SIEMENS

SICAM
Power Quality and Measurement

Catalog · Edition 6

Content

SICAM
Power Quality and
Measurement

Catalog · Edition 6.0

Invalid:
Edition 5

MANAGEMENT SYSTEM CERTIFICATION

DNV·GL

ISO 9001 = ISO 14001
OHSAS 18001

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).

General

Product Overview - Devices and Applications

Device		SICAM Q200	SICAM Q100
Main function		**Power meter and PQ recorder**	**Power meter and PQ recorder**
Display		■	■
Housing (width x height x depth in mm)		192 x 96 x 134.6	96 x 96 x 100
Assembly		Control panel	DIN rail/control panel
Degree of protection		IP40 (standard), option: IP54 (with separate seal between housing and switch panel) terminals: IP20 (behind switch panel)	IP40
Configuration and online view		Web browser	Web browser
Data analysis and reporting		Web-browser visualization (with Sigra plugin) and file download in CSV-, COMTRADE- or PQDiF format for reporting with SICAM PAS/PQS, SIGRA, Excel or SENTRON power manager	Web-browser visualization (with Sigra plugin) and file download in CSV-, COMTRADE- or PQDiF format for reporting with SICAM PAS/PQS, SIGRA, Excel or SENTRON power manager
Basic measurands	V, I, f, P, Q, S, energy, phase angle, cosφ	■	■
Accuracy % (V/I/P)		0.1/0.1/0.2	0.2/0.2/0.5
Adjustable limits		■	■
Harmonic	Detection	50th/63rd [1]	50th/63rd [1]
	to IEC 61000-4-7	■	■
Min, max, mean values		■	■
Power quality IEC 61000-4-30		Class A	Class A
EN 50160 power quality data		■	■
Flicker IEC 61000-4-15		■	■
Fault recording (see device specification)		■	■
Load profile (15 min. mean values)		■	■
Tariffs		■	■
Recording transients		1 µs	100 µs
Identification of the fault origin [2]		■	■
2 to 9 kHz		■	–
9 to 150 kHz		■	–
Sampling frequency		40.96 kHz for fault recording, 1 MHz for transient recording	10.24 kHz (oversampling with 12.8 kHz for fault recording)
Recorder		Measured values/mean, min, max values/PQ data (CSV and PQDIF), voltage events and fault recordings, events, load profiles, transient event, ripple-control signal (COMTRADE)	Measured values/mean, min, max values/PQ data (CSV and PQDIF), voltage events and fault recordings, events, load profiles, transient event, ripple-control signal (COMTRADE)
Averaging time intervals		1 min, 10 min	30 s, 1 min, 10 min, 15 min, 1 h, 2 h
Recording criterion (trigger)		RMS level V/I, binary	RMS level V/I, binary
Limit violation/notification		■	■
Mass storage unit		2 GB (expandable)	2 GB

(1) Harmonics up to 63rd are measured and shown in the Web browser. Harmonics up to 50th are transferred via IEC 61850 protocol (PQDIF).

(2) Measuring and calculating the harmonic active power/angle

SICAM P855
Power meter and PQ recorder
Optional
96 x 96 x 100
DIN rail/control panel
IP20/IP40/IP51
Web browser
Web-browser visualization and download for Excel and PQDIF, SICAM PQS/PQ Analyzer for PQDIF/ COMTRADE viewer for COMTRADE, SENTRON power manager
■
0.2/0.2/0.5
■
40th
■
■
Class S
■
■
■
■
–
–
–
–
–
10.24 kHz
Measured values/mean, min, max values/PQ data (CSV and PQDIF), voltage events and fault recordings (COMTRADE)
30 s to 2 h
RMS level
■
2 GB

General

Product Overview - Devices and Applications

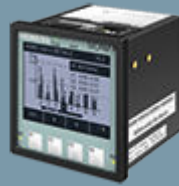| Device		SICAM Q200	SICAM Q100
Main function		**Power meter and PQ recorder**	**Power meter and PQ recorder**
Inputs/outputs	AC analog input (V/I)	4/4	4/4
	Binary outputs	6	2
	Binary inputs	6	2 + (12 E/12 A with 2x SICAM I/O unit)
	Analog outputs	–	–
	DC analog inputs	–	–
Time synchronization		NTP/serial	NTP/serial
Communication	Serial	Modbus RTU Master and Gateway	Modbus RTU Master and Gateway
	USB	–	–
	Ethernet	2 x Modbus TCP/IEC 6185	Modbus TCP/IEC 61850
Data formats	Fault recordings	COMTRADE (Web browser/SICAM PQS)	COMTRADE (Web browser/SICAM PQS)
	Power quality data	CSV, PQDIF (Web browser/SICAM PQS)	CSV, PQDIF (Web browser/SICAM PQS)
	Measured value recorder	CSV, PQDIF (Web browser/SICAM PQS)	CSV, PQDIF (Web browser/SICAM PQS)

1.1

SICAM P855
Power meter and PQ recorder
4/3
2
–
–
–
NTP/Seriell
Modbus RTU/IEC 60870-5-103
–
Modbus TCP/IEC 61850
COMTRADE (Web-Browser/SICAM PQS)
CSV, PQDIF (Web-Browser/SICAM PQS)
CSV, PQDIF (Web-Browser/SICAM PQS)

General

Product Overview - Devices and Applications

Device		SICAM P850	SICAM MMU
Main function		**Power meter and recorder**	**Monitoring unit**
Display		Optional	–
Housing (width x height x depth in mm)		96 x 96 x 100	96 x 96 x 104
Assembly		DIN rail/control panel	DIN rail
Degree of protection		IP20/IP40/IP51	IP20
Configuration and online view		Web browser	Web browser
Data analysis and reporting		Web-browser visualization and download for Excel, COMTRADE viewer for COMTRADE, SENTRON power manager	–
Basic measurands	V, I, f, P, Q, S, energy, phase angle, cosφ	■	■
Accuracy % (V/I/P)		0.2/0.2/0.5	0.2/0.2/0.5
Adjustable limits		■	■
Harmonic	Detection	40th	21st
	to IEC 61000-4-7	■	–
Min, max, mean values		■	–
Power quality IEC 61000-4-30		–	–
EN 50160 power quality data		–	–
Flicker IEC 61000-4-15		–	–
Fault recording (see device specification)		■	–
Load profile (15 min. mean values)		■	–
Tariffs		–	–
Recording transients		–	–
Identification of the fault origin		–	–
2 to 9 kHz		–	–
9 to 150 kHz		–	–
Sampling frequency		10.24 kHz	3.2 kHz
Recorder		Measured values/mean, min, max values/in CSV and fault recordings in COMTRADE	–
Averaging time intervals		–	–
Recording criterion (trigger)		RMS level	–
Limit violation/notification		■	■
Mass storage unit		2 GB	–
Inputs/outputs	AC analog input (V/I)	4/3	4/3
	Binary outputs	2	2 + 6 (opt. with SICAM I/O unit)
	Binary inputs	–	6 (opt. with SICAM I/O unit)
	Analog outputs	–	–
	DC analog inputs	–	–
Time synchronization		NTP/serial	NTP/serial
Communication	Serial	Modbus RTU/IEC 60870-5-103	Modbus RTU
	USB	–	–
	Ethernet	Modbus TCP/IEC 61850	Modbus TCP / IEC 60870-5-104 (redundant)
Data formats	Fault recordings	COMTRADE (Web browser/SICAM PQS)	–
	Power quality data	–	–
	Measured value recorder	CSV (Web-browser download)	–

SICAM P50/P55
Power meter
Optional
96 x 96 x 76.5
DIN rail/control panel
IP20/IP41/IP65
SICAM P Manager
–
–
0.2/0.2/0.5
■
21st
–
■
–
–
–
■
–
–
–
–
–
–
3.2 kHz
Mean value
–
–
■
1 MB
4/3
2 + 2 (opt.)
2 (opt.)
2 (opt.)
2 (opt.)
Serial
Modbus RTU/PROFIBUS/IEC 60870-5-103
–
–
COMTRADE (SIMEAS P Manager)
–
–

General

Product Overview - Devices and Applications

Device		SICAM T	SIPROTEC 7KE85
Main function		**Measuring transducer**	**Fault recorder opt. synchrophasors and PQ recorders**
Display		–	Optional
Housing (width x height x depth in mm)		96 x 96 x 104	145 (445) x 268 x 229
Assembly		DIN rail	Switch panel/mounting plate
Degree of protection		IP20	IP50/IP51
Configuration and online view		Web browser	DIGSI 5
Data analysis and reporting		–	DIGSI 5/SICAM PQS/SICAM PQ Analyzer
Basic measurands	V, I, f, P, Q, S, energy, phase angle, cosφ	■	■
Accuracy % (V/I/P)		0.2/0.2/0.5	0.1/ 0.1/0.3
Adjustable limits		■	■
Harmonic	Detection	–	50th [1]
	to IEC 61000-4-7	–	■
Min, max, mean values		–	Mean values
Power quality IEC 61000-4-30		–	Class S [1]
EN 50160 power quality data		–	■ [1]
Flicker IEC 61000-4-15		–	■
Fault recording (see device specification)		–	■
Load profile (15 min. mean values)		–	–
Tariffs		–	–
Recording transients		–	60 to 80 µs
Identification of the fault origin		–	–
2 to 9 kHz		–	–
9 to 150 kHz		–	–
Sampling frequency		3.2 kHz	Max. 16 kHz (1/2/4/8/16 adjustable)
Recorder		–	Fault recording/dynamic processes/continuous/sequence of events/PQ data
Averaging time intervals		–	1 s to 900 s
Recording criterion (trigger)		–	Level/gradients/GOOSE/manual/binary/logic trigger/...
Limit violation/notification		■	■
Mass storage unit		–	16 GB
Inputs/outputs	AC analog input (V/I)	4/3	8 to 40
	Binary outputs	2	3 to 15 [2]
	Binary inputs	–	from 11 to 203 [2] (8 + 3 + 192 with IO230)
	Analog outputs	4 (opt.)	–
	DC analog inputs	–	4 to 52 ± 20 mA, 8 – 32 ± 10 V
Time synchronization		NTP/serial	IRIG-B/DCF77/SNTP/IEEE 1588
Communication	Serial	Modbus RTU/IEC 60870-5-103	–
	USB	–	DIGSI 5
	Ethernet	Modbus TCP/IEC 61850	DIGSI 5/IEC 61850/IEEE C37.118
Data formats	Fault recordings	–	COMTRADE (DIGSI 5/SICAM PQS)
	Power quality data	–	PQDIF (SICAM PQS)
	Measured value recorder	–	–

(1) Harmonic (THD/TDD) to IEC 61000-4-7 in preparation

(2) Flexible extension via inputs/outputs

SIEMENS

Power Quality Recorder

Power Quality Recorder

Power Quality – Overview

Power Quality

The whole electrical system technological development, from generation until load characteristics, has being changing over the past decades and problems affecting the electricity supply that were once considered tolerable by the electric utilities and users are now often taken as a problem.

Therefore the quality control of electrical energy has become a major issue for all and especially for the following reasons:

- Need to increase economic competitiveness, reliability, quality of services, security facilities
- Increasing use of power electronic, frequency converters,
- The spread of sensitive equipment (electronics, IT equipment, process control units, ...) to disturbances and/or themselves-perturbing
- Deregulation of the electricity market
- Growing demands in the event of disruption, taxation on the public distribution network, or compensation in case of impact on other private networks
- Sustainable development, including energy efficiency, which depends also on the quality of energy might also contribute to fluctuating power infeed from renewable sources:
  - E.g. calm wind and cloudy sky combined with high network load or Low network load at a simultaneous high infeed of photovoltaic and wind energy. E.g at the upper voltage levels (wind parks) and at low voltage level (small PV installations)
  - Distributed and bidirectional power system structure changing energy flow direction, incl. energy transmission in higher voltage levels
- Decreasing short-circuit power and with that decreasing power system ruggedness and elasticity
- Infeed of harmonics at all voltage levels, caused by inverters and non-linear loads are increasing
- Voltage and currents peaks in distribution network
- Unbalance, particularly on the low voltage level

In fact, power quality problems don't always come from the supplier system, but in most of the cases are propagated through it. So as the consumer's awareness about power quality consequences and costs are increasing also the suppliers are very interested and aware that reducing cost of power quality problems must be seriously aimed. Suppliers know that the loss of customer confidence and that power quality is an important point in the relationship between them and as consequence it might become a contractual obligation that stress on improving voltage quality, availability, performance and efficiency.

Therefore, the aim of today's electric power system to produce and deliver to the consumer's power demand at all times and under all conditions became more challenging, but necessary.

Now it is clear for energy users that problems are occurring frequently, at least monthly, and often weekly. Improving power quality reduces risk, decreases the cost of doing business, and hence improves a business bottom line. It also raises throughput, through reducing downtime. „ but how to get there and reach the power quality I need?

For industries challenged by power quality problem impacting on process efficiency, the good news is that is decision to start understanding the problem and the related costs are less than living with its consequences. Each industry has facilities with its own specific power quality issues, depending on the installed loads, equipment, and the quality of supplied energy. Therefore understanding your own power quality problems and counter-measures will require you to start monitoring.

Voltage Quality

The voltage quality, also referred to as power quality (PQ), describes various features in a power-supply system. The quality of the voltage curve shape is the most important feature here. Although there are several technical regulations for the definition of the voltage quality, at the end of the day the quality is determined by the capability of the customer system to perform its tasks properly. The relevant technical phenomena are: Frequency fluctuations, fluctuations of the voltage level, transient voltage variations (dips, swells, and brief interruptions), long-term voltage variations (overvoltage or undervoltage) transients (temporary overvoltage), signal distortion, etc.

In many countries, the voltage quality is regulated within a certain range, frequently using standards that are recognized throughout industry, or processes to define power directives. Although today everybody is aware of the effects of poor power energy, only few really master it. To initiate adequate remedial measure before severe consequences occur, you must monitor the number of power-quality failures weekly, sometimes even daily. An energy-supply company is thus interested in monitoring the power quality to prove that they act properly and improve their knowledge about the system. High customer satisfaction is obtained with high-quality and reliable energy supply. Availability and quality of the power supply is even more important for power-distribution utilities. The liberalization of the electricity market put these companies in the awkward position of being influenced by the actions of other players. The situation evened out and the power quality is of maximum priority for the restructuration process. The increasing awareness of the customers for energy efficiency makes it obvious that high attentiveness will be given to the quality of supply. Most quality problems affect the ultimate consumer directly, or are noticed at that level. The ultimate consumers must measure the power quality and invest in local remedial measures. Frequently, the consumers address the utility and exert pressure on it to obtain the necessary quality of supply. Power-quality standard EN 50160 describes the main features of the voltage at the supply terminals of the customer in the public low-, medium- and even high-voltage systems.
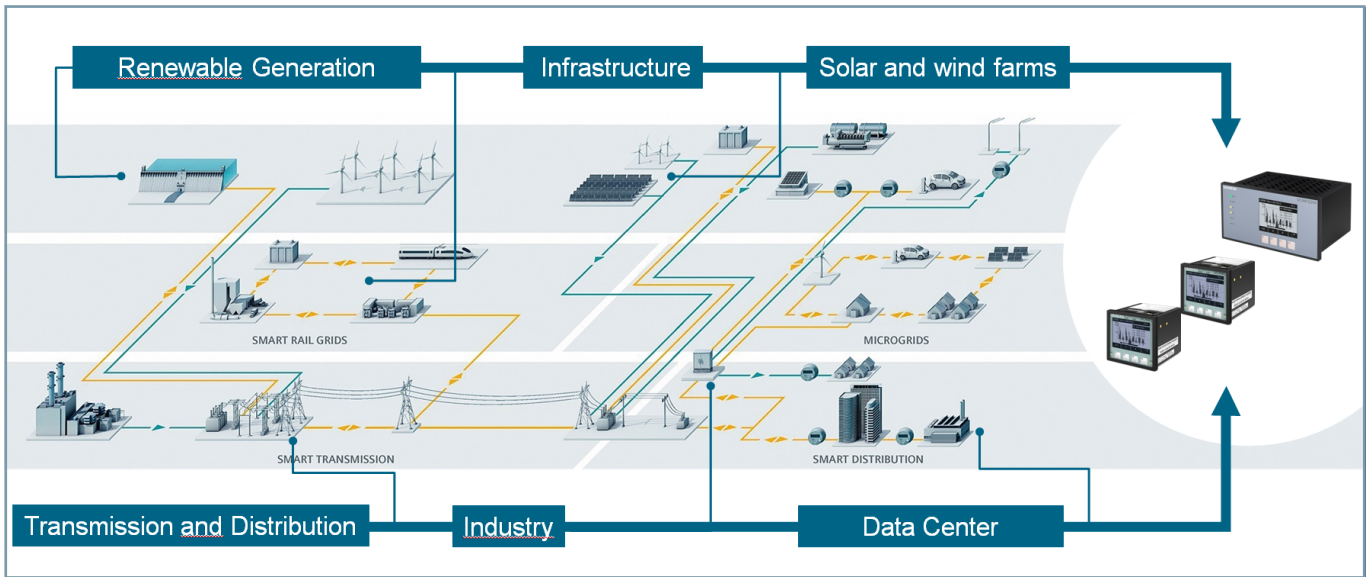
[Areas of application, 1, en_US]

Figure 2.1/1   Fields of Application

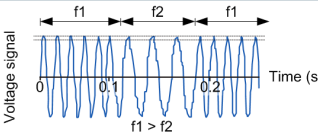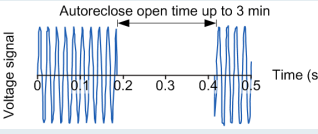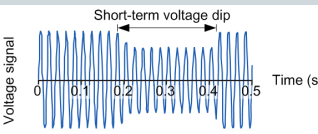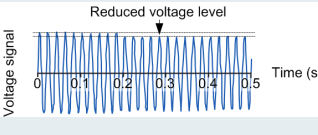# Power Quality Recorder

Power Quality – Overview

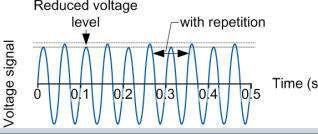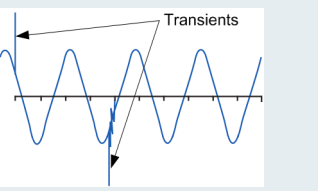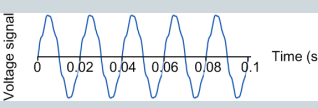| Problem	Description	Cause	Effects
	Frequency fluctuation: Fluctuation of the usually stable power frequency of 50 Hz or 60 Hz up or down.	• Connecting or disconnecting large consumers, such as motors • Connecting or disconnecting power generators or small heat and power plants • Energy sources with unstable frequency	• Disturbance, data loss, system failure, and damage of systems and motors • Certain drive types, for example in textile factories, require a sable frequency.
	Interruption of the power supply: Scheduled or unscheduled interruption of the power supply in a certain region, brief interruptions of half a second up to 3 minutes, and long interruptions of more than 3 minutes.	• Switching processes during the attempt of isolating an electrical failure and of maintaining the power supply in the region concerned • Incidents, natural phenomena, etc. • Fuses, effect of a protection function, such as automatic restart	• Shutdown or damage of sensitive processes and systems • Loss of memory contents of computers/controllers • Production failure or damage
	Voltage dip/spike (sag/swell): All transient (1 half-wave up to 60 seconds) voltage dips or swells	• Connecting or disconnecting large consumers, such as motors • Short-circuits (failures) • Undersized energy supply • Failure of systems or switching procedures at the utility	• Memory loss, data fault, fluctuating lighting, failures in screen representations, system shutdown • Rough motor operation, stopped motors, reduced motor service life
	Deviations of the supply voltage: Up or down deviations from the rated voltage during normal operating conditions	• Fluctuation of the power-system voltage due to load shedding	• System shutdown caused by undervoltage tripping • Overheating and/or damage of systems due to overvoltage • Reduced efficiency or service life of electrical systems
	Fast voltage change: Unsteady visual sensation, caused by a light stimulus whose brightness or spectral distribution changes over time	• Intermittent loads • Motor startup • Arc furnaces • Welding systems	• Fluctuating lighting can cause visual impairment in persons that can lead to concentration disorder, headache, etc.
	Transients: A transient is a sudden voltage change up to several thousand volts. It can occur in the form of a pulse of an oscillation (other names: impulse, surge voltage or voltage peak) **Dip:** This is a failure that acts with inverse polarity on the signal shape	• Switching processes at the utility, connecting or disconnecting large consumers, lifts, static discharge of welding systems, lightning	• Production defect • Data losses • Blockage of sensitive facilities • Scorched printed circuit boards
	Noise: These are unwanted electrical signals that are generated by other equipment **Harmonics:** Distortion of the ideal sinusoidal oscillation in the power distribution system	• Noise is produced by electromagnetic interference, such as microwaves, radio and TV signals, or poor grounding • The total harmonic distortion is produced by non-linear loads	• Noise disturbs sensitive electronics • It can cause production defects and data losses • Harmonic distortion causes motors, transformers, and lines to overheat • Failures of circuit-breakers, relays or fuses

Table 2.1/1   Main Power-Quality Problems

Norms

The following represents a basis for and future-proof power quality devices and systems.

- **IEC 61000-4-30** defines the measurement processes, accuracy and interpretation of network quality parameters for Class A and Class S devices.
- **IEC 62586-2** defines functional testing and uncertainty requirements for Power Quality Instruments (PQI).
- **EN 50160** sets forth how the measured variables must be evaluated.
- **IEC 61850** sets forth how data and information must be forwarded.
- The data formats are standardized for fault records in the form of **IEEE 1159 (PQDIF)** and **COMTRADE**.

The standard **IEC 62586-1 Edition 1** specifies the requirements for devices for the measurement of power quality (Power Quality Instruments - PQI) and provides a common system of references in order to facilitate their selection, comparison and evaluation of devices. This standard specifies a classification based on product performance, environment and safety.

The **IEC 62586-2 Edition 2** is a standard specifying functional and uncertainty tests intended to verify the compliance of a product to Class A and Class S measurement methods defined in IEC 61000-4-30. IEC 62586-2 therefore complements IEC 61000-4-30. This standard may also be utilized by other product standards (e.g. digital fault recorders, meters, MV or HV protection relays) specifying devices embedding Class A or Class S power quality functions. The compliance with relevant product standards (IEC 62586-1/-2) and the implementation of standardized measurement methods lead to a manufacturer independent comparability of devices for the end user thus increases transparency and guarantees future–proof investment.

The **IEC 61000-4-30** Class A method guarantees comparable measurements of devices provided by different manufacturers by a defined measurement method and gapless recording of power quality characteristics of the power supply. The evidence of compliance to defined emission limits at the point of connection between public network and customer as well as the analysis of problems (limit violation, decreasing tendencies of characteristics) and the derivations of measures for improvement are possible.

Additionally to the classical characteristics of voltage quality (power frequency, magnitude of the supply voltage, voltage unbalance, voltage harmonics and interharmonics, flicker and mains signalling voltages) and to the continuity of supply measurement (dips, swells, interruption) new characteristics (measurement method for rapid voltage changes (normative) and for conducted emissions in the frequency range between 2 kHz and 150 kHz (informative) and the measurement of currents and current characteristics (without regulatory evaluation) are taken into account in Edition 3 of IEC 61000-4-30.

E.g. Applications like the direction detection of harmonious/interharmonics and Rapid Voltage Changes (RVC) are becoming more important.

The use of standard data formats and interfaces for data exchange is another advantage for customers. This approach is actually incorporated in the communication standard **IEC 61850**. The IEC/TR 61850-90-17 describes the modeling and data exchange between power quality devices and network control, power automation or SCADA systems.

Limits and thresholds are specified in **EN 50160** or by local guidelines and agreements, as national or local grid-codes.
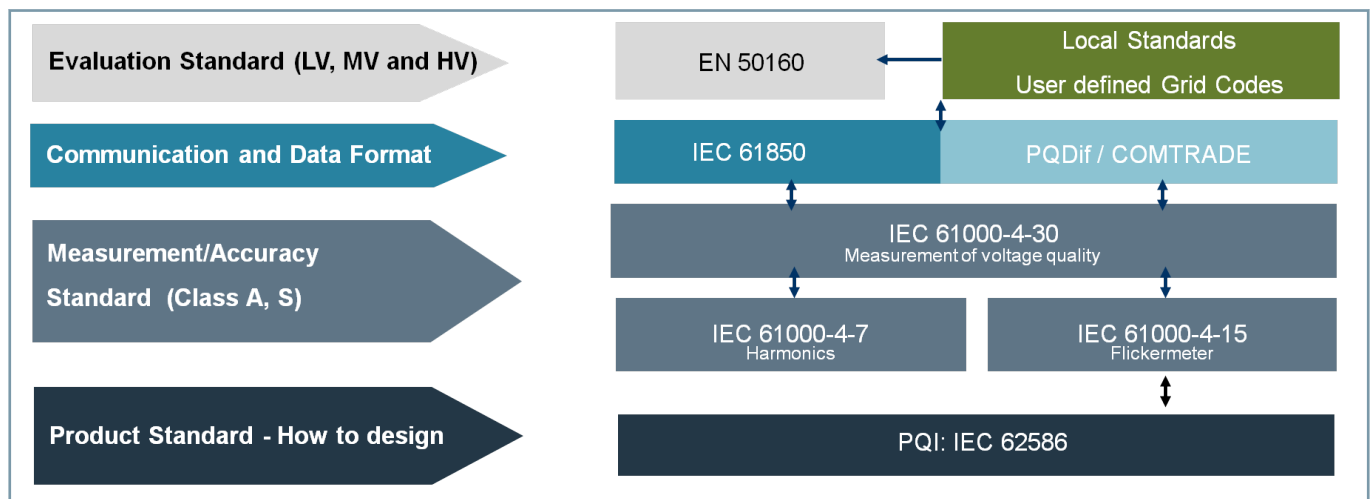
[PQ Standards, 1, en_US]

Figure 2.1/2   Overview – Power Quality Standards

Power Quality Recorder

Power Quality – Measuring Points

Measuring Points

Power-quality measurements are used to determine the supply performance by describing the quality of each interface in an electrical energy-supply system and in the systems of the individual customers. Identification, definition, and profiling of the measuring points for system-quality monitoring play a major role when planning a power-quality project. Since the power-distribution system is a dynamic system, the optimization of the measuring points is based on the information gained in the daily operation. Although this can not necessarily prevent changes, it permits taking more effective counter measures.

Identifying the Measuring Points

The measuring points can be assigned and established for example as in *Figure 2.1/3* / *Table 2.1/2*. In addition to selecting the measuring points, measuring the power quality requires definition and selection of the assessment criteria at the individual measuring points. Monitoring the "power quality" is a combination of data acquisition techniques that are classified by purpose and/or application.
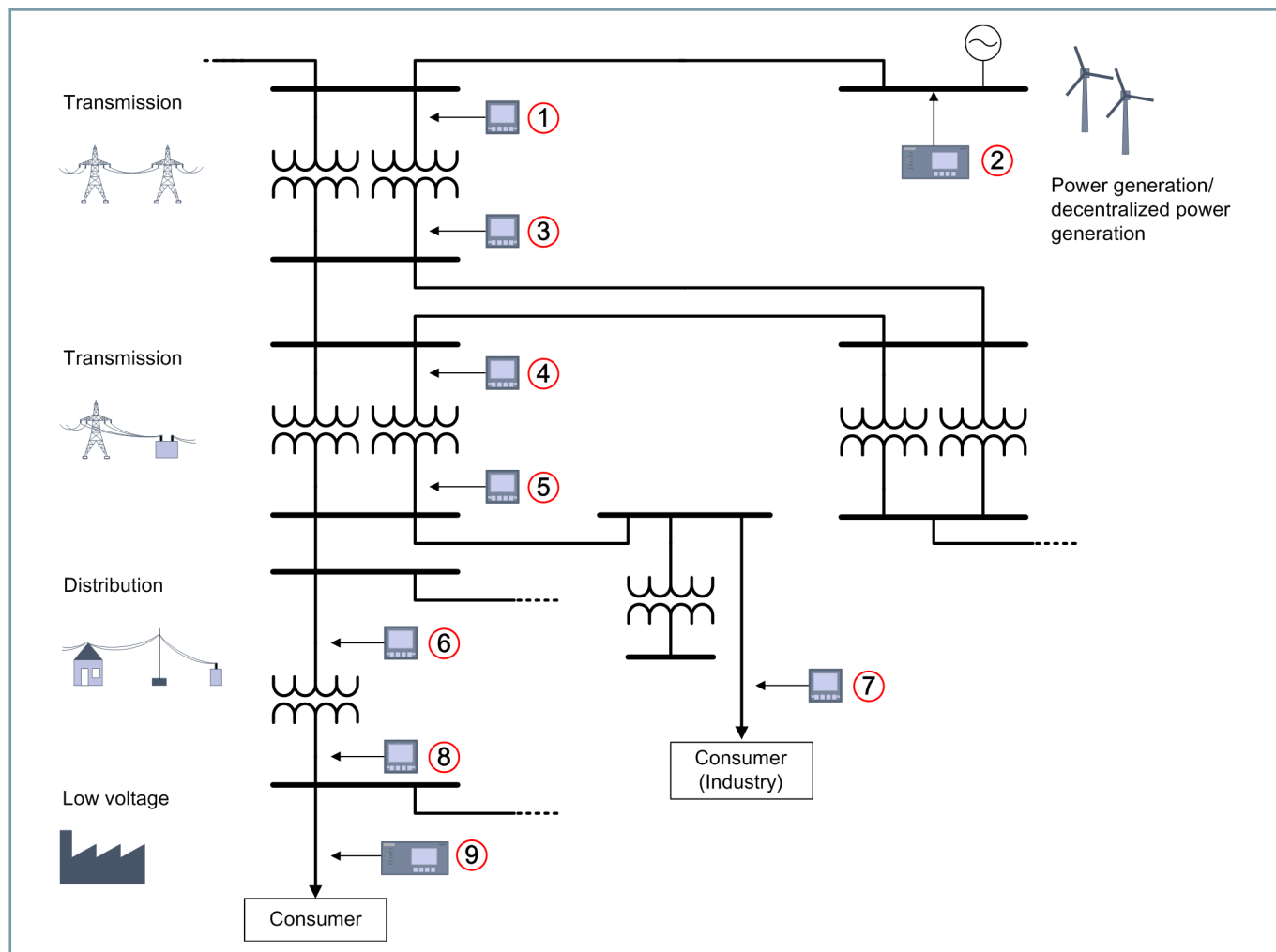
[dw_pq_general, 1, en_US]

Figure 2.1/3   General Representation of the System Connections

No.	Measuring Points	Location
1	Infeed (line or transformer)	Possibly busbar
2	Power generation/distributed power generation	Busbar, transformer, or generator connection
3	Forwarding, distribution system	Busbars (for example, if the busbar belongs to the transmission company and is run by it)
4	Forwarding, infeed (line or transformer)	Distributed line connections (for example, if the line belongs to the transmission company and is run by it)
5	Distribution, supply line	Transformer secondary circuit or cable to adjacent transformer substation
6	Distribution, infeed (line or transformer)	Distribution-system transformer
7	Distribution, consumer	Distribution-system transformers (for example, if the transformer belongs to the transmission company)
8	Low-voltage power supply	Transformer of the transmission company
9	Low-voltage consumer	Consumers or transformers at the customer's (industry, oil & gas, computer centers, hospitals, commercial buildings, etc.)

Table 2.1/2 Arrangement of Measuring Points

Power Quality Recorder

Power Quality – Solution from Siemens

Siemens Power Quality Solution

Troubleshooting measurements with portable devices were often used to locate and eliminate problems as quickly as possible after a production outage direct at the load. Nevertheless, measurement only at the classical point of connection between supplier and customer or at the sensible load are in many cases not sufficient enough and likely to be more expensive in operational costs since employees resources with transport, installation and evaluation are required.

Therefore also due to the increasing complexity and interfaces of the power system structure and loads the requirements for the continuous and gapless measurement and recording of voltage and currents characteristics for conformance evaluation at more locations, covering seasonal and weather conditions changing, and business cycles are becoming more effective and necessary to support the improvement the reliability and power quality levels.

The continuous measurement with fixed devices provides informative benefits as time when the problem occurs which can also provide important information about the nature of the power problem. If the problem occurs at a certain time of day, of the week, of the month, e.g. when the equipment or facility is switched on at that time should be suspect.

A distinction is made between "continuous phenomena" and "voltage events". Continuous phenomena require continuous measurements, with representative values recorded typically every 10 minutes using the time-aggregation methods prescribed in IEC 61000-4-30. Voltage events require a triggering mechanism as well as characteristics to be calculated upon triggering.

Measure	Evaluate	Optimize
Continuous measurement of relevant parameters at important points in the power supply network	Concentrate, analyze and evaluate recorded parameters:	Definition of proper mitigation measures:
• Point of coupling: In-feed from the utility • Transformer feeders • Point of coupling of specific production units/lines • Big loads causing disturbances • Use of standardized measurement methods (Class A, Class S)	• Assigning data to the point where they are measured • Evaluate data according to necessary limits and criteria (e.g. EN 50160) • Identification of trends, deviations and limit value violations together with the duration and value • Assigning evaluation results to the related points • Identification of possible originator of the disturbance	• Dedicated energy supply contract with a defined level of Power Quality • Filters, redundancies etc. • Process optimization • Use of less sensitive devices and equipment • Improvements on network planning (redundancy, earthing etc.)

Table 2.1/3   What to Do? – The ABC Approach

Continuous Power Quality Phenomena	Power Quality events
• Supply voltage variations • Power frequency • Rapid voltage changes • Flickers (voltage fluctuations) (temporary power frequency overvoltages) • Voltage unbalance • Harmonic distortions • Interharmonic, subharmonic voltages • Mains signalling on the supply voltage • Current measurements	• Interruption • Supply voltage dips • Supply voltage swells • Supply voltage unbalance • Transient overvoltages • Rapid voltage changes • Emissions in the 2 kHz to 150 kHz range (as information)

Siemens Power Quality Monitoring is a process, from measurement and optimization.

• Ensure that the optained energy is according to a definded quality

• Ensure that negative influences to the connected power supply network are within a certain limit

Benefits

Increase power availability, reliability and quality – 24/7 running process

- To ensure system availability monitor, visualize and evaluate and document certain power quality parameters to support the identification of (potential) voltage disturbances outages and losses is first and essential step to reduce or eliminate the cut down time-consuming processes and avoidance of losses due supply events
- Customer satisfaction since time schedule, quality problems can be avoid

Accurate assessment for Power Utilities and Renewable Sources

- Power Quality monitoring becomes even more necessary and important as renewable power penetration level increases quickly. There is a need to continue to monitor the effects of emerging technologies so as to identify not only possible problems but also good experiences and opportunities of their implementation on the network while ensuring that adequate power quality levels are maintained.
- Accurate assessment of the possible impacts of large and small grid-connected REGs on network performance is therefore very important. Performing such analysis can allow power utilities to become efficiently equipped to solve potential operational issues caused by RES improving the deployment and using effectively investments with sustainability.
- In case of clarification with customers and energy providers gapless documentation of power quality parameters are essential.
- Understanding the problems associated with power quality variations is the first step towards developing standards and the optimum approach to solutions. These standards developments must be taken into account for the measurement of power quality.

Improve Energy efficiency/CO2 reduction

- Monitoring power and power quality create transparency of energy flows that supports energy management systems to Identify energy savings potentia
- Energy inefficiency causes high costs and environmental damage
- Efficient use of energy ISO 50001/EN 16247-1

Increase Data transparency

- Power quality problems are one of the major causes of unplanned downtime and malfunction and damage of equipment. Continuous monitoring, acquisition and documentation of parameters relevant to supply quality are necessary to identify possible weak points and initiate appropriate measures to eliminate them.
- Tthe anticipation of potential problems and/or identification of counter measures and avoid process failure and losses
- In case of clarification and claiming with energy providers gapless documentation of power quality parameters are essential.

Continuous power system monitoring and quality of supply according to the standards

- Our power quality systems comply with international power quality standards and support you with a professional power quality system.
- The standard IEC 61000-4-30 defines measurement methods for each power quality parameter so that as Class A is guaranteed that the measurements are reliable, reproducible and the results comparable
- The standard IEC 62586-2 specifies functional tests and uncertainty requirements for Power Quality Instruments (PQI) whose functions include measuring, recording, and possibly monitoring power quality parameters in power supply systems, and whose measuring methods (Class A or Class S) are defined in IEC 61000-4-30.
- EN 50160 defines how these parametersc an be reported
- IEC 61850 defines how the data and information can be transmited
- Interoperability is guaranteed by using standard interfaces and standard protocols (IEC 61850, Modbus TCP) and data formats (PQDIF, COMTRADE and CSV)

Power Quality Recorder

Power Quality – Device Classes and Analysis System

Device Classes

Class A Devices	Class S Devices
This class is used when precise measurements are required. For example for contractual applications, where conflicts have to be resolved or the compliance with standards has to be verified. All measurements of a parameter require: 2 different devices that satisfy the Class A requirements, measure the same signal, product the same result within the uncertainty of measurement specified for this parameter.	This class is used for statistical applications, such as investigations or power-quality assessments, possibly with a restricted subset of parameters. Even when the measuring intervals of Class S are the same as the ones of Class A, the processing requirements of Class S are lower.

Power quality devices are subdivided into Class A devices and Class S devices to IEC 61000-4-30.

The SICAM Product Family

Many users use the well-proven Siemens Class A devices SICAM Q100 or SICAM Q200 at the power infeed point to verify and document the power quality of their utility.

If the incoming power quality is already known and priority is on the comparison of different feeders, loads, and production lines, the Siemens Class S device SICAM P855 is first choice. Further application examples are the internal measurement of the power quality or the continuous supervision of systems for uninterruptible power supply (UPS).

The Siemens SICAM PQS/SICAM PQ Analyzer software products evaluate the archived measured PQ data and records. They thus contribute significantly to the transparency of the energy supply, which facilitates identification and elimination of a system failure.

| SICAM Q200	SICAM Q100	SICAM P855
Device for the acquisition, visualization, and analysis of electrical measurands to IEC 61000-4-30: Class A, EN 50160, acquisition and assessment of high-frequency faults (2 to 150 kHz) and of transients with high resolution	Device for the acquisition, visualization, and analysis of electrical measurands to IEC 61000-4-30: Class A, EN 50160	Device for the acquisition, visualization, and analysis of electrical measurands to IEC 61000-4-30: Class S, EN 50160
SICAM PQS/SICAM PQ Analyzer		
Software to evaluate the archived measured PQ data and fault records – facilitates and accelerates the elimination of a system fault		

System Quality Analysis System

The improved analysis with SICAM PQS/PQ Analyzer offers central analysis, display, and archiving of the power-quality data from each corresponding measuring point.

- Information about the individual measuring point help to determine the kind of problem (data loss, unwanted tripping, component failure, control system failures, etc.)
- Possible sources of a deviation of the power quality within the system (motor startup, capacitor switching, operation of power electronic components, arcing of equipment, etc.) can be determined
- The chronological allocation of events that occur at different pieces of equipment can be determined: problems and known operations (such as capacitor switching) that occur simultaneously
- New check of important equipment after a configuration modification
- Checking the supply, taking standards into consideration
- Import and export of data of equipment from third parties

Flexibility and Scalability
Optionally, several instances of SICAM PQS as well as SICAM PQ Analyzer can be used.
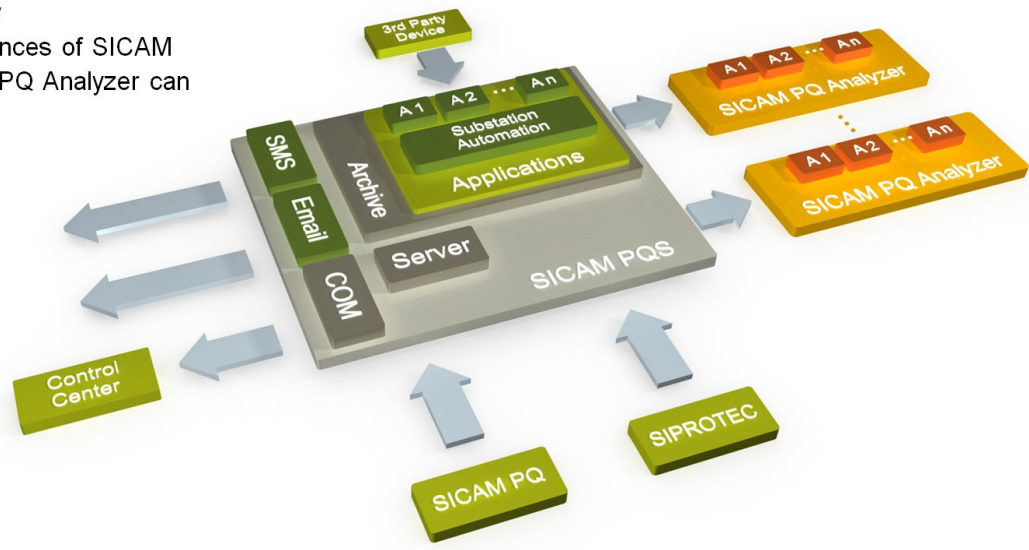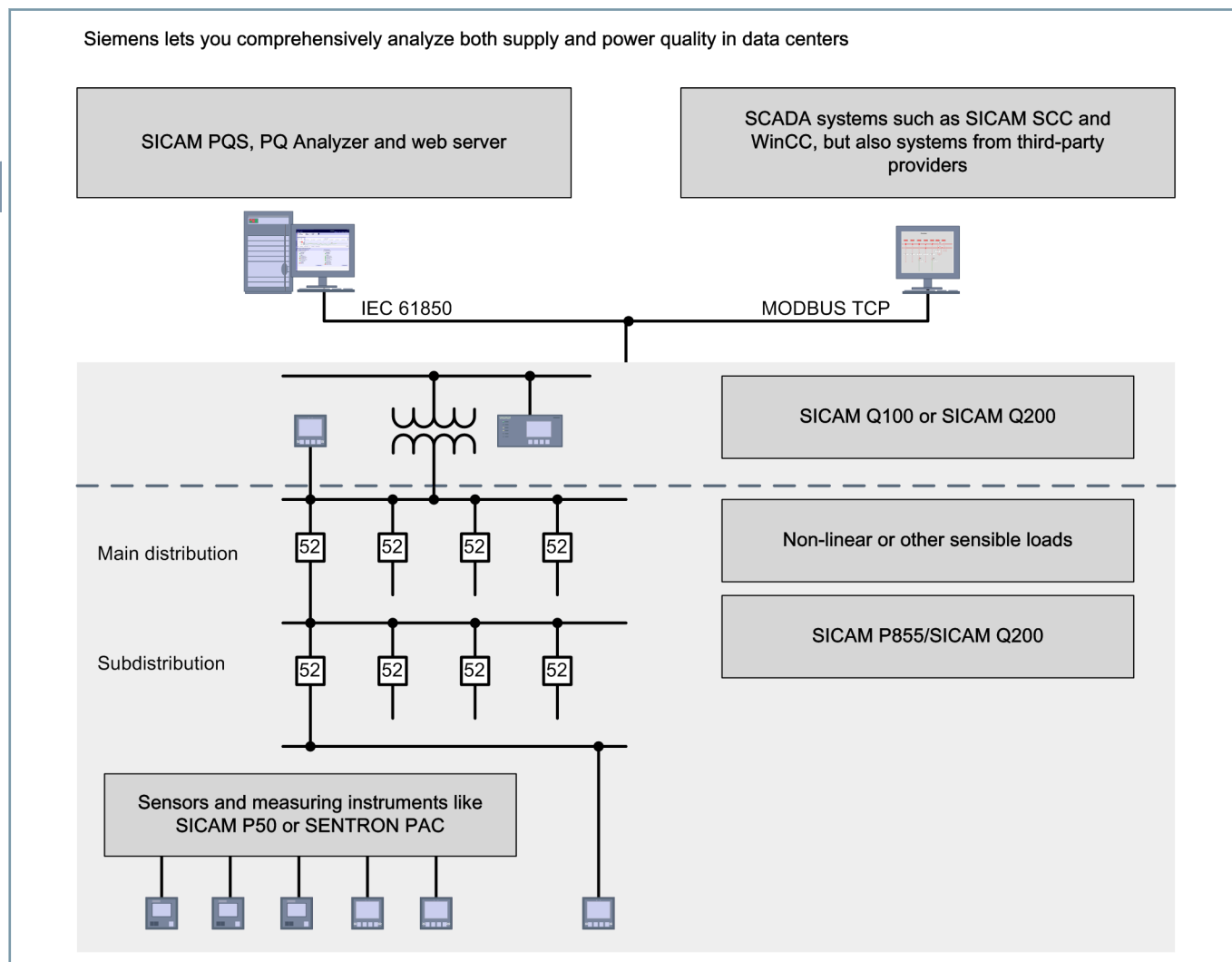

[SICAM PQS_PQ Analyzer, 1, en_US]

Figure 2.1/4   Fault Records and Power Quality Analysis System

Power Quality Recorder

Power Quality – Applications In Data Centers and Industry

Siemens lets you comprehensively analyze both supply and power quality in data centers

SICAM PQS, PQ Analyzer and web server	SCADA systems such as SICAM SCC and WinCC, but also systems from third-party providers

IEC 61850   MODBUS TCP

SICAM Q100 or SICAM Q200

Main distribution

Non-linear or other sensible loads

SICAM P855/SICAM Q200

Subdistribution

Sensors and measuring instruments like SICAM P50 or SENTRON PAC

[dw_appl_data_center, 1, en_US]

Figure 2.1/5   With Siemens You Have a Comprehensive System to Analyze the Quality of Supply of Current and Voltage in Data Centers and Industry

Quality of Power Supply in Data Centers

Failures in the power supply of a data center cause expensive domino effects in IT and telecommunication networks.

To achieve an availability of your data centers in accordance with the Six-Sigma specifications, and beyond, IT and telecommunication providers are dependent on a stable and reliable power supply. The stability of a system is determined by its weakest element. Redundancy systems must provide an uninterrupted constant power supply. If this is not the case, small problems can have enormous consequences. An example: The poor protection of their systems against transients and voltage dips costs a telephone company yearly approximately 24 million Euro. *Source: Leonardo Energy, www.leonardo-energy.org

Inadequate power quality can have far-reaching consequences:

- Costly customer demands
  IT and telecommunication companies are expected to provide perfect performance. Each voltage interruption causes expensive claims and credits.

- Bad reputation

A loss of voltage can severely damage the reputation of a company and lead to losing customers. Regaining confidence is a lengthy and expensive process.

- Site-crossing standstill
  The central data center of an IT company feeds data to many computers around the world. In the event of a standstill, data is globally not available. Turnover is lost, likewise the working time of the employees.

- Costs for experts
  External specialists are frequently required to solve the problem. This creates high unexpected costs.

- Expensive customer care
  The costs of an individual customer call are insignificant. In a telephone company with wide geographic coverage, however, the related costs rise exponentially.

- New setup of the electrical system
  A power event can require your electrical system to be rebuilt partly or as a whole. Preventive measures are more cost-effective than restoring!

- High repair costs
  Repairing damage on servers, switchgear, hubs, etc. is expensive. Replacing IT or telecommunication equipment can severely burden the budget of a company – in particular, if the expenses are unscheduled.

Maximum availability is the crucial factor in the operation of data centers and telecommunication networks. Consequently, monitoring the power quality and controlling and measuring the electrical energy is of utmost importance.

Energy monitoring with SICAM Power Quality and Measurement supports you in the best way of monitoring your energy system.

In your data center, too, Siemens provides higher operational safety and better planning possibilities. The Siemens SICAM solution ensures a simple continuous monitoring of power supply and voltage characteristic in each required monitoring interval. All data and events, such as dips, swells, interruptions, harmonics or voltage fluctuation are reported, documented in real time, and archived. A corresponding evaluation of the measured data enables you to detect potential problems at an early stage, initiate counter measures immediately, and avoid consequential damage. You create safety for your data and protect against data loss.

Power-Quality Monitoring in data centers with Siemens – benefits

- Around the clock maximum current availability and voltage quality for less downtime

- Better data transparency to determine weak points and measures for elimination

- Improved energy efficiency due to identification of potential savings

- Comprehensive documentation of all power-quality parameters to clarify any claims towards the power supplier

- Compliance with all relevant standards.

Optimum Power Supply in Industrial Businesses

Many companies underestimate the financial consequences of a poor quality of their electrical energy supply. Modern industrial production contains much electronic equipment and many automation devices. Such equipment is not only sensitive to voltage fluctuation from the energy supply system, but can also be the cause of failures which it feeds back into the energy supply network.

Copper Development Association estimates that the expenses for preventive measures in industry and commerce are less than 5 % of the costs that are caused by inadequate power quality. Studies show that the average return of investment for damage-limiting measures is less than 2 years.

Continuous acquisition and evaluation of power-quality-relevant measured data helps to detect and eliminate malfunctions at an early stage.

Energy monitoring with SICAM Power Quality does exactly this – in 3 steps, for each business sector

- Defining measuring points in the electrical supply system:
  Here we distinguish between the transfer point of the local utility and important measuring points within the own industrial network.
  The goal is to ensure the quality of the energy obtained from the utility, and the supervision of the power quality in the industrial network.

- Giving a precise statement of measuring devices using Class A devices, such as SICAM Q100 and SICAM Q200, is preferred for the measurement at a transfer point and for contractually agreed energy supply contracts. Class S devices are usually employed for a continuous acquisition of the power quality and/or for the identification of "disturbers" in the industrial network. Siemens offers the multi-function measuring device SICAM P855 for this purpose.
  The combination of these devices thus permits a comprehensive surveillance of the energy network.

- The measured data is completely saved and evaluated in the devices. This feature detects and documents information such as harmonics, voltage fluctuation and flickers.

Energy availability, reliability and quality – at any time

- Continuous monitoring, acquisition and documentation of the parameters that are relevant to the quality of supply in order to identify potential weak points and to initiate suitable measures for their elimination.

- A complete documentation of all relevant parameters is necessary to clarify claims against utilities.

More energy efficiency

- You obtain transparency of energy flow and can identify potential savings.

- The PQ devices provide valuable information for energy management systems that satisfy ISO 50001/EN16247-1 and the energy efficiency standard IEC 60364-8-1.

- Reduced power losses and aging of devices (part 8-1 of the IEC 60364-8-1 standard illustrates the large influence of power quality on energy efficiency)
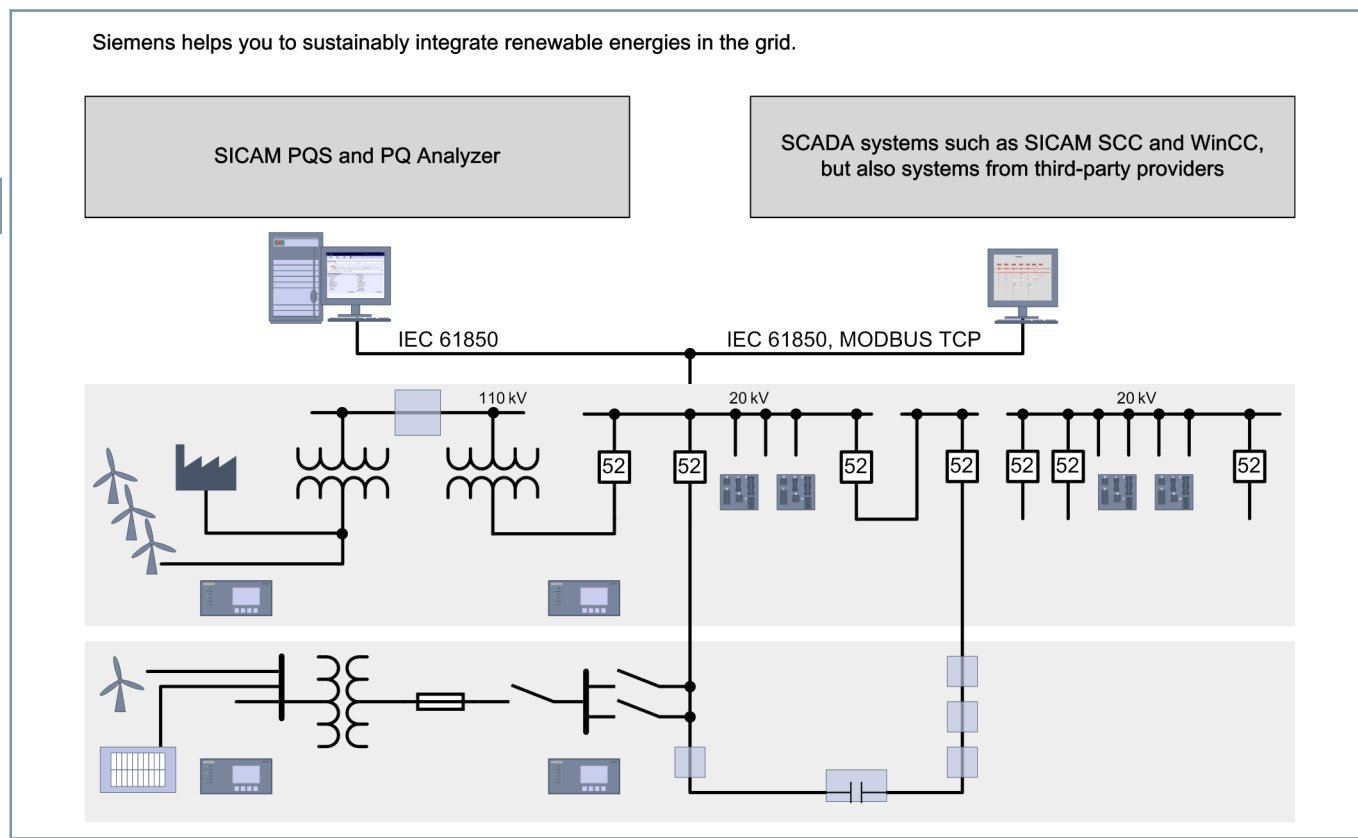
Poor power quality causes a yearly damage of

- EUR 150 billion due to downtime in production and IT in Europe

- 10 % loss of turnover in some companies

Source: J. Manson, R. Targosz: European Power Quality Survey Report, Leonardo Energy

Power Quality Recorder

Power Quality – Applications in Energy Supply

Siemens helps you to sustainably integrate renewable energies in the grid.

SICAM PQS and PQ Analyzer

SCADA systems such as SICAM SCC and WinCC, but also systems from third-party providers

IEC 61850   IEC 61850, MODBUS TCP

110 kV   20 kV   20 kV

[dw_appl_renewables, 1, en_US]

Figure 2.1/6   Siemens Supports You with Sustainable Integration of Renewable Energies Into the Network

Power Quality in Energy Supply

Quality of supply is a challenge for utilities. Reliable supply with electrical energy is the backbone of our society. Not only the availability of electricity, but increasingly the power quality is in the focus today. The increasing utilization of power electronics and frequency converters - resulting from the increasing amount of renewable energies in the infeed mix – reduces the power quality. Due to their far-reaching consequences, such problems are unacceptable today. The increasing competitive pressure and the general call for ecological relief, increased efficiency and cost reduction confront utilities with additional challenges.

