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Coordination of current ratings in low-voltage assemblies with those of the electrical installation

by Tom Mennell

Executive summary

IEC 61439-2, Edition 3, the standard for Power Switchgear & Controlgear assemblies was published in mid-2020. Recently it has been issued as BE EN IEC 61439-2 Edition 3: 2021. Many changes are included in these new documents, one very significant, the introduction of a new characteristic, 'group rated current of a main circuit of an assembly'.

This paper explains the new characteristic, 'group rated current of a main circuit of an assembly', identifies it's intent and suggests ways in which the installation designer & the assembly manufacturer can work together to achieve a cost effective assembly, without compromising the needs of the installation.

Summary

IEC 61439-2, Edition 3, the standard for Power Switchgear and Controlgear assemblies was published mid-2020. More recently it has been issued as a British Standard (BS EN IEC 61439-2: 2021) and has become the reference for all industrial and large commercial assemblies installed in the UK. The new standard will significantly change the way in which the rating of circuits within low-voltage assemblies are defined. A new characteristic the 'group rated current of a main circuit of an assembly' has been introduced.

The new characteristic in its broadest terms is essentially the current a circuit can carry when at least one other circuit in the same section is carrying a current, as defined by the assembly manufacturer. Accordingly, a given circuit can have a multitude of group rated currents, dependent on its position and the loading of adjacent circuits. This new characteristic provides a real opportunity for optimising the capabilities of a low-voltage assembly with the needs of the electrical installation. However, as always, when there is a change in established practises, the changes must be clearly understood and implemented if misunderstanding and issues are to be avoided.

In previous editions of BS EN 61439-2 it was assumed, but not clearly stated, that the specifier would define the rated current of each circuit within the assembly and the manufacturer would assume a rated diversity factor. Often it would be presumed by the assembly manufacturer it was the free air rated current of the device that was being specified; with all the vagaries this attracts. With the new approach it is recommended that the specifier details the design current for each circuit within the installation that is to be connected to the assembly, together with the characteristics of the load. In turn, the assembly manufacturer should provide, using their knowledge of the thermal characteristics of their assembly, the optimum arrangement of assembly for the application, and take full responsibility for the assembly's ability to deliver, without overheating, the defined load currents. For an assembly manufacturer to fully optimise their assembly to the application they do need more temperature rise test evidence than is necessary for basic compliance with the standard.

Of course, a specifier is at liberty to use one of the other rated currents associated with the circuits of low-voltage assemblies, but it is essential they make clear which characteristic they are using and that the requirements are fully specified. If only a simple current is stated for each circuit the assembly manufacturer will assume this is the free air rating of the device to be included in the circuit and some assumed loading factor, possibly of their definition. This is particularly important in respect of the low-voltage assembly's incoming circuit. Previously the incoming circuit had to be capable of carrying its rated current, without any diversity, when outgoing circuits were loaded. In Edition 3 of BS EN IEC 61439-2, the concept of group rated current applies equally to incoming and outgoing circuits. Just asking for a 1600A incoming circuit could result in one capable of carrying a very low current within a loaded assembly.

Correctly optimising the low-voltage assembly to the needs of the application can lead to economic benefits. In addition, as an optimised assembly is likely to use less material it can bring environmental benefits, something that is increasingly being considered.

Introduction

Edition 3 of BS IEC EN 61439-2 significantly changes the way in which the rating of circuits within low-voltage assemblies are defined. The characteristic ‘group rated current of a main circuit of an assembly’ has been introduced. Essentially this is the current a circuit can carry when at least one other circuit in the same section is carrying a current.

The new characteristic provides opportunity for much closer matching of the current carrying capacity of circuits within assemblies with the load currents in an electrical installation. However, if the optimising of the current carrying capability of an assembly with the needs of the electrical installation are to be carried out effectively and misunderstandings avoided, the electrical installation designer and the assembly manufacturer must understand their responsibilities and accordingly complete their actions. It is essential the load currents of circuits within an electrical installation are correctly determined and specified. The assembly manufacturer should then use the installation load currents specified and their knowledge of the thermal operation of their assembly to provide an arrangement of assembly that is most suitable for the application.

The electrical installation rules and the standard for low-voltage assemblies are coming closer to optimising the requirements of the installation with the capability of the assembly, but as yet the two are not full aligned. Both documents provide some guidance on marrying the needs and capabilities but there are still some grey areas that can lead to misunderstanding and issues.



This paper provides details of the new characteristic, some background into why the new characteristic is variable, the opportunities it brings and how to use it to the benefit of all parties involved. Guidance is provided on determining circuit rating together with a suggested division of responsibilities between those of the installation designer and the assembly manufacturer. The new characteristic is an opportunity to progress and improve, but it must be clearly understood and managed.

Applicable definitions and symbols

The requirements for an electrical installation, including the selection of equipment to be included in the installation in the UK are given in BS 7671: 2018, Requirements of the Electrical Installation; IET Wiring Regulations. The requirements for a low-voltage assembly to be installed in an installation are then detailed in the applicable product standard; BS EN IEC 61439-2: 2021, Low-voltage switchgear and controlgear assemblies – Part 2: Power switchgear and controlgear assemblies. BS EN IEC 61439-2 references very heavily on the general rules part of the series, BS EN IEC 61439-1. As a result, the general rules document provides the majority of requirements for power switchgear and controlgear assemblies (referred to as low-voltage assemblies throughout this paper).

Most standards include definitions and symbols, but without full coherence between different standards. Definitions and symbols from the relevant standards and pertinent to this paper are as follows:

Rated current or current setting of a protective device (I_n) (BS 7671 clause 433.11)

'For adjustable protective devices, the rated current I_n is the current setting selected.'

Design current (of a circuit) (I_b) (BS 7671, Part 2 Definitions)

'The magnitude of the current (rms value for AC) to be carried by the circuit in normal service'

Note: the symbol I_B is used for I_b in IEC documents and British Standards that adopt the content of IEC standards.

Rated current of an assembly (I_{nA}) (BS EN IEC 61439-1, clause 3.8.10.7)

'rated current which can be distributed by an assembly without the temperature-rise of any of the parts exceeding specified limits

Note 1 to entry: The rated current of the assembly is not to be exceeded if further circuits are added in the future.'

