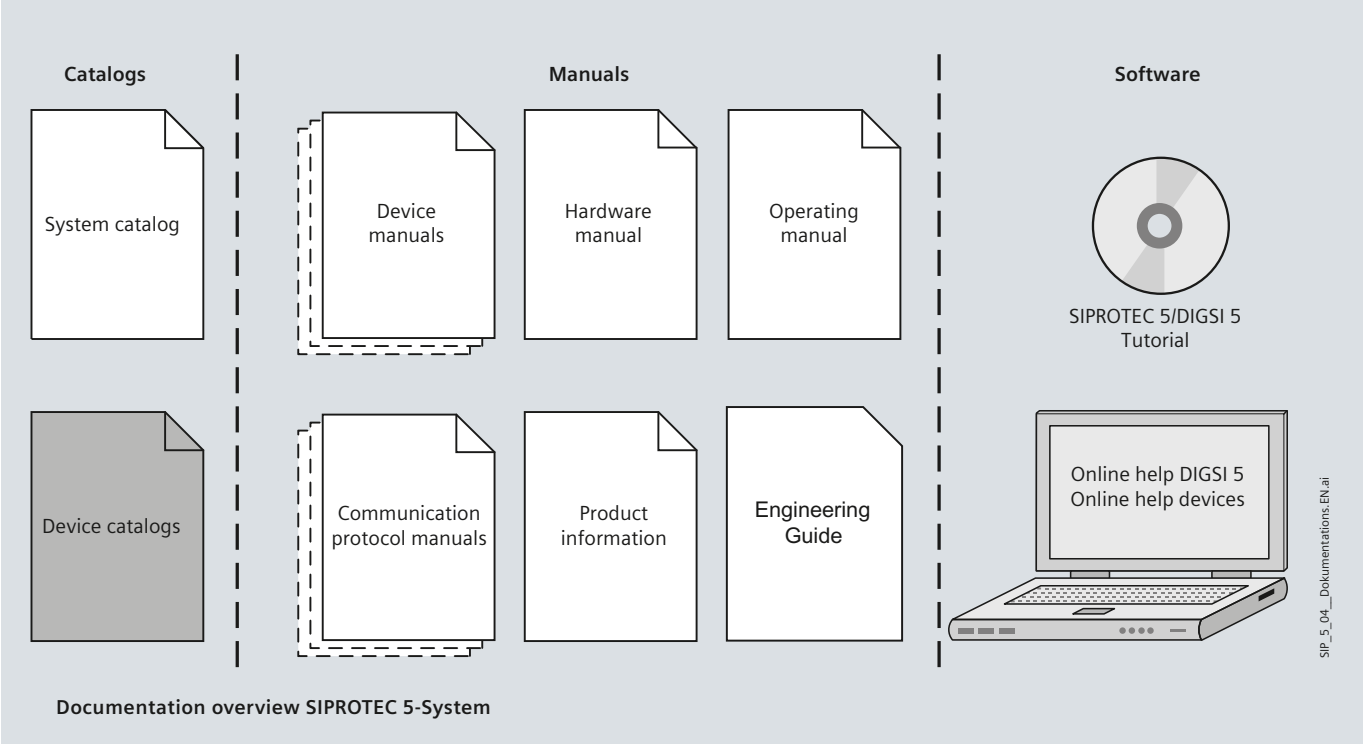
SIEMENS

Protection

SIPROTEC 5 – Digital Fault Recorder 7KE85

Catalog SIPROTEC 5.07 · Edition 1

Answers for infrastructure and cities.



Documentation overview SIPROTEC 5-System

System catalog

The system catalog describes the SIPROTEC 5 system features.

Device catalogs

The device catalogs describe device-specific features such as functional scope, hardware and applications.

Device manuals

The device manuals describe the functions and applications of a specific SIPROTEC 5 device.

Hardware manual

The hardware manual describes the hardware components and device combinations of the SIPROTEC 5 device family.

Operating manual

The operating manual describes the basic principles and procedures for operating and assembling the devices of the SIPROTEC 5 device family.

Communication protocol manuals

The communication protocol manuals include a description of specific protocols for communication within the SIPROTEC 5 device family and to higher-level control centers.

Product information

The product information includes general information about device installation, technical data, limiting values for input and output modules, and conditions when preparing for operation. This document is delivered with each SIPROTEC 5 device.

Engineering Guide

The Engineering Guide describes the important steps for Engineering with DIGSI 5. The Engineering Guide offers information on how to load a configuration to a SIPROTEC 5 device and how to update the device functionality of a SIPROTEC 5 device.

DIGSI 5 online help

The DIGSI 5 online help contains a help package for DIGSI 5. The help package for DIGSI 5 includes a description of the basic operation of software, the DIGSI principles and editors.

Online help devices

The online help for devices has the same information structure as the device manual.

SIPROTEC 5 / DIGSI 5 Tutorial

The tutorial on the DVD contains brief information about important product features, more detailed information about the individual technical areas, as well as operating sequences with tasks based on practical operation and a brief explanation.

Contents

SIPROTEC 5 –

Digital Fault Recorder

Energy Automation

Catalog SIPROTEC 5.07 · Edition 1

www.siemens.com/siprotec

ISO 9001
ISO 14001
DNV
Certified Company

OHSAS 18001
DNV
Certified Company

The products and systems described in this catalog are manufactured and sold according to a certified management system (acc.to ISO 9001, ISO 14001 and BS OHSAS 18001).

Editorial

SIPROTEC has been a recognized brand leader in digital protection and field devices on the energy market for decades. The Siemens high-performance SIPROTEC devices cover the entire power spectrum and can be implemented in a wide range of fields – from power generation to very high voltage transmission and distribution network applications.

"Smart automation for transmission grids" is the Siemens response to the present and future challenges to achieve a reliable and efficient energy supply. SIPROTEC 5 is an active component of the energy-efficient smart grid and an important building block in the complex distributed energy supply systems and networks solutions.

The next generation of SIPROTEC devices, SIPROTEC 5, is based on the proven features of SIPROTEC 4 to provide you with a new, modern platform including both hardware and software. This platform offers an excellent solution to the challenges associated with evolving grid structures and workflows. The quality, reliability and proven functions of the former system have been preserved. Innovative approaches including holistic workflow, safety and security, and network stability monitoring (PMU functionality) have been added.

The pioneering system architecture places you in full control of switchgear communications. A powerful, reliable communication infrastructure, combined with the flexible engineering capabilities serves as the basis for monitoring and controlling of distributed, decentralized systems. Seamless communications is the central component of the SIPROTEC 5 system architecture to provide flexibility, safety and security in the automated distributed network solutions.

With SIPROTEC 5, you are at the beginning of a new generation of intelligent, digital multifunction field devices. The new operating tool DIGSI 5 offers individual support for you – handles your specific workflow requirements, from system design to device selection and testing, covering the entire device lifecycle. The new tool offers cost savings over the entire lifecycle without compromising safety and system availability.

With the new SIPROTEC 5 generation, you are well equipped to meet the growing economic and reliability demands imposed on your networks. The philosophy of SIPROTEC 5 is reflected in the modularity and flexibility of its hardware and software components. Perfectly tailored fit – the custom fit for your switchgear and specifications for the application and standardization of energy automation.

Ingo Erkens

General Manager
Infrastructure and Cities Sector
Smart Grid Division
Energy Automation

SIPROTEC 5-Digital Fault Recorder 7KE85

SIPROTEC 5 fault recorders are part of the modular system of SIPROTEC 5. They support all SIPROTEC 5 system features and can be used individually as well as universally in the framework of system solutions. This catalog describes specific features of the SIPROTEC 5 motor protection devices.

The description of the SIPROTEC 5 system features is found in the system catalog. The following properties of SIPROTEC 5 are introduced there in detail:

- The SIPROTEC 5 system
- Areas of use
- Hardware
- Engineering
- Communication
- IEC 61850 – Simply usable
- Test and diagnostics
- Safety concept
- DIGSI 5.

The system catalog can be ordered free of charge from your Siemens contact partner under the order number E50001-K4605-A011-A1.

SIPROTEC 5 system catalog
Order No. E50001-K4605-A011-A1-7600

The 7KE85 fault recorder is designed to suit present and future requirements in a changing energy sector. Powerful and reliable monitoring combined with flexible engineering and communication features provide the basis for maximum supply reliability.

Commissioning and maintenance work can be completed safely, quickly and thus cost-effectively with high-performance test functions. Due to a modular design, the SIPROTEC 5 fault recorder can always be flexibly adapted to specific requirements.

Features

The digital fault recorder SIPROTEC 5 7KE85 can be configured with different basic features.

Basic features	
Digital fault recording	Comprehensive flexible event-triggered and continuous recording options
PMU	Synchrophasor measurement (PMU) according to C37.118 (2011)
Power Quality-Recorder	Continuous measurement of events and disturbances in electricity supply systems according to IEC 61000 (class S)

Table 1 Overview of different basic features

Function library and application templates

A common function library provides all protection, automation, monitoring and additional functions for the SIPROTEC 5 devices. These functions are truly the same for all devices. Once established, configurations can be transferred from device to device. This results in substantially reduced engineering effort.

