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My background

- Electrical industry for many years
- Installing within residential, commercial, agricultural and industrial environments
- Marketing & Product management covering Motor Control Gear and Automated Systems
- Marketing & Product management covering Electrical Distribution Systems
- Designing and testing Three-Phase and Single-Phase assemblies



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The importance of 61439 series within BS7671 Relating to

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR ASSEMBLIES –

**Part 3: Distribution boards intended to be operated
by ordinary persons (DBO)**



What are BS EN 61439 series of regulations

BS EN 61439 Series	Low-voltage switchgear and control gear assemblies	Applicable to:
PD IEC TR 61439-0: 2013*	Guidance to specifying assemblies	Users and specifiers
BS EN 61439-1: 2011	General rules	Reference document for low voltage assemblies
BS EN 61439-2: 2011	Power Switchgear and Controlgear (PSC) assemblies	Switchboards, Panel boards and Motor Control Centres
BS EN 61439-3: 2012	Distribution boards intended to be operated by ordinary person (DBO)	Consumer units and Distribution boards
BS EN 61439-4: 2013	Particular requirements for assemblies for construction sites (ACS)	Assemblies for temporary supplies
BS EN 61439-5: 2015	Assemblies for power distribution in public networks	Feeder pillars, fuse cabinets and fuse boards
BS EN 61439-6: 2012	Busbar trunking systems (busways)	Busbar trunking
IEC TS 61439-7:2014	Assemblies for specific applications such as marinas, camping sites , market squares, electric vehicles charging stations	Assemblies in public locations

Scope of 61439-3

This part of IEC 61439 defines the specific requirements for **D**istribution **B**oards intended to be operated by **O**rdinary persons (**DBO**). DBOs have the following criteria:

- Intended to be operated by ordinary persons (e.g. switching operations and replacing fuse-links), e.g. in domestic (household) applications;
- Outgoing circuits contain protective devices, intended to be operated by ordinary persons, complying e.g. with IEC 60898-1, IEC 61008, IEC 61009, IEC 62423 and IEC 60269-3;
- Rated voltage to earth does not exceed 300 V a.c.;
- Rated current (Inc) of the outgoing circuits does not exceed 125 A and the rated current (InA) of the DBO does not exceed 250 A;
- Intended for the distribution of electrical energy;
- Enclosed, stationary;
- For indoor or outdoor use.
- DBOs may also include control and/or signaling devices associated with the distribution of electrical energy.
- This standard applies to all DBOs whether they are designed, manufactured and verified on a one-off basis or fully standardised and manufactured in quantity.
- DBOs may be assembled outside the factory of the original manufacturer.
- This standard does not apply to individual devices and self-contained components, such as circuit breakers, fuse switches, electronic equipment, etc. which will comply with the relevant product standards.
- This standard does not apply to the specific types of assemblies covered by other parts of IEC 61439.

Definitions

Low voltage switchgear and controlgear assembly. Combination of one or more low voltage switching devices together with associated control, measuring, signalling, protective, regulating equipment, with all the internal electrical and mechanical interconnection and structural parts (see **BS EN 61439-1**)

From this point BS EN 61439 series of regulations are mentioned approximately 40 times in BS7671.

412: PROTECTIVE MEASURE: DOUBLE OR REINFORCED INSULATION

412.2.1.1 Electrical equipment shall be of the following types, **type-tested and marked to the relevant standards:**

- (i) electrical equipment having double or reinforced insulation (Class II equipment)
- (ii) electrical equipment declared in the relevant product standard as equivalent to Class II, such as assemblies of electrical equipment having total insulation (see **BS EN 61439** series).

NOTE: This equipment is identified by the symbol  refer to BS EN 60417: Class II equipment

421.1.201 Within domestic (household) premises, consumer units and similar switchgear assemblies **shall comply** with *BS EN 61439-3* and shall:

- (i) have their enclosure manufactured from non-combustible material, or
- (ii) be enclosed in a cabinet or enclosure constructed of non-combustible material and complying with Regulation 132.12. – (accessibility)

NOTE: Ferrous metal, e.g. steel, is deemed to be an example of a non-combustible material



422.5 Fire propagating structures

NOTE 3: Boxes and enclosures according to *BS EN 60670-1* and *BS EN 61439* series for use in hollow walls can be used

530.4 Fixing of equipment



530.4.2 Unenclosed equipment shall be mounted in a suitable mounting box or enclosure in compliance with the relevant part of BS EN 60670, BS EN 62208 or other relevant standards such as [BS EN 61439 series](#)

The unenclosed equipment will be devices to BS EN 60898, 61009, 61008, 62606 etc..

