

Low Voltage Switchgears Rulebook



Chapter-1 Introduction

www.eaeelektrotechnik.com

Table of Contents

1.	General Introduction	4
2.	Terms and Definitions	6
3.	Distribution of Responsibilities	8
4.	Design Aids	18
5.	Documentation	22

1 General Introduction

1.1 PanelMaster Type Tested Low Voltage Switchgears

PanelMaster low voltage switchgears are designed to fulfill different needs in various applications. It's unique structure and flexible modules are type tested and certified by internationally accepted laboratories.



General Introduction

1.2 Technical Data

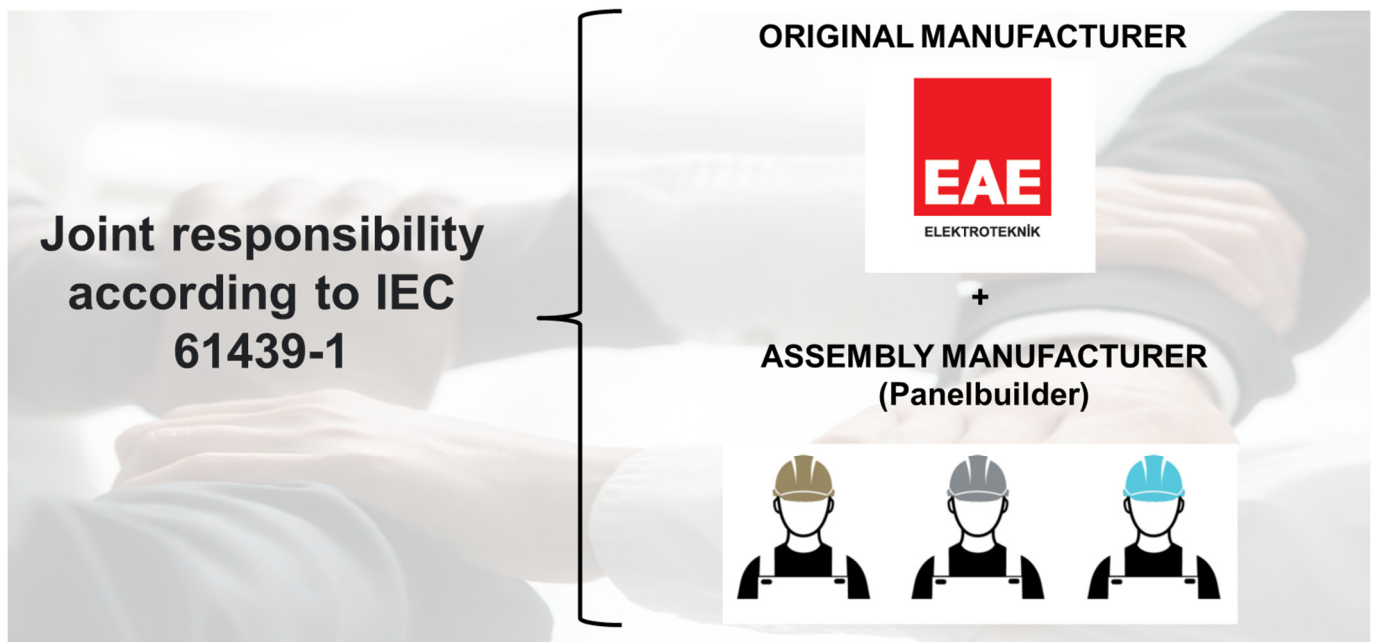
Electrical Data	Rated voltages	Rated operating voltage U_e	690 V AC, 3 Ph.
		Rated insulation voltage U_i	1000 V AC
		Rated impulse withstand voltage U_{imp}	up to 12 kV
		Rated frequency	up to 60 Hz
	Rated currents	Main Busbars:	
		Rated current I_n	up to 6800 A
		Rated peak withstand current I_{pk}	up to 264 kA
		Rated short-time withstand current I_{cw}	up to 120 kA / 1 s.
		Internal arc	Passive, 65 kA / 0,3 s.
Distribution Bars (MCC Unit):			
Rated current I_n		630 A / 1250 A	
Rated peak withstand current I_{pk}		105 kA	
Rated short-time withstand current I_{cw}	50 kA / 1 s.		
Mechanical Characteristics	Dimensions	Fixed Module Compartment	
		Height	2000, 2200 mm
		Width	300, 400, 500, 600, 700, 800, 1000 mm
		Depth	600, 800, 1000, 1200 mm
		Withdrawable Module Compartment	
		Height	2000, 2200 mm
		Width	600 mm
		Depth	600, 800, 1000, 1200 mm
		Cable Compartment for MCC	
		Height	2000, 2200 mm
	Width	400, 500, 600, 800 mm	
	Depth	600, 800, 1000, 1200 mm	
	Enclosure	Frame	Pre-galvanized, RAL 7035 painted
Cover, Door		Pre-galvanized, RAL 7035 painted	
Degrees of protection		IP41, IP54, IP55	
Internal separation		up to Form-4b	
Environmental Characteristics	Ambient conditions	Location type	Indoor
		Ambient air temperature (Operation)	-5 °C to +40 °C
		Maximum relative humidity	5 %-90 %
		Altitude	up to 2000 m
		Degree of pollution	3
Standards		Low voltage switchgear and controlgear assemblies Power switchgear and controlgear assemblies	IEC 61439-1 and 2
		Internal arc	IEC/TR 61641
		Seismic verification	IEC 60068-3-3 and IEEE-93/2005
Test Certificates		DEKRA Certification B.V., Arnhenm / Netherland	
		VIRLAB, S.A. Asteasu / Spain	

2 Terms and Definitions

With their industry-leading features and design capabilities PanelMaster fixed and withdrawable type low voltage switchgears provide solutions for today's most demanding power distribution and motor control applications. Besides superior product features and capabilities PanelMaster's customer support service enable implementation and operation quicker, easier, and more reliable.

