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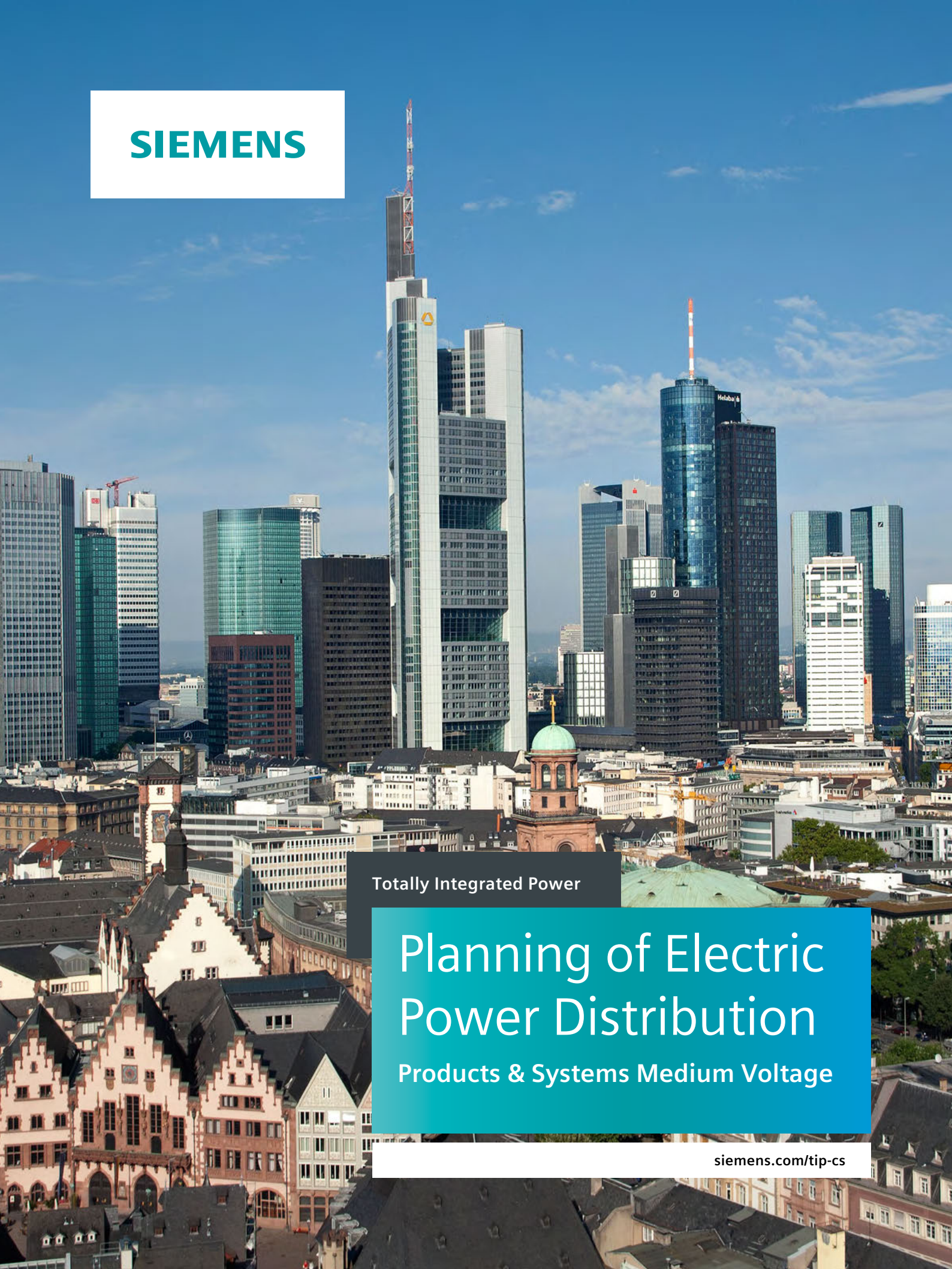

Totally Integrated Power

Planning of Electric Power Distribution

Products & Systems Medium Voltage

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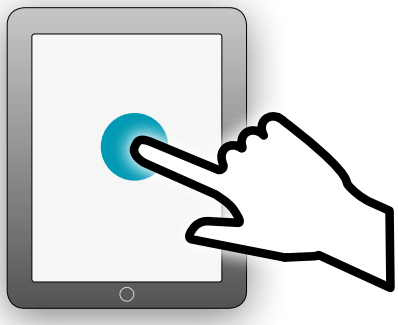
Navigation tips



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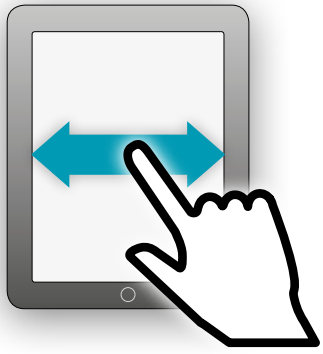

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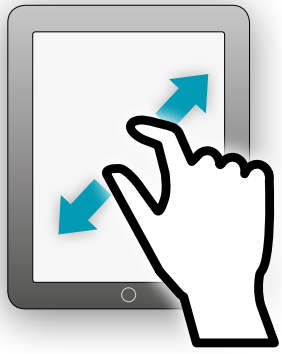

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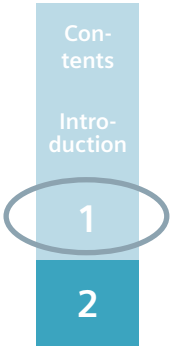

Navigation bar

On every page you will find a navigation bar.

Click on the chapter title/number in the navigation bar to move to the start page of the relevant chapter.

Click on “Contents” at the top to view the contents page.

Contents page

On the contents page you will find a listing of the subchapters.

Click on a subchapter to navigate to the relevant text section.

References to figures and tables

... standard EN 15232 can be used for the building management (see Tab. 2/9). However, note that energy efficiency class D from EN 15232 plays no role ...

A figure (Fig.) or table (Tab.) that is referred to for the first time in the text and does not appear on the same page will be indicated by a blue background (button).

Click on the reference to skip to the corresponding Fig./Tab.

Tab. 1/1: **Data centre (DaC) power demand dependent on the concept for redundancy and infrastructure** back to page 18

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Editorial

We are delighted to be able to present the first module of the new volume "Planning of Electric Power Distribution – Products and Systems" in our series of planning manuals.

The first volume in our series "Planning of Electric Power Distribution – Technical Principles", focused on general requirements and characteristics of relevance to planning electric power distribution systems. In this, the first module of the successor volume, we present the technical details and descriptions of products and systems required to meet the requirements specified in the first volume.

In a new departure, we have adopted a modular structure, with the key elements of power distribution each specified in separate brochures (⇒ volume 2 as a collection of separate modules). Structuring the manuals by modules offers two major advantages:
- It enables you to find what you need faster.
- It improves the clarity of the information provided.

The present module 1, "Medium-Voltage Switchgear and Protection/Switching Devices" thus marks the start of the new series, which will be gradually expanded. The following volumes are currently scheduled:
- Medium-Voltage Switchgear and Protection/Switching Devices (this volume)
- Low-Voltage Switchboard
- Busbar Trunking Systems
- Low-Voltage Protection and Switching Devices
- Distribution Transformers
- Power Quality and Power Transparency.

We would be happy to receive your comments and suggestions – especially for this introductory volume, as they will help us to address your needs and requirements relating to depth of content, style of presentation, and descriptions in the following modules. This of course also applies to the present modules, as Siemens is a key driver of development in the field of medium-voltage systems, thus making the periodic review of this and future texts essential to their relevance.

Please send your comments and suggestions by e-mail to *consultant-support.tip@siemens.com* with the subject line "TIP planning manuals".

Detlef Lucius

Head of Consultant Support for Totally Integrated Power

Contents

Introduction

General Planning Requirements

General Planning Requirements

Devising effective solutions when planning electrical power distribution requires a synthesis of basic technical knowledge, experience, and consistently state-of-the-art expertise. The assessment of specific project requirements and different operating conditions, in particular, make selecting products and systems a demanding and many-sided task for planners. It is therefore essential that they keep their basic technical expertise [Siemens AG, 2016: Planning of Electric Power Distribution – Technical Principles] and relevant product knowledge up-to-date and are in a position to combine them for optimum solutions on specific projects. Siemens' Consultant Support for Totally Integrated Power (TIP) supports planners in this task, with both personal advice and software tools, technical planning documents on the Internet, and printed documentation on all aspects of electrical power distribution.

Pioneering solutions bring electrical power where it is needed

Siemens assists planners in their work with its extensive, longstanding expertise and experience in the fields of electrification, automation technology, and digitalization. Its unique know-how is complemented by a wide range of products, solutions, and services, forming the basis of forward-looking planning processes.

For customers to benefit from the opportunities offered by the increasing convergence of information and operations technology, practical technologies and processes must be analyzed and transformed into a viable planning process that aims for maximum flexibility, durability, and responsiveness at an early stage. After all, customers expect the integrated planning of efficient, viable power infrastructures from their planners.

The benefits in detail:
- Perfect coordination prevents delays in construction and cost overruns
- Expandable plants secure the capital investment, even in the event of a subsequent change of building use
- Preventing an occasional oversize issue enables the resource-efficient manufacture of the equipment and minimizes the ecological footprint
- The professional design of modern products and systems reduces maintenance costs, increases availability, and improves safety for operating personnel
- Energy consumption and costs can be optimized with comprehensive monitoring and automated controls in line with customer operating requirements for building management systems and industrial engineering
- Coordinated interfaces and data protocols, user-friendly software tools, and future-proof components enable faster operational adjustments and a reduction in execution risks.

New challenges when planning electrical power distribution

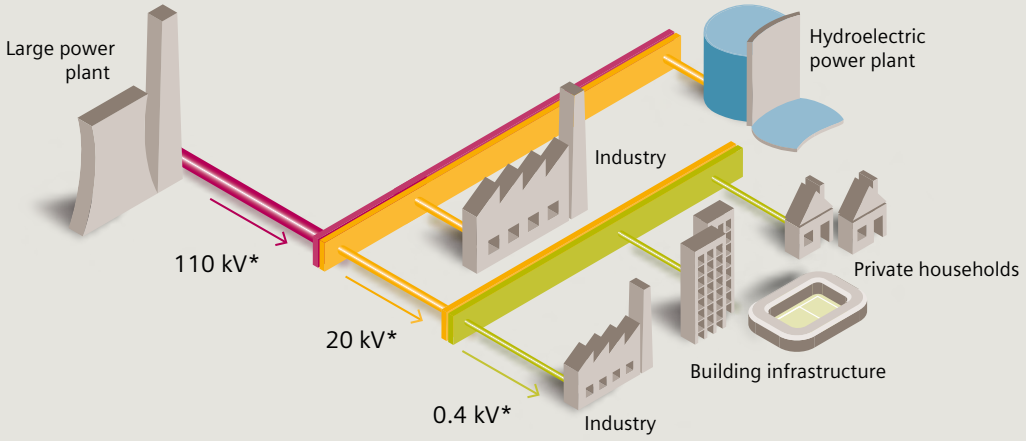
Electrical power is available everywhere, always – that is the norm for most people, at least in highly developed industrial nations. But it is not, however, as simple as it sounds. Operating electrical networks is not a static process but rather a challenge that is constantly changing.

The demands placed on electrical power distribution systems, and thus on medium- and low-voltage networks, are rising all the time. Varying load flow directions, load and voltage fluctuations particularly caused by the rapidly growing number of power supply plants that use volatile energy sources such as photovoltaic/biogas systems and wind farms (Fig. 1/1) are pushing today's distribution networks to their capacity limits.

Changed generation mix

The growing share of renewables in the energy mix is also the source of increasingly fluctuating generation. The switch from unidirectional to bidirectional energy flow, in particular, is making new planning and technical approaches necessary to ensure stability and availability.

Conventional network with unidirectional power flow



Network with bidirectional power flow and intelligent transformer stations

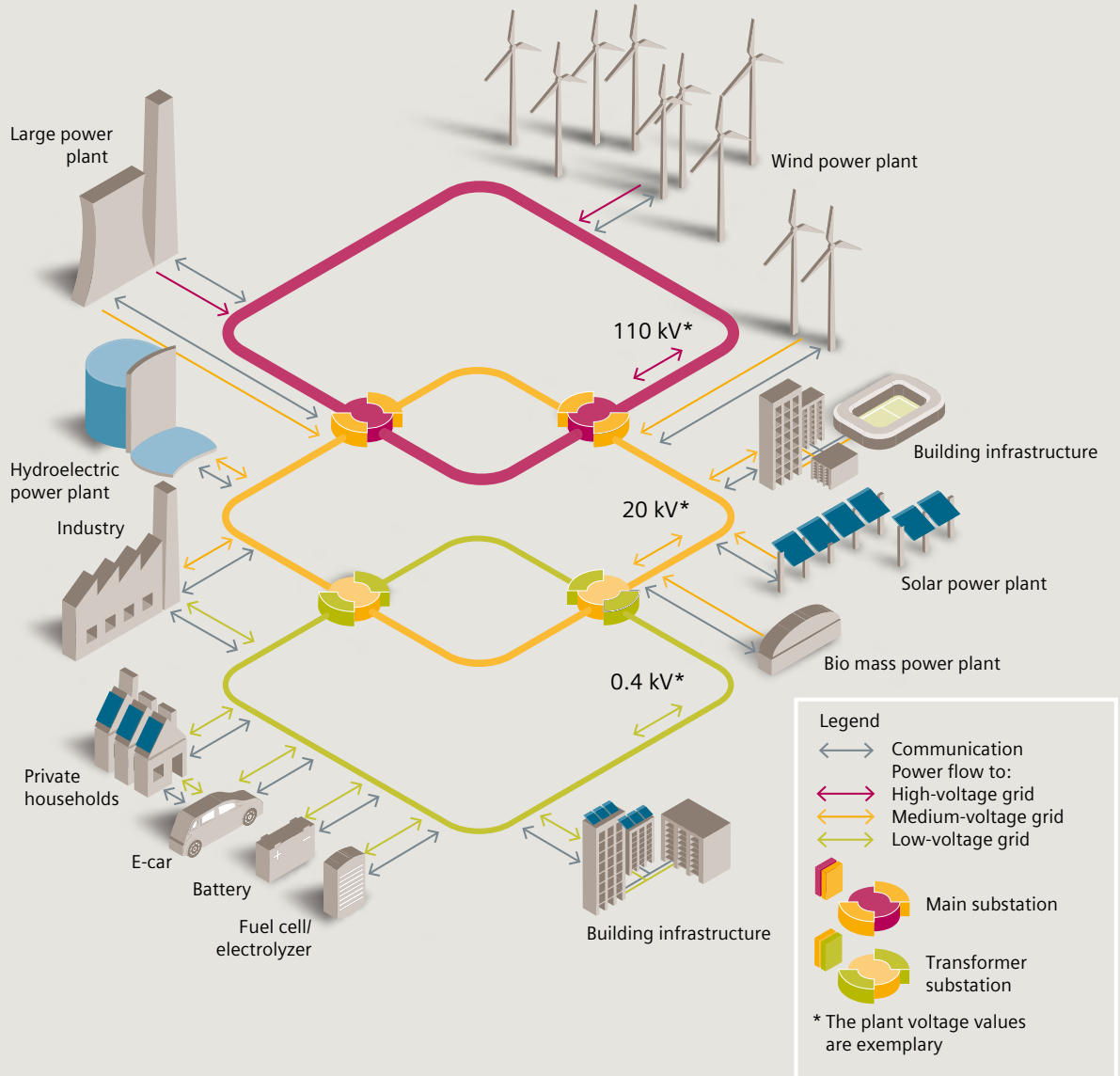


Fig. 1/1: **Comparison of conventional and bidirectional power distribution structure**

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Additional generating capacities

Demand for electrical power is growing all the time, and with it the need for sufficient network capacities to ensure reliable, safe, and efficient power supply. This has an impact on the requirements for supply and distribution structures as well as for the integration of products and systems.

Growing distance between generation and consumption

Large "reserves" or usage possibilities for renewables are often located far away from load centers. This creates a need for new technologies and their interlinking with existing facilities, so that power can be brought to where it is actually needed.

Public and private decentralization

Increasingly complex and distributed energy systems need to be managed using intelligent technology and assisted by energy storage systems.

The need for modernization and retrofits

Avoiding bottlenecks, overloading, and overstressing demands the use of most modern devices as well as solutions for cyber security and greater robustness under extreme or changed underlying conditions.

Reliable, safe, and efficient power supply

The basis of modern industrial processes, infrastructure solutions, buildings, and even the private sector is an absolutely reliable supply of affordable power.

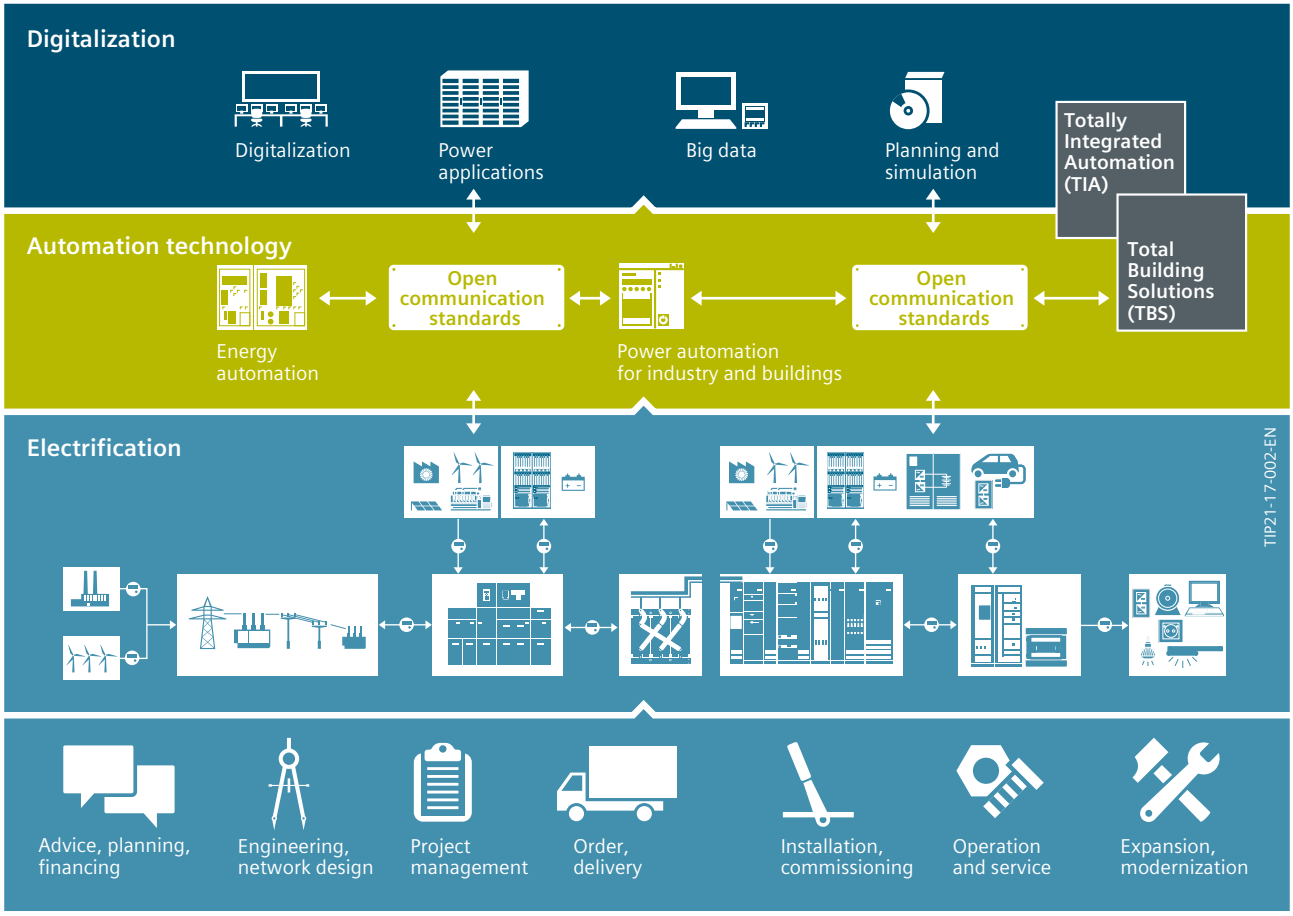

Fig. 1/2: **Planning as the starting point for standardized solutions in electrical power distribution**

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TIP as the energy base for TIA and TBS

Totally Integrated Power (TIP) delivers customized solutions for the most different power supply requirements in industry and infrastructure. The standardized TIP product portfolio enables comprehensive, integrated solutions from a single source that cover all aspects of reliable, safe, and efficient power distribution – from planning and design to operation, monitoring, and control; from software to hardware; from intelligent switchgear via uninterruptible power supplies to reliable, cost-effective components such as the new 3VA molded case circuit-breaker.

TIP is seamlessly integrated in digital environments through its interplay with Totally Integrated Automation (TIA) and Total Building Solutions (TBS) (Fig. 2). It supports automated engineering processes with a large range of software and data, is connected to industrial automation technology and building management systems with communication-capable devices and open interfaces, and forms the basis for universal energy efficiency concepts through systems, components, and software that collect power data.

Partner in all project phases

As implicitly shown in Fig. 2, end-to-end project management eliminates interface issues such that planners and their customers can gain economic advantages, save time, and boost quality if Siemens is involved at an early stage: from planning via installation and operation to expansion and modernization. A global reach combined with local presence and value creation is a further advantage offered by Siemens, for both planners and customers. Contacts at centers of excellence can provide help and support on a wide range of technologies, industry applications, and project specifics – as well as on topics such as project management, financial services, and lifecycle management.

A comprehensive range of additional services is available throughout the lifecycles of products and solutions. This makes it possible to boost returns on capital investments while at the same time complying with the most stringent technological, environmental, health, and safety standards. Project-centric solutions for many different industries and applications from a single source guarantee the fulfilment of specific requirements and the seamless integration of power supply systems for industrial and infrastructure buildings in the automation environment, in building management systems, and in the corporate IT landscape.

Planning turnkey solutions

The electrical systems specified in the two German industrial standards DIN 276-1 (Building costs – Building construction) and DIN 276-4 (Building costs – Civil constructions) are used to classify products and systems when planning electrical power distribution systems. The following are listed in cost group 440 for power installations (and 546 for power installations in technical equipment in outdoor installations) of DIN 276-1:

441 High- and medium-voltage systems: switchgear, transformers

442 Embedded power generating systems: power generating units, including cooling, exhaust systems, and fuel supplies, central battery and uninterruptible power supply systems, photovoltaic systems

443 Low-voltage switchgear: low-voltage main distributors, reactive power compensation systems, peak load monitoring systems

444 Low-voltage installation systems: cables, lines, sub-distribution boards, laying systems, installation devices

445 Lighting systems: fixed luminaires, safety lighting

446 Lightning protection and earthing systems: interceptors, arresters, earthing, equipotential bonding

449 Power installations, other: frequency converters

The 2013 edition of the German Fees Ordinance for Architects and Engineers (HOAI [Siemens AG, 2016: Planning of Electric Power Distribution – Technical Principles]) requires ongoing specification of the calculation and design of used system components and systems dovetailed with the planning process up to service phase 5, in addition to drawings indicating plant dimensions and function or line diagrams. Typical mechanical parameters such as dimensions and weights, as well as electric rating and disturbance variables such as powers, voltages, currents, etc. are needed to meet these requirements and be in a position to create erection, installation, and operating instructions as part of the planning documentation.

The HOAI breaks down the planning tasks for cost group 440 (power installations) into three fee bands:
- Fee band I: plants with low planning requirements
- Fee band II: plants with average planning requirements
- Fee band III: plants with high planning requirements.

Evaluation criteria for classification:
- Number of functional areas
- Integration requirements
- Technical design scope
- Technology requirements
- Design requirements.

With regard to electrical power distribution in accordance with cost group 440, the fee bands can be characterized as follows:
- Fee band I: simple low-voltage installations – typically with just one or two distribution levels from the interconnection point at the distribution network operator and a simple earthing system
- Fee band II: low-voltage installations for three low-voltage distribution levels and planning of compact stations with transformers, auxiliary power generation systems, lightning protection equipment, and associated cabling and distribution systems
- Fee band III: transition from the medium-voltage level to the low-voltage distribution system and a broader and deeper distribution structure with at least four low-voltage distribution levels or more than 1,000 A rated current; high- and medium-voltage systems, low-voltage switchboards, auxiliary power generation systems and converter systems, low-voltage line and distribution systems with short-circuit calculations; lightning protection systems with special requirements (for specific applications, for example, hospitals or data centers).

By way of example, technical specifications, diagrams, and overviews are presented in the following chapters and the following modules in this series on components, products, and systems for electrical power distribution. In the HOAI, energy monitoring and operational optimization are only listed as special services during the warranty period in the last service phase (9 – Property supervision). This, however, is only practical if the requirements for energy transparency and flexibility of power distribution networks have already been considered during the planning and, in particular, in the invitation to tender. Energy storage systems and digital power protection devices are basic elements of a secure and flexible network operation.

Measurability for planning and updating

These days, customers' satisfaction with the work carried out by planners no longer means only demonstrating the feasibility of a solution proven to adhere to technical rules and standards: Modern planners must also show that they are at the forefront of product technology knowledge and can deploy this technology economically and ecologically to the customers' advantage – in accordance with the assessment criteria of IEC 60364-8-1 for planning. The efficient design of power distribution systems is a demanding task that requires special attention as early as the planning phase, because the layout of cables, busbars, transformers, and distribution boards cannot usually be easily modified or rearranged during plant operation. Consequently, the effects of inadequate planning can influence not only capital costs but also cause operating costs to balloon; planners and customers should therefore always take future users and potential usage changes into consideration.

Product and system updates, improvements, and innovations in various areas of technology mean that planners practically need to compile relevant information from a multitude of documents on every new project. Especially when working on the initial planning steps, compiling relevant data and information from a wide range of product documentation can represent a not insignificant time factor. Using the separate modules from the "Products and Systems" planning manual series, a compendium is assembled to make planning-related data and information on the various technologies used for Siemens electrical power distribution systems quickly accessible while allowing the planner to maintain an overview of his selection.

The modules in the planning manual can be replaced via the updating service to ensure they are up-to-date and to integrate any new developments. In addition, the latest publications are available electronically on the TIP Consultant Support website *(www.siemens.com/tip-cs)*. It is also possible to contact Siemens TIP Consultant Support to obtain direct information on the latest updates and on how they may influence one's own work.

Product and system digitalization for the planning process

The increasing integration of information and communication systems to help manage planning tasks also enhances the amount of electronic data provided by manufacturers for their products and systems. Tendering documents, product specifications, operating and installation instructions, CAD drawings, and product images in digital form are all widely used today.

Special software tools can support planners in calculating and structuring the systems. These tools fall into two groups: Those supplied by a manufacturer specifically for its products and systems, and those that operate with manufacturer-independent data sets. In general, specific manufacturer tools are more wide-ranging and deliver more reliable results, as more detailed and newer data sets can be used. For example, the transmission of dimensioning results from SIMARIS design, as the starting point for configuring switchgear with SIMARIS project, represents a significant advantage. The SIMARIS tools can also be used for commissioning, as the digital data for the computed settings for the switching devices can be transferred to the actual products for operation of a plant.

The design and configuration of products and the integration of individual products to form an optimized system must not only result in a viable solution but also aim to minimize costs and environmental pollution. The planner must therefore think beyond the installation and also consider operation of the systems and their integration within the designated application. Relevant planning specifications are provided in IEC 60364-8-1 on energy efficiency [Siemens AG, 2017: Applications for power distribution – Energy transparency] when constructing low-voltage electrical installations:

- Consideration of load profiles
- Incorporation of auxiliary power generation
- Reducing losses of both active and reactive energy
- Definition of measuring requirements, for example, to support an energy management system in accordance with ISO 50001
- Selection of products and systems from an all-encompassing perspective (synergy of capital investment, operation, product lifetime, service, expansion, and replacement).

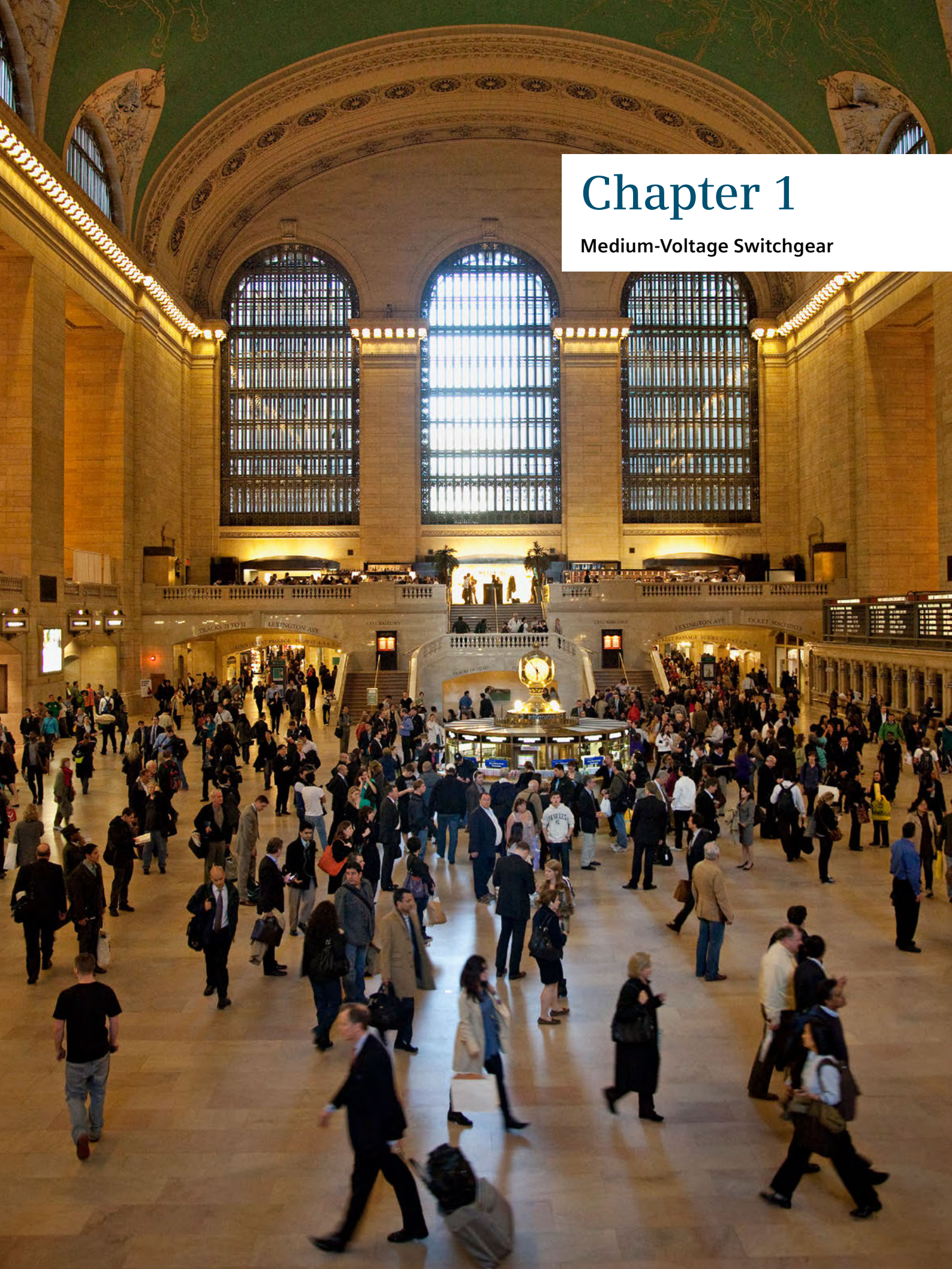
Building Information Modeling BIM

Standardization of product and system digitalization is being advanced by means of Building Information Modeling (BIM). BIM is more than just a way to specify electronic data management or create checklists and 3D models in a standardized data format – for definition, see [Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR – Bundesinstitut für Bau-, Stadt- und Raumforschung), 2013: BIM Guide for Germany]:

"Building Information Modeling (BIM) is a planning method in the building industry that includes the generation and management of digital virtual representations of the physical and functional properties of a structure. The structure models represent an information database relating to all aspects of the building, thus offering a reliable source of data for decision-making throughout the lifecycle; from preliminary planning to dismantling."

It should be noted that there are a multitude of instructions and guidelines supplementary to BIM in the international arena, and that digitalization is a strong priority. The next step in digitalization is the standardized linking of data and methodology to arrive at comparable results during planning and execution.

Nevertheless, one of the planner's core tasks will remain comparing underlying project conditions and project/system data to derive the ideal selection, carry out informed calculations, and thus prepare solid verifications. As it is not possible to predict when all the relevant parameters will be integrated in the BIM data formats to enable comprehensive planning of the electrical power distribution or when standardization of the calculation and assessment methods will be achieved, data pools such as the modules of the Siemens planning manual for products and systems will remain useful sources of information for the foreseeable future.



Chapter 1

Medium-Voltage Switchgear

1 Medium-Voltage Switchgear

For medium-voltage switchgear, the requirement profile is clear: a maximum level of safety, reliability, and availability by means of proven technologies. Minimizing the ecological footprint, as well as cost-efficient and smooth operation, contribute to sustainability and secure the investment in tested medium-voltage switchgear for decades.

The standard IEC 62271-200 defines the requirements on "prefabricated metal-enclosed switchgear and control-gear for alternating current of rated voltages above 1 kV and up to and including 52 kV for indoor and outdoor installation, and for service frequencies up to and including 60 Hz".

The enclosures can contain fixed-mounted or removable components. They can be filled with inert gas or air for insulation purposes. A metal-enclosed switchgear assembly can consist of one or several type-tested blocks, or completely of type-tested panels. Important physical ratings for switchgear according to IEC 62271-1 are:

- Rated voltage U_r
- Rated insulation level U_p
- Rated frequency f_r
- Rated normal current I_r
- Rated short-time withstand current I_k
- Rated peak withstand current I_p
- Rated duration of short circuit t_k.

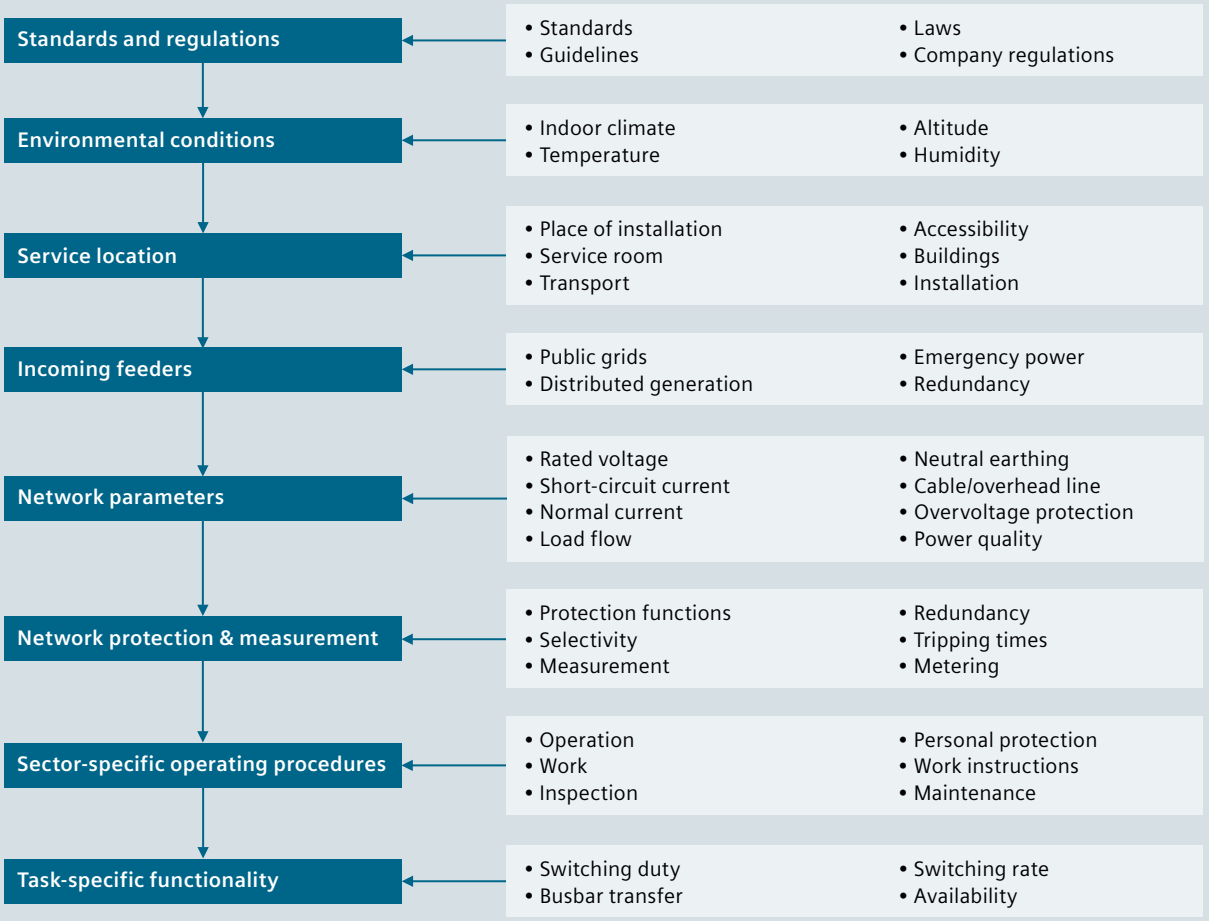


Fig. 1/1: **Factors of influence/functionalities for the selection of medium-voltage switchgear**

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Furthermore, the switchgear can be classified in respect of:

- Switchgear design (e.g., panel or block-type construction)
- Conductor insulation of current-carrying components (gas- or air-insulated)
- Busbar system (single- or double-busbar system)
- Loss of service continuity (LSC category, see [Siemens AG, 2016: Planning of Electric Power Distribution – Technical Principles])
- Accessibility of compartments
- Behavior in case of internal arc (IAC = Internal Arc Classification).

Other important magnitudes for room planning and transport are dimensions and weights. The application-specific characterization of the switchgear includes the panel types used, the design of the devices (e.g., fixed-mounted or withdrawable) and the IP degree of protection of the switchgear. Depending on the project-specific marginal conditions (Fig. 1/1) and the requested switchgear parameters as described above (Fig. 1/2), selection is possible from a variety of different switchgear types.

While selecting the switchgear, the planner must additionally evaluate the numerous interdependencies between the individual parameters and versions of the switchgear types. For example, due to the better insulation characteristics of SF_6 compared with air, SF_6 gas-insulated switchgear can be designed significantly smaller than air-insulated switchgear. In contrast, sealing requires higher efforts during manufacture. Resulting investment disadvantages can be more than compensated by lower operating costs thanks to the maintenance-free design of SF_6 gas-insulated switchgear. The corresponding holistic considerations also play an important part in respect of efficiency and environmental impact.

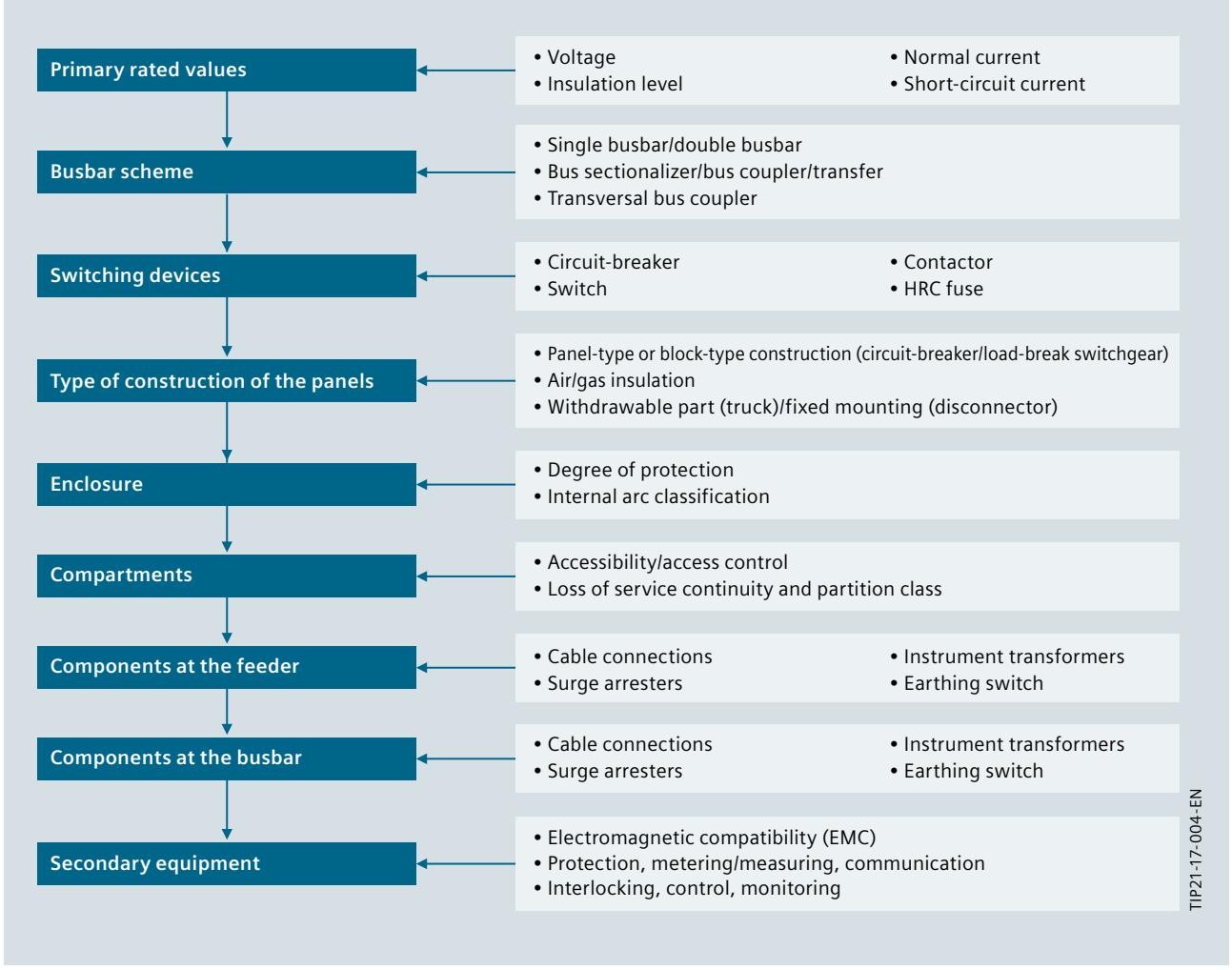

Fig. 1/2: **Parameters/equipment for medium-voltage switchgear selection**

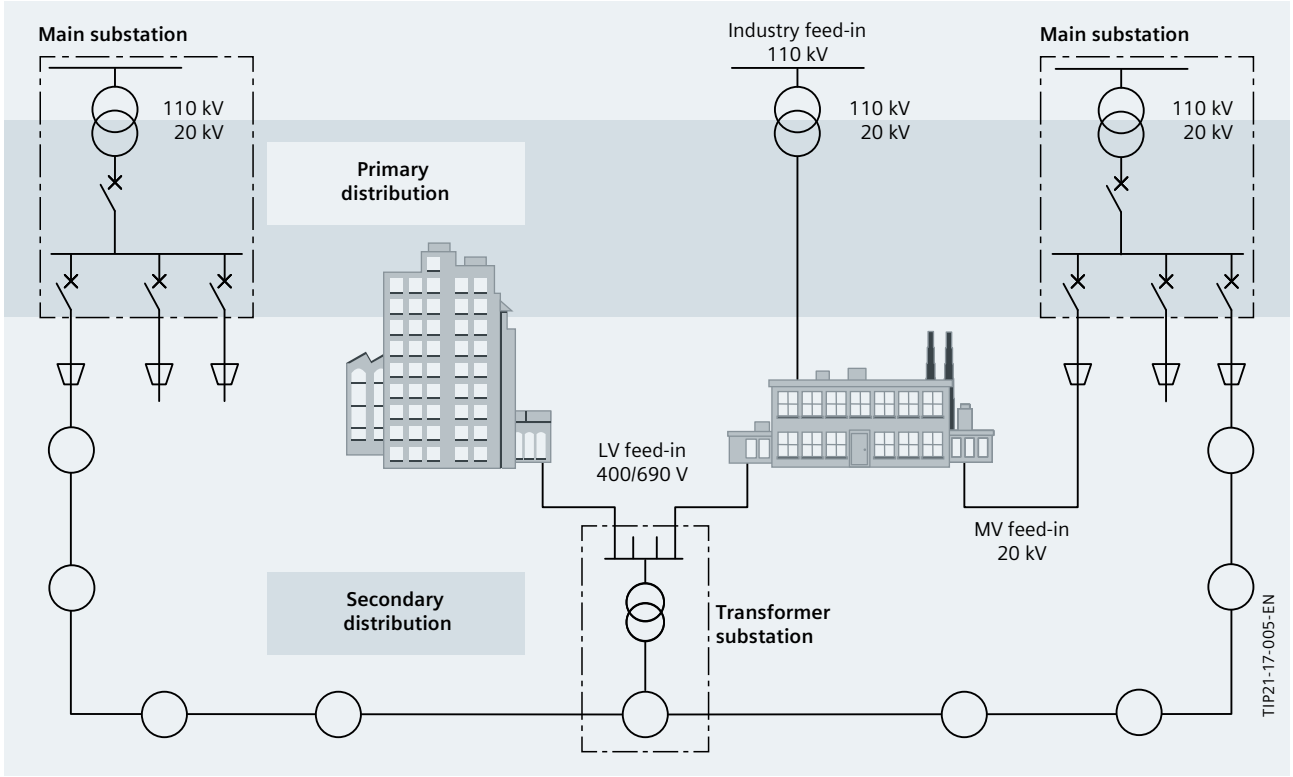

Fig. 1/3: **Simplified distribution structure in medium voltage**

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Switchgear type	Distribution level	Insulation	Construction	Loss of service continuity (LSC)	Busbar system
NXAIR	Primary	Air-insulated	Individual panels	LSC 2B	Single, double
NXPLUS C	Primary, secondary	Gas-insulated	Individual panels	LSC 2	Single Single Double
SIMOSEC	Primary, secondary	Air-insulated with gas-insulated switching devices	Individual panels	LSC 2 (R, T, L)*, LSC 1 (M, H, K)**	Single
8DJH	Secondary	Gas-insulated	Individual panels, block types	LSC 2 (R, T, L)*, LSC 1 (M, K, K(E))**	Single
8DJH Compact	Secondary	Gas-insulated	Compact switchgear	LSC 2	Single
8DJH 36	Secondary	Gas-insulated	Individual panels, block types	LSC 2 (R, T, L)*, LSC 1 (M, K)**	Single

* Depending on panel type (R: ring-main feeder; T: transformer feeder; L: circuit-breaker feeder)
** Depending on the panel type (M: metering panel; H: bus riser panel; K: cable feeder; K(E): cable feeder with make-proof earthing switch)
*** Maximum values, specific values depending on panel/block type

Tab. 1/1: **Characteristic data for the type series of medium-voltage switchgear**

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The application-specific characterization of the switchgear encompasses the panel types used, the cable connection, the IP degree of protection of the switchgear, and the options required, such as motor operating mechanisms and measuring, monitoring, and communication equipment. Tab. 1/1 shows an overview for medium-voltage switchgear with typical parameters and designs which are often used during infrastructure planning. Fig. 1/3 shows the division into primary and secondary distribution level.

Tab. 1/2 offers an overview of the most important panel types for switchgear assemblies made up of individual panels and Fig. 1/4 lists the available types of 8DJH compact switchgear series with single-line diagrams. On the next pages, the individual product series are described in more detail by means of planning-relevant information, both in tabular form and graphically.

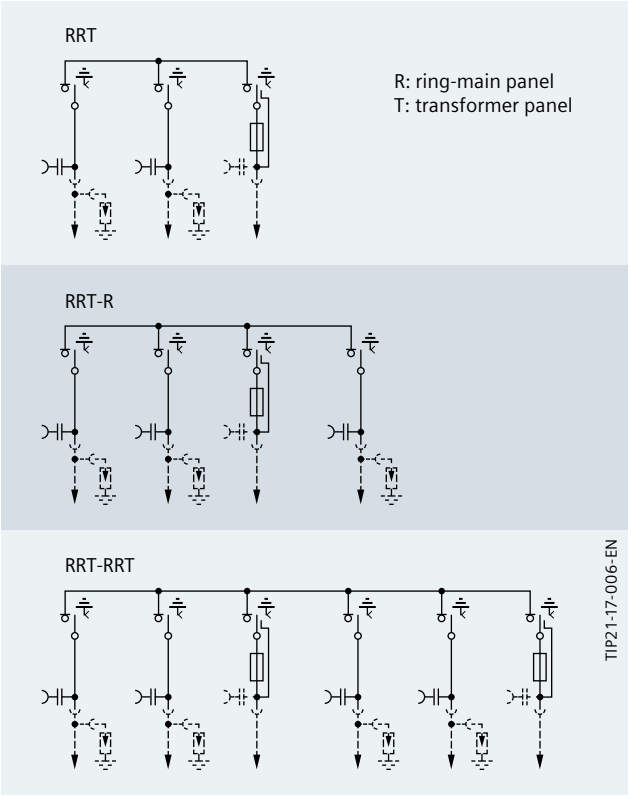
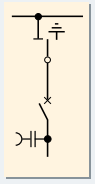
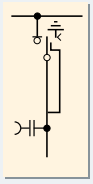
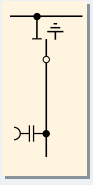
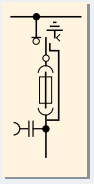
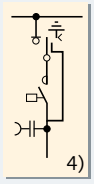
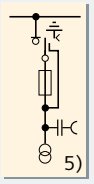
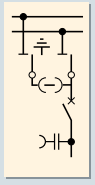
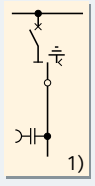
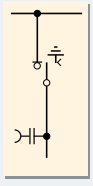
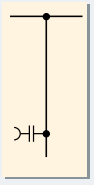
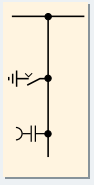
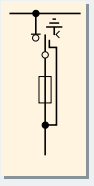
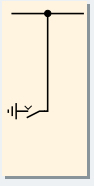
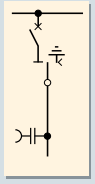
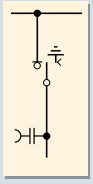
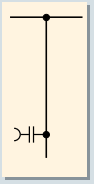
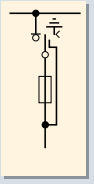
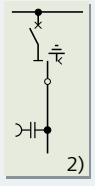
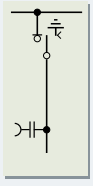
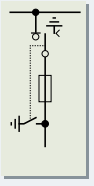
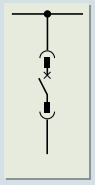
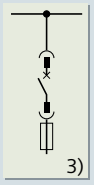
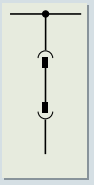
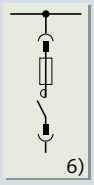


Fig. 1/4: **Single-line diagrams for compact switchgear 8DJH Compact (optional components are shown in dotted lines; symbol explanations for the components are given in the annex) Click here (not for mobile devices)**

	Internal arc classification	Rated voltage	Rated short-time withstand current for rated duration of short circuit t_k = 1 s	Rated short-time withstand current for rated duration of short circuit t_k = 3 s	Rated current of busbar	Rated current of feeders ***
	IAC A FLR 50 kA, 1 s	17.5 kV	50 kA	50 kA	4,000 A	4,000 A
	IAC A FLR 25 kA, 1 s	24 kV	25 kA	25 kA	2,500 A	2,500 A
	IAC A FLR 31.5 kA, 1 s	15 kV	31.5 kA	31.5 kA	2,500 A	2,500 A
	IAC A FLR 25 kA, 1 s	24 kV	25 kA	25 kA	2,500 A	2,000 A
	IAC A FLR 25 kA, 1 s	24 kV	25 kA	25 kA	2,500 A	1,250 A
	IAC A FL/FLR 21 kA, 1 s	24 kV	25 kA	21 kA	1,250 A	1,250 A
	IAC A FL/FLR 21 kA, 1 s	17.5 kV	25 kA	20 kA	630 A	630 A
	IAC A FL/FLR 20 kA, 1 s	24 kV	20 kA	20 kA	630 A	630 A
	IAC A F/FL/FLR 21 kA, 1 s	17.5 kV	25 kA	20 kA	630 A	630 A
	IAC A FL/FLR 20 kA, 1 s	24 kV	20 kA	20 kA	630 A	630 A
	IAC A FL/FLR 20 kA, 1 s	36 kV	20 kA	20 kA	630 A	630 A

Panel / Type	Circuit-breaker panel	Circuit-breaker/ fuse panel	Ring-main panel	Discon-nector panel	Cable connec-tion panel	Cable connec-tion panel with make-proof earthing switch	Discon-necting panel	Switch-discon-nector panel	Contactor panel	Trans-former panel	Busbar earthing panel
NXPLUS C, single busbar									 4)	 5)	
NXPLUS C, double busbar											
8DJH	 1)										
8DJH 36											
SIMOSEC	 2)										
NXAIR		 3)							 6)		

1) Circuit-breaker type 1.1 or type 2
2) Vacuum circuit-breaker
3) 24 kV only
4) Vacuum contactor panel
5) Auxiliary transformer
6) Up to 12 kV only

Tab. 1/2: **Important panel types for the different series of medium-voltage switchgear (symbol explanations for the components are given in the annex)**
Click here (not for mobile devices)

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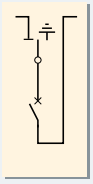
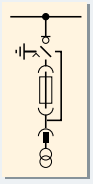
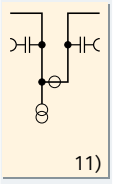
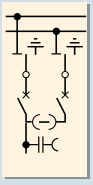
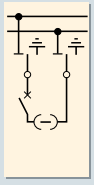
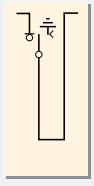
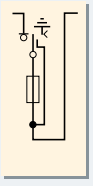
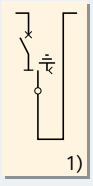
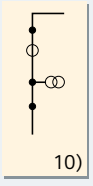
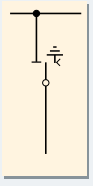
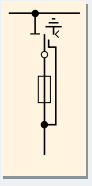
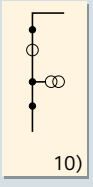
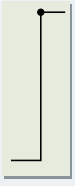
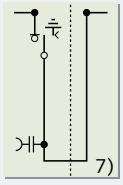
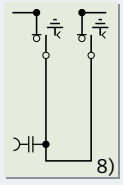
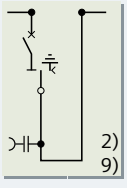
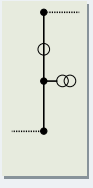
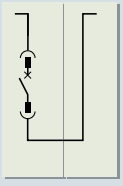
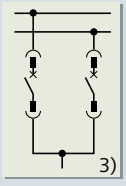
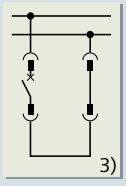
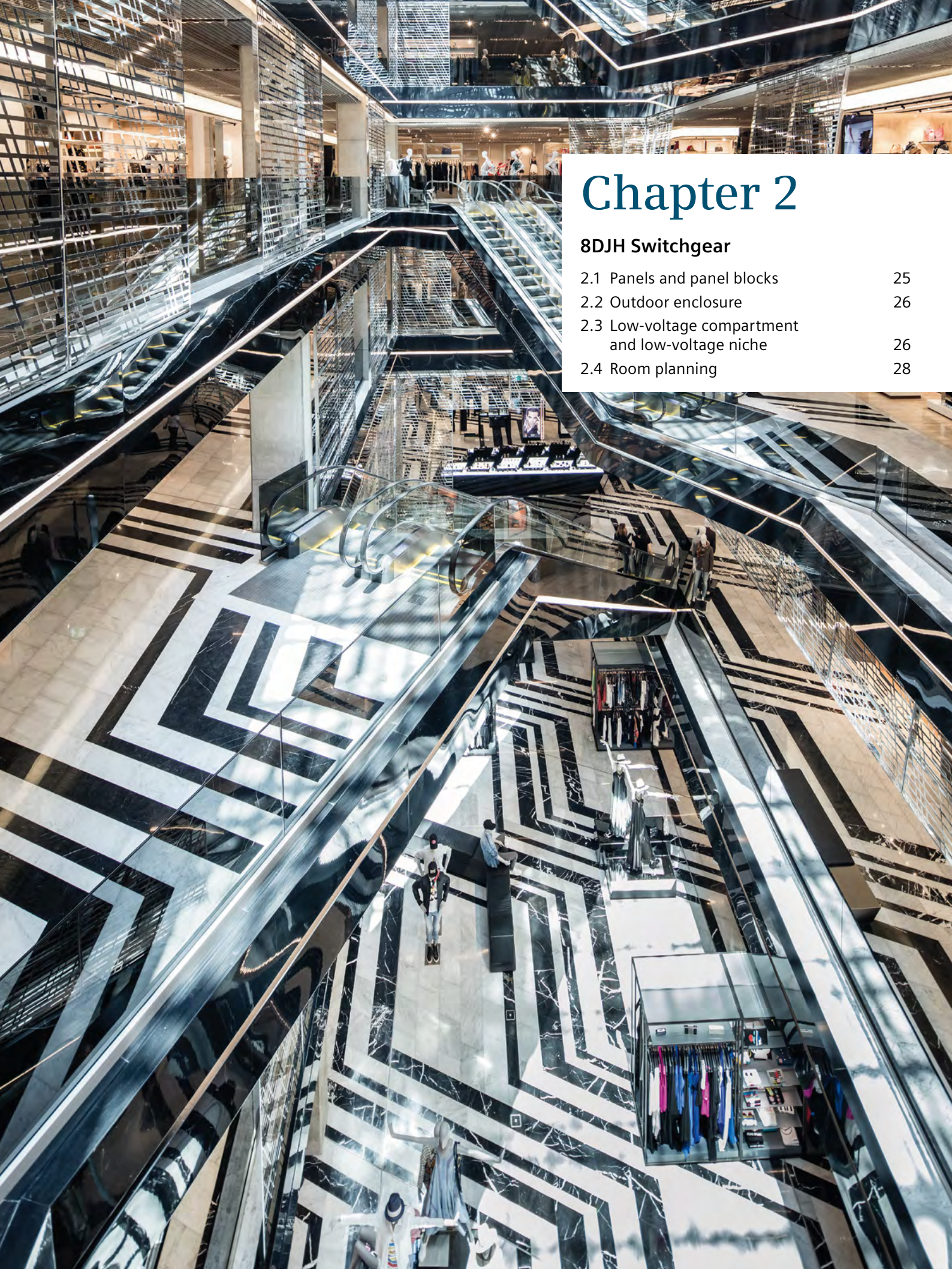
	Bus riser panel	Bus sectionalizer panel with three-position switch-disconnector	Bus sectionalizer panel with switch-fuse combination	Bus sectionalizer panel with circuit-breaker	Incoming sectionalizer	Bus coupler	Metering panel	Billing metering panel	Busbar voltage metering panel	Primary fuse-protected busbar voltage metering panel
								 11)		
										
				 1)				 10)		
								 10)		
		 7)  8)		 2) 9)						
					 3)	 3)				

7) As panel combination with bus riser panel
8) In combination with second switch-disconnector panel
9) In combination with bus riser panel
10) Air-insulated (BB, BC, CB, CC)
11) Air-insulated transfer metering panel



Chapter 2

8DJH Switchgear

2 8DJH Switchgear

8DJH switchgear (Fig. 2/1) is a prefabricated, 3-pole metal-enclosed single-busbar switchgear for indoor installation, type-tested according to IEC 62271-200. It is mostly used in public and industrial energy systems of the secondary distribution level, e.g. in

- Local ring-main units, customer transfer substations, and switching substations of power supply and public utilities
- Wind power plants and solar plants, hydroelectric power plants
- Water and sewage treatment plants
- Airports, railway stations, underground railway stations, and similar infrastructures
- Data centers and research facilities
- High-rise buildings and shopping centers.