Group rated current of a main circuit (I_{ng}) (BS EN IEC 61439-1, clause 3.8.10.6)

'rated current which a main circuit can carry considering the mutual thermal influences of the other circuits that are simultaneously loaded in the same section of the assembly

Note 1 to entry: I_{ng} can equal I_{nc} in some designs of assembly.

Note 2 to entry: An assembly can comprise only a single section.'

Rated current of a main circuit (I_{nc}) (BS EN IEC 61439-1, clause 3.8.10.5)

'rated current which a main circuit can carry when it is the only main circuit within a section of an assembly that is carrying current

Note 1 to entry: The rated current of a main circuit can be lower than the rated currents of the devices installed in the main circuit, according to the respective device standards.

Note 2 to entry: Due to the complex factors determining the rated currents, no standard values can be given.

Note 3 to entry: An assembly can comprise of only a single section.'

Applicable definitions and symbols (continued)

Rated diversity factor (RDF) (BS EN IEC 61439-1, clause 3.8.11)

'value, calculated by dividing the group rated current of an outgoing main circuit I_{ng} by the rated current I_{nc} of the same outgoing main circuit, where I_{ng} and I_{nc} are derived by test

Note 1 to entry: RDF therefore represents the per unit value of I_{nc}, to which two or more outgoing circuits in the same section of an assembly can be continuously and simultaneously loaded taking into account the mutual thermal influences.

Note 2 to entry: For a group of circuits that are continuously and simultaneously loaded, the rated current of a circuit (I_{nc}) multiplied by the rated diversity factor (RDF) normally is not less than the design current (I_b) of the circuit normally provided by the user i.e. $I_{nc} \times RDF \geq I_b$.'

Rated current (rating defined in relevant product standard) (I_n) (BS EN 60947-1, clause 3.10)

Within BS EN 61439-1 this is assumed to be the free air rating of the device under defined conditions in accordance with the devices product standard, e.g. BS EN 60947-2 for a circuit breaker.

NB: I_n in accordance with BS 7671 is often a different value to I_n in accordance with BS EN IEC 61439-2.

Requirements given in the standards

As the standard for the electrical installation and that for low-voltage assemblies have evolved, some guidance on matching the assembly to the installation has been included, but thus far this is not complete and does not fully enable optimising the assembly to electrical installation without further consideration. Today the applicable standards provide guidance on matching the requirements of the electrical installation to the assembly, as follows:

1. BS 7671

Clause 636.4.202 states; 'The relevant design current shall not exceed the rated current of an assembly (I_{nA}) or rated current of a circuit (I_{nc}) of the associated assembly, having taken any applicable diversity/loading factors into account.'

2. IEC TR 61439-0

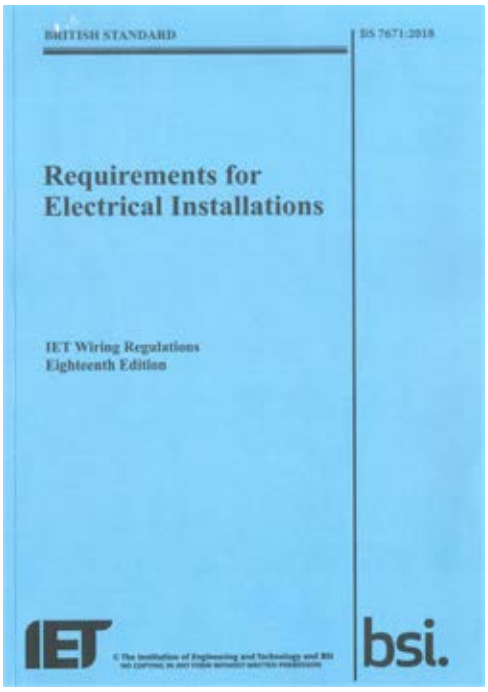
Whilst BS EN 61439-2 provides some guidance on matching assembly circuit current ratings to those of the electrical installation, IEC TR 61439-0: 2021; Low-voltage switchgear and controlgear assemblies – Part 0: Guidance to specifying assemblies, is more comprehensive.

Note: at the time of publication of this paper, IEC TR 61439-0: 2021 has been approved for publication and is awaiting publication by IEC.

Clause 13.1 of IEC TR 61439-0 states; 'Where the circuits are not loaded continuously and simultaneously and the adjacent circuit(s) is/are not fully loaded at the same time, I_b should not be greater than the rated current of the circuit (I_{nc}), that is $I_{nc} \geq I_b$. Where adjacent circuits are continuously loaded the group rated current of a circuit of an assembly, (I_{ng}) should be at least equal to I_b, ($I_{ng} \geq I_b$).'

Requirements given in the standards (continued)

Both of these documents are very clear that I_b should never exceed I_{nc}, and the latter document that with adjacent circuits loaded to I_{ng}, I_b for the circuit being considered should not exceed its I_{ng}. However, neither is clear on how to optimise the loading of circuits in the most likely scenario where circuits are not fully loaded for the majority of the time, some may be intermittently loaded, others on a duty/standby cycle, etc.



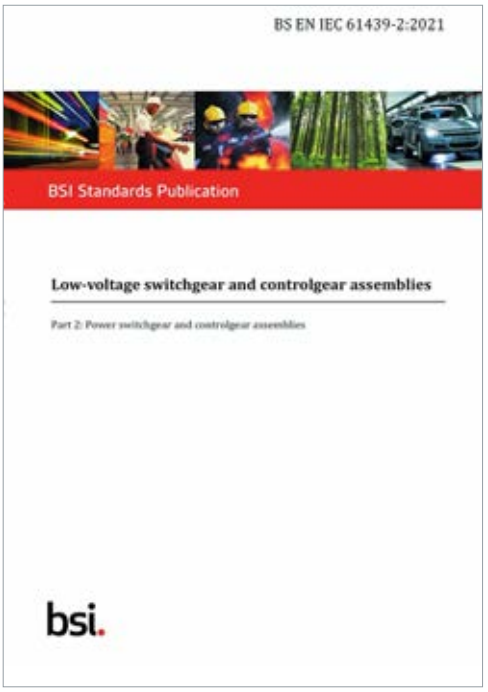


Figure 1
Applicable standards

Loading principles

A number of principles outlined within, or associated with, the applicable standards apply to the loading of circuits within low-voltage assemblies and electrical installations. These need to be understood in the context of the standards being considered.

