SIEMENS

Totally Integrated Power

Intelligent Transformer Substations for Future-Proof Power Distribution

The Modular Concept Based on 8DJH Medium-Voltage Switchgear

www.siemens.com/transformersubstations

Why smart grids?

The requirements on power distribution and therefore on medium- and low-voltage grids are increasing continuously.
Changing directions of power flow, load and voltage fluctuations, which are caused especially by the strongly growing number of power supplies from volatile power sources, e.g. photovoltaic/ biogas plants and wind farms, make the distribution grids of today go to their capacity limits.

Always well supplied – no chance for blackouts

Many of today's transformer substations, originally designed for a merely unidirectional energy flow and equipped with conventional transformers, are no longer capable of coping with the effects of volatile power sources. The consequences are more and more frequent supply breakdowns in the classical distribution grid, with ever increasing downtimes. In order to reduce such downtimes notably and to limit the associated blackout costs, quick adjustments to the changed load conditions must be possible.

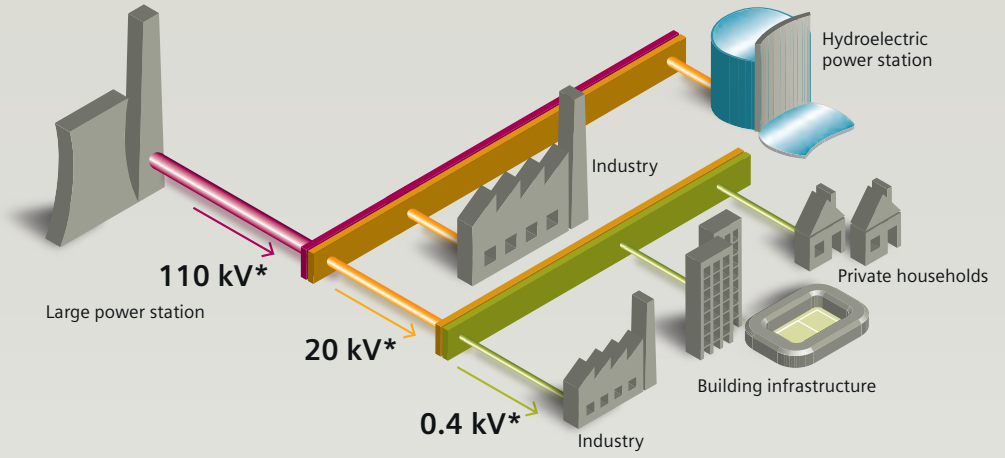
Active distribution grid with intelligent transformer substations for a smooth infeed of renewable energies

While the additional load capacity required due to the expansion of renewable energies can be provided by means of grid expansion, the effects resulting from the alternating direction of power flow, load fluctuations, and voltage range limitation can only be handled with intelligent solutions. The answer is an active distribution grid with intelligent transformer substations as key components. These contribute to an active load management in the distribution grid and enable an automatic and fast fault clearance in case of blackouts. In this way, you are always well supplied.

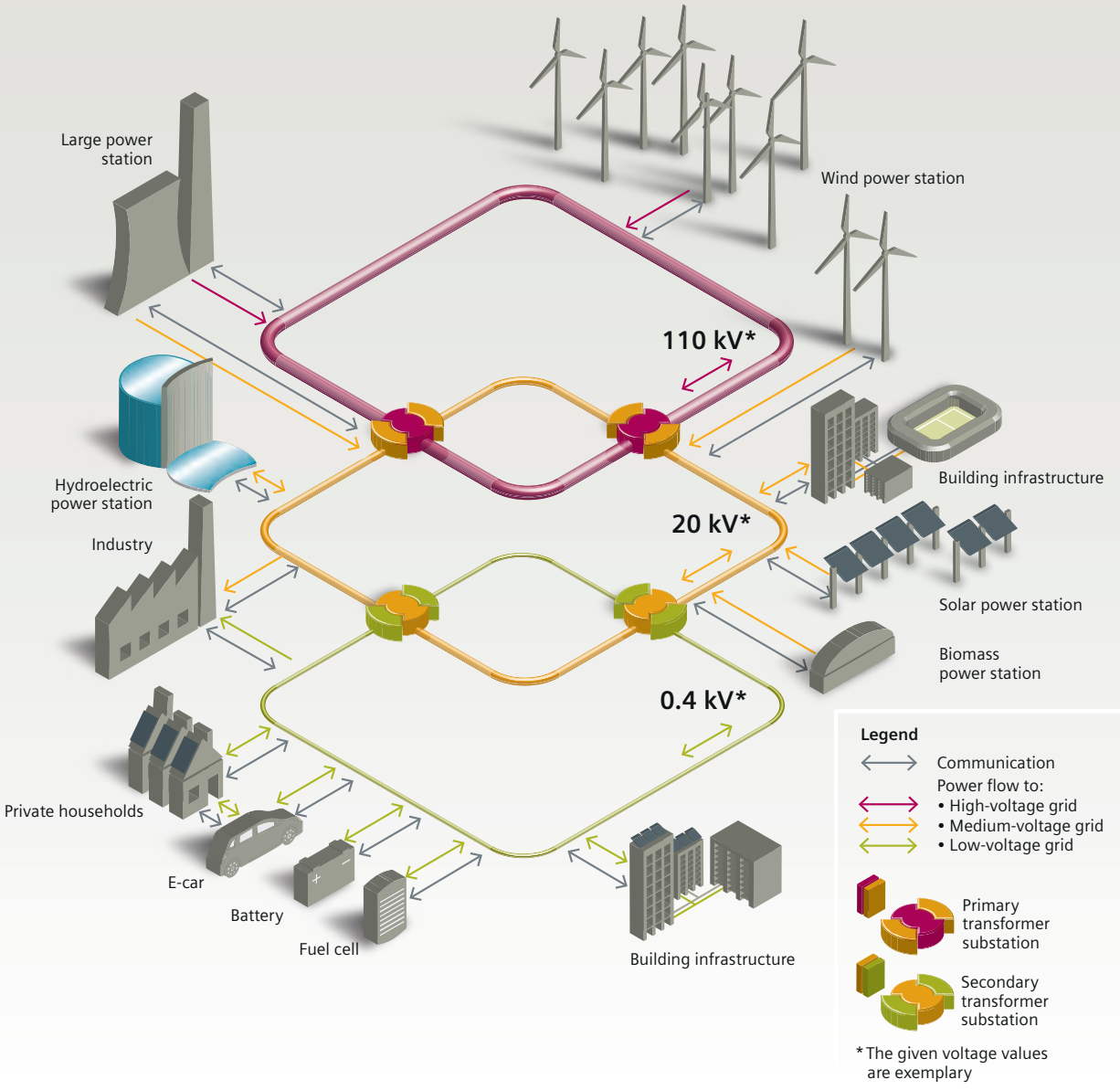
Benefits of intelligent transformer substations

- 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

Conventional grid with unidirectional power flow



Active distribution grid with intelligent transformer substations



* The given voltage values are exemplary

A consistent concept: The suitable component for every task

Distribution grids must meet the requirements resulting from the increasing integration of decentralized power sources. Counterbalancing the effects caused by changing directions of power flow as well as load and voltage fluctuations becomes the key task in the distribution grid.

Siemens offers distribution grid operators a consistent concept for intelligent transformer substations and the suitable component for every task. The concept includes compact medium-voltage switchgear with communication capability, regulated distribution transformers, as well as integrated telecontrol and automation solutions which monitor and control the medium- and low-voltage grid. In this way, overloads of operational equipment are detected earlier and voltage stability is ensured, e.g. by stipulation of setpoint values for the decentralized generators.