A typical feature of this switchgear type is the hermetically welded switchgear vessel made of stainless steel as a sealed pressure system with maintenance-free switching devices and enclosed cable plugs as well as a single-pole solid insulation. Thanks to the use of SF_6 insulating gas, compact dimensions are possible, without any need of gas work during installation, operation, or replacement. Individual panels and panel blocks can also be lined up and extended at will, without gas work on site. The low fire load increases operational reliability as well as the complete switchgear interlocking system with logical mechanical interlocks.

Cables are connected via an outside-cone plug-in system according to EN 50181. The degree of protection for the switchgear enclosure conforms to IP2X. For all high-voltage parts of the primary circuit in the gas-insulated panels, IP65 is achieved as standard. The enclosure consists of sendzimir-galvanized sheet steel, with the switchgear front powder-coated in color “light basic” (color 700 according to Siemens Standard SN 47030 G1, similar to RAL 7047).

Especially the preconfigured 8DJH Compact switchgear series is particularly space-saving and ideally suited as a retrofit solution. The panel combinations RRT (2 ring-main feeders and 1 transformer feeder), RRT-R (3 ring-main feeders and 1 transformer feeder), and RRT-RRT (4 ring-main feeders and 2 transformer feeders) shown in Fig. 1/4 are available.

Under normal operating conditions, the expected service life of gas-insulated switchgear 8DJH is at least 35 years – 40 to 50 years are a realistic expectation. The service life is limited by the maximum number of operating cycles of the switching devices installed:

- For circuit-breakers, according to the endurance class defined in IEC 62271-100
- For three-position disconnectors and earthing switches, according to the endurance class defined in IEC 62271-102
- For three-position switch-disconnectors and earthing switches, according to the endurance class defined in IEC 62271-103.

The switchgear can be installed close to the wall or freely in the room. Technical data (Tab. 2/1), dimensions of the individual panels of 8DJH and 8DJH 36 as well as 8DJH Compact switchgear (Tab. 2/2), options for individual panels (Fig. 2/3 for 8DJH up to 24 kV and Fig. 2/4 for 8DJH 36), and corresponding installation notes can be found on the following pages.

Fig. 2/1: **Examples for an 8DH Compact, an 8DJH block, and an 8DJH panel (on the left) as well as for an 8DJH 36 block (on the right)**

The power losses for the different individual panels of 8DJH switchgear are referred to a normal current of 630 A:

- Cable feeder 120 W
- Ring-main feeder, bus sectionalizer panel 170 W
- Circuit-breaker panel, bus sectionalizer panel (with circuit-breaker) 210 W
- Billing metering panel M(BB) (see Tab. 2/2) 130 W
- Billing metering panel M(BC) or M(CB) 65 W

or independently of the normal current:

- Transformer feeder, bus sectionalizer panel with switch-fuse combination (including power loss of fuses 3 × 45 W) 150 W.

In accordance with IEC 60071-1, the rated values are referred to site altitudes up to and including 1,000 m above sea level and normal atmospheric conditions (air pressure 1,013 hPa, temperature 20 °C, and air humidity 11 g/m^3). Accordingly, correction factors have to be applied for the insulation levels according to IEC 62271-1 at site altitudes of more than 1,000 m above sea level. These correction factors can be derived from Fig. 2/2:

- Rated short-duration power-frequency withstand voltage (site altitude > 1,000 m) ≥ $U_d \times K_a$
- Rated lightning impulse withstand voltage (site altitude > 1,000 m) ≥ $U_p \times K_a$.

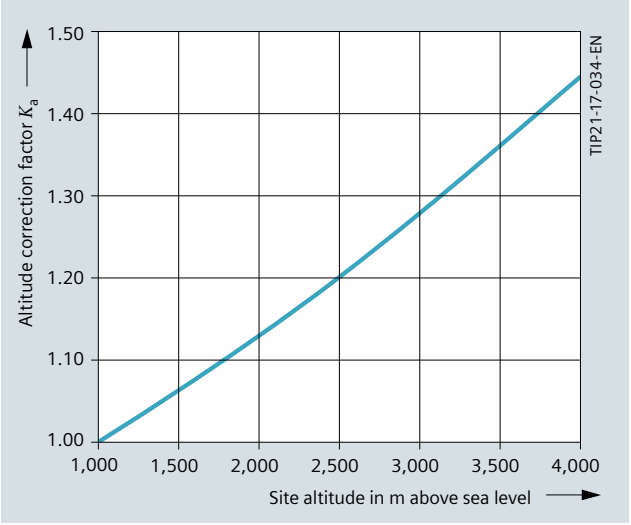


Fig. 2/2: **Altitude correction factor K_a (acc. to IEC 62271-1) for site altitudes of more than 1,000 m above sea level**

		8DJH, 8DJH Compact					8DJH 36
Rated voltage U_r		**7.2 kV**	**12 kV**	**15 kV**	**17.5 kV**	**24 kV**	**36 kV**
Rated short-duration power-frequency withstand voltage U_d – phase-to-phase, phase-to-earth, open contact gap – across the isolating distance		20 kV 23 kV	28/42 kV [1] 32/48 kV [1]	36 kV 39 kV	38 kV 45 kV	50 kV 60 kV	70 kV 80 kV
Rated lightning impulse withstand voltage U_p – phase-to-phase, phase-to-earth, open contact gap – across the isolating distance		60 kV 70 kV	75 kV 85 kV	95 kV 110 kV	95 kV 110 kV	125 kV 145 kV	170 kV 195 kV
Frequency f_r		50/60 Hz					
Rated normal current I_r [2] – Ring-main feeders – Busbar – Circuit-breaker feeders [3] – Transformer feeders		400 A, 630 A 630 A 250 A (type 2), 630 A (type 1.1, type 2) 200 A [4]					630 A 630 A 630 A 200 A [4]
Rated short-time withstand current I_k	t_k = 1 s	25 kA [5]	25 kA [5]	25 kA [5]	25 kA [5]	20/21 kA [1]	20 kA
	t_k = 3 s	20/21 kA [1]	20/21 kA [1]	20/21 kA [1]	20/21 kA [1]	20/21 kA [1]	20 kA
Rated peak withstand current I_p Rated short-circuit making current I_{ma} for ring-main, circuit-breaker [3], and transformer feeders (50/60 Hz)	50 Hz	63 kA	63 kA	63 kA	63 kA	50/52,5 kA [1]	50 kA
	60 Hz	65 kA	65 kA	65 kA	65 kA	52/55 kA [1]	52 kA

[1] Design option for 8DJH
[2] The rated normal currents apply to ambient air temperatures of max. 40 °C. The 24-hour mean value is max. 35 °C (according to IEC 62271-1)
[3] Circuit-breaker feeders not for 8DJH Compact
[4] Depending on the HV HRC fuse-link
[5] 8DJH Compact (7.2 up to 17.5 kV) at 60 Hz: I_k = 21 kA

Tab. 2/1: **Technical data for 8DJH, 8DJH Compact, and 8DJH 36**

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Example 1:

- Site altitude above sea level: 3,000 m
- Rated voltage U_r of the switchgear: 17.5 kV
- Rated lightning impulse withstand voltage U_p (3,000 m) 95 kV × 1.28 = 122 kV.

Result: A switchgear for a rated voltage of U_r = 24 kV with a rated lightning impulse withstand voltage of U_p = 125 kV is to be selected.

Example 2:

- Site altitude above sea level: 2,750 m
- Rated voltage U_r of the switchgear: 7.2 kV
- Rated lightning impulse withstand voltage U_p (2,750 m) 60 kV × 1.25 = 75 kV.

Result: A switchgear for a rated voltage of U_r = 12 kV with a rated lightning impulse withstand voltage of U_p = 75 kV is to be selected.

Pressure relief is usually downwards, or optionally to the rear or upwards via pressure absorber systems. The cable connections are designed as outside-cone system (for ring-main and circuit-breaker feeders as bolted contacts M16, for transformer feeders as plug-in contacts, optionally as bolted contacts M16).

8DJH	**E, K, R**	**H#, K(E), L(type 2), M, S, T**	**L(type 1.1)**	**E(500), L(500, type 2), M(500), R(500), S(500), V(type 2)**	**V(type 1.1), L(500, type 1.1)**	**S(620)**	**M(BB), M(CB), M(BC), M(CC)**
Width	310 mm	430 mm	430 mm	500 mm	500 mm	620 mm	840 mm
Depth	775 mm	775 mm	820 mm 775 mm*	775 mm	820 mm 775 mm*	775 mm	775 mm
Heights	1,200 mm 1,400 mm 1,700 mm	1,200 mm 1,400 mm 1,700 mm	1,200 mm 1,400 mm 1,700 mm	1,200 mm 1,400 mm 1,700 mm	1,200 mm 1,400 mm 1,700 mm	1,200 mm 1,400 mm 1,700 mm	1,400 mm 1,700 mm
* Depth of the mounting surface Overall heights of low-voltage compartment (option): 200 mm, 400 mm, 600 mm, 900 mm							
8DJH 36	**K, R**	**T**	**L(type 1), L(type 2)**	**M(BB), M(CB), M(BC), M(CC)**			
Width	430 mm	500 mm	590 mm	1,100 mm			
Depth	920 mm	920 mm	920 mm	980 mm			
Height	1,600 mm	1,600 mm	1,600 mm	1,600 mm			
Overall heights low-voltage compartment (option): 200 mm, 400 mm, 600 mm							
8DJH Compact	**RRT**	**RRT-R**	**RRT-RRT**				
Width (IAC A F)	620 mm	930 mm	1,240 mm				
Width (IAC A FLR)	700 mm	1,010 mm	1,400 mm				
Depth	775 mm	775 mm	775 mm				
Heights	1,400 mm 1,700 mm	1,400 mm 1,700 mm	1,400 mm 1,700 mm				

Tab. 2/2: **Dimensions of the individual panels of 8DJH and 8DJH 36 switchgear as well as of 8DJH Compact switchgear**

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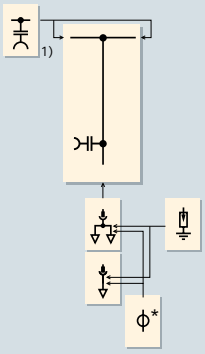
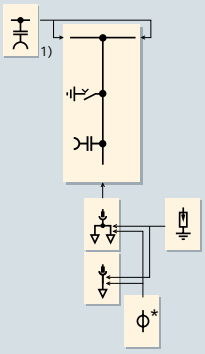
Cable feeder K [2]

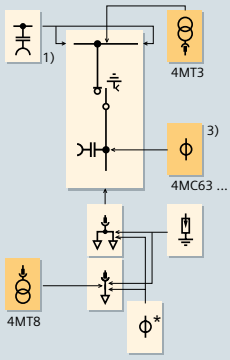


Cable feeder K(E) [2]



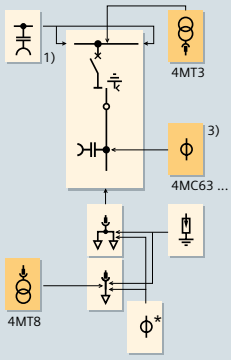
Ring-main feeder R, R(500)

Options only for R(500)

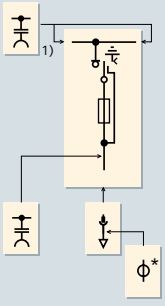


Circuit-breaker feeder L, L(500)

Options only for L(500)

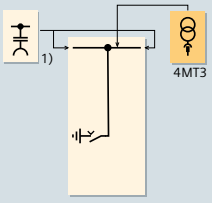


Transformer feeder T

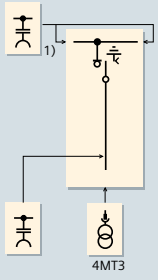


Busbar earthing panel E, E(500)

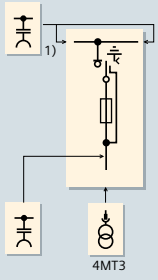
Options only for E(500)



Busbar voltage metering panel M(500)

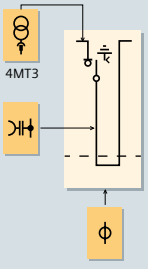


Busbar voltage metering panel M(430) fused on the primary side

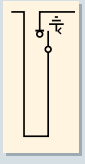


Bus sectionalizer panel S [5], S(500) (only possible on the right in blocks)

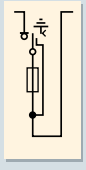
Options only for S(500)



Bus sectionalizer panel S(620) (earthing on the left)

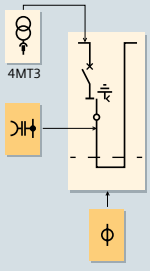


Bus sectionalizer panel H# [5] with switch-disconnector/ fuse combination



Bus sectionalizer panel V with circuit-breaker type 1.1 or type 2

Options only for design option with current transformer



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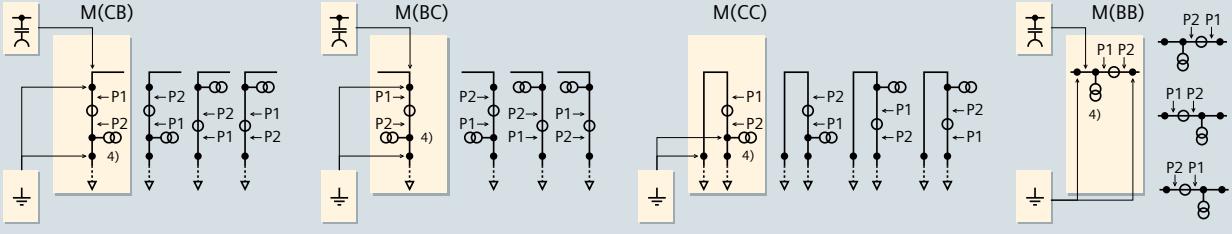
Billing metering panels as transfer panels with cable connection to the left M(CB), to the right M(BC), and on both sides M(CC), as well as with both-sided busbar connection M(BB)
(4 versions each for different instrument transformer positions; P1 and P2 are terminal designations of the current transformer)



[1] Only for end panel, on the free connection side of the busbar
[2] Only as individual panel and in blocks of 2
[3] Three-phase current transformer
[4] Cast-resin-insulated current and voltage transformers
[5] In panel blocks also possible as right end panel

Fig. 2/3: **Schematic design and options for panel types of 8DJH up to 24 kV (symbol explanations for the components are given in the annex)**
Click here (not for mobile devices)

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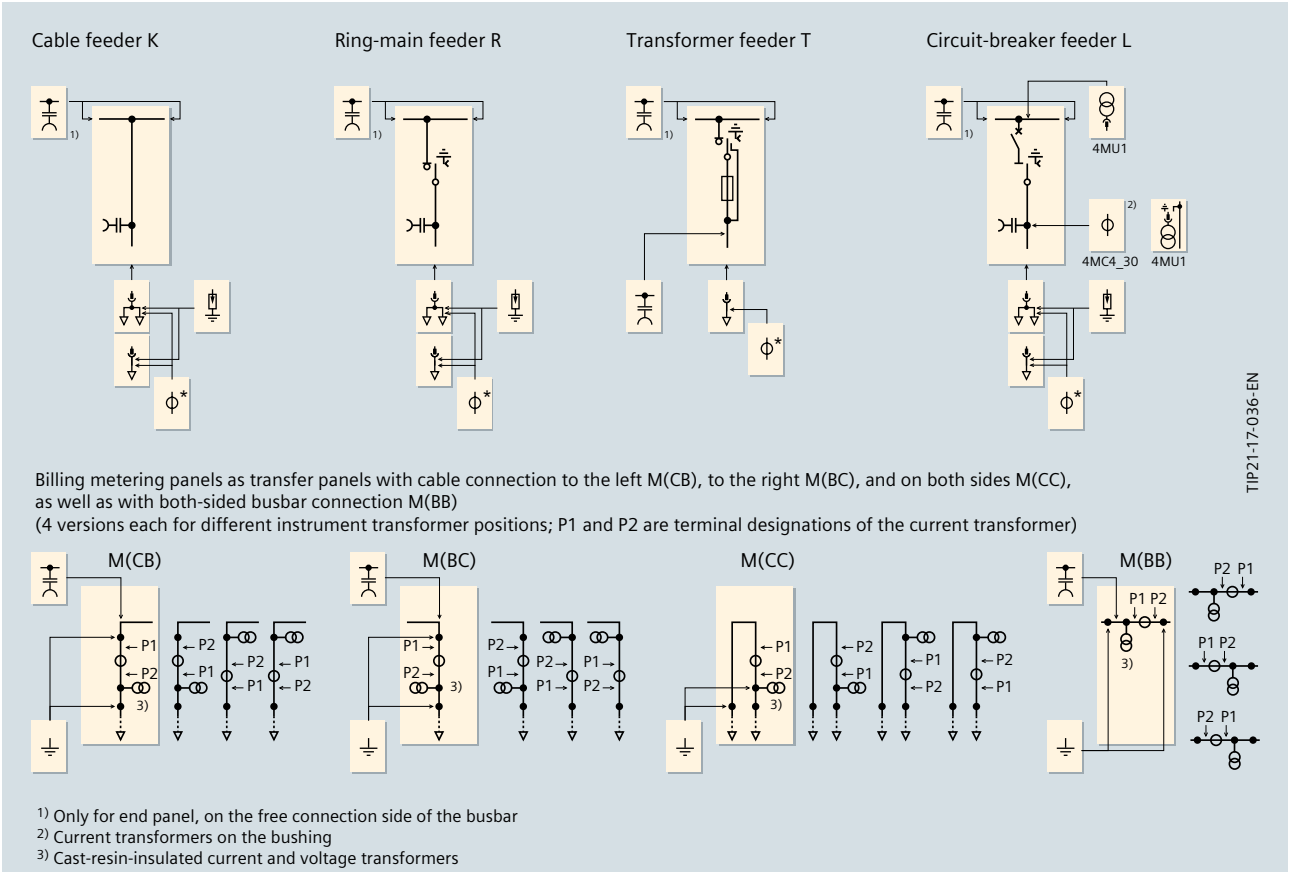

Fig. 2/4: **Schematic design and options for panel types of 8DJH 36**
(symbol explanations for the components are given in the annex)
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2.1 Panels and panel blocks

For simplification, abbreviations are introduced for the typical panels, which identify the function. As differentiation features, widths as well as connection and equipment options are partly specified in brackets to the type of function:

- Ring-main feeders R and R(500)
- Cable feeders K (German: Kabel) and cable feeders with make-proof earthing switch K(E)
- Transformer feeders T
- Circuit-breaker feeders L (German: Leistungsschalterfeld) with different widths and vacuum circuit-breaker types (e.g., number of breaking operations and different operating sequences); for 8DJH up to 24 kV: L and L(500) with circuit-breaker type 1.1 and type 2; for 8DJH 36: L with circuit-breaker type 1 and type 2
- Bus sectionalizer V(type 1.1) and V(type 2) with different vacuum circuit-breakers
- Bus sectionalizer H# (German: Hochführung – bus riser) with switch-fuse combination
- Bus sectionalizer S and S(500) with three-position switch-disconnector and earthing on the right as well as S(620) with earthing on the left instead of on the right
- Busbar earthing panels E and E(500)
- Busbar voltage metering panel with disconnectable voltage transformer M(500) and M(430); M(430) is fused on the primary side
- Billing metering panels without switching device M(BB), M(CB), M(BC), and M(CC), whereby the connection - viewed from the front – is done on the left (1st letter) or on the right (2nd letter), to the busbar "B" and/or to a cable "C".

For 8DJH and 8DJH 36 switchgear, multiple panel blocks are available (Tab. 2/3). The functional units are combined in a common gas vessel and can therefore not be separated. The units can be combined with other panels or blocks of the individual series. In contrast, 8DJH Compact switchgear (for dimensions of the available combinations RRT, RRT-R, RRT-RRT, see Tab. 2/2) is not extendable.

8DJH up to 24 kV: Height 1,200, 1,400 or 1,700 mm												
Depth in mm	775 (for panel type L with vacuum circuit-breaker type 2, the depth is 820 mm, the depth of the mounting surface is 775 mm)											
Width in mm	620	740	860	930	1,050	1,170	1,240	1,290	1,360	1,480	1,600	1,720
Block types	RR, RK, KR	RL, LR, RT, TR, KL, LK, KT, TK, RH#, RS	K(E)L, K(E)T, LL, TT	RRR	RRL, LRR, RRT, TRR, RTR, RLR, RRH#, RRS	RLL, LRL, LLR, RTT, TRT, TTR, LLL	RRRR	TTT	RRRL, LRRR, RLRR, RRLR, RRRT, TRRR, RRTR, RTRR, RRRH#, RRRS	RRLL, RRTT, LLRR, TTRR, RLLR, RTTR, LRRL, TRRT, RLRL, RTRT, LRLR, TRTR	RLLL, LLLR, RTTT, TTTR, LRLL, LLRL, TRTT, TTRT	LLLL, TTTT
8DJH up to 24 kV: Height 1,040 mm												
Depth in mm	775											
Width in mm	620	740	930	1,050								
Block types	RR	RT	RRR	RRT, RTR								
8DJH 36: Height 1,600 mm												
Depth in mm	920											
Width in mm	1,360		1,450									
Block types	RRT, RTR, KRT		RRL, RLR, KRL									

Tab. 2/3: **Panel block types and dimensions for 8DJH up to 24 kV and 8DJH 36**

2.2 Outdoor enclosure

On request, 8DJH switchgear up to 24 kV and 8DJH Compact switchgear can be provided in an outdoor enclosure (Fig. 2/5) with the following features:

- Enclosures with three different heights for 1,200 mm and 1,400 mm switchgear height (always optionally with low-voltage compartment as a 200 mm, 400 mm, or 600 mm high version)
- Enclosure with four different widths for freely configurable, non-extendable switchgear rows up to a switchgear width of 2,000 mm
- Internal arc classification IAC A FL or FLR up to 21 kA, 1 s according to IEC 62271-200
- Degree of protection IP54.

The outdoor enclosure is suitable, for example, for outdoor applications on company grounds. Moreover, it can be mounted to standard indoor panels.

2.3 Low-voltage compartment and low-voltage niche

Features of the optional low-voltage compartment for the whole 8DJH series (Fig. 2/6) are:

- Overall heights available: 200, 400, 600, and 900 mm (900 mm not for 8DJH 36), optionally with a cover
- Partitioned safe-to-touch from the high-voltage part of the panel
- Mounting on the panel possible per feeder; standard for circuit-breaker panels type 1.1 and bus sectionalizer panels for 8DJH up to 24 kV; optionally possible for all other panel types, depending on the extent to which secondary devices are equipped
- Customer-specific equipment possible for accommodation of protection, control, measuring, and metering equipment
- Separate wiring duct on the switchgear beside the low-voltage compartment (option)
- Door with hinge on the left (standard for heights of 400, 600, and 900 mm – 900 mm not for 8DJH 36).

Fig. 2/5: **Outdoor enclosure with closed front**

Fig. 2/6: **Open low-voltage compartment (size 500 x 600 mm here) with built-in equipment (option)**

The control cables of the panel are connected with the low-voltage compartment via multi-pole, coded module plug connectors. As an option, plug-in bus wires are possible from panel to panel in the separate wiring duct located on top of the panel.

A low-voltage niche (Fig. 2/7) is only possible inside billing metering panels type M for 8DJH up to 24 kV. It is used for accommodation of optional voltage transformer MCBs or small distribution fuse boxes with fuse-links (Diazed or Neozed).

Fig. 2/7: **Low-voltage niche of a billing metering panel type M (open cover) with built-in equipment (option)**

2.4 Room planning

Please observe the following for room planning:
- Switchgear installation
- Pressure relief
- Panel dimensions
- Switchgear fixing
- Door dimensions
- Weights and stipulations for transport
- Specifications, standards, and guidelines (e.g.local and use-specific stipulations).

2.4.1 Switchgear types 8DJH up to 24 kV and 8DJH Compact

Switchgear installation

Wall-standing arrangement with wall distances according to Fig. 2/8:
- 1 row
- 2 rows (for face-to-face arrangement).

Option: Free-standing arrangement.

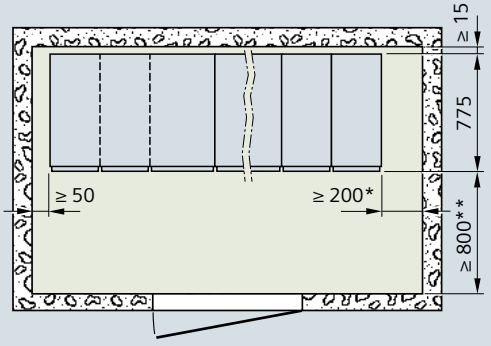
Pressure relief

The type of pressure relief selected has an effect on the switchgear depth, and places requirements on the size of the cable basement and/or the room height. In case of pressure relief upwards, the room heights reproduced in the type test are decisive for the internal arc classification according to IEC 62271-200.

The following type-tested versions of the pressure relief system are available for 8DJH switchgear up to 24 kV:
- Downwards into the cable basement (for individual panels and panel blocks, internal arc classification up to IAC A FL 21 kA, 1 s or IAC A FLR 21 kA, 1 s, minimum cross-section of the cable basement according to Fig. 2/9)
- To the rear (for non-extendable panel blocks with a switchgear height of 1,400 mm or 1,700 mm, internal arc classification up to IAC A FL 21 kA, 1 s, a rear pressure relief outlet with a minimum cross-section of 1 m^2 is required in the switchgear room and must be supplied by site)
- Upwards through rear pressure relief duct (for extendable and non-extendable panel blocks, internal arc classification up to IAC A FL 16 kA, 1 s, minimum room heights according to Fig. 2/9), with pressure absorber system
- Upwards through base and rear pressure relief duct (for individual panels and panel blocks, internal arc classification up to IAC A FL 21 kA, 1 s and IAC A FLR 21 kA, 1 s, minimum room heights according to Fig. 2/9), with pressure absorber system.

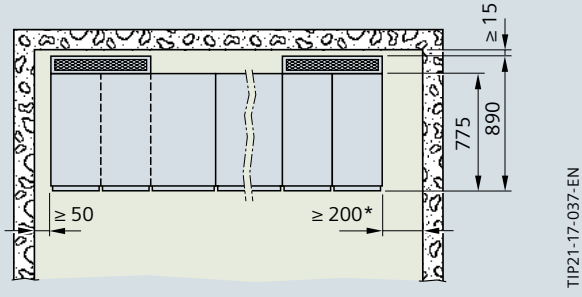
For 8DJH Compact, the following types of pressure relief (Fig. 2/10) can be selected:
- Downwards into the cable basement for all feeders (internal arc classification up to IAC A FL 21 kA, 1 s or IAC A FLR 21 kA, 1 s)
- Downwards into the cable basement for the ring-main feeders and to the rear for the transformer feeders (internal arc classification up to IAC A FL 21 kA, 1 s).

The dimensions for wall distances, control aisles, and cable basements correspond to those of the 8DJH in 24 kV design. The pressure relief to the rear was tested with a rear wall distance of ≥ 3 m. This design is recommended for application in prefabricated substations



Top view: Switchgear without pressure relief duct at the rear

*) For lined up switchgear
**) Depending on national requirements.
For extension or panel replacement, a control aisle of at least 1,000 mm is recommended.



Top view: Switchgear with pressure relief duct at the rear

Fig. 2/8: **Wall distances for 8DJH up to 24 kV and 8DJH Compact (dimensions in mm)**

without control aisle, with internal arcing test according to IEC 62271-202.

For 8DJH switchgear with outdoor enclosure (option), the direction of the pressure relief (Fig. 2/9 and Fig. 2/10) can be selected as follows:
- Downwards into the cable basement (internal arc classification up to IAC A FL or FLR 21 kA, 1 s, minimum cross-section of the cable basement according to (Fig. 2/9 and Fig. 2/10)
- To the rear (internal arc classification up to IAC A FL 21 kA, 1 s; for wall-standing arrangement, a rear pressure relief outlet with a minimum cross-section of 1 m^2 is required and must be supplied by the site)
- Upwards through rear pressure relief duct (internal arc classification up to IAC A FL or FLR 21 kA, 1 s, free space above the switchgear 600 mm as a minimum)

The dimensions for wall distances, control aisles, and cable basements correspond to those of the 8DJH design up to 24 kV. The outdoor enclosure is conceived for application on company grounds.

Panel dimensions

In addition to the information in Tab. 2/2 and Tab. 2/3, the cable and instrument transformer connections as well as their connection height are shown in the panel views (Fig. 2/11). For the panel blocks RR, RRR, RT, RRT, and RTR, a switchgear height of 1,040 mm is possible (but without the low-voltage compartment option). The height of the base cover E is then 32 mm, and the cable connection D is located at a height of 500 mm for ring-main panels and 62 mm for transformer panels. Panel views and dimensioning for 8DJH Compact panel blocks are shown in Fig. 2/12.

Floor openings and fixing points

Possible foundations for switchgear fixing:
- Steel girder construction
- Reinforced-concrete floor.

The dimensions for floor openings and fixing points of the switchgear are given in Fig. 2/13. Only standard designs are shown. For panel versions with double cable connection and deep cable compartment cover, as well as for special versions, please order the dimension drawings via your Siemens partner *(www.siemens.com/tip-cs/contact)*.

Weights and transport

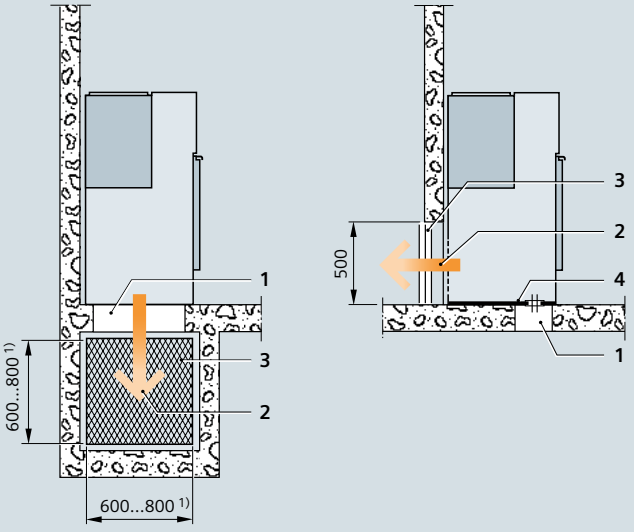
8DJH switchgear is completely delivered in transport units. The following must be observed:
- Means of transport and packing (Tab. 2/4)
- Transport facilities on site (Fig. 2/14)
- Transport dimensions (Tab. 2/5) and size of the door openings in the building
- Switchgear weights per transport unit and packing, depending on the size of the transport unit and the type of transport (Tab. 2/6).

The transport weight results from the switchgear weight per transport unit and the packing weight. The packing weight is determined by the transport dimensions and the type of transport.

The weight of the switchgear unit results from the sum of the weights per functional unit. Depending on the design and the degree to which the switchgear is equipped (e.g. current transformers, motor operating mechanism, low-voltage compartment), different values will result. Mean values are shown in Tab. 2/6.

The door dimensions have an influence on the size of the transport units and the factory assembly of panel groups, low-voltage compartments, and pressure absorber systems. If required, this installation work can also be performed on site by the customer.

Switchgear installation with pressure relief downwards (standard) or to the rear (option)



1 Floor opening
2 Direction of pressure relief
3 Expanded metal (supplied by site)
4 Pressure-resistant floor cover (divided plate for comfortable working at the cable connection)
5 Pressure absorber system with pressure relief duct

1) Total opening minimum 0.48 m²

Room heights for switchgear installation with rear pressure relief duct

(design with or without base)

Switchgear height	Room height
1,400 mm	≥ 2,000 mm
1,700, 1,800 mm	≥ 2,200 mm
2,300 mm	≥ 2,400 mm
2,600 mm	≥ 2,600 mm

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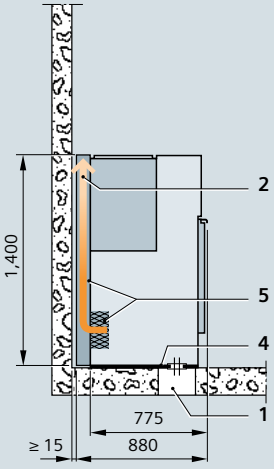
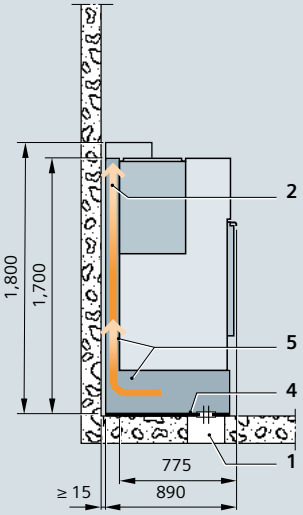
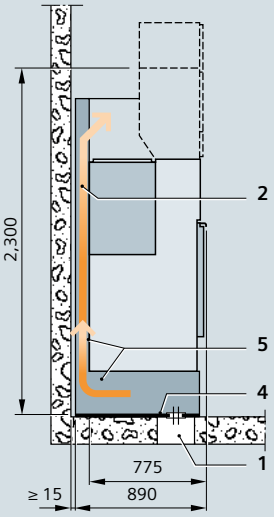
Switchgear installation with rear pressure relief duct (option) for panel blocks with IAC A FL or FLR up to 16 kA, 1 s



Switchgear installation with base and rear pressure relief duct (option) for switchgear with IAC A FL or FLR up to 21 kA, 1 s



Wall-standing arrangement without metering panel



Free-standing arrangement, also metering panel for wall-standing arrangement

Fig. 2/9: **Switchgear installation with pressure relief for 8DJH switchgear up to 24 kV (side views, dimensions in mm)**

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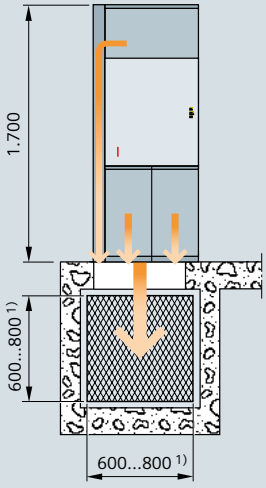
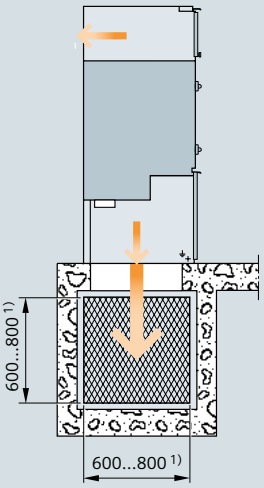
Switchgear installation with pressure relief downwards for all feeders (standard)



Switchgear installation with pressure relief downwards for the ring-main feeders, and to the rear for the transformer feeders (option)



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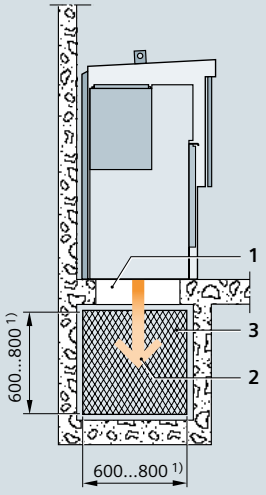
Switchgear installation for outdoor enclosure with pressure relief downwards



1 Floor opening
2 Direction of pressure relief
3 Expanded metal (supplied by site)
4 Pressure-resistant floor cover (divided plate for comfortable working at the cable connection)
5 Pressure absorber system with pressure relief duct
6 Relief opening (supplied by site)

1) Total opening minimum 0.48 m²

Switchgear installation for outdoor enclosure with pressure relief to the rear or upwards through rear duct

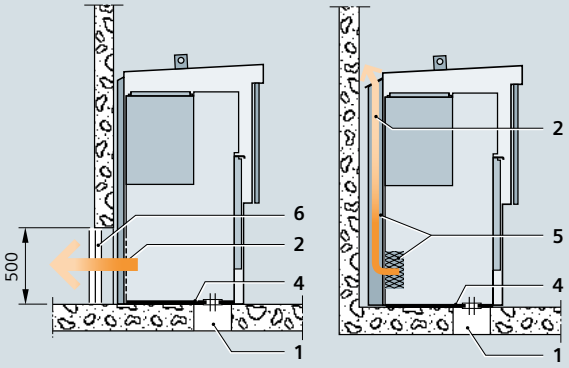


Fig. 2/10: **Switchgear installation with pressure relief for 8DJH Compact switchgear (side views, dimensions in mm)**

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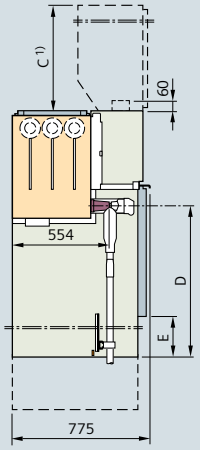
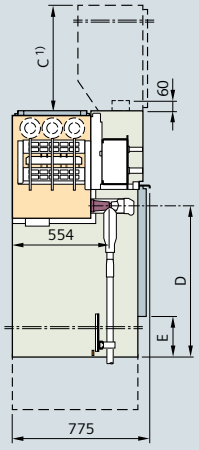
Side views of the panels

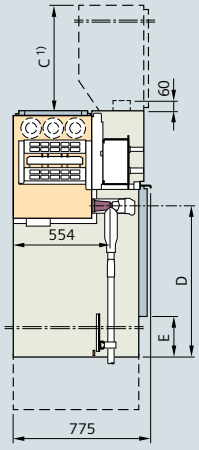
Type K



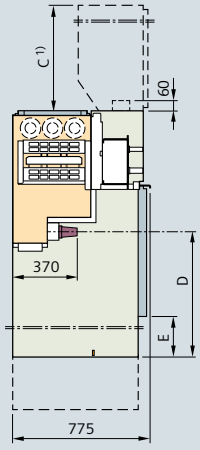
Type K(E)



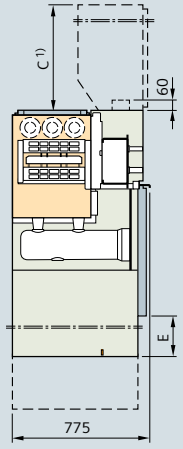
Type R



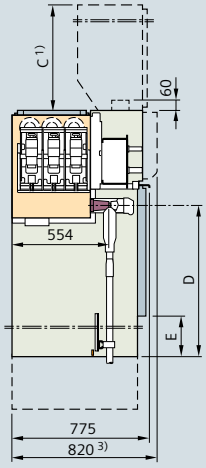
Type R(500)



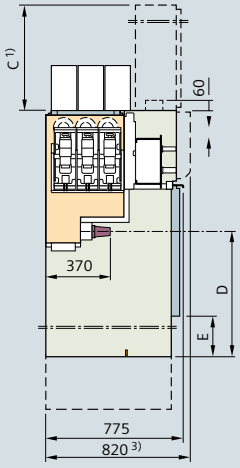
Type H#
with switch-fuse combination



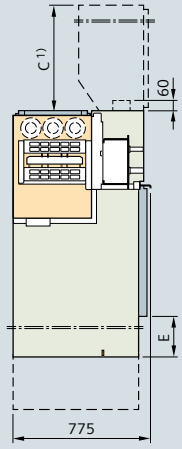
Type L



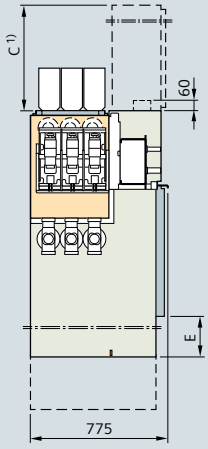
Type L(500)
with voltage transformer



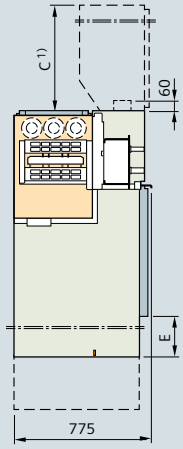
Type S



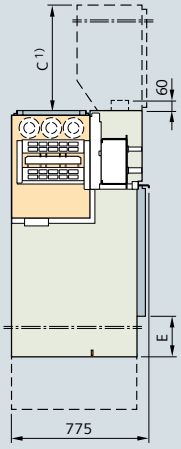
Type S(500)
with current and voltage transformer



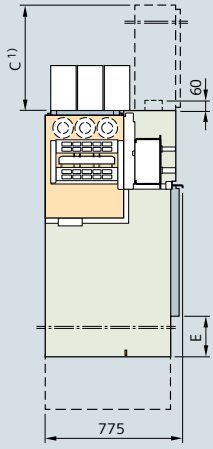
Type S(620)



Type E



Type E(500)
with voltage transformer



Type V
Design options with circuit-breaker type 2
with busbar voltage transformer and/or busbar current transformer

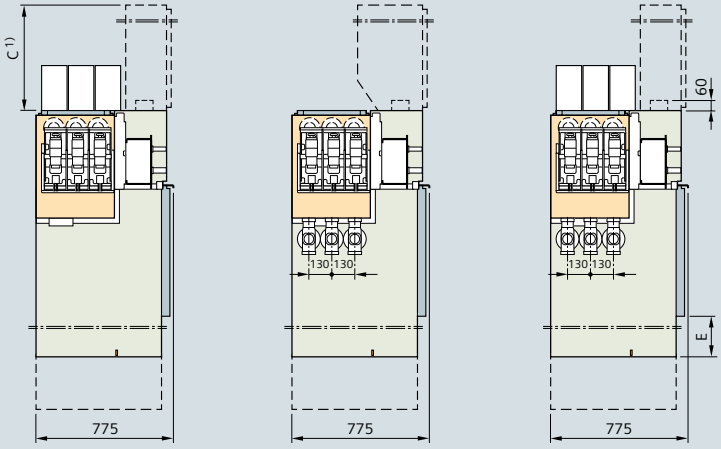


Fig. 2/11: **Side and front views with panel dimensions for 8DJH panels (dimensions in mm)**

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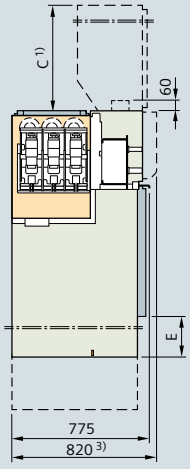
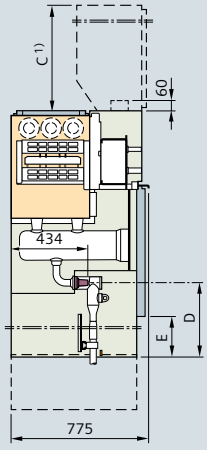
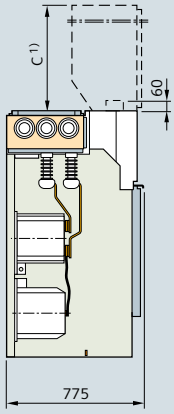
Type V
with circuit-breaker



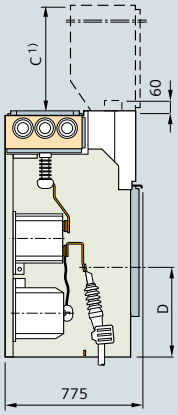
Type T



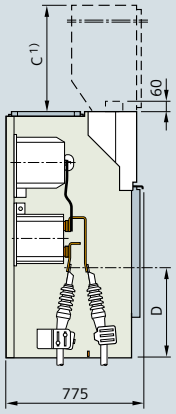
Type M(BB)
Connection:
busbar – busbar



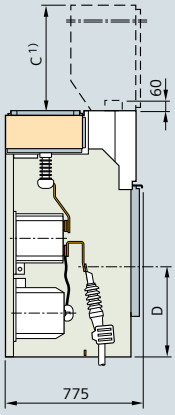
Type M(BC)
Connection: busbar on the left – cable on the right



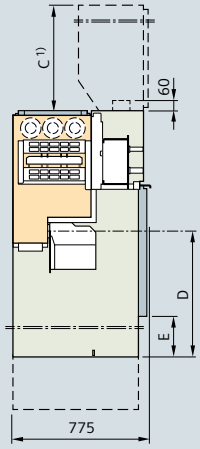
Type M(CC)
Connection:
cable – cable



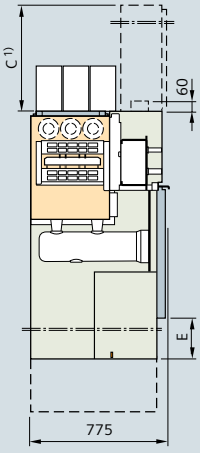
Type M(CB)
Connection: cable on the left – busbar on the right



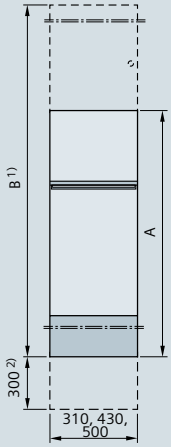
Type M(500)
with disconnectable voltage transformer

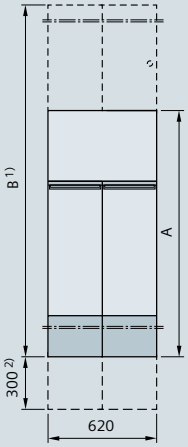


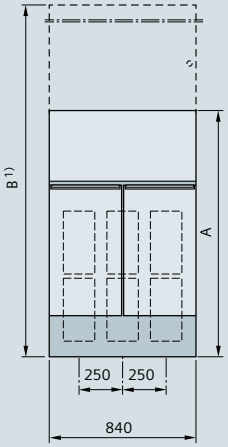
Type M(430)
with disconnectable voltage transformer, fused on the primary side



Front views with different distribution







TIP21-17-040-EN

1) Option: With low-voltage compartment

2) Base for switchgear height 1,700 mm or absorber
–> cable connection height = D + 300 mm

3) Only for circuit-breaker type 1.1

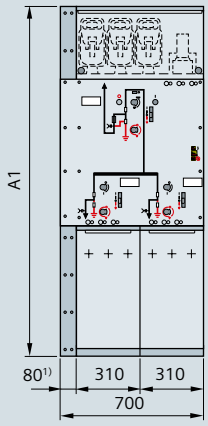
			Height in mm	
Switchgear height	without LV compart-ment	A	1,200	1,400
	with LV compart-ment	B	1,400 1,600 1,800 2,100	1,600 1,800 2,000 2,300
Low-voltage compartment		C	200, 400, 600, 900	
Cable connection	K, R, K(E), L	D	660	860
	T		222	422
	R(500), L(500)		510	710
	M(BC), M(CC), M(CB)		–	515/ 815 *)
Instrument transformer connection	M(500)	D	510	710
Base cover		E	32	232

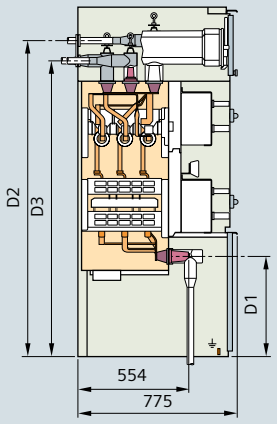
*) without absorber base: D = 515 mm;
with absorber base: D = 815 mm

Additionally available height for panel blocks RR, RRR, RT, RRT, and RTR:

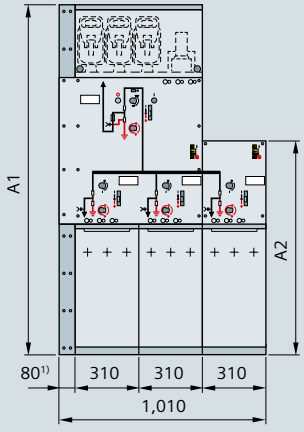
Switchgear height (without LV compartment):	A = 1,040 mm
Base cover:	E = 32 mm
Cable connection for R:	D = 500 mm
Cable connection for T:	D = 62 mm

8DJH Compact
Panel block RRT

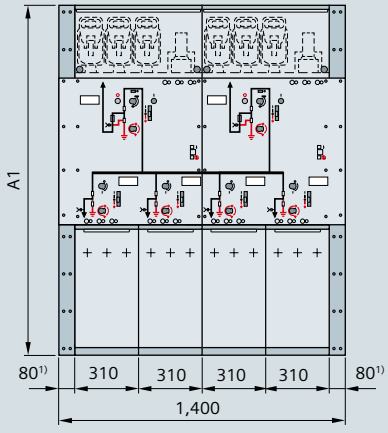




Panel block RRT-R



Panel block RRT-RRT



			Height in mm	
Switchgear height		A1	1,400	1,700
		A2	740	1,040
Cable connection	R	D1	200	500
Cable connection	T	D2	1,245	1,545
		D3	1,143	1,443

¹⁾ Only for pressure relief downwards for all feeders (IAC A FLR up to 21 kA, 1 s)

Fig. 2/12: **Side and front views with panel dimensions for 8DJH Compact panel blocks and for outdoor enclosures (dimensions in mm)**

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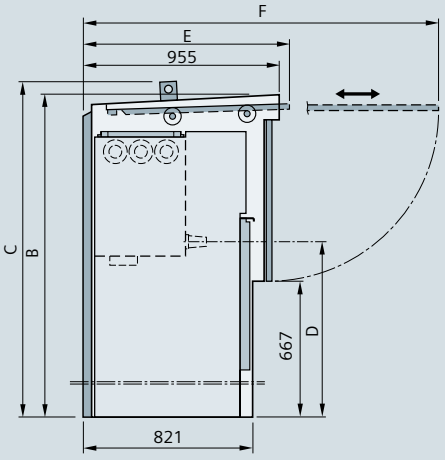
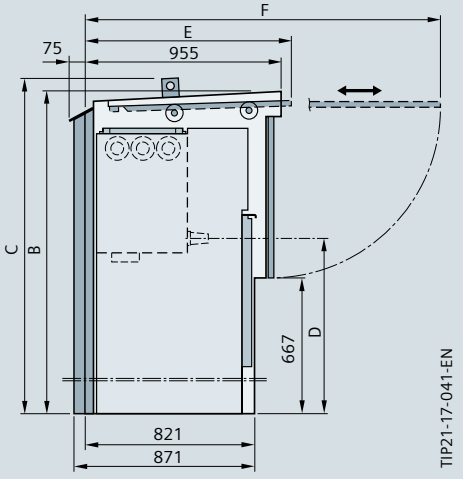
Outdoor enclosure

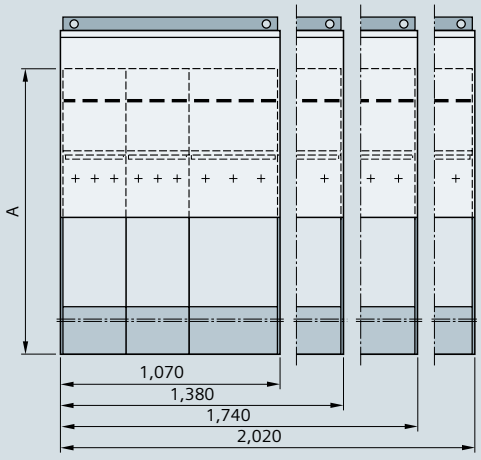
Side view with pressure relief downwards or to the rear



Side view with pressure relief upwards



Front view

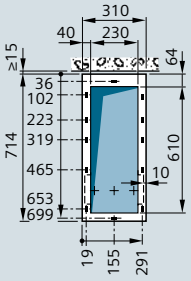


			Height in mm						
Panel height			1,200				1,400		
Low-voltage compartment height [1]			without	200	400	600	without	200	400
Switchgear height		A	1,200	1,400	1,600	1,800	1,400	1,600	1,800
Enclosure height	without crane profile	B	1,575	1,575	1,775	1,975	1,575	1,775	1,975
	with crane profile [2]	C	1,640	1,640	1,840	2,040	1,640	1,840	2,040
Cable connection	K, R, K(E), L		660				860		
	T	D	222				422		
	R(500), L(500)		510				710		
Enclosure depth (pressure relief downwards/to the rear)	Door closed	E	1,000	1,000	1,200	1,400	1,000	1,200	1,400
	Door open	F	1,725	1,725	1,925	2,125	1,725	1,925	2,125
Enclosure depth (Pressure relief upwards)	Door closed	E	1,025	1,025	1,225	1,425	1,400	1,600	1,800
	Door open	F	1,750	1,750	1,950	2,150	1,750	1,950	2,150

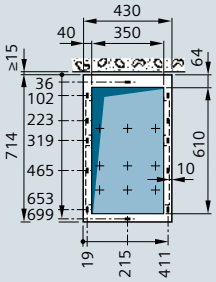
[1] Option: low-voltage compartment [2] Crane profile removable Note: maximum switchgear width = enclosure width – 20 mm

Standard for 8DJH panels up to 24 kV

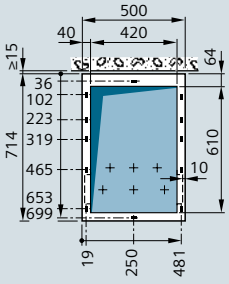
R, K, E



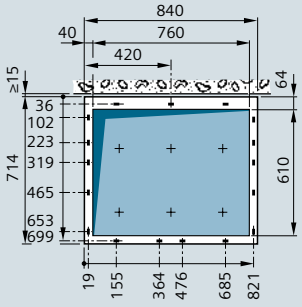
K(E), L, T, S, H#, M(430)



R(500), L(500), E(500), S(500), V, M(500)

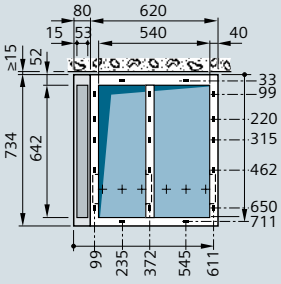


Billing metering panel M

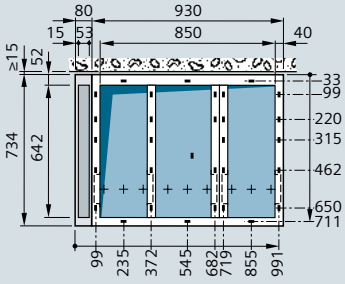


Standard for 8DJH Compact panel blocks

RRT Compact



RRT-R Compact



RRT-RRT Compact

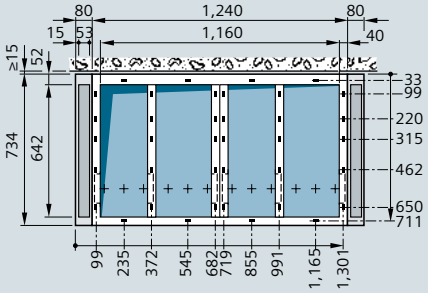


Fig. 2/13: **Floor openings and fixing points for 8DJH up to 24 and 8DJH Compact (dimensions in mm)**

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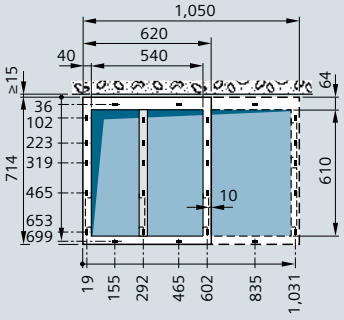
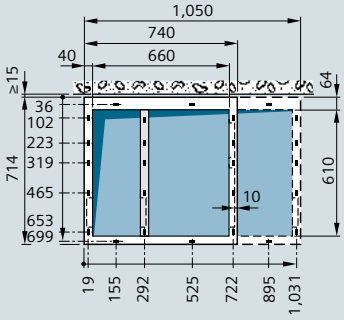
Standard for 8DJH panel blocks up to 24 kV (preferred versions)

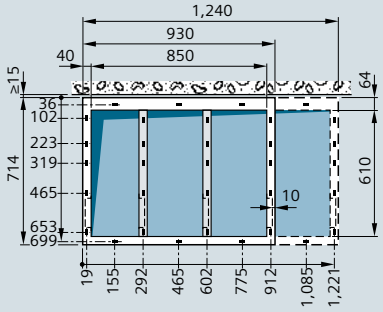
2 panels on the left: RR, RK, KR
All 3 panels: RRT, RRL, RRS, RRH#



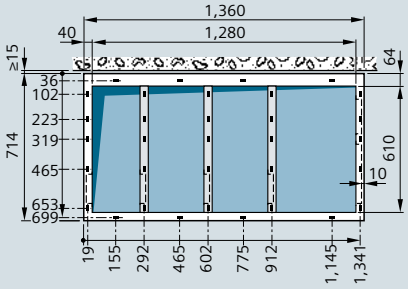
2 panels on the left: RT, RL, KT, KL
All 3 panels: RTR, RLR



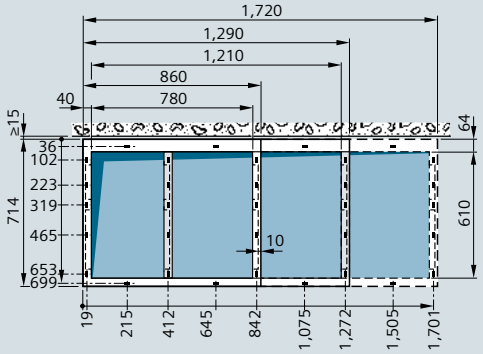
4 panels on the left: RRR
All 4 panels: RRRR



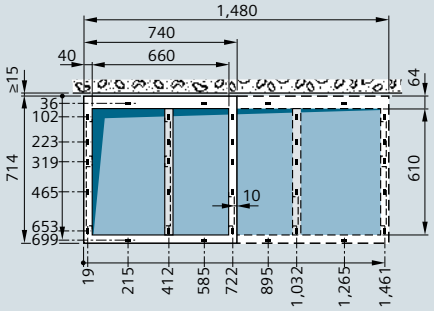
All 4 panels: RRRT, RRRL, RRRS, RRRH#



2 panels on the left: K(E)T, K(E)L, TT, LL
3 panels on the left: TTT, LLL
All 4 panels: TTTT, LLLL



2 panels on the left: TK, LK, TR, LR
All 4 panels: TRRT, LRRL



TIP21-17-042-EN

Means of transport	Examples for packing
Rail and truck (in Europe/ China)	Type: open PE protective film pulled over the switchgear, with wooden base
Ship (overseas)	Type: open (for container transport) PE protective film pulled over the switchgear, with wooden base
	Type: seaworthy crate (for open top container) Welded PE protective film, with closed wooden box, with desiccant bag
Airfreight (overseas)	Type: open PE protective film pulled over the switchgear, with wooden base and lattice or cardboard cover

Tab. 2/4: **Example for means of transport and packing for 8DJH**

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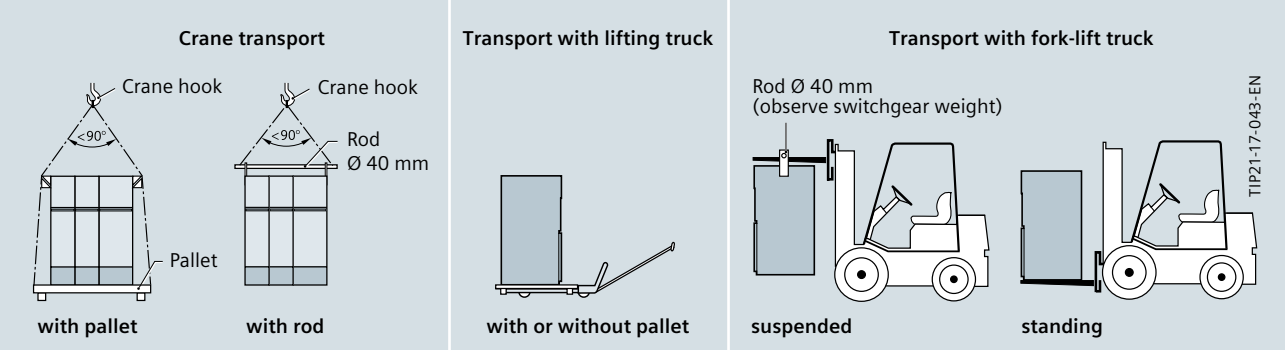

Fig. 2/14: **Examples for types of transport for the switchgear units on site**

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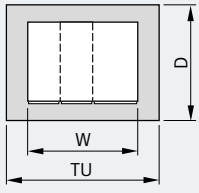
Maximum width of switchgear unit W	Transport dimensions (depth D = 1,100 mm/1,260 mm *)		
		Truck/rail/container	Seaworthy crate/ airfreight
	Transport unit TU	Height	Height
850 mm	1,100 mm	A + 200 mm	A + 400 mm min. 2,000 mm
1,200 mm	1,450 mm		
1,550 mm	1,800 mm		
1,800 mm	2,050 mm		
2,300 mm	2,550 mm		
A = Switchgear height with or without low-voltage compartment *) Deep transport base (for cable compartment cover deepened by 250 mm)			



Top view
to illustrate
the abbreviations

Tab. 2/5: **8DJH transport dimensions for Europe and overseas**

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8DJH panels up to 24 kV

Panel type	Width in mm	Gross weight in kg (approx.)			
		for switchgear height in mm			LV comp. height in mm
		1,200	1,400	1,700	600
R, K, E	310	100	110	120	40
K(E), S	430	130	140	160	50
T, H#	430	135	145	160	50
L	430	130	140	155	50
M(430) with 3x 4MT3	430	220	230	245	40
M(500) with 3x 4MT3	500	230	240	260	60
L(500, type 1.1) without 4MT3	500	210	220	240	60
L(500, type 2)	500	160	170	190	60
R(500), E(500)	500	140	150	170	60
V	500	240	250	270	60
S(500)	500	150	160	180	60
S(620)	620	200	220	240	2 × 40
M (BC/BB/CB)	840	-	370	400	70
M(CC)	840	-	270	300	70

8DJH Compact

Panel block	Width in mm	Gross weight in kg (approx.)	
		for switchgear height in mm	
		1,400	1,700
RRT	620	340	345
RRT [1]	700	365	380
RRT-R	930	450	455
RRT-R [1]	1,010	475	490
RRT-RRT	1,240	680	690
RRT-RRT [1]	1,400	730	760

Additional weights of pressure absorber

Absorber unit for	IAC classification	Weight in kg (approx.)
8DJH panel block (2 ... 4 panels)	A FL/FLR 16 kA, 1 s	110
8DJH switchgear (min. 2 panels)	A FL 21 kA, 1 s	120
	A FLR 21 kA, 1 s	145
Every additional panel (sum of panel widths ≤ 2,000 mm)		20
Metering panel M	A FL/FLR 21 kA, 1 s	145

8DJH panel blocks up to 24 kV

Panel block	Width in mm	Gross weight in kg (approx.)		
		for switchgear height in mm		
		1,200	1,400	1,700
with 2 panels				
RK, KR, RR	620	200	220	240
KT, TK, KL [2], LK [2], RT, TR, RL [2], LR 2), RS, RH#	740	230	250	280
K(E)T	860	240	260	290
K(E)L [2]	860	250	270	300
LL [2]	860	260	280	310
TT	860	270	290	320
with 3 panels				
RRR	930	300	330	360
RRL [2], RLR [2], RRS	1,050	320	350	390
RRT, RTR, RRH#	1,050	330	360	400
LLL [2]	1,290	400	430	480
TTT	1,290	410	440	490
with 4 panels				
RRRR	1,240	400	440	480
RRRS	1,360	420	460	510
RRRL [2], RRRT, RRRH#	1,360	430	470	520
LRRL [2]	1,480	460	500	550
TRRT	1,480	470	510	560
LLLL [2]	1,720	520	560	620
TTTT	1,720	540	580	640

Packing weight

Maximum width of switchgear unit in mm	Packing weight in kg (approx.)	
	Truck/rail/ container	Seaworthy crate/ airfreight
850	30	90
1,200	40	120
1,550	50	150
1,800	60	180
2,000	75	225

[1] With lateral pressure relief duct
[2] Weight information applies to design with circuit-breaker type 2

Tab. 2/6: **Weights for transport units and packing**

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2.4.2 Switchgear type 8DJH 36

Switchgear installation

Wall-standing arrangement with wall distances according to Fig. 2/15:
- 1 row
- 2 rows (for face-to-face arrangement).

