SIEMENS

Multifunctional Transducer SENTRON T 7KG966

Device Manual

E50417-H1040-C493-A1

NOTE

For your own safety, please observe the warnings and safety instructions contained in this document.

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Preface

Purpose of this Manual

This manual describes the application, functions, installation, commissioning and operation of the Multifunctional Transducer SENTRON T 7KG966

Target Group

This manual is intended for project engineers, commissioning and operating personnel in electrical systems and power plants.

Scope of Validity of this Manual

This manual is valid for the Multifunctional Transducer SENTRON T 7KG966.

Further Support

For any questions concerning your system, please contact your Siemens representative.

Hotline

Our Customer Support Center provides around-the-clock support.

Phone: +49 (1805) 24-7000

Fax: +49 (1805) 24-2471

Internet: http://www.powerquality.de

e-mail: support.energy@siemens.com

Training Courses

If you are interested in our current training program, please contact our training center:

Siemens AG

Siemens Power Academy

Humboldtstr. 59

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Fax: +49 (911) 433-7929

Internet: http://www.siemens.com/energy/power-academy

e-mail: power-academy.energy@siemens.com

Notes On Safety

This manual does not constitute a complete catalog of all safety measures required for operating the equipment (module, device) in question, because special operating conditions may require additional measures. However, it does contain notes that must be adhered to for your own personal safety and to avoid damage to property.

These notes are highlighted with a warning triangle and different keywords indicating different degrees of danger.

DANGER

Danger means that death or severe injury **will** occur if the appropriate safety measures are not taken.

✧ Follow all advice instructions to prevent death or severe injury.

WARNING

Warning means that death or severe injury **can** occur if the appropriate safety measures are not taken.

✧ Follow all advice instructions to prevent death or severe injury.

CAUTION

Caution means that minor or moderate injury can occur if the appropriate safety measures are not taken.

✧ Follow all advice instructions to prevent minor injury.

NOTICE

Notice means that damage to property can occur if the appropriate safety measures are not taken.

✧ Follow all advice instructions to prevent damage to property.

NOTE

is important information about the product, the handling of the product, or the part of the documentation in question to which special attention must be paid.

Personnel Qualified in Electrical Engineering

Commissioning and operation of the equipment (module, device) described in this manual must be performed by personnel qualified in electrical engineering only. As used in the safety notes contained in this manual, electrically qualified personnel are those persons who are authorized to commission, release, ground and tag devices, systems, and electrical circuits in accordance with safety standards.

Use as Prescribed

The equipment (device, module) must not be used for any other purposes than those described in the Catalog and the Technical Description. If it is used together with third-party devices and components, these must be recommended or approved by Siemens.

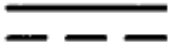
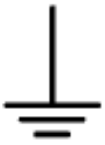
If the device is not used in accordance with the Product Information and this manual, the scheduled protection is impaired.

Correct and safe operation of the product requires adequate transportation, storage, installation, and mounting as well as appropriate use and maintenance.

During the operation of electrical equipment, it is unavoidable that certain parts of this equipment will carry dangerous voltages. Severe injury or damage to property can occur if the appropriate measures are not taken:

- Before making any connections at all, ground the equipment at the PE terminal.
- Hazardous voltages can be present on all switching components connected to the power supply.
- Even after the supply voltage has been disconnected, hazardous voltages can still be present in the equipment (capacitor storage).
- Equipment with current transformer circuits must not be operated while open.
- The limit values indicated in the manual and the Product Information must not be exceeded; this also refers to testing and commissioning.

Used Symbols

No.	Symbol	Description
1		Direct current IEC 60417-5031
2		Alternating current IEC 60417-5032
3		Three-phase alternating current
4		Erarth (ground) terminal IEC 60417-5017
5		Protective conductor terminal IEC 60417-5019
6		Caution, risk of electric shoc
7		Caution, risk of danger ISO 7000-0434

Statement of Conformity

CE	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.

Further Standards

This product is UL-certified to Standard UL 61010-1, based on the specification stated in chapter 13.1 (Technical Data). UL File No.: E228586.	
c UL US LISTED	Open-type Measuring Equipment 2UD1

Contents

1 User Information

Application

The digital measuring transducer SENTRON T 7KG966 is capable of measuring different quantities (alternating current, alternating voltage, etc. from power supply systems) and converting them into proportional direct current and direct voltage quantities. The device with protection class IP20 is used in 1-phase systems, in 3-wire and 4-wire systems (with neutral conductor). It is mainly applied by power utilities but also in other industrial and commercial sectors.

The measurements are obtained from the alternating quantities of current and voltage supplied to the AC inputs. Without using external voltage and current transformers, the device can process rated input AC voltages up to V_{ph-N} = 400 V (max. 347 V at Vph) and V_{ph-ph} = 690 V (max. 600 V at Vph) and rated input AC currents up to a maximum of 5 A.

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.

After conversion via the communication interfaces (Ethernet, RS485), the output values can be transferred as digital data to automation systems or other systems. Moreover, devices with DC analog outputs provide the option to transfer the output values as analog values. These values can, for example, be displayed on point meters or transmitted to peripheral devices for analysis.

The 4 DC analog outputs offer several options for the output of measured values:

- Direct voltages: 0 V to 10 V and -10 V to 10 V
- Direct currents: 0 mA to 20 mA, 4 mA to 20 mA and -20 mA to 20 mA

The response time of the measuring transducer outputs to measured value changes is 120 ms at 50 Hz and 100 ms at 60 Hz.

The device provides an Ethernet port for data exchange with peripheral devices; 2 device variants additionally provide an RS485 interface.

The integrated web server can be used to set the parameters and display the measured values on HTML pages from the connected PC or notebook.

Measurands

The following measurands 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

For detailed information on measurands and measured values, see chapter 4.1 and 4.2 and the technical data in Section 13.1.

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, counter values and indications and the time synchronization via NTP. The communication protocols are HTTP and Modbus TCP or IEC61850.

The RS485 interface supports the transmission of the measured data, counter values and indications and the time synchronization. Depending on the device version, you can use either the Modbus RTU or the IEC60870-5-103 communication protocol.

Time Synchronization

During operation SENTRON T 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 or the IEC60870-5-103 communication protocol
- Internal time synchronization via RTC (if external time synchronization is not available)

Parameterization

No special software is needed for parameterization. You can set the parameters from your computer via HTML pages and a web browser. Internet Explorer 6 (or higher) is necessary for this purpose.

2 Overview

2.1 Versions of SENTRON T 7KG966

Basic version (minimum equipment)

SENTRON T is a measuring device for the acquisition of electrical quantities in power supply systems, such as alternating current, alternating voltage, all power quantities, etc. The modules of the device detect, calculate, analyze and transmit measured values. In the basic version, the device is characterized as follows:

Device type:

- Top-hat rail mounted device
- Plastic case 96 mm x 96 mm x 100 mm (W x H x D)
- Protection class IP20

Input and output circuits:

- 4 inputs for alternating voltage measurements
- 3 inputs for alternating current measurements
- 2 individually programmable binary outputs

Communication:

- Via Ethernet

Variants

SENTRON T is available in various variants:

- AC input circuits
  - with voltage divider
  - galvanically isolated voltage inputs
- DC analog outputs
  - with 4 DC analog outputs (±20 mA or ±10 V, configurable individually)
  - without DC analog outputs
- RS485 interface
  - with RS485 interface
  - without RS485 interface
- Communication if RS485 interface exists
  - with Modbus RTU protocol
  - with Modbus RTU protocol and IEC60870-5-103 protocol
- Communication via Ethernet
  - with Modbus TCP protocol
  - with Modbus TCP protocol and IEC61850 server protocol

SENTRON T Variants

SENTRON T, Minimum Equipment

SENTRON T with DC Analog Outputs

SENTRON T with RS485 Interface

SENTRON T with DC Analog Outputs
and RS485 Interface

Fig. 2-1 SENTRON T Variants

2.2 Ordering Information, Scope of Delivery and Accessories

Ordering Information

Use the following ordering code to order the Multifunctional Transducer 7KG9661:

Description	Order No. / MLFB															
Multifunctional Transducer																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
SENTRON T	7	K	G	9	6	6	1	-		A		0	-	1	A	A	0
Device type																
Snap-on mounting unit without display, IP20																
Case 96 mm x 96 mm x 100 mm																
2 Binary outputs																
Web server																
UL Certification																
Measurements: V, I, f, P, Q, S, cos phi, energy																
Modbus TCP																
AC input circuits																
Resistive divider								1								
Galvanic isolated voltage transformers								2								
DC analog outputs																
Without									A							
4 DC analog outputs -20 mA to 20 mA/-10 V to 10 V									F							
Serial interface and communication protocol																
Without											0					
RS485 – Modbus RTU											1					
RS485 – IEC 60870-5-103 and Modbus RTU											3					

Fig. 2-2 Ordering Code for 7KG9661

Use the following ordering code to order the Multifunctional Transducer 7KG9662:

Description	Order No. / MLFB															
Multifunctional Transducer																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
SENTRON T – IEC 61850	7	K	G	9	6	6	2	-		A	0	0	-	2	A	A	0
Device type																
Snap-on mounting unit without display, IP20																
Case 96 mm x 96 mm x 100 mm																
2 Binary outputs																
Web server																
UL Certification																
Measurements: V, I, f, P, Q, S, cos phi, energy harmonics																
IEC 61850																
AC input circuits																
Resistive divider								1								
Galvanic isolated voltage transformers								2								
DC analog outputs																
Without									A							
4 DC analog outputs -20 mA to 20 mA/-10 V to 10 V									F							

Fig. 2-3 Ordering Code for 7KG9662

Scope of Delivery

The delivery comprises the following components depending on the ordering code:

- Multifunctional transducer according to ordering code (see Figure 2-2 or Figure 2-3)
- Battery (insulated in the battery compartment of the device)
- Product Information E50417-B1050-C493

Accessories

The following components are optionally available:

- Device Manual E50417-H1040-C493 (download available at www.powerquality.de)
- RS485 bus terminating plug 220 Ω in a 9-pin D-sub connector plug: 7XV5103-5AA00
- Sockets for AC voltage inputs

  Order via:

  Phoenix Contact GmbH & Co. KG

  Item number: 1700734

  Product name: GMSTB 2,5 HCV/ 4-ST-7,62 BK TS

  Minimum order quantity: 50 pieces
- Various cables as listed in the following tables:

Table 2-1 RS485-Y Bus Cable (2-wire, shielded, with 9-pin D-sub connector plugs)

Cable Length	Order No.
1 m	7XV5103-0AA01
3 m	7XV5103-0AA03
5 m	7XV5103-0AA05
10 m	7XV5103-0AA10

Table 2-2 RS485 Bus Extension Cable (2-wire, shielded, with 9-pin D-sub connector plugs)

Cable Length	Order No.
10 m	7XV5103-1AA10
20 m	7XV5103-1AA20
30 m	7XV5103-1AA30
40 m	7XV5103-1AA40
50 m	7XV5103-1AA50

Table 2-3 Ethernet Patch Cable (double shielded (SFPT), LAN connector plugs on both sides)

Cable Length	Order No.
0.5 m	7KE6000-8G-D00-0AA5
1.0 m	7KE6000-8G-D00-1AA0
2.0 m	7KE6000-8G-D00-2AA0
3.0 m	7KE6000-8G-D00-3AA0
5.0 m	7KE6000-8G-D00-5AA0
10.0 m	7KE6000-8G-D01-0AA0
15.0 m	7KE6000-8G-D01-5AA0
20.0 m	7KE6000-8G-D02-0AA0

3 Device Design

3.1 Mechanical Design

The electrical modules are installed in a plastic case with the dimensions 96 mm x 96 mm x 100 mm (W x H x D). The case is prepared for mounting on a DIN rail.

The top side of the device accommodates the RJ45 Ethernet connector with 2 LEDs and 4 additional LEDs. At the cover of the battery compartment there is a labeling strip for the configurable LEDs H1/H2/ERROR and a battery symbol that indicates the polarity. The label is also located on the top side and provides among other information the most important rated data of the device. A lithium battery is located under the removable cover of the battery compartment.

The terminals for connecting all inputs and outputs, for the supply voltage and the protective grounding are located on the terminal side. The number, type and position of the terminals differs according to device version and is described in detail in chapter 5.3. According to the ordering information (see chapter 2.2), SENTRON T can also be equipped with an RS485 plug connector (see Figure 3-1).

The snap-in unit is mounted in the center of the DIN rail side. The IP Addr. push-button is located in the lower right corner of the DIN rail side. Pressing it (> 3 s) activates the factory-set default IP address. The default IP address and the default subnet mask are imprinted on the side panel.

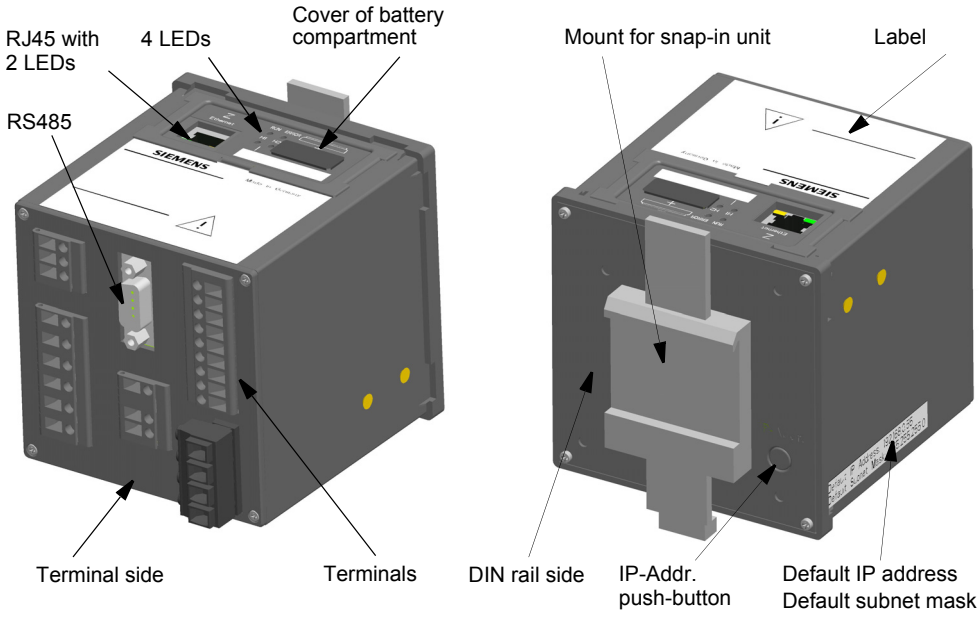


Fig. 3-1 Design of the Digital Transducer SENTRON T

3.2 Electrical Design

SENTRON T 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 (acc. to order version)

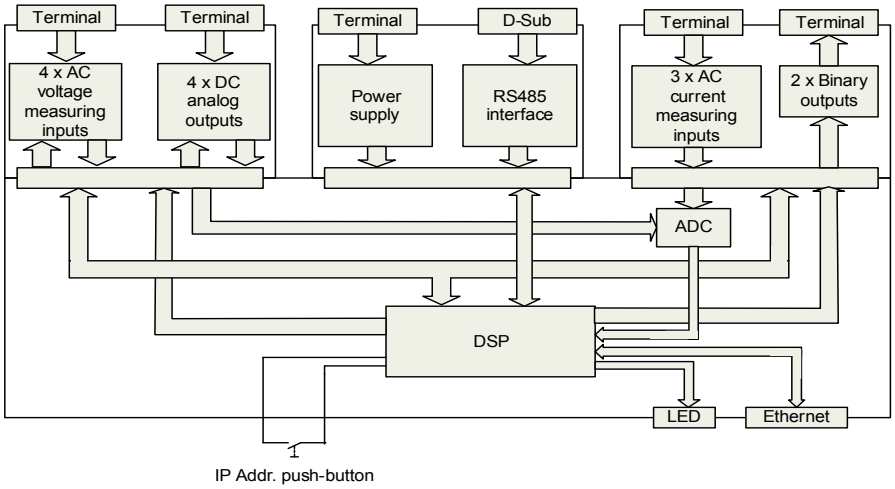


Fig. 3-2 Block Diagram SENTRON T

4 Measurands and Characteristics

4.1 Measurands

4.1.1 Measurands in 1-phase Systems

The Digital Transducer SENTRON T can measure and calculate quantities in 1-phase systems, chapter 4.1.3 contains a detailed list of all measurands.

Measured and Calculated Quantities

The operational quantities AC voltage V_{ph}, AC current I_P and frequency f are measured directly. All other operational measurands, power and energy quantities are calculated from the measured operational quantities.

Operational Measurands

SENTRON T measures or calculates the following operational quantities:

- AC voltage V_{ph} (mains voltage referred to the neutral conductor/protective ground N; RMS value): Va
- AC current I_P (current through the conductor, RMS value): Ia
- Active power factor cos ϕ: cos ϕ (a)
- Power factor PF: PFa
- Phase angle ϕ: ϕa
- Frequency (power frequency): f

Power Quantities

SENTRON T calculates the following power values from the measured operational quantities:

- Active power P: Pa
- Reactive power Q: Qa
- Apparent power S: Sa

Energy Quantities

SENTRON T calculates the following energy values from the measured operational quantities:

- Active energy WP: WPa (supply and demand)
- Reactive energy WQ: WQa (inductive and capacitive)
- Apparent energy WS: WSa

4.1.2 Measurands in 3-wire and 4-wire Networks

The Digital Transducer SENTRON T can measure or calculate the following quantities in 3-wire and 4-wire networks (delta and star connection): chapter 4.1.3 contains a detailed list of all measurands.

Measured and Calculated Quantities

The operational quantities AC voltage V_{ph-N}, AC voltage V_{ph-ph}, AC current I_{ph}, AC voltage across the neutral conductor V_N and frequency f are measured directly. All other operational measurands, power and energy quantities are calculated from the measured operational quantities.

Operational Measurands

SENTRON T measures or calculates the following operational quantities:

- AC voltage phase-neutral conductor (neutral conductor connected to protective ground; star connection) V_{ph-N}: Va, Vb, Vc
- AC voltage phase-phase (delta connection) V_{ph-ph}: Vab, Vbc, Vca
- AC current I_P (current through the conductor): Ia, Ib, Ic
- AC voltage across the neutral conductor: V_N
- Unbalanced voltage: V_{unbal}
- Unbalanced current: I_{unbal}
- Mean value of the 3 phase voltages: V_{avg}
- Current in neutral conductor: I_N
- Mean value of the 3 phase currents: I_{avg}
- Active power factor cos ϕ: cos ϕ (a), cos ϕ (b), cos ϕ (c), cos ϕ
- Power factor PF: PFa, PFb, PFc, PF
- Phase angle ϕ: ϕa, ϕb, ϕc, ϕ
- Frequency (power frequency): f (see Table 4-5)

Power Quantities

SENTRON T calculates the following power values from the measured operational quantities:

- Active power P: Pa, Pb, Pc, P
- Reactive power Q: Qa, Qb, Qc, Q
- Apparent power S: Sa, Sb, Sc, S

Energy Quantities

SENTRON T calculates the following energy values from the measured operational quantities:

- Active energy WP: WPa, WPb, WPc, WP (for supply and demand respectively)
- Reactive energy WQ: WQa, WQb, WQc, WQ (inductive and capacitive respectively)
- Apparent energy WS: WSa, WSb, WSc, WS

4.1.3 Measurands Depending on the Connection Type

4.1.3.1 Operational Measurands

Table 4-1 Measurands for the Operation 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							
Va	a-N	x				x	x
Vb	b-N						x
Vc	c-N						x
Vab	a-b		x	x	x		x
Vbc	b-c		x	x	x		x
Vca	c-a		x	x	x		x
V_N	a, b, c						x
Vavg	a, b, c		Σ Vph/3	Σ Vph/3	Σ Vph/3	a-N	Σ Vph/3
Vunbal	a-b, b-c, c-a		x	x	x		x
ACCurrent							
Ia	a	x	x	x	x	x	x
Ib	b			x	x		x
Ic	c			x	x		x
I_N	a, b, c			x			x
Iavg	a, b, c			x	x		Σ Iph/3
Iunbal	a, b, c			x	x		x
Active PowerFactor							
cos ϕ (a)	a	x					x
cos ϕ (b)	b						x

Table 4-1 Measurands for the Operation in Power Systems (cont.)

Measurand	Circuit	1-phase System	3-wire Network (delta)			4-wire Network (star)	
			Balanced (1I)	Unbalanced (3I)	Unbalanced (2I)	Balanced (1I)	Unbalanced (3I)
cos ϕ (c)	c						x
cos ϕ	a, b, c		x	x	x	x	x
Power factor							
PFa	a	x					x
PFb	b						x
PFc	c						x
PF	a, b, c		x	x	x	x	x
Phase angle							
ϕa	a	x					x
ϕb	b						x
ϕc	c						x
ϕ	a, b, c		x	x	x	x	x
Frequency							
f	see Table 4-5	x	x	x	x	x	x

4.1.3.2 Measurands of Power

Table 4-2 Measurands of Power in Power Systems

Measurand	Circuit	1-phase System	3-wire Network (delta)			4-wire Network (star)	
			Balanced (1l)	Unbalanced (3l)	Unbalanced (2l)	Balanced (1l)	Unbalanced (3l)
Active Power							
Pa	a	x					x
Pb	b						x
Pc	c						x
P	a, b, c		x	x	x	x	x
Reactive Power							
Qa	a	x					x
Qb	b						x
Qc	c						x
Q	a, b, c		x	x	x	x	x
Apparent Power							
Sa	a	x					x
Sb	b						x
Sc	c						x
S	a, b, c		x	x	x	x	x

4.1.3.3 Measurands of Energy

Table 4-3 Measurands of Energy in Power Systems

Measurand	Circuit	1-phase System	3-wire Network (delta)			4-wire Network (star)	
			Balanced (1l)	Unbalanced (3l)	Unbalanced (2l)	Balanced (1l)	Unbalanced (3l)
Active Energy - Supply							
WPa_ Supply	a	x					x
WPb_ Supply	b						x
WPc_ Supply	c						x
WP_ Supply	a, b, c		x	x	x	x	x
Active Energy - Demand							
WPa_ Demand	a	x					x
WPb_ Demand	b						x
WPc_ Demand	c						x
WP_ Demand	a, b, c		x	x	x	x	x
Reactive Energy - Inductive							
WQa_ inductive	a	x					x
WQb_ inductive	b						x
WQc_ inductive	c						x
WQ_ inductive	a, b, c		x	x	x	x	x
Reactive Energy - Capacitive							
WQa_ capacitive	a	x					x

Table 4-3 Measurands of Energy in Power Systems (cont.)

Measurand	Circuit	1-phase System	3-wire Network (delta)			4-wire Network (star)	
			Balanced (1l)	Unbalanced (3l)	Unbalanced (2l)	Balanced (1l)	Unbalanced (3l)
WQb_ capacitive	b						x
WQc_ capacitive	c						x
WQ_ capacitive	a, b, c		x	x	x	x	x
Apparent Energy							
WSa	a	x					x
WSb	b						x
WSc	c						x
WS	a, b, c		x	x	x	x	x

4.2 Display of Measurands

Table 4-4 Measurands

Measurands	Unit	Rated Value	Operat. Measurem. Uncertainty	
			acc. to IEC 61557-12 [1]	acc. to IEC 60688 [2]
Voltage V_{ph-ph} (delta) Acc. to parameterization	V	AC 110 V AC 190 V AC 400 V AC 690 V (max. AC 600 V for UL)	±0.2 %	±0.1 %
Voltage V_{ph-N} (star) Acc. to parameterization	V	AC 63.5 V AC 110 V AC 230 V AC 400 V (max. AC 347 V for UL)	±0.2 %	±0.1 %
Voltage unbalance V_{unbal}	%	-	±0.2 %	±0.2 %
Current I Acc. to parameterization	A	AC 1 A AC 5 A	±0.2 %	±0.1 %
Current unbalance I_{unbal}	%	-	±0.2 %	±0.2 %
Active power P + demand, - supply	W	-	±0.5 % 0,2S acc. to IEC 62053-21	±0.2 %
Reactive power Q + inductive, - capacitive	var	-	±0.5 %	±0.2 %
Apparent power S	VA	-	±0.5 %	±0.2 %
Power factor PF [3]	-	-	±1 %	±0.5 %
Active power factor cos ϕ [3]	-	-	±1 %	±0.5 %
Phase angle ϕ [3]	Degree	-	±2°	±1°
Frequency f	Hz	50 Hz and 60 Hz	See Table 4-5	See Table 4-5
Active energy WP demand	Wh	-	±0.5 %	±0.5 %
Active energy WP supply	Wh	-	±0.5 %	±0.5 %
Reactive energy WQ inductive	varh	-	±0.5 %	±0.5 %
Reactive energy WQ capacitive	varh	-	±0.5 %	±0.5 %
Apparent energy WS	VAh	-	±0.5 %	±0.5 %

1) for operating condition valid
2) At reference conditions (see chapter 13.2) are applicable from 0.1 to 1.2 x nominal range
3) Measurement from 2 % of the rated apparent power value onwards in the selected measuring range (see chapter 13.2)

Table 4-5 Accuracy of the Frequency Measurement

Circuit	Accuracy
Voltage to V_{a-N}	0 % to 15 % V_{rated}: invalid
	15 % to 30 % V_{rated}: 40 mHz
	30 % to 120 % V_{rated}: 10 mHz
Voltage to V_{b-N}	0 % to 15 % V_{rated}: invalid
	15 % to 30 % V_{rated}: 40 mHz
	30 % to 50 % V_{rated}: 30 mHz
	50 % to 120 % V_{rated}: 20 mHz
Voltage to V_{c-N}	0 % to 15 % V_{rated}: invalid
	15 % to 30 % V_{rated}: 40 mHz
	30 % to 120 % V_{rated}: 10 mHz

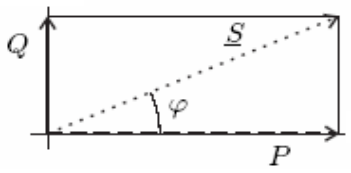
NOTE
The frequency at measuring circuit V_{a-N} is measured first. If the voltage V_{a-N} is smaller than 30 % of V_{rated}, the measurement will automatically be carried out at measuring circuit V_{c-N}. If the voltages V_{a-N} and V_{c-N} are smaller than 30 % of V_{nom}, the measurement will automatically be carried out at measuring circuit V_{b-N}.

4.3 Calculation of the Measurands

Table 4-6 Calculation of the Measurands

Measurand	Formula	Note
RMS voltage	$V_{rms} = \sqrt{\frac{1}{N}\sum_{a=0}^{N-1} v_a^2}$	N = 192; number of the measuring points via one RMS value calculation mode (3 periods)
Unbalanced voltage	$V_{unbal} = \sqrt{\frac{1-\sqrt{3-6\beta}}{1+\sqrt{3-6\beta}}} \times 100\%$	$\beta = \frac{V_{12\_fund}^4 + V_{23\_fund}^4 + V_{31\_fund}^4}{(V_{12\_fund}^4 + V_{23\_fund}^4 + V_{31\_fund}^4)^2}$
RMS current	$I_{rms} = \sqrt{\frac{1}{N}\sum_{a=0}^{N-1} i_a^2}$	
Unbalanced current	$I_{unbal} = \sqrt{\frac{1-\sqrt{3-6\beta}}{1+\sqrt{3-6\beta}}} \times 100\%$	$\beta = \frac{I_{12\_fund}^4 + I_{23\_fund}^4 + I_{31\_fund}^4}{(I_{12\_fund}^4 + I_{23\_fund}^4 + I_{31\_fund}^4)^2}$
Active power	$P = \frac{1}{N}\sum_{a=0}^{N-1} v_a \times i_a$	Simple multiplication of sampled voltage and current values with subsequent calculation of a sum
Reactive power	$Q = \frac{1}{N}\sum_{a=0}^{N-1} v_a \times i_{a-\Delta Nc}$ with $\Delta N_c = \frac{Nc}{4}$	Calculation same as active power but with 90° phase difference between V and I, additional fault for distorsion N = 192, number of measuring points via an RMS value calculation mode (3 periods) Nc = 64; number of measuring points in one period ΔNc = 16 samples at 90° (phase difference V to I)

Table 4-6 Calculation of the Measurands (cont.)