PanelMaster customer support and implementation system consists of two important actors which are EAE as "original manufacturer" and our panelbuilder partner, the "assembly manufacturer", as described in IEC 61439-1 and 2. Even though the standard describes responsibilities of both manufacturers precisely this rulebook clarifies these in more detail with practical perspective.

In addition to responsibilities of panelbuilder partner which are mandatory with respect to IEC 61439-1 and 2 there are complementary PanelMaster inspection system rules to be followed by the panelbuilder partner. Aim of this rulebook is to clarify all responsibilities of our panelbuilder partners.



Terms and Definitions

Original Manufacturer

organization that has carried out the original design and the associated verification of an assembly in accordance with the relevant assembly standard.

(IEC 61439-1, Clause 3.10.1)

Assembly Manufacturer

organization taking the responsibility for the completed assembly .

Note 1 to entry: The assembly manufacturer may can be the same or a different organization to the original manufacturer.

(IEC 61439-1, Clause 3.10.2)

User

party who will specify, purchase, use and/or operate the assembly, or someone acting on their behalf

(IEC 61439-1, Clause 3.11)

Specifier

person or organization providing the specification for the assembly; it is assumed the specifier is acting on behalf of the user.

(IEC TR 61439-0, Clause 3.11)

Distribution of Responsibilities

3.1 EAE Responsibilities

As the “original manufacturer” of PanelMaster switchgear EAE has carried out the original design and associated verification in accordance with IEC 61439-1 and 2.

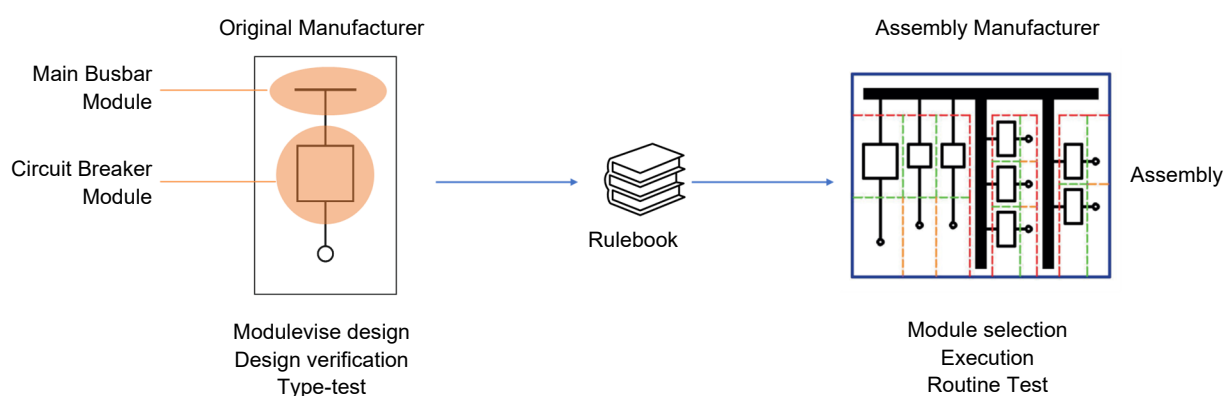
EAE has designed groups of comparable modules like functional units, selected the critical variant from the group for test and verified these with devices of different manufacturers by testing individually. All design verifications and their certification have been carried out in accordance with IEC 61439-1 and 2. Design rules are then applied to assign ratings to other circuits that are similar to critical variants tested.

This document, “PanelMaster Rulebook” describes design rules of PanelMaster switchgear which shall be followed by our panelbuilder partners.

PanelMasterPro design software, developed for assisting in the design of PanelMaster switchgears and appropriate product selection, is available to panelbuilders. For more details see Page 18.

EAE is inspecting each and every manufactured PanelMaster switchgear prior to shipment that it complies with its design rules. More details about PanelMaster inspection system are available in document “PanelMaster Inspection Guide”.

Customer-specific (non-repeating design)



Distribution of Responsibilities

3.2 Responsibilities of Panelbuilder Partner

As the “assembly manufacturer” of PanelMaster switchgear our panelbuilder partners are taking the responsibility for the completed assembly according to IEC 61439-1 and 2.

In addition, PanelMaster panelbuilder partners are responsible for conforming to EAE specific rules which are not described in the standards, like “not mixing different manufacturer brand devices in the same assembly” etc.

For specific business cases when PanelMaster inspection system is not demanded by the user or specifier, panelbuilders can use E-Kabin branded assemblies which have been certified for complying to IEC 61439-1 and 2.

Our panelbuilder partners can assemble and sell E-Kabin branded switchgears, type tested according to IEC 61439-1 and 2 under their own responsibility. In this case they are obliged to design and implement E-Kabin switchgears by referring to this PanelMaster Rulebook.

First of all, our panelbuilder partners shall strictly follow the rules and procedures described in IEC 61439-1 and 2, such as “Routine test” procedure. Therefore, in-depth knowledge of these standards is prerequisite.

Additionally, our panelbuilder partners shall follow design rules described in PanelMaster Rulebook and apply them during their manufacturing process knowing that any imperfection will result in wasted time during inspection process.