The table on page 8 list the available function from the library. Predefined templates are available in DIGSI for the standard applications. These templates already contain basic configurations, required functions and default settings.

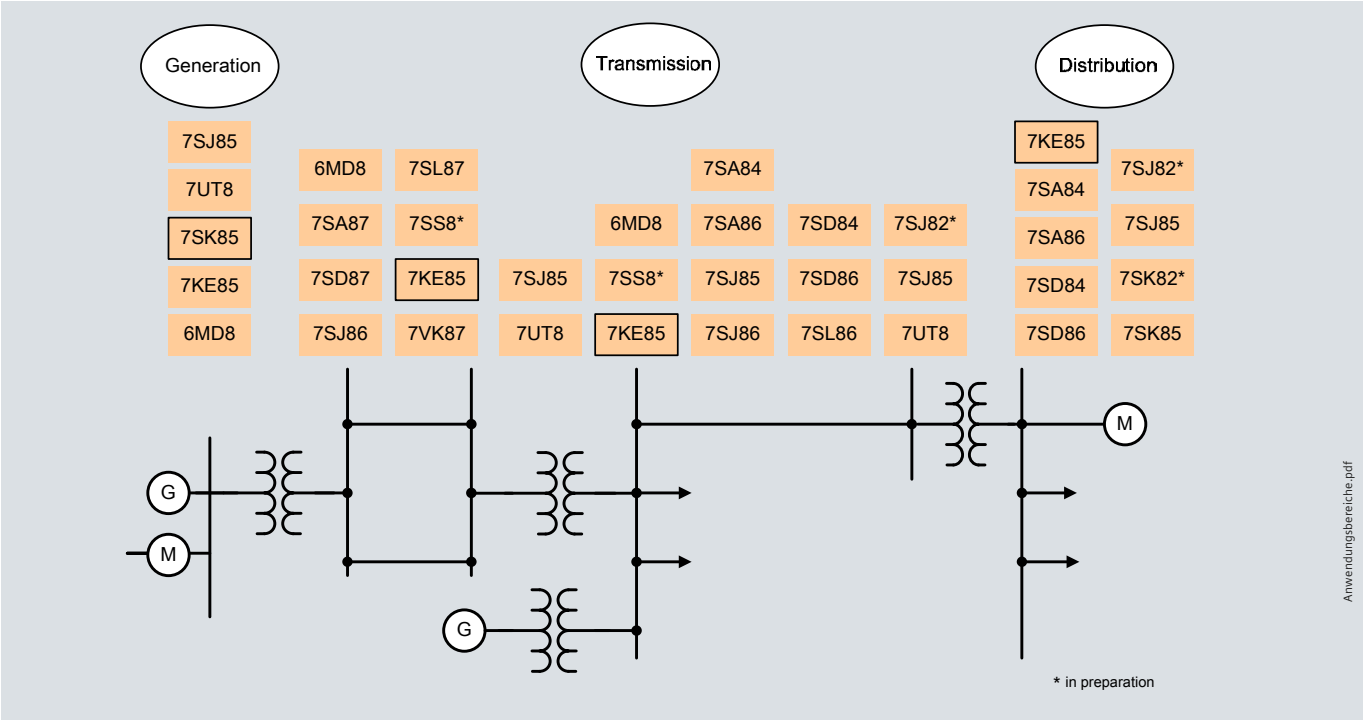


Fig. 1 Application of SIPROTEC 5 devices

Properties – 7KE85

Short description	Powerful digital fault recorder with integrated detection of synchrophasors (PMU) according to IEEE C37.118 and power quality measurement* according to IEC 61000 (class S). Due to the high flexibility of trigger functions, the 7KE85 is ideally suited to monitor the entire energy value chain from generation to distribution. The powerful automation and flexible configuration with DIGSI 5 complements the range of functions.
Inputs and Outputs Hardware flexibility	Predefined standard variants** with up to 16 current- and 16 voltage transformers, 35 binary inputs, 27 binary outputs or flexibly adjusted and expandable I/O quantity structure within the scope of the SIPROTEC 5 modular system
Width of housing	1/3 × 19" to 1/1 x 19"

- Digital fault recorder for medium-voltage systems, high-voltage systems and extra-high voltage systems and power plants
- Fast scan recorder
- Up to 2 slow scan recorders
- Up to 5 continuous recorders
- Power quality recorder* according to IEC 61000 (class S)
- Sequence of event recorder* for continuous recording of binary status changes
- Applicable as Phasor Measurement Unit (PMU) according to IEEE C37.118 standard
- Transmission of records and triggering via IEC 61850
- Variable sampling frequencies parameterizable from 1 kHz to 16 kHz
- The user can allocate the 16-gigabyte internal ring buffer to the various recorders.
- Intelligent monitoring routines of the storage medium ensure a high security of the archived data.
- Loss-free data compression
- Time synchronization via IRIG-B, DCF77 and SNTP
- Free routing of measured values to the individual recorders
- Free combination of the measuring groups for power calculation
- Quality bits for representing the current channel quality
- The trigger functions of a function block are the value of the fundamental component, RMS value, zero-sequence/positive-sequence/negative-sequence system, frequency, ∑ active power/ ∑ reactive power / ∑ apparent power
- Level trigger and gradient trigger for each trigger function
- Flexible cross and network trigger
- Creating trigger functions using the graphic automation editor CFC (Continuous Function Chart)
- Trigger functions by combining single-point/double-point indications, analog values, binary signals, Boolean signals and GOOSE messages
- Consistent monitoring concept
- Auxiliary functions for simple tests and commissioning

Fig. 2 Digital Fault Recorder 7KE85 (1/3 device with 1/6 expansion module and LED operation panel)

- Special test mode for commissioning
- Up to 4 pluggable communication modules can be used for different and redundant protocols.
- Intelligent terminal technology enables pre-wiring and easy device exchange.

Applications

Digital fault recording for medium-voltage to extra-high voltage systems with comprehensive trigger and recording functions

The 7KE85 fault recorder provides a clearly structured and event-related evaluation and documentation of your power system processes. It enables you to analyze disturbances and to optimize your power system.

The following processes usually have to be monitored and documented:

- Power system incidents such as critical load cases or short-circuits
- Disturbances of the supply quality
- Dynamic behavior of generators
- Starting and switch-off processes of transformers (saturation behavior)
- Power quality to EN 50160 such as harmonics, voltage dips, voltage peaks, flickers according
- Power fluctuations and power swing processes
- Test runs during commissioning

The device supports all SIPROTEC 5 system characteristics. It enables future-oriented system solutions with high investment security and low operating costs.

* in preparation

** extensions in preparation

Digital Fault Recorder 7KE85

Functions and Application templates

Functions

Table 2 shows all functions which are available in 7KE85. All functions can be freely configured with DIGSI 5 as a matter of principle. You need the appropriate number of free function points within the device for some of the functions. The function point calculator in the online configurator provides support in determining the required number of function points for your device.

Application templates

Templates are available in DIGSI for the standard applications. They comprise basic configurations and default settings.

Table 2 shows the functional scope for the described application templates.

The following application templates are available:

Digital fault recorder 4 V/4 I/11BI

- Application template referring to the monitoring of a total of 8 current or voltage transformers.

Digital fault recoder 8 V/8 I/19 BI

- Application template referring to the monitoring of a total of 16 current or voltage transformers.

ANSI	Function	Abbrev.	available in 7KE85	Digital fault recorder 4V/4I/11BI	Digital fault recorder 8V/8I/19BI
FL	Hardware quantity structure expandable	I/O	■	■	■
PMU	Synchrophasor measurement	PMU	■		
	Operational measured values, standard		■	■	■
	Measured values, extended: Min, Max, Avg		■	■	■
	CFC standard		■	■	■
	CFC arithmetic		■		
	Monitoring and supervision		■	■	■
FSR	Fast-scan recorder	FSR	■	■	■
SSR	Slow-scan recorder	SSR	■	■[1)]	■[1)]
CR	Continuous recorder	CR	■	■[2)]	■[2)]
PQR	Power quality recorder (class)*	PQR	■		
SOER	Sequence-of-events recorder*	SOER	■		
ExTrFct	Extended trigger functions	ExTrFct	■	■	■
	IRIG-B		■	■	■
	DCF77		■	■	■
	SNTP (Simple network time protocol)		■	■	■
	Minute - pulse		■	■	■
	1 s pulse (PPS)		■	■	■
	Function-points class:			0	0

The configuration and function points for your application can be ascertained in the SIPROTEC 5 order configurator: www.siemens.com/protection

* in preparation

[1)] Maximum 1 additional slow-scan recorder possible

[2)] Maximum 4 additional continuous recorder possible

Table 2 7KE85 Functions, applikation templates

Application examples:
Fault Recorder for feeder monitoring

Figure 3 and Figure 4 show simple application examples with one 7KE85 connected to monitor feeders. The different triggers are provided via the function group "FG UI_3phases" and are available to the function group "FG Recorder" and thus also to the event-triggered recorders. At the same time, CFC enables user-defined trigger functions (combination of GOOSE messages, single-point/double-point indications, binary signals...) to start a recorder and thereby generate a fault record.

