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Power Quality devices for all applications

SICAM Q100

Power Monitoring Device und Power Quality Recorder, Class A

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Products – SICAM Q100

Contents

Description

Universal unit for monitoring power quality and for energy management

SICAM Q100 is a Class A multifunctional measuring device for monitoring power quality according to the IEC 62586-1 (PQI-A-FI) product standard. It is used to acquire, visualize, analyze, and transmit measured electrical variables such as AC current, AC 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. Long-term data and events are evaluated directly in the device and displayed as a report in accordance with power quality standards (such as EN 50160).

The measured variables can be output to a PC or control center via one of the communication interfaces or shown on a display. In addition to acquiring the power supply quality according to Class A, SICAM Q100 also offers energy management functions such as the acquisition of load profiles and the relationship to different tariffs, as well as the Modbus Master function for connecting RS485 submeters (for example, PAC) and LV circuit breakers (such as 3WL).

Applications

SICAM Q100 is used in single-phase systems as well as three-wire and four-wire systems (with neutral conductors).

This universal device is most valuable for applications where the uninterrupted acquisition of supply quality data (e. g. EN 50160) must guarantee fault-free operation of the loads/consumers connected to the power supply system. In addition to acquiring supply quality data, the unit can also be used for the comprehensive acquisition of other measured electrical variables that are required by the particular application: as part of an automation solution in industrial plants, for energy management and building automation, in commercial applications (assignment of cost centers), and for the comprehensive monitoring of important points in a power company's network. With its Master function, SICAM Q100 makes it possible to integrate and further process data from peripheral devices (for example, a power meter or LV circuit breaker).

Whether the need is for comprehensive supply quality monitoring and logging or for energy management functions (for example, to reduce operating costs): SICAM Q100 is a key component in any power monitoring system.

Fig. 1/33 SICAM Q100

Benefits and key features

- Early detection of supply quality problems thanks to uninterrupted acquisition of important power parameters.
- Manufacturer-independent, comparable measured values for evaluating supply quality are obtained using standardized measurement methods according to IEC 61000-4-30 Class A (0.1% accuracy).
- Flexible "on-board" power quality logging according to EN 50160 performed directly via integrated a web server.
- Power monitoring functions for power control and as a prerequisite for energy management tasks such as identifying potential savings in the peak and base load ranges and identifying unnecessary power consumption.
- Recording of the fourth current channel to acquire neutral conductor current data.
- Highly precise measurements as part of energy management tasks, Class 0.2S according to IEC 62053-22 and ANSI C12.20 for obtaining power, reference, and energy measurements.
- Modbus Gateway and Master functions for easily integrating and displaying RS485 device data (such as PAC3100, 3200, SICAM P50) via a Modbus TCP network.
- Easy operation via integrated web server for parameterization, diagnosis, evaluation, and reporting.
- Interoperability through the use of standard interfaces, protocols (IEC 61850, Modbus TCP), and data formats (PQDIF, Comtrade, and CSV).

Products – SICAM Q100

Description

Voltage quality – application overview

Voltage quality (also known as power quality) refers to various characteristics in a power supply system. Voltage quality criteria are defined by a number of technical regulations, such as the EN 50160 power quality standard. These criteria describe the main characteristics of voltage at customers' power supply terminals in public low-, medium-, and high-voltage systems. Ultimately, however, quality is determined by the ability of customer systems to correctly perform their tasks.

Most quality problems affect the ultimate consumer directly or are perceived at this level. Today, production plants such as those in the paper and chemical industries are extraordinarily sensitive due to the wide use of microprocessor-supported controlling systems, information processing devices, and power electronics devices. Temporary interruptions of supply and undervoltages can already result in high costs due to, for example, damage to workpieces or tools, plant restarts, etc. Data centers and "provider houses," the number of which is growing, are also concerned about their plants' security of supply because voltage disturbances in these types of enterprises and operating areas can have serious consequences. Voltage measurements and evaluations can be used to determine voltage quality.

As consumers' awareness of energy efficiency grows, quality of supply becomes a major focus. So it is also in the interest of power utilities to monitor power quality, thus ensuring proper and efficient operation and improving the system. A high-quality, reliable power supply also means high customer satisfaction.

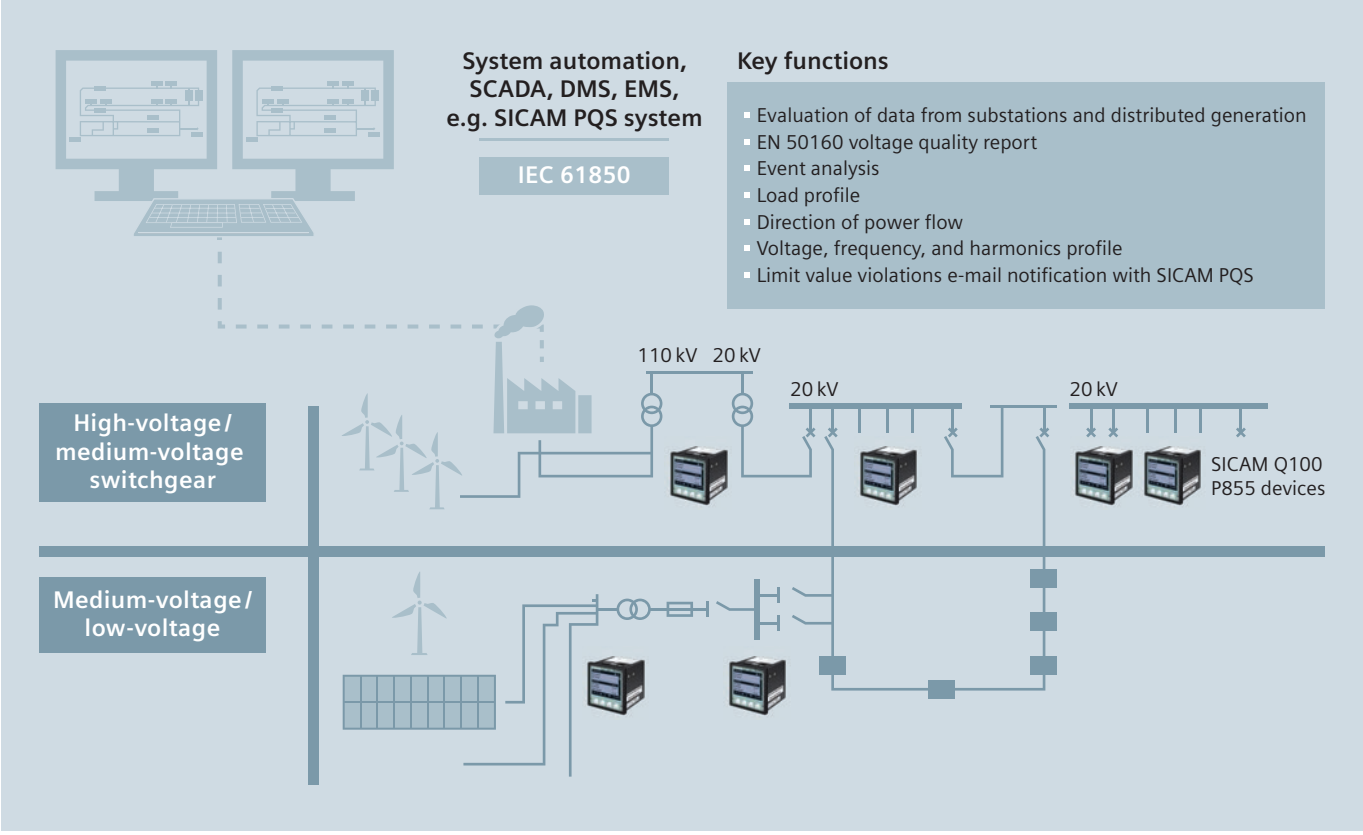

Fig. 2/33 Application – Voltage quality on all voltage levels of the power supply system

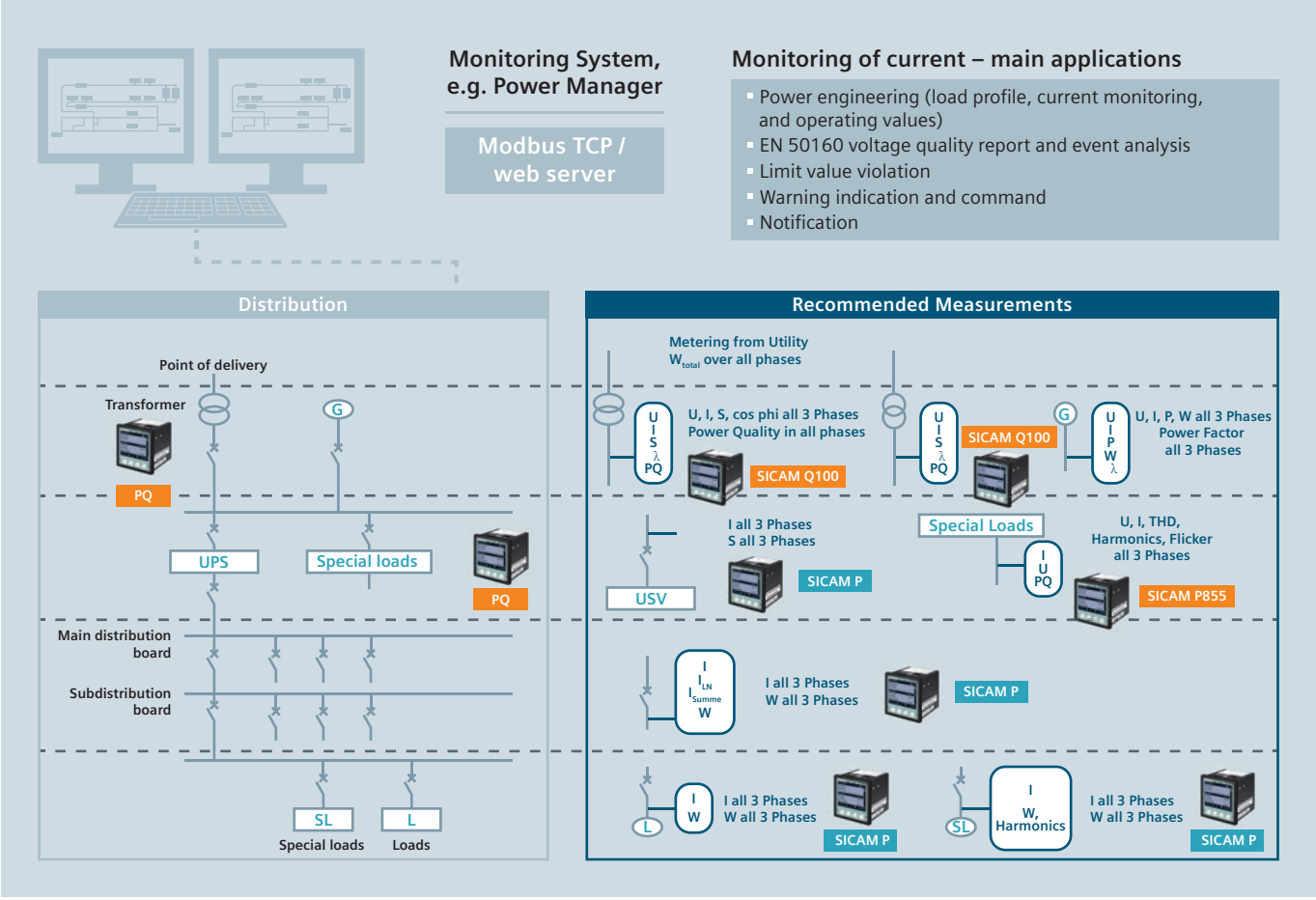

Fig. 3/33 Application – Voltage quality and power monitoring for industry, buildings, and data centers

