SENTRON T
Electrical Measurement Transducer

Energy Automation

Catalog SR 10.4.1 · V1.0

Answers for energy.

SIEMENS

SENTRON T Electrical Measurement Transducer

Energy Automation

Catalog SR 10.4.1 · V1.0 (PDF version)

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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).
DNV Certificate No.: 92113-2011-AHSO-GER-TGA and Certificate No.: 87028-2010-AHSO-GER-TGA.

Device Description

The **SENTRON T** is an electrical measurement transducer that allows the measurement of electrical quantities in electrical networks in a single unit. In industries, power plants and substations, especially transducers are used for measurand (e.g. 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 (W × H × D)
- Degree of protection IP20.

Input and output circuits
- 4 inputs for alternating voltage measurements
- 3 inputs for alternating current measurements up to 10 A continuous
- 4 DC analog outputs freely configured:
  – Direct currents: 0 mA to 20 mA, 4 mA to 20 mA and -20 mA to 20 mA
  – Direct voltages: 0 V to 10 V and -10 V to 10 V
- individually programmable binary outputs.

Signalization LEDs
automatically monitors the functions of its hardware, software, and firmware components.

Communication
- Ethernet: 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.

Measurands
The following measurands can be recorded or calculated from the measured quantities:
- TRMS (True RMS) for alternating voltage and current
- Active, reactive and apparent power
- Active, reactive and apparent energy
- Power frequency
- Phase angle
- Power factor and active power factor.

Time synchronization
For a common time basis when communicating with peripheral devices and time stamping of the process data.
- External time synchronization via Ethernet NTP
- External time synchronization via field bus using the MODBUS RTU or the IEC 60870-5-103 communication protocol
- Internal time synchronization via RTC (if external time synchronization is not available).

Response time for analog and binary outputs
The faster response time of the analog and binary output is a very important feature of SENTRON T that enables a reliable reaction of the controlling applications. The response time of the device is 120 ms at 50 Hz and 100 ms at 60 Hz.

Fig. 1 SENTRON T electrical measurement transducer

Applications
- Conversion and integration of measurands into substation automation, protection or SCADA process via RTU and/or via protocol IEC 60870-5-103 for further control and/or monitoring tasks
- Monitoring of lower voltage levels and heavy load control, e.g. air conditioning and motors.

Main 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 sectors applications
- Measurements: up to 60 measured or calculated values available
- Temperature range: -25 °C to +55 °C
- High accuracy: typically 0.2 % for voltage and current at rated input
- High EMC immunity: according to IEC 61000-6-2.

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

SENTRON T applications: local monitoring or control purposes through assignment of up to 60 available electrical parameters to analog outputs, notifications through binary outputs or integration into SCADA/monitoring systems through communication interface, e.g. serial IEC 60870-5-103, MODBUS RTU or MODBUS TCP Ethernet.