1. Cyclic loading

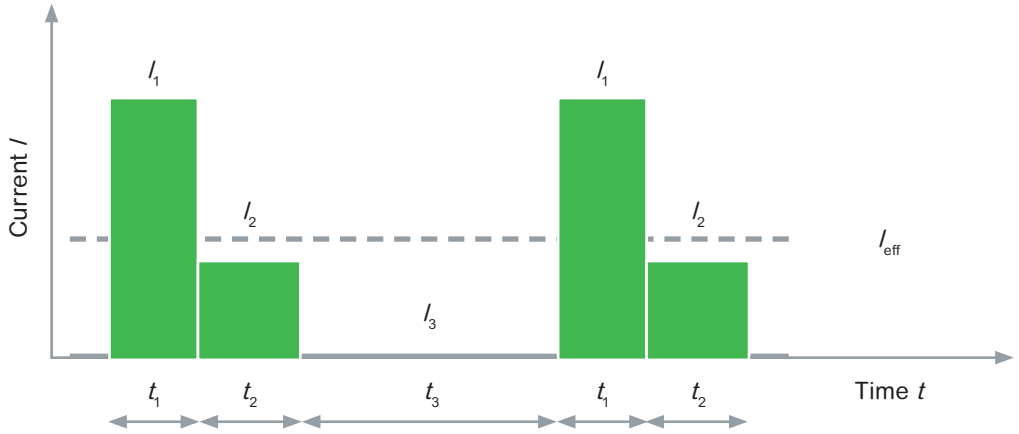
Many processes lead to cyclic loads, for example, metal presses, moulding machines.

Cyclic loading and the concept of a thermal equivalent current being considered as I_b is recognised in Regulation 533.2.1 of BS 7671, but without any guidance on how to determine the thermal equivalence. The Commentary of the IET Wiring Regulations provides a little more insight. This indicates that when the maximum current is not sustained for a long period, the thermal equivalent current is the sum of the squares of the current over the cyclic period. No OFF period is required in the cycle and no

Loading principles (continued)

indication is given of the total length of the cycle when considering switchgear.

Informative Annex I in BS EN IEC 61439-1 provides more specific guidance. For predictably varying loads, when the ON time does not exceed 30 minutes and the OFF time is longer than the ON time, the thermally equivalent current is as given in Figure 2:



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

Key

I_{eff}	Thermal equivalent current equal to I_b
t_1	Starting time at current I_1
t_2	Run time at current I_2
t_3	Interval time at $I_3 = 0$
$t_1 + t_2 + t_3$	Cycle time

Figure 2
Cyclic load current

BS EN IEC 61439-1 and BS 7671 together with its commentary do not provide definitive requirements that must be adhered to. The information given is for guidance only and can be adjusted to suit the particular circumstances.

Limiting the ON time to 30 minutes and requiring the OFF time to be greater than the ON time, as suggested in BS EN IEC 61439-1, can be conservative, particularly when considering circuits with higher rated currents. Also, a cycle with high current for a short time followed by a low current for a long time and no OFF period will result in a thermally equivalent current that is much lower than the high current; and which can be considered as equivalent to I_b for the purposes of the design of a low-voltage assembly.

Loading principles (continued)

In addition, an assembly manufacturer may know sufficient about the thermal behaviour and time constant of their equipment to; extend the cycle time beyond that given in BS EN IEC 61439-1; consider other cyclic current profiles, etc., when determining suitable thermal equivalent currents consistent with the assembly being provided.

Regardless of the profile of the cycle, care is always necessary to ensure any peak current does not cause the overload protective device to operate as a result of the high current part of the cycle.

2. Intermittent loads

Some loads are intermittent, for example, moving an air bridge at an airport. These circuits require a significant current for a short period, several minutes, and then negligible current for a period of hours or days. In such cases I_b can only be based up the short-term significant current.

3. Peak currents

The characteristics of some loads are such that they demand an inrush current for a few cycles when they are energised, for example, transformers and motors when they are started direct-on-line. Generally, such inrush current can be ignored when determining I_b unless the inrush occurs very frequently; as can be the case with a motor subjected to a plugging and inching duty.



4. Group rated current

BS EN IEC 61439-1 defines the group rated current of a main circuit of an assembly as detailed above. This is amplified in clause 5.3.3 where it is stated; ‘The group rated current of a main circuit is the current that can be carried by this circuit when it is loaded continuously and simultaneously together with at least one other circuit in the same section of the assembly, in a specific arrangement as defined by the original manufacturer.’

Loading principles (continued)

When defining the I_{ng} for a specific circuit, as a minimum, one other circuit within the same section must be assumed to be carrying an unspecified current. There are no requirements given for the relative rating or position of the two circuits. As a result, each design of circuit can have a multitude of values of I_{ng}, depending on the arrangement and loading of the circuits within the same section.

5. Diversity

Diversity is a term frequently used within BS 7671, but it is not clearly defined. Generally, in respect of an electrical installation, it is a term used to recognise that not all circuits are continuously fully loaded at the same time, but how it is determined and applied is not specified.

BS EN IEC 61439-1 uses the same term and is more specific in the context of a low-voltage assembly. It is defined as a calculated value where, RDF = I_{ng}/I_{nc} when I_{ng} and I_{nc} have been established by test. As I_{ng} can be established on the basis of an individual circuit and the loading arrangement of circuits in the same section, RDF can be a multitude of values for any given circuit.

6. Assumed loading

In the absence of other information, BS EN IEC 61439-2 permits, but does not mandate, an assembly manufacturer to assume that the loading on each circuit is the rated current of the protective device, I_n, (in accordance with BS EN IEC 61439-1) multiplied by the assumed loading factor given in Table 1.

Table 1

Values of assumed loading

Type of load	Assumed loading factor
Distribution – 2 and 3 circuits	0,9
Distribution – 4 and 5 circuits	0,8
Distribution – 6 to 9 circuits	0,7
Distribution – 10 and more circuits	0,6
Electric actuator	0,2
Motors ≤ 100 kW	0,8
Motors > 100 kW	1,0

NB: In most cases RDF and assumed loading are not the same value since RDF and assumed loading are functions of I_{nc} and I_n, respectively.

