 60269-3
- The rated voltage to ground is maximum 300 V AC;
- The rated current (I_{nc}) of the outgoing circuits is maximum 125 A, and the rated current (I_{nA}) of the DBO is maximum 250 A;
- They are intended for the distribution of electrical power;
- They are closed and stationary;
- For indoor or outdoor installation.

DBOs may also include controllers and indicators in conjunction with the distribution of electrical power.

A reminder: The following also applies for DBOs: If the *manufacturer of the switchgear and controlgear assembly* makes modifications to the DBO, it shall be responsible for this modification as original manufacturer and must supply the necessary (design) verification. The execution of the parts verification alone is insufficient.

[90] Attention! Not to be confused with the designation of the EMC environments A and/or B.
[91] This standard *does not apply to individual equipment* and only to usable assemblies e.g. circuit breakers, fuse switches, electrical assemblies etc., which must comply with the relevant product standards.

7.7.2 "Specialities" for DBOs

As regards some of the features, IEC EN 61439-3 contains (deviating from Part 1) changes and in some points even "simplifications" for practical working. Some of the changes are indicated below.

- Thus it is specified that the **rated surge voltage strength (U_{imp})** of the DBO must be larger than or equal to the stated values for transient overvoltages that may occur in the electrical system(s) to which the circuit is intended to be connected. Distribution boards must correspond in the very least to overvoltage category[92] III.
- The number of **neutral conductor connections** of a DBO must be at least as large as the number of outgoing circuits[93] that require a neutral conductor connection. These connections must be arranged or marked in the same order as the associated outer conductor connections.
- DBO must have at least two connections for **protective bonding conductors** of the electrical system.
- **Outgoing circuits** must include short-circuit protective devices to be operated by ordinary persons in accordance with e. g. EN 60898-1, EN 61008, EN 61009, EN 62423 and EN 60269-3
- The restoration of the **short-circuit protective device in the supply** if installed in a DBO must require the use of a key or tool if this short-circuit protective device does not comply with the standards for switchgear and controlgear intended to be operated by ordinary persons. Alternatively a sign must be affixed next to the protective device in the supply, stating that trained personnel or a qualified electrician may only restore the triggered device.
- If a short-circuit protective device in the supply that is installed in a DBO contains fuse links that do not comply with IEC 60269-3, access to replace the fuse links must be permitted by way of a key or tool. (Attention: The alternative of simply affixing a sign does not apply here!!)
- **Circuit breakers** must be designed or installed to ensure that the calibration settings can only be changed by a specific action using a key or tool and it must be ensured that the **setting or calibration** is **visible**.
- For DBOs for **indoor installation** the minimum value for the IK code is: IK 05, for **outdoor installation**: IK 07
- As regards the **rated diversity factor(RDF[94])** for DBOs, in any case where there is *no agreement* between the manufacturer of the DBO and the user regarding the respective load current, the assumed load of the outgoing circuits of the DBO or of the group of outgoing circuits is determined using the values in Table 7-2 .

As regards the **temperature-rise verification** required in the *design verification*, whereby it must be proven that the stipulated temperature-rise limits are not exceeded, only the procedure according to IEC EN 61439-1:2010, Section 10.10.4.2.1 may be used[95]. See also Table 3-3.

The important steps for preparing the design and parts verification for DBOs can be summarised in three examples[96] (see also [32], [33])

[92] Overvoltage category (see IEC 60364-4-44) according to Table G.1 in Appendix G of IEC EN 61439-1:2012-07-01, i.e. e. g. at least 4 kV in 230/400 V systems

[93] IEV number 826-14-01 [IEC 60050] (electric) circuit (of an electrical installation): assembly of electric equipment of the electrical installation protected against overcurrents by the same protective device(s).

[94] RDF … **R**ated **D**iversity **F**actor

[95] This procedure is permissible for DBOs because the rated current of all DBOs is limited to 250 A by definition.

Example I:

- Purchase of a tested system from an original manufacturer (design verification available).
- Condition: The DBO has been inspected by the original manufacturer with all integral and wired components.
- Production according to the manufacturing instructions (e. g. layout, diagram etc.) of the original manufacturer.

⇨ *The manufacturer of the switchgear and controlgear assembly must establish a parts verification.*

Example II:

- Production of a DBO with components by different manufacturers (enclosures, covers, mounting bars, terminals, switchgears, etc.) based on client specification.

⇨ *The manufacturer of the switchgear and controlgear assembly must establish a design and parts verification.*

- For complete assembly of the DBO in the workshop:

  ⇨ *Design and parts verification can be performed jointly by the manufacturer of the switchgear and controlgear assembly.*

- For assembly of the DBO on the construction site:

  ⇨ *Design verification and parts verification should be performed separately i.e. parts verification on-site at construction site.*

Example III:

- Repeated manufacture of identical or similar DBOs with components of various manufacturers (enclosure, covers, mounting bars, terminals, switchgears, etc.): e.g. with fewer final circuits but identical enclosures, etc.