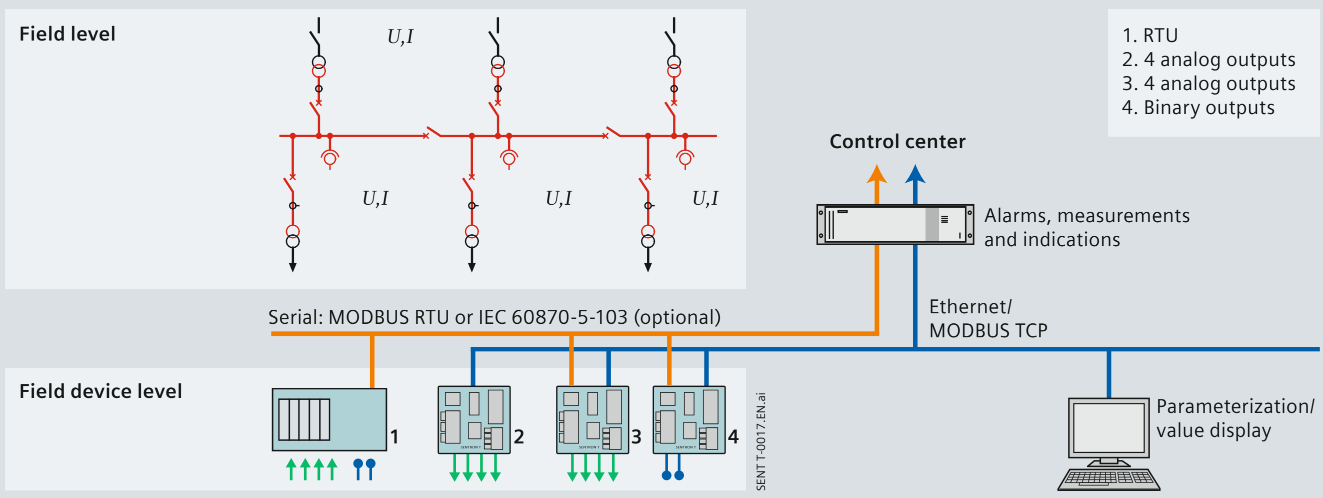


Fig. 2 SENTRON T applications

Application examples

Application Area		Voltage	Current	Power	Frequency	Phase angle	Energy	Alarm	Internal cost allocation
Generation substation	Generator	■	■	■	■	■	■	■	
Transmission substation	Incoming line	■	■	■					
	Outgoing line	■	■	■					
Transformer substation	Incoming line	■							
	Bus	■	■	■	■		■		
	Feeder	■	■	■					
Transformer distribution	Incoming line	■							
	Bus	■	■	■	■		■		
	Feeder	■	■	■					
Process	SCADA / EMS / DMS	■	■	■	■	■	■		
	Energy management	■	■	■	■	■	■	■	■
	Motors	■	■	■	■	■		■	■
	Commercial (e.g. air conditioning)	■	■	■				■	■

Specific Functions and Design

Measurement process and connections

The measurements are obtained from the alternating quantities of current and voltage supplied to the different measuring inputs. Rated input alternating voltages up to $U_{\text{ph-N}}$ = 400 V and $U_{\text{ph-ph}}$ = 690 V can be fed in using internal resistive input voltage dividers.
The internal current transformers process rated input alternating currents up to 5 A. The circuits connected on the input side are isolated galvanically from the current transformers to ensure that the potential is decoupled. The input values are processed and then output as analog values or digital data by the corresponding Interfaces, converted into direct currents and/or direct voltages depending on the parameter settings or transmitted to peripheral devices for analysis.

Response time for analog outputs

The faster response time of the analog and binary output is a very important feature of SENTRON T that enables a reliable reaction of the controlling applications. The response time of the device is 120 ms at 50 Hz and 100 ms at 60 Hz.

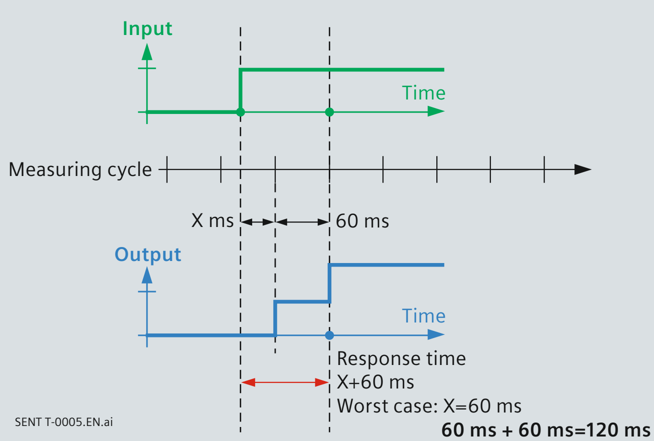


Fig. 3 Response time diagram

Communication

To communicate with the systems control and other process automation equipment, the device features an Ethernet interface, and if installed in the device model, an RS485 interface. Ethernet supports the device parameterization, the transmission of measured data, metered values and indications and the time synchronization via NTP. The communication protocols are HTTP and MODBUS TCP. The RS485 interface supports the transmission of the measured data, metered values and indications and the time synchronization. Depending on the device version, you can use either the MODBUS RTU or the IEC 60870-5-103 communication protocol.

Time synchronization

The following types of time synchronization can be executed:

- External time synchronization via Ethernet NTP (preferred)
- External time synchronization via field bus using the MODBUS RTU or the IEC 60870-5-103 communication protocol
- Internal time synchronization via RTC with quartz oscillator (if external time synchronization is not available)

Electrical assembling

SENTRON T 7KG9661 contains the following electrical modules depending on the device version:

- Digital signal processor (DSP)
- 4 inputs for AC voltage measurements
- 3 inputs for AC current measurements
- 4 DC analog outputs
- 2 binary outputs
- Supply voltage
- Serial RS485 interface (optional)

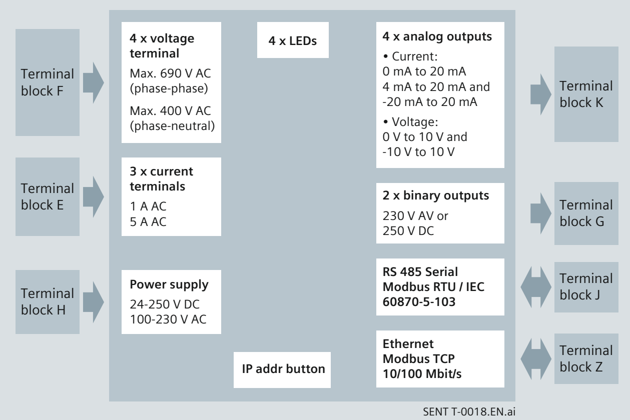
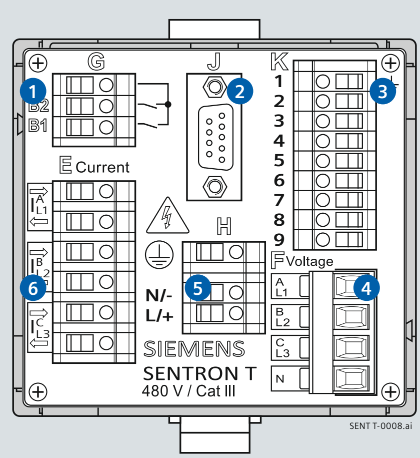