A stable grid without extension of the grid capacity

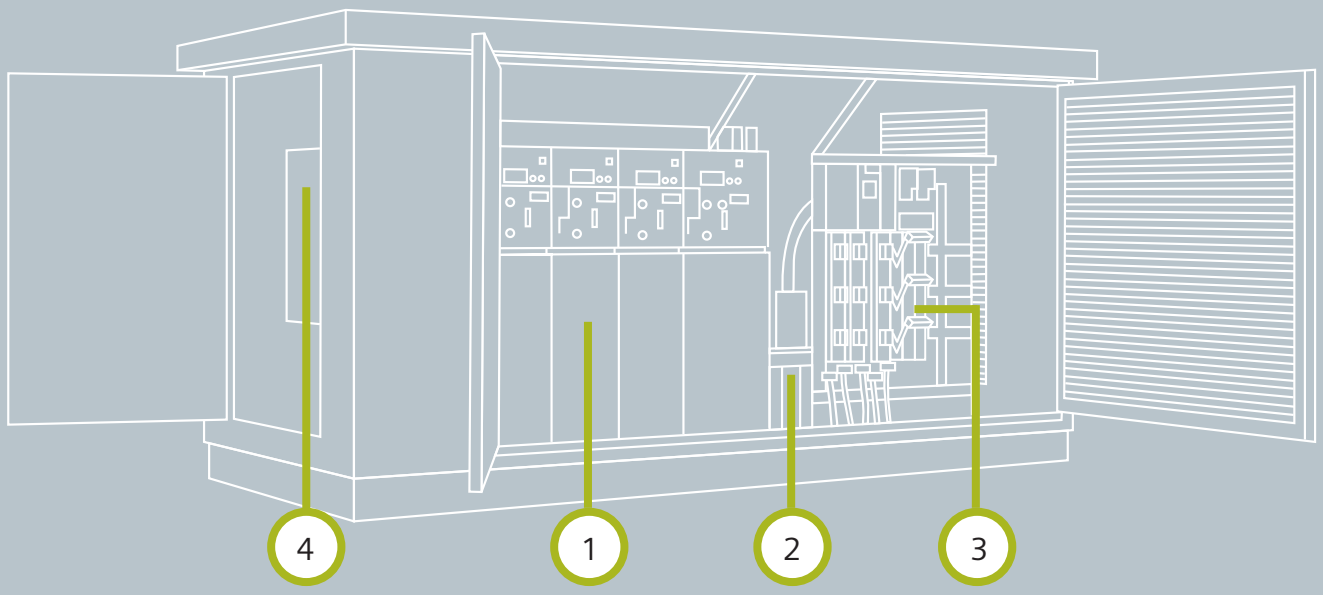
The benefits of this concept are that, in many cases, decentralized power sources can easily be integrated into the existing distribution grid without expensive investments in grid expansion. Thus, a stable grid offering reduced downtimes is guaranteed.

Modular design

The centerpiece of a substation is the associated medium-voltage switchgear. The switchgear can be integrated modularly into a smart grid together with the following components:

- Remote terminal units SICAM MIC / EMIC / CMIC
- Uninterruptible power supplies SITOP
- Communication solutions with TCP-IP, GPRS, GSM, WiMAX, BPL, UMTS, etc.
- Short-circuit / ground fault direction indicators SICAM FCM
- Current and voltage sensors
- Regulated distribution transformers FITformer® REG
- Power quality recorder SICAM P850 / 855
- Medium-voltage switchgear from the 8DJH family
- Decentralized energy management DEMS
- Control center system for utility companies SICAM 230
- Switchgear visualization SICAM SCC
- Connection to: Network control system SINAUT PowerCC
- Substation automation SICAM PAS / AK
- Electronic meters AMIS.

Solutions out of one hand make the distribution grids ready for the challenges created by the growing integration of renewable energies. In addition, they allow utilities a more efficient operation of their infrastructure, thus offering important competitive advantages.



Conceptual design of an intelligent transformer substation

The above illustration shows the conceptual design of an intelligent transformer substation

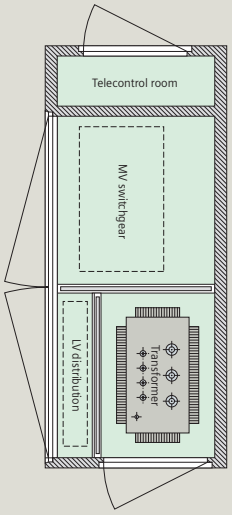
1 **Medium-voltage switchgear**
with motor operating mechanisms to actuate the switch-disconnectors or circuit-breakers from external switching points (e.g. network control center), sensors to measure currents and voltages, and intelligent short-circuit / ground fault direction indicators

2 **Transformer**
Standard transformer or regulated distribution transformer

3 **Low voltage**
Acquisition of load conditions, power quality measurement, position indicators

4 **Telecontrol unit**
RTU*, modem, uninterruptible power supply

Typical room planning of a transformer substation



* Remote Terminal Unit

The key components in the grid

Planning, design and maintenance of a smart distribution grid are complex tasks for municipalities and distribution grid operators. The ability to seamlessly integrate sensors, actuators, communication and IT systems into the existing infrastructure significantly reduces these challenges. Intelligent transformer substations – with switchgear, transformers, protection devices, as well as telecontrol and automation solutions – allow applications for higher reliability of supply.

Intelligent transformer substations as key components of the modern distribution grid

In the future, transformer substations will become a key component in the distribution grid.

Intelligent transformer substations allow for:

- Management of the low-voltage distribution grid with handling of meter data, compensation of reactive power and harmonics, regulation of the distribution transformer, as well as the coordination of supply and load
- Supervision and control of the transformer substation on the medium-voltage side regarding fault location and automatic recovery of supply.
- Provision and transmission of measured values and indications from the medium- and low-voltage system.

A smart grid communicates

Your benefits

- Comprehensive customer-specific communication solution optimized for the conditions on site
- Profit from our outstanding expertise both in the energy and the telecommunication fields

A basic precondition for the operation of smart grids is the monitoring and control of as many grid components as possible. The basis for this is a reliable telecommunication infrastructure.

This telecommunication infrastructure on the medium- and low-voltage level is usually heterogeneous. The most suitable technologies for this are substantially determined by the local structure (big city, rural region, distances), the regulatory marginal conditions (transmission power, availability of frequency bands and associated licenses), as well as the applications used.
They must therefore be adjusted individually to every customer and every case of application.

The following telecommunication technologies can usually be selected:
- Fiber optic or copper cables
- Broadband/high-speed powerline systems
- Private wireless networks (e.g. WiMAX)
- Public wireless networks.

Essential prerequisites for successful operation are both the contractual assurance of a stable communication, also in case of blackouts, and permanently attractive data tariffs for machine-to-machine-connections (M2M).

Siemens offers solutions for all mentioned telecommunication technologies, including especially hardened, standard-compliant routers and switches, in order to enable your grid to communicate intelligently.

SICAM CMIC

Universal automation and remote terminal unit SICAM CMIC

Universal remote terminal unit

SICAM CMIC is a universal automation and remote terminal unit. With a temperature range from –40 °C to +70 °C, a high EMC resistance and the small, compact dimensions, SICAM CMIC can be used in a rough environment also under smallest space conditions. With its technical and mechanical benefits, SICAM CMIC is suitable for electrical distribution substations, gas distribution stations, hydropower plants, pipelines, railway power supplies, object protection, or as an alarm device.