⇨ *The manufacturer of the switchgear and controlgear assembly must establish a design and parts verification.*

⇨ *Design verification of "prototypes" can be assumed.*

⇨ *Parts verification for each individual part required*[97].

8 Frequently asked questions

On the occasion of an informative event held by Eaton Industries (Austria) GmbH, the author had the opportunity to discuss the content of IEC EN 61439 with a range of users of this series of standards from all over Austria. The subjects that were discussed are summarised in this section in question-answer form.

[96] This representation is inspired by a concept by Marcel Schellenberg, Head of Department at Electrosuisse, CH-8320 Fehraltorf, Switzerland.

[97] This corresponds to the procedure in series production.

8.1 Which switchgears for overcurrent protection may be used in outgoing circuits of DBOs?

Overcurrent protective devices contain elements for overload and short-circuit protection. Part 3 of the series of standards, which applies to the design of DBOs, states that, in principle, only short-circuit protective devices that are designed to be operated by ordinary persons may be installed for outgoing circuits.

These are low-voltage switchgear and controlgear assemblies that comply with the relevant European standards such as IEC EN 60898-1 (circuit breakers), IEC EN 61008 (residual current circuit breakers), etc., which clearly demonstrate that these switchgears are intended to be operated by ordinary persons.

The indication of HD 60269-3 the exemplary list of short-circuit protective devices provided in IEC EN 61439-3: 2013-06-01, Section 8.5.3 forms a special position. This standard describes additional requirements for fuses that are designed to be operated by ordinary persons. These statements are related to the fuses themselves, but not to the switchgears in which the fuses are used. This means that when using fused switchgear and controlgear assemblies (sometimes also a fused load circuit breakers), it must be ensured that this switchgear and controlgear is specified as "for ordinary persons" (by the manufacturer of the switchgear and controlgear).

8.2 A frequency converter with rated current of more than 1600 A is installed in a metal enclosure. No switchgear and controlgear is housed in this enclosure. Does this arrangement fall under IEC EN 61439?

In the narrower sense of the term, frequency converters do not fall under "switchgears". Thus IEC EN 61439 would not be applicable. However, the international definition of the term "switchgear and controlgear and controlgear" arguably contains the term "control" (i. e., the term "control" is implied).

In this context the International Electrotechnical Vocabulary (IEV 826-16-03) states:

switchgear and controlgear and controlgear: electric equipment intended to be connected to an electric circuit for the purpose of carrying out one or more of the following functions: protection, control, isolation, switching

Therefore, there is no unequivocal answer from a standards perspective.

In practice this means that in cases where a standard-compliant frequency converter is installed in a metal enclosure (without other switchgears) and is supplied as equipment, the manufacturer must nonetheless ensure that the whole arrangement satisfies the *Essential Requirements* of the Low-Voltage and EMC Directives. As such the manufacturer may apply one or more technical requirements or specification from the series of standards IEC EN 61439 and thus declare conformity with the stipulated directives, affix CE marks and legally circulate the equipment.

8.3 Does the temperature-rise calculation have to be transferred to the client (operator, user) to be stored in the asset ledger?

The standards do not stipulate any obligation to transfer the calculation procedure and/or details of the temperature-rise calculation to the client. Of course this may be agreed under private law (when placing the order).

8.4 Is an assembly for construction sites according to IEC EN 61439-4 a distribution board that may be operated by ordinary persons?

For a construction site distribution board to comply with IEC EN 61439-4:2013-10-01, the accessible parts must be designed to ensure that only plug and socket devices, control elements and buttons are accessible without the use of a key or tool[98]. Apart from that the design of the construction site distribution board must provide protection against any contact with active parts when using devices or replacing components[99].

Manually-operated devices may be used by ordinary persons in a standard-compliant construction site distribution board.

For the sake of completion it should be stated here that the provisions for construction site distribution boards do *not apply to switchgear and controlgear assemblies* that are used in the administration and business premises (offices, changing rooms, meeting rooms, sleeping quarters, sanitation facilities, canteens, etc.) of *construction sites*.

8.5 Does the term "original manufacturer" in IEC EN 61439 refer to the manufacturer e.g. of the residual current circuit breaker that I install in the switch cabinet?

No. This refers to the (original) manufacturer of the *low-voltage switchgear assembly*, sometimes referred to as the system manufacturer (see also Section 2.1.1 of this specialist publication).

8.6 Why must the switchgear and controlgear assembly wiring be designed for 125 % of the rated current?

This question came up in connection with the temperature-rise verification of power switchgear and controlgear assemblies with a rated current of no more than 1600 A.

It is only possible to verify the temperature-rise using the calculation methods in IEC 60890 [19] under certain conditions.

One such condition is that the rated currents of the switchgear and controlgear assembly circuits may not exceed 80% of the conventional free-air thermal current (I_{th}), if applicable, or the rated current (I_n) of the electrical equipment in the circuit.