Fig. 4 Block diagram SENTRON T 7KG9661

Mechanical design

The electrical modules are installed in a plastic case with the dimensions 96 mm × 96 mm × 100 mm (W × H × D). The case is prepared for mounting on a top-hat rail.
The top side of the device accommodates the RJ45 Ethernet connector with two LEDs and four additional LEDs.



1. Binary outputs
2. RS485 interface
3. DC analog outputs
4. Inputs for AC voltage measurement
5. Supply voltage
6. Inputs for AC current measurement

Fig. 5 Connectors on the device

Measurands According to the Connection Type

Power measurands in power systems

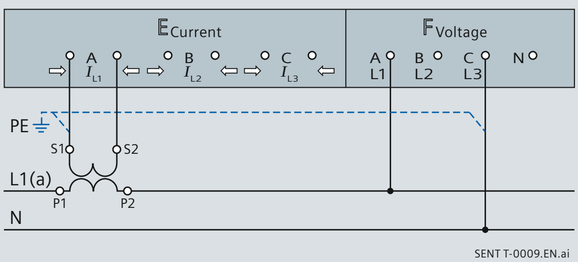
Measurand		Circuit	1-phase system	3-wire network (delta)			4-wire network (star)	
				balanced (1I)	unbalanced (3I)	unbalanced (2I)	balanced (1I)	unbalanced (3I)
AC voltage	U_a	a-N	■				■	■
	U_b	b-N						■
	U_c	c-N						■
	U_{ab}, U_{bc}, U_{ca}	a-b, b-c, c-a		■	■	■		■
	U_N	a, b, c						■
	U_{avg}	a, b, c		■	■	■	■	$\Sigma U_{ph}/3$
AC current	I_a	a	■	■	■	■	■	■
	I_b, I_c	b, c			■	■		■
	I_N	a, b, c			■			■
	I_{avg}	a, b, c			■	■		$\Sigma U_{ph}/3$
Active power factor	cos (a)	a	■					■
	cos (b), cos (c)	b, c						■
	cos	a, b, c		■	■	■	■	■
Power factor	PF_a	a	■					■
	PF_b, PF_c	b, c						■
	PF	a, b, c		■	■	■	■	■
Phase angle	$_a$	a	■					■
	$_b$, $_c$	b, c						■
		a, b, 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 – demand	$WP_{a\ demand}$	a	■					■
	$WP_{b\ demand}$, $WP_{c\ demand}$	b, c						■
	WP_{demand}	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		■	■	■	■	■
Apparent energy	WS_a	a	■					■
	WS_b, WS_c	b, c						■
	WS	a, b, c		■	■	■	■	■

Connection Types

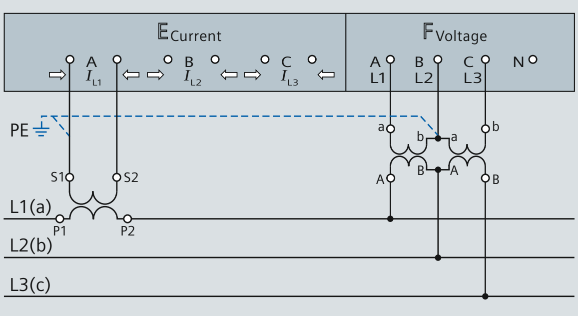
SENTRON T 7KG9661 supports the following connection types:

- 1-phase system
- 3-wire network (balanced)
- 3-wire network (unbalanced), 2 current inputs
- 3-wire network (unbalanced), 3 current inputs
- 4-wire network (balanced)
- 4-wire network (unbalanced)

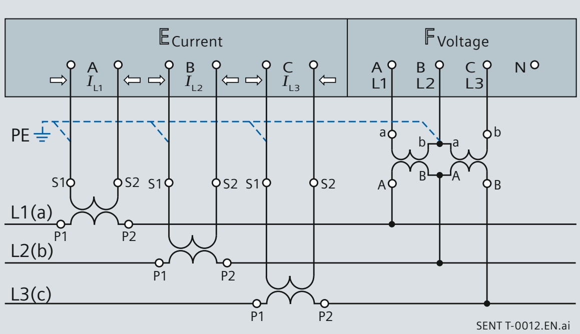
1-phase system, no voltage transformer



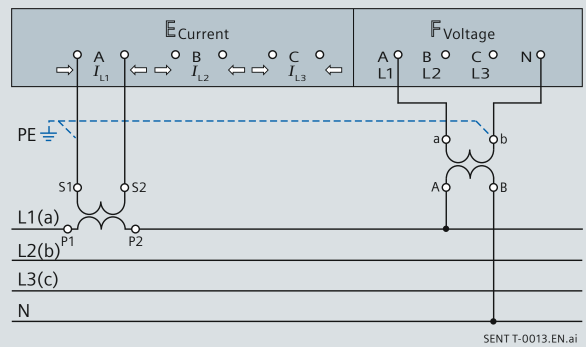
3-wire network, 2 voltage transformers and 1 current transformer, balanced*