Measurand	Formula	Note
Apparent power	$S = \sqrt{P^2 + Q^2}$	
Power factor	$PF = \frac{\lvert P \rvert}{S}$	
Active power factor (see Figure 4-1)	$\cos\varphi = \frac{P}{S}$	
Phase angle	$\varphi = \arctan\frac{Q}{P}$	
Active energy, demand	$WP_{sum} = \sum_{x=1}^{3} P_{Lx}$	For P > 0
Active energy, supply	$WP_{sum} = \sum_{x=1}^{3} P_{Lx}$	For P < 0
Reactive energy, inductive	$WQ_{sum} = \sum_{x=1}^{3} Q_{Lx}$	
Reactive energy, capacitive	$WQ_{sum} = \sum_{x=1}^{3} Q_{Lx}$	
Apparent energy	$WS_{sum} = \sum_{x=1}^{3} S_{Lx}$	

Legend:

N: Number of the measuring points via an RMS value calculation mode (3 periods)

N_c: Number of the values sampled during a period of the system frequency.
v_a: Sampled voltage values

i_a: Sampled current values

Lx: Phase a to c

ΔN_c: Number of delayed samplings (phase difference V to I of 90°)

fund: Fundamental wave

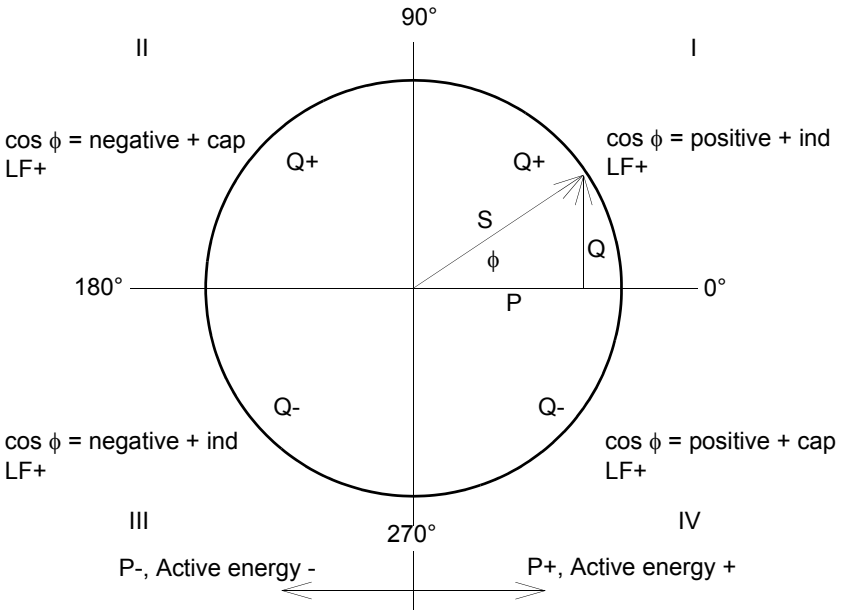


Fig. 4-1 4-quadrant System

4.4 Transfer Characteristics of the DC Analog Outputs

The following types of characteristics are used for the transmission of measured values to the DC analog outputs:

NOTE

The following quantities are used with the characteristics shown below:

- Output quantities at the DC analog outputs: I_O, V_O
- Input quantities to be measured: I_I, V_I, x

Characteristic - Linear

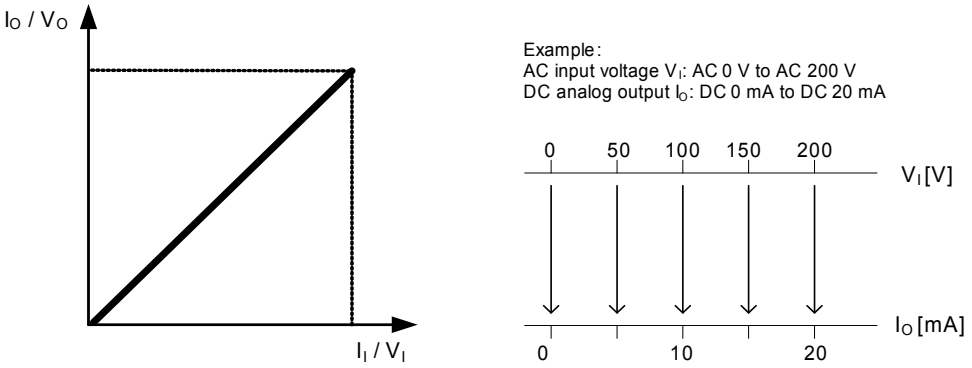


Fig. 4-2 Characteristic - Linear

Characteristic - Zoom

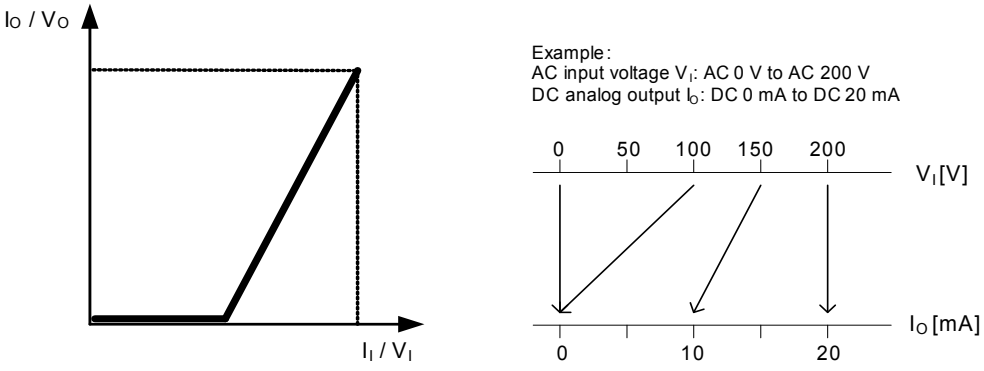
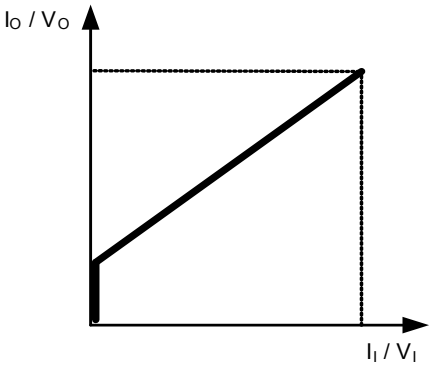


Fig. 4-3 Characteristic - Zoom

Characteristic - Live Zero



Example:
AC input voltage V_I: AC 0 V to AC 200 V
DC analog output I_O: DC 4 mA to DC 20 mA

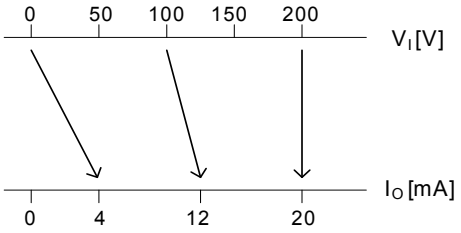
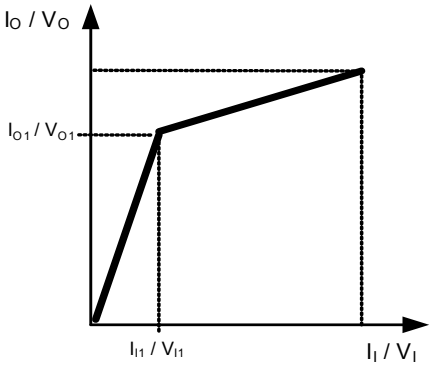


Fig. 4-4 Characteristic - Live Zero

Characteristic - Knee-point



Example:
AC input voltage V_I: AC 0 V to AC 200 V
DC analog output I_O: DC 0 mA to DC 20 mA

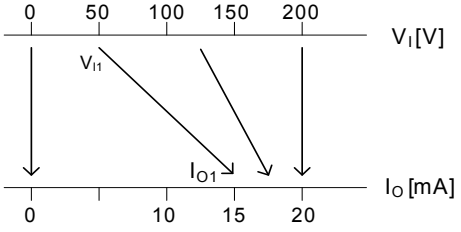
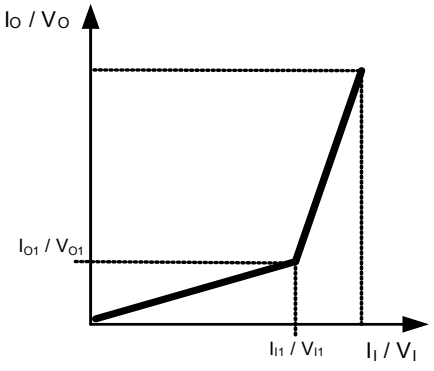


Fig. 4-5 Characteristic - Knee-point

Characteristic - Knee-point Zoom



Example:
AC input voltage V_I: AC 0 V to AC 200 V
DC analog output I_O: DC 0 mA to DC 20 mA

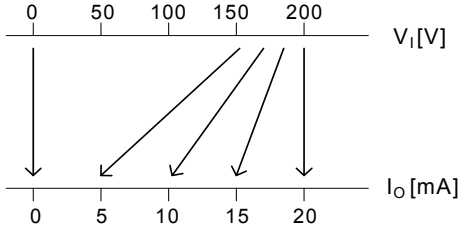
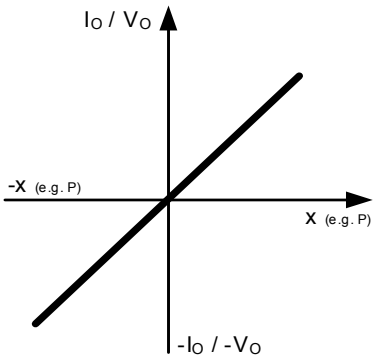


Fig. 4-6 Characteristic - Knee-point zoom

Characteristic - Bipolar Linear



Example:
Active power P: -100 kW (supply) to 100 kW (demand)
DC analog output V_O: DC -10 V to DC 10 V

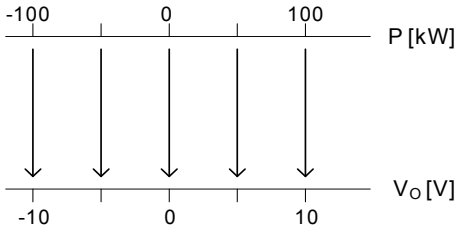
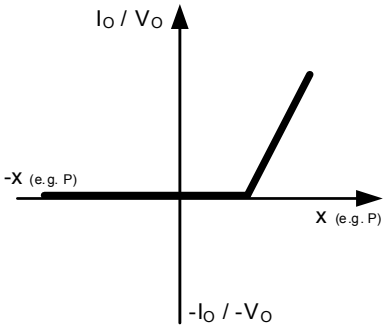


Fig. 4-7 Characteristic - Bipolar Linear

Characteristic - Bipolar Knee-point Zoom



Example:
Active power P: -200 kW (supply) to 200 kW (demand)
DC analog output I_O: DC 0 mA to DC 20 mA

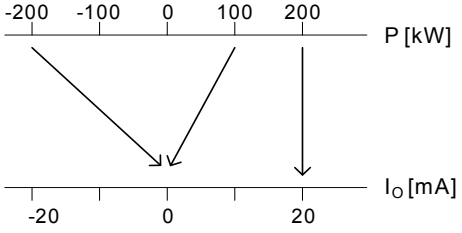
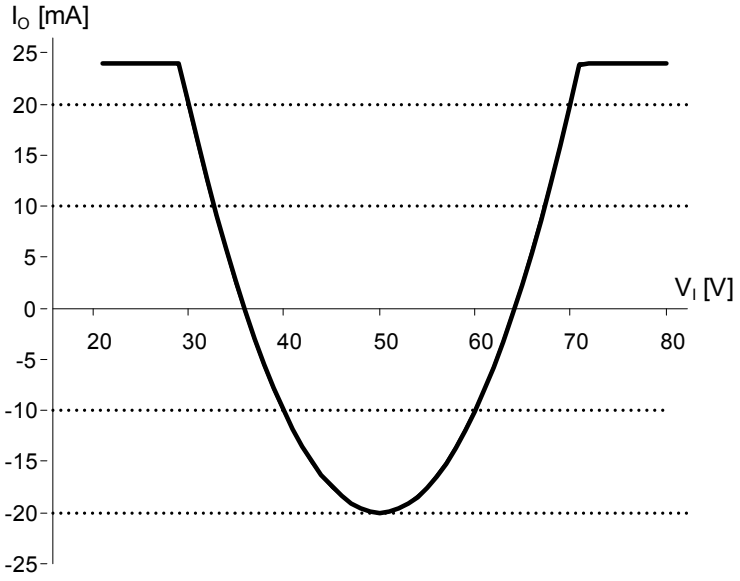


Fig. 4-8 Characteristic - Bipolar Knee-point zoom

Square Transfer Characteristic

Example: Input voltage V_I: AC 20 V to 80 V; DC analog output I_O: DC -20 mA to 20 mA



Calculation formula

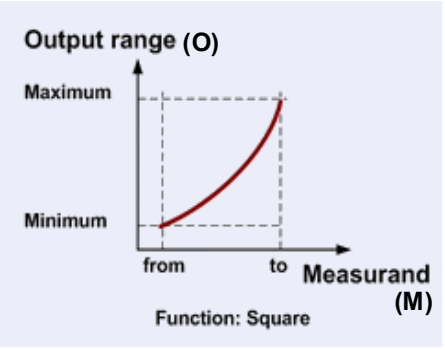
$$M < M_1 \qquad O = O_{max} \cdot 1.2$$

$$M_1 < M < M_2 \qquad O = O_{min} + (O_{max} - O_{min}) \cdot \frac{(M - M_{from})^2}{(M_{to} - M_{from})^2}$$

$$M > M_2 \qquad O = O_{max} \cdot 1.2$$

$$M_1 = M_{from} - \sqrt{\frac{(1.2 \cdot O_{max} - O_{min})}{(O_{max} - O_{min})}} \cdot (M_{to} - M_{from})$$

$$M_2 = M_{from} + \sqrt{\frac{(1.2 \cdot O_{max} - O_{min})}{(O_{max} - O_{min})}} \cdot (M_{to} - M_{from})$$



M : Measurand Value O : Output Value

Fig. 4-9 Square Transfer Characteristic

V_I [V]	20	25	30	36	40	45	50	55	60	64	70	75	80
I_O [mA]	24	24	20	-0,4	-10	-17,5	-20	-17,5	-10	-0,4	20	24	24

5 Getting Started

5.1 Unpacking, Inspecting the Delivery and Installing the Battery

Unpacking

The 7KG966 has been safely packed for transport in the factory. Unpack the device with care and do not use force. Use an appropriate tool if necessary. After unpacking, inspect the device visually for any mechanical defects.

NOTE

If the device has been damaged during transport, do not connect and operate it.

Observe any additional notes enclosed with the packaging.

Keep the transport packaging for future transport.

Inspecting the Delivery

After unpacking, first compare the packing list against your original purchase order to check that the delivered device has the desired rated data and functions and that all necessary and ordered accessories are enclosed.

Installing the Battery

If you want to operate the device immediately after the delivery, first insert the battery before beginning the installation. Upon delivery the battery is insulated in the battery compartment of the device.

If you want to operate the device later, insert the battery only just before you intend to use the device.

NOTE

The battery powers the battery-buffered memory (SRAM) and the real-time clock (RTC). But the device can still be operated when no battery is inserted or when the battery is discharged. If, however, the supply voltage is lost, all metered energy values and error reports are deleted and the real-time clock is reset (2000-01-01 00:00).

Customer-specific parameters are permanently stored in the Flash-EPROM even without a battery.

To insert the battery, observe the notes in the supplied Product Information E50417-B1050-C493 and proceed as follows:

✧ Lever the cover of the battery compartment out of the socket with a suitable tool (e.g. precision engineer screwdriver 2.0 mm).

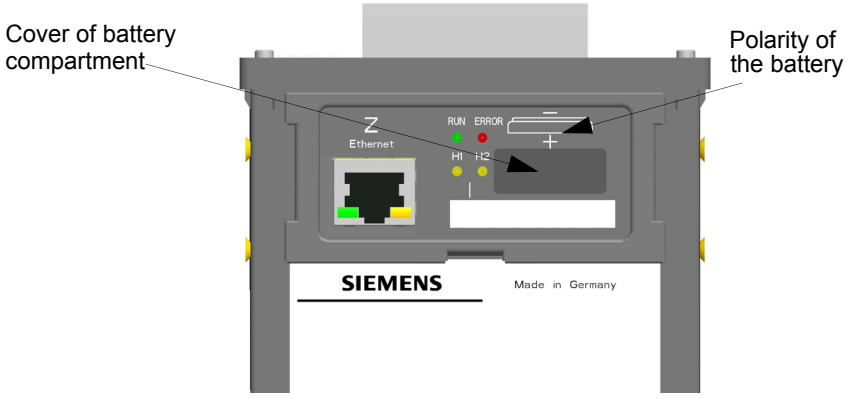


Fig. 5-1 Top side of the SENTRON T

- ✧ Take the wrapped battery out of the battery compartment.
- ✧ Remove the plastic foil from the battery.
- ✧ Insert the battery into the battery compartment with the polarity imprinted on the top side of the device (see Figure 5-1).
- ✧ Close the cover of the battery compartment.

NOTE

The Product Information E50417-B1050-C493 describes how to replace the battery. Information on battery life can be found in chapter 13.1.5.

WARNING

Warning of incorrect treatment of the lithium battery (type PANASONIC CR2032 or VARTA 6032 101 501) or the use of an incorrect battery type. In the case of incorrect treatment or the wrong battery type, the battery may burn, explode or trigger a chemical reaction.

See product information for type of battery to be used.

Non-observance may lead to death or serious injury.

- Installing the battery or replacing it may only be carried out by trained personnel (see preface) who are familiar with and observe the safety requirements and precautions.
- Do not reverse the polarity of the battery.
- Do not attempt to open the battery.
- Do not attempt to recharge the battery.
- Servicing of the circuitry involving the batteries and replacement of the lithium batteries shall be done by a trained technician.
- Replace battery with VARTA 6032 101 501 or PANASONIC CR2032 only. Use of another battery may present a risk of fire or explosion. See manual for safety instructions.
- Caution: The battery used in this device may present a fire or chemical burn hazard if mistreated. Do not recharge, disassemble, heat above 100 °C (212 °F) or incinerate.
- Dispose of used battery promptly. Keep away from children.

5.2 Assembly

5.2.1 General Assembly Notes

SENTRON T is intended to be installed on a hat rail, e.g. in a control cabinet.

WARNING

Warning: do not touch any voltage-carrying parts

Non-observance may lead to death or serious injury.

✧ After installation of the device and wiring, close the control cabinet.

- The installation site must be be vibration-proof. The permitted ambient temperature must be observed (see the technical data in chapter 13).
- Operating the device outside the permitted operating temperature range can lead to measuring errors and device failure.
- The terminals are designed for wire cross-sections of 2.5 mm² max.
- The device must not be exposed to condensation during operation.
- The device must be be installed in a location where it is not exposed to direct sunlight and strong temperature variations.

5.2.2 Assembly

Mount the SENTRON T to a top-hat rail according to EN 60750 in the following way:

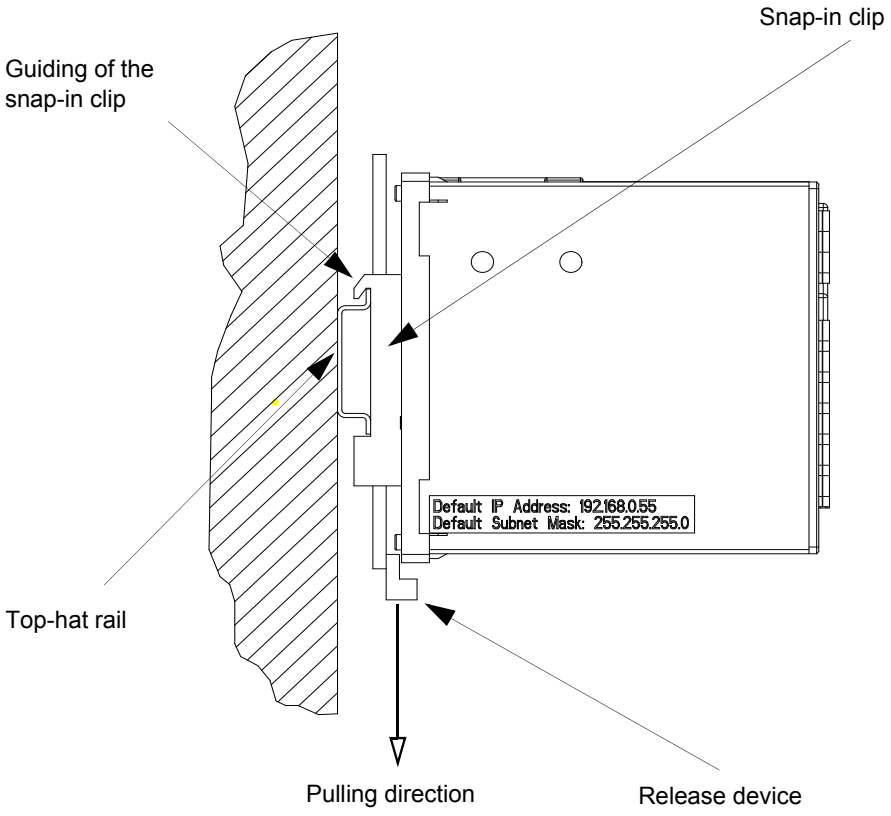


Fig. 5-2 Mounting on a Top-hat Rail

- ✧ Pull down the release device at the snap-in clip and hold it in this position.
- ✧ Slide the device with the guiding of the snap-in clip onto one side of the top-hat rail.
- ✧ Move the device into the desired position on the top-hat rail.
- ✧ Release the release device. The device is now firmly mounted on the top-hat rail.

NOTE

The snap-in clip is adjusted to a certain height setting by the manufacturer. You can change this setting if necessary. To do so, lever the release device out of its guiding (no special tool required) and move the release device into the desired position. Subsequently, press the release device back into its guiding.

UL-certification conditions

Field Wires of Control Circuits shall be separated from other circuits with respect to the end use requirements!

5.3 Electrical Connection

5.3.1 Safety Notes

DANGER

Hazard due to high voltage

Non-observance will lead to death or serious injury.

- Work may only be carried out by trained personnel (see Preface) who are familiar with and observe the safety requirements and precautions.
- Work may never be carried out if there is any dangerous voltage present.
- Deenergize the device.
- **Circuit breaker:** A suitable isolating device shall be connected upstream in order to permit disconnection of the device from the power supply. The circuit breaker must be mounted close to the device, be easily accessible to the user and marked as a circuit breaker for the device.
- Secure the supply voltage with an approved (UL/IEC) fuse: 1.6 A, type C.
- If a melting fuse is used, a suitable approved (UL/IEC) fuse holder has to be used.

NOTE

For electrical installations you have to observe and comply with the national and international provisions concerning the installation of electrical power installation and the low voltage directive 2006/95/EG.

- Before commissioning the device, you have to check that all connections are made properly.
- Connect the protective grounding terminal H ⏚ to the protective ground of the switch panel or of the control cabinet.
- The secondary connections of interconnected current transformers must be short-circuited at these before you disconnect the power supply leads to the device.
- **Voltage measuring inputs:** In the case of a **direct connection** and **transformer connection**, the device has to be safeguarded with a **listed 10 A backup fuse** or a listed 10 A miniature circuit breaker. When using voltage transformers, their secondary connections must never be short-circuited!
- Check the polarity and the phase assignment at the instrument transformers.
- Siemens recommends leaving the device for a minimum of 2 hours in the operating room, before using it to allow temperature equalization and to avoid dimness and condensation.

NOTE

Before you switch on the supply voltage, verify that the operational data match the rated data on the label and the technical data according to chapter 13. This applies in particular to the supply voltage V_H and to the maximum values of AC current and AC voltage.

5.3.2 Electrical Connection of SENTRON T

NOTE

The electrical connections for all devices described in this manual are identical. They are described at the example of SENTRON T 7KG966x-1FA00-1AA0.

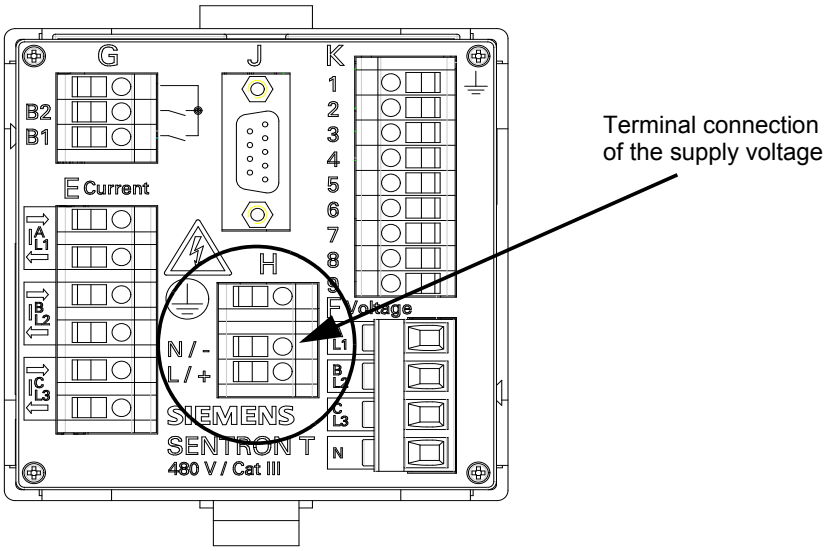


Fig. 5-3 Terminal Connection of the Supply Voltage at the SENTRON T 7KG966x-1FA00-1AA0

DANGER

Hazard due to high voltage

Non-observance will lead to death or serious injury.

- Work may only be carried out by trained personnel (see Preface) who are familiar with and observe the safety requirements and precautions.
- Work may never be carried out if there is any dangerous voltage present.
- Deenergize the device.
- **Circuit breaker:** A suitable isolating device shall be connected upstream in order to permit disconnection of the device from the power supply. The circuit breaker must be mounted close to the device, be easily accessible to the user and marked as a circuit breaker for the device.
- Secure the supply voltage with an approved (UL/IEC) fuse: 1.6 A, type C.
- If a melting fuse is used, a suitable approved (UL/IEC) fuse holder has to be used.

Connect the cables of the supply voltage on the terminal side of the device at **terminal block H** as follows:

Supply from the AC Voltage System

Terminal N/-:	Neutral conductor of the supply voltage
Terminal L/+:	Phase of the supply voltage
Terminal ⏚ :	Protective grounding terminal

Supply from a Direct Voltage Source

Terminal N/-:	Negative supply voltage
Terminal L/+:	Positive supply voltage
Terminal ⏚ :	Protective grounding terminal

NOTE

The grounding on the SENTRON T always has to be connected to the terminal for protective conductor ⏚ (terminal block H).

Terminals

Terminals for supply voltage (H), inputs for current measurement (E), inputs for voltage measurement (F), binary outputs (G), DC analog outputs (K) on the terminal side:

Conductor cross-section, rigid max.	2.5 mm² (AWG 14)
Conductor cross-section with ferrule	1.5 mm² (AWG 16)
Conductor cross-section with ferrule (terminal F)	2.5 mm² (AWG 14)
Tightening torque	0.4 Nm to 0.5 Nm (3.5 in-lb to 4.5 in-lb)
RS485 interface (J) on the terminal side:	9-pole D-SUB miniature female connector
Ethernet interface (Z) on the top side:	Ethernet patch cable or crossover cable

Voltage measuring inputs: In the case of a **direct connection** and **transformer connection**, the device has to be safeguarded with a **listed 10 A backup fuse** or a listed 10 A miniature circuit breaker. When using voltage transformers, their secondary connections must never be short-circuited!

5.4 System Requirements

To operate SENTRON T with a PC or notebook, the following system requirements must be met:

- PC or notebook with Intel Pentium processor (or compatible type); clock frequency min. 800 MHz
- Operating system: Microsoft Windows XP Professional with Internet Explorer 6.0 (or higher)
- Minimum 1 GB RAM primary storage
- VGA display 1024 x 768 with truecolor
- Mouse and keyboard

5.5 Access Rights

Access Rights forConfiguration and Maintenance

To determine access rights, you have to set up passwords when configuring the device. You have to specify an activation password and a maintenance password. chapter 7.3.4.4 describes how to set up passwords.