A reminder: The rated current of a circuit is the value of the current that can be carried by this circuit under normal operating conditions when it is operated alone. This energy must be able to be

[98] IEC EN 61439-4:2013-10-01, Section 8.5.101
[99] IEC EN 61439-1:2012-07-01, Section 8.4.6.1

conducted without the temperature-rises of the individual components of the switchgear and controlgear assembly exceeding the values specified in the standard[100] .

Another condition for being able to use the calculation method in IEC 60890 is that all conductors must have a minimum cross-section corresponding to 125 % of the permissible rated current. Therefore the cross-sections of the conductors must be designed for the conventional free-air thermal current (I_{th}) or the rated current (I_n) of the circuit.

In terms of calculating the temperature-rise, this means that although the rated current must be below the rated current of the circuit (80 % value), the full cross-section of the conductor must be available for heat dissipation. Only then does the applied calculation method deliver meaningful results.

8.7 What is the Rated Diversity Factor (RDF)?

As a distinguishing feature of a low-voltage switchgear and controlgear assembly, the rated diversity factor[101]is particularly important for safe operation.

Provided that the supply load does not exceed its rated current, the load factor represents the proportion of the respective rated currents that each assembly of outgoing circuits can simultaneously and permanently conduct, without overloading the switchgear and controlgear assembly.

The rated diversity factor is normally defined for the entire switchgear and controlgear assembly. However, the original manufacturer can also specify the load factor for groups of circuits, for example, for the circuits in one field.

The rated diversity factor is therefore a distinguishing feature of the low-voltage switchgear and controlgear assembly.

In contrast the simultaneity factor, which is also frequently used in discussion in this context, describes the power ratio of all consumers in operation at the same time and that are supplied through the outgoing circuits to the sum of the rated output of all consumers supplied through the outgoing circuits.

Therefore, the simultaneity factor is a property that arises from the (presumed, estimated, calculated) operation of the installation, and not a characteristic property of the switchgear and controlgear assembly. For example, enlarging the mounting distance of two fuse holders in a switchgear and controlgear assembly influences the RDF but not the simultaneity factor of the consumer.

8.8 Are editions of this series of standards not considerably "stricter" than previously?

The requirements have not been strengthened from a technical perspective. There are now additional options for verifying compliance with this standard (key word: calculation instead of inspection) and a clearer arrangement of responsibilities.

[100] IEC EN 61439-1:2012-07-01, Section 9.2
[101] RDF … **R**ated **D**iversity **F**actor

In this context it should be pointed out that almost all technical requirements of the series of standards IEC EN 61439 have been included in ÖVE/ÖNORM EN 8001-2-30[102] for many years.

8.9 Do output terminals now have to be erected in every distribution board or can these be wired directly to the switchgear and controlgear terminals?

Unfortunately there is no yes/no answer for all types and designs of switchgear and controlgear assembly. IEC EN 61439:2012-07-01, Section 8.8 entitled "Connections for conductors inserted from outside" can be consulted for clarification.

Here it is stipulated that the conductors may not be exposed to any stresses that reduce their usual life expectancy. In particular this refers to tension and compression stresses[103].

Similarly when thinking about "wiring directly to the switchgear and controlgear assembly" it is up to the manufacturer to decide whether the stipulation that connections intended for incoming and outgoing neutral conductors, protective conductors and PEN conductors must be arranged *close to the associated outer conductor connections* can be adhered to.

Last but not least it's also a question of whether the terminals are designed for "direct wired" switchgears, possibly for clamping several conductors primarily by the manufacturer of the switchgear and controlgear in question; and if so, for what number and/or combinations of conductor cross-sections.

8.10 How should the cable lengths of the incoming and outgoing cables of the switchgear and controlgear assembly be factored into the rise calculation?

The cable lengths must be factored in using their actual lengths or using the ("estimated") cable length derived from comparison with reference designs.

8.11 What is a Type A or Type B DBO?

Distribution boards (DBO) of *Type A*, which are (only) designed to accommodated unipolar equipment and those of *Type B*, which are designed to accommodate multipolar and/or unipolar equipment.

However, this term should not be confused with the EMC environments A and/or B (see also Section 1.4 of this specialist publication).

[102] ÖVE/ÖNORM E 8001-2-30:2008-12-01; Construction of electrical systems with nominal voltages up to AC 1000 V and DC 1500 V -Part 2-30: switchgear and controlgear and controlgear and distributors

[103] Also in ÖVE/ÖNORM E 8001-2-30:2008-12-01, Section 5.4.1 is referred to here.

8.12 Does the temperature-rise also have to be determined (calculated) if the switchgear and controlgear assembly is installed in a space where the air temperature is kept at a specific temperature (e.g. with air conditioning)?

Yes. The temperature-rise is an important factor particularly in selecting the switchgear and controlgear, the size of the distribution board (cooling surfaces), etc., and last but not least, also for the air conditioning provided in the space, whereby the volume of heat generated by the low-voltage switchgear and controlgear assembly must be factored into the design.

8.13 Does the temperature-rise also have to be determined (calculated) for "small distribution boards"?

Yes. "Fitted small distribution boards" are classified as low-voltage switchgear and controlgear assemblies if they are not manufactured and put into circulation as "enclosures for accommodating protective devices and similar power-consuming devices" according to IEC EN 60670-4:2014-05-01.