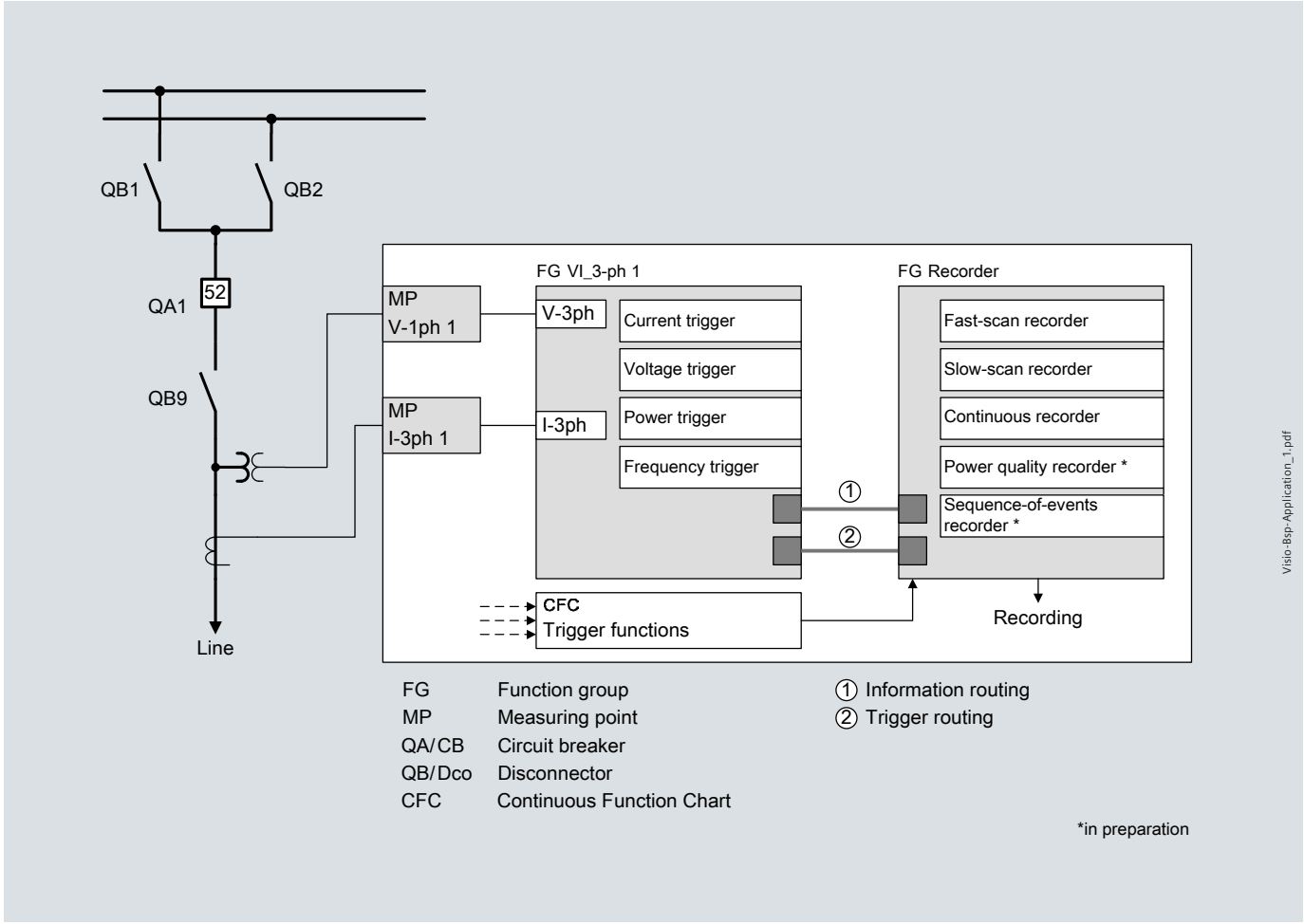


Fig. 3 Application example: Digital Fault Recorder 7KE85 for feeder monitoring

Application examples

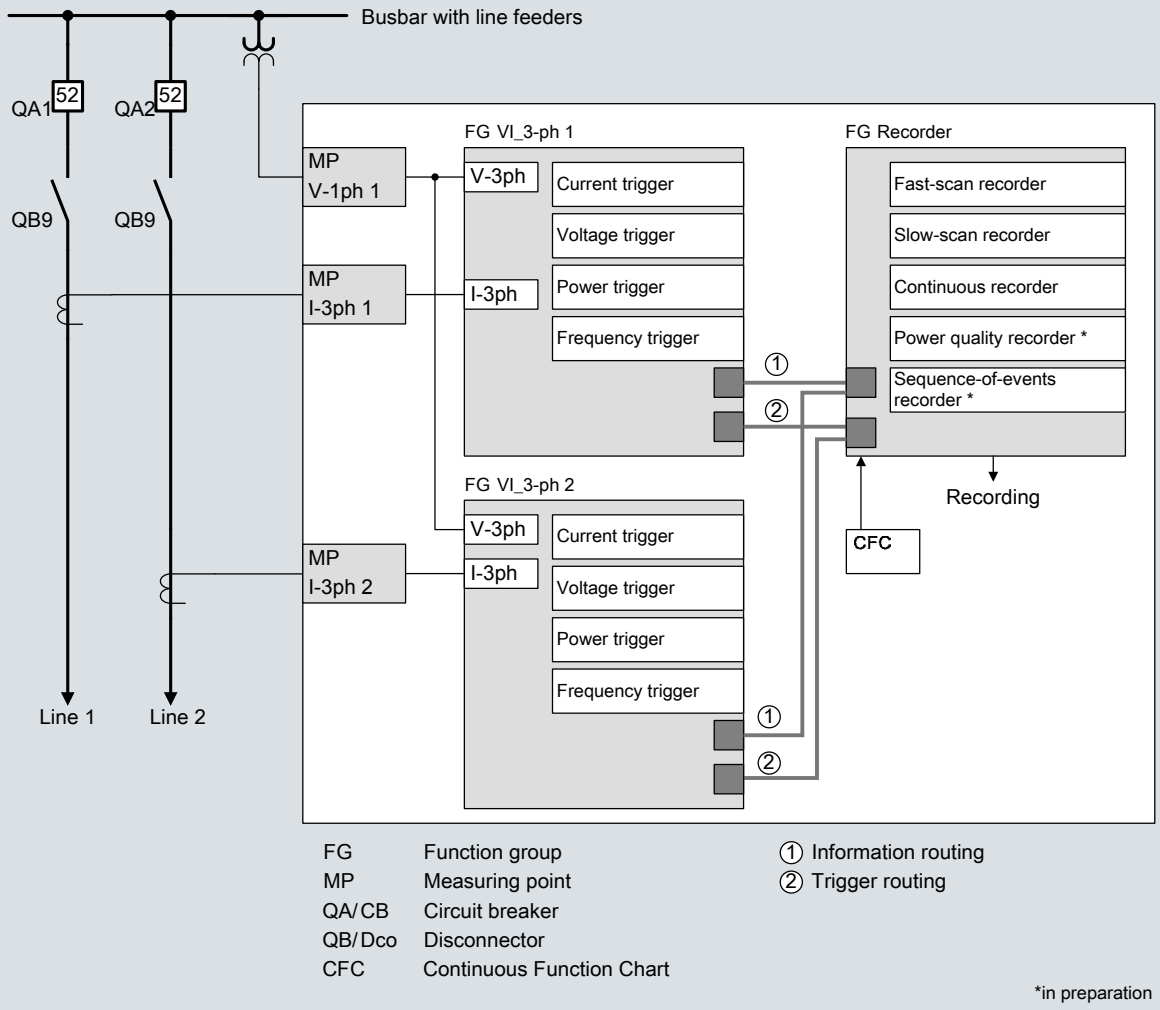


Fig. 4 Application example: Digital Fault Recorder 7KE85 for monitoring of two feeders

Application example: Phasor Measurement Unit

The "Phasor Measurement Unit" (PMU) function can be operated simultaneously in the 7KE85 digital fault recorder.

Figure 5 shows the principle. PMUs measure current and voltage by amount and phase at selected stations of the transmission system. The high-precision time synchronization (via GPS) allows comparing measured values from different substations far apart and drawing conclusions as to the system state and dynamic events such as power swing conditions.

When selecting the option "Phasor Measurement Unit", the devices determine current and voltage phasors, provide them with highly accurate time stamps and transmit them for analysis together with other measured values (frequency, speed of frequency change) using the IEEE C37.118 communication protocol, see Figure 6.

Using synchrophasors and a suitable analysis program (for example SIGUARD PDP) it is possible to automatically detect power swings and trigger alarms, which are sent to the control center, for example.