Current rating associated with low-voltage assemblies

Ratings associated with circuits within a low-voltage assembly is a very complex matter. Without testing and/or the addition of significant safety margins it is very difficult to determine assured ratings and performance.

The rated current of a device in free air, I_n, will be as declared by the device manufacturer. However, the margin, if any, in the current rating I_n, of a device is unlikely to be known; usually a device manufacturer will only confirm it conforms to the product standard.

The rated current of a circuit within an assembly, I_{nc}, includes all the variables associated with I_n together with those of; the mounting attitude of the device, the means of enclosing the device including size of compartment, ventilation, connections from the device to the busbars and busbar temperature, etc.

When the group rated current of a circuit of an assembly, I_{ng}, is considered more complexities are introduced. All the variable associated with I_{nc} apply plus the mutual heating effects caused by one or more circuits in the same section carrying some current as defined by the assembly manufacturer.

Figure 3 shows the results of temperature rise tests with constant current and only two variables, (i) the position of the circuit within the section, and (ii) the IP rating of the enclosure. The temperature rise of the circuit in the bottom compartment is little more than two thirds of those in the upper compartment, creating the opportunity for the circuits at the bottom of the section to have a much higher I_{ng}. With a constant load current equal to I_{ng} on each circuit the variation in I_{ng} for the circuits due to position within the section can typically be as shown in figure 4.

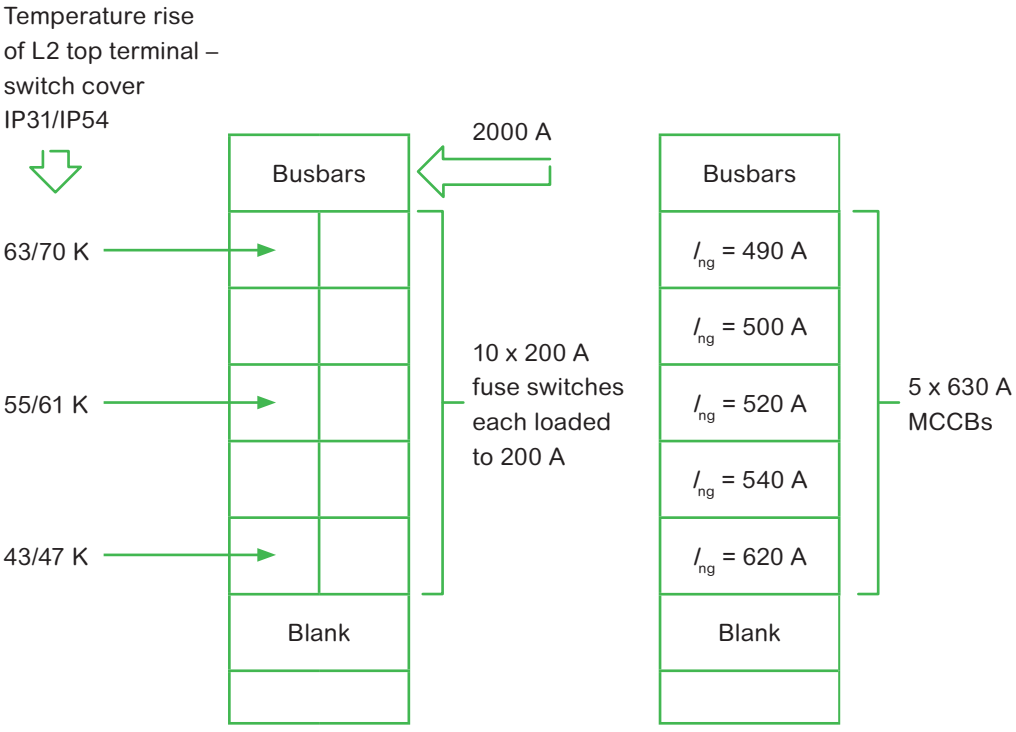


Figure 3 (left)

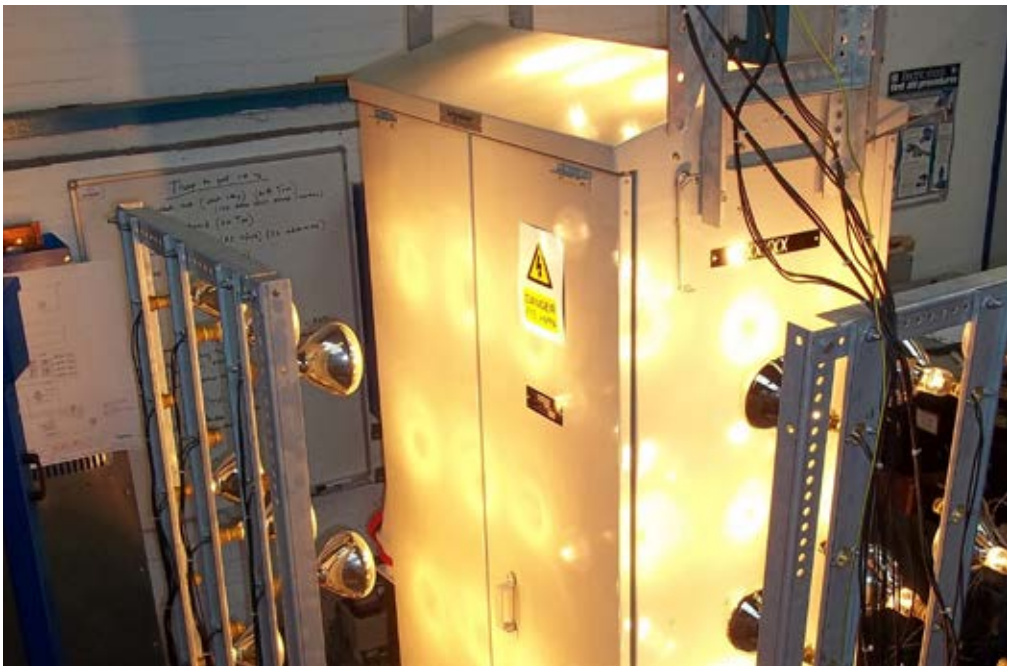
Temperature rise distribution in a section as determined by test

Figure 4 (right)

Variations in I_{ng} resulting from position within the section.