8.14 Does IEC EN 61439 also apply to "switchgear and controlgear assemblies for supplying machinery"?

The electrical equipment of a machine must meet the safety requirements that were identified in the machine risk assessment performed by the manufacturer of the machine. Some of these requirements can be met by applying IEC EN 60204-1[104][105].

Depending on the machine, its intended use and its electrical equipment, the manufacturer of the machine may select components of the electrical equipment of the machine that comply with IEC EN 61439-1 and/or other parts of this series of standards.

In these cases the purpose of the technical requirements for switchgear and controlgear assemblies according to IEC EN 61439 is to satisfy the Essential Requirements of the Machinery Directive; EC Conformity with these requirements is established with the EC Declaration of Conformity of the machine manufacturer.

These "switchgear and controlgear assemblies" then count as Electrical Equipment of the Machine and are marked according to IEC EN 60204-1.

8.15 What exactly is clearance and creepage distance?

The *clearance distance*[106] is the shortest distance between two conductive parts.

The *creepage distance*[107] is the shortest distance along the surface of a fixed insulation material between two conductive parts.

[104] IEC EN 60204-1:2009-12-01; Safety of machinery – Electrical equipment of machinery Part 1: General requirements
[105] IEC EN 60204-1:2009-12-01, Section 4.2.2; here reference is made to the previously applicable series of standards EN 60439, update will probably take place with the next issue.
[106] Definition according to IEC EN 60664-1:2008-03-01, Section 3.2
[107] Definition according to IEC EN 60664-1:2008-03-01, Section 3.3

8.16 Does a risk analysis have to be performed for the low-voltage switchgear and controlgear assembly as part of the conformity assessment procedure?

If the specifications in the part of IEC EN 61439 relevant to the switchgear and controlgear assembly are complied with, a risk analysis is not strictly necessary. However, this does not apply if not all specifications in the respective part of the standard are covered by the series of standards IEC EN 61439 or for any risks that may occur that are not covered by this standard.

A detailed representation on this subject is provided in [1].

8.17 Are NH isolators permitted in "riser distribution boards"? Is this distribution board a DBO?

The term "riser distribution board" is not covered precisely by any standards. Ordinary persons may not replace live NH-fuses. Those in fuse switch-disconnectors up to 125 A are an exception to this rule.

For specific designs of the installation it will be important to accurately note whether these distribution boards are power switchgear and controlgear assemblies or DBOs.

8.18 Can I also verify the temperature-rise with a thermal camera?

No. Using a thermal camera alone is not a permissible verification method according to IEC EN 61439.

8.19 Reserve space in the distribution board according to ÖVE/ÖNORM E 8015-2. Can I fill this up with equipment without knowing the thermal reserve?

Prior to using the reserve space[108] in "Electrical installation distribution boards" according to ÖVE/ÖNORM E 8015-2:2006-10-01[109] , this is only conceivable if it is known (or recently calculated) whether the thermal arrangement of the distribution board is not unduly influenced by the new, additional equipment. If no manufacturer information is available, the calculation must be performed prior to the assembly of additional equipment and measures should be taken according to the results of the calculation. (Refrain from installing, additional ventilation, re-evaluation of the RDF, …)

8.20 Can Neozed fuses (D0 fuses) be used in the outgoing circuits of DBOs?

D0 fuses (manufacturer's name: Neozed fuses) are contained in HD 60269-3, and thus permitted as short-circuit protective devices in outgoing circuits[110] of DBOs.

8.21 Does the CE mark have to be affixed? Can anyone do this or is a particular authorisation required?

The manufacturer of the low-voltage switchgear and controlgear assembly is obligated to affix the CE mark. The conformity assessment process is normally assigned to a qualified electrician who must possess the necessary knowledge and experience.

[108] ÖVE/ÖNORM E 8015-2:2006-10-01, Section 4.5.1
[109] ÖVE/ÖNORM E 8015-2:2006-10-01, Electrical installations in residential buildings Part 2: Type and scope of the minimum equipment
[110] IEC EN 61439-3:2013-06-01, Section 8.5.3

8.22 Idle power loss and electronic counters; what should be observed for conversion/retrofitting to electronic counter?

For conversion/retrofitting to electronic counters the power loss of the new counter and the resulting effect caused by the thermal arrangement of the low-voltage switchgear and controlgear assembly must be observed.

8.23 Must the detailed design verification be transferred to the user?

In principle, the conformity of the switchgear and controlgear assembly is established with the application of the CE mark. The detailed design verification does not have to be transferred to the user. Any case where the transfer of the detailed design verification was agreed upon acceptance of the order (private law) is an exception.

8.24 Does IEC EN 61439 include specifications for EMC?

Yes. The specifications are provided in IEC EN 61439-1:2012-07-01 in Sections 9.4 and 10.12 and in Appendix J.

8.25 Must switchgears also be constructed with frequency converters in accordance with IEC EN 61439?

Yes.