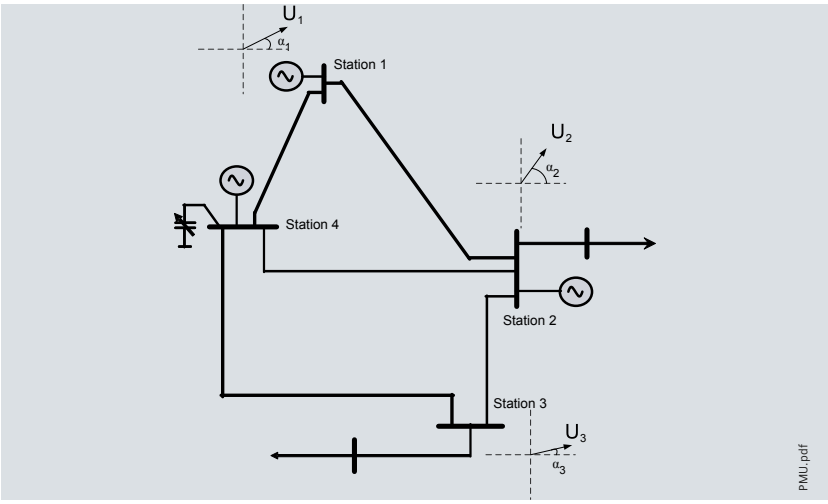


Fig. 5 Principle of distributed phasor measurement

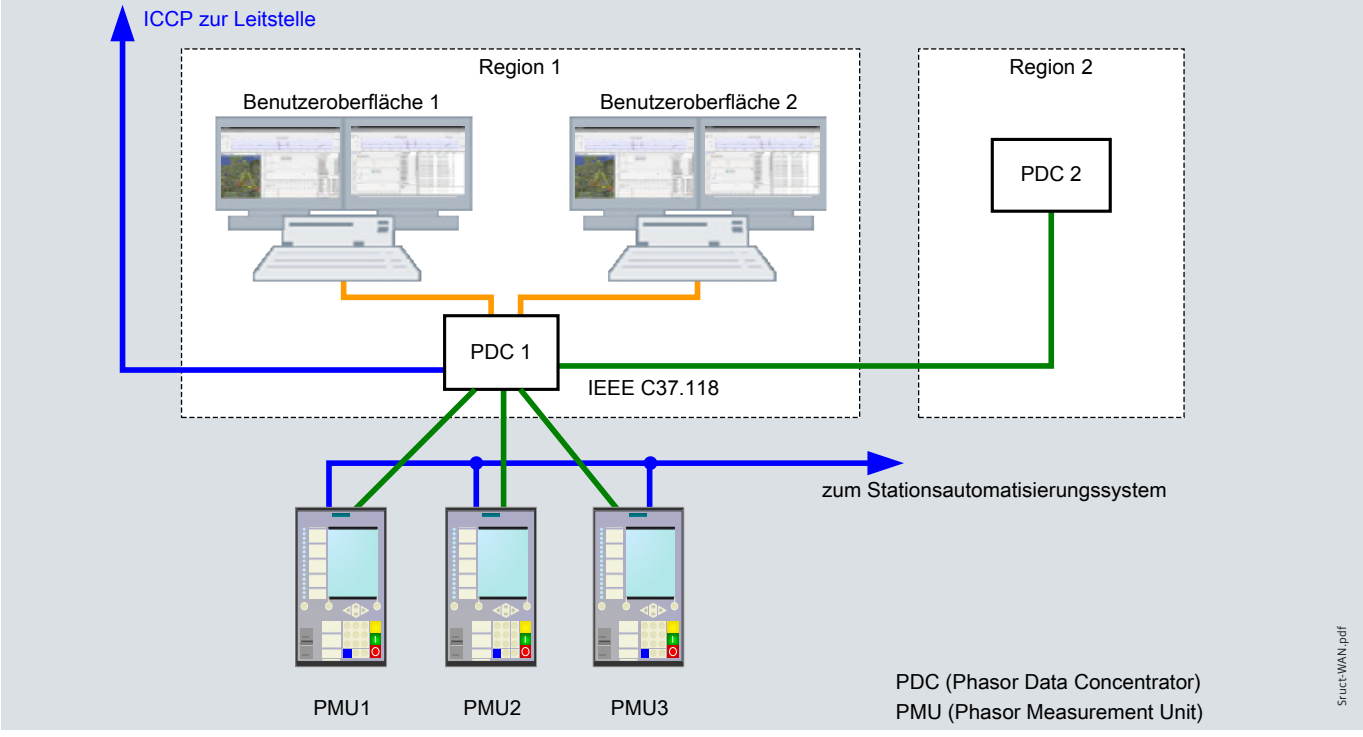


Fig. 6 Connection of 3 Phasor Mesurement Units with two Phasor Data Concentrators (PDCs) SIGUARD PDP

Application examples

Application example: Fault recorder with PMU

When using the PMU function, a function group "FG PMU" is created in the device, see Figure 7. This function group calculates the phasors and analog values, conducts the time stamping and sends the data to the selected Ethernet interface using the IEEE C37.118 protocol. There, the data can be received, stored and processed by one or more clients. Up to three client IP addresses can be assigned in the device.

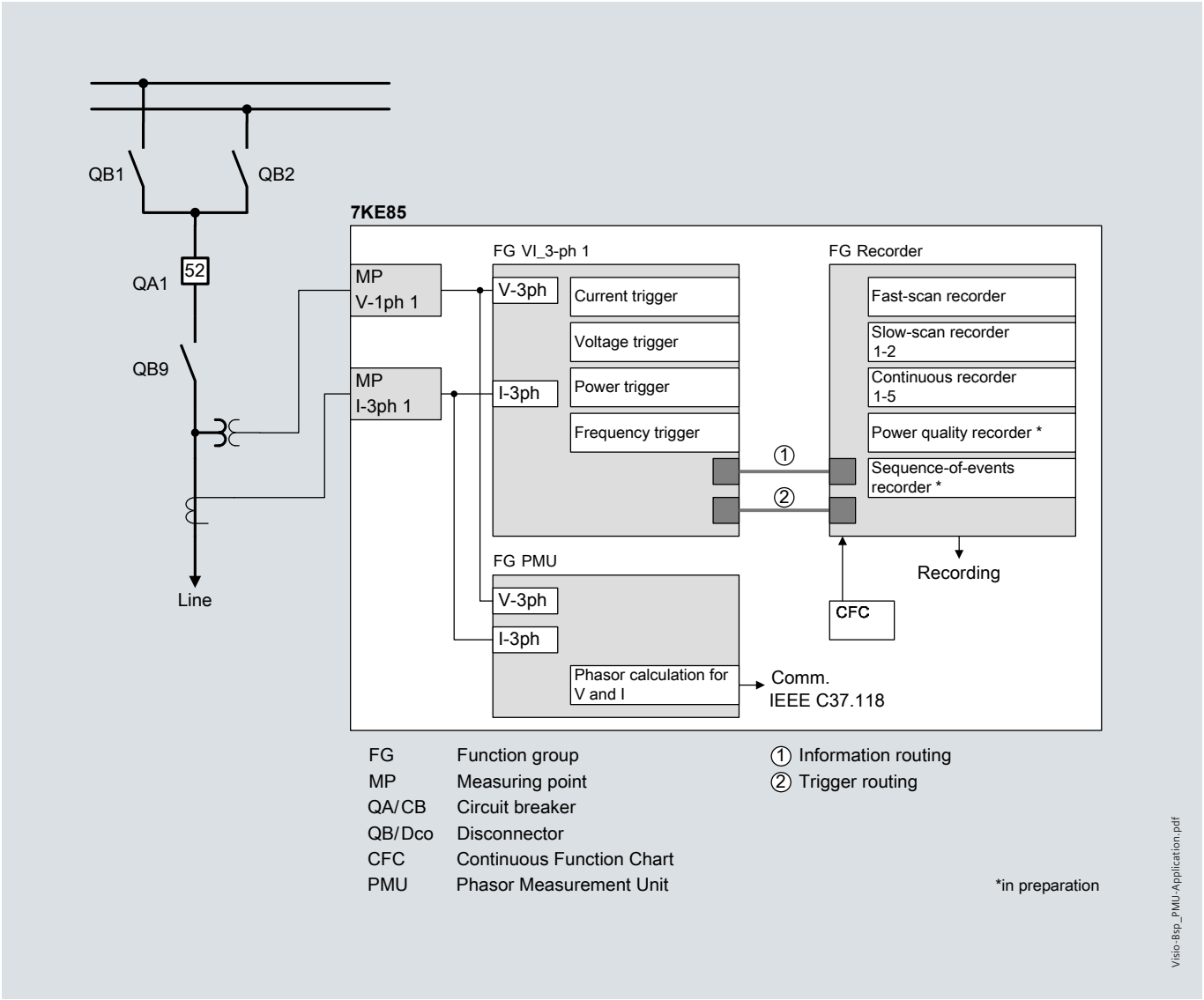


Fig. 7 Application example: Double busbar with 7KE85 used as fault recorder and Phasor Measurement Unit (PMU)

Funktionale Integration

Due to the modular design of its hardware and software and the powerful engineering tool DIGSI 5, SIPROTEC 5 is ideally suited for protection, automation, measurement and monitoring tasks in the electrical power systems.

The devices are not only pure protection and control equipment, their performance enables them to assure functional integration of desired depth and scope. For example, they can also serve to perform monitoring, phasor measurement, powerful fault recording, a wide range of measurement functions and much more, concurrently, and they have been designed to facilitate future functionality expansion. SIPROTEC 5 provides extensive and precise data acquisition and bay level recording for these functions.