Option: Free-standing arrangement.

Note: As billing metering panels are 60 mm deeper than other panels, the wall distances in Fig. 2/15 follow these panels (then, +60 mm wall distance for the other panel types).

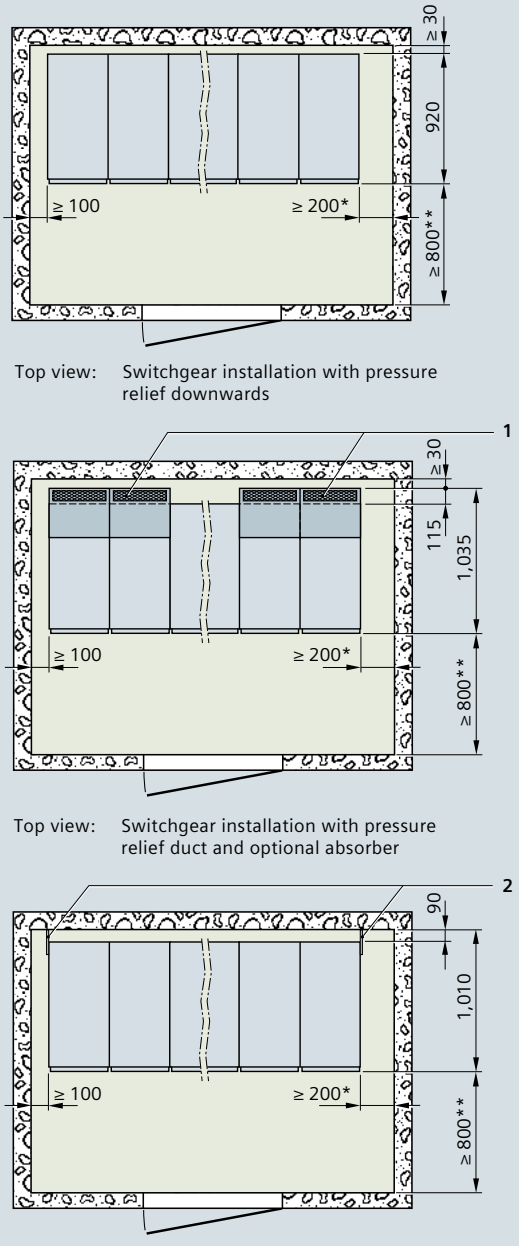
Pressure relief and room heights

The type of pressure relief selected has an effect on the switchgear depth, and determines the requirements on the size of the cable basement and/or the room height. In case of pressure relief upwards, the room heights reproduced in the type test are decisive for the internal arc classification according to IEC 62271-200.

The following type-tested versions of the pressure relief system (see Fig. 2/16) are available for 8DJH 36 switchgear:
- Downwards into the cable basement (for individual panels and panel blocks, internal arc classification up to IAC A FL 20 kA, 1 s or IAC A FLR 20 kA, 1 s)
- To the rear/upwards (for individual panels and panel blocks, internal arc classification up to IAC A FL 20 kA, 1 s)
- Upwards through rear pressure relief duct and additional absorber (for individual panels – except billing metering panels – and for panel blocks, internal arc classification up to IAC A FL 20 kA, 1 s or IAC A FLR 20 kA, 1 s).

The minimum room height for pressure relief to the rear/upwards and for switchgear with pressure relief duct at the rear is 2,000 mm. Deviating from this, a minimum room height of 2,200 mm applies to all pressure relief designs in circuit-breaker panels with busbar voltage transformers. For billing metering panels with pressure relief to the rear/upwards and with rear duct, a minimum room height of 2,400 mm is required.

Note: For 8DJH 36, no outdoor enclosures are available as standard.



1 Pressure relief duct
2 End cover

*) For lined up switchgear
**) Depending on national requirements.
For extension or panel replacement, a control aisle of at least 1,000 mm is recommended.

Fig. 2/15: **Wall distances for 8DJH 36 (dimensions in mm)**

Panel dimensions

In addition to the information in Tab. 2/2 and Tab. 2/3, the cable and instrument transformer connections as well as their connection height are shown in the panel views (Fig. 2/17).

Floor openings and fixing points

Possible foundations for switchgear fixing:
- Steel girder construction
- Reinforced-concrete floor.

The dimensions for floor openings and fixing points for panels and switchgear blocks are given in Fig. 2/18. Only standard designs with the different pressure relief possibilities are shown. For panel versions with deep cable compartment cover (deepened by 105 mm or 250 mm), as well as for other versions, please order the dimension drawings via your Siemens partner (*www.siemens.com/tip-cs/contact*).

Weights and transport

8DJH 36 switchgear is completely delivered in transport units. The following must be observed:
- Means of transport and packing (Tab. 2/4)
- Transport facilities on site (Fig. 2/14)
- Transport dimensions (Tab. 2/7) and size of the door openings in the building
- Switchgear weights per transport unit and packing, depending on the size of the transport unit and the type of transport (Tab. 2/8).

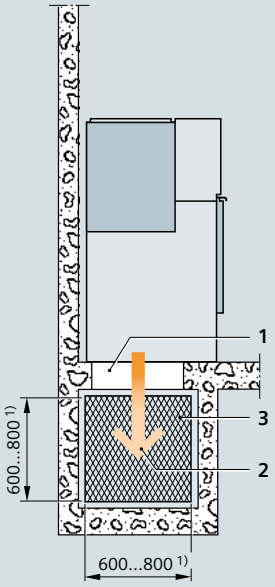
The transport weight results from the switchgear weight per transport unit and the packing weight. The packing weight results from the transport dimensions and the type of transport.

The weight of the switchgear unit results from the sum of the weights per functional unit. Depending on the design and the degree to which the switchgear is equipped (e.g. current transformers, motor operating mechanism, low-voltage compartment), different values will result. Mean values are shown in Tab. 2/6.

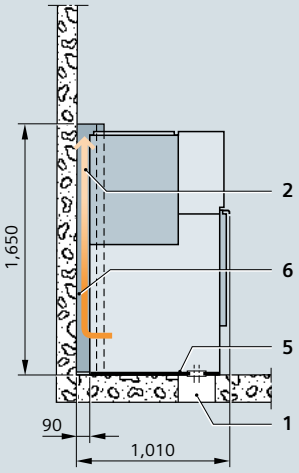
The door dimensions limit the size of the transport units and the factory assembly of panel groups, low-voltage compartments, and pressure absorber systems. If required, this installation work can also be performed on site by the customer.

For the optional pressure absorber, the weights of the absorber cooling unit, of the individual duct construction, and of the floor plates must be added per panel depending on the switchgear height (see Tab. 2/8).

Switchgear installation with pressure relief downwards (standard)



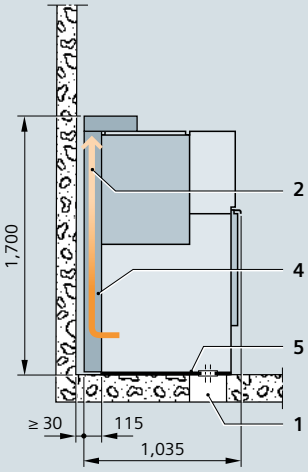
Switchgear installation with pressure relief to the rear/upwards (option)



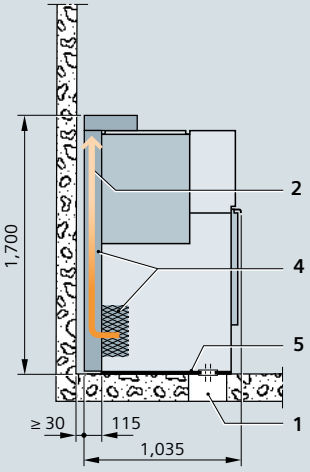
1 Floor opening
2 Direction of pressure relief
3 Expanded metal
4 Pressure relief with and without absorber and pressure relief duct directed upwards at the rear
5 Divided floor cover for cable insertion, local installation
6 Termination plate

1) Total opening minimum 0.48 m^2

Switchgear installation with pressure relief duct (option)



Switchgear installation with pressure relief duct and absorber (option)



TIP21-17-045-EN

Fig. 2/16: **Switchgear installation with pressure relief for 8DJH 36 switchgear (side views, dimensions in mm)**

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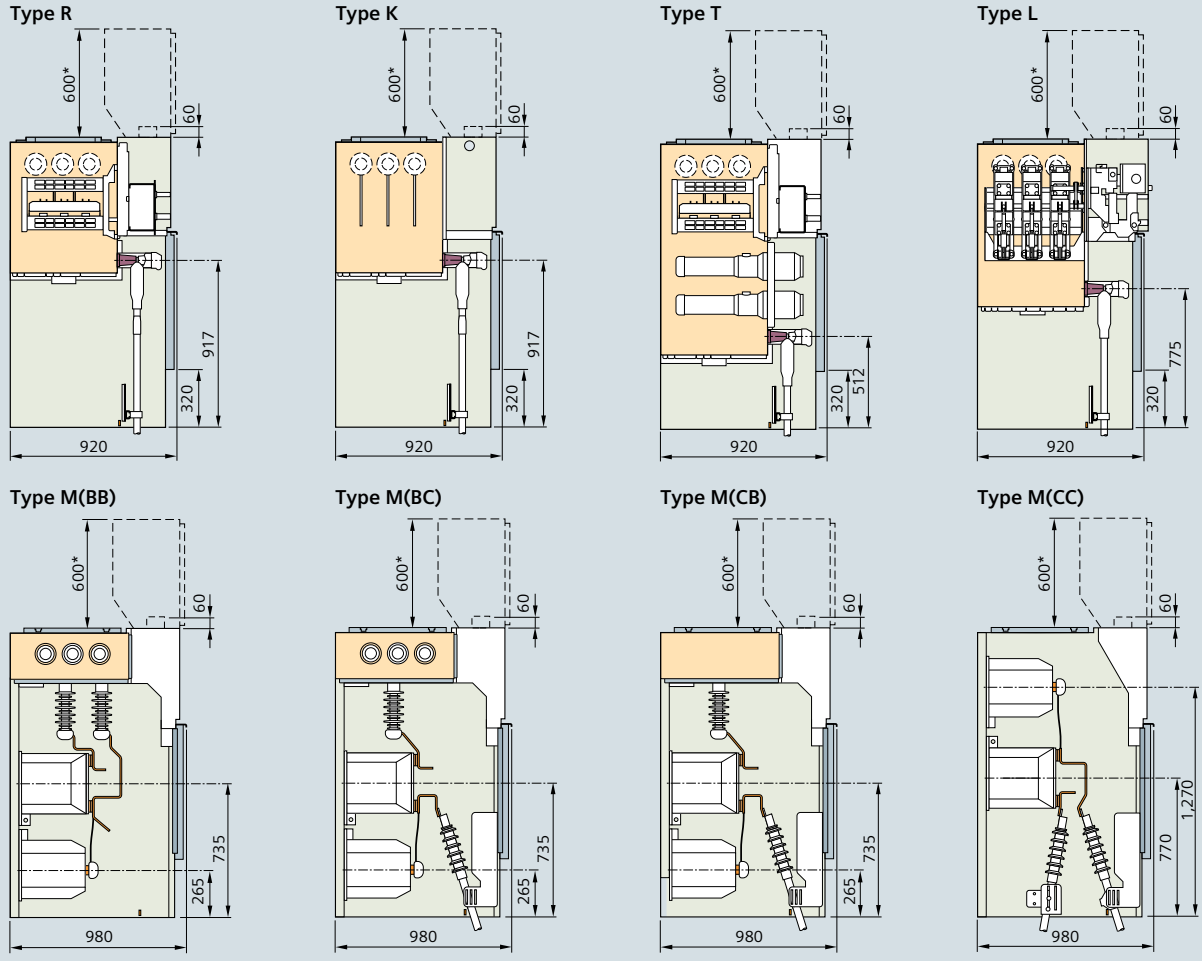
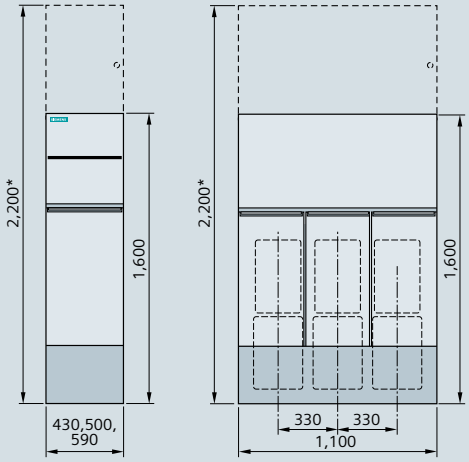
Side views of the panels



Front views of the panels



* Option: with low-voltage compartment 600 mm

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Fig. 2/17: **Side and front views with panel dimensions for 8DJH 36 panels (dimensions in mm)**

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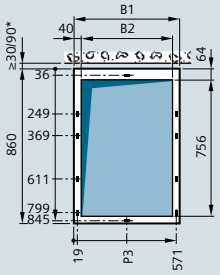
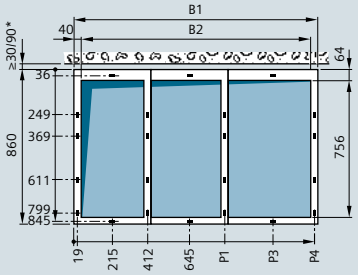
Pressure relief downwards

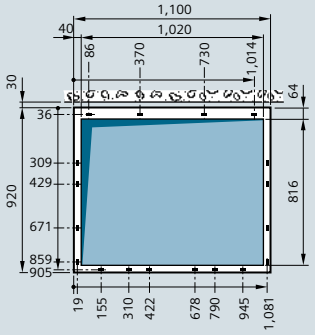
Panel types R, K, T, L



Block types RRT, KRT or RRL, KRL

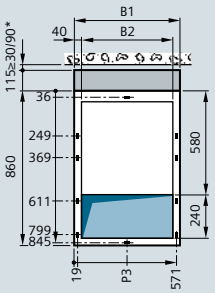


Billing metering panel

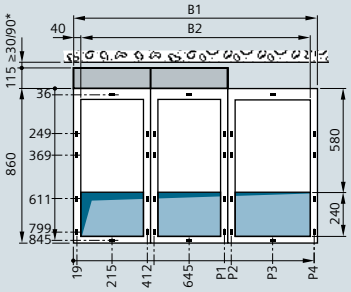


Pressure relief with duct and optional absorber

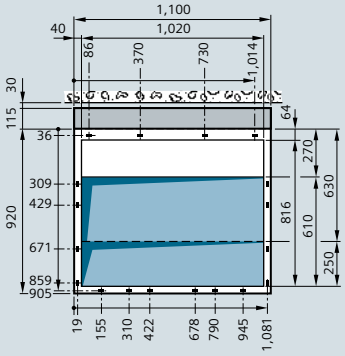
Panel types R, K, T, L



Block types RRT, KRT or RRL, KRL

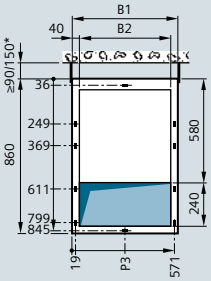


Billing metering panel

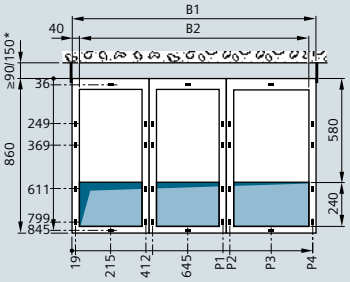


Pressure relief to the rear/upwards

Panel types R, K, T, L



Block types RRT, KRT or RRL, KRL



TIP21-17-047-EN

Panel/block type	Widths and fixings points in mm, according to the panel/block					
	B1	B2	P1	P2	P3	P4
R, K	430	350	-	-	430	-
L	500	420	-	-	250	-
T	590	510	-	-	295	-
RRT, KRT	1,360	1,280	841	879	1,110	1,341
RRL, KRL	1,450	1,370	842	880	1,155	1,431

*) For switchgear with billing metering panels, all panel types except the billing metering panel have a wall distance of 90 mm

Fig. 2/18: **Floor openings and fixing points for 8DJH 36 panels and panel blocks (dimensions in mm)**

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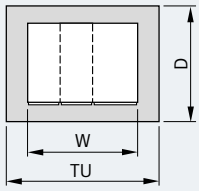
Maximum width of switchgear unit W	Transport dimensions				
	Transport unit TU	Truck/rail/container		Seaworthy crate/airfreight	
		Height	Depth D	Height	Depth D
860 mm	1,100 mm	A + 200 mm	1,100 mm/ 1,400 mm [1]	A + 400 mm min. 2,000 mm	1,150 mm/ 1,450 mm [1]
1,200 mm	1,400 mm				
1,550 mm	1,800 mm				
1,880 mm	2,050 mm				

A = Switchgear height (with or without low-voltage compartment)
[1] For switchgear with deep cable compartment cover, as well as for switchgear with pressure relief duct and pressure relief to the rear/upwards



Top view
to illustrate
the abbreviations

Tab. 2/7: **8DJH 36 transport dimensions for Europe and overseas**

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8DJH 36 panels

Panel type	Width	Gross weight in kg (approx.)	
		Switchgear height 1,600 mm (without LV compartment)	LV comp. height 600 mm
R, K	430 mm	180	50
T	500 mm	300	60
L (without 4MU)[1]	590 mm	400	70
L (with 4MU)[1]	590 mm	550/700 [1]	70
M (BC/BB/CB)	1,100 mm	740	80
M(CC)	1,100 mm	680	80

[1] 550 kg with one 4MU1 voltage transformer (on the busbar or at the cable connection)
700 kg with two 4MU1 voltage transformers (on the busbar and at the cable connection)

8DJH 36 panel blocks

Block type	Width	Gross weight in kg (approx.)
RRT, KRT, RTR	1,360 mm	650
RRL, KRL, RLR	1,450 mm	750

Packing weight

Max. width of switchgear unit in mm	Packing weight in kg (approx.)			
	Truck/rail/container		Seaworthy crate/ airfreight	
	Depth 1,100 mm	Depth 1,400 mm [2]	Depth 1,100 mm	Depth 1,400 mm [2]
860 mm	30	40	90	120
1,200 mm	40	50	120	160
1,550 mm	50	65	150	200
1,880 mm	60	80	180	235

[2] For switchgear with deep cable compartment cover, as well as for switchgear with pressure relief duct and pressure relief to the rear/ upwards

Additional weights of pressure absorber

Switchgear height 1,600 mm	Weight in kg (approx.)
Absorber cooling unit	30
Duct (IAC A FL/FLR 20 kA, 1 s)	60
Floor plate per panel	5

Example for RRT panel block: 60 + 30 + 3 × 5 = 105 kg

Tab. 2/8: **Weights for 8DJH 36 transport units and packing**

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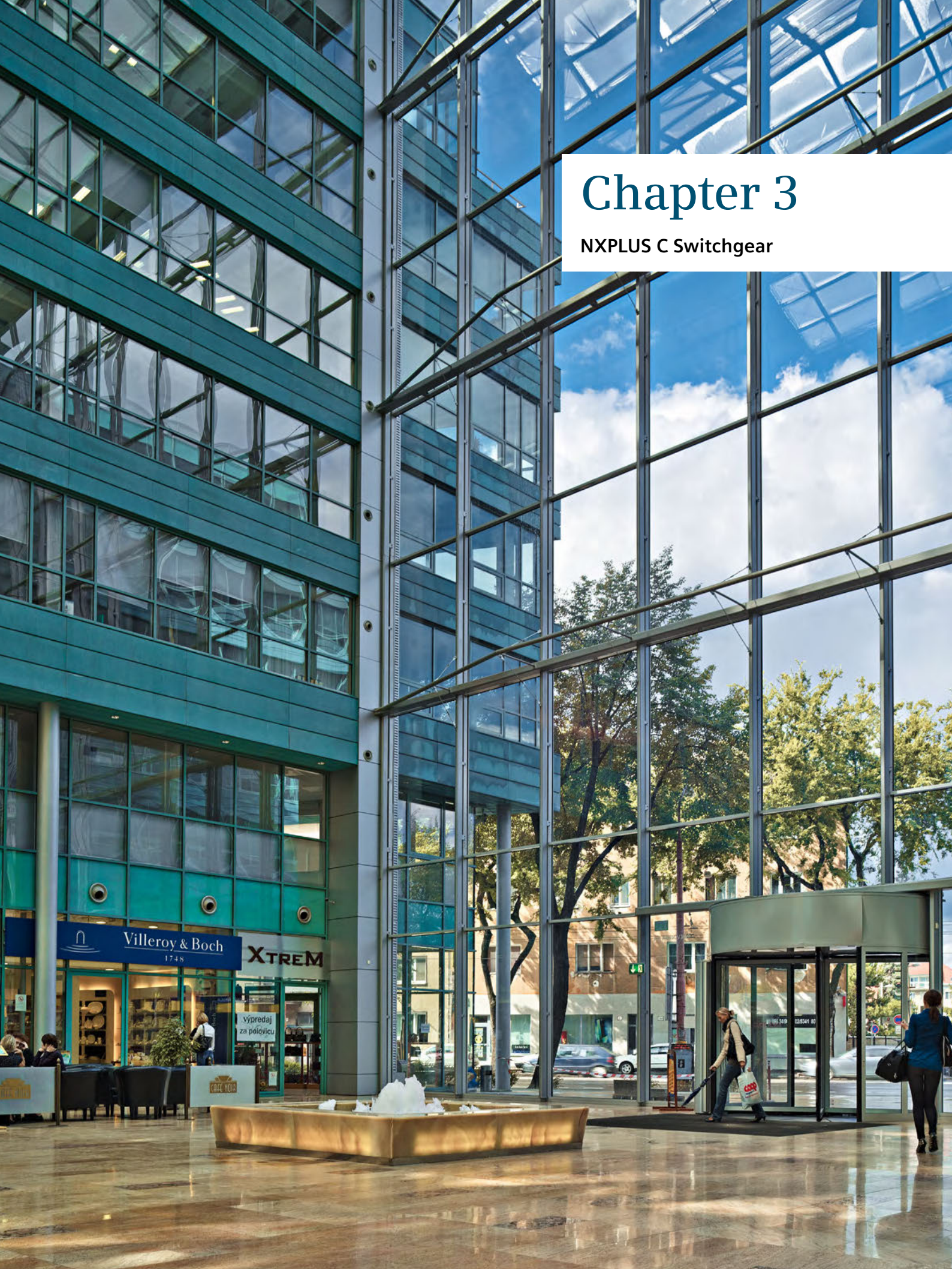

Chapter 3

NXPLUS C Switchgear

3 NXPLUS C Switchgear

Fixed-mounted circuit-breaker switchgear NXPLUS C (Fig. 3/1) is a prefabricated, type-tested, metal-enclosed, SF_6 insulated switchgear with metallic partitions ("metal-clad" according to old standard IEC 60298) for single-busbar and double-busbar applications for indoor installation.

It is used in transformer and switching substations for the primary and secondary distribution level up to 24 kV, e.g. in:

- Power supply companies, power plants, traction power supply facilities, offshore installations
- Diesel power plants, emergency power supply installations, pipeline installations
- Lignite open-cast mines, mining industry, iron and steel works
- Cement industry, mineral oil industry, petrochemical plants, electrochemical plants, chemical industry
- Automotive industry, shipbuilding industry, textile, paper, and food industry.

The hermetically welded switchgear vessel made of stainless steel as well as the single-pole solid insulation make the parts of the primary circuit under high voltage of NXPLUS C switchgear maintenance-free and safe in almost every environment. Thanks to the SF_6 insulation, compact dimensions are possible. Considering the tightness of the hermetically welded switchgear vessel, the expected service life of gas-insulated switchgear NXPLUS C under normal operating conditions is at least 35 years, probably 40 to 50 years. It is limited by the service life of the switching devices installed; more specifically, by the maximum number of operating cycles:

- For circuit-breakers, according to the endurance class defined in IEC 62271-100
- For three-position disconnectors and earthing switches, according to the endurance class defined in IEC 62271-102
- For three-position switch-disconnectors and earthing switches, according to the endurance class defined in IEC 62271-103.

The switchgear is suitable for both wall-standing and free-standing arrangement. The loss of service continuity category is LSC 2 (according to IEC 62271-200). Options to improve the resistance against shock, vibration, or earthquakes are available on request. The switchgear is also approved for application on ships and platforms. A type approval has been given by the following companies:

Fig. 3/1: **NXPLUS C switchgear panels**

- Lloyds Register (LR)
- Det Norske Veritas (DNV)
- Germanischer Lloyd (GL)
- Russian Maritime Register of Shipping (RMR)
- American Bureau of Shipping (ABS).

By certification in the system GOST R, NXPLUS C is approved for application at the voltage levels 6 kV, 10 kV, and 20 kV in Russia, Belarus, Kazakhstan, and Ukraine. By approval FSK/MRSK No. 80-10 (from 2011), NXPLUS C can be installed in all transmission and distribution grids in Russia. The approval of NXPLUS C in Canada is valid for the voltage levels 4.16 kV, 7.2 kV, and 13.8 kV. Compliance with the requirements of the CSA Group (formerly Canadian Standards Association) has been confirmed in the Certificate of Compliance No. 70043303 (from 2015).

The switchgear front as well as the end walls of the sendzimir-galvanized sheet-steel enclosure are powder-coated in color "light basic" (color 700 according to SN 47030 G1).

In the following tables and figures, data and views of NXPLUS C switchgear are quoted for planning:
- Common technical data (Tab. 3/1)
- Compilation of the panel types and options (Fig. 3/2) available for single-busbar and double-busbar switchgear
- Technical data of the panels for single-busbar switchgear (Tab. 3/2)
- Technical data of the panels for double-busbar switchgear (Tab. 3/3)
- Power losses (Tab. 3/4)
- Dimensions of the individual panels (Fig. 3/3 to Fig. 3/8)
- Room dimensions (Fig. 3/9)
- Pressure relief duct (Fig. 3/10)
- Weights and transport dimensions (Tab. 3/5).

Technical data

Rated voltage U_r	**7.2 kV**	**12 kV**	**15 kV**	**17.5 kV**	**24 kV**
Rated short-duration power-frequency withstand voltage U_d – phase-to-phase, phase-to-earth, open contact gap – across the isolating distance	 20 kV [1] 23 kV [1]	 28 kV [2] 32 kV [2]	 36 kV 39 kV	 38 kV 45 kV	 50 kV 60 kV
Rated lightning impulse withstand voltage U_p – phase-to-phase, phase-to-earth, open contact gap – across the isolating distance	 60 kV [1] 70 kV [1]	 75 kV [2] 85 kV [2]	 95 kV 110 kV	 95 kV 110 kV	 125 kV 145 kV
Frequency f_r	50/60 Hz				
Rated normal current I_r [3] for the busbar	2,500 A				
Rated filling pressure p_{re} [4]	150 kPa (absolute) at 20 °C				
Minimum functional level p_{me} [4]	130 kPa (absolute) at 20 °C				
Ambient air temperature	-5 °C to +55 °C [5]				

Footnotes for tables 3/1, 3/2, and 3/3:

[1] Higher rated short-duration power-frequency withstand voltage available with:
– 32 kV for phase-to-phase, phase-to-earth, and open contact gap, as well as
– 37 kV across the isolating distance
Higher rated lightning impulse withstand voltage:
– 60 kV for phase-to-phase, phase-to-earth, and open contact gap, as well as
– 70 kV across the isolating distance

[2] Higher rated short-duration power-frequency withstand voltage available with:
– 42 kV for phase-to-phase, phase-to-earth, and open contact gap, as well as
– 48 kV across the isolating distance
Higher rated lightning impulse withstand voltage:
– 95 kV for phase-to-phase, phase-to-earth, and open contact gap, as well as
– 110 kV across the isolating distance

[3] The rated normal currents apply to ambient air temperatures of max. 40 °C. The 24-hour mean value is max. 35 °C (according to IEC 62271-1)

[4] Pressure values for SF_6 insulated switchgear vessels

[5] Optional ambient air temperature -25 °C to +55 °C (secondary devices, e.g. protection devices, meters, measuring transducers, etc., must be suitable for the given ambient air temperature)

[6] Bus sectionalizer panel 1,000 A and disconnector panel 1,000 A only possible with rated short-time withstand current I_k = 25 kA (t_k = 1 s and 3 s), with rated peak withstand current I_p = 63 kA and rated short-circuit breaking current I_{SC} = 25 kA

[7] Bus sectionalizer panel 1,250 A in 2 panel widths only possible with rated short-time withstand current I_k = 25 kA (t_k = 1 s and 3 s), with rated peak withstand current I_p = 63 kA and rated short-circuit breaking current I_{SC} = 25 kA

[8] For circuit-breaker panel up to 15 kV, up to 31.5 kA, up to 1,250 A, the following operating cycles are optionally available:
– 30,000 operating cycles for circuit-breaker; three-position disconnector: 5,000 operating cycles for DISCONNECTING function and 5,000 operating cycles for READY-TO-EARTH function
– 30,000 operating cycles for circuit-breaker; three-position disconnector: 10,000 operating cycles for DISCONNECTING function and 10,000 operating cycles for READY-TO-EARTH function

[9] Depending on the HV HRC fuse-link, observe max. permissible let-through current I_D of the HV HRC fuse-links

[10] Extension tube (150 mm long) required additionally

[11] Applies to combination of vacuum contactor with HV HRC fuses: Vacuum contactor without HV HRC fuse reaches rated short-time withstand current I_k = 8 kA (t_k = 1 s) and rated peak withstand current I_p = 20 kA (applies to the complete switchgear)

[12] Without mechanical closing latch: 500,000
With mechanical closing latch: 100,000
Max. 60 operating cycles per hour.

[13] Bus coupler 1,250 A on request

Tab. 3/1: **Common technical data NXPLUS C as well as footnotes for the following tables Tab. 3/2 and Tab. 3/3**

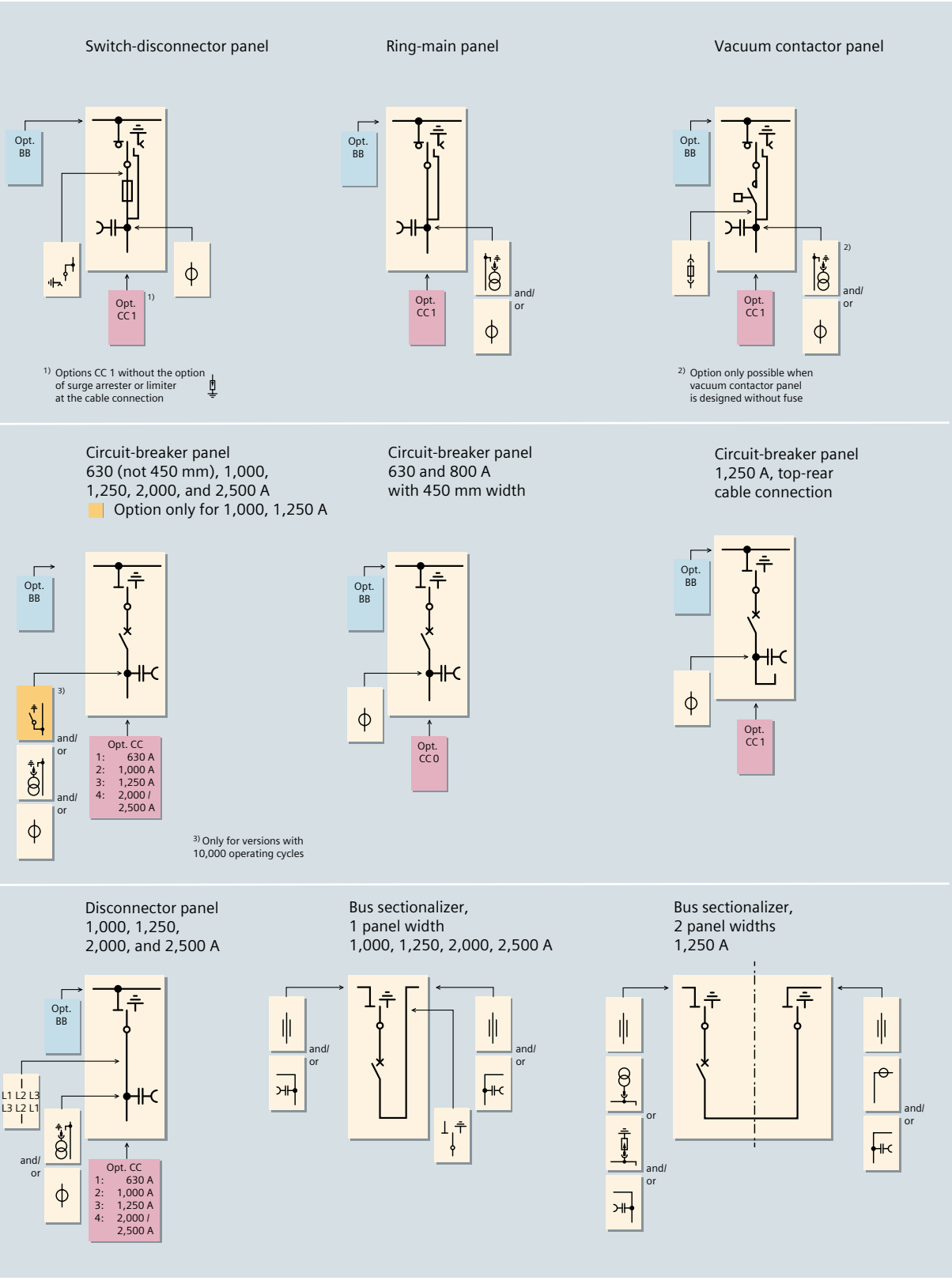

Fig. 3/2: **Panel types and options for NXPLUS C (symbol explanations for the components are given in the annex)**
Click here (not for mobile devices)

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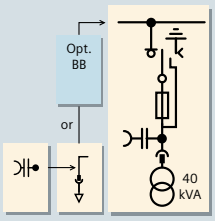
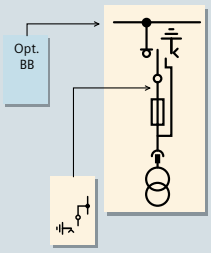
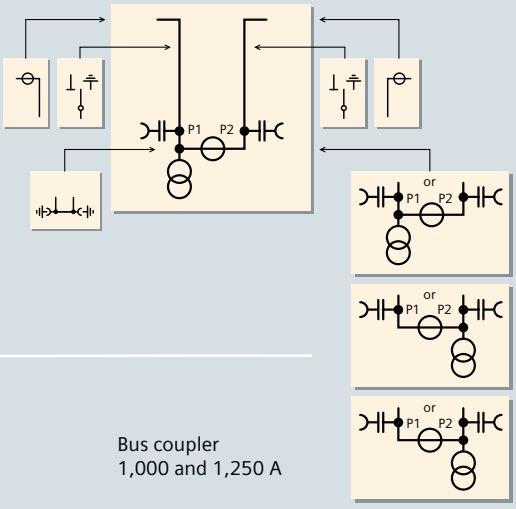
Auxiliary transformer panel



Metering panel

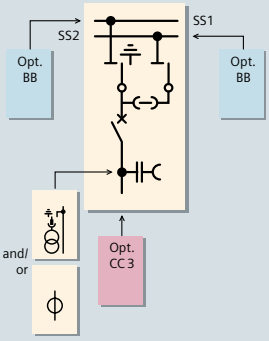


Air-insulated transfer metering panel

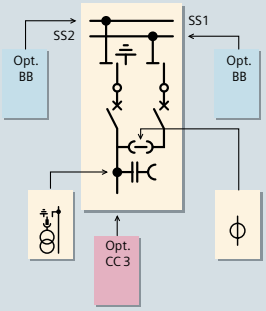


Double-busbar panels

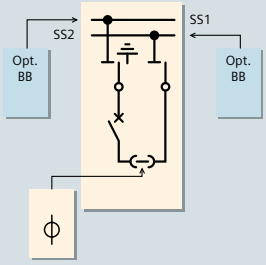
Circuit-breaker panel 1,000 A



Incoming sectionalizer 1,250 A



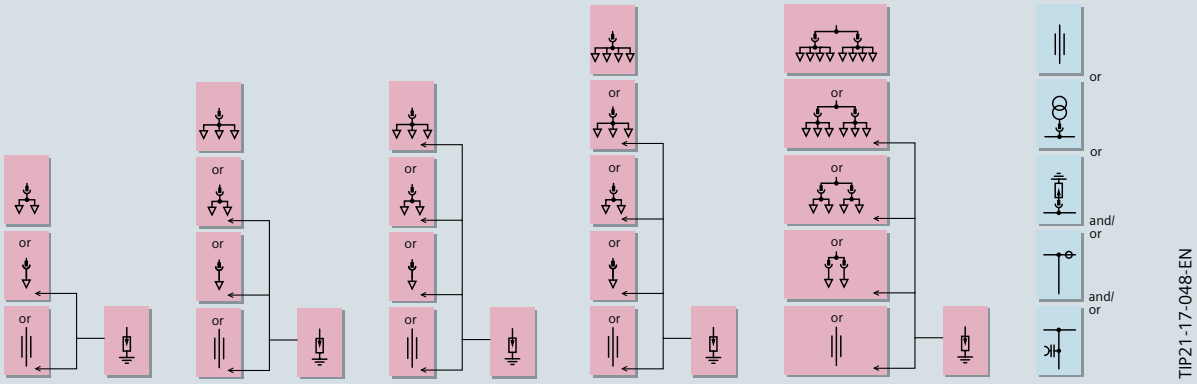
Bus coupler 1,000 and 1,250 A



Cable connection CC

Busbar BB

Options CC 0 | Options CC 1 | Options CC 2 | Options CC 3 | Options CC 4 | Options BB



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Technical data of single-busbar panels						
Rated voltage U_r		**7.2 kV**	**12 kV**	**15 kV**	**17.5 kV**	**24 kV**
Circuit-breaker panel 630, 800 A						
Rated normal current I_r [3]		630, 800 A				
Rated short-time withstand current I_k	with t_k = 1 or 3 s	25 kA				
Rated peak withstand current I_p (50/60 Hz)		63/65 kA				
Rated short-circuit making current I_{ma} (50/60 Hz)		63/65 kA				
Rated short-circuit breaking current I_{sc} (50/60 Hz)		25 kA				
Electrical endurance of vacuum circuit-breakers	at rated normal current	10,000 operating cycles				
	at rated short-circuit breaking current	50 breaking operations				
Circuit-breaker panel/bus sectionalizer 1,000 [6], 1,250 [7], 2,000 or 2,500 A						
Rated normal current I_r [3]		1,000, 1,250, 2,000, 2,500 A			1,000, 1,250, 2,000 A	
Rated short-time withstand current I_k	with t_k = 1 or 3 s	31.5 kA			25 kA	
Rated peak withstand current I_p (50/60 Hz)		80/82 kA			63/65 kA	
Rated short-circuit making current I_{ma} (50/60 Hz)		80/82 kA			63/65 kA	
Rated short-circuit breaking current I_{sc} (50/60 Hz)		31.5 kA			25 kA	
Electrical endurance of vacuum circuit-breakers	at rated normal current	10,000 operating cycles [8]				
	at rated short-circuit breaking current	50 breaking operations				
Disconnector panel 1,000 [7], 1,250, 2,000 or 2,500 A						
Rated normal current I_r [3]		1,000, 1,250, 2,000, 2,500 A			1,000, 1,250, 2,000 A	
Rated short-time withstand current I_k (with t_k = 1 or 3 s)		31.5 kA			25 kA	
Rated peak withstand current I_p (50/60 Hz)		80/82 kA			63/65 kA	
Switch-disconnector panel/auxiliary transformer panel (with HV HRC fuses) 200 A [9]						
Rated normal current I_r [3]		200 A [9]				
Rated short-time withstand current I_k	with t_k = 1 or 3 s	31.5 kA			25 kA	
Rated peak withstand current I_p (50/60 Hz) [9]		80/82 kA			63/65 kA	
Rated short-circuit making current I_{ma} (50/60 Hz) [9]		80/82 kA			63/65 kA	
Dimension "e" of HV HRC fuse-links		292 mm [10]	292 mm [10]	442 mm	442 mm	442 mm
Ring-main panel (switch-disconnector panel without HV HRC fuses)						
Rated normal current I_r [3]		630 A				
Rated short-time withstand current I_k	with t_k = 1 s	25 kA (20 kA for 2.500 A)				
	with t_k = 3 s	20 kA				
Rated peak withstand current I_p (50/60 Hz)		50/52 (I_k = 20 kA) or 63/65 kA (I_k = 25 kA)				
Rated short-circuit making current I_{ma} (50/60 Hz)		50/52 (I_k = 20 kA) or 63/65 kA (I_k = 25 kA)				
Vacuum contactor panel (with HV HRC fuses) 450 A [9]						
Rated normal current I_r [3]		450 A [9]				
Rated short-time withstand current I_k	with t_k = 1 or 3 s	31.5 kA [11]			25 kA [11]	
Rated peak withstand current I_p (50/60 Hz) [9]		80/82 kA			63/65 kA	
Rated short-circuit making current I_{ma} (50/60 Hz) [9]		80/82 kA			63/65 kA	
Electrical endurance at rated normal current		100,000 or 500,000 operating cycles [12]				
Dimension "e" of HV HRC fuse-links		292 mm [10]	442 mm	442 mm	442 mm	442 mm
Metering panel (with HV HRC fuses)						
Rated short-time withstand current I_k	with t_k = 1 or 3 s	31.5 kA			25 kA	
Rated peak withstand current I_p (50/60 Hz) [9]		80/82 kA			63/65 kA	
Dimension "e" of HV HRC fuse-links		292 mm [10]	292 mm [10]	442 mm	442 mm	442 mm
Metering panel (air-insulated) 1,250 A						
Rated normal current I_r [3]		1,250 A				
Rated short-time withstand current I_k	with t_k = 1 or 3 s	25 kA				
Rated peak withstand current I_p (50/60 Hz) [9]		63/65 kA				

Tab. 3/2: **Technical data for NXPLUS C single-busbar panels (footnotes see Tab. 3/1 on page 49)**

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Technical data for double-busbar panels			
Panel (rated voltage U_r = 7.2 kV, 12 kV, 15 kV, 17.5 kV, 24 kV)		**Circuit-breaker panel/ bus coupler**	**Incoming sectionalizer**
Rated normal current I_r [3]		1,000 A [13]	1,250 A
Rated short-time withstand current I_k with t_k = 1 or 3 s		25 kA	25 kA
Rated peak withstand current I_p (50/60 Hz)		63/65 kA	63/65 kA
Rated short-circuit making current I_{ma} (50/60 Hz)		63/65 kA	63/65 kA
Rated short-circuit breaking current I_{sc} (50/60 Hz)		25 kA	25 kA
Electrical endurance of vacuum circuit-breakers	at rated normal current	10,000 operating cycles	10,000 operating cycles
	at rated short-circuit breaking current	50 breaking operations	50 breaking operations

Tab. 3/3: **Technical data for NXPLUS C double-busbar panels (footnotes see Tab. 3/1 on page 49)**

Power losses per panel								
Normal current I_b	**400 A**	**630 A**	**800 A**	**1,000 A**	**1,250 A**	**2,000 A**	**2,300 A**	**2,500 A**
Panels with rated voltage U_r up to 15 kV	70 W	160 W	250 W	400 W	600 W	1,100 W	1,100 W	1,300 W
Panels with rated voltage U_r up to 24 kV	70 W	160 W	250 W	400 W	600 W	1,100 W		

Tab. 3/4: **Power losses per panel for NXPLUS C (footnotes see Tab. 3/1 on page 49)**

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Installation notes, dimensions, and room dimensions

For single-busbar applications, both wall-standing arrangement and free-standing arrangement are possible. Face-to face arrangement of the switchgear is possible observing the necessary distances [Siemens AG, 2016: Planning of Electric Power Distribution – Technical Principles]. For double-busbar applications, only free-standing installation is possible due to the back-to-back arrangement.

For a room height ≥ 2,750 mm, all types of installation can be planned with or without horizontal pressure relief duct. For pressure relief to the outside through a particular duct, the duct units shown in Fig. 3/10 are available, among others. The panel height with horizontal pressure relief duct is 2,640 mm. For more information, please contact your Siemens partner *(www.siemens.com/tip-cs/contact)*.

For a room height between 2,400 mm and 2,750 mm, no pressure relief duct is required in case of wall-standing and free-standing arrangement as long as a rear-side pressure relief duct, a busbar with 1,250 A and, if requested, a low-voltage compartment with a height of 761 mm are provided for. Recommended door dimensions are:

Door height: ≥ 2,500 mm

Door width: ≥ 900 mm for panel widths up to 600 mm

≥ 1,200 mm for panel widths of 900 mm

Information to floor openings and fixing points is given in Fig. 3/3 to Fig. 3/6. As foundations, the following can be used:

- Steel girder construction
- Steel-reinforced concrete with foundation rails, welded or bolted on.

For adaptation of the insulation levels to site altitudes of more than 1,000 m above sea level, a correction factor K_a can be derived from the curve of Fig. 2/2 (see examples in chap. 2).

Legend:
1 Left-side floor opening for control cables
2 Pressure relief duct
2* Option: Pressure relief duct
3 Fixing hole for M8/M10
4 Fixing hole for M8/M10 (only for resistance against shock, vibration, earthquakes, or optionally for a width of 450 mm)
5 Floor opening for high-voltage cables
6 Pressure relief duct/cable compartment
7 Right-side floor opening for control cables (only required for zero-sequence current transformers in the cable basement)
8 Cross member (necessary for panel replacement)
9 Option: HV HRC fuses

Footnotes:
1) 2,650 mm for higher low-voltage compartment
2) With a deep cable compartment cover, the dimension increases by 20 mm
3) When only one cable is connected, the dimension is reduced by 275 mm

Fig. 3/3: **Front view, side views, and mounting surface with floor fixing points for switch-disconnector panels, ring-main panels, and vacuum contactor panels of NXPLUS C with single busbar, as well as legend and footnotes for Fig. 3/3 to Fig. 3/8 (dimensions in mm)**

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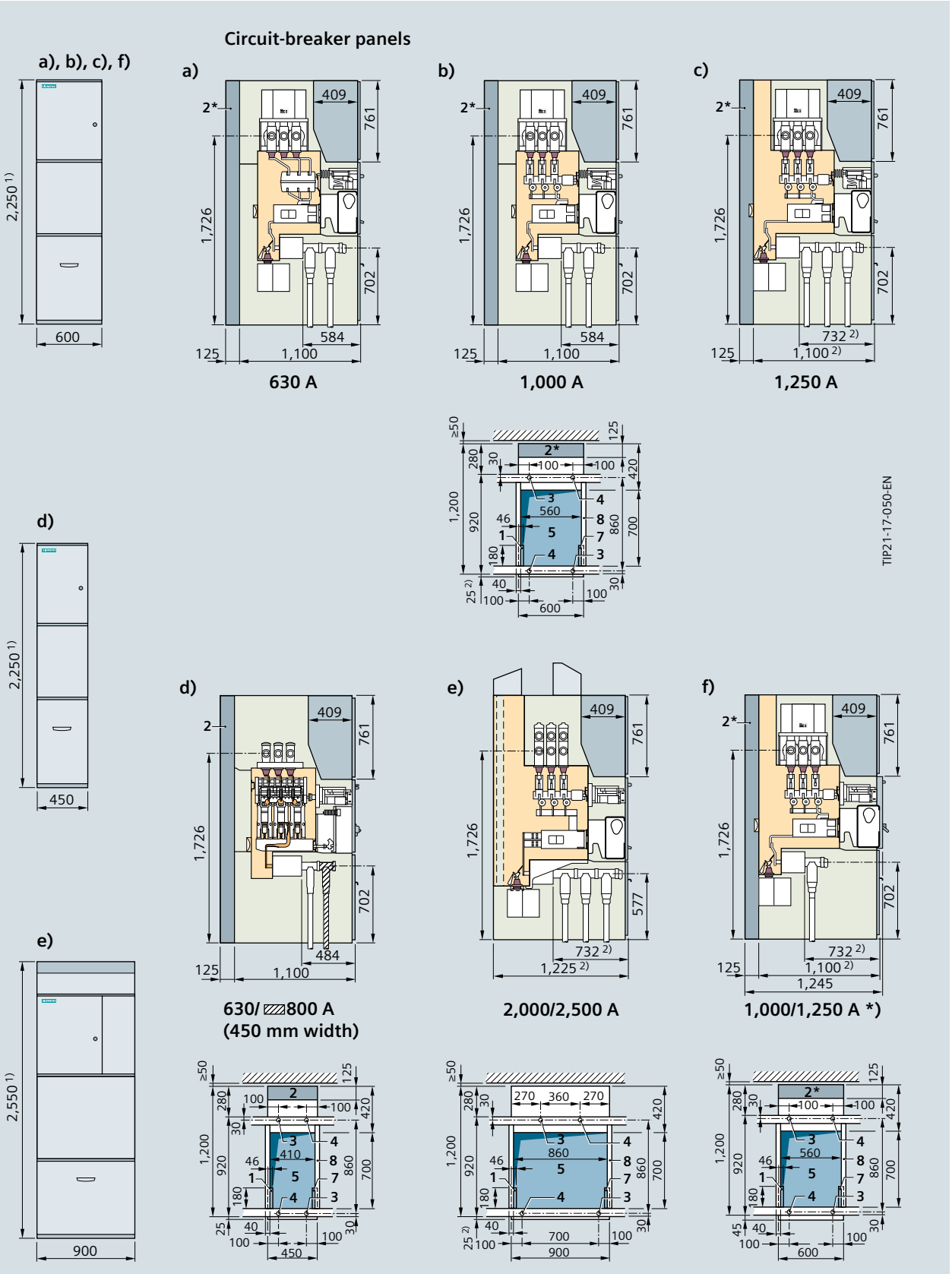

Fig. 3/4: **Front and side views as well as mounting surfaces with floor fixing points for circuit-breaker panels with cable connection from below (dimensions in mm; legend and footnotes see Fig. 3/3 on page 54)**

*) Circuit-breaker panel for 30,000 operating cycles (with 5,000 or 10,000 operating cycles for the DISCONNECTING/READY-TO-EARTH functions)

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Fig. 3/5: **Front and side views as well as mounting surfaces with floor fixing points for circuit-breaker panels with top-rear or bottom-rear cable connection and auxiliary transformer panels of NXPLUS C with single busbar (dimensions in mm; legend and footnotes see Fig. 3/3 on page 54)**

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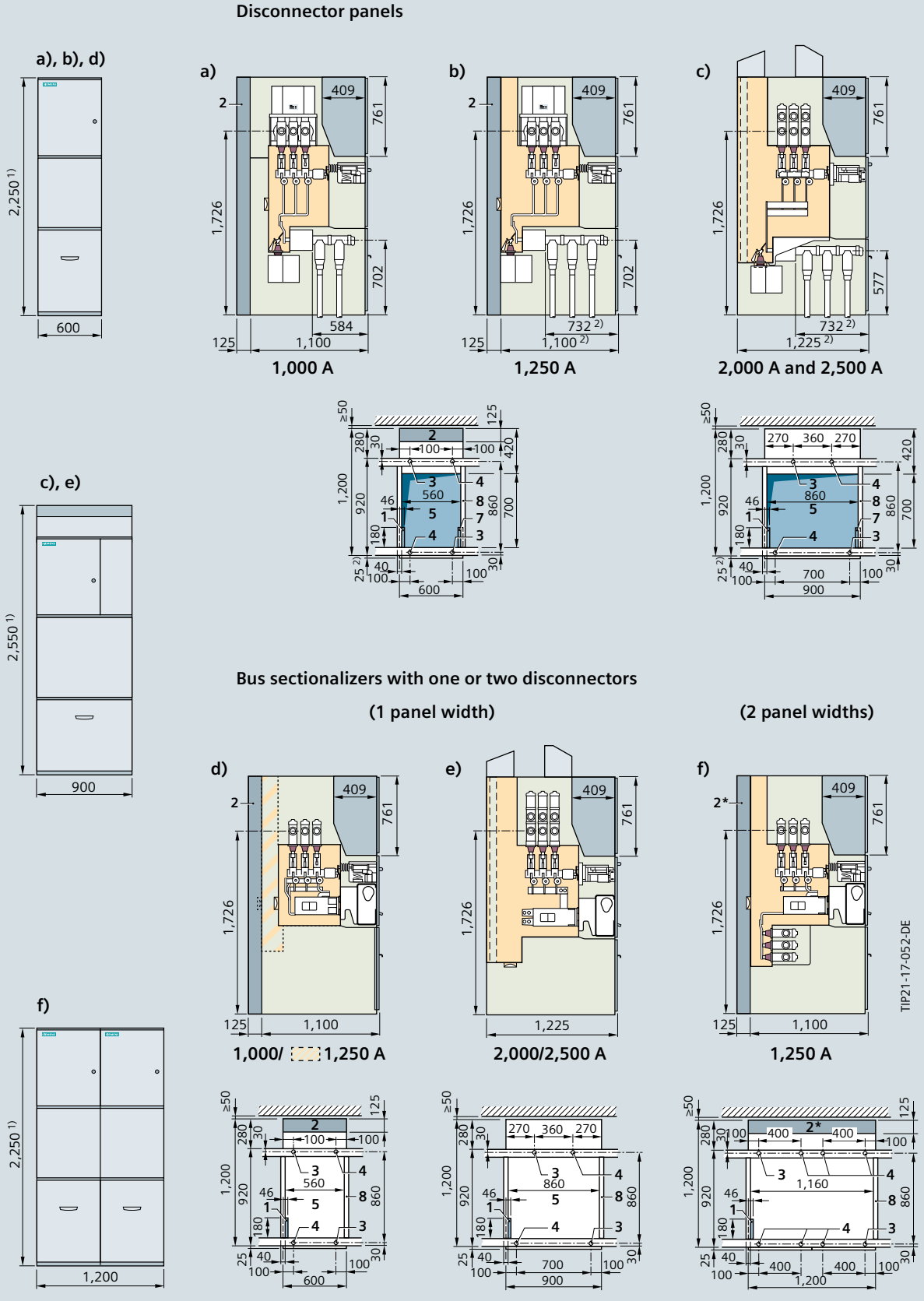

Fig. 3/6: **Front and side views as well as mounting surfaces with floor fixing points for disconnector panels and bus sectionalizers of NXPLUS C with single busbar (dimensions in mm; legend and footnotes see Fig. 3/3 on page 54)**

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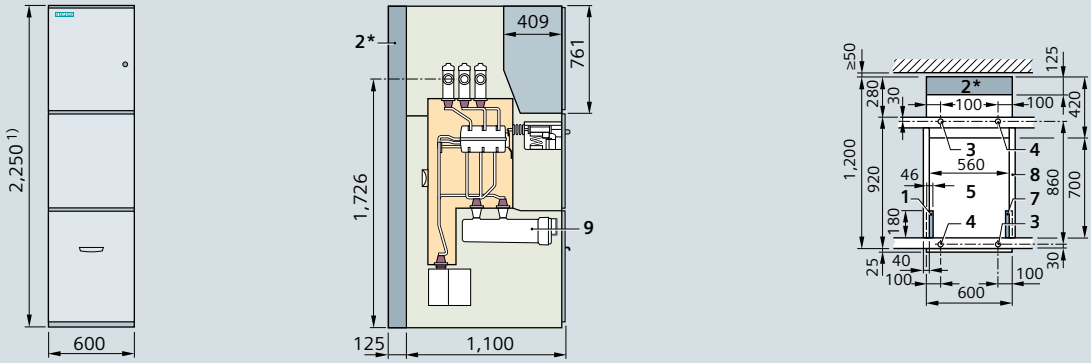
Metering panel with HV HRC fuses



Air-insulated metering panel

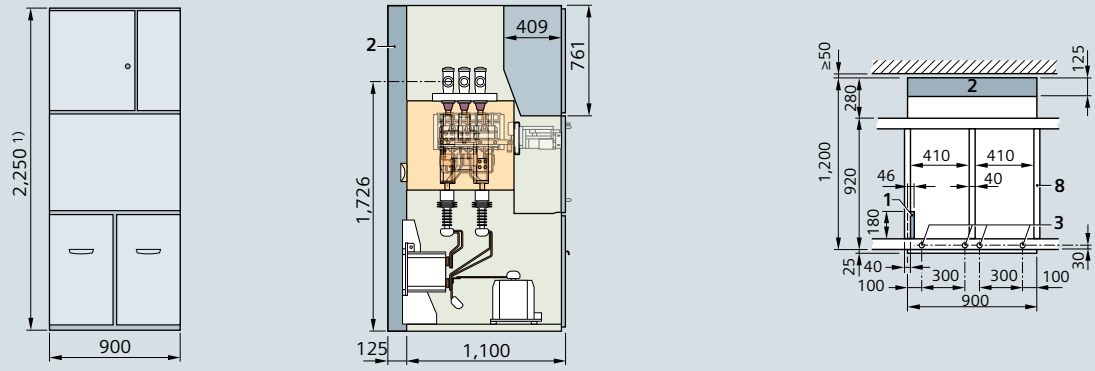


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Fig. 3/7: **Front and side views as well as mounting surfaces with floor fixing points for metering panels of NXPLUS C with single busbar (dimensions in mm; legend and footnotes see Fig. 3/3 on page 54)**