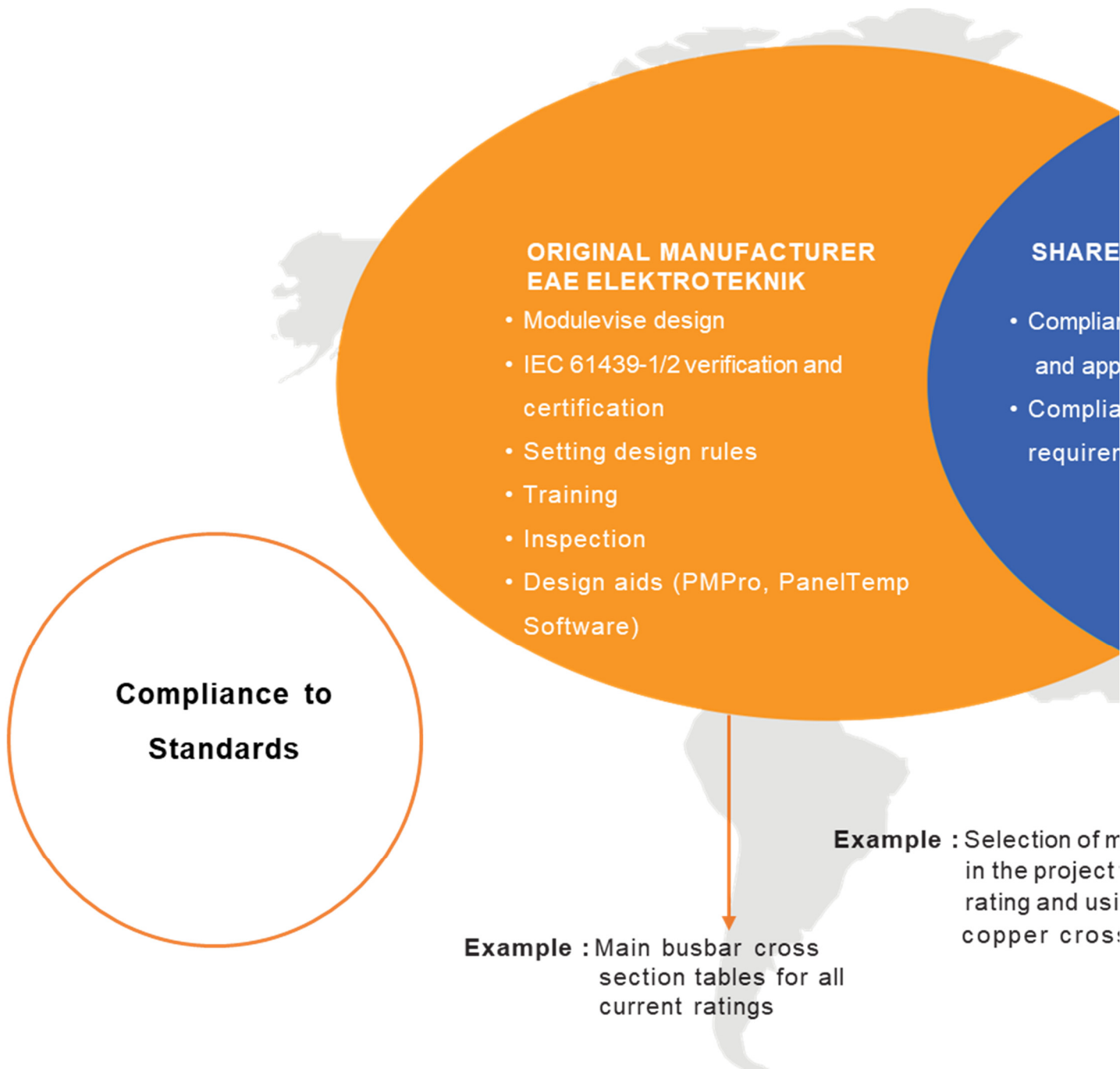
In the case of design modification or device integration that have not been type-tested in PanelMaster switchgear system “verification assessment method” according to IEC 61439-1 must be applied by the panelbuilder partner. Respective calculation documentation shall be prepared and presented.

PanelTemp temperature rise calculation (according to IEC 60890) and reporting software is available to panelbuilders. For more details see Page 20. In practice reactive power compensation and some motor drive assemblies are in this scope.