The **activation password** is necessary to enable parameter changes in the device. The **maintenance password** is necessary to make changes in the device using the Maintenance tab.

NOTE

If you do not specify new passwords, the factory-set default passwords (see chapter 7.3.4.4) are valid.

Access Rights for Communication

The access rights for the communication via **Ethernet** with **Modbus TCP** protocol are made for port 502 and for the user port. You can assign either full access rights or read-only authorization. chapter 7.3.4.2 describes the settings.

You can also determine the access rights for **serial communication** using the **Modbus RTU** protocol. You can assign either full access rights or read-only authorization. chapter 7.3.4.3 describes the settings.

No access rights are required when **serial communicating** via the **IEC 60870-5-103** protocol.

Communication via **Ethernet** with **IEC 61850 server** protocol and **serial communication** with **IEC 60870-5-103** protocol do not require any access rights.

5.6 Meaning of the LEDs

7KG966 automatically monitors the functions of its hardware and software components. The LEDs on the top side of the housing indicate the current device status.

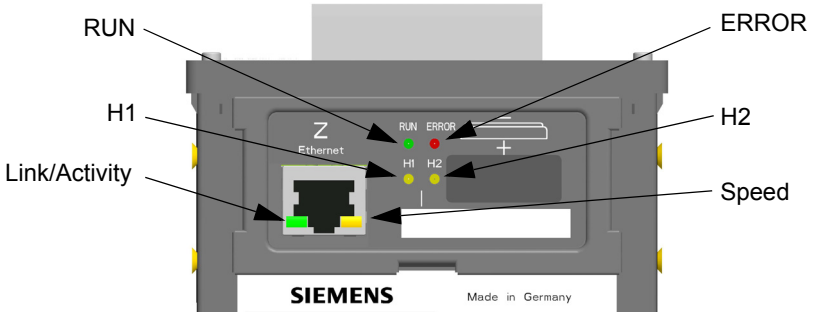


Fig. 5-4 Designation of the LEDs

Depending on the status, the LEDs can be permanently on, flash or off. The states are described in chapter 12.3. The meaning of the LEDs during normal operation is explained in the following table:

Table 5-1 Meaning of the LEDs

LED	Meaning
RUN	Device active
ERROR	Indicates an error and indicates according to parameterization
H1	According to parameterization
H2	According to parameterization
Link/Activity	LED on: Ethernet link is up LED flashing: Ethernet link is up and data are transferred LED off: no Ethernet partners connected
Speed	LED on: 100 Mbit/s LED off: 10 Mbit/s

5.7 Commissioning

5.7.1 Initial Commissioning

DANGER

Hazard due to high voltage

Non-observance will lead to death or serious injury.

- Work may only be carried out by trained personnel (see Preface) who are familiar with and observe the safety requirements and precautions.
- Work may never be carried out if there is any dangerous voltage present.
- Deenergize the device.
- **Circuit breaker:** A suitable isolating device shall be connected upstream in order to permit disconnection of the device from the power supply. The circuit breaker must be mounted close to the device, be easily accessible to the user and marked as a circuit breaker for the device.
- Secure the supply voltage with an approved (UL/IEC) fuse: 1.6 A, type C.
- If a melting fuse is used, a suitable approved (UL/IEC) fuse holder has to be used.

After you have inserted the battery, assembled the device and connected the supply voltage lines, you can start the device for the first time. Proceed as follows:

✧ Check that the operational data match the rated data on the label and the technical data of the device (see chapter 13). This applies in particular to the supply voltage and to the maximum values of AC current and AC voltage.

NOTE

The wiring of the terminals described below depends on the type of measurement and analysis of the measurement result. You only have to wire the terminals needed for your purposes.

✧ On the terminal side of the device connect the measuring lines linked with the measurement objects at the terminal blocks E (current) and F (voltage). chapter 6 describes interfaces, connection principles and examples of connection possibilities.

✧ On the terminal side of the device connect the process connections required for the measurements.

✧ For instance, connect a cable to the systems control on the terminal side of the device at terminal block J (RS485 interface, only for 7KG966x-xxA10-xAA0/-xxA30-xAA0).

✧ On the top side of the device, connect the network cable to the PC at the RJ45 socket Z (Ethernet).

✧ Close the door of the control cabinet to prevent touching live parts accidentally.

✧ Switch on the connected peripheral devices (PC, measuring device or modules) for measurand analysis.

✧ Switch on the supply voltage of the device.

NOTE

The device does not have a power on/off switch. The supply voltage must be switched on or off directly at the respective supply cable.

After an operating time of approximately 15 minutes, the device will stay within the tolerances specified in the technical data.

- ✧ Switch the AC voltages and AC currents to be measured at the measurement object on the measuring lines.
- ✧ Carry out the measurements as described in chapter 7.

NOTE

The operation requires JavaScript. If JavaScript is not yet enabled, activate it as described in chapter 7.2.2.

5.7.2 Changes During Operation

The device is designed for permanent operation.

If you want to change the measurement setup, e.g. by connecting terminals so far unused, proceed analogously to the Initial Commissioning.

NOTE

If you change the measurement setup, you must de-energize the supply voltage lines and all measuring lines before opening the control cabinet. Please note the warnings in chapter 5.7.1.

5.7.3 Starting the Device with the Default IP Address

SENTRON T has the following internal default IP address: **192.168.0.55**.

If you have entered a custom IP address during device configuration, you can temporarily activate the internal default IP address of the device if necessary. For this purpose, press the IP-Addr. push-button on the DIN rail side for at least 3 s.

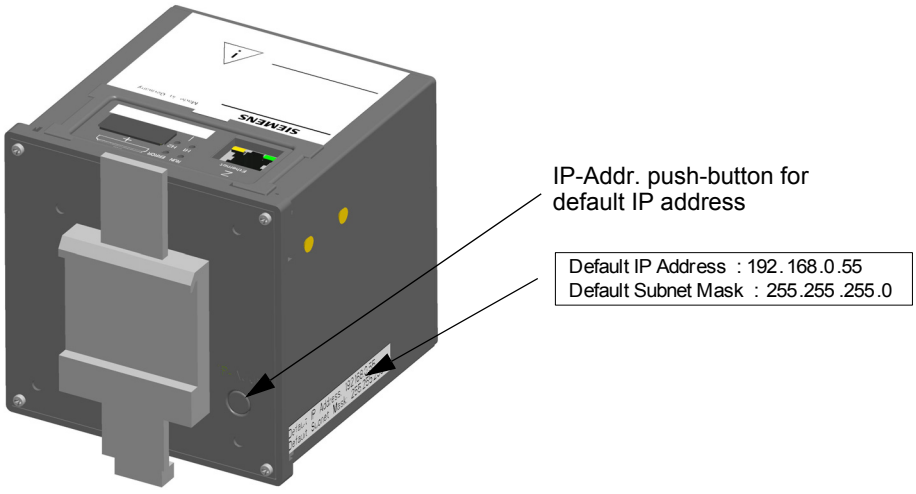


Fig. 5-5 Location of the Push-button for Activating the Default IP Address

When you press the IP-Addr. push-button, SENTRON T will reset and use the default IP address until you have set a new IP address or switched the device off and on again.

NOTE

Changing the IP address will lead to a device reset, and the LEDs on the top side of the device indicate that the device was started with the default IP address (see chapter 12.3).

In this case, the parameterized IP address and the default IP address are displayed on the **Information** tab, **Device information** item (see chapter 7.2.5).

When the device has started with the default IP address, the factory-set default passwords are also active (see chapter 7.3.4.4).

6 Connection Principle

6.1 Terminals

The terminals on the terminal side of the device are designed as terminal blocks:

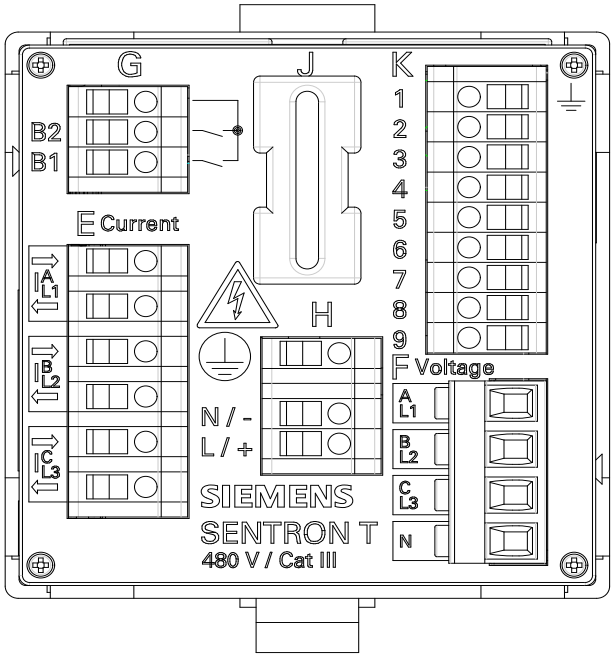


Fig. 6-1 Terminal Blocks on the Terminal Side of the 7KG966x-xFA00-xAA0

7KG966x-xFA00-xAA0 has the following terminal blocks:

Table 6-1 Terminal Blocks at 7KG966x-xFA00-xA00

Terminal Block	Description
E	3 inputs for AC current measurement
F	4 inputs for AC voltage measurement
G	2 binary outputs (freely programmable)
H	Supply voltage
K	4 DC analog outputs

NOTE

7KG966x-xFA00-xAA0 has a covered cutout in position **J** on the terminal side and 7KG966x-xFA10-xAA0/-xFA30-xAA0 has the RS485 interface in this position, see chapter 6.2.2.

Functions of the Terminals at 7KG966x-xFA00-xAA0

Table 6-2 Functions of the Terminals

Terminal	Assigned Function, Measured Value or Indication	Description
E: $I^{A}_{L1}{}^{=>}$	Ia	Conductor a, input, current measurement
E: $I^{A}_{L1}{}^{<=}$	Ia	Conductor a, output, current measurement
E: $I^{B}_{L2}{}^{=>}$	Ib	Conductor b, input, current measurement
E: $I^{B}_{L2}{}^{<=}$	Ib	Conductor b, output, current measurement
E: $I^{C}_{L3}{}^{=>}$	Ic	Conductor c, input, current measurement
E: $I^{C}_{L3}{}^{<=}$	Ic	Conductor c, output, current measurement
F: $^{A}_{L1}$	Van	Conductor a, voltage measurement
F: $^{B}_{L2}$	Vbn	Conductor b, voltage measurement
F: $^{C}_{L3}$	Vcn	Conductor c, voltage measurement
F: N	N	Neutral conductor, voltage measurement
G:	Root	Common root for both binary outputs
G: B2	Binary output 2	Binary output 2
G: B1	Binary output 1	Binary output 1
H: ⏚	Protective conductor	-
H: N / -	N/-	Neutral conductor of the mains voltage or negative supply voltage
H: L / +	ph/+	Phase of the mains voltage or positive supply voltage
K1: ⏚	Functional ground	-
K: 2/3	DC analog Output 1	K2, K4, K6, K8 are the positive (+) outputs Current. DC ±20 mA or Voltage: DC ±10 V Combinations are possible, for example, 1 x current and 3 x voltage
K: 4/5	DC analog Output 2	
K: 6/7	DC analog Output 3	
K: 8/9	DC analog Output 4	

NOTE

When using the DC analog outputs (K1 through K9), you must connect the function ground ⏚ to terminal K1.

Connecting the functional ground is necessary to comply with the EMC properties.

6.2 Communication Interfaces

6.2.1 Ethernet Interface

The Ethernet interface **Z** is located on the top side of the SENTRON T. Data are exchanged via the RJ45 Ethernet socket, see also chapter 9.1.1.

.

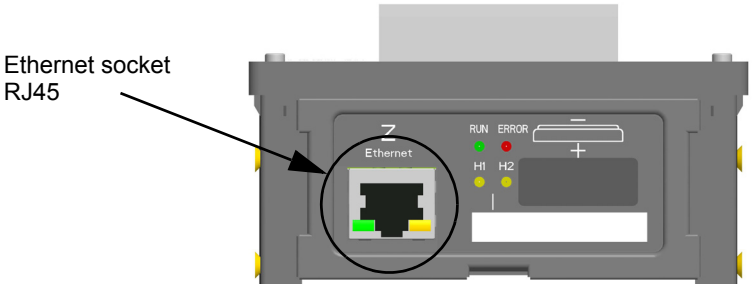


Fig. 6-2 Ethernet Interface Z (detail of the top side)

NOTE

If you do not connect a cable to the RJ45 socket, Siemens recommends covering to cover the socket with a cap or dummy plug (not included in the delivery) to prevent the contacts from becoming dirty.

6.2.2 RS485 Interface

The RS485 interface **J** is located on the terminal side of the 7KG966x-xxA10-xAA0/-xxA30-xAA0, see also chapter 9.1.2.

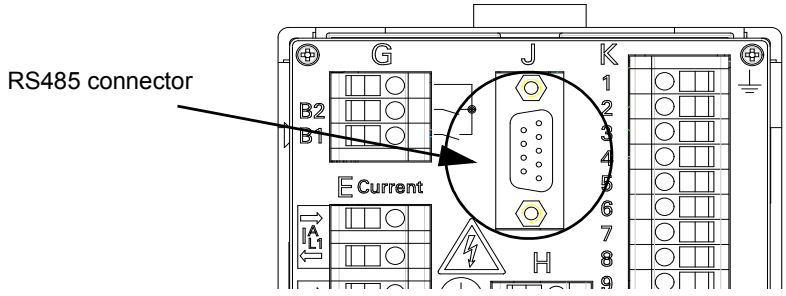


Fig. 6-3 RS485 Interface J (detail of the terminal side)

NOTE

If you do not connect a cable to the RS485 connector, Siemens recommends to cover it with a cap (not included in the delivery) to prevent the contacts from becoming dirty.

6.3 Connection Types and Connection Examples

6.3.1 Using SENTRON T in the Power Systems IT, TT and TN

The following operating conditions must be observed when using SENTRON T in the various power systems:

Table 6-3 SENTRON T Operating Conditions

Voltage Measurement Inputs of SENTRON T acc. to Ordering Information (see chapter 2.2)	**Power System**		
	IT	**TT**	**TN**
Potential divider	Only with voltage transformers (see examples chapter 6.3.3)	Yes	Yes
Galvanic isolated	Yes	Yes	Yes

NOTICE

Only for SENTRON T 7KG966x-1xAx0-xAA0 (voltage measurement via potential divider):

In IT systems, SENTRON T cannot be connected directly because the measuring voltage is measured against the protective ground connection (PE) and the input impedance of the device causes a leakage current to ground. The leakage current can cause the insulation monitoring in IT systems to pick up.

Non-observance can result in property damage.

- Make sure that the maximum permissible voltage at the inputs of SENTRON T to ground V_{a-N} = 480 V (max. 347 V at Vph) is not exceeded (e.g. in the case of a single-phase-to-ground fault).
- In IT systems, voltage transformers **must** be used.

6.3.2 Connection Types

SENTRON T 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)

6.3.3 Examples - Standard Application

The following input wiring diagrams are examples. Up to the maximum allowable current and voltage values (see chapter 13.1) SENTRON T can also be connected without interconnected current and voltage transformers.

Required voltage transformers can be operated in star connection or delta connection.

All input and output terminals that are not needed for measurements remain unwired.

NOTE

The illustration of the consistent ground connection of the instrument transformers is simplified in the following connection examples. The secondary windings of the current transformers installed in a high-voltage power system must be grounded on one side.

For SENTRON T 7KG966x-2xAx0-xAA0 (voltage measurement inputs galvanically isolated), the electrical connection PE-N is not mandatory.

NOTE

Take care at the following connection examples at the parameter setting that the parameter **Calculate VN** is setting for **yes** (see chapter 7.3.3.1.1).

DANGER

Hazard due to high voltages in the event of a breakdown of the winding insulation

Non-observance will lead to death or serious injury.

- Ground the secondary windings of the current transformers on one side. They are installed in a high-voltage power system.

Example 1-phase System, No Voltage Transformer

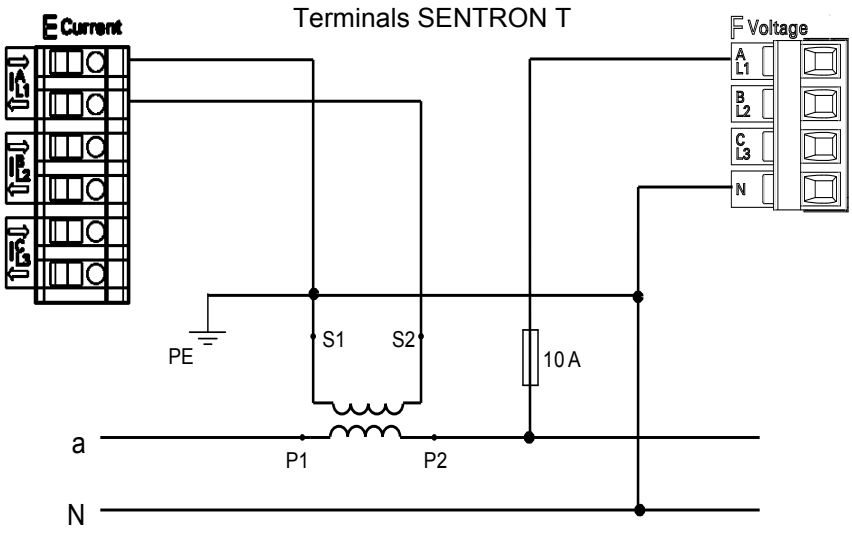


Fig. 6-4 Example 1-phase System, No Voltage Transformer

NOTICE

Observe the connection conditions according to Table 6-3.

Example 3-wire Network, 2 Voltage Transformers and 1 Current Transformer, Balanced

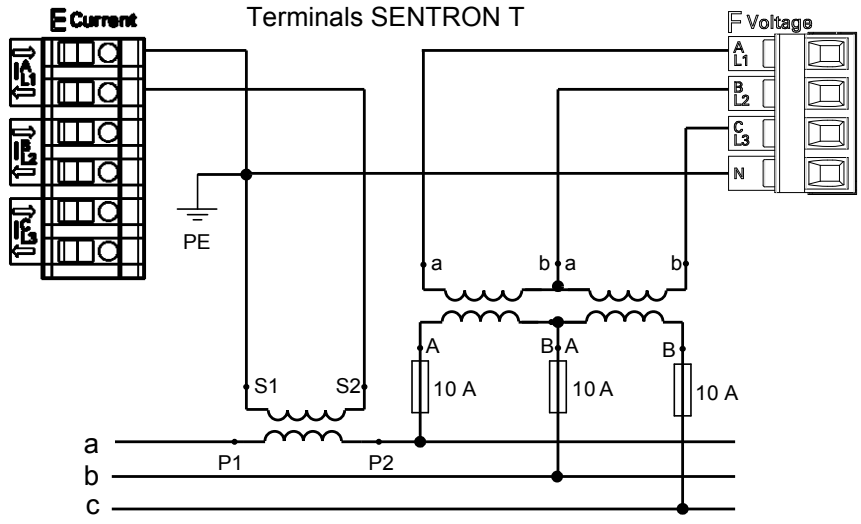


Fig. 6-5 Example 3-wire Network, 2 Voltage Transformers and 1 Current Transformer, Balanced

NOTICE

The secondary voltage on terminal F (voltage) must not exceed AC 480 V (max. AC 347 V for UL).

This could cause material damage.

- Please make sure that the maximum permissible voltage on conductor - ground (PE) is not exceeded.

NOTE

For SENTRON T 7KG966x-2xAx0-xAA0 (voltage measurement inputs galvanically isolated), the electrical connection PE-N is not mandatory.

Example 3-wire Network, No Voltage Transformer, 3 Current Transformers, Unbalanced

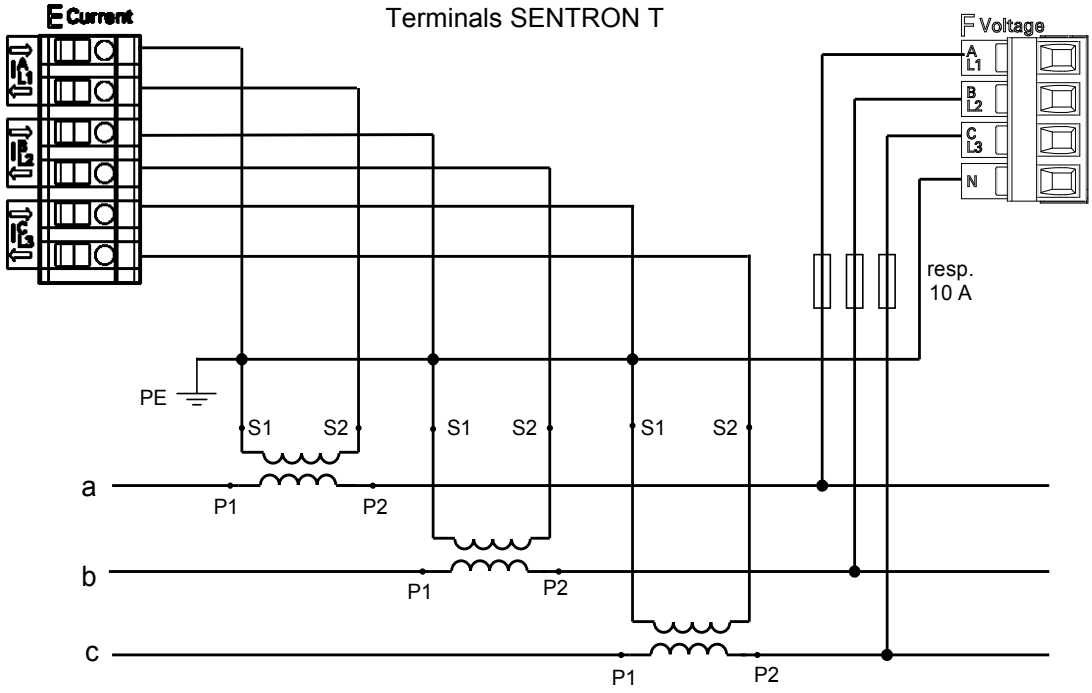


Fig. 6-6 Example 3-wire Network, No Voltage Transformer, 3 Current Transformers, Unbalanced

NOTICE

Observe the connection conditions according to Table 6-3.

Example 3-wire Network, No Voltage Transformer, 2 Current Transformers, Unbalanced

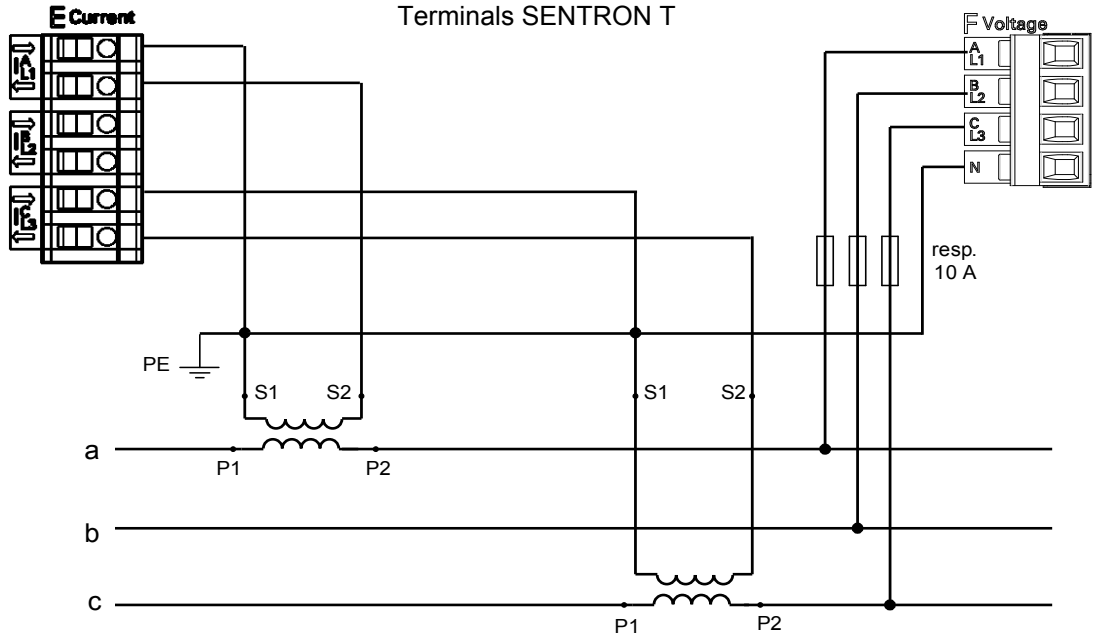


Fig. 6-7 Example 3-wire Network, No Voltage Transformer, 2 Current Transformers, Unbalanced

NOTICE

Observe the connection conditions according to Table 6-3.

Example 3-wire Network, 2 Voltage Transformers and 2 Current Transformers, Unbalanced

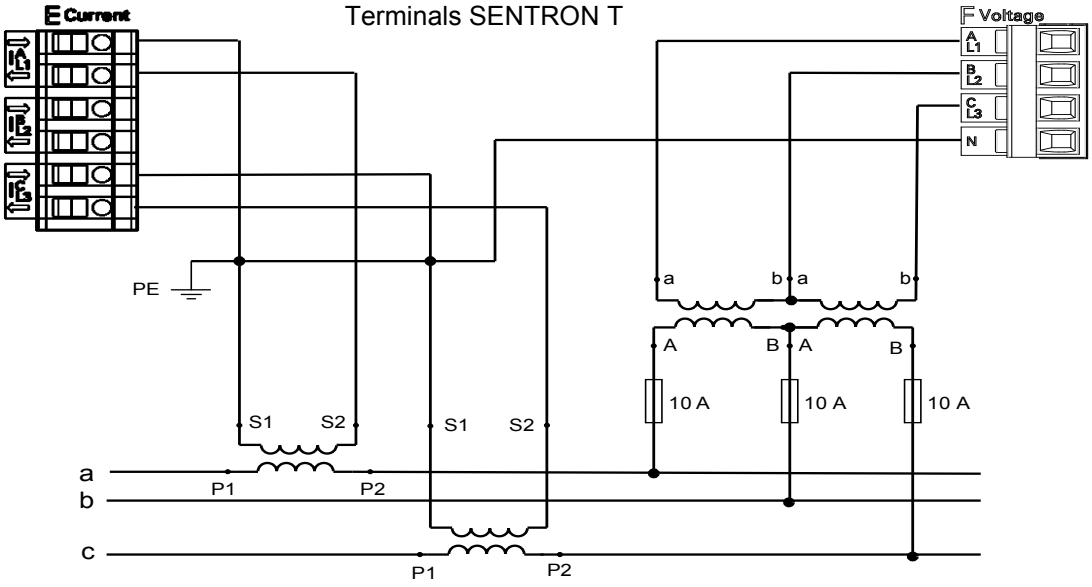


Fig. 6-8 Example 3-wire Network, 2 Voltage Transformers and 2 Current Transformers, Unbalanced

NOTICE

The secondary voltage on terminal F (voltage) must not exceed AC 480 V (max. AC 347 V for UL).

This could cause material damage.

- Please make sure that the maximum permissible voltage on conductor - ground (PE) is not exceeded.

NOTE

For SENTRON T 7KG966x-2xAx0-xAA0 (voltage measurement inputs galvanically isolated), the electrical connection PE-N is not mandatory.