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Current rating associated with low-voltage assemblies (continued)



Figures 3 and 4 only consider a very limited number of variables. When others are introduced such as different rating circuits, devices with different thermal margins, types of load, etc. the possible group ratings of circuits are endless. There is no simple and accurate way of relating I_n to I_{ng}. BS EN IEC 6149-1 (and similarly the American UL standards) suggest when using calculations to verify temperature rise performance of an assembly, I_{ng} is equal to 80% of I_n. This at times is very conservative, but on other occasions the derating is far from sufficient.

When considering the three-current rating, I_n, I_{nc} and I_{ng}, associated with a circuit within an assembly, all three can have the same value, but this is very unlikely as the effects of enclosing a device and mutual heating lead to different values. Figure 5 illustrate the likely relative ratings.

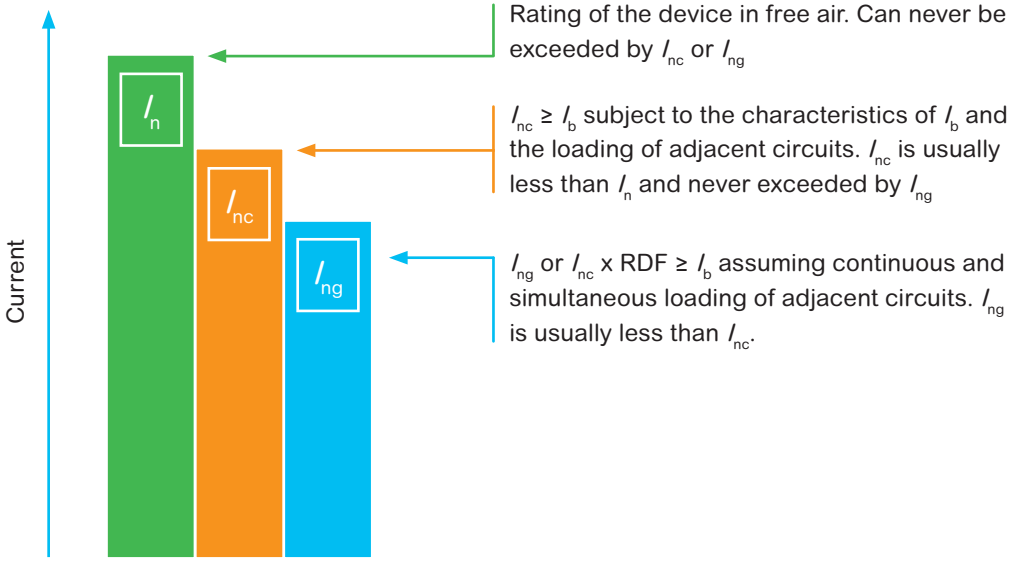


Figure 5

Relative values of current ratings associated with a circuit within an assembly

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Manufac-turer's obligations and options

In accordance with BS EN IEC 61439-1 and 2 an assembly manufacturer is obliged to declare either the group rated current of each main circuit, I_{ng}, or the rated current of each circuit, I_{nc}, and the RDF. If I_{ng} is established and declared the assembly manufacturer does not have to declare I_{nc}. When I_{ng} is declared this cannot be just the rated current of the circuit, the loading of adjacent circuits, and possibly the position of the circuit, for which the rating I_{ng} applies must also be given. Due to the thermal distribution within a section it is likely an assembly manufacturer will declare a higher I_{ng} when a circuit is in the bottom compartment of a section.

There are several ways in which the data the assembly manufacturer is obliged to provide can be obtained and presented; some are more conservative than others. Table 2 summarise the common options.

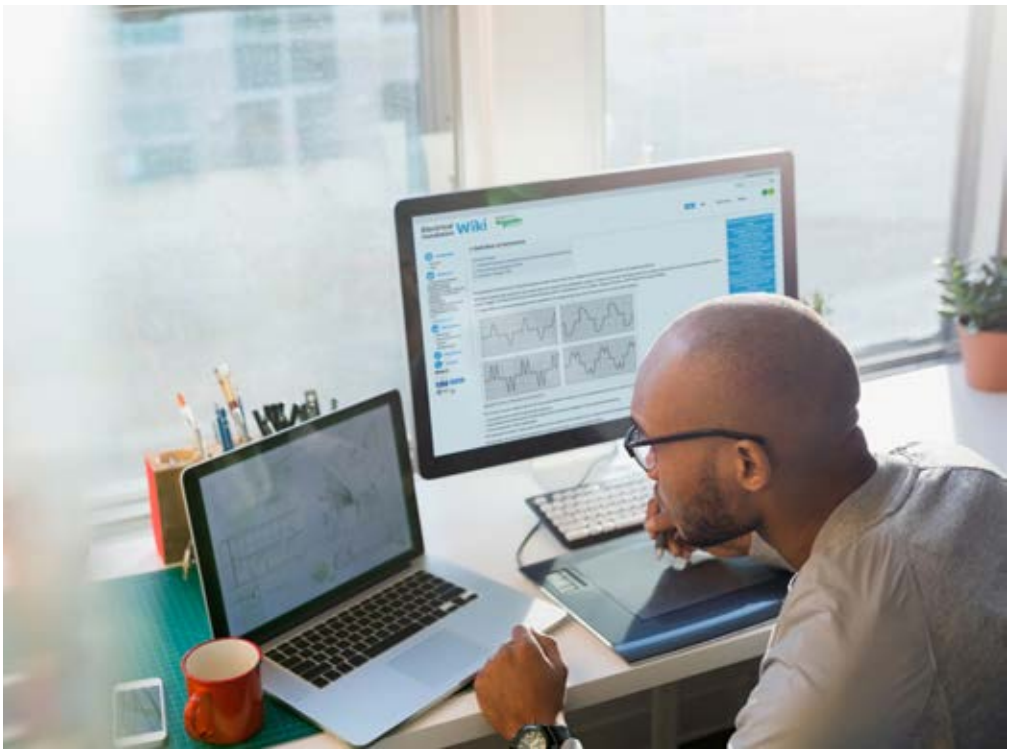
Option	Approach	Assembly manufacturer's specification	Remarks
Historical data	Temperature rise verifications in accordance with BS EN 61439-1 and 2: 2011 established the rated current for each circuit, I_{nc}, and an RDF for each section and/or each assembly.	When I_{nc} and RDF are known for each type of circuit, the assembly manufacturer calculates and declares I_{ng} for each type of circuit and the conditions under which it applies as an RDF for each section and/or each assembly. (I_{ng} = I_{nc} x RDF)	The assembly manufacturer knows the I_{nc} for each type of circuit. At their discretion it can be declared and used to optimise loading of the assembly.
Generalised approach	Assembly manufacturer conducts temperature rise verification considering a 'worst case' arrangement and the assumed loading given in BS EN IEC 61439-2.	Assembly manufacturer declares I_{ng} as the current used in the tests for each type of circuit and the conditions under which it applies as an assumed loading factor for each section and/or each assembly. (I_{ng} = I_n x Assumed loading factor)	Without further design verification I_{nc} is not available to enable optimisation of loading of the assembly.
Optimised approach	Assembly manufacturer conducts temperature rise verifications considering section arrangements and loadings they have defined. The assembly manufacturer also determines I_{nc} for each type of circuit.	Assembly manufacturer declares I_{ng} for each type of circuit and the detailed conditions under which it applies. For example: a) For a given type of circuit I_{ng} = 'X' A when the circuit is in the bottom compartment of a section and 'Y' A in any other position. b) For a given type of circuit in any position, I_{ng} = 'Z' A when all other circuits in the same section are not simultaneously loaded to more than 50% of I_n.	A given design of circuit can have a multitude of I_{ng} values depending on the sec tion arrangement and the loading of other circuits in the same section. As the assembly manufacturer has established I_{nc} it is available to aid further optimisation of loading within the assembly.