Once you have understood the problems that result from voltage fluctuation, you can take the first step to develop standards and solutions.

Power-quality monitoring permits fault phenomena to be detected and identified in time, so that can actively be countered. Examples of these phenomena are power events such as dips, interruptions, overvoltage, flickers, imbalances, harmonics and "superharmonics" in the range of 2 to 150 kHz that can be produced by inverters in modern generation systems.

Only a comprehensive power-quality monitoring with defined criteria provides the transparency that is necessary for swift intervention. These criteria are established in the European power-quality standard EN 50160. Data that does not reach or exceed the defined limiting values must also be recorded and stored. This is the only way of achieving a meaningful overall analysis of the power quality.

Siemens offers you a complete and proven portfolio of PQ solutions that were developed and certified on the basis of the latest standards. They comprehensively measure and document the power-supply continuity. This enables you to forecast potential problems and to take counter measures immediately.

Benefit for utilities and their customers – PQ monitoring with SICAM Power Quality and Measurement:

- Ensures maximum transparency within the distribution system, thus providing important information for utility and customer. For example, you can use this information to adequately dimension the immunity of newly procured system components.
- Contributes to identifying potential energy savings.
- Helps in allocating priorities to investments, thus making investments purposefully.
- Permits easier and more efficient structures of preventive maintenance of the network technology.
- Provides higher current availability and power quality every day and around the clock to achieve better or improved performance and more customer satisfaction.
- Identifies optimization measures to support higher energy efficiency and reduced CO_2 emission. This reduces costs and pollution.

Quality of Supply and Renewable Energies

The world need the transition to a safer, more affordable and CO2-reduced energy system.

The climatic and energy goals for the years 2020 and 2030, that were passed by the European Union, can only be achieved with a strong consolidation of renewable energies. However, the quality of the produced electrical energy is very important for their efficiency and reliability.

Practice shows: Technologies like photovoltaic technology and wind power can have a negative effect on the quality of the generated energy. The number of inverter increases as the share of renewable energy increase – and thus the number of high-frequency levels (2 to 150 kHz) in the electricity-supply system.

The following phenomena and challenges are to be met:

- Voltage fluctuation (influenced by daytime or weather, for example) can cause shutdown, reduced efficiency, and reduced service life of electrical systems. Such phenomena can also show with flickering lighting.

- Harmonics caused by inverters can increase the risk of transformers and capacitor banks to overheat, which causes an overload of the neutral phase and malfunctioning protective equipment.

- Transients and rapid voltage changes, caused by switching activities, for example, can cause hardware failures and data losses and can destroy power supply units.

Meeting these challenges requires exact measurements first and foremost. The Siemens multifunction measuring devices SICAM P855, SICAM Q100, and SICAM Q200 ensure comprehensive monitoring of all relevant parameters in the electrical energy supply network. In accordance with the IEC 61000-4-30 standard, all necessary power-quality parameters are measured, stored and evaluated continuously and completely.

The Siemens SICAM PQS/SICAM PQ Analyzer software is available for an efficient further processing of the measured data. The software automatically evaluates the archived measured PQ data and records, and provides you with extensive information about the compliance with the "grid codes". This facilitates identification and elimination of a system fault, and generally contributes to more transparency in energy supply.

The use of standard communication protocols and data formats, such as IEC 61850, PQDIF, and COMTRADE, makes data exchange easy. In addition, measured values and event information are completely available via Modbus TCP for SCADA systems, such as WinCC.

Power Quality-monitoring with Siemens: Your benefits

- Monitoring-relevant network parameter not only helps you in identifying problems, it also informs you about the integration of renewable energy into the network and the resulting effects. You thus ensure the required quality of the electrical energy supply within the scope of the necessary limits.

- The analysis the effect of the renewable energies has on the energy supply prepares utilities for potential operational problems. It contributes to improving the integration of the renewable energies and to structure investments as sustainably as possible.

- Understanding the problems that result from the fluctuation of the power quality is the first step towards the definition of "grid codes" and the development of preventive measures.

Power Quality Recorder

SICAM Q200 – Description

Description

One of the most frequent causes of unplanned downtimes and device failures is the insufficient quality of the supplied electrical energy. The acquisition and documentation of parameters relevant to supply quality is an important step to identify possible weak points and initiate appropriate measures to eliminate them.

SICAM Q200 is a network analyzer for high-definition acquisition and assessment of the power quality in electrical power supply systems. It offers algorithms and functions for energy management applications. The device supports continuous acquisition and analysis of all relevant parameters. These results help to identify and implement quality programs to ensure the supply quality. This increases the service life of the equipment while at the same time reducing downtimes.

Device type	Switch panel
Auxiliary voltage	AC/DC 100 to 230 V
Memory	2 GB for approx. several months EN 50160 PQ data (expandable)
Inputs and output circuits	4x alternating voltage
	4x alternating current
	Up to 6 binary inputs, 6 outputs, individually programmable
Operation and display	Graphic display including operation via 4 function keys
	Integrated web server to interact with PC and HTML pages
Communication	2 x Ethernet (IEC 61850, Modbus TCP), Modbus gateway/master, integrated switch, SNMPv3
	Modbus RTU master and gateway function for RS485 devices
Time synchronization	Via Ethernet: NTP client (Network Time Protocol)
	Optical IRIG-B (planned)

Benefits

- The early identification of supply quality problems allows for time and cost savings due to comprehensive acquisition of network parameters
- High level of investment security through the use of standards, for example, measuring methods in accordance with IEC 61000-4-30 Class A Edition 3 – ensure manufacturer-independent comparable measured values, standard interfaces and protocols (IEC 61850, Modbus TCP) and data exchange formats (PQDIF, Comtrade, and CSV) – and thus guarantee interoperability
- Versatile application areas thanks to the high measuring accuracy and the wide measuring range for high-frequency noise (2 to 150 kHz and transients with 1 MHz)

Functions

SICAM Q200 is a PQ device Class A acc. to IEC 62586-1/2 and IEC 61000-4-30 Edition 3 beyond Class A and acquires, visualizes, analyzes and transmits alternating current characteristics such as current, voltage, frequency, performance, harmonic, etc. The measured variables can be provided to a PC, an energy automation/SCADA system and/or shown on a display using communi-

[ph_SICAM_Q200, 1, --_--]

Figure 2.2/1 SICAM Q200

cation interfaces. In addition, the SICAM Q200 provides a combined recording and analysis function for measured values directly in the device. Long-term data and events can be transferred to SICAM PQS/PQ Analyzer System via IEC 61850, and flexible analyses and reports (for example EN 50160) can be generated.

Measured Characteristics and Power Quality

- Measurement compliant with IEC 61000-4-30 Class A Edition 3, reporting and analyses compliant with EN 50160 (CBEMA)
- True RMS of voltage and current with 8192 sampled values/10 sampling cycles (sampling rate 40 kHz @50 Hz), voltage transients with a sampling rate of 1 MHz
- Harmonics up to the 63rd harmonic
- Measurement, visualization*, recording in PQDIF of frequencies in the range of 2 kHz to 9 kHz (IEC 61000-4-7) and 9 kHz to 150 kHz (IEC 610000-4-30 (2015))
- Rapid voltage changes
- Power of harmonics for harmonic direction detection
- Active, reactive and apparent power and energy
- Phase angles

* in preparation

Energy Management

- Load profile peaks and average values; time of use (TOU) with 4 tariffs
- Complies with the following standards: IEC 62053-22 accuracy Class 0.2 S, ANSI C12.20 Class 0.2
- ANSI C12.20 Electricity meter, accuracy Class 0.2
- 4 Quadrant Power: received and delivered/inductive and capacitive

Data Export

- CSV data, for example for further processing in MS Excel
- PQDIF data compliant with IEEE 1159.3, for PQ recordings
- COMTRADE data compliant with IEC 60255-24/IEEE Std C37.111 for waveform records

Special Features

- PQ reporting according to EN 50160 and CBEMA directly over HTML Web server
- Multi web browser support (IE, Chrome, Firefox)
- Evaluation of events directly in HTML via COMTRADE viewer/ SIGRA plug-in

Applications

SICAM Q200 is used in single-phase as well as in threewire and four-wire systems (with neutral conductor) in power utilities, industries, data centers and in commerce.
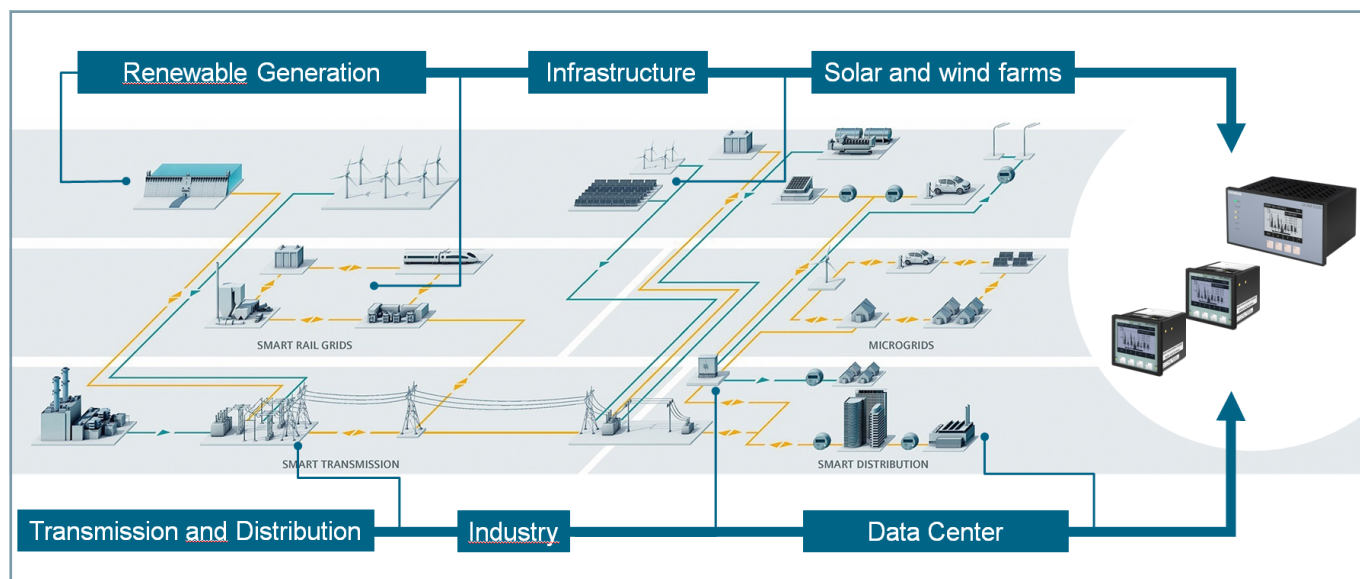
[Areas of application, 1, en_US]

Figure 2.2/2   Fields of Application

Power Quality Recorder

SICAM Q200 – Applications and Application Examples

SICAM Q200 Standalone

The device is installed as a standalone device for uninterrupted recording of all relevant parameters relating to power quality, event analysis, and power management, e.g. at the customer transformer or other system interface.

When SICAM Q200 is used as a stand-alone analyzer, data and information can be accessed directly via HTML pages, displayed, and flagged. Other export functions such as PQDIF, CSV, and COMTRADE are available directly from the device.

Additional programs such as SIGRA and COMTRADE Viewer can be used to further analyze fault records.

Power Quality Application Industry and Data Center

- Only a web browser for configuration and visualization
- Infeed Transformer and Critical Loads
- Manual Data Export CSV
- Serial Modbus Slave Devices
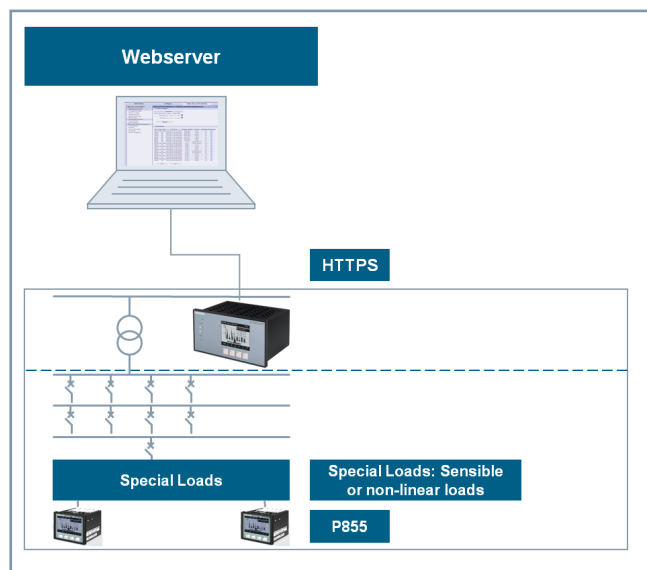
[Q200_Appl_Simple_Exa, 1, en_US]

Figure 2.2/3   Standalone Analyzer

SICAM Q200 with automation systems or evaluation stations

SICAM Q200 is able to communicate flexibly **with SCADA systems, and automation systems or evaluation stations** via standard protocols such as IEC 61850 and Modbus TCP. With IEC 61850 Ed. 2, historical data such as power quality and event recordings can be transmitted to the SICAM PQS system in standard data formats such as PQDIF and COMTRADE.

In addition, Modbus TCP can be used to monitor all device operating parameters, protocols, and indications, as well as information on voltage events.

Power Quality Application in Utility – Example

- Topological Assignment of devices
- Automatic Data Evaluation and Archiving
- 3rd Party Device Integration
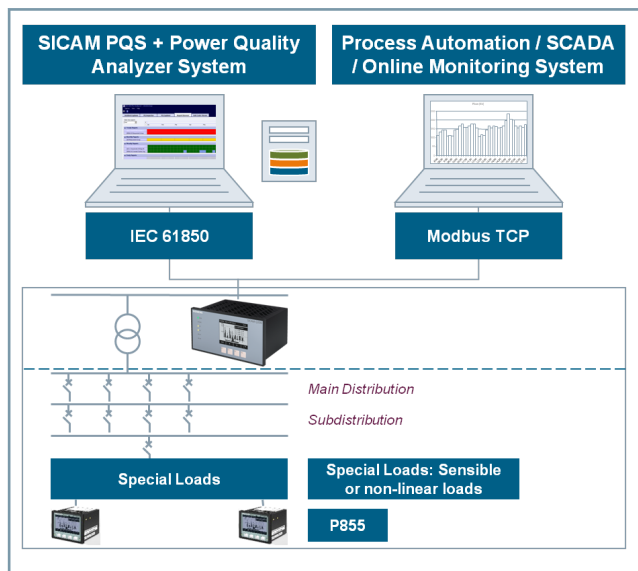 - Power meters
  - Protection

- Fault recorders
- Operational Value integration into Control center, SCADA and DMS systems
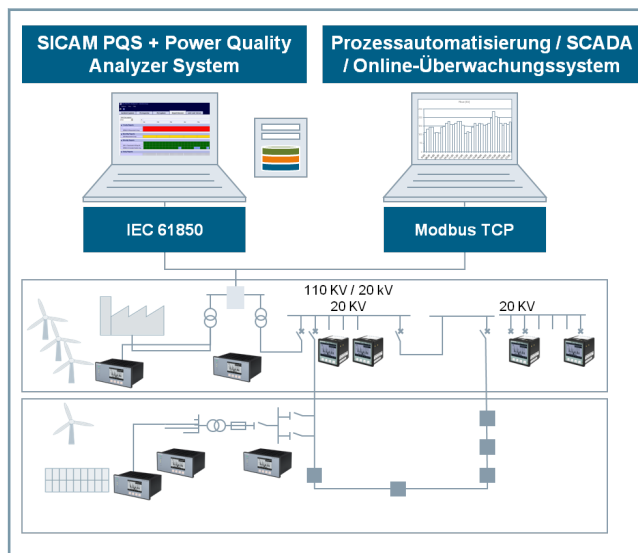
[Q200_Appl_Utility_Exa, 1, de_DE]

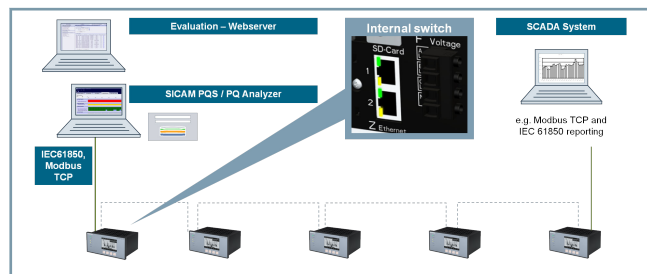**Figure 2.2**/4   Application Example in the Utility

[Q200_Appl_Ind_Exa, 1, en_US]

Figure 2.2/5   Application Example in the Industry

Communication Applications

SICAM Q200 is equipped with 2 Ethernet interfaces that permit ring communication configurations.


[Q200_Appl_Parallel, 1, en_US]

Figure 2.2/6   Example: Parallel Power-Quality Evaluation and Operating-Value Processing

SICAM Q200 as Modbus gateway and master

SICAM Q200 uses the RS485 interface to implement the Modbus master and Modbus gateway functions.

The gateway functionality permits a swift and easy integration of other serial RS485 devices into the Modbus TCP or IEC 61850 network.

The Modbus master function permits data from up to 16 of the above-mentioned devices to be monitored and displayed on the display or via an HTML page.
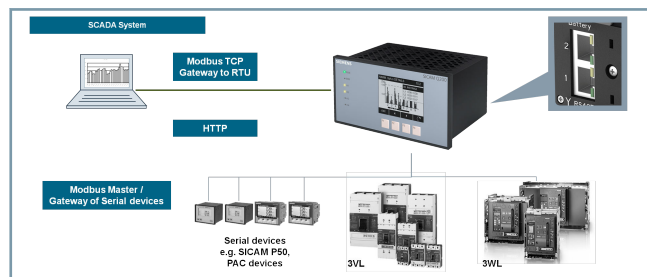
[Q200_Appl_Modbus, 1, en_US]

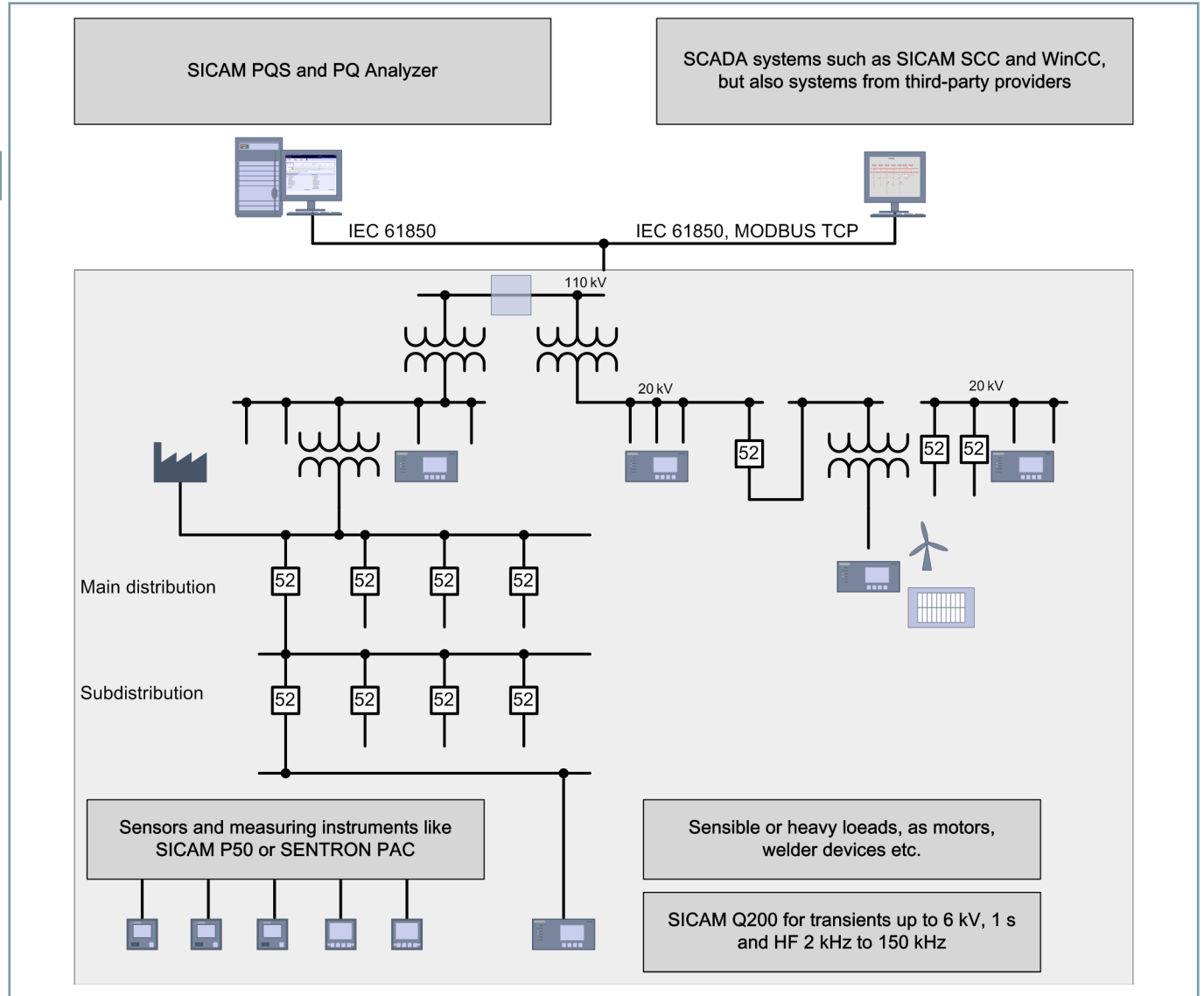**Figure 2.2**/7   Example: Modbus Master and Gateway

2.2

Power Quality Recorder

SICAM Q200 – Special Applications

The new SICAM Q200 measures **high-frequency emissions** that are caused by renewable energy carriers. It supports the **meas-** **urement of transients** in consumers, whether in industrial systems or data centers.
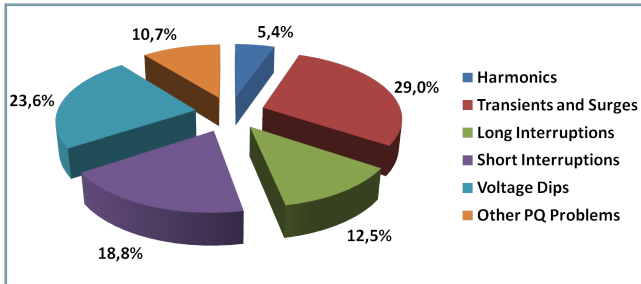
[dw_supply overview, 1, en_US]

Figure 2.2/8   Power Distribution System Overview in Different Environments

Recording and Logging Transient Overvoltages

Transient overvoltages can damage and destroy electronic devices in power-distribution systems, and thus lead to production losses. As shown in the quality of supply report from Leonardo Energy, poor power quality causes yearly losses of at least 150 billion Euro in Europe – transients are approximately 28 % of the yearly faults. According to the "Control Engineering Magazine", US experts estimate the yearly expenses for US companies that arise in the power supply sector due to problems with transient overvoltage to 26 billion Dollars.

Pie chart legend:
- 5,4% Harmonics
- 29,0% Transients and Surges
- 12,5% Long Interruptions
- 18,8% Short Interruptions
- 23,6% Voltage Dips
- 10,7% Other PQ Problems

[Diagramm, 1, en_US]

Impulsive or oscillatory transients typically have spectral contents in the kHz/MHz range, with a duration in the µs/ms range and a magnitude up to 6 kV in low-voltage systems

Transient voltages can occur in your system or in the distribution system:

- Origin in the distribution system: Due to lightning strike in power lines, switching operations or electrical incidents in the distribution network
- Origin in the system: Switching internal heavy-load motors, welding equipment, PFC banks, electrical furnaces, induction heaters or overvoltage protection devices (disconnectors, switches, ...)

Transients can propagate through different electrical system levels, thus affecting the electrical insulation, for example. This can lead to sudden failures or to a gradual failure of individual devices or even of the entire system operation. Many failures of integrated circuits and damage on computers or electronic equipment can be attributed to transient voltage. Since the damage caused by transients can remain unnoticed, there is not frequently a correct diagnosis of the reason of the damage to a component, and be entered as "unknown" in the work order. Although not all transients can be avoided, measuring and detecting transient helps in finding the proper measures for risk minimization, such as transient voltage surge suppressors (TVSS), overvoltage protection, and interference filters. Transients can also be reduced by a correct system structure with proper EMC measures (screened cables and screen handling in distribution systems), correct ground dimensioning, selection of devices of adequate overvoltage categories, etc.

	Siemens Power Quality and monitoring solution
SICAM Q200	
State-of-the-art	• Compliant IEC 61000-4-30 Ed.3 Class A • Measuring and assessing high-frequency problems (2 kHz to 150 kHz) • Detection, measurement and recording of transients: time resolution 1µs, (1 mio. samplings/s), up to 6 kV
Data and communication standards	PQDIF and COMTRADE files, no special tools required. IEC 61850 and Modbus for integration into the system
Enhanced information to SCADA systems	Information about the current quality can easily be integrated into your SCADA systems (such as Power CC, SICAM SCC, SICAM PQS/PAS) via standard protocols (such as Modbus TCP or IEC 61850)
Complete solution	SICAM PQS and PQ Analyzer permit central display, evaluation, and archiving of the power-quality data from the corresponding measurements.

Benefits

Understanding transients and their classification is the basis and the first step of developing standards and optimal possible solutions:

- Comprehensive monitoring, acquisition, and documentation of the parameters that are relevant to quality of supply and transients
- Supporting the measurements to understand the effect of transients on the system performance
- Identification of potential weak points in the energy supply
- Continuous monitoring of the effects new technologies have on loads and energy consumers

Customer Benefits

- Taking suitable counter measures to avoid problems in the operational sequence, downtimes, failures, and equipment damage
- Improved availability, safety and quality of the power – 24/7
- Creating transparent energy flows to support energy management systems in determining potential savings

2.2

Power Quality Recorder

SICAM Q200 – Special Applications

Supraharmonics – a New Theme of Power Quality

The classical power-supply structure generation-transmission-distribution-consumer with centralized generation and current flow only in one direction changes towards distributed and bidirectional network structures.
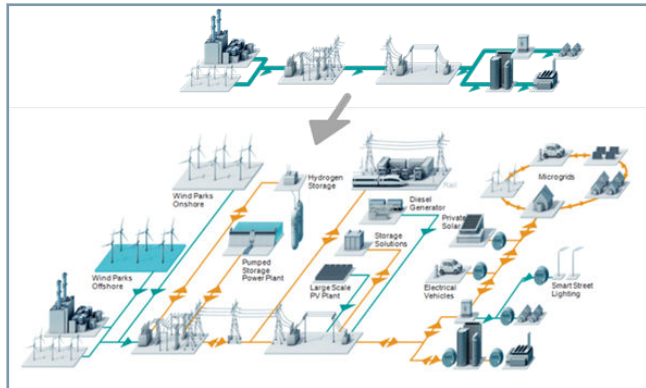
[sc_Application HF, 1, --_--]

The large number of distributed renewable energy sources with their fluctuating power infeed can have an increasingly negative influence on the electricity-supply system. The high-frequency emissions in our future grids and the connected consumers will therefore increase. New IEC standards for limiting values of supraharmonics in low-voltage power systems will be published in the near future.

High-frequency emissions, known as "supraharmonics" (2 kHz to 150 kHz), can highly affect neighboring devices and influence them. The sensitive devices include smart-meter gateways, dimmers for lamps, and PLC communication. This can also be the cause of failures of touch-controlled operator elements.

Facts about high frequency

- The increasing number of renewable energy sources (photovoltaic fields, wind farms, and energy storage units) increases the influence by required optimal switching frequencies of converters.
Typical switching capacity of semiconductors in converters:
1 kW to 100 kW in the range from 20 kHz to
100 kHz > 100 kW in the range from 9 kHz to 20 kHz

- Increasing requirements and standards compel efficient power supplies for drives, and result in an increasing number of switching power converters

- The grid "of the future" increasingly requires the use of communication (PLC communication, building automation)

Possible consequences of emissions in the frequency range from 2 kHz to 150 kHz

- Increasing capacitive currents can damage the power supply, increase the neutral current and thus increase the safety risk

- More failures in touch-controlled operator elements and dimmers for lamps

- Reduced service life of LED lamps

- Causes communication problems (such as PLC communication)

- Can cause failures in protective devices

Benefits

Monitoring of Power Quality with Siemens

- Improves the knowledge with respect to the correlation between power fluctuation and power quality

- Supports the development of standards up to optimal possible solutions:
  - Supporting the measurements to understand the effect of converters, caused by the integration of renewable energies
  - Identification of potential weak points in the power supply
  - Continuous monitoring of the impact of new technologies on loads and energy consumers

Customer Benefits

- Taking suitable counter measures to avoid problems during operation and to avoid down times, failures, and equipment damage

- Improved availability, safety and quality of the power – 24/7

- Creating transparent energy flows to support energy-management systems in determining potential savings

Device Properties

All devices consistently provide the following properties:

- Device type:
  - Power Monitoring Device and Power Quality Recorder, class A, with measured-value recorders and exchangeable 2-GB microSD card
  - Panel flush-mounting device with display for measured values and parameterization
  - Plastic case 192 mm/7.56 inch x 96 mm/3.78 inch x 134.6 mm/5.3 inch (W x H x D)
  - Web server for parameterization, visualization, and data management
  - Transmitting measured values using communication protocols
  - Degree of protection:
    - Front: IP40 (standard)
    - Front: IP54 (with separate seal between housing and switch panel)
    - Terminals: IP20 (behind switch panel)
- Input and output circuits:
  - 4 inputs for alternating voltage measurements
  - 4 inputs for alternating current measurements
  - Up to 2 binary modules; each binary module has:
    - 3 binary inputs, for example, for synchronization pulses of the load profile or external triggers
    - 3 binary outputs (relay contacts)
- Measurement acc. to standard IEC 61000-4-30 Ed. 3, class A
- Measured quantities:
  - Voltage V
  - Current I
  - Phase angle ϕ
  - System frequency f (fundamental)
  - 10-s frequency
  - Active power P (accuracy class 0.2S; ANSI C12.20 current class 2 and current class 10)
  - Reactive power Q
  - Apparent power S
  - Energy measured values W
  - Active power factor cos ϕ
  - Power factor PF
  - Voltage and current harmonics up to 63rd, voltage and current interharmonics up to 49th, and voltage harmonics in the range from 2 kHz to 9 kHz and from 9 kHz to 150 kHz
  - THDS
  - Flicker acc. to IEC 61000-4-15
- Measurements for evaluation and supervision
  - Minimum/mean/maximum values
  - Event detection: voltage dips, voltage swells, voltage interruptions
  - Limit violations
  - Energy management (load profiles and tariffs)
  - Rapid voltage change (RVC)
- Communication interfaces
  - Communication via Ethernet:
    - Only Modbus TCP protocol (device version 7KG9700-0BA0x-xAA0)
    - Modbus TCP protocol and/or IEC 61850 server protocol (device version 7KG9700-0BA0x-xBA0)
  - Serial communication via RS485
    - Protocol Modbus RTU slave
    - Protocol Modbus RTU master protocol and gateway function
- Data export
  - CSV data
  - PQDIF data
    $IEEE1159.3$: PQDIF for PQ records (events, measurements, records)
  - COMTRADE data
    $IEC\ 60255\text{-}24/IEEE\ Std\ C37.111$: Measuring relays and protection equipment – Part 24: Common format for transient data exchange (COMTRADE for power systems) for fault records
- Internal Ethernet switch
- Certificates
  - CE certification
  - UL certification

Communication

The device has 2 Ethernet ports which can be used as 2 independent Ethernet interfaces (in different networks) or as 2 ports of the integrated Ethernet switch (in 1 network). Ethernet supports the device parameterization, transmission of measured values, metered values, load profiles, and indications/events and the time synchronization with NTP. The supported Ethernet communication protocols are HTTP, IEC 61850, Modbus TCP, and SNMPv3.

The RS485 interface (1 interface with 2 connectors) allows Modbus RTU master and Modbus RTU slave functionality.

Security

To ensure a high level of security (for example IT industry), the access to the device is password-protected.

Further security features are:

- SNMPv3
- Automatic logoff after a timeout of no action
- Disabling of ports
- Modbus TCP as read only

Time Synchronization

During operation, SICAM Q200 needs the date and time for all time-relevant processes. This ensures that a common time basis exists when communicating with peripheral devices and enables time stamping of the process data.

2.2

Power Quality Recorder

SICAM Q200 – Properties and Functions

The following types of time synchronization can be executed:

- External time synchronization via Ethernet NTP (preferred)
- External time synchronization via fieldbus
- Internal time synchronization via RTC (if external time synchronization is not available)

Functionality of Recorders

The recorders can record measured values, events, and load profiles in parameterizable time intervals. The following recorder types are used:

- Measurement recorder:
  Recording of PQ measured quantities acc. to IEC 61000-4-30 (for example, frequency and voltage magnitude) and non-PQ measured quantities (for example, currents and power) as well as parameterized periods, for example, 10-second frequency, voltage aggregation, current, and power, emissions 2 kHz to 9 kHz, and emissions 9 kHz to 150 kHz

- Trend recorder:
  Long-term recording and monitoring of the voltage-change history within a parameterized time period in programmable tolerance ranges; 1/2 cycle RMS values

- Sine recording:
  Recording of voltage and current sampled values with 40.96 kHz (at 50 Hz, about 819 samples per cycle) using programmable triggers

- Event recorder:
  Recording of 819 samples per period of voltage: voltage events (acc. to IEC 61000-4-30: swells, dips, interruptions)

The device hosts a 2-GB micro SD card for storing the recorder data.

General

The load profile reflects the history of the electric power and documents the distribution of power fluctuations and peaks. The load profile is determined on the basis of subperiods of 10/12 cycles (50 Hz/60 Hz).

SICAM Q200 supports 2 methods of load-profile determination: **Fixed block** and **Rolling block**.

The load profile is stored in the ring buffer of the device and provided at the communication interfaces (see Communication manual). In addition, it can be output as CSV file.

The load profile can be recorded in synchronized or non-synchronized form. The synchronization is made by external or internal triggers.

The following diagram shows a 45-min measuring period which consists of 3 subperiods of 15 min each.

The measured and calculated load-profile data are stored in the ring buffer at the end of each subperiod. After 3 subperiods, the average power value of the measuring period is calculated from the 3 load-profile data of the subperiods. The values (cumulative values and averages) can be retrieved at any time within a subperiod via the communication.
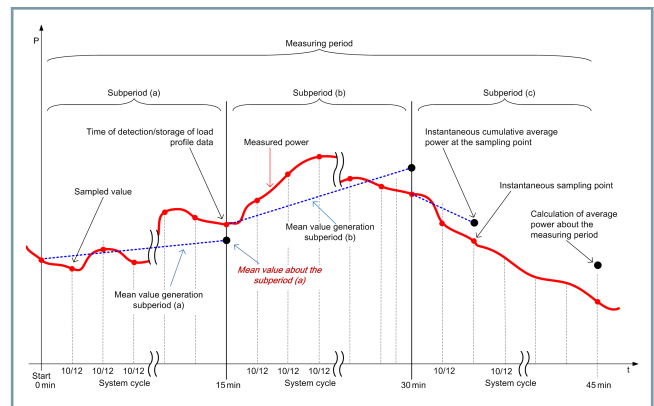

[dw_power-history-15-min, 1, en_US]

Figure 2.2/9   Power History of a Measuring Period Consisting of Three 15-min Subperiods

SICAM Q200 supports up to 4 tariffs for energy meters. The 4 tariffs include the supplied or consumed active energy, the reactive energy, and the apparent energy. If the tariff change is controlled via protocol, up to 4 tariffs can be set. If the tariff change is controlled via binary inputs, up to 2 tariffs can be set.

The tariffs are changed via the external interfaces. A time-related tariff changing is only possible by a superordinate system.

Tariff Change with Load-Profile Synchronization

The recorded load profile is always assigned to the current tariff.

If you change the tariff during a running measuring period, for example, from high to low tariff, it has initially no effect on the load-profile recording.

The new tariff becomes effective in the power meters of SICAM Q200 only with the start of the next measuring subperiod.

Configuration of Power Quality Reports

The report configuration function can be used to set PQ threshold values. Threshold values can be adapted to the installation environment and various settings can be entered, for example, to generate standardized reports according to EN 50160 LV & MV or EN 50160 HV, or to generate user-defined reports.

Recordings with support from COMTRADE Viewer and the SIGRA plug-in, SICAM Q100 can display the following recordings:

- Measurements for visualizing mean, minimum, and maximum values in tables or graphs
- Trend recordings with resolution up to 1/2 period for visualizing voltage quality events
- Fault recordings of triggered voltages and currents

The signals can be downloaded and then displayed on a PC using COMTRADE Viewer.

[sc_Q200_configuration, 1, --_--]

Figure 2.2/10   Configuration of Power Quality Reports

Power Quality Recorder

SICAM Q200 – Measuring and Recording Functionalities

Recording	Measurements	Interval/storage method	Application	Availability
Continuous Measurements of operational (IEC 61000-4-30 Ed 3 where applicable) values	Operational values (voltage, current, power, counters, cos φ, THD, harmonics, 2 kHz to 9 kHz, THD-R, K-Factor)	Each 10/12, 150/180 period available	Display, HTML view, SCADA systems,	IEC 61850 or Modbus TCP register HTML visualization
Measurement recorder (IEC 61000-4-30 Ed 3 where applicable)	Frequency	Frequency value (fixed in 10 sec aggregation interval) as IEC 61000-4-30	Long-term monitoring of the power quality, e.g. according to EN 50160 or user defined standard	Modbus TCP or IEC 61850 (PQDif format) HTML visualization CSV export
	Mains voltage level	1 min, 10 min, 2 h		
	Unbalance of the mains voltage			
	Harmonics and inter-harmonics of the mains voltage			
	Additional data (e.g. power values, min/max values, etc.)			
	Flicker	Pst determined over 10 min; Plt over 2 h (12 Pst values)	Monitoring of the power quality according to IEC 61000-4-15	Modbus TCP or IEC 61850 (PQDif format) HTML visualization CSV export
Trend recorder	Vrms (1/2) cycle	For measured value changes (in percent or absolute) and cyclic (time interval)	Subsequent analysis of the power quality with any grid codes in PQS and visualization in Webserver	IEC 61850 (record PQDif format) HTML visualization (SIGRA plugin)
Event Recorder (IEC 61000-4-30 Ed 3 where applicable)	Voltage dips, voltage interruptions	Residual voltage V_{rms} (1/2) and time stamp (duration)	Long-term monitoring of the power quality according to EN 50160, classification of voltage events, e.g. ITIC/CBEMA curve	Modbus TCP – 10 last events or IEC 61850 (LN) HTML visualization
	Voltage swells	Maximum voltage magnitude V_{rms} (1/2) and time stamp (duration)		
Sine recording	Voltages, currents	Voltage/current variation triggers, acquisition of sampled values (max. 3 s)	Analyzing the causes of power quality problems	IEC 61850 (COMTRADE format) HTML visualization (COMTRADE Viewer)
Energy Monitoring and counter functions	Load profile	Fixed Block method or Rolling Block method	Determining the load profi for supply and consumption of electric power	Modbus TCP
High Frequency	2 kHz to 150 kHz High-frequency measurement for voltage	1 min, 10 min, 2 h	Long-term monitoring of the power quality	IEC 61850 (PQDIF-format) HTML-Visualization (in preparation)
Transient	Voltage – Transient detection 1,024 MHz; 20480 sample points per cycle 50 Hz; 17067 sample points per cycle 60 Hz	Up to 40 ms sine recording with high resolution	Transient logging and recording	IEC 61850 (COMTRADE-Format), COMTRADE Viewer-Visualization

Table 2.2/1   Measurement and Recording – Recorder functionality and applications

Measured Quantities

The following measured quantities can be recorded or calculated:

Power quality parameters

- Power frequency
- Magnitude of supply voltage
- Flicker
- Supply voltage dips, swells, and interruptions
- Voltage unbalance
- Voltage harmonics and interharmonics
- Rapid voltage changes (RVC)
- Current magnitude
- Current harmonics and interharmonics
- Current unbalance
- Emissions 2 kHz to 9 kHz
- Emissions 9 kHz to 150 kHz

Other parameters

- Active, reactive, and apparent power
- Active, reactive, and apparent energy
- Power factor and active power factor
- Harmonic power
- Voltage and current THDS (Subgroup Total Harmonic Distortion)
- Phase angles
- Harmonic phase angles

The uncertainty of operational measured quantities is compliant to the IEC 62586-1 product standard, class A (leading standard), the IEC 61000-4-30, Ed. 3 power quality standard, and the IEC 62586-1, Ed. 1 standard.

Power Quality Recorder

SICAM Q200 – Device Parameterization, Visualization, Evaluation

Device Parameterization

SICAM Q200 devices are parameterized from a connected PC using the web browser integrated in the device.
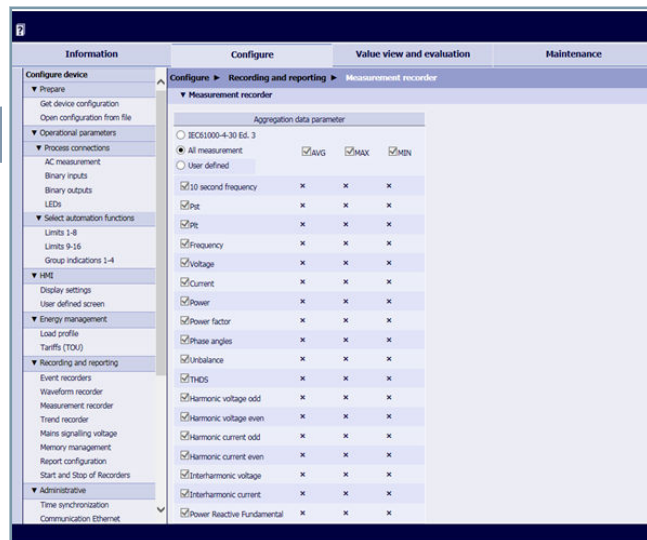
[sc_Q200_parameterization, 1, --_--]

Figure 2.2/11   Screenshot of configuration

Visualization of Values

Depending on which operating parameters are selected, the input/output window displays either the measured values in the corresponding unit of measure or a tabular list that is updated every 5 seconds.

[sc_Q200_Visualization, 1, --_--]

Figure 2.2/12   Screenshot of Visualizattion of Values

Voltage Quality Data and Reporting

[sc_Q200_harmonic voltages, 1, --_--]

Figure 2.2/13   Screenshot of Voltage Quality Data and Reporting

With SICAM Q100, the evaluation of recorded voltage events (such as overvoltages, undervoltages, interruptions, etc.), the generation of the PQ report according to EN 50160, data transmission, and memory management are performed directly in the device via HTML. A calendar function is used to set the start and end times for the PQ report. The report can be generated, printed, saved, and edited from the SICAM Q200 HTML page.

Supply Voltage

Direct Voltage Block H

Rated input voltages	110 V to 250 V
Admissible input voltage tolerance	±20 %
Permitted ripple of the input voltage	15 %
Maximum inrush current	
At 110 V to 250 V	≤ 22 A; after 250 µs: < 5 A
Maximum power consumption	15 W

Alternating Voltage Block H

Rated input voltages	110 V to 230 V
System frequency at AC	50 Hz/60 Hz
Admissible input voltage tolerance	±20 %
Permitted harmonics	2 kHz
Maximum inrush current	
At 230 V	≤ 22 A; after 250 µs: < 5 A
Maximum power consumption	30 VA

Inputs and Outputs

Inputs for Alternating Current Measurements, Connector Block E

Input alternating currents	
Rated input current range	AC 1 A to 5 A (autorange)
Max. input current	AC 10 A (sinusoidal only)
	Max. ±14.2 A peak
Power consumption per input	
At 5 A	2.5 mVA at $_{in}$ = 100 µΩ
Further information about the current measuring inputs	
Max. rated input voltage	150 V
Measuring error under environmental influences	Acc. to IEC 61000-4-30 Ed. 3 Class A
Thermal stability	10 A continuous
	100 A for max. 1 s
Sampling rate	40.96 kHz

Inputs for Alternating Voltage Measurements, Connector Block F

Rated input alternating voltage range	
Phase-N/PE	AC 57.73 V to 400 V (autorange)
	IEC 61000-4-30 Ed. 3 Class A:
	• Up to AC 230 V: 200 % overvoltage
	• > AC 230 V to 400 V: 200 % to 15 % overvoltage
	UL conditions:
	• Up to AC 170 V: 200 % overvoltage
	• > AC 170 V to 300 V: 200 % to 15 % overvoltage
Phase-phase	AC 100 V to 690 V (autorange)
	IEC 61000-4-30 Ed. 3 Class A:
	• Up to AC 400 V: 200 % overvoltage
	• > AC 400 V to 690 V: 200 % to 15 % overvoltage
	UL conditions:
	• Up to AC 290 V: 200 % overvoltage
	• > AC 290 V to 520 V: 200 % to 15 % overvoltage
Maximum input alternating voltage	
Phase-N/PE	460 V (347 V for UL)
Phase-phase	796 V (600 V for UL)
Input impedances	
a, b, c to N	3.0 MΩ
a-b, b-c, c-a	3.0 MΩ
a, b, c, N to PE	1.5 MΩ
Further information about the voltage measuring inputs	
Power consumption per input for U_{max} 460 V	70 mW
Permissible power frequency	42.5 Hz to 69.0 Hz
Measuring error under environmental influences	Acc. to IEC 61000-4-30 Ed. 3 Class A
Sampling rate	40.96 kHz

Binary Inputs, Connector Blocks R and S

Number	6
Rated input voltage range	24 V to 250 V
Maximum input voltage	DC 300 V
Static input current	1.34 mA ± 20 %
Threshold voltages (adjustable)	
Threshold voltage 19 V	U high ≥ 19 V
(at rated voltage 24 V)	U low ≤ 10 V
Threshold voltage 88 V	U high ≥ 88 V
(at rated voltage 110 V)	U low ≤ 44 V
Threshold voltage 176 V	U high ≥ 176 V
(at rated voltage 220 V)	U low ≤ 88 V
Progapation delay low to high	2.8 ms ± 0.3 ms

Binary Outputs (Relay Outputs), Connector Blocks R and S

Type of relay:	Number acc. to order number:
NO relay	Max. 4
CO relay	Max. 2
Output values	
Switching capacity	On: 1000 W/VA
	Off: 30 VA; 40 W ohmic
	25 W/VA at L/R ≤ 40 ms
Contact voltage AC and DC	250 V
Permissible current per contact	Continuous: 5 A
	Switching on and holding:
	30 A for 500 ms (make contact)
Total permissible current for contacts connected to common potential	5 A

2.2

Power Quality Recorder

SICAM Q200 – Technical Data

Switching time (OOT)	≤ 5 ms; (OOT = Output Operating Time) additional delay of the output medium used
Anti-interference capacitor across the contacts	4.7 nF
Contact life	
Expected contact life	> 10^7, mechanical, at 300 switching cycles/min
Expected contact life (resistive load)	> 10^5, electric (AC), at 20 switching cycles/min

Communication Interfaces

Ethernet, Electrical (Connectors Z1 and Z2)

Connection	RJ45 connector socket 100Base-T acc. to IEEE802.3 LED yellow: ● On: Ethernet Link exists ● Flashing: Ethernet activity ● Off: no connection LED green: ● On: 100 Mbit/s ● Off: no connection
Protocols	Modbus TCP IEC 61850
Voltage strength	DC 2200 V
Transmission rate	100 Mbit/s
Cable for 10/100 Base-T	100 Ω to 150 Ω STP, CAT5
Maximum cable length 10/100 Base-T	100 m, if correctly installed

Serial Interface RS485 (Connectors Y1 and Y2)

Connection	RJ45 connector socket
Protocol	Modbus RTU Slave, Modbus RTU Master, and gateway function
Baud rate (adjustable)	Min. 1200 bit/s Max. 115 200 bit/s
Maximum distance of transmission	Max. 1 km (depending on transmission rate)
Transmission level	Low: -5 V to -1.5 V High: +1.5 V to +5 V
Reception level	Low: ≤ -0.2 V High: ≥ +0.2 V
Bus termination	Integrated, connectable termi-nating resistors, 120 Ω between A and B
Fail safe for idle bus	Integrated, connectable fail safe resistors, 680 Ω between B and VCC_RS485 as well as A and GND_RS485.
Dielectric strength	DC 700 V

Pin No.	Assignment
Pin assignment acc. to Modbus via Serial Line specification	
1	Not assigned
2	Not assigned

Pin No.	Assignment
3	Not assigned
4	B RS485 connection pin B
5	A RS485 connection pin A
6	Not assigned
7	Not assigned
8	GND

Optical Interfaces J (Input, Output)

Not used in this version.

Ambient Conditions

Environmental Conditions

Temperature data	Operating tempera-ture Devices with display: the legibility of the display is impaired at temperatures < 0 °C (+32 °F)	-25 °C to +55 °C -13 °F to +131 °F
	Temperature during transport	-40 °C to +70 °C -40 °F to +158 °F
	Temperature during storage	-40 °C to +70 °C -40 °F to +158 °F
	Maximum tempera-ture gradient	20 K/h
Air humidity data	Mean relative humidity per year	≤ 75 %
	Maximum relative humidity	95 % 30 days a year
	Condensation during operation	Not permitted
	Condensation during transport and storage	Permitted
Altitude and operation site	Max. altitude above sea level	2000 m
	Operating condition	Indoors use
Pollution degree	2	

General Data

Battery	Type	PANASONIC CR2032 or VARTA 6032 101 501
	Voltage	3 V
	Capacity	230 mAh
	Typical life	For operation with permanently applied supply voltage: 10 years
		For operation with sporadically inter-rupted supply voltage: A total of 2 months over a 10-year period
Internal memory	Capacity	2 GB

Degree of protection	
Housing	IP20
Front	IP40
Front	IP54, dust-tight type 12
(with separate seal between housing and switch panel; seal is part of the IP54 kit of SICAM Q200 accessories)	NEMA 12

Dimensions
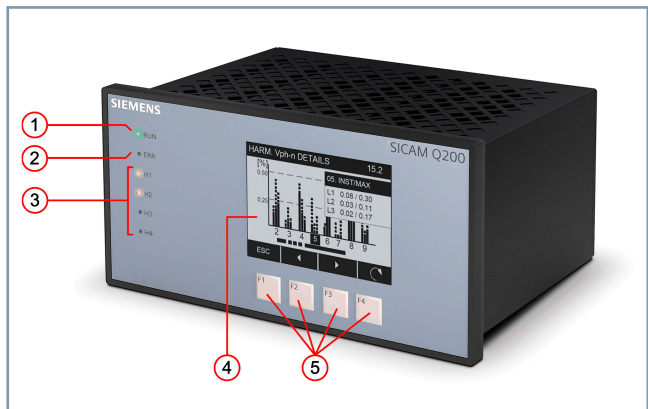
[le_Q200_front side, 2, --_--]

Figure 2.2/14   Layout of SICAM Q200 – Front Side

(1) LED RUN

(2) LED ERROR for error configuration

(3) LEDs H1 to H4 for free configuration

(4) Display

(5) Softkeys F1 to F4
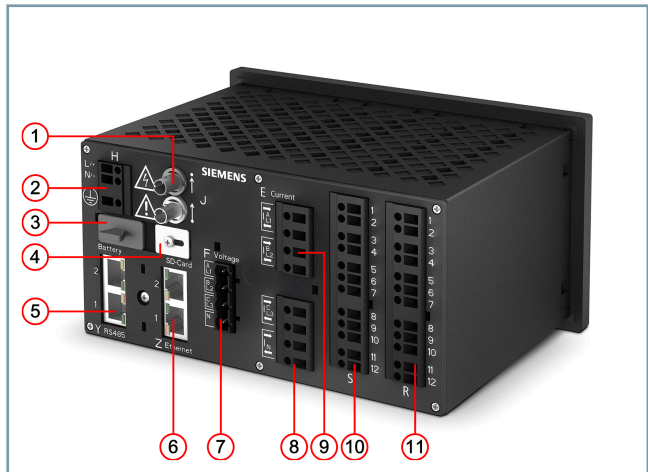
[le_Q200_rear-side, 2, --_--]

Figure 2.2/15   Layout of SICAM Q200 – Rear Side

(1) Optical interfaces J (input, output)

(2) Terminal block H for power supply

(3) Battery compartment

(4) Cover of micro SD card

(5) Serial interface Y (2 parallel ports, RS485)

(6) 2 Ethernet interfaces Z1 and Z2

(7) Terminal block F for voltage measurement

(8) Terminal block E for current measurement (phase I_C and neutral phase I_N)

(9) Terminal block E for current measurement (phases I_A and I_B)

(10) Terminal block S, 3 binary inputs and 3 binary outputs

(11) Terminal block R, 3 binary inputs and 3 binary outputs

Mass	Approx. 1.2 kg
Dimension (W x H x D), without clips	192 mm x 96 mm x 134.6 mm
	7.56 inch x 3.78 inch x 5.3 inch
Distances to adjacent devices	On the side: ≥ 20 mm (0.79 inch)
	Below and above: 15 cm (5.91 inch)
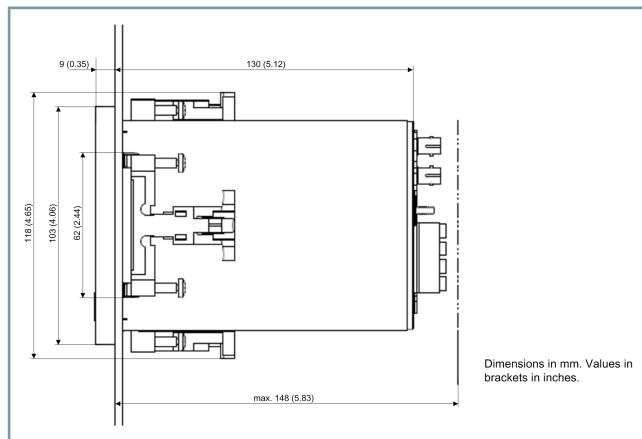
[dw_dim-q200_side-view, 1, en_US]

Figure 2.2/16   Side View SICAM Q200
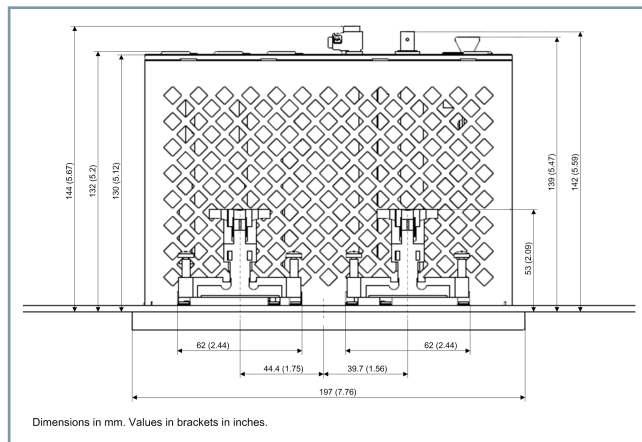
[dw_dim-q200_top-view_Variant-1, 1, en_US]

Figure 2.2/17   Top View SICAM Q200, Variant 1

Power Quality Recorder

SICAM Q200 – Technical Data

Dimensions in mm. Values in brackets in inches.
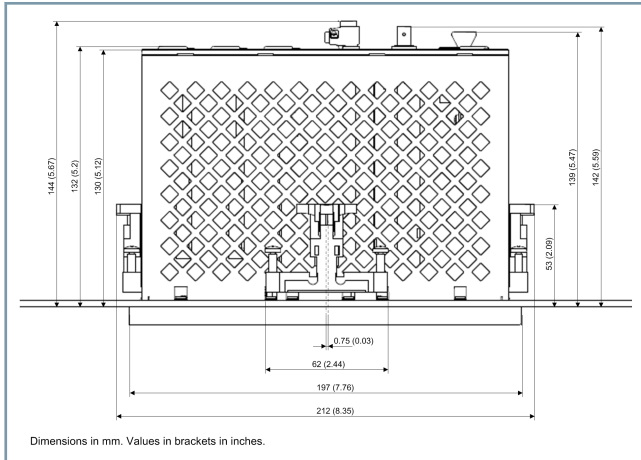
[dw_dim-q200_top-view_Variant-2, 1, en_US]

Figure 2.2/18   Top View SICAM Q200, Variant 2

Dimensions in mm. Values in brackets in inches.
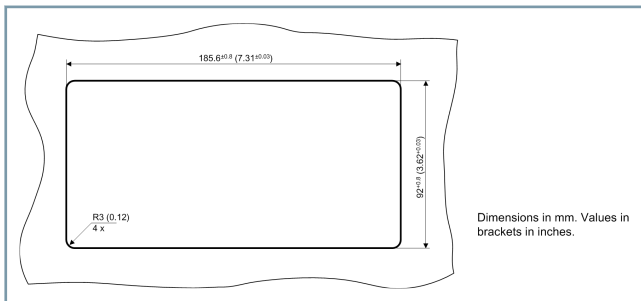
[dw_cut-out_in_switch_panel, 1, en_US]

Figure 2.2/19   Cut-Out in Switch Panel

Selection and Ordering Data

Description	Variants	Order No.															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
SICAM Q200 – Multifunctional Recorder		7	K	G	9	7	□	□ -	□	□	□	□	0 -		0	□	□	0
							▲	▲	▲	▲	▲	▲				▲	▲	
Dimensions: 192 mm x 96 mm x 134.6 mm; Flush-mounting switch panel device with graphic display; Web server for parameterization and data visualization; Industrial 2-GB memory; Internal Ethernet switch; CE marking and UL approval. _Connections:_ Voltage and current measuring inputs. _Communication:_ Modbus RTU Master/Gateway protocol via RS 485; 2 x 100-Mbits/s Ethernet, as line; Topology in a network or independent protocols in 2 networks; RS485 – Modbus RTU Master and Gateway function. _Synchronization:_ NTP synchronization	_Measured values:_ Power-quality measurements to IEC 61000-4-30 Class A. Basic measured values: voltages, currents, frequency, P (Class 0.2S), Q, S, cos phi, flicker. Measurement and recording of min/max and mean values. Measurement of voltage and current harmonics up to 63rd limiting-value violations. _Energy management:_ Load profile and utilization period. Measurement from 2 kHz to 9 kHz (IEC 61000-4-7) and 9kHz to 150 kHz (IEC 61000-4-30 (2015)). Recorder for power-quality measured values. Detection and visualization of voltage events and transients recordings. Online power-quality report, for example to EN 50160						1											
On-site operation																	
	Integrated LCD display							1									
Auxiliary power supply																	
	Power supply unit AC/DC (110 V bis 230 V)								0								
I/O modules																	
	Without (position 10 must be "A")									A							
	Binary I/O, 3 binary inputs and 3 relay outputs (position 10 must be "J")									J							
I/O modules																	
	Without (position 9 must be "A")										A						
	Binary I/O, 3 binary inputs and 3 relay outputs (position 9 must be "J")										J						
Ethernet interface and communication protocols, RJ45 and Ethernet																	
	Modbus TCP (operational measured values and PQ measured values/events)											0					
	Modbus TCP (operational measured values and PQ measured values/events) and IEC 61850 (with COMTRADE and PQDIF file transfer for PQ data)											1					
Current measurement																	
	4 x 1 A/5 A current measurement inputs														B		
Voltage measurement																	
	4 x voltage measurement inputs (PQI Class A) and high-resolution transient acquisition and logging															B	
IP54 - kit		7	K	G	9	7	9	8 -	0	P	K	5	4					

Table 2.2/2 Selection and Ordering Data

Power Quality Recorder

SICAM Q100 – Description

Description

The SICAM Q100 multifunctional measuring device is used for acquisition, visualization, evaluation and transmission of electrical measured variables such as alternating current, alternating voltage, frequency, power, harmonics etc. The acquisition, processing and accuracy of measured variables and events are performed according to the IEC 61000-4-30 Class A power quality measurement standard. The measured variables can be output to a PC or system control via communication interfaces or shown on a display. In addition to the monitoring function, the SICAM Q100 all-in-one device provides a combined recording and evaluating function: measured values can be recorded in parameterizable time intervals with various recorders such as power quality and fault recorders. Long-time data and events are evaluated directly in the device and displayed as a report according to the power quality standards (e.g., EN 50160).