Socket-outlets, connection units, plate switches and similar accessories shall be fitted to a mounting box complying with BS4662 or BS 5733 and with the relevant part of BS EN 60670



536.4.5 Low voltage assemblies according to BS EN 61439 series

The **interface characteristics** of an assembly conforming to BS EN 61439 series shall be compatible with the ratings of the circuits to which it is connected and with the installation conditions. The characteristics of the assembly shall be declared by the manufacturer, taking into account the interface characteristics of the relevant BS EN 61439 product standard.

5.2 Voltage ratings

- 5.2.1 Rated voltage (U_n) (of the assembly)
- 5.2.2 Rated operational voltage (U_e) (of a circuit of an assembly)
- 5.2.3 Rated insulation voltage (U_i) (of a circuit of an assembly)
- 5.2.4 Rated impulse withstand voltage (U_{imp}) (of the assembly)

- 5.4 Rated diversity factor (RDF)
- 5.5 Rated frequency (f_n)

5.3 Current ratings

- 5.3.1 Rated current of an assembly (I_nA)
- 5.3.2 Rated current of a main outgoing circuit (I_{nc})
- 5.3.3 Group rated current of a main circuit (I_{ng})
- 5.3.4 Rated peak withstand current (I_{pk})
- 5.3.5 Rated short-time withstand current (I_{cw}) (of a main circuit of an assembly)
- 5.3.6 Rated conditional short-circuit current (I_{cc}) (of an assembly or a circuit of an assembly)

Assemblies, A Type Consumer units, B Type Distribution Boards, Switchboards etc. are designed and tested to BS EN 61439 to meet specific installation demands.

Residential installs will generally be nominal 230V : 63A, 80A or 100A fused incoming supplies. Typically populated with protection devices supplying final circuits, socket, lighting, cooker, showers.... And devices tested will be the devices selected for each type of circuit. Assembly (I_nA) 100A. Groups of circuits, RCCBs with a number of outgoing MCBs as an example.



5.6 Other characteristics

The following characteristics shall be declared:

- a) additional requirements depending on the use of a functional unit (e.g. type of coordination, overload characteristics);
- b) pollution degree of the macro-environment (see 3.6.10.2);
- c) types of earthing system for which the assembly is designed;
- d) indoor and/or outdoor installation (see 3.5.1 and 3.5.2);
- e) stationary or movable (see 3.5.3 and 3.5.4);
- f) degree of protection against contact with hazardous live parts, ingress of solid foreign bodies and water, IP code (see 8.2.2);
- g) intended for use by ordinary or authorized persons (see 3.7.16 and 3.7.17);
- h) electromagnetic compatibility (EMC) classification (see Annex J);
- i) special service conditions, if applicable (see 7.2);
- j) external design (see 3.3);
- k) degree of protection against mechanical impact, IK code, if applicable (see 8.2.1);
- l) type of construction – fixed or removable parts (see 8.5.1 and 8.5.2);
- m) type of short-circuit protective device(s) (see 9.3.2);
- n) measures for protection against electric shock;
- o) overall dimensions (including projections e.g. handles, covers, doors), if required;
- p) weight, if required



And more..... Its not just any box to put devices in

DBO Assembly tests to BS EN 61439

Design and test standards

Not just an Enclosure		
BS EN 61439-1 (3)		
No.	Characteristic to be Verified	Clause / subclause
1	Strength of material and parts	10.2
	Resistance to Corrosion	10.2.2
	Properties of Insulating Materials	10.2.3
	Thermal stability	10.2.3.1
	Resistance to abnormal heat and fire due to internal electric effects	10.2.3.2
	Resistance to ultra-violet (UV)	10.2.4
	Lifting	10.2.5
	Mechanical Impact	10.2.6
	Marking	10.2.7
2	Degree of protection of Enclosure	10.3
3	Clearances	10.4
4	Creepage distances	10.4
5	Protection against electric shock and integrity of protective circuits	10.5
	Effective continuity between the exposed conductive parts of the	10.5.2
	Exposed conductive parts of the assembly and the protective circuit	
	Short-circuit withstand strength of the prospective circuit	10.5.3
6	Incorporation of switching devices and components	10.6
7	Internal electrical circuits and connections	10.7
8	Terminals for external conductors	10.8
9	Dielectric properties	10.9
	Power-frequency withstand voltage	10.9.2
	Impulse withstand voltage	10.9.3
10	Temperature-rise limits	10.1
11	Short-circuit withstand strength	10.11
12	Electromagnetic compatibility	10.12
13	Mechanical operation	10.13
11A	Additonal test: Verification to withstand 16kA fault	10.11.5

BS7671 identifies short circuit requirements for the **DBO**

536.4.201 Fault current (short-circuit) ratings

The relevant fault current (short-circuit) rating of the assembly should be equal to or exceed the maximum prospective fault current at the point of connection to the system.