8.26 Must a 16-A protective contact socket in a switchgear and controlgear assembly also be equipped with additional protection?

Yes. This requirement comes from ÖVE/ÖNORM E 8001-1:2010-03-01, Section 6.1 and from the applicable occupational safety specifications (Electrical Protection Act[111] 2012). However, this requirement is not imposed in all member states of the European Union for all types of installations. National specifications for the establishment of low-voltage installations (installation regulations) and occupational safety specifications must also be observed here.

8.27 What is considered to be a "significant expansion of equipment" in a retrofit/conversion?

This is regulated directly in the Austrian Electrotechnical Act[112] .

> *"(5) A significant change to electrical equipment exists if one of the following conditions is met:*
>
> *1. One or more of the sizes or properties type of current, rated voltage, rated current, rated output, nominal operating mode, rated speed or rated frequency of the power supply are changed unless the equipment is designed so that this change is possible without structural intervention and the effects of this change have already been factored into the design of the equipment.*
>
> *2. Parts of the electrical equipment whose purpose is to protect users and other persons have been changed or permanently removed.*
>
> *(6) A significant expansion of electrical equipment occurs if this is aggregated with at least one other piece of electrical equipment in operation, but this creates neither an electrical installation according to*

[111] BGBl. II/33/2012; Ordinance on the Protection of Workers from Risks related to Electrical Current, as well as amendment of the Construction Worker Protection Ordinance and the Explosive Atmospheres Directive
[112] BGBl. 106/1993; Electrotechnical Act 1992 (ETG-1992), § 1(5) and § 1(6)

Para. 2 nor another type of electrical equipment, unless the equipment is designed so that this aggregation is possible without significant change to the equipment and the effects of this aggregation are already factored into the design of the equipment."

9 Concluding remark

This publication was only able to present a detailed account of selected content taken from the series of standards IEC EN 61439.

The selection was made with the intention of introducing qualified electricians who work as original manufacturers, manufacturers, planners, installers or operators to the central ideas on which this series of standards is based.

The aim was also to give all persons involved in the planning, tender process and inspection of low-voltage switchgear and controlgear assemblies or the systems in which these are integrated an overview of the protection philosophy that underlies this series of standards.

This paper can in no way replace intensive involvement with the detailed contents of IEC EN 61439, observing the further development of the series of standards, studying further literature and attending advanced training events on this subject.

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11 Appendix / Sample documents

11.1 Agreement between manufacturer of the switchgear and controlgear assembly and the user for power switchgear and controlgear assemblies

Technical parameters to be agreement between the manufacturer of power switchgear and controlgear assemblies (PSC) and the user[113]

No.	*Functions and features specified by operator/planner*	*Standard priority design [where available][114]*	*Operator / Planner requirement[115]*
1	**Electrical grid**		
1.1	System according to type of ground connection	Standard design of the manufacturer, selected according to local requirements	
1.2	Nominal voltage (V)	According to the local installation conditions	
1.3	Transient overvoltages	Determined by the electrical system	
1.4	Temporary overvoltages	Nominal voltage of the system + 1200 V	
1.5	Rated frequency f_n (Hz)	According to the local installation conditions	
1.6	Additional requirements for on-site inspections: Wiring, performance, function	Standard design of the manufacturer, according to application	
2	**Short-circuit strength**		
2.1	Uninfluenced short-circuit current to the supply connections I_{cp} (kA)	Determined by the electrical system	
2.2	Uninfluenced short-circuit current in the neutral conductor	Min. 60 % of the outer conductor value	
2.3	Uninfluenced short-circuit current in the protective earth circuit	Min. 60 % of the outer conductor value	
2.4	Requirement, whether SCPD [short circuit protection device] in the supply	According to the local installation conditions	
2.5	Information for coordination of short-circuit protective devices including short-circuit protective devices outside the switchgear and controlgear assembly	According to the local installation conditions	
2.6	Information on loads that may contribute to the short-circuit current	No loads permissible that	

[113] Based on IEC EN 61439-2:2012-07-01, Table BB.1

[114] All incomplete fields must be specified by the operator/planner; there is no detailed standard specification for these functions and features.

[115] For exceptionally difficult applications it may be necessary for the operator / planner to specify stricter requirements than in IEC EN 61439.