The Modbus Gateway function supports RS485 devices (e.g., PAC 3100, 3200, SICAM P50) to connect to your Modbus TCP network, reducing cabling and converter costs, and more flexible monitoring applications. With the Modbus master device, the data of the RS485 device can be visualized directly from the device in the web server.

Device Type	DIN rail/control panel
Supply voltage	DC 24 to 250 V
	AC 110 to 230 V; 50 Hz/60 Hz
Input and output circuits	4 inputs for alternating voltage measurements
	4 inputs for AC current measurements
	2 binary inputs, for example for load profile synchronization pulses or external triggers
	2 binary outputs
	I/O-expansion (up to 12 inputs and 12 outputs) using SICAM I/O Unit peripheral devicest*
Operation and display	Automatically monitor the functions of its hardware, software and firmware components
	Full graphic display, operation via 4 function keys
	Integrated web server to interact with PC via HTML pages
Communikation	Ethernet communication via the Modbus TCP or IEC 61850 Edition 2 protocol; serial communication via Modbus RTU and IEC 60870-5-103 via the RS485 interface is optional
	MODBUS Master and Gateway function for RS485 devices (as Switcher 3WL, PAC3x00, SICAM P50)
Time synchronization	Via Ethernet: NTP client (Network Time Protocol)

* Only the 2 built-in DIs can start a fault recording and can be recorded in COMTRADE

Benefits

- Comprehensive acquisition of relevant network parameters for early identification of supply-quality problems
- Manufacturer-independent, comparable measured values obtained by using the IEC 61000-4-30 Class A standard measurement methods
- PQ reporting according to EN 50160 directly in the Web server

[ph_SICAM_Q100_W3_1.0_ISO2, 1, --_--]

Figure 2.3/1 SICAM Q100 – Multifunctional Measuring Device

- Easy operation via integrated Web server for parameterization, diagnosis, evaluation, and reporting
- Interoperability is guaranteed by using standard interfaces and standard protocols (IEC 61850, Modbus TCP) and data formats (PQDIF, Comtrade, and CSV)

Applications

The SICAM Q100 device is used in single-phase as well as in 3-wire and 4-wire systems (with neutral conductor). The device is applied wherever comprehensive measurement of supply quality is necessary - at power utilities as well as in industry and trade sectors.

Special Features

- PQ reporting according to EN 50160 and CBEMA direct over HTML web server
- Evaluation of events directly in HTML via COMTRADE Viewer/ SIGRA Plugin
- Flexible data export in the PQDIF, COMTRADE and CSV format
- Memory capacity of 2 GB for storage of the recorder data for years of power quality data
- Modbus Master and Gateway function
- Web server for parameterization, vVisualization and data management
- Electrically isolated voltage measuring inputs

Measurements

The following measurements can be recorded or calculated from the measured quantities:

- Alternating voltage and alternating current
- Unbalanced of alternating voltage and alternating current
- Active, reactive, and apparent power
- Active, reactive, and apparent energy
- Power frequency

- Phase angle
- Power factor and active power factor
- THDS (Subgroup Total Harmonic Distortion) of alternating voltage and alternating current
- Harmonics and interharmonics of alternating voltage and alternating current
- Flicker acc. to IEC 61000-4-15
- Transients
- Mains signalling voltage (MSV)

The uncertainty of operational measurements of the measurands is defined as per IEC 62586-1 product standard, class A (leading standard), the IEC 61000-4-30 power quality standard, and the IEC 62586-1, Edition 1 standard.

Functionality of the Recorders

The recorders are capable of recording measurands, events, and load profiles in parameterizable time intervals. The following recorder types are used:

- Measurement recorder: recording of PQ measurands acc. to IEC 61000-4-30 (for example, frequency, voltage magnitude, etc.) and non-PQ measurands (for example, currents, power, etc.) over parameterized periods, for example, 10-second frequency, aggregation of voltage, current, power etc.
- Trend recorder: long-term recording and monitoring of the voltage change history over a parameterized period of time in programmable tolerance ranges; 1/2 cycle RMS values.
- Fault recorder: recording of sampled values of voltage and current using programmable triggers.
- Event recorder: recording with 256 samples/period of voltage events, frequency events, and voltage unbalance events.
- Mains signalling voltage recorder: recording of mains signalling voltage on the supply voltage.

The device features a 2-GB memory for storing the recorder data.

Communication

SICAM Q100 has an Ethernet interface and an electric RS485 interface.

Ethernet supports the device parameterization, transmission of measured data, metered values, load profiles, and indications/events and the time synchronization with NTP. The communication protocols used are HTTP, Modbus TCP, and IEC 61850 server.

The RS485 interface supports the transmission of measured data, metered values, load profiles, and indications and the time synchronization. The communication protocol is Modbus RTU.

The integrated Ethernet switch in the device allows cascading further network components (SICAM subdevices) via a Y cable and integrating them in an existing network with IEC 61850 or another Ethernet protocol.

Time Synchronization

During operation SICAM Q100 needs the date and time for all time-relevant processes. This ensures that a common time basis exists when communicating with peripheral devices and enables time stamping of the process data.

The following types of time synchronization can be executed:

- External time synchronization via Ethernet NTP (preferred)
- External time synchronization via fieldbus using the Modbus RTU communication protocol
- Internal time synchronization via RTC (if external time synchronization is not available)

Parameterization

Parameters are set using an internal Web browser with HTML pages from the connected computer. Internet Explorer 6 (or higher) is required for this purpose. Devices featuring a display offer a limited parameterization function using the front softkeys.

Data Export

Recorded data can be exported via the following standard formats:

- CSV data
- PQDIF data – IEEE1159.3: PQDIF for PQ recordings (events, messages, protocols)
- COMTRADE data IEC 60255-24/IEEE Std C37.111: Electrical relay – part 24: Standard format for the exchange of transient data of electrical energy supply systems (COMTRADE)

Automation Functions

Upper or lower limiting values can be parameterized for up to 16 measured values. Warnings can be output for limit violations. Up to 4 limiting-value violations can be output at the device via the 2 binary outputs and the LEDs H1 and H2. In addition, all 16 limiting-value violations can be sent to peripheral units via Ethernet.

2.3

Power Quality Recorder

SICAM Q100 – Types of Recorders and Evaluations

Recorder Functionality and Applications

Recordings	Measurands	Storage interval/storage method	Application	Availability
Measured values, binary signals and subdevices	Online values (voltage, current, power, counter, cos φ, THD, harmonic	Available per 10/12 system periods	Display, HTML view, SCADA systems, power manager	IEC 61850 or Modbus TCP register HTML visualization
Measured value recorder	Frequency	Frequency value (captured at a 10-second aggregation interval) as IEC 61000-4-30	Long-term monitoring of the mean values, for example for the evaluation of the system quality to EN 50160	Modbus TCP or IEC 61850 (PQDif format) HTML visualization system voltage level 10 min (30 s, 1 min, 10 min, 15 min, CSV export)
	System voltage unbalance			
	Harmonics and interharmonics of the system voltage			
	Additional specifications (such as power values, min/max values, etc.)			
	Flicker	Pst determined over 10 min; Plt over 2 h (12 Pst values)	Monitoring the power quality to IEC 61000-4-15	Modbus TCP or IEC 61850 (PQDif format) HTML visualization CSV export
Event recorder	Voltage dips and interruptions	Residual voltage V_{RMS} (1/2) and time stamp (duration)	Long-term monitoring of the system quality to EN 50160, classification of voltage events, such as ITIC curve	Modbus TCP - last 10 events or IEC 61850 (LN)HTML visualization
	Voltage increase	Max. overvoltage V HTML visualization $_{RMS}$ (1/2) and time stamp (duration)		
Trend recorder	V_{RMS} (1/2) period	With measured value changed (in per cent or absolute) and cyclic (time interval)	Subsequent analysis of the system quality with any grid code in PQS and visualization in Web server	IEC 61850 (recording in PQDif format) HTML visualization (SIGRA plug-in)
Sine recording	Voltages, currents	Voltage/current fluctuation trigger, acquisition of sampled values (max. 3 s)	Analysis of the cause of system quality problems	IEC 61850 (COMTRADE format) HTML visualization (COMTRADE Viewer)
Load profile recording and TOU	Load profile	Fixed-block or rolling-block method	Determining the load profile for power supply and consumption	Modbus TCP or
Transient logs	Transient detection/logging	Logging Number of the event, time at which the transient starts (time stamp with date and time), affected phase(s) (a, b, c), transient duration	Identification and classification of transients up to 80 microseconds	HTML

Table 2.3/1   Recordings and Applications

In addition to the normal measured-value acquisition, SICAM Q100 additionally offers various recorders for monitoring and analyzing the power quality, and energy-management data for the evaluation of the load profile.

Measured-Value Recorder

The measured-value recorder records measured values to determine the power quality and many additional measured values (such as min/max values).

Recording the following measurements can be parameterized on the user interface:

- PQ measurements to determine the power quality
- Averaging intervals frequency (fixed to 10 s)
- Averaging intervals for voltage, voltage unbalance, harmonics and interharmonics (30 s, 60 s, 10 min, 15 min, 30 min, 1 h, 2 h)

- Flicker: short-term flicker strength Pst (10 min) and long-term flicker strength Plt (2 h)
- Additional data: current, current unbalance, active, apparent and reactive power, THD of voltage, THD of current, power factor, active power factor, phase angle, energy values
- Recording the minimum values (mean values) and recording the maximum values (mean values)

The measuring interval can be set to different levels from 30 s to 2 h. For frequency measurement, the interval is fixed to 10 s.

Event Recorder

The event recorder records only PQ events (voltage, frequency, voltage unbalances).
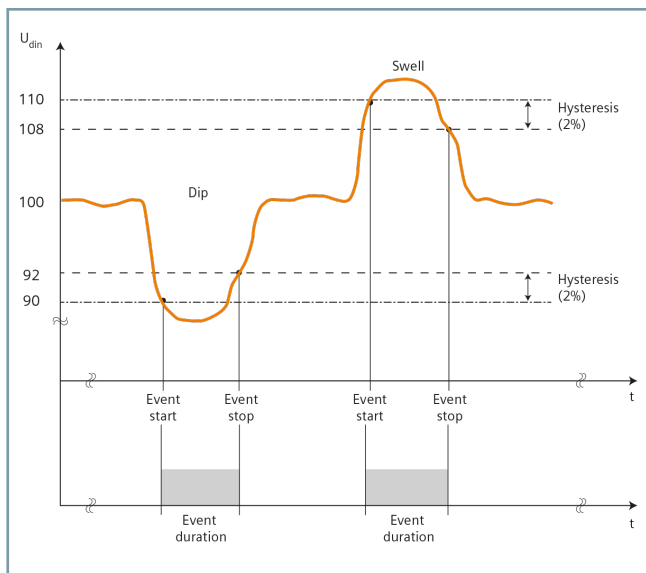
[Event recorder, 1, en_US]

Figure 2.3/2 Recording of the Event Recorder: Overvoltage and Undervoltage

Trend Recorder

The trend recorder guarantees the continuous acquisition and long-term monitoring of the voltage V_{RMS} (1/2). This new RMS value is recorded when, during the parameterized measuring interval, the change of the measured quantity against the last measured RMS value is outside the selected tolerance range.

Sine Recording

Sine recording records 2048 sampled values per 10/12 system periods in selectable time units. The sine recording function can be activated for the measurands voltage and current. For event analysis, you can select a pre-trigger time (pre-trigger ratio in %) so that the history of the measurement before the fault inception can be analyzed.
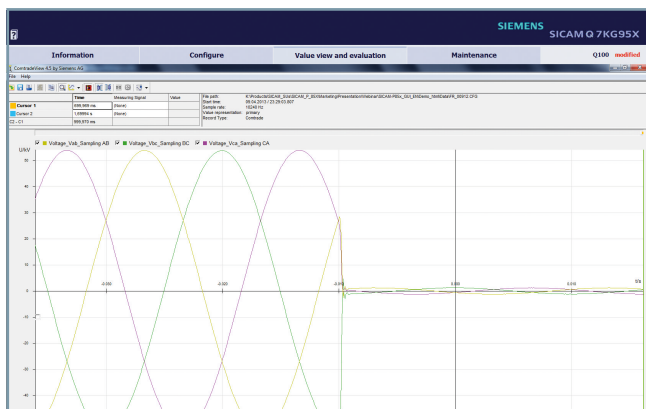
[Faultrecorder, 1, --_--]

Figure 2.3/3 Sine Recording in COMTRADE View with COMTRADE Viewer Software and SIGRA Plug-In

Energy Management

As part of the energy management, SICAM Q100 records load profiles according to the Fixed Block and Rolling Block method for all power quantities. Additionally, it is possible to calculate up to 4 tariffs (TOU = Time of Use). The synchronization is made with external or internal triggers.

Storage of Load-Profile Data

The load-profile data are stored in a ring buffer with up to 4 000 datasets. Every new dataset overwrites the oldest dataset. Every dataset contains the average power values, minimum/maximum values, a time stamp, and status information for a completed subperiod.

The traceability of the load profile depends on the length of the subperiod:

- Fixed Block method: length of the measuring period = 15 min
- Rolling Block method: length of the subperiod = 15 min

On the condition that all periods correspond to the configured period length, the recording period is longer than 40 days.

Fixed Block method

The Fixed Block method with a measuring-period length of 15 minutes is the default setting. In addition, the **number of subperiods** of this method is set to 1. The load-profile data are determined at the end of every measuring period and stored in the ring buffer and transmitted, if necessary, or displayed on the user interface.
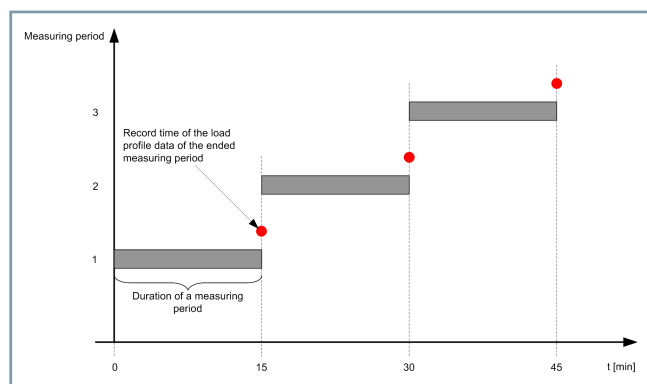

[dw_load-profile-fixed-block, 1, en_US]

Figure 2.3/4   Determination of the load profile according to the Fixed Block method

Rolling Block Method

A **measuring period** of the Rolling Block method consists of 2 to 5 **subperiods** depending on the parameterization.

The length of a measuring period is the product of the number of subperiods and the parameterized length of the subperiod.

The following figure shows the history of the measuring periods during the load-profile determination:

[dw_load-profile-rolling-block, 1, en_US]
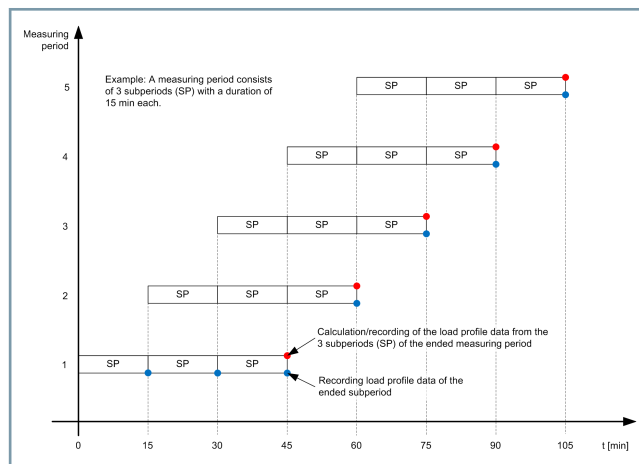
Figure 2.3/5   History of the measuring periods for determination of the load profile according to the Rolling Block method

Load-Profile Data at the Communication Interface

The following load-profile data are available during a measuring period:

- Average power values for all power quantities during the measuring period, calculated from the average power values at the end of every subperiod (red dots in *Figure 2.3/5*)
- Average power values for all power quantities during the subperiods (blue dots in *Figure 2.3/5*)
- Maximum and minimum values for all power quantities within the subperiods
- Cumulated power values for all power quantities at every sampling point within the current subperiod

The arithmetic average power values and the extreme values per subperiod are stored in the ring buffer. The cumulated power values can be retrieved via communication or displayed in the user interface.

Historical Load-Profile Data

SICAM Q100 records the following measurands:

Measurement	Cumulated Power Values	Arithmetic Average Power Values	Maximum Values	Minimum Values
P_{Import}	x	x	±x	±x
P_{Export}	x	x		
Q_{Import}	x	x	±x	±x
Q_{Export}	x	x		
S	x	x	x	x

Table 2.3/2   Historical Load-Profile Data

Tariffs

SICAM Q100 supports up to 4 tariffs for power meters for supplied or consumed active energy, reactive energy, and apparent energy. If the tariff change is controlled, up to 4 tariffs can be set. If tariffs are changed via binary inputs, up to 2 tariffs can be set. The value of the binary inputs which there is at the time of the beginning of the subperiod at the binary input is decisive for it.

The tariff is changed via the external interfaces. A time-related tariff change is only possible by a superordinate system.

[sc_tariffs_ISO2, 1, en_US]
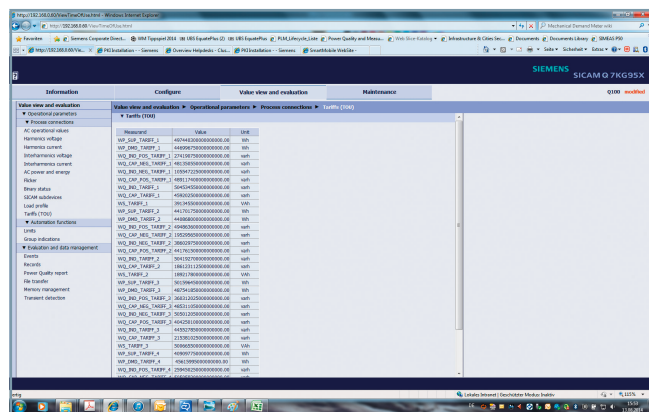
Figure 2.3/6   Evaluation Tariffs

Tariff Change on Load-Profile Synchronization

The recorded load profile is always assigned to the current tariff.

If, during a running measuring period, a tariff change is made, for instance, from high to low tariff, this has initially no effect on the load-profile recording.

The new tariff becomes effective in the load-profile recording and in the power meters of SICAM Q100 only with the start of the next measuring period.

Tariff Change without Load-Profile Synchronization

If no external and internal synchronization of the load profile is performed, the tariff change becomes effective immediately. A tariff change without synchronization exists if in the parameteri-

zation of the load profile "None" has been selected as synchronization source.

Additional Information

Please refer to the current *manual* for further information.

2.3

Power Quality Recorder

SICAM Q100 – Connection Types and Examples

Connection Methods and Types

SICAM Q100 can be operated in IT, TT, and TN systems.

Typical Standard Application

The following input circuits are examples. Up to the maximum admissible current and voltage values, SICAM Q100 can be connected without intermediate current or voltage transformer. Necessary voltage transformers can be operated in star or delta connection.
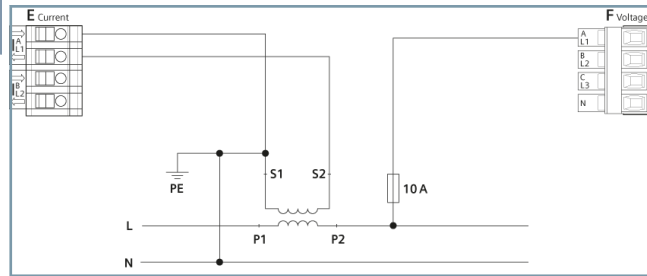
[Appl_single phase_1, 1, --_--]

Figure 2.3/7   Connection Example 1-Phase System, 1 Current Transformer
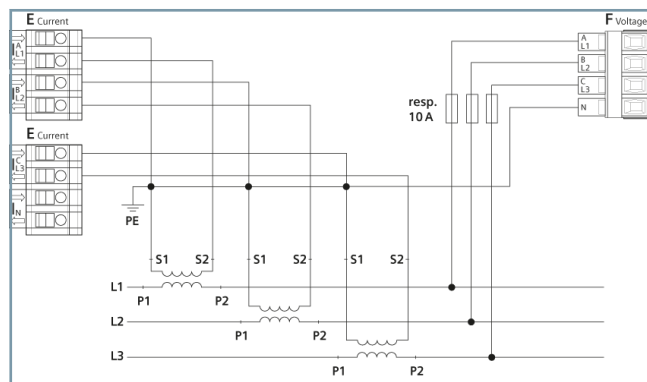
[Appl_three-wire_3, 1, en_US]

Figure 2.3/8   Connection Example 3-Wire Network, 3 Current Transformers, Any Load
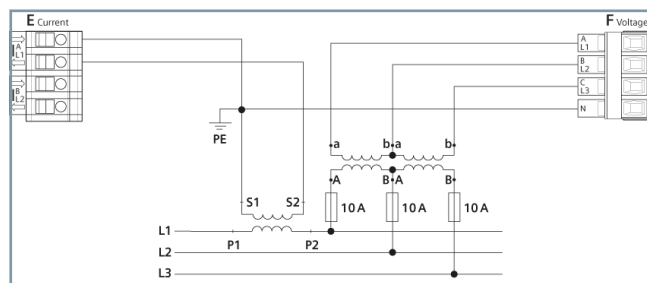
[Appl_three-wire_2_1, 1, --_--]

Figure 2.3/9   Connection Example 3-Wire Network, 2 Voltage Transformers and 1 Current Transformer, Same Load
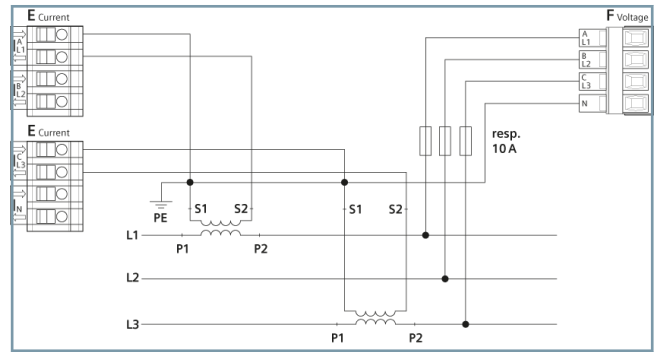
[Appl_three-wire_2, 1, en_US]

Figure 2.3/10   Connection Example 3-Wire Network, 2 Current Transformers, Any Load
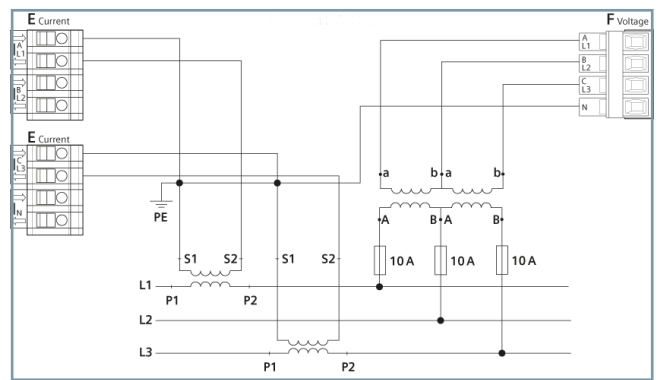
[Appl_three-wire_2_2, 1, --_--]

Figure 2.3/11   Connection Example 3-Wire Network, 2 Voltage Transformers and 2 Current Transformers, Any Load
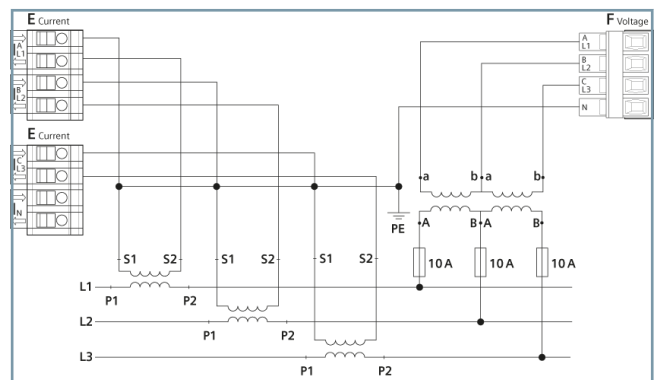
[Appl_three-wire_2_3, 1, --_--]

Figure 2.3/12   Connection Example 3-Wire Network, 2 Voltage Transformers and 3 Current Transformers, Any Load

[Appl_four-wire_3_3, 1, en_US]

Figure 2.3/13 Connection Example 4-Wire Network, 3 Voltage Transformers and 3 Current Transformers, Any Load

[Appl_single phase_1_1, 1, --_--]

Figure 2.3/14 Connection Example 1-Phase System, 1 Voltage Transformer and 1 Current Transformer, Same Load

[Appl_four-wire_3_3_1, 1, en_US]

Figure 2.3/15 Connection Example 4-Wire Network, 3 Voltage Transformers and 3 Current Transformers, Any Load, 1 Current Transformer on the Neutral Phase

[Appl_four-wire_3, 1, en_US]

Figure 2.3/16 Connection Example 4-Wire Network, No Voltage Transformer and 3 Current Transformers, Any Load

[Appl_three-wire_3_3, 1, en_US]

Figure 2.3/17 Special Circuit: Connection Example 3-Wire Network, 3 Voltage Transformers and 3 Current Transformers, Any Load

2.3

SICAM Q100 – Measurands and Operational Uncertainty of Measurement

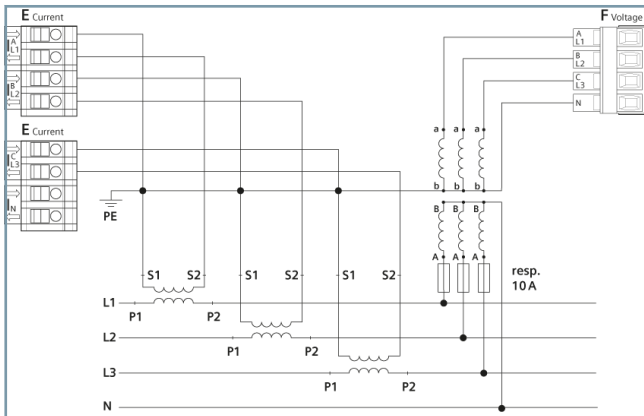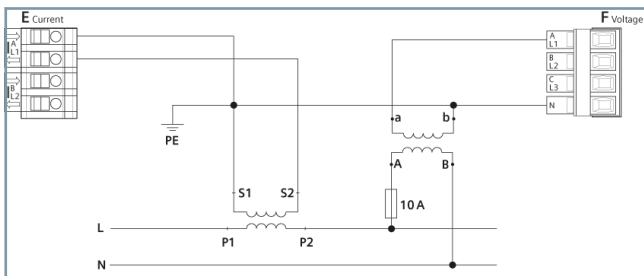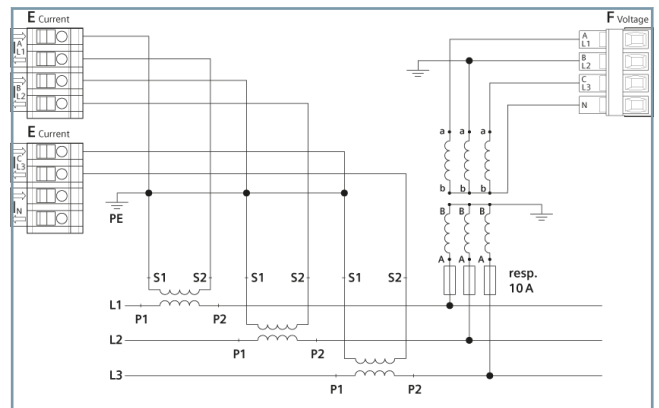**Measurands and Operational Measurement Uncertainty acc. to IEC 62586-1 Product Standard, Class A, and Standards IEC 61000-4-30, Ed. 2 and IEC 61000-4-7 and IEC 61000-4-15**

Measurement	Unit	Measurement Range	Operat. Measurem. Uncertainty acc. to IEC 62586-1, Class A, IEC 61000-4-30, IEC 61000-4-7, IEC 61000-4-15
Frequency f	Hz	±10 mHz in the measuring ranges: 50 Hz (±15 %): 42.5 Hz to 57.5 Hz 60 Hz (±15 %): 51.0 Hz to 69.0 Hz	10 mHz Magnitude of the supply > 2 V required
Voltage $V_{ph-N/PE}$ (star)	V	10 % to 150 % Udin AC 57.73 V to 400 V (autorange) • IEC 61000-4-30 Class A: to AC 230 V: 200 % overvoltage • > AC 230 V to 400 V: 200 % to 15 % overvoltage UL conditions: • to AC 170 V: 200 % overvoltage • > AC 170 V to 300 V: 200 % to 15 % overvoltage	±0.1 % Udin
Voltage V_{ph-ph} (delta)	V	10 % to 150 % Udin AC 100 V to 690 V (autorange) • IEC 61000-4-30 Class A: to AC 400 V: 200 % overvoltage • > AC 400 V to 690 V: 200 % to 15 % overvoltage UL conditions: • to AC 290 V: 200 % overvoltage • > AC 290 V to 520 V: 200 % to 15 % overvoltage	±0.1 % Udin
Flicker Pst, Plt	-	Pst, Plt: 0.2 to 10	Acc. to class A, IEC 61000-4-30: Pst: ±5 %; Plt: ±5 %, Accuracy Pinst: ±8 %
Undervoltages (dips) and overvoltages (swells) of the mains voltage	V, s	-	Amplitude ±0.1 % Udin; 1 cycle
Voltage interruptions of the mains voltage	V, s	-	Duration: 1 cycle
Voltage unbalance	%	Measurement range for u2 and u0: 0.5 % to 5.0 %	±0.1 %
Harmonics of voltage H_xV_{ph}	% or V	10 % to 200 % acc. to IEC 61000-2-4, class 3	IEC 61000-4-7, class 1: Condition: $V_m > 1 \% V_{rated}$ Maximum error: ±5 % V_m ------------------------------- Condition: $U_m < 1 \% V_{rated}$ Maximum error: ±0.05 % V_{rated}
Mains signalling voltage MSV_{ph-N}(star) / MSV_{ph-ph}(delta)	V	1 % to 15 % Udin	Condition: 3 % to 15 % of Udin Maximum error: ±5 % of measured value ------------------------------- Condition: 1 % to 3 % of Udin Maximum error: ±0.15 % of Udin
Udin: Primary nominal voltage, corresponds to the primary rated voltage in SICAM Q100 V_m: Measured value V_{rated}: Rated voltage u2: Value of Neg.seq.comp.V u0: Value of Zero seq.comp.V			

Table 2.3/3   Measurements and their Operational Measurement Uncertainty

2.3

Measurements and Operational Measurement Accuracy acc. to IEC 61557-12

Measurement	Unit	Rated Value	Measurement Range	Accuracy Class
Current I Acc. to parameterization	A	Auto range (1 A to 5 A)	10 % to 200 % I_{rated}	0.2
Current unbalance	%	–	0 % to 100 % I_{rated}	±0.2 % [1]
Active power P + demand, - supply	W	–	1 % to 200 % I_{rated}	0.2
Reactive power Q inductive, capacitive	var	–	2 % to 200 % I_{rated}	1
Apparent power S	VA	–	–	0.2
Power factor PF [2]	–	–	0.5 inductive to 0.8 capacitive	1
Active power factor cosφ [2]	–	–	-1 to +1	±1 % [1]
Phase angle φ [1]	Degree	–	-180° to +180°	±2° [1]
Active energy WP + demand, - supply	Wh	–	1 % to 200 % I_{rated}	0.2 Class 0.2S acc. to IEC 62053-22
Reactive energy WQ inductive, capacitive	varh	–	2 % to 200 % I_{rated}	2 Class 0.5S acc. to IEC 62053-24
Apparent energy WS	VAh	–	2 % to 200 % I_{rated}	0.2
Subgroup total harmonics distortion of voltage THDS V_{ph}	%	–	0 % to 100 %	±0.5 % [1]
Subgroup total harmonics distortion of current THDS I_{ph}	%	–	0 % to 100 %	±0.5 % [1]
Harmonics of current H_xI_{ph}	A	–	–	Condition: $I_m \geq$ 10 % I_{rated} Maximum error: ±5 % I_m -------------------------- Condition: $I_m <$ 10 % I_{rated} Maximum error: ±0.5 % I_{rated}

Table 2.3/4   Measurements and their Operational Measurement Accuracy

(1)   The IEC 61557-12 standard does not specify any accuracy class for these variables. The specifications refer to the maximum deviation from the actual value.

(2)   Measurement from 2 % of the rated apparent power value onwards in the selected measuring range

2.3

Power Quality Recorder

SICAM Q100 – Technical Data

Supply Voltage

Direct Voltage

Rated input voltages	24 V to 250 V
Admissible input voltagetolerance	±20 %
Permitted ripple of the input voltage	15 %
Maximum inrush current	
At ≤110 V	< 15 A
At 220 V to 300 V	≤ 22 A; after 250 µs: < 5 A
Maximum power consumption	6 W

Alternating Voltage

Rated input voltages	110 V to 230 V
System frequency at AC	50 Hz/60 Hz
Admissible input voltage tolerance	±20 %
Permitted harmonics	2 kHz
Maximum inrush current	
At ≤ 115 V	< 15 A
At 230 V	≤ 22 A; after 250 µs: < 5 A
Maximum power consumption	16 VA

Inputs and Outputs

Inputs for Alternating Current Measurements, Connector Block E – Cat III

Input alternating currents	
Rated input current range	AC 1 A to 5 A (autorange)
Max. input current	AC 10 A
Power consumption per input	
at 5 A	2.5 mVA
Further information about the current measuring inputs	
Max. rated input voltage	150 V
Measuring error under environmental influences: see technical data	acc. to IEC 61000-4-30 Ed. 2 Class A (0.1 %)
Thermal stability	10 A continuous 100 A for max. 1 s
Sampling rate	10.24 kHz

Binary Inputs, Connector Block U – Cat III

Maximum input voltage	DC 300 V
Static input current	1.34 mA ± 20 %
UIL min (at threshold voltage 19 V)	DC 14 V
UIL max (at threshold voltage 19 V)	DC 19 V
UIL min (at threshold voltage 88 V)	DC 66 V
UIL max (at threshold voltage 88 V)	DC 88 V
UIL min (at threshold voltage 176 V)	DC 132 V

UIL max (at threshold voltage 176 V)	DC 176 V
Progagation delay low to high	2.8 ms ± 0.3 ms

Binary Outputs, Connector Block G – Cat III

Maximum contact voltage	
Alternating voltage	230 V
Direct voltage	250 V
Maximum currents	
Maximum continuous contact current	100 mA
Maximum pulse current for 0.1 s	300 mA
Further information about the binary outputs	
Internal impedance	20 Ω
Admissible switching frequency	10 Hz

Communication Interfaces

Ethernet (Connector Z)

Ethernet, electrical	Connection	Device top side
		RJ45 connector socket
		10/100Base-T acc. to IEEE 802.3
		LED yellow: 100 Mbit/s (off/on)
		LED green:
		- Flashing: active
		- On: not active
		- Off: no connection
	Protocols	Modbus TCP
		IEC 61850 Server
	Voltage strength	DC 700 V, AC 1500 V
	Transmission rate	100 Mbit/s
	Cable for 10/100 Base-T	100 Ω to 150 Ω STP, CAT5
	Maximum cable length 10/100 Base-T	100 m, if well installed

2.3

Serial Interface (Connector J)

RS485	Connection	Terminal side, 9-pin D-sub socket
	Protocol	Modbus RTU Master and gateway function
	Baud rate (adjustable)	Min. 1200 bit/s Max. 115 200 bit/s
	Maximum distance of transmission	Max. 1 km (depending on transmission rate)
	Transmission level	Low: -5 V to -1.5 V High: +1.5 V to +5 V
	Reception level	Low: ≤ -0.2 V High: ≥ +0.2 V
	Bus termination	Not integrated, bus termination using plugs with integrated bus terminating resistors

Ambient Conditions and Climatic Conditions

Environmental Conditions

Temperature data	Operating temperature Devices with display: the legibility of the display is impaired at temperatures < 0 °C (+32 °F)	-25 °C to +55 °C -13 °F to +131 °F
	Temperature during transport	-40 °C to +70 °C -40 °F to +158 °F
	Temperature during storage	-40 °C to +70 °C -40 °F to +158 °F
	Maximum temperature gradient	20 K/h
Air humidity data	Mean relative humidity per year	≤ 75 %
	Maximum relative humidity	95 % 30 days a year
	Condensation during operation	Not permitted
	Condensation during transport and storage	Permitted
Altitude and operation site	Max. altitude above sea level	2000 m
	Operation site	Only indoors

General Data

Battery	Type	PANASONIC CR2032 or VARTA 6032 101 501
	Voltage	3 V
	Capacity	230 mAh
	Typical life	For operation with permanently applied supply voltage: 10 years
		For operation with sporadically interrupted supply voltage: a total of 2 months over a 10-year period
Internal memory	Capacity	2 GB
Degree of protection		
Housing (without front panel and terminals)	IP20	
Panel flush mounting (front)	IP40	
Terminals	IP20	

2.3

Power Quality Recorder

Dimensions

Mass	Approx. 0.55 kg
Dimension (W x H x	96 mm x 96 mm x 103 mm
	3.78 inch x 3.78 inch x 4.06 inch

Dimensions in mm. Values in brackets in inches.
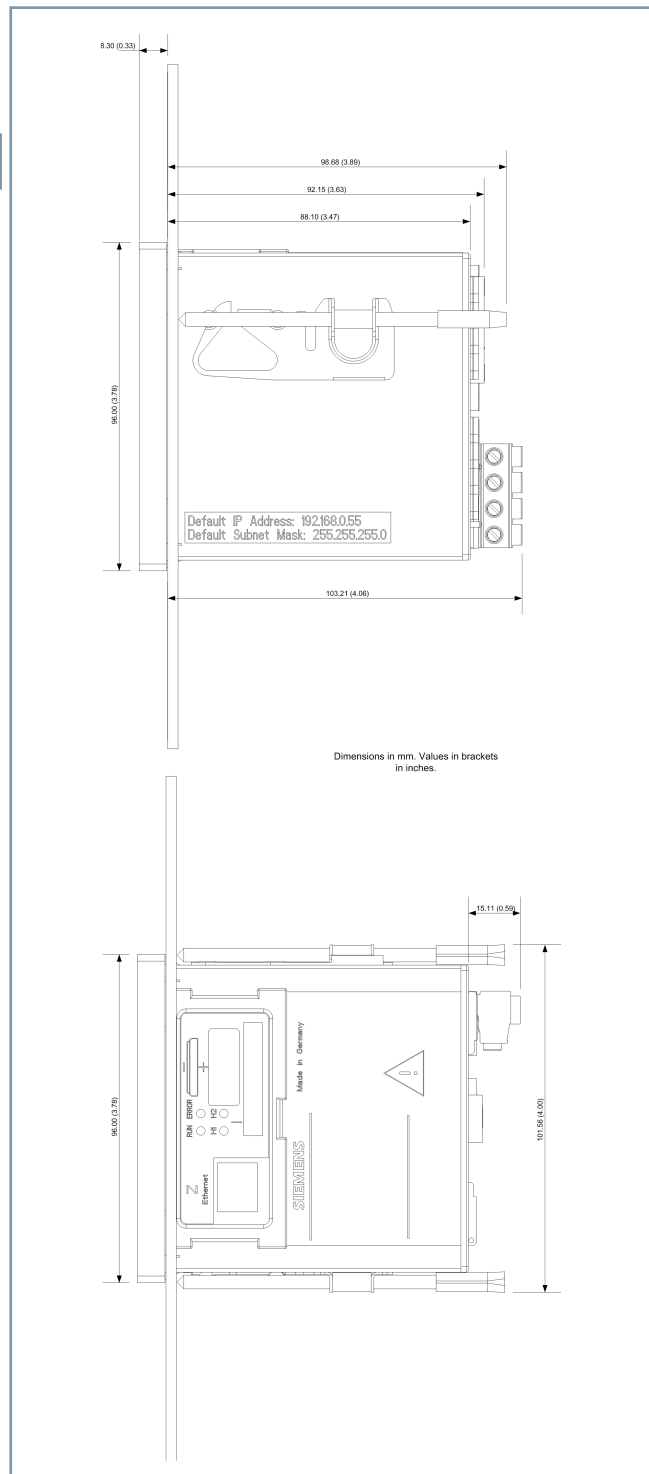
[dw_dimensional-drawing, 1, en_US]

Figure 2.3/18   Dimensional Drawing of SICAM Q100
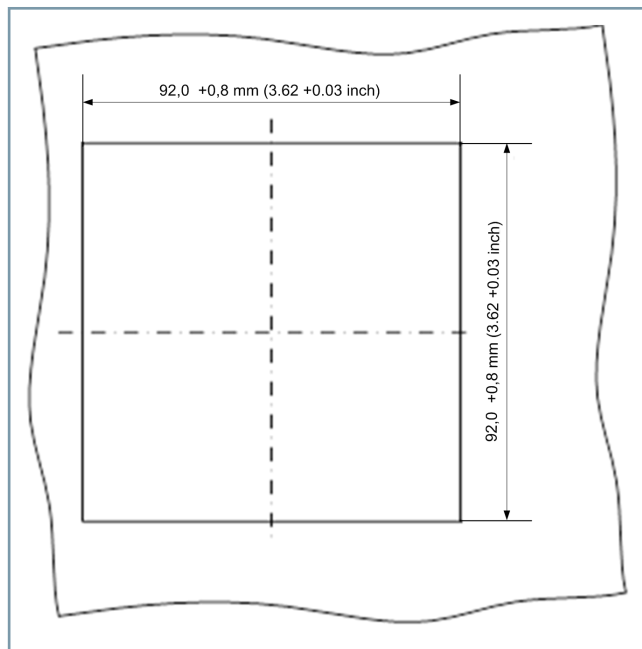
[dw_cut-out-in-switch-panel, 1, --_--]

Figure 2.3/19   Cut-Out in Switch Panel

Variants

SICAM Q100 is available in different variants:

- Communication via Ethernet
  - Only Modbus TCP protocol
  - Modbus TCP protocol or IEC 61850 server protocol
- Serial communication
  - Without RS485 interface
  - With RS485 interface:
    - Modbus RTU slave protocol
    - Modbus RTU master protocol and gateway function
- Degree of protection of front
  - IP40

Selection and Ordering Data

Description	Variants	Order No.															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
SICAM Q100 – Multifunction Measuring Device and Class A Power Quality Recorder		7	K	G	9	5	0	1	- 0	A	A	□	1	- □	A	A	1
												▲		▲			
Dimensions:	_Serial interface and communication protocol_											|		|			
96 mm x 96 mm x 100 mm	Without											0		|			
Flush-mounting switch panel device with graphic display	RS485 Modbus RTU master and gateway function											3		|			
4 inputs for alternating voltage measurements	_Protection class front side_													|			
4 inputs for AC current measurements	IP40													|			
2 binary outputs*	_Ethernet interface and communication protocol, RJ45_													|			
2 binary inputs*	Modbus TCP													0			
Web server for parameterization, visualization and data management	Modbus TCP and IEC 61850 server													2			
Ethernet switch																	
Internal 2 GB memory																	
Measurements to standard:																	
IEC 61000-4-30 – Class A measurands: V, I, f, P (class 0.2S), Q, S,W, cos phi, flicker measurement min/max and mean values measurement up to 63rd harmonic (current, voltage)																	
Energy management limiting-value violations:																	
Load profiles and tariffs, transient detection and transient logging recorder for power quality measured values, event recording (such as Vdip), visualization online PQ reports to EN 50160, for example																	
* Use SICAM IO unit (7XV5673) and Y cable (7KE6000-8GD00-0BA2) for enhanced requirements of binary inputs and outputs.																	

Table 2.3/5 Selection and Ordering Data

2.3

Power Quality Recorder

Description

The SICAM P855 multifunctional device is used to collect, display, and transmit measured electrical variables such as AC current, AC voltage, power types, harmonics, etc. The measurands and events are collected and processed according to the Power-Quality standard IEC 61000-4-30. The communication interfaces can be used to output the measurands to a PC and the control center or display them on a display.

The front protection class is IP20 for DIN-rail devices without displays. Devices for panel-flush mounting with displays have protection class IP40 or IP51.

In addition to the monitoring function, the SICAM P855 all-in-one device also provides a combined recording and evaluation function. It can record measurands at programmable time intervals, using a wide range of recorders, such as power quality and fault recorders. Long-term data and events are evaluated directly in the device according to the power quality standards (such as EN 50160) and output as reports.

Device type	DIN-rail or switch panel flush-mounting device
Supply voltage	DC 24 V to 250 V
	AC 110 V to 230 V; 50 Hz/60 Hz
Input and output circuits	4 inputs for alternating voltage measurements
	3 inputs for AC current measurements
	2 binary outputs (parameterization as required)
LED indicators	For the automatic function monitoring of hardware and software components
Communication	Ethernet communication via the protocols Modbus TCP or IEC 61850 Edition 2; optionally serial communication via Modbus RTU and IEC 60870-5-103 via RS485 interface

Benefits

- Use in the IT, TT, and TN power systems
- Robust and compact design according to IEC 62586-1, Class S (leading standard)
- Ethernet communication via the Modbus TCP or IEC 61850 Edition 2 protocol; serial communication via Modbus RTU and IEC 60870-5-103 via the RS485 interface is optional
- External time synchronization via the Network Time Protocol (NTP)
- The measurands and events are detected according to the Power-Quality standard IEC 61000-4-30. The measurement system corresponds to Class A. In terms of functional scope, measuring ranges and accuracy, SICAM P855 are Class S devices.
- Additional measurands: Minimum/mean/maximum values, flicker, event detection, voltage dips (U_{dip}), voltage interruptions and overvoltages (swells)
- Events are evaluated directly in HTML via the integrated Web server
- 2-GB memory for recording recorder data
- Evaluations: Power-quality reports and online-viewer output directly on the HTML page
- Data export: PQDIF and COMTRADE data

[ph_SICAM P85x, 1, --_--]

Figure 2.4/1   SICAM P855

Applications

SICAM P855 device is used in single-phase systems, 3-phase systems and 4-phase systems (with neutral phases). They are used primarily in power utilities but also in other industrial and commercial applications.

The Web server integrated into the device is used to configure the parameters and output measured values via HTML pages on a connected PC/laptop. In devices with displays, the parameters can also be configured with the function keys on the front of the device, and the measured values can be output to the display. The output variables can also be transmitted to control or other systems such as SICAM PQS via the communications interfaces (Ethernet, for example, IEC 61850 Edition 2) in the form of digital data.

Application Example

Using open protocols, such as IEC 61850 or Modbus TCP, SICAM P855 can communicate flexibly with automation systems and evaluation stations.

SICAM P855 permits power quality and event records to be exported as sine recordings into open data formats, such as PQDIF or COMTRADE. These recordings are available on a connected PC as HTML pages directly from the device. Additional programs, such as SICAM PQS/SIGRA or COMTRADE Viewer, provide further evaluation and report functions for SICAM P855.

2.4
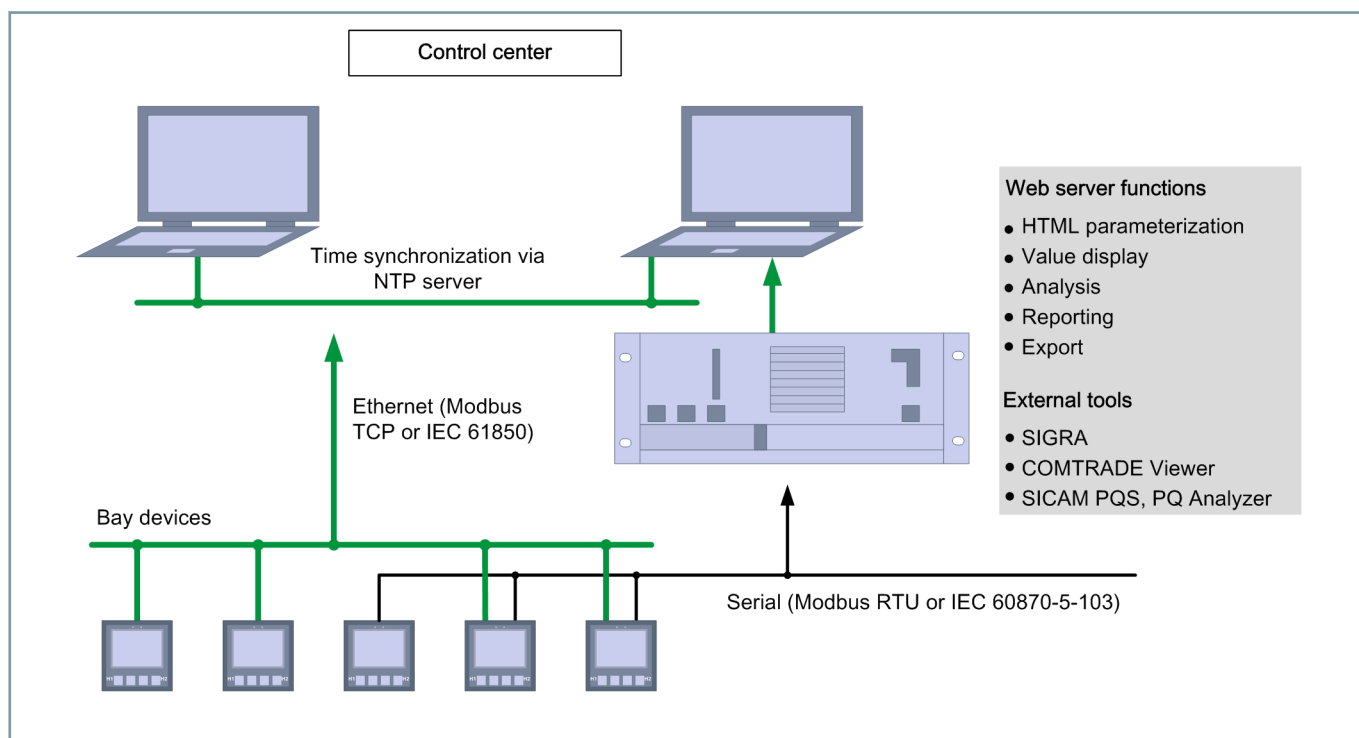
[dw_SICAM P855_Application, 1, en_US]

Figure 2.4/2   Application Example with SICAM P855

Hardware Design

Depending on the device variant, the following electrical components are contained:

- Digital signal processor (DSP)
- Display and front buttons
- 4 inputs for alternating voltage measurements
- 3 inputs for AC current measurements
- 2 binary outputs
- Power supply
- Ethernet interface
- RS485 interface (according to order variant)
- 2-GB primary storage

Measurands

The following measurands are captured or calculated by the device from the measured quantities:

- True RMS alternating voltage and alternating current
- 2048 sampled values per 10/12 system periods
- Root-means-square value measurement (TRMS) up to the 100th harmonic
- Power frequency
- Active, reactive, and apparent power
- Active, reactive, and apparent energy
- Power factor and active power factor
- Unbalance of alternating voltage and alternating current
- Harmonics up to the 40th order of alternating voltage and alternating current are stored for evaluation
- THD (Total Harmonic Distortion) of alternating voltage and alternating current
- Phase angle
- Flicker

SICAM P855 Recorder Functionality

You can record measurands or events at different time intervals.