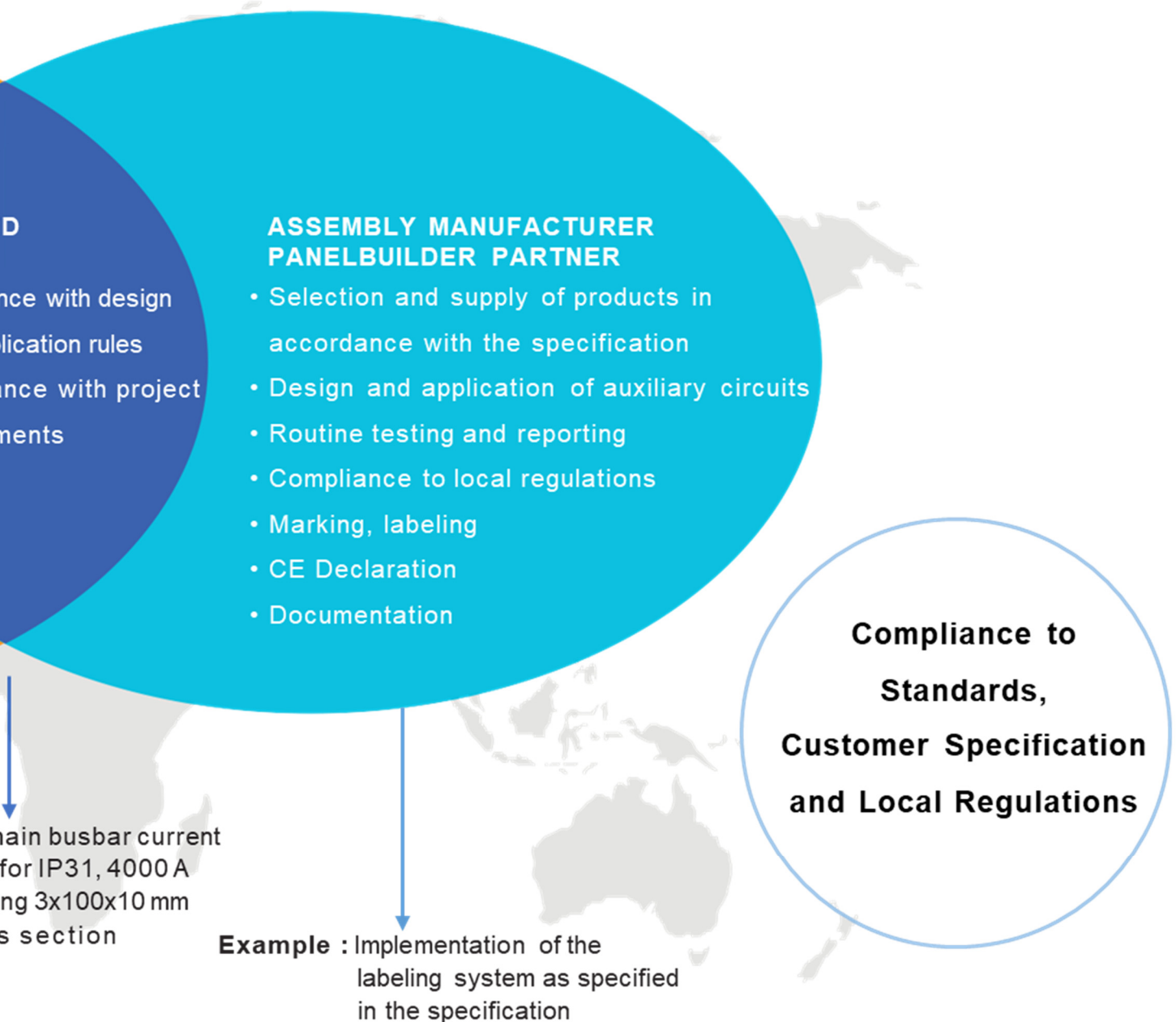
Most importantly, carrying the responsibility of the completed assembly, our panelbuilder partners shall design and manufacture according to the specifications given by the “user” or client. The term “user” is defined in IEC 61439-1 as “party who will specify, purchase, use and/or operate the assembly, or someone acting on their behalf”.

Compliance with local regulations and customer-specific specifications must be achieved by the panelbuilder. In case of a discrepancy with the PanelMaster rules, technically best option shall be preferred. The following documents regarding the switchgear shall be provided by panelbuilder:

- Declaration of conformity (CE Declaration)
- Routine verification report
- User manual integrated components (may be as online links)
- Wiring diagram



Distribution of Responsibilities



3.3 Responsibilities of User or Specifier

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.

Technical report IEC 61439-0 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 IEC 61439-0 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.

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.

Unless otherwise specified or not specified at all default arrangement as detailed in IEC 61439-2 will apply see Table-1.

Table-1 is typical of the items to be agreed between the specifier or end user and manufacturer when specifying an assembly.

Distribution of Responsibilities

Factory Acceptance Test (FAT) is the process in which the manufacturer tests the switchgear in presence of the user before it is delivered. The purpose is to ensure that the switchgear meets the requirements that were ordered by the end user. FAT is to be conducted at the manufacturer's facility and may include functional testing and performance testing. During the FAT, faults and problems can be identified and rectified before handover to the end user takes place. FAT is usually conducted by the assembly manufacturer, with customer representatives present to witness and verify the tests. Before shipping the switchgear, both parties must agree on the functionality of the equipment.

Unless otherwise specified or not specified at all storage, transportation, assembly, and commissioning of PanelMaster switchgear, must be carried out in accordance with the rules specified by the original manufacturer, EAE. See Chapter-9 and Chapter-10 for more details.

The consulting engineer, specifier, installer and/or end user is responsible for compliance with all applicable laws and local regulations including building codes etc. relating to the application, installation, and operation of this product.

In principle below given informations must be provided by the end user or specifier:

- Electrical system characteristics
- Short-circuit withstand capability
- Current carrying capacity
- Installation environment
- Installation method
- Storage and handling conditions

PanelMaster panelbuilder partners carries the responsibility to inform (and warn—if necessary) the end user or specifier for followings:

1. Transportation and Storage Conditions (referring Chapter-9)
2. Installation, Erection and Maintenance (referring Chapter-10 and Chapter-8 if seismic protection is specified)

3.4 Table-1 : Items subject to agreement between the assembly manufacturer and the user

Characteristics	Reference	Default arrangement ^a	Options listed in standard ^b	User requirement ^c
Electrical system				
Earthing system	5.6, 8.4.3.1, 8.4.3.2.3, 8.6.2, 10.5, 11.4	Manufacturer's standard, selected to suit local requirements	TT / TN-C / TN-C-S / IT / TN-S	
Nominal voltage of the supply system (V)	3.8.9.1, 5.2.1, 8.5.3	Local, according to installation conditions	Max 1 000 V AC or 1 500 V DC	
Transient overvoltages	5.2.4, 8.5.3, 9.1, Annex G	Determined by the electrical system	Overvoltage category I / II / III / IV	
Temporary overvoltages	9.1	Nominal system voltage + 1 200 V	None	
Rated frequency f_n (Hz)	3.8.12, 5.5, 8.5.3, 10.10.2.3, 10.11.5.4	According to local installation conditions	DC/50 Hz/60 Hz	
Additional on-site testing requirements: wiring, operational performance and function	11.10	Manufacturer's standard, according to application	None	
Short-circuit withstand capability				
Prospective short-circuit current at supply terminals I_{cp} (kA)	3.8.7	Determined by the electrical system	None	
Prospective short-circuit current in the neutral	10.11.5.3.5	Max. 60 % of phase values	None	
Prospective short-circuit current in the protective circuit	10.11.5.6	Max. 60 % of phase values	None	
SCPD in the incoming functional unit requirement	9.3.2	According to local installation conditions	Yes / No	
Coordination of short-circuit protective devices including external short-circuit protective device details	9.3.4	According to local installation conditions	None	
Data associated with loads likely to contribute to the short-circuit current	9.3.2	No loads likely to make a significant contribution allowed for	None	
Protection of persons against electric shock in accordance with IEC 60364-4-41				
Type of protection against electric shock Basic protection (previously protection against direct contact)	8.4.2	Basic protection	According to local installation regulations	
Type of protection against electric shock Fault protection (previously protection against indirect contact)	8.4.3	According to local installation conditions	Automatic disconnection of supply / Electrical separation / Double or reinforced insulation	