Device description

SICAM Q100 is a multifunctional measuring device used to acquire, calculate, record, analyze, display, and transmit measured electrical variables. Its key features are:

- Power Monitoring and Power Quality Recorder, including Measurand Recorder for measurement accuracy according to IEC 61000-4-30, Class A
- Web server for parameterization, visualization, and data management
- Galvanically separated voltage measurement inputs
- Transmission of measured values via various communication protocols
- 4 inputs for AC voltage measurements
- 4 inputs for AC current measurements
- 2 binary inputs, for example for load profile synchronization pulses or external triggers
- 2 binary outputs
- Binary expansion (up to 12 inputs and 12 outputs) using SICAM I/O Unit peripheral devices

Communication

SICAM Q100 has one Ethernet interface and one optional electrical RS485 interface. Device parameterization, the transmission of measured data, counts, and messages, as well as time synchronization (via NTP) are supported via Ethernet. The HTTP, Modbus TCP, and IEC 61850 Server communication protocols can be used. The integrated Ethernet switch makes it possible to connect additional devices (such as subordinate SICAM devices) via a Y-cable and integrate them into an existing network using IEC 61850 or another Ethernet protocol.
The optional RS485 interface supports the Modbus RTU communication protocol for the purpose of transmitting measured data, counts, load profiles, and messages, and for time synchronization.

Time synchronization

SICAM Q100 must have an unambiguous time basis during operation to acquire time-relevant data such as voltage events. This guarantees that connected peripheral devices have a uniform time basis for all measured data.

Products – SICAM Q100

Function overview

The following types of time synchronization can be performed:
- External time synchronization via Ethernet NTP (preferred)
- External time synchronization via field bus using the Modbus RTU communication protocol
- Internal time synchronization via RTC (if external time synchronization is not possible)

Continuous measured value acquisition:
- Alternating voltage U
- Alternating current I
- Power frequency f (fundamental component)
- Active power P (accuracy Class 0.2S; ANSI C12.20 Class 2 and Class 10)
- Reactive power Q
- Apparent power S
- Power measurements W
- Active power factor cos phi
- Measurements up to the 63rd harmonics order
- Interharmonics of voltage and current
- Flicker according to IEC 61000-4-15

Event-specific measured value acquisition:
- Min./max./mean values
- Recording of events such as voltage dips, overvoltages, interruptions
- Limit value violations
- Acquisition of load profiles
- Transient recording

Power management
As part of power management, SICAM Q100 uses the fixed block and rolling block methods to acquire load profiles with all characteristics. Power data is acquired through up to four different tariff ranges (TOU = time of use); the switchover is via external or internal trigger.

Measured value acquisition via recorders
Different recorders can record measured values, events, and load profiles at parameterizable intervals. The following recorder types can be used:
- **Measurand recorder:** Records mean value measured variables according to IEC 61000-4-30 (such as frequency, voltage, etc.) and logs relevant data (such as currents, power, etc.) over a parameterized time period.
- **Trend recorder:** Long-term recording and monitoring of voltage changes over a parameterizable time period, including programmable tolerance ranges; effective values with up to 1/2 period resolution.
- **Fault recorder:** Records measured values for current and voltage using parameterizable triggers.
- **Event recorder:** With 256 sampled values per period, records events in terms of voltage, frequency, and voltage unbalances.
- **Load profile recording:** The load profile reflects the variations in electrical power over time and thus documents the distribution of power fluctuations and peaks. Two methods of load profile recording are supported: the fixed block method and the rolling block method.

The device has a 2-GB memory for logging the recorder data.

Parameterization
Parameterization is performed from a connected PC using an integrated web browser with HTML pages. Selected parameters can also be configured using the function keys on the front of the device.

Evaluations
Power quality values and other events are displayed directly via a web browser with HTML pages. The following evaluations can be used:
- Operational measured values and messages from SICAM Q100 and from the relevant Modbus slave device displayed via HTML and on the display
- Event evaluations und power quality recordings as well as mean values displayed in tables or graphs
- Power Quality Reports generated according to the EN 50160 standard
- Logging of transient data

Data export
Recorded data can be exported in the following standard formats:
- CSV data
- PQDIF data – IEEE1159.3: PQDIF for PQ recordings (events, measurements, logs)
- COMTRADE data – IEC 60255-24/IEEE Std C37.111: Electrical relay – Part 24: Common format for transient data exchange (COMTRADE) for power systems

Automation functions
Upper and lower limit values can be parameterized for up to 16 measured values. Warning indications can be output if these limits are exceeded. Up to four limit value violations are output to the device via the two binary outputs as well as the H1 and H2 LEDs. In addition, all 16 limit value violations can be sent to peripheral devices via Ethernet.

Special feature
Embedded Ethernet switch for the quick and economical integration of additional Ethernet-compatible devices without having to add a supplemental network switch.

Data availability

	Data	Operational measured values (10/12 periods)	Event analysis information (dips, overvoltages, interruptions)	COMTRADE fault recorder file	Trend recorder (1/2 period effective value, event recording) – COMTRADE file	Measurand recorder (30 s, 60 s, 10 min, 15 min, 30 min, 1 h, 2 h)		
	Interface	Modbus TCP, Modbus RTU, IEC 61850, HTML and display	Modbus TCP, IEC 61850, HTML and display	IEC 61850, export	IEC 61850, HTML visualization, export as PQDIF	IEC 61850 protocol (m PQDIF format), HTML visualization, export as PQDIF, CSV		
	Type	Values	Values	COMTRADE	PQDIF	Mean values	Min. values	Max. values
AC voltage	$U_{L1, L2, L3}$	x	x[1]	x	x	x	x	x
	$U_{L12, 23, 31}$	x	x[1]	x	x	x	x	x
	U_N	x				x	x	x
	U_{tot}	x				x	x	x
	U_{unbal}	x				x	x	x
AC current	$I_{L1, L2, L3}$	x		x		x	x	x
	I_0	x				x	x	x
	I_{tot}	x				x	x	x
	I_{unbal}	x				x	x	x
Active power factor	cos φ (L1), (L2), (L3)	x				x	x	x
	cos φ	x				x	x	x
Power factor	PF_{L1}, PF_{L2}, PF_{L3}	x				x	x	x
	PF	x				x	x	x
Phase angle	ϕ_{L1}, φ_{L2}, φ_{L3}	x				x	x	x
	ϕ	x				x	x	x
Frequency	f (power freq.)	x						
	10 s freq (10 freq.)					x[2]	x[2]	x[2]
Harmonics, voltage, amount	H_U_{L1-x}, U_{L2-x}, U_{L3-x}	x[5]				x	–	x
Harmonics, current, amount	H_I_{L1-x}, H_I_{L2-x}, H_I_{L3-x}	x[5]				x[6]	–	x[6]
THD, voltage	THD_U_{L1}, THD_U_{L2}, THD_U_{L3}	x				x	x	x
THD, current	THD_I_{L1}, THD_I_{L2}, THD_I_{L3}	x				x	x	x
Voltage interharmonics	HI_V_{a-y}, HI_V_{b-y}, HI_V_{c-y}	x[6]				x[6]	–	x[6]
Current interharmonics	HI_I_{a-y}, HI_I_{b-y}, HI_I_{b-y}	x[6]				x[6]	–	x[6]
Flicker (short)	P_{st1}, P_{st2}, P_{st3}					x[3]	x[3]	x[3]
Flicker (long)	P_{lt1}, P_{lt2}, P_{lt3}					x[4]	x[4]	x[4]
Active power factor	P_{L1}, P_{L2}, P_{L3}	x				x	x	x
	P	x				x	x	x
Reactive power	Q_{L1}, Q_{L2}, Q_{L3}	x				x	x	x
	Q	x				x	x	x
Apparent power	S_{L1}, S_{L2}, S_{L3}	x				x	x	x
	S	x				x	x	x
Active energy – supply	WP_{L1}, WP_{L2}, WP_{L3}_Supply	X – Cumulated						
	WP_Supply	X – Cumulated						

Table 1/7 Data availability

Data availability

	Data	Operational measured values (10 12 periods)	Event analysis information (dips, overvoltages, interruptions)	COMTRADE fault recorder file	Trend recorder (1 2 period effective value, event recording) – COMTRADE file	Measurand recorder (30 s, 60 s, 10 min, 15 min, 30 min, 1 h, 2 h)		
	Interface	Modbus TCP, Modbus RTU, IEC 61850, HTML and display	Modbus TCP, IEC 61850, HTML and display	IEC 61850, export	IEC 61850, HTML visualization, export as PQDIF	IEC 61850 protocol (m PQDIF format), HTML visualization, export as PQDIF, CSV		
	Type	Values	Values	COMTRADE	PQDIF	Mean values	Min. values	Max. values
Active energy – reference	WP_{L1}, WP_{L2}, WP_{L3}_Reference	X – Cumulated						
	WP_Reference	X – Cumulated						
Reactive energy – inductive	WQ_{L1}, WQ_{L2}, WQ_{L3}_Inductive	Cumulated						
	WQ_Inductive	X – Cumulated						
Reactive energy – capacitive	WQ_{L1}, WQ_{L2}, WQ_{L3}_Capacitive	X – Cumulated						
	WQ_Capacitive	X – Cumulated						
Apparent energy	WS_{L1}, WS_{L2}, WS_{L3}	X – Cumulated						
	WS	X – Cumulated						
Tariff (TOU) – power values – Tariff 1 to 4	WP_SUP_Tariff_1-4, WP_DMD_Tariff_1-4, WQ_IND_POS_Tariff_1-4, WQ_CAP_NEG_Tariff_1-4, WQ_IND_NEG_Tariff_1-4, WQ_CAP_POS_Tariff_1-4, WQ_IND-Tariff_1-4, WQ_CAP-Tariff_1-4, WS_Tariff_1-4	X – Cumulated						
Load profile data	PRef, PSupply, QRef, QSupply, S	Last interval completed				x[7]	x[7]	x[7]

Table 1/7 Data availability

[1] Event information according to EN 50160, e.g. voltage dip, overvoltage, interruption.
[2] Frequency is permanently defined with a 10 second mean value recording.
[3] IEC 61000-4-15: Flicker P_{st} is permanently defined with a 10-minute recording.
[4] Flicker P_{lt} is permanently defined with a 2-hour recording.
[5] Available as of 1st to 63rd order.
[6] Available as of 1st to 49th order.