The following functions are available with the SICAM P855 device:

- **Measured-value recorder**

  Recording measured PQ quantities (voltage values, frequency, harmonics, flicker) and non-PQ quantities (such as current or power). Measured quantities and events are captured in accordance with the power quality standards IEC 61000-4-30, IEC 61000-4-7, and IEC 61000-4-15.

- **Trend recorder**

  Long-term recording and monitoring of RMS values (1/2 period) of voltage and, optionally, of current.

- **Sine recording**

  Recording dips, swells, and interruptions of voltage or current over a parameterized time interval in parameterizable tolerance ranges.

- **Event recorder**

  Recording voltage, frequency, and voltage unbalance events by any selectable standard, such as EN 50160.

Power Quality Recorder

SICAM P855 – Description

To save the recorder data, the device is equipped with a 2-GB memory. The stored data can manually be exported in COMTRADE or PQDIF format (IEEE standard 1159.3), or be transferred via IEC 61850.

Communication

An Ethernet interface and an optional RS485 interface are available for the communication with the systems control and with other process automation systems. The RS485 interface supports the transfer of operational measured values, counts, and messages. Depending on the device version, you can use the communication protocol Modbus RTU or IEC 60870-5-103. Device parameterization, transfer of measured data, counts and messages/events, and the time synchronization with the Network Time Protocol (NTP) are supported via Ethernet. The device supports the transfer of operational measured values with both Ethernet protocol options – via Modbus TCP and via IEC 61850 Edition 2.

Time Synchronization

All time-relevant processes require date and time during operation. Consequently, there is a time synchronization during the communication with peripheral devices. This ensures a uniform time base and permits time stamping of the process data. The following time synchronization methods are possible:

- **Time synchronization via Ethernet NTP (preferred)**

    The device is equipped with an SNTP client (Simple Network Time Protocol) that can be connected to 2 NTP servers (Network Time Protocol) for external time synchronization. These are the primary and the secondary (redundant) NTP server.

- **External time synchronization via Fieldbus**

    with communication protocol Modbus RTU or IEC 60870-5-103

- **Real Time Clock (RTC)**

    If external time synchronization is not available, you can synchronize data with the time signal from an internal clock.

Parameterization and Visualization

All versions are operated via a connected PC. Parameterization is always performed with an internal Web browser with HTML pages.

[sc_Messwerterfassung, 1, en_US]

Figure 2.4/3   Parameterization of the Process Connections

Visualization of Values

Depending on the selection of the operating parameters, the I/O window shows measured values together with the related unit, or a tabular message list that is updated every 5 seconds.

- Operational measured values
- Harmonics of the voltage
- Harmonics of the current
- Power and energy
- Binary outputs
- Limiting values
- Group alarms
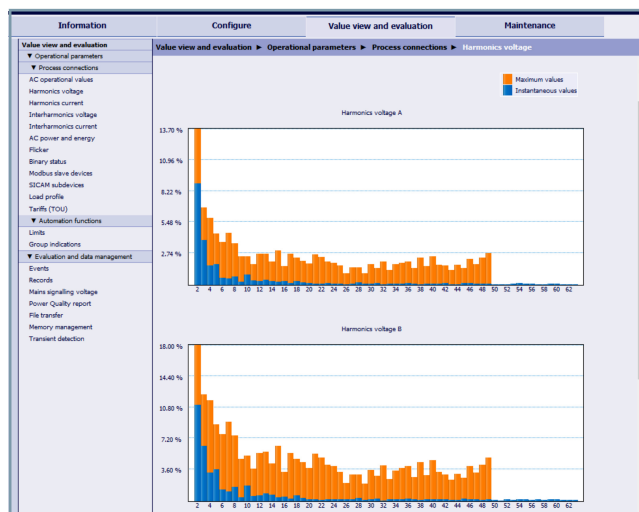
[sc_0226_Harmonische, 1, en_US]

Figure 2.4/4   Graphical Representation of the Harmonics

Automation Functions

Upper or lower limiting values can be parameterized for up to 16 measured values. A violation of these limiting values can be issued as a message. Up to 4 limiting-value violations can be output at the device via the 2 binary outputs and the LEDs H1 and H2. In addition, all 16 limiting-value violations can be sent to peripheral units via Ethernet.

[sc_Werte_betrachten, 1, en_US]

Figure 2.4/5   Visualization of Operational Measured Values

Other maintenance tasks, such as firmware updates or reading operational indications and error messages can also be performed via the HTML pages.
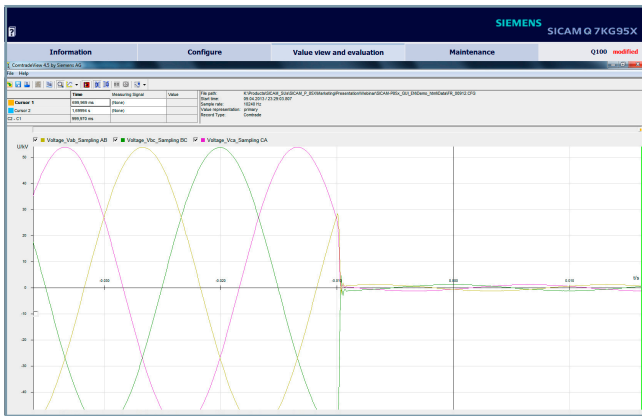
[sc_Faultrecord, 1, en_US]

Figure 2.4/6   Visualization of Operational Indications

2.4

2.4

Data [1]		Operating/Instantaneous Measured Value (10/12 Periods)	Sine Recording	Measured-Value Recorder (30 s, 60 s, 10 min, 15 min, 30 min, 1 h, 2 h)			Event Evaluation (Undervoltages, Overvoltages, Interruptions)	Trend Recorder (1/2 Period RMS Event Recording)
Interface		Modbus TCP, Modbus RTU, IEC 60870-5-103, IEC 61850, HTML, and Display	IEC 61850 (COMTRADE File Transfer) and HTML COMTRADE Download for COMTRADE Viewer or SIGRA Visualization	HTML CSV Download and Modbus TCP Protocol			Modbus TCP, IEC 61850 Report Generation, HTML and Display	IEC 61850 (PQDIF File Transfer), Event Visualization with COMTRADE Viewer Plug-In, HTML PQDIF Download
Type		Values/Graphical	Graphical	Mean Values	Max Values	Min Values	Protocols	Graphical
Voltage (AC)	$V_{A,B,C}$	■	■	■	■	■	■	■
	$V_{A-B, B-C, C-A}$	■	■	■	■	■		
	V_N	■	■	■	■	■		
	V_{sum}	■		■				
	V_{asym}	■		■	■	■		
Current (AC)	$I_{A,B,C}$	■	■	■	■	■		
	I_0	■	■	■				
	I_{sum}	■	■	■				
	I_{asym}	■	■	■	■	■		
Active power factor	$\cos\varphi_{A,B,C}$	■		■	■	■		
	$\cos\varphi$	■		■	■	■		
Power factor	$PF_{A,B,C}$	■		■	■	■		
	PF	■		■	■	■		
Phase angle	$\varphi_{A,B,C}$	■		■	■	■		
	φ	■		■	■	■		
	Voltage $\varphi_{A,B,C}$, current $\varphi_{A,B,C}$	■		■				
Frequency	f (system frequency)	■		■	■	■		
	10-s frequency (10-freq.)			■ [2]	■	■		
Harmonic, voltage, magnitude	H_V_{A-x}, V_{B-x}, V_{C-x} (x = 1 to 40)	■ [3]		■	■			
Harmonic, current, magnitude	H_I_{A-x}, H_I_{B-x}, H_I_{C-x} (x = 1 to 40)	■ [3]		■	■			
THD, voltage	THD_V_A, THD_V_B, THD_V_C	■ [3]		■	■	■		
THD, current	$THD\_I_{A,B,C}$	■ [3]		■	■	■		
Flicker (undelayed)	P undelayed$_{A,B,C}$	■						
Flicker (short)	$Pst_{A,B,C}$	■ [4]		■ [4]				
Flicker (long)	$Plt_{A,B,C}$	■ [5]		■ [5]				
Active power	$P_{A,B,C}$	■		■	■	■		
	P	■		■	■	■		
Reactive power	$Q_{A,B,C}$	■		■	■	■		
	Q	■		■	■	■		
	$Q_{A,B,C}$	■		■	■	■		
	$Q1$	■		■	■	■		
Apparent power	$S_{A,B,C}$	■		■	■	■		
	S	■		■	■	■		

Data [1]		Operating/Instanta-neous Measured Value (10/12 Periods)	Sine Recording	Measured-Value Recorder (30 s, 60 s, 10 min, 15 min, 30 min, 1 h, 2 h)			Event Evaluation (Undervoltages, Overvoltages, Interruptions)	Trend Recorder (1/2 Period RMS Event Recording)
	Interface	Modbus TCP, Modbus RTU, IEC 60870-5-103, IEC 61850, HTML, and Display	IEC 61850 (COMTRADE File Transfer) and HTML COMTRADE Download for COMTRADE Viewer or SIGRA Visualization	HTML CSV Download and Modbus TCP Protocol			Modbus TCP, IEC 61850 Report Genera-tion, HTML and Display	IEC 61850 (PQDIF File Transfer), Event Visualization with COMTRADE Viewer Plug-In, HTML PQDIF Download
	Type	Values/Graphical	Graphical	Mean Values	Max Values	Min Values	Protocols	Graphical
Active energy – supply	WP_supply$_{A, B, C}$	■ [6]						
	WP_supply	■ [6]						
Active energy – import	WP_import$_{A, B, C}$	■ [6]						
	WP_import	■ [6]						
Reactive energy – inductive	WQ_inductive $_{A, B, C}$	■ [6]						
	WQ_inductive	■ [6]						
Reactive energy – capacitive	WQ_capacitive $_{A, B, C}$	■ [6]						
	WQ_ capacitive	■ [6]						
Apparent energy	WS$_A$, WS$_B$, WS$_C$	■ [6]						
	WS	■ [6]						
Detailed information about data availability and measurands can be found in the SICAM 85x, 7KG85xx device manual.								

Table 2.4/1 Data Availability

(1) Data availability depends on the type of the connected circuit (1-phase, delta, or star connection).

(2) The frequency value (captured at a 10-second aggregation interval) is captured to IEC 61000-4-30.

(3) Harmonics are only available via IEC 61850 inquiry (no report generation) and in PQDIF format.

(4) Flicker Pst is invariably defined with 10-minute recording.

(5) Flicker Plt is invariably defined with 2-hour recording.

(6) Cumulated values

2.4

Power Quality Recorder

Connection Types And Examples

Special operating conditions need not be taken into account when used in the IT, TT and TN systems.

Connection Types

Possible connection types:

- 1-phase system
- 3-wire network with same (symmetrical) load
- 3-wire network with any (asymmetrical) load (2 current inputs)
- 3-wire network with any (asymmetrical) load (3 current inputs)
- 4-wire network with same (symmetrical) load
- 4-wire network with any (asymmetrical) load

Connection Examples
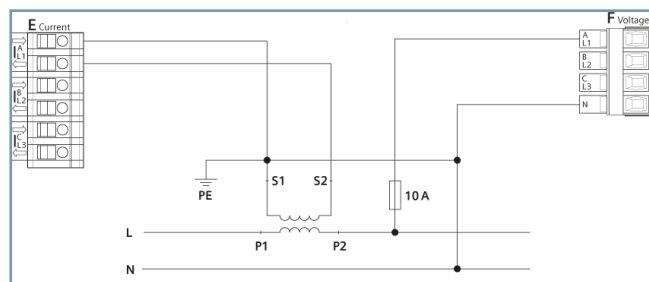
[Appl_single ph, 1 ct_P85, 1, --_--]

Figure 2.4/7   Connection Example 1-Phase System, 1 Current Transformer
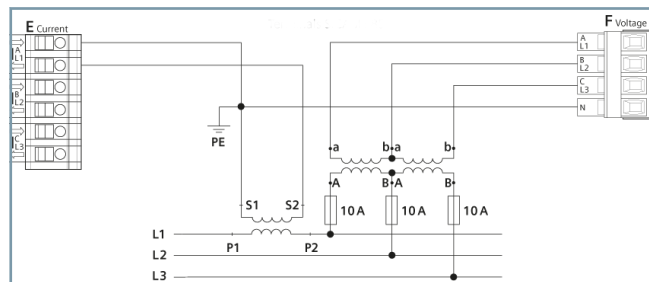
[Appl 3 ph, 2 v, 1 c, 1, --_--]

Figure 2.4/8   Connection Example 3-Wire Network, 2 Voltage and 1 Current Transformer, Same Load
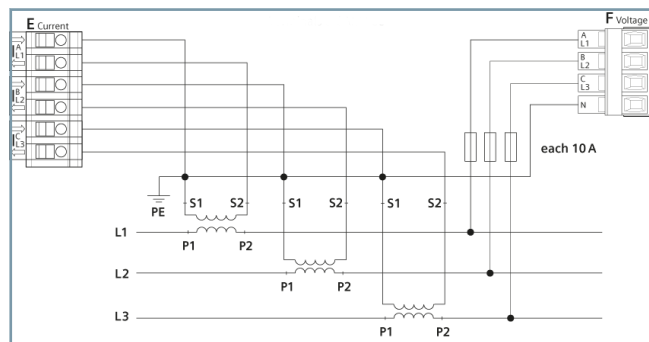
[Appl 3 wire, no vt, 1, en_US]

Figure 2.4/9   Connection Example 3-Wire Network, No Voltage Transformer and 3 Current Transformers, Any Load
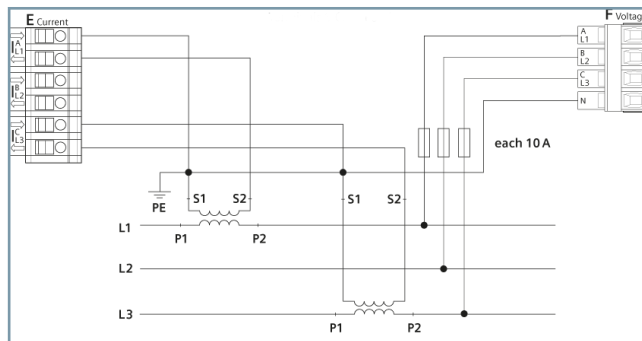
[Appl 3 wire, no vt, 2 ct, 1, en_US]

Figure 2.4/10   Connection Example 3-Wire Network, No Voltage Transformer and 2 Current Transformers, Any Load
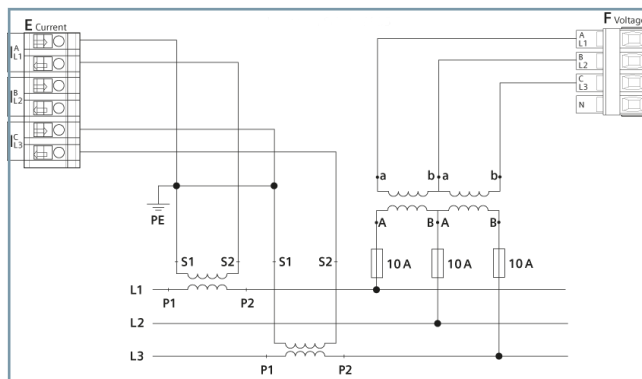
[Appl 3 wire, 2 vt, 2 ct, 1, --_--]

Figure 2.4/11   Connection Example 3-Wire Network, 2 Voltage and 2 Current Transformers, Any Load
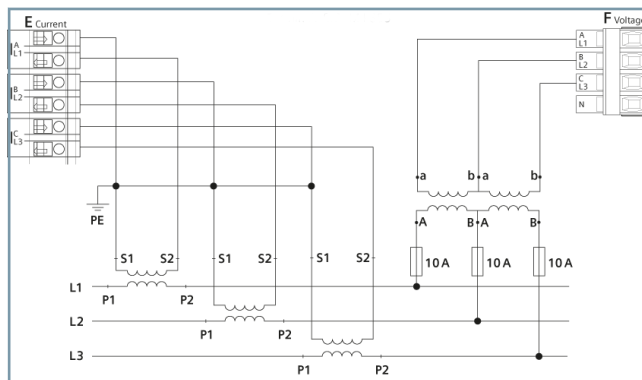
[Appl 3 wire 2 vt, 3 ct, 1, --_--]

Figure 2.4/12   Connection Example 3-Wire Network, 2 Voltage and 3 Current Transformers, Any Load
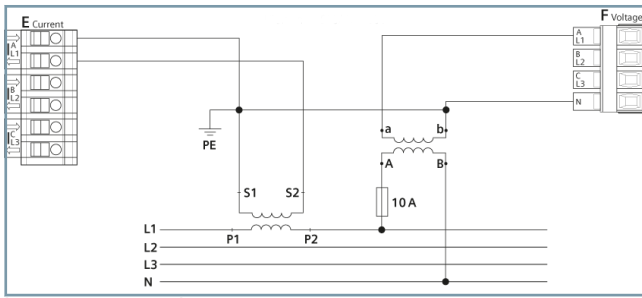
[Appl 4 wire, 1 vt, 1 ct, 1, --_--]

Figure 2.4/13   Connection Example 3-Wire Network, 1 Voltage and 1 Current Transformer, Any Load
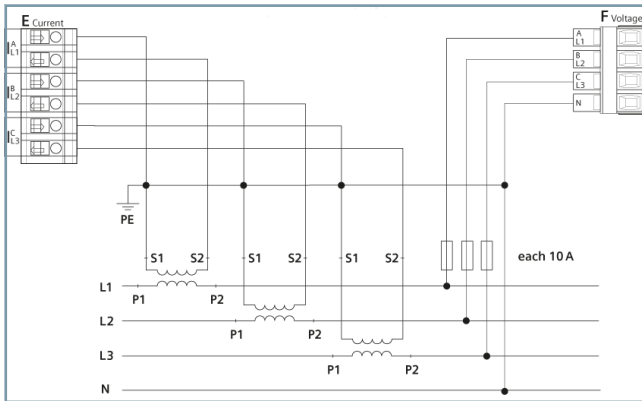
[Appl 4 wire, no vt, 1, en_US]

Figure 2.4/14   Connection Example 4-Wire Network, No Voltage Transformer and 3 Current Transformers, Any Load
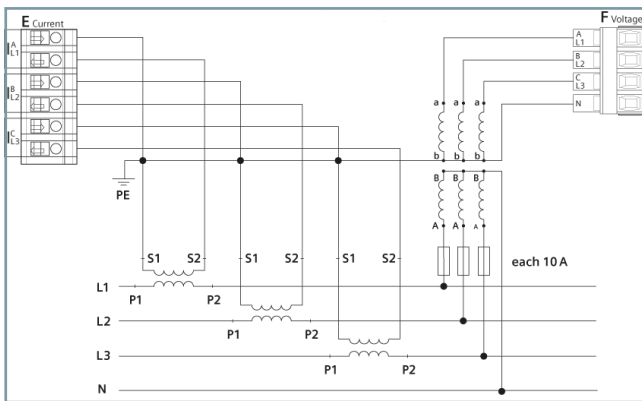
[Appl 4 wire, 3 vt, 3 ct, 1, en_US]

Figure 2.4/15   Connection Example 4-Wire Network, 3 Voltage and 3 Current Transformers, Any Load

Power Quality Recorder

SICAM P855 – Technical Data

Supply Voltage

Direct Voltage

Rated input voltage	24 V to 250 V
Admissible input voltage tolerance	±20 %
Admissible ripples of the DC input voltage	15 %
Maximum inrush current	
At ≤ 110 V	< 15 A
At 220 V to 300 V after 250 µs:	≤ 22 A; after 250 µs: < 5 A
Maximum power consumption	5 W

Inputs and Outputs

| Rated Input Alternating Voltages	
Ph-N/PE	63.5 V 110 V 230 V 400 V (347 V at UL conditions)
Ph-ph	110 V 190 V 400 V 690 V (600 V at UL conditions)
Maximum rated input alternating voltage depending on parameterization	1.2-fold rated input alternating voltage
Maximum rated input alternating voltage	
Ph-N/PE	480 V (347 V at UL conditions)
Ph-ph	831 V (600 V at UL conditions)
Input resistances	
A, B, C to N	6.0 MΩ
A-B, B-C, C-A	6.0 MΩ
Further specifications of the voltage measurement inputs	
Power consumption per input at V_{rated} 400 V	38 mW
Admissible frequency	42.5 Hz to 69.0 Hz
Measuring error (with compensation) at 23 ℃ ± 1 ℃ 50 Hz or 60 Hz	Typical 0.1 % at reference conditions

Table 2.4/2   Inputs for Alternating Voltage Measurements (Terminal Block F)

Communication Interfaces

Ethernet (Connection Z)

Ethernet, electrical	Connection	Housing top RJ45 connector socket 10/100Base-T to IEEE 802.3 LED yellow: 100 Mbits/s (OFF/ON) LED green: – Flashing: activity – ON: no activity – OFF: no connection
	Protocols	Modbus TCP IEC 61850-Server
	Voltage strength	DC 700 V
	Transmission rate	100 Mbits/s
	Cable for 10/100 Base-T	100 Ω to 150 Ω STP, CAT5
	Max. cable length 10/100 Base-T	100 m, at best routing

Environmental Data

Temperature specifications	Temperature during operation Device with display: The readability of the display is reduced at a temperature of < 0 ℃.	-25 ℃ to +55 ℃
	Temperature during transportation	-40 ℃ to +70 ℃
	Temperature during storage	-40 ℃ to +70 ℃
	Maximum temperature gradient	20 K/h
Humidity specifications	Mean relative humidity	≤ 75 %
	Maximum relative humidity	95 % on 30 days per year
	Condensation during operation	Not permitted
	Condensation during transportation and storage	Permitted
Application altitude	Maximum altitude above sea level	2000 m

General Data

Battery	Type	PANASONIC CR2032 VARTA 6032 101 501
	Voltage	3 V
	Capacity	230 mAh
	Typical service life	Operation with permanently applied supply voltage: 10 years
		Operation with sporadically interrupted supply voltage: Total of 2 months inside of 10 years
Internal memory	Storage capacity	2 GB
Degree of Protection		
DIN rail housing	IP20	

Panel flush mounting (front)	IP40 (with display, without door)
	IP51 (with display and door)
Terminals	IP2x

Additional Information

Please refer to the current *manual* for further information.

Dimensions

Mass	Device without display: approx. 0.49 kg
	Device with display, without door: approx. 0.52 kg
	Device with display and door: approx. 0.6 kg
Dimensions (W x H x D)	96 mm x 96 mm x 100 mm

[SICAM P85_Massbild_mit Hutschiene_2_Ansichten, 1, --_--]

Figure 2.4/16   Dimensional Drawing of the SICAM P850/P855, DIN-Rail Device
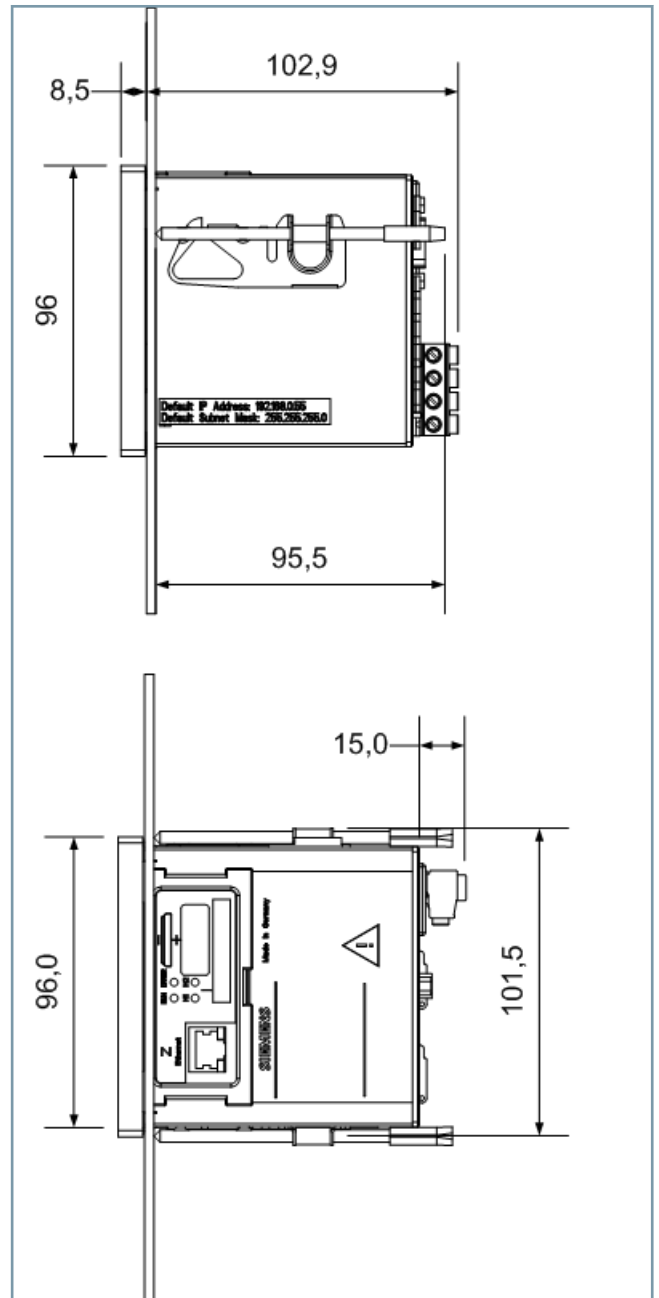
[SICAM P85_Massbild_mit_Display_2_Ansichten, 1, --_--]

Figure 2.4/17   Dimensional Drawing of the SICAM P850/P855 with Display

2.4

Power Quality Recorder

SICAM P855 – Technical Data
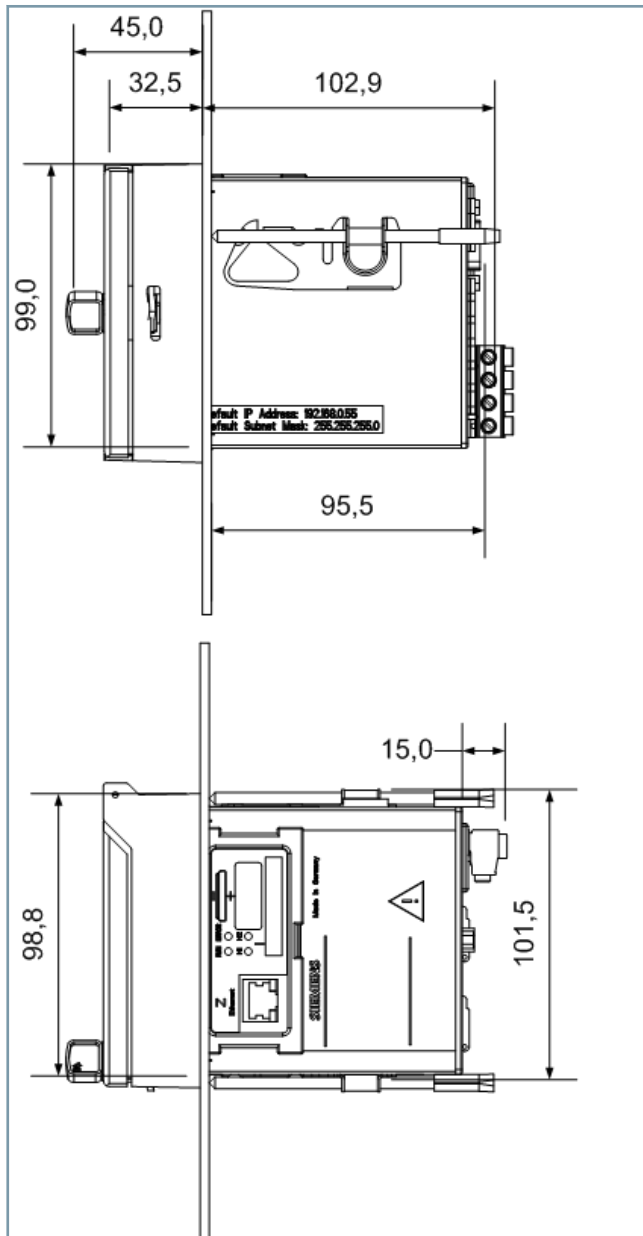
[SICAM P85_Massbild_mit_Tür_2_Ansichten, 1, --_--]

Figure 2.4/18   Dimensional Drawing of the SICAM P850/P855 with Display and Cover
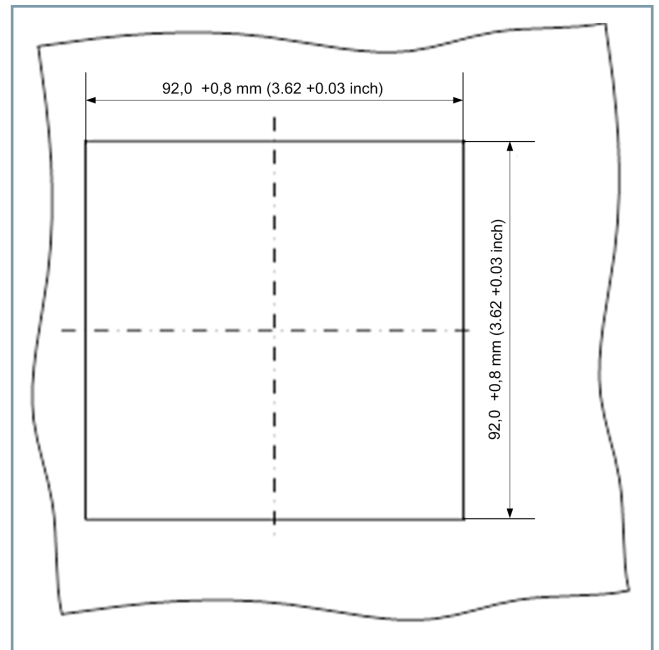
[dw_cut-out-in-switch-panel, 1, --_--]

Figure 2.4/19   Cutout In the Control Panel

Selection and Ordering Data

Description	Variants	Order No.															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
SICAM P855 – Multifunction Measuring Device		7	K	G	8	5	□	□	- 0	A	A	□	□	- □	A	A	0
							▲	▲				▲	▲	▲			
Dimensions: 96 mm x 96 mm x 100 mm 4 inputs for alternating voltage measurements 3 inputs for AC current measurements 2 binary outputs Isolated voltage measuring inputs Web server for parameterization and visualization Internal 2-GB memory Measurements to IEC 61000-4-30 standard	*Base recording and power quality recorder* Measurands: power quality device – IEC 61000-4-30 cos φ, limiting-value violations, energy measurements, measurements up to 40th harmonic, flicker to IEC 61000-4-15 min./max./mean value recorder, fault recording (data export in COMTRADE format) voltage-event recognition, visualization (for example, Vdip) online PQ reports to EN 50160 measured value transmission with communication protocols						5	|				|	|	|			
	Housing						|					|	|	|			
	DIN-rail housing without display							0				|	0	|			
	Switch panel flush-mounting device with graphic display							1				|	|	|			
	Serial interface and communication protocol											|	|	|			
	Without											0	|	|			
	RS485 - Modbus RTU											1	|				
	RS485 - IEC 60870-5-103 and Modbus RTU											3	|	|			
	Protection class front side												|	|			
	IP20 (position 7 = 0)												0	|			
	IP40 (position 7 = 1)												1	|			
	IP51 (position 7 = 1)												2	|			
	Ethernet interface and communication protocol, RJ45													|			
	Modbus TCP													0			
	Modus TCP and IEC 61850 server													2			

Table 2.4/3   Selection and Ordering Data

2.4

Power Meters

Power Meters

SICAM P850 – Description

Description

SICAM P850 are multifunctional devices to capture, represent and transfer measured electrical quantities, such as alternating current, alternating voltage, power types, harmonics, etc. The measured quantities can be output via the communication interfaces to a PC and to the systems control, or be shown on an optional display.

SICAM P850 is a flush-mounting switch panel with a graphic display for the representation of measured values and for parameterization. SICAM P850 is also available as a DIN-rail device without a display. Communication via Ethernet uses the communication protocol Modbus TCP or IEC 61850 Edition 2. Serial communication is optionally possible with an RS485 interface via Modbus RTU or IEC 60870-5-103. The degree of protection at the front of a DIN-rail device without display is IP20. The degree of protection of the devices with display for switch panel flush mounting is IP40 or IP51.

Device type	DIN rail or switch panel flush mounting device
Supply voltage	DC 24 V to 250 V
	AC 110 V to 230 V; 50 Hz/60 Hz
Input and output circuits	4 inputs for alternating voltage measurements
	3 inputs for AC current measurements
	2 binary outputs (parameterization as required)
LED indicators	For the automatic function monitoring of hardware and software components
Communication	Ethernet communication via the protocols Modbus TCP or IEC 61850 Edition 2; optionally serial communication via Modbus RTU and IEC 60870-5-103 via RS485 interface

Benefits

- Used in the IT, TT and TN systems
- Robust and compact design to IEC 62586-1, Class S (leading standard)
- Measurands and events are captured in accordance with the power quality standard IEC 61000-4-30
- Ethernet communication via the protocols Modbus TCP or IEC 61850 Edition 2; optionally serial communication via Modbus RTU and IEC 60870-5-103 via RS485 interface
- External time synchronization via the Network Time Protocol (NTP)
- 2-GB memory for the storage of the recorder data
- Fault recording and data export in COMTRADE format
- Additional measurands: min/mean/max values in CSV

Functions

In addition to the monitoring function, SICAM P850 as an all-in-one device with internal 2-GB memory offers new write functions.

- Sine recording and capturing with voltage- and current-trigger settings in COMTRADE
- Recording mean, minimum, and maximum values of different network parameters at flexible intervals in CSV
- Flexible data export in CSV and/or COMTRADE formats

[ph_SICAM P850, 1, --_--]

Figure 3.1/1   SICAM P850

Applications

SICAM P850 is used in 1-phase systems and in 3- and 4-wire networks (with neutral phase). The device is chiefly used in power utilities, but also in other industry sections and in trades.

The Web server, which is integrated in the device, is used for parameterization and measured-value output via HTML pages on the connected PC/laptop computer. The devices with display permit parameterization via the function buttons at the front and measured-value output via the display. Furthermore, the output variables can be transferred as digital data via the communication interfaces (Ethernet, for example IEC 61850 Edition 2) to control systems or other systems (such as SICAM PQS).
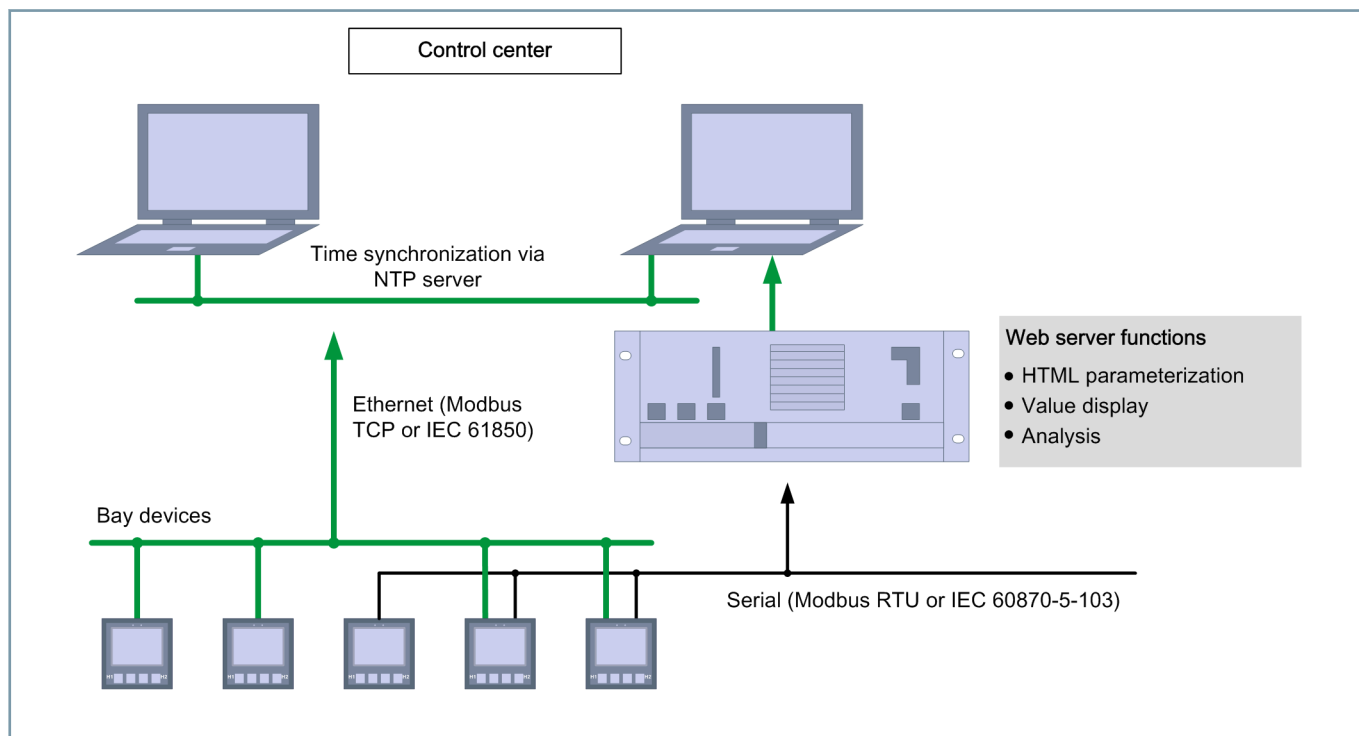
[dw_SICAM P850_Application, 1, en_US]

Figure 3.1/2   Application Example

Hardware Design

Depending on the device variant, the following electrical components are contained:

- Digital signal processor (DSP)
- Display and front buttons
- 4 inputs for alternating voltage measurements
- 3 inputs for AC current measurements
- 2 binary outputs
- Power supply
- Ethernet interface
- RS485 interface (according to order variant)
- 2-GB primary storage

Measurands

The following measurands are captured or calculated by the device from the measured quantities:

- True RMS alternating voltage and alternating current
- 2048 sampled values per 10/12 system periods
- Root-means-square value measurement (TRMS) up to the 100th harmonic
- Power frequency
- Active, reactive, and apparent power
- Active, reactive, and apparent energy
- Power factor and active power factor
- Unbalance of alternating voltage and alternating current

- Harmonics up to the 40th order of alternating voltage and alternating current are stored for evaluation
- THD (Total Harmonic Distortion) of alternating voltage and alternating current
- Phase angle

Communication

An Ethernet interface and an optional RS485 interface are available for the communication with the systems control and with other process automation systems. The RS485 interface supports the transfer of operational measured values, counts, and messages. Depending on the device version, you can use the communication protocol Modbus RTU or IEC 60870-5-103. Device parameterization, transfer of measured data, counts and messages/events, and the time synchronization with the Network Time Protocol (NTP) are supported via Ethernet. The device supports the transfer of operational measured values with both Ethernet protocol options – via Modbus TCP and via IEC 61850 Edition 2.

Time Synchronization

All time-relevant processes require date and time during operation. Consequently, there is a time synchronization during the communication with peripheral devices. This ensures a uniform

time base and permits time stamping of the process data. The following time synchronization methods are possible:

- **Time synchronization via Ethernet NTP (preferred)**

  The device is equipped with an SNTP client (Simple Network Time Protocol) that can be connected to 2 NTP servers (Network Time Protocol) for external time synchronization. These are the primary and the secondary (redundant) NTP server.

- **External time synchronization via Fieldbus**

  with communication protocol Modbus RTU or IEC 60870-5-103

- **Real Time Clock (RTC)**

  If external time synchronization is not available, you can synchronize data with the time signal from an internal clock.

Parameterization and Visualization

All versions are operated via a connected PC. Parameterization is always performed with an internal Web browser with HTML pages.

[sc_Messwerterfassung, 1, en_US]

Figure 3.1/3   Parameterization of the Process Connections

Visualization of Values

Depending on the selection of the operating parameters, the I/O window shows measured values together with the related unit, or a tabular message list that is updated every 5 seconds.

- Operational measured values
- Harmonics of the voltage
- Harmonics of the current
- Power and energy
- Binary outputs
- Limiting values
- Group alarms
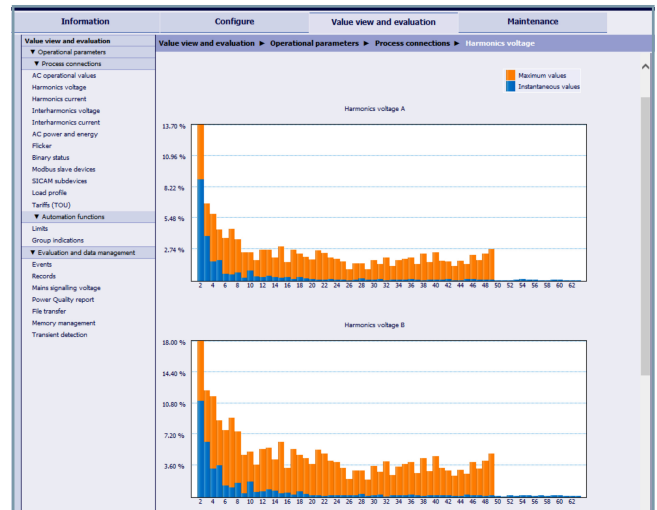
[sc_0226_Harmonische, 1, en_US]

Figure 3.1/4   Graphical Representation of the Harmonics

Automation Functions

Upper or lower limiting values can be parameterized for up to 16 measured values. A violation of these limiting values can be issued as a message. Up to 4 limiting-value violations can be output at the device via the 2 binary outputs and the LEDs H1 and H2. In addition, all 16 limiting-value violations can be sent to peripheral units via Ethernet.

[sc_Werte_betrachten, 1, en_US]

Figure 3.1/5   Visualization of Operational Measured Values

Other maintenance tasks, such as firmware updates or reading operational indications and error messages can also be performed via the HTML pages.
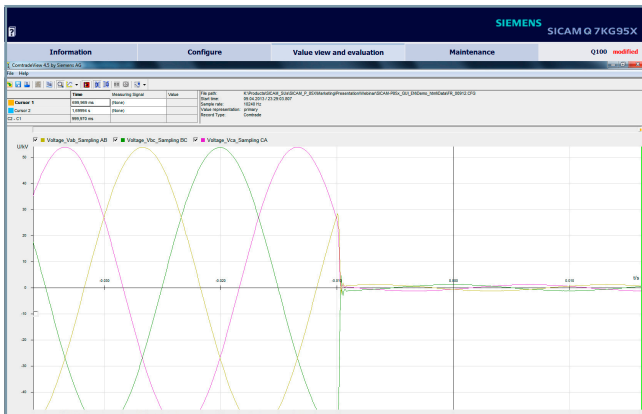
[sc_Faultrecord, 1, en_US]

Figure 3.1/6   Visualization of Operational Indications

Power Meters

	Data [1]	Operating/Instantaneous Measured Values (10/12 Periods)	Sine Recording	Measured-Value Recorder (30 s, 60 s, 10 min, 15 min, 30 min, 1 h, 2 h)		
	Interface	Modbus TCP, Modbus RTU, IEC 60870-5-103, IEC 61850, HTML and Display	IEC 61850 (COMTRADE File Transfer) and HTML COMTRADE Download for COMTRADE Viewer or SIGRA Visualization	HTML CSV Download and Modbus TCP Protocol		
	Type	Values/Graphical	Graphical	Mean Values	Max Values	Min Values
Voltage (AC)	$V_{A, B, C}$	x	x	x	x	x
	$V_{A-B, B-C, C-A}$	x	x	x	x	x
	V_N	x	x	x	x	x
	V_{sum}	x		x		
	V_{asym}	x		x	x	x
Current (AC)	$I_{A, B, C}$	x	x	x	x	x
	I_0	x		x		
	I_{sum}	x		x		
	I_{asym}	x		x	x	x
Active power factor	$\cos \varphi_{A, B, C}$	x		x	x	x
	$\cos \varphi$	x		x	x	x
Power factor	$PF_{A, B, C}$	x		x	x	x
	PF	x		x	x	x
Phase angle	$\varphi_{A, B, C}$	x		x	x	x
	φ	x		x	x	x
	Voltage $\varphi_{A, B, C}$, current $\varphi_{A, B, C}$	x		x		
Frequency	f (system frequency)	x		x	x	x
	10-s frequency (10-freq.)			x [2]	x	x
Harmonic, voltage, magnitude	H_V_{A-x}, V_{B-x}, V_{C-x} (x = 1 to 40)	x [3]		x	x	
Harmonic, current, magnitude	H_I_{A-x}, H_I_{B-x}, H_I_{C-x} (x = 1 to 40)	x [3]		x	x	
THD, voltage	THD_V_A, THD_V_B, THD_V_C	x [3]		x	x	x
THD, current	$THD\_I_{A, B, C}$	x [3]		x	x	x
Active power	$P_{A, B, C}$	x		x	x	x
	P	x		x	x	x
Reactive power	$Q_{A, B, C}$	x		x	x	x
	Q	x		x	x	x
	$Q_{A, B, C}$	x		x	x	x
	Q1	x		x	x	x
Apparent power	$S_{A, B, C}$	x		x	x	x
	S	x		x	x	x
Active energy – supply	$WP\_supply_{A, B, C}$	x [4]				
	WP_supply	x [4]				
Active energy – import	$WP\_import_{A, B, C}$	x [4]				
	WP_import	x [4]				
Reactive energy – inductive	$WQ\_inductive_{A, B, C}$	x [4]				
	WQ_inductive	x [4]				
Reactive energy – capacitive	$WQ\_capacitive_{A, B, C}$	x [4]				
	WQ_capacitive	x [4]				

Data [1]		Operating/Instantaneous Measured Values (10/12 Periods)	Sine Recording	Measured-Value Recorder (30 s, 60 s, 10 min, 15 min, 30 min, 1 h, 2 h)		
Interface		Modbus TCP, Modbus RTU, IEC 60870-5-103, IEC 61850, HTML and Display	IEC 61850 (COMTRADE File Transfer) and HTML COMTRADE Download for COMTRADE Viewer or SIGRA Visualization	HTML CSV Download and Modbus TCP Protocol		
	Type	Values/Graphical	Graphical	Mean Values	Max Values	Min Values
Apparent energy	WS_A, WS_B, WS_C	x [4]				
	WS	x [4]				
Detailed information about data availability and measurands can be found in the SICAM 85x, 7KG85xx device manual.						

Table 3.1/1   Data Availability of the Operational Measured Quantities 1)

(1)   Data availability depends on the type of the connected circuit (1-phase, delta, or star connection).

(2)   IEC 61850 inquiry (no report generation)

(3)   The frequency value (captured at a 10-second aggregation interval) is captured to IEC 61000-4-30.

(4)   Cumulated values

3.1

Power Meters

SICAM P850 – Connection Types and Examples

Connection Types And Examples

Special operating conditions need not be taken into account when used in the IT, TT and TN systems.