Taken from standard IEC EN 61439-2.

Distribution of Responsibilities

Characteristics	Reference	Default arrangement ^a	Options listed in standard ^b	User requirement ^c
Installation environment				
Location type	3.5, 8.1.4, 8.2	Manufacturer's standard, according to application	Indoor / outdoor	
Protection against ingress of solid foreign bodies and ingress of water	8.2.2	Indoor (enclosed): IP2X Outdoor (min.): IP23	None	
Protection after removal of withdrawable part	8.2.3 8.2.101	Manufacturer's standard	After removal of removable or withdrawable parts: As for connected position / Reduced protection to manufacturer's standard	
External mechanical impact (IK code) NOTE IEC 61439-2 does not nominate specific IK codes.	8.2.1, 10.2.6	None	None	
Resistance to UV radiation (applies for outdoor assemblies only unless specified otherwise)	10.2.4	Indoor: Not applicable. Outdoor: Temperate climate	None	
Resistance to corrosion	10.2.2	Normal Indoor/Outdoor arrangements	None	
Ambient air temperature – Lower limit	7.1.1	Indoor: -5 °C Outdoor: -25 °C	None	
Ambient air temperature – Upper limit	7.1.1	40 °C	None	
Ambient air temperature – Daily average maximum	7.1.1, 9.2	35 °C	None	
Maximum relative humidity	7.1.1	Indoor: 95 % at -5 °C to +30 °C 70 % at +35 °C 57 % at +40 °C Outdoor: 100 % at -25 °C to +27 °C 60 % at +35 °C 46 % at +40 °C	None	
Pollution degree of the macro-environment (of the installation environment)	7.1.2	Industrial: 3	1, 2, 3, 4	
Altitude	7.1.1	≤ 2 000 m	None	
EMC environment (A or B)	9.4, 10.12, Annex J	A/B	A/B	
Special service conditions (e.g. vibration, exceptional condensation, heavy pollution, corrosive environment, strong electric or magnetic fields, fungus, small creatures, explosion hazards, heavy vibration and shocks, earthquakes)	7.2, 8.5.4, 9.3.3 Table 7	No special service conditions	None	

Taken from standard IEC EN 61439-2.

Distribution of Responsibilities

Characteristics	Reference	Default arrangement ^a	Options listed in standard ^b	User requirement ^c
Installation method				
Type	3.3, 5.6	Manufacturer's standard	Various e.g. floor standing / wall mounted	
Stationary/Movable	3.5	Stationary	Stationary / movable	
Maximum overall dimensions and weight	5.6, 6.2.1	Manufacturer's standard, according to application	None	
External conductor type(s)	8.8	Manufacturer's standard	Cable / Busbar Trunking System	
Direction(s) of external conductors	8.8	Manufacturer's standard	None	
External conductor material	8.8	Copper	Copper / aluminium	
External line conductor, cross-sections, and terminations	8.8	As defined within the standard	None	
External protective, neutral, mid-point, PEL, PEM, PEN conductors cross-sections, and terminations	8.8	As defined within the standard	None	
Special terminal identification requirements	8.8	Manufacturer's standard	None	
Storage and handling				
Maximum dimensions and weight of transport units	6.2.2, 10.2.5	Manufacturer's standard	None	
Methods of transport (e.g. forklift, crane)	6.2.2, 8.1.6	Manufacturer's standard	None	
Environmental conditions different from those given in 7.3	7.3	–25 °C to + 55 °C and for periods not exceeding 24 h, up to +70 °C.	None	
Packing details	6.2.2	Manufacturer's standard	None	
Operating arrangements				
Access to manually operated devices	8.4		Authorized persons	
Location of manually operated devices	8.5.5	Easily accessible	None	
Isolation of load installation equipment items	8.4.2, 8.4.3.3, 8.4.6.2	Manufacturer's standard	Individual / groups / all	

Taken from standard IEC EN 61439-2.