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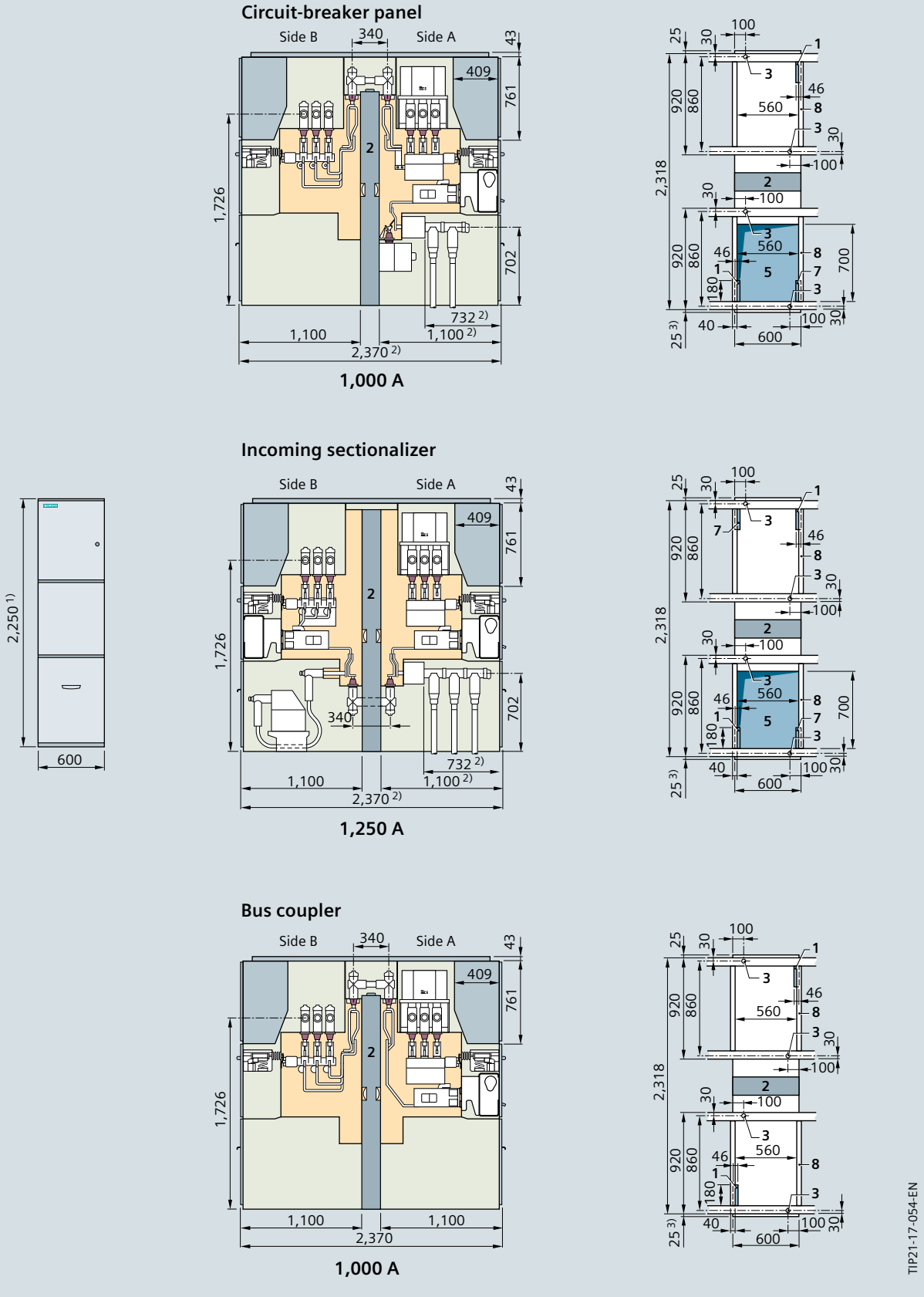

Fig. 3/8: **Front and side views as well as mounting surfaces with floor fixing points for circuit-breaker panels and sectionalizers/ couplers of NXPLUS C with double busbar (dimensions in mm; legend and footnotes see Fig. 3/3 on page 54)**

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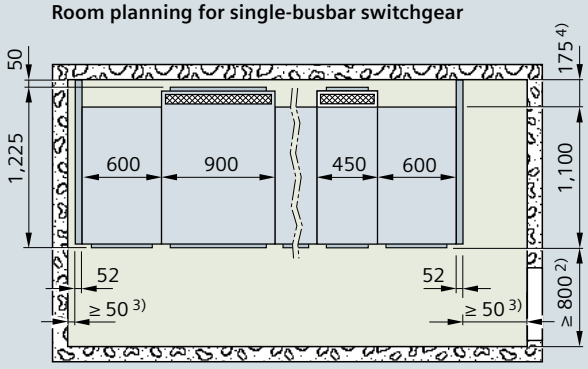
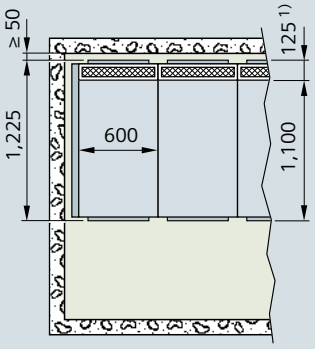
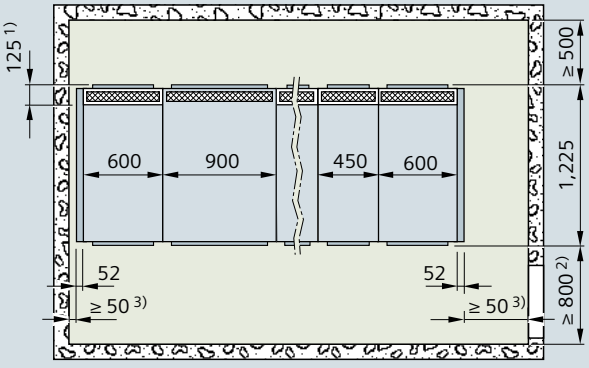
Room planning for single-busbar switchgear



Wall-standing arrangement (top view)
Panels without rear pressure relief duct

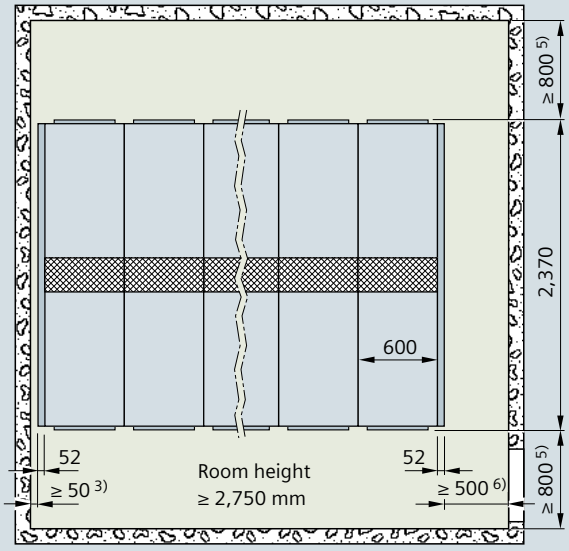


Wall-standing arrangement
(same as left side), but panels
with rear pressure relief duct



Free-standing arrangement (top view),
panels with rear pressure relief duct

Room planning for double-busbar switchgear



Free-standing arrangement (top view)

1) Rear pressure relief duct:
Depth 125 mm
2) Depending on national requirements;
for extension/panel replacement:
Control aisle
≥ 1.400 mm recommended (600 mm panels)
≥ 1.600 mm recommended (900 mm panels)
3) Lateral wall distances on the left or on the right:
≥ 500 mm recommended
4) 125 mm, if there are exclusively 600 mm panels
5) For panel replacement:
Control aisle
≥ 1.400 mm necessary
6) Lateral wall distance on one side
≥ 500 mm optionally possible
on the left or on the right

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Fig. 3/9: **Dimensions for room planning of NXPLUS C (dimensions in mm)**

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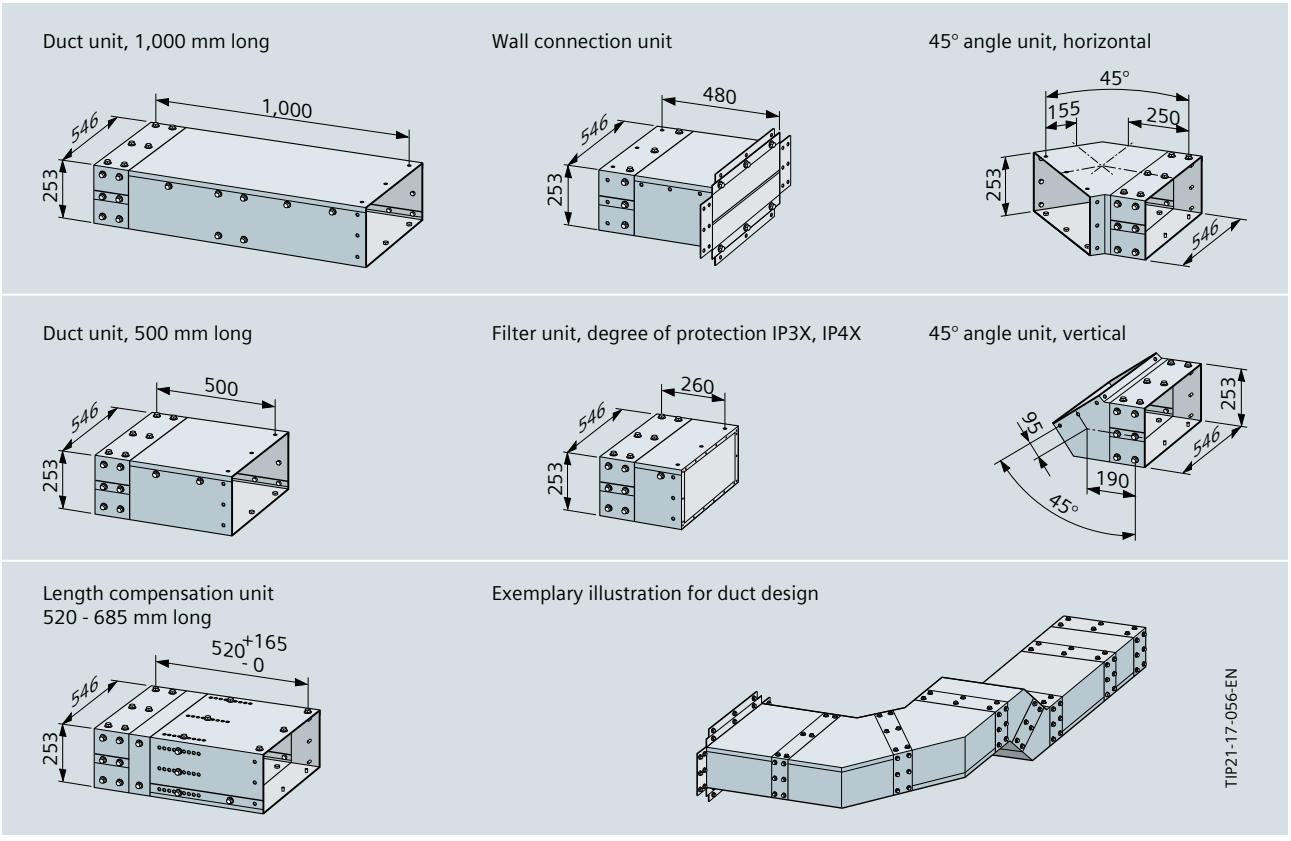

Fig. 3/10: **Duct units for pressure relief duct and exemplary arrangement (dimensions in mm)**

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Panel widths	Weight without packing [1] in kg (approx.)	Transport weight with packing [1] in kg (approx.)	Transport dimensions Width × Height × Depth in mm × mm × mm	
			with rail or truck	with ship or airplane
Single-busbar switchgear 1 × 450 mm or 1 × 600 mm	800	900	1,100 × 2,460 × 1,450	1,130 × 2,550 × 1,450
Single-busbar switchgear 1 × 900 mm	1,400	1,500	1,100 × 2,460 × 1,450	1,130 × 2,550 × 1,450
Single-busbar switchgear 1 × 600 mm (top-rear cable connection)	800	900	1,100 × 2,460 × 2,100	1,130 × 2,550 × 2,100
Auxiliary transformer (built-in component)	425	500	800 × 1,200 × 1,200	800 × 1,200 × 1,200
Single-busbar switchgear 2 × 600 mm (bus sectionalizer)	2 × 800	2 × 900	2 × (1,100 × 2,460 × 1,450)	2 × (1,130 × 2,550 × 1,450)
Double-busbar switchgear 2 × 600 mm	2 × 800	2 × 900	2 × (1,100 × 2,460 × 1,450)	2 × (1,130 × 2,550 × 1,450)

[1] Average values, depending on the degree to which panels are equipped

Tab. 3/5: **Weights and transport dimensions for NXPLUS C panel widths**

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Weights and transport

Weights and data for transport are given in Tab. 3/5. NXPLUS C switchgear is delivered in form of individual panels. Please observe the following:
- Transport facilities on site
- Transport dimensions and transport weights
- Size of door openings in building.

In case of double-busbar panels, the A and B sides are supplied separately.

For transport via train or truck, the panels are delivered openly packed with PE protective film. For transport via ship or airplane, the panels are placed on pallets in a closed box (cardboard). Thereby, they are standing on a tightly closed wooden base. In addition, a welded PE protective film envelops the transport unit. Thanks to the enclosed desiccant bags, a maximum storage time of 6 months is possible with this packing method.

Environmental influences

NXPLUS C switchgear is suitable for operation in indoor installations under normal operating conditions as defined in the standard IEC 62271-1. Furthermore, the high-voltage part can be used in environmental conditions of the climatic category 3C2 according to the standard IEC 60721-3-3.

For the switchgear enclosure, the degrees of protection IP3XD according to IEC 60529 and IK07 according to IEC 62262 apply. As an option, the degrees of protection IP31D, IP32D, IP34D, IP4X, or IP54 can be reached. The parts of the primary circuit under high voltage conform to IP65 as standard.

Optionally, NXPLUS C can be upgraded for stresses such as shock or vibration, as well as for use in regions at risk from earthquakes. The associated shock and vibration tests have been carried out in accordance with the following standards:
- ETSI EN 300 019-2-2 (ETSI: European Telecommunications Standards Institute, EN: European Norm), test conforming to T2.3: Public Transportation
- IEC 60068-2-6, Environmental testing – Part 2-6: Tests – Test Fc: Vibration
- IEC 60068-2-64, Environmental testing – Part 2-64: Tests – Test Fh: Vibration, broadband random (digital control) and guidance.

For upgrading, earthquake qualification testing has been carried out in accordance with the following standards:
- IEC 60068-3-3, Environmental testing – Part 3-3: Guidance – Seismic test methods for equipments
- IEC 60068-2-57, Environmental testing – Part 2-57: Tests – Test Ff: Vibration – Time-history and sine-beat method
- IEEE 693-2005, Recommended Practice for Seismic Design of Substations.

For installation on even and rigid concrete or steel structure (without considering building influences), the tested ground accelerations meet the following requirements:
- UBC 1997 (Uniform Building Code) – Zone 4
- CBC 1998 (California Building Code) – Zone 4
- IEEE 693-2005 – Figure A.1: High required response spectrum.

Chapter 4

SIMOSEC Switchgear

4 SIMOSEC Switchgear

SIMOSEC medium-voltage switchgear (Fig. 4/1) is a pre-fabricated, type-tested, three-pole metal-enclosed indoor switchgear with single busbar according to the international standard IEC 62271-200 and, especially for China, according to the standard GB 3906. It is used for power distribution in distribution grids up to 1,250 A, mainly for the secondary distribution level up to 24 kV.

The rated short-time withstand current reaches up to 25 kA.

The rated normal currents of the feeders reach up to
- 800 A, e.g. for ring-main and metering panels
- 1,250 A for circuit-breaker panels and bus sectionalizer panels

Fig. 4/1: **Example for SIMOSEC switchgear**

The modular, space saving design enables application in:
- Substations, customer transfer substations, distribution substations, and switching substations of power supply and public utilities
- Infrastructure buildings such as railway stations, airports, data centers
- Public buildings such as high-rise buildings, shopping centers, hospitals, and administration centers
- Industrial plants such as automobile plants, refineries, chemical industrial plants, and electrochemical plants
- Power supply installations such as traction power supply systems, emergency power supply installations, wind farms, and solar parks.

The multiple possibilities of application are based on individual panels that can be freely lined up and extended, as well as on circuit-breaker panels for different applications. The switchgear can be easily extended on site without gas work. In addition, low-voltage compartments can be supplied in two overall heights as an option. The following technical characteristics and equipment features ensure reliability and personal safety:
- Type and routine testing of the panels
- No cross-insulation between phases
- High product quality by standardized, numerically controlled manufacturing processes and a quality management system according to ISO 9001
- All switching operations can only be performed with closed panel front
- Metal-enclosed LSC 2 panels
- Access to HV HRC fuses and cable terminations only possible when the outgoing feeders are earthed
- Logical mechanical interlocking
- Capacitive voltage detecting system to verify safe isolation from supply
- Earthing of outgoing feeders by means of make-proof earthing switches
- Partition class: PM (metallic partition).

Preconditions for cost-efficient switchgear operation are low "lifecycle costs" and a high availability throughout the entire product service life. Under normal operating conditions, the expected service life is at least 35 years, probably 40 to 50 years (the hermetically welded switchgear vessel can be assumed to be tight throughout this time). Other benefits are provided by the compact dimensions of the gas-insulated switching-device vessel. Thus, e.g. existing switchgear rooms can be used more effectively, or new buildings can be constructed in a more cost-effective way.

Further technical characteristics and equipment features:
- Air-insulated indoor switchgear
- Three-pole primary enclosure
- Phases arranged one behind the other
- Busbar system at the top
- Air-insulated busbar and cable connection system
- Three-position switch, metal-enclosed, with air-insulated primary terminals, and gas-insulated switching functions
- Three-position disconnector and earthing switch according to the endurance class defined in IEC 62271-102
- Three-position switch disconnector according to the endurance class defined in IEC 62271-103
- Vacuum circuit-breaker, metal-enclosed, up to 1,250 A, fixed-mounted in the gas-insulated switching-device vessel
- Option on request: Vacuum circuit-breaker (type designation 3A ...), air-insulated, up to 1,250 A, removable design: Easy to remove after loosening the fixing bolts
- Circuit-breaker according to the endurance class defined in IEC 62271-100
- Hermetically sealed by welded switching-device vessel
  - for switching devices
  - with insulating gas SF_6
- The degree of protection of the switchgear enclosure conforms to IP2X, optionally IP3X. All parts of the primary circuit under high voltage in switching-device vessels fulfill IP65. The IK degree of protection corresponds to IK07
- The enclosure consists of sendzimir-galvanized sheet steel, with the switchgear front powder-coated in color "light basic" (color 700 according to Siemens Standard SN 47030 G1, similar to RAL 7047)
- LSC 2 panels, LSC 1 panels (without isolating distance)
- Pressure relief
  - to the rear and upwards
  - separately for each compartment
  - downwards (option)
- Air-insulated cable connection system for conventional cable sealing ends
- Integrated low-voltage niche (standard) for installation of, e.g.
  - terminals, MCBs, pushbuttons
  - protection devices (e.g. digital multifunction protection relay with SIPROTEC protection device family)
- Option: Factory-assembled three-phase current transformer on the feeder bushings
- Option: Top-mounted low-voltage compartment
- Option: Panel heating for severe ambient conditions, e.g. condensation.

4.1 Technical data and equipment

The technical data is listed in Tab. 4/1. For adaptation of the insulation levels to site altitudes of more than 1,000 m above sea level, a correction factor K_a can be derived from Fig. 2/2 (see examples in chap. 2). In Tab. 4/2, the power losses of the individual panels are listed according to the normal current.

Tab. 4/3 offers an overview of the panel types and their equipment. The ring-main panel can be attached to a panel of the type M, M(-K) or H as a transfer panel type R(T). In analogy, transfer panels L(T) and L1(T) can be attached to the panels type M or H. For further information about the panel combinations, such as the bus sectionalizer with a combination of ring-main transfer panel type R(T) and bus riser panel type H or the combination of type L(T) and H, please contact your Siemens partner, who can be found on the website *www.siemens.com/tip-cs/contact*.

Rated voltage U_r		**7.2 kV**	**12 kV**	**17.5 kV**	**24 kV**
Rated short-duration power-frequency withstand voltage U_d – Phase-to-phase, phase-to-earth, open contact gap – Across the isolating distance		 20 kV 23 kV	 28 kV (42 kV [1]) 32 kV (48 kV [1])	 38 kV 45 kV	 50 kV 60 kV
Rated lightning impulse withstand voltage U_p – Phase-to-phase, phase-to-earth, open contact gap – Across the isolating distance		 60 kV 70 kV	 75 kV (95 kV [1]) 85 kV (110 kV [1])	 95 kV 110 kV	 125 kV 145 kV
Frequency f_r		50/60 Hz			
Rated normal current I_r [2] – Busbar – Ring-main panels type R, R1, R(T) – Cable panels type K, K1 – Transformer panels type T [3], T1 [3] – Circuit-breaker panels type L, L1, L(T), L1(T) [4] – Bus riser panels type H – Metering panels type M, M(-K), M(-B), M(-BK), M(KK) [5] – Busbar voltage metering panels type M(VT), M1(VT), M(VT-F) [3], M1(VT-F) [3]		 630 A (800 A, 1,250 A as an option) 630 A (800 A as an option) 630 A (800 A as an option, for type K1 also 1,250 A) 200 A 630 A 630 A (800 A, 1,250 A as an option) 630 A (800 A, 1,250 A as an option) 200 A			
Rated short-time withstand current I_k (50 and 60 Hz) [3], [6]	with t_k = 1 s [7]	25 kA			
	with t_k = 3 s [8]	21 kA			
Rated peak withstand current I_p [3]	for 50 Hz	63 kA (52,5 kA for I_k = 21 kA; 50 kA for I_k = 20 kA)			
	for 60 Hz	65 kA (55 kA for I_k = 21 kA; 52 kA for I_k = 20 kA)			
Rated short-circuit making current I_{ma} for type R, R1, R(T), K, K1, T [3], T1 [3], L, L1, L(T), L1(T)	for 50 Hz	63 kA (52,5 kA for I_k = 21 kA; 50 kA for I_k = 20 kA)			
	for 60 Hz	65 kA (55 kA for I_k = 21 kA; 52 kA for I_k = 20 kA)			
Rated short-circuit breaking current I_{sc} for type L, L1, L(T), L1(T)	for 50 Hz	25 kA			
	for 60 Hz	25 kA			

1) Design option, according to national requirements (e.g. GOST, GB, ...)
2) The rated normal currents apply to ambient air temperatures of max. 40 °C.
The 24-hour mean value is max. 35 °C (according to IEC 62271-1)
3) Depending on HV HRC fuse-link (let-through current) for type T, T1, M(VT-F), M1(VT-F)
4) With vacuum circuit-breaker in gas-filled switching-device vessel (maintenance-free under normal ambient conditions according to IEC 62271-1)
5) No option I_r = 1,250 A for type M(KK)
6) Busbar for type T, T1, M(VT-F), M1(VT-F)
7) Rated duration of short circuit t_k = 2 s as design option according to national requirements (e. g. GOST, GB, ...)
8) I_k up to 20 kA for t_k = 4 s as design option according to national requirements (e.g. GOST, GB, ...)

Tab. 4/1: **Technical data for the switchgear type SIMOSEC**

All panels are equipped with a low-voltage niche as terminal compartment. As an option, a low-voltage compartment or a cover can be provided. The overall height for the low-voltage compartment can be 350 mm or 550 mm, depending on the panel-specific configuration of primary and secondary equipment. Further equipment options available for all panels are:

- Floor cover (design according to pressure relief direction; in special cases, a deep floor cover might be required for panels with cable feeders)
- Panel heating (wired to terminal)
- Secondary equipment (see [Siemens AG, 2017: Applications for power distribution – Energy transparency]).

	Power loss per panel at normal current I_b					
	200 A	**300 A**	**400 A**	**630 A**	**800 A**	**1,250 A**
Ring-main panel R	16 W	36 W	63 W	157 W	252 W	–
Transformer panel T (without losses by fuses)	70 W	–	–	–	–	–
Circuit-breaker panels L, L1 with circuit-breaker type CB-f VSA12020	24 W	53 W	94 W	232 W	–	–
Circuit-breaker panels L, L1 with circuit-breaker type CB-f VSG24125	18 W	41 W	72 W	179 W	266 W	649 W
Metering panel M including three sets of current and voltage transformers each	29 W	65 W	114 W	283 W	456 W	704 W
Bus riser panel H without current and voltage transformers	10 W	22 W	39 W	97 W	156 W	380 W
Cable panel K without current and voltage transformers	10 W	22 W	39 W	97 W	156 W	380 W

Tab. 4/2: **Power losses for SIMOSEC panels**

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	Ring-main panel			Transformer panel		Cable panel	
	R	R1	R(T)	T	T1	K	K1
Manual operation for three-position switch [1) 2)]	× [1)]	× [1)]	× [1)]	×	×	–	–
Interlock for cable compartment cover	×	×	×	×	×	–	–
Cable compartment cover locked in place	–	–	–	–	–	×	×
C-rail as cable bracket	×	×	–	×	×	×	×
Release as shunt release	–	–	–	O	O	–	–
Mechanical ready-for-service indicator for three-position switch [1) 2) 3)]	×	×	×	×	×	–	–
Signaling switch (1 S) for remote electrical ready-for-service indication for three-position switch [1) 2) 3)]	O	O	O	O	O	–	–
Auxiliary switch for three-position switch and make-proof earthing switch. Switch-disconnector and EARTHING: For CLOSED and OPEN 2NO + 2NC each	O	O	O	O	O	–	–
Motor operating mechanism for three-position switch [1) 2)]	O	O	O	O	O	–	–
Local-remote switch for motor operating mechanism of three-position switch [1) 2)]	O	O	O	O	O	–	–
Interlock in circuit-breaker panel between three-position switch [1)] and vacuum circuit-breaker	–	–	–	–	–	–	–
"Spring charged" indicator (for stored-energy "CLOSED"/"OPEN")	–	–	–	×	×	–	–
Closing lockout for three-position switch [1) 2)]	O	O	O	O	O	–	–
De-earthing lockout for make-proof earthing switch	–	–	–	O	O	–	–
Inspection window in the connection/cable compartment cover	O	O	–	×	×	O	O
Motor operating mechanism for vacuum circuit-breaker	–	–	–	–	–	–	–
Release as CT-operated release in vacuum circuit-breaker [4)]	–	–	–	–	–	–	–
Locking device for three-position switch [1) 2)] or earthing switch	O	O	O	O	O	–	–
Short-circuit or earth-fault indicator	O	O	–	–	–	O	O
Preassembled cable clamps	O	O	–	O	O	O	O
Loss of service continuity category LSC	2	2	2	2	2	1	1

(× standard O option – not available)
[1)] Three-position switch as three-position switch-disconnector
[2)] Three-position switch as three-position disconnector
[3)] Earthing switch in panel type E
[4)] Circuit-breaker type "CB-f"

Tab. 4/3: **Overview of equipment and options for SIMOSEC panels (× = standard, o = option, – = not available)**

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	Circuit-breaker panel [4]				Metering panel								Bus riser panel	Busbar earthing panel
	L	L1	L(T)	L1(T)	M	M(-K) M(KK)	M(-B)	M(-BK)	M(VT)	M1(VT)	M (VT-F)	M1 (VT-F)	H	E
	× [2]	× [2]	× [2]	× [2]	–	–	–	–	× [1]	× [1]	× [1]	× [1]	–	× [3]
	×	×	×	×	–	–	–	–	×	×	×	×	–	–
	–	–	–	–	×	×	×	×	–	–	–	–	×	x
	×	×	–	–	–	×	–	×	–	–	–	–	–	–
	o	o	o	o	–	–	–	–	–	–	–	–	–	–
	×	×	×	×	–	–	–	–	o	o	o	o	–	×
	o	o	o	o	–	–	–	–	o	o	o	o	–	o
	o	o	o	o	–	–	–	–	o	o	o	o	–	o
	o	o	o	o	–	–	–	–	o	o	o	o	–	–
	o	o	o	o	–	–	–	–	o	o	o	o	–	–
	×	×	×	×	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	o	o	o	o	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	o	o	o	o	–	–
	o	o	–	–	o	o	o	o	–	–	o	o	–	o
	o	o	o	o	–	–	–	–	–	–	–	–	–	–
	o	o	o	o	–	–	–	–	–	–	–	–	–	–
	o	o	o	o	–	–	–	–	–	–	–	–	–	o
	o	o	–	–	–	–	–	–	–	–	–	–	–	–
	o	o	–	–	–	o	–	o	–	–	–	–	–	–
	2	2	2	2	1	1	1	1	2	2	2	2	1	2

4.2 Single-line diagrams and options

In the single-line diagrams of the panels (Fig. 4/2), the selection and positioning of options for the individual panels are shown.

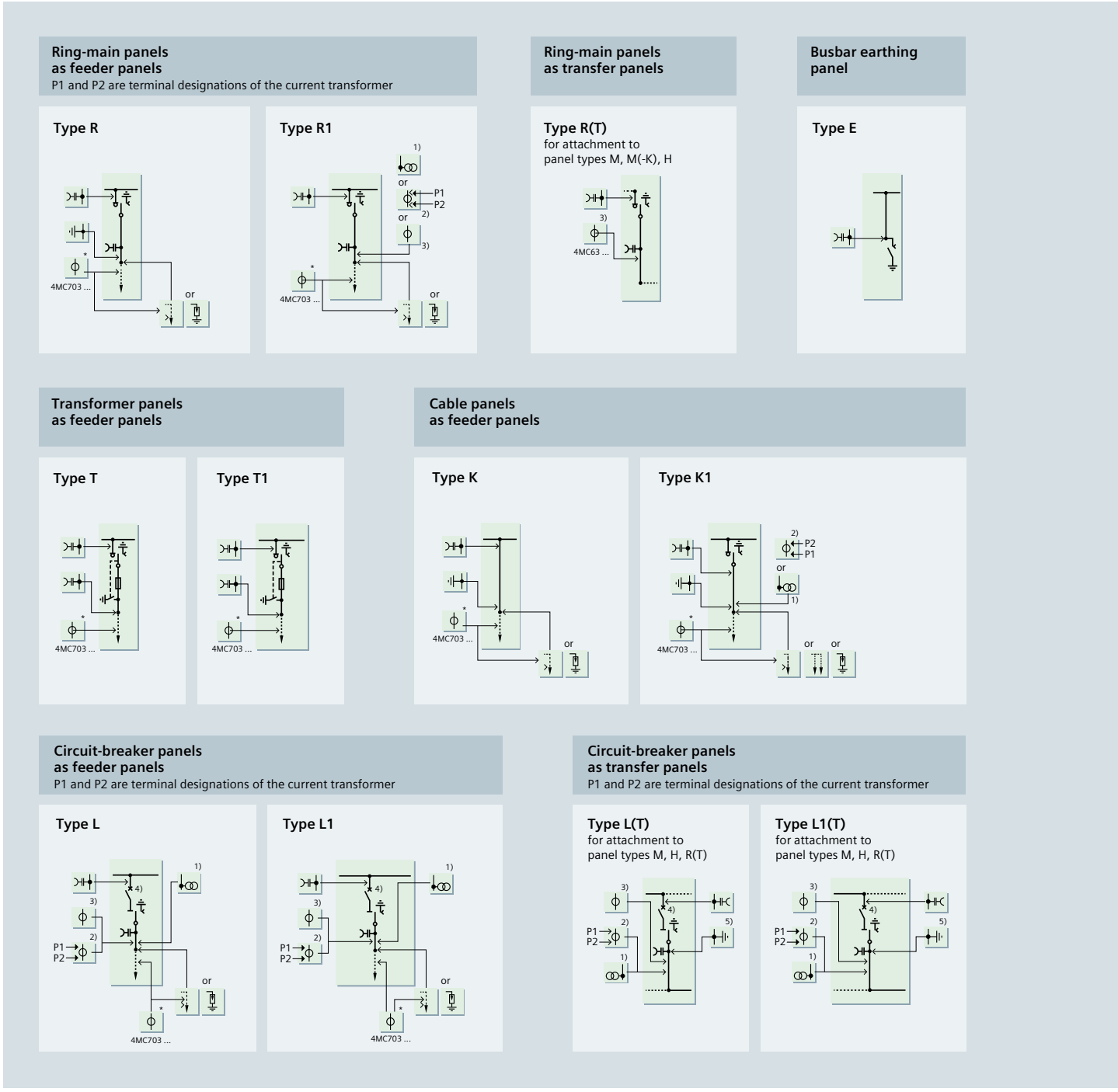
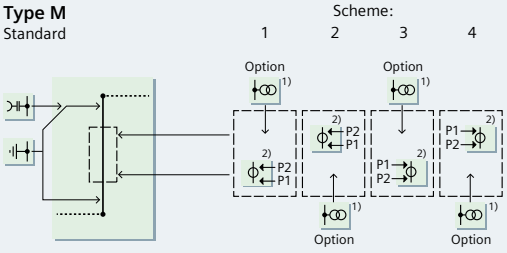


Fig. 4/2: **Single-line diagrams and options for the SIMOSEC panels (symbol explanations for the components are given in the annex)**
Click here (not for mobile devices)

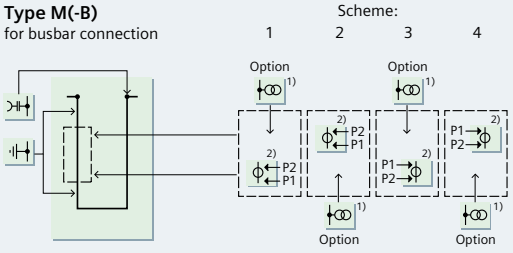
Billing metering panels

4 versions each: Scheme 1, 2, 3, 4 (P1 and P2 are terminal designations of the current transformer)
Type M, M(-B), M(-BK): Standard = Transfer to the right; Option = Transfer to the left)

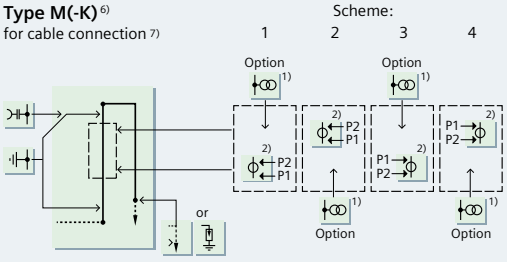
Type M
Standard



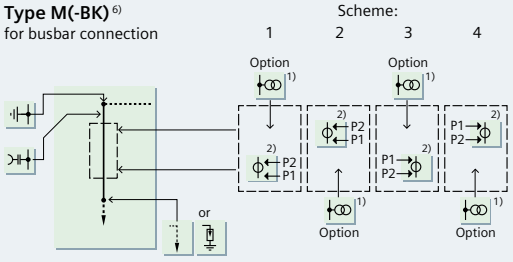
Type M(-B)
for busbar connection



Type M(-K) [6]
for cable connection [7]

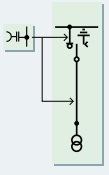


Type M(-BK) [6]
for busbar connection

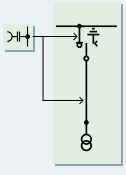


Busbar voltage metering panels

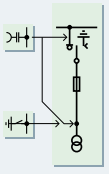
Type M (VT)
up to 17,5 kV



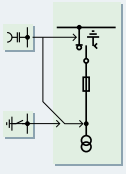
Type M1 (VT)



Type M (VT-F)
up to 17,5 kV



Type M1 (VT-F)

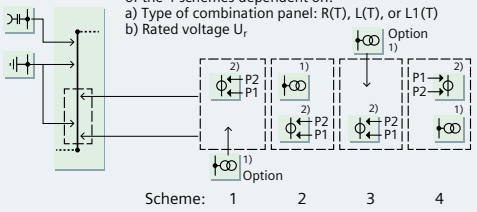


Bus riser panels

for attachment to panel types R(T), L(T), L1(T)

Type H

Possible instrument transformer options
of the 4 schemes dependent on:
a) Type of combination panel: R(T), L(T), or L1(T)
b) Rated voltage U_r



1) Voltage transformer, e.g. 4MR, 1-pole, cast-resin-insulated
2) Block-type current transformer 4MA, cast-resin-insulated
3) Three-phase current transformer 4MC63 ...
4) Vacuum circuit-breaker (type 3A ...)
5) Standard: feeder earthing through the vacuum circuit-breaker (type 3A ...) (with interlocking, without earthing switch)
6) Connection of two cables possible
7) On request: possible as individual metering panel type M(KK) with cable entry and cable feeder

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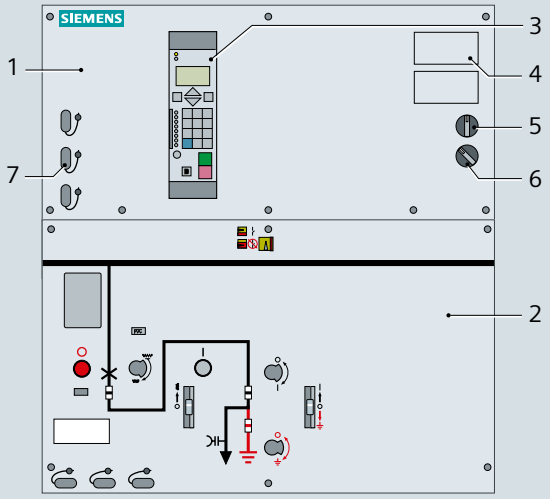
4.3 Low-voltage compartment and low-voltage niche

At the top of the panel, the low-voltage niche is located as standard (Fig. 4/3), for accommodation of terminals and standard protection devices (e.g. combined with a frame cover in circuit-breaker panels). For bus wires and/or control cables, the niche is open at the side towards the adjacent panel. The low-voltage niche is partitioned safe-to-touch from the high-voltage part of the panel, and conforms to the degree of protection IP3X as standard. Optionally, a door can be ordered instead of the screwed-on cover.

For each feeder, a low-voltage compartment can be mounted on the panel as an option (Fig. 4/4), with an overall height of 350 mm or 550 mm. The overall height depends on the panel-specific equipment with primary and secondary devices (customer-specific accommodation of protection, control, measuring, and metering equipment). The low-voltage compartment is also partitioned safe-to-touch from the high-voltage part of the panel, and has a door with hinge on the left (a door with hinge on the right is available as an option). The control cables from of the panel to the low-voltage compartment can be connected via multi-pole, coded module plug connectors. Plug-in bus wires from panel to panel inside the low-voltage niche, or in the separate wiring duct on the panel are available as an option.



1 Frame cover of low-voltage niche (can be unscrewed)
2 Panel front
3 Protection relay as option (on request: type 7SJ80)
4 Short-circuit/earth-fault indicator
5 Option: local-remote switch for three-position switch-disconnector
6 Option: momentary-contact rotary control switch CLOSED-OPEN for motor operating mechanism of the three-position switch-disconnector
7 Option: sockets for capacitive voltage detecting system at the busbar

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Fig. 4/3: **Low-voltage niche for a circuit-breaker panel type L1 with optional protection device (SIPROTEC type 7SJ80 on request)**

Fig. 4/4: **Example for an open low-voltage compartment of the size 750 mm x 350 mm (width x height)**

4.4 Room planning

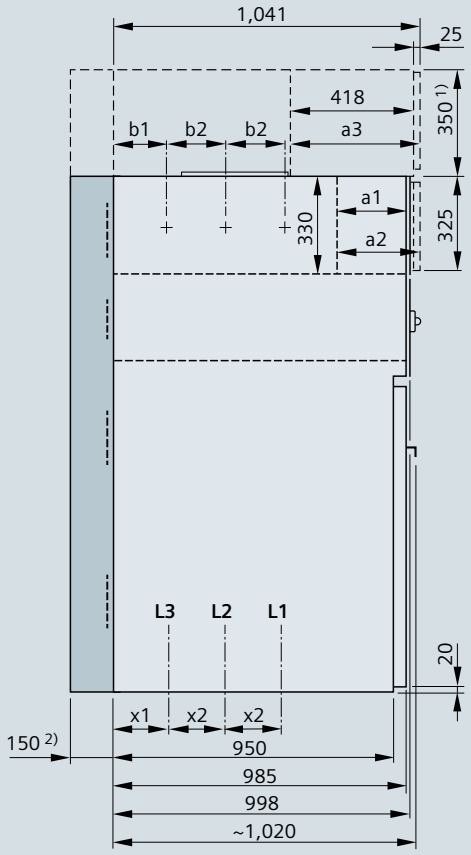
Please observe the following for room planning:
- Switchgear installation
- Pressure relief
- Panel dimensions
- Switchgear fixing
- Door dimensions
- Weights and transport

Note: Specifications due to local or use-specific standards, regulations, or guidelines must be observed for room planning.

Switchgear installation and panel dimensions

Wall-standing and free-standing arrangements are possible with wall distances according to Fig. 4/5:
- 1 row
- 2 rows (for face-to-face arrangement)

In Fig. 4/5 to Fig. 4/7 and Tab. 4/4, standard dimensions and dimensions for options and connections of the panels are listed, among others.



Available mounting depth for low-voltage equipment:

Low-voltage niche with front cover	a1 = 201 mm
Low-voltage niche with door (option)	a2 = 246 mm
Low-voltage compartment (option)	a3 = 443 mm

Other dimensions:

Position of cables Δ)	x1 = 187 mm
	x2 = 210 mm
Position of busbar	b1 = 187 mm
	b2 = 210 mm

Δ) The position of the cables in the panel depends on the additional, optional built-in panel components (e.g. current or voltage transformers). Therefore, the dimensions x1 and x2 may be different (see Tab. 4/4).

1) Option: low-voltage compartment or front cover available in two heights: 350 mm and 550 mm
2) Option: pressure relief duct

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Fig. 4/5: **Standard dimensions of the switchgear (dimensions in mm)**

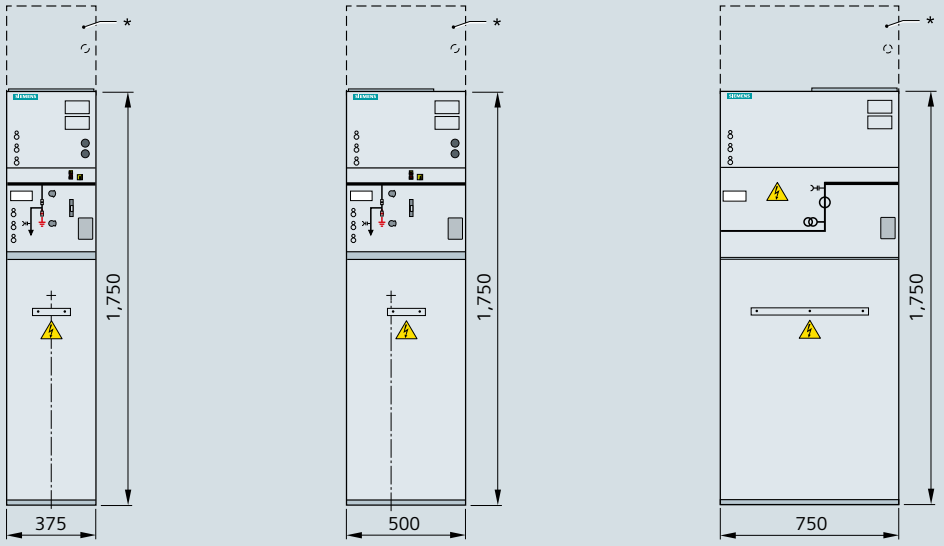

Fig. 4/6: **Front views for SIMOSEC panels (type R, R1, and M as examples for widths 375 mm, 500 mm, and 750 mm; dimensions in mm)**

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Panel type	Rated voltage U_r = 17.5 kV			Rated voltage U_r = 24 kV		
	Dimension			Dimension		
	x1	x2	c1	x1	x2	c1
R, R1, T, T1, K, K1, L, L1 (1 cable)	187 mm	210 mm	187.5 mm	187 mm	210 mm	187.5 mm
L1 (2 cables)	187 mm	210 mm	172.5 mm	187 mm	210 mm	172.5 mm
L (with CT, VT)	187 mm	210 mm	250 mm	187 mm	230 mm	300 mm
L1 (with CT, VT; 1 or 2 cables)	187 mm	210 mm	235 mm	235 mm	230 mm	335 mm
M(-K), M(-BK)	187 mm	210 mm	375 mm	215 mm	250 mm	375 mm

CT, VT: Current Transformer, Voltage Transformer
Note: For double cable connection, the cable distance is approx. 110 mm depending on the panel type and the version of the sealing end.
The position of the cables in the panel depends on the additional built-in panel components such as current and voltage transformers. Therefore, the dimensions x1, x2, and c1 may differ from the stipulated values.

Tab. 4/4: **Panel-specific dimensions x1, x2, and c1 in Fig. 4/5 and up to Fig. 4/8 for the position of the cables in the different panels**

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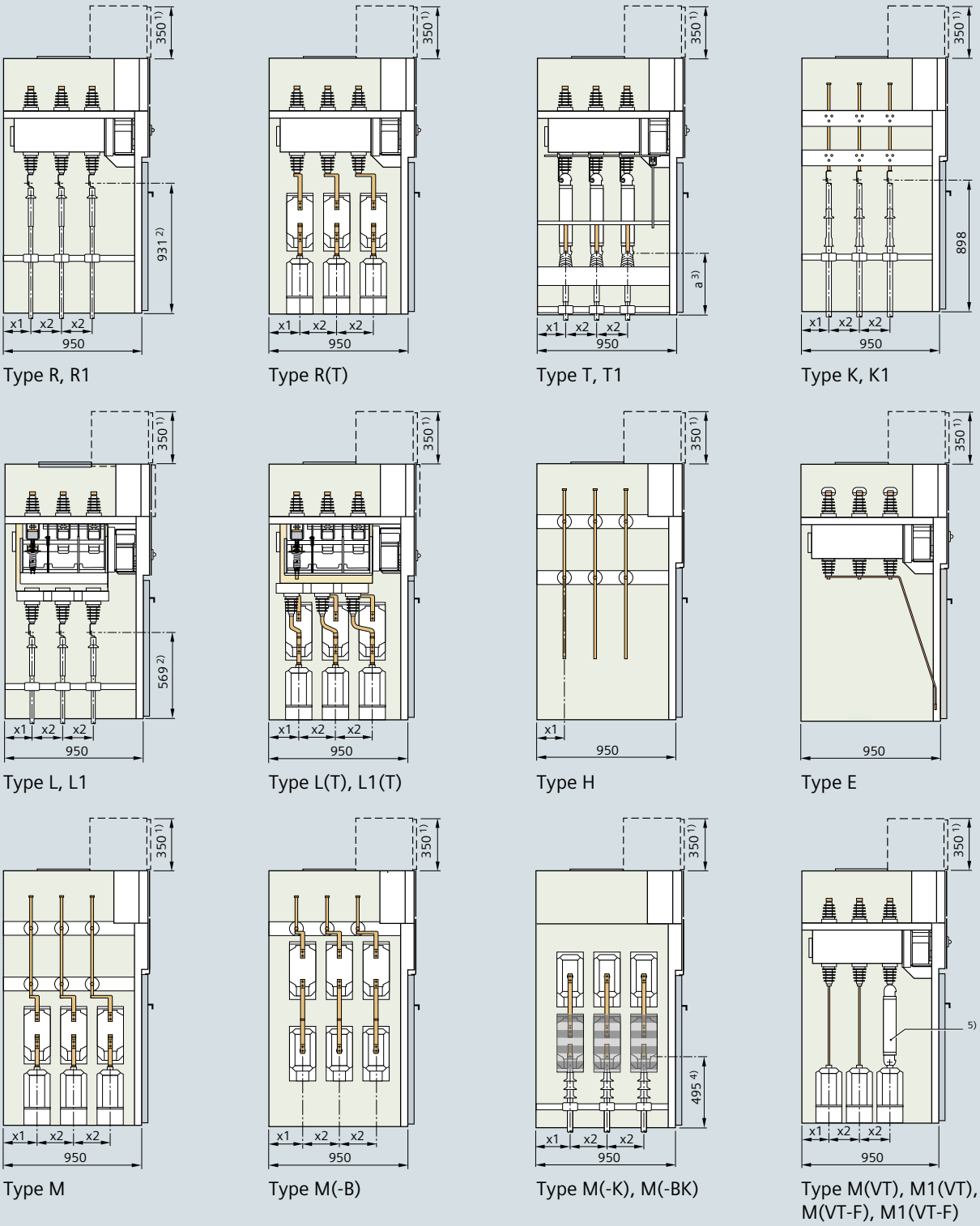

1) Option: Low-voltage compartment
2) For panel design with 4MA block-type current transformer, the cable connection height is reduced
3) Dimension a: approx. 384 mm for fuses with dimension "e" = 442 mm
approx. 534 mm for fuses with dimension "e" = 292 mm
4) The cable connection height depends on the rated voltage, the transformer design, and the number of cable connections
5) Option: Fuses

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Fig. 4/7: **Side views for SIMOSEC panels (specifications for x1 and x2 see Tab. 4/4; dimensions in mm)**

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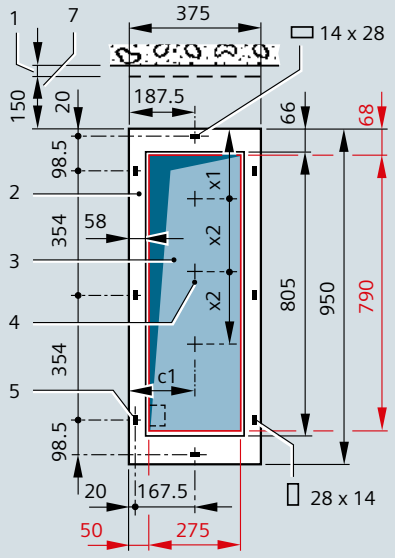
Floor openings and fixing points

The dimensions of the floor openings and the positions of the fixing points for safe standing of the switchgear are given in Fig. 4/8.

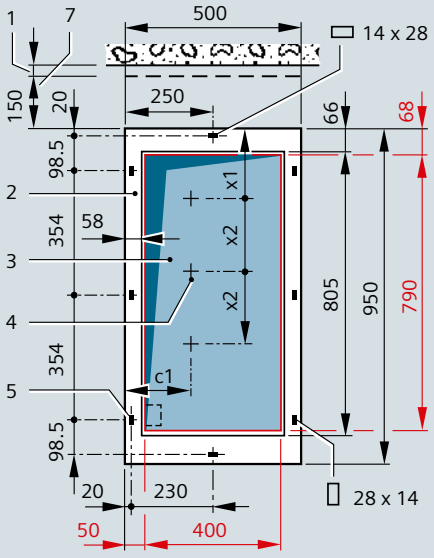
With cable connection

For panel width 375 mm



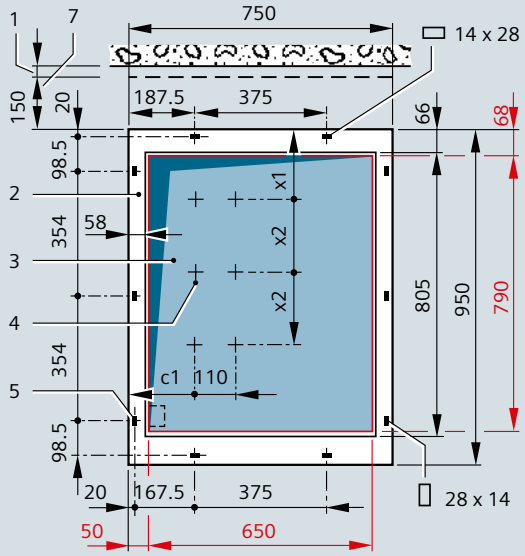
Type R, T, K

For panel width 500 mm



Type R1, T1, K1, L, L (with voltage/current transformers)

For panel width 750 mm



Type L1, L1 (with voltage/current transformers), M(-K), M(-BK)

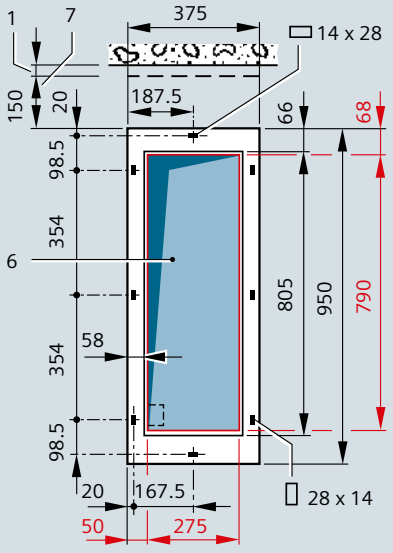
1 Wall distance (see Fig. 4/9)
2 Fixing frame (standing surface) of an individual panel or panel block
3 Floor opening for high-voltage cable and, if applicable, control cables
4 Position of the led-in cables for the feeder (dimensions for x1, x2, and c1, see Tab. 4/4)
5 Fixing points
6 Floor opening, if required, for panels without cable connection
7 Option: Pressure relief duct

Note:
For double cable connection, the cable distance is approx. 110 mm depending on the panel type and the version of the sealing end.

Fig. 4/8: **Floor openings (rectangle and corresponding specifications in red) and fixing points for SIMOSEC panels (dimensions in mm)**

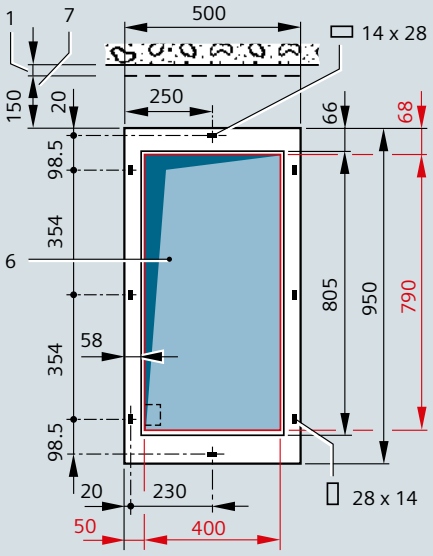
Without cable connection

For panel width 375 mm



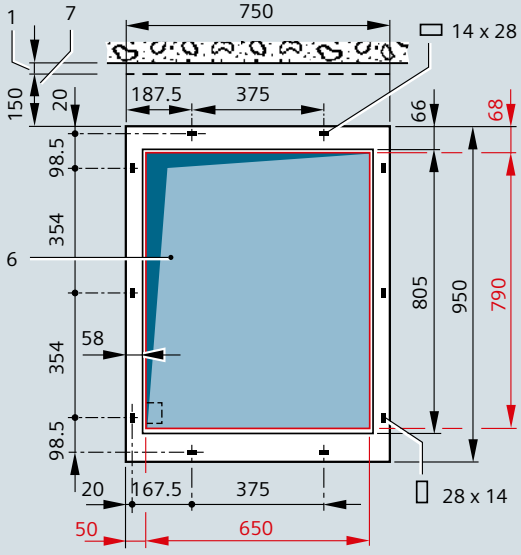
Type R(T), T(T), H, E, M(VT), M(VT-F)

For panel width 500 mm



Type L(T), M1(VT), M1(VT-F)

For panel width 750 mm



Type L1(T), M, M(-B)

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Pressure relief

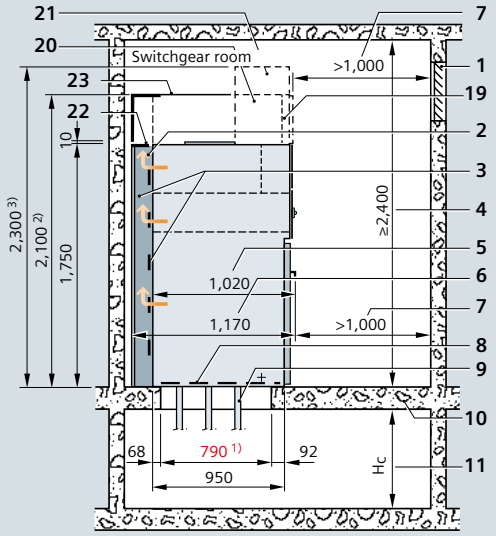
For room planning, both switchgear installation and the type of pressure relief play an important part. The corresponding dimensions are given in Tab. 4/5 and Fig. 4/9. On request, a pressure relief to the outside via pressure relief duct is possible, with a length up to 2.5 m. For more information, please contact your Siemens partner *(www.siemens.com/tip-cs/contact)*.

Internal arc classification	Pressure relief duct Depth 150 mm (add to panel depth)	Direction of pressure relief	Switchgear installation	Distance "a" (Fig. 4/9) from switchgear to rear wall of switchgear room	Panel depth [1) 2)]	Switchgear depth	Switchgear height
Without IAC (standard)	without	to the rear/ upwards	Wall-standing arrangement	-	1,020 mm [2)]	1,170 mm [2)]	1,750 mm [3)]
		to the rear	Free-standing arrangement	-			
	with	upwards	Wall-standing arrangement	≥ approx. 35 mm			
		upwards	Free-standing arrangement	≥ approx. 35 mm			
IAC A FL	with (duct is standard)	upwards	Wall-standing arrangement	≥ approx. 35 mm	1,020 mm [2)]	1,170 mm [2)]	≥ 2,100 mm [4)] (≤ 21 kA, 1 s)
IAC A FLR	with (duct is standard)	upwards	Free-standing arrangement	≥ approx. 800 mm			

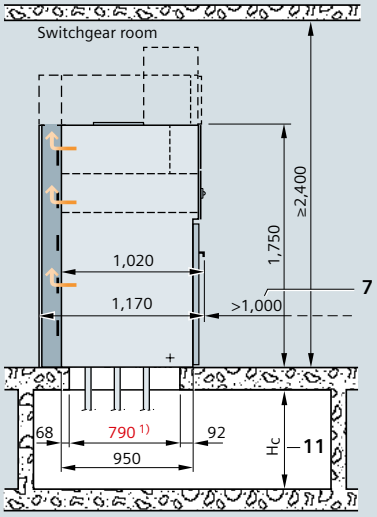
1) For option of low-voltage niche with door: Panel depth approx. 1,041 mm
2) For circuit-breaker panels type L, L1, L(T), L1(T) with circuit-breaker type "CB-f AR" (3AH569):
Panel depth: 1,080 mm, switchgear depth: 1,230 mm
3) With an optional low-voltage compartment, the switchgear height changes according to the height of the low-voltage compartment
4) Including front cover or low-voltage compartment

Tab. 4/5: **Installation and dimensions of the switchgear according to the internal arc classification**

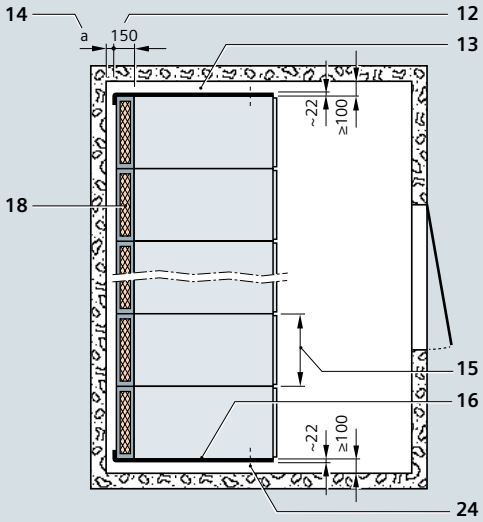
Wall-standing arrangement (side view)



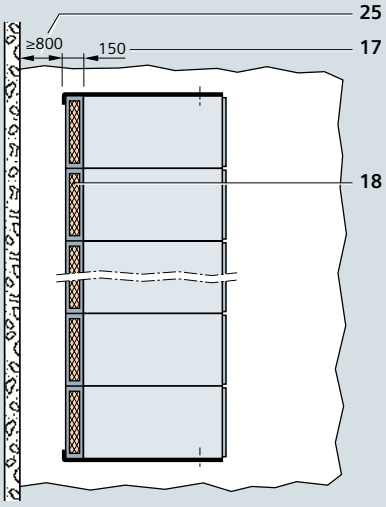
Free-standing arrangement (side view)



Top view



Top view



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1 Relief opening
2 Direction of pressure relief
3 Pressure relief of switchgear
4 Room height
5 Depth of individual panel
(1,080 mm for panel type L, L1, L(T), L1(t) with VCB 3AH569)
6 Switchgear depth including end wall
(1,230 mm for panel type L, L1, L(T), L1(t) with VCB 3AH569))
7 Depending on national requirements:
Control aisle ≥ 1,000 mm recommended (in Germany ≥ 800 mm) When extending or replacing panels, it might be necessary – depending on the room dimensions – to disassemble adjacent panels
8 Option: floor cover (optionally deeper)
9 Cable
10 Foundation
11 Height H_c of the cable basement (recommendation for internal space) for:
– Cable fixing underneath the panel (in the cable basement)
≥ 1,400 mm
– Use of deep floor cover
≥ 1,400 mm
– Cable fixing in the panel, without deep floor cover (depending on the bending radius of the cable)
≥ 600 mm
12 Wall distance, dimension of pressure relief duct (= option)
13 Lateral wall distance
14 Wall distance a (see Tab. 4/4)
15 Panel width
16 End wall
17 Depth of pressure relief duct
18 Option: pressure relief duct for each panel, for wall-standing or free-standing arrangement
19 Option: front cover
20 Option: low-voltage compartment: 350 mm high or
21 Option: low-voltage compartment: 550 mm high
22 End wall: 1,750 mm high or
23 End wall: 2,100 mm high (option)
24 Earthing connection
25 Distance to rear wall

1) Floor opening
2) Switchgear height 2,100 mm with height of low-voltage compartment 350 mm
3) Switchgear height 2,300 mm with height of low-voltage compartment 350 mm

Fig. 4/9: **Room planning and dimensions for SIMOSEC regarding pressure relief (dimensions in mm)**

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Weights and transport

The weight of a panel depends on the extent to which it is equipped (e.g. with motor operating mechanism, voltage transformer). SIMOSEC switchgear is completely delivered in transport units. Please observe the following:

- Transport facilities on site (Fig. 2/14)
- Weights (Tab. 4/6) and transport dimensions (Tab. 4/7)
- Size of door openings in building
- Switchgear with low-voltage compartment: Please observe other transport dimensions and weights (Tab. 4/6 and Tab. 4/7).