The terminology used to define the short-circuit rating of an assembly is given in the [BS EN 61439 series](#) as follows:

Icw – withstand, Ipk – peak, Icc - conditional

The assembly manufacturer's ratings and instructions shall be taken into account.

For an installation with a 230 V single-phase supply rated up to 100 A that is under the control of ordinary persons, switchgear and controlgear assemblies shall either comply with [BS EN 61439-3](#) having a suitable fault current (short-circuit) rating for the maximum prospective fault current at the point of connection to the system or be a consumer unit incorporating components and protective devices specified by the manufacturer complying with [BS EN 61439-3](#), **including the 16 kA conditional short-circuit test described in Annex ZB of the standard.**

NOTE: When the single-phase PSCC value of 19.6 kA is cited from Engineering Recommendation P25, the 16 kA conditional rating described in Annex ZB of [BS EN 61439-3](#), for incoming service equipment, will satisfy design requirements where the service cable is at least 2 metres in length

Important note. Generally the protective devices within the consumer MCBs, RCBOs, AFDDs for residential installs will have.

1. Rated ultimate short-circuit breaking capacity (icu) & 2. Rated serviceable short-circuit breaking capacity (ics) 6kA or 6000A breaking capacity.

Where PSCC values are equal to or less than 6kA (6000A) the protective devices installed will clear the fault.

If the PSCC is higher than 6kA and below 16kA, the protective devices may not clear the fault without damage. As such the installation cannot be signed off as safe.

Options open are. Install 10kA protective devices. If the CU has also been tested with these device, or by substitution the manufacturer can prove the performance is identical to previous tested device/s. Or if the PCSS is just over 6000A increasing the length of tails will increase impedance and reduce PSCC.

Example a 6.7kA PCSS could be reduced to under 6kA on 25mm tails by adding extra 5 meter length of tails, or SWA. appropriately supported to avoid movement.

Maximum PSCC can be determined by measurement or by calculation

536.4.202 Current ratings

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.

BS EN 61439 series terminology used (I_{nA}) Maximum design load & (I_{nc}) maximum circuit load with devices

From initial assembly verification, devices may need derating of (I_n) when used within an assembly

During the verification process, rated diversity factor (RDF), will be used and stated by each manufacturer for individual circuits or groups of circuits.

Heat rise verification / testing 61439 -3

- 3 Methods. 1. **Verification** of complete assembly where the functionality and loading is identical every time
3. **Verification** individual functional units and the main and distribution busbars separately as well as the complete assembly.

Method 2. 10.10.2.3.6 **Verification** considering individual functional units separately and the complete assembly

The group rated currents, I_{ng} , rated currents, I_{nc} , of outgoing circuits shall be verified in two stages:

- 1 individual Functioning Units.
- 2. The complete assembly with most onerous configuration/s tested.
- Sufficient test sets shall be created containing all variations of outgoing devices.

Devices to consider. MCB, RCBO, AFDD, RCCBs timers, contactors, etc.. Heat generating, cable connection points

Each assembly variation shall be tested at Full load rating... maximum heat dissipated through every assembly tested.

Every device must be tested adjacent to all device ratings to determine thermal influence

All tests are performed to an assembly using the RDF associated with the number of outgoing ways.

Rated Diversity Factor: RDF

It can be confusing for designers at times as well

Table 101. Same table number

But from differing specific standards.

Part 3 has attributed specific RDF factor for DBOs for use by ordinary persons.

BS EN 61439-3

Table 101 – Values of assumed loading

Number of outgoing circuits	Assumed loading factor
2 and 3	0,8
4 and 5	0,7
6 to 9 inclusive	0,6
10 and above	0,5

BS EN 61439-2

Table 101 – 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 or more circuits	0,6
Electric actuator	0,2
Motors ≤ 100 kW	0,8
Motors > 100 kW	1,0

The RDF is specifying the "average" loading conditions for which the assembly is designed.

The rated diversity factor confirms the per unit value of rated current (I_{nc}) to which outgoing circuits, within the assembly can be continuously and simultaneously loaded.