To learn more about data availability and measured variables, refer to the SICAM Q100, 7KG95xx System Manual.

[7] – The load profile data for the current and most recently completed periods is output via the communication interfaces.
– Data can be transmitted via the Modbus TCP, Modbus RTU Master, and IEC 61850 communication protocols.
– The load profile data can be displayed in the user interface or downloaded in CSV format. The load profile data does not appear on the display.
– Load profile data mean values can be calculated from cumulated power or arithmetic power demand.

Functions of the IEC 61000-4-30 Ed. 2 measurement system
SICAM Q100 devices serve to measure voltage quality according to IEC 61000-4-30 Ed. 2 and to perform other measurements in single-phase and multi-phase supply systems. The measurement system is implemented according to Class A, meaning that the functional scope, measuring ranges, and accuracy are those of Class A measuring devices. The basic measuring interval for determining the values of mains voltage, mains voltage harmonics, and mains voltage unbalance is a 10-period interval for 50-Hz supply systems and a 12-period interval for 60-Hz supply systems. The10/12-period interval values are aggregated over additional time intervals.

10-minute interval
The value aggregated in a 10-minute interval is stamped with the absolute time (e.g. 01:10:00). The time is indicated at the end of the aggregation interval. The values for the 10-minute interval are calculated without interruption from 10/12-period intervals.

Flagging concept
During voltage dips, overvoltages, and interruptions, the measurement method may supply implausible data for other measured values (such as frequency measurements or voltage harmonics). The flagging concept prevents individual events from being accounted for multiple times by different measured variables (e.g. a dip simultaneously recorded as dip and frequency change).

Measurements for evaluating voltage quality
Mains voltage level: This measurement determines the effective value of mains voltage over a 10-period interval for 50-Hz supply systems and over a 12-period interval for 60-Hz supply systems. All 10/12-period intervals are detected without interruption or overlapping.

Voltage events – interruption, voltage dip, overvoltage, and transients
The basic measurement of the effective value U_{eff} of a voltage event determines the effective value U_{eff} (1/2) for each individual measuring channel. The limit value for voltage, hysteresis, and duration (t) characterizes one voltage event for each individual measuring channel.
Mains voltage unbalance: Determined on the basis of the balanced component method. In the case of unbalance, both the positive-sequence component U1 and the negative-sequence component U2 are determined.
Mains voltage harmonics: Uninterrupted 10/12-period measurement of a harmonic subgroup $U_{sg,n}$ according to IEC 61000-4-7. The total distortion is calculated as the subgroup total distortion (THDS) according to IEC 61000-4-7. Measurements are performed up to the 63rd harmonics order and recorded up to the 50th harmonics order.

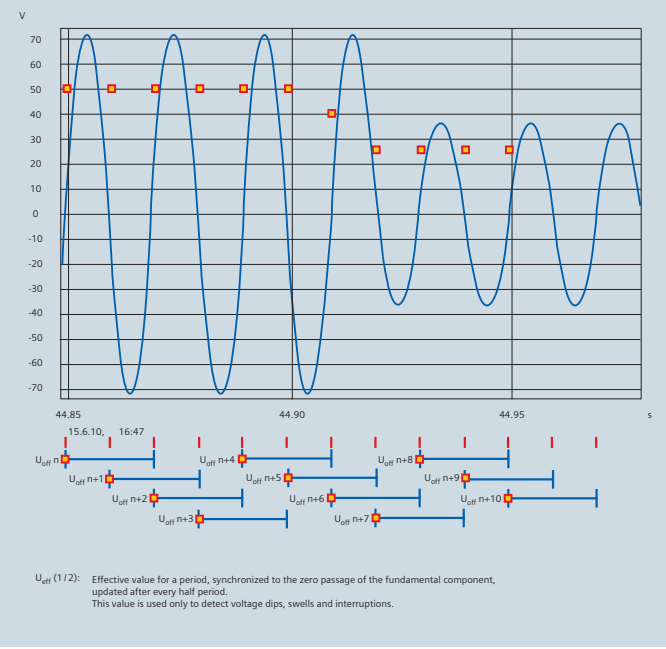

Fig. 4 33 Representation of the 1/2 cycle RMS measurement method, e.g. for a voltage dip

Power quality acquisition and recording

Flicker: Uninterrupted recording according to IEC 61000-4-15. The following measurements are performed simultaneously for all three-phase voltages: instantaneous flicker P_{inst} (10/12 measurement interval), short-term flicker strength P_{st} (10 min), and long-term flicker strength P_{lt} (2 h).

Transient recording: SICAM Q100 records temporary overvoltages as transients if the instantaneous value of the primary rated voltage exceeds the parameterized reference value at multiple sampling times. SICAM Q100 records the following data and values during transient analysis and displays them in the transient list window:

- Number of events
- Transient's start time (timestamp with date and time)
- Affected phase (a, b, c)
- Transient duration
- Relative value (in %) up to 200% of the primary rated voltage: If the primary rated voltage is exceeded by more than 200%, the analysis will show only > 200%.

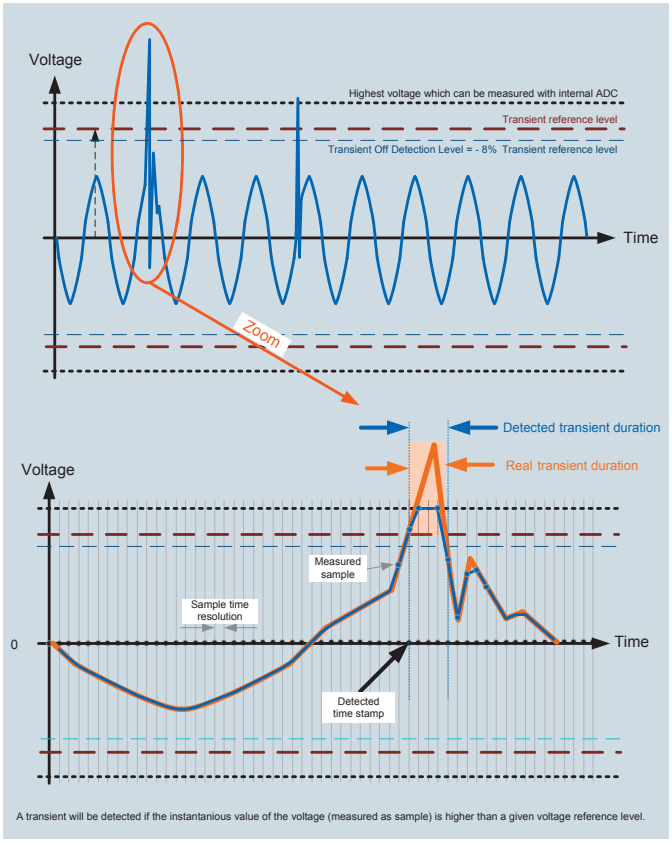

Fig. 5/33 Representation of the measurement system concept, e.g. when a transient is detected

Recorder functionality and applications

In addition to standard measured value acquisition, SICAM Q100 offers various recorders for monitoring and analyzing power quality, as well as power management data for evaluating the load profile.

Recording	Measured variables	Storage interval/storage method	Application
Measurand recorder	Frequency	10 s (permanently set)	Long-term monitoring of mean values, e.g. to evaluate power quality according to EN 50160
	Mains voltage level	10 min (30 s, 1 min, 10 min, 15 min, 30 min, 1 h, 2 h)	
	Mains voltage unbalance		
	Mains voltage harmonics and interharmonics		
	Additional data (e.g. power values, min/max values, etc.)		
	Flicker	P_{st} determined over 10 min.; P_{lt} over 2 h (12 P_{st} values)	Monitoring of power quality according to IEC 61000-4-15
Event recorder	Voltage dips Voltage interruptions	Residual voltage U_{rms} (1/2) and timestamp (duration)	Classification of voltage and frequency events, e.g. according to EN 50160, ITIC curve
	Voltage swells	Max. overvoltage U_{rms} (1/2) and timestamp (duration)	
Trend recorder	U_{rms} (1/2) period	For measured value changes (as percentage or absolute) and cyclic (time interval)	Long-term monitoring and recording of voltage U_{rms} (1/2) period for precise visualization and subsequent analysis of voltage events according to power quality grid codes
Fault recorder	Voltages, currents	Voltage/current fluctuation trigger, acquisition of sampled values (max. 3 s)	Sampled values (fault record) recording to determine and analyze causes of power quality problems
Load profile recording	Load profile	Fixed block or rolling block method	Determination of load profile for power supply and consumption

Table 2/7 Recorders and applications

Recorder types and evaluation

Measurand recorder

The measurand recorder records measured values for determining power quality as well as various other measurements (for example, minimum/maximum values). Recording of the following measured values can be parameterized in the user interface:

- PQ measurements for determining power quality
- Averaging intervals for frequency (permanently set 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 P_{st} (10 min) and long-term flicker strength P_{lt} (2 h)
- Additional data: Current, current unbalance, active power, apparent power, reactive power, THD of voltage, THD of current, power factor, active power factor, phase angle, energy values
- Recording of minimum values (mean values) and recording of maximum values (mean values)

The measuring interval can be set in increments ranging from 30 seconds to 2 hours. The interval for frequency measurement is permanently set to 10 seconds.

Trend recorder

The trend recorder guarantees the continuous recording and long-term monitoring of the U_{eff} (1/2) voltage. If the measured variable changes over the effective value last detected during the parameterized measuring interval, exceeding or falling below the set tolerance range, this new effective value is recorded.

Event recorder

The event recorder records PQ events only (voltage, frequency, voltage unbalances).

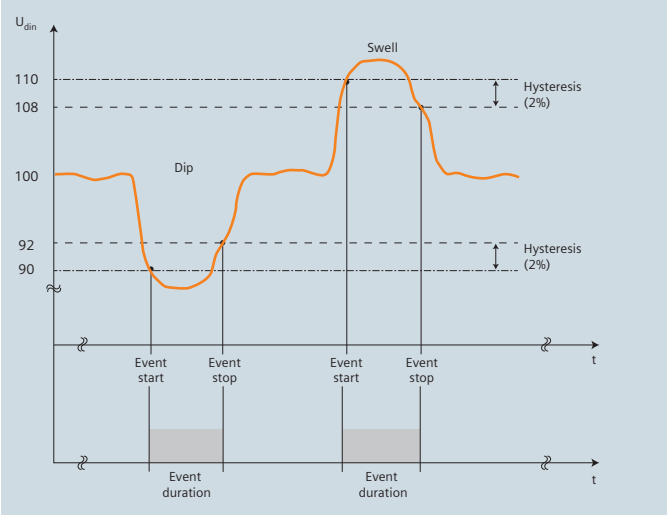

Fig. 6/33 Recording by the event recorder: overvoltages and undervoltages

Fault recorder

The fault recorder records 2560 sampled values per 10/12 period in programmable time units. The fault recorder functionality can be activated for the voltage and current measured variables. For event analysis, a pretrigger time (pretrigger ratio in %) can be set, which allows the history of the measured value to be analyzed prior to the fault's inception.