Door dimensions

The door dimensions required for bringing in depend on the

- Number of panels in a transport unit
- Design with or without low-voltage compartment.

To suit the types of transport and target regions, different packing types are used (Tab. 2/4).

Panel type	Type	Width B1	Net weight [1]		Gross weight [1]	
			without [2]	with LVC [2]	without [2]	with LVC [2]
Ring-main panel	R	375 mm	160 kg	220 kg	220	280 kg
	R1	500 mm	180 kg	240 kg	240 kg	300 kg
	R(T)	375 mm	250 kg	310 kg	310 kg	370 kg
Transformer panel	T, T(T)	375 mm	180 kg	240 kg	240 kg	300 kg
	T1, T1(T)	500 mm	200 kg	260 kg	260 kg	320 kg
Cable panel	K	375 mm	140 kg	200 kg	200 kg	260 kg
	K1	500 mm	150 kg	210 kg	210 kg	270 kg
Circuit-breaker panel	L, L(T)	500 mm	300 kg	360 kg	360 kg	420 kg
	L1, L1(T)	750 mm	340 kg	400 kg	400 kg	460 kg
Metering panel	M, M(-K), M(-B), M(-BK)	750 mm	270 kg	330 kg	340 kg	390 kg
Individual metering panel	M(KK)	750 mm	270 kg	330 kg	340 kg	290 kg
Busbar voltage metering panel	M(VT)	375 mm	210 kg	270 kg	270 kg	330 kg
	M(VT-F)	375 mm	230 kg	290 kg	290 kg	350 kg
	M1(VT)	500 mm	240 kg	300 kg	310 kg	370 kg
	M1(VT-F)	500 mm	250 kg	310 kg	330 kg	390 kg
Bus riser panel	H	375 mm	170 kg	230 kg	230 kg	290 kg
	H [3]	375 mm	280 kg	340 kg	340 kg	400 kg
Busbar earthing panel	E	375 mm	180 kg	240 kg	240 kg	300 kg

Option	Width B1	Additional weight per panel (approx.)
Pressure relief duct for wall-standing/free-standing arrangement [4]	375 mm	30 kg
	500 mm	40 kg
	750 mm	60 kg
	875 mm	70 kg

[1] The net weight and the gross weight are approximate values. They depend on the delivering factory and on the extent to which the panel is equipped (e.g. current transformers, motor operating mechanisms) and are therefore given as mean value
[2] Low-voltage compartment LVC, 350 mm high, weight approx. 60 kg depending on the panel type and on the extent to which it is equipped (optional height 550 mm)
[3] Panel types including CTs and VTs: Weight per CT or VT as cast-resin design, approx. 20 kg (example: 3 CTs and 3 VTs mean approx. additionally 100 to 120 kg per panel)
[4] Additional weight for pressure relief duct must be added to the gross weight, if applicable

Tab. 4/6: **Weights for panels and for transport**

Transport unit "TU" [1]	Maximum width W3 of switchgear unit	Width W2	Height of transport unit [2]		Depth D2	Volume		Packing weight [4]
			without LVC [3]	with LVC [3]		without LVC [3]	with LVC [3]	
Standard packing for: – Truck – Seaworthy crate, airfreight	On request	0.70 m	1.95 m	2.30 m	1.40 m	1.91 m³	2.25 m³	
	≤ 0.875 m	1.08 m				2.95 m³	3.48 m³	70 kg
	≤ 1.00 m [5]	1.20 m				3.28 m³	3.86 m³	80 kg
	≤ 1.50 m	1.78 m				4.64 m³	5.47 m³	100 kg
	≤ 2.125 m	2.33 m				6.36 m³	7.50 m³	120 kg
Container packing, standard [6]	≤ 0.875 m	1.10 m				3.00 m³	3.00 m³	80 kg
	≤ 2.00 m	2.20 m				6.00 m³	7.10 m³	120 kg

[1] – Standard: As individual panels arranged side by side and not bolted together
– Option: As multi-panel transport unit (TU), panels bolted together
[2] Other heights "H" of the transport unit are possible (depending on the equipment of the panel type and on the packing type)
[3] Low-voltage compartment LVC, 350 mm high, weight approx. 60 kg depending on the panel type and on the extent to which it is equipped, or optionally 550 mm
[4] The gross weight is the sum of all net weights of the individual panels plus the packing weight, depending on the switchgear width W3
[5] On request: max. panel width W3 ≤ 1,125 mm (e.g. for 3 x 375 mm) possible
[6] Other dimensions on request

Tab. 4/7: **Transport dimensions for panels and panel combinations**

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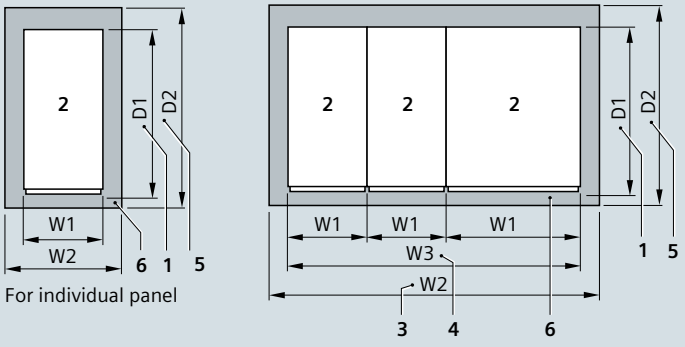
Transport units (= TU) for shipping (plan view)



1 D1 = Depth of individual panel
2 Dimensions of individual panel W1 x D1
3 W2 = Width of the transport unit
4 W3 = Overall width of combination of different individual panels
5 D2 = Depth of the transport unit
6 Transport unit, dimension W2 x D2

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Fig. 4/10: **Sketch for explanation of the transport dimensions of Tab. 4/6 and Tab. 4/7**

Chapter 5

NXAIR Switchgear

5 NXAIR Switchgear

The air-insulated NXAIR medium-voltage switchgear (Fig. 5/1) is a prefabricated, type-tested, metal-enclosed, and metal-clad switchgear for indoor installation according to the international standard IEC 62271-200, corresponding to the following classifications:

- Loss of service continuity category LSC 2B
- Partition class PM
- Accessibility to compartments
  - Busbar compartment — tool-based
  - Switching-device compartment — interlock-controlled
  - Connection compartment — interlock-controlled or tool-based
- Internal arc classification
  - IAC A FLR 50 kA, 1s (option: arc duration 0.1 s) — NXAIR ≤ 17.5 KV
  - IAC A FLR 25 kA, 1s (option: arc duration 0.1 s). — NXAIR 24 kV

In this way, NXAIR switchgear is suitable for unrestricted application (wall- or free-standing arrangement) in electrical service locations up to the maximum short-circuit ratings. It is used in transformer and switching substations, mainly for the primary distribution level up to 24 kV, e.g. in:

- Power supply companies, power plants, traction power supply facilities, offshore installations
- Diesel power plants, emergency power supply installations, pipeline installations
- Lignite open-cast mines, mining industry, iron and steel works
- Cement industry, mineral oil industry, petrochemical plants, electrochemical plants, chemical industry
- Automotive industry, shipbuilding industry, textile, paper, and food industry.

Especially for application on ships and platforms, NXAIR switchgear has been granted a type approval by

- Lloyds Register (LR)
- Det Norske Veritas (DNV).

By certification in the system GOST R, NXAIR is approved in Russia for application at the voltage levels 6, 10, and 20 kV. This approval is valid in the countries Russia, Belarus, Kazakhstan, and Ukraine. In addition, NXAIR is authorized for application in all transmission and distribution systems in Russia. Other reasons for the application of NXAIR are listed in Tab. 5/1.

Fig. 5/1: **Example for NXAIR switchgear**

Customer benefit	Features
Peace of mind For power supply companies and industrial plants, the platform concept of the NXAIR family introduced at all production locations has very concrete advantages: – Smooth operation – Exemplary availability – Optimal safety.	• No handling of insulating gas and no pressure monitoring required • As insulating medium, air is always available • Prefabricated, type-tested switchgear according to IEC 62271-200 • Platform concept introduced worldwide, centrally controlled development, local manufacture • Use of standardized block-type current transformers • Use of standard components available worldwide, locally manufactured components, and consideration of regional standards • More than 450,000 air-insulated switchgear panels of Siemens in operation worldwide • Use of maintenance-free vacuum circuit-breakers or contactors • Type testing of the vacuum circuit-breaker and the make-proof earthing switch in the panel • Pressure-resistant partitions • Flexibility regarding the low-voltage equipment (removable compartment, plug-in wires) • Quality assurance in accordance with ISO 9001.
Saves lives All switchgear types of the NXAIR family are approved with internal arc classification IAC A FLR, loss of service continuity category LSC 2B, and partition class PM. This makes them suitable for universal installation, meeting the highest requirements regarding personal safety.	• All operations with closed high-voltage door • Metallic enclosure, earthed shutters and partitions • Internal arc classified switchgear according to IAC A FLR; front, lateral, and rear accessibility; for all short-circuit currents and an arc duration of 1 s, optionally 0.1 s • Loss of service continuity category LSC 2B (separate partitions for busbar, connection, and switching-device compartments) • Partition class PM (metal-clad in pressure-resistant design) • Unambiguous position indicators and control elements on the high-voltage door • Use of vacuum circuit-breakers or contactors • Standard degree of protection IP3XD; different degrees of protection possible as an option • Positively driven shutters (separately lockable) • Logical mechanical interlocking system • As insulating medium, air is always available.
Increases productivity Properties such as modular design, type tests of the circuit-breaker in the switchgear, and confinement of an internal arc to the respective compartment, provide maximum operational reliability, enabling optimum operation combined with a remarkable increase of productivity.	• Loss of service continuity category LSC 2B (separate partitions for busbar, connection, and switching-device compartments) • Partition class PM • Maximum degree of protection IP51 possible • Positively driven shutters • Use of standardized block-type current transformers • Cable testing without isolating the busbar • Functions such as establishment of the isolating distance, as well as feeder and busbar earthing, can be completely controlled from remote • Confinement of an internal arc to the respective compartment up to 31.5 kA • Use of maintenance-free vacuum circuit-breakers or contactors • Control cables in metallic wiring ducts • Easy access to all panel components.
Saves money The compact design of the NXAIR family pays twice for owners due to the use of the new SION circuit-breaker series. On the one hand, building costs can be reduced in this way, and on the other hand, the maintenance-free circuit-breakers and the modular design enable continuous operation without expensive shutdown times.	• Use of maintenance-free vacuum circuit-breakers or contactors • Maintenance-free switchgear within up to 10 years • Interruption of operation reduced to a minimum by logical mechanical interlocking system • Minimized space requirements (reduced building investments) due to compact design and flexible cable connection options and/or flexible pressure relief duct systems.
Preserves the environment Air used as insulating medium, local production locations with short transportation ways and times, as well as a service life of more than 30 years, optimize the total energy balance.	• As insulating medium, air is absolutely neutral to the environment • Local production presence in all regions, minimized energy consumption (CO_2) regarding transport • Service life of more than 30 years optimizes the energy balance additionally • The materials used are fully recyclable without special knowledge • Easy disposal.

Tab. 5/1: **Features and customer benefits of NXAIR**

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In respect of seismic requirements, NXAIR switchgear is tested in accordance with the following internationally accepted requirements:
- IEC/TS 62271-210
- IEC 60068-3-3
- IEC 60068-2-6
- IEEE 693
- Uniform Building Code UBC, Chapter 16, Division IV.

NXAIR can be equipped with generator circuit-breakers tested according to IEEE C37.013 and (Dual-Code-Standard) IEC/IEEE 62271-37-013. In this way, the generator application and the auxiliaries application can be combined in a common switchgear. This reduces both space requirements and interfaces, increasing the cost-efficiency.

5.1 Design

A typical panel is divided into
- Switching-device compartment
- Busbar compartment
- Connection compartment
- Low-voltage compartment.

The enclosures of these individual elements consist of sendzimir-galvanized sheet steel. The individual elements are characterized as follows:

Switching-device compartment

- Pressure relief upwards
- Panel front powder-coated with epoxy resin
- Standard color RAL 7035
- Separate shutter mechanism for opening and closing the
  - Busbar compartment
  - Connection compartment
- High-voltage door (pressure-resistant in the event of internal arcs in the panel)
- Pressure-resistant partitions to connection and busbar compartments
- Lateral metallic wiring duct for laying the control cables
- Low-voltage plug connector for connection of control cables between primary part and secondary part
- Switching-device compartment for the different panel versions with withdrawable devices:
  - Vacuum circuit-breaker [1)]
  - Vacuum contactor
  - Withdrawable disconnector link
  - Withdrawable metering part
- Endurance classes for:
  - Circuit-breaker: E2, M2, C2
  - Isolating distance (wtihdrawable part): M0 manually or optionally motor-operated for withdrawable circuit-breaker and disconnector link
  - Vacuum contactor 250,000, 500,000, or 1,000,000 × I_N.

Busbar compartment

- Pressure relief upwards
- Busbars made of flat copper, bolted from panel to panel
  - Option: Insulated
- Pressure-resistant partitions to connection and switching-device compartments, pressure-resistant rear wall
- Transverse partition from panel to panel:
  - Standard in NXAIR for 40 kA and 50 kA
  - Otherwise as an option
- Shutters can be opened and locked separately
- Bushing-type insulators for supporting the busbars and for accommodating the upper fixed contacts for the switching device
- Option: Coupling electrode for capacitive voltage detecting system
- Options: (see Fig. 5/2; but not for panels with natural and forced ventilation)
  - Voltage transformers
  - Make-proof earthing switch (endurance class: M0, E1; manual operation or optionally motor operation)
  - Bar or cable connection.

Connection compartment

- Pressure relief upwards through rear pressure relief duct
- Pressure-resistant partitions to switching-device and busbar compartments
- Shutters can be opened and locked separately
- Earthing busbar
- Pressure-resistant floor cover
- Connection from front/bottom, or from rear/bottom, or from rear/top
- Suitable for connection of
  - XLPE single-core cables up to 6 × 500 mm^2 [2)]
  - Three-core cables 3 × 240 mm^2 per panel [2)]
  - Flat copper bars with bushings in a base plate or fully-insulated bars including floor cover
- Installation of voltage transformers
  - Cast-resin-insulated
  - 3 × 1-pole
  - Fixed-mounted, without primary fuses
  - or withdrawable with primary fuses [3)]
- Make-proof earthing switch
  - With manual operating mechanism, optionally motor operating mechanism
  - In addition to the standard interlock: Earthing switch optionally lockable or electromagnetically interlocked against the withdrawable switching device
- Endurance class for earthing switch: M0, E1
- Surge arrester or surge limiter
  - Surge arrester for protecting the switchgear against external overvoltages
  - Surge limiter for protecting consumers against switching overvoltages while operating motors with starting currents ≤ 600 A.
- Options:
  - Installation of bushing-type insulators or block-type current transformers
  - Coupling electrode for capacitive voltage detecting system

Low-voltage compartment

- Partitioned safe-to-touch off the high-voltage part
- Removable, as all bus wires and control cables are plugged in
- Flexible low-voltage cables protected by metal covers
- Connection of withdrawable part and panel wiring to low-voltage compartment via 10-pole, coded plug connectors
- Bus wires are pluggable from panel to panel
- Options:
  - Test sockets for capacitive voltage detecting system at the feeders or the busbar
  - Higher low-voltage compartment
  - Separation wall from panel to panel.

Footnotes:

1) Available for NXAIR 24 kV in combination with withdrawable HV HRC fuses in the connection compartment as switch-fuse function for particularly high demands regarding switching capacity and switching rate

2) Depending on the rated normal current and other built-in components

3) For NXAIR ≤ 17.5 kV: in its own compartment with bushings and shutters towards the connection compartment;
for NXAIR 24 kV: withdrawable with fuses

5.2 Technical data and equipment

The technical data is listed in Tab. 5/2. For adaptation of the insulation levels to site altitudes of more than 1,000 m above sea level, a correction factor K_a can be derived from Fig. 2/2 (see examples in Chapter 2).

The power losses are listed in Tab. 5/3 for the panels of the different rated short-circuit breaking currents and different rated operational voltages. Fig. 5/2 offers an overview of the panel types and their equipment.

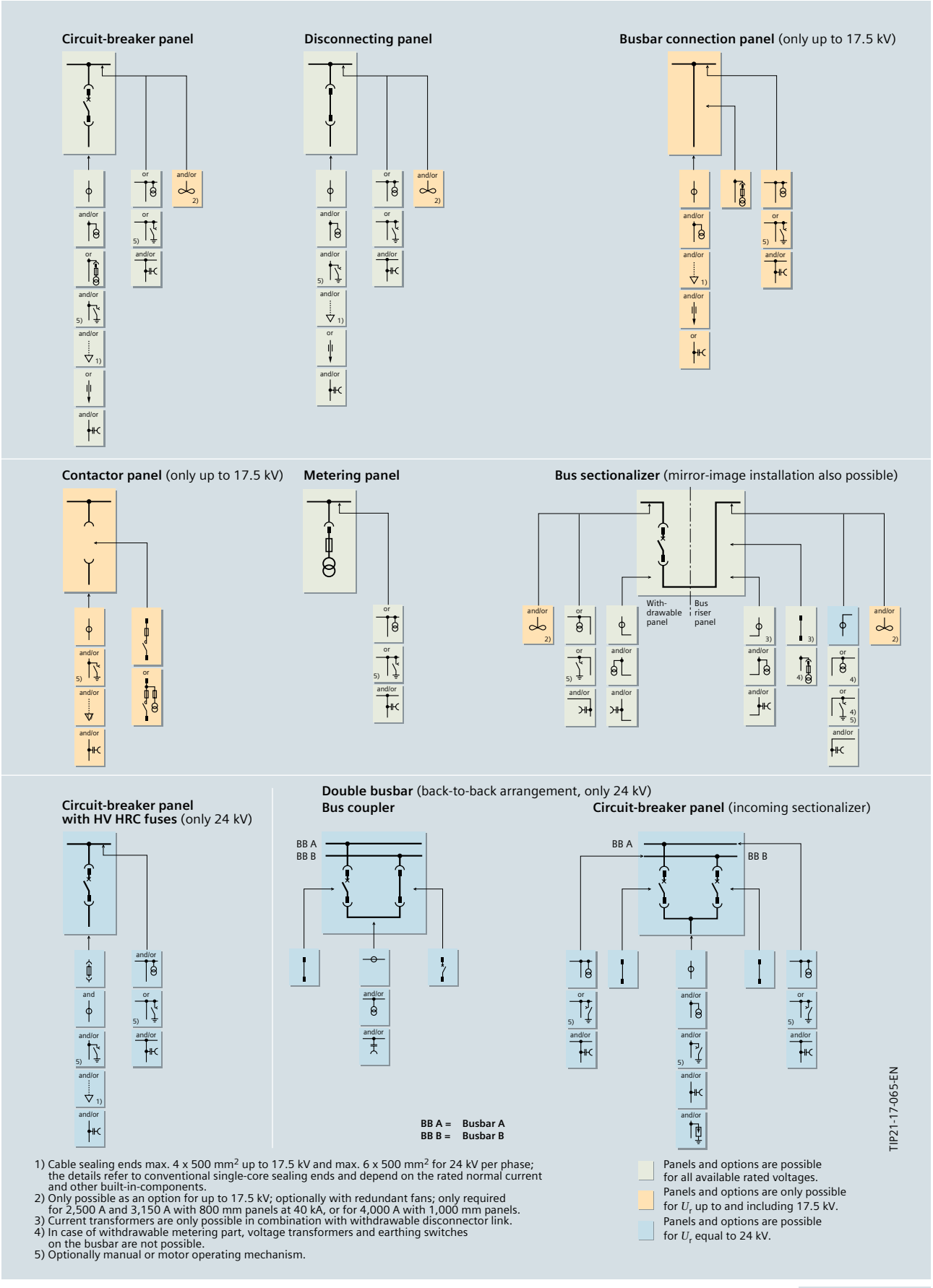
NXAIR	up to 17.5 kV/40 kA			up to 17.5 kV/50 kA			24 kV/25 kA
Rated voltage U_r	**7.2 kV**	**12 kV**	**17.5 kV**	**7.2 kV**	**12 kV**	**17.5 kV**	**24 kV**
Rated short-duration power-frequency withstand voltage U_d (phase-to-phase, phase-to-earth)	20 kV [1]	28 kV [2]	38 kV	20 kV [1]	28 kV [2]	38 kV	50 kV [3]
Rated lightning impulse withstand voltage U_p (phase-to-phase, phase-to-earth)	60 kV	75 kV	95 kV	60 kV	75 kV	95 kV	125 kV
Rated frequency f_r	50/60 Hz			50/60 Hz			50/60 Hz
Rated normal current I_r max.							
– Busbar – Busbar connection panel – Bus sectionalizer – with circuit-breaker – with withdrawable contactor [4] – with withdrawable disconnector link	4,000 A 4,000 A 4,000 A 4,000 A 400 A 4,000 A	4,000 A 4,000 A 4,000 A 4,000 A 400 A 4,000 A	4,000 A 4,000 A 4,000 A 4,000 A - 4,000 A	4,000 A 4,000 A 4,000 A 4,000 A 400 A 4,000 A	4,000 A 4,000 A 4,000 A 4,000 A 400 A 4,000 A	4,000 A 4,000 A 4,000 A 4,000 A - 4,000 A	2,500 A - 2,500 A 2,500 A - 2,500 A
Rated short-time withstand current I_k with t_k = 3 s, max.	40 kA			50 kA			25 kA
Rated peak withstand current I_p (50/60 Hz) max.	100/104 kA			125/130 kA (137/137 kA) [5]			63/65 kA
Rated short-circuit making current I_{ma} (50/60 Hz) max.	100/104 kA			125/130 kA (137/137 kA) [5]			63/65 kA
Rated short-circuit breaking current I_{sc} max.	40 kA			50 kA			25 kA

1) 32 kV optional for GOST standard
2) 42 kV optional for GOST standard
3) 65 kV optional for GOST standard
4) Current values dependent on HV HRC fuses, for GOST standard max. 32 kV short-duration power-frequency withstand voltage
5) 137 kA in combination with generator circuit-breaker 3AK7

Tab. 5/2: **Technical data for NXAIR**

	Power loss per panel at rated current I_r								
	< 630 A	**800 A**	**1,000 A**	**1,250 A**	**1,600 A**	**2,000 A**	**2,500 A**	**3,150 A**	**4,000 A**
NXAIR: U_r up to 17.5 kV, I_{SC} up to 40 kA	220 W		500 W	800 W	870 W	1,350 W	2,000 W		
NXAIR: U_r up to 17.5 kV, I_{SC} up to 50 kA				910 W	1,150 W		2,500 W	3,300 W	6,750 W
NXAIR: U_r = 24 kV, I_{SC} up to 25 kA		250 W	400 W	500 W		800 W	1,400 W		

Tab. 5/3: **Power loss data for NXAIR**



1) Cable sealing ends max. 4 x 500 mm² up to 17.5 kV and max. 6 x 500 mm² for 24 kV per phase; the details refer to conventional single-core sealing ends and depend on the rated normal current and other built-in-components.
2) Only possible as an option for up to 17.5 kV; optionally with redundant fans; only required for 2,500 A and 3,150 A with 800 mm panels at 40 kA, or for 4,000 A with 1,000 mm panels.
3) Current transformers are only possible in combination with withdrawable disconnector link.
4) In case of withdrawable metering part, voltage transformers and earthing switches on the busbar are not possible.
5) Optionally manual or motor operating mechanism.

Panels and options are possible for all available rated voltages.
Panels and options are only possible for U_r up to and including 17.5 kV.
Panels and options are possible for U_r equal to 24 kV.

Fig. 5/2: **Panel types and options for NXAIR (symbol explanations for the components are given in the annex)**
Click here (not for mobile devices)

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5.3 Dimensions, transport and room planning

Please observe the following for room planning:
- Switchgear installation
- Pressure relief
- Panel dimensions
- Switchgear fixing
- Door dimensions
- Weights and transport.

Note: Specifications due to local or use-specific standards, regulations or guidelines must be observed for room planning.

In Tab. 5/4, the dimensions of the individual panel types are summarized. To illustrate the sizes (Fig. 5/3), a front view as well as the side views for a single-busbar and a double-busbar panel are shown schematically hereafter.

The NXAIR switchgear is delivered in form of individual panels. Please observe the following:
- Transport facilities on site (Fig. 2/14)
- Transport weights and dimensions (Tab. 5/5)
- Size of door openings in building.

The panels are transported on pallets. For transport via train and/or truck, the panels are openly packed with PE protective film. For airfreight, the panels are delivered in a wooden latticed crate with sealed upper and lower PE protective film. For seafreight or airfreight, the panel is sealed in PE protective film and put into a wooden crate with tightly closed wooden base. In addition, desiccant bags are placed in the crate, thus enabling a maximum storage time of 6 months for this packing method.

The specified weights are average values depending on the degree to which the panels are equipped. The double-busbar panels (back-to-back arrangement) are delivered as individual panels. Interconnection is done on site.

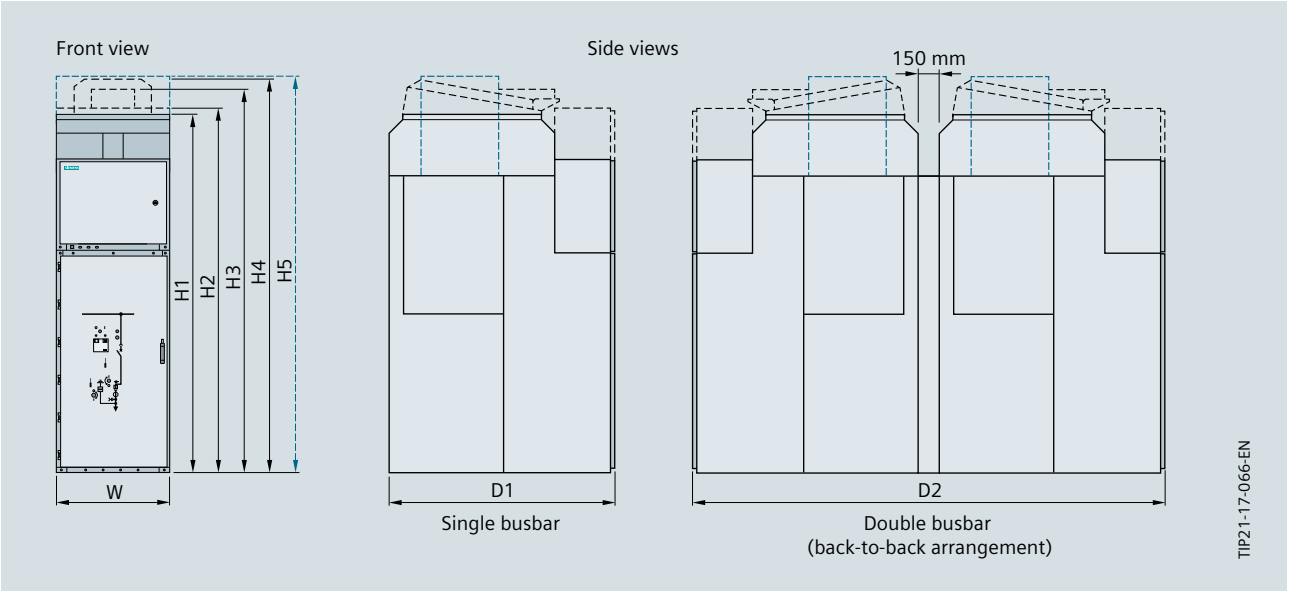

Fig. 5/3: **NXAIR – schematic representation of the front and side views**

		Panel type	I_r	Short-time withstand current for NXAIR			
				up to 17.5 kV			for 24 kV
				≤ 31.5 kA	40 kA	50 kA	≤ 25 kA
Width	W	Circuit-breaker panel, disconnecting panel	≤ 1,000 A 1,250 A 1,600 A 2,000 A 2,500 A 3,150 A 4,000 A	600 mm [1] 800 mm 800 mm 800 mm 1,000 mm 1,000 mm 1,000 mm	800 mm 800 mm - 800 mm 800/1,000 mm [2] 800/1,000 mm [2] 1,000 mm	- 800 mm 800 mm - 1,000 mm 1,000 mm 1,000 mm	800 mm 800 mm - 1,000 mm 1,000 mm - -
		Bus sectionalizer	1,250 A ≥ 2,500 A	2 × 800 mm 2 × 1,000 mm	2 × 800 mm 2 × 1,000 mm/ 2 × 800 mm [3]	2 × 800 mm 2 × 1,000 mm	2 × 800 mm 2 × 1,000 mm
		Metering panel	-	800 mm	800 mm	800 mm	800 mm
		Contactor panel	≤ 400 A	435/600 mm	435/600 mm	435 mm	-
		Circuit-breaker panel with HV HRC fuses	800 A	-	-	-	800 mm
Height	H1	Standard panel (or standard panel with natural ventilation [4])	-	2,300 mm	2,300 mm	2,500 mm	2,510 mm
	H2	With higher low-voltage compartment (or additional compartment for busbar components [4])	-	2,350 mm	2,350 mm	2,550 mm	2,550 mm
	H3	With forced ventilation	-	2,450 mm	2,450 mm	2,650 mm	2,680 mm
	H4	With optional arc absorber [5] (for 12 kV, 25 kA, or in general for 17.5 and 24 kV)	-	2,500 mm	2,500 mm	2,680 mm	2,750 mm
	H5	With additional compartment for busbar components	-	-	-	-	2,770 mm
Depth	D1	Single busbar, all panel types (except contactor panel)	-	1,350 mm [6]	1,500 mm [6]	1,650 mm	1,600 mm
		Single busbar, contactor panel	-	1,400 mm	1,500 mm	1,650 mm	-
	D2	Double busbar	-	-	-	-	3,350 mm

[1] Disconnecting panel not in 600 mm
[2] 800 mm with forced ventilation
[3] Depending on the rated normal current I_r and the design of the bus riser panel
[4] Only up to 17.5 kV
[5] Number of absorbers depending on switchgear configuration
[6] Depth D1 = 1,540 mm for panels with rated normal current I_r = 3,150 A and 4,000 A

Tab. 5/4: **Dimensions for NXAIR**

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		Panel width	Transport dimensions			Transport weights	
			Width	Height	Depth	with packing	without packing
NXAIR up to 17.5 kV, up to 40 kA	Transport by rail and/or truck	435 mm 600 mm 800 mm 1,000 mm	800 mm 800 mm 1,000 mm 1,200 mm	2,510 mm	1,610 mm	800 kg 980 kg 1,360 kg 1,690 kg	770 kg 950 kg 1,320 kg 1,650 kg
	Seafreight or airfreight	435 mm 600 mm 800 mm 1,000 mm	820 mm 820 mm 1,020 mm 1,220 mm	2,541 mm	1,830 mm	900 kg 1,090 kg 1,470 kg 1,810 kg	770 kg 950 kg 1,320 kg 1,650 kg
NXAIR up to 17.5 kV, 50 kA	Transport by rail and/or truck	435 mm 800 mm 1,000 mm	800 mm 1,000 mm 1,200 mm	2,650 mm	1,850 mm	830 kg 1,590 kg 1,840 kg	800 kg 1,550 kg 1,800 kg
	Seafreight or airfreight	435 mm 800 mm 1,000 mm	822 mm 1,022 mm 1,222 mm	2,666 mm	1,872 mm	940 kg 1,720 kg 1,980 kg	800 kg 1,550 kg 1,800 kg
NXAIR 24 kV, up to 25 kA	Transport by rail and/or truck	800 mm 1,000 mm	1,175 mm 1,200 mm	2,980 mm	1,810 mm 1,860 mm	1,350 kg 1,460 kg	1,300 kg 1,400 kg
	Seafreight or airfreight	800 mm 1,000 mm	1,200 mm 1,400 mm	2,500 mm [1)]	2,000 mm	1,480 kg 1,600 kg	1,300 kg 1,400 kg

[1)] Pressure relief ducts are packed separately; packing units must be inquired

Tab. 5/5: **Transport weights and dimensions for NXAIR panels (details are average values and depend on the extent to which the panels are equipped)**

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Rated voltage/short-time withstand current					
	≤ 17.5 kV/25 kA	≤ 17.5 kV/31.5 kA	≤ 17.5 kV/40 kA	≤ 17.5 kV/50 kA	24 kV/25 kA
Minimum ceiling height D for pressure relief out of the switchgear room through a pressure relief duct	2,500 mm	2,500 mm	2,500 mm	2,700 mm	3,000 mm [1)]
Minimum ceiling height D for pressure relief into the switchgear room through absorbers	2,800 mm (≤ 12 kV) 3,500 mm (17.5 kV)	3,000 mm (≤ 12 kV) 3,500 mm (17.5 kV)	3,500 mm	3,500 mm	3,300 mm
Control aisle width E, minimum	1,250 mm	1,250 mm	1,250 mm	1,350 mm	1,350 mm

[1)] In case of a lower ceiling height, please contact your Siemens partner *(www.siemens.com/tip-cs/contact)*

Tab. 5/6: **Ceiling heights D and control aisle widths E for NXAIR room planning and installation**

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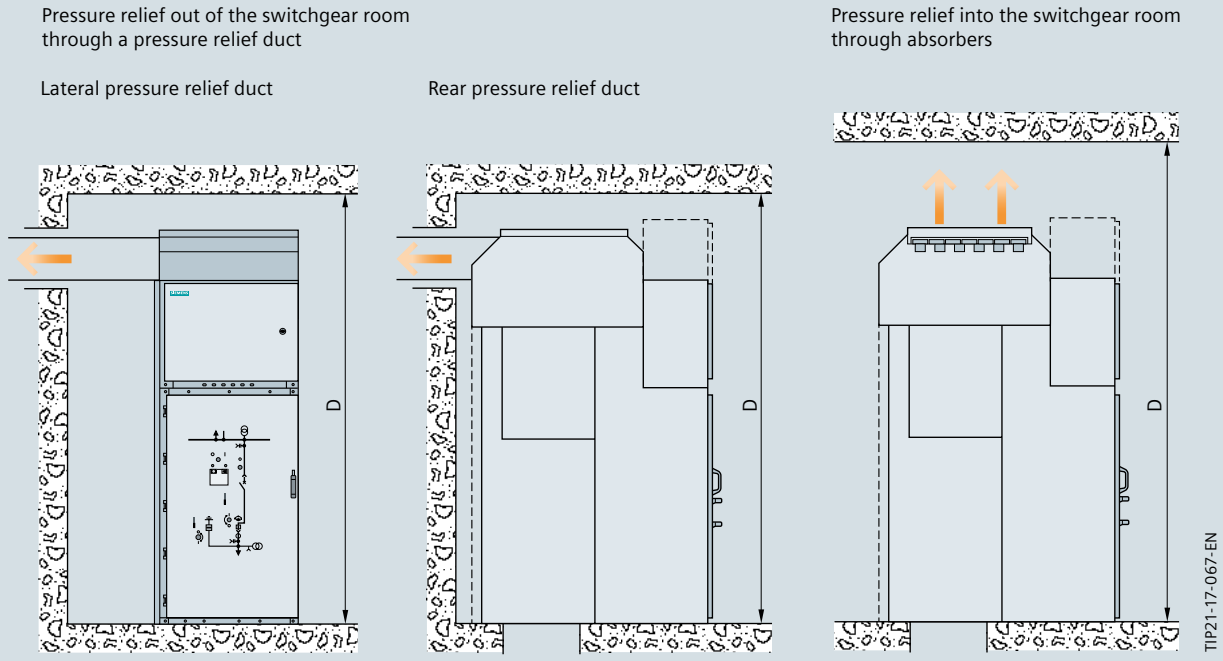

Fig. 5/4: **Pressure relief for NXAIR (for details to the ceiling height D, see Tab. 5/6)**

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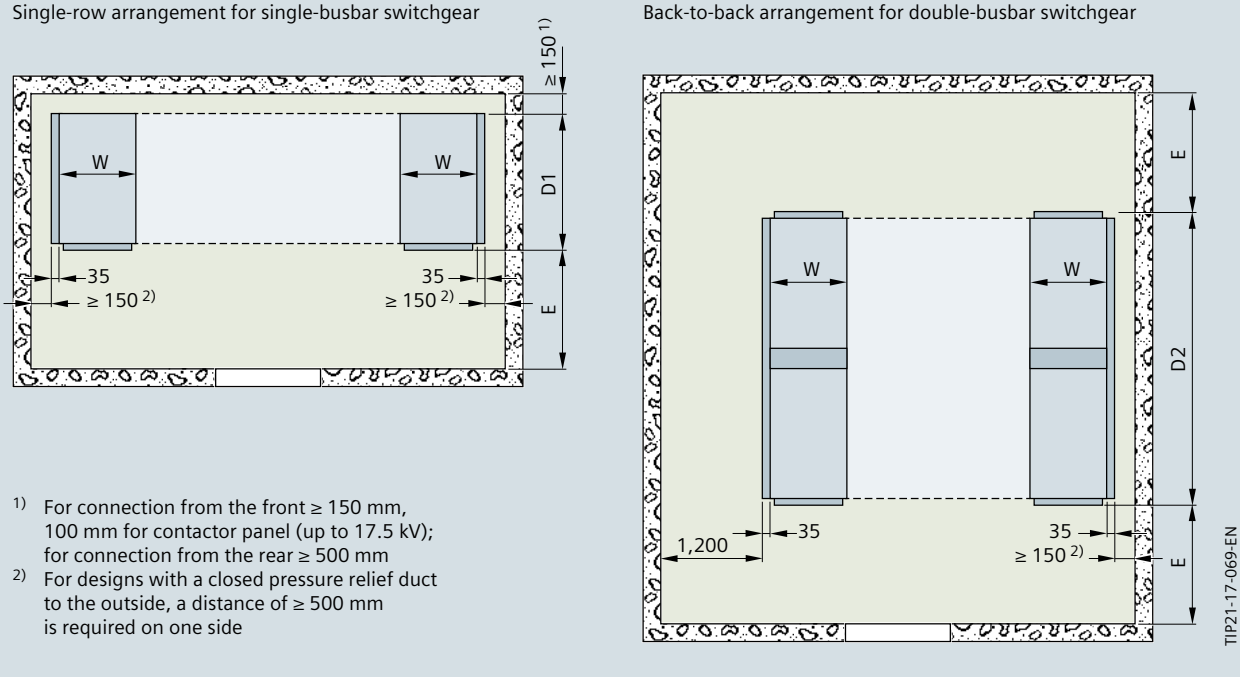

1) For connection from the front ≥ 150 mm, 100 mm for contactor panel (up to 17.5 kV); for connection from the rear ≥ 500 mm

2) For designs with a closed pressure relief duct to the outside, a distance of ≥ 500 mm is required on one side

Fig. 5/5: **Distances for installation of NXAIR (for details to the panel width W as well as panel depths D1 and D2, see Tab. 5/5; for details to the width of the control aisle E, see Tab. 5/6; dimensions in mm)**

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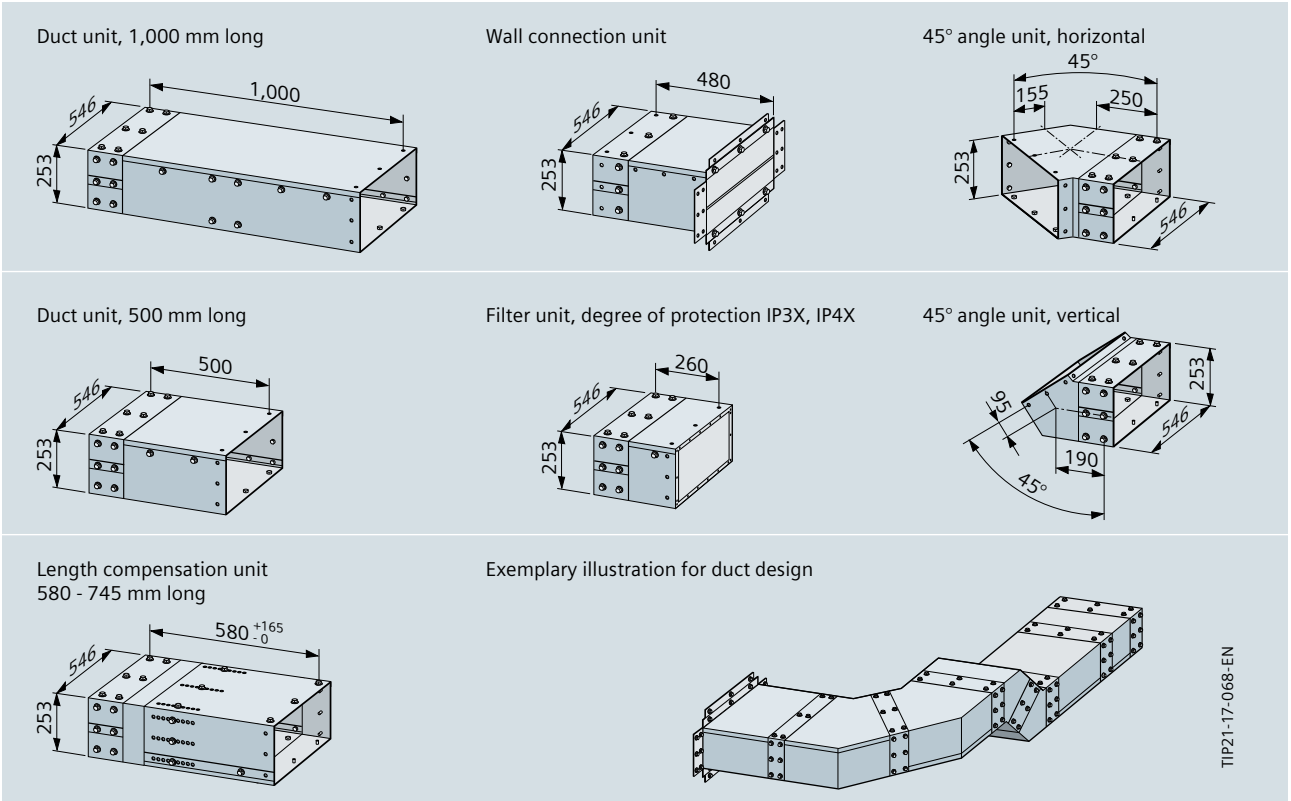

Fig. 5/6: **Elements for the design of a horizontal pressure relief duct (dimensions in mm)**

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Rated voltage/short-time withstand voltage/rated normal current			
	≤ 17.5 kV/≤ 31.5 kA/≤ 2,500 A	≤ 17.5 kV/40 kA, 50 kA and ≤ 17.5 kV/≤ 31.5 kA/> 2,500 A	24 kV/25 kA
Panel connection with single-core cable per phase	4 × 500 mm²	6 × 500 mm²	Panel width 800 mm: 4 × 300 mm² Panel width 1,000 mm: 4 × 500 mm²
Panel connection with three-core cable	3 × 240 mm²	6 × 240 mm²	2 × 240 mm²

Tab. 5/7: **Cable dimensions for panel connection in NXAIR**

In case of internal arcing, the pressure can be relieved into the switchgear room through an absorber, or out of the switchgear room through a horizontal pressure relief duct. On the other hand, the pressure relief duct can be led from the panel to the side or to the rear (Fig. 5/4). Tab. 5/6 shows the values belonging to the corresponding ceiling height D (Fig. 5/4). The elements for the pressure relief duct, their dimensions and an installation example are depicted in Fig. 5/6.

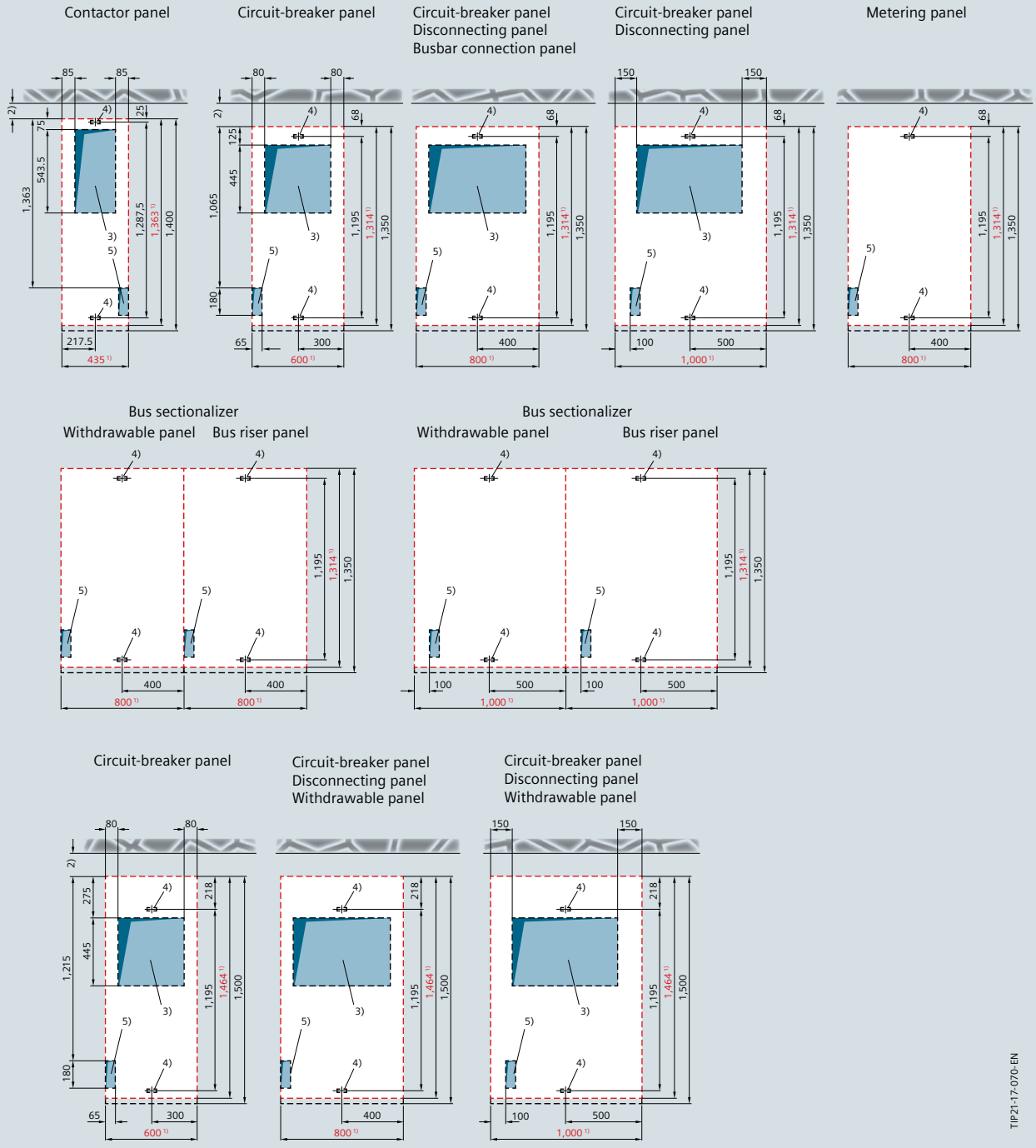
For single-row arrangement of single-busbar switchgear, the wall distances are given in Fig. 5/5. The values for width W and depth D1 of the panels are listed in Tab. 5/4. In addition, the details to the control aisle E are provided in Fig. 5/5 and in Tab. 5/6.

For back-to-back and face-to-face arrangement of single-busbar switchgear, the room dimensions apply accordingly to those for single-row arrangement. For back-to-back arrangement, a 1,200 mm wide control aisle is required on the left or on the right of the switchgear. This control aisle must be also planned for double-busbar switchgear (in Fig. 5/5 e.g. on the left side).

A suitable foundation can be a false floor, a double floor or a reinforced-concrete foundation. The reinforced-concrete floor must be equipped with foundation rails for supporting the panels.
(for more information, please contact your Siemens partner, www.siemens.com/tip-cs/contact).

Tolerances for the foundation according to DIN 43661:
- Straightness: 1 mm per 1 m length and 2 mm for the total length
- Evenness: 1 mm within 1 m measuring length.

Panel connection with cables is possible via conventional terminations (Tab. 5/7). The position and size of the floor openings and fixing points for the panels is given in the drawings in Fig. 5/7 to Fig. 5/10.



Comments:
- A combination of panels with a depth of 1,350 mm and 1,500 mm is possible.
- Metering panels, busbar connection panels, and bus riser panels are not possible with a depth of 1,500 mm

Legend:
1) Standing surface and its dimensions in red
2) Wall distance (see Fig. 5/5)
3) Floor opening for high-voltage cables
4) Fixing points (elongated hole 60 x 20 mm)
5) Floor opening for control cables

Fig. 5/7: **Layouts, floor openings, and fixing points for NXAIR with U_r up to 17.5 kV, I_{sc} up to 31.5 kA, I_r up to 2,500 A (dimensions in mm)**

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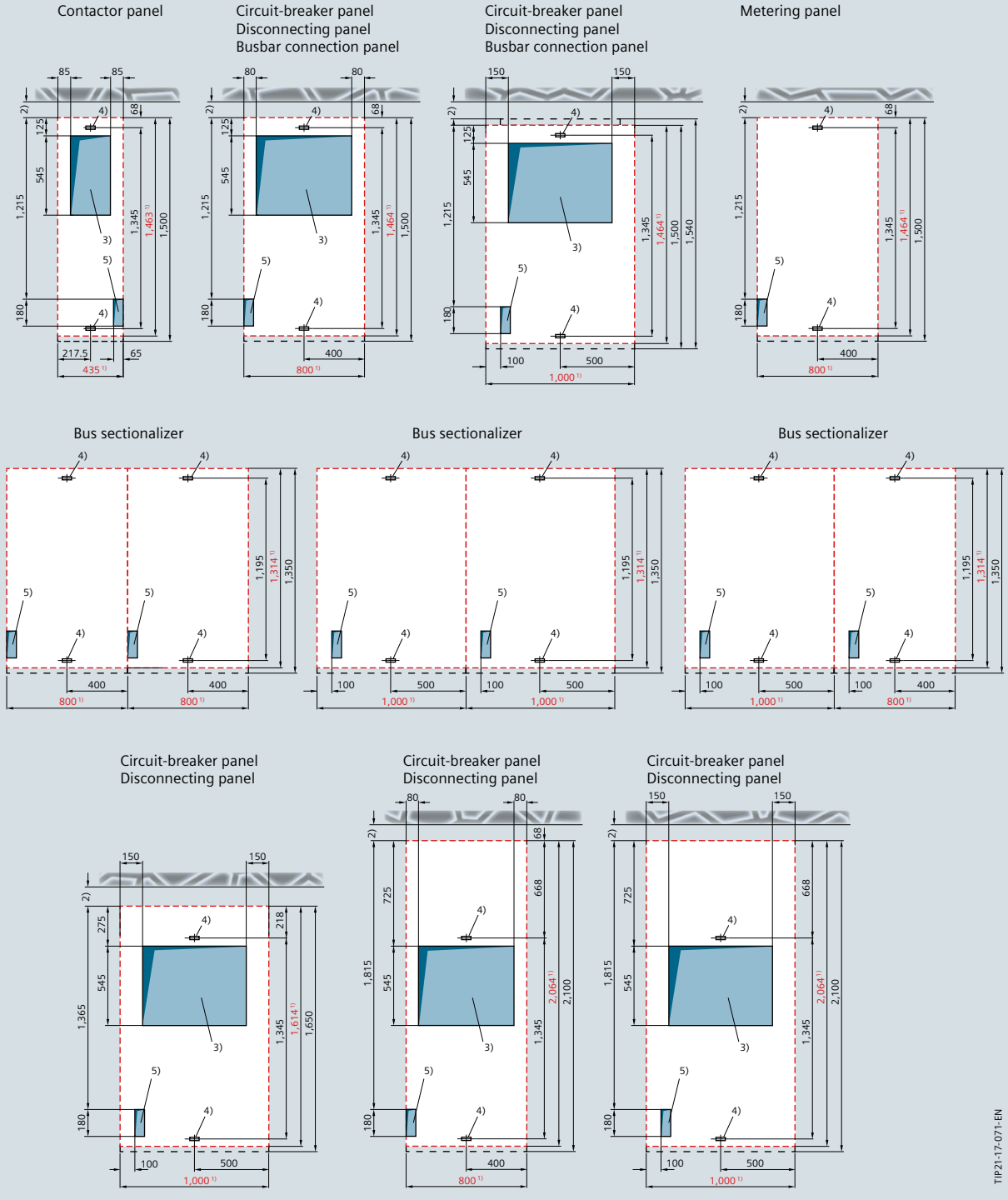

Comments:
- A combination of panels with a depth of 1,500, 1,540, 1,650, and 2,100 mm is possible. The wall distance 2) is stipulated by the panel with the largest depth.
- Metering panels, busbar connection panels, bus sectionalizers, contactor panels, and panels with current transformers on the busbar are not possible with depths of 1,650 mm or 2,100 mm.

Legend:
1) Standing surface and its dimensions in red
2) Wall distance (see Fig. 5/5)
3) Floor opening for high-voltage cables
4) Fixing points (elongated hole 60 x 20 mm)
5) Floor opening for control cable

Fig. 5/8: **Layouts, floor openings, and fixing points for NXAIR with U_r up to 17.5 kV, I_{sc} up to 31.5 kA, I_r over 2,500 A and NXAIR with U_r up to 17.5 kV, I_{sc} equal to 40 kA (dimensions in mm)**

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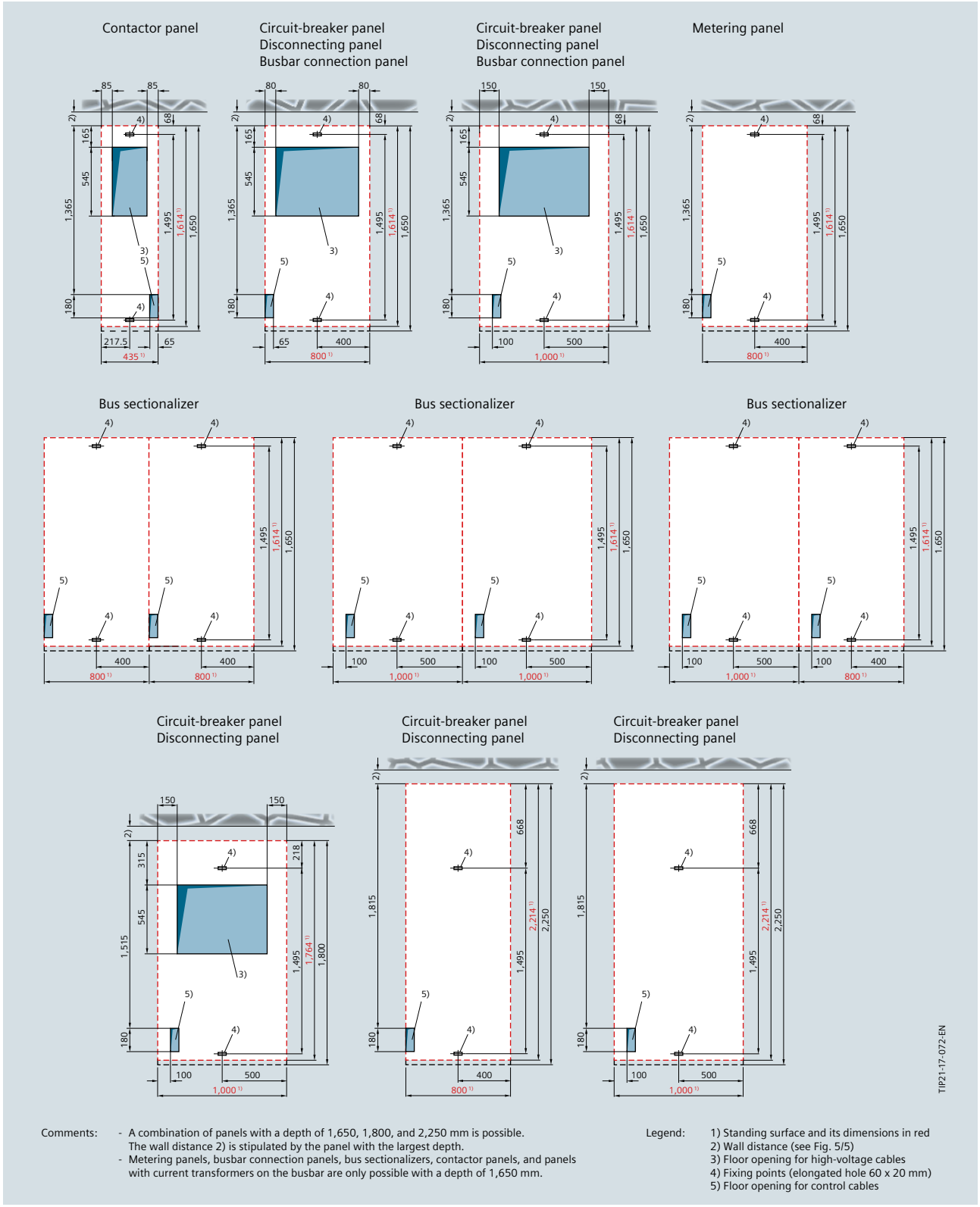

Comments:
- A combination of panels with a depth of 1,650, 1,800, and 2,250 mm is possible. The wall distance 2) is stipulated by the panel with the largest depth.
- Metering panels, busbar connection panels, bus sectionalizers, contactor panels, and panels with current transformers on the busbar are only possible with a depth of 1,650 mm.

