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TECHNICAL REPORT

RAPPORT TECHNIQUE

Low-voltage switchgear and controlgear assemblies –
Part 0: Guidance to specifying assemblies

Ensembles d'appareillage à basse tension –
Partie 0: Recommandations pour la spécification d'ensembles

IEC TR 61439-0:2022-07(en-fr)

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Low-voltage switchgear and controlgear assemblies – Part 0: Guidance to specifying assemblies

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR ASSEMBLIES –

Part 0: Guidance to specifying assemblies

FOREWORD

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IEC TR 61439-0 has been prepared by subcommittee 121B: Low-voltage switchgear and controlgear assemblies, of IEC technical committee 121: Switchgear and controlgear and their assemblies for low voltage. It is a Technical Report.

This third edition cancels and replaces the second edition published in 2013. It constitutes a technical revision.

This third edition includes the following significant technical changes with respect to the previous edition:

a) alignment with IEC 61439-1:2020;
b) addition of new content in Clause 13 regarding current ratings;
c) addition of a new subclause 12.8.1 detailing the fundamentals of the forms of internal separation;
d) alignment of Annex B with Annex AA of 61439-2:2020;
e) removal of the annexes detailing items subject to agreement between specifier and manufacturer for all product parts as not all of them can always be up to date

The text of this Technical Report is based on the following documents:

Draft	Report on voting
121B/126/DTR	121B/152/RVDTR

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

The language used for the development of this Technical Report is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

The reader's attention is drawn to the fact that Annex E lists all of the "in-some-country" clauses on differing practices of a less permanent nature relating to the subject of this document.

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

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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

INTRODUCTION

Low-voltage assemblies form an integral part of most electrical distribution networks. In their application they have two prime functions:

– to safely control and distribute electrical energy; and

– to safely isolate sections of faulted networks.

Whilst these two functions place very different demands on the assembly, an assembly has to be capable of performing both these functions throughout its expected service life. Controlling and distributing electrical energy is the assembly's routine ongoing duty. The second function, fault management, is a very rare occurrence within a well-managed and maintained system. Some assemblies will never be called upon to manage a fault, but if a fault does occur, it can place immense thermal and mechanical stresses on the assembly in an instant. Any ageing or deterioration of the assembly should be limited such that its safety function is not impaired.

Due to the nature of the application, if there are weaknesses in the design or application of an assembly, it is possible they will not be identified until years after the assembly was installed. In order to avoid latent issues, and to ensure that assemblies are suitable for their application, they will be designed and verified to meet the exacting requirements defined in the IEC 61439 series of standards. However, as the IEC 61439 series covers a wide range of applications, and some applications can be partially outside the scope of the standard, it is equally important that assemblies are correctly specified. Where options are given in the IEC 61439 series, the most suitable for the application will be selected; where the requirements are outside the scope of the standards, detailed requirements will be agreed between the specifier and manufacturer.

This document identifies the significance of each characteristic to be considered when specifying an assembly and provides the specifier with guidance on defining a suitable assembly for their application.

For the purposes of this document, the specifier is the party who specifies or selects the assembly characteristics. The specifier may be the same party as the one who will use and operate the assembly, or someone acting on their behalf. The aim of this document is to provide the specifier with guidance on the specification that should be provided in order to obtain an assembly with the required performance and at optimised costs.

Throughout this document, the term "assembly" is used for a low-voltage switchgear and controlgear assembly. The term "manufacturer" refers to the assembly manufacturer unless specifically indicated otherwise.

The term "line conductor" is used in many places throughout this document. Previously the terminology was phase conductors.

This document is focussed on the specifier, that is, the person or organization providing the specification for the assembly. It is assumed the specifier is acting on behalf of the user.

The purpose of the IEC 61439 series of standards is to harmonize, as far as practicable, all the general rules and requirements that apply to assemblies. The series further seeks, in order to obtain uniformity of requirements for assemblies, consistency in the verification of assemblies and to avoid the need for verification to other standards.