Note: RDF only applies to continuously and simultaneously loading circuits. In principle this means adjacent circuit breakers having a load 'on' time exceeding 30 minutes or where a load not exceeding 30 minutes has an 'off' time less than the 'on' time will need to have the rating diversity factor applied as indicated by the manufacturer within data sheets. This will generally be the RDF as indicated on previous slide

With this in mind, circuits of continuous current of say 30A. May require an over current protective device rated at 63A if placed within a consumer unit with 10 or more outgoing circuits.

The expectation might exist for the protective device to function continuously at the nominal rating (I_n). Lighting circuits loading with LEDs is low. Socket circuits have in the most part intermittent loads.

Showers... unless its one of my daughters will have an on time of less than 30 minutes.

Immersion heaters, could feasibly be on for 1.5 to 3 hours for the heating process and many are only turned on when required. This may lead to a 16A overcurrent protection device overheating within an assembly.

EV final circuits & PV supplies will have similar issues if the overcurrent protection device is located within the residential consumer unit. *(note, manufacturer to advise on specific loading for specific final circuits)*

From BS61439-3

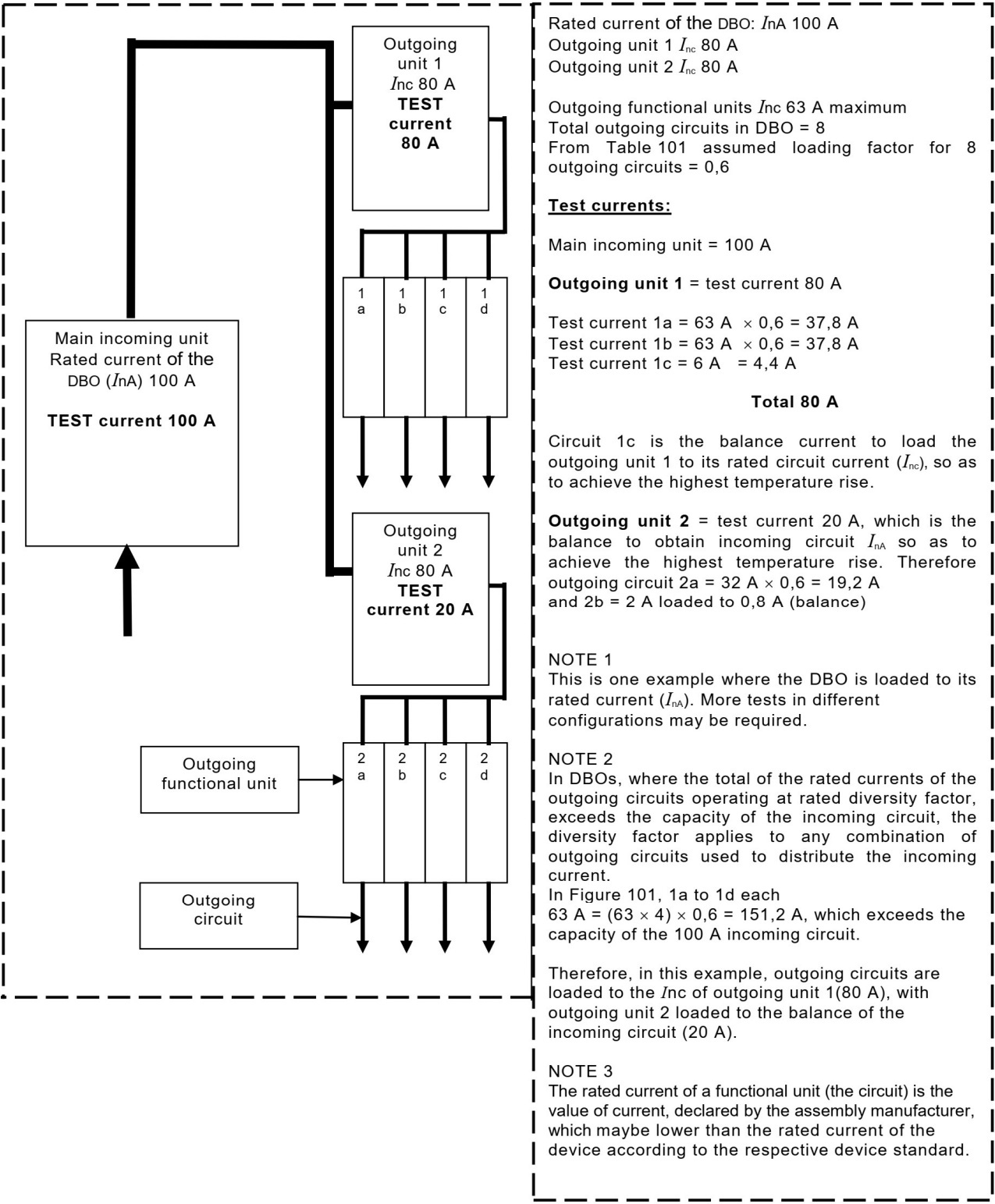
Figure 101 – Example of temperature rise verification by test of a complete DBO as in 10.10.2.3.6