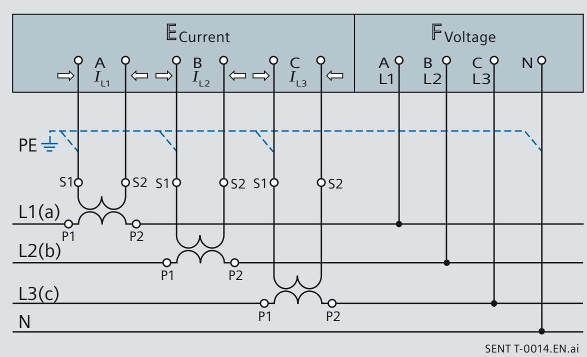
3-wire network, 2 voltage transformers and 3 current transformers, unbalanced*



4-wire network, 1 voltage transformer and 1 current transformer, balanced



4-wire network, no voltage transformer and 3 current transformers, unbalanced



4-wire network, 3 voltage transformers and 3 current transformers, unbalanced

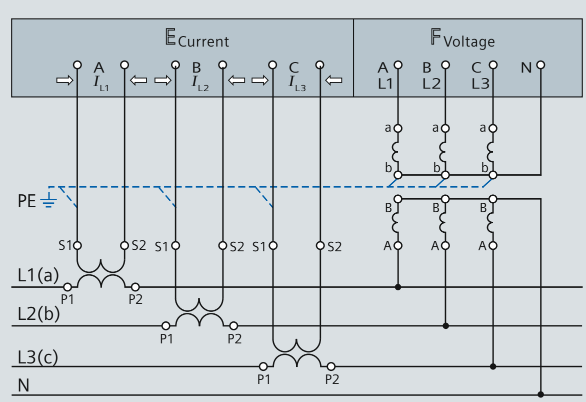
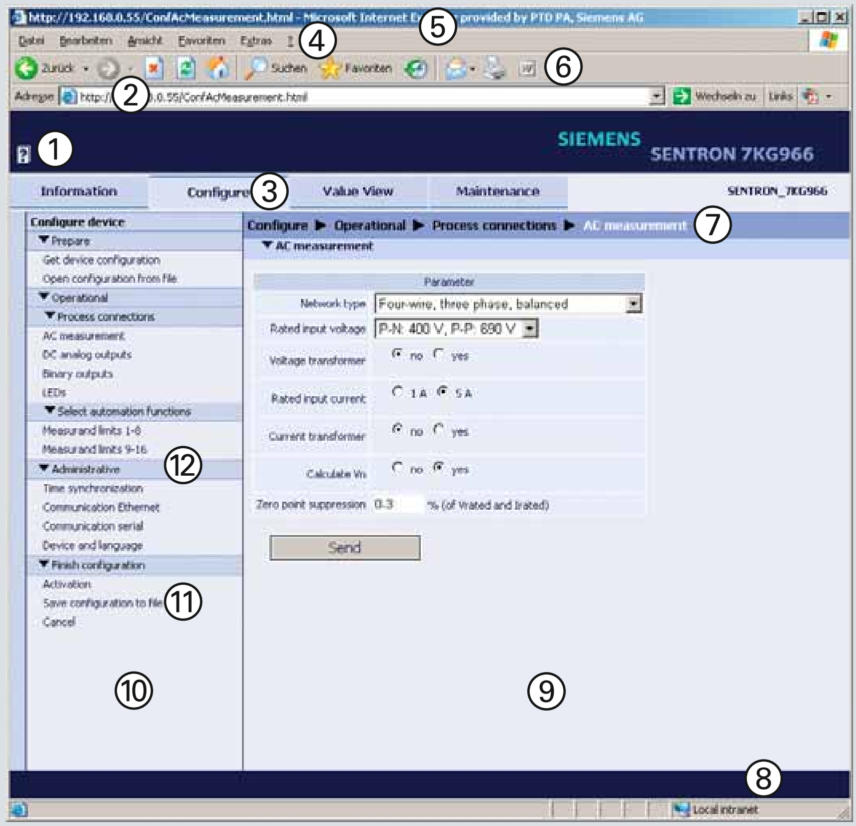


Fig. 6 Connection types

* **Important:** The maximum secondary voltage for this connection example is AC 480 V. The maximum allowable voltage between phase and ground must not be exceeded. For IT network connection, please carefully read the device manual for detailed description.