Versatility of SICAM CMIC:

- Nodal functionality for use as subordinate remote terminal unit with serial and Ethernet connection
- Coupling of additional devices over Modbus RTU
- Freely programmable user programs for local control, interlocking or regulation tasks, according to IEC 61131-3
- Remote maintenance, remote diagnostics, and remote parameterizing
- Configuration, diagnostics and test through a web browser, alternatively via SICAM TOOLBOX II.

Intelligence of SICAM CMIC:

If all possibilities offered by SICAM CMIC are retrieved, the unit can be integrated into an intelligent transformer substation in three steps:

1. Supervision/monitoring
2. Telecontrol
3. Automation and load flow control.

SICAM CMIC: Portrait

Communication interfaces and protocols
- Ethernet: IEC 61850, IEC 60870-5-104, DNP(i)
- Serial: IEC 60870-5-101/-103, Modbus RTU

Operation and display
- Display (128 x 96 pixels) incl. operation via 4 function keys
- LEDs for status indications and status of the communication interfaces
- Integrated web server for configuration and diagnostics

Inputs/outputs
- 12 digital inputs (24-60 V DC)
- 8 digital outputs
- Extension modules from the TM series

Auxiliary voltage
- 18-72 V DC

Temperature range
- From –40 °C to +70 °C

Safety
- Security requests from tomorrow (BDEW white paper conformity and integrated crypto chip)

SITOP

Reliable 24 V DC – also in case of power failure
SITOP power supply unit

SITOP: Portrait

- Reliable power supply units for almost all system voltages, ratings and demands on regulated 24 V DC, as well as on other output voltages
- SITOP power supply unit PSU200M 24 V DC/5 A and 10 A with ultra wide-range input 85-264/176-550 V AC and high overload capacity
- Additional modules to increase the availability, e.g. for uninterruptible 24 V DC power supply, for further operation on hour level (UPS1600) or minute level (UPS500)
- DC-UPS SITOP UPS1600 24 V DC/10 A and 20 A with digital inputs/outputs, optionally with USB or two Ethernet/PROFINET interfaces
- Remote monitoring with integrated web server (UPS1600)

A reliable, constant power supply is imperative for safe system operation. Depending on the requirements, the SITOP power supply units can be individually upgraded with extension modules as well as with uninterruptible power supply units.

The SITOP product range offers high-quality power supply units for almost every requirement. The technology product line SITOP modular includes the single-phase power supply units SITOP PSU200M for maximum demands. Thanks to their ultra wide-range input they guarantee constantly regulated 24 V DC even in case of large voltage fluctuations, and are as well suitable for two-phase operation. The power boost delivers up to three times the rated current for a short time in order to switch high loads also without problems.

DC-UPS for 24 volts nonstop

In case of a power failure, guaranteed uninterrupted operation of protection and control units is decisive. The motor operating mechanism of the switch-disconnector or circuit-breaker must also still operate safely in case of a power failure. To ensure this, the SITOP power supply units can be upgraded to an uninterruptible 24 V DC power supply system. Depending on the energy demand, maintenance-free battery modules with lead-gel batteries enable further operation in the range of hours. The intelligent battery management of the DC-UPS module SITOP UPS1600 monitors all relevant operating data.

Extremely communicative

The grid and battery status can even be transmitted to PC or PLC systems via Ethernet/PROFINET. The integrated web server also enables remote diagnostics.

SCALANCE M874 coupled with SICAM CMIC

Mobile communication router SCALANCE M874

The SCALANCE M874 are mobile communication routers for the cost-effective and safe connection of Ethernet-based subnetworks and automation devices via the mobile communication network. SCALANCE M874-3 uses mobile communications of the 3rd generation (UMTS) and supports HSPA+ (High Speed Packet Access). In this way it allows high transmission rates of up to 14.4 Mbit/s downlink, and up to 5.76 Mbit/s uplink (depending on the infrastructure of the mobile communication provider). SCALANCE M874-2 uses the mobile communication network of the 2nd generation (GSM) and supports GPRS (General Packet Radio Service) and EDGE (Enhanced Data Rates for GSM Evolution). Access and communication security is guaranteed by the safety functions of the integrated firewall, and by the VPN tunnel (end-to-end encryption of the communication connection by the establishment of IPsec tunnels).

Applications:

The SCALANCE M874 routers are universally applicable. Due to their design and electrical properties, the routers are especially suitable for industrial applications:

- World-wide flexible system access for maintenance and diagnostics purposes
- Connection of static and mobile participants for control and monitoring of e.g.
  - Sewage and water treatment plants
  - Oil and gas supply
  - District heating networks
  - Power distribution
  - Pumping stations
  - Traffic engineering
- Applicable world-wide* by
  - UMTS (penta-band technology)
  - GSM (quad-band technology).

SCALANCE M874: Portrait

- Robust plastic enclosure
- Automatic dial-up and holding of the IP-based online connection to the Internet
- Integrated IPsec
- VPN tunnel encryption
- Management and configuration via comfortable WBM
- Diagnostics via SNMP
- Comprehensive logging information available via SysLog
- Extended event management via e-mail, SMS and digital input
- Fast mobile diagnostics with smartphone/tablet thanks to WebApp

* Note: Country-specific approvals must be observed!

SICAM FCM

Digital SC indicator with measuring function SICAM FCM feeder condition monitor

SICAM FCM: Portrait

Communication
- Interface RS485 Modbus RTU

Operation and display
- 4 function keys, 3 LEDs and display

Inputs/outputs
- 3 inputs for alternating voltage 100 V/√3 or low-power sensors 3.25 V/√3
- 3 inputs for alternating current low-power sensors 225 mV@300 A
- Alternative current input L2 for low-power sensor 225 mV@60 A for sensitive ground fault detection

Auxiliary voltage
- 24-60 V DC, 230 V AC
- Battery for 2,000 hours, service life approx. 20 years

Temperature range
- From –30 °C to +70 °C

Measurands
- TRMS (True RMS) measured values
- Phase voltage and currents; ground current; power frequency and cosφ; active, reactive and apparent power

On the pulse of your distribution grid

SICAM FCM is a short-circuit and ground fault indicator with direction indication, operating with protection algorithms and the latest low-power sensor technology according to IEC 60044. This provides best results, especially in isolated or compensated distribution grids. For workload monitoring of distribution grid components, SICAM FCM offers comprehensive measured values. The evaluation of this data can be used for a specific network planning regarding grid expansion and the application of investment funds. Through a Modbus RTU interface, SICAM FCM delivers all relevant information, thus allowing to evaluate and display the status of the distribution grid correctly and precisely.

Benefits at a glance:

- The first short-circuit indicator to employ sensors conforming to the standard IEC 60044-7/-8
- High-precision measurement without calibration and adjustment to the primary values
- Usable in all grid types
- Precise and fast fault localization for minimum expenses regarding personnel and traveling costs
- Selective fault information with direction indication as a basis for "self-healing" applications
- Resupply times possible in the range of minutes or seconds (depending on the primary equipment)
- Minimum loss of power grid and end customer revenue
- Reliable measured values for operational management and planning.

Low-power sensors

Intelligent current and voltage sensors

Low-power sensors

Our low-power sensors conform to the standards IEC 60044-7 and -8.
They offer measured values for current and voltage which are e.g. acquired and processed in SICAM FCM. This enables high-precision measurements without calibration or adjustment to the primary values.

Current sensors

The current sensors are inductive current transformers whose secondary winding delivers a voltage signal through a precision shunt. At the rated primary current, this is 225 mV. The current sensors are available in two versions: Divisible cable-type current transformers – used especially for retrofitting existing switchgear, and closed ring cores – mounted on the outside-cone bushing of the 8DJH switchgear in a single- or three-phase version.