No.	Functions and features specified by operator/planner	Standard priority design [where available][114]	Operator / Planner requirement[115]
		may contribute to the short-circuit current	
3	**Protection of persons against electric shock according to ÖVE/ÖNORM E 8001-1 for outgoing circuits**		
3.1	Protection against direct contact	Basic protection	
3.2	Protection for indirect contact	According to the local installation conditions	
3.3	Additional protection	According to the local installation conditions	
4	**Installation environment**		
4.1	Installation site	Standard design of the manufacturer, according to application	
4.2	Protection against penetration of solid foreign bodies and water incursion	Interior (closed): IP2X exterior (min.): IP 23	
4.3	Protection against removal of insert	Standard design of the manufacturer	
4.4	External mechanical influence (IK)		
4.5	Resistance to UV radiation (Only applies to exterior installation, unless stipulated otherwise)	Interior: not applicable, Exterior: moderate climate	
4.6	Corrosion resistance	Normal interior / exterior installation	
4.7	Ambient temperature – Lower limit	Interior: -5 °C Exterior: - 25°C	
4.8	Ambient temperature – Upper limit	40 °C	
4.9	Ambient temperature – maximum daily (24 h) average	35 °C	
04:10	Maximum relative humidity	Interior: 50 % at 40 °C Exterior: 100 % at 25 °C	
04:11	Pollution level (of installation environment)	Industry: 3	
04:12	Altitude	≤ 2000 m	
04:13	EMC environment (A or B)	A/B	
04:14	Special operating conditions (e.g. oscillation, extreme condensation, heavy pollution, corrosive atmosphere, strong electric or magnetic fields, fungus, small animals, explosion risk, severe tremors and jolts, earthquakes)	No special operating conditions	
5	**Type of installation**		

No.	*Functions and features specified by operator/planner*	*Standard priority design [where available][114]*	*Operator / Planner requirement[115]*
5.1	Model	Standard design of the manufacturer	
5.2	Stationary/Portable	Stationary	
5.3	Maximum external dimensions and mass	Standard design of the manufacturer, according to application	
5.4	Types of conductors inserted from outside	Standard design of the manufacturer	
5.5	Location of conductors inserted from outside	Standard design of the manufacturer	
5.6	Material of conductors inserted from outside	Copper	
5.7	Cross-section and connection of external conductors inserted from outside	As stipulated in the standard	
5.8	Cross-section and connection of the PE, N and PEN conductor inserted from outside	As stipulated in the standard	
5.9	Special requirements for marking connections	Standard design of the manufacturer	
6	**Storage and transportation**		
6.1	Maximum dimensions and weight of transport units	Standard design of the manufacturer	
6.2	Type of transportation (e. g. forklift, crane)	Standard design of the manufacturer	
6.3	Ambient temperatures deviating from operating conditions	As conditions in operation	
6.4	Packaging details	Standard design of the manufacturer	
7	**Serviceability**		
7.1	Access to manually operated equipment		
7.2	Positioning of manually operated equipment	Easily accessible	
7.3	Isolation of outgoing circuits	Standard design of the manufacturer	
8	**Maintenance and expansion**		
8.1	Requirements related to accessibility for inspections and similar activities	No accessibility requirements	
8.2	Requirements related to accessibility during operation for maintenance by authorised persons	No accessibility requirements	
8.3	Requirements related to accessibility during operation for expansion by authorised persons	No accessibility requirements	
8.4	Type of electrical connection of functional units	Standard design of the manufacturer	
8.5	Protection against electric shock through direct contact with internal, dangerous, live parts during maintenance or expansion (e.g. functional units, main busbars, distribution busbars)	No requirements for protection during maintenance or expansion	

No.	Functions and features specified by operator/planner	Standard priority design [where available][114]	Operator / Planner requirement[115]
8.6	Service passages	Basic protection	
8.7	Types of electrical connection of functional units related to the possibility of removing and replacing functional units		
8.8	Type of internal subdivision		
8.9	Option for separate functional testing of auxiliary circuits while the functional unit is isolated.		
9	**Ampacity**		
9.1	Rated current of the switchgear and controlgear assembly I_{nA} (A)	Standard design of the manufacturer, according to application	
9.2	Rated current of circuits I_{nc} (A)	Standard design of the manufacturer, according to application	
9.3	Rated Diversity Factor	According to the standard	
9.4	Ratio of neutral conductor cross-section to outer conductor cross-section: Outer conductor up to and including 16 mm² [The current through the neutral conductor can be influenced by significant harmonic oscillations, uneven outer conductor currents or by other conditions that require a larger conductor cross-section.]	100 %	
9.5	Ratio of neutral conductor cross-section to outer conductor cross-section: Outer conductor larger than 16 mm² [The current through the neutral conductor can be influenced by significant harmonic oscillations, uneven outer conductor currents or by other conditions that require a larger conductor cross-section.]	50 % (min. 16 mm²)	

11.2 Agreement between manufacturer of the switchgear and controlgear assembly and the user for distribution boards operated by ordinary persons

Technical parameters to be agreed between the manufacturer of distribution boards operated by ordinary persons (DBO) and users[116]

No.	Functions and features specified by operator/planner	Standard priority design [where available][117]	Operator / Planner requirement[118]

[116] Based on IEC EN 61439-2:2012-07-01, Table BB.1

[117] All incomplete fields must be specified by the operator/planner; there is no detailed standard specification for these functions and features.

[118] For exceptionally difficult applications it may be necessary for the operator / planner to specify stricter requirements than in IEC EN 61439.