Example 3-wire Network, 2 Voltage Transformers and 3 Current Transformers, Unbalanced

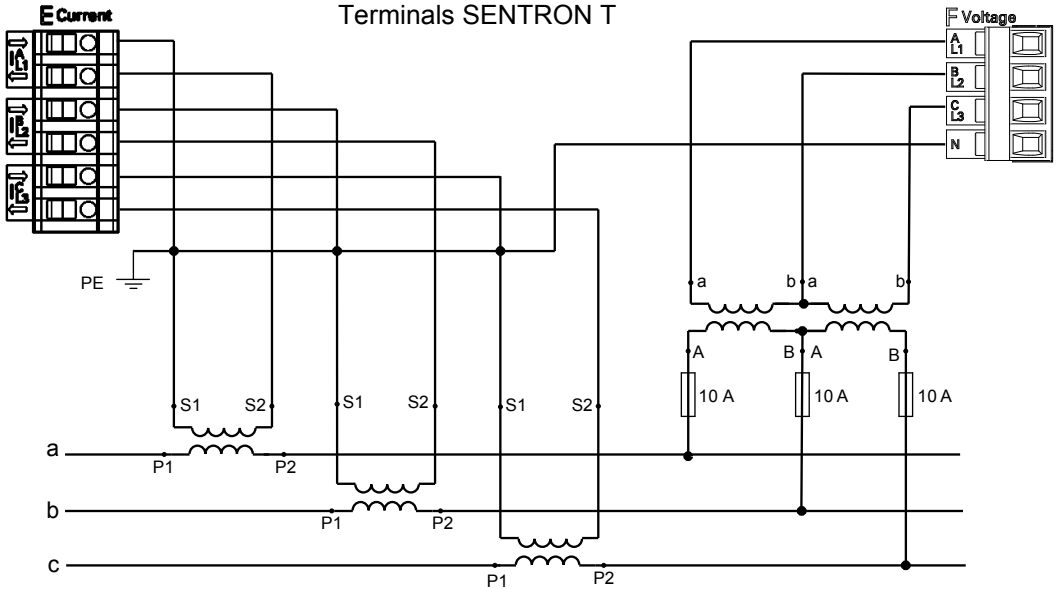


Fig. 6-9 Example 3-wire Network, 2 Voltage Transformers and 3 Current Transformers, Unbalanced

NOTICE

The secondary voltage on terminal F (voltage) must not exceed AC 480 V (max. AC 347 V for UL).

This could cause material damage.

- Please make sure that the maximum permissible voltage on conductor - ground (PE) is not exceeded.

NOTE

For SENTRON T 7KG966x-2xAx0-xAA0 (voltage measurement inputs galvanically isolated), the electrical connection PE-N is not mandatory.

Example 4-wire Network, 1 Voltage Transformer and 1 Current Transformer, Balanced

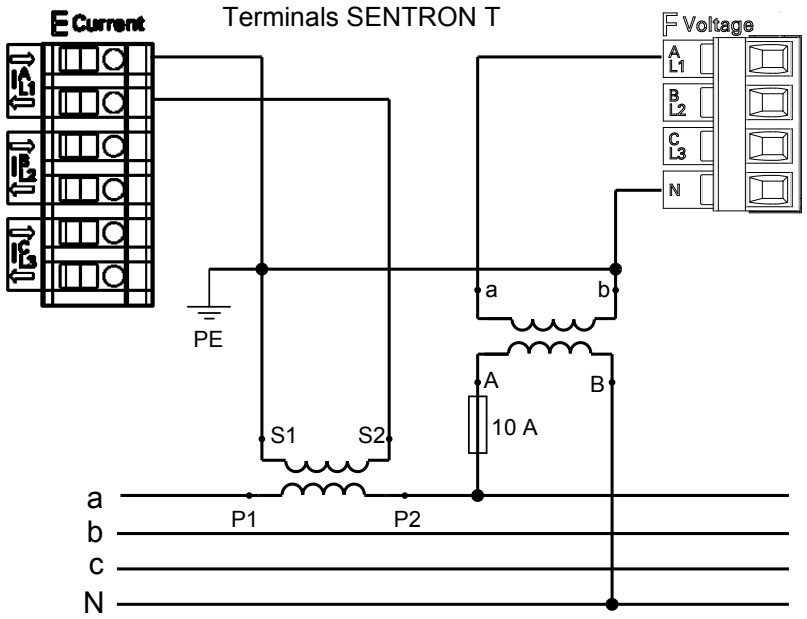


Fig. 6-10 Example 4-wire Network, 1 Voltage Transformer and 1 Current Transformer, Balanced

NOTICE

Observe the connection conditions according to Table 6-3.

Example 4-wire Network, No Voltage Transformer, 3 Current Transformers, Unbalanced

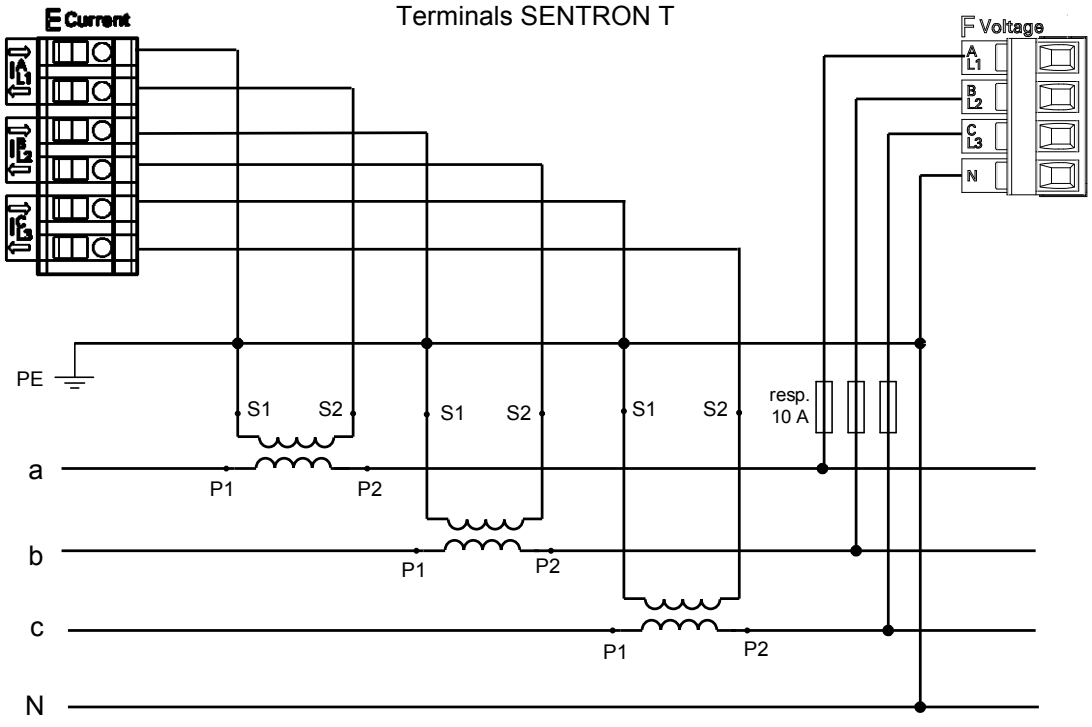


Fig. 6-11 Example 4-wire Network, No Voltage Transformer, 3 Current Transformers, Unbalanced

NOTICE

Observe the connection conditions according to Table 6-3.

Example 4-wire Network, 3 Voltage Transformers and 3 Current Transformers, Unbalanced

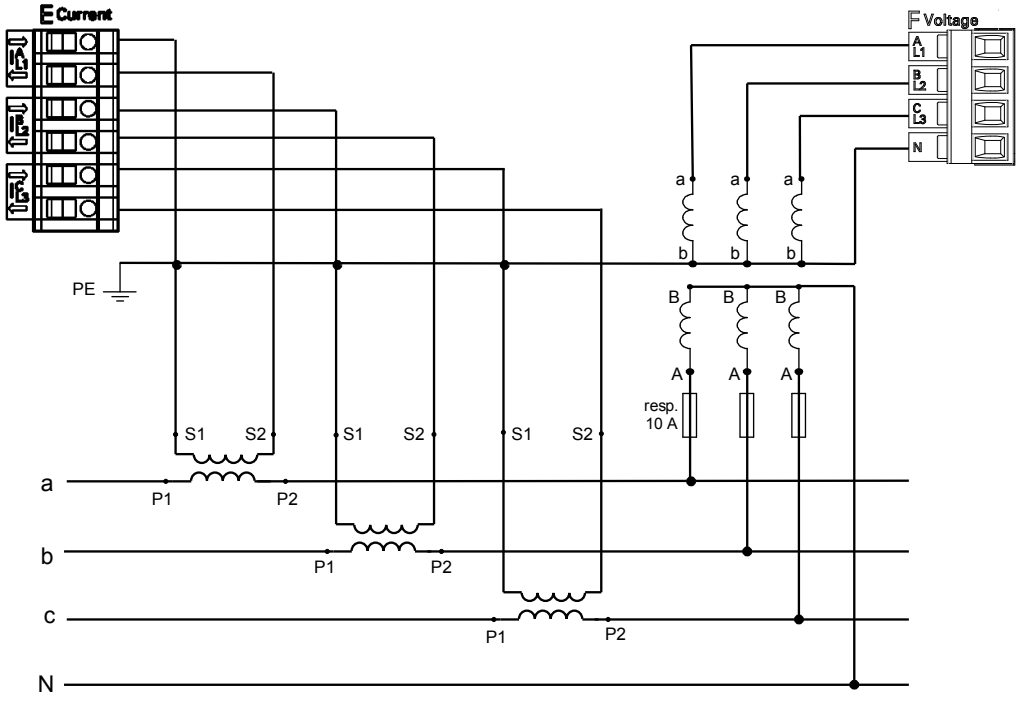


Fig. 6-12 Example 4-wire Network, 3 Voltage Transformers and 3 Current Transformers, Unbalanced

6.3.4 Example - Special Application

NOTE

Take care at the following connection examples at the parameter setting that the parameter **Calculate VN** is setting for **no** (see chapter 7.3.3.1.1).

Example 3-wire Network, 3 Voltage Transformers and 3 Current Transformers, Unbalanced

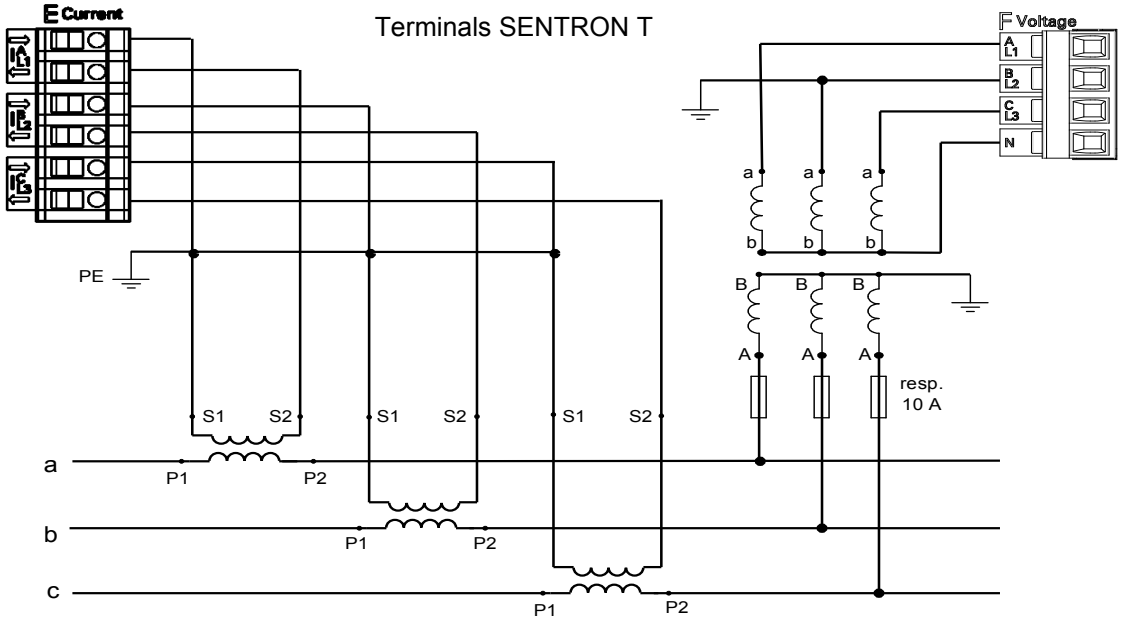


Fig. 6-13 Example 3-wire Network, 3 Voltage Transformers and 3 Current Transformers, Unbalanced

7 Operation

7.1 General Usage Notes

The device is operated from a connected PC or notebook only. The graphical user interface is stored in the device. To display the User Interface, start Microsoft Internet Explorer 6.0 (or higher) and enter the IP address of the device.

You can navigate through Microsoft Internet Explorer using the icons on the toolbar, for example back, forward, print etc. The User Interface itself does not contain any navigation icons.

Operating actions are performed with the mouse. Parameters and text are entered using the keyboard.

The following table lists the control elements.

Table 7-1 Control Functions

Control Element	Control Function
	Option button: selects one option
	List box: selects an item from a list
	Button: Executing an action by clicking the button, i.e. the current settings on the user interface are transmitted to the device.
	Active tab (light blue)
	Inactive tab (dark blue)
	Selects and opens the item to be activated, for example a tab

7.2 Start and Design of the User Interface

7.2.1 Initial Start of the User Interface

Requirements

Before starting the User Interface, the following preconditions must be satisfied:

- ✧ Assemble the SENTRON T as described in chapter 5.2.
- ✧ Connect the lines for measurement, communication and supply voltage as described in chapter 5.3 and observe the safety provisions.
- ✧ Switch on the devices needed for the measurement.
- ✧ Switch on the supply voltage of the SENTRON T.
- ✧ Check whether the LEDs at the SENTRON T indicate that the device is ready (see chapter 12.3).
- ✧ Match the IP address and the subnet mask of the network interface card of your computer to the device settings.
- ✧ Check on the computer screen whether the LAN connection is up. Activate the LAN connection if it is down (see the Windows manual or the Windows online help for information).
- ✧ For checking purposes, carry out the ping test as follows (example for Windows XP):
  - Click **Start** on the Windows interface.
  - Select **Execute...**.
  - Enter **cmd** in the dialog and click **OK**.
  - Enter: **ping 192.168.0.55**.
  - Press the **Enter** button.
  - Check the following output in the window.

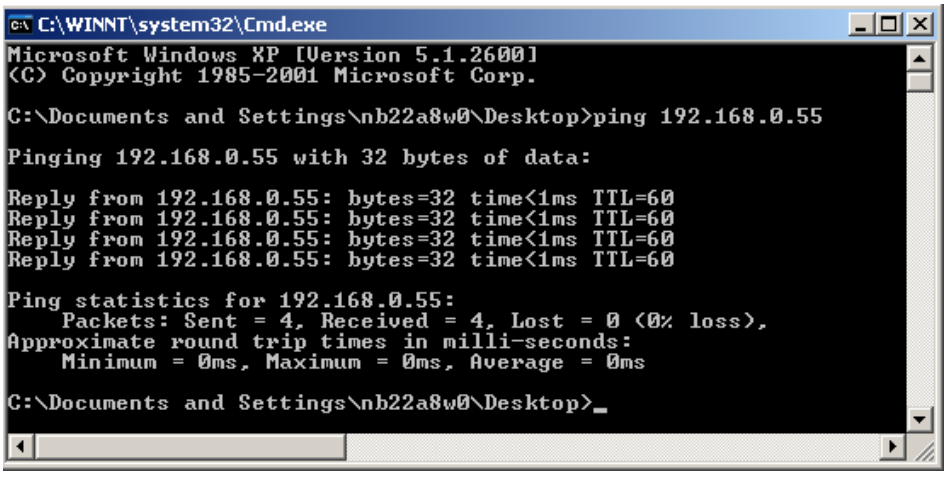


Fig. 7-1 Ping Test

- ✧ Start Microsoft Internet Explorer.
- ✧ Enter the IP address in Microsoft Internet Explorer (e.g. default IP address: http://192.168.0.55) of SENTRON T and press ENTER.

  The User Interface opens with the **Information** tab → **Show device information** (see figure 7-4).

NOTE

When starting the device for the first time, a set of parameters with factory settings is loaded. You can modify these settings during the parameterization (see chapter 7.3).

To set a different user language for the User Interface, open the **Administrative** menu on the **Configure** tab, select the **Device and language** menu item and change the user language as described in chapter 7.3.4.4.

NOTE

If User Interface does not open or the displayed User Interface does not show the view depicted in figure 7-3, JavaScript may be the cause. The operation of User Interface requires JavaScript. You may have to activate JavaScript as described in chapter 7.2.2.

7.2.2 Enabling JavaScript

The operation of User Interface requires JavaScript.

Enable JavaScript as follows:

- ✧ Start Microsoft Internet Explorer.
- ✧ Click the **Tools** menu on the menu bar of Microsoft Internet Explorer.
- ✧ Select **Internet options...** from the **Tools** menu.
- ✧ In the **Internet options** dialog open the **Security** tab.

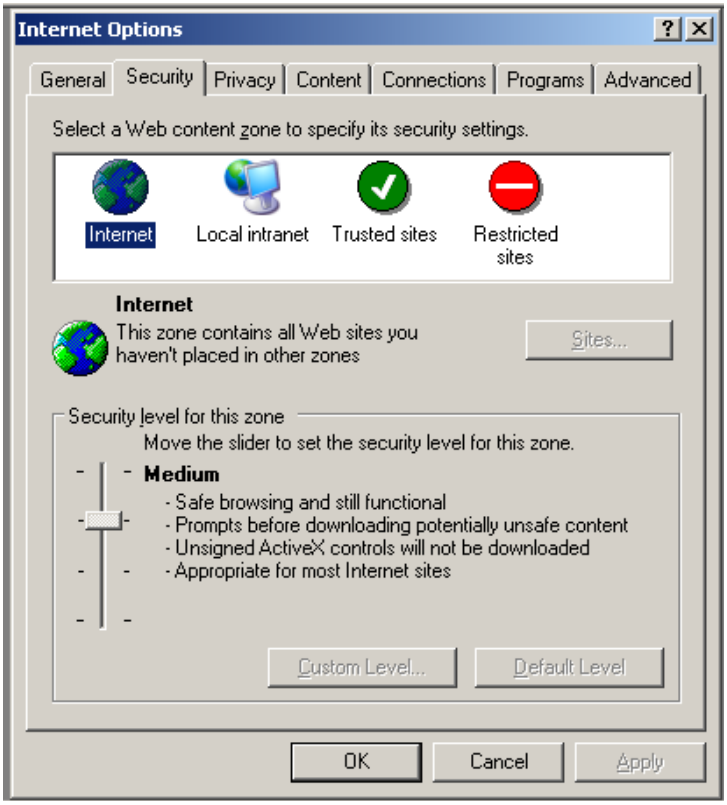


Fig. 7-2 Enabling JavaScript

- ✧ In the window of the **Security** tab select the **Internet** icon.
- ✧ On the **Security** tab scroll to **Medium** by moving the scroll bar with your mouse. Alternatively, if there is no scroll bar, click the **Default Level** button and set the scroll bar that appears to **Medium**.
- ✧ Click the **Apply** button.
- ✧ Click the **OK** button.

7.2.3 Number of Connections via HTML

Three connections maximum are possible via HTML.

7.2.4 Layout of the User Interface

The User Interface has the following layout:

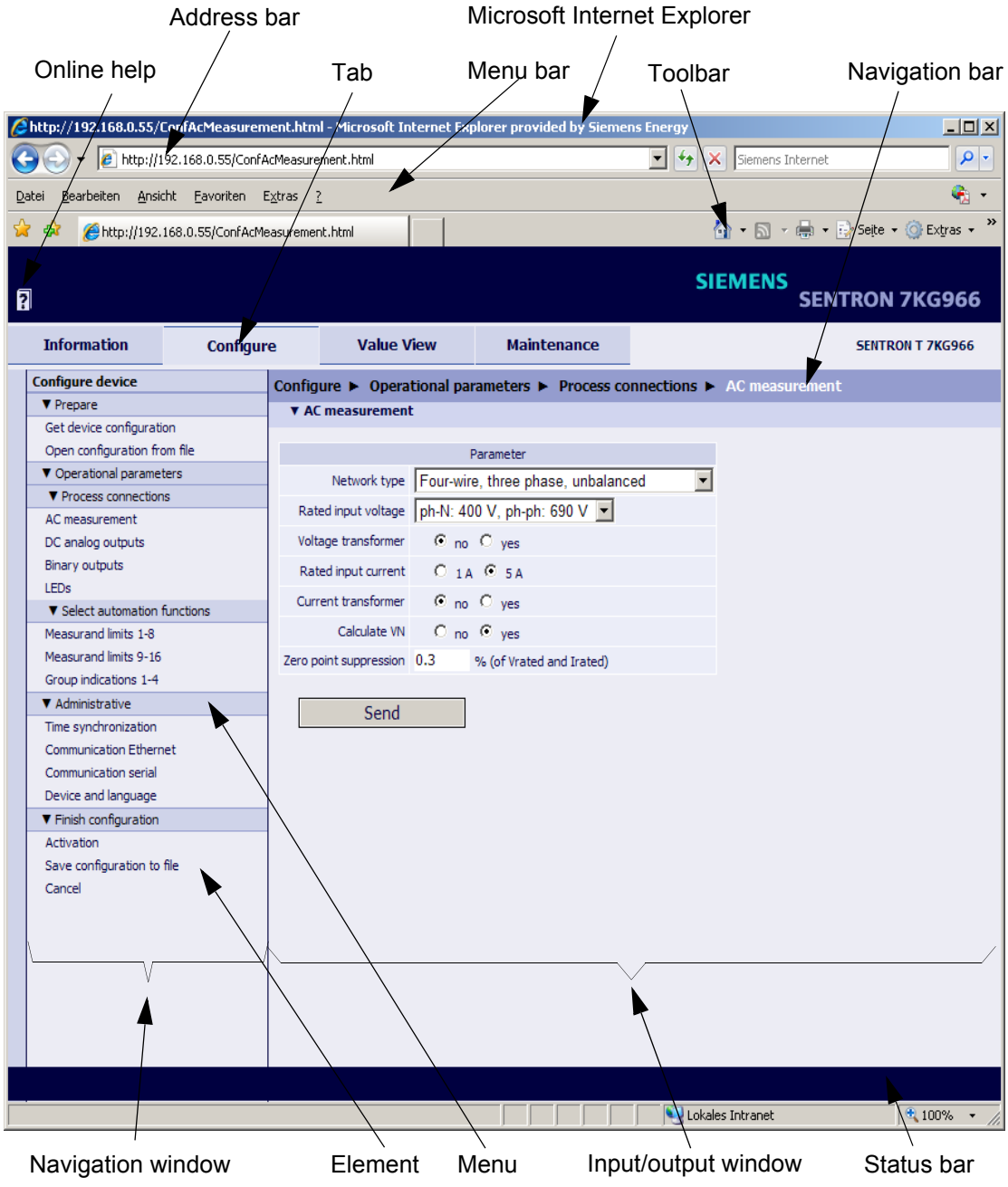


Fig. 7-3 Designations in the User Interface

7.2.5 Starting the User Interface during Operation

Starting the User Interface

To start the User Interface, proceed as follows:

- ✧ Start Microsoft Internet Explorer.
- ✧ Enter the IP address in Microsoft Internet Explorer (for example the default IP address: 192.168.0.55) of SENTRON T and press ENTER.

  The User Interface opens with the **Information** tab → **Show device information** item (see figure 7-4).

Information Tab

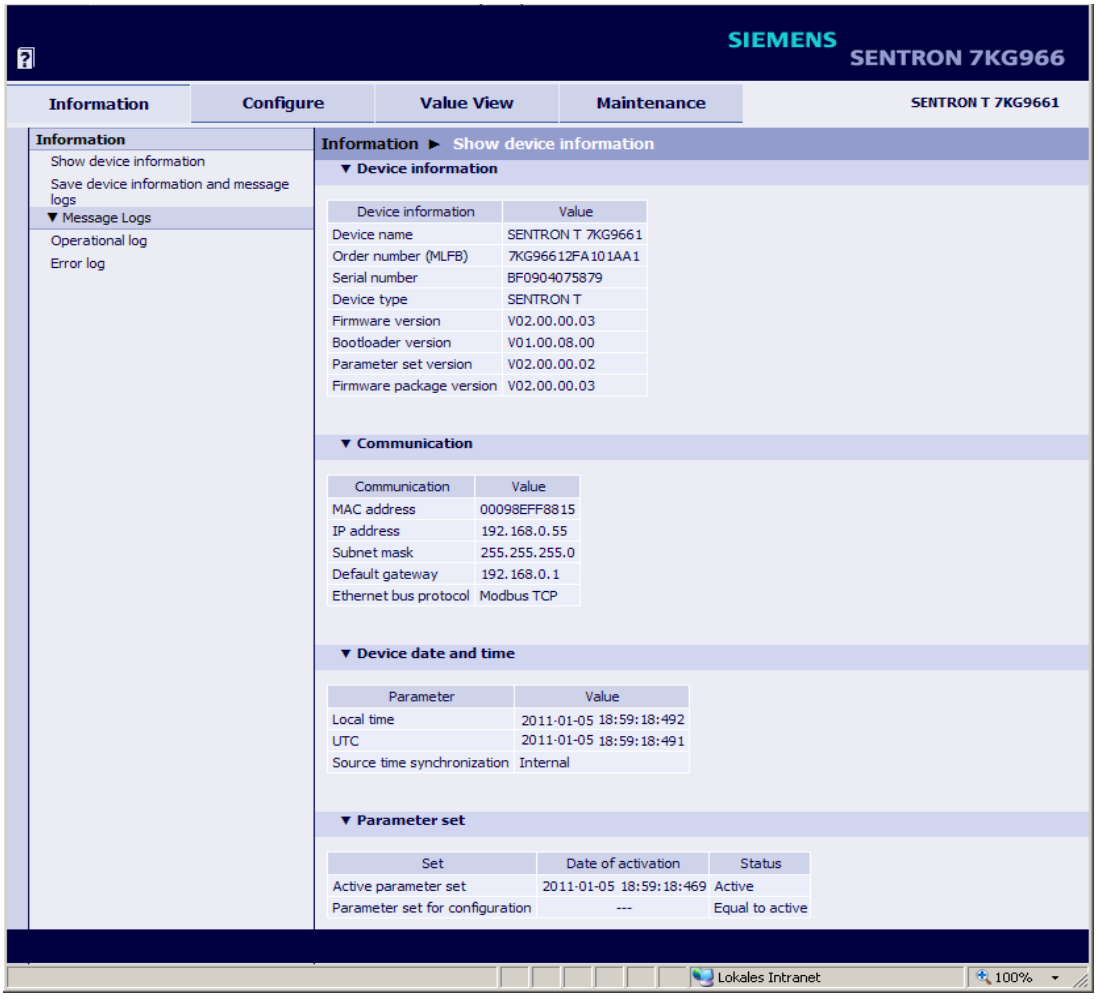


Fig. 7-4 Information Tab, Show Device Information Input/output Window

Navigation Window of the Information Tab

The navigation window of the **Information** tab contains the elements **Show Device Information**, **Save device information and message logs** and the **Message Logs** menu with the elements **Operational log** and **Error log**.

7.2.5.1 Show Device Information

✧ Click the **Show device information** item in the navigation window.

The **Show device information** input/output window shows the following information (see figure 7-4):

- **Device information**: Information about the device and the installed software
- **Communication**: Information about the data transfer between device and periphery
- **Device date and time**: Information about the time settings of the device
- **Parameter set**: Information about the active and passive set of parameters

7.2.5.2 Save Device Information and Message Logs

✧ Click the **Save device information and logs** item in the navigation window.

The **Save device information** input/output window displays the **Save** button.

Fig. 7-5 Information Tab, Save Device Information Input/output Window

✧ Click the **Save** button.

The **File Download** dialog opens.

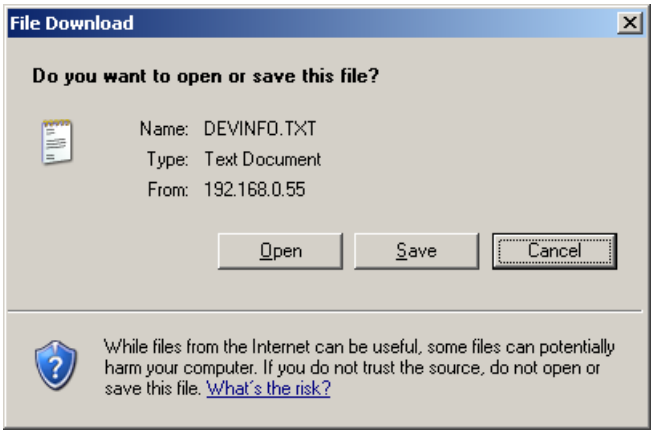


Fig. 7-6 File Download Dialog

File Download → Save

✧ Click the **Save** button.

The **Save As** dialog opens.