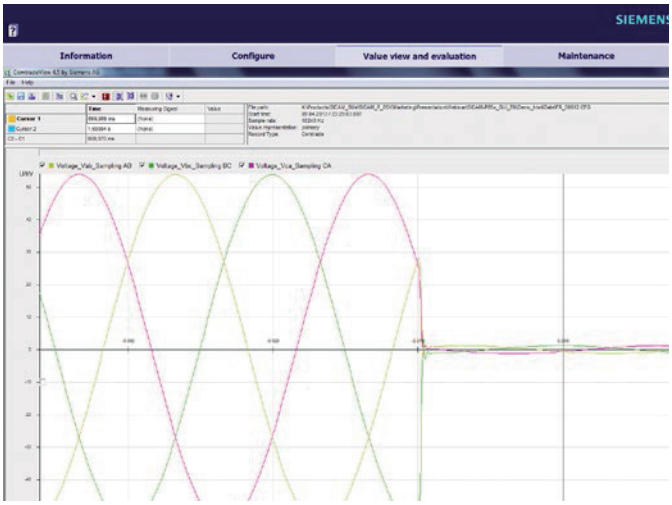

Fig. 7/33 Fault record in COMTRADE view using COMTRADE Viewer software and SIGRA plug-in

Load profile recording

The load profile reflects system behavior and documents the distribution of power fluctuations and peaks. The recordings help to identify potential savings in the peak and base load ranges. The appropriate recording and visualization of power flows in the system permits a transparent analysis of the energy flow, making it possible to optimally configure the process in terms of energy. The measured load profile data thus obtained permits a preliminary evaluation of existing savings potential while also serving as a basis for intelligent, efficient power management.

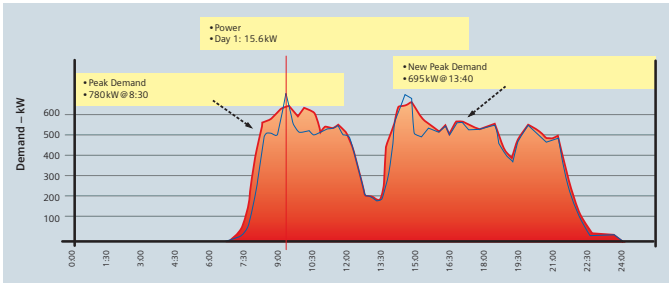

Fig. 8/33 Load profile

SICAM Q100 supports two load profile recording methods: fixed block and rolling block.

Fixed Block: The default setting is a 15-minute measuring period; the number of subperiods is set to 1. At the end of each measuring period, the load profile data is calculated, stored in the ring buffer and, if necessary, forwarded or displayed on the user interface.

Rolling Block: With this method, a measuring period comprises 2 to 5 subperiods, depending on parameterization. The duration of a measuring period is based on the number of subperiods and the programmed duration of the subperiods. The figure below shows the sequence of measuring periods during load profile recording:

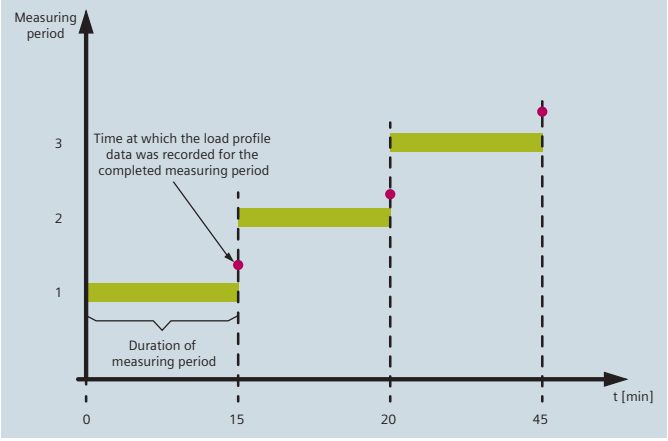

Fig. 9/33 Load profile recording using the fixed block method

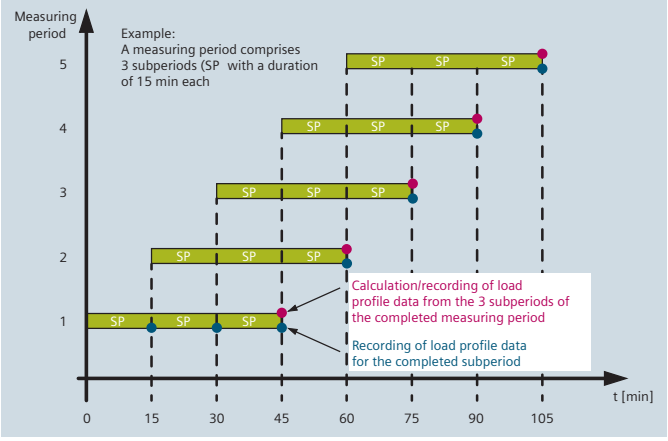

Fig. 10/33 Sequence of measuring periods for recording the load profile using the rolling block method

The load profile is stored in the device's ring buffer, is available via the communication interfaces, and can be output as a CSV file. Load profile recording can be synchronized or unsynchronized. Synchronization is via an external or internal trigger. The arithmetic power demand values and extreme values for each subperiod are stored in the ring buffer. The cumulated power values can be retrieved via the communication interfaces or the user interface.

The load profile data is stored in a ring buffer with up to 4000 data records. Each new data record overwrites the oldest record. Each data record contains the power demand values, minimum/maximum values, a timestamp, and the status information for a completed subperiod.

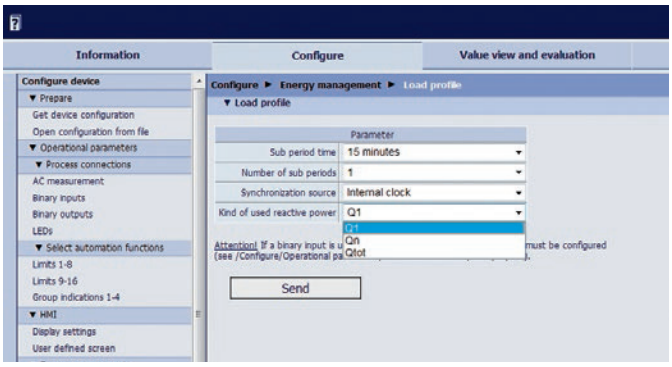

Fig. 11/33 Load profile

Historic load profile data

SICAM Q100 records the following historic measured values:

Measure-ment	Cumulated power values	Arithmetic power demand 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 3/7 Historic load profile data

Tariffs

SICAM Q100 supports up to four power meter tariffs for supplied or consumed active, reactive, and apparent energy. If the tariffs are changed via binary inputs, up to 2 tariffs can be set. If tariff change is controlled, up to 4 tariffs can be set. The tariff is changed via external interfaces. A tariff time change is possible only from a subordinate system.

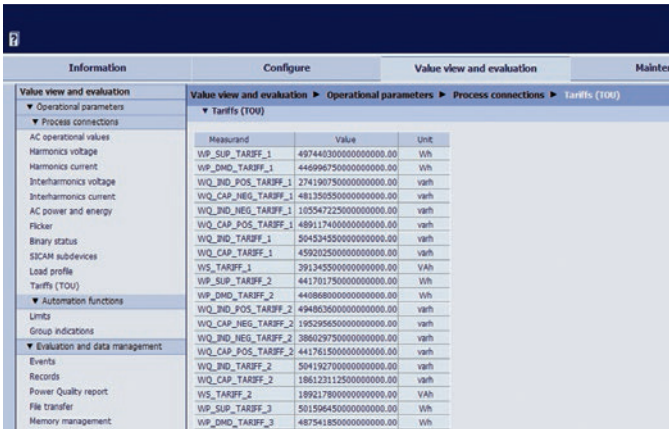

Fig. 12/33 Tariff analysis

Parameterization, visualization, and evaluation

Device parameterization

SICAM Q100 devices are parameterized from a connected PC using the web browser integrated in the device.

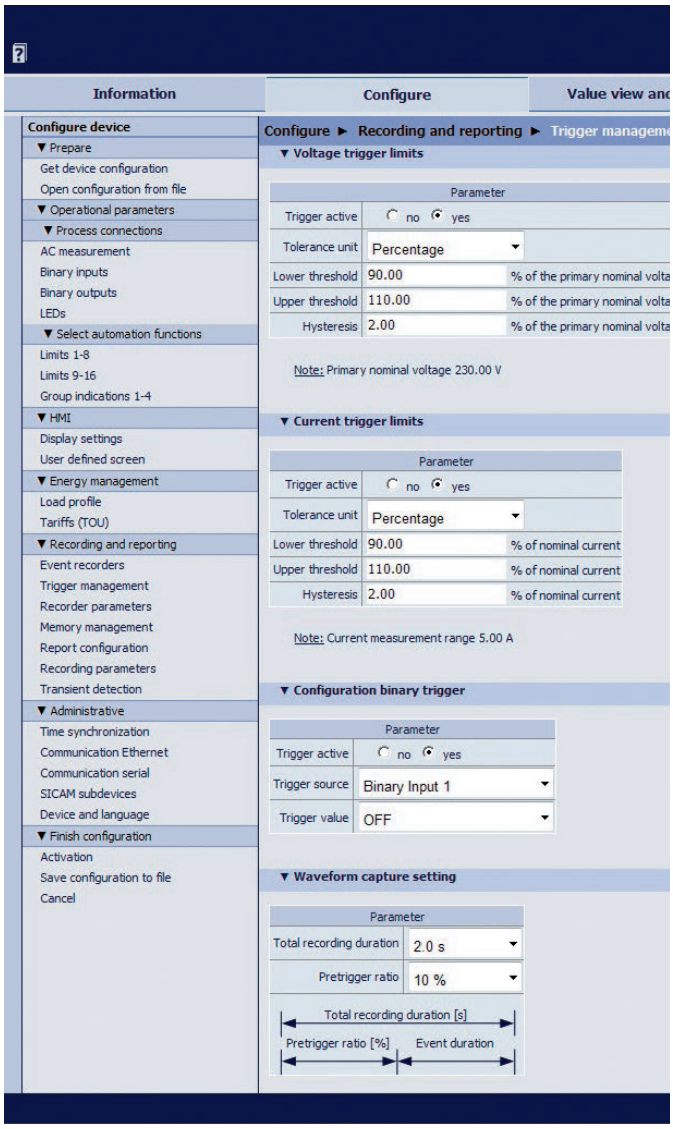

Fig. 13/33 Configure tab, Trigger Management Input/Output window

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.