In this context, the three-phase version can also be equipped with two phase current sensors and a zero-sequence current sensor for sensitive ground fault detection.

Voltage sensors

The voltage sensors are resistor dividers which provide an output signal of 3.25 V/$\sqrt{3}$ at the rated primary voltage. The voltage sensors are available as cast-resin plugs, which are inserted into the cable T-plugs instead of the blind plugs. Here, the cone conforms to the type C standardized in EN 50180/50181.

Low-power sensors: Portrait

- Current and voltage sensors according to the international instrument transformer standards IEC 60044-7 or -8
- Accuracy class 0.5, 1 or 3
- No calibration or adjustment to the primary values
- Small size for retrofitting and for new systems
- Tested for severe ambient conditions (temperature/condensation/EMC)
- Installation Switchgear minimally interfered with during installation

FITformer® REG

Regulated distribution transformer FITformer® REG

FITformer® REG: Portrait

- Power range up to 630 kVA, max. operating voltage: 36 kV
- Low-voltage load regulation range in three steps
- Operating properties and dimensions correspond to those of common distribution transformers
- Design example 21 kV/420 V

Example for possible load regulation range:

+/- 3.57% @ 400 kVA

+/- 4.34% @ 630 kVA

- Additional setting range on the high-voltage side for optimum operation: +/- 2.5% and +/- 5% (adjustable in de-energized condition)

As one of the main components in distribution stations, transformers fulfill an important task: They are responsible for the final customers being supplied with the correct voltage. Grid operators must therefore guarantee a low voltage supply within the allowed voltage band for every household. However, the rising infeed of renewable energies overstrain many transformer substations. Considerable voltage fluctuations are the consequence and can even lead to an infringement of the permissible voltage band.

Increasing trend towards regulated distribution transformers

In case of non-compliance with the voltage quality criteria due to the decentralized supply from renewable energies, grid operators are forced to a costly expansion of the distribution grid.
In this context, regulated distribution transformers, such as FITformer® REG, represent a cost-efficient alternative.

Their application helps to decouple the medium- and low-voltage grid as regards voltage stability. Thus, ranges of +/- 10% are available in both grids for regulation purposes.

Regulated distribution transformers have established themselves as an integral component of smart grids, as real-time monitoring and control of the low-voltage grid is absolutely necessary for a stable power supply as the proportion of renewable energies increases.

FITformer® REG – the adaptable distribution transformer

The ratio of the regulated distribution transformer FITformer® REG can be changed under load. These adjustments are possible due to the three-step low-voltage load regulation range of the transformer. With this transformer, energy suppliers can guarantee the supply voltage within the tolerance limits, and comply with the standard EN 50160.

SICAM P850/855

Power meter and power quality recorder SICAM P850/855

Device description

The multifunction measuring device SICAM P85x serves for acquisition, visualization, and transmission of measured electrical values such as alternating current, alternating voltage, frequency, power, harmonics, etc. Acquisition and processing of measurands and events are performed according to the power quality standard IEC 61000-4-30.
Through the communication interfaces, the measurands can be transmitted to a PC and to the control and protection system, or shown on a display.
As an all-in-one device, SICAM P855 offers a combined recording and evaluation function in addition to the monitoring function: Measured values can be recorded at programmable time intervals with various recorders, e.g. power quality and fault recorders.
Long-time data and events are evaluated directly in the device according to the power quality standards (e.g. EN 50160), and issued as a report.

Benefits at a glance:

- Universal for single-phase, three- and four-wire grids (with neutral conductor)
- Large current measuring range (up to 10 A max.)
- High accuracy due to small measuring error
- Easy parameterizing by integrated web server
- Safe data storage by battery buffering
- High interference immunity.

SICAM P850/855: Portrait

Communication interfaces and protocols
- Ethernet: MODBUS TCP, IEC 61850 Edition 2
- Serial: Modbus RTU, IEC 60870-5-103

Operation and display
- Full graphic display incl. operation via 4 function keys
- 4 LEDs for status and fault indications
- Integrated web server for interaction with PC via HTML pages

Input measuring circuits
- 4 x alternating voltage, 3 x alternating current up to max. 10 A

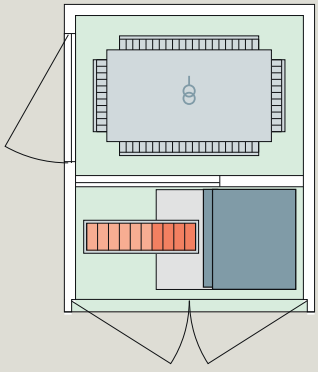
Auxiliary voltage
- 24 - 250 V DC
- 110 - 230 V AC, 50/60 Hz

Housing specification
- Plastic enclosure for top-hat-rail mounting, optionally flush mounting
- Dimensions: 96 x 96 x 100 mm (W / H / D)
- Degree of protection: max. IP51

8DJH switchgear

The 8DJH family for the medium-voltage distribution grid

Space saving: The 8DJH Compact



The illustration shows the space gained for four low-voltage in-line feeders, or an additional medium-voltage cable feeder, by installing 8DJH Compact with a width of 700 mm in comparison with a conventional ring-main unit with a width of 1,050 mm

Medium-voltage switchgear 8DJH and 8DJH 36

The gas-insulated medium-voltage switchgear types 8DJH and 8DJH 36 are the basis for applications in intelligent transformer substations. These modular switchgear assemblies allow the variable arrangement of the functions – both within a panel block and in more complex switchgear layouts. All individual panels and panel blocks can optionally be extended. Thus, almost all scheme arrangements can be implemented with 8DJH switchgear.

The compact 8DJH Compact

8DJH Compact has been especially developed for transformer substations in which space requirements are an important issue. This switchgear provides maximum functionality on minimum space. With its smaller standing surface in comparison to other block-type or extendable switchgear types, 8DJH Compact leaves more space for additional low-voltage feeders, more medium-voltage cable feeders, or intelligent functions. Shorter transformer cables and reduced expenses for laying these cables inside the transformer substation provide further advantages, reducing the investment costs.

8DJH Compact switchgear

8DJH 36 switchgear

Characteristics of the 8DJH family:

Environmentally independent

Hermetically welded switchgear vessels made of stainless steel as well as single-pole solid insulation make the parts under high voltage of 8DJH switchgear

- Insensitive to aggressive ambient conditions, such as:
  - Saline air
  - Air humidity
  - Dust
  - Condensation
- Tight to ingress of foreign objects, such as:
  - Dust, pollution
  - Liquids
  - Small animals
  - Humidity.

Compact

Thanks to the use of SF_6 insulation, compact dimensions are possible. Thus:

- Existing switchgear rooms and sub-station rooms can be used effectively
- New constructions cost little
- Costly city-area space is saved.

Safe for operation and cost-efficient

Switchgear vessels designed as sealed pressure systems, maintenance-free switching devices and enclosed cable plugs ensure:

- Maximum supply reliability
- Personnel safety
- Sealed-for-life design according to IEC 62271-200 (sealed pressure system)
- Installation, operation, extension and replacement without SF_6 gas work
- No maintenance cycles
- Reduced operating costs
- Cost-efficient investment.