Table 2

Possible options for declaring rated currents

Installation designer's obligation

In accordance with BS 7671 the installation designer has to establish a design current for each circuit. When applicable, this should take into account cyclic loading and the determination a thermal equivalent current, I_b.



Guidance for specifiers

IEC TR 61439-0 provides the following guidance for specifiers:

a) Preferably, the design current, I_b, for each circuit connected to the assembly together with any known loading arrangements for groups of circuits, e.g. circuit not fully loaded at the same time, should be included in the assembly specification.

b) The specific current rating specified for each circuit, I_b, I_{ng}, I_{nc} or I_n should be clearly identified in the assembly specification. If not, the assembly manufacturer will assume it is I_n that is being specified.

c) If device ratings, I_n, are specified or assumed, devices with the same I_n from different assembly manufacturers and/or they are installed in different enclosure systems will result in differing values of I_{nc} and I_{ng} being provided for the same specification.

d) When I_n without further details, rather than I_b, is specified, the assembly manufacturer may assume continuous loading values as given in Table 2.

Matching the assembly to the installation design current

The simple approach is to ensure $I_{ng} \geq I_b$. However, this can lead to a conservative arrangement of assembly for many applications. Some circuits may be only intermittently loaded, some may deliver a low current for the majority of the time, but have to be sized on the basis of a high current for a short time, some may only be delivering load at night while others are only loaded during the day, other circuits may be in duty/standby pairs, etc.

To take account of these variables requires a detailed knowledge of the applications and the capabilities of the assembly. If a heavy load current is delivered for a short period, e.g up to 30 minutes and then negligible load to several hours it is safe to allow the design current to be equal to the rated current of the circuit, $I_{nc} \geq I_b$. More difficult to determine is when it is safe to allow the design current to be greater that the group rated current due to the adjacent circuit being lightly loaded at the same time.

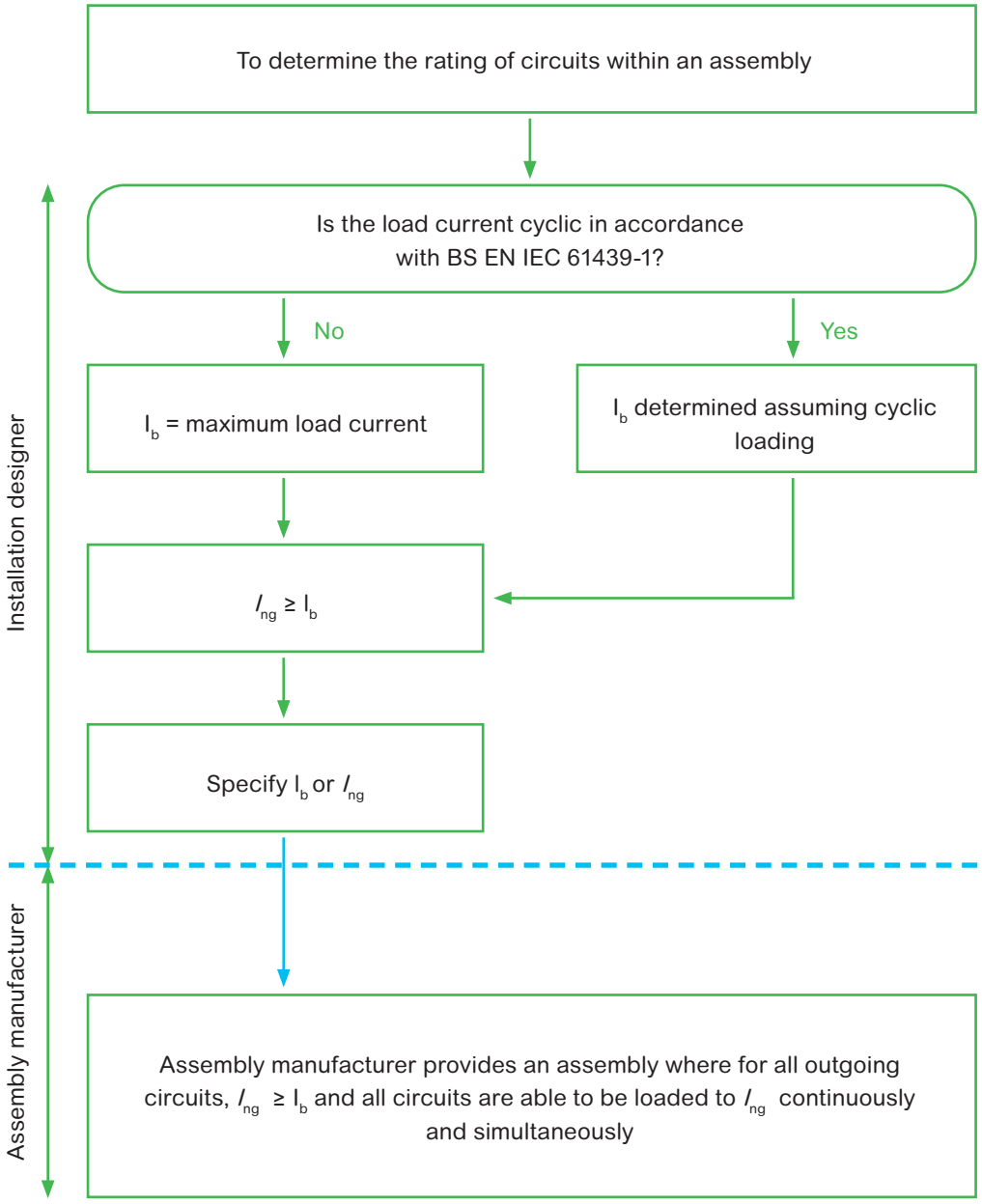
What can be considered as light loading to the extent where it will allow I_b to be greater than I_{ng} is very dependent on the design of assembly and the thermal margins, if any, of the circuit to be heavily loaded. If an assembly manufacturer has suitable detailed test results available, they may be able to use this data in optimising the assembly design.