- Operational measured values
- Voltage harmonics
- Current harmonics
- Interharmonics
- Power and energy
- Binary outputs
- Limit values
- Group indications
- Flicker

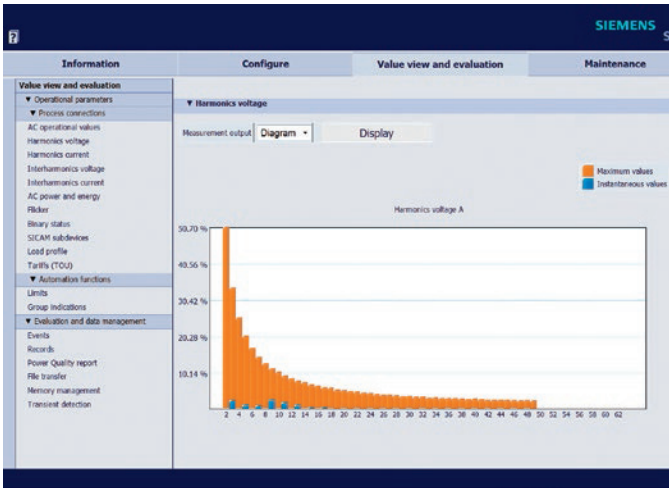

Fig. 14/33 HTML display of harmonics

Voltage quality data

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 Q100 HTML page.

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 NS&MS or EN 50160 HS, or to generate user-defined reports.

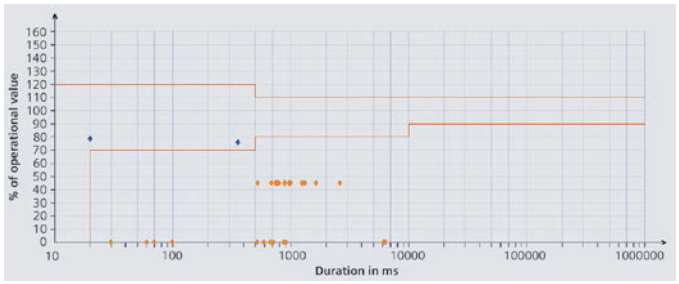

Fig. 15/33 Evaluation of voltage events

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.

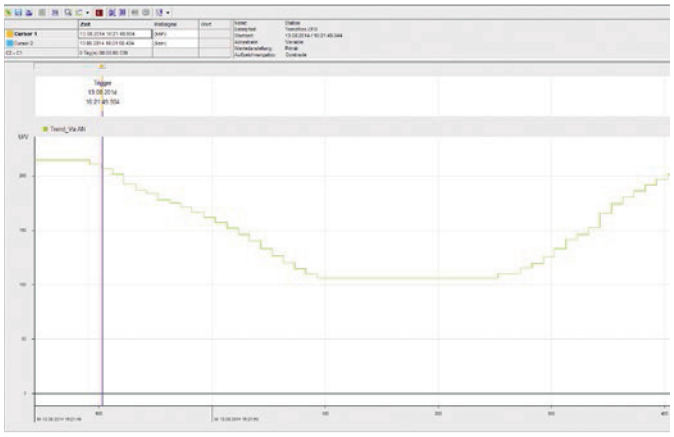

Fig. 16/33 Analysis of voltage events

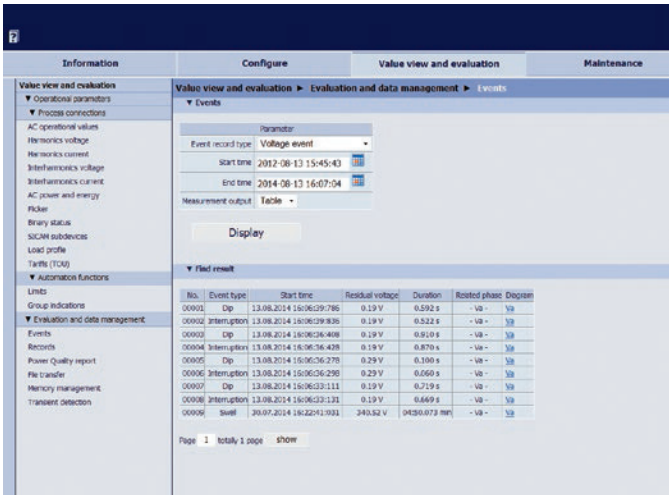

Fig. 17/33 Measured Value Display and Analysis tab, "Events" Input/Output window, voltage events

Data transmission and download

Via IEC 61850, stored data from SICAM Q100 can be transmitted from the 2-GB memory, exported, or downloaded manually via HTTP. The following data formats are supported:

- Measurements: PQDIF and CSV files
- Fault recordings: COMTRADE files
- Trend recordings: PQDIF files

Selected data can be flexibly downloaded using the calendar function.

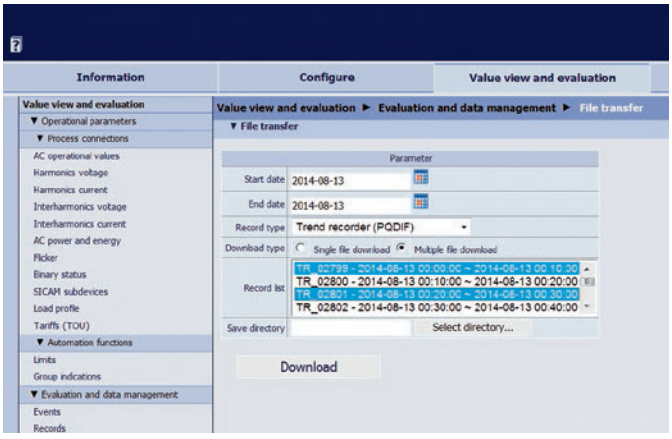

Fig. 18/33 Data transmission and down

Products – SICAM Q100

Communication

SICAM Q100 has an Ethernet interface and an optional electrical RS485 interface. Device parameterization, transmission of measured data, counts, and messages, as well as time synchronization via NTP are supported via Ethernet.
The HTTP, Modbus TCP, and IEC 61850 Server communication protocols can be used. The integrated Ethernet switch makes it possible to connect additional devices (such as subordinate SICAM devices) via a Y-cable and integrate them into an existing network using IEC 61850 or another Ethernet protocol.
The optional RS485 interface supports the Modbus RTU communication protocol for the purpose of transmitting measured data, counts, load profiles, and messages, and for time synchronization.

Ethernet
- Ethernet 100 Base-T with RJ45 connector
- Integrated 2-port Ethernet switch with external cable switch (for configuring line topologies with Ethernet and for reducing costs for external Ethernet switches)

Serial
- RS485 half-duplex with D-SUB connector
- Support for various baud rates (1200 – 115,200 bit/s) and parities (even/odd/none)

Data transmission protocols and functions
- Modbus TCP (server) with up to 4 connections/Modbus RTU Slave
- Modbus RTU Master
- Modbus TCP/RTU Gateway
- SICAM I/O sub-devices UDP connection (2)
- IEC 61850 (server) with up to six connections
- NTP client (redundant), SNMP (server), HTTP (server)

When SICAM Q100 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.
SICAM Q100 is able to communicate flexibly with automation systems and 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.
The integrated Ethernet switch permits the integration of additional devices via a Y-cable. An external Ethernet switch can also be used to expand the I/O functions – for example, to connect up to two subordinate SICAM I/O Unit 7XV5673 devices.
Via the optional RS485 interface, SICAM Q100 also provides Modbus Gateway and a Master functions. The Gateway functionality permits the quick and easy integration of other RS485 devices – such as SENTRON PAC 3x00/4200, SICAM P50, and 3VL/3WL low-voltage circuit breakers – into the Modbus TCP or IEC 61850 network.
The Modbus Master function makes it possible to view and monitor data from up to 8 of the above-mentioned devices on the display or via HTML page.

Application 1: The device is installed as a standalone device for uninterrupted recording of all relevant parameters relating to power quality, event analysis, and power management.
Application 2: In addition to Application 1, the device provides binary expansions using up to two SICAM I/O Unit devices for flexible status monitoring and external trigger functions.
Application 3: SICAM Q100 uses the RS485 interface to implement the Modbus Master and Modbus Gateway functions. Connected and parameterized SICAM sub-devices output indications via their binary inputs and outputs.

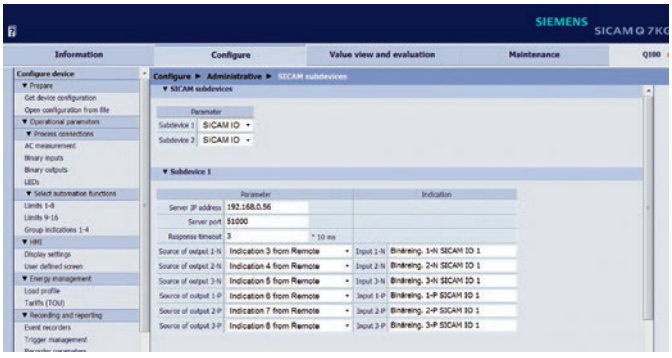

Fig. 19/33 Indications from SICAM sub-devices

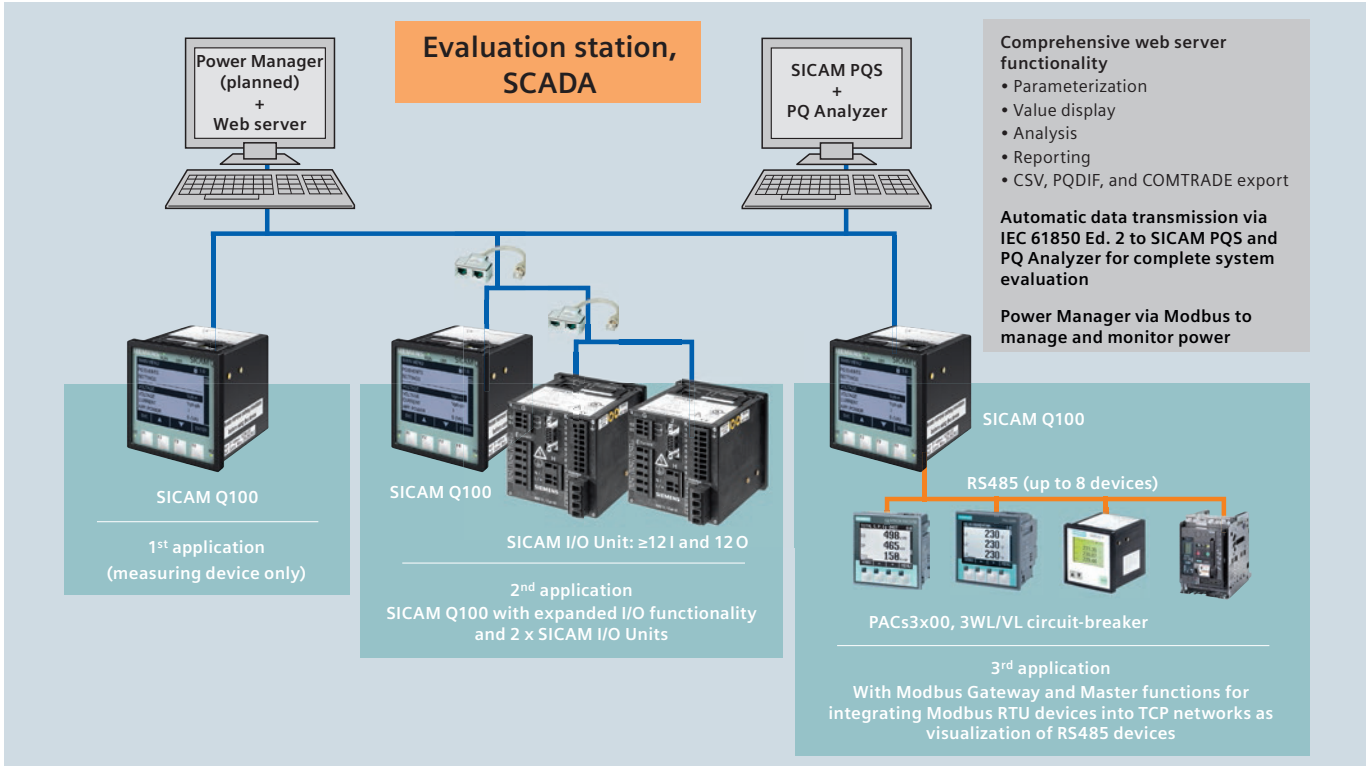

Fig. 20/33 Sample application

Voltage quality measurements and operating measurement uncertainty

Voltage quality measurements and operating measurement uncertainty according to the IEC 62586-1, Class A product standard, and the power quality standards IEC 61000-4-30, Ed. 2, IEC 61000-4-7, and IEC 61000-4-15