Parameterization and monitoring software

The device is configured from a connected PC or notebook only. The user interface SENTRON T GUI (GUI = Graphical User Interface) is implemented in the device, meaning that for the whole operation and parameterization of the device no additional software is required. You can navigate through Microsoft Internet Explorer using the icons on the toolbar.
Device status, so as communication, parameterization, log files, value view, and maintenance can be easily proceeded through SENTRON T GUI interface.



① Online help
② Address bar
③ Tab
④ Menu bar
⑤ Microsoft Internet Explorer
⑥ Toolbar
⑦ Navigation bar
⑧ Status bar
⑨ Input/output window
⑩ Navigation window
⑪ Element
⑫ Menu

Fig. 7 Layout of the SENTRON T GUI user interface

Information

The navigation window of the "Information" tab contains the device information, and operative and device logs. Here you get the complete overview about the device status.

Fig. 8 Information tab, shows device information input/output window

Configuration

The configuration mode allows you to set the device parameters. You can tailor the process connections to the installation environment, specify the limits of the measuring ranges, parameterize the communication and make various operational settings.

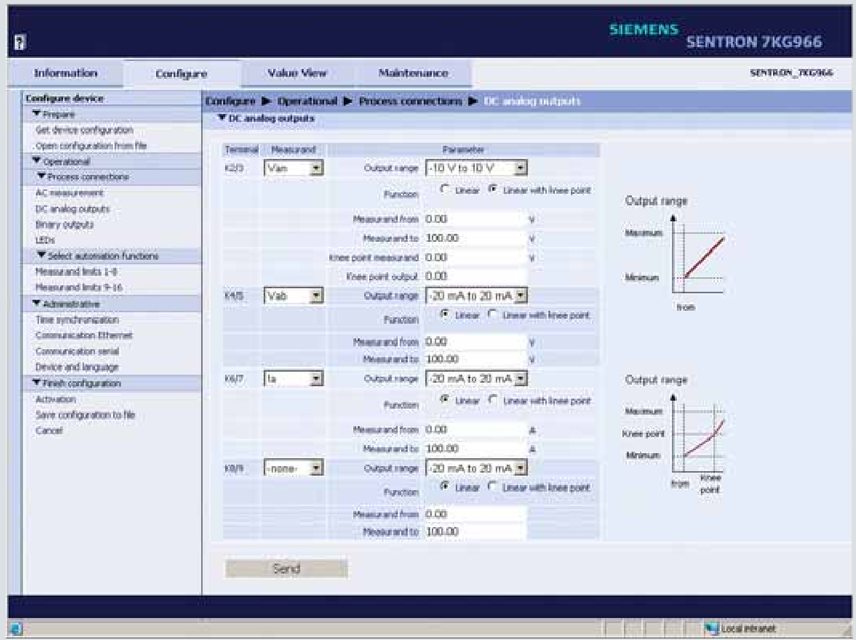


Fig. 9 DC analog outputs input/output window

Value View

The measured values are displayed in the “Value View” tab.

- AC operational values
- AC power and energy
- DC analog outputs
- Binary outputs
- Measurand limits

Depending on which operational parameters are selected, the input/output window displays the measured values of the measurands with the corresponding unit or indications in a tabular list that is updated every 5 s.

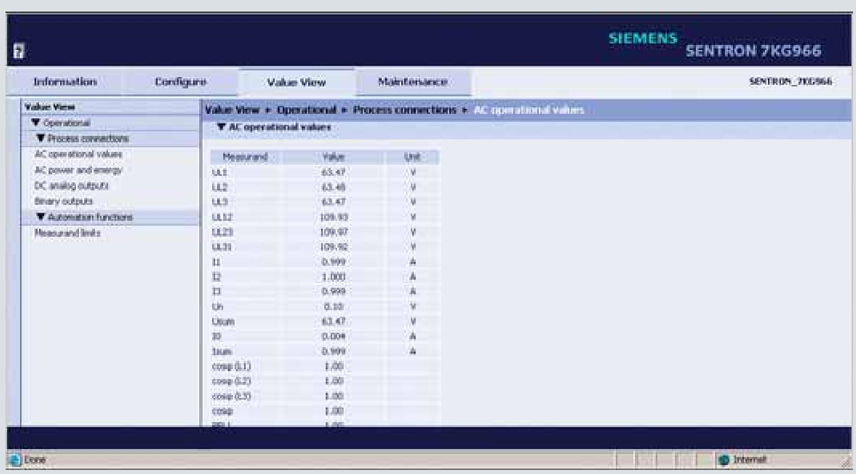


Fig. 10 Value View tab

Maintenance

In the “Maintenance” tab, you can update the firmware, perform calibration, make various presettings, view and delete logs and analyze protocol-specific communication data of MODBUS / IEC 60870-5-103.