With so many variables, fully optimising every assembly is not practical. It requires time and a lot of detailed interaction between the installation designer and the assembly manufacturer. In some instances, a more pragmatic and/or conservative approach is expedient. The following outlines three possible approaches with a division of responsibilities between the installation designer/specifier and the assembly manufacturer.

Matching the assembly to the installation design current (continued)

1. Conservative approach

Flow chart 1 shows how to the determine and specify the rating of circuits within an assembly with minimal knowledge of the assembly and consideration of the characteristics of the loads.



Flow chart 1

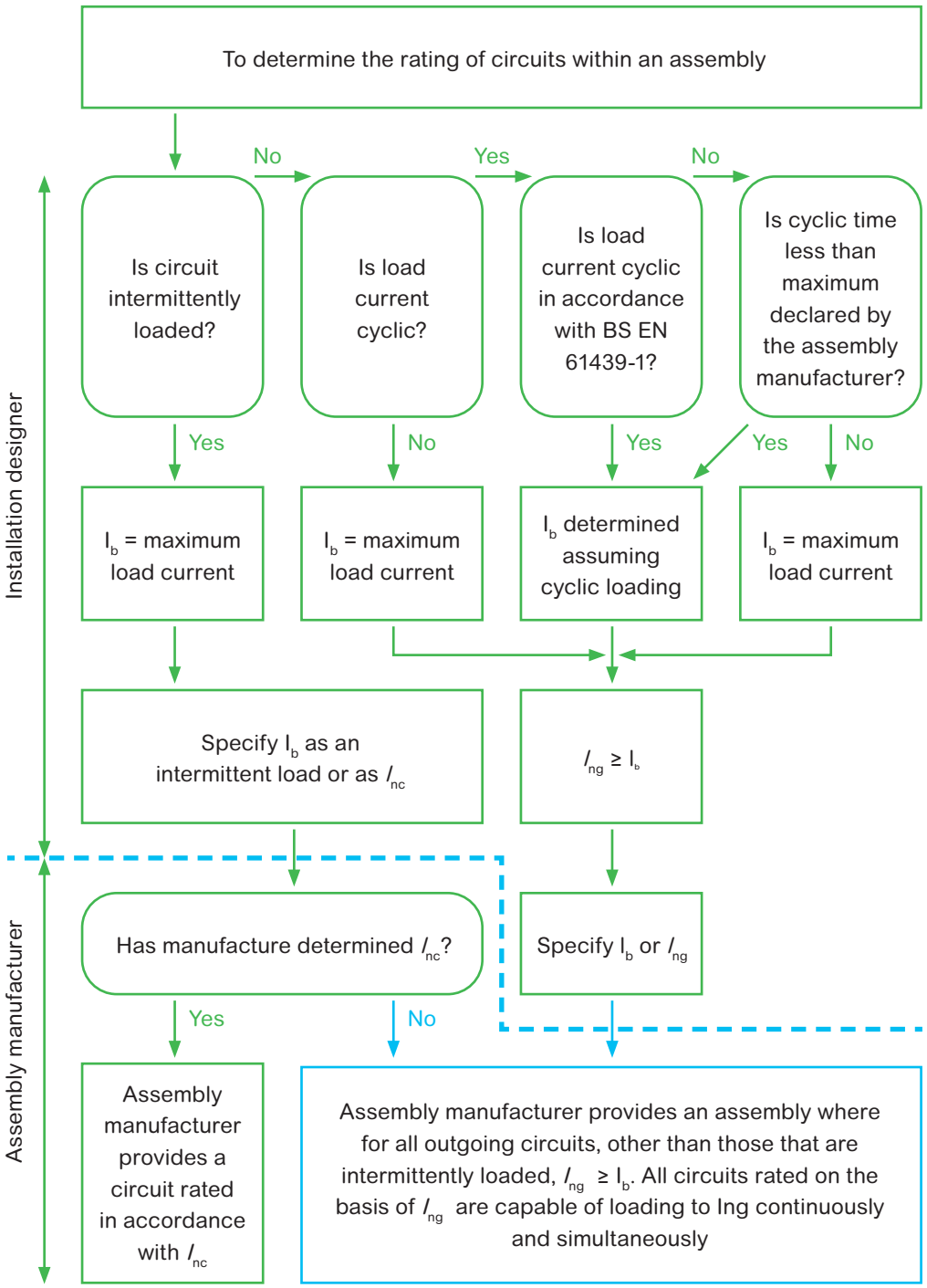
Conservative approach to specifying the rating of circuits within an assembly

Minimum rated current of the assembly I_{nA} = Maximum sum of the design current of all the circuits that are loaded simultaneously

Matching the assembly to the installation design current (continued)

2. Pragmatic approach

Flow chart 2 shows an approach with some of the conservatism removed.