All the requirements for the various assemblies that can be considered as general, together with specific subjects dedicated to performances and application, for example temperature rise, short-circuit, dielectric properties, have therefore been gathered in IEC 61439-1 as general rules. For each type of assembly only two main standards are necessary to determine all requirements and the corresponding methods of verification:

1) the standard giving the general rules designated "IEC 61439-1", and

2) the specific product part of the IEC 61439 series, hereinafter referred to as the relevant product part of the IEC 61439 series.

The IEC 61439 series of standards encompasses assemblies for a wide variety of uses, some of which have specific needs as imposed by their particular application. In order to clearly define these specific needs, relevant product parts of the IEC 61439 series focussed on a particular type of application have been (or are being) developed. These are identified as IEC 61439-2, IEC 61439-3, and so on (for a list of all parts of the IEC 61439 series, refer to the IEC web site). Each relevant product part of the IEC 61439 series with reference to IEC 61439-1, the general rules, as appropriate, specifies the characteristics and performance required by an assembly within its defined scope of application. Each relevant product part of the IEC 61439 series includes, as an annex, a template for “items subject to agreement between the assembly manufacturer and the specifier” to facilitate the specifying of an assembly.

General characteristics of all types of assemblies are considered in this document. Details which are applicable to each type of assembly can be determined by reference to the specification schedule in the relevant product part of the IEC 61439 series.

Within this document, reference to IEC 61439 means the current edition of the IEC 61439 series of standards, including:

- IEC 61439-1, *Low-voltage switchgear and controlgear assemblies – Part 1: General rules*
- IEC 61439-2, *Low-voltage switchgear and controlgear assemblies – Part 2: Power switchgear and controlgear assemblies*
- IEC 61439-3, *Low-voltage switchgear and controlgear assemblies – Part 3: Distribution boards intended to be operated by ordinary persons (DBO)*
- IEC 61439-4, *Low-voltage switchgear and controlgear assemblies – Part 4: Particular requirements for assemblies for construction sites (ACS)*
- IEC 61439-5, *Low-voltage switchgear and controlgear assemblies – Part 5: Assemblies for power distribution in public networks*
- IEC 61439-6, *Low-voltage switchgear and controlgear assemblies – Part 6: Busbar trunking systems (busways)*
- IEC 61439-7, *Low-voltage switchgear and controlgear assemblies – Part 7: Assemblies for specific applications such as marinas, camping sites, market squares, electric vehicles charging stations*

Refer to the IEC web site for the latest edition of each product part of the IEC 61439 series and additional product part of the IEC 61439 series published for other specific applications.

NOTE Each product part of the IEC 61439 series is related to the appropriate edition of IEC 61439-1, as listed in the product part, and the corresponding edition of IEC TR 61439-0.

A reference to “general rules” means a reference to IEC 61439-1:2020.

A reference to “product standard” means the relevant part or parts of the IEC standard for the components used in the assembly (e.g. IEC 60947-2 for circuit-breakers).

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR ASSEMBLIES –

Part 0: Guidance to specifying assemblies

1 Scope

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

This part of IEC 61439, which is a technical report, identifies from the specifier's perspective those functions and characteristics that are defined when specifying assemblies. It provides:

– an explanation of the assembly characteristics and options within the IEC 61439 series;
– a guidance on how to select the appropriate options and define characteristics so as to meet specific application needs; and
– an assistance in the specification of assemblies.

References within this document to the interface characteristics of an assembly and the requirements with which they will comply assume that the assembly is designed, manufactured, and verified in accordance with the relevant part of the IEC 61439 series.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61439 (all parts), *Low-voltage switchgear and controlgear assemblies*

IEC 61439-1:2020, *Low-voltage switchgear and controlgear assemblies – Part 1: General rules*

IEC 61439-2:2020, *Low-voltage switchgear and controlgear assemblies – Part 2: Power switchgear and controlgear assemblies*

IEC 61439-3, *Low-voltage switchgear and controlgear assemblies – Part 3: Distribution boards intended to be operated by ordinary persons (DBO)*