Connection Types

Possible connection types:

- 1-phase system
- 3-wire network with same (symmetrical) load
- 3-wire network with any (asymmetrical) load (2 current inputs)
- 3-wire network with any (asymmetrical) load (3 current inputs)
- 4-wire network with same (symmetrical) load
- 4-wire network with any (asymmetrical) load

Connection Examples
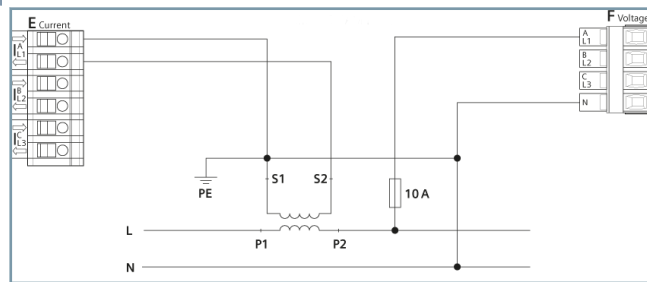
[Appl_single ph, 1 ct_P85, 1, --_--]

Figure 3.1/7   Connection Example 1-Phase System, 1 Current Transformer
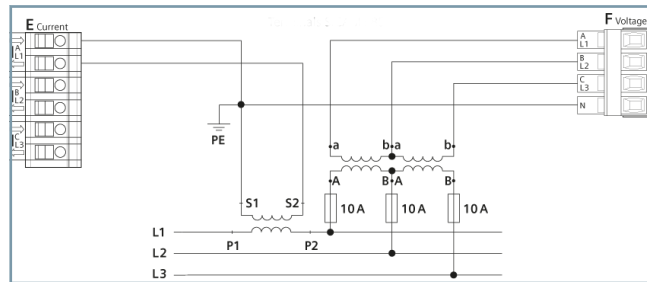
[Appl 3 ph, 2 v, 1 c, 1, --_--]

Figure 3.1/8   Connection Example 3-Wire Network, 2 Voltage and 1 Current Transformer, Same Load
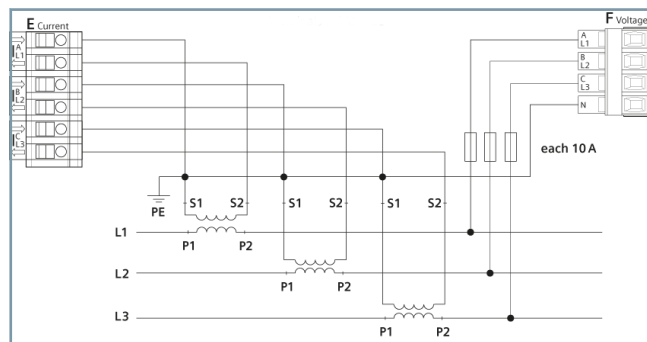
[Appl 3 wire, no vt, 1, en_US]

Figure 3.1/9   Connection Example 3-Wire Network, No Voltage Transformer and 3 Current Transformers, Any Load
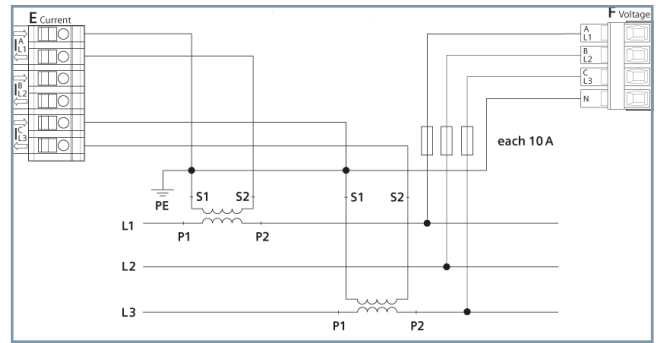
[Appl 3 wire, no vt, 2 ct, 1, en_US]

Figure 3.1/10   Connection Example 3-Wire Network, No Voltage Transformer and 2 Current Transformers, Any Load
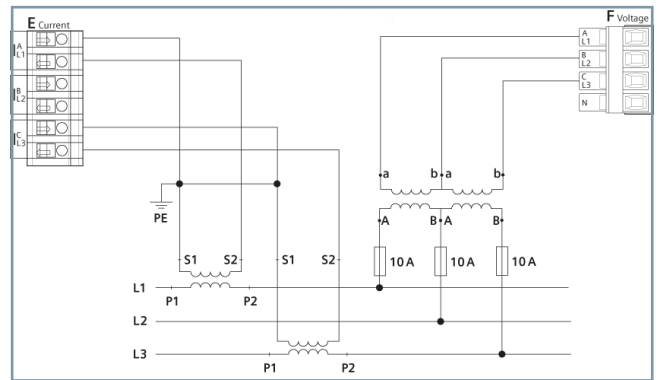
[Appl 3 wire, 2 vt, 2 ct, 1, --_--]

Figure 3.1/11   Connection Example 3-Wire Network, 2 Voltage and 2 Current Transformers, Any Load
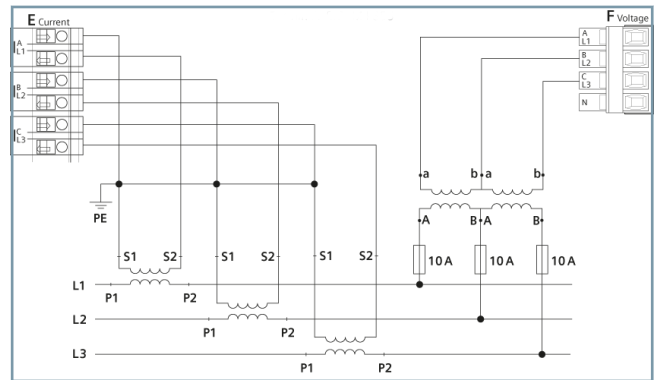
[Appl 3 wire 2 vt, 3 ct, 1, --_--]

Figure 3.1/12   Connection Example 3-Wire Network, 2 Voltage and 3 Current Transformers, Any Load

3.1
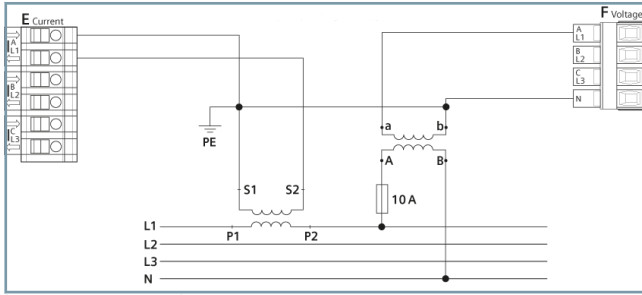
[Appl 4 wire, 1 vt, 1 ct, 1, --_--]

Figure 3.1/13   Connection Example 3-Wire Network, 1 Voltage and
1 Current Transformer, Any Load
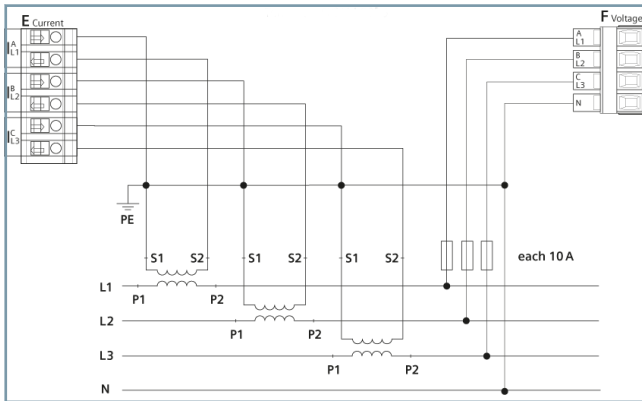
[Appl 4 wire, no vt, 1, en_US]

Figure 3.1/14   Connection Example 4-Wire Network, No Voltage Trans-
former and 3 Current Transformers, Any Load
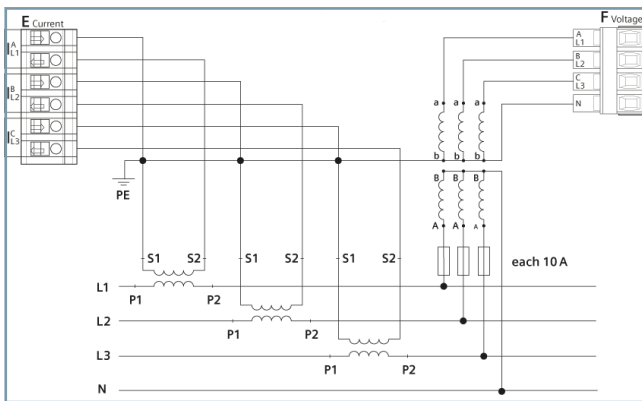
[Appl 4 wire, 3 vt, 3 ct, 1, en_US]

Figure 3.1/15   Connection Example 4-Wire Network, 3 Voltage and
3 Current Transformers, Any Load

Power Meters

SICAM P850 – Technical Data

Supply Voltage

Direct Voltage

Rated input voltage	24 V to 250 V
Admissible input voltage tolerance	±20 %
Admissible ripples of the DC input voltage	15 %
Maximum inrush current	
At ≤ 110 V	< 15 A
At 220 V to 300 V after 250 µs:	≤ 22 A; after 250 µs: < 5 A
Maximum power consumption	5 W

Alternating Voltage

Rated input voltage	110 V to 230 V
Power frequency	50 Hz/60 Hz
Admissible input voltage tolerance	±20 %
Admissible higher harmonic	2 kHz
Maximum inrush current	
At ≤ 115 V	< 15 A :
At 230 V	≤ 22 A; after 250 µs: < 5 A
Maximum power consumption	16 VA

Inputs and Outputs

Rated Input Alternating Voltages	
Ph-N/PE	63.5 V
	110 V
	230 V
	400 V (347 V at UL conditions)
Ph-ph	110 V
	190 V
	400 V
	690 V (600 V at UL conditions)
Maximum rated input alternating voltage depending on parameterization	1.2-fold rated input alternating voltage
Maximum rated input alternating voltage	
Ph-N/PE	480 V (347 V at UL conditions)
Ph-ph	831 V (600 V at UL conditions)
Input resistances	
A, B, C to N	6.0 MΩ
A-B, B-C, C-A	6.0 MΩ
Further specifications of the voltage measurement inputs	
Power consumption per input at V_{rated} 400 V	38 mW
Admissible frequency	42.5 Hz to 69.0 Hz
Measuring error (with compensation) at 23 °C ± 1 °C 50 Hz or 60 Hz	Typical 0.1 % at reference conditions

Table 3.1/2   Inputs for Alternating Voltage Measurements (Terminal Block F)

Inputs for AC Current Measurements (Terminal Block E)

| Input AC currents	
Rated input AC current ranges (can be parameterized)	1 A
	5 A
Maximum input AC current	2 x rated input AC current
Power consumption per input	
At 1 A	1 mVA
At 5 A	2.5 mVA
Additional information about the current measurement inputs	
Maximum voltage	150 V
Measuring error (with compensation) at 23 °C ± 1 °C 50 Hz or 60 Hz	Typical 0.1 % at reference conditions
Thermal stability	10 A continuously 100 A for maximum of 1 s

Binary Outputs (Terminal Block G)

Maximum contact voltage	
Alternating Voltage	230 V
Direct Voltage	250 V
Maximum currents	
Maximum continuous touch current	100 mA
Maximum pulse current for 0.1 s	300 mA
Additional information about the binary outputs	
Internal resistance	35 Ω
Admissible switching frequency	10 Hz
Number of switching cycles	Unlimited

Communication Interfaces

Ethernet (Connection Z)

Ethernet, electrical	Connection	Housing top
		RJ45 connector socket
		10/100Base-T to IEEE 802.3
		LED yellow: 100 Mbits/s (OFF/ON)
		LED green:
		– Flashing: activity
		– ON: no activity
		– OFF: no connection
	Protocols	Modbus TCP IEC 61850-Server
	Voltage strength	DC 700 V
	Transmission rate	100 Mbits/s
	Cable for 10/100 Base-T	100 Ω to 150 Ω STP, CAT5
	Max. cable length 10/100 Base-T	100 m, at best routing

Serial Interface (Connection J), Optional

RS485	Connection	Terminal side, 9-way D-Sub socket	
	Protocol	Modbus RTU (optional)	IEC 60870-5-103 (optional)
	Baud rate (adjustable)	Min. 1200 bits/s Max. 115 200 bits/s	Min. 9600 bits/s Max. 38 400 bits/s
	Bridgeable distance	Max. 1 km (depends on transmission rate)	
	Transmission level	Low: -5 V to -1.5 V High: +1.5 V to +5 V	
	Receive level	Low: ≤ -0.2 V High: ≥ +0.2 V	
	Bus termination	Not integrated; bus termination by connector with integrated termination resistors	

Environmental Data

Temperature specifications	Temperature during operation Device with display: The readability of the display is reduced at a temperature of < 0 °C.	-25 °C to +55 °C
	Temperature during transportation	-40 °C to +70 °C
	Temperature during storage	-40 °C to +70 °C
	Maximum temperature gradient	20 K/h
Humidity specifications	Mean relative humidity	≤ 75 %
	Maximum relative humidity	95 % on 30 days per year
	Condensation during operation	Not permitted
	Condensation during transportation and storage	Permitted
Application altitude	Maximum altitude above sea level	2000 m

General Data

Battery	Type	PANASONIC CR2032 VARTA 6032 101 501
	Voltage	3 V
	Capacity	230 mAh
	Typical service life	Operation with permanently applied supply voltage: 10 years
		Operation with sporadically interrupted supply voltage: Total of 2 months inside of 10 years
Internal memory	Storage capacity	2 GB
Degree of Protection		
DIN rail housing	IP20	
Panel flush mounting (front)	IP40 (with display, without door)	
	IP51 (with display and door)	
Terminals	IP2x	

3.1

Dimensions

Mass	Device without display: approx. 0.49 kg
	Device with display, without door: approx. 0.52 kg
	Device with display and door: approx. 0.6 kg
Dimensions (W x H x D)	96 mm x 96 mm x 100 mm

[SICAM P85_Massbild_mit Hutschiene_2_Ansichten, 1, --_--]

Figure 3.1/16   Dimensional Drawing of the SICAM P850/P855, DIN-Rail Device
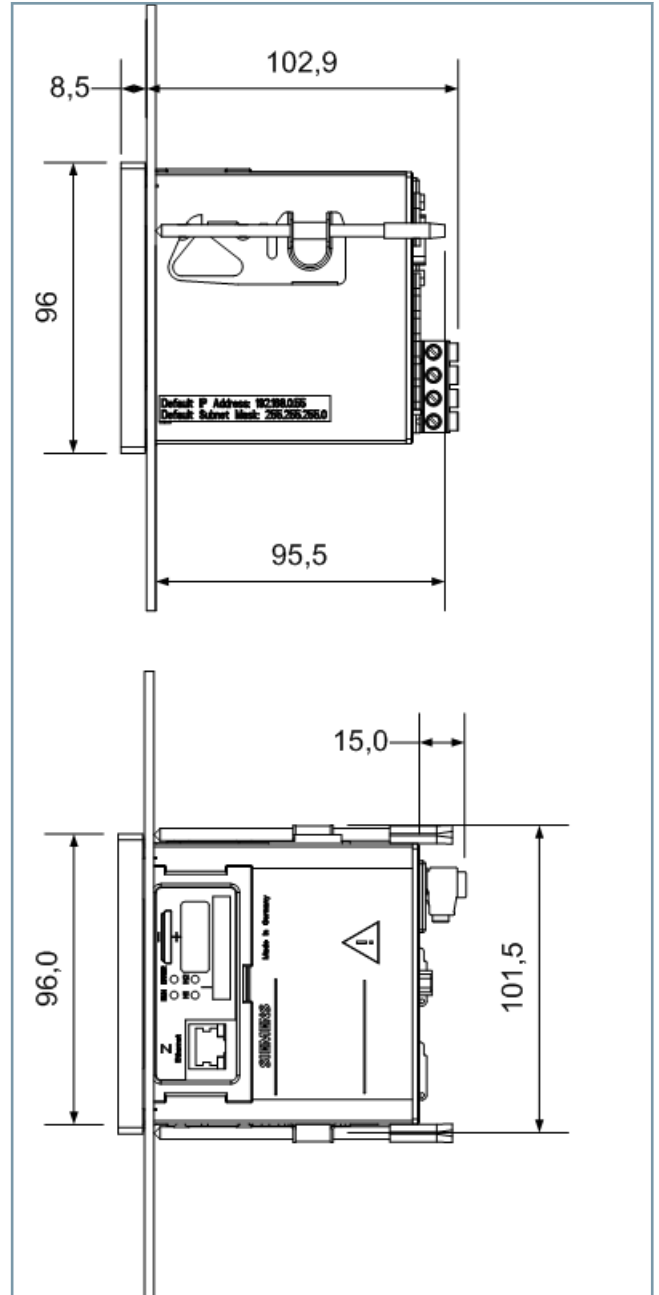
[SICAM P85_Massbild_mit_Display_2_Ansichten, 1, --_--]

Figure 3.1/17   Dimensional Drawing of the SICAM P850/P855 with Display

[dw_cut-out-in-switch-panel, 1, --_--]

Figure 3.1/19   Cutout In the Control Panel
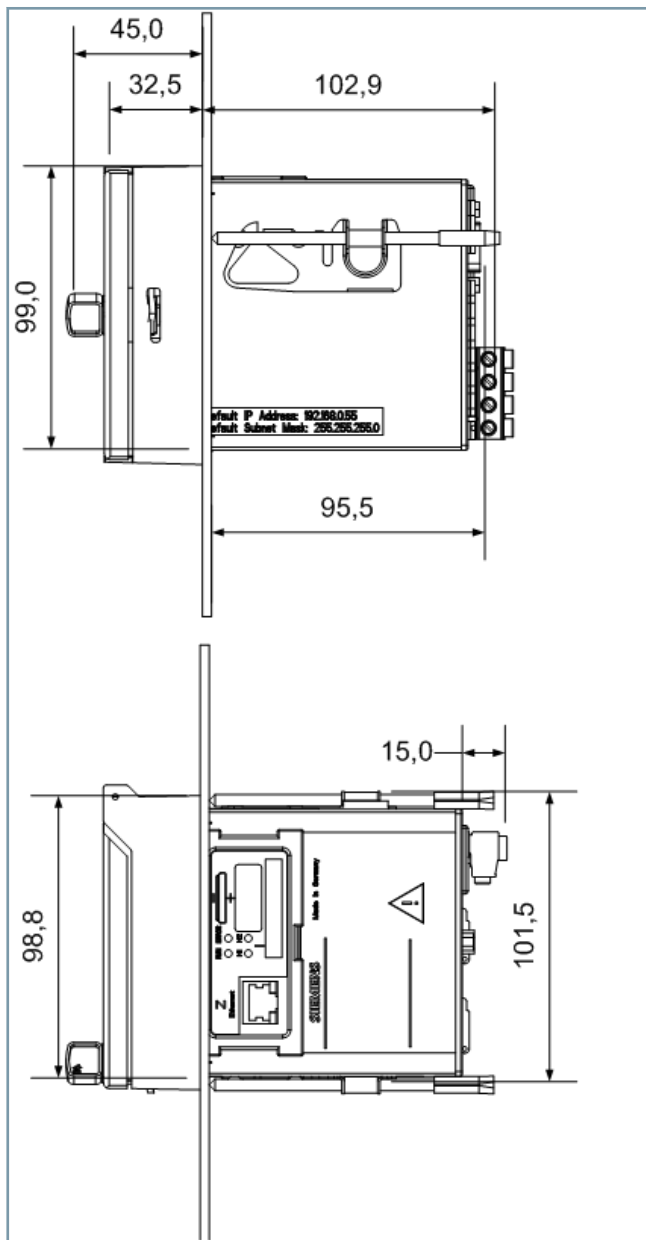
[SICAM P85_Massbild_mit_Tür_2_Ansichten, 1, --_--]

Figure 3.1/18   Dimensional Drawing of the SICAM P850/P855 with Display and Cover

3.1

Selection and Ordering Data

Description	Variants	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
SICAM P850 - Multi-Function Measuring Device		7	K	G	8	5	□	□	- 0	A	A	□	□	- □	A	A	0
							▲	▲				▲	▲	▲			
Dimensions: 96 mm x 96 mm x 100 mm 4 inputs for alternating voltage measurements 3 inputs for AC current measurements 2 binary outputs Isolated voltage measuring inputs Web server for parameterization and visualization Internal 2 GB memory Measurements to IEC 61000-4-30 standard	*Monitoring, recording and power quality (PQ) functions* Base measurements: V, I, f, P, Q, S, cos φ, limiting-value violations, energy measurements, measurements up to 40th harmonic, base recordings: Min./max./mean value recorder - (data export in CSV format) fault recording (data export in COMTRADE format) measured-value transmission with communication protocols						0	|				|	|	|			
	Housing							|				|	|	|			
	DIN-rail housing without display							0				|	0	|			
	Switch panel flush-mounting device with graphic display							1				|	|	|			
	Serial interface and communication protocol											|	|	|			
	Without											0	|	|			
	RS485 - Modbus RTU											1	|				
	RS485 - IEC 60870-5-103 and Modbus RTU											3	|	|			
	Protection class front side												|	|			
	IP20 (position 7 = 0)												0	|			
	IP40 (position 7 = 1)												1	|			
	IP51 (position 7 = 1)												2	|			
	Ethernet interface and communication protocol, RJ45													|			
	Modbus TCP													0			
	Modus TCP and IEC 61850 server													2			

Table 3.1/3   Selection and Ordering Data

3.1

Description

SICAM MMU (Measurement and Monitoring Unit) is a power monitoring device that measures electrical quantities in power supply system.

SICAM MMU is used in industrial plants, power plants and substations to measure and calculate parameters (for example current, voltage, power, phase angle, harmonics, energy, or frequency) and forward these measured values to network control systems (SCADA, DMS, EMS etc.) via IEC 60870-5-104 or to automation systems via Modbus where they can be further processed and visualized.

Device type	DIN rail mounting device
	Plastic case 96 mm × 96 mm × 100 mm/ 3.78 in. x 3.78 in. x 3.94 in. (W×H×D)
	Degree of protection IP20
Supply voltage	DC 24 to 250 V
	AC 110 to 230 V; 45 to 65 Hz
Input and output circuits	4 inputs for alternating voltage measurements
	3 inputs for alternating current measurements up to 10 A continuous current
	Individually programmable binary outputs
	Je 6 Binäreingänge und -ausgänge mit SICAM I/O Unit erweiterbar
Signalization LEDs	To automatically monitor the functions of hardware, software, and firmware components
Communication	Ethernet: IEC 60870-5-104 or Modbus TCP communication protocol

Benefits

- Compact and rugged design
- Over 100 measured or calculated values available
- Temperature range: -25 °C to +55 °C / -13 °F to 131 °F
- Measuring accuracy: 0.1 % deviation for rated input voltage and rated input current according to IEC 60688 and 0.2 s according to IEC 62053-21
- High EMC immunity: according to the requirements of EN 61000-62 and EN 61000-6-4 for the EMC directives and the requirements of EN 61010-1 for the lowvoltage directive
- UL certification according to UL 61010-1 standard
- Flexible current measuring range (up to 2 x I_n)
- 2 individual binary outputs for fast switching, indications (for example, limit violation) and operation status monitoring
- Ethernet communication via IEC 60870-5-104 or Modbus TCP protocols
- Internal battery to power the real-time clock and save the energy counter values in case of auxiliary-voltage failure
- Real-time clock (RTC), field bus synchronization or network synchronization possible via NTP

Customer Benefit

- Reliable and cost-efficient support of power system management and planning by measurements from distribution systems
- Reduced cabling through Ethernet

[ph_SICAM MMU SR10-001, 2, --_--]

Figure 3.2/1   SICAM MMU

- Real-time data transmission via mobile communications (for example GPRS, UMTS) through reduced data rate
- User-friendly operation through Web server (no extra software for parameterization needed, no converters and extra cables)

Applications

- Equipping secondary substations with measurement instrumentation and communication link
- SICAM MMU is used at power utilities as well as industrial and commercial applications connection in 1-phase systems, in 3-wire and 4-wire systems
- Support of the integration of online measurements into network control systems and automation systems, protocols via IEC 60870-5-104 or Modbus TCP, for example for voltage and load control
- Monitoring of transformers and distributed power generation
- Alarming and notification of limit violations via protocol or binary outputs
- Basic power quality profile monitoring (voltage, frequency, harmonics and unbalance)
- Option to support all power systems IT, TT and TN

3.2

Power Meters

SICAM MMU – Description

Field of Application		Voltage	Current	Power	Frequency	Phase-angle	Harmonics	Energy	Message	Internal cost allocation
Generation and distributed generation	Generator/superordinate transformer	■	■	■	■	■	■	■	■	
Power transmission substation	Incoming feeder	■	■	■						
	Outgoing line	■	■	■						
Transformer substation	Incoming feeder	■								
	Busbar	■	■	■	■			■		
	Feeder	■	■	■	■			■		
Transformer power distribution	Incoming feeder	■	■	■	■		■	■		
	Busbar	■								
	Feeder	■	■	■	■	■		■	■	
Process	SCADA/EMS/DMS	■	■	■	■	■	■	■		
	Energy management	■	■	■	■	■	■	■	■	■
	Motors	■	■	■	■	■	■		■	■
	Commercial (for example air conditioning units)	■	■	■					■	■

Table 3.2/1   Application and Selection Fields
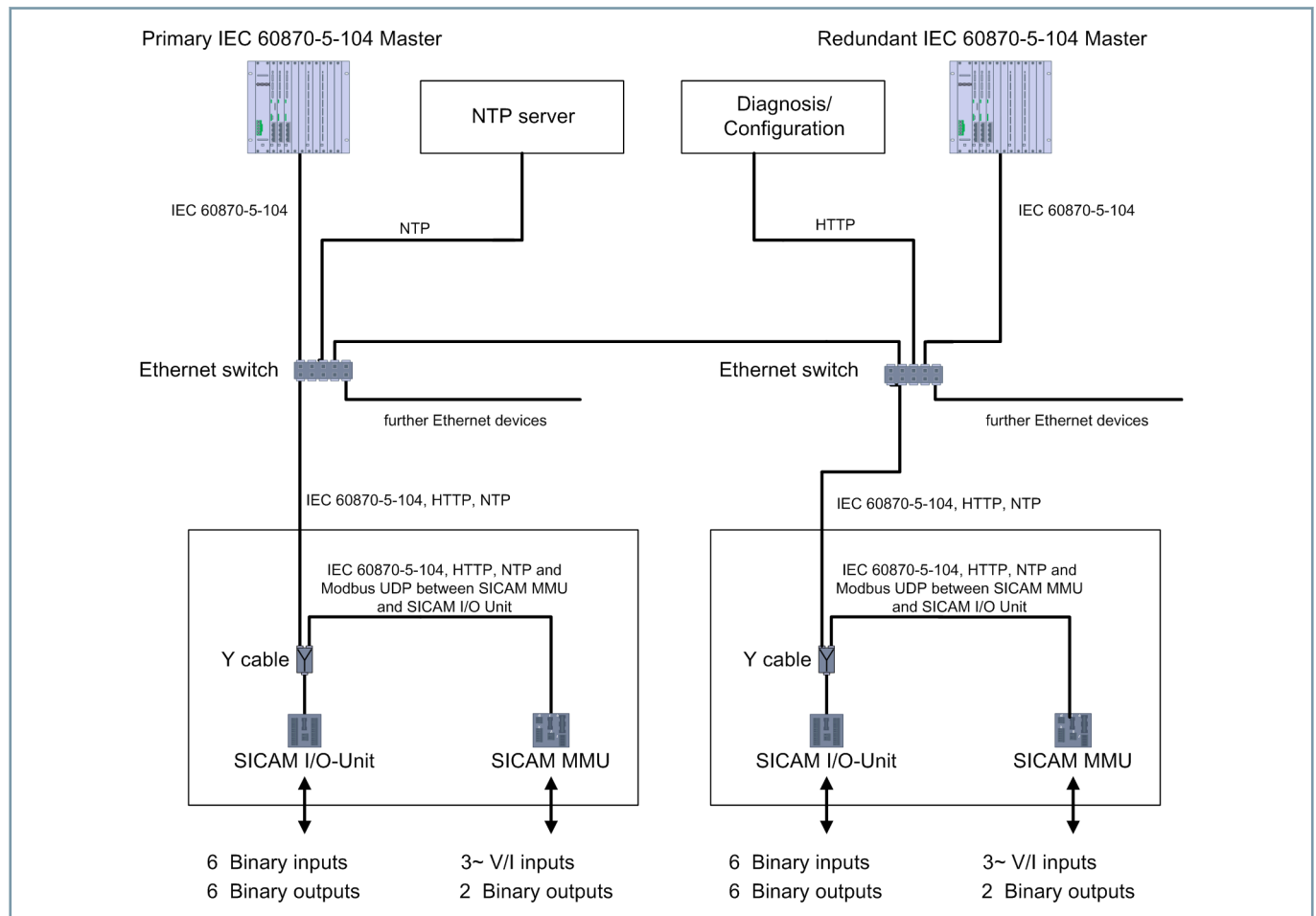
[dw_connection_device_sub_con, 1, en_US]

Figure 3.2/2   Application Example SICAM MMU
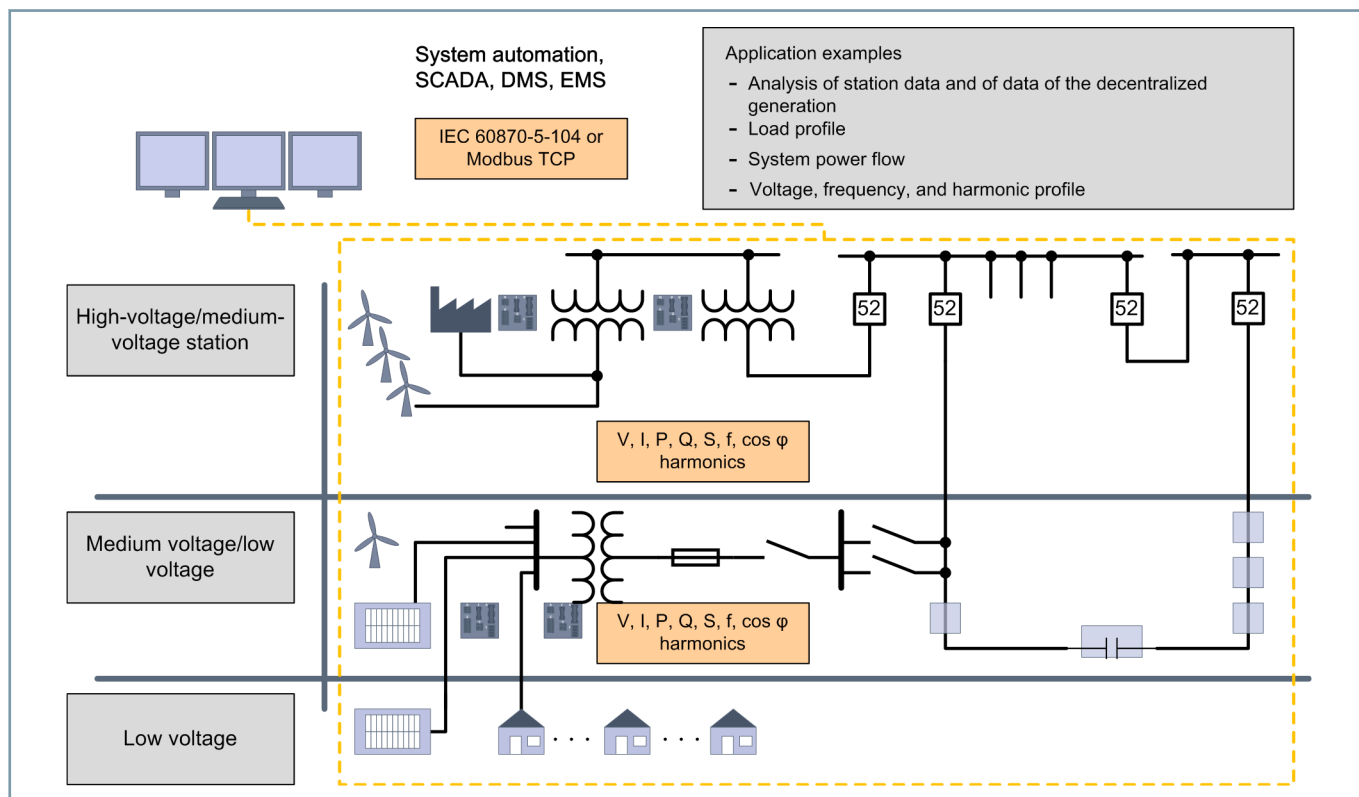
[dw_structure_SICAM_MMU, 1, en_US]

Figure 3.2/3   Wide Application on All Voltage Levels

Communication

The device is equipped with an Ethernet interface to communicate with the systems control and with other automation systems. Device parameterization, transfer of measured data, counts and messages, and time synchronization with NTP are supported via Ethernet. The communication protocols are HTTP, IEC 60870-5-104 (redundant if necessary) and Modbus TCP.

Time Synchronization

For a uniform basis in the communication with peripheral devices and time stamping of process data.

The following time synchronization methods are possible:

- External time synchronization via Ethernet NTP
- Internal time synchronization via RTC with quartz oscillator (if external time synchronization is not available)

Measurands

- TRMS (TRUE RMS) RMS value for alternating voltage and alternating current
- Active, reactive, and apparent power
- Active, reactive, and apparent energy
- Power frequency
- Phase angle
- Power factor and active power factor
- Voltage and current unbalance up to the 21st harmonic
  - Mean value of the 3-phase voltage: V_{sum}
  - Mean value of the 3-phase current: I_{sum}

Measuring Process and Connections

The periodic quantities of current and voltage are fed to the individual measuring inputs for the measurement. Rated input alternating voltages up to Vph-N = 400 V and Vph-ph = 690 V can be fed via internal resistive input voltage dividers.

The internal current transformers process rated input AC currents up to 5 A. To ensure galvanic separation, the circuits connected at the inputs galvanically separated from the current transformers. After the input values have been processed, they are output as analog values/digital data via the related interfaces and/or – depending on the parameter settings – converted into DC currents and/or DC voltages, and transferred to peripheral devices for further processing.

Power Meters

SICAM MMU – Measurands

Measurand		Measuring Circuit	1-Phase System	3-Wire Network (Delta)			4-Wire Ntwork (Star)	
				Same Load (1I)	Any Load (3I)	Any Load (2I)	Same Load (1I)	Any Load (3I)
Alternating voltage	V_a	a-N	■				■	■
	V_b	b-N						■
	V_c	c-N						■
	V_{ab}, V_{bc}, V_{ca}	a-b, b-c, c-a		■	■	■		■
	V_N	a, b, c						■
	V_{sum}	a, b, c		$\Sigma V_L/3$	$\Sigma V_L/3$	$\Sigma V_L/3$	a-N	$\Sigma V_L/3$
	V_{asym}	a-b, b-c, c-a		■				■
AC current	Ia	a	■	■	■	■	■	■
	I_b, I_c	b, c			■	■		■
	I_N	a, b, c			■			■
	Is_{um}	a, b, c			■	■		$\Sigma V_L/3$
	I_{asym}	a, b, c			■	■		■
Active power factor	cos φ (a)	a	■					■
	cos φ (b), cos φ (c)	b,c						■
	cos φ	a, b, c		■	■	■	■	■
Power factor	PF_a	a	■					■
	PF_b, PF_c	b, c						■
	PF	a, b, c		■	■	■	■	■
Phase angle	φ_a	a	■					■
	φ_b, φ_c	b, c						■
	φ	a, b, c		■	■	■	■	■
Angle between phase-to-ground voltages	φ_{ab}	a-b						■
	φ_{ac}	a-c						■
Frequency	f	a, b, c	■	■	■	■	■	■
Active power	P_a	a	■					■
	P_b, P_c	b, c						■
	P	a, b, c		■	■	■	■	■
Reactive power	Q_a	a	■					■
	Q_b, Q_c	b, c						■
	Q	a, b, c		■	■	■	■	■
Apparent power	S_a	a	■					■
	S_b, S_c	b, c						■
	S	a, b, c		■	■	■	■	■
Active energy – supply	$WP_{a\ supply}$	a	■					■
	$WP_{b\ supply}, WP_{c\ supply}$	b, c						■
	WP_{supply}	a, b, c		■	■	■	■	■
Active energy – import	$WP_{a\ import}$	a	■					■
	$WP_{b\ import}, WP_{c\ import}$	b, c						■
	WP_{import}	a, b, c		■	■	■	■	■
Reactive energy – inductive	$WQ_{a\ inductive}$	a	■					■
	$WQ_{b\ inductive}, WQ_{c\ inductive}$	b, c						■
	$WQ_{inductive}$	a, b, c		■	■	■	■	■
Reactive energy – capacitive	$WQ_{a\ capacitive}$	a	■					■
	$WQ_{b\ capacitive}, WQ_{c\ capacitive}$	b, c						■
	$WQ_{capacitive}$	a, b, c		■	■	■	■	■

3.2

Measurand		Measuring Circuit	1-Phase System	3-Wire Network (Delta)			4-Wire Ntwork (Star)	
				Same Load (1I)	Any Load (3I)	Any Load (2I)	Same Load (1I)	Any Load (3I)
Apparent energy	WS_a	a	■					■
	WS_b, WS_c	b, c						■
	WS	a, b, c		■	■	■	■	■
Harmonic voltage	HV_a	a-N	■				■	■
	HV_b	b-N						■
	HV_c	c-N						■
Harmonic current	HI_a	a	■	■	■	■	■	■
	HI_b	b			■	■		■
	HI_c	c			■	■		■

Table 3.2/2   Measurands Corresponding to the Connection Type: Power Values in Networks

3.2

Power Meters

SICAM MMU – Graphical User Interface

Graphical User Interface

Device parameterization and monitoring software

The unit is configured exclusively via a connected PC or laptop computer. The GUI user interface (GUI = Graphical User Interface) is integrated in the device. This means that additional software is not required for operating and parametering the device. Navigation is performed in Microsoft Internet Explorer via the icons in the toolbar. The user interface permits device state, communication, parameterization, log files, measured values, and maintenance information to be displayed and edited easily.
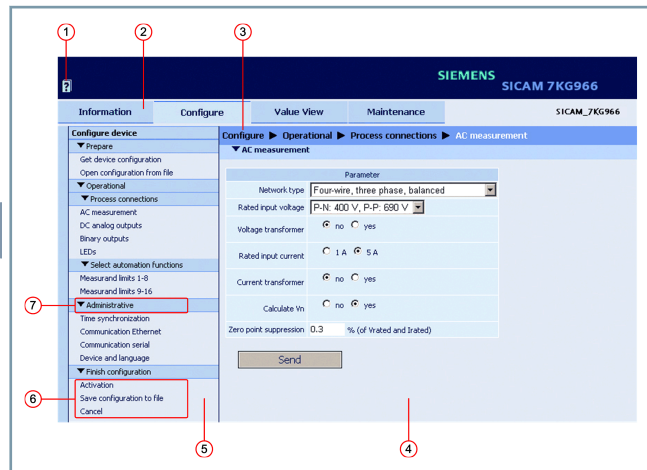
[sc_SR10_aufbau_benutzeroberfl_Sicam-MMU-GUI, 1, en_US]

Figure 3.2/4   Structure of the User Interface

(1)   Online help

(2)   Tab

(3)   Navigation bar

(4)   I/O window

(5)   Navigation window

(6)   Menu item

(7)   Menu

Information

The navigation window of the "Information" tab contains the elements device information, logs, and operational indications (*Figure 3.2/5*). Here you obtain a complete overview of the device state.
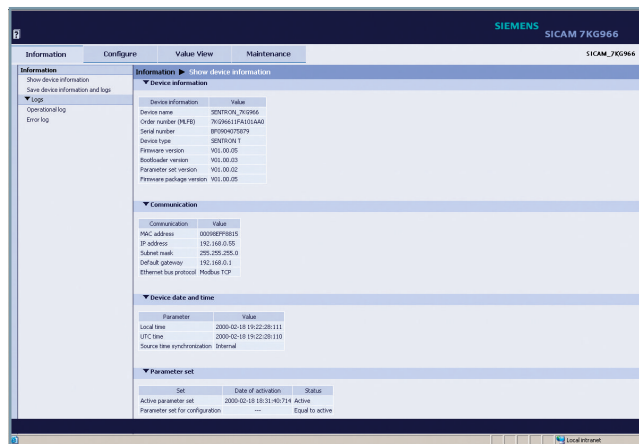
[sc_SR10-005, 1, en_US]

Figure 3.2/5   The Device Information is Shown on the "Information" Tab

Configuring

The device parameters can be set in the configuration menu. You can adjust the process connections to the installation environment, define the measuring range limits, parameterize the communication data, and make various operational settings.

Viewing the values

The measured values are displayed on the "View values" tab (*Figure 3.2/6*).

● Operational measured values (AC)

● Power and energy (AC)

● DC analog outputs

● Binary outputs

● Limiting values of the measurands

Depending on the selection of the operating parameters, the input/output window shows a table with the measured values of the measurands with the corresponding unit or messages. The display is updated every 5 s.

[sc_SR10-007, 1, en_US]

Figure 3.2/6   "View Values" Tab

Maintenance

In the "Maintenance" tab (*Figure 3.2/7*), you can update the firmware, compensate, make various presettings, view and clear log files, and show protocol-specific communication data.

[sc_SR10-008, 1, en_US]
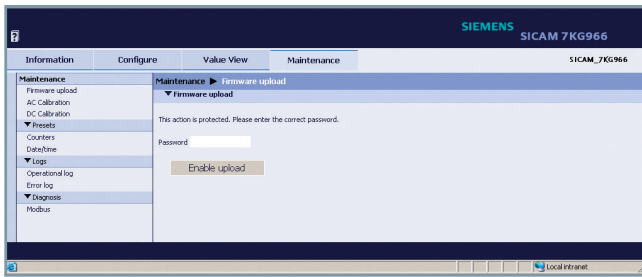
Figure 3.2/7 "Maintenance" Tab

Power Meters

SICAM MMU – Connection Types and Examples

Connection Types

The following connection types are supported:

- 1-phase system
- 3-wire network (same load)
- 3-wire network (any load), 2 current inputs
- 3-wire network (any load), 3 current inputs
- 4-wire network (same load)
- 4-wire network (any load)

Connection Examples
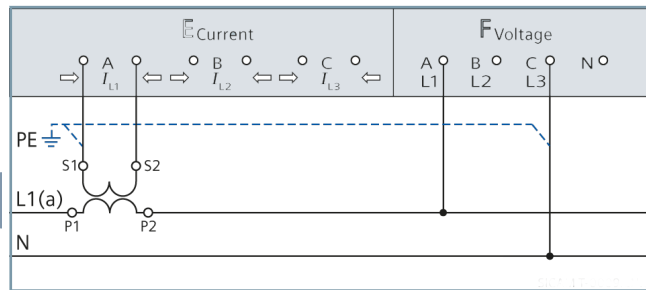
[Appl-1, 1, en_US]

Figure 3.2/8   1-Phase System
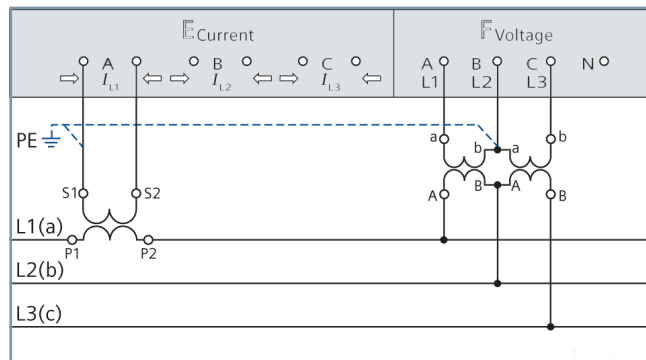
[Appl-3_2_1, 1, en_US]

Figure 3.2/9   3-Wire Network, 2 Voltage and 1 Current Transformers, Same Load*
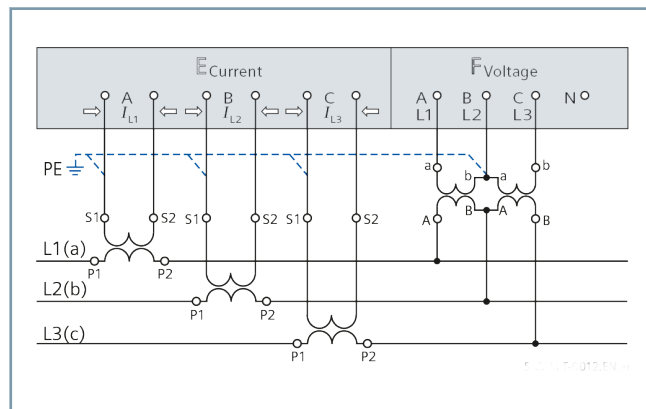
[Appl-3_2_3, 1, en_US]

Figure 3.2/10   3-Wire Network, 2 Voltage and 3 Current Transformers, Any Load*
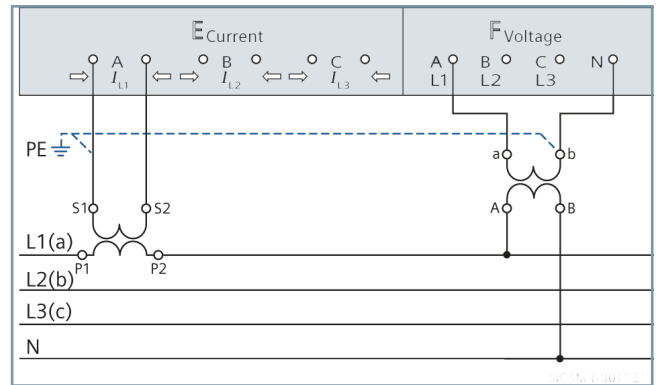
[Appl-4_1_1, 1, en_US]

Figure 3.2/11   4-Wire Network, 1 Voltage and 1 Current Transformer, Same Load
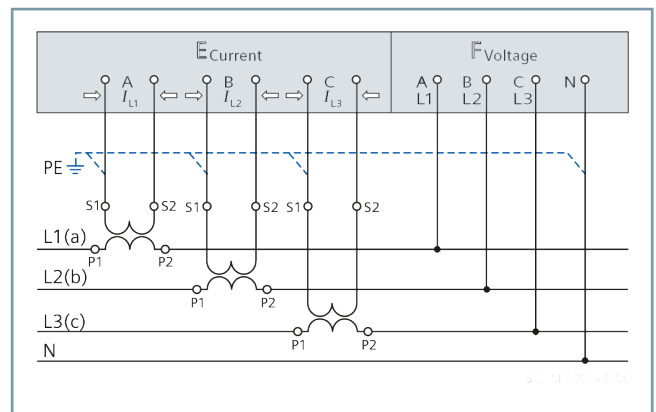
[Appl-4_0_3, 1, en_US]

Figure 3.2/12   4-Wire Network, No Voltage Transformer, 3 Current Transformers, Any Load
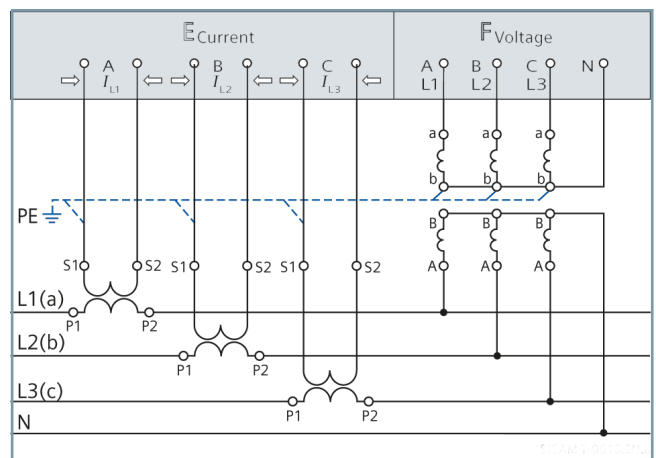
[Appl-4_3_3, 1, en_US]

Figure 3.2/13   4-Wire Network, 3 Voltage and 3 Current Transformers, Any Load

* Important: In this connection example, the maximum secondary voltage is AC 480 V. The maximum admissible voltage between phase and ground must not be exceeded. For IT mains connections, please take note of the exact description in the device manual.

Supply Voltage

Direct Voltage

Rated input voltage	24 V to 250 V
Admissible input voltage tolerance	±20 %
Admissible ripples of the DC input voltage at 24 V, 48 V, 60 V, 110 V, 220 V, 250 V	15 %
Maximum inrush current	
At ≤ 110 V	< 15 A
At 220 V to 300 V after 250 µs:	≤22 A; after 250 µs:< 5 A
Maximum power consumption	5 W

Alternating Voltage

Rated input voltage	110 V to 230 V
Power frequency	45 Hz to 65 Hz
Admissible input voltage tolerance	±20 %
Admissible higher harmonics at AC 115 V and AC 230 V	2 kHz
Maximum inrush current	
At ≤ 115 V	< 15 A
At 230 V	≤22 A; after 250 µs:< 5 A
Maximum power consumption	16 VA

Inputs and Outputs

Inputs for Alternating Voltage Measurements (Terminal Block F)

Rated input alternating voltages (can be parameterized)	
Ph-N/PE	63.5 V
	110 V
	230 V
	400 V (maximum 347 V for UL)
	Operational measuring uncertainty to IEC 60688: ±0.1 %
Ph-ph	110 V
	190 V
	400 V
	690 V (max. 600 V for UL)
	Operational measuring uncertainty to IEC 60688: ±0.1 %
Maximum rated input alternating voltage depending on parameterization	1.2-fold rated input alternating voltage
Maximum rated input alternating voltage	
Ph-N/PE	480 V (max. 347 V for UL)
Ph-ph	831 V (max. 600 V for UL)
Input resistances	
A, B, C to N	7.9 MΩ
A, B, C, N, to PE	3.9 MΩ
A-B, B-C, C-A	7.9 MΩ
Further specifications of the voltage measurement inputs	

| Power consumption per input at V_{rated} 400 V	38 mW
Admissible frequency	45 Hz to 65 Hz
Measuring error (with compensation) at 23 °C ± 1 °C 50 Hz or 60 Hz	Typical 0.1 % at rated input alternating voltage to IEC 60668
Continuous overload capacity	1.5 x rated input voltage Ph-N: max. 347 V for UL Ph-ph: max. 600 V for UL
Surge overload capacity	2 x rated input voltage to IEC 60255-2 Ph-N: max. 347 V for UL Ph-ph: max. 600 V for UL

Inputs for AC Current Measurements (Terminal Block E)

Input AC currents	
Rated input AC current ranges (can be parameterized)	1 A 5 A Operational measuring uncertainty to IEC 60688: ±0.1 %
Maximum input AC current	2 x rated input AC current
Power consumption per input	
At 1 A	1 mVA
At 5 A	2.5 mVA
Additional information about the current measurement inputs	
Admissible frequency	45 Hz to 65 Hz
Maximum voltage	150 V
Measuring error (with compensation) at 23 °C ± 1 °C 50 Hz or 60 Hz	Typical 0.1 % at rated input AC current
Thermal stability	10 A continuous 100 A for maximum 1 s to IEC 60688

Binary Outputs (Terminal Block G)

Maximum contact voltage	
Alternating Voltage	230 V
Direct Voltage	250 V
Maximum currents	
Maximum continuous touch current	100 mA
Maximum pulse current for 0.1 s	300 mA
Additional information about the binary outputs	
Internal resistance	35 Ω
Admissible switching frequency	10 Hz
Number of switching cycles	Unlimited

3.2

Power Meters

SICAM MMU – Technical Data

Communication Interfaces

Ethernet (Connection Z)

Ethernet, electrical	Operation	With device-internal soft-ware
	Connection	Housing top RJ45 connector socket 100BaseT to IEEE 802.3 LED yellow: 100 Mbits/s (OFF/ON) LED green: Connection/no connection (ON/OFF)
	Protocols	Modbus TCP IEC 60870-5-104
	Voltage strength	DC 700 V
	Transmission rate	100 Mbits/s
	Cable for 100Base-T	100 Ω to 150 Ω STP, CAT5
	Maximum cable length 100Base-T	100 m, at best routing

Environmental Data

Temperature specifications	Temperature during operation	-25 °C to +55 °C
	Temperature during transportation	-25 °C to +70 °C
	Temperature during storage	-25 °C to +70 °C
	Temperature during storage	20 K/h
Humidity specifications	Mean relative humidity	≤ 75 %
	Maximum relative humidity	95 % on 30 days per year
	Condensation during operation	Not permitted
	Condensation during transportation and storage	Permitted

General Data

Battery	Type	PANASONIC CR2032 VARTA 6032 101 501
	Voltage	3 V
	Capacity	230 mAh
	Typical service life	10 years; Operation with permanently applied supply voltage 2 months inside of 10 years; Operation with not permanently applied supply voltage
Protection class to IEC 60529	DIN-rail side	IP20
	Terminal side (connections)	IP20
	Top	IP20

Dimensions

Mass	Approx. 0.5 kg
Dimensions (W x H x D)	96 mm x 96 mm x 100 mm

Table 3.2/3   Dimensions

[SICAM MMU Maßbild, 1, en_US]
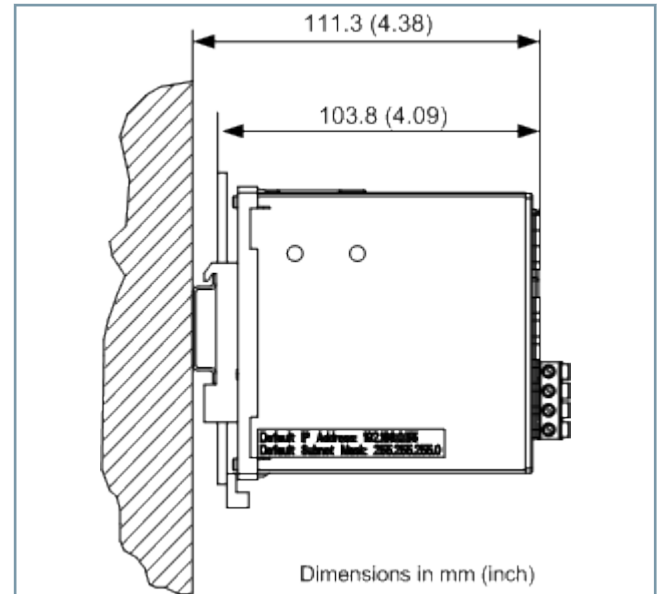
Figure 3.2/14   Dimensional Drawing of the SICAM MMU

Selection and Ordering Data

Description	Variants	Order No.																
		1	2	3	4	5	6	7	8	9	10	11	12		13	14	15	16
SICAM MMU – Measurement and Monitoring Unit		7	K	G	9	6	6	3	-	□	A	A	0	0	-	□	A	A	0
									▲						▲			
Dimensions: 96 mm x 96 mm x 100 mm	*Voltage measurement circuit*																	
DIN-rail device without display	Resistive voltage divider								1									
2 binary outputs	Isolated voltage transformer								2									
Integrated Web server	*Ethernet interface and communication protocol*																	
Measurements: V, I, f, P, Q, S, cos φ	Modbus TCP														1			
Energy	Modbus TCP and IEC 60870-5-104														4			
Harmonics																		
UL approval																		
Ethernet interface RJ45																		
Use SICAM IO unit (7XV5673) and Y cable (7KE6000-8GD00-0BA2) for more digital inputs and outputs																		

Table 3.2/4   Selection and Ordering Data

3.2

Power Meters

SICAM P50/P55 – Description

Description

SICAM P is a power meter for panel mounting with graphic display and background illumination, or for standard rail mounting, used for acquiring and/or displaying measured values in electrical power supply systems. More than 100 values can be measured, including RMS values of voltages (phase-to-phase and/or phase-to ground), currents, active, reactive and apparent power and energy, power factor, phase angle, harmonics of currents and voltages, total harmonic distortion per phase plus frequency and symmetry factor, energy output, as well as external signals and states.

Device Type	Switch panel mounting with display (SICAM P50)
	DIN rail mounting without display: (SICAM P55)
	Degree of protection IP41, IP65 (SICAM P50)
	Degree of protection IP20 (SICAM P55)
	Dimensions 96 mm x 96 mm/3.78 in. x 3.78 in.
Supply voltage	DC 24 to 250 V
	AC 110 to 230 V; 50 to 60 Hz
Input and output circuits	2 Analog outputs DC 0 mA to 20 mA/DC 4 mA to 20 mA
	2 Analog inputs DC 0 mA to 20 mA
	Expandable with additional module for analog input or analog output
	2 freely programmable binary outputs: e.g. energy counters, limit violations or status signals
	2 Binary inputs
	3 Relais outputs
Communication	PROFIBUS DP and Modbus RTU/ASCII/RS485; IEC 60870-5-103 and Modbus RTU/ASCII/RS485

Benefits

- Trigger function for settable limits programmed for sampled or r.m.s. values
- Generating lists of minimum, average and maximum values for currents, voltages, power, energy, etc.
- Independent settings for currents, voltages, active and reactive power, power factor, etc.
- Up to 6 alarm groups can be defined using AND/OR for logical combinations
- Alarms can be used to increase counter values, to trigger the oscilloscope function or to generate binary output pulses

The use of power meters in connection with energy monitoring systems provides numerous benefits, including for the:

- Environment
  A better knowledge of how energy is used within a facility allows to identify an array of prospects to improve efficiency, minimize waste, and reduce energy consumption, thereby allowing the facility to be a better steward of its allotted natural resources.
- Reliability
  Assessment of data in the master station from SICAM P Power Meters can reveal existing or imminent issues that can affect the operation and product within a facility. Historical data

[ph_SICAM P50, 2, --_--]

Figure 3.3/1 SICAM P

from power monitoring systems can help locate and optimize the productivity.

- Safety
  Monitoring systems can limit the exposure of personnel to potentially hazardous electrical environments by providing remote status and operational parameters of equipment within hazardous areas. Some monitoring devices also offer a variety of additional parameters (temperature, pressure, flow rate, vibration, status indicators, etc.) through the use of I/O modules of the SICAM P.
- Financial
  Each benefit discussed above either directly or indirectly influences a business' bottom line. In most cases, the monetary impact from even one or two benefits can quickly justify the purchase and installation of a power monitoring system with power meters.

Functions

- Measurement of voltage, current, active and reactive power, frequency, active and reactive energy, power factor, symmetry factor, voltage and current harmonics up to the 21st, total harmonic distortion
- 1-phase, 3-phase balanced or unbalanced connection, four-wire connection
- Communications: PROFIBUS DP, Modbus RTU/ASCII, or IEC 60870-5-103 communication protocol
- Simple parameterization via front key or RS485 communication port using SICAM P Manager software
- Graphic display with background illumination with up to 20 programmable screens
- Real-time clock: Measured values and states will be recorded with time stamps
- 1-MB memory management:

- Recording and display of limit value violations and log entries
- Battery: Recordings like limit value violations or energy counter values stay safely in the memory up to 3 months in case of a blackout

Measuring Functions

Measured input voltages and input currents are sampled for calculation of the corresponding RMS values. All parameters derived from the measured values are calculated by a processor. They can be displayed on the screens and/or transmitted via the serial interface. Measurement of voltage, current, active and reactive power, frequency, active and reactive energy, power factor, symmetry factor, voltage, and current harmonics up to the 21st, total harmonic distortion are available. With the SICAM P it is also possible to define several limit value groups with different limit values for the measured parameters. These can be combined with logical elements, such as AND, OR. Violations are counted and indicated on the screen or made available at the binary outputs. Triggering of the oscilloscope is possible as well.

Applications

Power-monitoring systems with SICAM P, a permanently installed system, enables continuous logging of energy-related data and provides information on operational characteristics of electrical systems. SICAM P helps identify sources of energy consumption and time of peak consumption. This knowledge allows to allocate and reduce energy costs. The major application area is power monitoring and recording at MV and LV level. The major information types are measured values, alarms, and status information.

The input modules work with external signals with a measurement range of DC 0 mA to 20 mA. Mean values of all external analog channels as well as states of digital channels can be recorded and saved into the memory. All recorded quantities and binary state information can be "read out" and evaluated with the configuration software SICAM P Manager. Output modules can be used for conversion of any electrical quantity (current, voltage, etc.) into a DC 0 mA to 20 mA/4 mA to 20 mA output signal, generation of impulses for metering, indication of limit value violations, as well as for switching operations.

Application Example 1

SICAM P as flush-mounting device (*Figure 3.3/2*) for direct indication of the electrical energy. Easiest parameterization enables each user to customize the measured-values representation as required.