Distribution of Responsibilities

Characteristics	Reference	Default arrangement ^a	Options listed in standard ^b	User requirement ^c
Maintenance and upgrade capabilities				
Requirements related to accessibility in service by authorized persons; requirement to operate devices or change components while the assembly is energized	8.4.6.2	Basic protection	None	
Requirements related to accessibility for inspection and similar operations	8.4.6.2.2	Manufacturer's recommendations	None	
Requirements related to accessibility for maintenance in service by authorized persons	8.4.6.2.3	Manufacturer's recommendations	None	
Requirements related to accessibility for extension in service by authorized persons	8.4.6.2.4	Manufacturer's recommendations	None	
Protection against direct contact with hazardous live internal parts during maintenance or upgrade (e.g. functional units, main busbars, distribution busbars)	8.4	Manufacturer's recommendations	None	
Gangways	8.4.6.2.101	Basic protection	None	
Method of functional unit's connection	8.5.1, 8.5.2, 8.5.101		F fixed connections D disconnectable connections W withdrawable connections	
NOTE This coding system relates to the capability to remove and re-insert functional units.				
Form of separation	8.101	No requirement	Form 1, 2a, 2b, 3a, 3b, 4a, 4b	
IP rating of separation (protection against contact with hazardous live parts and ingress of solid foreign bodies)	8.101	IPXXB	IP2X or as agreed between the user and manufacturer	
Capability to test individual operation of the auxiliary circuits relating to specified circuits while the functional unit is isolated	3.1.102, 3.2.102, 3.2.103, 8.5.101, Table 103		None	
Current carrying capacity				
Maximum total load current to be supplied by the assembly (from which the rated current of the assembly I_{nA} (A) will be determined)	3.8.10.1, 5.3, 8.5.3, 8.8, 10.10.2, 10.10.3, 10.11.5, Annex E	Manufacturer's standard, according to application	None	
Design current I_b and nature of load for each circuit, alternatively, I_n of the devices and nature of the load (in such cases, the assumed loading factors as given in Table 101 can be used.	3.8.10.8	As given in Table 101	None	
Ratio of cross-section of the neutral conductor to line conductors: line conductors up to and including 16 mm ²	8.6.1	100 %	None	
Ratio of cross-section of the neutral conductor to line conductors: line conductors above 16 mm ²	8.6.1	50 % (min. 16 mm ²)	None	

^a In some cases information declared by the assembly manufacturer may take the place of an agreement.

^b 'None' in this column means that there are no options in the standard other than the default condition or value.

^c For exceptionally onerous applications, the user may need to specify more stringent requirements to those in the standard.

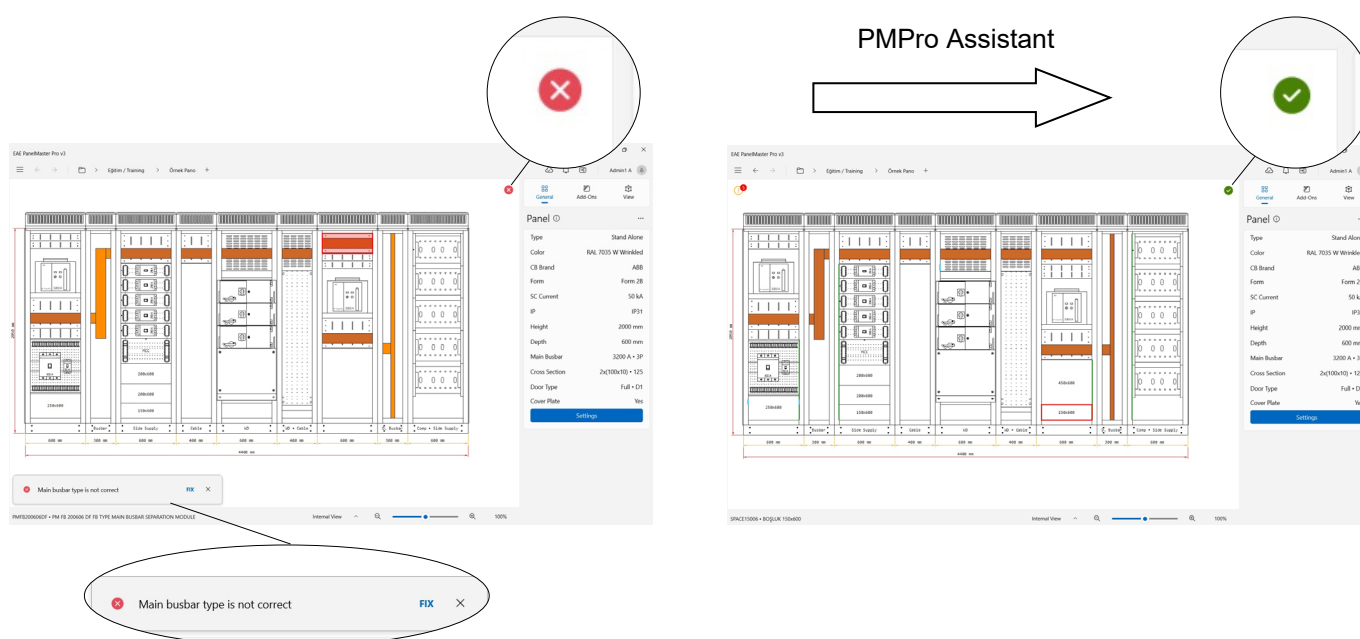
Taken from standard IEC EN 61439-2.

4.1 PanelMasterPro Design Software

PanelMasterPro is a software specifically developed for our partners to facilitate and accelerate the design of PanelMaster type tested switchgears. It's main features are;

Smarter, Faster, Verified

- **Compatible with 8 switchgear brands** – ensuring flexibility and wide usability.
- **Modular design capability** – step by step, module by module design
- **Simple drag-and-drop interface** – user-friendly design process.
- **Full integration with PanelMaster Rule Book** – delivering maximum speed and efficiency for users.
 - a) Automatic definition of copper busbar cross-sections.
 - b) Automatic calculation of busbar support insulator quantities based on short-circuit withstand current.
 - c) Automatic adjustment of section width and depth according to selected circuit breakers and pole number
- **Design-verified software** – compliant with IEC 61439-1 and IEC 61439-2 type-test standards.
- **PMPPro Assistant** – This assistant verifies that your designs comply with IEC standards and the rules defined in the PanelMaster Rulebook. This powerful tool eliminates possibility of errors. If a design error occurs, the assistant turns red to indicate an error and provides guidance on how to fix it. This feature also serves as a mentor for future designs. If everything is OK, it turns green and allows the user to proceed.