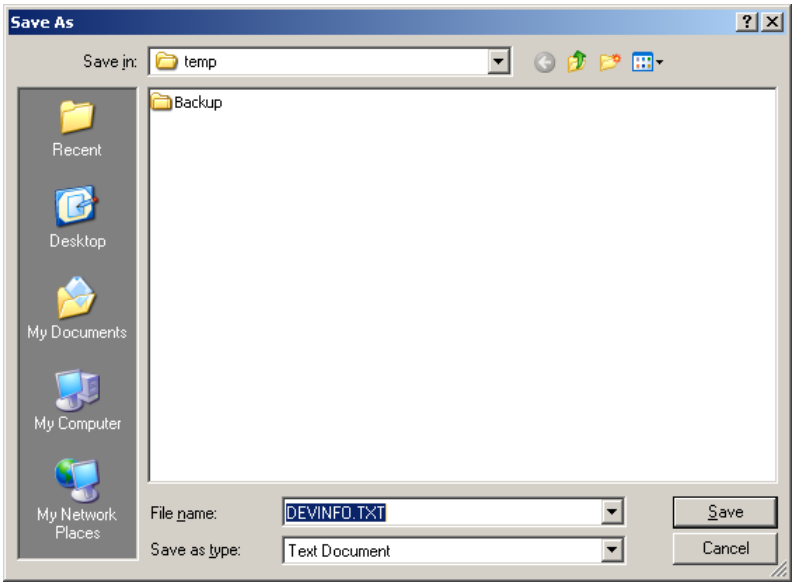


Fig. 7-7 Save As Dialog

✧ Select the file path in the **Save in:** list box.

✧ Use the file name suggested in the **File name:** list box or enter a new file name with the file extension .TXT.

✧ Click the **Save** button.

The **Download complete** dialog opens.

✧ In the **Download complete** dialog, click the **Close** button.

File Download → Open

Alternatively, you can view the device information and logs on the screen and print them if needed. Proceed as follows:

✧ In the **File download** dialog (see figure 7-6), click the **Open** button.

This action opens a text editor containing the device information (DEVICE INFORMATION), the operational indications (OPERATIONAL LOG) and the error messages (ERROR LOG).

✧ On the menu bar of the text editor, click **File** → **Print...**, select the desired printer in the following **Print** dialog and click the **Print** button.

The list is printed on the connected printer.

✧ Close the text editor.

✧ Click an element on the navigation window or a tab, or alternatively, click the **Back** icon on the toolbar of Microsoft Internet Explorer twice.

7.2.5.3 Message Logs Menu

The **Message Logs** menu contains operational indications and error messages registered and saved by the device during operation. The device can save up to 128 operational indications and up to 128 error messages. When the storage capacity is exceeded, the oldest indications will be overwritten successively.

Operational Log

To show the operational indications, proceed as follows:

✧ In the navigation window, click the **Message Logs** menu and then the **Operational log** menu item.

The operational indications are listed in the input/output window as follows:

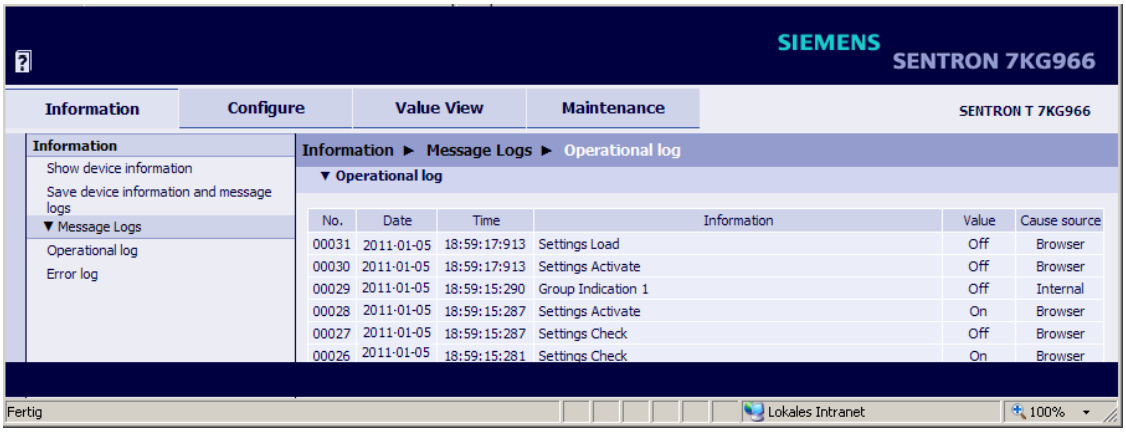


Fig. 7-8 Information Tab, Operational Log

- Serial **No**.
- **Date** of registration
- **Time** of registration
- **Information** on the indication
- **Value** of the indication (On, Off or invalid)
- **Cause source** of the indication (e.g. Intern, Browser)

NOTE

The operational indications can be printed as described in chapter 7.2.5.2, section **File Download** → **Open**.

The chapter 7.5.4.1 explains how to delete the operational indications manually.

Error Log

NOTE

The information about error messages described below is intended for service purposes. Inform the customer service about this information when there are problems with your device.

To display the error messages, proceed as follows:

✧ In the navigation window, click the **Message Logs** menu and then **Error log**.
The error messages are listed in the input/output window as follows:

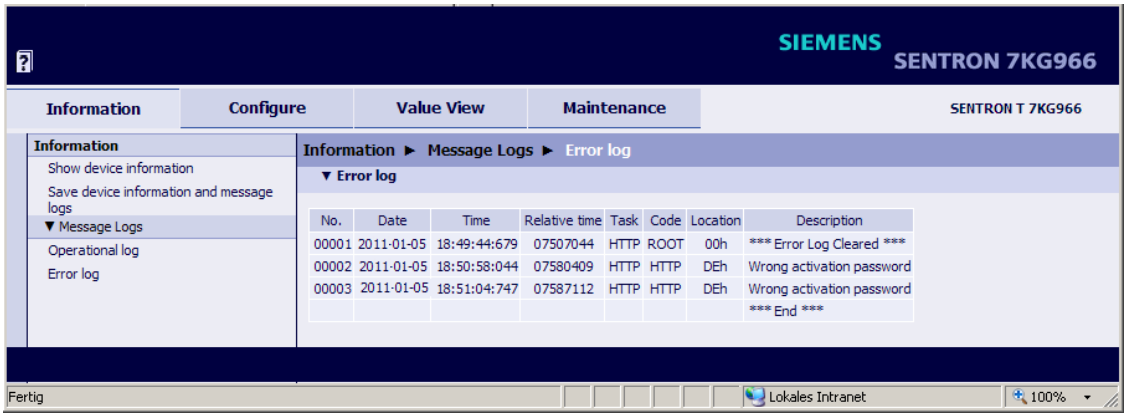


Fig. 7-9 Information Tab, Error Log

- Serial **No.**
- **Date** of registration
- **Time** of registration
- **Relative time** (referring to the start of operation, output in milliseconds)
- **Task**, **Code** and **Location** are service information for the manufacturer.
- **Description** of the error

NOTE

The error messages can be printed as described in chapter 7.2.5.2, section **File Download** → **Open**.

The chapter 7.5.4.2 explains how to delete the error messages manually.

7.3 Configuration of the Device

NOTE

The device contains two set of parameters. The set of parameters currently used for device operations is the **active set of parameters**. The inactive set of parameters is called the **passive set of parameters**.

The following sections describe how to change and enable the passive set of parameters.

7.3.1 Device Configuration Procedure

If you have not changed the set of parameters since the first start of the device (see chapter 7.2.1), use the factory settings (see chapter 7.3.3 and chapter 7.3.4). To change the settings of the set of parameters, proceed as follows:

✧ Click the **Configure** tab on the User Interface.

The **Configure** tab opens.

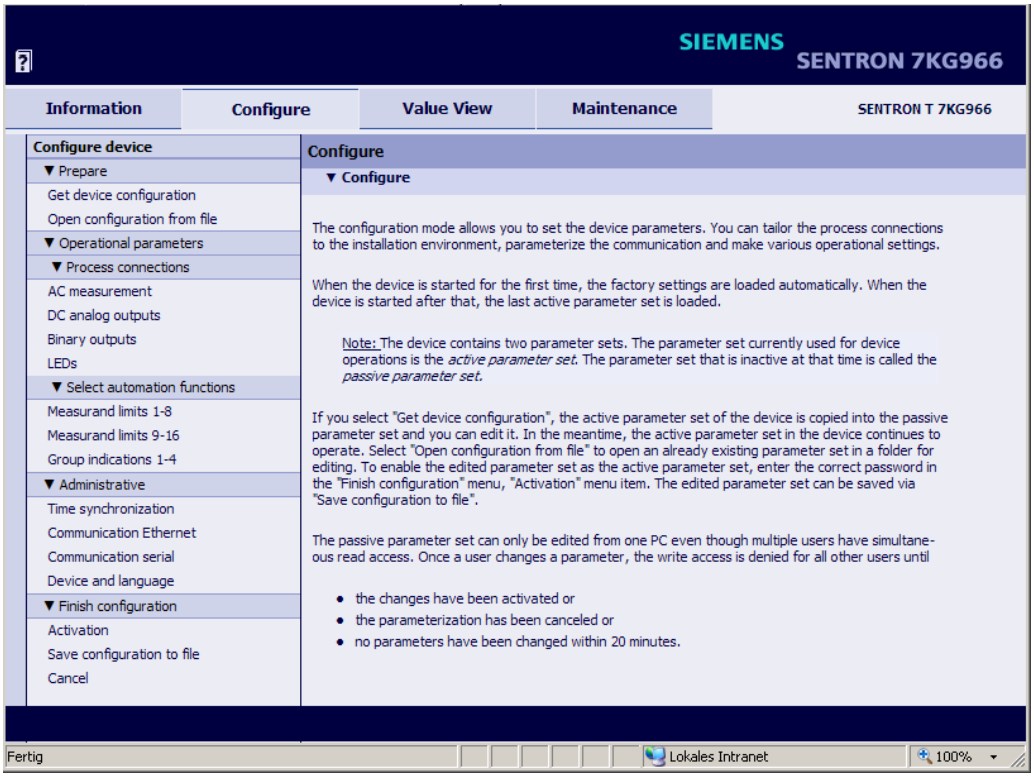


Fig. 7-10 Configure Tab

NOTE

The items in the **Process connections** menu show the current hardware and software configuration of the device.

✧ Select the **Prepare** menu in the navigation window and then either **Get device configuration** or **Open configuration from file**.

NOTE

If you have selected **Get device configuration**, an editable copy of the active set of parameters of the device is displayed on the screen. In the meantime, the active set of parameters in the device continues to operate. If you have selected **Open configuration from file**, you can open and enable or edit the copy of a set of parameters that was already created and saved to a folder.

7.3.1.1 Get Device Configuration

If you have selected **Get device configuration** in the **Configure** tab, you can open and edit either the **Get active configuration** or the **Get default configuration** in the input/output window. Proceed as follows:

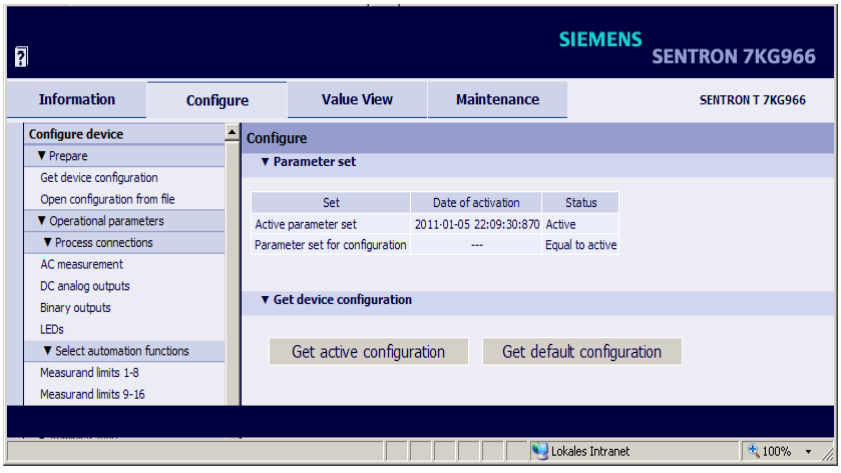


Fig. 7-11 Configure Tab, Get Device Configuration

Get Active Configuration and Editing

✧ Click the **Get active configuration** button.

A copy of the active set of parameters (= passive set of parameters) of the device is opened for editing.

✧ Check and, if necessary, change the set parameters by opening the desired **Operational** menu described in chapter 7.3.4 and the **Administrative** menu according to chapter 7.3.3.

✧ Activate the modified configuration as described in chapter 7.3.1.3.

Get Default Configuration and Editing

✧ Click the **Get default configuration** button.

A copy of the factory settings (= passive set of parameters) of the device is opened for editing.

NOTE

You can edit the displayed factory settings, activate and use them as active set of parameters. The original factory settings are not overwritten and can be used at anytime.

✧ Activate the modified configuration as described in chapter 7.3.1.3.

7.3.1.2 Open Configuration from File

If you have selected **Open configuration from file** in the **Configure** tab, you can open an already existing file in a folder. Proceed as follows:

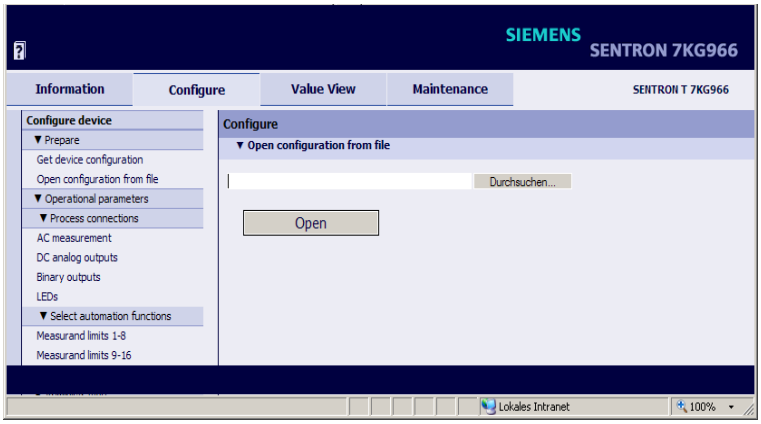


Fig. 7-12 Configure Tab, Open Configuration from File

✧ Click the **Browse...** button.
The **Choose file** dialog opens.

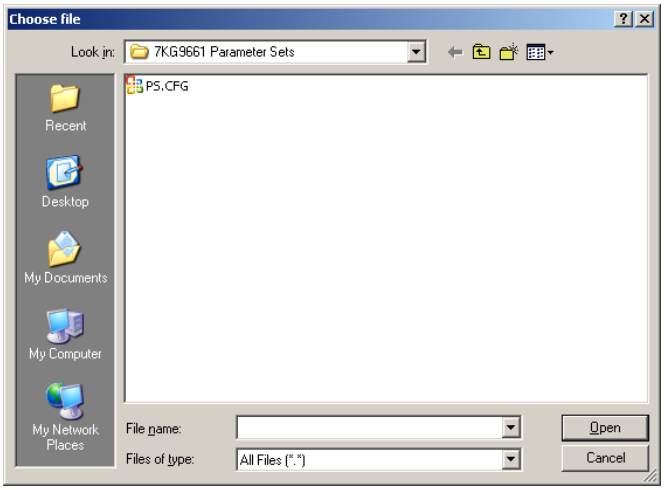


Fig. 7-13 Choose File

✧ Select the desired file (extension .cfg) in the directory.

✧ Click the **Open** button.
The selected path is inserted into the **Browse** field in the input/output window, figure 7-12.

✧ Click the **Open** button.
The device configuration from the CFG file is loaded.

7.3.1.3 Finish Configuration

When you have changed the configuration, you must either enable it as the active set of parameters or save it.

Activating the Set of Parameters

To **activate** the set of parameters, proceed as follows:

✧ In the navigation window, click the **Finish configuration** menu and then the **Activation** menu item.
The **Activation** input/output window opens.

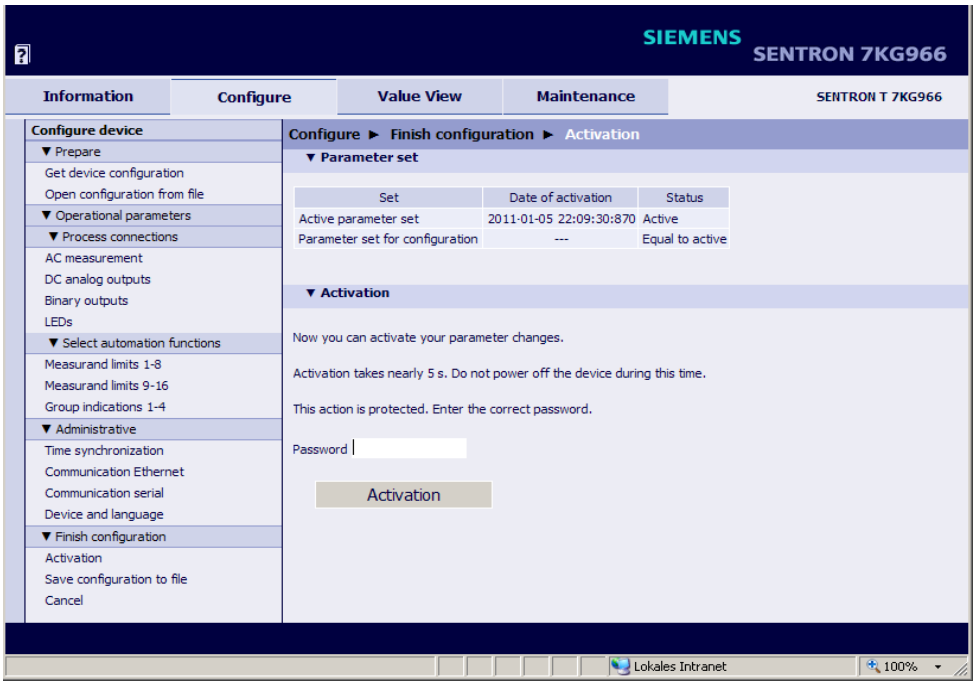


Fig. 7-14 Configure Tab, Activation Input/output Window

✧ In the **Activation** input/output window, enter the valid activation password into the **password** field. chapter 7.3.4.4 explains how to set the password.

✧ Click the **Activation** button.
At first the message **Parameter activation is still in progress** will be shown and then the message **Parameter activation is complete** in the input/output window.

The modified set of parameters is loaded as the active set of parameters into the device and the new parameters take effect immediately.

If the password is wrong, this message appears: **The password is wrong. Please enter the correct password.**

NOTE

The active and passive set of parameters are listed in the **Activation** input/output window in the **Set** column for your information.

Save Configuration to File

You can save both the active and the passive configuration to a file. Proceed as follows:

✧ In the navigation window, click the **Finish configuration** menu and then **Save Configuration to File**.
The **Save Configuration to File** input/output window opens.

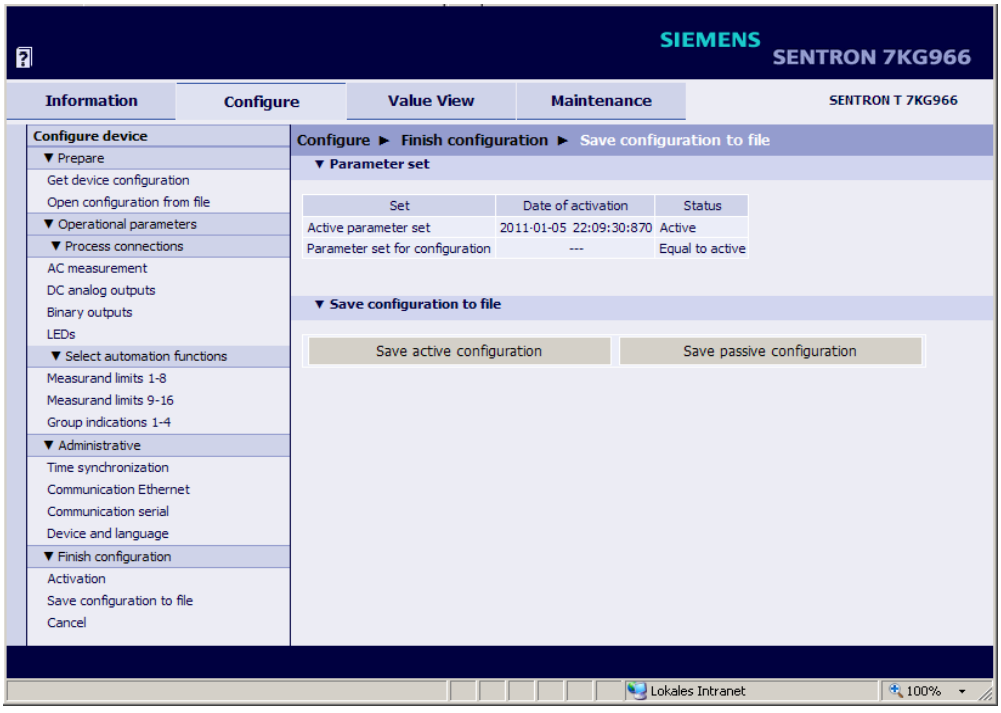


Fig. 7-15 Configure Tab, Save Configuration to File Input/output Window

✧ Click either of the buttons **Save active configuration** or **Save passive configuration**.
The **File Download** dialog opens.

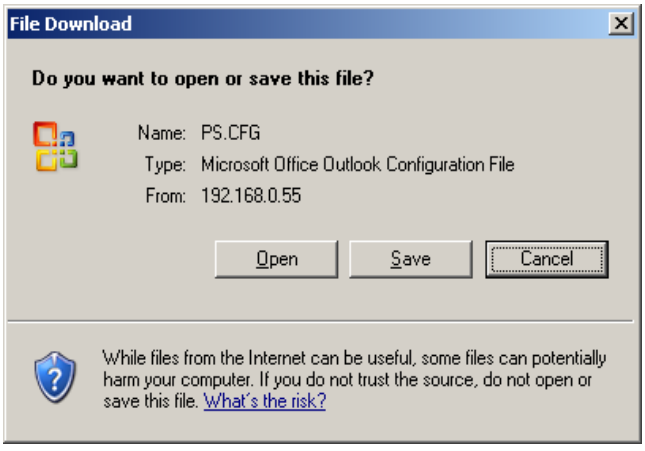


Fig. 7-16 File Download Dialog

File Download → Save

✧ Click the **Save** button.

The **Save As** dialog opens.

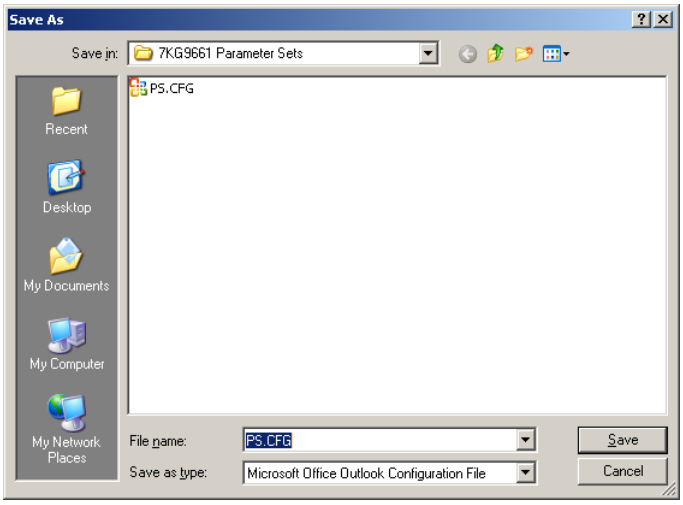


Fig. 7-17 Save As Dialog

- ✧ Select the file path in the **Save in:** list box.
- ✧ Use the file name suggested in the **File name:** list box or enter a new file name with the file extension .CFG.
- ✧ Click the **Save** button.
  The **Download complete** dialog opens.
- ✧ In the **Download complete** dialog, click the **Close** button.

Cancel

To cancel the configuration, proceed as follows:

✧ In the navigation window, click the **Finish configuration** menu and then **Cancel**.

The **Cancel** input/output window opens.

Fig. 7-18 Configure Tab, Cancel Input/output Window

✧ Click the **Cancel** button in the input/output window.

NOTE

After clicking the **Cancel** button, the active set of parameters is copied into the passive set of parameters. This action is the same as **Get device configuration** → **Get active configuration** described in chapter 7.3.1.1.

When you have clicked the **Cancel** button, the parameterization is released and can be run from a different computer if necessary.

7.3.2 Access to the Passive Set of Parameters by Multiple Users

Reading the Passive Set of Parameters

The User Interface allows the simultaneous read access of up to 3 web servers to the passive set of parameters.

Editing the Passive Set of Parameters

The passive set of parameters can only be edited from one PC or notebook even though multiple users have simultaneous read access.

Once a user changes a parameter on the User Interface, the write access is denied for all other users.

If the write access is blocked, **modified** in brackets will be displayed in the upper right corner of the User Interface. The user making the changes will see **modified** without brackets.

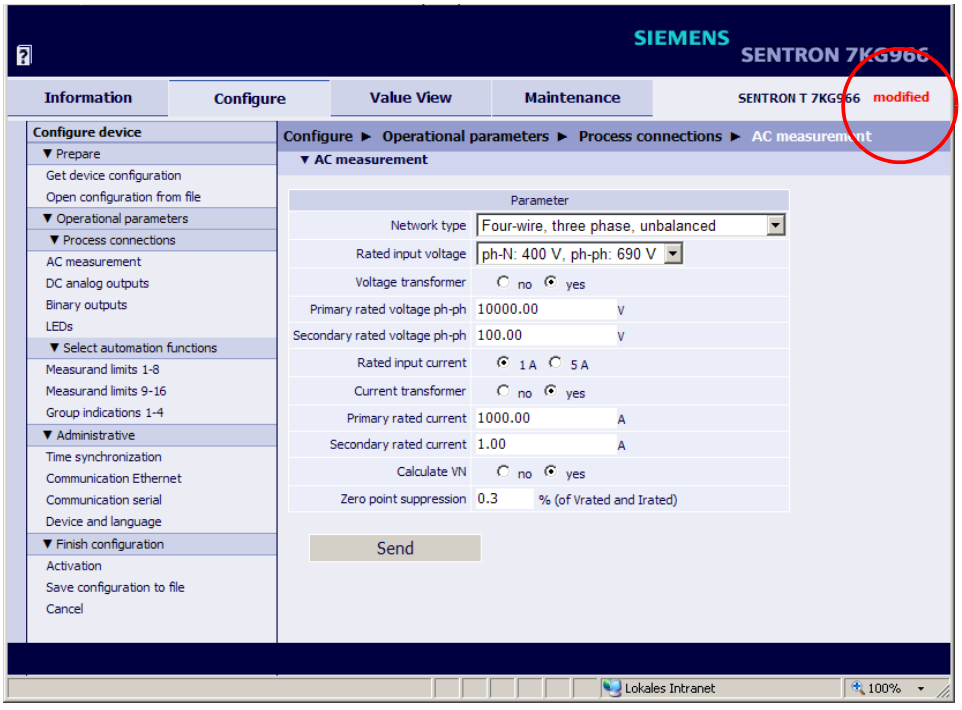


Fig. 7-19 Access Blocked

If a user makes a change, the server starts a 20-minute timer. If no further changes to the set of parameters are entered by the time the timer has counted down, write access is released again for all users. In this case, the modified data are discarded and the passive set of parameters is overwritten with the content of the active set of parameters.

If new changes to the passive set of parameters are made during the 20-minute countdown, the timer is restarted by each action.

If the user has completed his changes to the passive set of parameters or finished the parameterization by clicking the **Cancel** button, write access for all users is also released.

7.3.3 Setting the Operational Parameters

In the **Configure** tab you can view and edit the set operational parameters. You can select the parameters in the **Operational** menu in the navigation window. The submenus **Process connections**, **Select automation function** and **Administrative** are available for making the settings. The submenus contain the following elements:

- Process connections
  - AC measurement
  - DC analog outputs
  - Binary outputs
  - LEDs
- Select automation functions
  - Measurand limits 1-8
  - Measurand limits 9-16
  - Group indications 1-4
- Administrative
  - Time synchronization
  - Communication Ethernet
  - Communication serial
  - Device and language

NOTE

Observe the procedure for the device configuration described in chapter 7.3.1 when you set the operational parameters.