No.	*Functions and features specified by operator/planner*	*Standard priority design [where available][117]*	*Operator / Planner requirement[118]*
1	**Electrical grid**		
1.1	System according to type of ground connection	Standard design of the manufacturer, selected according to local requirements	
1.2	Nominal voltage of the power supply (V)	According to the local installation conditions	
1.3	Transient overvoltages	Determined by the electrical system; at least: overvoltage category III	
1.4	Temporary overvoltages	Nominal voltage of the system + 1200 V	
1.5	Rated frequency f_n (Hz)	According to the local installation conditions	
1.6	Additional requirements for on-site inspections: Wiring, performance, function	Standard design of the manufacturer, according to application	
2	**Short-circuit strength**		
2.1	Uninfluenced short-circuit current to the supply connections I_{cp} (kA)	Determined by the electrical system	
2.2	Uninfluenced short-circuit current in the neutral conductor	Min. 60 % of the outer conductor value	
2.3	Uninfluenced short-circuit current in the protective earth circuit	Min. 60 % of the outer conductor value	
2.4	Requirement, whether SCPD [short circuit protection device] in the supply	According to the local installation conditions	
2.5	Information for coordination of short-circuit protective devices including short-circuit protective devices outside the switchgear and controlgear assembly	According to the local installation conditions	
2.6	Information on loads that may contribute to the short-circuit current	No loads permissible that may contribute to the short-circuit current	
3	**Protection of persons against electric shock according to ÖVE/ÖNORM E 8001-1 for outgoing circuits**		
3.1	Protection against direct contact	Basic protection	
3.2	Protection for indirect contact	According to the local installation conditions	
3.3	Additional protection	According to the local installation	

No.	Functions and features specified by operator/planner	Standard priority design [where available][117]	Operator / Planner requirement[118]
		conditions	
4	**Installation environment**		
4.1	Installation site	Standard design of the manufacturer, according to application	
4.2	Protection against touching active parts, against penetration of solid foreign matter and water	Interior (closed): IP2XC exterior (min.): IP 23	
4.3	External mechanical influence (IK)	Interior IK 05, exterior IK 07	
4.4	Resistance to UV radiation (Only applies to exterior installation, unless stipulated otherwise)	Interior: not applicable, Exterior: moderate climate	
4.5	Corrosion resistance	Normal indoor/outdoor installation	
4.6	Ambient temperature – Lower limit	Interior: -5 °C Exterior: - 25°C	
4.7	Ambient temperature – Upper limit	40 °C	
4.8	Ambient temperature – maximum daily (24 h) average	35 °C	
4.9	Maximum relative humidity	Interior: 50 % at 40 °C Exterior: 100 % at 25 °C	
04:10	Pollution level (of installation environment)	2	
04:11	Altitude	≤ 2000 m	
04:12	EMC environment (A or B)	A/B	
04:13	Special operating conditions (e.g. oscillation, extreme condensation, heavy pollution, corrosive atmosphere, strong electric or magnetic fields, fungus, small animals, explosion risk, severe tremors and jolts, earthquakes)	No special operating conditions	
5	**Type of installation**		
5.1	Model	Standard design of the manufacturer	
5.2	Stationary/Portable	Stationary	
5.3	Maximum external dimensions and mass	Standard design of the manufacturer, according to application	
5.4	Types of conductors inserted from outside	Standard design of the manufacturer	
5.5	Location of conductors inserted from outside	Standard design of the manufacturer	

No.	Functions and features specified by operator/planner	Standard priority design [where available][117]	Operator / Planner requirement[118]
5.6	Material of conductors inserted from outside	Copper	
5.7	Cross-section and connection of external conductors inserted from outside	As stipulated in the standard	
5.8	Cross-section and connection of the PE, N and PEN conductor inserted from outside	As stipulated in the standard	
5.9	Special requirements for marking connections	Standard design of the manufacturer	
6	**Storage and transportation**		
6.1	Maximum dimensions and weight of transport units	Standard design of the manufacturer	
6.2	Type of transportation (e. g. forklift, crane)	Standard design of the manufacturer	
6.3	Ambient temperatures deviating from operating conditions	As conditions in operation	
6.4	Packaging details	Standard design of the manufacturer	
7	**Serviceability**		
7.1	Access to manually operated equipment	Ordinary persons	
7.2	Positioning of manually operated equipment	Easily accessible	
8	**Maintenance and expansion**		
8.1	Requirements related to accessibility during operation by ordinary persons to service devices or replace components while the switchgear and controlgear assembly is live	Basic protection	
8.2	Requirements related to accessibility for inspections and similar activities	No accessibility requirements	
8.3	Requirements related to accessibility during operation for maintenance by authorised persons	No accessibility requirements	
8.4	Requirements related to accessibility during operation for expansion by authorised persons	No accessibility requirements	
8.5	Type of electrical connection of functional units	Standard design of the manufacturer	
8.6	Protection against electric shock through direct contact with internal, live parts during maintenance or expansion (e.g. functional units, main busbars, distribution busbars)	No requirements for protection during maintenance or expansion	
9	**Ampacity**		
9.1	Rated current of the switchgear and controlgear assembly I_{nA} (A)	≤ 250 A	
9.2	Rated current of circuits I_{nc} (A)	≤ 125 A	
9.3	Rated Diversity Factor	According to the standard	
9.4	Ratio of neutral conductor cross-section to outer conductor cross-section: Outer conductor up to and including 16 mm² [The current through the neutral conductor can be influenced by significant harmonic oscillations, uneven outer conductor currents or by other conditions that require a larger conductor cross-section.]	100 %	