By combining device functionality with communication flexibility SIPROTEC 5 has the ability to meet a wide range of today's applications as well as the functional expansion capability to adapt changing needs in the future. With SIPROTEC 5 you can improve the safety and reliability of your application. Fig. 8 shows the possible functional expansion of a SIPROTEC 5 device.

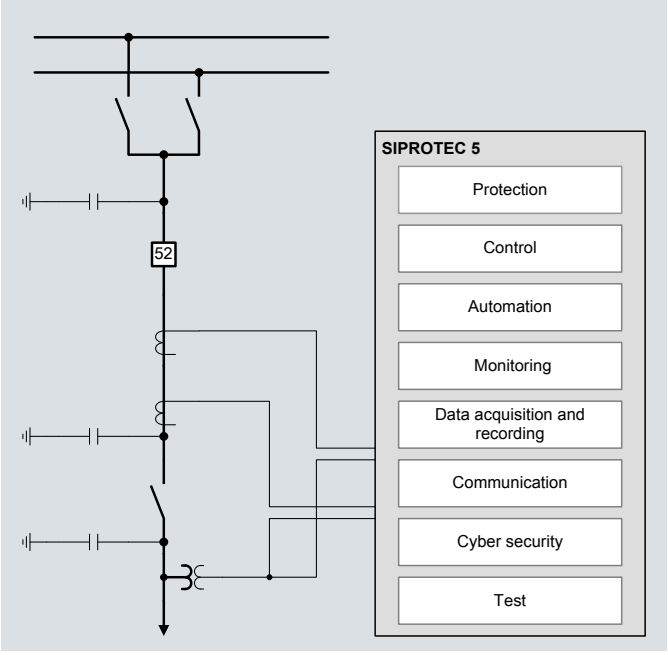


Fig. 8 SIPROTEC 5 – Functional integration

Automation

The integrated graphical automation editor CFC (Continuous Function Chart) enables you to create logic diagrams clearly and simply. DIGSI 5 supports this with powerful logic modules on the basis of the IEC 61131-3 standard. The 7KE85 comes with a powerful basic automation package. It enables specific functions for automating triggers to be implemented conveniently and efficiently.

For the realization of your solutions, the following different configurations of CFCs are available:

- Basic function chart (CFC)
- Arithmetic function chart (CFC)

With the basic function chart (CFC) package you can graphically link all internal digital information, such as internal protection signals or operating states directly to the logic modules and process them in real time. The arithmetic function chart (CFC) package enables you additionally to link measured values or to monitor thresholds.

The following information can be processed with CFC, for example, and used as triggers:

- Single- and double-point indication
- Analog values
- Binary signals
- GOOSE indications
- Interlocking checks
- Switching sequences (switching sequence function chart (CFC))
- Message derivations of switching actions
- Messages or alarms by linking available information Control & automation
- Load shedding a feeder (arithmetic function chart (CFC) and switching sequence function chart (CFC))
- Management of decentralized energy feeds
- System transfer depending on the grid status
- Automatic grid separations in the event of grid stability problems.

Of course, SIPROTEC 5 provides a substation automation system such as SICAM PAS/PQS with all necessary information, thus ensuring consistent, integrated and effi cient solutions for further automation.

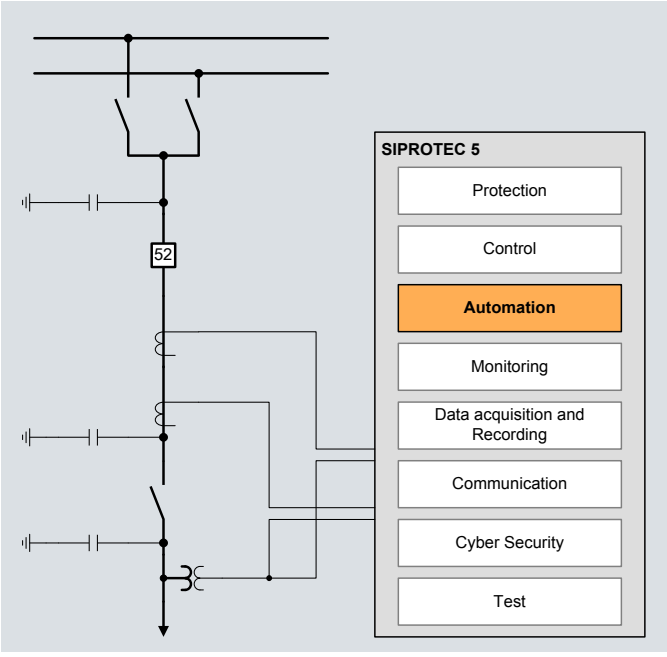


Fig. 9 SIPROTEC 5 – Functional integration

Monitoring

Monitoring

SIPROTEC 5 devices can take on a wide variety of monitoring tasks. These are divided into four groups:

- Self-monitoring
- Monitoring of grid stability
- Monitoring of power quality
- Monitoring of equipment (condition monitoring).

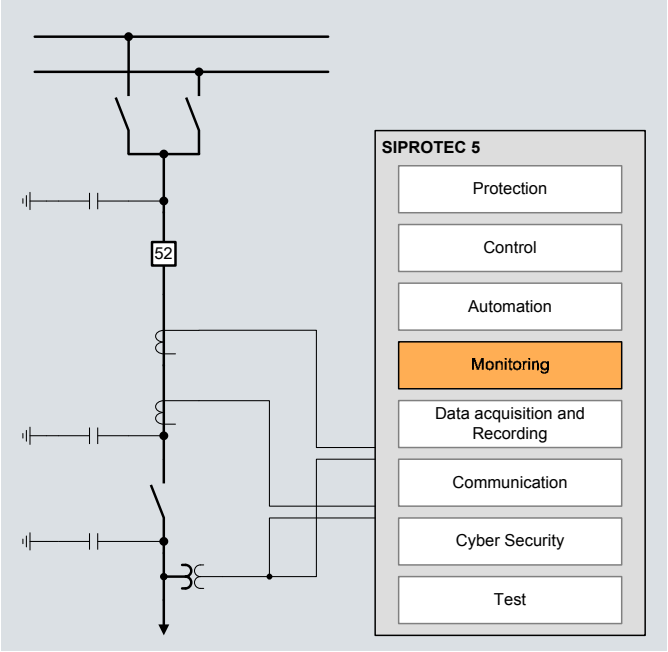


Fig. 10 SIPROTEC 5 – Functional integration

Self-monitoring

SIPROTEC 5 devices are equipped with many monitoring procedures. These procedures detect internal and external faults, store them in buffers for recording and reporting. This stored information is used to help determine the cause of the device fault in order to take appropriate corrective actions. One example is the monitoring of the additional internal mass storage by the digital fault recorder. It continuously monitors the storage and ensures data security and informs the user in time if problems occur.

Grid stability

Grid Monitoring combines all of the monitoring systems that are necessary to assure grid stability during normal grid operation. SIPROTEC 5 provides all necessary functionalities, e.g., fault recorders, continuous recorders, fault locators and Phasor Measurement Units (PMUs) for grid monitoring. The SIGUARD PDP Wide Area Monitoring System is available for analyzing and displaying the synchrophasor measurement units. The grid monitoring functionality of SIPROTEC 5 devices allows them to be programmed to monitor grid limit violations (e.g., Dynamic Stability Assessment via load angle control) and actively trigger the appropriate responses. This data in the grid control systems can also be used as input variables for online load flow calculation and enable significantly faster response if statuses in the grid change.

Power quality

Besides availability, the end consumers demand that the electrical energy they receive is also of high quality. The increasing use of power electronic components can have detrimental effects on power quality. Poor power quality can cause interruptions, production outages, and high follow-up costs. Accordingly, it is essential to capture and evaluate the grid variables reliably according to generally valid quality criteria as defined in the standard EN 50160. For this, SIPROTEC 5 provides corresponding power quality recorders. These can be used to detect weak points early so that appropriate corrective measures can be taken. The large volume of data is archived centrally and analyzed neatly with the SICAM PQS system.

Equipment

The monitoring of equipment (condition monitoring) is an important tool in asset management and operational support-from which both the environment and the company can benefit. Equipment that typically requires monitoring includes for example: circuit breakers, transformers and gas compartments in gas-insulated switchgear (GIS).

The measuring-transducer inputs (analog inputs) (0 mA to 20 mA) enable connection to various sensors and monitoring of non-electrical variables, such as for example gas pressure, gas density and temperature. Thus, SIPROTEC 5 enables a wide range of monitoring tasks to be carried out.

SIPROTEC 5 provides the process interfaces, buffers, recorders and automation functions necessary for monitoring the system:

- Process values are stored together with a time stamp in the operational log
- The circuit-breaker statistics provide essential data for condition based maintenance
- Process variables (e.g., pressure, SF6 loss, speed, temperature etc.) are monitored to ensure they remain within the limits via measurement transducers connected to the sensors.

Data acquisition and recording

The recorded and logged fi eld data is comprehensive. It represents the image and history of the bay. It is also used by the functions in the SIPROTEC 5 device for monitoring, inter-bay and substation automation tasks. It therefore provides the basis for these functions now and in the future.