Legend:
1) Standing surface and its dimensions in red
2) Wall distance (see Fig. 5/5)
3) Floor opening for high-voltage cables
4) Fixing points (elongated hole 60 x 20 mm)
5) Floor opening for control cables

Fig. 5/9: **Layouts, floor openings, and fixing points for NXAIR with U_r up to 17.5 kV, I_{sc} equal to 50 kA (dimensions in mm)**

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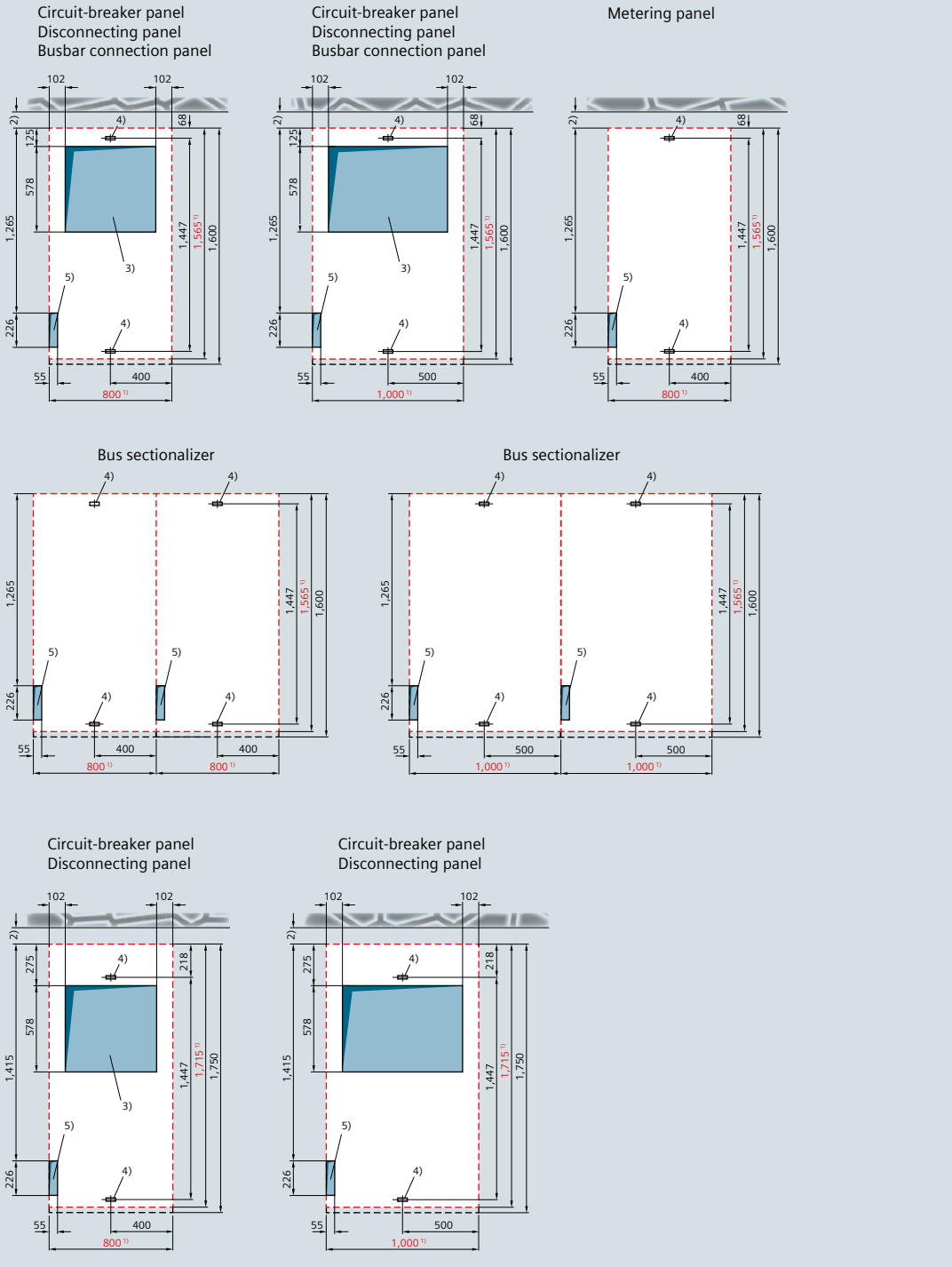

Comments:
- A combination of panels with a depth of 1,600 mm and 1,750 mm is possible. The wall distance 2) is stipulated by the panel with the largest depth.
- Metering panels, busbar connection panels, and bus riser panels are not possible with a depth of 1,600 mm.

Legend:
1) Standing surface and its dimensions in red
2) Wall distance (see Fig. 5/5)
3) Floor opening for high-voltage cables
4) Fixing points (elongated hole 60 x 20 mm)
5) Floor opening for control cables

Fig. 5/10: **Layouts, floor openings, and fixing points for NXAIR with U_r equal to 24 kV (dimensions in mm)**

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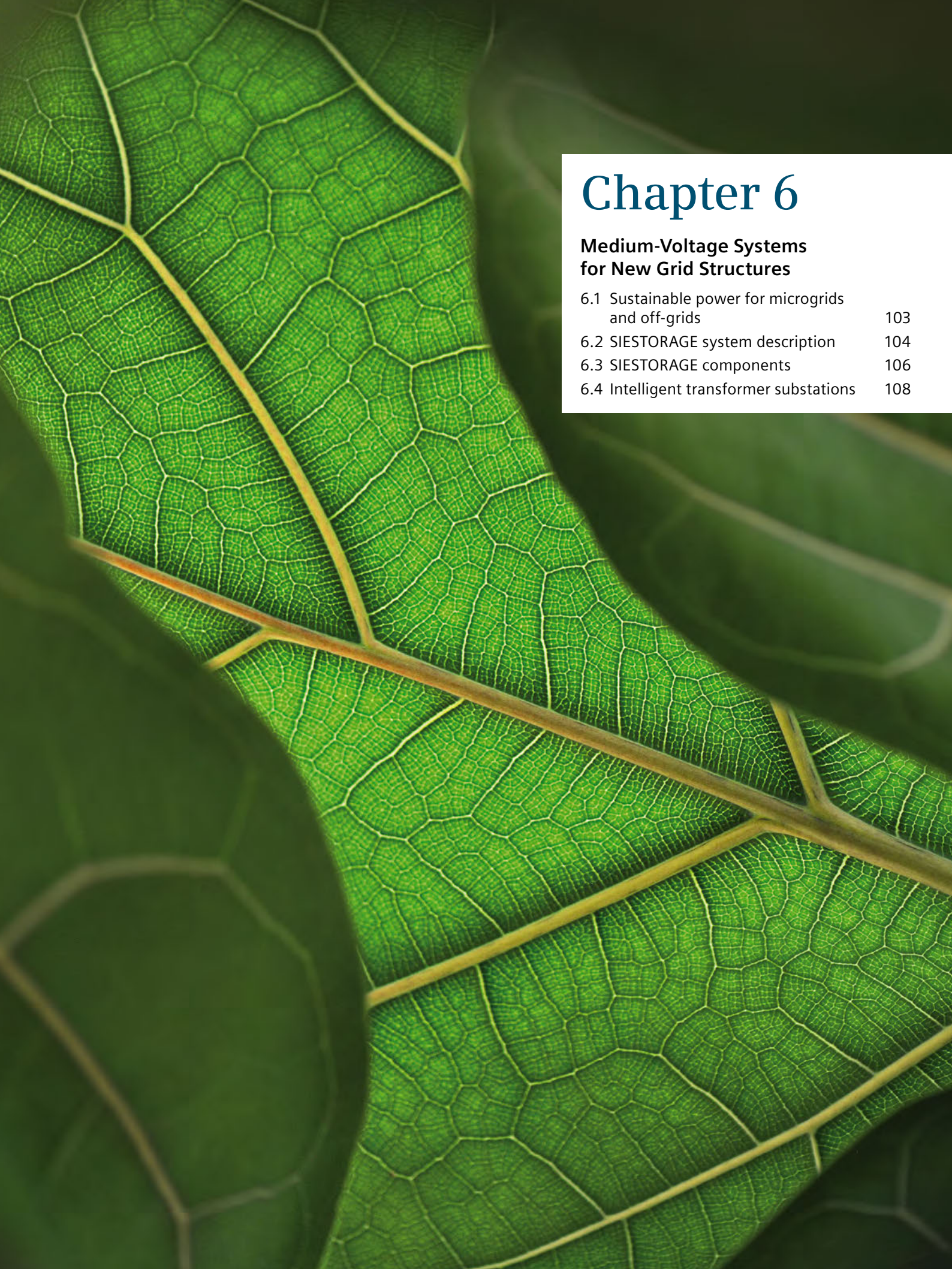

Chapter 6

Medium-Voltage Systems for New Grid Structures

6 Medium-Voltage Systems for New Grid Structures

The application of renewable energies on a higher scale leads to new challenges for regulation of the grid stability. A unidirectional electric power distribution, as we were used to until now, will be less and less the case due to the change between power supply and power consumption, which is increasing with the decentralization of power generation.

Changing directions of power flow, load and voltage fluctuations, which are caused especially by the strongly growing number of power supplies from volatile energy sources, e.g. photovoltaic/biogas plants and wind farms, make the distribution grids of today go to their capacity limits. Accordingly, the demands placed on performance and safety of the technology used are growing.

To avoid the initiation and execution of a radical remodeling of the grid at short term, a good balance has to be provided for in the distribution grid. SIESTORAGE can absorb, store, and feed back surplus energy as soon as it is required. The balance between producers and consumers reduces failures and improves the efficiency of traditional energy producers. By securing the power flow in the supply and distribution grid, SIESTORAGE also renders some grid expansions or costly grid modifications unnecessary.

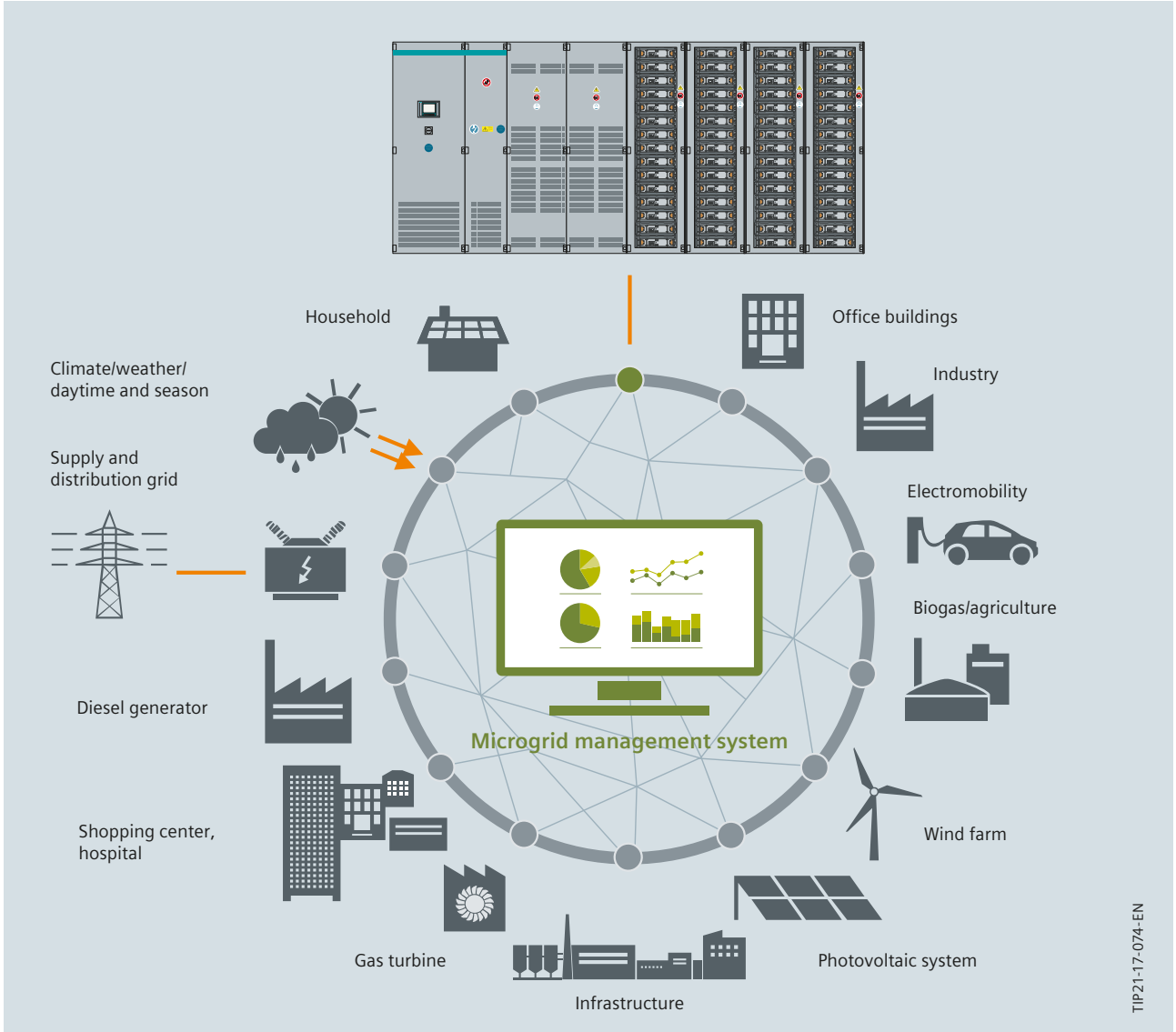

Fig. 6/1: **SIESTORAGE and microgrid management from Siemens**

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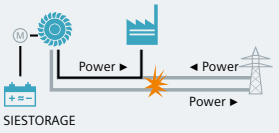
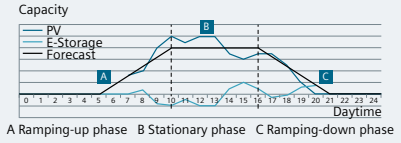
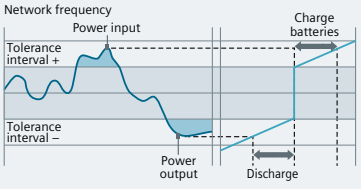
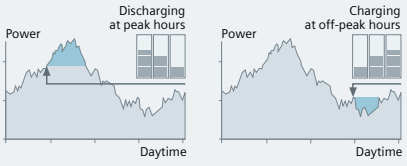
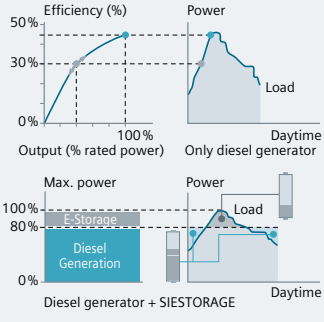
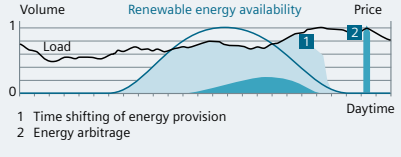
6.1 Sustainable power for microgrids and off-grids

A microgrid is characterized by the combination of local power generation, energy consumers, and a suitable monitoring and control system for supply and load management (Fig. 6/1). Grid operation is possible as required by means of an off-grid or by interconnection with a larger supply grid. Apart from a certain balance of power generation with variable energy sources, storage solutions such as SIESTORAGE can be applied in many other use cases (Tab. 6/1):

Application	Description	Illustration
Black start	The black-start capability of SIESTORAGE allows the start-up of a grid when the main supply is not available. The stored energy is enough, for example, to start a gas turbine and to set the quality parameters before reconnecting to the grid so that the gas turbine can synchronize itself with the grid.	
Integration of renewable energy sources and planning reliability	Compensation of irregularities in the power infeed from renewable energy sources, and adjustment of the real consumption to the purchasing schedules agreed upon with the power supply companies.	
Frequency regulation	Changes on both the consumer side and the power infeed impair the grid stability due to frequency fluctuations, which can be reduced by targeted charging and discharging.	
Peak load management	Avoidance of higher charges by reducing the energy amount consumed during peak load times (OpEx, operational expenditure, as well as avoidance of upgrade measures (CapEx, capital expenditure) resulting from higher peak load demand. For microgrid operators, this challenge is even worse, as they are not always able to source additional power or access market-based balancing services.	
Replacement of diesel generators, or diesel operation with optimized efficiency	SIESTORAGE can replace back-up diesel generation, or can be co-located to it. This provides low operational costs (OpEx), reduces ramping, and ensures better running efficiency. By consuming power during times of low load and injecting to support peaks, smaller machines can be used (CapEx). Running closer to their operational design characteristics, they run more efficiently and with less pollution.	
Flexibility for energy trade	When energy supply exceeds demand, market prices often reflect this mismatch through negative prices. SIESTORAGE stores surplus energy from renewable sources and injects it into the grid when the demand is high. Moreover, energy can be fed into the grid exactly when it is mostly needed and high earnings can be achieved	

Tab. 6/1: **Possibilities of application for SIESTORAGE**

- Optimization of diesel generator or gas turbine operation in the microgrid
- Rapid frequency regulation for slow starting of generators
- Efficient balance of low and peak demand to reduce costs
- Provision of energy for black start of emergency generators
- Balance in case of ramping-up and ramping-down of large consumers
- "Energy time shift" for balancing in the case of time shifting between power generation by renewable energy sources (for example, photovoltaic systems) and power consumption.

The SICAM Microgrid Manager from Siemens, a fully developed end-to-end solution to monitor and control microgrids, is a smart, user-friendly, and versatile tool for energy management. It constantly monitors and controls the grid, power generation, energy storage, and consumption. Being of modular design and scalable, the SICAM Microgrid Manager can be precisely adapted to the specific conditions of the microgrid. This engineering to reproduce complex structures aims at providing a simple and efficient solution, in order to prevent possible errors in operation by means of automated functions and intuitive actuation.

In interaction with SIESTORAGE, the SICAM Microgrid Manager (Fig. 6/2 shows the SICAM Microgrid Controller for control and monitoring) provides for cost-effective operation with extensive optimization options, reduced environmental impact by efficient use of resources, simple integration of renewable energy sources, an optimized mode of operation for district heating, as well as a safe and reliable power supply with assured quality:

Fig. 6/2: **SICAM Microgrid Controller**

- Safe monitoring with grid visualization, alarm management, event lists, control options
- Automatic voltage regulation, power and frequency regulation for improved grid stability
- Balance of fluctuating generation for reliable supply
- Reliable real-time forecast for generation and consumption
- Planning of operational activities; creation and automatic controlling of operational plans for all resources
- Real-time optimization in operation
- Control of a local district heating network as an optional possibility.

6.2 SIESTORAGE system description

SIESTORAGE is a modular energy storage system (Fig. 6/3 and Fig. 6/4) based on lithium-ion (Li-ion) battery technology. Active power can be transmitted between the storage system and the electric power grid. In addition, it can also provide reactive power to stabilize the grid voltage.

The converter electronics of the SIESTORAGE system are controlled via one central controller, the SIESTORAGE Control Unit (SCU). The system, which is operated in real time, monitors the voltage, current, frequency, and power as well as the state of the Li-ion battery, and it is controlled via a SIMATIC S7 as Master Controller. The SCU runs the control algorithms, which are received from the user's SCADA system via the Master Controller, or transferred directly by the operating personnel.

As user interface, the SIMATIC-HMI is used, among others, for indication of warnings, alarms, and analyzes referred to trends of numerous variables. All relevant data can be saved for later processing. Optionally, Siemens services can be inquired, which access SIESTORAGE from remote. Furthermore, switching, protection, and control components as well as instrument transformers for the medium- and low-voltage area belong to the SIESTORAGE system. For grid connection, a SIESTORAGE solution is completed by a MV switchgear and/or GEAFOL transformers and a LV switchboard, depending on the specific requirements (Fig. 6/3).

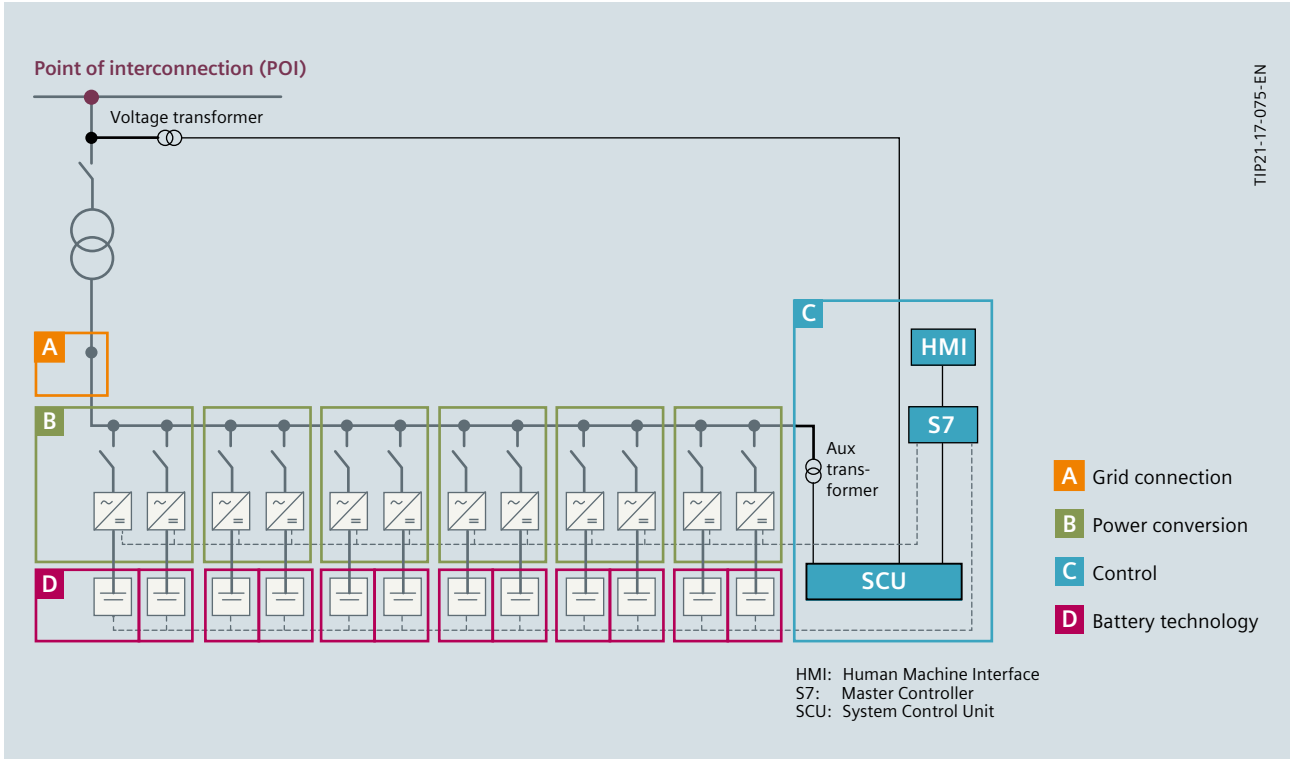


Fig. 6/3: **Basic structure of a SIESTORAGE solution with the individual modules**

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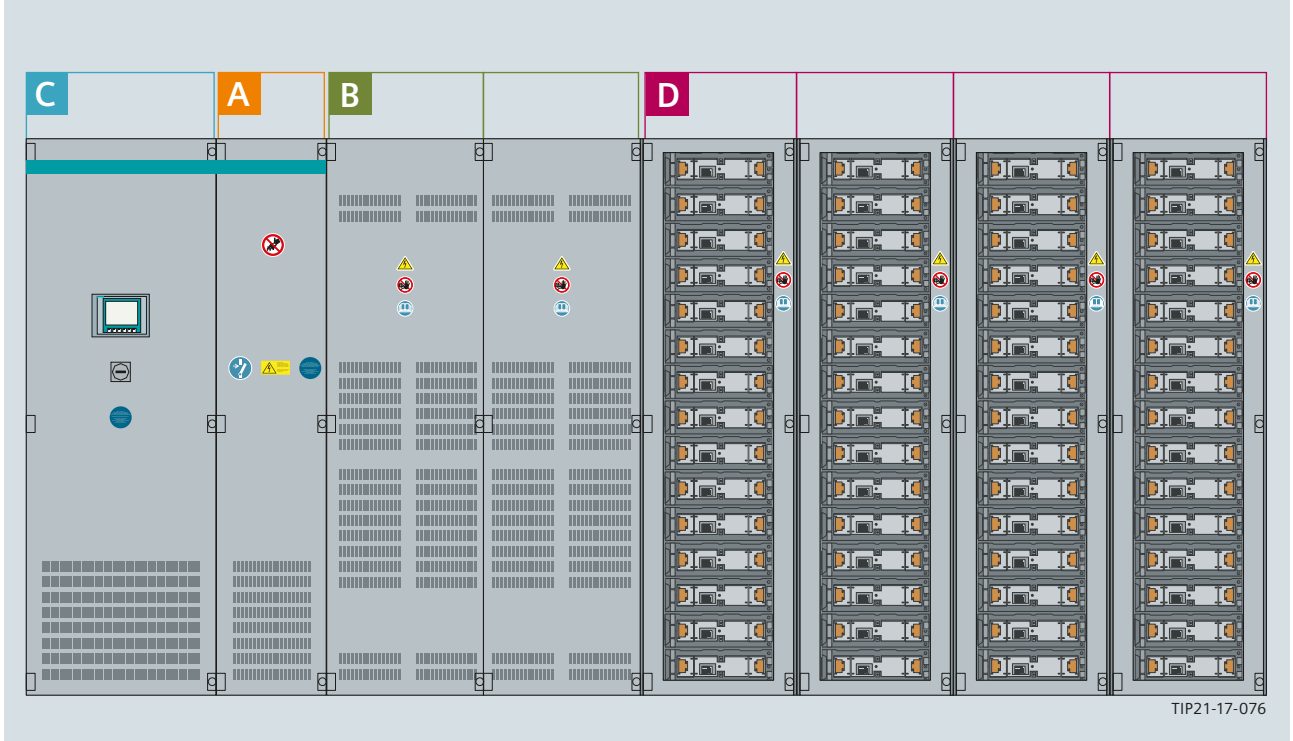

Fig. 6/4: **Front view of an example configuration of modules for a SIESTORAGE system**

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6.3 SIESTORAGE components

All SIESTORAGE components are mounted in standardized cabinets for easy setup. The system's modularity and scalability enables quick and efficient configuration that meets the application-specific energy requirements and requested storage capacities. With the simple combination of the appropriate number of module types (A: grid connection cabinet ; B: converter cabinet; C: control cabinet; D: battery cabinet), a suitable solution can be created. Some properties of the components are shown in Fig. 6/5.

Depending on the battery supplier, up to five battery cabinets can be connected with one converter cabinet. With ratings ranging from approx. 0.1 to 20 MW, SIESTORAGE can be designed – integrated in a standard container – so as to conform to the energy storage and

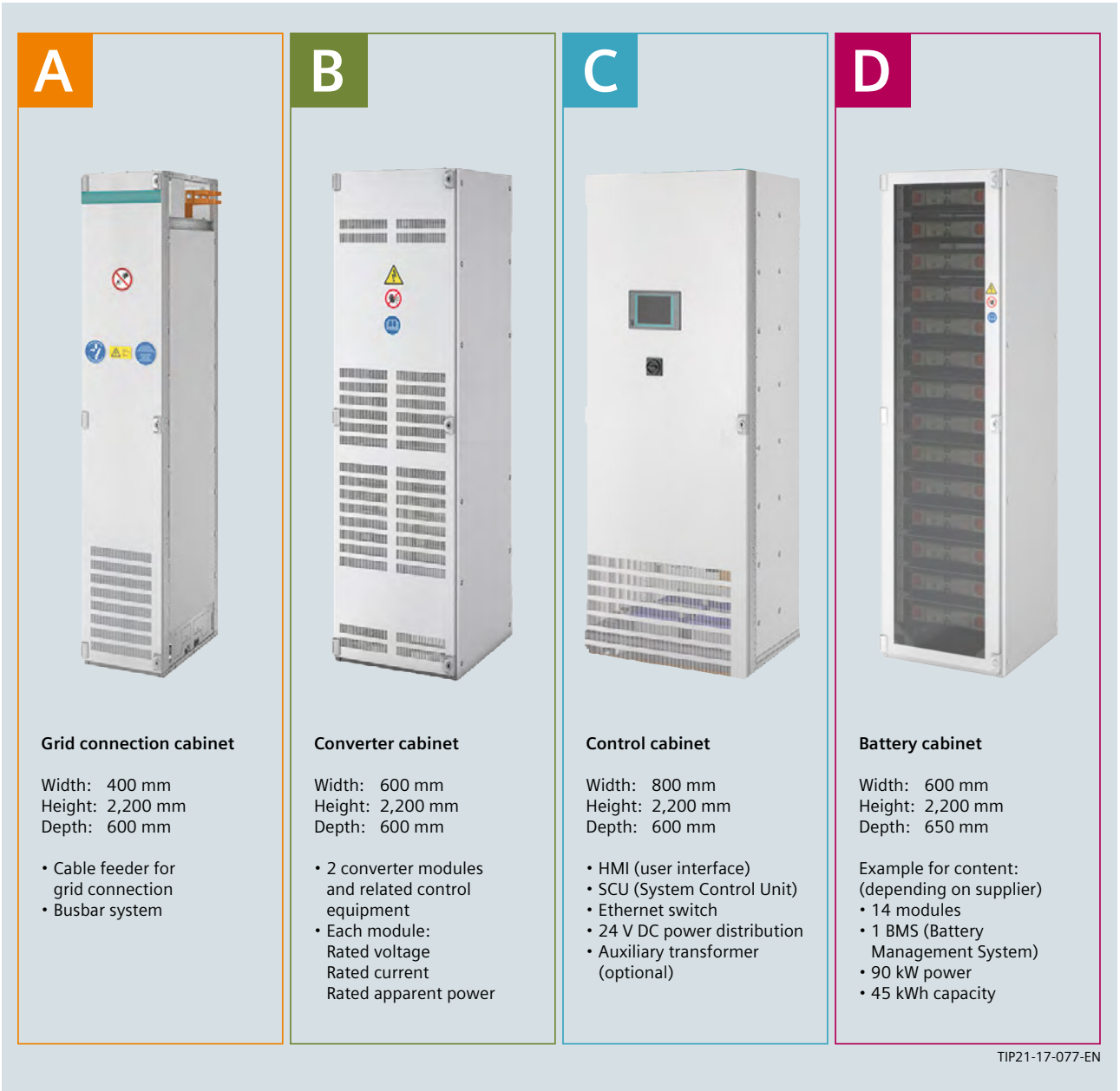

Fig. 6/5: **Components of the SIESTORAGE systems**

capacity needs for all applications. Fig. 6/6 shows a schematic sectional view of a container solution with components for SIESTORAGE, power distribution, and building technologies. Technical features are, among others:

- High system dynamics:
  Voltage regulation at the point of interconnection within less than 10 ms
- High short-circuit power
  (approx. double or triple rated power)
- Design endurance (electronics) minimum 20 years
- Meeting the requirements of IEC and IEEE
- Large voltage range:
  Grid voltage LV/MV ± 15 %
- Large frequency range: 45 to 65 Hz
- External communication interfaces possible according to IEC 61850, IEC 60870-5-104, DNP3 or others
- IT safety (remote access) according to IEC 62443-3-3.

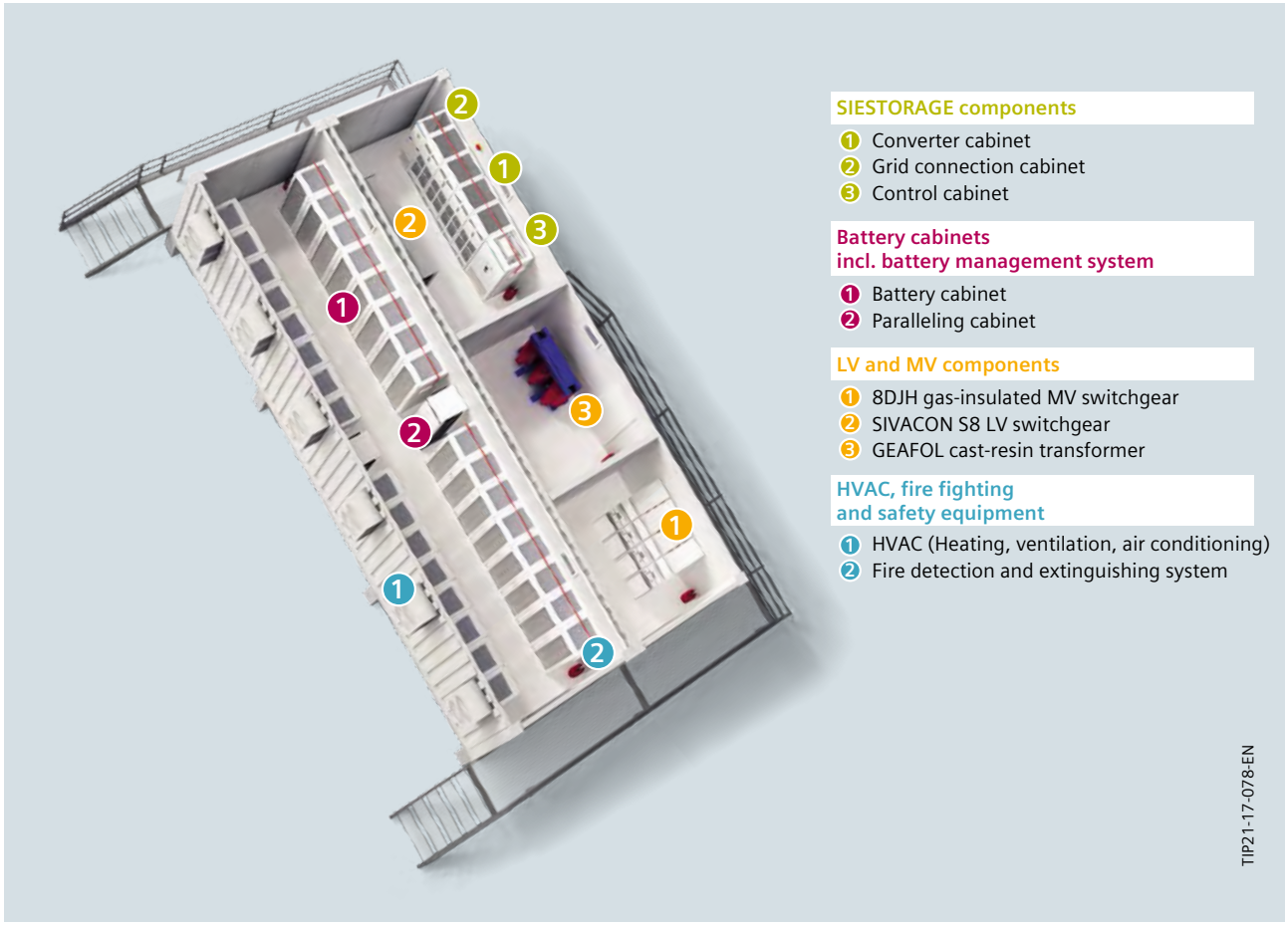

Fig. 6/6: **Schematic representation of a 40-feet container solution (a container length of 40 feet corresponds to approx. 13 m)**

6.4 Intelligent transformer substations

Due to the growing decentralization of power generation and increased use of cogeneration plants, it must be possible to use the grids more flexibly. The solution is an active distribution network with intelligent transformer substations (Fig. 6/7) at the key points. The transformer substations contribute to an active load management in the distribution grid and enable an automatic and fast fault clearance in case of blackouts:

- Monitoring and assurance of power quality
- Controlling of overload situations
- Minimization of loss of power grid revenue by notably reduced interruption times
- Optimization of grid expansion
- Object monitoring of the transformer substation.

The conceptual design of an intelligent transformer substation consists of four elements (Fig. 6/8):

- Medium-voltage switchgear
  with motor operating mechanisms to actuate the switch-disconnectors or circuit-breakers from external switching points (e.g. network control center), sensors to measure currents and voltages, and intelligent short-circuit/earth-fault direction indicators.
- Transformer
  Standard transformer or regulated distribution transformer (RDT)
- Low-voltage distribution board
  for protection with integrated measuring functions, motor operating mechanism, and communication for power monitoring and energy management of the individual low-voltage feeders
- Telecontrol unit
  consisting of a RTU (Remote Terminal Unit), communication device, and uninterruptible power supply.

Typical components (Fig. 6/9) of an intelligent transformer substation are:

- Remote terminal units SICAM CMIC
- Uninterruptible power supply units SITOP
- Communication solutions with TCP/IP, GPRS, GSM, UMTS, LTE, WiMAX, BPL, etc., e.g. with SCALANCE or RUGGEDCOM
- Short-circuit/earth-fault direction indicators SICAM FCM, SICAM FPI
- Current and voltage sensors
- Regulated distribution transformers FITformer® REG
- Power meter/power quality recorder SICAM P850/P855
- Medium-voltage switchgear from the 8DJH family
- Decentralized energy management DEMS
- Network control system for municipalities SICAM 230
- Switchgear visualization SICAM SCC
- Connection to:
  – Network control system SINAUT PowerCC
  – Substation automation SICAM PAS/AK 3
- Electronic meters AMIS
- Protection and switching devices from the SENTRON portfolio for protection of the low-voltage power distribution board.

Fig. 6/7: **Example for an intelligent transformer substation**

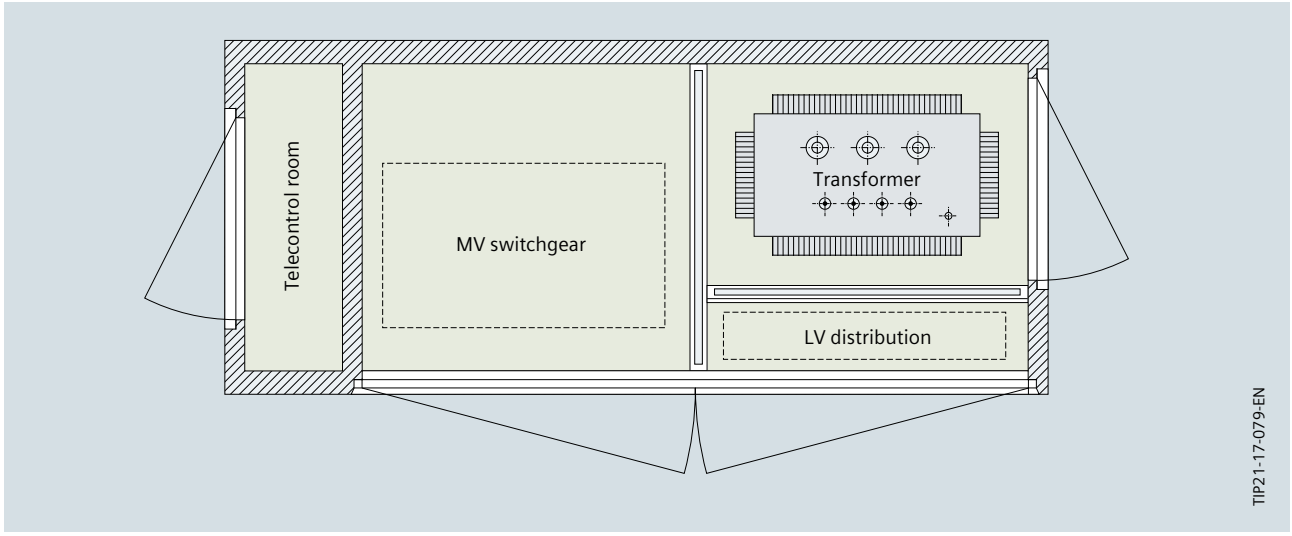

Fig. 6/8: **Typical room planning of a transformer substation**

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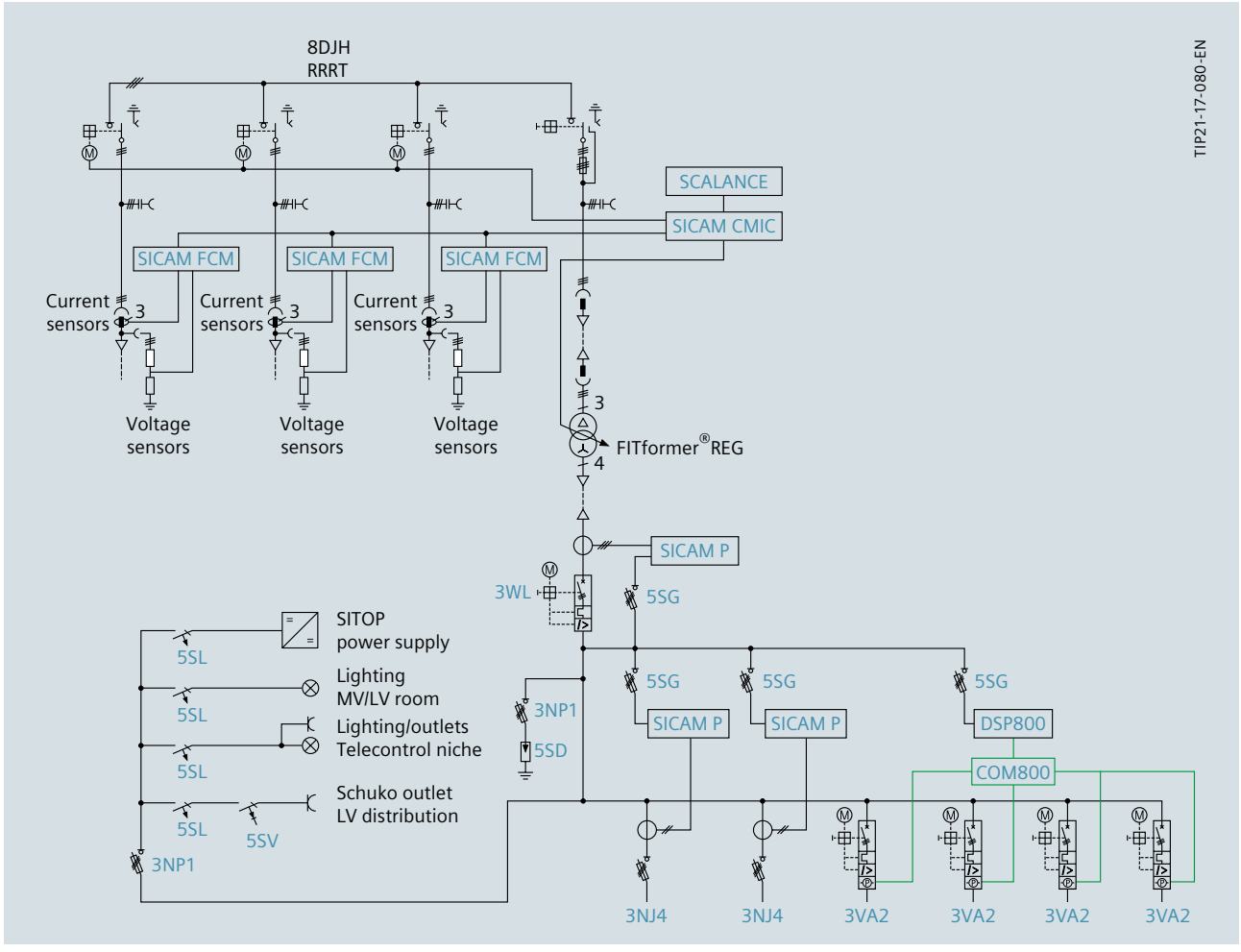

Fig. 6/9: **Example for an intelligent transformer substation**

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Chapter 7

Medium-Voltage Components

7 Medium-Voltage Components

The term medium-voltage equipment summarizes all products and components required for operation of medium-voltage systems. It comprises switching and non-switching components. Depending on the case of application, these devices are installed in the network as independent products, or as components inside a switchgear assembly.

Requirements

When the devices operate in the network, they are subjected to a number of stresses that are decisive for the selection and dimensioning of the devices. The main stresses are briefly summarized in the following, whereby only a limited selection of these values is relevant depending on the type of device:

- Dielectric strength during normal operation: This comprises both the operating voltage (as a rated value including arising voltage fluctuations) and overvoltages (switching and lightning overvoltages)
- Conducting the current: The normal current, continuously; overcurrents, temporarily; fault currents up to short-circuit currents, momentarily
- Making or breaking the current while dominating the arising transient processes, whereby only a part of the listed currents can be switched depending on the type of device:
  - Normal current
  - Fault currents
  - Currents with a (temporarily) special characteristic, such as capacitive currents, inductive currents, high-frequency transient currents
- Establishing a safe, i.e. surge-proof isolating distance in open condition: This is requested according to the European standard EN 50110-1 as a precondition for isolating and subsequent working on the isolated section. This does not mean the operational segregation of network sections
- Recurring breaking/making operations in short succession and defined time intervals.

7.1 Overview of system data

Medium-voltage equipment must be selected in accordance with the stresses appearing at the respective place of use. The ratings of the components describe the maximum values the components can be used for.

Rated voltage

The rated voltage is the upper limit of the highest operating voltage the device is designed for. It must be equal to or greater than the maximum appearing operating voltage under consideration of the permissible voltage fluctuations. The ratio between the rated voltage and the necessary withstand voltage values is defined in the product standards.

Rated insulation level or withstand voltage

The rated insulation level is the dielectric strength from phase to earth, between phases, and across the open contact gap, or across the isolating distance. The dielectric strength is the capability of an electrical component to withstand overvoltages. These can be overvoltages with operating frequency or higher frequency caused e.g. by switching operations or earth faults (internal overvoltages), as well as lightning strikes (external overvoltages). The dielectric strength is defined by the rated lightning impulse withstand voltage and the rated power-frequency withstand voltage. Both values are verified by type tests. A power-frequency withstand voltage test is also an integral part of the routine test.

Rated normal current

This is the current the device can continuously carry under defined ambient conditions. The dimensioning criterion is the maximum permissible temperature rise, which must not exceed the defined temperatures. If a device is mounted in a switchgear, the maximum permissible normal current is determined by the temperature-rise limits when the device is operated in this switchgear.

Rated breaking current

The rated breaking current defines the breaking capacity of load (normal) currents. For Siemens vacuum switching devices, this value corresponds to the normal current, and is therefore not stated separately.

Rated short-circuit breaking current

The rated short-circuit breaking current is the root-mean-square value of the breaking current in case of short circuit. It is stated as a symmetrical current, and corresponds to the short-circuit current after decay of a superimposed DC component.

Rated peak withstand current

The peak withstand current arises in case of short circuit, and it is the peak value of the first half-wave of the short-circuit current after the beginning of the current flow. It is a measure for the electrodynamic (mechanical) load of an electrical component. This value is highly dependent on the time when the short circuit occurs as well as on the connected equipment, and it can vary with each switching operation. The rated peak withstand current is the maximum value the device can carry in closed state. The peak withstand current is tested in accordance with IEC 62271-1, which specifies a fixed ratio between the rated short-circuit breaking current and the rated peak withstand current.

Rated short-circuit making current

The rated short-circuit making current is the peak value of the making current in case of short circuit on the load side of the switching device. Its value corresponds to the rated peak withstand current, but it represents a greater stress for the switching device, as dynamic forces work against the closing movement.

7.2 Overview of standards

The state of the art the devices must conform to is described in national and international standards. Tab. 7/1 comprises the essential international product standards or standard series (IEC: International Electrotechnical Commission) for the device types listed in the following:

- Vacuum circuit-breakers
- Vacuum contactors, contactor-fuse combination
- Reclosers
- Fusesavers
- Surge arresters.

In many countries, there are local standards that are mostly based on the international IEC standards. However, these standards often contain some specific particularities. The planner must make himself familiar with both these and further regulations, guidelines, and stipulations.

Standard/series	Title
IEC 60099	Surge arresters
IEC 60282-1	High-voltage fuses – Part 1: Current limiting fuses
IEC 60644	Specification for high-voltage fuse-links for motor circuit application
IEC 61869	Instrument transformers
IEC 62271-1	High-voltage switchgear and controlgear – Part 1: Common specifications
IEC 62271-100	High-voltage switchgear and controlgear – Part 100: Alternating current circuit-breakers
IEC 62271-102	High-voltage switchgear and controlgear – Part 102: Alternating current disconnectors and earthing switches
IEC 62271-103	High-voltage switchgear and controlgear – Part 103: Switches for rated voltages above 1 kV up to and including 52 kV
IEC 62271-105	High-voltage switchgear and controlgear – Part 105: Alternating current switch-fuse combinations
IEC 62271-106	High-voltage switchgear and controlgear – Part 106: Alternating current contactors, contactor-based controllers and motor-starters
IEC 62271-111	High-voltage switchgear and controlgear – Part 111: Automatic circuit reclosers and fault interrupters for alternating current systems up to 38 kV – Reclosers
IEC 62271-37-013	High-voltage switchgear and controlgear – Part 37-013: Alternating-current generator circuit-breakers
IEC 62271-200	High-voltage switchgear and controlgear – Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV

Tab. 7/1: **Product standards and standard series for medium-voltage components**

7.3 Vacuum circuit-breaker

An important distinguishing criterion for the circuit-breakers is the application environment. For indoor applications, they are installed in switchgear. Outdoor vacuum circuit-breakers are especially designed for outdoor installation.
Typical applications for vacuum circuit-breakers are (see also [Siemens AG, 2016: Planning of Electric Power Distribution – Technical Principles]):

Circuit-breaker type	Characteristics	
SION 3AE	Standard circuit-breaker for variable application: • As fixed-mounted circuit-breaker or complete withdrawable module • Maintenance-free up to 10,000 operating cycles; 30,000 operating cycles with maintenance • Ideally suited as retrofit • With air-insulated and embedded poles	
3AH5	Standard circuit-breaker for small switching capacities: • Maintenance-free up to 10,000 operating cycles	
3AH3	Circuit-breaker for high switching capacities: • Rated short-circuit breaking currents up to 63 kA • Rated normal currents up to 4,000 A • Maintenance-free up to 10,000 operating cycles • For IEC and IEEE/ANSI	
3AH4	Circuit-breaker for a high number of operating cycles: • Up to 120,000 operating cycles (with maintenance) • Rated normal currents up to 4,000 A • Rated short-circuit breaking currents up to 40 kA	
3AH36, 37, 38	Circuit-breakers for high-current and generator applications: • Rated normal currents up to 8,000 A • Maintenance-free up to 10,000 operating cycles • According to IEC/IEEE 62271-37-013 • Rated short-circuit breaking currents up to 72 kA • Design for phase segregation up to 24 kV, 100 kA, 12,000 A	
3AH47	Circuit-breakers for applications in traction systems: • Developed for different system frequencies, 16 2/3 Hz, 25 Hz, 50 Hz or 60 Hz • 1-pole or 2-pole • Up to 60,000 operating cycles	
3AK7	Circuit-breaker for industrial applications and generators: • Maintenance-free up to 10,000 operating cycles • For IEC and IEC/IEEE 62271-37-013	

Tab. 7/2: **Vacuum circuit-breaker types for indoor applications**

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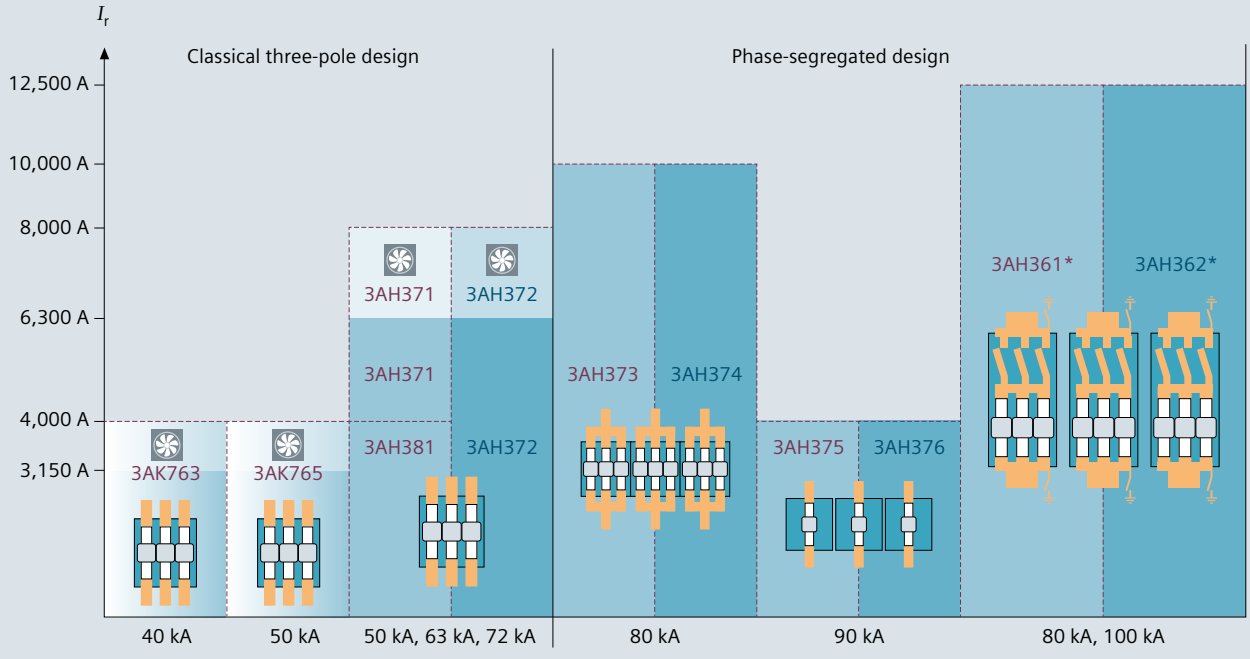
- Switching of overhead lines and cables
- Breaking of short-circuit currents
- Switching with multiple-shot reclosing
- Switching of transformers
- Switching of capacitors
- Switching of filter circuits
- Switching of motors and small inductive currents
- Rapid load transfer between incoming feeders
- Switching of generators
- Synchronizing, e.g. of generators.

Siemens offers various circuit-breaker types for different purposes of application and service conditions. The portfolio is briefly presented in Tab. 7/2 by means of product photos and characteristic features.
Tab. 7/3 gives an overview over the rated values covered by the respective types. Further order information, e.g. for pole-center distances, releases, built-in or withdrawable designs, as well as for other auxiliary equipment and options is provided in the product-specific catalogs. In addition, the available models of the generator circuit-breaker series 3AH36, 3AH37, 3AH38, and 3AK7 are classified in Fig. 7/1 according to their rated short-circuit breaking current and rated normal current.



Rated voltage: 7.2 kV, 12 kV, 17.5 kV

Rated voltage: 7.2 kV, 12 kV, 17.5 kV with forced ventilation

Rated voltage: 17.5 kV

Rated voltage: 17.5 kV with forced ventilation

Rated voltage: 24 kV

Rated voltage: 24 kV with forced ventilation

* Complete module per phase with integrated disconnector, earthing switch, and start-up disconnector

TIP21-17-082-EN

Limits of performance depending on the rated voltage:

Rated current I_n	Rated voltage U_n			
	7.2 kV	12 kV	17.5 kV	24 kV
3,150 A	39 kVA	65 kVA	90 kVA	130 kVA
4,000 A	50 kVA	83 kVA	120 kVA	160 kVA
6,300 A	78 kVA	130 kVA	190 kVA	260 kVA
8,000 A	100 kVA	165 kVA	240 kVA	330 kVA
10,000 A	125 kVA	205 kVA	300 kVA	410 kVA
12,500 A	155 kVA	260 kVA	370 kVA	510 kVA

Fig. 7/1: **Vacuum circuit-breaker types for generator switching applications**

		Rated voltage						
I_{sc}	I_r	7.2 kV	12 kV	15 kV	17.5 kV	24 kV	36 kV	40.5 kV
12.5 kA	800 A				SION 3AE	SION 3AE		
	1,250 A				SION 3AE	SION 3AE		
13.1 kA	800 A		3AH5					
16 kA	800 A	SION 3AE	SION 3AE, 3AH5		SION 3AE	SION 3AE, 3AH5		
	1,250 A	SION 3AE	SION 3AE, 3AH5		SION 3AE	SION 3AE, 3AH5	3AH5	
	1,600 A	SION 3AE	SION 3AE		SION 3AE			
	2,000 A		3AH5		SION 3AE	SION 3AE		
20 kA	800 A	SION 3AE	SION 3AE, 3AH5			SION 3AE		
	1,250 A	SION 3AE	SION 3AE, 3AH5			SION 3AE, 3AH5		
	1,600 A	SION 3AE	SION 3AE					
	2,000 A		3AH5			SION 3AE, 3AH5		
	2,500 A					SION 3AE, 3AH5		
25 kA	800 A	SION 3AE	SION 3AE, 3AH5		SION 3AE, 3AH5	SION 3AE		
	1,250 A	SION 3AE	SION 3AE, 3AH5		SION 3AE, 3AH5		3AH5	SION 3AE [2]
	1,600 A	SION 3AE	SION 3AE		SION 3AE			SION 3AE [2]
	2,000 A	SION 3AE	SION 3AE, 3AH5		SION 3AE		3AH5	SION 3AE [2]
	2,500 A		SION 3AE, 3AH5		SION 3AE, 3AH5	SION 3AE, 3AH5		SION 3AE [2]
31.5 kA	800 A	SION 3AE	SION 3AE					
	1,250 A	SION 3AE	SION 3AE, 3AH5, 3AH4	3AH4	SION 3AE, 3AH5, 3AH4		3AH3, 3AH4	3AH3, 3AH4, SION 3AE [2]
	1,600 A	SION 3AE	SION 3AE		SION 3AE			SION 3AE [2]
	2,000 A	SION 3AE	SION 3AE, 3AH5, 3AH4	3AH4	SION 3AE, 3AH5, 3AH4		3AH3, 3AH4	3AH3, 3AH4, SION 3AE [2]
	2,500 A	SION 3AE	SION 3AE, 3AH5		SION 3AE, 3AH5		3AH3, 3AH4	3AH3, 3AH4, SION 3AE [2]
	3,150 A		SION 3AE				3AH3, 3AH4	3AH3, 3AH4
	4,000 A		SION 3AE [1], [2]				3AH3, 3AH4	3AH3, 3AH4
40 kA	1,250 A	SION 3AE	SION 3AE, 3AH4	3AH4	SION 3AE, 3AH4	3AH3		
	1,600 A		3AH4	3AH4	3AH4			
	2,000 A	SION 3AE	SION 3AE, 3AH4	3AH4	SION 3AE, 3AH4	3AH3		
	2,500 A	SION 3AE	SION 3AE, 3AH4	3AH4	SION 3AE, 3AH4	3AH3, 3AH4	3AH3, 3AH4	3AH3, 3AH4
	3,150 A	SION 3AE	SION 3AE, 3AH4	3AH4	SION 3AE, 3AH4	3AH3, 3AH4	3AH3, 3AH4	3AH3, 3AH4
	4,000 A		SION 3AE [1], [2]				3AH3, 3AH4	3AH3, 3AH4
50 kA	1,250 A	3AH3, 3AK7	3AH3, 3AK7, SION 3AE [2]	3AH3	3AH3, 3AK7	3AH3		
	1,600 A		SION 3AE [2]					
	2,000 A	3AH3, 3AK7	3AH3, 3AK7, SION 3AE [2]	3AH3	3AH3, 3AK7	3AH3		
	2,500 A	3AH3, 3AK7	3AH3, 3AK7, SION 3AE [2]	3AH3	3AH3, 3AK7	3AH3		
	3,150 A	3AH3, 3AK7	3AH3, 3AK7, SION 3AE [2]	3AH3	3AH3, 3AK7	3AH3		
	4,000 A	3AH3, 3AK7	3AH3, 3AK7, SION 3AE [1], [2]	3AH3	3AH3, 3AK7	3AH3		
63 kA	1,250 A	3AH3	3AH3	3AH3	3AH3			
	2,000 A	3AH3	3AH3	3AH3	3AH3			
	2,500 A	3AH3	3AH3	3AH3	3AH3			
	3,150 A	3AH3	3AH3	3AH3	3AH3			
	4,000 A	3AH3	3AH3	3AH3	3AH3			
72 kA	3,150 A	3AH3	3AH3	3AH3	3AH3			
	4,000 A	3AH3	3AH3	3AH3	3AH3			

[1] With forced ventilation [2] Only for China according to GB/DL

Tab. 7/3: **Overview of the vacuum circuit-breakers according to the rated short-circuit breaking current I_{sc} and the rated normal current I_r (without 3AH47 for traction applications)**

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7.4 Vacuum circuit-breakers for outdoor applications

For outdoor application, Siemens offers four types of vacuum circuit-breakers which differ in respect of equipment and design:
- Live tank design (without controller)
- Dead tank design (without controller)
- Recloser (with controller)
- Fusesaver (with controller).