7.3.3.1 Process Connections

7.3.3.1.1 AC Measurement

Default Settings and Setting Ranges of Measured-value Acquisition

Table 7-2 Settings for Measured-value Acquisition

Parameter	Default Setting	Setting Range
Network type	Four-wire, three phase, unbalanced	Acc. to list box (see chapter 15)
Rated input voltage	ph-N: AC 400 V (max. AC 347 V for UL), ph-ph: AC 690 V (max. AC 600 V for UL)	Acc. to list box (see chapter 15)
Voltage transformer	no	yes no
Primary rated voltage ph-ph	AC 10000.00 V	AC 100.00 V to 1 000 000.00 V
Secondary rated voltage ph-ph	AC 100.00 V	AC 1.00 V to 600.00 V
Rated input current	AC 5 A	AC 1 A AC 5 A
Current transformer	no	yes no
Primary rated current	AC 1000.00 A	AC 1.00 A to 100 000.00 A
Secondary rated current	AC 1.00 A	AC 0 A to 1.2 A AC 0 A to 6 A
Calculate VN *)	yes	yes no
Zero-point suppression	0.3 %	0.0 % to 10.0 %

*) This option field is only visible in the device variants SENTRON T 7KG966x-1xAx0-xAA0.

To change the parameters of the measured-value acquisition, proceed as follows:

✧ In the navigation window, select the **Operational** menu, then the **Process connections** submenu and click the **AC measurement** menu item.

The **AC measurement** input/output window opens.

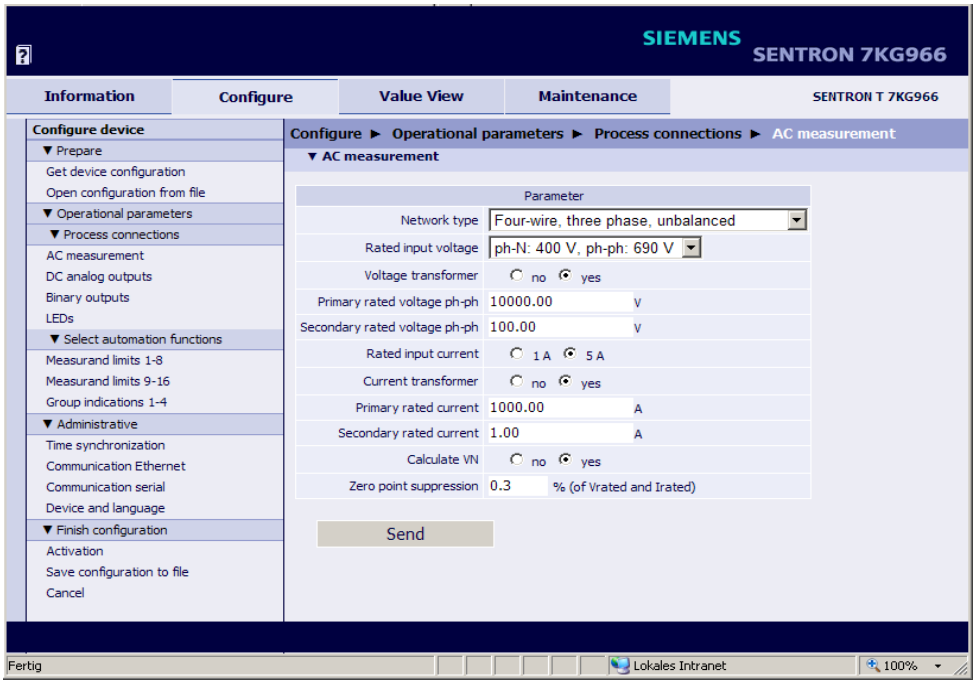


Fig. 7-20 Configure Tab, AC Measurement Input/output Window

✧ Select the desired network type in the **Network type** list box. The following network types are available:
- Single-phase network
- Three-wire network balanced or unbalanced with 2 or 3 current transformers
- Four-wire network balanced or unbalanced

✧ In the **Rated input voltage** list box select the desired input voltage. The following voltages are available:
- Phase (ph)-Ground (N): AC 63.5 V or Phase (ph)-Phase (ph): AC 110 V
- ph-N: AC 110 V or ph-ph: AC 190 V
- ph-N: AC 230 V or ph-ph: AC 400 V
- ph-N: AC 400 V (max. AC 347 V for UL) or ph-ph: AC 690 V (max. AC 600 V for UL)

✧ Click either the **yes** or the **no** option button in the **Voltage transformer** section to specify whether you are using voltage transformers for the measurement between measuring object and measuring device.

✧ If you use voltage transformers, enter the rated values of the voltage transformers into the fields **Primary rated voltage** ph-ph and **Secondary rated voltage ph-ph**. If you do not use voltage transformers, no entries are possible in these fields.

- ✧ Select the input current by clicking one of the options offered under **Rated input current**. The following currents are available:
  - ─ AC 1 A
  - ─ AC 5 A
- ✧ Click either the **yes** or the **no** option button in the **Current transformer** section to specify whether you are using current transformers for the measurement between measuring object and measuring.
- ✧ If you use current transformers, enter the rated values of the current transformer into the fields **Primary rated current** and **Secondary rated current**. If you do not use current transformers, no entries are possible in these fields.
- ✧ Specify in the **Calculate VN** section whether the voltage of the neutral conductor must be measured (**yes**) or calculated (**no**).

NOTE

This option field is only visible in the device variants SENTRON T 7KG966x-1xAx0-xAA0.

NOTE

The voltage in the neutral conductor is calculated if it is grounded (standard).

The voltage in the neutral conductor is measured if b is grounded (special connection type).

NOTE

If Ethernet communication with **Bus protocol IEC 61850** is active and you change **Net work type** the device will reset.

- ✧ Click the **Send** button.

  The parameters are transmitted to the device but not enabled yet (passive set of parameters).
- ✧ If you do not want to make any additional settings, continue with the **activation** of the device configuration according to “Activating the Set of Parameters”. If you want to change other settings, enter the changes and then enable the device configuration as described in “Activating the Set of Parameters”.

7.3.3.1.2 DC Analog Outputs

Only parameterize the DC analog outputs (terminals K2/3 through K8/9) you actually use for the output of measured values.

Default Settings and Setting Ranges of the DC Analog Outputs

Table 7-3 Settings of the DC Analog Outputs

Parameter	Default Setting	Setting Range
Measurand	-none-	Acc. to list box (see chapter 15)
Output range	-20 mA to 20 mA	Acc. to list box (see chapter 15)
Function	Linear	Linear Linear with knee-point Square
Measurand from [1)] (unit according to measured value)	0.0	-1 000 000 000.0 to 1 000 000 000.0
Measurand to [1)] (unit according to measured value)	100.0	-1 000 000 000.0 to 1 000 000 000.0
Knee-point measurand[1)] (unit according to measured value)	0.0	-1 000 000 000.0 to 1 000 000 000.0
Knee-point output only at function “Linear with knee-point” (unit according to measured value)	0.0	-20 mA to 20 mA -10 V to 10 V

1) "Measured value from" ≤ "Knee-point measured value" ≤ "Measured value to"

To change the parameters of the DC analog outputs, proceed as follows:

✧ In the navigation window, select the **Operational** menu, then the **Process connections** submenu and click **DC analog outputs**.

The **DC analog outputs** input/output window opens.

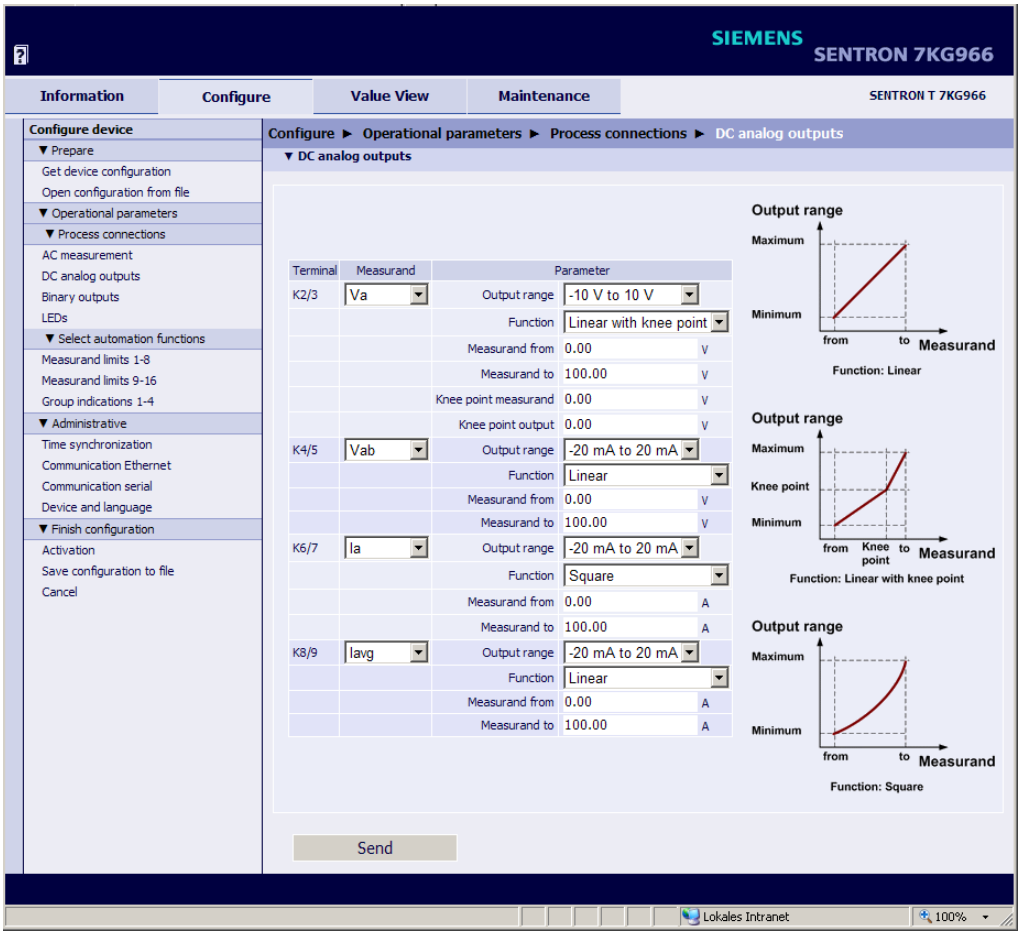


Fig. 7-21 Configure Tab, DC Analog Outputs Input/output Window

NOTE

The bottom right part of the user interface provides representations of the linear characteristic (top), the knee-point characteristic (middle) and the square characteristic (bottom) of measured values. The characteristics are for your information and do not reflect real measured values.

Parameterizing a DC Analog Output, for Example Terminals K2/3

- ✧ In the **Measurand** list box select the measured value you want to output via the DC analog output. You can parameterize the DC analog output for the following measured values:
  - ─ Voltages
  - ─ Currents
  - ─ Active, reactive and apparent power
  - ─ Active power factor cos ϕ
  - ─ Power factor PF
  - ─ Phase angle ϕ
  - ─ Frequency

  Select **-none-** to disable the DC analog output.

NOTE

Which quantities are offered in the **Measurand** list box depends on the configured network type. The **Network type** is specified in the **Process connections** submenu, **AC measurement** input/output window, see chapter 7.3.3.1.1.

- ✧ In the **Output range** list box select the current or voltage range within which the measured value will be output. You can parameterize the following outputs:
  - ─ 0 mA to 20 mA
  - ─ 4 mA to 20 mA
  - ─ -20 mA to 20 mA
  - ─ 0 V to 10 V
  - ─ -10 V to 10 V
- ✧ Select one of the list box **Function** to specify whether to output the measured value as a **Linear** characteristic, as **Linear** characteristic **with knee-point** or as **square** characteristic within the **Output range**.

Output as Linear Characteristic

- ✧ Enter the start value of the measurement in the **Measurand from** field.
- ✧ Enter the final value of the measurement in the **Measurand to** field.

Output as Linear Characteristic with Knee-point

- ✧ Enter the start value of the measurement in the **Measurand from** field.
- ✧ Enter the final value of the measurement in the **Measurand to** field.
- ✧ Enter the value at which the knee-point is displayed on the x-axis of the characteristic in the **Knee point measurand** field.
- ✧ Enter the value at which the knee-point is displayed on the y-axis of the characteristic in the **Knee point output** field.

Output as Square Characteristic

- ✧ Enter the start value of the measurement in the **Measurand from** field.
- ✧ Enter the final value of the measurement in the **Measurand to** field.

✧ Parameterize the other DC analog outputs or click the **Send** button to leave these DC analog outputs unchanged.

After clicking the **Send** button, the parameters are transmitted to the device but not enabled yet (passive set of parameters).

✧ If you do not want to make any additional settings, continue with the **activation** of the device configuration according to “Activating the Set of Parameters”. If you want to change other settings, enter the changes and then enable the device configuration as described in “Activating the Set of Parameters”.

7.3.3.1.3 Binary Outputs

Default Settings and Setting Ranges of the Binary Outputs

Table 7-4 Settings of Binary Outputs

Parameter	Default Setting	Setting Range
Source type	Indication	Indication Energy counter
Indication [1]	-none-	Acc. to list box (see chapter 15)
Energy counter [2]	-none-	Acc. to list box (see chapter 15)
Source inverted [1]	no	no yes
Operating mode [1]	Persistent	Acc. to list box (see chapter 15)
Energy increase per pulse [2]	1.0 Wh	0.1 Wh/VAh/varh to 1 000 000 Wh/VAh/varh
Output time pulse operating mode [3]	20 = 200 ms	50 ms to 3 600 000 ms

[1] Only if source type = indication

[2] Only if source type = energy counter

[3] Only if source type = indication and pulse or pulse with retrigger or source type = energy counter

To change the outputs of a binary output, proceed as follows:

✧ In the navigation window, select the **Operational** menu, then the **Process connections** submenu and click **Binary outputs**.

The **Binary outputs** input/output window opens.

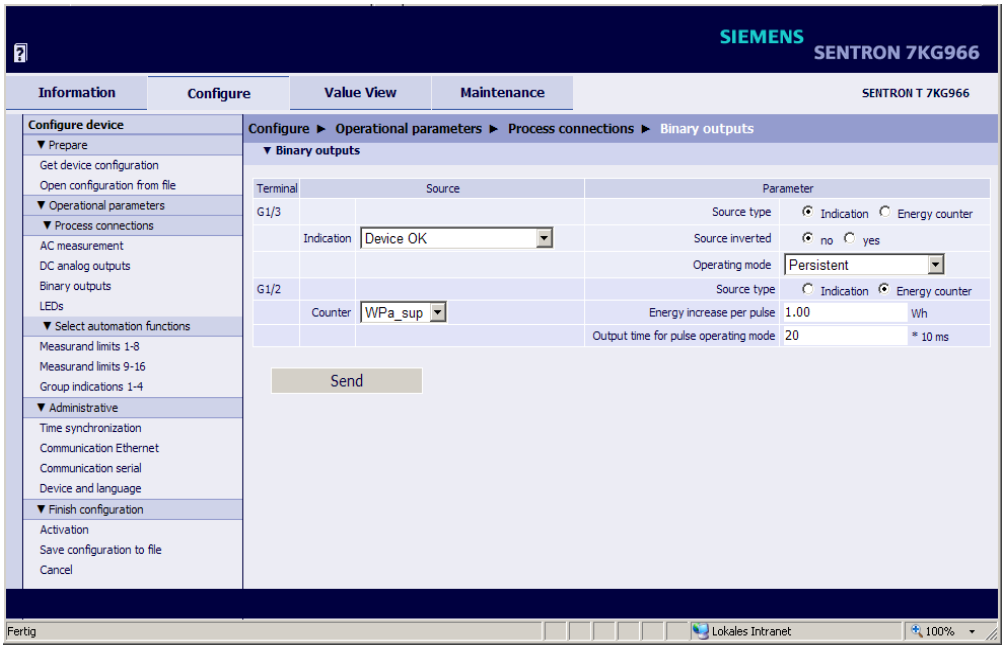


Fig. 7-22 Configure Tab, Binary Outputs Input/output Window

NOTE

The parameterization of both binary outputs is identical. figure 7-22 depicts binary output **Terminal G1/3** as output for indications and binary output **Terminal G1/2** as energy counter.

You can only set either an indication or an energy counter for a binary output.

Parameterizing an Indication (see figure 7-22, for example terminal G1/3)

- ✧ Select the **Indication** option button under **Source type**.
- ✧ Select the source of the indication from the **Indication** list box. You can select from the following indications:
  - ─ Ready and status indications, for example Device OK, Modbus TCP OK
  - ─ Indications about present device activities, for example Settings load
  - ─ Group indication, example Group indication 2
  - ─ Error indications, for example Battery Failure, Ethernet Link Error
  - ─ Administrative indications, for example Daylight Saving Time
  - ─ Limit violation indications, for example Limit Violation 1 (see chapter 7.3.3.2)
  - ─ Communication indications, for example Indication 1 from Remote
  - ─ Rotation voltage

  Select **-none-** to disable the binary output.
- ✧ In the **Source inverted** section select whether you want to invert the indication for the output (**yes**) or not (**no**).

✧ Select the output mode at the binary outputs in the **Operating mode** list box. The following output types are available:

– **Persistent**: The binary output has the status ON or OFF. If the indication becomes invalid, the binary output continues to maintain its current status.

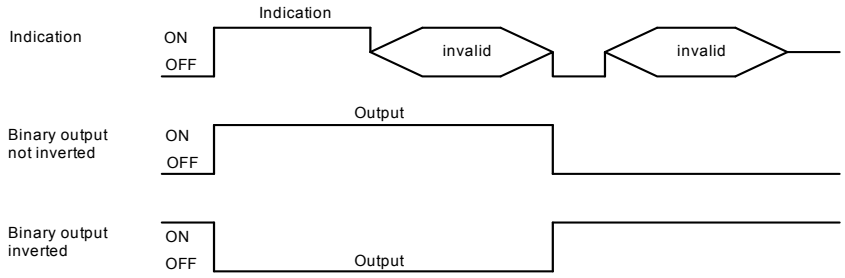


Fig. 7-23 Persistent

– **Persistent with fail save**: If the indication becomes invalid, the binary output switches into the OFF state, that is if **Source inverted** = **no**, or it switches into the ON state if **Source inverted** = **yes**.

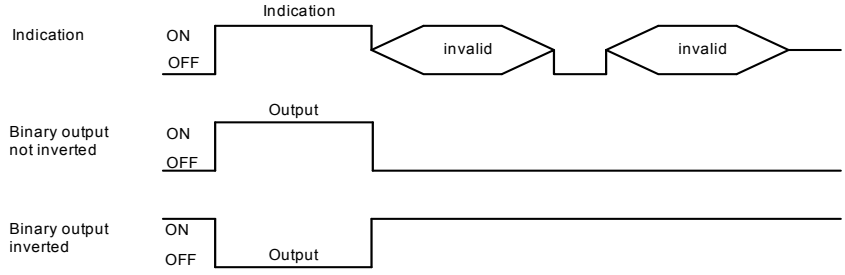


Fig. 7-24 Persistent with Fail Save

– **Pulse** without retrigger: This indication is output as pulse. If the indication changes again while the output pulse is ON, the pulse output time is not restarted. This means that a change of the indication during the pulse output will be ignored.

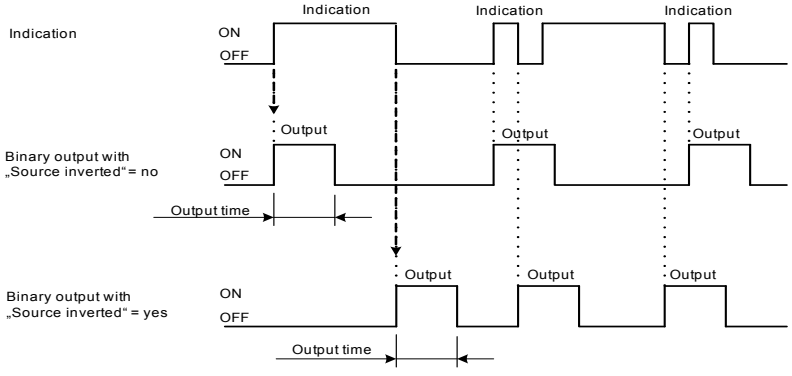


Fig. 7-25 Pulse without Retrigger

– **Pulse with retrigger**: This indication is output as pulse. The output pulse is retriggered if the indication is changed during the pulse output. This means that the pulse output is extended.

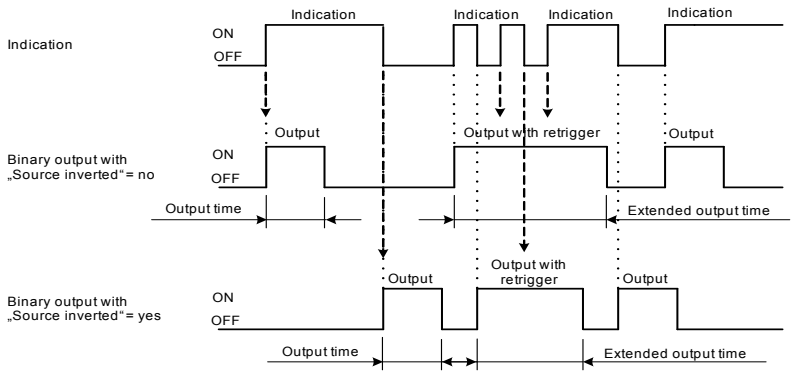


Fig. 7-26 Pulse with Retrigger

✧ If you have selected one of the two **Pulse** types in the **Operating mode** list box, enter an output time x (in x *10 ms) into the **Output time for pulse operating mode** field.

✧ Parameterize the second binary output (e.g. energy counter) or click the **Send** button to leave it unchanged.

After clicking the **Send** button, the parameters are transmitted to the device but not enabled yet (passive set of parameters).

✧ If you do not want to make any additional settings, continue with the **activation** of the device configuration according to “Activating the Set of Parameters”. If you want to change other settings, enter the changes and then enable the device configuration as described in “Activating the Set of Parameters”.

Behavior when Activating the Set of Parameters after the Set of Parameters was Changed

Persistent:

The binary output is set to the new status (ON or OFF) as defined by the current indication.

Pulse:

If the binary output is ON in **pulse** mode while activating the set of parameters, the binary output is immediately switched to the OFF status after the set of parameters has been successfully activated. This happens even if the parameterized **Output time for pulse operating mode** has not yet elapsed.

Parameterizing an Energy Counter (see figure 7-22, for example terminal G1/2)

✧ In the **Source type** section select the **Energy counter** option button.

✧ Select the source of the counter from the **Counter** list box. You can select from the following counters:

– Active power supply and demand
– Reactive power inductive and capacitive
– Apparent power

Select **-none-** to disable the binary output.

✧ Enter the increment (in Wh/VAh/varh) for energy counting in the **Energy increase per pulse** field.

✧ Parameterize the second binary output (indication or energy counter) or click the **Send** button to leave it unchanged.

After clicking the **Send** button, the parameters are transmitted to the device but not enabled yet (passive set of parameters).

✧ If you do not want to make any additional settings, continue with the **activation** of the device configuration according to “Activating the Set of Parameters”. If you want to change other settings, enter the changes and then enable the device configuration as described in “Activating the Set of Parameters”.

7.3.3.1.4 LEDs

Default Settings of the LEDs

Table 7-5 LED Settings

LED	Default Setting	Setting Range
RUN	Device ready	Not settable
ERROR	-none-	Indicates an error and indicates according to parameterization Acc. to list box (see chapter 15)
H1	-none-	Acc. to list box (see chapter 15)
H2	-none-	Acc. to list box (see chapter 15)
Indication inverted	no	no yes

To change the outputs of the LEDs H1, H2, ERROR, proceed as follows:

✧ In the navigation window, select the **Operational** menu, then the **Process connections** submenu and click **LEDs**.

The **LEDs** input/output window opens.

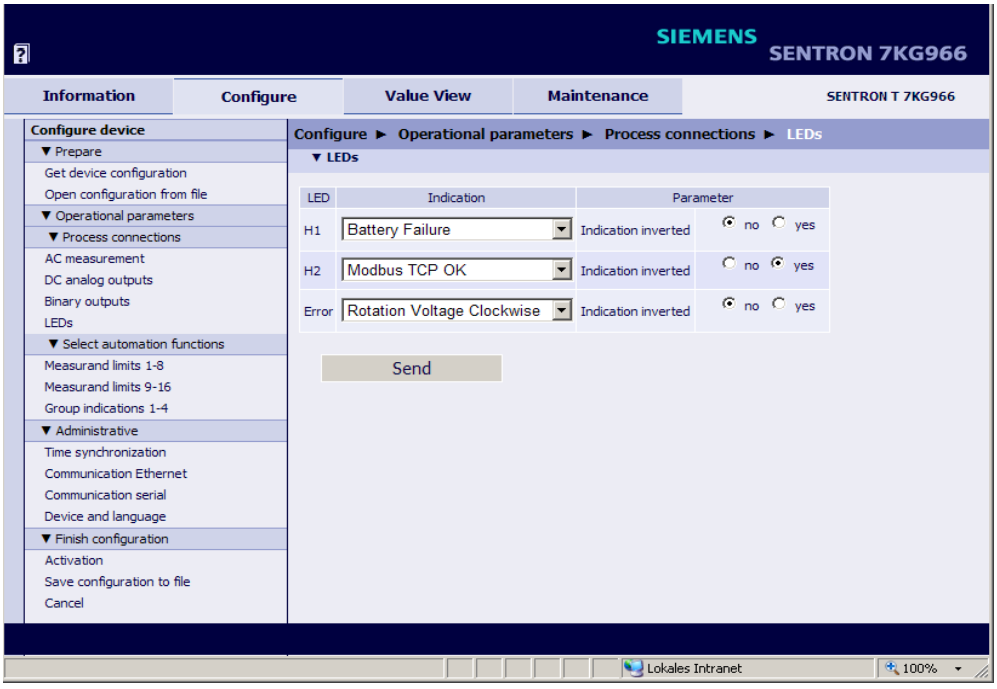


Fig. 7-27 Configure Tab, LEDs Input/output Window

- ✧ Select the indication to be assigned to the corresponding LED from the **H1** or **H2** list box. You can select from the following indications:
  - ─ Ready and status indications, for example Device OK, Modbus TCP OK
  - ─ Indications about present device activities, for example Settings load
  - ─ Group indication, example Group indication 2
  - ─ Error indications, for example Battery Failure, Ethernet Link Error
  - ─ Administrative indications, for example Daylight Saving Time
  - ─ Limit violation indications, for example Limit Violation 1 (see chapter 7.3.3.2)
  - ─ Communication indications, for example Indication 1 from Remote
  - ─ Rotation voltage

  Select **-none-** to disable the corresponding LED.
- ✧ In the **Indication inverted** section select whether you want to invert the indication for the output (**yes**) or not (**no**).
- ✧ Click the **Send** button.

  The parameters are transmitted to the device but not enabled yet (passive set of parameters).
- ✧ If you do not want to make any additional settings, continue with the **activation** of the device configuration according to “Activating the Set of Parameters”. If you want to change other settings, enter the changes and then enable the device configuration as described in “Activating the Set of Parameters”.

Behavior of the LEDs

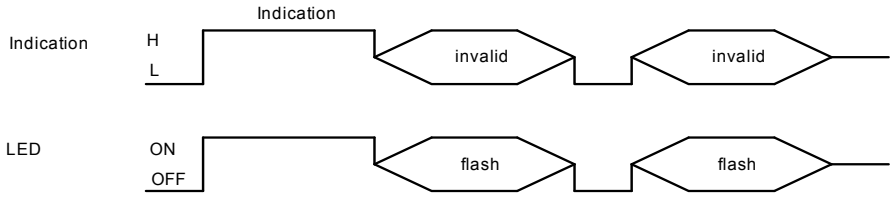


Fig. 7-28 Behavior of the LEDs

7.3.3.2 Automation Functions

7.3.3.2.1 Limit Settings

In the **Select automation functions** menu you can set upper or lower limits for up to 16 measured values. Limit violations of the upper or lower value range can be output as indications. Up to 4 limit value violations can be signaled at the device via the two binary outputs and the LEDs H1 and H2. Furthermore, all 16 limit violations can be sent to peripheral devices via Ethernet.