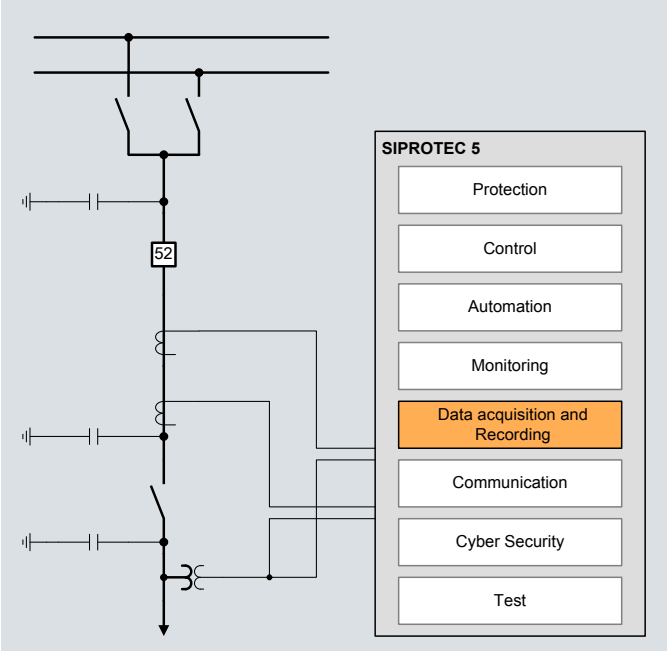


Fig. 11 SIPROTEC 5 – Functional integration

Measurement

A large number of measured values is derived from the input variables and presents a current image of the process. Depending on the device design, the following base measured-values are available:

- Operational measured values
- Fundamental phasor and symmetrical components
- Protection-specifi c measured values, e.g., differential and restraint current for differential protection
- Mean values
- Minimum values and maximum values
- Energy measured values
- Statistical values
- Limiting values.

Besides the base measured values, phasor-measured units (PMUs) can also be activated in the devices.

The analog inputs of the SIPROTEC 5 devices can be selected with a corresponding accuracy class and dynamic range suitable for connection to both protection and measurement cores. The innovative current terminal technology enables the secondary rated current to be changed via setting. The current transformer input can also be changed on site if for example a measurement instead of protection class CT input is required (exchange of CT terminal module).

The following precisions are typical:

Processing via the protection-input transformer

- V, I ≤ Cl. 0,5 (0.5 % accuracy)
- P, Q ≤ Cl. 1 (1 % accuracy)

Processing via the measuring-input transformer:

- V, I ≤ Cl. 0.2 (0.2 % accuracy)
- P, Q ≤ Cl. 0.5 (0.5 % accuracy)

Separate measuring transducers (analog inputs) are therefore unnecessary. The highly precise measured data enables extended energy management and makes commissioning much easier.
SIPROTEC 5 thus provides the following measured values for analysis and further processing:

- The base measured values with high dynamic range and high accuracy (protection-class current transformer)
- The base measured values with very high accuracy (instrument transformer)
- Phasor measurement with highly precise time stamping for subsequent task such as grid stability monitoring.

Recorder

In SIPROTEC 5, recorders can acquire comprehensive data. They feature a large number of analog and binary inputs, and a high sampling frequency. An extremely wide range of records can be implemented, either continuously or as determined by various trigger criteria.

Various recordings can be implemented either continuously or by applying different trigger criteria.

Besides storing the data on internal bulk storage units, SIPROTEC 5 devices can also transfer the data to central analysis systems like SICAM PQS. Consequently, you are able to monitor networks with regard to typical characteristics.

The digital fault recorder 7KE85 has the following additional functionality compared to SIPROTEC 5 protection devices and bay controllers:

- Sampling configurable from 1 to 16 kHz
- 16-gigabyte ring buffer
- All recorders can run simultaneously
- Recorders triggered individually
- Continuous recorders
- Separate activation of the recorders
- Freely configurable storage allocation
- Additional quality information complements the records

Description of the Device Functions

Data acquisition and Recording

Fast scan recorder

The fast scan recorder allows analyzing transient processes, for example, high-frequency disturbances in the electricity supply system caused by switching operations, short-circuits or ground faults and also the behavior of protection devices. The fast scan recorder is capable of recording the development of the sampled values of all analog inputs, of internally calculated measured values and binary signals during a fault for a period of 90 seconds with a pre-trigger time of 1 second. The sampling rate can be set between 20 and 320 sampled values per period. This corresponds to a sampling frequency of 1 kHz to up to 16 kHz.

Binary changes are detected with a resolution of 1 ms. The input signals are analyzed according to the specified trigger conditions and recorded if the limit values are violated. This fault record contains the pre-trigger time, the trigger instant and the fault recording. Additionally, the trigger cause is stored. The trigger limit values and recording times can be determined easily using DIGSI 5.

Slow scan recorder

The functioning is similar to the fast scan recorder. However, the difference is that the values are calculated every 10 ms and are averaged over a configurable interval. The averaging interval can be configured from 1 to up to 3000 rated periods. The slow scan recorder stores the averaged values as recording in the mass storage. Analogous to the fast scan recorder, binary changes are detected with a resolution 1 ms.Slow scan recorders are therefore ideally suited to detect, for example, the load conditions before, during and after a disturbance and along with that the power swing processes of electrical parameters such as fluctuations of active and reactive power.

The slow scan recorder is capable of recording the development of the sampled values of all analog inputs, of internally calculated measured values and binary signals during a fault for a period of 90 minutes with a pre-trigger time of 90 seconds. Here, too, the input signals are analyzed according to the specified trigger conditions and recorded if the limit values are violated. These recorded fault records contain the pre-trigger time, the trigger instant and the fault recording. Additionally, the trigger cause is stored. For this purpose, the user specifies trigger limit values and recording times in DIGSI 5. Additionally, it is possible to create up to 2 independent instances of the slow scan recorder.

Continuous recorder

The 7KE85 features up to 5 continuous recorders used for data acquisition of the analog quantities and internally calculated measured values over longer periods of time. This enables performing an accurate long-term analysis of the power system behavior. An average is formed and stored in the storage for each quantity recorded by the continuous recorder over settable period of time. Each continuous recorder can be activated separately and is organized as ring buffer with parameterizable quantities.

Trigger functions

The event-triggered recorders (fast scan recorder and slow scan recorder) contain a variety of analog and binary triggers which enable the user to determine the specific power system problem and avoid unnecessary recordings. The input signals are sampled according to the trigger conditions and start the fault recording. In the 7KE85 all triggers can also be assigned multiple times to the different recorders.

Analog triggers

The analog triggers can basically be divided into level triggers and gradient triggers. Level triggers monitor whether measured values stay inside the parameterized limit values (min/max). The trigger is initiated once the measured value violates the corresponding limit value.Gradient triggers respond to the level change per time.

Each analog trigger can be parameterized as primary, secondary or percentage value.
There are frequency triggers, voltage triggers, current triggers, and power triggers. If the trigger quantity is current and voltage, the fundamental component, RMS and symmetrical components are available for selection.

Binary triggers

A binary trigger starts a recording due to the logical status change of a binary signal.
Besides manual triggers initiated via the device keypad, DIGSI 5 or any IEC 61850 client (for example SICAM PAS/PQS), there are also external triggers, network triggers and logical triggers. The external trigger is enabled by the status change at each binary input of the 7KE85. The network trigger, which responds to information from other devices in the IEC 61850 network, is activated by GOOSE messages. The logical triggers are implemented via the powerful graphical logic editor (CFC). All available analog values (absolute values or phases), binary signals, boolean signals, GOOSE messages, single-point indications and double-point indications can be freely combined here using boolean or arithmetic operaions. You as the user can thus define the trigger conditions suitable for your problem and start recording.

	Common Data Class (IEC 61850)	pre-trigger time (max.)	seal-in time (max.)	sampling/resolution	averaging time
Fast scan recorder	SMV/MV	3 s	90 s	1 kHz to 16 kHz	-
	SPS	3 s	90 s	1 ms	-
Slow scan recorder	MV	90 s	5400 s	MVs all 10 ms	1 - 3000 periods
	SPS	90 s	5400 s	1 ms	-
Continuous recorder	MV	-	-	MVs all 10 ms	1 s to 900 s
SMV= Sample Measured Values / SPS= Single Point Status / MV= Measured Values					

Table 4 Recorder

Phasor Measurement Unit (PMU)

Phasor Measurement Units make a valuable contribution to dynamic monitoring of transient processes in energy supply systems. Contrary to the RMS values, phasor measurements are transmitted as continuous data stream with adjustable reporting rate. Additionally, current and voltage are measured and transmitted with their phase angles. Due to the high-precision time synchronization (via GPS), the measured values of different, widely separated substations can be compared, and it is possible to draw conclusions about the system condition and dynamic events such as power swings from the phase angles and dynamic curves.