They all have in common the vacuum circuit-breaker, which is used for outdoor switching duties.

Live tank design

In live tank circuit-breakers such as the 3AF0, the vacuum interrupter is housed inside a weatherproof insulating enclosure, e.g. made of porcelain or composite materials. As the interrupter unit is not earthed, it is live during operation, providing the term "live tank". Due to their special design, these vacuum circuit-breaker types are preferably used in power systems with a large extent of overhead lines. When using outdoor vacuum circuit-breakers, it is not necessary to provide for closed service locations for the installation of circuit-breakers. According to IEC 62271-100, in overhead line applications higher values are requested for the transient recovery voltage TRV, according to class S2, which are fulfilled by the 3AF0 (Fig. 7/2; for technical data see Tab. 7/4).

Dead tank design

The significant property of the dead tank design is the arrangement of the vacuum interrupter in an earthed metal enclosure, thus defined as dead tank (Fig. 7/3). The SDV7 family now includes an option for arc-resistant construction. The arc-resistant enclosure has been tested in accordance with ANSI/IEEE C37.20.7, accessibility type 2B. The arc-resistant design shares the same footprint dimensions as the non-arc-resistant design, for ease in application.

Fig. 7/2: **Live tank 3AF0**

Fig. 7/3: **Dead tank 3SDV7**

	Live tank design type			Dead tank design type	
Rated values	**3AF01**	**3AF03**	**3AF09**	**SDV7-S**	**SDV7-M**
Operating voltage	36/40.5 kV	17.5 kV	12 kV	15.5 – 38 kV	15.5 – 27.6 kV
Normal current	1,600/2,000/2,500 A	2,000 A	630 A	1,200 – 3,000 A	1,200 – 2,000 A
Short-circuit breaking current	25/31.5 kA	25 kA	20 kA	20 – 40 kA	20 – 25 kA
Short-duration power-frequency withstand voltage	70/95 kV	42 kV	48 kV	50 – 80 kV	50 – 60 kV
Lightning impulse withstand voltage	170 kV	95/110 kV	85 kV	110 – 200 kV	110 – 150 kV

Tab. 7/4: **Technical data for live tank 3AF0 and dead tank SDV7 (SDV7-S with stored-energy spring mechanism, and SDV7-M with magnetic actuator)**

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This circuit-breaker fulfills the same switching duties as the live tank circuit-breaker 3AF0. The SDV7 is optionally equipped with a spring energy store (SVD7-S) or a magnetic actuator (SVD7-M).

Reclosers

The vacuum recloser 3AD breaks normal and fault currents. It fulfills all requirements according to the standards IEC 62271-37-013 and IEC 62271-111, and can trip and reclose up to four times in case of a temporary fault, thus avoiding significantly longer grid interruptions. For ratings related to operating sequence and further technical data, see Tab. 7/5.

The recloser consists of two main components: the switch unit, similar to a circuit-breaker, and the controller as protection and control unit. The controller is located inside a separate control cubicle, together with the electronics and the auxiliary circuits (Fig. 7/4). The control cubicle is usually located at the bottom of the pole. Based on the two established protection device families Reyrolle and SIPROTEC, Siemens offers two different controllers: the Reyrolle 7SR224 and the SIPROTEC 7SC80.

Communication access to relay functionality is via a front USB port for local PC connection. On the rear side, there are additional ports available depending on the controller: RJ45, RS232, and RS485 interface. Additional rear port options including wireless connections and optical ports are available. Communication is provided through network protocols like IEC 61850, IEC 60870-5-101, -103, -104 and DNP 3, MODBUS, TCP/IP.

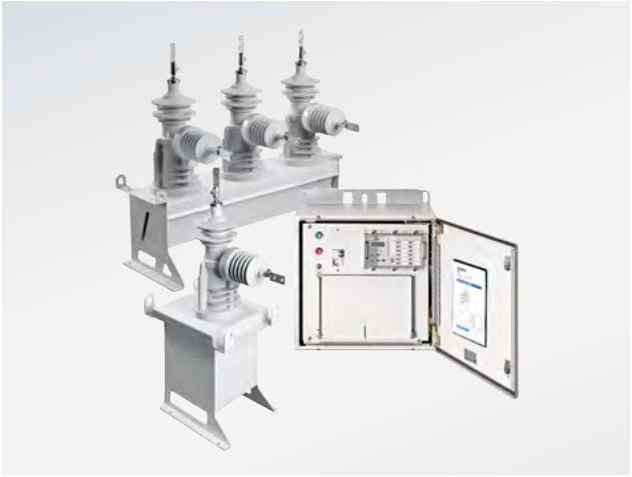

Fig. 7/4: **Vacuum recloser 3AD (single- and three-phase) with control cubicle**

3AD	Technical data
Rated voltage	up to 38 kV
Rated normal current	up to 800 A
Rated short-circuit breaking current	up to 16 kA
Rated lightning impulse withstand voltage	up to 170 kV
Recloser sequence	O-0.2-CO-2 s-CO-2 s-CO
Number of operating cycles	10,000 maintenance-free
Opening time	< 35 ms
Closing time	< 60 ms
Number of phases	three-phase, single-phase, triple-single

Tab. 7/5: **Technical data for vacuum recloser 3AD**

Fusesaver

Since typically 80% of the overhead line's faults are transient, 80% of interruptions by fuses are unnecessary. The Fusesaver 3AD8 (Fig. 7/5) is the world's fastest outdoor vacuum circuit-breaker for optimizing reliability while minimizing operating costs of rural distribution systems (technical data in Tab. 7/6 and Fig. 7/6). It is capable of almost completely removing the impacts of temporary faults on lateral lines. Fusesaver is a new class of intelligent, compact, and low-cost single-phase circuit-breaker fulfilling the requirements of IEC 62271-100.

Fig. 7/5: **Fusesaver 3AD8 with RCU (Remote Control Unit)**

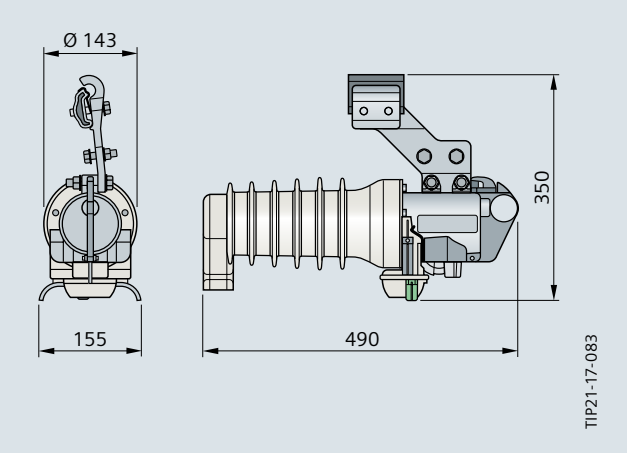

Fig. 7/6: **Dimensions for Fusesaver 3AD8 with communication module and cable connection system (dimensions in mm)**

Order number	Rated operating voltage	Rated normal current	Minimum normal current of the line	Rated normal current of the fuse	Rated short-circuit breaking current	Rated short-circuit making current	Rated duration of short circuit	Rated lightning impulse withstand voltage	Rated power-frequency withstand voltage (60 s)	Fault current trippings (100 %)	Impedance between the connections	Weight
	U_r	I_r	I_{line}	I_{fuse}	I_{SC}	I_{peak}	t_k	U_p	U_d			
3AD8 234	15.5 kV	40 A	0.15 A	2 – 20 A	1.5 kA	3.75 kA	0.2 s	110 kV	50 kV	300 times	11.5 MΩ	5.5 kg
3AD8 222		100 A	0.50 A	5 – 50 A	4 kA	10 kA	0.2 s	110 kV	50 kV	70 times	1.35 MΩ	5.5 kg
3AD8 223		200 A	1.00 A	5 – 100 A	4 kA	10 kA	1.0 s	110 kV	50 kV	70 times	0.34 MΩ	5.5 kg
3AD8 434	27 kV	40 A	0.15 A	2 – 20 A	1.5 kA	3.75 kA	0.2 s	125 kV	60 kV	300 times	11.5 MΩ	5.5 kg
3AD8 422		100 A	0.50 A	5 – 50 A	4 kA	10 kA	0.2 s	125 kV	60 kV	70 times	1.35 MΩ	5.5 kg
3AD8 423		200 A	1.00 A	5 – 100 A	4 kA	10 kA	1.0 s	125 kV	60 kV	70 times	0.34 MΩ	5.5 kg

Tab. 7/6: **Technical data for Fusesaver versions with rated operating voltages 15.5 kV and 27 kV**

In case of temporary faults in the downstream grid, the fault disappears during the Fusesaver's dead time. After closing, the energy supply is restored and the Fusesaver is ready for responding to the next fault.

In case of a permanent fault, two application possibilities are distinguished for which the Fusesaver can be configured according to the customer's requirements:

1. Fusesaver connected in series with a fuse

When the Fusesaver senses a fault current, it will open before the fuse can melt, and stays open for a pre-determined time (dead time). Then, the Fusesaver closes again, reconnecting the supply (O-1s-C), and stays closed. A permanent fault current trips the fuse.

2. Fusesaver replacing the fuse

The Fusesaver performs the same OPEN-CLOSE functionality as described for the O-C Fusesaver with fuse to clear a transient fault. However, it can also perform a second opening operation to clear a permanent fault without the help of a fuse (O-2s-CO). Then it remains open, and a crew has to bring back the Fusesaver to operation after removing the fault from the line.

7.5 Surge arresters and limiters

Surge arresters and limiters protect operational equipment both from external overvoltages caused by lightning strikes in overhead lines and from internal overvoltages produced by switching operations or earth faults (Fig. 7/7). Normally, the arrester is installed between phase and earth, but also between the phases in some applications. The built-in stack of non-linear, voltage-dependent resistors (varistors) made of metal oxide (MO) becomes conductive from a defined overvoltage limit value onwards, so that the surge can be discharged through the arrester. The product selection listed here complies with the requirements of the IEC 60099-4 standard and the instructions for their selection and application according to IEC 60099-5.

When the overvoltage underflows this limit value, called "discharge voltage", the varistors return to their original high resistance value, so that only a so-called leakage current of a few mA flows through the varistor. In continuous operation, this leakage current heats up the MO elements and thus the arrester. Therefore, the device must be designed according to the neutral-point treatment of the system or the connection of the arresters, in order to prevent impermissible heating of the arrester.

The product range includes:

- The 3EK silicone-housed surge arrester for distribution systems for medium-voltage switchgear up to 72.5 kV and for outdoor use
- The 3J series for the protection of motors, cast-resin dry-type transformers, older cable sheaths, as well as for protection of converters for drives, especially in case of overvoltages due to switching impulses.

For technical data beyond the basic data of Tab. 7/7 and for further surge arresters/limiters, please contact your Siemens partner *(www.siemens.com/tip-cs/contact)*.

Fig. 7/7: **Surge arresters 3EK and 3EJ**

Type	3EK4	3EK7	3EJ0	3EJ9	
Application	Distribution systems and medium-voltage switchgear		Motors, cast-resin transformers, cables, protection of converters for drives		
Highest voltage for equipment U_m	40.5 kV	72.5 kV	12 kV	10 kV	
Maximum rated voltage U_r	36 kV	60 kV	15 kV	12 kV	
Rated discharge current I_n	10 kA	10 kA	5 kA	10 kA	20 kA
Rated short-circuit current I_s	20 kA	20 kA	20 kA	50 kA	50 kA
Surge arrester class according to IEC 60099-4	DH	DH	DM	SM	SH
Discharge capacity Q_{rs}	0.4 C	0.4 C	0.4 C	2 C	6 C
Thermal energy absorption capability W_{th}	–	–	1 kJ/kV	4 kJ/kV	
Thermal discharge capacity Q_{th}	1.1 C	1.1 C	–	–	
Environment	Outdoor	Indoor, outdoor	Indoor	Outdoor	

Tab. 7/7: **Technical data for surge arresters**

7.6 Vacuum contactors and contactor-fuse combinations

3TL and 3TM vacuum contactors are three-pole contactors (Fig. 7/8) with electromagnetic operating mechanism for medium-voltage switchgear. They are load breaking devices with a limited short-circuit making and breaking capacity for applications with high switching rates of up to one million electrical and mechanical operating cycles (see Tab. 7/8) and/or unlimited operation time. The vacuum contactors are suitable for operational switching of alternating current consumers in indoor switchgear, and can be used, e.g., for the following switching duties:

- AC-3: Squirrel-cage motors: Starting, stopping of running motor
- AC-4: Squirrel-cage motors: Starting, plugging, and inching
- Switching of three-phase motors in AC-3 or AC-4 operation (e.g. in conveying and elevator systems, compressors, pumping stations, ventilation, and heating)

  As the chopping currents of the contactors are below 3 A, no impermissibly high overvoltages are produced when accelerated motors are switched during normal operation. However, when high-voltage motors with starting currents ≤ 600 A are stopped during start-up, switching overvoltages may arise under certain

Fig. 7/8: **Vacuum contactors 3TL81 (left) and 3TM; contactor-fuse combination 3TL6 (right)**

Type	3TL61	3TL65	3TL68	3TL71	3TL81	3TM32	3TM33	3TM34	3TM35
Rated voltage	7.2 kV	12 kV	15 kV	24 kV	7.2 kV	7.2 kV	7.2 kV	12 kV	12 kV
Rated normal current	450 A	400 A	320 A	800 A	400 A	450 A	450 A	450 A	450 A
Rated making current [1]	4.5 kA	4.0 kA	3.2 kA	4.5 kA	4.0 kA	4.5 kA	4.5 kA	4.5 kA	4.5 kA
Rated breaking current [1]	3.6 kA	3.2 kA	2.56 kA	3.6 kA	3.2 kA	3.6 kA	3.6 kA	3.6 kA	3.6 kA
Mechanical endurance of the contactor [2]	3 million	1 million	1 million	1 million	1 million	1 million	1 million	1 million	1 million
Electrical endurance of the vacuum interrupters (rated current) [2]	1 million	0.5 million	0.25 million	0.5 million	0.25 million	0.25 million	0.5 million	0.5 million	0.5 million
Rated lightning impulse withstand voltage	60 kV	75 kV	75 kV	125 kV	60 kV	60 kV	60 kV	75 kV	75 kV
Rated short-duration power-frequency withstand voltage	20 kV	28 kV	38 kV	50 kV	20 kV	23 kV	32 kV	28 kV	42 kV

[1] Switching capacity according to utilization category AC-4 (cos φ = 0.35) [2] Values in millions operating cycles

Tab. 7/8: **Technical data for vacuum contactors 3TL and 3TM (data for type 3TM36 with rated voltage 15 kV on request)**

circumstances. The magnitude of these overvoltages must be reduced to harmless values by means of special surge limiters
- Switching of transformers (e.g. in secondary distribution switchgear, industrial distributions) When inductive currents are interrupted, current chopping can produce overvoltages at the contact gap. Thanks to the use of a special contact material, the chopping current of the vacuum contactor is ≤ 3 A, so that no dangerous overvoltages are produced when the unloaded transformers are switched off
- Switching of reactors (e.g. DC-link reactors, in industrial distributions, in reactive power compensation installations)
- Switching of resistive consumers (e.g. heating resistors, electric furnaces)
- Switching of capacitors (e.g. in reactive power compensation installations, in capacitor banks); vacuum contactors can interrupt capacitive currents up to 250 A up to the rated voltage without restrikes and thus without overvoltages.

Technical data of both types are summarized in Tab. 7/8. In contactor-type reversing starter combinations (reversing duty), only one contactor is required for each direction of rotation if high-voltage high-rupturing capacity fuses are used for short-circuit protection.

The contactor-fuse combinations 3TL62/63/66 (Fig. 7/8; technical data in Tab. 7/9) are type-tested units of the 3TL6 vacuum contactors in combination with HV HRC fuses. A fuse holder for one or two fuses per phase and a control transformer for power supply have been integrated. This enables frequent switching of high normal currents in a compact space. The 3TL62/63/66 contactor-fuse combinations are suitable for applications in withdrawable modules and for fixed mounting. The available bushings and the different widths across flats enable easy integration.

Type	3TL62	3TL63	3TL66
Rated voltage	7.2 kV	7.2 kV	12 kV
Rated normal current [1]	450 A	400 A	400 A
Maximum let-through current	46 kA	46 kA	46 kA
Rated short-circuit breaking current, RMS (prospective)	50 kA	50 kA	40 kA
Mechanical endurance of the contactor [2]	1 million	1 million	1 million
Switching rate	1,200 operating cycles/h	600 operating cycles/h	600 operating cycles/h
Fuse per phase max.	1 × 315 A or 2 × 250 A	1 × 315 A or 2 × 250 A	1 × 200 A or 2 × 200 A
Rated short-duration power-frequency withstand voltage	20 kV	32 kV	28 kV

[1] Depending on installation and coordination with the selected fuses [2] Values in millions operating cycles

Tab. 7/9: **Technical data for contactor-fuse combinations 3TL62/63/66**

Chapter 8

Digital Protection Devices

8 Digital Protection Devices

Siemens has always been at the forefront of digital protection technology (Fig. 8/1). 1977 saw the first digital application in Würzburg, Germany. The standardized integration of protection and control functions for all SIPROTEC devices was the innovation of the 1990s. On the adoption of communication standard IEC 61850 in 2004, Siemens was the world's first manufacturer to commission a plant that applied this standard.

The products manufactured by the established British company Reyrolle are rightly considered outstandingly efficient and reliable in many markets. Reyrolle is part of Siemens and its latest digital products show its pioneering approach to developing new technologies and enhancing solutions, always to the benefit of customers. The company is consistently expanding its range of protection technology (Fig. 8/2), primarily in Great Britain and the Commonwealth.

Diverse protection tasks efficiently covered

With its SIPROTEC and Reyrolle brands, Siemens is a leading manufacturer of digital protection technology. More than 1.5 million protection relays (> 0.4 million thereof with IEC 61850 protocol) are in operation around the world, offering a safe and reliable solution for power supply networks.

Large installed base, proven in operation

The protection relays quickly and reliably detect electrical errors and faults in equipment. They can selectively trip, thereby ensuring plant protection and both high availability and network stability.

Over 100 years of experience in the field of protection devices and substation automation almost says it all. Yet the highest appreciation must be given to some milestones in the history of this great product. The very first family of SIPROTEC products already had a head start in being ahead of its competitors. Find out how the continuous drive for technological improvements and brilliant minds have kept this success story going and going and going.

Several milestones in the history of SIPROTEC have defined not only the technology of this product family but its fundamental character. With more than one million SIPROTEC units in the field, we are clearly the market leader in Digital Protection Technology.

1910
Schuckert & Co. (1987)
DC meter based on Georg Hummel's principle

1925
First overcurrent relay RA1 and time relay RS1

1940
Introduction of new overcurrent relay RA5

1970
Introduction of analog electronic relays

1977
First digital application in Würzburg, Germany

1980s
The digital era for relays begins

Fig. 8/1: **SIPROTEC – pioneer over generations**

Customer benefits

Flexible device lines with comprehensive protection functions for all applications simplify storage and engineering.

Support for all common communication interfaces such as PROFIBUS and PROFINET IO enables easy adaptation to existing communication infrastructures.

Simple engineering and parameterization with DIGSI software (based on STEP 7 and TIA Portal).

Integrated safety: All devices meet stringent cyber security requirements, including those of the BDEW White Paper (the German Association of Energy and Water Industries) and NERC CIP (North American Electric Reliability Corporation, Critical Infrastructure Protection).

Fig. 8/2: **Siemens protection technology – SIPROTEC and Reyrolle**

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1985
Introduction of first numerical relay in combination with control technology SINAUT LSA

1998
Introduction of SIPROTEC 4 family

2004
Siemens installs the world's first substation with IEC 61850-based control in Winz-nauschachen, CH

2006
Siemens awarded the Frost & Sullivan "Technology Leaders hip Award" for the implementation of IEC 61850

2008
SIPROTEC Compact, the new member of the SIPROTEC family, is introduced

2010
Introduction of the new SIPROTEC 5 family

8.1 Overview of product types

The SIPROTEC protection device family can be used for all applications. The properties and benefits of the individual product series set out below make them ideal for use in specific applications, as shown in Fig. 8/3.

SIPROTEC 5

Thanks to the high degree of modularity in the SIPROTEC 5 series, the devices' functionality and hardware can be adapted to meet the applications' changing requirements. The comprehensive, standardized engineering tool DIGSI 5 further provides a solution for increasingly complex processes, from design and engineering to testing and operation. In addition to its powerful protection functions, SIPROTEC 5 offers:

- Individually configurable devices
- Easily integrated and retrofitted arc protection, transient earth-fault detection, and process bus
- User-friendly design of devices and software
- High-performing communication components
- Full compatibility between IEC 61850 Ed. 1 and Ed. 2
- Integrated switch for redundant optical and electrical Ethernet rings
- Redundancy protocols: RSTP (Rapid Spanning Tree Protocol), PRP (Parallel Redundancy Protocol), HSR (High-availability Seamless Redundancy)
- Efficient operating concepts with flexible engineering according to IEC 61850 Ed. 2
- Extensive database for monitoring modern power systems
- Smart automation platform with integrated PMU (Phasor Measurement Unit) and power quality functions.

SIPROTEC 5 devices have a basic housing width of 1/3 x 19" and can be flexibly extended, with the exception of "7xx82" models.

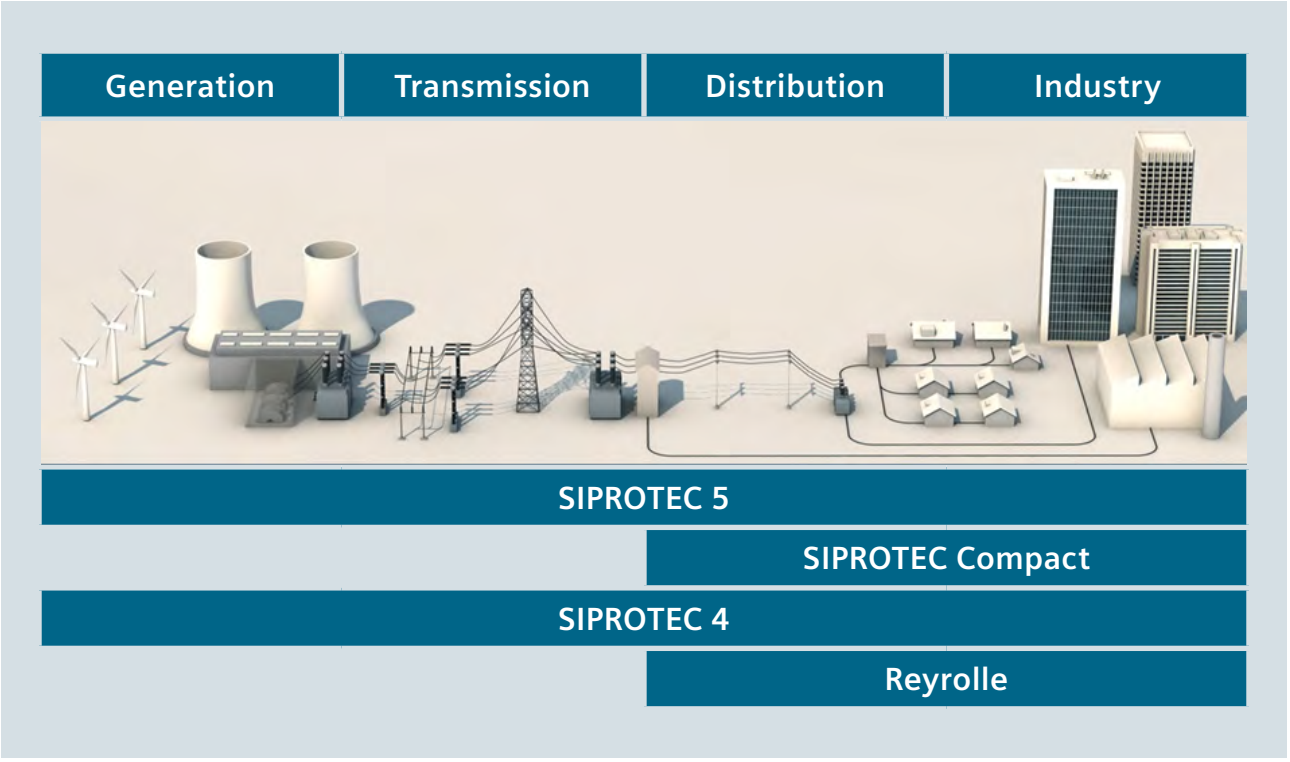


Fig. 8/3: **Protection devices for all applications**

SIPROTEC Compact

The devices of the SIPROTEC Compact family provide a wide variety of functions in a compact and thus space-saving 1/6 x 19" housing. The devices can be used as the main protection in medium-voltage applications or as back-up protection in high-voltage systems. Further advantages:

- Pluggable current and voltage terminal blocks
- Thresholds adjustable via software (three stages)
- Easy adjustment of secondary current transformer values (1 A/5 A) to the primary transformers with DIGSI 4
- Nine freely programmable function keys
- Clear overview with six-line display
- Buffer battery replaceable at the front side
- USB port at the front
- Integration in the communication network by means of two further communication interfaces
- Integrated switch for redundant optical Ethernet rings
- Ethernet redundancy protocols RSTP, PRP, and HSR
- Reduction of wiring between devices by means of cross-communication via Ethernet (IEC 61850 GOOSE)
- Time synchronization to the millisecond via Ethernet with SNTP for targeted fault evaluation
- "Flexible protection functions" for adaptation to protection requirements
- Comfortable engineering and evaluation with DIGSI 4.

SIPROTEC 4

The SIPROTEC 4 device line ideally combines the integration of protection, control, measuring, and automation functions in one device. In many fields of application, from generation and transmission to distribution and industrial deployment, all the tasks of the secondary systems can be performed with one single device. The open and future-proof SIPROTEC 4 concept is ensured for the entire device line thanks to the implementation of IEC 61850.

- Proven protection functions guarantee the safety of your equipment and employees
- Comfortable engineering and evaluation with DIGSI 4
- Simple creation of automation solutions with the integrated CFC
- Targeted and easy operation of devices and software thanks to user-friendly design
- Powerful communication components guarantee safe and effective solutions
- Future-proof due to exchangeable communication interfaces and integrated CFC
- Integrated switch for redundant optical Ethernet rings
- Ethernet redundancy protocols RSTP, PRP, and HSR for highest availability.

Reyrolle

The comprehensive range of Reyrolle products provides the total protection requirements of distribution markets – ranging from overcurrent protection via transformer protection and voltage control to a full spectrum of auxiliary and trip relays. A range of proven products such as the "Argus" overcurrent relay, the "Solkor" line differential protection relay, and the "Rho" motor protection devices are available to serve specific needs in industrial applications.

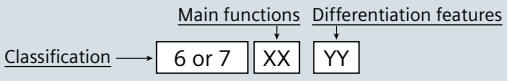
- Thanks to their high user friendliness, the pluggable product solutions are flexible and easy to operate
- One size fits all – the 4HE enclosure height and the latest generation of digital devices features a 1 A/5 A current transformer input; some models are provided with universal DC power supply units
- Standardization in programming and querying, and in the look and feel of digital Reyrolle devices across product generations
- "Reydisp Evolution" software toolkit, compatible with all prior digital Reyrolle devices for settings, fault queries, and network data transmission
- IEC 61850 communication interface.

8.2 Definition of device types by designation

SIPROTEC and Reyrolle devices are easy to identify by their 5-digit codes. The first digit (6 or 7) indicates the classification (for example, field control technology or protection device). The two letters that follow (XX) specify the main functionality (see Tab. 8/1), and the last two digits (YY) identify typical properties.

8.3 Device-specific overview of applications

In addition to the application options for the various types of the modern and versatile SIPROTEC 5 and SIPROTEC Compact device series, Tab. 8/2 also shows the proven SIPROTEC 4 and Reyrolle device types.

Overview of main functions	
	
XX	Main function
SIPROTEC devices	
KE	Fault recorder
MD	Bay controller
RW	Voltage and frequency protection
SA	Distance protection
SC	Distribution network protection
SD	Line differential protection
SJ	Overcurrent protection
SK	Motor protection
SL	Combined line differential and distance protection
SS	Busbar protection
UM	Machine protection
UT	Transformer protection
VK	Circuit-breaker management
VU	Fast switching device
Reyrolle devices	
SR	Digital protection
PG	Electromechanical protection

Tab. 8/1: **Assignment of device designations to device functions**

Main function	SIPROTEC 5	SIPROTEC Compact	SIPROTEC 4	Reyrolle
Overcurrent and feeder protection				
Overcurrent protection with PMU[1)] and control system	7SJ82/85	7SJ80/81	7SJ61/62/63/64/65	7SR10/11/12/21/22
Overcurrent protection with transformer current supply			7SJ45	7SR45
Line protection				
Distance protection with PMU[1)] and control system	7SA82/86/87		7SA61/63/64	
Line differential protection with PMU[1)] and control system	7SD82/86/87	7SD80	7SD610, 7SD5	7SR18 Solkor
Combined line differential and distance protection with PMU[1)] and control system	7SL82/86/87		7SD5	
Circuit-breaker management device with PMU[1)] and control system	7VK87		7VK61	
Overcurrent protection for lines with PMU[1)]	7SJ86			
Transformer protection				
Transformer protection with PMU[1)], control system, and monitoring	7UT82/85/86/87		7UT612/613/63	7SR242 Duobias
Motor and generator protection				
Motor protection with PMU[1)] and control system	7SK82/85	7SK80/81	7SJ61/62/63/64/65	7SR105 Argus, 7SR17 Argus
Generator protection with PMU[1)] and control system	7UM85		7UM61/62	
Busbar protection				
Central busbar protection	7SS85		7SS52	
Bay controllers				
Bay controllers for control/interlock tasks with PMU[1)], monitoring and protection functions[1)]	6MD85/86		6MD63/66	
Fault recorder				
Fault recorder, fault recorder with power quality recordings, and fault recorder with PMU	7KE85			
Voltage and frequency protection				
Used for power system disconnection, load shedding, and load connecting		7RW80		7SR158 Argus
Synchronization				
Synchronization			7VE61/63	7SR157 Argus
Distribution network automation				
Protection and automatic functions for overhead lines		7SC80		7SR224 Argus
Protection of capacitor banks				
Protection of capacitor banks	7SJ82/85			7SR191 Capa
High impedance protection				
High impedance protection				7SR23 DAD
Busbar fast switching				
Busbar fast switching			7VU68	

[1)] Optional for SIPROTEC 5

Tab. 8/2: **Available digital device types for SIPROTEC 5, SIPROTEC Compact, SIPROTEC 4, and Reyrolle**

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8.4 SIPROTEC 5

The SIPROTEC 5 series offers a freely configurable device. You have the choice: Either you use a pre-configured device with a quantity structure already tailored to your application, or you build a device yourself from the extensive SIPROTEC 5 hardware building blocks to exactly fit your application.

The flexible hardware building blocks offer you:
- Base modules and expansion modules, each with different I/O modules
- Various on-site operation panels
- A large number of modules for communication, measured value conversion, and memory extension.

With the devices SIPROTEC 7xx85, 7xx86, and 7xx87 you can also combine different base and expansion modules, add communication modules, and select an installation variant that fits the space you have available.

The devices 7xx82 cannot be extended with expansion modules. With this modular principle, you can realize any quantity structures you desire. In this way, hardware that is tailored to the application can be selected. Fig. 8/4 shows a modular device consisting of a base module and 4 expansion modules.

Fig. 8/4: **Modular SIPROTEC 5 device**

The SIPROTEC 5 hardware building blocks offer you:

Durability and reliability

- Tailored hardware extension
- Robust housing
- Excellent EMC shielding in compliance with the most recent standards and IEC 61000-4
- Extended temperature range – 25 °C to + 70 °C
- Modular principle
- Freely configurable and extendable devices
- Large process data range (up to 40 current and voltage transformers for protection applications and up to 80 for central busbar protection as well as more than 200 inputs and outputs for recording applications possible)
- Operation panel, freely selectable for all device types (e.g. large or small display, with or without key switches, detached operation panel)
- Identical wiring of flush-mounting and surface-mounting housings.

User-friendly operation panel

- 9 freely assignable function keys for frequently required operator control actions
- Separate control keys for switching commands
- Context-sensitive keys with labeling in the display
- Complete numeric keypad for simple entry of setting values and easy navigation in the menu
- Up to 80 LEDs for signaling, 16 of which are in two colors.

Application-friendly design

- No opening of device necessary for installation and servicing
  - Easy battery replacement on the back of the device
  - Simple exchange of communication modules with plug-in technology
  - Electronically settable (no jumpers) threshold for binary inputs
  - Rated current (1 A/5 A) of current transformer inputs configurable electronically
- Removable terminal blocks
  - Pre-wiring of terminals is possible
  - Simple replacement of current transformers, e.g. with sensitive earth current transformers in cases of network conversions
  - Increased safety, since open current transformer circuits are no longer possible (safety CT plug).

Base and expansion modules

A SIPROTEC 5 device consists of one base module, up to 9 expansion modules, and a power-supply module for the optional second tier. Base and expansion modules are distinguished firstly by their width. The base module is 1/3 × 19" wide. Located on the rear panel are process connections and space for up to two plug-in modules. The expansion modules and the power supply for the second tier are each 1/6 × 19" wide. Expansion modules can provide either additional process or communication connections and are available for the 7xx85, 7xx86, 7xx87, and 6MD8 devices.

Fig. 8/5 shows the rear side of a device consisting of a base module in which the power supply, the CPU module, and an I/O board are permanently installed, as well as 4 expansion modules for extending the I/O quantity structure and communication modules. Each expansion module contains an I/O board. The components are connected by bus connector plugs and mechanical interlockings.

Such a device can be ordered pre-configured from the factory. In this context you can choose between the standard variants predefined by Siemens and the devices you have combined yourself. Every SIPROTEC 5 device can also be converted or extended according to your wishes. The modular concept absolutely ensures that the final device meets all standards, particularly with regard to EMC and environmental requirements. Further hardware properties of the SIPROTEC 5 devices can be found in Tab. 8/3.

Standard variants

To make it easier to select the correct devices, Siemens offers you pre-configured devices, which are called standard variants. These combinations of a base module and one or more expansion modules are intended for specific applications. In this way, you can order exactly the right device with a single order number. And standard variants can also be modified easily and quickly with additional expansion modules. Thus, it is just as easy to add modules as it is to replace certain modules with others. The available standard variants can be found in the order configurator at *www.siemens.com/siprotec*.

Fig. 8/6 shows one possible standard variant for the 7SL87. This variant describes a 1/2 × 19" wide device having the following quantity structure:
- 15 binary inputs
- 20 binary outputs
- 8 current inputs
- 8 voltage inputs.

Fig. 8/5: **Rear view of SIPROTEC 5 device**

Fig. 8/6: **Standard variant for SIPROTEC 7SL87**

On-site operation panel

The on-site operation panel is a separate component within the SIPROTEC 5 modular system. This allows you to combine a base or expansion module with a suitable operation panel, according to your requirements. The modular system offers 3 different on-site operation panels for selection, both for base modules and for expansion modules.

The following variants are available for base modules:
- With a large display, keypad, and 16 two-colored LEDs
- With a small display, keypad, and 16 two-colored LEDs
- 16 two-colored LEDs.

The following variants are available for expansion modules:
- Without operating or control elements
- With 16 LEDs (single-colored)
- With 16 LEDs (single-colored) and key switch
- With 8 LEDs (single-colored) and 8 pushbuttons.

Elements of the on-site operation panels

The operator elements are illustrated with the example of the on-site operation panel with a large display (Fig. 8/7). The central element is the generously sized display for text and graphics. With its high resolution, it creates ample space for symbols in graphical representations.

Below the display there is a 12 key keypad. In combination with 4 navigation keys and 2 option keys you have everything you need to navigate conveniently and quickly through all information that is shown in the display.

2 LEDs on the upper border of the operation panel inform you about the current device operating state.

16 additional LEDs, to the left of the keypad, ensure quick, targeted process feedback. The USB interface enables fast data transfer. It is easily accessible from the front and well protected with a plastic cover.

The operation panel with large display also enables representation of a more complex control display and thus offers more room for measured values and the display of event lists. This operation panel is therefore the first choice for bay controllers, busbar protection, or combined protection and control devices.

As a third option, an economical variant is available without keypad and display. This variant is appropriate for devices that are seldom or never used by the operational crew.

The keys O and I (red and green) for the direct control of equipment, a reset key for the LEDs, and the control key for switching to the control display (mimic diagram), complete the operation panel.

1 Graphical display
2 Labeling field for LEDs
3 16 LEDs (green or red, settable parameters)
4 16 LEDs (red)
5 LED reset
6 USB interface
7 Labeling field for function keys
8 Numerical keys and function keys
9 Control/command keys
10 Context-sensitive keys
11 Cursor keys
12 Key switch S5 "Remote/Local"
13 Key switch S1 "Interlocking Off/Normal"

Fig. 8/7: **SIPROTEC 5 operation panel: base module (left) and expansion module (right)**

Installation variants

You can order any SIPROTEC 5 device, regardless of its individual configuration, in 3 different installation variants:

- As flush-mounting device
- As surface-mounting device with integrated on-site operation panel
- As surface-mounting device with the on-site operation panel detached.

Surface-mounting device with integrated on-site operation panel

For wall installation, the SIPROTEC 5 devices can be ordered in the surface-mounting housing (Fig. 8/8). Thanks to a new concept, these devices have terminal connection diagrams that are identical to the corresponding flush-mounting devices. This is achieved by installing the devices using the principle "with the face to the wall" and then attaching the operation panels to the terminal side. With the brackets that are used, sufficient space remains for the wiring, which can be routed away upwards and downwards.

Surface-mounting device with the on-site operation panel detached

If the operation panel is to be installed detached from the device (Fig. 8/9), it can be installed as a separate part and connected to the device with a 2.5 m or 5 m long connecting cable. In this way, the SIPROTEC 5 device can be situated, for example, in the low-voltage fixture and the operation panel can be installed precisely at the correct working height in the cabinet door. In this case, the device is fastened like a surface-mounting device on the cabinet wall. For the operation panel an opening must be provided in the door.

	7xx82	7xx85/86/87, 6MD8
Hardware expandable	No	Yes
Binary inputs	11/23	Flexible
Binary outputs	9/16	Flexible
Analog measuring transducer inputs (20 mA)	0 to 4	Flexible, 0 to 12
Current inputs	4/8	Flexible
Voltage inputs	4/0	Flexible
Housing (x 19")	⅓	⅓ to 2
Flush-mounting device	Yes	Yes
Surface-mounting device with integrated on-site operation panel	Yes, with assembly frame	Yes
Surface-mounting device with detached on-site operation panel	No	Yes
Small display (lines)	8	8
Large display (pixels)	320 × 240	320 × 240
Function keys	9	9
Key switch	No	Optional
LEDs	16	
Power supply	DC 24-48 V and DC 60-250 V/ AC 115-230 V	DC 24-48 V and DC 60-250 V/ AC 115-230 V

Tab. 8/3: **Hardware properties of SIPROTEC 5**

Fig. 8/8: **Device in surface-mounting housing with integrated operation panel**

Fig. 8/9: **Device with detached operator panel**

Integrated interfaces

USB connections on the front side

The device can be accessed with the operating program DIGSI 5 by plugging a standard USB cable into the USB-B socket on the front side of the base module. The complete configuration and setting of the device is carried out via this connection.

Integrated interfaces on the rear panel of the base module

The base module offers various, permanently installed interfaces on the rear. For even greater flexibility, 2 slots are available for plug-in modules.

Integrated Ethernet interface (port J)

This electrical RJ45 interface serves to connect DIGSI 5 via a local Ethernet network. In this way, several devices can be operated from DIGSI 5 via an external switch. DIGSI 5 detects the devices even without an IP configuration on the local network and can then assign them network addresses. Optionally, the IEC 61850 protocol for connections with 6 clients can be activated on this interface. On 7Sx82 devices and SIPROTECT 5 with CP300, GOOSE messages are also supported on this interface.

Time-synchronizing interface (port G)

Via the 9-pole Sub-D socket (connection compatible with SIPROTEC 4), the time in the device can be synchronized. The set clock telegram IRIG-B005 (007) of a GPS receiver can be fed with 5 V, 12 V, or 24 V levels. In addition, the Central European DCF77 format with summer and winter time changes is supported. An additional second pulse input enables microsecond-precise synchronization of the device from a highly precise time source, e.g. a special GPS receiver. This accuracy is needed for special protection and measuring tasks. In this way, devices can be precisely synchronized to the microsecond supra-regionally. For this, Siemens provides a prefabricated complete solution with time receiver, optical fiber converters, and appropriate connection cables.

Connecting a detached operation panel (port H)

A detached operation panel provided together with the connection cable can be connected to this interface. The maximum distance is 2.5 or 5 meters.

Connecting the extension unit CB202 (port K)

The base module offers slots for 2 plug-in modules (Fig. 8/10). Further plug-in modules can be provided via a special expansion module CB202 connected via port K. The expansion module is delivered with an appropriate cable, and is connected with port L on the base module. The CB202 has its own wide-range power supply. Because the switch integrated in an Ethernet module can continue to execute its data forwarding function for neighboring devices even if the power supply of the base device is switched off, and the CB202 is still powered, an Ethernet ring is not disconnected when one device is in service.

Via plug-in modules, the devices can be extended with protocol interfaces and analog inputs. The devices can be ordered with assembled modules or be extended with modules retroactively. An expansion module CB202 (Fig. 8/10) can also be assembled with plug-in modules. The modules are easy to service and can be plugged in, without having to open the device. Since the modules have their own processor, the base functions of the device, e.g. the protection functions and the protocol application, are largely independent.

Modules are delivered without configured protocols or applications. One or more appropriate modules are suggested in the order configurator corresponding to the desired protocol on a module. There are serial modules with 1 or 2 electrical and optical interfaces. Different applications can run on both interfaces.

Fig. 8/10: **Rear view of the device with integrated interfaces and module slots (left side: basic module; right side: CB202)**

The SIPROTEC 5 terminals

Innovative terminals were developed for the SIPROTEC 5 family. All terminals are individually removable (Fig. 8/11). This enables pre-wiring of the systems, as well as simple device replacement without costly re-wiring.

Current terminals

The 8-pole current terminal with 4 integrated current transformers is available in 3 designs:
- 4 protection transformers
- 3 protection transformers + 1 sensitive protection transformer
- 4 measuring transformers.

The terminal design enables the following advantages for the connection of currents:
- Exchange of the current transformer type also possible retroactively on-site (e.g. protection transformer against measuring transformer, sensitive for normal earth current transformers in cases of network conversions)
- Additional safety during tests or device replacement, since the secondary current transformer circuits always remain closed.

Voltage terminal

The voltage transformers and the binary input and output signals are connected via the 14-pole voltage terminal. The cable entry to the terminal enables clear access to the terminal connection. Bridges precisely matching the current and voltage terminals are available for bridging contacts with common potential.

Modules

Which and how many process connections a base or expansion module has depends on the choice of a particular input/output board. The modular system includes different input/output boards. The IO202 input/output board (Fig. 8/12) is used, e.g., as a base measuring module. By equipping several modules with this board, you can achieve up to 40 measuring channels per SIPROTEC 5 device.

In the module there are connections for:
- 4 voltage transformers
- 4 current transformers, optionally protection current transformers, sensitive protection current transformers or measuring transformers
- 8 binary inputs (BI)
- 6 binary outputs (BO), designed as 4 fast normally-open contacts and 2 fast changeover contacts.

The connections are distributed on:
- 1 × 8-pole current terminal block
- 3 × 14-pole voltage terminal blocks.

Select the modules suitable for your purposes so that you can build the SIPROTEC 5 device that precisely matches your application. You will find an overview of the modules that are available and their quantity structures in the SIPROTEC 5 catalog.

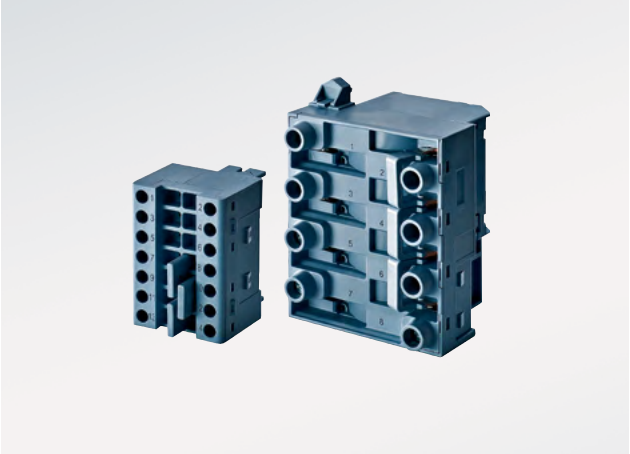


Fig. 8/11: **Voltage and current terminal block with bridges**

Fig. 8/12: **Rear view of an expansion module IO202**

Second module tier

If the quantity structure of a unit with 4 expansion modules is not enough, a second tier can be added. This requires a PS203 power supply in the second tier on the first mounting position. The remaining 5 positions can be filled with expansion modules from the SIPROTEC 5 module range. Exception: The CB202 must always be in the first tier and only one can be used for each device.

Module CB202

Module CB202 represents a special case (Fig. 8/13). CB202 provides 3 plug-in module positions for up to 2 communication modules or up to 3 measuring transducer modules. Combinations are also possible, e.g. 2 communication modules and 1 measuring transducer module.

The power supply is integrated, so that the CB202 can be powered independently of the main device. Communication with the main device is assured via an RJ45 connector and the bus connection on the front of the module.

Process bus module PB201

The SIPROTEC 5 expansion module PB201 (Fig. 8/14) makes it easy to extend SIPROTEC 5 devices. The module provides 24 channels for measured values (sampled measured values) for communication according to IEC 61850-9-2 with a merging unit. Integrated resampling makes it possible to connect merging units having different sampling frequencies. To ensure network redundancy, IEC 62439 redundancy protocols PRP and HSR are integrated. Moreover, PB201 has an integrated web server for expanded diagnostic functions.

Interfaces:
- A: 2 LC duplex interfaces channel A
- B: 2 LC duplex interfaces channel B
- C: 2 LC duplex interfaces channel C
- Service: 1 LC duplex interface service port.

Fig. 8/13: **Expansion module CB202**

Fig. 8/14: **Process module PB201**

Measuring ranges of the current transformer modules

The measuring range (full modulation) of the current transformers can be set to different values electronically – depending on the field of application. In all cases, you can choose between protection and measuring transformers. Only protection transformers can be used for busbar protection because of the large dynamic range involved. The possible measuring ranges according to rated current are shown in Tab. 8/4.

A large dynamic range is necessary for network protection applications, so that short-circuit currents can be recorded without distortion. A value of 100 × I_{rated} has proven optimal. For 5 A transformer rated current, this corresponds to a setting of 500 A, and consequently of 100 A for 1 A transformers. For applications in generator protection, while it is true that there are very large primary currents, a dynamic range of 20 × I_{rated} is still quite sufficient. Thus, a measuring range of 100 A is obtained for a setting I_{rated} = 5 A, and a measuring range of 20 A for I_{rated} = 1 A.

	Rated current I_{rated}	Measuring range	Measuring range 7xx82 devices
Protection transformers	5 A	500 A	250 A
	1 A	100 A	50 A
Measuring transformers	5 A	8 A	8 A
	1 A	1.6 A	1.6 A
Sensitive earth current input	5 A	8 A	8 A
	1 A	1.6 A	1.6 A

Tab. 8/4: **Measuring ranges according to rated current**

A smaller dynamic range means that greater accuracy is achieved in the rated current range. Consequently, the dynamic range for instrument transformers and sensitive protection current transformer input for earth-fault currents is extremely limited. In this case, limited means that the input current is chopped on the analog side. Of course, the inputs in this case are protected against overdriving.

Plug-in modules

Plug-in modules are available for communication, analog inputs, and arc protection. The communication modules are described in the SIPROTEC 5 catalog.

Measuring transducer module ANAI-CA-4EL

The module has four 20 mA inputs. It can be plugged into one of the slots in the PS201 or CB202. Multiple measured-value modules can be used with each device (one in each available slot). The connections are established via an 8-pole screwed terminal trip (Fig. 8/15).

Arc protection module ARC-CD-3FO

Up to 3 optical point or line sensors can be connected per arc protection plug-in module (Fig. 8/16). This provides a maximum number of up to 15 sensors for modular SIPROTEC 5 devices.

- The point sensors can be ordered with connection cable lengths from 3 to 35 m
- Line sensors detect arcs over the entire length of the sensor. Lengths from 5 to 40 m are available
- Line sensors are connected to the arc protection module via an incoming cable. The incoming cable can be ordered in lengths from 3 to 10 m.

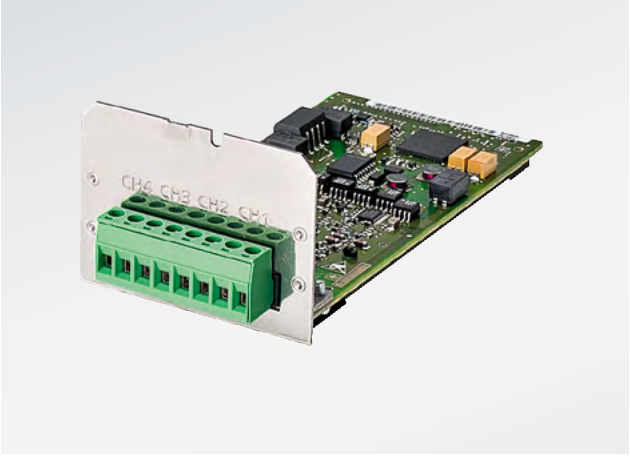


Fig. 8/15: **Measuring transducer module ANAI-CA-4EL**

Fig. 8/16: **Arc protection module ARC-CD-3FO**

8.5 SIPROTEC Compact

The SIPROTEC Compact series has been especially conceived for the requirements of the medium-voltage and industrial sector, but it can of course also be used for other applications such as high-voltage switchgear, for example.

The outstanding feature of the SIPROTEC Compact series is the compact design offering, at the same time, a high functional density and user friendliness. In the development of the SIPROTEC Compact series we have integrated our experience from more than 100 years of protection systems, the proven functions of SIPROTEC 4, and many customer suggestions.

Local operation

All operations and information can be executed via an integrated user interface (Fig. 8/17):

Battery compartment accessible from outside

2 operation LEDs

In an illuminated 6-line LC display, process and device information can be indicated as text in different lists

4 navigation keys

8 freely programmable LEDs serve for indication of process or device information. The LEDs can be labeled user-specifically. The LED reset key resets the LEDs

9 freely configurable function keys support the user in performing frequent operations quickly and comfortably

Numerical operation keys

USB user interface (type B) for modern and fast communication with the operating software DIGSI

Keys “O” and “I” for direct control of operational equipment

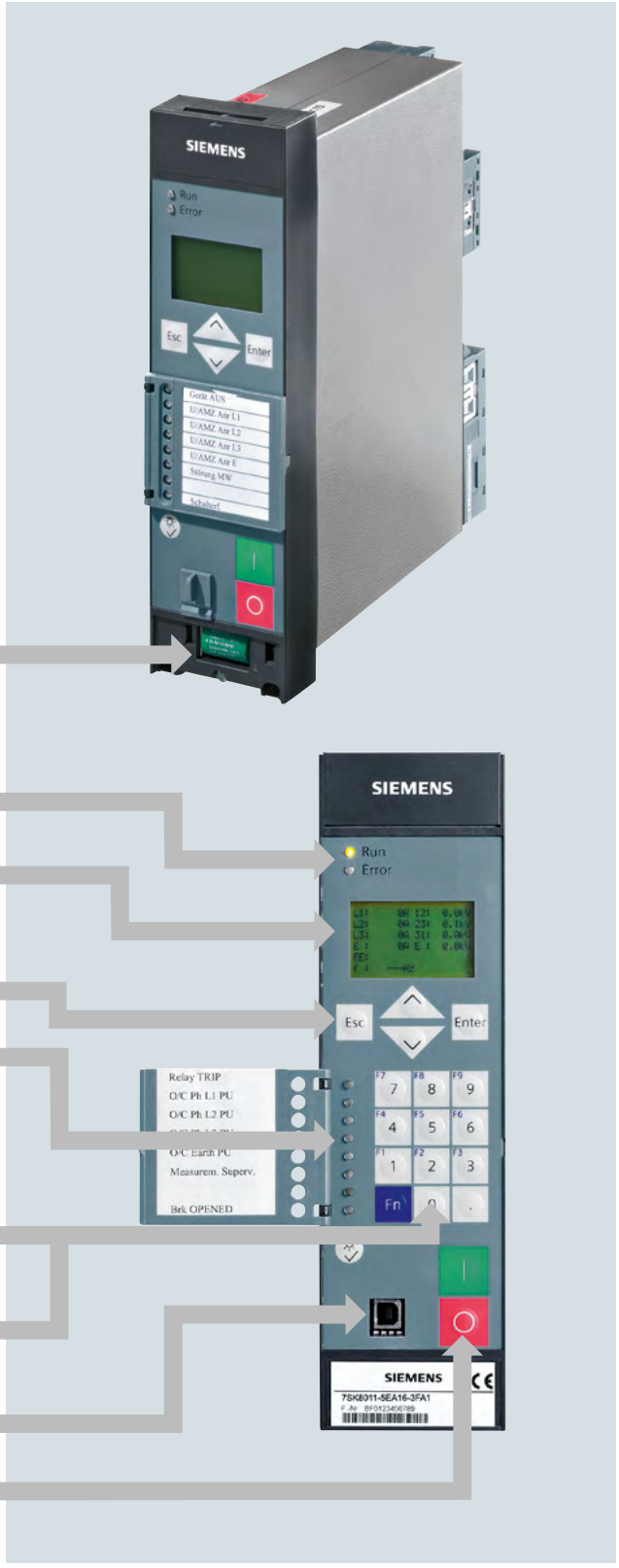


Fig. 8/17: **SIPROTEC Compact: top – with closed cover and open battery compartment; bottom – with open cover**

Connection techniques and housing with many advantages

The relay housing is 1/6 of a 19" rack and makes replacement of predecessor models very easy. The height for flush- and surface-mounting housings is 244 mm (views in Fig. 8/18).

Pluggable current and voltage terminals allow for prewiring and simplify the exchange of devices in the case of support (Tab. 8/5). As the current transformers are integrated in the removable current terminal block, it is not possible to open secondary current transformer circuits.

All binary inputs are independent. The threshold values are settable via DIGSI (3 stages). The secondary values of the current transformers – 1 A or 5 A – can also be adjusted via DIGSI. Up to 9 function keys can be programmed for predefined menu entries, switching sequences, etc. The assigned function of the function keys is shown in the display. With the time-overcurrent protection SIPROTEC 7SJ81, there is also a device available for connection to low-power current transformer applications.

Current terminals – ring-type lugs	
Connection	W_{max} = 9.5 mm
Ring-type lugs	d_1 = 5.0 mm
Conductor cross-section	2.0 – 5.2 mm² (AWG 14 – 10)
Current terminals – single cables	
Conductor cross-section	2.0 – 5.2 mm² (AWG 14 – 10)
Wire end ferrule with plastic sleeve	L = 10 mm (0.39 in) or L = 12 mm (0.47 in)
Stripping length (conductor without wire end ferrule)	15 mm (0.59 in) Only solid copper wires may be used
Voltage terminals – single cables	
Conductor cross-section	0.5 – 2.0 mm² (AWG 20 – 14)
Wire end ferrule with plastic sleeve	L = 12 mm (0.47 in)
Stripping length (conductor without wire end ferrule)	12 mm (0.42 in) Only solid copper wires may be used

Tab. 8/5: **Wiring specifications for process connection**

7SK80, 7SJ80, 7SD80 rear view

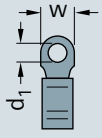
Voltage terminal block

Current terminal block

7SJ81, 7SK81 rear view

7RW80 rear view

Front view,
surface-mounting housing



Ring lug

Fig. 8/18: **SIPROTEC Compact: front and rear views as well as cable lug, voltage and current terminal block**

Control

In addition to the protection functions, SIPROTEC Compact devices also support all control and monitoring functions that are required for operating medium-voltage or high-voltage switchgear. Information about the position of the switching devices (primary or auxiliary devices) are obtained from auxiliary contacts and communicated to the unit via binary inputs. Therefore it is possible to detect and indicate not only the defined CLOSED and OPEN positions, but also a fault or intermediate position of the circuit-breaker. The switchgear panel or circuit-breaker can be controlled via:

- Integrated operator panel
- Binary inputs
- Substation control and protection system
- DIGSI 4.

Automation

With an integrated logic functionality, the user can create, through a graphic user interface (CFC), specific functions for automation of his switchgear panel or switchgear assembly. Functions are activated using function keys, a binary input, or through the communication interface.

Switching authority

Switching authority for local/remote operation is determined by set parameters or communication. Each switching operation and switch-position change will be recorder in the operational log. Command source, switching device, cause (i.e., spontaneous change or command) and result of a switching operation will be stored.

Command processing

All functionalities of the command processing are available. This includes the processing of single and double commands with or without feedback, sophisticated monitoring of the control hardware and software, checking of the external process, control actions using functions such as runtime monitoring, and automatic command termination after output. Here are some typical applications:

- Single and double commands using 1-, 1½-, 2-pole command output
- User-definable panel/bay interlocks
- Operating sequences combining several switching operations such as control of circuit-breakers, disconnectors, and earthing switches
- Triggering of switching operations, indications, or alarms by combination of existing information.

Assignment of feedback to command

The positions of the switching devices and transformer taps are acquired through feedback. These feedback inputs are logically assigned to the corresponding command outputs. The unit can therefore distinguish whether the indication change is a result of an intended switching operation or whether it is a spontaneous change of state (faulty position).

Chatter disable

The chatter disable feature evaluates whether, in a programmable period of time, the number of status changes of an indication input exceeds a specified number. If exceeded, the indication input is blocked for a certain period, so that the event list will not record excessive entries.

Indication filtering and delay

Indications can be filtered and/or delayed. Filtering serves to suppress brief changes in potential at the indication input. The indication is passed on only if the indication voltage is still present after a set period of time. In the event of an indication delay, the system waits for a preset time. The information is passed on only if the indication voltage is still present.

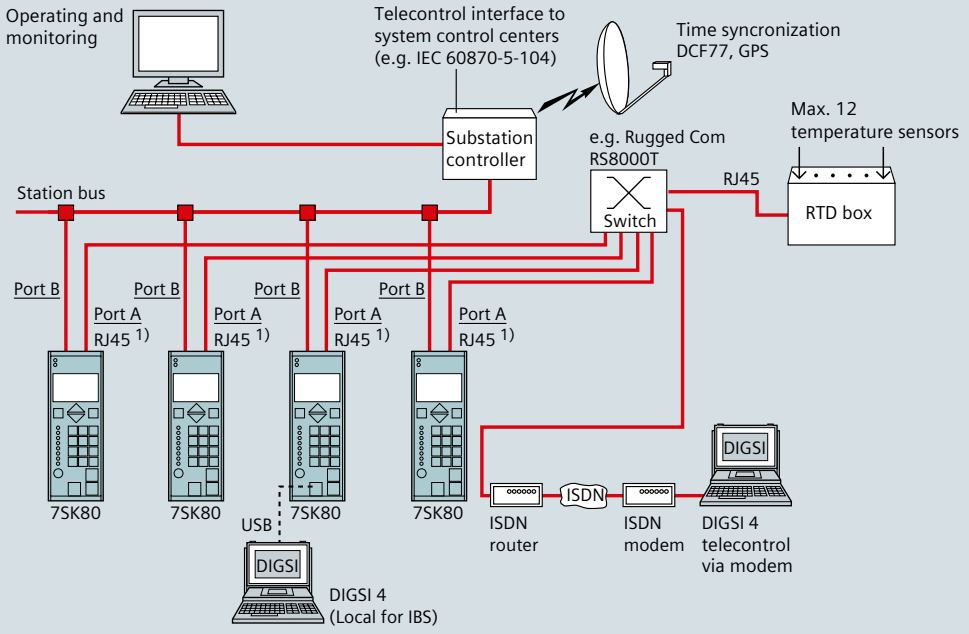
Indication derivation

Another indication (or even a command) can be derived from a specific indication. Group indications are also possible. These grouped indications can reduce the extent of information to the system interface to the essential.