IEC 61439-4, *Low-voltage switchgear and controlgear assemblies – Part 4: Particular requirements for assemblies for construction sites (ACS)*

IEC 61439-5, *Low-voltage switchgear and controlgear assemblies – Part 5: Assemblies for power distribution in public networks*

IEC 61439-6, *Low-voltage switchgear and controlgear assemblies – Part 6: Busbar trunking systems (busways)*

IEC 61439-7, *Low-voltage switchgear and controlgear assemblies – Part 7: Assemblies for specific applications such as marinas, camping sites, market squares, electric vehicle charging stations*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in the IEC 61439 series apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

4 Application of assemblies within the IEC 61439 series

4.1 General

Assemblies manufactured in accordance with the relevant product part of the IEC 61439 series are suitable for installation in the majority of operating environments. Many of the characteristics of assemblies are fully defined within the standard and do not require further consideration by the specifier. In some instances, there can be a default condition specified within the standard and a range of other identified alternative options, from which the specifier can choose to suit the application. For other characteristics, the specifier can be required to choose from a list of options within the standard.

Specifiers are cautioned against over-specifying their requirements; it may not lead to a more appropriate assembly for their application. More onerous requirements for one criterion usually have a negative impact on others. For example, an outdoor assembly being specified to comply with IP66 of IEC 60529, when a lower IP degree, for example IP33, will suffice, can:

– increase temperatures within the assembly due to the lack of ventilation with the effect that the insulation ages more quickly;
– increase the risk of condensation causing tracking due to there being no ventilation and therefore no air exchange with the environment outside of the assembly; and
– make the assembly larger and more expensive due to the need to manage the lack of ventilation.

If special and exceptionally onerous conditions are likely to exist, these conditions should be identified by the specifier. Examples of these onerous conditions include high ultraviolet (UV) radiation applications, conditions of high particulates/pollutants, more stringent short-circuit conditions, special fault protection, special protection due to risk of fire, internal arc-faults, explosions, burns, etc.

In some instances, the specifier can wish to seek the advice of experts in order to identify their requirements correctly, for example the cross section of the neutral conductor considering the system harmonics.

Annex C is typical of the items to be agreed between the specifier and manufacturer when specifying an assembly. The equivalent annex for each product can be found in the relevant part of the IEC 61439 series. The specifier should complete the appropriate annex when defining the interface characteristics for the assembly for their particular application. An explanation of each interface characteristic is given in Clause 5 to Clause 14 inclusive.

Annex D provides guidance on optional information that a specifier may require for their specific application.

4.2 Assembly design and verification

An assembly is intended to be used within an electrical installation of defined characteristics. The assembly can be designed and verified with a specific set of application criteria, to suit a

particular use, or more usually, it can be designed and verified to meet typical application criteria that make it usable in a range of common applications.

The configuration for a particular specifier application of an assembly usually requires four main steps:

a) Specification of the requirements and functions particular to the application. The specifier should complete the table given in Annex C of the relevant product part of the IEC 61439 series.

b) The manufacturer derives the necessary interface characteristics and design of the assembly to meet the specification. The design will generally be based on the manufacturer's previously developed assembly arrangements, characteristics and functions.

c) For assemblies or parts of assemblies where the design is not previously proven, design verification is carried out by the manufacturer.

d) Routine verification, carried out on each assembly by the manufacturer.

It is essential that the specifier always insists upon assemblies that are fully verified in accordance with the appropriate product part of the IEC 61439 series. The nature of the application is such that deficiencies in an assembly design may not be initially apparent or readily identified from a cursory examination. For example:

1) The complex thermal effects within an assembly cannot be determined without formal verification (test, comparison or assessment). Operating components, particularly insulation, within an assembly at temperatures higher than intended may not cause an immediate failure but accelerated ageing of insulation can cause a premature failure.