[ph_SICAM P, 1, --_--]

Figure 3.3/2   SICAM P

Application Example 2

SICAM P as flush-mounting device or plug-on device to be used on a process bus (*Figure 3.3/3*). An integrated RS485 interface with the PROFIBUS DP standard protocol and the Modbus RTU/ASCII communication protocol permit easy integration into networks. In addition, SICAM P50 with the IEC 60870-5-103 standard protocol can be integrated into communication networks. This permits measured values from several SICAM P units to be displayed, evaluated and processed centrally in a master station. The main field of application is the integration as transducers into PLC systems.
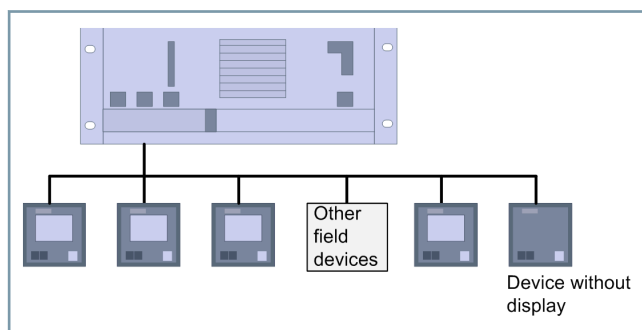
[dw_SICAM P Processbus, 1, en_US]

Figure 3.3/3   SICAM P with PROFIBUS DP, Modbus, and IEC 60870-5-103

Application Example 3

A snap-on kit is available to install SICAM P on a 35-mm DIN rail. Parameterization of the device requires the parameterization software (*Figure 3.3/4*).

3.3

Power Meters

SICAM P50/P55 – Description
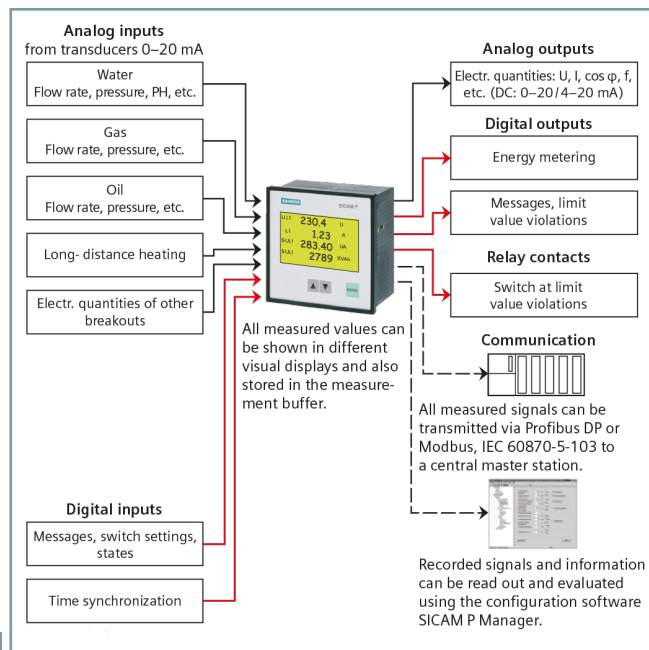
[Anwendungsbeispiel, 1, en_US]

Figure 3.3/4   SICAM P – Application Example

Communication

To communicate via RS485 interface and a standardized 9-way D-Sub connector plug, SICAM P offers the following standard communication protocols:

- PROFIBUS DP V1 to EN 50170 Volume 2 and Modbus RTU/ASCII
- Modbus RTU/ASCII and IEC 60870-5-103

Limit Values

Selecting several (up to 7) limiting-value groups with up to 6 measurands in SICAM P is possible. The measured values can be logically ANDed/ORed. Limit violations are counted, output at binary outputs or used for triggering the oscilloscope.
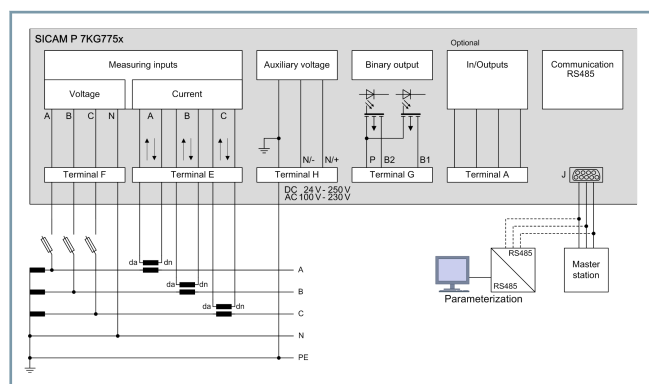
[dw_Sicam-P_BI_BO, 1, en_US]

Figure 3.3/5   Input and Output Wiring from SICAM P

Depending on the network type, unused inputs remain unconnected.

Parameterization

Parameterization of SICAM P is very easy. It is possible either directly via the device display (if available) or via the SICAM P Manager parameterization software. A clear menu and operation with cursor and Enter button permit fast parameterization, even without a manual.

Parameterizable password protection protects parameterization and calibration to be protected against unauthorized access.
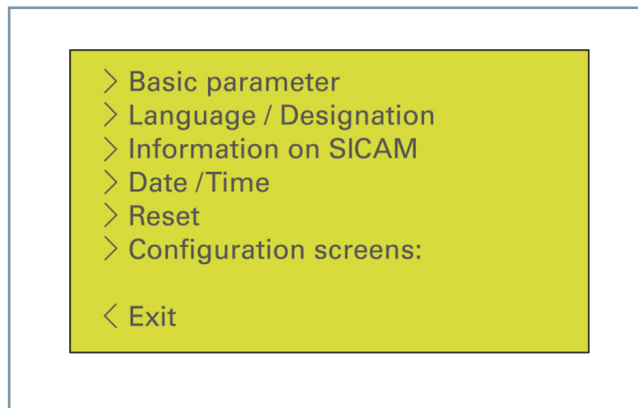
[PQ11-0044, 1, en_US]

Memory Management

The measured-value memory (1 MB) and the integrated memory management permit the storage to be split as required to record mean values, power value, oscilloscope, limit violation, and binary states. Once you have entered the per cent value, the related storage time is calculated and displayed automatically.
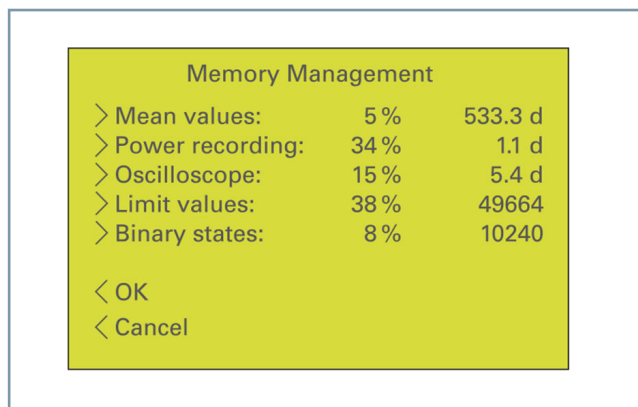
[PQ11-0028, 1, en_US]

Reading the Measured-Value Storage

Using the SICAM P Manager parameterization software, the measured values and binary states stored in the device storage can be read via the RS485 interface. This requires a separate cable and an RS232/RS485 converter. The parameterization software contains functions to display and evaluate all stored measured values and binary data. Additional information can be found at the *SICAM P parameterization software package*.

3.3

Display and Screens

You can structure the representation of all measurands on the SICAM P display individually. Using the front buttons, you can define and select up to 20 screens on the display. Changing screens is possible in manual or in automatic operation. Unambiguous names and menu-controlled settings ensure easy and swift operation of the SICAM P screens.

Number, type, contents, and sequence of the screens can be parameterized as required. For example:

- 2, 3, 4, or 6 measured values on a screen
- A list screen for minimum, mean, and maximum values
- Screens for harmonics
- Screen as phasor (vector) diagram

SICAM P is preset at delivery. A status bar in the measured-value screens shows the status and the interface and diagnosis messages of SICAM P. The display is updated every second.

Typical Measured-Value Displays (Screens)

[PQ11-0037, 1, en_US]
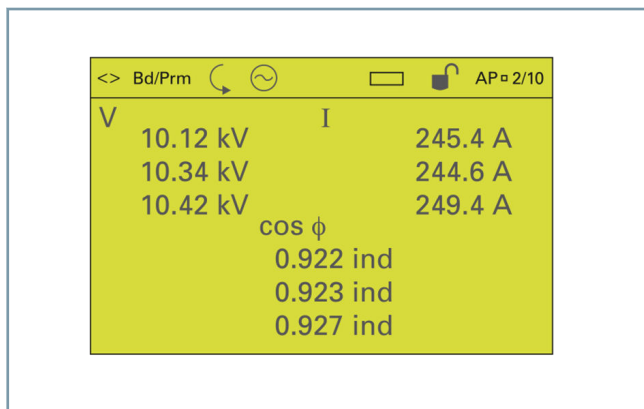
Figure 3.3/6   3-Phase Screen Values – V, I, cos φ

[PQ11-0036, 1, en_US]
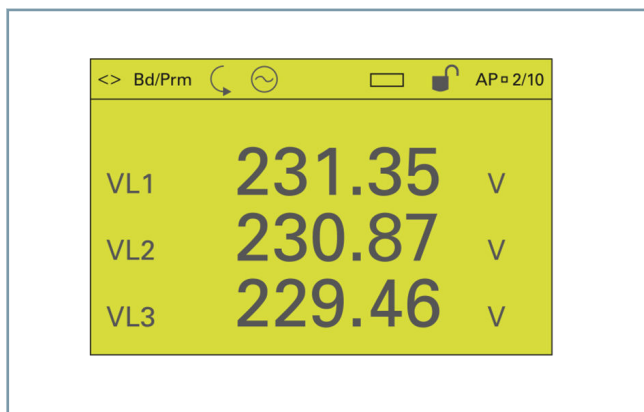
Figure 3.3/7   Digital Screen Values – 3 Measured Values – Digital/Analog

[PQ11-0035, 1, --_--]
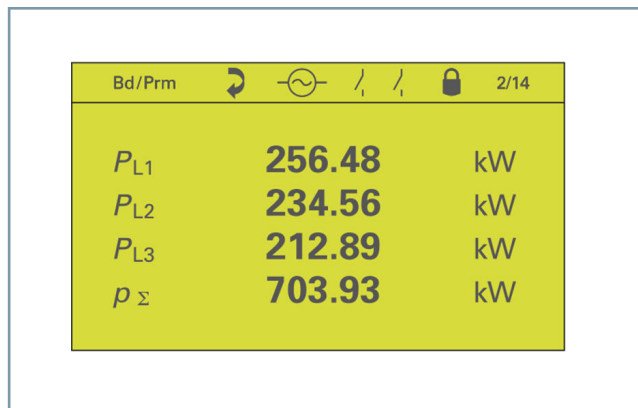
Figure 3.3/8   Digital/Analog Screen – 4 Measured Values – Digital

[PQ11-0033, 1, --_--]
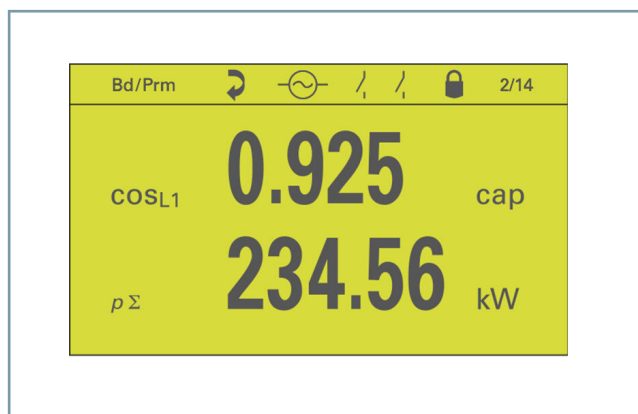
Figure 3.3/9   Digital Screen Values – 2 Measured Values – Digital

3.3

Power Meters

SICAM P50/P55 – Measured Values and Accuracy

Measured Values	Measuring Path [1]	Output to	Accuracy [2]
Voltage	A-N, B-N, C-N, (N-E)	▼ ■ □ ·	± 0.1 % [2] / ± 0.3 % [6]
Voltage	A-B, B-C, C-A, Σ [3]	▼ ■ □ ·	± 0.1 % [2] / ± 0.3 % [6]
Current	A, B, C, N, Σ [3]	▼ ■ □ ·	± 0.1 % [2] / ± 0.3 % [6]
Active power P + import, – supply	A, B, C, Σ	▼ ■ □ ·	± 0.5 %
Reactive power Q + capacitive, – inductive	A, B, C, Σ	▼ ■ □ ·	± 0.5 %
Apparent power S	A, B, C, Σ	▼ ■ □ ·	± 0.5 %
Power factor |cos φ| [4]	A, B, C, Σ	▼ ■ □ ·	± 0.5 %
Active power factor |cos φ| [4]	A, B, C, Σ	▼ ■ □ ·	± 0.5 %
Phase angle [4]	A, B, C, Σ	▼ ■ □ ·	± 2°
Power frequency [5]	A- N	▼ ■ □ ·	± 10 mHz
Active energy, import	A, B, C, Σ	▼ ■ □	± 0.5 %
Active energy, supply	A, B, C, Σ	▼ ■ □	± 0.5 %
Active energy, total	A, B, C, Σ	▼ ■ □	± 0.5 %
Active energy Σ, total	Σ	▼ ■ □	± 0.5 %
Reactive energy, inductive	A, B, C, Σ	▼ ■ □	± 0.5 %
Reactive energy, capacitive	A, B, C, Σ	▼ ■ □	± 0.5 %
Reactive energy, total	A, B, C, Σ	▼ ■ □	± 0.5 %
Apparent energy	A, B, C, Σ	▼ ■ □	± 0.5 %
Voltage unbalance	Four-wire network	▼ ■ □ ·	± 0.5 %
Current unbalance	Four-wire network	▼ ■ □ ·	± 0.5 %
THD voltage	A, B, C	▼ ■ □ ·	± 0.5 %
THD current	A, B, C	▼ ■ □ ·	± 0.5 %
Harmonic voltage V 3rd, 5th, 7th, 11th, 13th, 17th, 19th, 21st harmonic	A, B, C	▼ ■ □ ·	–
Harmonic current I 3rd, 5th, 7th, 11th, 13th, 17th, 19th, 21st harmonic	A, B, C	▼ ■ □ ·	–
Limiting-value violations	Counter 1, 2, 3, 4	▼ ■	–
Analog inputs	external	▼ ■	–
Binary inputs	external	▼ ■	–

[1] The representation of the phases depends on the connection type.

[2] Accuracy at reference conditions related to: 0.5 to 1.2 × nominal range

[3] Mean value of all phase circuits

[4] Measurement from 2 % of the internal apparent power

[5] Measurement from 30 % of the input voltage A-N

[6] Limiting values at full temperature range, related to: 0.1 to 1.2 × rated range

▼ Measured values can be shown on measured value screens.

■ Measured values are transferred via the Profibus DP and Modbus communication protocols.

□ Measured values are transferred via IEC 60870-5-103.

· Selectable measured values for list screens

Table 3.3/1   Measured Values And Accuracy

3.3
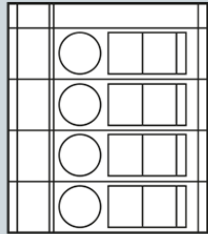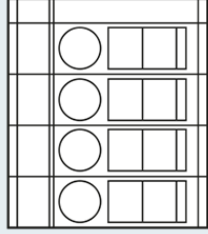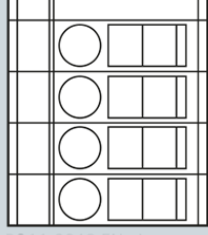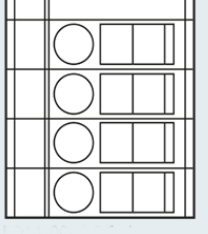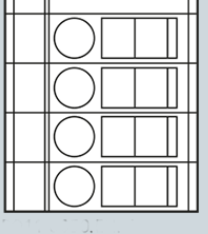
Description and Fields of Application	Connection/terminal assignments
Analog Input Module SICAM P can be equipped with a maximum of 1 analog input module. The module features 2 analog inputs that are designed for a rated measuring range of DC 0 mA to 20 mA. The module is galvanically separated from the internal circuit. The two module channels are not galvanically separated from each other. The analog input modules can be used for: • Capturing and displaying measured signals in the range DC 0 mA to 20 mA • Recording limiting-value violations	1 AI1+ 2 AI1- 3 AI2+ 4 AI2-
Binary Input Module SICAM P can be equipped with a maximum of 1 binary input module. The module features 2 galvanically separated binary input channels that are connected to common potential. The input voltage is converted into a constant current. The binary input modules can be used for: • Reporting binary states/messages • SICAM P time synchronization	1 BI1+ 2 BIR 3 BIR 4 BI2+
Analog Output Module SICAM P can be equipped with a maximum of 1 analog output module. The module features 2 outputs that are designed for a rated output current of DC 0 mA to 20 mA. The module is galvanically separated from the internal circuit. The 2 module channels are not galvanically separated from each other. The analog output modules can be used for: • The output of electrical measurands (current, voltage, power factor φ, |cos φ|, frequency, etc.) in the measuring range of DC 0 mA to 20 mA or AC 4 mA to 20 mA	1 AO1+ 2 AO1- 3 AO2+ 4 AO2- PQ11-0048.EN.ai
Binary output module SICAM P can be equipped with a maximum of 1 binary output module. The module features 2 binary output channels that are connected to common potential and are built as 2 solid-state contacts. The binary output modules can be used for: • Generating count impulses • Indicating limiting-value violations • Indicating the device status • Indicating the rotational vector	1 BOR 2 BO1+ 3 BO2+ 4 free
Relay Output Module SICAM P can be equipped with a maximum of 1 relay output module. The relay output module features 3 electro-mechanical contacts that are connected to common potential. These contacts can switch higher power levels that can not be switched with solid-state contacts. The relay outputs are parameterized like the channels of the binary output module. The relay contacts can be used for: • Switching in case of limit violations, for example, for reactive power compensation	1 RO1 2 RO2 3 RO3 4 ROR

Table 3.3/2   Description of Input and Output Modules

3.3

Power Meters

SICAM P50/P55 – Parameterization Software Package

Applications

With the SICAM P parameterization software package, you have a simple tool to adjust the devices. The package contains the parameterization software, a connecting cable with RS232/RS485 converter and a plug-in power-supply unit for the converter. Using the RS232/RS485 converter, you can connect the SICAM P via a 9-way D Sub connector with a commercially available PC.
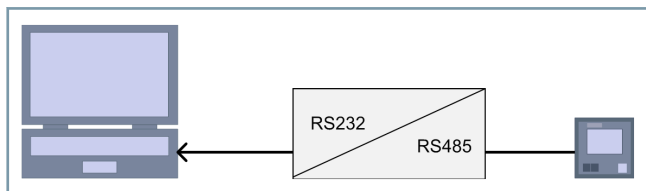
[dw_parameterization, 1, --_--]

The software runs with Windows 2000

With the parameterization software, you can set parameters of the SICAM P devices even faster. Alternatively, you can set and save parameters in offline mode (without device). Use the "Send to device" command to transfer the measurands to the SICAM P. This permits several SICAM P devices to be set within a very short time. When you replace a device, you can easily load the saved parameter set into the new device. Another possibility is loading firmware updates via the SICAM P parameterization software.

The parameterization software package supports all SICAM P devices. It is necessary for parameterizing the SICAM P55 devices.

Parameterization of Measured-Value Storage

In a device with measured-value storage, measurands and states can be recorded in the storage device. The parameterization software provides functions that permit the values and states to be selected that shall be stored.
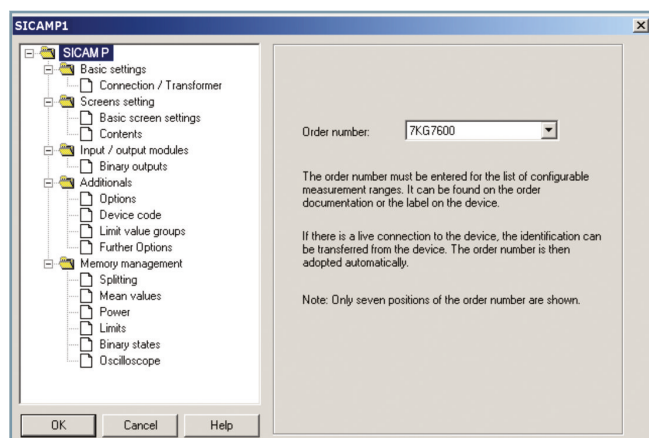
[sc_LSP2501, 1, en_US]
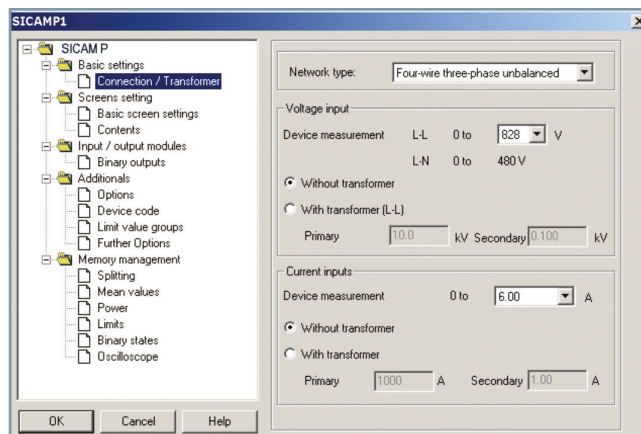
[sc_LSP2502, 1, en_US]

Figure 3.3/10   Parameterization

Reading the Measured-Value Storage

An additional function of the parameterization software permits the following information to be read from the storage device:

- Mean values
- Mean values of power
- Oscilloscope recordings
- States of binary channels
- Limiting-value violations
- Log entries
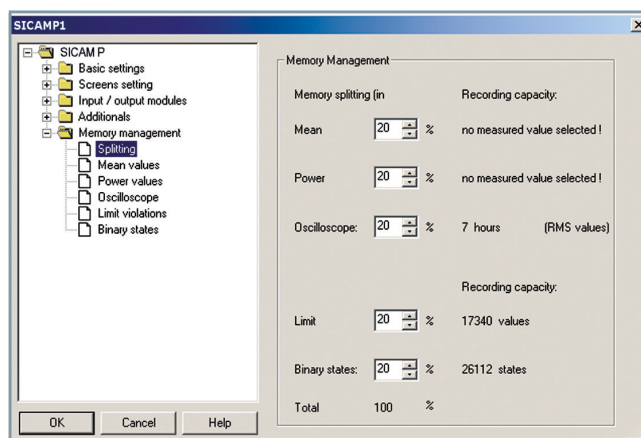
[sc_LSP2503, 1, en_US]

Figure 3.3/11   Parameterization of Measured-Value Storage

Display and Evaluation

The measured values from the device are displayed automatically on the screen in graphical and tabular form, including time information. The context menu provides various functions (hiding/displaying signals, copying, zoom, and measuring functions) for an easy analysis of measurands and states (*Figure 3.3/12* and *Figure 3.3/13*).

The following measurands can be shown graphically:

- Mean values of voltages and currents
- Mean values of power

- Oscilloscope recordings
- States of binary channels

The following information is displayed in a tabular form:

- Limiting-value violations
- Log entries
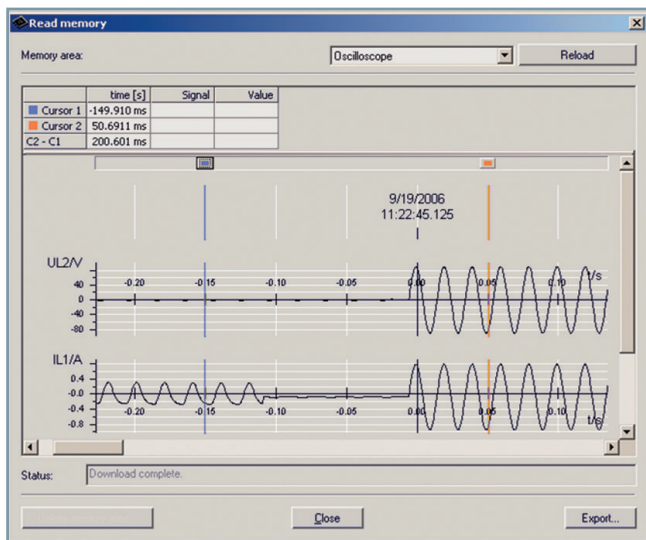
[sc_LSP2918, 1, en_US]

Figure 3.3/12   Oscilloscope View for Evaluation
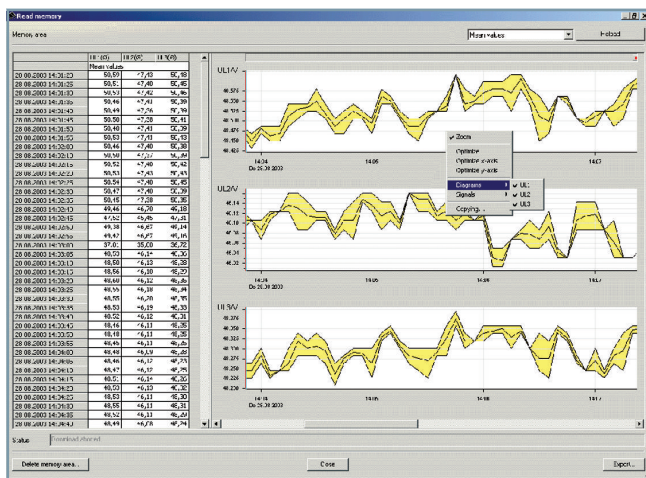
[sc_LSP2492, 1, en_US]

Figure 3.3/13   Display and Evaluation

Export Function

The software permits the transferred measured values and infor-
mation to be exported to an ASCII file. This file can then be used
for further processing, for example in MS-Excel. Oscilloscope
recordings can be exported in COMTRADE-formatted files.

3.3

Power Meters

SICAM P50/P55 – Connection Types and Examples

Connection Types
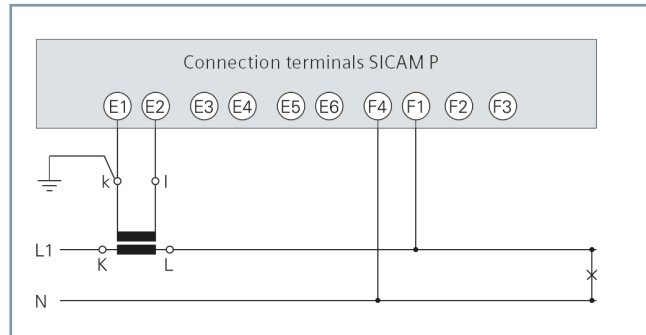
[Appl_single ph, 1, en_US]

Figure 3.3/14   Alternating Voltage, 1-Phase
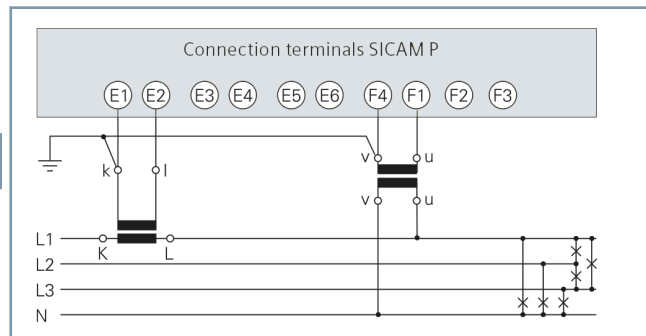
[Appl_4wire 3ph, 1, en_US]

Figure 3.3/15   4 Conductors, 3 Phases, Uniform Load
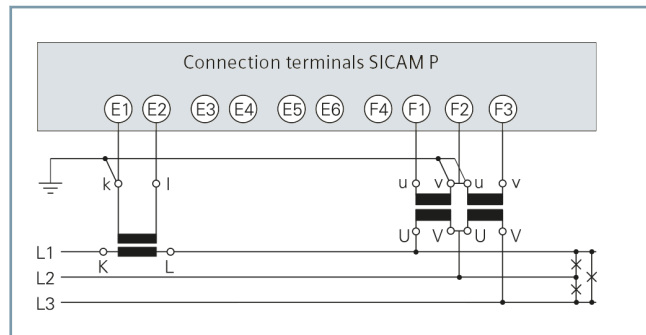
[Appl_3wire 3ph (balanced), 1, en_US]

Figure 3.3/16   3 Conductors, 3 Phases, Uniform Load
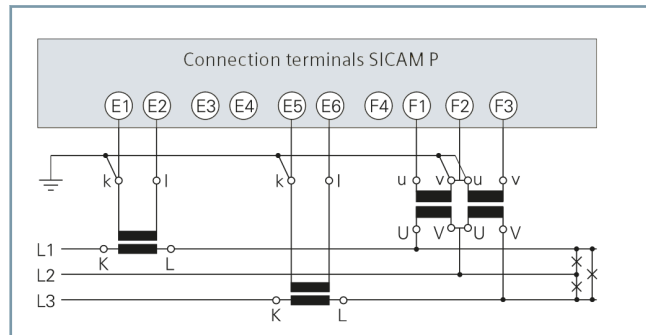
[Appl_3wire 3ph, 1, en_US]

Figure 3.3/17   3 Conductors, 3 Phases
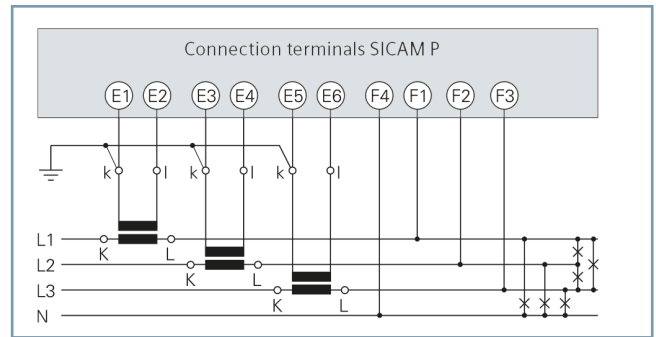
[Appl_4wire 3ph(lv), 1, en_US]

Figure 3.3/18   4 Conductors, 3 Phases (Low-Voltage System) 1,2
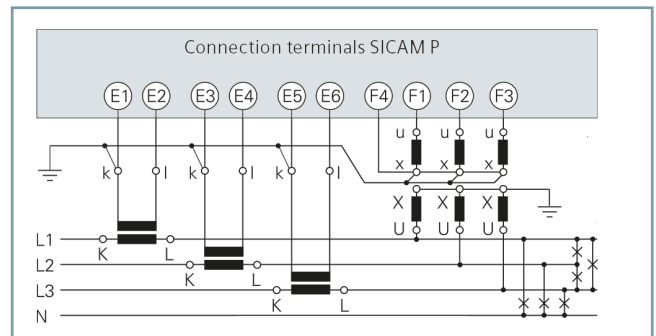
[Appl_4wire 3ph(hv), 1, en_US]

Figure 3.3/19   4 Conductors, 3 Phases (High-Voltage System)

The connection types above are only a few typical arrangements. A current or voltage transformer is not obligatory within the admissible maximum current and voltage values.

However, you can use voltage transformer in Y or V connection. Input and output connections remain free if they are not needed for measurement.

Comments on low-voltage applications:

[1] to V_{ph-N} = 480 V, SICAM P can be connected directly without transformer. In a 3- or 4-wire network, with the exception of 3-wire networks without neutral phase: up to V_{ph-ph} = 690 V, SICAM P can be connected without transformer.

[2] In an IT low-voltage system, SICAM P50 must be connected via a voltage transformer to avoid false alarms of the disconnector monitor.

Supply Voltage

Direct Voltage

Rated input voltage	24 V to 250 V
Admissible input voltage tolerance	±20 %
Admissible ripples of the DC input voltage	15 %
Maximum inrush current	
At ≤ 110 V	< 15 A
At 220 V to 300 V after 250 µs:	≤ 22 A; after 250 µs: <5 A
Maximum power consumption	6 W

Alternating Voltage

Rated input voltage	100 V to 230 V
Power frequency	50 Hz/60 Hz
Admissible input voltage tolerance	±20 %
Admissible higher harmonic	2 kHz
Maximum inrush current	
At ≤ 115 V	< 15 A
At 230 V	≤ 22 A; after 250 µs: < 5 A
Maximum power consumption	9 VA

Inputs and Outputs

Rated input alternating voltages	
Ph-N/PE	100 V/110 V
	190 V
	400 V
Ph-Ph	100 V/110 V
	190 V
	400 V
	690 V
Overload	20 %
Maximum rated input alternating voltage	
Ph-N/PE	480 V
Ph-Ph	831 V
Input resistances	
A, B, C to N	8.4 MΩ, one phase
	4.2 MΩ, 3 phases symmetrical
A-B, B-C, C-A	8.4 MΩ
Further specifications of the voltage measurement inputs	
Power consumption per input at V_{rated} 400 V	38 mW
Admissible frequency	45 Hz to 65 Hz from > 30 % V_E
Curve shape	Sine or up to 21st harmonic
Measuring error (with compensation) at 23 °C ± 1 °C 50 Hz or 60 Hz	Typical ±0.1 % under reference conditions

Table 3.3/3   Inputs for Alternating-Voltage Measurements (Terminal Block F)

Inputs for Alternating Voltage Measurements (Terminal Block E)

Input AC currents	
Rated input AC current ranges (can be parameterized)	1 A
	5 A
Maximum input AC current	2 x rated input AC current
Power consumption per input	
At 1 A	83 µVA
At 5 A	2.1 mVA
Additional information about the current measurement inputs	
Maximum voltage	150 V
Measuring error (with compensation) at 23 °C ± 1 °C 50 Hz or 60 Hz	Typical ±0.1 % under reference conditions
Thermal stability	10 A continuous
	100 A for maximum of 1 s

Binary Outputs (Terminal Block G)

Maximum contact voltage	
Alternating voltage	230 V
Direct voltage	250 V
Maximum currents	
Maximum continuous touch current	100 mA
Maximum pulse current for 0.1 s	300 mA
Additional information about the binary outputs	
Rated resistance	35 Ω
Admissible switching frequency	10 Hz
Number of switching cycles	Unlimited

Binary Inputs (Terminal Block A, Optional)

Maximum input voltage	DC 150 V
Current consumption at high level	DC 1.8 mA
Low level	≤ 10 V
High level	≥ 19 V
Signal delay	max. 3 ms

Analog Inputs (Terminal Block A, Optional)

Measuring range	DC 0 mA to 20 mA
Modulation range	DC 0 mA to 24 mA
Input impedance	50 Ω ± 0.1 %
Accuracy	0.5 % of the upper range limit

Analog Outputs (Terminal Block A, Optional)

Rated output current	DC 0 mA to 20 mA
Modulation range	DC 0 mA to 24 mA
Max. load impedance	250 Ω
Accuracy	Typ. 0.2 %; max. 0.5 % of rated value

Relay Outputs (Terminal Block A, optional)

Max. contact voltage	AC 150 V; DC 150 V
Max. continuous contact current	AC 5 A; DC 5 A

3.3

SICAM P50/P55 – Technical Data

Min. continuous contact current	1 mA at DC 5 V
Max. switching capacity (resistive load)	AC 5 A/150 V or DC 5 A/30 V
Max. pre-arcing time	10 ms
Max. release time	7 ms

Communication Interface (Connection J)

Connection	Terminal side, 9-way D-Sub socket, RS485
Protocol PROFIBUS DP-V1	
Baud rate	Baud rate
Protocol IEC 60870-5-103	
Baud rate	9600 bits/s, 19 200 bits/s, 38 400 bits/s
Protocol Modbus RTU/ASCII	
Baud rate	300 bits/s, 600 bits/s, 1200 bits/s, 2400 bits/s, 4800 bits/s, 9600 bits/s, 19 200 bits/s, 38 400 bits/s, 57 600 bits/s, 115 200 bits/s

Environmental Data

Temperature specifications IEC/EN 60068	Temperature during operation Device with display: The readability of the display is reduced at a temperature < 0 ℃.	-25 ℃ to +55 ℃
	Temperature during transportation	-25 ℃ to +70 ℃
	Temperature during storage	-25 ℃ to +70 ℃
	Maximum temperature gradient	20 K/h
Humidity specifications	Mean relative humidity	≤ 75 %
	Maximum relative humidity	80 %, at a temperature up to +31 ℃; linearly decreasing to 50 % at +40 ℃
	Condensation during operation	Not permitted
	Condensation during transportation and storage	Permitted
Application altitude	Maximum altitude above sea level	2000 m
Degree of pollution	2	

General data

Battery	Type	PANASONIC CR2032 VARTA 6032 101 501
	Voltage	3 V
	Capacity	230 mAh
	Typical service life	Operation with permanently applied supply voltage: 10 years
		Operation with sporadically interrupted supply voltage: Total of 2 months inside of 10 years
Display SICAM P50 (SICAM P 7KG7755 does not contain a display)		

Resolution	(128 x 64) pixel	The readability of the display is reduced at a temperature ≤ 0 ℃.
Dimensions	40 mm x 60 mm	
Background lighting	Yellow	
Degree of protection		
Front	IP41	
	IP65	
Terminals	IP20	
Protection of persons	IP1x	
Fuses		
Internal fuse	Type: T1.6A/250V to IEC 60127	Not replaceable
Internal fuse, secondary	Type: F2A/125V to UL 248-14	Not replaceable

3.3

Dimensions

Dimensions (W x H x D)	See dimensional drawings; all dimensions in mm	
Mass	Mass without input/output module	Approx. 0.6 kg
	With one module	Approx. 0.65
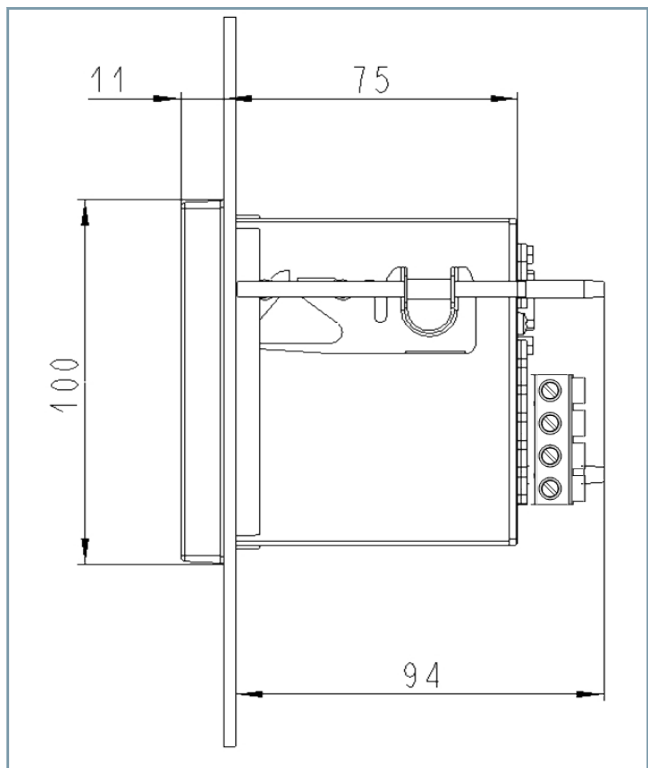
[SICAM P5_Massbild_7KG7750_IP65, 1, en_US]

Figure 3.3/20   SICAM P 7KG7750, Variant IP 65
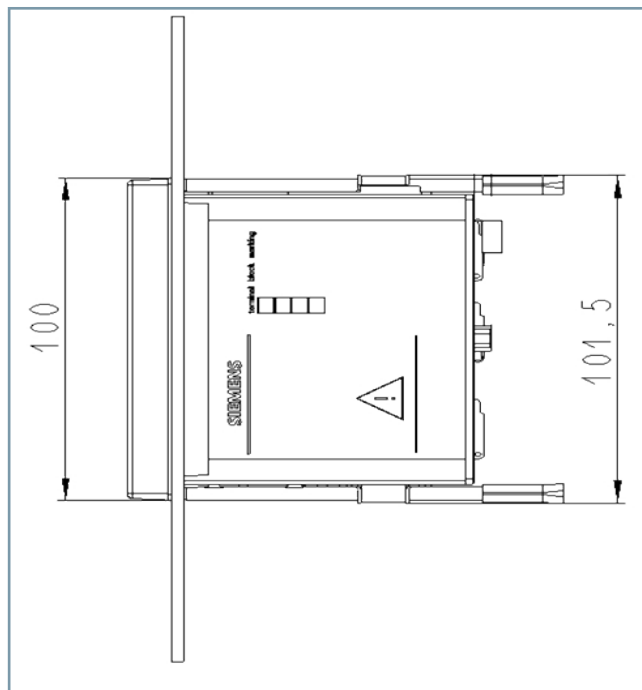
[SICAM P5_Massbild_7KG7750_Draufsicht, 1, en_US]

Figure 3.3/21   SICAM P 7KG7750
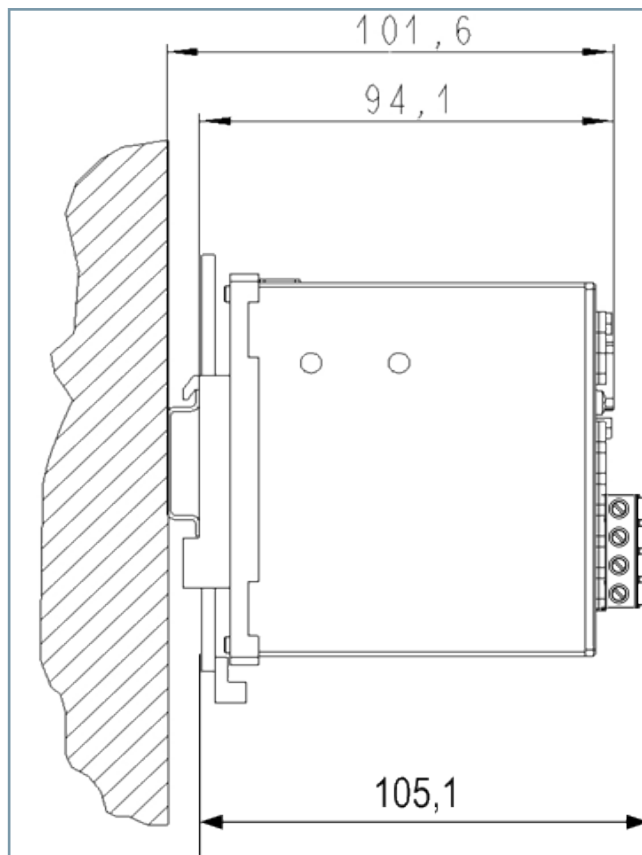
[SICAM P5_Massbild_7KG7755_Hutschienenmontage, 1, en_US]

Figure 3.3/22   Sicam P 7KG7755 for DIN-Rail Installation

SICAM P50/P55 – Selection and Ordering Data

Selection and Ordering Data

Description	Variants	Order No.															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
SICAM P50 – Power Meter with Display		7	K	G	7	7	5	0	0	□	A	0	□	0	A	A	□
										▲			▲				▲
Flush-mounting switch panel with graphic display (standard)	*I/O module (optional)*																
	Without									A							
Dimensions: 96 mm x 96 mm	2 binary outputs									B							
	2 binary inputs									C							
2 binary outputs	2 analog outputs (DC 0 to 20/4 to 20 mA)									D							
Isolated voltage measuring inputs	2 analog outputs (DC 0 to 20 mA)									E							
	3 relay outputs									G		0					
	Protection class front side																
	IP41 (standard)												1				
	IP65												3				
	Communication modules																
	RS485 with PROFIBUS DP and Modbus RTU/ASCII																0
	RS485 with IEC 60870-5-103 and Modbus RTU/ASCII																1
SICAM P55 – Power Meter without Display		7	K	G	7	7	5	5	0	□	A	0	0	0	A	A	□
										▲							▲
DIN-rail device	*I/O module (optional)*																
Dimensions: 96 mm x 96 mm	Without									A							
	2 binary outputs									B							
2 binary outputs	2 binary inputs									C							
Protection-class front	2 analog outputs (DC 0 to 20/4 to 20 mA)									D							
IP20	2 analog outputs (DC 0 to 20 mA)									E							
	3 relay outputs									G							
	Communication modules																
	RS485 with PROFIBUS DP and Modbus RTU/ASCII																0
	RS485 with IEC 60870-5-103 and Modbus RTU/ASCII																1

Table 3.3/4   Selection and Ordering Data

3.3

Digital Measuring Transducer

Digital Measuring Transducer

SICAM T – Description

SICAM T is a digital measurement transducer that allows the measuring of electrical quantities in electrical networks in a single unit. In industries, power plants and substations, transducers are especially used for measurand (for example current, voltage, power, phase angle, energy, or frequency) assignment into further processing through analog outputs or communication interface for precise control, notification or visualization tasks.

Device Type	Top-hat rail mounted device
	Plastic case 96 mm × 96 mm × 100 mm/3.78 in. x 3.78 in. x 3.94 in. (WxHxD)
	Degree of protection IP20
Supply voltage	DC 24 to 250 V
	AC 110 to 230 V; 45 to 65 Hz
Input and output circuits	4 inputs for alternating voltage measurements
	3 inputs for alternating current measurements up to 10 A continuous
	Individually programmable binary outputs.
	4 DC analog outputs
LED indicators	Automatically monitor the functions of its hardware, software, and firmware components
Communication	Ethernet: IEC 61850 or Modbus TCP communication protocol
	Optional serial RS485 interface that enables the device to communicate via the Modbus RTU or the IEC 60870-5-103 communication protocol.

[ph_SICAM T, 1, --_--]

Figure 4.1/1   SICAM T – digitaler Messumformer

- Internal battery for real-time clock and saving of energy counter values in case of a power outage
- User-friendly operation through Web server (no extra software for parameterization needed, no converters and extra cables)
- Real-time clock (RTC), field-bus synchronization or network synchronization possible via NTP

Applications

- Conversion and integration of measurands into substation automation, protection or SCADA process via RTU and/or via protocols IEC 61850 (for 7KG9662 variant), Modbus TCP, IEC 60870-5-103 for further control and/or monitoring tasks
- Monitoring of lower voltage levels and heavy load control, for example air conditioning and motors
- Depending on the device type, the input circuits for voltage measurement are either designed as voltage dividers or they are galvanically isolated. Devices with galvanic isolation can be used without voltage transformers in the power systems IT, TT, and TN. Devices with a voltage divider can also be used in these power systems; for IT power systems, however, an upstream voltage transformer is required.

Features

- Design: compact and robust for flexible application in industrial and utility environments
- Connections in 1-phase systems, in 3-wire and 4-wire systems
- Applications: flexible for power utilities, industrial and commercial sector applications
- Measurements: up to 60 measured or calculated values available
- Temperature range: -25 °C to +55 °C/-13 °F to 131 °F
- Uncertainty: typically 0.1 % for voltage and current at rated input IEC 60688, and 0.2 s acc. to IEC 62053-21
- High EMC immunity: according to standards EN 61000-6-2 and EN 61000-6-4 for the EMC directives, and with the standard EN 61010-1 for the low-voltage directive
- UL Certfication: this product is UL-certified to standard UL 61010-1

Benefits

- Flexible current measurement range (up to 2 × In)
- 4 fast analog outputs (reaction approx. 120 ms at 50 Hz and 100 ms at 60 Hz) for reliable control
- 2 individual binary outputs for fast switching, indications (for example, limit violation) and operation status monitoring
- 4 LEDs for local status visualization
- Ethernet communications via IEC 61850 and Modbus TCP and serial interface via Modbus RTU or IEC 60870-5-103

Application Example

Using the analog and binary outputs for local monitoring and control purposes, including the integration of the measure-

ments into higher-order systems (such as SCADA) via the existing communication interfaces, serial or via Ethernet (see *Figure 4.1/2*; *Table 4.1/1*).

Figure 4.1/2   Fields of Application for SICAM T
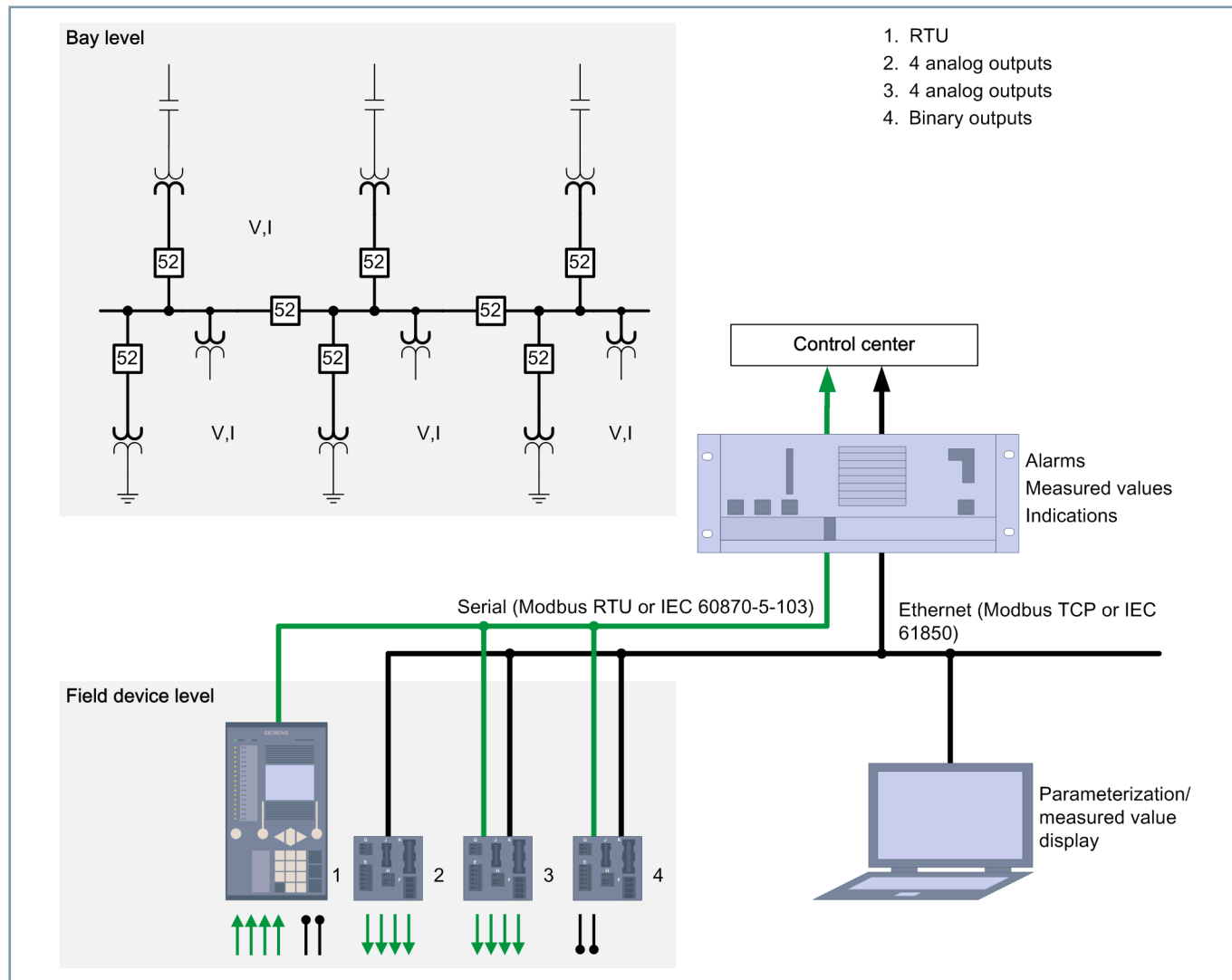
[dw_SICAM T Application, 1, en_US]

Digital Measuring Transducer

SICAM T – Field of Application and Utilization

Field of Application		Voltage	Current	Power	Frequency	Phase Angle	Energy	Message	Internal Cost Allocation
Energy generation substation	Generator/higher-order transformer	■	■	■	■	■	■	■	
Power transmission substation	Incoming feeder	■	■	■					
	Outgoing line	■	■	■					
Transformer substation	Incoming feeder	■							
	Busbar	■	■	■	■		■		
	Feeder	■	■	■					
Transformer power distribution	Incoming feeder	■							
	Busbar	■	■	■	■		■		
	Feeder	■	■	■					
Process	SCADA/EMS/DMS	■	■	■	■	■	■		
	Energy management	■	■	■	■	■	■	■	■
	Motors	■	■	■	■	■		■	■
	Commercial (for example air conditioning units)	■	■	■				■	■

Table 4.1/1   Application and Selection Fields

Communication

The device is equipped with an Ethernet interface and, if installed in accordance with the device version, an RS485 interface to communicate with the control and protection system and with other automation systems. Device parameterization, transfer of measured data, counts and messages, and time synchronization with NTP are supported via Ethernet. The communication protocols are HTTP, 61850 (7KG9662) and Modbus TCP. The optional RS485 interface permits measured data, counts, and messages to be transferred and the device time to be synchronized. Depending on the device version, you can use the communication protocol Modbus RTU or IEC 60870-5-103.

Time Synchronization

For a uniform basis in the communication with peripheral devices and time stamping of process data.