Parameter	Unit	Uncertainty	Measuring range	Comments
Frequency	Hz	±10 MHz	42.5~57.5 Hz (50 Hz) 51~69 Hz (60 Hz)	Mains voltage level must be > 2 V!
Supply level	U	±0.1% of U_{din}	10 %~150 % U_{din}	**Voltage $U_{L-N/PE}$ (star connection)** – AC 57.73 V to 400 V (autorange) – up to AC 230 V: up to 200% measuring range – > AC 230 V to 400 V: up to 200% measuring range and 15% overvoltage UL conditions: – up to AC 170 V: up to 200% measuring range – > AC 170 V to 300 V: up to 200% measuring range and 15% overvoltage
				Voltage U_{L-L} (delta connection) – AC 100 V to 690 V (autorange) – up to AC 400 V: 200% measuring range – > AC 400 V to 690 V: up to 200% measuring range and 15% overvoltage UL conditions: – up to AC 290 V: up to 200% measuring range – > AC 290 V to 520 V: up to 200% measuring range and 15% overvoltage
Flicker	–	±5%	0.2~10.0 P_{st}	Accuracy P_{inst}: ±8%
Dips, overvoltage	U, s	Amplitude ± 0.2% U_{din} Duration + - 1 period	N A	
Interruptions	U, s	Duration + - 1 period	N A	
Unbalance	%	±0.15%	0.5~5% u2 0.5~5% u0	
Voltage harmonics	% or U	IEC61000-4-7 Class I	10%~200% of Class 3 from IEC 61000-2-4	U_m > 1% U_{din}: ±5% U_m U_m < 1% U_{din}: ±0.05% of U_{din}

Table 4/7 Voltage quality measurements and operating measurement uncertainty

U_{din}: Primary rated voltage, corresponds to primary rated voltage from SICAM Q100
U_m: Measured value
U_{rated}: Rated voltage

Measurements and operating measurement uncertainty

Measurements	Unit	Rated value	Measuring range	Operating measurement uncertainty
Current I according to parameterization	A	AC 5 A	1% to 200% I_{rated}	±0.4% at 1% up to 5% I_{rated} ±0.2% at 5% up to 200% I_{rated}
Current unbalance I_{unbal}	%	–	0% to 100%	±0.2%
Active power P + Reference, – Supply	W	–	–	±0.5%, Class 0.2S according to IEC 62053-22; ANSI C12.20 Class 2 and Class 10
Reactive power Q + Inductive, – Capacitive	var	–	–	±0.5%, Class 2 according to IEC 62053-24, Class 0.5S
Apparent power S	VA	–	–	±0.5%
Power factor PF	–	–	0 to 1	±1%
Active power factor cos phi	–	–	–1 to +1	± %
Phase angle phi	Degree	–	–180° to +180°	±2°
Active energy WP Reference	Wh	–	–	±0.2%
Active energy WP Supply	Wh	–	–	±0.2%
Reactive energy WQ Inductive	varh	–	–	±0.2%
Reactive energy WQ Capacitive	varh	–	–	±0.2%
Apparent energy WS	VAh	–	–	±0.2%
Total harmonic distortion of voltage THD U_L	%	–	0% to 100%	±0.5%
Total harmonic distortion of current THD I_L	%	–	0% to 100%	±0.5%
Harmonics of current H_xI_L	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 5/7 Measured variables and their operating measurement uncertainty

Measuring circuit	Accuracy
Voltage to U_{L1-N}	0 V to 2 V: invalid > 2 V: 10 mHZ
Voltage to U_{L2-N}	
Voltage to U_{L3-N}	

Table 6/7 Accuracy of frequency measurement

Connection types and examples

Using SICAM Q100 in power systems

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

Examples of standard applications

The input circuits below are intended as examples. SICAM Q100 can be connected to the maximum admissible current and voltage values even without in-line current or voltage converters. Required voltage converters can be operated in a star or delta connection.

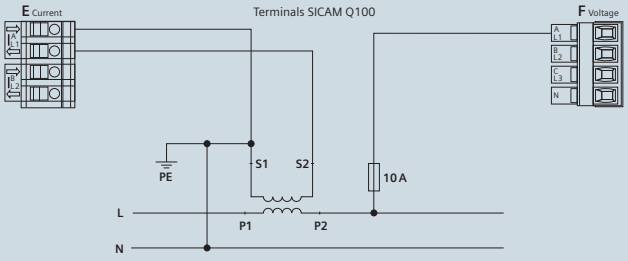

Fig. 21/33 Connection example: single-phase system, 1 current converter

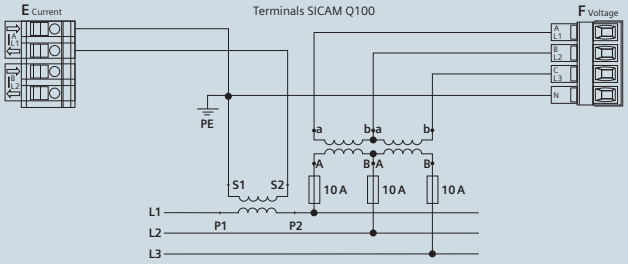

Fig. 22/33 Connection example: three-wire system, 2 voltage converters and 1 current converter, equal load

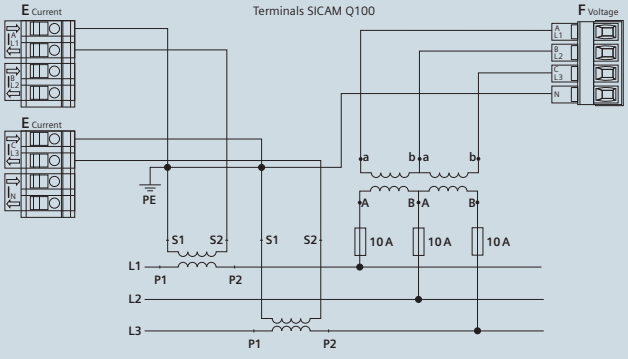

Fig. 23/33 Connection example: three-wire system, 2 voltage converters and 2 current converters, any load

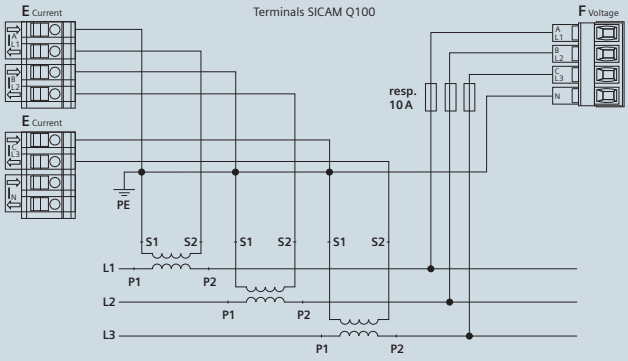

Fig. 24/33 Connection example: three-wire system, 3 current converters, any load

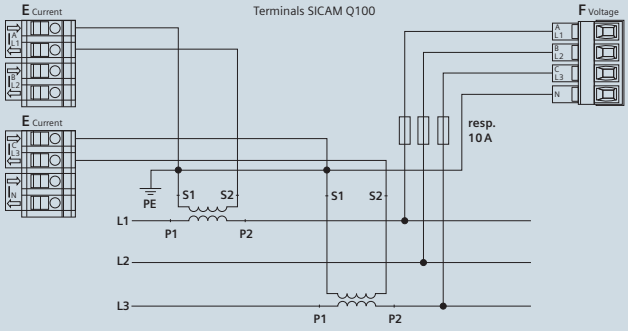

Fig. 25/33 Connection example: three-wire system, 2 current converters, any load

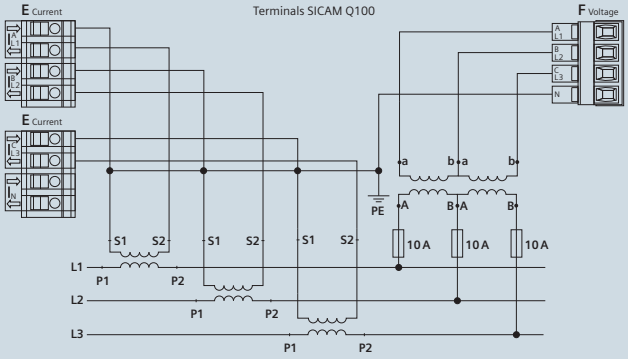

Fig. 26/33 Connection example: three-wire system, 2 voltage converters and 3 current converters, any load

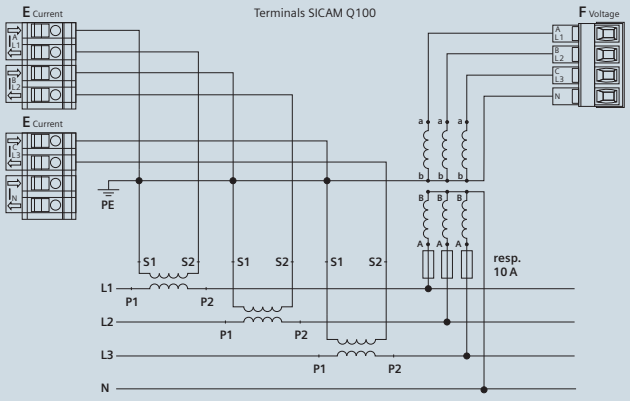

Fig. 27/33 Connection example: four-wire system,
3 voltage converters and 3 current converters, any load

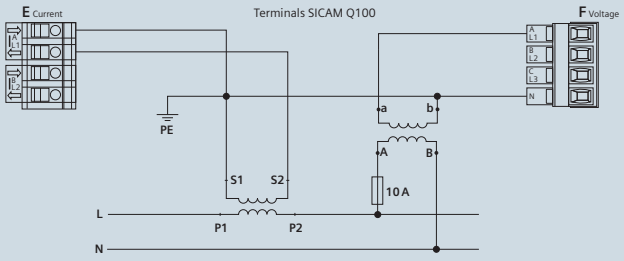

Fig. 30/33 Connection example: single-phase system,
1 voltage converter and 1 current converter, equal load