2) Short-circuit protective devices operate rarely during the lifetime of the assembly to interrupt a fault. When some types of short-circuit protective devices interrupt a fault, they emit a hot ionized gas which can bridge clearances and/or reduce creepage distances and cause a flashover within the assembly. There can also be sudden build-up of gas pressure within the assembly that forces doors and covers to open, possibly endangering anyone in close proximity.

3) On the rare occasions that a short-circuit occurs, there are complex magnetic effects associated with high short-circuit currents. These impose substantial mechanical loads on conductor supports. The forces on the supports are affected by the shape of the conductors, bends in the conductors, proximity of conductors to each other and ferrous metalwork, phase relationships between the current in different conductors, and transient effects. All these effects are very complex and therefore difficult to determine. If not correctly addressed, conductors can pull together and create an internal arc-fault, or earthed steel housings or structural supports can be pulled onto live busbar or connections, resulting in assembly failure.

4) Voltage surges can occur due to switching, lightning and similar. Particularly those associated with lightning are random occurrences. If and when they do occur, the assembly has to offer sufficient tolerance (impulse voltage withstand) to the transient overvoltages or a flashover will occur.

   NOTE Surge protective devices can also be required to limit voltage surges. See installation rules for further details.

5) Corrosion takes time, possibly years. If sufficient protection is not offered, particularly corrosion protection of parts made of ferrous material, the life of the assembly can be reduced, and safety compromised, by, for example, reduced mechanical properties of mounting plates and/or busbar support systems, and reduced earth continuity between different constructional parts.

6) The ageing of insulating materials is mainly a function of temperature and time, but different insulating materials age at dramatically different rates for given operating conditions. When insulating materials age their mechanical, and in some instances electrical properties, degrade and can cause failures.

The issues listed above, and others, are avoided by using completely verified assemblies. In some instances, with suitable design margins, the IEC 61439 series permits the verification to be undertaken by assessment or comparison to a reference design. Where the performance is less predictable the standard insists on testing as the means of design verification.

For further information on the design and routine verification carried out by the manufacturer, see Clause 14.

4.3 Service conditions and interface characteristics

The characteristics of the assembly should be compatible with the ratings of the circuits to which it is connected and the installation conditions.

Where no specification is provided, information given in the manufacturer's documentation may take the place of an agreement between the manufacturer and the specifier.

It is assumed that the specifier will provide an electrical single line diagram, or equivalent, to define the incoming and outgoing circuit arrangements, prospective short-circuit current at the incoming terminals, loads, external conductors, and selected interface characteristics that are required for the application of a specific assembly.

4.4 Application design

Once the requirements and functions particular to the application have been specified, the manufacturer is responsible for the design of the assembly, so that it complies with the relevant product part of the IEC 61439 series. From the information provided by the specifier, the manufacturer will derive additional assembly characteristics necessary to provide an assembly that fulfils the application requirements stated. Where the specifier does not indicate particular requirements, the manufacturer may adopt their usual arrangement or the default arrangement as given in the relevant product part of the IEC 61439 series.

5 Electrical system

5.1 General

The electrical system determines the electrical characteristics (capabilities, e.g. short-circuit withstand) an assembly should have in order to perform its required duty safely for the installation. The characteristics of the assembly should at all times be at least equal to the requirements of the application and, where essential, they may exceed those offered in the standard options detailed in the IEC 61439 series.

The specifier should provide an electrical single line diagram and/or any other information necessary to define their requirements for the assembly, as detailed in 5.2 to 5.6.

5.2 Earthing system

The means of earthing a low-voltage network, when, how and where, differ depending on the installation. For a particular network, the earthing system used can be imposed by local regulation, the supply authority, legacy requirements, or the benefits of one system relative to others.

The standard configurations of earthing system are TN-C, TN-S, TN-C-S, TT and IT. Specific systems require and/or permit different solutions. For example, during the isolation of a supply for maintenance:

- in TN-C systems, the PEN conductor is not permitted to be isolated or switched, but,
- in TN-S systems and TN-C-S systems the neutral conductors may or may not be isolated or switched. The need to switch the neutral is determined by the effectiveness of the earthing