The following time synchronization methods are possible:

- External time synchronization via Ethernet NTP
- External time synchronization via fieldbus with communication protocol Modbus RTU or IEC 60870-5-103
- Internal time synchronization via RTC with quartz oscillator (if external time synchronization is not available)

Response Time of the Analog Outputs

The short response time of the analog and binary outputs is a substantial feature of SICAM T that permits reliable functioning of control applications. The response time of the device is 120 ms at 50 Hz and 100 ms at 60 Hz.
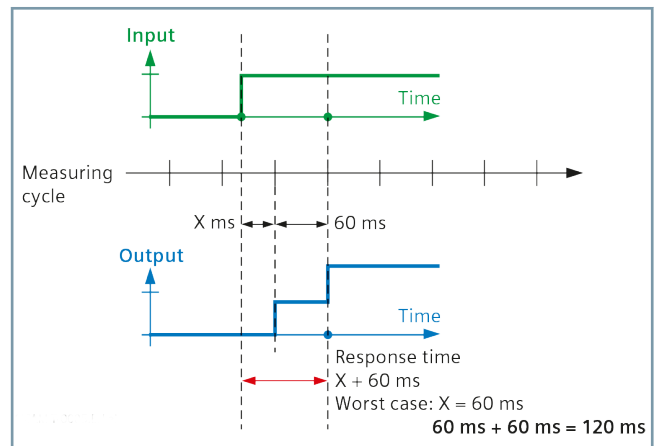
[SICAM T Time Diagram, 1, en_US]

Figure 4.1/3   Pre-Arcing Diagram

Measurand		Measuring Circuit	1-Phase System	3-Wire Network (Delta)			4-Wire Network (Star)	
				Same Load (1I)	Any Load (3I)	Any Load (2I)	Same Load (1I)	Any Load (3I)
Alternating voltage	V_a	a-N	■				■	■
	V_b	b-N						■
	V_c	c-N						■
	V_{ab}, V_{bc}, V_{ca}	a-b, b-c, c-a		■	■	■		■
	V_N	a, b, c						■
	V_{sum}	a, b, c		$\Sigma V_L/3$	$\Sigma V_L/3$	$\Sigma V_L/3$	a-N	$\Sigma V_L/3$
	V_{asym}	a-b, b-c, c-a		■				
AC current	I_a	a	■	■	■	■	■	■
	I_b, I_c	b, c			■	■		■
	I_N	a, b, c			■			■
	I_{sum}	a, b, c			■	■		$\Sigma V_L/3$
	I_{asym}	a, b, c			■	■		■
Active power factor	$\cos \varphi$ (a)	a	■					■
	$\cos \varphi$ (b), $\cos \varphi$ (c)	b,c						■
	$\cos \varphi$	a, b, c		■	■	■	■	■
Power factor	PF_a	a	■					■
	PF_b, PF_c	b, c						■
	PF	a, b, c		■	■	■	■	■
Phase angle	φ_a	a	■					■
	φ_b, φ_c	b, c						■
	φ	a, b, c		■	■	■	■	■
Angle between phase-to-ground voltages	φ_{ab}	a-b						■
	φ_{ac}	a-c						■
Frequency	f	a, b, c	■	■	■	■	■	■
Active power	P_a	a	■					■
	P_b, P_c	b, c						■
	P	a, b, c		■	■	■	■	■
Reactive power	Q_a	a	■					■
	Q_b, Q_c	b, c						■
	Q	a, b, c		■	■	■	■	■
Apparent power	S_a	a	■					■
	S_b, S_c	b, c						■
	S	a, b, c		■	■	■	■	■
Active energy – supply	$WP_{a\ supply}$	a	■					■
	$WP_{b\ supply}, WP_{c\ supply}$	b, c						■
	WP_{supply}	a, b, c		■	■	■	■	■
Active energy – import	$WP_{a\ import}$	a	■					■
	$WP_{b\ import}, WP_{c\ import}$	b, c						■
	WP_{import}	a, b, c		■	■	■	■	■
Reactive energy – inductive	$WQ_{a\ inductive}$	a	■					■
	$WQ_{b\ inductive}, WQ_{c\ inductive}$	b, c						■
	$WQ_{inductive}$	a, b, c		■	■	■	■	■
Reactive energy – capacitive	$WQ_{a\ capacitive}$	a	■					■
	$WQ_{b\ capacitive}, WQ_{c\ capacitive}$	b, c						■
	$WQ_{capacitive}$	a, b, c		■	■	■	■	■

4.1

Digital Measuring Transducer

SICAM T – Measurands

Measurand		Measuring Circuit	1-Phase System	3-Wire Network (Delta)			4-Wire Network (Star)	
				Same Load (1I)	Any Load (3I)	Any Load (2I)	Same Load (1I)	Any Load (3I)
Apparent energy	WS$_a$	a	■					■
	WS$_b$, WS$_c$	b, c						■
	WS	a, b, c		■	■	■	■	■
Harmonic voltage	HV$_a$	a-N	■				■	■
	HV$_b$	b-N						■
	HV$_c$	c-N						■
Harmonic current	HI$_a$	a	■	■	■	■	■	■
	HI$_b$	b			■	■		■
	HI$_c$	c			■	■		■

Table 4.1/2 Measurands Corresponding to the Connection Type Power Values in Networks

Measurands

The following measurands can be captured or calculated:

- RMS value for alternating voltage and alternating current
- Active, reactive, and apparent power
- Active, reactive, and apparent energy
- Power frequency
- Phase angle
- Power factor and active power factor
- Voltage and current unbalance
    - Mean value of the 3-phase voltage: V$_{sum}$
    - Mean value of the 3-phase current: I$_{sum}$

Measuring Process and Connections

The periodic quantities of current and voltage are fed to the individual measuring inputs for the measurement. Rated input alternating voltages up to Vph-N = 400 V and Vph-ph = 690 V can be fed via internal resistive input voltage dividers.

The internal current transformers process rated input AC currents up to 5 A. To ensure galvanic separation, the circuits connected at the inputs are galvanically decoupled from the current transformers. After the input values have been processed, they are output as analog values/digital data via the related interfaces and/or – depending on the parameter settings – converted into DC currents and/or DC voltages, and transferred to peripheral devices for further processing.

Graphical User Interface

Device parameterization and monitoring software

The unit is configured exclusively via a connected PC or laptop computer. The GUI user interface (GUI = Graphical User Interface) is integrated in the device. This means that additional software is not required for operating and parametering the device. Navigation is performed in Microsoft Internet Explorer via the icons in the toolbar. The user interface permits device state, communication, parameterization, log files, measured values, and maintenance information to be displayed and edited easily.
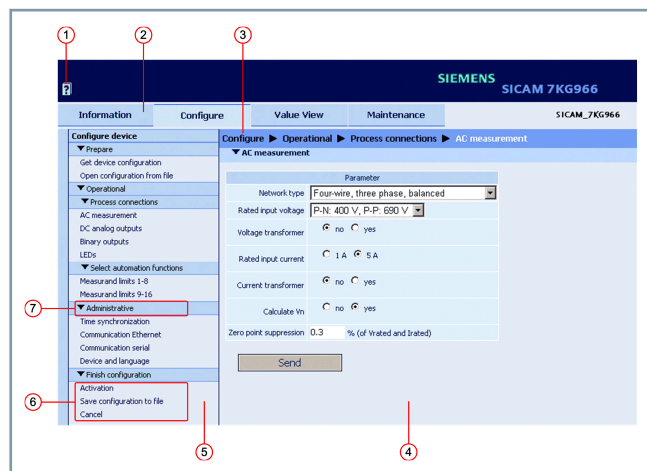
[sc_SR10_aufbau_benutzeroberfl_Sicam-MMU-GUI, 1, en_US]

Figure 4.1/4   Structure of the User Interface

(1)   Online help

(2)   Tab

(3)   Navigation bar

(4)   I/O window

(5)   Navigation window

(6)   Menu item

(7)   Menu

Information

The navigation window of the "Information" tab contains the elements device information, logs, and operational indications (*Figure 3.2/5*). Here you obtain a complete overview of the device state.
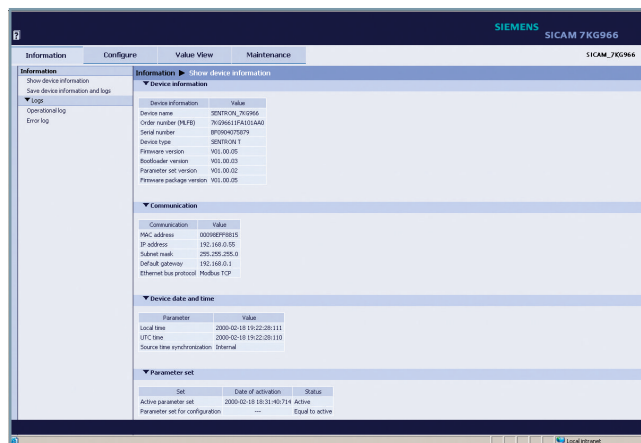
[sc_SR10-005, 1, en_US]

Figure 4.1/5   The Device Information is Shown on the "Information" Tab

Configuring

The device parameters can be set in the configuration menu. You can adjust the process connections to the installation environment, define the measuring range limits, parameterize the communication data, and make various operational settings.

Viewing the values

The measured values are displayed on the "View values" tab (*Figure 3.2/6*).

- Operational measured values (AC)
- Power and energy (AC)
- DC analog outputs
- Binary outputs
- Limiting values of the measurands

Depending on the selection of the operating parameters, the input/output window shows a table with the measured values of the measurands with the corresponding unit or messages. The display is updated every 5 s.

[sc_SR10-007, 1, en_US]

Figure 4.1/6   "View Values" Tab

Maintenance

In the "Maintenance" tab (*Figure 3.2/7*), you can update the firmware, compensate, make various presettings, view and clear log files, and show protocol-specific communication data.

Digital Measuring Transducer

SICAM T – Graphical User Interface

[sc_SR10-008, 1, en_US]
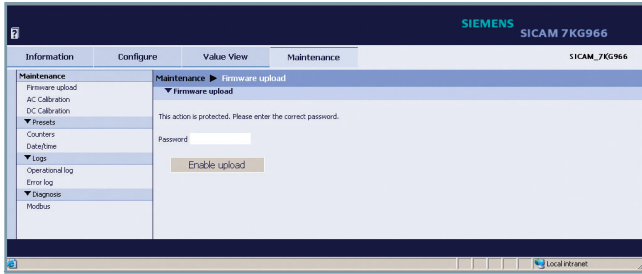
Figure 4.1/7   "Maintenance" Tab

Analog Outputs (AO)

The following features are used for transferring measured values at DC analog outputs: linear, zoom, live-zero, knee-point, knee-point zoom, bipolar linear, bipolar knee-point zoom, square transfer characteristic curve.

[GUI, 1, en_US]
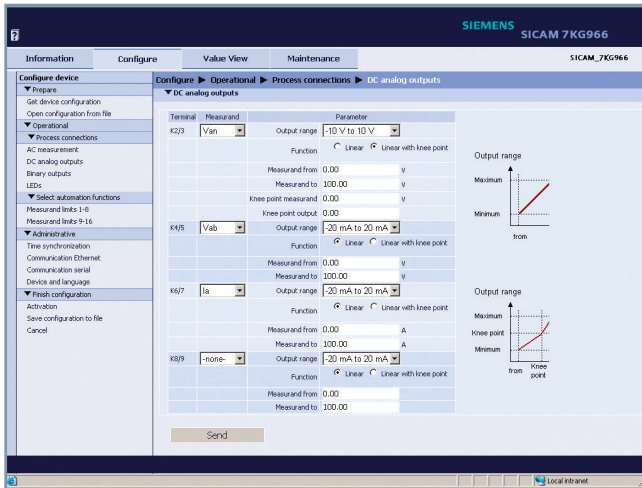
Figure 4.1/8   Input/Output Window Analog Outputs (AO)

Connection Types

The following connection types are supported:

- 1-phase system
- 3-wire network (same load)
- 3-wire network (any load), 2 current inputs
- 3-wire network (any load), 3 current inputs
- 4-wire network (same load)
- 4-wire network (any load)

Connection Examples
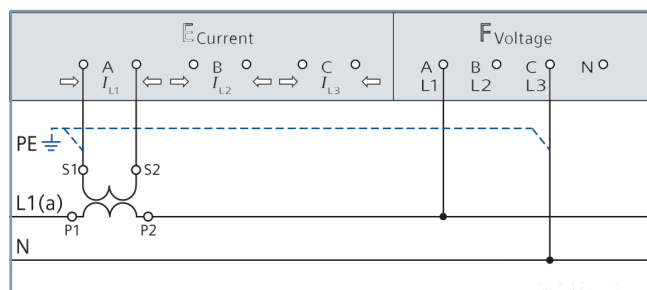
[Appl-1, 1, en_US]

Figure 4.1/9   1-Phase System
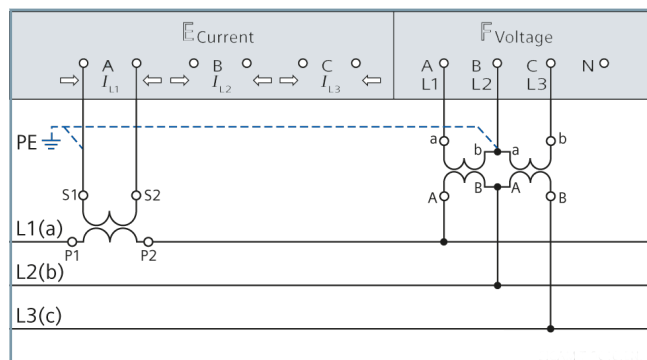
[Appl-3_2_1, 1, en_US]

Figure 4.1/10   3-Wire Network, 2 Voltage and 1 Current Transformers, Same Load*
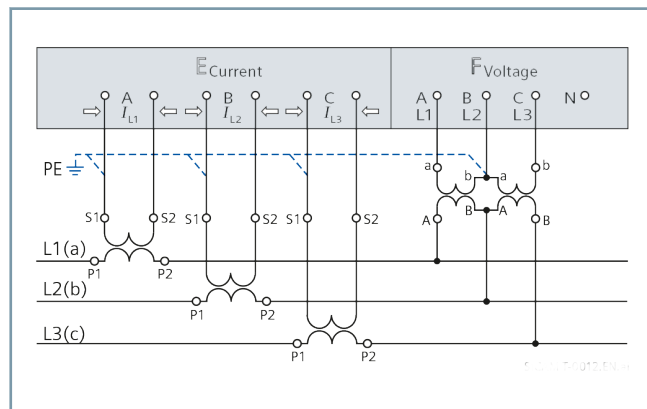
[Appl-3_2_3, 1, en_US]

Figure 4.1/11   3-Wire Network, 2 Voltage and 3 Current Transformers, Any Load*
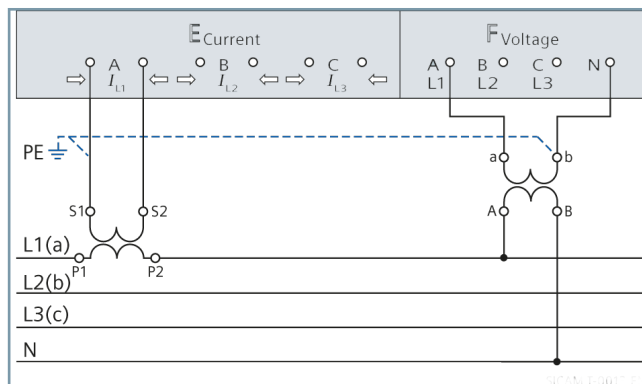
[Appl-4_1_1, 1, en_US]

Figure 4.1/12   4-Wire Network, 1 Voltage and 1 Current Transformer, Same Load
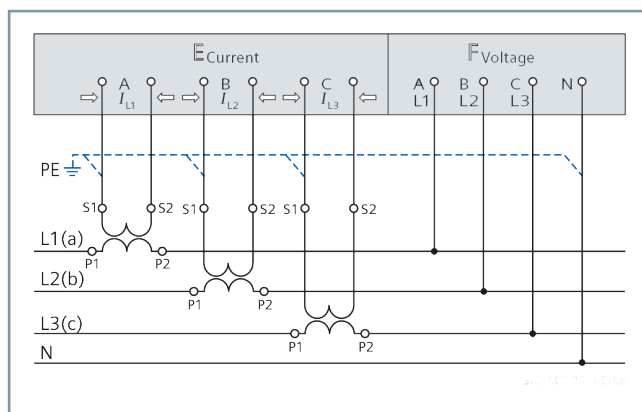
[Appl-4_0_3, 1, en_US]

Figure 4.1/13   4-Wire Network, No Voltage Transformer, 3 Current Transformers, Any Load
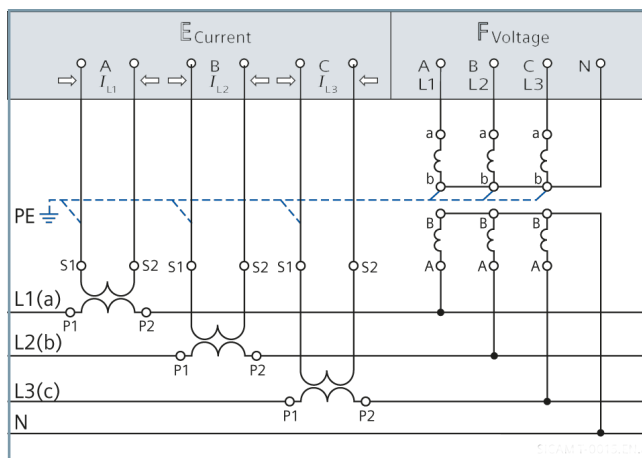
[Appl-4_3_3, 1, en_US]

Figure 4.1/14   4-Wire Network, 3 Voltage and 3 Current Transformers, Any Load

* Important: In this connection example, the maximum secondary voltage is AC 480 V. The maximum admissible voltage between phase and ground must not be exceeded. For IT mains connections, please take note of the exact description in the device manual.

4.1

Digital Measuring Transducer

SICAM T – Technical Data

Supply Voltage

Direct Voltage

Rated input voltage	24 V to 250 V
Admissible input voltage tolerance	±20 %
Admissible ripples of the DC input voltage at 24 V, 48 V, 60 V, 110 V, 220 V, 250 V	15 %
Maximum inrush current	
At ≤ 110 V	< 15 A
At 220 V to 300 V after 250 µs	≤ 22 A; after 250 µs: < 5 A
Maximum power consumption	5 W

Alternating Voltage

Rated input voltage	110 V to 230 V
Power frequency	45 Hz to 65 Hz
Admissible input voltage tolerance	±20 %
Admissible higher harmonics at AC 115 V and AC 230 V	2 kHz
Maximum inrush current	
At ≤ 115 V	< 15 A :
At 230 V	≤ 22 A; after 250 µs: < 5 A
Maximum power consumption	16 VA

Inputs and Outputs

Inputs for Alternating Voltage Measurements (Terminal Block F)

Rated input alternating voltages (can be parameterized)	
Ph-N/PE	63.5 V
	110 V
	230 V
	400 V (347 V for UL)
	Operational uncertainty of measurement to IEC 60688: ±0.1 %
Ph-ph	110 V
	190 V
	400 V
	690 V (max. 600 V for UL)
	Operational uncertainty of measurement to IEC 60688: ±0.1 %
Maximum rated input alternating voltage depending on parameterization	1.2-fold rated input alternating voltage
Maximum rated input alternating voltage	
Ph-N/PE	480 V (max. 347 V for UL)
Ph-ph	831 V (max. 600 V for UL)
Input resistances	
A, B, C to N	7.9 MΩ
A, B, C, N, to PE	3.9 MΩ
A-B, B-C, C-A	7.9 MΩ
Further specifications of the voltage measurement inputs	

Power consumption per input at V_{rated} 400 V	38 mW
Power consumption per input at V_{rated} 400 V	38 mW
Admissible frequency	45 Hz to 65 Hz
Measuring error (with compensation) at 23 °C ± 1 °C 50 Hz or 60 Hz	Typical 0.1 % at rated input alternating voltage to IEC 60668
Continuous overload capacity	1.5 x rated input voltage
	Ph-N: max. 347 V for UL
	Ph-ph: max. 600 V for UL
Surge overload capacity	2 x rated input voltage to IEC 60255-2
	Ph-N: max. 347 V for UL
	Ph-ph: max. 600 V for UL

Inputs for AC Current Measurements (Terminal Block E)

Input AC currents	
Rated input AC current ranges (can be parameterized)	1 A
	5 A
	Operational uncertainty of measurement to IEC 60688: ±0.1 %
Maximum input AC current	2 x rated input AC current
Power consumption per input	
At 1 A	1 mVA
At 5 A	2.5 mVA
Additional information about the current measurement inputs	
Admissible frequency	45 Hz to 65 Hz
Maximum voltage	150 V
Measuring error (with compensation) at 23 °C ± 1 °C 50 Hz or 60 Hz	Typical 0.1 % at rated input AC current
Thermal stability	10 A continuous
	100 A for maximum 1 s to IEC 60688

Binary Outputs (Terminal Block G)

Maximum contact voltage	
Alternating voltage	230 V
Direct voltage	250 V
Maximum currents	
Maximum continuous touch current	100 mA
Maximum pulse current for 0.1 s	300 mA
Additional information about the binary outputs	
Internal resistance	35 Ω
Admissible switching frequency	10 Hz
Number of switching cycles	Unlimited

DC Analog Outputs (Terminal Block K)

Use as current outputs (direct current)	
Rated output current	± 20 mA
Maximum output current	±24 mA
Maximum load impedance	< 400 Ω (incl. line resistance)
Short-circuit current	±24 mA, short-circuit proof
No-load voltage	15 V, stable at no load
Measuring error (with compensation) at 23 °C ± 1 °C	Maximum 0.2 % at rated current

4.1

Response time of the device	120 ms at 50 Hz
	100 ms at 60 Hz
Use as voltage outputs (direct voltage)	
Rated output voltage	±10 V
Maximum output voltage	±12 V
Maximum load impedance	1 kΩ
Short-circuit current	±24 mA, short-circuit proof
Measuring error (with compensation) at 23 °C ± 1 °C	Maximum 0.1 % at rated voltage
Response time of the device	120 ms at 50 Hz
	100 ms at 60 Hz

Communication Interface

Ethernet (Connection Z)

Ethernet, electrical	Operation	With device-internal software
	Connection	Housing top
		RJ45 connector socket
		100Base-T to IEEE 802.3
		LED yellow: 100 Mbits/s (OFF/ON)
		LED green: Connection/no connection (ON/OFF)
	Protocols	Modbus TCP
		IEC 61850 server
	Voltage strength	DC 700 V
	Transmission rate	100 Mbits/s
	Cable for 100Base-T	100 Ω to 150 Ω STP, CAT5
	Maximum cable length 100Base-T	100 m, at best routing

Serial Interface (Connection J)

RS485	Connection	Terminal side, 9-way D-Sub socket	
	Protocol	Modbus RTU	IEC 60870-5-103
	Baud rate (adjustable)	Min. 1200 bits/s	Min. 9600 bits/s
		Max. 115 200 bits/s	Max. 38 400 bits/s
		Factory setting 19 200 bits/s	Factory setting 9 600 bits/s
	Bridgeable distance	Max. 1 km (depends on transmission rate)	
	Transmission level	Low: -5 V to -1.5 V	
		High: +1.5 V to +5 V	
	Receive level	Low: ≤ -0.2 V	
		High: ≥ +0.2 V	
	Measured value ranges	–	120 % or 240 %
	Bus termination	Not integrated; bus termination by connector with integrated termination resistors	

Environmental Data

Temperature specifications	Temperature during operation	-25 °C to +55 °C
	Temperature during transportation	-25 °C to +70 °C
	Temperature during storage	-25 °C to +70 °C
	Maximum temperature gradient	20 K/h
Humidity specifications	Mean relative humidity	≤ 75 %
	Maximum relative humidity	95 % on 30 days per year
	Condensation during operation	Not permitted
	Condensation during transportation and storage	Permitted

General Data

Battery	Type	PANASONIC CR2032
		VARTA 6032 101 501
	Voltage	3 V
	Capacity	230 mAh
	Typical service life	Operation with permanently applied supply voltage: 10 years
		Operation with sporadically interrupted supply voltage: Total of 2 months inside of 10 years
Protection class to IEC 60529	Storage capacity	IP20
	Terminal side (connections)	IP20
	Terminal side (connections)	IP20

Dimensions

Mass	Approx. 0.5 kg
Dimensions (W x H x D)	96 mm x 96 mm x 100 mm
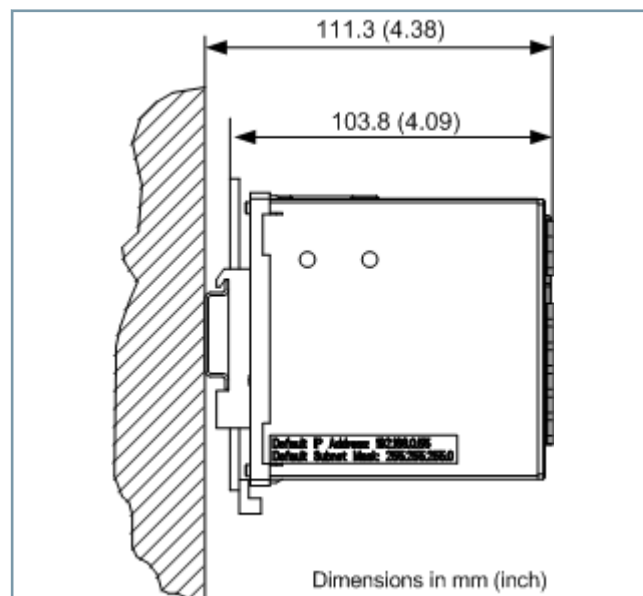
[SICAM T Maßbild, 1, en_US]

Figure 4.1/15   SICAM T Dimensions

4.1

Digital Measuring Transducer

SICAM T – Selection and Ordering Data

Selection and Ordering Data

Description	Variants	Order No.																		
									1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
SICAM T - Digital Measuring Transducer		7	K	G	9	6	6	1	-	□	□	A	□	0	-	1	A	A	0
									▲	▲		▲						
Dimensions: 96 mm x 96 mm x 100 mm	*Voltage measurement circuit*								│	│		│						
DIN-rail device without display	Resistive voltage divider								1	│		│						
IP20	Isolated voltage transformer								2	│		│						
2 binary outputs	*DC analog outputs*									│		│						
Web server	Without									A		│						
Measurements: V, I, f, P, Q, S, cosφ	4 analog outputs (-20 mA to 20 mA/-10 V to 10 V)									F		│						
Energy	*Serial interface and communication protocol*											│						
UL approval	Without											0						
Ethernet interface RJ45 with Modbus TCP	RS485/Modbus RTU											1						
	RS485/IEC 60870-5-103 and Modbus RTU											3						
SICAM T - IEC 61850 - Digital Measuring Transducer		7	K	G	9	6	6	2	-	□	□	A	0	0	-	2	A	A	0
									▲	▲								
Dimensions: 96 mm x 96 mm x 100 mm	*Voltage measurement circuit*								│	│								
DIN-rail device without display	Resistive voltage divider								1	│								
IP20	Isolated voltage transformer								2	│								
2 binary outputs	*DC analog outputs*									│								
Web server	Without									A								
Measurements: V, I, f, P, Q, S, cos φ	4 analog outputs (-20 mA to 20 mA/-10 V to 10 V)									F								
Energy																		
UL approval																		
Ethernet interface RJ45 with Modbus TCP																		

Table 4.1/3   Selection and Ordering Data

4.1

SIEMENS

Fault Recorder

Fault Recorder
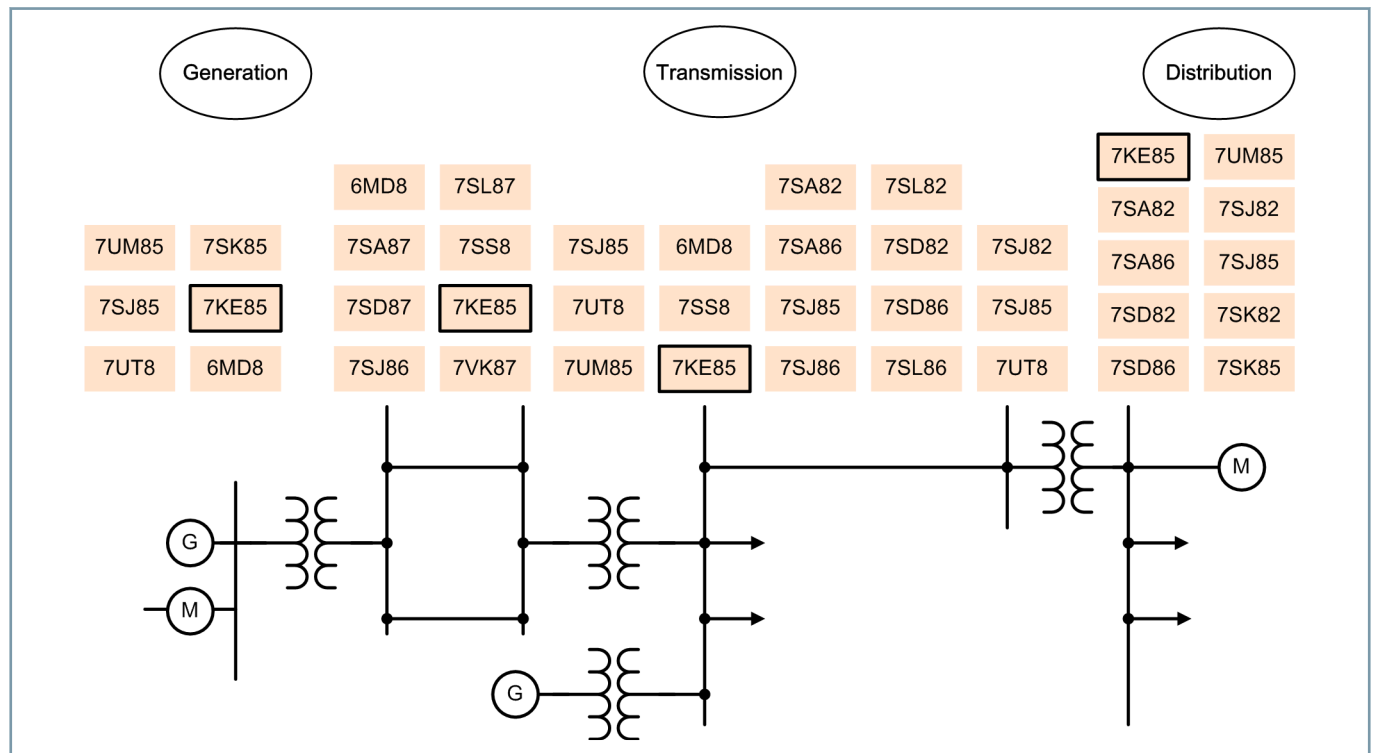
[dw_7KE85_anwendung, 1, en_US]

Figure 5.1/1   Fields of Application of the SIPROTEC 5 Devices

SIPROTEC 7KE85

SIPROTEC fault recorders are a component of the SIPROTEC 5 modular system and support all SIPROTEC 5 system properties. They can be used individually as well as universally within the scope of system solutions.

The SIPROTEC 7KE85 fault recorder is designed to suit present and future requirements in a changing energy market. 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 their modular structure, SIPROTEC 5 fault recorders can always be flexibly adapted to specific requirements.

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

- Sampling configurable from 1 to 16 kHz
- Mass storage of 16 GB
- All recorders capable of running in parallel
- Individually triggered recorders
- Continuous recorders
- Separate activation of the recorders
- Freely configurable memory for each device
- Additional quality information supplements the records

- Power quality recordings
- Recording of GOOSE messages in a continuous recorder

Distinguishing features

The SIPROTEC 7KE85 fault recorder can be configured with different basic functions.

Basic Functions	
Fault recorder	Comprehensive flexible, event-triggered and continuous recording options
PMU	Synchrophasor measurement (PMU) to IEEE C37.118-2011
Power quality recordings	Continuous measurement of events and failures in the electrical energy supply system to IEC 61000-4-30

5.1

Description

Powerful fault recorders with integrated measurement of synchrophasors (PMU) according to IEEE C37.118 and power quality measurement according to IEC 61000-4-30. Due to the great flexibility of trigger functions, the SIPROTEC 7KE85 is ideally suited for monitoring the entire energy value added chain, from generation to distribution. The powerful automation and flexible configuration with DIGSI 5 complements the range of functions.

Main function	Fault recorder
Inputs and outputs	4 predefined standard variants with up to 40 current transformers and 40 voltage transformers, 43 binary inputs, 33 binary outputs
Hardware flexibility	Flexibly adjustable and expandable I/O quantity structure within the scope of the SIPROTEC 5 modular system
Housing width	1/3 to 1/1 x 19"

Benefits

- Clearly organized documentation and focused analysis of power system processes and failures
- Data security and transparency over the entire lifecycle of the plant save time and money
- Purposeful and simple operation of the devices and software thanks to user-friendly design
- Increased reliability and quality of the engineering process
- Powerful communication components ensure secure and effective solutions
- Full compatibility between IEC 61850 Editions 1 and 2
- Highly available Ethernet communication due to integrated Ethernet redundancy protocols PRP and HSR

Functions

DIGSI 5 permits all functions to be configured and combined as required.

- Up to 40 analog channels
- Fast-scan recorder
- Up to 2 slow-scan recorders
- Up to 5 continuous recorders and 2 trend recorders
- Power Quality recordings according to IEC 61000-4-30 (harmonics, THD, TDD – in preparation)
- Sequence-of-events recorder for continuous recording of binary status changes and IEC 61850 GOOSE messages
- Usable as Phasor Measurement Unit (PMU) according to IEEE C37.118 protocol
- Transmission of the records and triggering via IEC 61850 GOOSE messages
- Variable sampling frequencies parameterizable between 1 kHz and 16 kHz
- Distribution of the mass storage of 16 GB to the various recorders by the user as desired
- Intelligent monitoring routines of the storage medium ensure a high level of availability and integrity for archived data
- Lossless data compression

[SIP5_GD_SS_LED_LED_LED_W3, 1, --_--]

Figure 5.1/2   Fault Recorder SIPROTEC 7KE85 (1/3 Device with Expansion Modules)

- Time synchronization via Precision Time Protocol (PTP) IEEE 1588 protocol, IRIG-B, DCF77, and SNTP
- Routing of the measured values to the individual recorders as desired
- Combination of the measuring groups for the power calculation as desired
- Quality attributes for representing the instantaneous signal quality in the time signal view
- Trigger functions of a function block are fundamental component value, RMS value, zero-sequence, positive-sequence, negative-sequence system power, frequency power, Σ active power, Σ reactive power, and Σ apparent power
- Level trigger and gradient trigger for every trigger function
- Flexible cross trigger and system trigger, manual trigger
- Creation of independent trigger functions with the graphic automation editor CFC (continuous function chart)
- Trigger functions via a combination of single-point, double-point indications, analog values, binary signals, Boolean signals and GOOSE messages
- Consistent monitoring concept
- Auxiliary functions for simple tests and commissioning
- Special test mode for commissioning
- Integrated electrical Ethernet RJ45 for DIGSI 5 and IEC 61850 (reporting and GOOSE)
- Redundancy protocols PRP and HSR
- Cyber security in accordance with NERC CIP and BDWE Whitepaper requirements
- Up to 4 pluggable communication modules usable for different and redundant protocols
- Intelligent terminal technology enable prewiring and a simple device replacement

Fault Recorder

SIPROTEC 7KE85 – Description

Applications

The fault recorder is for use in medium, high and extra-high voltage systems and in power plants with comprehensive trigger and recording functions. With the fault recorder SIPROTEC 7KE85, you receive a clearly organized and event-related evaluation and documentation of your power system processes. You are thereby able to analyze failures in a targeted manner and optimize your power system.

Typical processes to be monitored and documented:

- System incidents, such as critical load cases or short circuits
- Failures of the quality of supply
- Dynamic behavior of generators
- Closing and breaking operations of transformers (saturation response)
- Power fluctuations and power-swing cycles
- Test runs during commissioning.

Application Templates

Application templates are available in DIGSI for standard applications. They comprise basic configurations and default settings.

The following application templates are available:

Fault recorder 4 V/4 I/11BI

- Application templates related to the monitoring of a total of 8 current/voltage transformers.

Fault recorder 8 V/11 BI

- Application templates related to the monitoring of a total of 8 voltage transformers.

Fault recorder 8 V/8 I/19 BI

- Application templates related to the monitoring of a total of 16 current/voltage transformers.

Fault Recorder 20 V/20 I/43 BI

- Application templates related to the monitoring of a total of 40 current/voltage transformers.

[dw_7KE85_Applicationsbsp-1, 2, en_US]
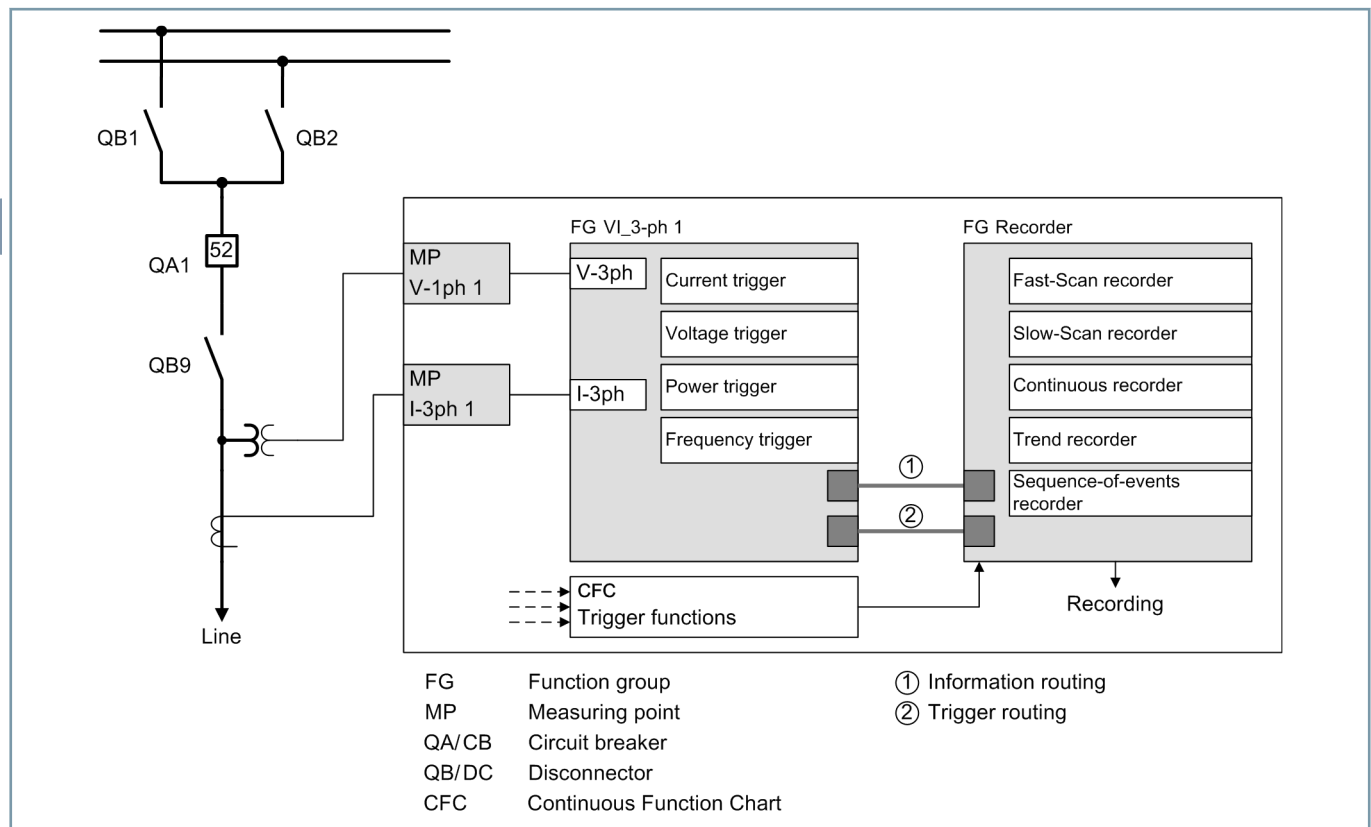
Figure 5.1/3 Application Example: Fault Recorder SIPROTEC 7KE85 for Monitoring a Feeder

Fault Recorder for Monitoring Feeders

Figure 5.1/3 and *Figure 5.1/4* show simple application examples with a SIPROTEC 7KE85, which is connected for monitoring feeders. In these examples, the various triggers are provided via function group "FG VI_3-phase" and are available to the function group "FG Recorder" and, thus, to the event-triggered recorders. In parallel, individually generated trigger functions (combination of GOOSE messages, single-point/double-point indications, binary signals, etc.) can start a recorder via the CFC and thus generate a fault record.
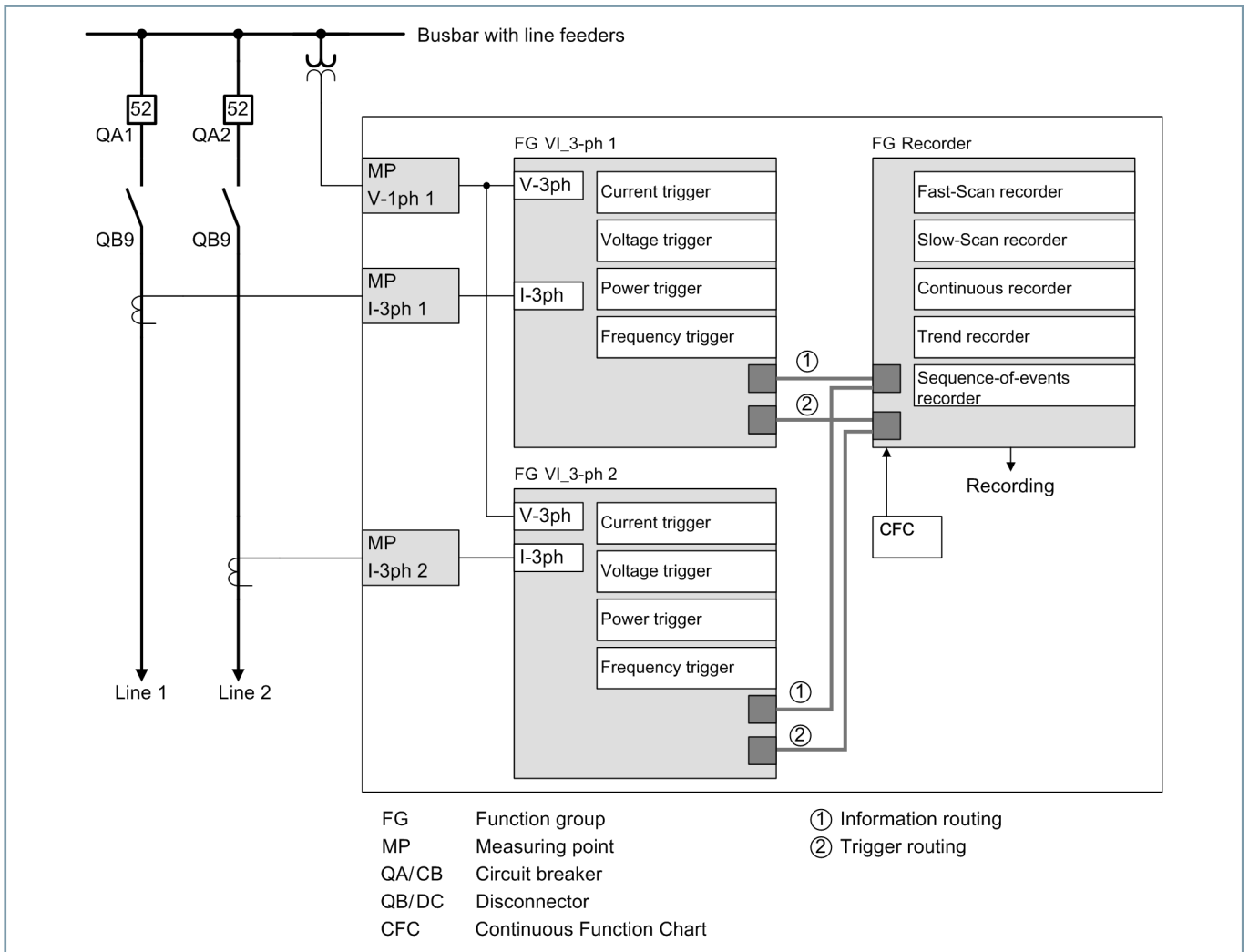
[dw_7KE85_Applicationsbsp-2, 2, en_US]

Figure 5.1/4   Application Example: Fault Recorder SIPROTEC 7KE85 for Monitoring 2 Feeders

Dimensions

Side view   Front view

Dimensions in mm. Values in brackets in inches.

Attention!

1) For FO cables, a minimum bending radius R = 50 mm (1.97 inch) must be considered according to the type.

2) For D-sub connector plugs, the axial length of the plug + cable bending radius must be considered. Minimum bending radius R = 50 mm (1.97 inch)

[dw_surface_mounting_in, 1, en_US]
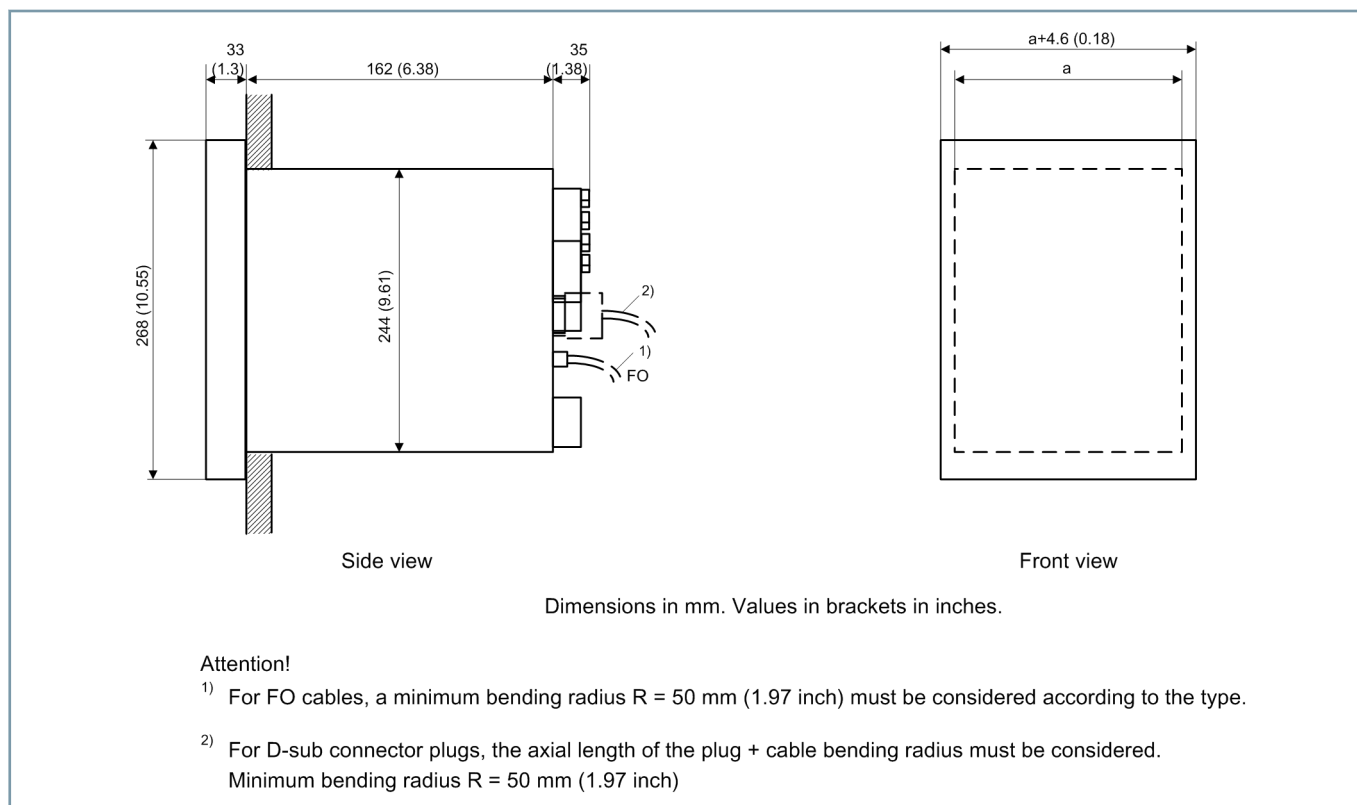
Figure 5.1/5   Flush-Mounting Devices, Dimensions from the Side And Front Views

Technical Data

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

Selection and Ordering Data

Fault recorder – 7KE85	
Housing: Extendable, 1/3 x 19" to 2/1 x 19"	
Basic function with hardware standard variant [1]	
	N1: 1/3, 11 BI, 9 BO (1 Life, 2S, 6F), 4 current transformers, 4 voltage transformers[2]
	N2: 1/3, 11 BI, 3 BO (1 Life, 2S), 8 voltage transformers [2]
	N5: 1/2, 19 BI, 15 BO (1 Life, 2S, 12F), 8 current transformers, 8 voltage transformers [2]
	N6: 1/1, 43 BI, 33 BO (1 Life, 2S, 30F), 20 current transformers, 20 voltage transformers[2]
Number of supported current transformers and voltage transformers	
	8 current transformers and voltage transformers
	16 current transformers and voltage transformers
	24 current transformers and voltage transformers
	32 current transformers and voltage transformers
	40 current transformers and voltage transformers
Application templates/function points [3]	
	PMU (40 function points)
	CFC arithmetic blocks (40 function points)
	Additional instance of a slow-scan recorder (40 function points) [4]
	Additional instance of a continuous recorder (25 function points) [5]
	Additional instance of a trend recorder (25 function points) [6]
	Instance for power quality recordings per measuring point (150 function points) [7]
Warranty extension	
	Warranty extension, annually
Communication	
	Integrated Ethernet interface (RJ45) for DIGSI
	Integrated Ethernet interface (RJ45) for DIGSI and IEC 61850 without GOOSE
	Integrated Ethernet interface (RJ45) for DIGSI and IEC 61850 incl. GOOSE
	SIPROTEC 5 plug-in modules
Display, housing, key switch, LEDs, etc.	
	Prices specifications for the order options
For product configuration and order no., see www.siemens.com/siprotec (SIPROTEC 5 – configuration)	
[1] Abbreviations: Housing width in 19-inch design, large display, 16 LEDs/BI: binary inputs/BO: binary outputs/S: standard relay, F: fast relay	
[2] With integrated Ethernet interface RJ45 for DIGSI, IEC 61850 incl. Goose.	
[3] Available functional scope as specified in the catalog or function point calculator in the order configurator	
[4] Maximum 1 additional slow-scan recorder	
[5] Maximum 4 additional continuous recorders	
[6] Maximum 1 additional trend recorder	
[7] Maximum 5 instances for power quality recordings, 1x per measuring point 4 current + 4 voltage transformers	

5.1

Table 5.1/1   Selection and Ordering Data

5.1

SIEMENS

Software for Power Quality

Software for Power Quality

SICAM PQS – Description

The protection of power distribution substations is a crucial task in ensuring a reliable electricity supply. Customers expect maximum availability of electrical energy and current at a constantly high quality level. As a result, it becomes more and more difficult in power system protection, for instance, to distinguish between critical load currents and short circuits with very low fault currents. The requirements for the optimum use of protection devices and for their parameterization are steadily increasing. An intensive evaluation of the existing secondary equipment information with regard to fault recorders is therefore indispensable to ensure that the high reliability and availability of electric transmission and distribution systems, which is standard today will be maintained in the future.

Another point is that the increasing use of power electronics has often a noticeable impact on voltage quality. The consequence is an insufficient voltage quality leading to interruptions, production downtimes, and high consequential costs. Compliance with the generally applicable power system quality criteria specified in the European standard EN 50160 is therefore a must. The basis for this is the reliable detection and evaluation of all quality parameters, so that weaknesses and potential sources of errors can be detected and eliminated.

Basic Principles for the Evaluation of Power Quality

The power quality of an electric power grid is characterized by 2 main properties:

- Grid stability
  Grid stability problems are recorded in the fault records of the PQ devices.

- Voltage quality
  The SICAM PQS system evaluates the voltage and current quality by comparing the measured data with the Grid Codes.

Grid Codes define the limiting values of power quality criteria, that is, which limits may never be exceeded, or which limiting values may be exceeded how often/how long. Grid Codes can be based on power quality standards such as the EN 50160.

The PQ Index gives you a quick overview of the power quality of your grid. Grid problems can be recognized at a glance.

The SICAM PQ Analyzer is a tool for display of the data measured by a PQ device and for their evaluation against the power quality criteria by SICAM PQS system.

[dw_sicam_pq_analyzer_available-data, 1, en_US]

Figure 6.1/2   Available Data
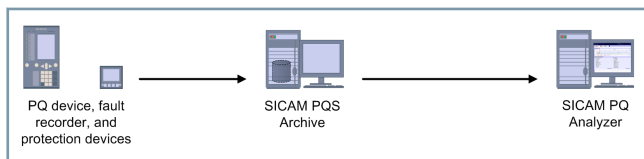
[dw_sicam_pq_analyzer, 1, en_US]

Figure 6.1/1   SICAM PQ Analyzer

Functions of SICAM PQS System

SICAM PQS system collects PQ data (such as measurements, fault records) from the connected PQ devices, creates a comprehensive power quality analysis based on these data, and saves the PQ data and the evaluations in a dedicated archive.

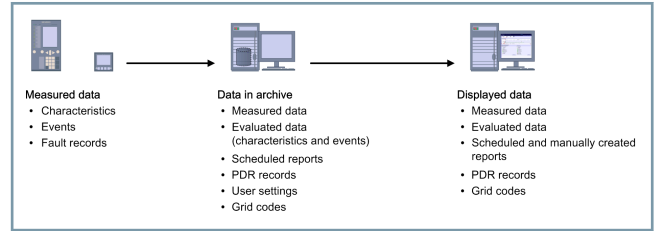| Description	Variants	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Bundles (base package including a communication application)		7	K	E	9	0	0	0	1	□	A	1	0	8	□	A	0
										▲				▲	▲		
	Version 8.0									|				8	|		
Supports up to 4 devices										|				|			
	SICAM PQS incl. SICAM Q80									R					B		
	SICAM PQS incl. SIMEAS R									R					C		
	SICAM PQS incl. IEC 61850 (monitoring direction)									R					D		
Supports up to 15 devices										|				|			
	SICAM PQS incl. SICAM Q80									M					B		
	SICAM PQS incl. SIMEAS R									M					C		
	SICAM PQS incl. IEC 61850 (monitoring direction)									M					D		
Supports up to 180 devices										|				|			
	SICAM PQS incl. SICAM Q80									A					B		
	SICAM PQS incl. SIMEAS R									A					C		
	SICAM PQS incl. IEC 61850 (monitoring direction)									A					D		
Additional V8.05 order for special use		C	5	3	2	0	7		A	4	0	4	D	4	4	8	2
	DVD with V8.05 software, latest version released for Windows XP, SICAM Station Unit V2.20, Windows Server 2003 R2 and the use of Profibus FMS; requirement: License/dongle order with MLFBs 6MD90..-.....-8..0 / 7KE90..-.....-8..0																
Upgrades		6	M	D	9	0	0	□	0	□	A	□	□	8	A	A	0
Functional upgrades with respect to the supported number of devices								▲		▲		▲	▲				
"Full Server" - runtime (up to 15 devices/ 2000 master information objects)	Prerequisite: 7KE9000-1RA10-8AA0							4		R		1	0				
"Full Server" - runtime (up to 180 devices)	Prerequisite: 7KE9000-1MA10-8AA0							4		M		1	0				
Version upgrade	SICAM PAS/PQS upgrade to V8.0x SPx (the 1st order must be referenced in the order)							3		A		0	0				
Options & Add-ons																	
Master protocols Power Quality		7	K	E	9	0	0	0	0	C	B	1	□	8	A	A	0
	SIMEAS R master												1				
	SICAM Q80 Master												2				
Master protocols Power Automation (monitoring direction)		6	M	D	9	0	0	0	0	C	□	1	0	8	A	A	0
	IEC 60870-5-103 master (monitoring direction)										B						
	IEC 61850 client (monitoring direction)										E						
Power Quality applications		7	K	E	9	0	0	0	0	B	A	6	□	8	A	A	0
	Automatic Comtrade import												0				
	Automatic Comtrade export												1				
	Automatic PQDif import												2				
	Automatic PQDif export												3				
	Automatic report export												4				
	Automatic fault location												5				
	Message (e-mail, SMS)												6				
	Automatic GridCode evaluation												7				
	Scheduled PQ reports												8				

Table 6.1/1   Selection and Ordering Data

6.1

Software for Power Quality

SICAM PQS – Selection and Ordering Data

The SICAM PQS system can be enhanced with SICAM PAS applications. You need a configuration license for the project engineering of such a system. You can either add a configuration license to the existing runtime license [=> a)]. Or you can carry out project engineering in a separate configuration PC [=> b)].