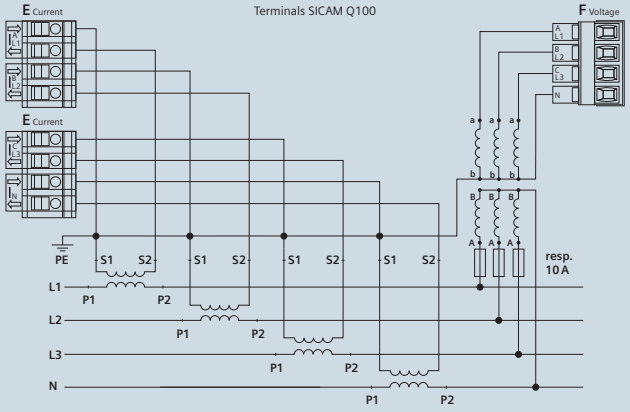

Fig. 28/33 Connection example: four-wire system,
3 voltage converters and 3 current converters, any load,
1 current converter connected to neutral conductor

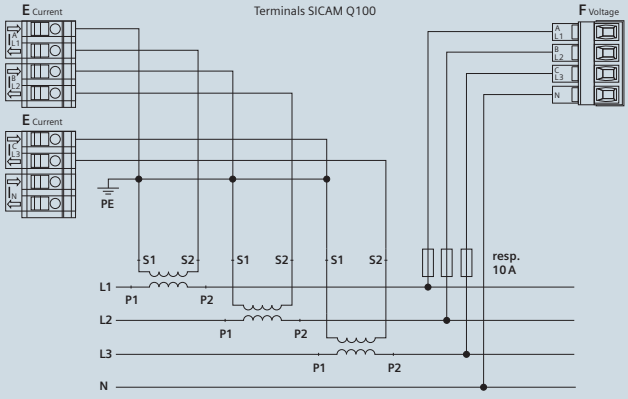

Fig. 31/33 Connection example: four-wire system,
no voltage converter and 3 current converters, any load

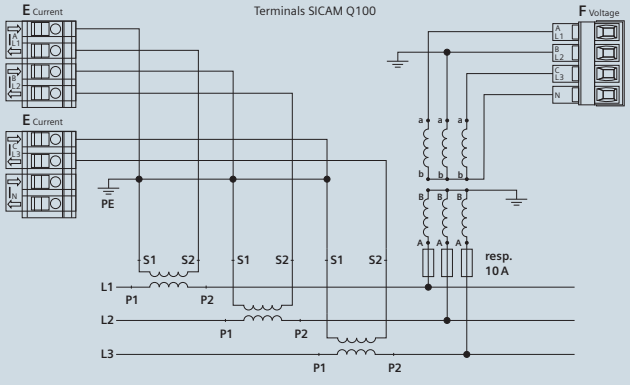

Fig. 29/33 Special circuit: Connection example: three-wire system,
3 voltage converters and 3 current converters, any load

Variants and dimensions

Device variants
SICAM Q100 is available in the following variants.
1. With standard Ethernet interface
- Modbus TCP protocol
- Optional IEC 61850 Server protocol

2. With optional RS485 interface:
- For Modbus RTU and Modbus RTU Master protocol and Gateway function

Housing
- Panel flush-mounted device with full graphical display
- Front protection class IP40

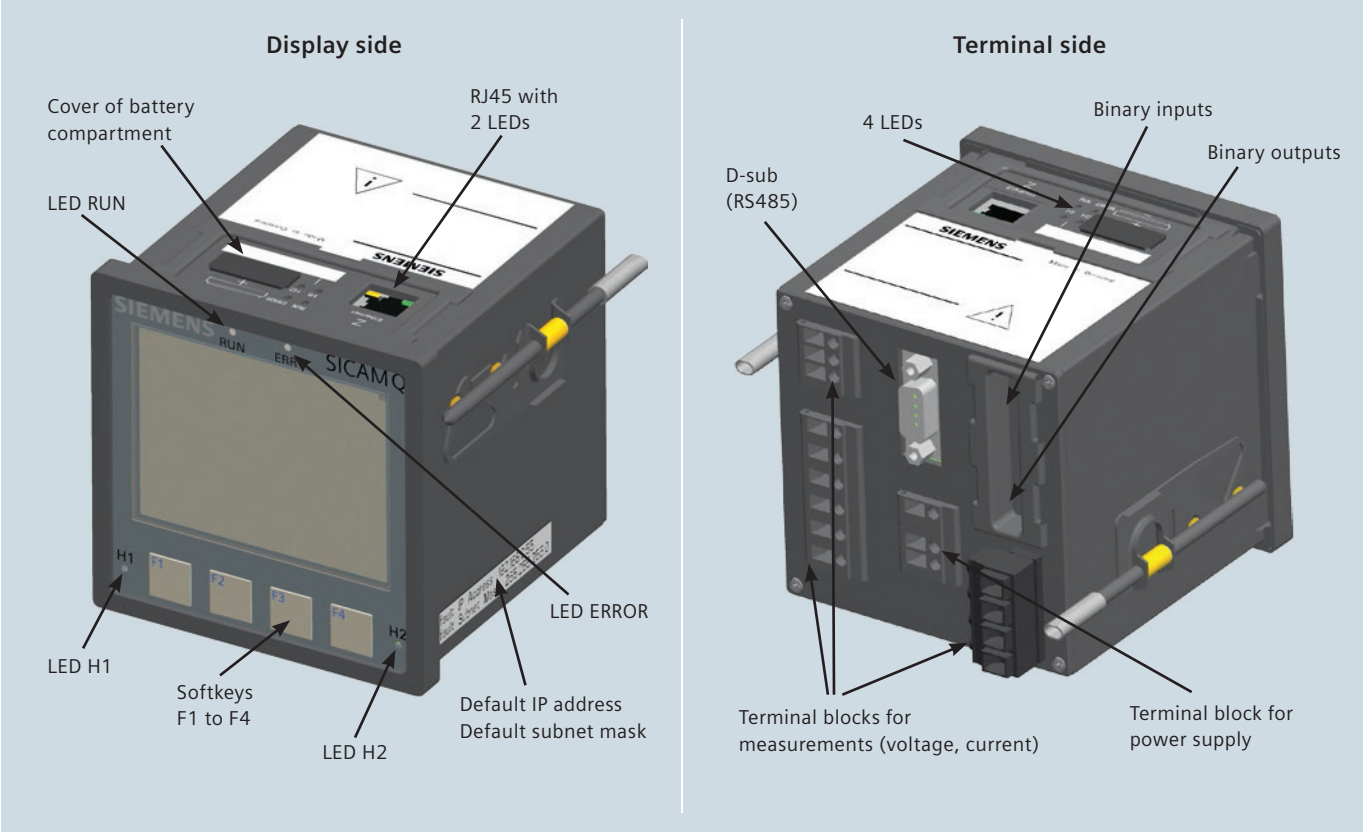

Fig. 32/33 Housing

Dimensions

- Weight 0.55 kg
- Dimensions (W x H x D) 95,5 mm x 96 mm x 102,9 mm
- 3.78" x 3.78" x 4.06"

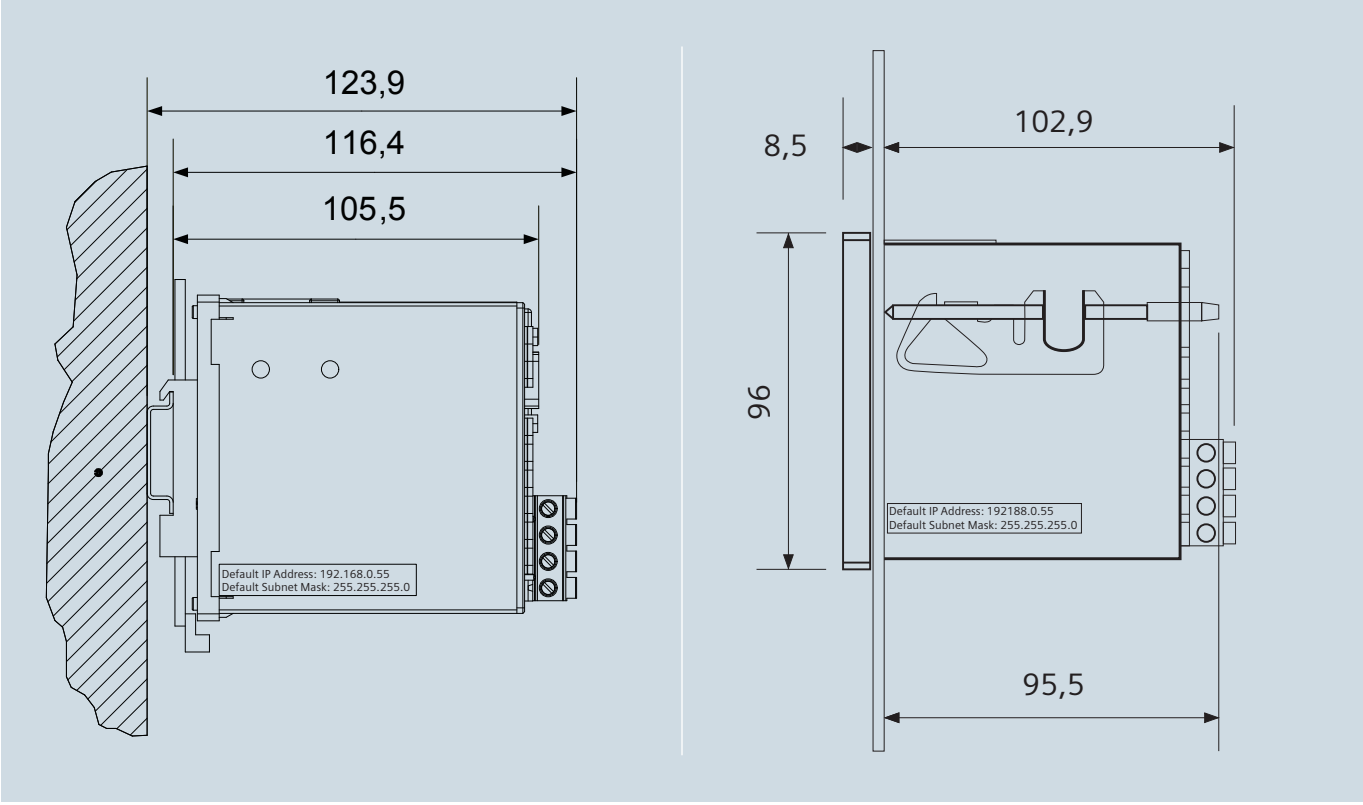

Fig. 33/33 Dimensions

Technical data

Supply voltage

Direct voltage	
Rated input voltage	24 V to 250 V
Admissible input voltage tolerance	± 20%
Admissible 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 voltage	110 V to 230 V
Power frequency at AC	50 Hz / 60 Hz
Admissible input voltage tolerance	± 20%
Admissible 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 voltage measurements, connector block F – Cat. III	
Rated input AC voltage range	
Phase–N/PE	AC 57 73 V to 400 V (autorange) – IEC 61000-4-30 Class A: up to AC 230 V: 200 % overvoltage – AC 230 V to 400 V: 200 % up to 15 % overvoltage UL conditions: – up to AC 170 V: 200 % overvoltage – AC 170 V to 300 V: 200 % up to 15 % overvoltage
Phase–phase	AC 100 V to 690 V (autorange) – IEC 61000-4-30 Class A: up to AC 400 V: 200 % overvoltage – AC 400 V to 690 V: 200 % up to 15 % overvoltage UL conditions: – up to AC 290 V: 200 % overvoltage – AC 290 V to 520 V: 200 % up to 15 % overvoltage