8DJH family: Portrait

- Comprehensive supply of gas-insulated switchgear for secondary distribution grids
- High cost-efficiency by climate-independent, durable and maintenance-free switchgear
- High switchgear availability and personal safety
- Minimized space requirements by compact dimensions
- High product quality from Siemens, one of the pioneers of gas-insulated switchgear
- Protection of investment by possible integration in smart distribution grids
- Reliable and competent support on site – from planning to operation

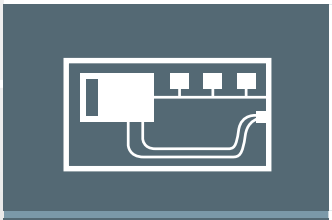
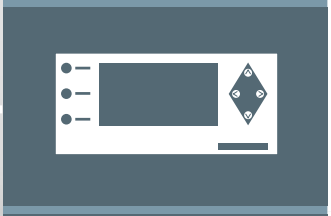
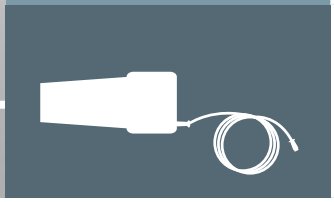
The integration of components into the medium-voltage switchgear

The switchgear of the 8DJH series is optionally equipped with motor operating mechanisms, short-circuit indicators, voltage detecting systems, as well as with further sensors.

RTUs can be optionally integrated inside the switchgear, in additional low-voltage compartments or in a separate wall cubicle via a plug connection. In this way, the switchgear fulfills all preconditions for integration in an intelligent network infrastructure.

Depending on the purpose, different components for monitoring and control are used: These components can also be easily and quickly retrofitted at a later time.

Overview and explanation of the components:

	Component	Function
	**Uninterruptible power supply (UPS)** Depending on the requested bridging time in case of power failures, an uninterruptible power supply based on battery or capacitor modules is used.	The task of the UPS is to continue to ensure the communication and/or the possibility to telecontrol the transformer substation in case of power failure.
	**Remote terminal unit** The remote terminal unit (RTU) is equipped with binary inputs and outputs, various communication interfaces, and freely programmable user programs.	Inside the intelligent transformer substation, the RTU serves as a connecting element to the network control center. It collects all relevant signals and receives control commands, or works autonomously according to predetermined control or regulation algorithms.
	**Communication modem** The selection of the communication modem to be used is determined by the selected or available telecommunication technology.	Communication modems are employed for safe data transmission from the remote terminal unit to the network control center using the selected telecommunication technology.
	**Intelligent SC indicators** Intelligent short-circuit and ground fault indicators with or without direction indication can be used in all grid types. For communication with the RTU, a Modbus RTU interface is available.	Intelligent short-circuit / ground fault direction indicators report short-circuits or ground faults in the medium-voltage distribution grid. Relevant measured values are acquired, allowing for an active load management in the distribution grid.
	**Remotely controllable operating mechanisms** Motor operating mechanisms inside the ring-main unit are available in original equipment manufacturer quality. If required, retrofitting is easily possible.	In order to reduce the reclosing times in case of fault, the switch-disconnectors or circuit-breakers are equipped with motor operating mechanisms for remote control.
	**Current sensors** Current sensors with low-power transformer technology are available as closed or divisible ring cores.	The current signal serves to detect short-circuits and ground faults, and can be used as a measured value for load flow control or for optimal utilization of the grid capacity.
	**Voltage sensors** Voltage sensors as resistor dividers are available as cast-resin plugs for insertion into the cable T-plug.	The voltage signal serves to detect the direction of the short-circuit or ground fault, and can be used as a measured value for load flow control or voltage regulation.

Step by step to more intelligence

- Increase of availability
- Fast fault localization

1. Monitoring

- Remote terminal unit with communication connection
- Short-circuit / ground fault direction indicators
- Current sensors
- Voltage sensors
- Auxiliary switch contacts
- Uninterruptible power supply

+

- Minimization of downtimes (“h“ => “min“)

2. Telecontrol

- Remote terminal unit with communication connection
- Short-circuit / ground fault direction indicators
- Current sensors
- Voltage sensors
- Auxiliary switch contacts
- Uninterruptible power supply

- Motor operating mechanisms of the switch-disconnectors or circuit-breakers

The illustration shows the stepwise expansion levels: Monitoring, telecontrol and load flow control

The 3-level concept
In order to conform to the increased requirements also in the future, three levels of intelligence can be implemented.
In the first level, the focus is on substation monitoring, in order to increase the availability and to allow for a fast fault localization.

The second level contains, besides monitoring, also the possibility to telecontrol the switchgear, thus allowing the minimization of down-times.
In the third level, the effects of decentralized power supplies are managed via automation. Grid losses can thus be notably reduced.

By installation of intelligent control, measurement and regulation systems, conventional transformer substations can be upgraded step by step. In this way they are perfectly prepared for their integration into smart grids. Depending on the desired expansion level, the necessary components must be configured.

- Minimization of losses
- Management of decentralized power supplies

\+ **3. Load flow control** =

The modular concept for the smart grid of the future

- Remote terminal unit with communication connection
- Short-circuit / ground fault direction indicators
- Current sensors
- Voltage sensors
- Auxiliary switch contacts
- Uninterruptible power supply

- Motor operating mechanisms of the switch-disconnectors or circuit-breakers

- Power meter and power quality recorder
- Regulated distribution transformer
- Regulation algorithms, software components for flow control
- Regulation algorithms for the regulated distribution transformer