Flow chart 2

Pragmatic approach to specifying the rating of circuits within an assembly

Minimum rated current of the assembly I_{nA} = Maximum sum of the design current of all the circuits that are loaded simultaneously

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Matching the assembly to the installation design current (continued)

3. Optimised approach

To more fully optimise the rating of circuits within an assembly with the requirements of the electrical installation requires a more detailed knowledge of the installation and of the thermal behaviour of the assembly. In addition, the arrangement of the assembly and the position of a circuits relative to all the other circuits must be known. The arrangement of the assembly and relative position of circuits is usually determined by the assembly manufacturer when engineering the assembly.

Determining which circuits should be based on I_{ng} and which can operate at the higher current I_{nc} is best approached in a tabular format with input from both the installation designer and the assembly manufacturer, as shown in Table 3.

Installation designer					Assembly Manufacturer[c]	
Circuit	I_b determined as in the pragmatic approach (A)	Circuit intermittently loaded (Y/N)	Load profile[d]	Adjacent circuits lightly loaded[a] (Y/N)	Circuit rating I_{ng} or I_{nc}[b]	Comments
Incoming	1305	N		N	I_{ng}	
Outgoing No. 1	368	N	Continuous	N	I_{ng}	Must be in bottom compartment
Outgoing No. 2	93	Y	10 minutes on, off for a minimum of 2 hours	N	I_{nc}	
Outgoing No. 3	695	N	Reduces to 230A 6:00PM to 6:00AM	N/A	I_{nc}	Only circuit in section.
Outgoing No. 4	78	N	6:00PM to 6:00AM only	Y	I_{nc}	
↓						
Outgoing No. N	23	N	Continuous	N	I_{ng}	

[a]Determining if the adjacent circuits can be considered as lightly loaded depends on the arrangement of the assembly and the thermal margin in the particular circuit being considered. The assembly manufacturer is not obliged to provide this data.

[b]A circuit can operate with a load current of I_{nc} if the circuit is intermittently loaded or the adjacent circuits are lightly loaded.

[c]The installation designer may determine the arrangement of the assembly and complete these columns if they have sufficient knowledge of the assembly being considered.

[d]Installation designer to provide details of load profile, e.g. duty/standby for a pair of circuits, day or night loading, 100% load between 7:00AM and 10:00AM, not more than 50% load at all other times.

Table 3

Optimised loading of assemblies

Minimum rated current of the assembly I_{nA} = Maximum sum of the design current of all the circuits that are loaded simultaneously

Matching the assembly to the installation design current (continued)

4. Specifying the rated current of a device I_n

In the foregoing 3 methods of determining and specifying the rating of circuits within an assembly, the rating of the devices I_n has not been mentioned. The rating of a device, or more specifically the protection setting or the fuse link rating is very important in respect of protection coordination for the circuit, but if used alone to specify the rating of a circuit (and this is the assumed rating if nothing else is specified) it can lead to many different ratings for the circuit within the assembly. The assembly manufacturer is not mandated to use the assumed loading factors given in Table 1. They can declare values of their choosing.

If a specifier wishes to specify I_n to minimise adverse effects on the protection coordination for a circuit, it should be qualified with the assumed loading factor they have used when designing the installation.

5. Specifying the rating of the incoming circuit(s) of an assembly

The defining of the rating of the incoming circuit(s) of an assembly requires particular attention. BS EN IEC 6439-2 permits it to be given a group rated current, I_{ng}, exactly the same as the outgoing circuits. If only a rated current is stated, the assembly manufacturer will assume this is I_n, and define their own I_{ng} for the incoming circuit, alternatively they can apply the assumed loading factor from Table 1 to I_n. For an assembly with 10 or more distribution circuits the assumed loading factor is 0.6, leading to an incoming circuit within the assembly having a rated current of 60% of the device rating. It is unlikely a rating this low is that expected.

Specifiers should make clear the rating required for the incoming circuit. For example, if the incoming circuit from a 1000kVA transformer is required to match the usual overload capability of the transformer and be able to carry 1600A for several hours, the rating should be specified as I_{ng} or alternatively I_b for the incoming circuit as 1600A.



Summary of the methods of determining and specifying the rating of circuits within assemblies

The outcome from the three approaches outlined to defining the ratings within installations can be summarised as shown in Table 4.

Circuit	Specification	Assembly
Outgoing circuits: fully optimised	Define I_b for each circuit together with details of loading, e.g. continuous/intermittent, load profile with timing.	Enables the assembly manufacturer to use their knowledge of the design of the assembly and put forward the most competitive arrangement for the application.
Outgoing circuits: pragmatic rating.	Specify; 1. I_b for each outgoing circuit and identify any that are intermittently loaded; or, 2. I_{ng} for each circuit deemed to be continuously loaded where I_{ng} is at least equal to I_b and I_{nc} for intermittently loaded circuits.	Considers intermittently loaded circuits and cyclic loading as defined in BS EN IEC 61439-1 and BS 7671. However, if the assembly manufacturer has not determined I_{nc}, over-rated circuits rated in accordance with I_{ng} must be provided for intermittently loaded circuits.
Outgoing circuits: conservative rating.	Specify; 1. I_b for each outgoing circuit; or 2. I_{ng} for each circuit where I_{ng} is at least equal to I_b; or, 3. I_n together with an assumed loading factor.	Quick approach that leads to a margin in the assembly rating in most applications.
Incoming circuits	Specify I_b or I_{ng} or I_n with an assumed loading factor.	Essential to be clear on the rating of incoming circuits if misunderstandings are to be avoided.

Table 4

Summary of methods of determining and specifying the rating of circuits within an assembly

Clearly there are benefits to be gained with the new approach to defining current ratings within assemblies. To take full advantage of this the installation designer needs to provide more details of the load current than has been the norm previously and to avoid any misunderstandings it is essential the specifier makes clear which current they are detailing in their specification.

References

BS EN IEC 61439-1: 2020; Low-voltage switchgear and controlgear assemblies, Part 1: General Rules

BS EN IEC 61439-2: 2020; Low-voltage switchgear and controlgear assemblies, Part 2: Power switchgear and controlgear assemblies.

IEC 61439-0: 2020 draft; Low-voltage switchgear and controlgear assemblies, Part 0: Specifiers guide.

IEC 60947-1: 2020; Low-voltage switchgear and controlgear, Part 1: General rules.

IEC 60947-2: 2020; Low-voltage switchgear and controlgear, Part 2: Circuit breakers.

Commentary on the IET Wiring Regulations: 17th Edition.

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