Via an own Ethernet module, the PMU function transmits its data by means of the standardized protocol IEEE C37.118. The analysis can be carried out with a Wide Area Monitoring System, for example SIGUARD PDP, see Fig. 12

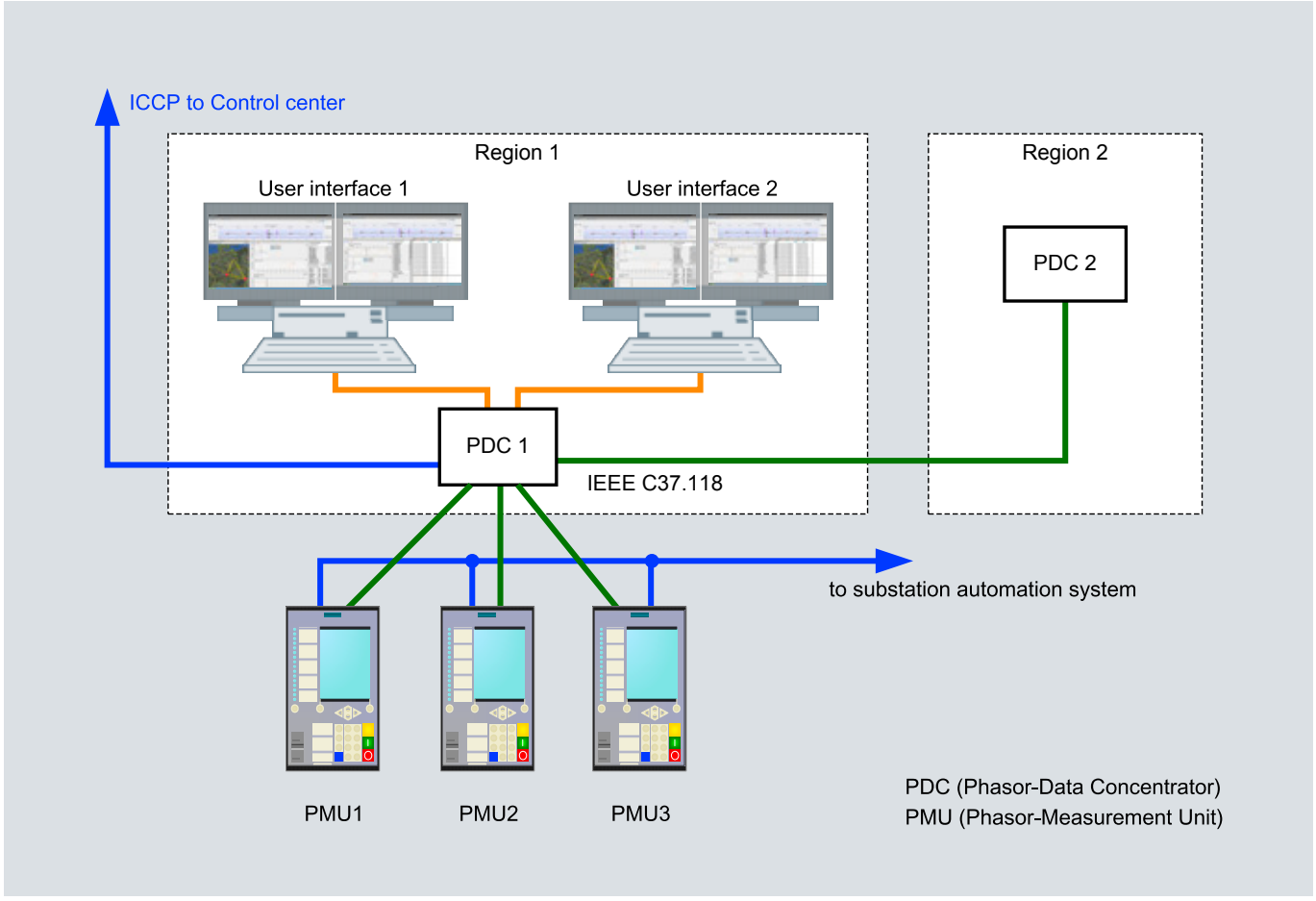


Fig. 12 SIPROTEC 5 devices used as Phasor Measurement Units at a SIGUARD PDP analysis system

Time synchronization

High-precision time synchronization of all devices is necessary to allow the recordings of digital fault recorders at different locations to be compared with each other. Hence, the time synchronization of 7KE85 is an important property and must be performed with high accuracy. Especially the use of the Phasor Measurement Unit (PMU) requires precise time stamping.
Time synchronization of 7KE85 is implemented by either:

- DCF77 signal
- IRIG-B
- SNTP
- Minute pulse
- Second pulse

The recommended GPS time signal receiver (7XV5664-1) from Meinberg (illustration) synchronizes the internal time of all connected protection devices. The internal clock of the protection devices are updated using the respective telegram (IRIG-B, DCF77). Optical fiber can also be used to transmit time signals (telegrams or pulses) without interference even over larger distances and in electromagnetically polluted environments.

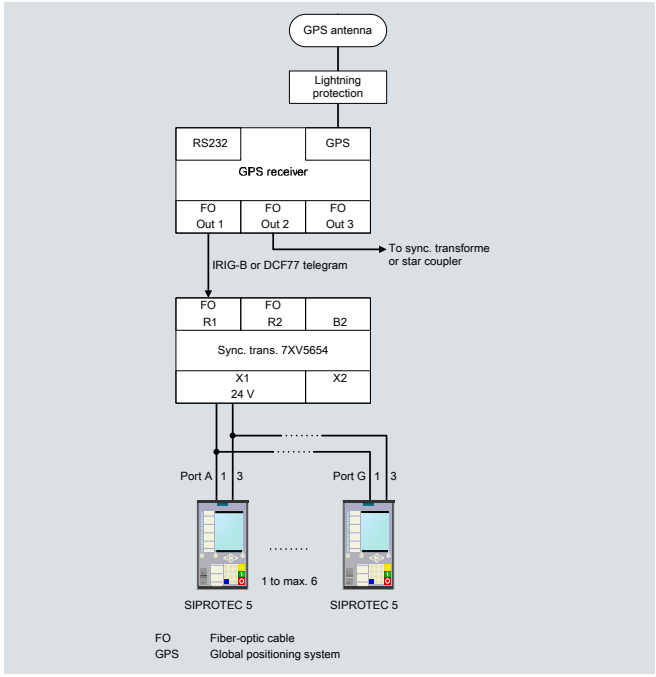


Fig. 13 SIPROTEC 5 device with IRIG-B or DCF77 time synchronization

Event-log buffer

Event-log buffers mark important events with a time stamp (accurate to 1 ms) for subsequent analysis.

The long recording length is achieved with large event-log buffers and separate buffers for different event categories. The events to be logged are freely configurable and for improved manageability.

Configuration of user-specific event-log buffers for cyclical or event-driven recording is also supported.

Convenient and thorough analysis

Event-log buffers of different categories enable easier, targeted analysis. Changes to parameters and configuration data are recorded.

Ease of maintenance

Hardware and software are constantly monitored and irregularities are detected immediately. In this way, extremely high levels of security, reliability and availability are achieved at the same time. Important information about essential maintenance activities (e.g., battery supervision), hardware defects detected by internal monitoring or compatibility problems are recorded separately in the diagnostic buffer.

All entries include specific instructions for taking action. Table 3 provides an overview of typical operational logs.

Operational log	2000 indications	Cyclical recording of operational indications (e.g., control processes)
Fault log	1000 indications per fault	Event-controlled recording of faults. Maximum of 128 faults can be stored. Maximum of 1000 indications per fault can be recorded
User-specific log	200 indications	Option of cyclical or event-drive recording of user-defined signals
Ground-fault log	100 indications per ground-fault	Event-controlled recording of ground-faults. Maximum of 10 ground faults can be stored. Maximum of 100 indications per ground-fault can be recorded
Logs of parameter setting history (cannot be erased)	200 indications	Recording of all parameter changes and configuration downloads
Communication buffer	500 indications	Recording of status of all configured communication connections, such as e.g., faults that arise, testing and diagnostic operation and communication loads
Security log (cannot be erased)	500 indications	Recording of successful and unsuccessful access attempts to areas of the device with restricted access rights
Diagnostic buffer	500 indications	Recording and display of concrete instructions for action in case of necessary maintenance (e.g., battery monitoring), detected hardware defects or compatibility problems

Table 3 Overview of typical operational logs

Communication

SIPROTEC 5 devices are equipped with high-performance communication interfaces.

These are integrated interfaces or interfaces that are extendable with plug-in modules to provide a high level of security and flexibility. There are various communication modules available. At the same time, the module is independent of the protocol used. This can be loaded according to the application. Particular importance was given to the realization of full communication redundancy:

- Multiple redundant communication interfaces
- Redundant, independent protocols to control center possible (e.g., IEC 60870-5-103 and IEC 61850 or double IEC 60870-5-103)
- Full availability of the communication ring when the switchgear bay is enabled for servicing operations.
- Redundant time synchronization (e.g., IRIG-B and SNTP)
- Ethernet-Redundancy Protocols RSTP, PRP* and HSR*.