Description	Variants	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Base Package (SICAM PAS)		6	M	D	9	0	0	0	1	□	A	2	0	8	A	A	0
Configuration										▲							
	b) Up to 15 devices or up to 2000 master information objects									M							
	b) More than 15 devices and/or more than 2000 master information objects									A							
Upgrades (SICAM PAS)		6	M	D	9	0	0	4	0	□	□	□	□	8	A	A	0
Functional upgrades - from "Runtime" to "Runtime & Configuration"										▲	▲	▲	▲				
	a) Configuration upgrade ≤15 (runtime already available) Requirements: 7KE9000-1MA10-8*A0									A	A	2	4				
	a) Configuration upgrade >15 (runtime already available) Requirement: 7KE9000-1AA10-8*A0									A	A	2	3				
Functional upgrades with regard to the supported device number										|	|	|	|				
"Full Server" - runtime up to 180 devices, configuration more than 15 devices/ 2000 master information objects	Prerequisite: 7KE9000-1MA10-8*A0 6MD9004-0AA24-8AA0									M	A	0	0				
Configuration (more than 15 devices/ 2000 master information objects)	Prerequisite: 6MD9000-1AA20-8AA0									M	A	2	0				
"Full Server" - runtime (more than 180 devices)	Prerequisite: 6MD9000-1AA10-8AA0 6MD9000-1AA00-8AA0									A	A	1	0				
Options & Add-ons		6	M	D	9	0	0	0	0	□	□	□	□	8	□	A	0
Applications (Power Automation)										▲	▲	▲	▲		▲		
	Automation									B	A	5	0		A		
	PDR – recorder (Post Disturbance Review)									B	A	7	0		A		
Add-ons (Power Automation)										|	|	|	|		|		
	SICAM PAS applications (f-based load shedding, GIS monitoring, converter monitoring)									P	A	0	1		A		
	Secure communication (for TCP/IP-based communication protocols T104 slave, DNP 3 slave, DNP 3 master)									S	C	0	0		A		
Master protocols (field devices, RTUs)										|	|	|	|		|		
	IEC 61850 client (monitoring direction)									C	E	0	0		M		
	IEC 61850 client									C	E	0	0		A		
	IEC 61850 GOOSE publisher									C	E	0	1		A		
	IEC 60870-5-101 master									C	D	0	0		A		
	IEC 60870-5-103 master (monitoring direction)									C	B	0	0		M		
	IEC 60870-5-103 master									C	B	0	0		A		
	IEC 60870-5-104 master									C	D	0	4		A		
	DNP3 master									C	B	0	7		A		
	Modbus master									C	B	0	5		A		
	Driver module for PROFIBUS DP									C	B	0	1		A		
	PROFINET IO master									C	B	0	8		A		
	SINAUT LSA – LSA									C	B	0	3		A		
	OPC client									B	A	4	0		A		
Slave protocols to connect to control centers										|	|	|	|		|		
	IEC 60870-5-101 slave									C	C	0	0		A		
	IEC 60870-5-104 slave									C	C	0	4		A		

6.1

Description	Variants	Order no.														
	IEC 61850 server (control center communication)								C	F	0	0		A		
	DNP3								C	C	0	7		A		
	Modbus slave								C	C	0	5		A		
	CDT slave (serial)								C	C	0	8		A		
	TG8979 slave (serial)								C	C	1	0		A		
	OPC XML-DA server								C	A	4	1		A		
Functional upgrades for communication applications that support only the monitoring direction									I	I	I	I		I		
IEC 60870-5-103 Master (additionally supports command direction)	Prerequisite: 6MD9000-0CB00-8MA0								C	B	0	0		A		
IEC 61850 Client (additionally supports command direction)	Prerequisite: 6MD9004-0CE00-8MA0								C	E	0	0		A		

Table 6.1/2   Selection and Ordering Data

6.1

Description

SICAM PQ Analyzer provides comprehensive evaluation options for archived PQ measured data and fault records. In addition to clearly structured fault-record analysis, the fault locator facilitates and accelerates the elimination of faults in the power network. PQ Violation Reports provide a quick and comprehensive overview of limiting-value violations. Scheduled reports provide an overview of the development of measured data over selectable time ranges. Using a calendar tool, that is available in all views, you can quickly and easily select any time range over which data is to be displayed in a diagram. The calculated PQ index delivers concise information on the quality of your network.

Functions of SICAM PQS System

SICAM PQS system collects PQ data (such as measurements, fault records) from the connected PQ devices, creates a comprehensive power quality analysis based on these data, and saves the PQ data and the evaluations in a dedicated archive.
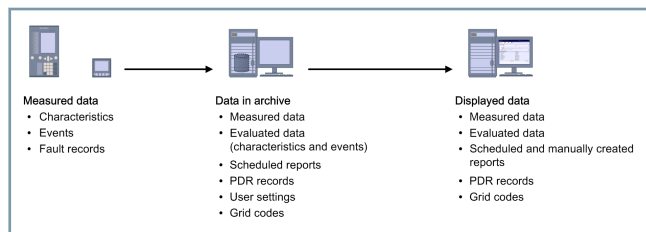
[dw_sicam_pq_analyzer_available-data, 1, en_US]

Figure 6.2/1   Available Data

Functions of the SICAM PQ Analyzer

The SICAM PQ Analyzer connects to the archive of the SICAM PAS/PQS system and displays the data in the archive. Depending on the license, the SICAM PQ Analyzer provides a wide range of tools for analyzing these data.

The SICAM PQ Analyzer can be installed on the same computer as the SICAM PAS/PQS system, or on a separate computer in the network.

The archived PQ measured data and grid faults are evaluated in the different views of the SICAM PQ Analyzer.

- **Incident Explorer**

  The Incident Explorer allows a time-related analysis and provides a topological or configuration view of:
  – Fault records
  – Slow-scan records
  – Fault location reports
  – PQ Violation reports (is generated as soon as a PQ violation against Grid Code happens)
  – PDR records (Post Disturbance Review
  – SIPROTEC fault records (high-resolution fault record generated from a 7KE85 device)
  – SIPROTEC slow-scan records (slow-scan records generated from a 7KE85 device)

Furthermore, you can export individual fault records. You can reduce the amount of data and select a COMTRADE export format.

- **PQ Explorer**

  The PQ Explorer gives access to all PQ data stored in the archive.
  It provides a topological view of the measuring points of your station.
  The measured and calculated PQ data are evaluated by means of PQ diagrams.
  Furthermore, you can create reports of the analysis and preview the reports.

- **PQ Inspector**

  The PQ Inspector shows the grid condition over a selectable time range based on the calculated PQ Index.
  It selectively provides a status overview of measured value groups which can be arbitrarily combined, as well as user guidance for the creation of PQ reports.

- **Report Browser**

  The Report Browser gives an overview of the scheduled reports, which are generated automatically at defined intervals (daily, weekly, monthly, and yearly).

- **Grid Code Viewer**

  The Grid Code Viewer displays the Grid Codes defined in SICAM PQS. The Grid Codes contain standardized or customer-specific limiting values for evaluating the grid quality. The PQ Index is determined on the basis of a comparison between the measured values and the limiting values of a Grid Code.

Fields of application

Incident Explorer

The topological structure of the archive data corresponds to the structure that was defined when the SICAM PAS/PQS station was configured.

The Incident Explorer serves for the following tasks:
- Reading the events (confirm)
- Calling up the analysis programs
- Deleting the events from the archive summary
- Manual fault location

Various filter functions are available for selection of events in the power network
- Selecting the time range in the archive
- Filtering for events
- Commenting events
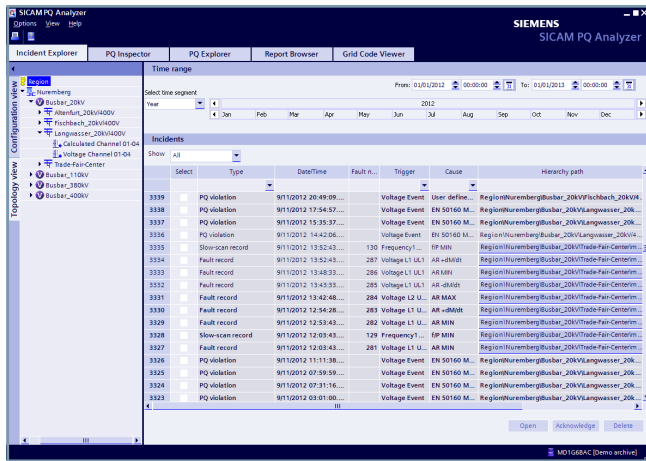
[sc_PQ IncidentEx, 1, en_US]

Figure 6.2/2   Incident Explorer

PQ Inspector

The PQ Inspector provides the operator with a quick overview of the plant's power quality based on the PQ index. The archived data is analyzed via any selectable time ranges. Causes of deviations in the measured values for the grid codes can thus be detected immediately.

PQ Inspector is divided into 3 steps:

- In **Select time range**, define the observation period and identify possible influencing factors for deviations of the power quality.
- In **Select diagrams**, select the properties of a specific measuring point, and define the diagrams in which you want to show these data items.
- In **Complete report**, complete your report.

Use the **Select time range** step to view the state of the power quality of the system at a glance. You can set up individual measuring point groups and feature groups so that you can observe critical areas in a targeted manner.

The step **Select diagram** allows the compilation of evaluation diagrams with specific features for a report. The diagrams are represented in a synchronized manner. Hence you can rapidly identify connections in the event of fluctuations in power quality.

The step **Prepare report** allows reports to be prepared and commented upon.

PQ Explorer

PQ Explorer allows access to all PQ data stored in the archive. It offers a topological view of the measuring points in your plant. Measured and calculated PQ data is evaluated via PQ diagrams. Furthermore, you can generate analysis reports and display these in a preview.

Report Browser

The Report Browser provides an overview of the scheduled reports that are created automatically at specified time intervals (daily, weekly, monthly and yearly). You can view the reports with a viewer, print them and store them for future use.

[sc_pqa_ReportBrowser, 2, en_US]
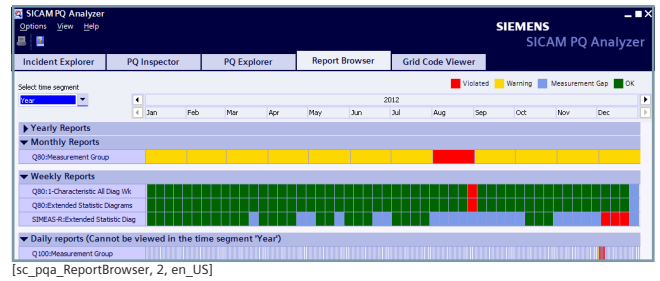
Figure 6.2/3   Report Browser

In Report Browser, the reports are shown for the selected time range – separated into yearly reports, monthly reports, weekly reports and daily reports. If you select the year time grid you cannot open daily reports. However, you can view the status and the time lapses for which infringement reports are available. Scheduled reports are automatically generated by the SICAM PQS system using the set up report templates. If you set up report templates, among other things define the intervals in which the reports are created, and the PQ devices for which the reports are created. The colors of the reports show their status.

Grid Code Viewer

The Grid Code Viewer displays the grid codes defined in SICAM PQS. The grid codes include normalized or customer-specifically defined limiting values for evaluating the power quality. The PQ Index is determined from a comparison of the measured values with the limiting values of a grid code.

The Grid Code Viewer provides the overview required for a supporting analysis:

- Which grid codes are available?
- To which elements in the topology have the grid codes been assigned?
- What features do the grid codes contain?
- What limits have been defined?

SICAM PQ Collector

The SICAM PQ Collector collects the archive data of the individual (source) archives in a central (collector) archive. Depending on the system configuration, the SICAM PQ Analyzer accesses the data of the (source) archives or (collector) archives for its archive evaluation.

In redundant archive systems, two SICAM PQ Collectors are connected. In the event of an interruption of the connection to (source) archives or after the failure of a SICAM PQ Collectors, this permits the archives to be matched, thus reaching an identical and complete contents of both (Collector) archives.

Architecture

- SICAM PAS/PQS with (source) archive and SICAM PQ Analyzer
- System with
  - SICAM PAS/PQS with (source) archive
  - SICAM PQ Analyzer clients
- System with
  - SICAM PAS/PQS
  - Archive servers with (collector) archive
  - SICAM PQ Analyzer clients

6.2

Software for Power Quality

The number of components which can be used in a system depends on the individual license.

(Source) archive

SICAM PAS/PQS collects the PQ measured data and fault records from the connected devices and stores them in its local (source) archive. This archive data can be directly evaluated by one or more SICAM PQ Analyzer(s).

(Collector) archive

In distributed systems with one or several SICAM PAS/PQS, the data of the (source) archives is collected by the SICAM PQ Analyzer collector and stored in a central (Collector) archive on an archive computer. This archive data is evaluated by one or more SICAM PQ Analyzer(s).

6.2

One of the following operating systems is required:

- Windows Embedded 7 (SICAM Station Unit V2.40, 32-bit)
- Windows Server 2012 R2 Standard (64-bit)
- Windows 8.1 Professional (64-bit)
- Windows 10 Professional (64-bit)

Computer equipped with:

- Processor:
  - Minimum: Intel Core 2 Duo 1.6 GHz
  - Recommended: Quad Core CPU 3 GHz
- Primary storage capacity:
  - Minimum: 2 GB
  - Recommended: 4 GB
- Hard disk capacity:
  - Minimum: 4 GB
  - (Collector) archive: > 100 GB
- Graphics card:
  - Minimum: 1600 x 1200
  - Recommended: 1920 x 1080
- Monitor suitable for graphics card
- DVD drive
- Keyboard
- Mouse
- Network interface
- USB port

SICAM PQ Analyzer is released for computers with multi-core processors. Computers with multi-processor main boards are supported when working in single-processor mode.

6.2

Selection and Ordering Data

Description	Variants	Order No.																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Incident Explorer for Fault Record Processing		6	M	D	5	5	3	0	- 0	A	A	1	0	- 3	□	□	0
														▲	▲	▲	
	Version 3.0x													3	│	│	
	Use on the SICAM PAS/PQS Full Server														A	A	
	Up to 5 clients, archive transfer of 1 Server/Full Server														B	A	
	Up to 5 clients, archive transfer of up to 5 Servers/Full Servers														B	B	
	Up to 5 clients, archive transfer of more than 5 Servers/Full Servers														B	C	
	More than 5 clients, archive transfer of 1 Server/Full Server														C	A	
	More than 5 clients, archive transfer of up to 5 Servers/Full Servers														C	B	
	More than 5 clients, archive transfer of more than 5 Servers/Full Servers														C	C	

Notes:

- 2 redundant PAS/PQS Full Servers are counted as 1 server
- In addition to fault records, SIMEAS R and SIPROTEC 7KE85 deliver continuous average value reports that are managed in PQ Explorer.
=> The use of PQ Basic is recommended as a minimum for a complete evaluation of SIMEAS R and SIPROTEC 7KE85 data.

Description	Variants	Order No.																
PQ Basic		7	K	E	9	2	0	0	- 0	B	A	1	0	- 3	□	□	0
Including Incident Explorer for fault-record analysis and PQ Explorer Recommended SICAM PAS/PQS option: Automatic grid code evaluation <-> 7KE9000-0BA67-8AA0															▲	▲	
	Use on the SICAM PAS/PQS Full Server														A	A	
	Up to 5 clients, archive transfer of 1 Server/ Full Server														B	A	
	Up to 5 clients, archive transfer of up to 5 Servers/Full Servers														B	B	
	Up to 5 clients, archive transfer of more than 5 Servers/Full Servers														B	C	
	More than 5 clients, archive transfer of 1 Server/Full Server														C	A	
	More than 5 clients, archive transfer of up to 5áServers/Full Servers														C	B	
	More than 5 clients, archive transfer of more than 5 Servers/Full Servers														C	C	
PQ Standard		7	K	E	2	0	0	- 0	C	A	1	0	- 3	□	□	0	
Including PQ Basic and extended PQ Explorer and Report Browser Recommended SICAM PAS/PQS options: Automatic grid code evaluation <-> 7KE9000-0BA67-8AA / scheduled PQ reports <-> 7KE9000-0BA68-8AA0															▲	▲	
	Use on the SICAM PAS/PQS Full Server														A	A	
	Up to 5 clients, archive transfer of 1 Server/ Full Server														B	A	
	Up to 5 clients, archive transfer of up to 5 Servers/Full Servers														B	B	
	Up to 5 clients, archive transfer of more than 5 Servers/Full Servers														B	C	
	More than 5 clients, archive transfer of 1 Server/Full Server														C	A	
	More than 5 clients, archive transfer of up to 5 Servers/Full Servers														C	B	
	More than 5 clients, archive transfer of more than 5 Servers/Full Servers														C	C	

Table 6.2/1   SICAM PQ Analyzer Selection and Ordering Data

6.2

Description	Variants	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Continued from previous page																	
PQ Professional		7	K	E	2	0	0	0	0	D	A	1	0	3	□	□	0
Including PQ Standard and PQ Inspector														▲	▲		
Recommended SICAM PAS/PQS options: Automatic grid code evaluation <-> 7KE9000-0BA67-8AA0/scheduled PQ reports <-> 7KE9000-0BA68-8AA0																	
	Use on the SICAM PAS/PQS Full Server													A	A		
	Up to 5 clients, archive transfer of 1 Server/Full Server													B	A		
	Up to 5 clients, archive transfer of up to 5 Servers/Full Servers													B	B		
	Up to 5 clients, archive transfer of more than 5 Servers/Full Servers													B	C		
	More than 5 clients, archive transfer of 1 Server/Full Server													C	A		
	More than 5 clients, archive transfer of up to 5 Servers/Full Servers													C	B		
	More than 5 clients, archive transfer of more than 5 Servers/Full Servers													C	C		
Functional upgrades																	
Power Quality functions		7	K	E	9	2	0	0	4	□	□	0	0	3	A	A	0
	From Incident Explorer to PQ Basic									B	A						
	From PQ Basic to PQ Standard									C	B						
	From PQ Basic to PQ Professional									D	B						
	From PQ Standard to PQ Professional									D	C						
Number of clients		6	M	D	5	5	3	0	4	A	A	0	0	3	□	A	0
	Up to 5 clients														B		
	From "up to 5 clients" to "more than 5 clients"														C		
Number of Full Servers		6	M	D	5	5	3	0	4	A	A	0	0	3	A	□	0
	Up to 5 Full Servers															B	
	From "up to 5 Full Servers" to "more than 5 Full Servers"															C	
Version upgrade																	
	Upgrade from SICAM Recpro V5.x to SICAM PQ Analyzer (Incident Explorer)	6	M	D	5	5	3	0	3	A	A	0	0	3	A	A	0
	Version upgrade SICAM PQ Analyzer	6	M	D	5	5	3	0	3	A	A	0	1	3	A	A	0

Table 6.2/2   SICAM PQ Analyzer Selection and Ordering Data

SICAM PQ Analyzer can be extended with SIGRA for extended fault-record analysis (separate order)

6.2

Software for Power Quality

SIGUARD PDP – Description

SIGUARD PDP (Phasor Data Processing) is a software for monitoring the status of power transmission in widespread power-supply systems. It detects and displays early the approach to critical states (frequency stability, voltage stability, transmission stability, and power swing). At any time you can define and change the threshold at which a critical state is reached and requires intervention. In addition, SIGUARD PDP supports you in the analysis of the power-supply system.

SIGUARD PDP works together with PMUs (Phasor Measurement Units). These measuring devices are installed in the power distribution systems and connected to the current and voltage transformers. The time of the PMUs must be synchronized via GPS with an accuracy of < 5 µs. This enables the PMUs to acquire the measured values with magnitude and phase as phasors (indicator values) with high precision and to transmit them via the communication interface. Using SIGUARD PDP, you can collect and evaluate these time-synchronized measured values from locally widespread measuring points.

Possible causes of critical states in energy networks:

- The increasing boundary-crossing electricity trading, for example, puts in Europe new requirements on the tie lines between the control zones. From 1975 to 2008, the transfer of energy via tie lines in the European power grid rose by almost 6 times (source: Statistical yearbook of ENTSO-E 2008)
- The transfer distances between generation and consumers increase due to the increasing infeed from wind power plants and the planned disconnection of existing power plants.
- More frequently occurring thunderstorms and hurricanes can put vital lines out of operation, thus exposing the remaining network briefly to higher loads.

Consequently, network operation is closer to the stability limit, which results in new power flows to which the control center operators are not used. This is where SIGUARD PDP (Phasor Data Processor) starts. This system for network monitoring using synchrophasors helps with fast appraisal of the current situation. Power swings and transients are indicated without delay to help the control center personnel find the causes and take countermeasures.

Benefits

- As a **fast monitoring system**, SIGUARD PDP captures the events and trends in networks with fluctuating power flow or heavily stressed lines, that are not or only too late detected by conventional systems.
- An extensive **location of the cause** can be carried out after a failure.
- **Investment decisions** for new equipment can be made on the basis of well founded dynamic measurements.
- **Protection settings** can be checked and improved on the basis of the measured dynamic operations.

Applications

- Analysis of the power flows in the system
- Observing power swings
- Assessment of power-swing attenuation
- Monitoring the loading schedule of transfer routes
- Island-state detection

- Reverse event analysis
- Alarm generated at limiting-value violation, with alarm list and color change in the geographic overview image
- Display of the power-system status as characteristic key value for system stability
- Phase-angle display
- Event-controlled archiving
- Automatic failure detection
- High-precision frequency calculation
- E-mail notification
- Deriving actions from phase-angle measurements (Wide Area Control)

- *Analysis of the power flows in the system*

  Already with a few measured values from widespread Phasor Measurement Units (PMU), SIGUARD-PDP can represent a clear and current image of the current power flows in the system. This does not require any knowledge of the network topology. The power flows are represented via the phase-angle differences (see *Figure 6.3/1*).
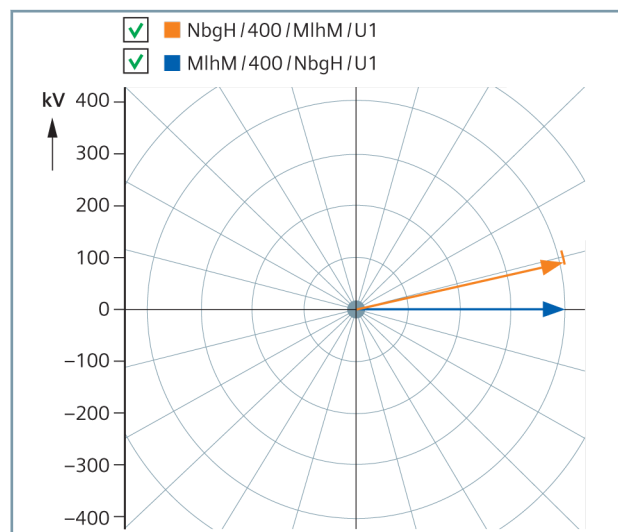

[Voltage vector, 1, --_--]

Figure 6.3/1   Voltage Phasors of 2 Measuring Points in the Power System

- *Observing power swings*

  Using easily configurable phasor ant time diagrams, you can display and monitor all measured PMU quantities. Power swing is detected swiftly and reliably. Time, geography and contents of the monitored area can flexibly be adapted to the current situation.

● *Assessment of power-swing attenuation*

The "Power-swing recognition" function detects the beginning of a power swing and determines the attenuation. The detection of a power swing and, if applicable, its weak or non-existing attenuation, are reported (alarm list). 2 types of power-swing detection are possible - based on the angle difference between 2 voltages (2 PMUs required), or based on 1 active-power swing (1 PMU with measured current and voltage values is sufficient). Detected power swings are shown in the tree-view control, in a mode- or job-oriented overview and in a frequency attenuation diagram.
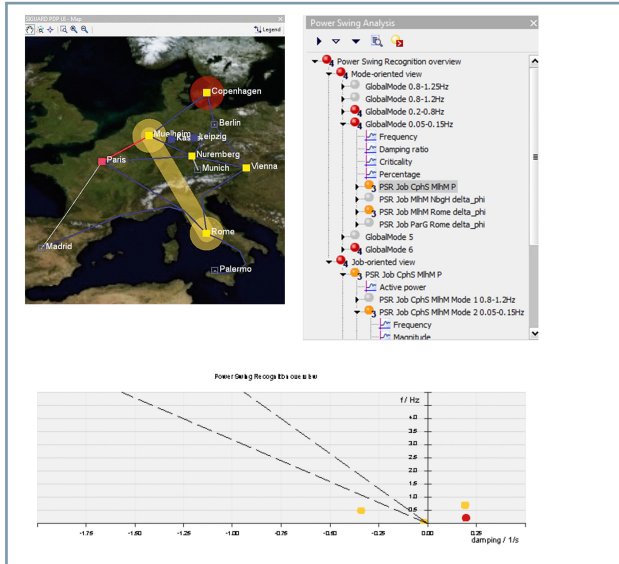

[SIGUARD Monitoring Diagrams, 1, --_--]

Figure 6.3/2   Overview Diagram of the "Power-Swing Recognition" Application

● *Monitoring the loading situation of transfer corridors*

The voltage-stability curve is particularly suitable for displaying the current loading situation of a transfer corridor. The currently measured operating point is shown on the operating curve of the line (voltage as a function of the transferred power). The remaining reserve can thus be retrieved at any time. This requires PMUs at both ends of the line.
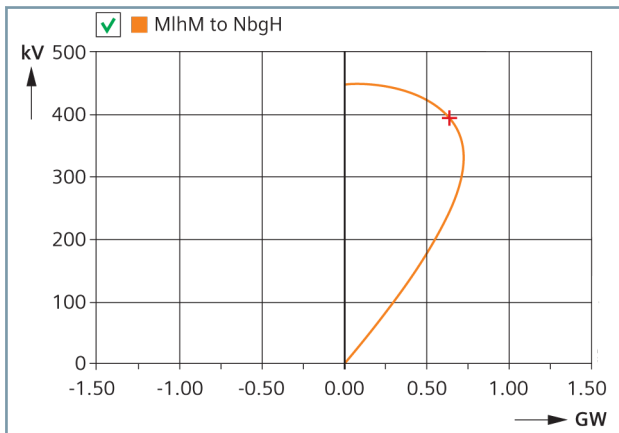
[Voltage-stability curve, 1, --_--]

Figure 6.3/3   Voltage Stability Curve

● *Island-state detection*

This function shows automatically when parts of the network are separated from the remaining network. It also permits frequency differences and frequency change rates to be monitored automatically. Detected islands generate warnings and event messages. In addition, the islands are marked as colored areas in the graphical overview.

[Island stae detection, 1, --_--]

Figure 6.3/4   Island-State Detection

● Reverse event analysis
SIGUARD PDP is particularly suitable for the analysis of critical events in the network. After you have switched over to offline mode, you can analyze the entire archive systematically, and play the event back as often as necessary. This makes dynamic events transparent, and reports can be prepared quickly and precisely. Merely copy the meaningful diagrams from SIGUARD PDP into your reports.

● *Alarm generated at limiting-value violation, with alarm list and color change in the geographic overview map*

This enables you to quickly detect location and cause of a failure. This function is also available when you analyze the archive.

● *Display of the power- system status as characteristic key value for system stability*

The permanently displayed power-system status curve in the upper part of the screen informs the operator continuously about the trend of the dynamic system behavior and about the availability of reserves. This curve shows weighted mean values of the distances of all measured values from their limiting values.

6.3

- *Phase-angle display*

    The phase-angle display function can be activated in the map view (*Figure 6.3/5*). It shows the phase-angle differences between PMUs as colored areas. Based on the displayed color scale for the angles, you can assess the network stability situation at a glance. Color scale and min. and max. values can be specified in SIGUARD PDP Engineer (*Figure 6.3/6*).
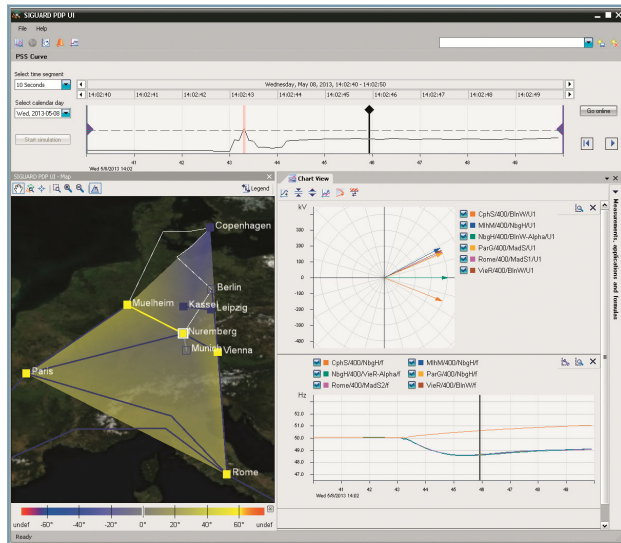

[SIGUARD PDP-UI, 1, --_--]

Figure 6.3/5   Phase-Angle Display

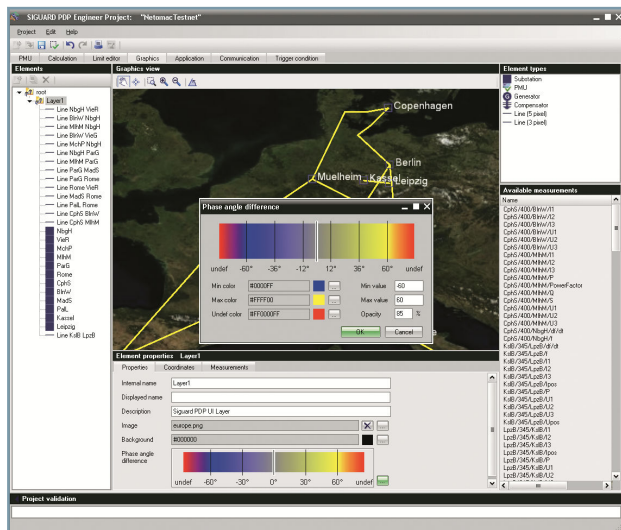[SIGUARD PDP-Engineer_PA, 1, --_--]

Figure 6.3/6   Engineering the Phase-Angle Display with the SIGUARD PDP Engineer

- *Event-controlled archiving*

    SIGUARD PDP enables you have recordings of abnormal network events saved automatically. You can define trigger events, such as limiting-value violations, detected power swings, etc. And you define the lead time and the follow-up time with SIGUARD PDP Engineer (*Figure 6.3/7*). The system then automatically saves all measured values when the selected event occurs.
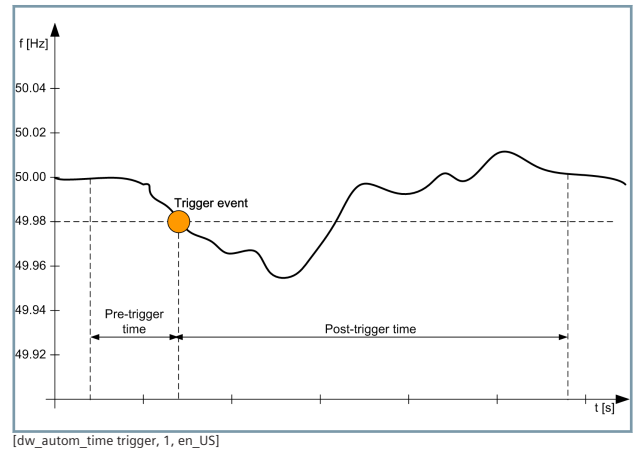

[dw_autom_time trigger, 1, en_US]

Figure 6.3/7   Automatic Time Trigger (for the Frequency, for Example)

- *Automatic disturbance recognition, ADR*

    Based on the synchrophasor data flows of current and voltage, SIGUARD PDP can detect and classify short-circuits in the transmission network. Frequency analysis permits irregular changes in the generation and in the consumers to be detected.
    Typical messages of short-circuit detection, SCD:

    – "2013-03-23 15:15:44.800 PMU ST1 C03 2-phase short circuit detected appearing A-C"
    – "2013-03-23 15:15:44.800 PMU ST3 C05 2-phase short circuit detected appearing A-C"
    – "2013-03-23 15:15:44.800 PMU ST2 C04 2-phase short circuit detected appearing A-C"
    – "2013-03-23 15:15:44.900 PMU ST1 C03 2-phase short circuit detected disappearing A-C"
    – "2013-03-23 15:15:44.900 PMU ST2 C04 2-phase short circuit detected disappearing A-C"
    – "2013-03-23 15:15:44.900 PMU ST3 C05 2-phase short circuit detected disappearing A-C"

6.3

[SIGUARD_PDP_UI-Map_Triangle, 1, --_--]

Figure 6.3/8   Visualization of a Detected Short-Circuit A Red Triangle Connects the 3 Stations Most Affected by the Short-Circuit

The short circuit is most likely in the area that is marked by the red triangle.

- *High-precision frequency calculation*

  SIGUARD PDP can calculate the frequency from the phase-angle difference between voltage phasors. This method eliminates the noise, is very accurate and permits the exact source for the frequency calculation to be determined. This method permits the frequency to be determined at an accuracy better than 1 mHz.

- *E-mail notification*

  SIGUARD PDP can send e-mail notifications when an event occurs. This function can be configured as required. To avoid too many emails, you can select how long an event (such as a limiting-value violation of the voltage) must be active before an e-mail is sent.

- *Deriving actions from phase-angle measurements (Wide Area Control)*

  Using suitable formula blocks (calculations), SIGUARD PDP permits corrective actions (such as positioning commands to SVCs) to be derived from phase-angle measurements. This permits wide area control systems to be established. The principle is shown in *Figure 6.3/9*.
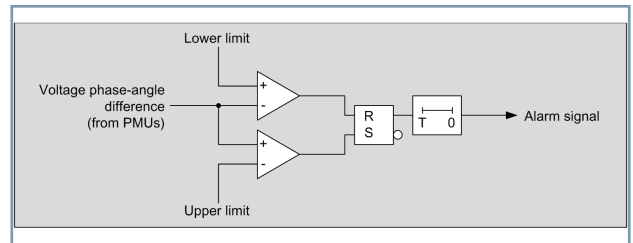
[dw_Deriving_with_symbols, 1, en_US]

Figure 6.3/9   Deriving a Signal From Voltage-Angle Differences

A flip-flop is set when the phase-angle difference between 2 voltage phasors exceeds the limiting value. The alarm signal is set if this condition lasts longer than a predefined time. This signal can then be sent from SIGUARD PDP via the IEC 60870-5-104 interface to an RTU that issues the signal via IEC 61850 to the SIPROTEC devices concerned, for output to the actuator (such as a Static Var Compensator, SVC) (*Figure 6.3/10*). The control loop is thus closed to form a wide area control system.
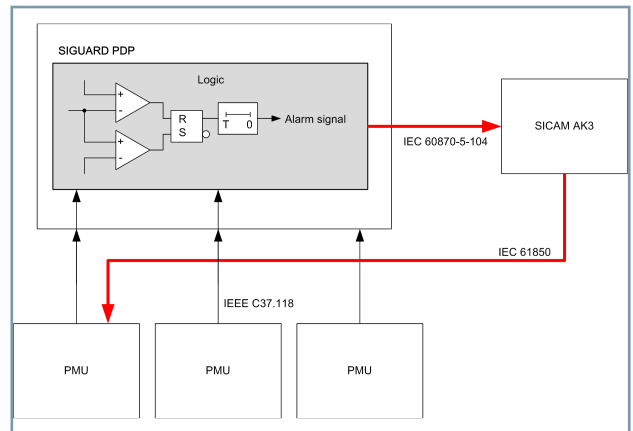
[dw_loop, 1, en_US]

Figure 6.3/10   Closing the Control Loop via IEC 60870-5-104 and RTU

Synchrophasor Technology, PMU

Synchrophasors are measured vector values. This means that magnitude and phase of current and voltage are measured and transferred. A time stamp is transferred together with each measured vector value. This permits the measured values from different locations in the system to be compared. *Figure 6.3/11* shows how measured vector values are collected from different system regions and merged at a central location.

6.3

Software for Power Quality

SIGUARD PDP – Synchrophasor Technology, PMU
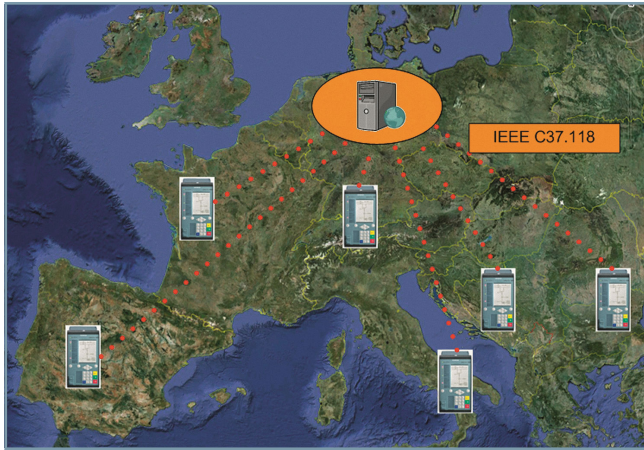
[Prinzip, 1, --_--]

Figure 6.3/11   Principle of Geographically Distributed Measured Values

The information gained from the synchrophasors is only useful if time stamping is extremely accurate. The PMUs are therefore equipped with a GPS-controlled time synchronization.

Measured values from substation automation technology or remote terminal unit	Synchrophasor from a PMU
Slow update cycle (typically once every 5 seconds, for example)	Continuous updating (measured value-stream), typically 10 values per second (reporting rate), for example
Measured values without time stamp	Each measured value with a precise time stamp
RMS values without phase angle	Current and voltage are supplied as phasor value with amplitude and phase

Table 6.3/1   Significant Differences from the "Conventional" Measuring Points (Substation Automation Technology, RTU)

With these features, the synchrophasors permit a dynamic view in real time on power swings and other phenomena in network operation.

Phase Measurement Units (PMUs)

A phasor measuring unit (PMU, *Figure 6.3/12*) is a measuring device that measures and transfers synchrophasors. It also captures frequency and frequency changes (df/dt). A PMU can be a stand-alone unit or be integrated into a protection device or a fault recorder. Siemens offers the SIPROTEC 5-PMU here. The SIPROTEC 5-PMU (available in the SIPROTEC 6MD85 bay controller, for example) satisfies the IEEE C37.118-2011 standard that specifies the communication protocol of the synchrophasors and the requirements for the dynamic response of the PMU.

[SIP5_GD_W3, 1, --_--]

Figure 6.3/12   SIPROTEC 5 - PMU

6.3

Software for Power Quality

[dw_redund_config_siguard_pdp-server, 1, en_US]

Figure 6.3/14   Redundant Configuration of the SIGUARD PDP Servers

System Structure

SIGUARD Phasor Data Processing System (PDP)

The SIGUARD PDP system (Phasor Data Processing) is of a modular structure. It can be distributed to several computers. *Figure 6.3/13* shows the system structure.
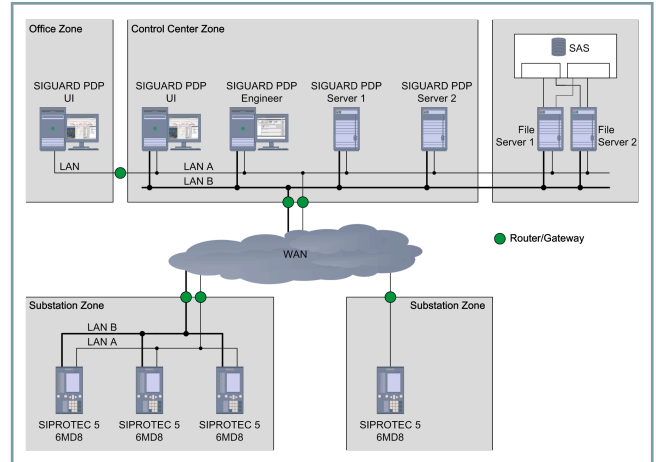

[dw_structur_siguard_pdps, 1, en_US]

Figure 6.3/13   Structure of the SIGUARD Phasor Data Processing System

SIGUARD PDP Server

The server is the central component of SIGUARD PDP. It is communication node and archive interface. It also provides basic services, such as system monitoring. There can be several operator consoles (SIGUARD® PDP UI). The operator terminal can be remote of the server or operated on in the same computer. In a typical configuration, the server executes in a server computer with secure power supply (UPS), while the operator console is in an office environment or in the network control center.

SIGUARD PDP Server Redundancy

When high redundancy is requested, you can set up the SIGUARD PDP server in a redundant configuration. See *Figure 6.3/14*. Although both servers receive the phasor measured data flow from all PMUs, only one writes the information into the archive. This configuration can also be implemented with redundant communication lines.

SIGUARD PDP COM

This system block provides the communication connection to other PDCs. The IEEE C37.118 protocol is also used here. SIGUARD PDP COM sends the configured data with selectable transmission rate (frames per second) to up to 5 receivers. The transmission rates can be selected separately. For each channel, you can select the measured values you want to transfer from all available measured PMU values. Communication with the control center is also supported. Important warnings are sent to the control center to draw the operator's attention to them. The connection can be implemented via ICCP or IEC 60870-5-104 protocols.

SIGUARD PDP UI Operator Console

The operator console is usually remote of the Phasor Data Concentrator. You can connect more than one operator terminal. At the operator console you can watch the measured values in **online mode**. In **offline mode**, you can analyze significant events exactly in replay. All windows are time-synchronized here. The figures *Figure 6.3/15* and *Figure 6.3/16* show examples of the user interface.
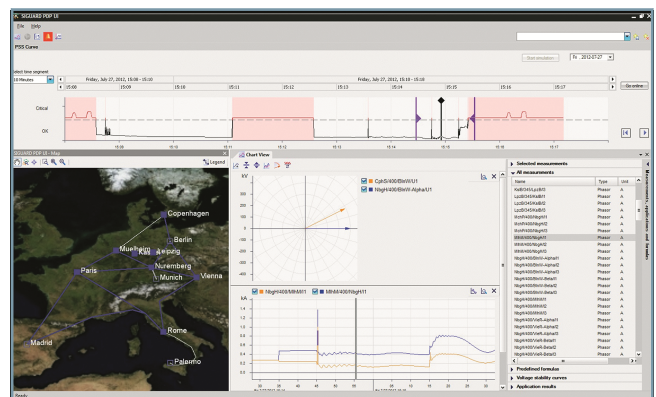
[SIGUARD Bsp1, 1, --_--]

Figure 6.3/15   SIGUARD PDP User Interface (Example 1, Offline)

Software for Power Quality

SIGUARD PDP – System Structure
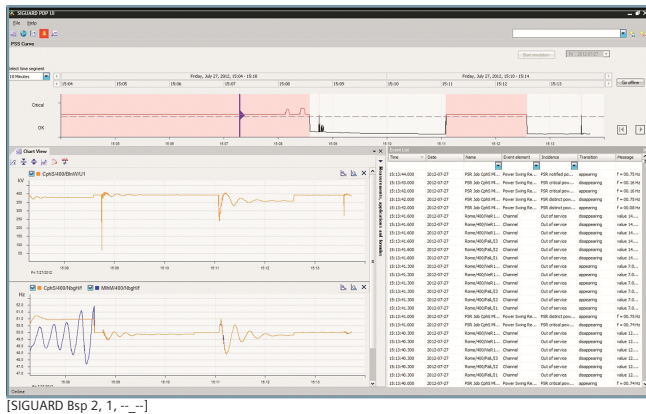

[SIGUARD Bsp 2, 1, --_--]

Figure 6.3/16   SIGUARD PDP User Interface (Example 2, Online)

The user interface can swiftly and easily be adjusted while the system is running. The Power-system status curve (in the upper part of the screen) shows the weighted sum of the distances of all measured values from their limiting values. It thus permits network status and trend to be recognized at a glance. The curve turns red when it exceeds the limiting value. A geographic overview in the lower part of the screen shows the system area that are in a critical state. Next to it is the working area where the vector diagrams, time charts and application curves (such as voltage-stability curves) can be positioned. Additional windows show the selection of the measured values, pending messages or the formula editor. If necessary, you can distribute the user interface to several screens.
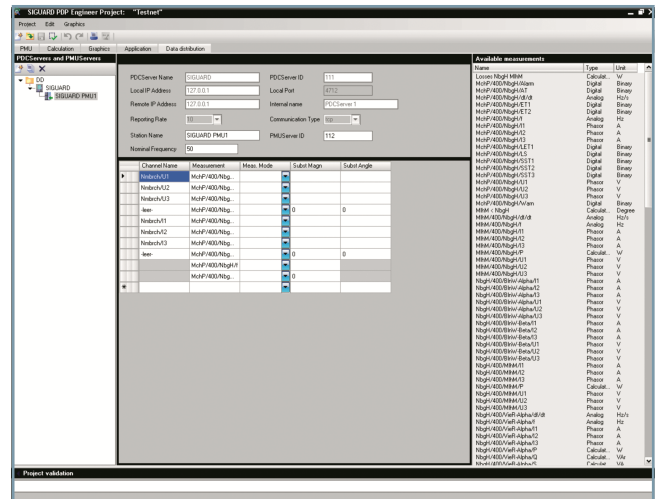
SIGUARD PDP Engineer

With SIGUARD PDP Engineer (*Figure 6.3/17*), you have a convenient configuration tool for the entire SIGUARD PDP system.

The 5 working areas of the main screen clearly structure the work sections:

- PMU configuration
- Mathematical calculations
- Graphic for the geographic overview
- Applications (voltage-stability curve, island-state detection)
- Communication/data distribution

An integrated plausibility checks ensures configuration consistency.

[SIGUARD PDP Engineer, 1, --_--]

Figure 6.3/17   SIGUARD PDP Engineer

Communication Connections

- IEEE C37.118 server/client
- OPC to OPC clients (application: automation functions)
- ICCP (to network control centers)
- IEC 60870-5-104 (to network control centers)

Highlights

- Phasor Data Processor to IEEE C37.118 standard
- 2 selectable monitoring modes:
  - Online mode
  - Offline mode (analysis of past events)
- Vector view or time-chart view selectable for all phasors
- Calculation and display of the power-system status curve
- Intelligent functions to display and analyze problems (such as power-swing detection, island-state detection)
- System monitoring incl. communication connections and PMU status
- Geographic overview
- Basis for swift reporting after failures
- Flexible analysis with formula editor to interconnect measured values
- Online modification of limiting values
- Executes under Windows XP and Windows 7 (32-bit or 64-bit version), as pure PDC (without user interface) or under Windows Server 2008 (32-bit or 64-bit version)

6.3

Ordering Information

Version	MLFB Master	Description
Select whether you want to use SIGUARD PDP in the compact version "Substation PDC" as a communication machine, or use the full scope of user interface and applications ("Enhanced PDC"). Alternatively, you can configure your own tailored solution within these product families. Basically, 3 different SIGUARD PDP variants are available.		
SIGUARD PDP substation PDC	7KE6041	Low-cost PDC variant, max. one operator console and no applications (such as island network detection) possible. Use in the substation as data node for synchrophasor measured values
SIGUARD PDP enhanced PDC	7KE6042	Full version with all possibilities for the connection of operator terminals and for applications
SIGUARD PDP functions upgrade	7KE6040	Using the upgrade, you can add exactly the options you want to a basis license or a predefined combination

Table 6.3/2   SIGUARD PDP Versions

Selection and Ordering Data see next page.

6.3

Software for Power Quality

Order No.	Description	Description
Basis Licenses		
7KE6041-0AA00-2AA0	Basis licenses "SIGUARD PDP Substation PDC"	Substation PDC, 1 UI and no application possible, max. 5 PMUs, max. 2 PDC connections, Substation PDC, 1 UI (not expandable) and no application possible, max. 200 channels, max. 2 PDC connections
7KE6042-0AA00-2AA0	Basis licenses "SIGUARD PDP Enhanced PDC"	Enhanced PDC, 2 UIs, max. 5 PMUs, max. 2 PDC connections
Predefined Combinations		
7KE6041-0BA00-2AA0	Predefined combinations "SIGUARD PDP substation PDC"	Substation PDC, 1 UI and no application possible, max. 600 channels, max. 2 PDC connections
7KE6042-0CB10-2AA0	Predefined combinations "SIGUARD PDP enhanced PDC"	Enhanced PDC, max. 4000 channels, max. 3 PDC connections, 3 UIs
7KE6042-0CD44-2DA0	Predefined combinations "SIGUARD PDP enhanced PDC"	Enhanced PDC, unlimited number of channels (see manual), unlimited number of PDC connections (see manual), unlimited number of UIs (see manual), applications "Island network detection", "Power-swing detection", "automatic fault detection", ICCP, OPC, IEC 60870-5-104 (full functionality of version V5.10)
Function Upgrade		
7KE6040-0BA00-2AA0	Function upgrade "600 channels"	Connection of 600 channels
7KE6040-0CA00-2AA0	Function upgrade "4000 channels"	Connection of 4000 channels
7KE6040-0DA00-2AA0	Function upgrade "Unlimited number of channels (see manual)"	Number of connectable channels not limited by license
7KE6040-0AB00-2AA0	Function upgrade "Max. 3 PDCs"	Connection to up to 3 other PDCs as PDC server
7KE6040-0AC00-2AA0	Function upgrade "Max. 4 PDCs"	Connection to up to 4 other PDCs as PDC server
7KE6040-0AD00-2AA0	Function upgrade "Max. 5 PDCs"	Connection to up to 5 other PDCs as PDC server
7KE6040-0AE00-2AA0	Function upgrade "Unlimited number of PDCs"	Number of connectable PDCs not limited by license
7KE6040-0AA10-2AA0	Function upgrade "Max. 3 UIs"	Connection of up to 3 operator terminals
7KE6040-0AA20-2AA0	Function upgrade "Max. 5 UIs"	Connection of up to 5 operator terminals
7KE6040-0AA30-2AA0	Function upgrade "Max. 7 UIs"	Connection of up to 7 operator terminals
7KE6040-0AA40-2AA0	Function upgrade "Max. 8 UIs"	Connection of up to 8 operator terminals
7KE6040-0AA50-2AA0	Function upgrade "Unlimited number of UIs (see manual)"	Number of connectable UIs not limited by license
7KE6040-0AA01-2AA0	Function upgrade "Island network detection"	Release of the "Island network detection" application (only possible when UI available)
7KE6040-0AA02-2AA0	Function upgrade "Island network detection" and "Power swing detection"	Release of the "Island network detection" and "Power swing detection" applications (only possible when UI available)
7KE6040-0AA04-2AA0	Function upgrade "Automatic fault recognition"	Release of the "Automatic fault recognition" application (only possible when UI available)
7KE6040-0AA00-2BA0	Functional upgrade "OPC communication"	Release of communication to OPC protocol
7KE6040-0AA00-2CA0	Functional upgrade "ICCP communication"	Release of communication to ICCP protocol
7KE6040-0AA00-2DA0	Function upgrade "ICCP and OPC communication"	Release of communication to ICCP and OPC protocol
7KE6040-0AA00-2EA0	Functional upgrade "IEC50870-5-104 communication"	Release of communication to IEC 60870-5-104 protocol
Software Upgrade		
7KE6043-0AA00-5AA1	Software upgrade to version 5.10	No license, only DVD with software

Table 6.3/3   Selection and Ordering Data

Description

With the SICAM P parameterization software package, you have a simple tool to adjust the devices.

SICAM P is a power meter with graphical display and backlight for panel flush mounting or standard DIN-rail installation that is used for capturing and/or displaying measured values in electrical power supply networks. You can measure more than 100 measurands, including the rms values of the voltages (phase-to-phase and/or phase-to-ground), currents, active/reactive/apparent power and energy, power factor, phase angle, harmonic currents and voltages, total harmonic distortion (THD) per phase plus frequency and balance factor, energy and external signals and states.

Applications

With the SICAM P parameterization software package, you have a simple tool to adjust the devices. The package contains the parameterization software, a connecting cable with RS232/RS485 converter and a plug-in power-supply unit for the converter. Using the RS232/RS485 converter, you can connect the SICAM P via a 9-way D Sub connector plug to a commercially available PC. The software runs with Windows 2000 and XP Professional Edition. With the parameterization software, you can set parameters of the SICAM P devices even faster. Alternatively, you can set and save parameters in offline mode (without device). Use the "Send to device" command to transfer the measurands to the SICAM P. This permits several SICAM P devices to be set within a very short time. When you replace a device, you can easily load the saved parameter set into the new device. Another possibility is loading firmware updates via the SICAM P parameterization software. The parameterization software package supports all SICAM P devices. It is necessary for parameterizing the SICAM P55 devices.

Parameterization of the Measured-Value Storage

In a device with a measured-value storage, measurands and states can be recorded in the storage device. The parameterization software provides functions that permits the values and states to be selected that shall be stored.

Reading the Measured-Value Storage

An additional function of the parameterization software permits the following information to be read from the device storage device:

- Mean values
- Mean values of power
- Oscilloscope recordings
- States of binary channels
- Limiting-value violations
- Log entries

[SICAM P Par, 1, --_--]

Figure 6.4/1   SICAM P Par - Parameterization Software

6.4

Selection and Ordering Data

Description	Variants	Order No.												
		1	2	3	4	5	6	7		8	9	10	11	12
SICAM P Parameterization Package		7	K	G	7	0	5	0	-	8	A	□		
												▲		
This includes, in particular:	*Plug-in power supply unit for RS232/RS485 converter*											|		
Software	AC 230 V/50 Hz											A		
for parameterizing, calibrating the SIMEAS P with a PC	AC 120 V/60 Hz											B		
Connecting cables SIMEAS P an PC														
5 m long with RS232/RS485 converter, connector														
At the PC side														
9-pole D-sub socket														
At the SICAM P side														
9-pole D-sub plug														
Converter Set RS232/RS485		7	X	V	5	7	0	0	-	□	□	□	0	0
Converter RS232 to RS485 with connecting cable for relay 7SJ600, 7RW60, 7SV60 length 1 m										▲	▲	▲		
	Rated auxiliary voltage									|	|	|		
	Via plug-in auxiliary power supply (PSU) AC 230 V/50 Hz									0	|	|		
	Via plug-in auxiliary PSU AC 110 V/60 Hz									1	|	|		
	Connecting cables										|	|		
	With RS485 connecting cable for 7SJ60, 7RW60, 7SV60, 1 m long										A	|		
	With RS485 connecting cable for SICAM Q and SIPROTEC 4 and SICAM P, 1 m long										B	|		
	With RS485 connecting cable for SIMEAS T, 1 m long										C	|		
	Without RS232 connecting cable											A		
	With RS232 connecting cable 7XV5100-2 for PC/laptop computer, 9-pole											B		
	With RS232 adaptor, 25-way plug to 9-pole socket for PC/laptop computer											C		
USB-RS485 Converter Cable		7	X	V	5	7	1	0	-	0	A	A	0	0
1.8 m (without galvanic separation) for the connection of up to 31 SIPROTEC 4 devices with RS485 interface to PC/laptop computer with USB 1.1/2.0 interface, can also be used for SICAM P														

6.4

Table 6.4/1   Selection and Ordering Data

CE conformity

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 Directive 2014/30/EU) and concerning electrical equipment for use within specified voltage limits (Low Voltage Directive 2014/35/EU).

This conformity has been proved by tests performed according to the Council Directive in accordance with the generic standard EN 61000-6-5 (for EMC directive) and with the product standard EN 62586-1 (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 EN 62586 and the German standard VDE 0415.

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