Considers a dual split load Consumer unit as an example

Outgoing Circuit 1 (group Ing) loaded to the rating of RCCB in this instance 80A, Could be 63A or 100A.

Point of note: 100A RCCBs in this configuration can only be loaded to 80A to meet Regulations 314 division of circuit

Applied RDF for this test configuration would be 0.6. outgoing final circuits between 6 to 9



536.4.203 Integration of devices and components

The relevant part of the [BS EN 61439 series](#) shall be applied to the integration of mechanical and electrical devices and components, e.g. circuit-breakers, control devices, busbars into an empty enclosure or existing low voltage assembly.

In low voltage assemblies to the [BS EN 61439 series](#), e.g. consumer units, distribution boards, incorporated devices and components shall only be those declared suitable according to the assembly manufacturer's instructions or literature.

NOTE 1: The use of individual components complying with their respective product standard(s) does not indicate there compatibility when installed with other components in a low voltage switchgear and controlgear assembly.

NOTE 2: Incorporated components inside the assembly **can** be from different manufacturers. It is essential that all incorporated components should have had their compatibility for the final enclosed arrangements **verified by the original manufacturer** of the assembly and be assembled in accordance with their instructions e.g. the consumer unit, distribution board manufacturer.

The original manufacturer is the organization that carried out the original design and the associated verification of the low voltage switchgear and controlgear assembly to the relevant part of the [BS EN 61439 series](#).

If an assembly deviates from its original manufacturer's instructions, or includes components not included in the original verification, **the person introducing the deviation becomes the original manufacturer with the corresponding obligations**

Key take aways from 61439 relating to BS7671

1. Consumer unit Assemblies all shall be tested to 61439-3 Annex ZB A-deviations 16kA conditional short circuit
 - 1.1. PSCC higher than 6kA and lower than 16kA must not be ignored.
2. Rated Diversity factors (RDF) are used when testing all DBOs.
 - 2.1. See each manufactures RDF for each consumer unit. Devices have not been tested at FLC. And may not be capable of carrying FLC within an assembly.
3. Regulation 536.4.203: Integration of devices and components. Do not install devices from alternative manufacturer in any DBO, consumer unit. Connection points may not enable safe connection. May impact on adjacent devices by thermal effect. If this happens. The installer is now responsible for design and testing of the assembly.
4. All consumer units must meet BS EN 61439-3 and relevant parts from BS EN 61439-1 to be installed within residential, commercial, agricultural and Industrial applications.
5. When considering the integration of PV, Battery storage & EV consider the affects on the consumer unit. And consult the manufacturer of the consumer unit regarding the suitability of “EV charger manufacturers” recommended overcurrent protective device. Is a 40A device OK at > 0.5 RDF for over 30 minute period

Part 7 Special Locations



construction

Caravan and
Camping



704.511.1: All assemblies on construction and demolition sites for the distribution of electricity shall be in compliance with the requirements of [BS EN 61439-4](#)

708.55.1.7: Switchgear and controlgear assemblies used in caravan/tent pitch supplies shall comply with the requirements of [BS EN IEC 61439-7](#)

710.511.1: Distribution boards shall meet the requirements of [BS EN 61439 series](#).

712.511: Distribution boards and switchgear assemblies shall comply with [BS EN 61439 series](#)



Medical

722.511: Where an EV charging point is built into a low voltage switchgear or controlgear assembly the requirements of the relevant part of [BS EN 61439 series](#) shall apply



PV & EV



Consumer unit Meets 18th edition wiring regulations

No consumer unit meets BS7671 18th edition wiring regulations

BS7671 wiring regulation compliance is determined by meeting the regulations for the complete install.

The installer must 1st determine the design criteria for each circuit.

Then select the assembly capable of enabling the protection of the installation

Verified to BS EN 61439 series of standards in this case BS EN 61439-3





Any
Questions?