Fig. 11 Maintenance tab

Electrical data / inputs

Inputs for alternating voltage measurements	
Rated input voltage phase-N/PE (selectable via parameter)	63.5 V, 110 V, 230 V, 400 V
Max. input voltage	1.2 × rated input voltage
Max. supply voltage phase-N/PE phase-phase	480 V 831 V
Power consumption per input for U_{rated} 400 V AC	38 mW
Permissible power frequency	45 Hz to 65 Hz
Input impedances a, b, c to N a, b, c, N to PE a-b, b-c, c-a	7.9 MΩ 3.9 MΩ 7.9 MΩ
Measuring error (with calibration) at 23 °C ±1 °C; 50 Hz or 60 Hz	typically 0.2 % at rated input voltage
Continuous overload capacity	1.5 × rated input voltage (600 V)
Surge overload capacity	2 × rated input voltage (800 V) according to IEC 60255-27

Inputs for alternating current measurements	
Rated input current ranges (via Parameter selectable)	1 A, 5 A
Max. input current	2 × rated input current
Max. rated input voltage	150 V
Power consumption per input at 1 A AC at 5 A AC	 1 mVA 2.5 mVA
Permissible power frequency	45 Hz to 65 Hz
Measuring error (with calibration) at 23 °C ±1 °C; 50 Hz or 60 Hz:	typically 0.2 % at rated input current
Thermal stability	10 A continuous 100 A for max. 1 s according to IEC 60688

Electrical data / outputs

DC analog outputs	
Use as current outputs (direct current)	
Rated output current	±20 mA
Maximum output current	±24 mA
Maximum load impedance (incl. line impedance)	< 400 Ω
Short-circuit current (short-circuit proof)	±24 mA
No-load voltage (idling-proof)	15 V,
Measuring error (with calibration) at 23 °C ±1 °C	max. 0.1% at rated current
Response time	120 ms (50 Hz), 100 ms (60 Hz)

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

Binary outputs	
Maximum switching voltage Alternating voltage Direct voltage	 230 V 250 V
Maximum continuous contact current	100 mA
Maximum pulse current for 0.1 s	300 mA
Internal impedance	35 Ω
Admissible switching frequency	10 Hz
Number of switching cycles	unlimited

Tolerance limits

Measurand	Unit	Rated value	Tolerance limits [1)]
Voltage $U_{ph\text{-}ph}$ (delta) acc. to parameterization	V	AC 110 V AC 190 V AC 400 V AC 690 V	±0.2 %
Voltage $U_{ph\text{-}N}$ (star) acc. to parameterization		AC 63.5 V AC 110 V AC 230 V AC 400 V	±0.2 %
Current I acc. to parameterization	A	AC 1 A AC 5 A	±0.2 %
Active Power *P* + demand, -supply	W	–	±0.5 %
Reactive Power *Q* + inductive, -capacitive		–	±0.5 %
Apparent power *S*		–	±0.5 %
Power factor *PF* [2)]		–	±1.0 %

Measurand	Unit	Rated value	Tolerance limits [1)]
Power factor *PF* [2)]		–	±1.0 %
Active power factor *cos* [2)]		–	±1.0 %
Phase angle [2)]	Degree	–	2 °
Frequency f	Hz	50 Hz, 60 Hz	10 mHz (from 30 % to 120 % U_{rated})
Active energy $WP_{\_Demand}$	Wh	–	±0.5 %
Active energy $WP_{\_Supply}$	Wh	–	±0.5 %
Reactive energy $WQ_{\_inductive}$	varh	–	±0.5 %
Reactive energy $WQ_{\_capacitive}$	varh	–	±0.5 %
Apparent energy *WS*	VAh	–	±0.5 %

1) Tolerance limits under reference conditions
2) Measurements from 2 % of the rated apparent power value onwards in the selected measuring range

Technical Data

General electrical data and reference conditions

Supply Voltage	
Rated input voltages	AC 110 V to AC 230 V or DC 24 V to DC 250 V
System frequency at AC	45 Hz to 65 Hz
Admissible input voltage tolerance (valid for all input voltages)	±20 %
Permitted ripple of the input voltage at 24 V DC, 48 V DC, 60 V DC, 110 V DC, 220 V DC, 250 V DC	15 %
Permitted harmonics at 115 V, 230 V	2 kHz
Max. inrush current at ≤ 110 V DC; ≤ 115 V AC at 220 V DC to 300 V DC; 230 V AC	 < 15 A ≤ 22 A (after 250 µs: < 5 A)
Maximum power consumption	6 W / 9 VA

Battery	
Type	CR2032
Voltage	3 V
Capacity	230 mAh

Degree of protection according to IEC 60529	
Device front	IP20
Device rear (connections)	IP20