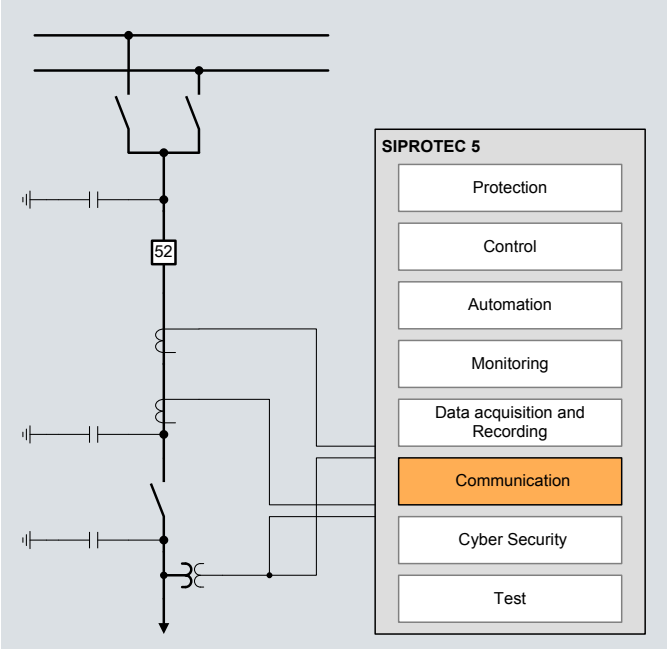


Fig. 14 SIPROTEC 5 – Functional integration

Cyber Security

A multilevel security concept for the device and DIGSI 5 provides the user with a high level of protection against communication attacks from the outside and conforms to the requirements of the BDEW Whitebook and NERC CIP.

Authentication

In general, secure authentication takes place between the device and DIGSI 5. This precludes another program from accessing the devices and reading or writing data there.

Establishment of connection after password testing

Remote access via the Ethernet cannot take place until the password has been entered. Once the connection has been established, the user has read access to the device.

Access control with confirmation code

Security prompts must be answered for security-critical actions, e.g., changing parameters, in order to obtain write access to the device. These prompts can be configured by the user, and may be different for different application areas.

Accesses to areas of the device with restricted access rights are logged. This makes it possible to track which groups had access to protected areas and when. Unsuccessful and unauthorized access attempts are also recorded and an alarm can be triggered by an independent telecontrol link.

In addition, security-critical operations are logged in the device and safeguarded against deletion. All files that can be loaded into the device via DIGSI 5 are signed. In this way, corruption from outside by viruses or trojans is reliably detected. Unused Ethernet services and the associated ports can be disabled in the device with DIGSI.

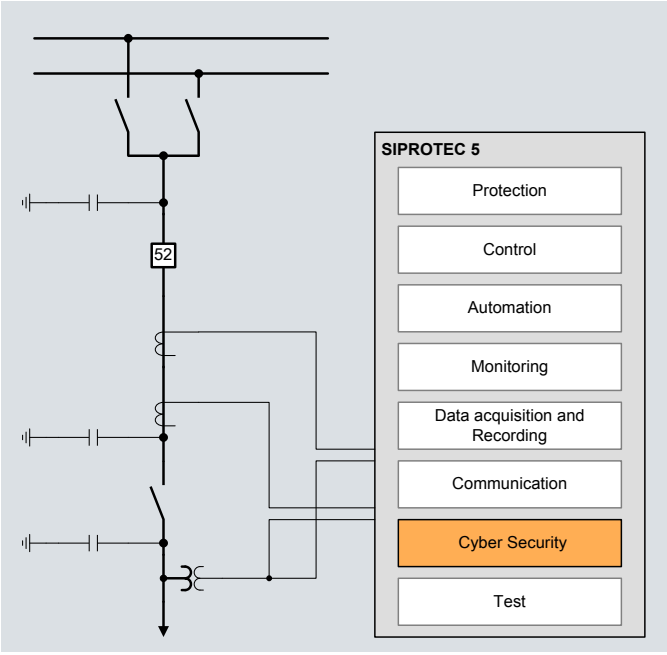


Fig. 15 SIPROTEC 5 – Functional integration

* in preparation

Test

Test

To shorten testing and commissioning times, extensive test and diagnostic functions are available to the user in DIGSI 5. These are combined in the DIGSI 5 Test Suite.

The test spectrum includes, among other tests:

- Hardware and wiring test
- Protection-function test
- Simulation of binary signals and analog sequences by integrated test equipment
- Debugging of function charts
- Circuit-breaker test and AR (automatic reclosing) test function
- Communication testing
- Loop test for communication connections
- Protocol test.

The engineering, including the device test, can therefore be done with one tool.

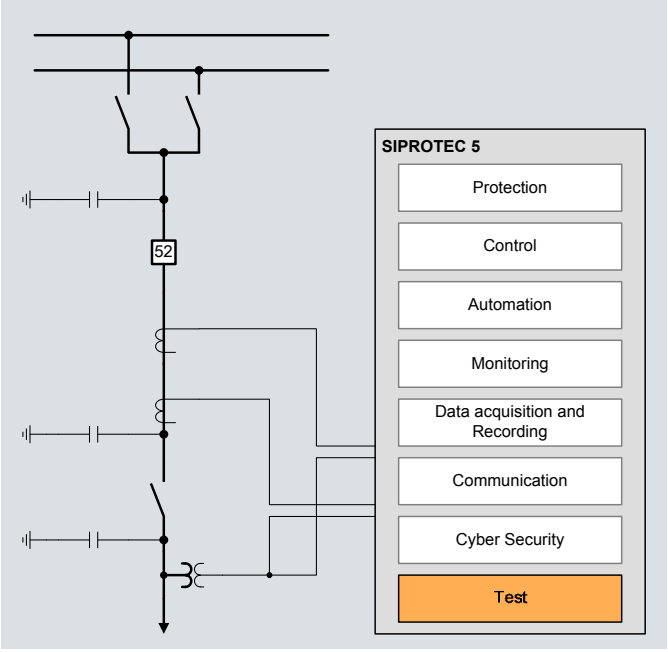
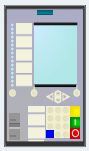
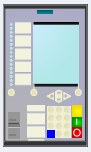
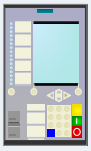
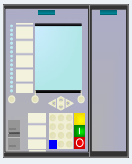


Fig. 16 SIPROTEC 5 – Functional integration

Standard variants for 7KE85

N1	1/3, 11 BI, 9 BO, 4 I, 4 V	
	Housing width 1/3 x 19" 11 binary inputs, 9 binary outputs(1 life contact, 2 standard, 6 fast), 4 current transformer inputs, 4 voltage transformer inputs Contains the modules: Base module with PS201 and IO202	
N2*	1/3, 11 BI, 3 BO, 8 V	
	Housing width 1/3 x 19" 11 binary inputs, 3 binary outputs (1 life contact, 2 standard), 8 voltage transformer inputs Contains the modules: Base modules with PS201 and IO211	
N3*	1/3, 7 BI, 7 BO, 8 I,	
	Housing width 1/3 x 19" 7 binary inputs, 7 binary outputs (1 life contact, 2 standard, 4 fast), 8 current transformer inputs Contains the modules: Base module with PS201 and IO203	
N5	1/2, 19 BI, 15 BO, 8 I, 8 V	
	Housing width 1/2 x 19" 19 binary inputs, 15 binary outputs (1 life contact, 2 standard, 18 fast), 8 current transformer inputs, 8 voltage transformer inputs Contains the modules: Base module with PS201 and IO202 expansion module IO202	

The technical data can be found in the manual
www.siemens.com/siprotec

Notes

Indication of conformity

CE This product complies with the directive of the Council of the European Communities on harmonization of the laws of the Member States relating to electromagnetic compatibility (EMC Council Directive 2004/108/EC) and concerning electrical equipment for use within specified voltage limits (Low Voltage Directive 2006/95/EC).

This conformity has been proved by tests performed according to the Council Directive in accordance with the generic standards EN 61000-6-2 and EN 61000-6-4 (for EMC directive) and with the standard EN 60255-27 (for Low Voltage Directive) by Siemens AG.

The device is designed and manufactured for application in an industrial environment. The product conforms with the international standards of IEC 60255 and the German standard VDE 0435.

Disclaimer of liability

This document has been subjected to rigorous technical review before being published. It is revised at regular intervals, and any modifications and amendments are included in the subsequent issues. The content of this document has been compiled for information purposes only. Although Siemens AG has made best efforts to keep the document as precise and up-to-date as possible, Siemens AG shall not assume any liability for defects and damage which result through use of the information contained herein.

This content does not form part of a contract or of business relations; nor does it change these. All obligations of Siemens AG are stated in the relevant contractual agreements. Siemens AG reserves the right to revise this document from time to time.

Document version: 01

Release status: 02.2013

Version of the product described: Edition 1

Registered trademarks

SIPROTEC, DIGSI, SIGUARD, SIMEAS and SICAM are registered trademarks of Siemens AG. Any unauthorized use is illegal. All other designations in this document can be trademarks whose use by third parties for their own purposes can infringe the rights of the owner.

Published by and copyright © 2013:
Siemens AG
Infrastructure & Cities Sector
Smart Grid Division
Energy Automation
Humboldtstr. 59
90459 Nuremberg, Germany

For more information, please contact our
Customer Support Center.
Phone: +49 180 524 84 37
Fax: +49 180 524 24 71
(Charges depending on provider)
E-Mail: support.ic@siemens.com
www.siemens.com/siprotec

Order No. IC1000-K4605-A071-A1-7600
Printed in Germany
Dispo 06200, c4bs 769
KG 02.13 2.0 24 En
AU 300125 | PRO MK
Printed on elementary chlorine-free bleached paper.