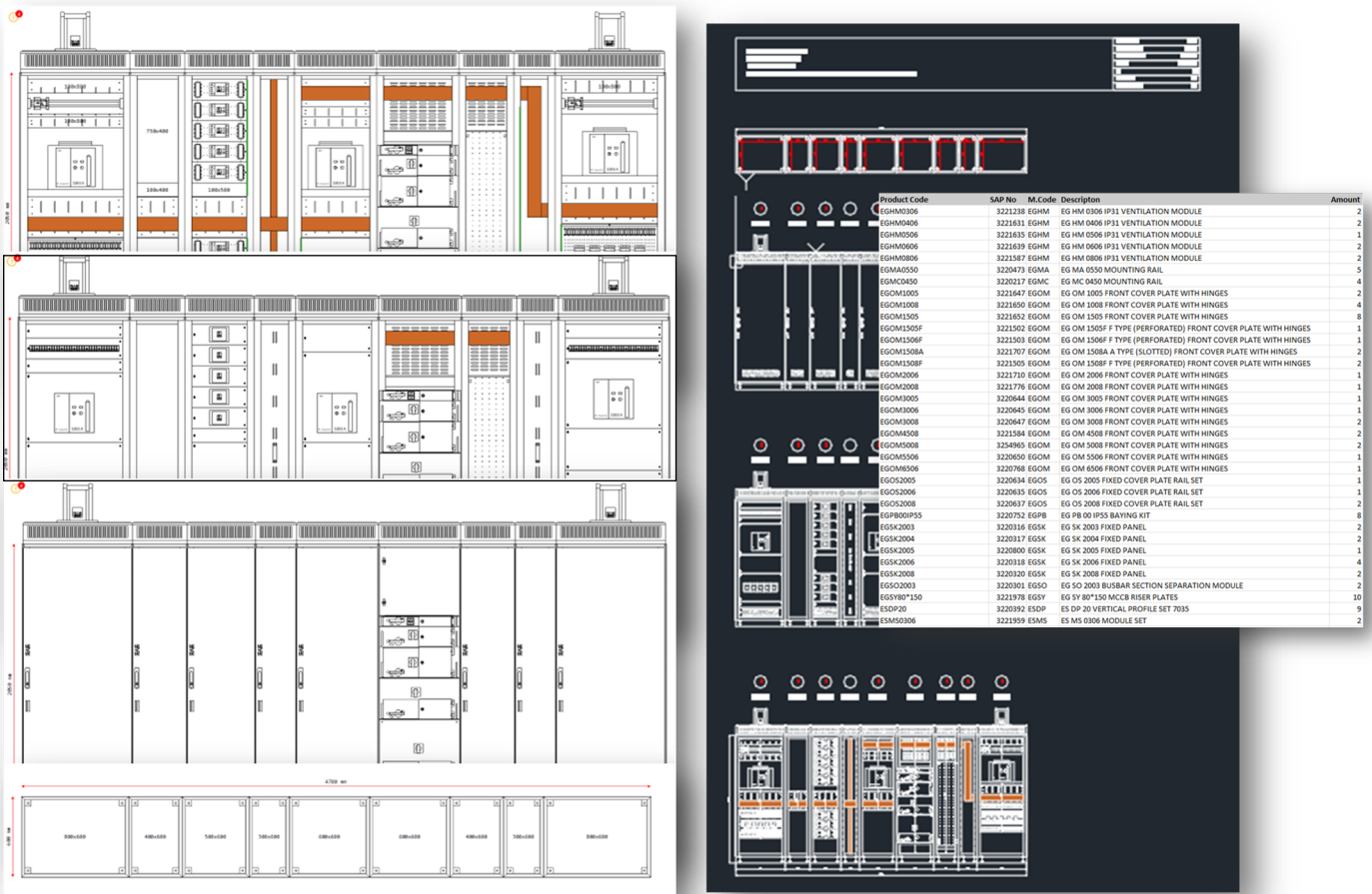
Design Aids

4.1 PanelMasterPro Design Software

Switchgear Views, Manufacturing Document and Bill of Materials

- **One-click export** – Generation of switchgear front views, manufacturing documents in DWG format, and complete bill of materials.
- **Add-Ons section** – Additional standard components can easily be added into the material list.
- **Flexible door design options** – Selection of partial doors, plain doors, glazed doors, and louvered doors
- **Hybrid design capability** – Combination of withdrawable and fixed PanelMaster modules in the same assembly
- **Quick duplication** – Capability of duplication of created panels and transferring into other projects.
- **Instant pricing**– By importing the bill of materials in Excel format directly into KabinPro B2B pricing tool for instant quotations.

PANELMASTER PRO



4.2 PanelTemp Temperature Rise Calculation Software

PanelTemp is an engineering software designed to simplify temperature rise calculations in low-voltage switchgears, enabling a quick and easy way to check design compliance in accordance with IEC standards.

To calculate temperature rise in switchgears, knowledge of power losses of the devices used within the switchgear is needed. In addition factors such as the switchgear's location, ambient temperature, and altitude are also significant determinants.