1. Monitoring

The expansion levels for the modular concept
1st level: Monitoring

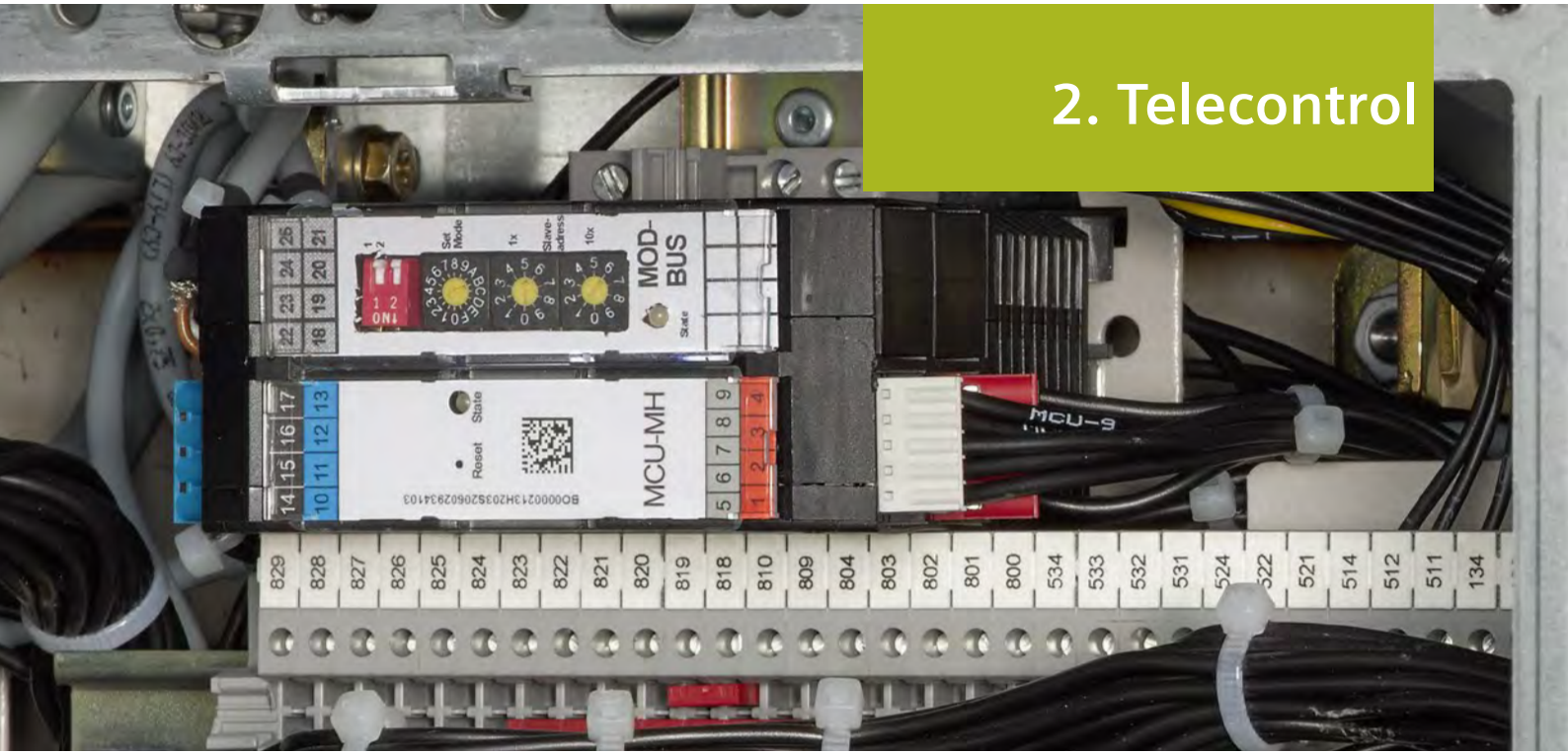
Benefits

- Higher availability
- Faster fault localization
- Object monitoring of the transformer substation
- Current and voltage values from the medium-voltage side

Target:
In the first level, the focus is on transformer substation monitoring, in order to allow for a fast fault localization and to reach a higher availability. However, travel time to the transformer substations is still necessary to eliminate the fault, preventing a substantial reduction of the downtimes.

To do this, the following components are used:

- Remote terminal unit with communication connection
- Short-circuit / ground fault direction indicators
- Current sensors
- Voltage sensors
- Auxiliary switch contacts
- Uninterruptible power supply.



2. Telecontrol

2nd level: Telecontrol

Target:
Today, typical downtimes of transformer substations are in the range of hours, as the maintenance teams must identify the fault location in the affected ring on site, drive to the individual transformer substation, and isolate the fault. The application of short-circuit or ground fault direction indicators only represents an improvement for a fast fault localization.

A further reduction of time is possible today by using remote terminal units, with characteristics especially tailored for this task. Downtimes can thus be reduced from hours to just a few minutes.

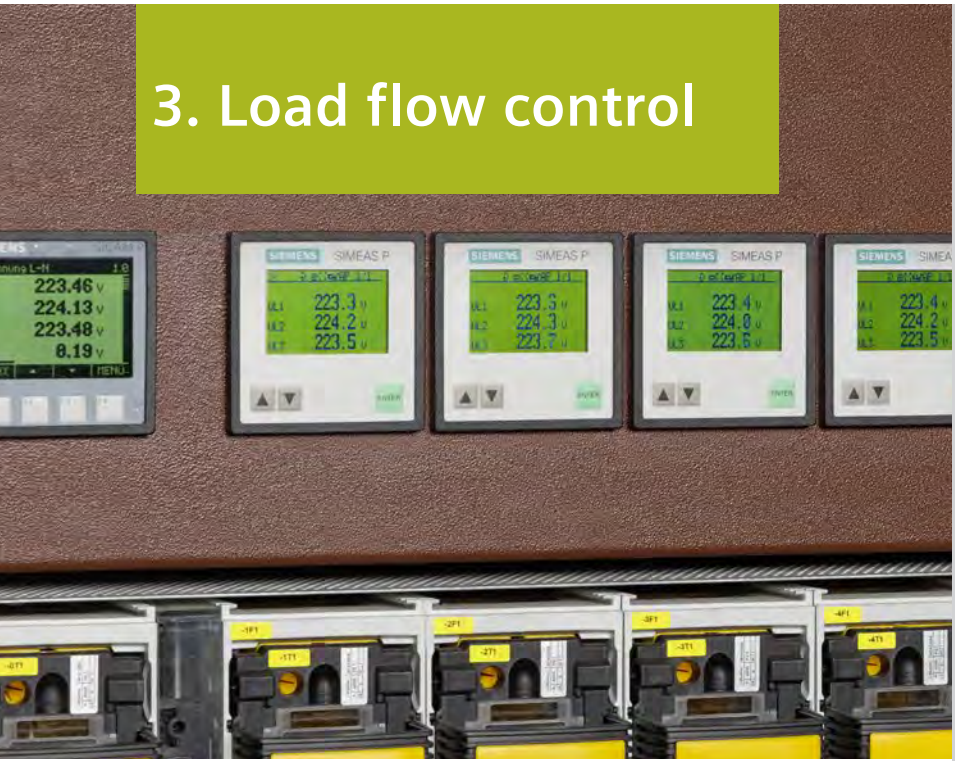
To do this, the following components are used:
- Remote terminal unit with communication connection
- Short-circuit / ground fault direction indicators
- Current sensors
- Voltage sensors
- Auxiliary switch contacts
- Uninterruptible power supply
- Motor operating mechanisms of the switch-disconnectors or circuit-breakers.

Benefits

- Higher availability
- Faster fault localization
- Object monitoring of the transformer substation
- Current and voltage values from the medium-voltage side

- Minimization of downtimes
- Reduction of the reclosing times

3. Load flow control



3rd level: Load flow control

Benefits

- Higher availability
- Faster fault localization
- Object monitoring of the transformer substation
- Current and voltage values from the medium-voltage side

- Minimization of downtimes
- Reduction of the reclosing times

- Minimization of losses
- Management of effects from decentralized power supplies
- Reduction of grid losses
- Regulation of RDT

Target:

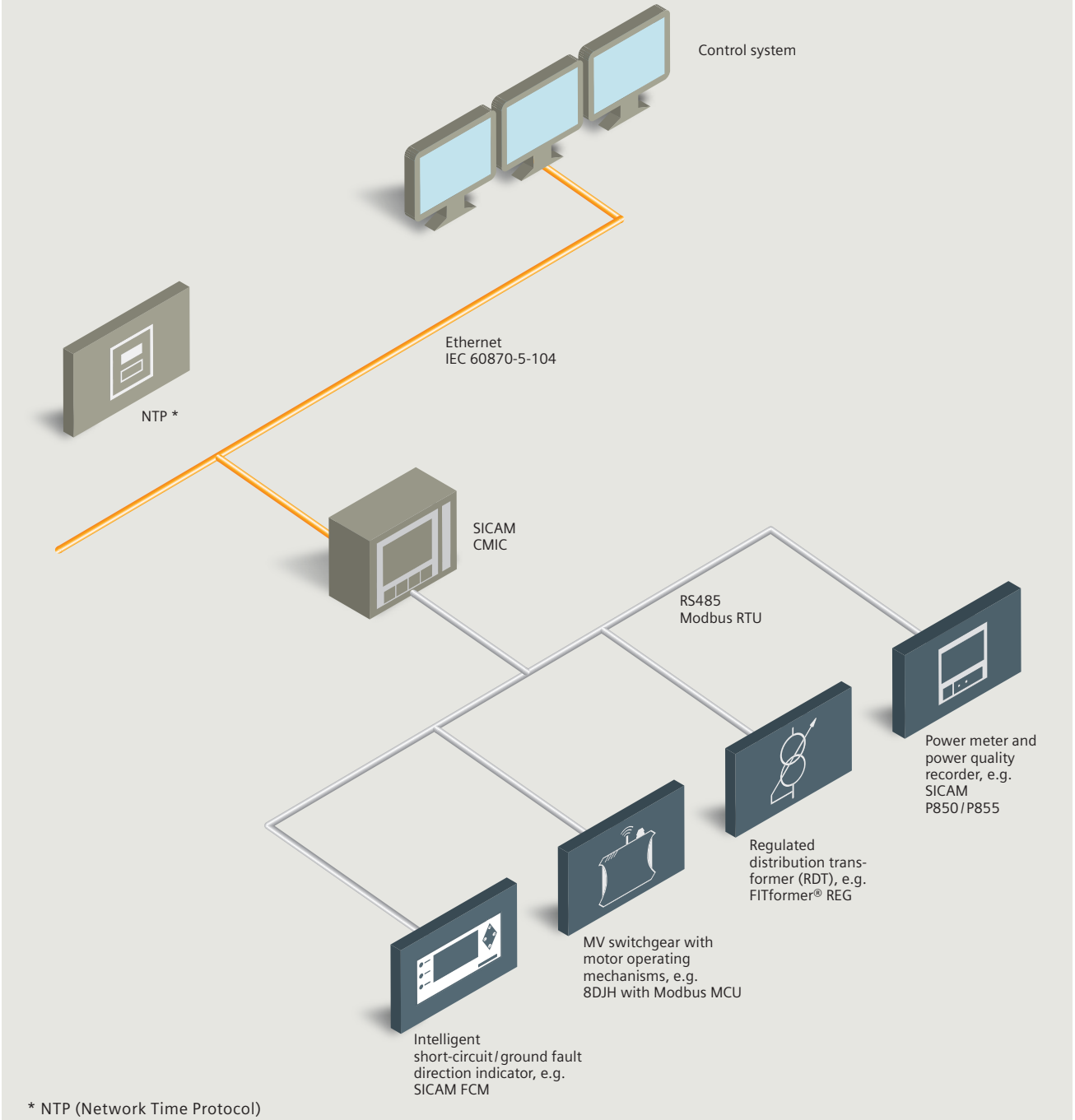
Changing directions of the energy flow as well as load and voltage fluctuations, caused by a continuously rising number of renewable energy producers, make the distribution grids of today go more and more to their limits, and partially also exceed the allowed voltage limits. The aim of the third level is to counteract these effects by means of control and regulation algorithms, to adhere to the allowed limits of the distribution grid again, and to postpone or even avoid an expensive grid expansion.

To do this, the following components are used:

- Remote terminal unit with communication connection
- Short-circuit / ground fault direction indicators
- Current sensors
- Voltage sensors
- Auxiliary switch contacts
- Uninterruptible power supply
- Motor operating mechanisms of the switch-disconnectors or circuit-breakers
- Power meter and power quality recorder
- Regulated distribution transformer
- Regulation algorithms, software components for flow control
- Regulation algorithms for the regulated distribution transformer.

Able to cope with all requirements: The communication for an intelligent secondary distribution

Communication concept: Transformer substation – RTU – network control center including time synchronization



* NTP (Network Time Protocol)

Configuration examples

8DJH

Technical features		
Rated values up to	**17.5 kV, 25 kA, 1 s**	**24 kV, 20 kA, 3 s**
Rated frequency	50/60 Hz	50/60 Hz
Busbar current up to	630 A	630 A
Feeder current up to	630 A	630 A
Busbars	Single busbar	
Insulation	Gas-insulated	
Switchgear vessel	Hermetically enclosed	
Type of switchgear	Factory-assembled, type-tested, metal-enclosed switchgear according to IEC 62271-200, modular and extendable (option), panel blocks consisting of 2, 3 and 4 panels	
Internal arc classification (option)	IAC A FL/FLR 21 kA, 1 s	
Dimensions		
Block width depending on number and type of panels	620 mm to 1720 mm	
Block height	Optionally 1200 mm, 1400 mm or 1700 mm (each without low-voltage compartment)	
Height of LV compartment	Optionally 200 mm, 400 mm, 600 mm, 900 mm	
Block depth tiefe	775 mm, 890 mm (with pressure relief duct at the rear)	

8DJH Compact

Technical features		
Rated values up to	**17.5 kV, 25 kA, 1 s**	**24 kV, 20 kA, 3 s**
Rated frequency	50/60 Hz	50/60 Hz
Busbar current up to	630 A	630 A
Feeder current up to	630 A	630 A
Busbars	Single busbar	
Insulation	Gas-insulated	
Switchgear vessel	Hermetically enclosed	
Type of switchgear	Factory-assembled, type-tested, metal-enclosed switchgear according to IEC 62271-200, panel blocks consisting of 3, 4 and 6 panels	
Internal arc classification (option)	IAC A F/FLR 21 kA, 1 s	
Dimensions		
Block width depending on number and type of panels	620 mm, 700 mm, 930 mm, 1010 mm, 1240 mm, 1400 mm	
Panel height	Optionally 1400 mm or 1700 mm	
Panel depth	775 mm	

8DJH 36

Technical features	
Rated values up to	**36 kV, 20 kA, 3 s**
Rated frequency	50/60 Hz
Busbar current up to	630 A
Feeder current up to	630 A
Busbars	Single busbar
Insulation	Gas-insulated
Switchgear vessel	Hermetically enclosed
Type of switchgear	Factory-assembled, type-tested, metal-enclosed switchgear according to IEC 62271-200, modular and extendable, individual panels and panel blocks
Internal arc classification (option)	IAC A FL/FLR 21 kA, 1 s
Dimensions	
Panel width according to panel type	430 mm, 500 mm
Panel height	1600 mm (without low-voltage compartment)
Panel depth	920 mm

for intelligent transformer substations

1. Monitoring

Configuration

MV switchgear	**Cable feeder**	☐	- Auxiliary switch at the three-position switch
		☐	- Intelligent short-circuit/ground fault direction indicator with associated current and voltage sensors Siemens SICAM FCM
	Transformer feeder with switch-disconnector/ fuse combination	☐	- Auxiliary switch at the three-position switch
		☐	- Signaling switch "HV HRC fuse tripped"
	Transformer feeder with circuit-breaker	☐	- Auxiliary switch at the circuit-breaker
		☐	- Auxiliary switch at the three-position switch
		☐	- Definite-time overcurrent protection Siemens SIPROTEC
	Remote terminal unit	☐	- Remote terminal unit as compact unit Siemens SICAM CMIC
		☐	- Remote terminal unit with extension modules for binary inputs/outputs Siemens SICAM CMIC, optionally SICAM EMIC
	Communication modem	☐	- Mobile communication (GPRS, UMTS), e.g. Siemens SCALANCE M
		☐	- WiMax, e.g. RUGGEDCOM WIN
		☐	- Broadband/high-speed powerline, e.g. MV200
		☐	- Fiber optic, e.g. Siemens SCALANCE X
		☐	- xDSL (ADSL, SHDSL), e.g. Siemens SCALANCE M
	Uninterruptible power supply	☐	- Siemens SITOP power supply units
		☐	- Siemens DC-UPS SITOP UPS1600 with battery modules
		☐	- Siemens DC-UPS SITOP UPS500S with capacitors

2. Telecontrol

Configuration

MV switchgear	**Cable feeder**	☐
		☐
	Transformer feeder with switch-disconnector/ fuse combination	☐
		☐
	Transformer feeder with circuit-breaker	☐
		☐
		☐
	Remote terminal unit	☐
		☐
	Communication modem	☐
		☐
		☐
		☐
		☐
	Uninterruptible power supply	☐
		☐
		☐
	Cable feeder	☐
		☐
		☐