No.	*Functions and features specified by operator/planner*	*Standard priority design [where available][117]*	*Operator / Planner requirement[118]*
9.5	Ratio of neutral conductor cross-section to outer conductor cross-section: Outer conductor larger than 16 mm² [The current through the neutral conductor can be influenced by significant harmonic oscillations, uneven outer conductor currents or by other conditions that require a larger conductor cross-section.]	50 % (min. 16 mm²)	

11.3 Design verification

Design verification for power switchgear and controlgear assemblies and distribution boards intended to be operated by ordinary persons in accordance with IEC EN 61439, Part 2:2012-07-01 and Part 3:2013-06-01	
Type of switchgear and controlgear assembly	
Manufacturer	
Type designation/identification number	
Date of manufacture	

Section in IEC EN 61439-1	***Features to be verified***	***Possible verification through[119]***	✔
10.2	Strength of materials and parts		
		Empty enclosure according to EN 62208	
10.2.1 to 10.2.7.	General remarks for the verification: mechanical, electrical and thermal suitability in accordance with 10.2.1 to 10.2.7 (Document test results of the individual points 10.2.1 to 10.2.7)	Inspection	
		Assessment	
10.3	Protection class of enclosures [IP protection class: ……..]	Inspection	
		Assessment	
10.4	Clearance and creepage distance	Inspection	
10.5	Protection against electric shock and patency of earth conductor circuits		
	Patency of the connection between bodies of the switchgear and controlgear assembly and the protective earth circuit Maximum resistance 0.1 Ω with a test current of at least 10 A (AC or DC)	Inspection	
	Short-circuit strength of the protective earth circuit	Inspection	
		Comparison with reference design	
10.6	Installation of equipment	Assessment	
10.7	Internal circuits and connections	Assessment	
10.8	Connections for conductors inserted from outside	Assessment	
10.9	Insulation properties		
	Operating frequency dielectric strength	Inspection	
	Surge voltage strength	Inspection	
		Assessment	
10:10	Temperature-rise limits (proof of temperature-rise)	Inspection	
		Comparison with reference design	
		Assessment	

[119] Inspection and calculation results are attached to this verification

Section in IEC EN 61439-1	*Features to be verified*	*Possible verification through*[119]	✔
10:11	Short-circuit strength	Inspection	
		Comparison with reference design	
10:12	Electromagnetic compatibility	Inspection	
		Assessment	
10:13	Mechanical function	Inspection	

Inspector (Name):		Company stamp
Date:		
Place:		
Signature of inspector:		

11.4 Parts verification

Parts verification for power switchgear and controlgear assemblies and distribution boards intended to be operated by ordinary persons in accordance with IEC EN 61439, Part 2:2012-07-01 and Part 3:2013-06-01	
Type of switchgear and controlgear assembly	
Manufacturer	
Type designation/identification number	
Date of manufacture	

Section in ÖVE/ÖNORM EN 61439-1	***Features to be verified***	***Possible verification through[120]***	✔
11.2	Enclosure protection class	Visual inspection	
11.3	Creepage distance	Visual inspection	
		Measurement	
11.3	Clearance		
	Smaller than in Table 1 of EN 61439-1	Inspect	
	Not obviously larger than in Table 1 of EN 61439-1	Measurement/Inspection	
	Larger than in Table 1 of EN 61439-1	Visual inspection	
11.4	Protection against electric shock and patency of earth conductor circuits		
	Basic protection, fault protection, additional protection	Visual inspection	
	Screwed connections of earth conductor circuits	Sampling inspection	
11.5	Installation of equipment	Visual inspection	
11.6	Internal electrical circuits and connections		
	Connections of electrical circuits tightened properly	Sampling inspection	
	Wiring complies with manufacturing instructions (assembly instructions)	Visual inspection	
11.7	Compliance of connections for cables inserted from outside with assembly documents	Visual inspection	
11.8	Mechanical function	Inspect	
11.9	Insulation properties		
	Inspection of operating frequency dielectric strength	Inspection	
	Insulation measurement (only for switchgear and controlgear assemblies with overcurrent protection device up to 250 A in the supply)	Inspection	
11:10	Wiring, performance and function		
	Completeness of markings and documentation	Visual inspection	
	Functional testing in complex switchgear and controlgear	Inspection	

[120] Inspection and calculation results are attached to this verification

Section in ÖVE/ÖNORM EN 61439-1	*Features to be verified*	*Possible verification through*[120]	✔
	assemblies		

Inspector (Name):		Company stamp
Date:		
Place:		
Signature of inspector:		


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Printed in Austria (06/14)
Publication number

Grafics: SRA
DigiPics, Lithos:
Print:

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