PanelTemp, developed by EAE Elektrotechnik, is a software tool designed to perform IEC-compliant temperature rise calculations for low-voltage switchgears, taking all relevant factors into account. With PanelTemp, users can efficiently determine the suitability of their electrical switchgear designs by calculating internal temperature rise and generating reports. It also enables users to implement design changes if required.

www.paneltemp.com

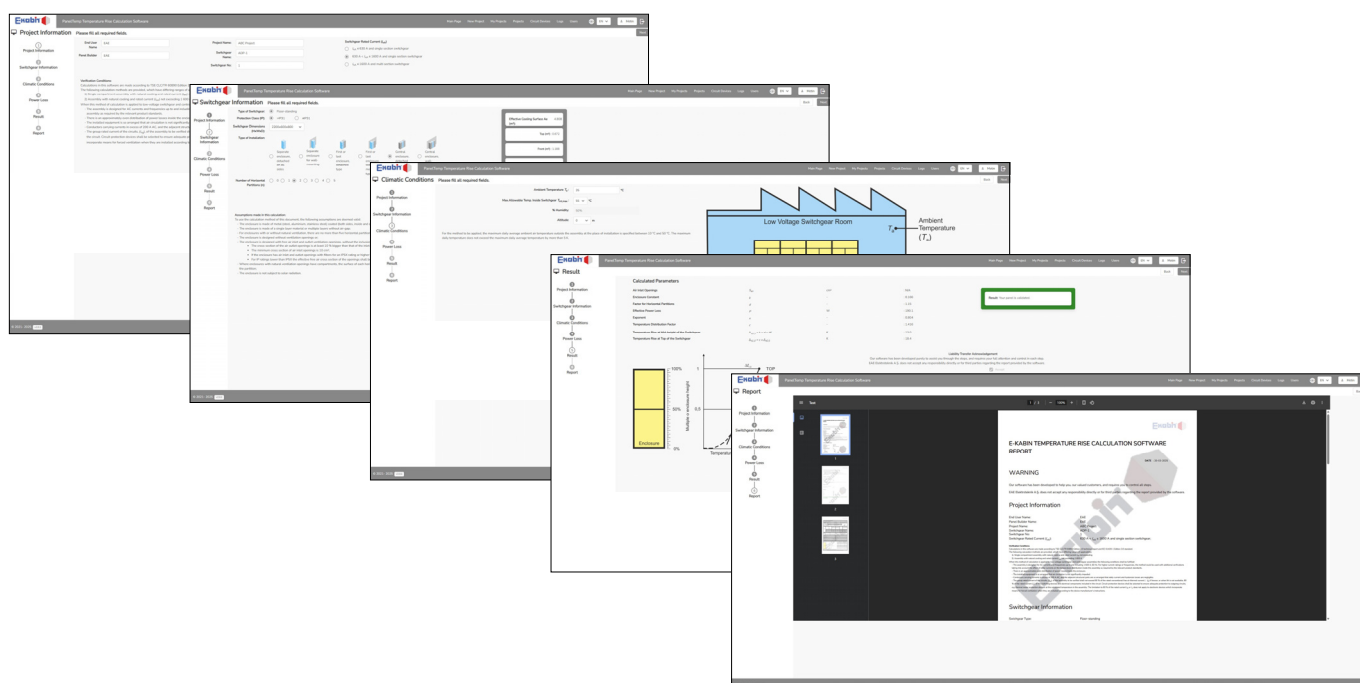


Design Aids

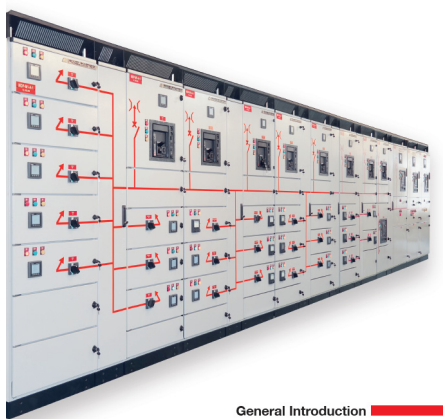
4.2 PanelTemp Temperature Rise Calculation Software

This software is developed in accordance with the rules and conditions specified in the IEC TR 60890:2022 standard.

- **Standard-compliant temperature rise control:** Detailed calculations prepared in accordance with the IEC TR 60890:2022 standard allow users to easily check compliance of designed low-voltage switchgears by calculating the temperature rise within them.
- **Extensive device library:** Extensive device library allows for quick determination of total power loss of the devices within the switchgear. New devices can also be added to this library when necessary.
- **Selection and calculation possibility in different ambient conditions:** The software allows calculations to be performed by changing ambient temperature and altitude of the switchgear's location.
- **Easy simulation:** Conditions can be changed to conduct trials to ensure the switchgears' compliance.
- **Detailed reporting:** Detailed reports in accordance with IEC standards can be obtained from the software for each panel.
- **Fan calculation tool:** The software also facilitates fan calculations easily for switchgears exhibiting over-limit temperature rises.
- **Project Storage:** Users can create user names to store projects and have access when needed.



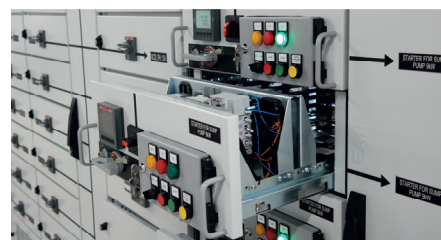
PANELMASTER



General Introduction

General Introduction

PANELMASTER



PanelMaster MCC Product Catalogue

MCC Product Catalogue

PANELMASTER



PanelMaster Design Guide

Design Guide

PANELMASTER



PanelMaster Low Voltage Switchgear
PANELBUILDER MCC APPLICATION GUIDE

Panelbuilder MCC Application Guide

Documentation



Copper Busbar Assembly Implementation Guide

PANELMASTER



PanelMaster Low Voltage Switchgear
INSTALLATION, OPERATION AND MAINTENANCE MANUAL

Installation, Operation and Manual

PANELMASTER



PanelMaster Licensing Guide

Licensing Guide



Technical Paper
Circuit breaker's inside low voltage switchgear
and de-rating

Technical Paper: De-rating



ELEKTROTEKNİK

İkitelli O.S.B. Mahallesi
Eski Turgut Özal Caddesi No: 20/2
34490 Başakşehir / İSTANBUL
Phone: +90 212 549 26 39
Fax: +90 212 549 37 91
panelmaster@eaegroup.com

www.eaeelektroteknik.com