Reference conditions for determining the test data (precision specifications under reference conditions)	
Rated input current	±1 %
Rated input voltage	±1 %
Frequency	45 Hz to 65 Hz
Curve shape sine, total harmonic distortion	≤ 5 %
Ambient temperature	23 °C ±1 °C
Supply voltage	VHN ±1 %
Warm-up time	≥ 15 min
Interfering fields	none

Communication data

Ethernet	
Bus protocol	MODBUS TCP
Transmission rate	10/100 Mbit/s
Communication protocol	IEEE 802.3
Connection	100Base-T (RJ45)
Cable for 100Base-T	100 Ω to 150 Ω STP, CAT5
Maximum cable length 100Base-T	100 m (if well installed)
Voltage strength	700 V DC

Serial RS485 interface	
Connection	9-pin D-sub plug connector

Bus protocol MODBUS RTU	
Baud rate	9,600 bit/s, 19,200 bit/s, 38,400 bit/s, 57,600 bit/s
Parity	even, even (fixed) ,odd, no (1 or 2 stop bits)
Protocol	half-duplex
Max. cable length, depending on data rate	1,000 m
Transmission level	low: -5 V to -1.5 V high: +5 V to +1.5 V
Reception level	low: ≤ -0.2 V high: ≥ +0.2 V
Bus termination	not integrated, bus termination using plugs with integrated bus terminating resistors

Bus protocol IEC 60870-5-103	
Baud rate	9,600 bit/s, 19,200 bit/s, 38,400 bit/s
Max. cable length, depending on data rate	1,000 m
Transmission level	low: -5 V to -1.5 V high: +5 V to +1.5 V
Reception level	low: ≤ -0.2 V high: ≥ +0.2 V
Bus termination	not integrated, bus termination using plugs with integrated bus terminating resistors

Environmental data

Supply voltage	
Operating temperature continuous operation	 -25 °C to +55 °C
Temperature during transportation during storage	 -25 °C to +70 °C -25 °C to +70 °C
Maximum temperature gradient	20 K/h
Air humidity mean relative air humidity per year maximum relative air humidity	 ≤ 75 % 95 % 30 days a year
Condensation during operation during transportation and storage	 not permitted permitted

Regulations and standards

Climate	
Cold	IEC 60068-2-1 Test Ad IEEE C37.90
Dry heat during operation, storage, and transportation	IEC 60068-2-2 Test Bd IEEE C37.90
Damp heat	DIN EN 60068-2-78:2002-09 IEEE C37.90
Damp heat – cyclic	IEC 60068-2-30 Test Db
Change of temperature	IEC 60068-2-14 Tests Na and Nb
Individual gas test, industrial atmosphere, sequential gas test	IEC 60068-2-42 Test Kc IEC 60068-2-43
Flowing mixed gas	IEC 60068-2-60 Method 4
Salt fog test	IEC 60068-2-11 Test Ka

Mechanics	
Vibration during operation	IEC 60068-2-6 Test Fc IEC 60255-21-1

Description	Order No.
Electrical measurement transducer Ethernet RJ45, MODBUS TCP and Web server on board	7KG 9 6 6 1 - 1 F A ▯ 0 - 1 A A 0 (positions 123, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16)
Device type	
Din-rail mounting device without display, IP20 4 inputs for AC voltage measurements, 3 inputs for AC current measurements 2 binary outputs	1 (position 7)
AC input circuits and case	
Resistive voltage divider Case 96 mm × 96 mm × 100 mm (W × H × D)	1 (position 8)
DC analog outputs	
4 DC analog outputs: -20 mA to 20 mA / -10 V to 10 V (individually parameterizable)	F (position 9)
Serial interface and communication protocol	
Without	0
RS485/MODBUS RTU	1
RS485/MODBUS RTU and IEC 60870-5-103	3

Description	Order No.
Ethernet patch cable for parameterization with double shield (SFTP), cross-over connection LAN connector at both ends SENTRON T <–> PC; length: 3 m	7KE 6 0 0 0 - 8 G E 0 0 - 3 A A 0 (positions 123, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16)

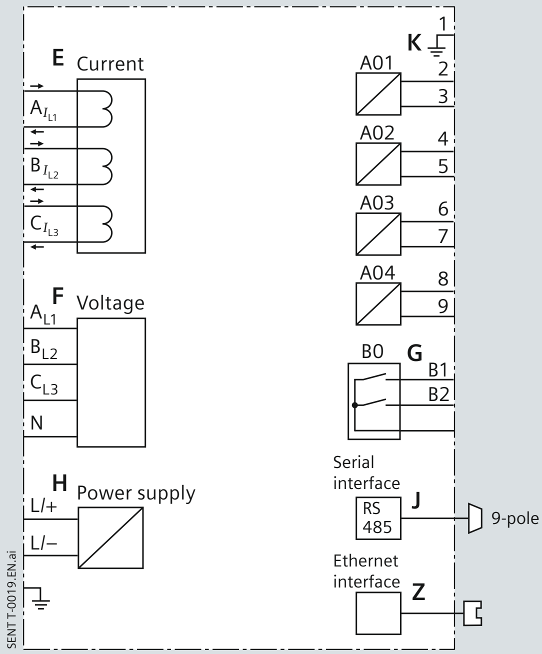
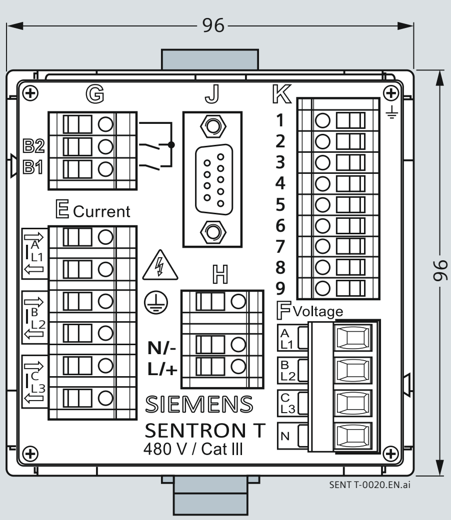