The programmable limits are divided into two groups **Measurand limits 1-8** and **Measurand limits 9-16**. The parameterization is identical for all limits.

Default Settings and Setting Ranges of the Limits

Table 7-6 Limit Settings

Parameter	Default Setting	Setting Range
Measurand	-none-	Acc. to list box (see chapter 15)
Limit	0.0	-1 000 000 000 to 1 000 000 000 (unit)
Limit type	Lower	Lower Upper
Hysteresis (%)	1.0	0.0 to 10.0
Violation indication	Limit Violation x (x = 1 to 16)	The name of the limit violation indication is customizable.

Parameterizing a Limit

To change for example limit 1, proceed as follows:

✧ In the navigation window, select the **Operational** menu, then the **Select automation functions** submenu and click **Measurand limits 1-8**.

The **Measurand limits** input/output window opens.

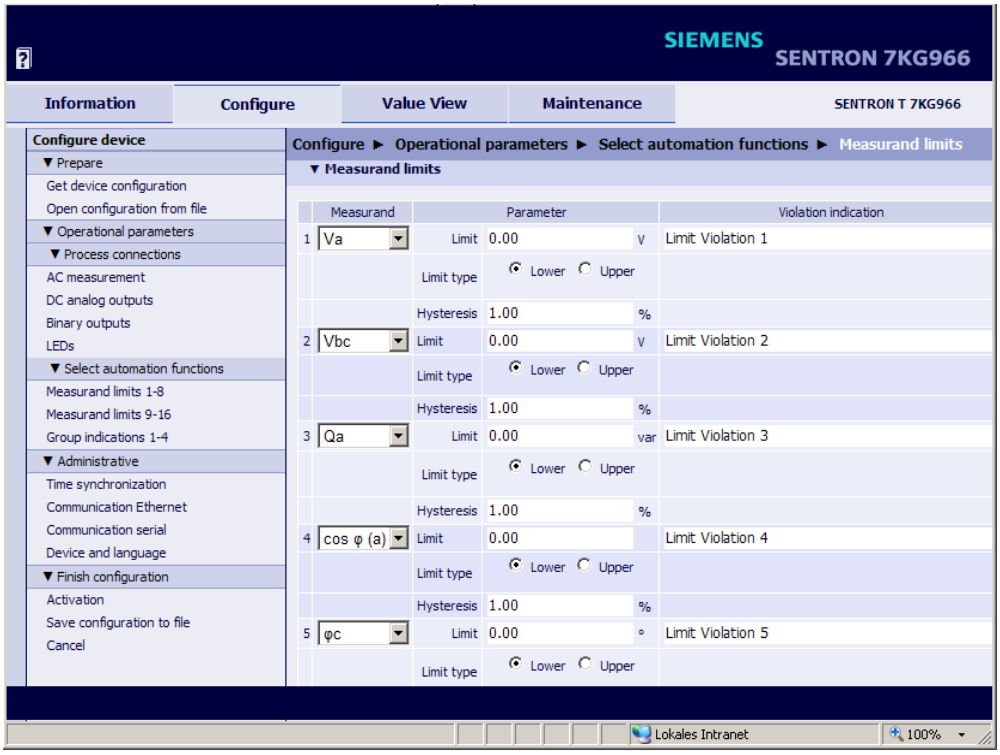


Fig. 7-29 Configure Tab, Measurand Limits 1-8 Input/output Window (Detail)

✧ Select the measured value for which you want to parameterize the limit value indication from the **Measurand** list box. You can parameterize a limit value indication for the following measured values:

- Voltages
- Currents
- Active, reactive and apparent power
- Active power factor cos ϕ
- Power factor
- Phase angle ϕ
- Frequency

Select **-none-** to disable the limit value indication.

NOTE

Which quantities are offered in the **Measurand** list box depends on the configured network type. The **Network type** is specified in the **Process connections** submenu, **AC measurement** input/output window, see chapter 7.3.3.1.1.

✧ Enter a limit value into the **Parameter** column in the **Limit type** option field that lies below the permitted value range (**Lower** limit value) or above the permitted value range (**Upper** limit value).

✧ Enter the limit value into the **Limit** field.

✧ In the **Hysteresis** field enter a value for the hysteresis of the limit value violation.

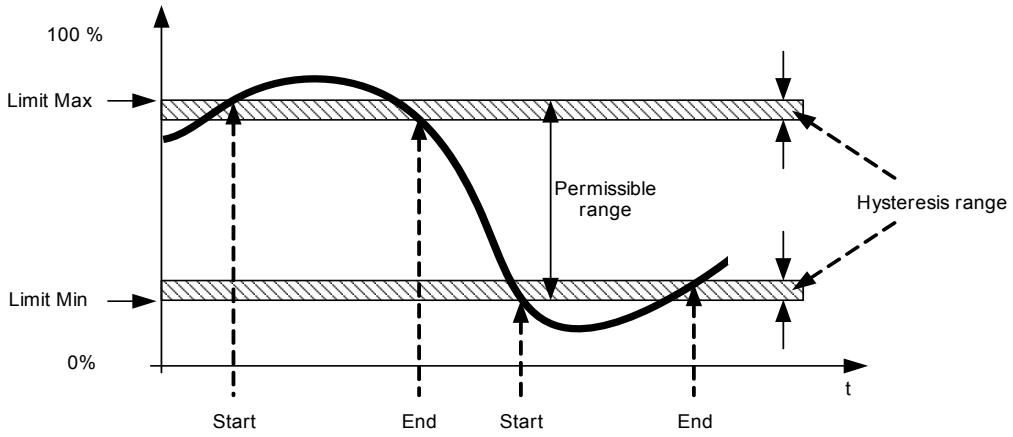


Fig. 7-30 Hysteresis (General Representation)

✧ Enter a name for the limit violation indication in the **Violation indication** field. By doing so, the original entry is overwritten.

✧ Click the **Send** button.

After clicking the **Send** button, the parameters are transmitted to the device but not enabled yet (passive set of parameters).

✧ If you do not want to make any additional settings, continue with the **activation** of the device configuration according to “Activating the Set of Parameters”. If you want to change other settings, enter the changes and then enable the device configuration as described in “Activating the Set of Parameters”.

7.3.3.2.2 Group Indications

In the **Select automation functions** menu, up to 4 **Group indications** can be parameterized and each of them can be assigned up to 4 logically linked single-point indications. The single point indications can be inverted.

Default Settings and Setting of the Group Indications

Table 7-7 Group Indications

Parameter	Default Setting	Setting Range
Source	-none-	Acc. to list box (see chapter 15)
Source inverted	no	no yes
Logic operation	NONE	NONE OR AND
Group indication name	Group Indication x	Any

Rule for Linking Indications to a Group Indication

In a group indication, up to 4 indications can sequentially be linked logically. The indications 1 to 4 are always linked successively as follows:

Indication 1 with Indication 2 = Indication 1/2

Indication 1/2 with Indication 3 = Indication 1/2/3

Indication 1/2/3 with Indication 4 = Group indication

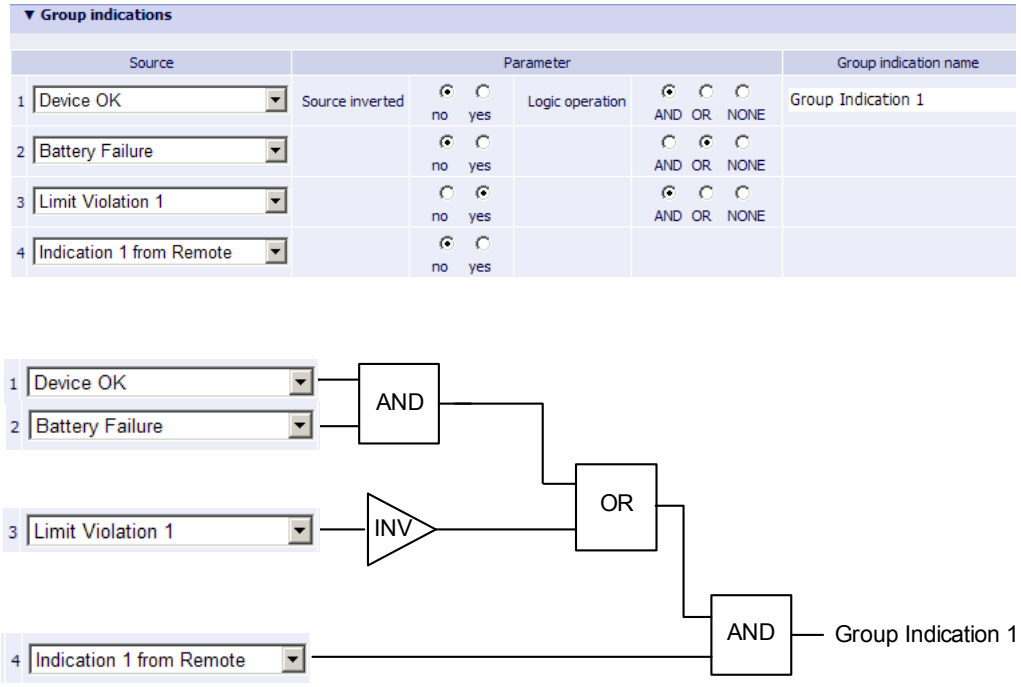


Fig. 7-31 Example: Linking 4 Indications to a Group Indication

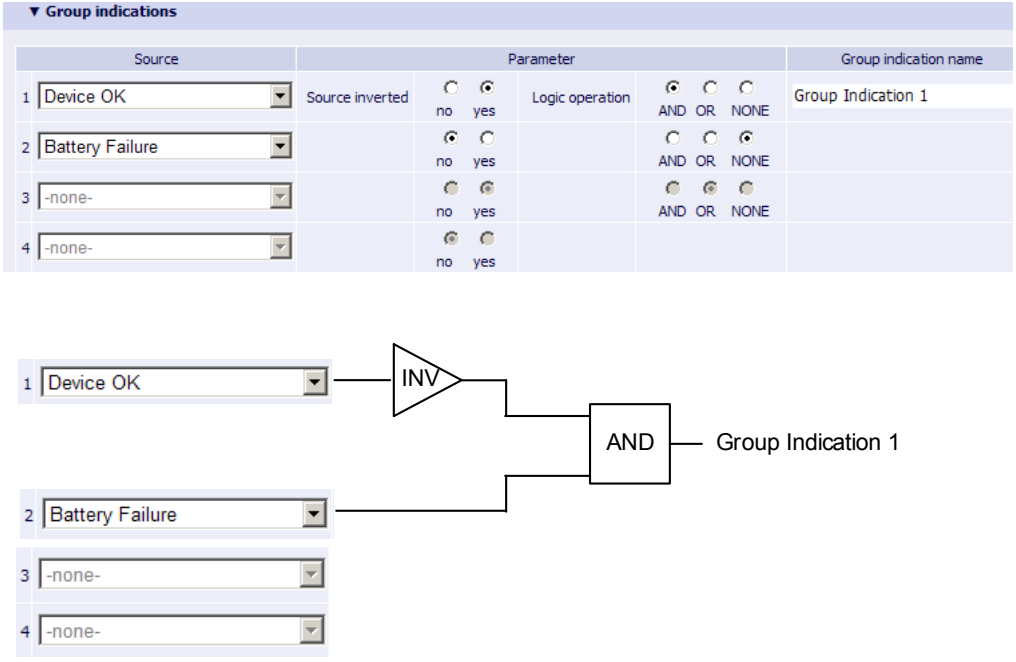


Fig. 7-32 Example: Linking 2 Indications to a Group Indication

Parameterizing a Group Indication

To change for example group indication 1, proceed as follows:

✧ In the navigation window, select the **Operational parameters** menu, then the **Select automation functions** submenu and click **Group indications 1-4**.

The **Group indications** input/output window opens.

Fig. 7-33 Configure Tab, Group Indications Input/output Window (Detail)

✧ For Group Indication 1, select those indications which you want to assign to Group Indication 1 in the up to 4 **Source** selection lists. The following indications can be assigned to a group indication:

- Ready and status indications, for example Device OK, Modbus TCP OK
- Indications about present device activities, for example Settings load
- Group indication, example Group indication 2
- Error indications, for example Battery Failure, Ethernet Link Error
- Administrative indications, for example Daylight Saving Time
- Limit violation indications, for example Limit Violation 1 (see chapter 7.3.3.2)
- Communication indications, for example Indication 1 from Remote
- Rotation voltage

If you select **-none-** for all 4 indications of a group indication, the respective group indication is inactive.

- ✧ Click the **Send** button.

  After clicking the **Send** button, the parameters are transmitted to the device but not enabled yet (passive set of parameters).

- ✧ If you do not want to make any additional settings, continue with the **activation** of the device configuration according to “Activating the Set of Parameters”. If you want to change other settings, enter the changes and then enable the device configuration as described in “Activating the Set of Parameters”.

7.3.4 Setting Administrative Parameters

In the **Configure** tab you can view and if necessary edit the administrative settings. You can select the parameters in the **Administrative** menu in the navigation window. These parameters can be changed in the input/output windows **Time synchronization**, **Communication** (consisting of **Communication Ethernet** and **Communication serial**) and **Device and language**.

NOTE

Observe the procedure for the device configuration described in chapter 7.3.1 when setting the administrative parameters.

7.3.4.1 Time Synchronization

Default Settings and Setting Ranges of the Time Synchronization

Table 7-8 Time Synchronization Settings

Parameter	Default Setting	Setting Range
Source time synchronization	Internal	Acc. to list box (see chapter 15)
Time zone offset to UTC	+00:00	-12 to +13 (hours) (in increments of 0.5 h)
Daylight Saving Time switchover	yes	no yes
DST offset to UTC	+01:00	0 to + 2 (hours) (in increments of 0.5 h)
Start of DST	March Last week Sunday 02:00 AM	Acc. to list boxes (see chapter 15)
End of DST	October Last week Sunday 03:00 AM	Acc. to list boxes (see chapter 15)
Additional Parameters if the Source is Ethernet NTP (Modbus TCP and IEC 61850)		
Primary NTP server IP address	192.168.0.254	Any
Secondary NTP server IP address	192.168.0.253	Any No polling of the NTP server if 0.0.0.0 was entered
Error indication after	10 min	2 min to 120 min
Additional Parameter if the Source is Fieldbus (Modbus RTU and IEC 60870-5-103)		
Error indication after	10 min	2 min to 120 min

To change the time synchronization, proceed as follows:

✧ In the navigation window, click the **Administrative** menu and then **Time synchronization**.

The **Time synchronization** input/output window opens.

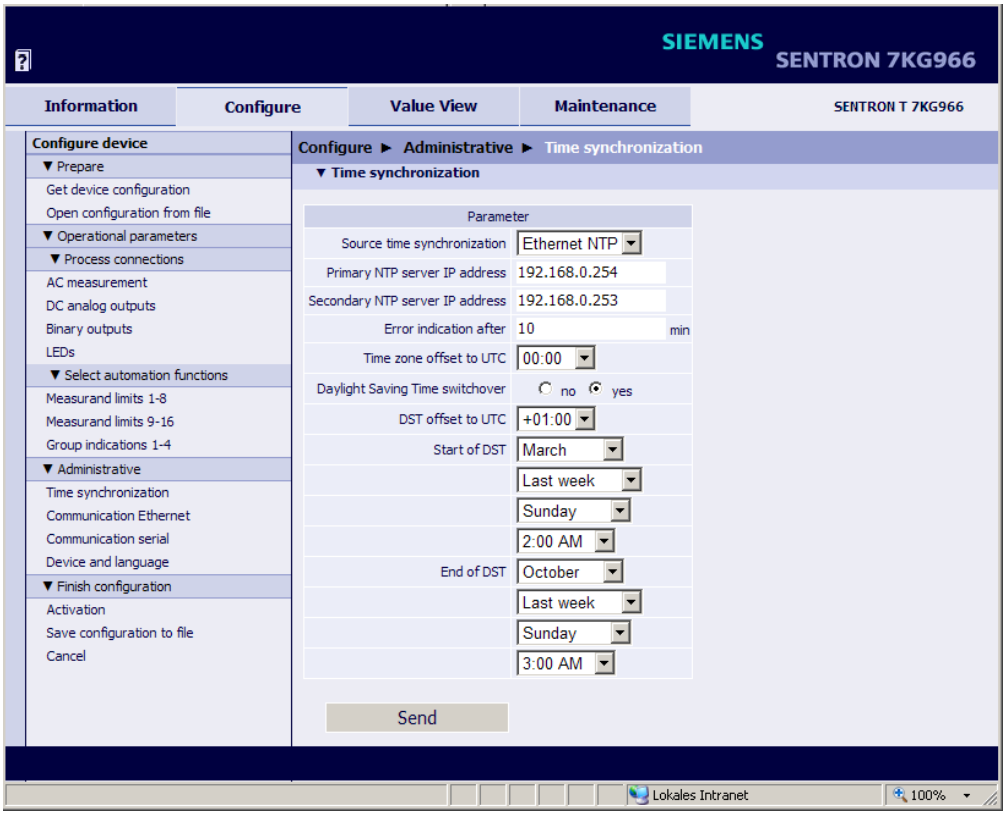


Fig. 7-34 Configure Tab, Time Synchronization Input/output Window, Ethernet NTP Selected

✧ Select one of the three following sources from the **Source time synchronization** list box:
- Internal (no time synchronization)
- Ethernet NTP
- Fieldbus

✧ Parameterize the time synchronization according to the selected source.

Internal Time Synchronization

✧ Select **Internal** as the source from the **Source time synchronization** list box:

✧ In the **Time zone offset to UTC** list box select the time difference to UTC (Universal Time Coordinated).

✧ The option buttons at **Daylight Saving Time switchover** allow you to enable (**yes**) or disable (**no**) the automatic Daylight Saving Time adjustment.

If you have selected the **no** option button, the time synchronization is complete. Click the **Send** button in this case. If you have selected the **yes** option button, continue the parameterization as follows:

✧ Select the time difference to UTC in the **DST offset to UTC** list box.

✧ In the list boxes under **Start of DST** specify the month, week, day and time for starting Daylight Saving Time.

✧ In the list boxes under **End of DST** specify the month, week, day and time for switching back to standard time.

- ✧ Click the **Send** button.

  After clicking the **Send** button, the parameters are transmitted to the device but not enabled yet (passive set of parameters).

- ✧ If you do not want to make any additional settings, continue with the **activation** of the device configuration according to “Activating the Set of Parameters”. If you want to change other settings, enter the changes and then enable the device configuration as described in “Activating the Set of Parameters”.

Time Synchronization via Ethernet NTP

- ✧ Select **Ethernet NTP** as the source from the **Source time synchronization** list box:
- ✧ Enter the IP address in the **Primary NTP server IP address** field.
- ✧ Enter the IP address of the redundant NTP server in the **Secondary NTP server IP address** field.
- ✧ In the **Error indication after** field enter the time in **min** after which the operational indication "Clock error" is output.
- ✧ Select the time difference to UTC in the **Time zone offset to UTC** list box.
- ✧ The option buttons at **Daylight Saving Time switchover** allow you to enable (**yes**) or disable (**no**) the automatic Daylight Saving Time adjustment.

  If you have selected the **no** option button, the time synchronization is complete. Click the **Send** button in this case. If you have selected the yes option button, continue the parameterization as follows:

- ✧ Select the time difference to UTC in the **DST offset to UTC** list box.
- ✧ In the list boxes under **Start of DST** specify the month, week, day and time for starting Daylight Saving Time.
- ✧ In the list boxes under **End of DST** specify the month, week, day and time for switching back to standard time.
- ✧ Click the **Send** button.

  After clicking the **Send** button, the parameters are transmitted to the device but not enabled yet (passive set of parameters).

- ✧ If you do not want to make any additional settings, continue with the **activation** of the device configuration according to “Activating the Set of Parameters”. If you want to change other settings, enter the changes and then enable the device configuration as described in “Activating the Set of Parameters”.

Time Synchronization via Fieldbus

- ✧ Select **Fieldbus** as the source from the **Source time synchronization** list box:
- ✧ In the **Error indication after** field enter the time in **min** after which the operational indication "Clock error" is output.
- ✧ Select the time difference to UTC in the **Time zone offset to UTC** list box.
- ✧ The option buttons at **Daylight Saving Time switchover** allow you to enable (**yes**) or disable (**no**) the automatic Daylight Saving Time adjustment.

  If you have selected the **no** option button, the time synchronization is complete. Click the **Send** button in this case. If you have selected the **yes** option button, continue the parameterization as follows:

- ✧ Select the time difference to UTC in the **DST offset to UTC** list box.
- ✧ In the list boxes under **Start of DST** specify the month, week, day and time for starting Daylight Saving Time.
- ✧ In the list boxes under **End of DST** specify the month, week, day and time for switching back to standard time.

- ✧ Click the **Send** button.

  After clicking the **Send** button, the parameters are transmitted to the device but not enabled yet (passive set of parameters).

- ✧ If you do not want to make any additional settings, continue with the **activation** of the device configuration according to “Activating the Set of Parameters”. If you want to change other settings, enter the changes and then enable the device configuration as described in “Activating the Set of Parameters”.

7.3.4.2 Ethernet Communication

Default Settings and Setting Ranges of the Ethernet Communication

Table 7-9 Ethernet Communication Settings

Parameter	Default Setting	Setting Range
IP address [1]	192.168.0.55	Any 0.0.0.0 = DHCP
Subnet mask [1]	255.255.255.0	Any
Default gateway [1]	192.168.0.1	Any
Enable SNMP	no	no yes
Bus protocol	Modbus TCP	Modbus TCP IEC 61850 -none-
Bus Protocol Modbus TCP		
Use a user-port number [2]	no	no yes
User-port number [2] (can only be set when *Use a user-port number* is parameterized with *yes*)	10000	10000 to 65535
Access rights for user port (can only be set when *Use a user-port number* is parameterized with *yes*)	Full	Full Read only
Access rights for port 502	Full	Full Read only
Keep Alive time	10 s	0 s = switch off 1 s to 65 535 s
Communication supervision time	600 * 100 ms	0 s = none 100 ms to 6 553 400 ms
Bus Protocol IEC 61850		
IED Name NO.	1	0 to 65534
Voltage - Dead band	5 %	0 % to 5 %, in 1-% steps
Current - Dead band	5 %	0 % to 5 %, in 1-% steps
Power - Dead band	5 %	0 % to 5 %, in 1-% steps
Power factor - Dead band	0.05	0 % 2 % to 5 %, in 1-% steps
Frequency - Dead band	0.05	0 % 0.02 % 0.05 %

1) After the parameter changes have been enabled, the device will reset.
2) After enabling the parameter changes, any currently active Modbus TCP connections will be closed. The Modbus TCP client must later reopen these connections.

To change the Ethernet communication settings, proceed as follows:

✧ In the navigation window, click the **Administrative** menu and then **Communication Ethernet**.
The **Communication Ethernet** input/output window with **Protocol Modbus TCP** opens.

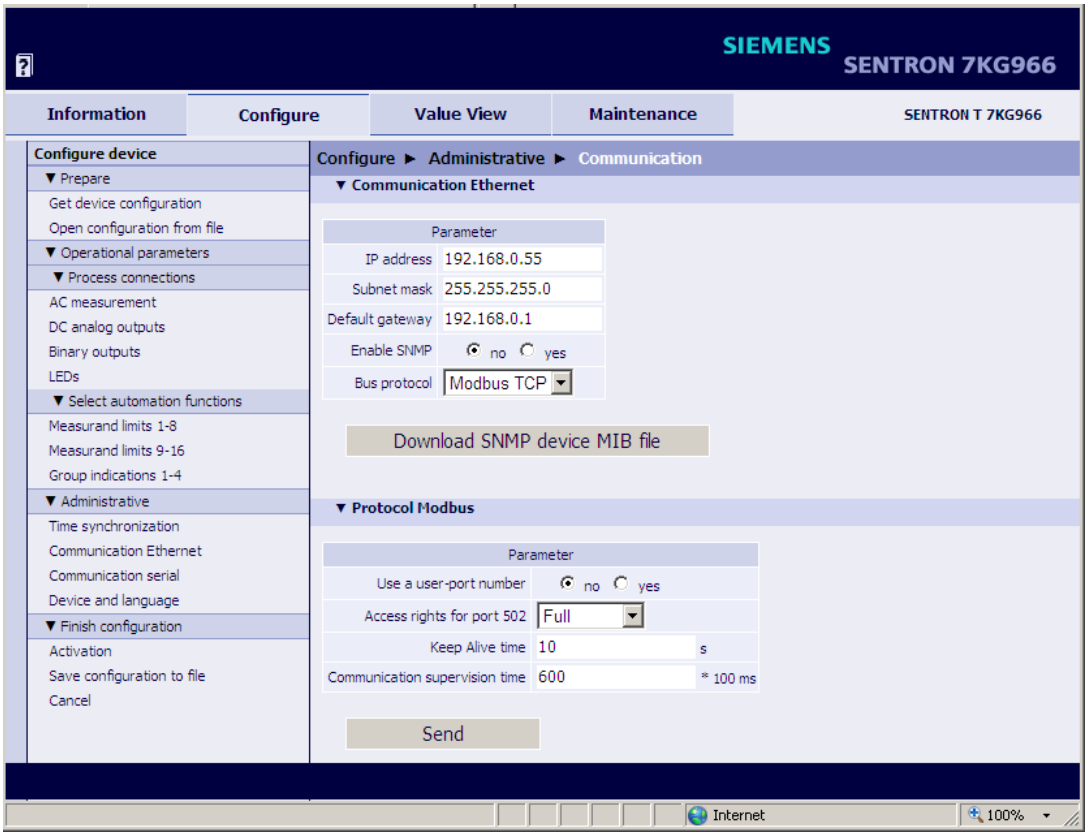


Fig. 7-35 Configure Tab, Communication Ethernet via Modbus TCP Input/output Window

✧ Enter the IP address into the **IP address** field.

✧ Enter the subnet mask into the **Subnet mask** field.

✧ Enter the gateway into the **Gateway** field.

✧ In the **Enable SNMP** option field, select whether SNMP is to be enabled (**yes**) or not (**no**).
The enabling of SNMP is only required if you want to save the SENTRONT.mib file and use it in a MIB browser (see section Download SNMP Device MIB File).

Download SNMP Device MIB File

NOTE

The SNMP protocol is implemented in SENTRON T in order to be able to retrieve manufacturer-specific information.
To retrieve information via SNMP, a MIB browser and the SENTRONT.mib file are required. The MIB browser allows the displaying of SNMP information objects and their content.

- ✧ Select **yes** in the **Enable SNMP** option field.
- ✧ In the **Communication Ethernet** input/output window, click the **Download SNMP device MIB file** button (see figure 7-35).

  The **File Download** dialog box opens.

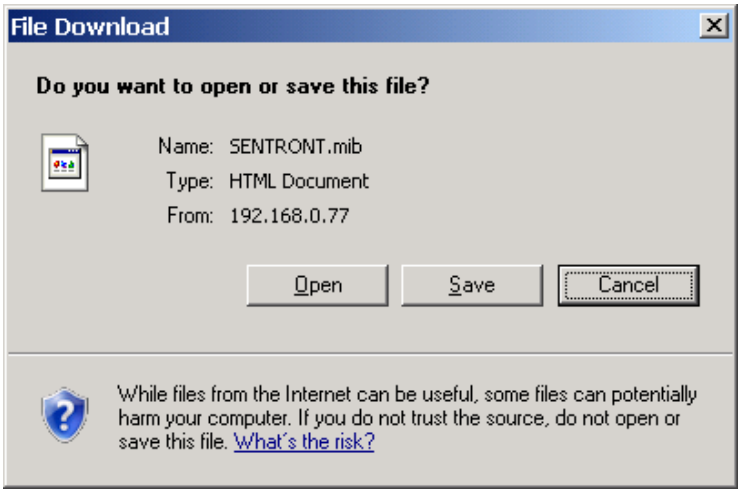


Fig. 7-36 File Download Dialog Box

- ✧ Click the **Save** button.

  The **Save As** dialog box opens (see figure 7-7) and you can save the SENTRONT.mib file in any folder and use it in a MIB browser.
- ✧ If you want to abort the process, click the **Cancel** button.

Ethernet Communication with Bus Protocol Modbus TCP (see figure 7-35)

- ✧ In the **Bus protocol** list box select the entry **Modbus TCP**.
- ✧ Under **Use a user-port number** select the option **yes** to enter your own port number.