Maximum input AC voltage	
Phase–N/PE	460 V (347 V for UL)
Phase–phase	796 V (600 V for UL)
Input impedances	
L1 L2 L3 to N	3 0 MΩ
L12 L23 L31	3 0 MΩ

Additional information about voltage measurement inputs	
Power consumption per input for U_{max} 460 V	70 mW
Admissible frequency	42 5 Hz to 69 0 Hz
Measuring error due to environmental factors: see technical data	Acc IEC 61000-4-30 Ed 2 Class A (0 1%)
Sampling rate	10 24 kHz

Inputs for alternating current measurements, connector block E – Cat III	
Input alternating currents	
Rated input alternating current range	AC 1 A to 5 A (autorange)
Maximum input alternating current	AC 10 A
Power consumption per input	
At 5 A	2.5 mVA
Additional information about current measurement inputs	
Max. rated input voltage	150 V
Measuring error due to environmental factors: 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	
Max. input voltage	DC 300 V
Static input current	1.34 mA ± 20 %
$U_{IL\ min}$ (at threshold voltage of 19 V)	DC 14 V
$U_{IL\ max}$ (at threshold voltage of 19 V)	DC 19 V
$U_{IL\ min}$ (at threshold voltage of 88 V)	DC 66 V
$U_{IL\ max}$ (at threshold voltage of 88 V)	DC 88 V
$U_{IL\ min}$ (at threshold voltage of 176 V)	DC 132 V
$U_{IL\ max}$ (at threshold voltage of 176 V)	DC 176 V
Runtime 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
Additional information about binary outputs	
Internal resistance	50 Ω
Admissible switching frequency	10 Hz

Communication interfaces

Ethernet (connector Z)	
Ethernet, electrical	
Connection	Device top side RJ45 connector socket 10 100 Base-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 immunity	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

Serial interface (connector J)	
RS485	
Connection	Terminal side, 9-pin D-sub socket
Protocol	Modbus RTU Master and Gateway functions
Baud rate (adjustable)	Min. 1200 Bit s Max. 115 200 Bit s
Maximum transmission distance	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 terminal resistors (see Fig. 13-1)

Technical data

Environmental conditions	
Temperature data	
Operating temperature Devices with display: 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 air humidity per year	≤ 75 %
Maximum relative air humidity	95 % 30 days a year
Condensation during operation	Not permitted
Condensation during transport and storage	Permitted
Altitude and installation location	
Maximum altitude above sea level	2000 m
Installation location	Indoor installation only

Climatic stress tests
Standards: IEC 60068
Dry cold: IEC 60068-2-1 test Ad
Dry cold during operation, storage, and transport: IEC 60068-2-2 test Bd
Damp heat: IEC 60068-2-78 test Ca
Temperature change: IEC 60068-2-14 tests Na and Nb

General data

Battery	
Type	PANASONIC CR2032 or VARTA 6032 101 501
Voltage	3 V
Capacity	230 mAh
Typical service life	Operated with permanently applied supply voltage: 10 years
	Operated with sporadically interrupted supply voltage: total of 2 months over a 10-year period

Internal memory	
Capacity	2 GB
Housing (without front plate or terminals)	IP20
Panel flush mounting (front)	IP40
Terminals	IP20

Test data

Reference conditions according to IEC 62586-1 for determining test data	
Ambient temperature	23 °C ± 2 °C
Relative humidity	40 % to 60 % RH
Supply voltage	U_{HN} ± 1 %
Phases (3-wire system)	3
External continuous magnetic fields	DC field: ≤ 40 A/m
	AC field: ≤ 3 A/m
DC components U/I	None
Signal waveform	None
Frequency	50 Hz ± 0.5 Hz
	60 Hz ± 0.5 Hz
Voltage magnitude	U_{din} ± 1 %
Flicker	P_{st} < 0.1 %
Unbalance (all channels)	100 % ± 0.5 % of U_{din}
Harmonics	0 % to 3 % of U_{din}
Interharmonics	0 % to 0.5 % of U_{din}

Electrical tests

Standards	
Standards	IEC EN 61000-6-2 IEC EN 61000-6-4 IEC EN 61010-1 IEC EN 61010-2-030

Insulation test according to IEC EN 61010-1 and IEC EN 61010-2-030				
Inputs outputs	**Insulation**	**Rated voltage**	**ISO test voltage**	**Category**
Current measuring inputs	Reinforced	150 V	AC 2 3 kV	Cat III
Voltage measuring inputs	Reinforced	600 V	Surge voltage 9 76 kV	Cat III
		300 V		Cat IV
Supply voltage	Reinforced	300 V	DC 3 125 kV	Cat III
Binary outputs	Reinforced	300 V	AC 3 51 kV	Cat III
Binary inputs	Reinforced	300 V	AC 3 51 kV	Cat III
Ethernet interface	SELV	< 24 V	AC 1500 V	–
RS485 interface	SELV	< 24 V	DC 700 V	–

EMC tests for immunity (type tests)	
Standards	IEC EN 61000-6-2 For more standards, also see individual tests
Electrostatic discharge, Class III, IEC 61000-4-2	6 kV contact discharge; 8 kV air discharge; Both polarities; 150 pF; Ri = 330 Ω with connected Ethernet cable
HF electromagnetic field, amplitude-modulated, Class III IEC 61000-4-3	10 V m; 80 MHz to 3 GHz; 80 % AM; 1 kHz
Fast transient disturbance variables bursts, Class III IEC 61000-4-4	2 kV; 5 ns 50 ns; 5 kHz; Burst length = 15 ms; Repetition rate 300 ms; Both polarities; R_i = 50 ; Test duration 1 min
High-energy surge voltages (SURGE), Installation Class III IEC 61000-4-5	Impulse: 1 2 µs 50 µs
Auxiliary voltage	Common mode: 2 kV; 12 ; 9 µF Diff mode:1 kV; 2 ; 18 µF
Measuring inputs, binary inputs, and relay outputs	Common mode: 2 kV; 42 ; 0 5 µF Diff mode: 1 kV; 42 ; 0 5 µF
HF on lines, amplitude-modulated, Class III IEC 61000-4-6	10 V; 150 kHz to 80 MHz; 80 % AM; 1 kHz
Power system frequency magnetic field IEC 61000-4-8, Class IV	30 A m continuous; 300 A m for 3 s
1 MHz test, Class III, IEC 61000-4-18	2 5 kV (peak); 1 MHz; τ = 15 µs; 400 surges per s; Test duration 1 min; R_i = 200

EMC tests for emitted interference (type test)	
Standard	IEC EN 61000-6-4
Radio noise voltage to lines, auxiliary voltage only IEC-CISPR 22	150 kHz to 30 MHz Limit Class A
Interference field strength IEC-CISPR 22	30 MHz to 1000 MHz Limit Class A

Mechanical tests

Vibration and shock stress in stationary use	
Standards	IEC 60068
Oscillation IEC 60068-2-6 test Fc	Sinusoidal 10 Hz to 60 Hz: ±0 075 mm amplitude; 60 Hz to 150 Hz: 1 g acceleration Frequency sweep rate 1 octave min 20 cycles in 3 orthogonal axes
Shock IEC 60068-2-27 test Ea	Semi-sinusoidal 5 g acceleration, duration 11 ms, 3 shocks each in both directions of the 3 axes
Seismic vibration IEC 60068-3-3 test Fc	Sinusoidal 1 Hz to 8 Hz: ±7 5 mm amplitude (horizontal axis) 1 Hz to 8 Hz: ±3 5 mm amplitude (vertical axis) 8 Hz to 35 Hz: 2 g acceleration (horizontal axis) 8 Hz to 35 Hz: 1 g acceleration (vertical axis) Frequency sweep rate 1 octave min 1 cycle in 3 orthogonal axes

Vibration and shock stress in transport	
Standards	IEC 60068
Oscillation IEC 60068-2-6 test Fc	Sinusoidal 5 Hz to 8 Hz: ±7 5 mm amplitude; 8 Hz to 150 Hz: 2 g acceleration Frequency sweep 1 octave min 20 cycles in 3 orthogonal axis
Shock IEC 60068-2-27 test Ea	Semi-sinusoidal 15 g acceleration, duration 11 ms, 3 shocks each (in both directions of the 3 axes)
Continuous shock IEC 60068-2-29 test Eb	Semi-sinusoidal 10 g acceleration, duration 16 ms, 1000 shocks each (in both directions of the 3 axes)
Free fall IEC 60068-2-32 test Ed	0 5 m

Safety standards
IEC EN 61010: IEC EN 61010-1, IEC EN 61010-2-30

Weight and dimensions	
Weight	Approx 0 55 kg
Dimensions (W x H x D)	95,5 mm x 96 mm x 102,9 mm 3 78" x 3 78" x 4 06"

Technical data, selection and ordering data

Description	Order No. / MLFB
Power Monitoring Device and Power Quality Recorder, Class A	
SICAM Q100 – CE approval and UL approval	**7KG9501-0AA□1-□AA1**
Device type	
Dimensions 95,5 mm x 96 mm x 102,9 mm Panel flush-mounted device with graphical display 4 inputs for AC voltage measurements 4 inputs for AC current measurements 2 binary inputs 2 binary outputs Web server for parameterization, visualization, and data management Ethernet switch 2-GB internal memory	
Measurements, monitoring, PQ recordings, and power management functions	
Measurements according to IEC 61000-4-30, Class A Measurements: U, I, f, P (Class 0.2S), Q, S, W, cos phi, flicker Fault data storage with transient detection and event recording Logging of power quality, e.g. according to EN 50160 ANSI C12.20, Class 2 and Class 10 Online visualization Recording of mean and min/max values Measurements up to 63rd harmonics order (current, voltage) Limit value violations Power management: Load profile and tariffs (TOU)	
Serial interface and communication protocol	
without	**0**
RS485 – Modbus RTU Slave, and Modbus RTU Master and Gateway functions	**3**
Front protection class	
IP40	
Ethernet interface and communication protocol, RJ45	
Modbus TCP	**0**
Modbus TCP and IEC 61850 server	**2**

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