3. Load flow control

Configuration

- Auxiliary switch at the three-position switch	MV switchgear	**Cable feeder**	- Auxiliary switch at the three-position switch
- Intelligent short-circuit/ground fault direction indicator with associated current and voltage sensors Siemens SICAM FCM			- Intelligent short-circuit/ground fault direction indicator with associated current and voltage sensors Siemens SICAM FCM
- Auxiliary switch at the three-position switch		**Transformer feeder with switch-disconnector/ fuse combination**	- Auxiliary switch at the three-position switch
- Signaling switch "HV HRC fuse tripped"			- Signaling switch "HV HRC fuse tripped"
- Auxiliary switch at the circuit-breaker		**Transformer feeder with circuit-breaker**	- Auxiliary switch at the circuit-breaker
- Auxiliary switch at the three-position switch			- Auxiliary switch at the three-position switch
- Definite-time overcurrent protection Siemens SIPROTEC			- Definite-time overcurrent protection Siemens SIPROTEC
- Remote terminal unit as compact unit Siemens SICAM CMIC - Remote terminal unit with extension modules for binary inputs/outputs Siemens SICAM CMIC, optionally SICAM EMIC		**Remote terminal unit**	- Remote terminal unit as compact unit Siemens SICAM CMIC - Remote terminal unit with extension modules for binary inputs/outputs Siemens SICAM CMIC, optionally SICAM EMIC
- Mobile communication (GPRS, UMTS), e.g. Siemens SCALANCE M - WiMax, e.g. RUGGEDCOM WIN - Broadband/high-speed powerline, e.g. MV200 - Fiber optic, e.g. Siemens SCALANCE X - xDSL (ADSL, SHDSL), e.g. Siemens SCALANCE M		**Communication modem**	- Mobile communication (GPRS, UMTS), e.g. Siemens SCALANCE M - WiMax, e.g. RUGGEDCOM WIN - Broadband/high-speed powerline, e.g. MV200 - Fiber optic, e.g. Siemens SCALANCE X - xDSL (ADSL, SHDSL), e.g. Siemens SCALANCE M
- Siemens SITOP power supply units		**Uninterruptible power supply**	- Siemens SITOP power supply units
- Siemens DC-UPS SITOP UPS1600 with battery modules - Siemens DC-UPS SITOP UPS500S with capacitors			- Siemens DC-UPS SITOP UPS1600 with battery modules - Siemens DC-UPS SITOP UPS500S with capacitors
- Motor control unit for easy activation of the "disconnecting" function of the three-position switch, Siemens MCU RI - Motor control unit for two-pole switching of the "disconnecting" function of the three-position switch and/or switching of the "earthing" function, Siemens MCU-MH - Motor control unit for activation of the three-position switch via Modbus-RTU, Siemens MCU-MH-MOD		**Cable feeder**	- Motor control unit for easy activation of the "disconnecting" function of the three-position switch, Siemens MCU RI - Motor control unit for two-pole switching of the "disconnecting" function of the three-position switch and/or switching of the "earthing" function, Siemens MCU-MH - Motor control unit for activation of the three-position switch via Modbus-RTU, Siemens MCU-MH-MOD
		Power meter and power quality recorder	- Multifunctional measuring device for acquisition of power quality measurands in the low-voltage distribution grid, together with the associated current transformers, SICAM P850/855
		Regulated distribution transformer	- Regulated distribution transformer according to the existing high and low voltage or power, Siemens FITformer® REG
		Regulation algorithms and software components	- Control and regulation software

Intelligent transformer substation version with the RTU in the low-voltage compartment of the switchgear

The solution

In order to install the RTU in a space-saving way inside the existing substation building without having to change to a bigger substation type, there is the following possibility:
The 8DJH is planned with a switchgear height of 1200 mm instead of the normal 1400 mm, and the RTU is integrated in the 200 mm high low-voltage compartments mounted on the top. In this way, the overall switchgear height of 1400 mm remains.

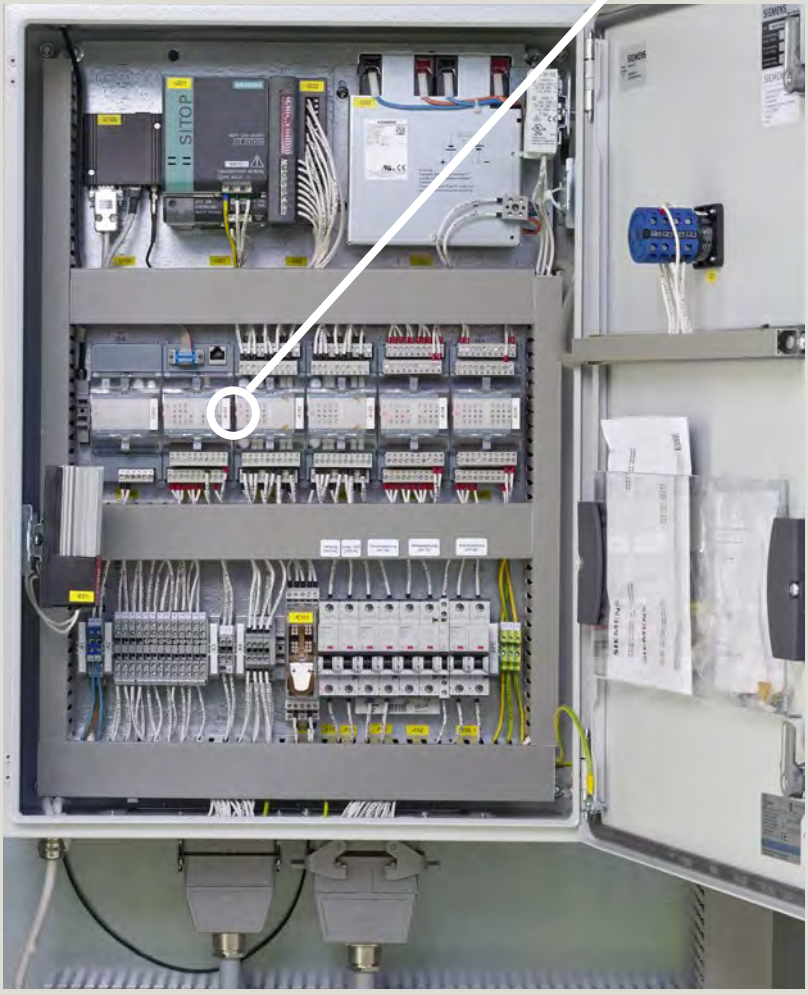
SICAM EMIC installed in the low-voltage compartment on top of the 8DJH switchgear

Intelligent transformer substation version with the RTU in a separate RTU cubicle

The solution

For retrofitting or to clearly divide competencies between the grid operation and the telecontrol departments, the version with the RTU in a separate RTU cubicle is particularly suitable. For this purpose, the RTU cubicle is placed in a separate telecontrol area of the transformer substation, and connected to the medium-voltage switchgear via a plug-in connection. This solution also allows an easy replacement of the whole RTU cubicle at the end of the service life.

SICAM MIC installed in a separate RTU cubicle inside the transformer substation



Intelligent transformer substation version with the RTU integrated in the switchgear

The solution

In order to design intelligent transformer substations in an especially compact and space-saving way, the version with the RTU integrated in the front operating mechanism of the 8DJH is particularly suitable.

SICAM CMIC integrated in the front operating mechanism of the transformer feeder of the 8DJH

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