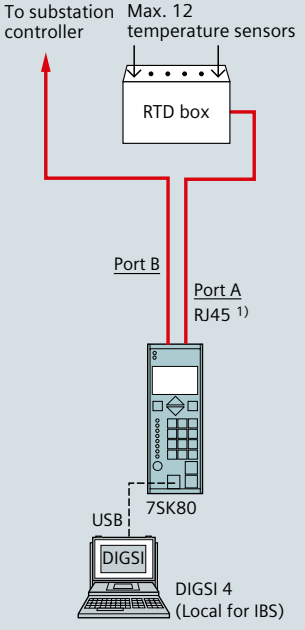
Communication

As regards communication, the devices offer high flexibility for the connection to industrial and energy automation standards (Fig. 8/19). The concept of the communication modules running the protocols enables exchangeability and retrofittability. Thus, the devices can also be perfectly adjusted to a changing communication infrastructure in the future, e.g., when Ethernet networks
will be increasingly used in the utilities sector in the years to come.

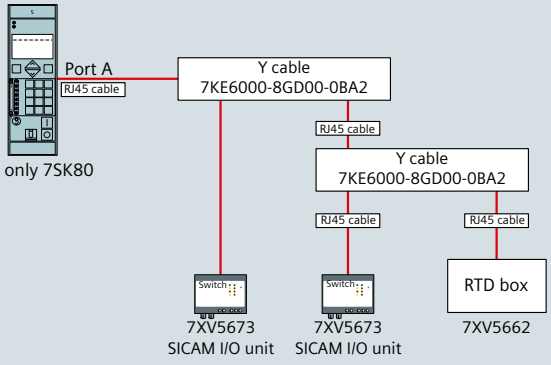
System solution/communication



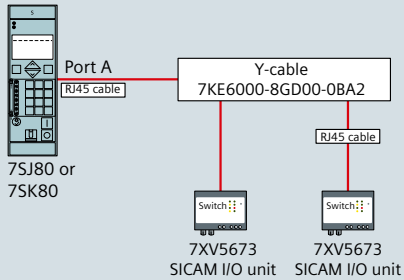
Connection of an RTD box to 7SK80 using Ethernet interface



Connection of 2 SICAM I/O units and 1 RTD box using Y cable (maximum 2 SICAM I/O units connectable)



Connection of 2 SICAM I/O units on port A using Y cable (maximum 2 SICAM I/O units connectable)



1) On SIPROTEC 7SK80, the RJ45 interface at port A can be used for connection of an RTD box. On SIPROTEC 7SD80, port A is reserved for the optical interface.

Fig. 8/19: **SIPROTEC Compact: flexible system solutions for communication**

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8.6 Medium-voltage application examples

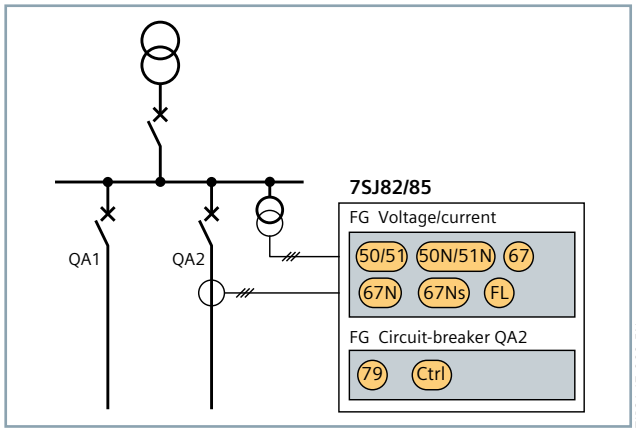

Fig. 8/20: **Medium-voltage application for all power system types**

Properties, Fig. 8/20

- Reliable detection of transients and static earth faults
- Cost saving due to integrated transient function
- Directional and non-directional protection and control functions
- Acquisition and transmission of PMU variables possible.

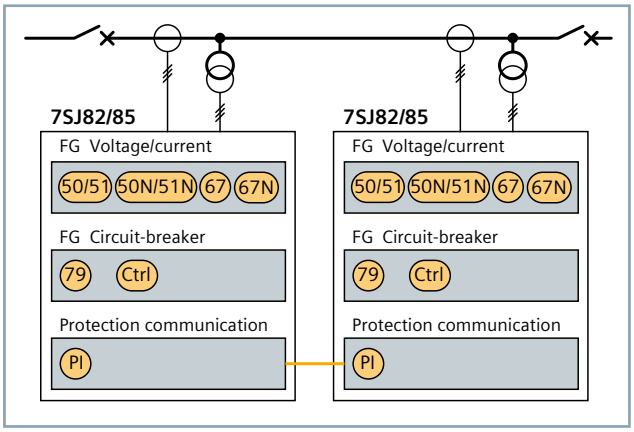

Fig. 8/22: **Fast fault clearance in double-feed lines**

Properties, Fig. 8/22

- Directional DMT/IDMTL protection without grading times
- Fast fault clearance
- Low-cost due to integrated protection interface
- Monitored data exchange
- Adaptable to different communication infrastructures.

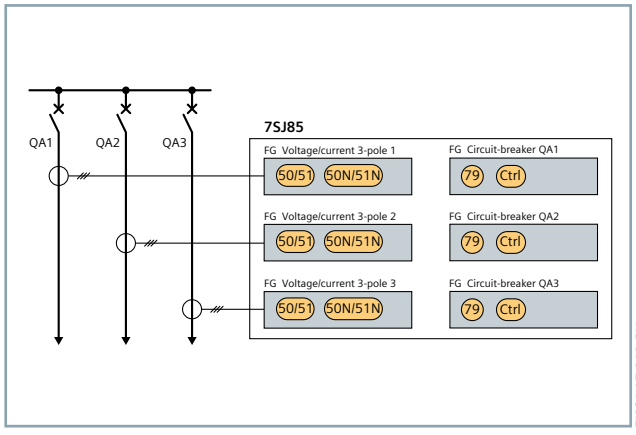

Fig. 8/21: **Protection and control of several feeders with one device**

Properties, Fig. 8/21

- Reduced investment with one device for several feeders
- Easy parameterization
- Shorter commissioning times
- Protecting up to seven feeders with a single device reduces costs.

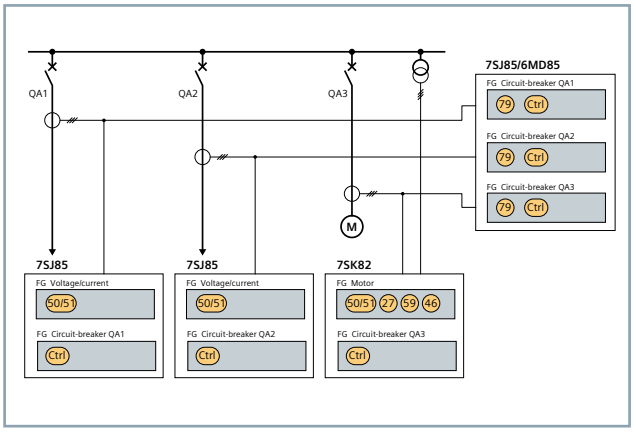

Fig. 8/23: **Central control of multiple feeders and dedicated protection**

Properties, Fig. 8/23

- Protection for each panel/bay
- Central control for multiple feeders
- High availability because backup protection functions can be activated in the controllers.

The abbreviations and ANSI function numbers in Fig. 8/20 to Fig. 8/43 can be found in Tab. 8/6 on page 152.

8.7 Motor protection application examples

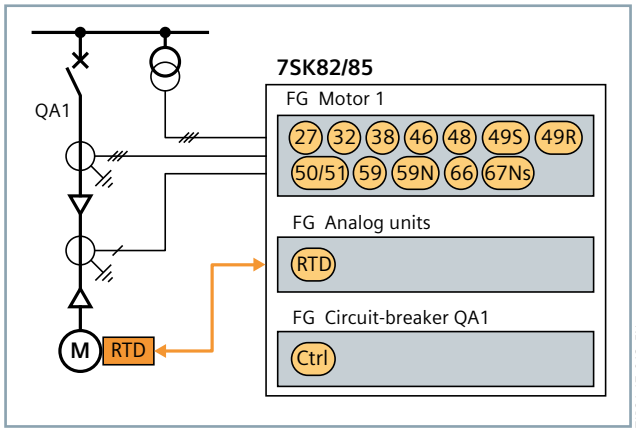

Fig. 8/24: **Induction motor: protection and control**

Properties, Fig. 8/24

- Reduced investment due to protection and control in one device
- Thermal motor protection functions for reliable motor monitoring
- Thermal motor protection functions with direct connection of temperature sensors.

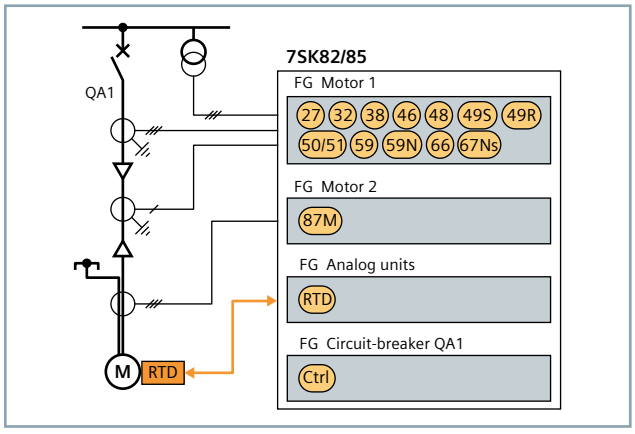

Fig. 8/26: **Protection and control of several feeders with one device**

Properties, Fig. 8/26

- High sensitivity and short tripping times due to differential protection function
- Integration of the differential protection function in a separate function group reduces costs.

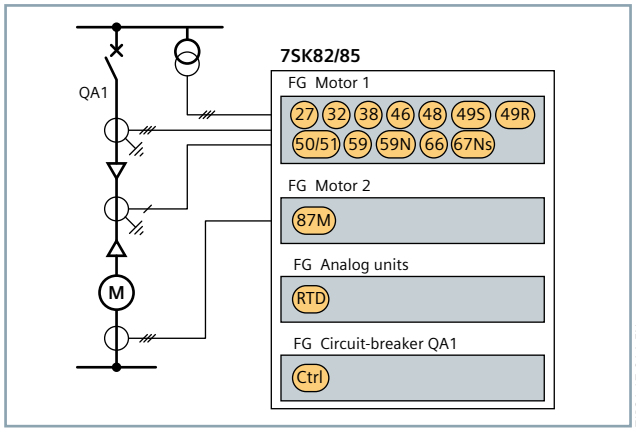

Fig. 8/25: **Motor protection with differential protection**

Properties, Fig. 8/25

- Autonomous differential protection functions
- High sensitivity and short tripping times due to differential protection function
- Separate acquisition and monitoring of the current transformers.

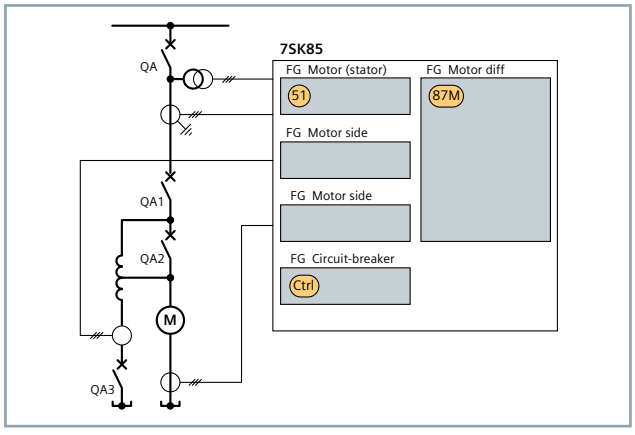

Fig. 8/27: **Differential motor protection for Korndörfer starter**

Properties, Fig. 8/27

- Acquisition, monitoring, and control of all circuit-breakers
- Differential protection function also available during start-up.

The abbreviations and ANSI function numbers in Fig. 8/20 to Fig. 8/43 can be found in Tab. 8/6 on page 152.

8.8 Transformer protection application examples

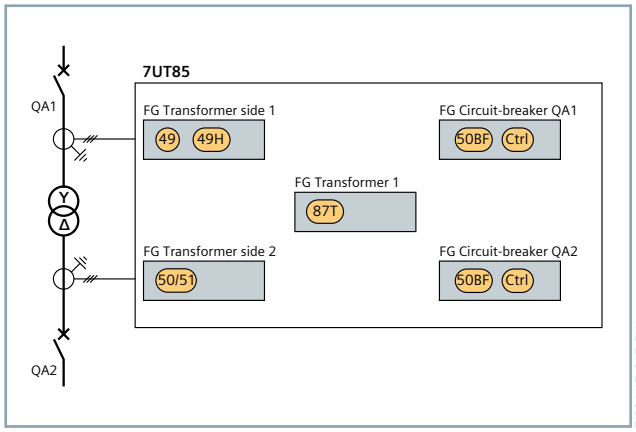

Fig. 8/28: **Two-winding transformer**

Properties, Fig. 8/28

- Clear assignment of the functions to the primary element
- Reduced investment
- Easy parameterization
- Reduced wiring and faster commissioning.

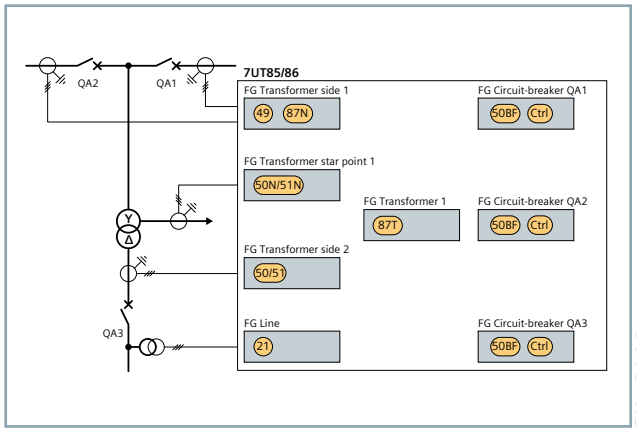

Fig. 8/29: **Two-winding transformer with 2 incoming feeders (for example, double circuit-breaker switchgear)**

Properties, Fig. 8/29

- Separate acquisition, monitoring, and control of all circuit-breakers
- High sensitivity with single-phase earth-fault differential protection
- Cost savings due to 87T and 87N T in one unit.

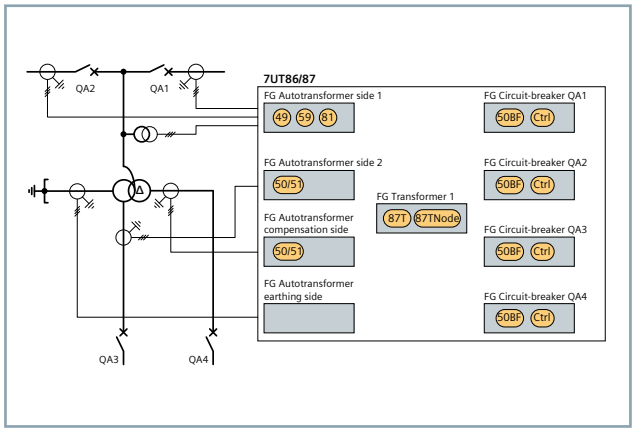

Fig. 8/30: **Autotransformer bank**

Properties, Fig. 8/30

- Reduced investment due to integration of the differential and node protection function in one unit (87 and 87 Node)
- High sensitivity with single-phase earth-fault differential protection.

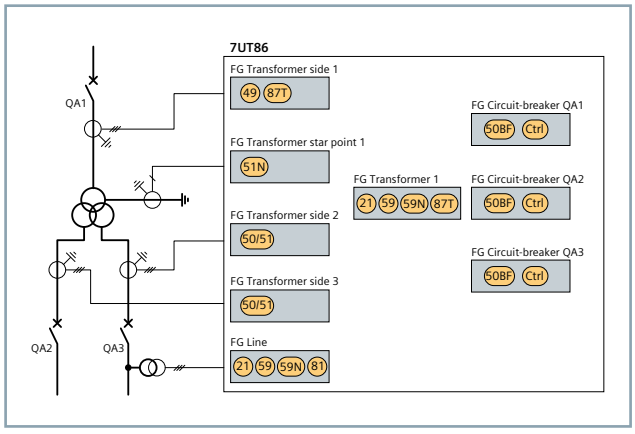

Fig. 8/31: **Three-winding transformer with differential protection 87T and distance protection 21**

Properties, Fig. 8/31

- Integrated backup protection function for the power system
- Simpler engineering
- Increased flexibility for different plant versions.

The abbreviations and ANSI function numbers in Fig. 8/20 to Fig. 8/43 can be found in Tab. 8/6 on page 152.

8.9 Generator protection application examples

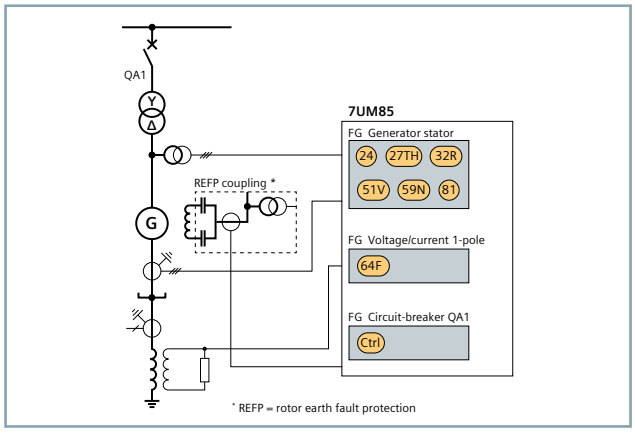

Fig. 8/32: **Unit connection of a small-power generator**

Properties, Fig. 8/32

- All functions in one device keep investments low
- Basic hardware (1/3 x 19")
- Preconfigured with the "Generator basis" application template.

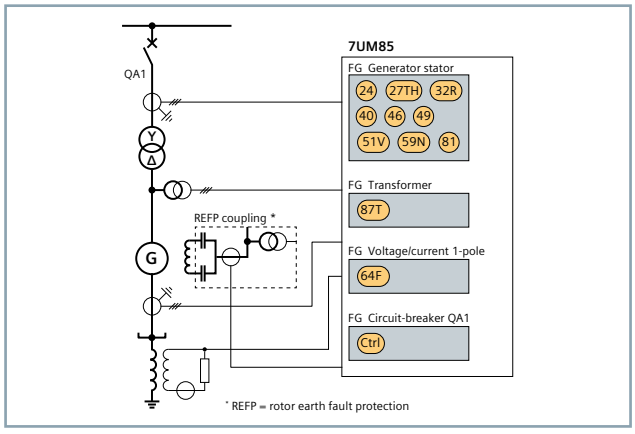

Fig. 8/33: **Unit connection of a medium-power generator**

Properties, Fig. 8/33

- All functions in one device keep investments low
- Basic hardware (1/2 x 19") preconfigured with the "Generator unit connection basis" application template
- Stator earth-fault protection protects 100% of the stator winding by evaluating the residual voltage via the fundamental component and the 3rd harmonic (59N, 27TH)
- Differential protection via generator transformer with function 87T.

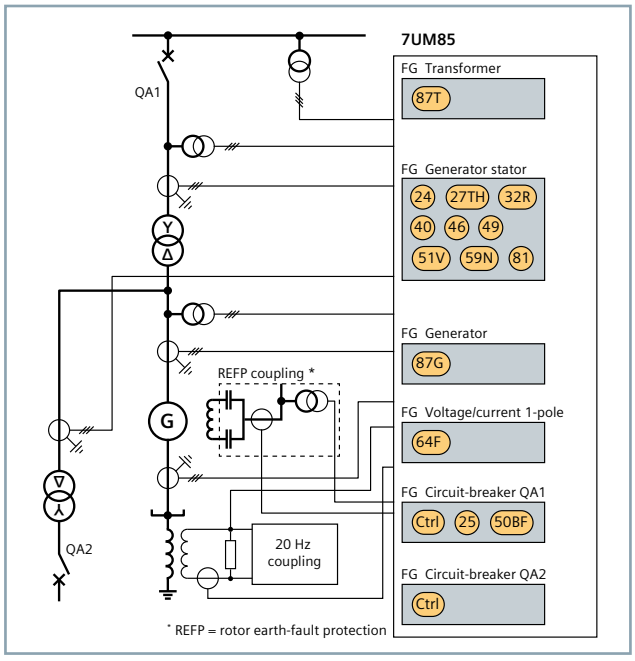

Fig. 8/34: **Unit connection of a generator with auxiliary transformer**

Properties, Fig. 8/34

- All functions in one device keep investments low
- Minimum hardware (2/3 × 19")
- Modification of the "Generator unit connection enhanced" application template
- Stand-alone differential protection for generator (87G) and generator transformer (87T)
- Design of transformer differential protection as T differential protection
- Real 100% stator earth-fault protection by coupled 20 Hz voltage
- Stator earth-fault protection possible at plant standstill
- Synchrocheck release by the device during manual synchronization
- Redundancy by device doubling.

The abbreviations and ANSI function numbers in Fig. 8/20 to Fig. 8/43 can be found in Tab. 8/6 on page 152.

8.10 Line protection application examples

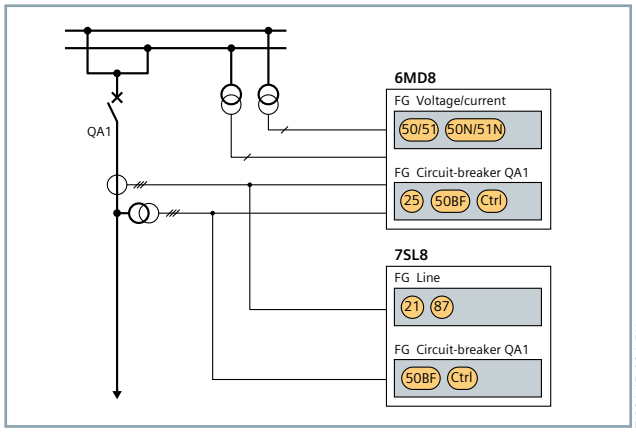

Fig. 8/35: **Line protection – protection and control separately**

Properties, Fig. 8/35

- Clear assignment of protection and control in separate devices
- Fewer external components by detection and selection of busbar voltage in the device
- High reliability due to backup protection functions in the SIPROTEC 6MD8 bay controller
- High availability due to emergency control in the SIPROTEC 7SL8 protection device.

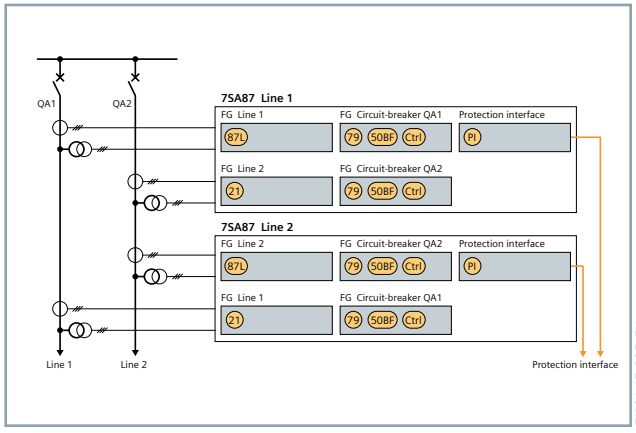

Fig. 8/36: **Low-cost protection and device redundancy**

Properties, Fig. 8/36

- High availability due to protection and device redundancy
- Low-cost because only 2 devices required for 2 lines
- Reliable because of parallel processing of the protection functions in the devices.

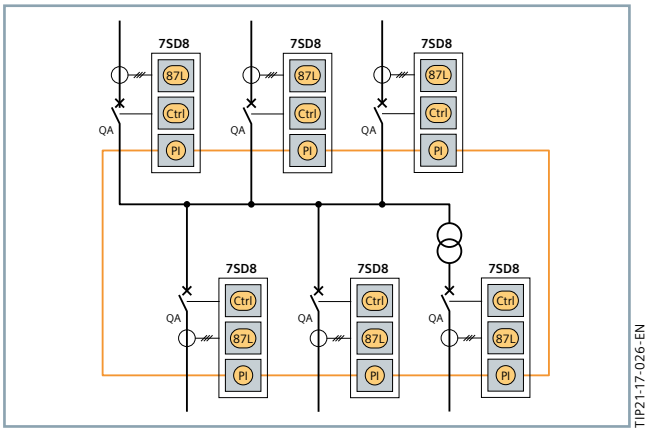

Fig. 8/37: **Line protection – protection and control separately**

Properties, Fig. 8/37

- High availability because differential protection is also active when a communication link fails
- Self-restoring due to automatic switchover from ring to chain topology
- High ease of maintenance because single line ends can be taken out of the differential protection configuration for commissioning and servicing.

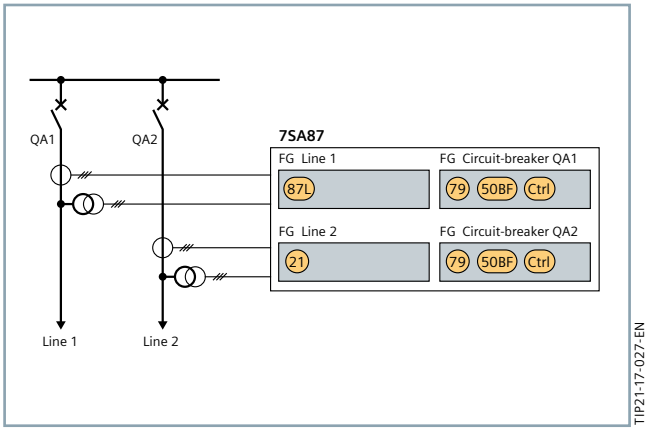

Fig. 8/38: **Distance protection of two parallel lines with one device**

Properties, Fig. 8/38

- Low-cost due to protection of both lines in one device
- Stable due to consideration of the influences of the parallel line for the distance protection function.

The abbreviations and ANSI function numbers in Fig. 8/20 to Fig. 8/43 can be found in Tab. 8/6 on page 152.

8.11 Breaker-and-a-half application examples

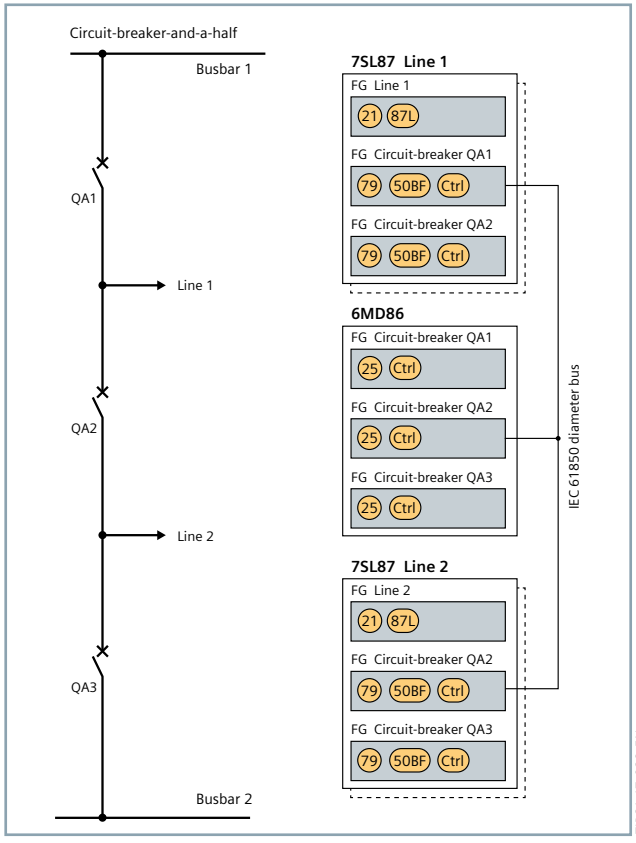

Fig. 8/39: **Modular and distributed protection and control solution**

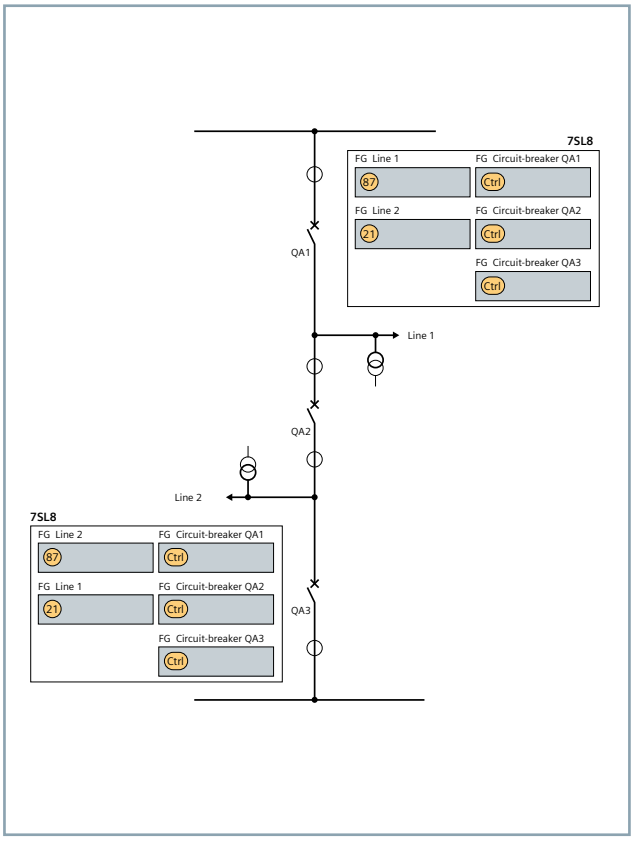

Fig. 8/40: **Low-cost device and protection redundancy in breaker-and-a-half arrangements**

Properties, Fig. 8/39

- Clarity due to clear assignment of protection and control
- High availability due to protection redundancy (main 1 and main 2)
- Simple reliable central control of the entire diameter
- Reliable due to emergency control in every line in the protection device
- Reduced wiring due to integrated voltage selection
- System-wide diameter bus based on IEC 61850
  - Electrically isolated data exchange
  - Reduced wiring
  - Easy expansion.

Properties, Fig. 8/40

- Unambiguous allocation of the main protection function (line differential protection 87) to one line in one device (main 1 or main 2)
- The distance protection function (21) is implemented in the protection device of the other line by a second "line 1" or "line 2" function group
- High availability and safety by device and protection redundancy
- Low costs due to protecting and controlling a complete diameter with only two devices.

The abbreviations and ANSI function numbers in Fig. 8/20 to Fig. 8/43 can be found in Tab. 8/6 on page 152.

8.12 Double-busbar feeder with coupler application example

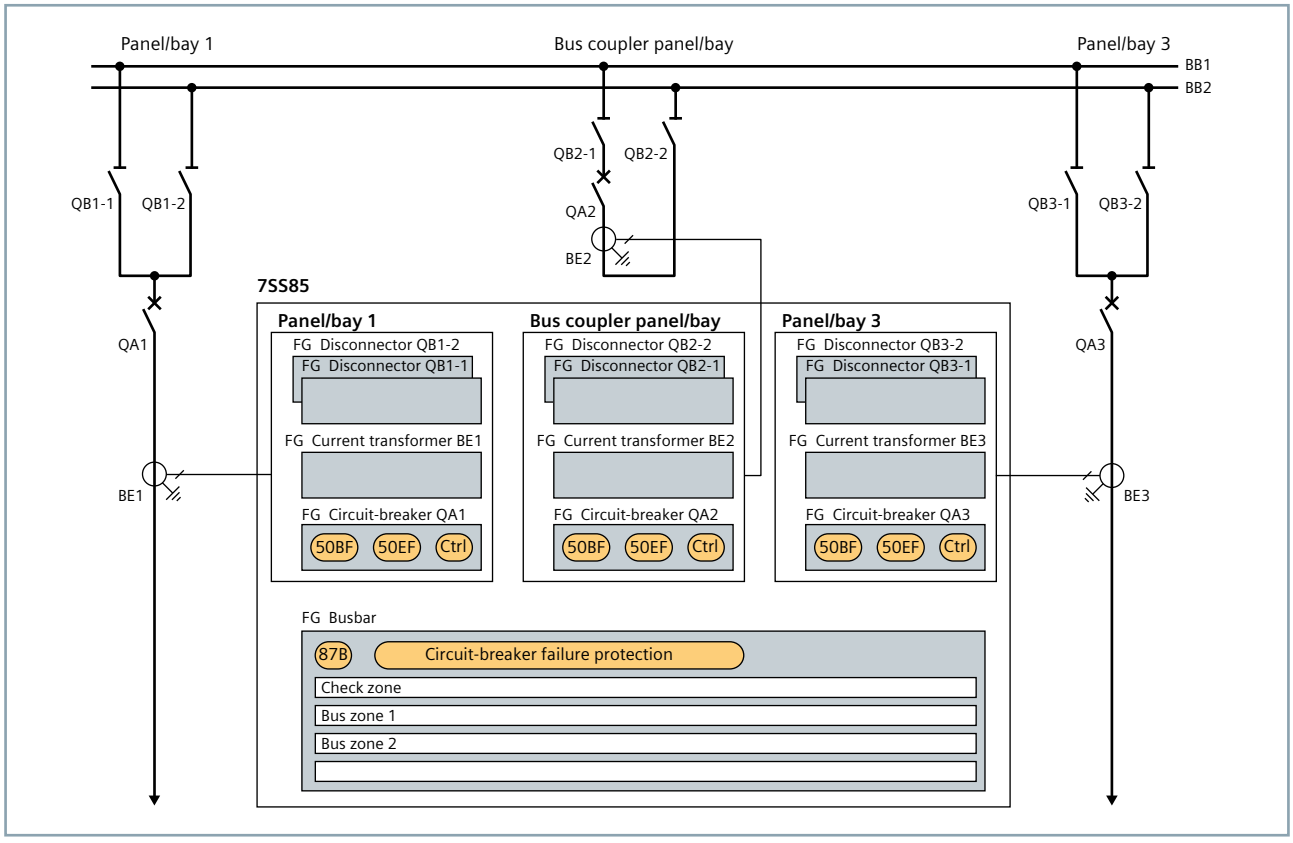

Fig. 8/41: **Double busbar feeder with coupler**

Properties, Fig. 8/41

- Central busbar protection (BB1 and BB2)
- Summary of all primary components of a panel/bay in the "Bay Proxy"
- One device for up to 20 measuring points
- Flexible adaptation to the topology (up to four busbar sections and four busbar couplers configurable)
- Integrated disconnector image
- Comfortable graphical configuration with DIGSI 5.

The abbreviations and ANSI function numbers in Fig. 8/20 to Fig. 8/43 can be found in Tab. 8/6 on page 152.

8.13 Capacitor banks application examples

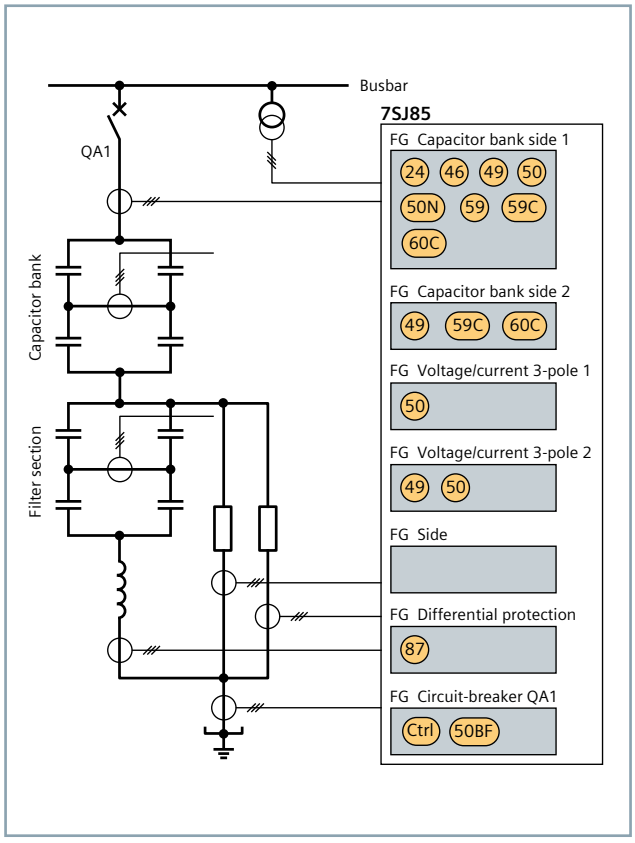

Fig. 8/42: **Protection of an MSCDN (mechanically switched capacitor with damping network) capacitor bank**

Properties, Fig. 8/42

- Optimum protection of complex banks and filter circuits with flexible hardware and a flexible function design
- Low costs due to the integration of all necessary functions in one device for up to seven 3-phase measuring points
- Generation of current sum and current difference at the current interface of the protection function group "3-phase V/I"
- Detection of current and voltage signals up to the 50th harmonic with a high accuracy for protection and operational measured values.

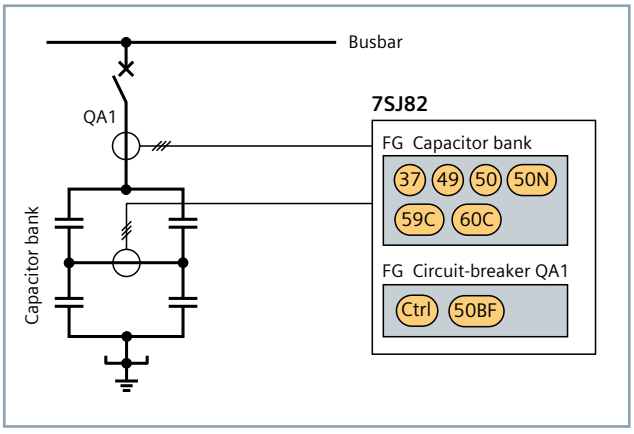

Fig. 8/43: **Protection of a capacitor bank in an H connection**

Properties, Fig. 8/43

- Precisely adapted due to dedicated function group and application-specific protection function, such as peak overvoltage protection (ANSI 59C) and sensitive current unbalance protection (ANSI 60C)
- Low cost due to integration of all required functions into one device.

The abbreviations and ANSI function numbers in Fig. 8/20 to Fig. 8/43 can be found in Tab. 8/6 on page 152.

8.14 Power system monitoring and PMU application example

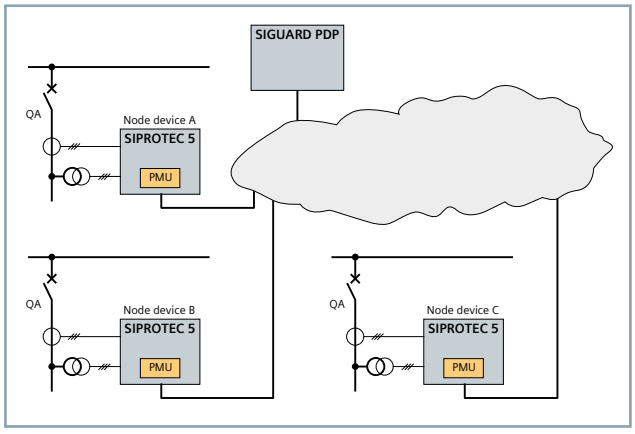

Fig. 8/44: **Principle of distributed phasor measurement**

Properties, Fig. 8/44

- Each SIPROTEC 5 device can be equipped or retrofitted with the PMU (Phasor Measurement Unit) function
- Online and offline evaluation of the PMU data in the monitoring system, SIGUARD PDP.

FG	Function group
FL	Fault locator
PI	Protection data interface
Crtl	Control
QA	Circuit-breaker
RTD	Indications from RTD box
27	Undervoltage protection
32	Power protection, active power
38	Temperature supervision
46	Unbalanced-load protection
48	Starting time supervision
49	Thermal overload protection
49H	Hot-spot calculation
49R/49S	Thermal overload protection, rotor/stator.
50/51	Time-overcurrent protection, phases
50N/51N	Time-overcurrent protection, earth
50BF	Circuit-breaker failure protection
59/59N	Overvoltage protection: “3-phase”, or “zero-sequence component U0”, or “positive-sequence component U1”, or “universal Ux”
66	Restart inhibit for motors
67	Directional time-overcurrent protection, phase
67N	Directional time-overcurrent protection, earth
67Ns	Sensitive earth-fault detection for resonant-earthed and isolated systems
79	Automatic reclosing
87M	Motor differential protection
87T	Transformer differential protection

Tab. 8/6: **Abbreviations and ANSI function numbers**

Chapter 9

Annex

9 Annex

9.1 List of Abbreviations

A	
ABS	American Bureau of Shipping
ANSI	American National Standards Institute
B	
BIM	Building Information Modeling
BMS	Battery Management System
BPL	Broadbank over Power Lines
C	
CAD	Computer Aided Design
CapEx	Capital Expenditure
CBC	California Building Code
CE	Conformity with European standards
CFC	Continuous Function Chart; for programming control and automatic control tasks
CSA	formerly the Canadian Standards Association
CT	Current Transformer
D	
DC	Direct Current
DEMS	Decentralized Energy Management System
DIN	German Institute for Standardization
DMT	Definite time-overcurrent protection
DNP	Distributed Network Protocol
DNV	Det Norske Veritas (today: DNV GL)
E	
E-car	Electric car
EMC	Electromagnetic compatibility
EN	European standard
ETSI	European Telecommunications Standards Institute
F	
FSK/MRSK	Federal Grid Company/holding company of the interregional power supply companies in Russia
G	
GB	Chinese standards (Guobiao standards)
GL	German Lloyd (today: DNV GL)
GOOSE	Generic Object Oriented Substation Events
GOST	Russian standards (Gosudarstvennyy Standart)
GPRS	General Packet Radio Service
GPS	Global Positioning System
GSM	Global System for Mobile Communications (2^{nd}-generation wireless communication standard)
H	
HMI	Human Machine Interface
HOAI	Fee structure for engineers and architects (in Germany)
HV	High Voltage
HV HRC	High-Voltage High-Rupturing-Capacity
HVAC	Heating, Ventilation, Air Conditioning
HSR	High-availability Seamless Redundancy (industrial communication network)
I	
IAC	Internal Arc Classification
IDMTL	Inverse time-overcurrent protection
IEC	International Electrotechnical Commission
IEC/TS	Technical Specification issued by the International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IK	International code of classification of resistance to mechanical impacts
IP	International Protection: international code of classification of protection with regard to ambient conditions
ISO	International Standardization Organization
IT	Information Technology
ISDN	Integrated Services Digital Network

L

Li-ion	Lithium ion
LR	Lloyds Register
LSC	Loss of Service Continuity
LTE	Long Term Evolution (4th-generation wireless communication standard, actually only 3.9G)
LV	Low Voltage
LVC	Low-Voltage Compartment

M

MCB	Miniature Circuit-Breaker
Modbus RTU	Remote Terminal Unit: binary communication protocol for data transmission between terminals
MSCDN	Mechanically Switched Capacitor with Damping Network
MV	Medium Voltage

O

OpEx	Operational Expenditure

P

PE	Polyethylene
PM	Partition class: Metallic partition
PMU	Phasor Management Unit
PRP	Parallel Redundancy Protocol (industrial communication network)

R

RAL	Color matching system of the RAL Institute
RCU	Remote Control Unit
RDT	Regulated Distribution Transformer
RMR	Russian Maritime Register of Shipping
RMS	Root Mean Square
RSTP	Rapid Spanning Tree Protocol (network protocol for quick access in a “spread” tree structure)
RTD	Resistance Temperature Device
RTU	Remote Terminal Unit

S

SCADA	Supervisory Control And Data Acquisition
SCU	System Control Unit
SF_6	Sulphur hexafluoride
SNTP	Simple Network Time Protocol (network protocol with simplified time synchronization)

T

TBS	Totally Building Solutions
TCP/IP	Transmission Control Protocol/ Internet Protocol
TIA	Totally Integrated Automation
TIP	Totally Integrated Power
TRV	Transient Recovery Voltage

U

UBC	Uniform Building Code
UMTS	Universal Mobile Telecommunications System (3G, 3rd-generation wireless communication standard)
USB	Universal Serial Bus

V

VCB	Vacuum Circuit-Breaker
VT	Voltage Transformer

W

WiMAX	Worldwide interoperability for Microwave Access (4G, wireless communication standard for broadband internet)

X

XLPE	Cross-Linked Polyethylene

9.2 List of standards cites

International	National	German title	English title
IEC 60068-2-57	VDE 0468-2-57	Umgebungseinflüsse – Teil 2-57: Prüfungen – Prüfung Ff: Schwingen – Zeitverlaufverfahren und Sinusimpulse	Environmental testing – Part 2-57: Tests – Test Ff: Vibration – Time-history and sine-beat method
IEC 60068-2-6	VDE 0468-2-6	Umgebungseinflüsse – Teil 2-6: Prüfverfahren – Prüfung Fc: Schwingen (sinusförmig)	Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal)
IEC 60068-2-64	VDE 0468-2-64	Umgebungseinflüsse – Teil 2-64: Prüfverfahren – Prüfung Fh: Schwingen, Breitbandrauschen	Environmental testing – Part 2-64: Tests – Test Fh: Vibration, broadband random and guidance
IEC 60068-3-3		Umweltprüfungen; Seismische Prüfverfahren für Geräte; Leitfaden	Environmental testing; seismic test methods for equipments; guidance
IEC 60071-1	VDE 0111-1	Isolationskoordination – Teil 1: Begriffe, Grundsätze und Anforderungen	Insulation co-ordination – Part 1: Definitions, principles and rules
IEC 60099	VDE 0675	Reihe: Überspannungsableiter	Series: Surge arresters
IEC 60099-4	VDE 0675-4	Überspannungsableiter – Teil 4: Metalloxidableiter ohne Funkenstrecken für Wechselspannungsnetze	Surge arresters – Part 4: Metal-oxide surge arresters without gaps for a.c. systems
IEC 60099-5	VDE 0675-5	Überspannungsableiter – Teil 5: Anleitung für die Auswahl und die Anwendung	Surge arresters – Part 5: Selection and application recommendations
IEC 60282-1	VDE 0670-4	Hochspannungssicherungen – Teil 1: Strombegrenzende Sicherungen	High-voltage fuses – Part 1: Current-limiting fuses
IEC 60298	VDE 0670-6	Zurückgezogen: Metallgekapselte Wechselstrom-Schaltanlagen für Bemessungsspannungen über 1 kV bis einschließlich 52 kV	Withdrawn: A.C. metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV
IEC 60364-8-1	VDE 0100-801	Errichten von Niederspannungsanlagen – Teil 8-1: Energieeffizienz	Low-voltage electrical installations – Part 8-1: Energy efficiency
IEC 60529	VDE 0470-1	Schutzarten durch Gehäuse (IP-Code)	Degrees of protection provided by enclosures (IP Code)
IEC 60644	VDE 0670-401	Anforderungen für Hochspannungs-Sicherungseinsätze für Motorstromkreise	Specification for high-voltage fuse-links for motor circuit application
IEC 60721-3-3		Klassifizierung von Umweltbedingungen – Teil 3: Klassen von Umwelteinflußgrößen und deren Grenzwerte; Hauptabschnitt 3: Ortsfester Einsatz, wettergeschützt	Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities; section 3: Stationary use at weatherprotected locations
IEC 60870-5-101		Fernwirkeinrichtungen und -systeme – Teil 5-101: Übertragungsprotokolle – Anwendungsbezogene Norm für grundlegende Fernwirkaufgaben	Telecontrol equipment and systems – Part 5-101: Transmission protocols – Companion standard for basic telecontrol tasks
IEC 60870-5-103		Fernwirkeinrichtungen und -systeme – Teil 5-103: Übertragungsprotokolle; Anwendungsbezogene Norm für die Informationsschnittstelle von Schutzeinrichtungen	Telecontrol equipment and systems – Part 5-103: Transmission protocols; companion Standard for the informative interface of protection equipment

International	National	German title	English title
IEC 60870-5-104		Fernwirkeinrichtungen und -systeme – Teil 5-104: Übertragungsprotokolle – Zugriff für IEC 60870-5-101 auf Netze mit genormten Transportprofilen	Telecontrol equipment and systems – Part 5-104: Transmission protocols – Network access for IEC 60870-5-101 using standard transport profiles
IEC 61000-4	VDE 0847-4	Reihe: Elektromagnetische Verträglichkeit (EMV) – Teil 4- ...: Prüf- und Messverfahren – ...	Series: Electromagnetic compatibility (EMC) – Part 4- ...: Testing and measurement techniques – ...
IEC 61850		Reihe: Kommunikationsnetze und -systeme für die Automatisierung in der elektrischen Energieversorgung	Series: Communication networks and systems for power utility automation
IEC 61850-9-2		Kommunikationsnetze und -systeme für die Automatisierung in der elektrischen Energieversorgung – Teil 9-2: Spezifische Abbildung von Kommunikationsdiensten (SCSM) – Abgetastete Werte über ISO/ IEC 8802-3	Communication networks and systems for power utility automation – Part 9-2: Specific communication service mapping (SCSM) – Sampled values over ISO/ IEC 8802-3
IEC 61869	VDE 0414-9	Reihe: Messwandler	Series: Instrument transformers
IEC 62262	VDE 0470-100	Schutzarten durch Gehäuse für elektrische Betriebsmittel (Ausrüstung) gegen äußere mechanische Beanspruchung (IK-Code)	Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)
IEC 62271-1	VDE 0671-1	Hochspannungs-Schaltgeräte und -Schaltanlagen – Teil 1: Gemeinsame Bestimmungen	High-voltage switchgear and controlgear – Part 1: Common specifications
IEC 62271-100	VDE 0671-100	Hochspannungs-Schaltgeräte und -Schaltanlagen – Teil 100: Wechselstrom-Leistungsschalter	High-voltage switchgear and controlgear – Part 100: Alternating-current circuit-breakers
IEC 62271-102	VDE 0671-102	Hochspannungs-Schaltgeräte und -Schaltanlagen – Teil 102: Wechselstrom-Trennschalter und -Erdungsschalter	High-voltage switchgear and controlgear – Part 102: Alternating current disconnectors and earthing switches
IEC 62271-103	VDE 0671-103	Hochspannungs-Schaltgeräte und -Schaltanlagen – Teil 103: Lastschalter für Bemessungsspannungen über 1 kV bis einschließlich 52 kV	High-voltage switchgear and controlgear – Part 103: Switches for rated voltages above 1 kV up to and including 52 kV
IEC 62271-105	VDE 0671-105	Hochspannungs-Schaltgeräte und -Schaltanlagen – Teil 105: Wechselstrom-Lastschalter-Sicherungs-Kombinationen für Bemessungsspannungen über 1 kV bis einschließlich 52 kV	High-voltage switchgear and controlgear – Part 105: Alternating current switch-fuse combinations for rated voltages above 1 kV up to and including 52 kV
IEC 62271-106	VDE 0671-106	Hochspannungs-Schaltgeräte und -Schaltanlagen – Teil 106: Wechselstrom-Schütze, Kombinationsstarter und Motorstarter mit Schützen	High-voltage switchgear and controlgear – Part 106: Alternating current contactors, contactor-based controllers and motor-starters
IEC 62271-111	VDE 0671-111	Hochspannungs-Schaltgeräte und -Schaltanlagen – Teil 111: Automatische Wiedereinschalter (Recloser) und Fehlerunterbrecher für Wechselspannungssysteme bis 38 kV	High-voltage switchgear and controlgear – Part 111: Automatic circuit reclosers and fault interrupters for alternating current systems up to 38 kV

International	National	German title	English title
IEC 62271-200	VDE 0671-200	Hochspannungs-Schaltgeräte und -Schaltanlagen – Teil 200: Metallgekapselte Wechselstrom-Schaltanlagen für Bemessungsspannungen über 1 kV bis einschließlich 52 kV	High-voltage switchgear and controlgear – Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV
IEC 62271-202	VDE 0671-202	Hochspannungs-Schaltgeräte und -Schaltanlagen – Teil 202: Fabrikfertige Stationen für Hochspannung/Niederspannung	High-voltage switchgear and controlgear – Part 202: High-voltage/low-voltage prefabricated substation
IEC/TS 62271-210	VDE 0671-210	Hochspannungs-Schaltgeräte und -Schaltanlagen – Teil 210: Erdbebenqualifikation für gekapselte Schaltanlagen mit Bemessungsspannungen über 1 kV bis einschließlich 52 kV	High-voltage switchgear and controlgear – Part 210: Seismic qualification for metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV
IEC/IEEE 62271-37-013		Hochspannungs-Schaltgeräte und -Schaltanlagen – Teil 37-013: Wechselstrom-Generatorschalter/Gilt in Verbindung mit IEC 62271-1	High-voltage switchgear and controlgear – Part 37-013: Alternating-current generator circuit-breakers/Applies in conjunction with IEC 62271-1
IEC 62439		Reihe: Industrielle Kommunikationsnetze – Hochverfügbare Automatisierungsnetze	Industrial communication networks – High availability automation networks
IEC 62443-3-3		IT-Sicherheit für industrielle Leitsysteme – Netz- und Systemschutz – Teil 3-3: Anforderungen an die Systemsicherheit und Sicherheitsstufen	Industrial communication networks – Network and system security – Part 3-3: System security requirements and security levels
ANSI/IEEE C 37.20.7		Anleitung zur Prüfung von metallgekapselten Wechselstrom-Schaltanlagen bis 38 kV hinsichtlich innerer Störlichtbogenfehler	IEEE Guide for Testing Metal-Enclosed Switchgear Rated Up to 38 kV for Internal Arcing Faults
IEEE 693		Empfehlungen für die seismische Auslegung von Unterstationen	Recommended practices for seismic design of substations
GB/T 3906		Metallgekapselte Wechselstrom-Schaltanlagen und Schaltgeräte für Bemessungsspannungen über 3,6 kV bis einschließlich 40,5 kV	Alternating-current metal-enclosed switchgear and controlgear for rated voltages above 3.6 kV and up to and including 40.5 kV
	DIN 276-1	Kosten im Bauwesen – Teil 1: Hochbau	Building costs – Part 1: Building construction
	DIN 276-4	Kosten im Bauwesen – Teil 4: Ingenieurbau	Building costs – Part 4: Civil constructions
	DIN 43661	Fundamentschienen in Innenanlagen der Elektrotechnik; Angaben für Konstruktion und bauliche Ausführung	Foundation bars for indoor switchgear; design and mounting particulars
ETSI EN 300 019-2-2		Geräte-Entwicklung – Umweltbedingungen und Umweltprüfungen für Telekommunikationsanlagen - Teil 2-2: Spezifikationen für Umweltprüfungen, Transport	Environmental Engineering (EE) – Environmental conditions and environmental tests for telecommunications equipment; Part 2-2: Specification of environmental tests; Transportation
EN 50110-1	VDE 0105-1	Betrieb von elektrischen Anlagen – Teil 1: Allgemeine Anforderungen	Operation of electrical installations – Part 1: General requirements

International	National	German title	English title
EN 50181		Steckbare Durchführungen über 1 kV bis 52 kV und von 250 A bis 2,50 kA für Anlagen anders als flüssigkeitsgefüllte Transformatoren	Plug-in type bushings above 1 kV up to 52 kV and from 250 A to 2,50 kA for equipment other than liquid filled transformers
ISO 9001		Qualitätsmanagementsysteme – Anforderungen	Quality management systems – Requirements
ISO 50001		Energiemanagementsysteme – Anforderungen mit Anleitung zur Anwendung	Energy management systems – Requirements with guidance for use
SN 47030 G1		Zurückgezogen: Thermoplastische Formmassen; Technische Vorzugskunststoffe; Eigenschaften, Farben, Kennzeichnung	Withdrawn: Thermoplastic Molding Materials; Preferred Engineering Plastics; Properties, Colors, Marking

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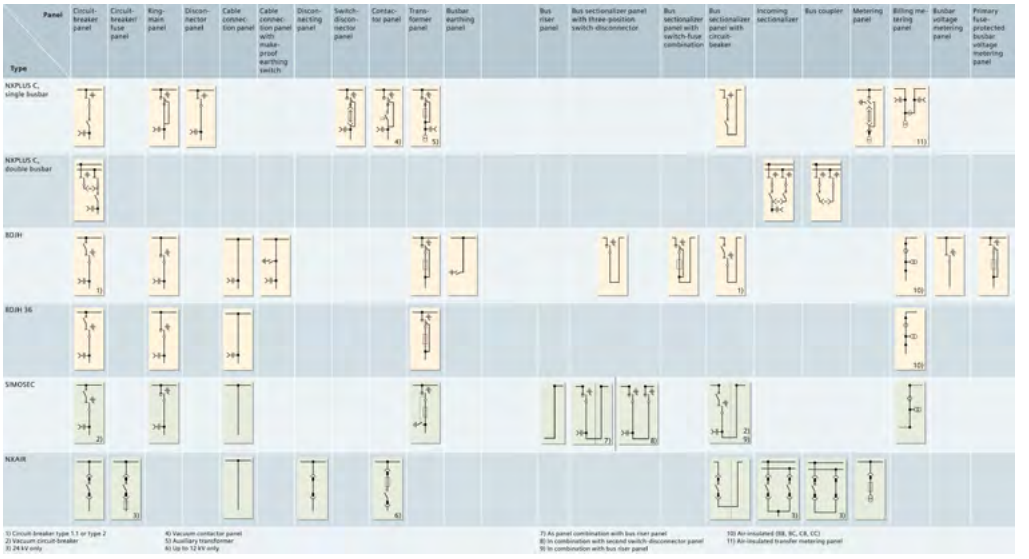
The symbol explanations for the panel components
(e.g., on pages 16f.) are given on the inside of the foldout page.



Explanation of circuit symbols

Vacuum circuit-breaker

■ ● ▲

Withdrawable circuit-breaker, optionally manual or motor operating mechanism

✚

Three-position switch-disconnector

■ ● ▲

Three-position disconnector

■ ● ▲

Vacuum contactor

●

Withdrawable contactor with HV HRC fuse

✚

Withdrawable contactor with control transformer and HV HRC fuses

✚

Capacitive voltage detecting system

■ ● ▲ ✚

HV HRC fuse

■ ● ▲ ✚

Withdrawable HV HRC fuse

✚

Current transformer

■ ▲ ✚

Cable-type current transformer

■ ● ▲

Voltage transformer

■ ▲ ✚

Plug-in voltage transformer

■ ●

Disconnectable and plug-in voltage transformer

■ ●

Plug-in voltage transformer, mounted separately, connection via short cable

●

Withdrawable voltage transformer with primary fuses

✚

Surge arrester or limiter [1]

■ ● ▲ ✚

Phase shift

●

Auxiliary transformer

●

Earthing switch

▲

Make-proof earthing switch

■ ▲ ✚

2nd earthing switch for fuses

●

Fixed earthing point (spherical connection bolt)

●

Fixed earthing point

▲

Fixed earthing point for busbar earthing

■ ▲

Busbar earthing switch

●

Forced ventilation

✚

Panel bars

●

Solid-insulated bar

●

Bar feeder

✚

Cable terminations

✚

Withdrawable disconnector link with manual operating mechanism (or motor operating mechanism – 24 kV only)

✚

Cable [2]

▲

2nd cable [2]

▲

2nd cable, 3rd cable [2]

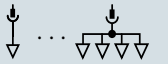
▲

Lateral cable connection with outside-cone plug [2]

●

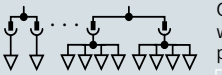
Cable connection with outside-cone plug [2]

■



Cable connection with outside-cone plug [2]

●



Cable connection with outside-cone plug [2]

●

1) SIMOSEC: surge arrester
2) Not included in the scope of supply

■ **8DJH, 8DJH 36**
● **NXPLUS C**
▲ **SIMOSEC**
✚ **NXAIR**

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