Fig. 12 Connection diagram



Dimensions in mm

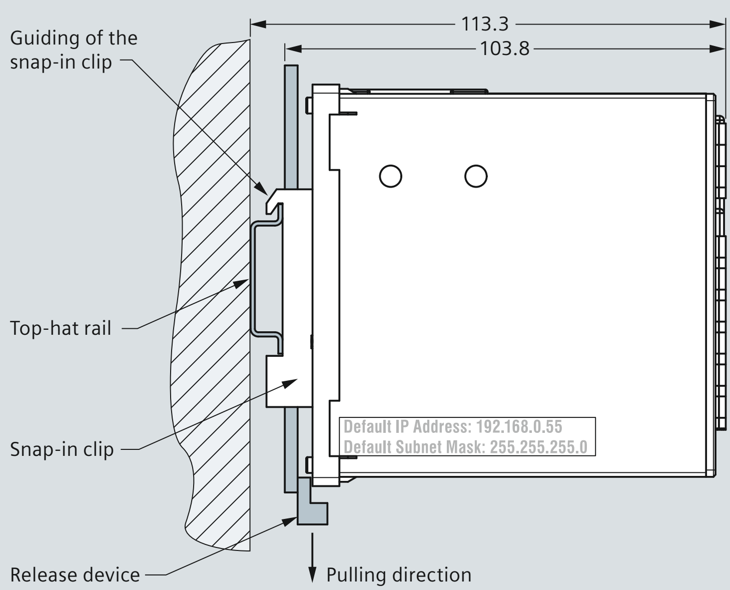


Fig. 13 Dimension drawings

CE and IEC 60870-5-103 conformity certificate

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

This conformity has been established by means of tests conducted by Siemens AG according to the Council Directive in agreement with the generic 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.

The device has been designed and produced for industrial use. The product conforms to the standard EN 60688.

Disclaimer of liability

This document has been subjected to rigorous technical review before being published. It is revised at regular intervals, and any modifications and amendments are included in the subsequent issues.

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Siemens AG reserves the right to revise this document from time to time.

Document version: 01
Release status: 02.2011
Version of the product described: V1.0

ATTESTATION OF CONFORMITY

No. 30920590-Consulting 10-0145

Issued to: Siemens AG Wernerwerkdamm 5 13629 Berlin, Germany	for the product: SENTRON T 7KG9661 Type: Slave station Firmware version V01.10.03.01

With the implemented communication protocol:

IEC 60870-5-103 (IS 1998)

Companion Standard for basic telecontrol tasks and the IEC 60870-5-103 protocol implementation description in the Device manual of the SENTRON T 7KG9661, Edition 11.2009

The product has not been shown to be non-conforming to the specified protocol standard, including the interface requirements.

End-to-End data element tests for the information and control points as described in manufacturer Protocol Implementation Conformance Statement (PICS) have been performed on the product's protocol implementation. Functional tests in controlled mode are performed for the following levels:

• Station initialization in Unbalanced mode • Cyclic data transmission • Acquisition of events	• General Interrogation • Clock synchronisation • Command Transmission

The test campaign did not reveal any errors in the product's protocol implementation.

This Attestation is granted on account of tests made at location of KEMA in Arnhem, The Netherlands and performed with UnIECim 60870-5-103 version 2.17.03 (April 2008) running CS103 Test Suite version CS103MasterNormal 2.2. The results, including remarks and limitations, are laid down in our report no. 30920590-Consulting 09-0144.

The tests have been carried out on one single specimen of the product, submitted by Siemens. The Attestation does **not** include an assessment of the manufacturer's production. Conformity of his production with the specimen tested by KEMA is not the responsibility of KEMA.

Arnhem, January 21, 2010

W. Strabbing
Manager Intelligent Networks and Communication

P.H.S. Ermens
Test Consultant

IMPORTANT: Remarks apply to this implementation. See the resulting report for full details.
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