NOTE

If you have selected **no** under **Use a user-port number**, you can adjust only the **Access rights for user port 502**, the **Keep Alive time** and the **Communication supervision time** parameters.

- ✧ Enter the user port number (≥ 10000) into the **User port number** field.
- ✧ Under **Access rights for user port** you can select either the **Full** access rights or **Read only** authorization.
- ✧ Under **Access rights for user port 502** you can select either the **Full** access rights or **Read only** authorization.
- ✧ Enter the time in **s** in the **Keep Alive time** field.
- ✧ Enter the time in x *** 100 ms** into the **Communication supervision time** field.
- ✧ Click the **Send** button.

  After clicking the **Send** button, the parameters are transmitted to the device but not enabled yet (passive set of parameters).
- ✧ If you do not want to make any additional settings, continue with the **activation** of the device configuration according to “Activating the Set of Parameters”. If you want to change other settings, enter the changes and then enable the device configuration as described in “Activating the Set of Parameters”.

NOTE

After changing the network settings and subsequent parameter activation the device will reset.

Ethernet Communication with Bus Protocol IEC 61850

✧ In the **Bus protocol** list box select the entry **IEC 61850**.

The **Communication Ethernet** input/output window with **Protocol IEC 61850** opens.

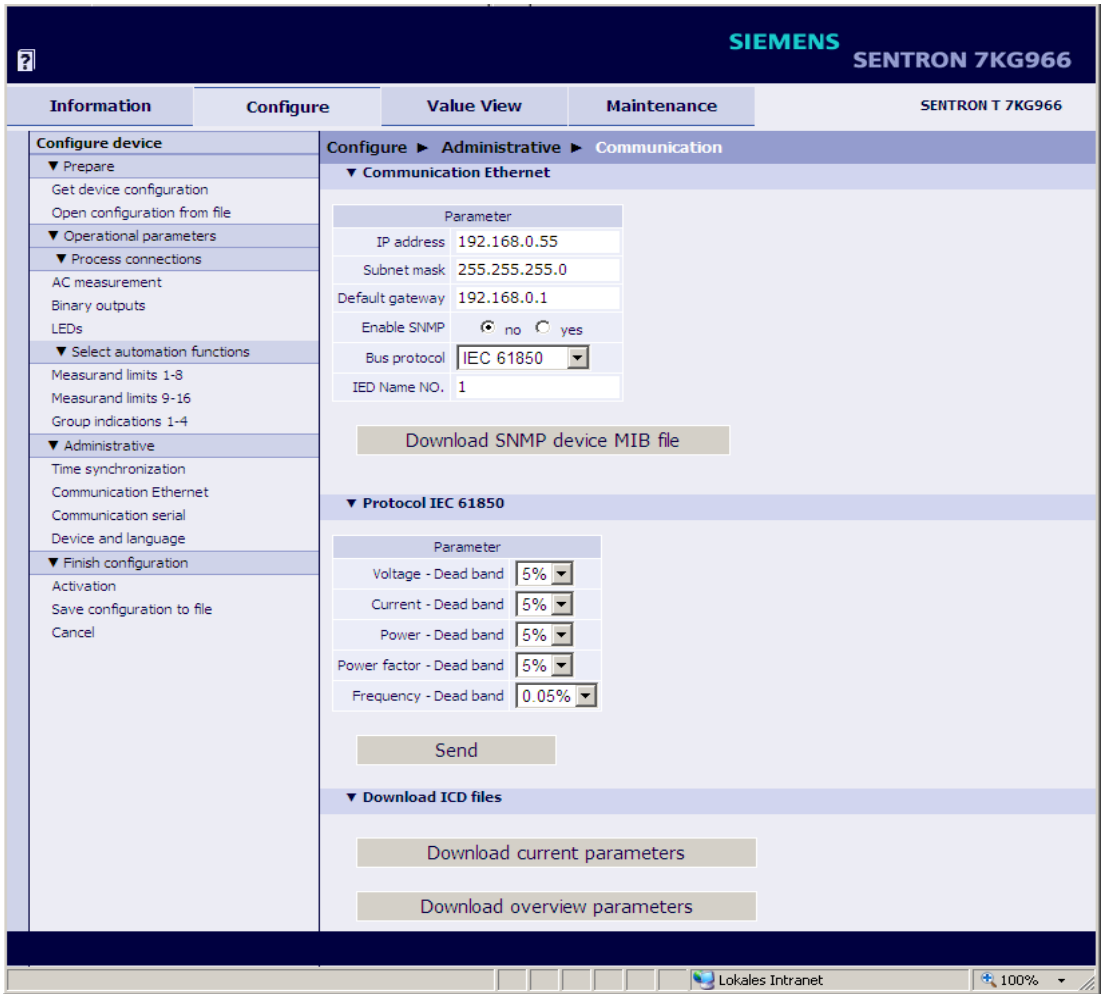


Bild 7-37 Configure Tab, Communication Ethernet via IEC 61850 Input/output Window

✧ In the **IED Name NO.**, change the serial number of the SENTRON T (factory setting 1) if several SENTRON T devices are used in the substation.

This number must be identical with the number parameterized for this SENTRON T in the configurator of the substation.

NOTE

When parameterizing the **IED Name NO.** in the configurator of the substation, the entered number must be five-digit (e.g. 00134).

By entering the IED Name NO., the SENTRON T is unambiguously identified in the network.

✧ In the **Parameter** field, select a percentage between 0 % and 5 % in the **Voltage - Dead band** selection list.

✧ In the **Parameter** field, select a percentage between 0 % and 5 % in the **Current - Dead band** selection list.

- ✧ In the **Parameter** field, select a percentage between 0 % and 5 % in the **Power - Dead band** selection list.
- ✧ In the **Parameter** field, select a percentage between 0 % and 5 % in the **Power factor - Dead band** selection list.
- ✧ In the **Parameter** field, select a percentage between 0 % and 0.05 % in the **Frequency - Dead band** selection list.
- ✧ Click the **Send** button.

  After clicking the **Send** button, the parameters are transmitted to the device but not enabled yet (passive set of parameters).
- ✧ If you do not want to make any additional settings, continue with the **activation** of the device configuration according to “Activating the Set of Parameters”. If you want to change other settings, enter the changes and then enable the device configuration as described in “Activating the Set of Parameters”.

Download ICD Files

Download current parameters

- ✧ Click the **Download current parameters** button.

  The currently set parameters of SENTRON T are downloaded.

Download overview parameters

- ✧ Click the **Download overview parameters** button.

  All parameters of SENTRON T are downloaded.

No Ethernet Communication

- ✧ In the **Bus protocol** list box select the entry **-none-**.

  If you select **-none-**, no protocol will be available. Click the **Send** button in this case.

  After clicking the **Send** button, the parameters are transmitted to the device but not enabled yet (passive set of parameters).

  If you do not want to make any additional settings, continue with the **activation** of the device configuration according to “Activating the Set of Parameters”. If you want to change other settings, enter the changes and then enable the device configuration as described in “Activating the Set of Parameters”.

7.3.4.3 Serial Communication for Devices with RS485 Interface

Default Settings and Setting Ranges of the Serial Communication

Table 7-10 Serial Communication Settings

Parameter	Default Setting	Setting Range
Bus protocol	Modbus RTU	-none- Modbus RTU IEC 60870-5-103
Bus Protocol Modbus RTU		
Device address	1	1 to 247
Baud rate	19 200 bit/s	Acc. to list box (see chapter 15)
Parity	Even	Acc. to list box (see chapter 15)
Access rights	Full	Full Read only
Communication supervision time	600 * 100 ms	0 s = none 100 ms to 6 553 400 ms
Bus Protocol IEC 60870-5-103		
Device address	1	1 to 254
Baud rate	9600 bit/s	Acc. to list box (see chapter 15)
Measured value range	120 % corresponds to a measured value range from -4096 to +4095 (-120 % to +120 %)	120 % 240 % corresponds to a measured value range from -4096 to +4095 (-120 % to +120 % or -240 % to +240 %)
Transmit energy	no	yes (every minute) no
Communication supervision time	600 * 100 ms	0 s = none 100 ms to 6 553 400 ms

NOTE

For the serial communication via IEC 60870-5-103, the parity is permanently set to **even**.

To change the serial communication settings, proceed as follows:

- In the navigation window, click the **Administratives** menu and then the **Communication serial** menu item.

  The **Communication serial** input/output window opens.

- In the **Bus protocol** list box select one of the entries **Modbus RTU**, **IEC 60870-5-103** or **none**.

  If you select **-none-**, no protocol will be available. Click the **Send** button in this case.

  If you select **Modbus RTU** or **IEC 60870-5-103** (available depending on the device variant), set the parameters for the corresponding protocol as follows:

Serial Communication via the Modbus RTU Protocol

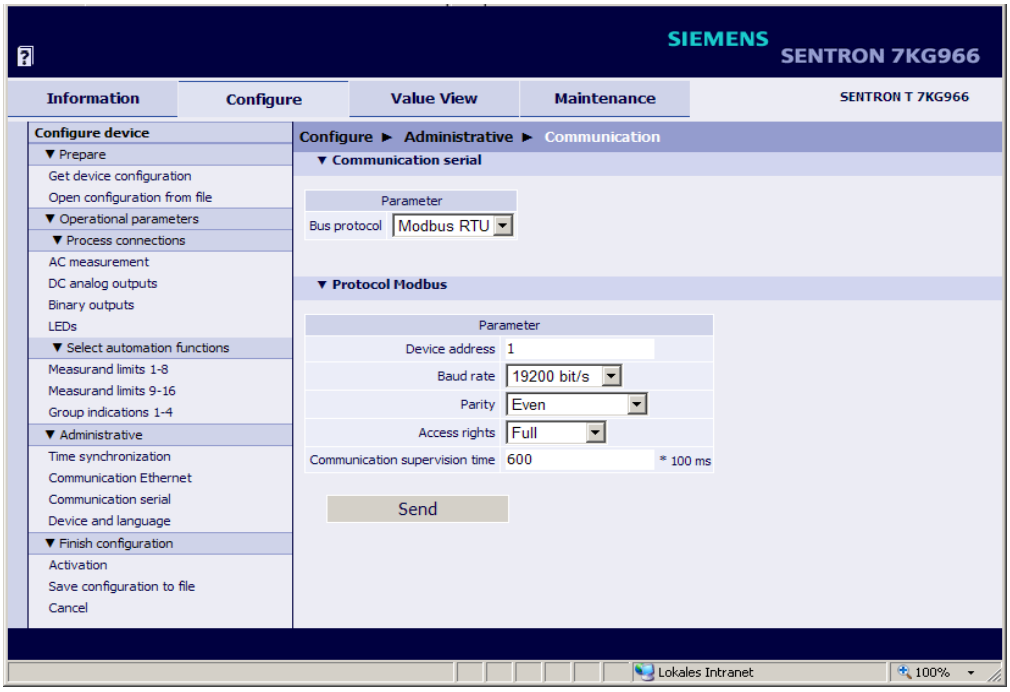


Fig. 7-38 Configure Tab, Communication Serial via Modbus RTU Input/output Window

- Select the entry **Modbus RTU** in the **Bus protocol** list box.
- Enter the slave address into the **Device address** field.
- Select the baud rate in the **Baud rate** list box.
- Select the parity in the **Parity** list box.
- Under **Access rights** you can select either the **Full** access rights or **Read only** authorization.
- Enter the time in x *** 100 ms** into the **Communication supervision time** field.

✧ Click the **Send** button.

After clicking the **Send** button, the parameters are transmitted to the device but not enabled yet (passive set of parameters).

✧ If you do not want to make any additional settings, continue with the **activation** of the device configuration according to “Activating the Set of Parameters”. If you want to change other settings, enter the changes and then enable the device configuration as described in “Activating the Set of Parameters”.

Serial Communication via the IEC 60870-5-103 Protocol

The IEC 60870-5-103 protocol is only available with SENTRON T 7KG9661-xxA30-xAA0.

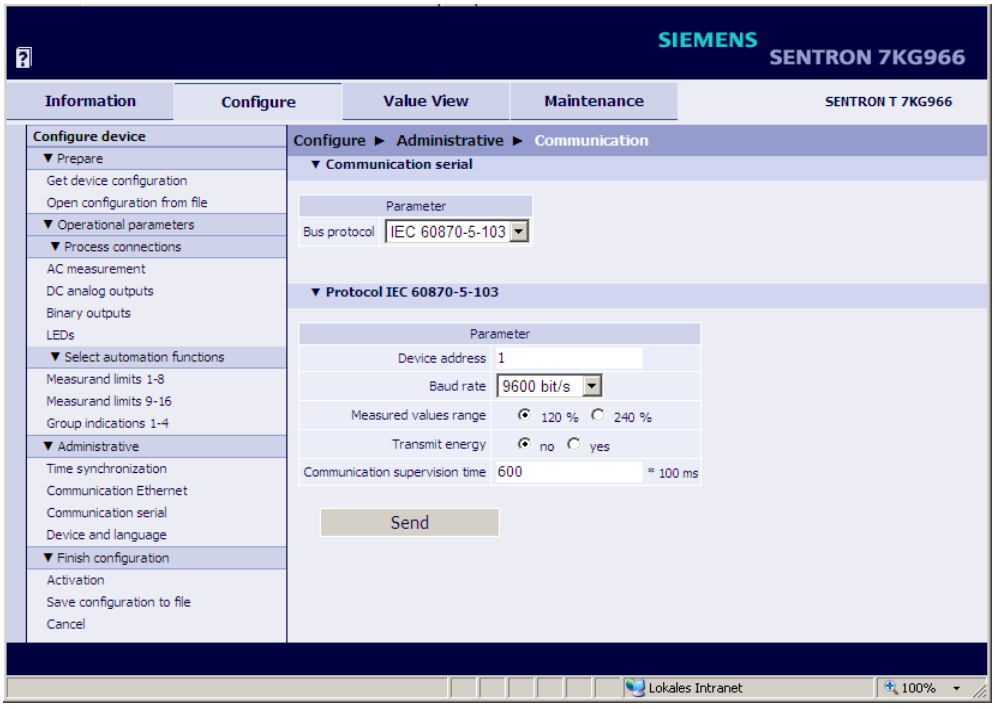


Fig. 7-39 Configure Tab, Input/output Window Communication Serial via IEC 60870-5-103

✧ Select the entry **IEC 60870-5-103** in the **Bus protocol** list box.

✧ Enter the slave address into the **Device address** field.

✧ Select the baud rate in the **Baud rate** list box.

✧ In the section **Measurement value range** select the measured-value range **120 %** or **240 %**.

✧ In the **Transmit energy** list box specify whether a counter telegram is transmitted once every minute (**yes**) or not (**no**).

✧ Enter the time in x *** 100 ms** into the **Communication supervision time** field.

✧ Click the **Send** button.

After clicking the **Send** button, the parameters are transmitted to the device but not enabled yet (passive set of parameters).

✧ If you do not want to make any additional settings, continue with the **activation** of the device configuration according to “Activating the Set of Parameters”. If you want to change other settings, enter the changes and then enable the device configuration as described in “Activating the Set of Parameters”.

7.3.4.4 Device and Language

Default Settings and Setting Ranges for Device and Language

Table 7-11 Device and Language Settings

Parameter	Default Setting	Setting Range
Device name	SENTRON 7KG966	Max. 32 characters
Language	ENGLISH (US)	ENGLISH (US) User language acc. to preselection of user language: DEUTSCH (DE) or FRANCAIS (FR)
Date/time format	YYYY-MM-DD, Time with 24 hours	Acc. to list box (see chapter 15)
Activation password	000000	Any 6 to 14 characters
Maintenance password	311299	Any 6 to 14 characters
User language preselection	DEUTSCH (DE)	DEUTSCH (DE) FRANCAIS (FR)

To change the settings of device and language, proceed as follows:

✧ In the navigation window, click the **Administrative** menu and then **Device and language**.

The **Device and language** input/output window opens.

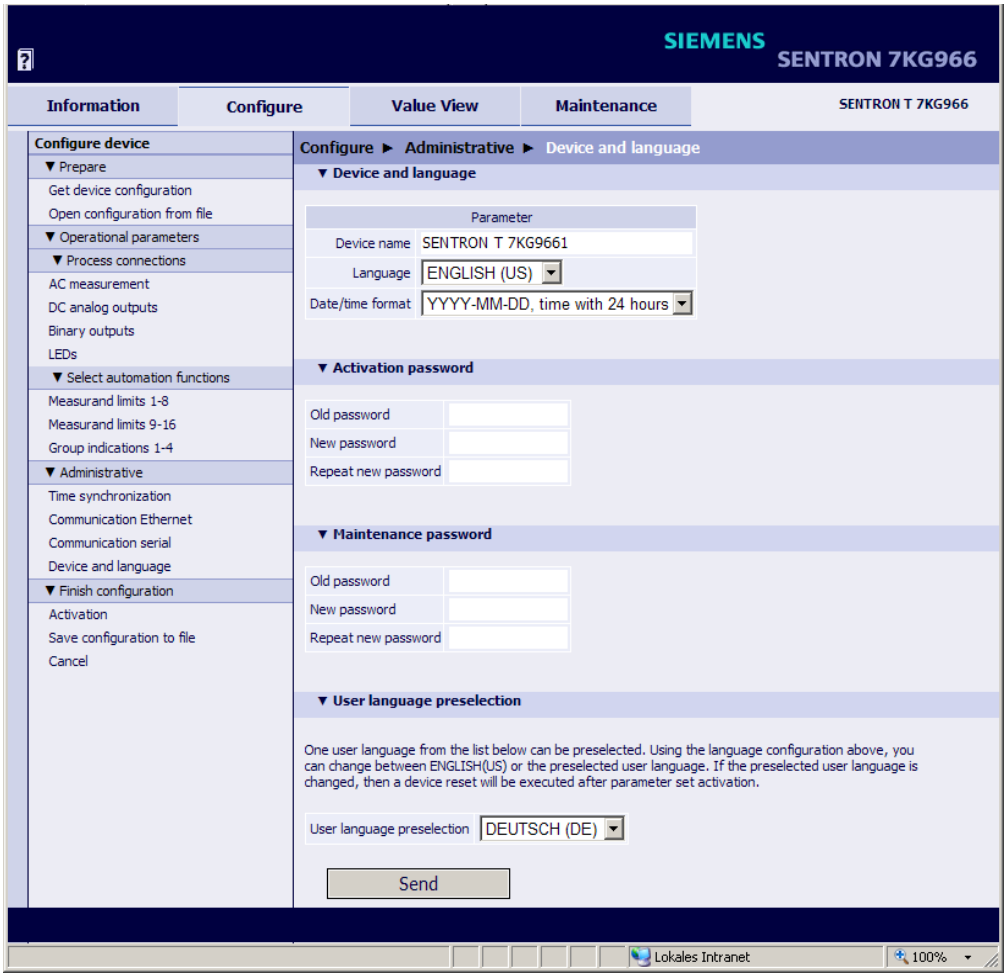


Fig. 7-40 Configure Tab, Device and Language Input/output Window

7.3.4.4.1 Changing the Parameters

Changing the Device Name

✧ Enter the name of the device into **Device name** field.

Changing the Language

✧ Select the user interface language of User Interface in the **Language** list box.
In the list box you can select either the standard language English (US) or a preset user language. English (US) is set as the default language and you cannot change the language. The user language can be pre-selected for example when first starting the User Interface and is described in detail in the section **Changing the User Language Preselection** in this chapter.

Changing the Time Format

✧ Select the date and time format in the **Date/time format** list box.

7.3.4.4.2 Changing the Passwords

Changing the Activation Password

- ✧ Enter the old activation password in the **Old password** field.
- ✧ Enter the new activation password (any 6 to 14 characters of the keyboard) into the **New Password** field.
- ✧ Repeat the new activation password in the **Repeat new Password** field.

Changing the Maintenance Password

- ✧ Enter the old maintenance password in the **Old password** field.
- ✧ Enter the new maintenance password (any 6 to 14 characters of the keyboard) into the **New password** field.
- ✧ Repeat the new maintenance password in the **Repeat new Password** field.
- ✧ Click the **Send** button.

  After clicking the **Send** button, the parameters are transmitted to the device and take effect.

7.3.4.4.3 Changing the User Language Preselection

The user language can be preset, for example when starting the User Interface for the first time (see chapter 7.2.1). ENGLISH (US) is set by default.

NOTE

If you change the user language, the device will restart after pressing the **Send** button and subsequently activating the settings.

To change the user language, proceed as follows:

- ✧ Select the user language of the User Interface in the **User language preselection** list box.
- ✧ Click the **Send** button.

  The message "User language was changed, automatic restart shall take place after Activation!" is displayed in red on the status bar.
- ✧ **Activate** the device configuration as described in “Activating the Set of Parameters”.

  After the activation, the **Language** list box in the upper part of the input/output window shows the standard language ENGLISH (US) and the selected user language.

NOTE

You can also change individual parameters in the **Device and language** input/output window and apply them by clicking the **Send** button.

7.3.5 Finish Configuration

The items in the **Finish configuration** menu in the navigation window are described in chapter 7.3.1, Device Configuration Procedure, in these subsections:

Activation: see “Activating the Set of Parameters”

Save configuration to file: see “Save Configuration to File”

Cancel: see “Cancel”

7.4 Value View

The measured values are displayed in the **Value view** tab. To display the measured values on the screen, proceed as follows:

✧ Click the **Value view** tab on the User Interface.

The **Value view** tab opens.

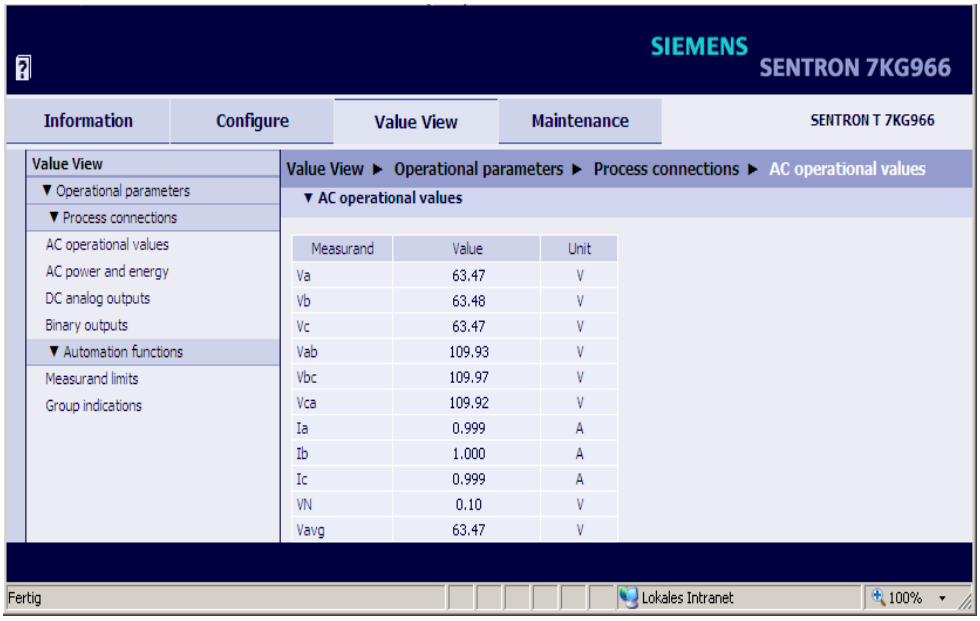


Fig. 7-41 Value View Tab

✧ In the navigation window open the **Operational** menu, then the **Process connections** or **Automation functions** submenu and click one of the following items:

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

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.

NOTE

If *** is displayed instead of a measured value, this measured value is invalid.

If ^^^ is displayed instead of a measured value, this measurand is in overflow.

✧ To print out the measured values, click the (**Print**) icon on the toolbar of Microsoft Internet Explorer.

7.5 Maintenance

In the **Maintenance** tab you can:

- update the firmware
- perform the calibration
- make various presettings
- view and delete logs
- analyze protocol-specific communication data of Modbus

If you want to edit this tab, you need the Maintenance password.

To open the **Maintenance** tab, proceed as follows:

✧ Click the **Maintenance** tab on the User Interface.
The **Maintenance** tab opens.

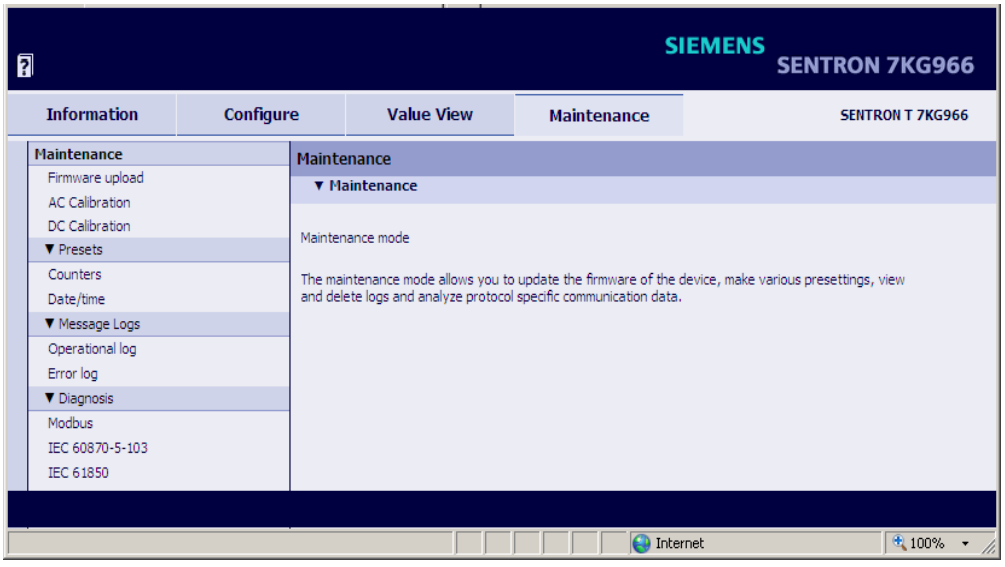


Fig. 7-42 Maintenance Tab

7.5.1 Firmware Upload

During a firmware update, the device firmware, the default set of parameters, text libraries, HTML files or parts thereof are updated.

NOTE

Before updating the firmware, Siemens recommends saving the current parameters set as described in “Save Configuration to File”.

To update the firmware proceed as follows:

✧ Click the **Firmware upload** element in the navigation window.
The **Firmware upload** input/output window opens.

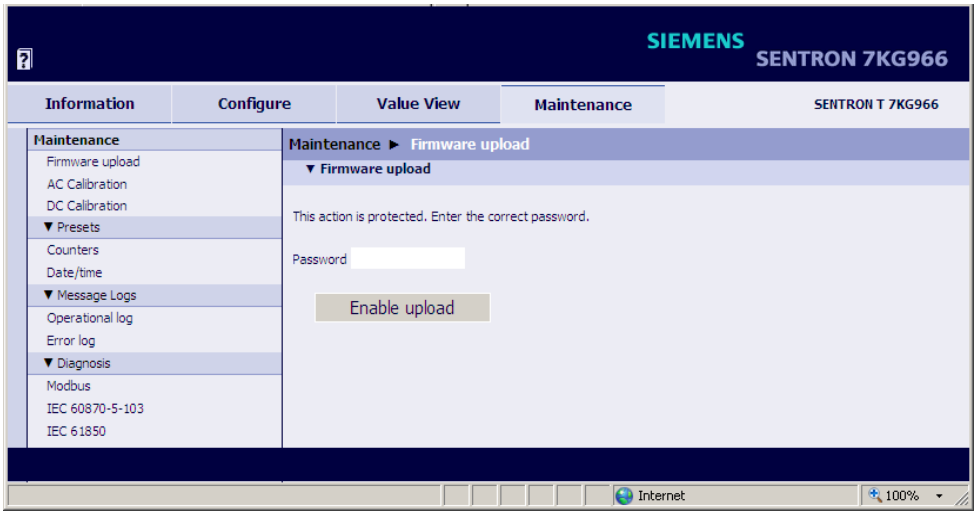


Fig. 7-43 Maintenance Tab, Firmware Upload - Enable Upload Input/output Window

✧ Enter the maintenance password

✧ Click the **Enable upload** button.
The following window opens:

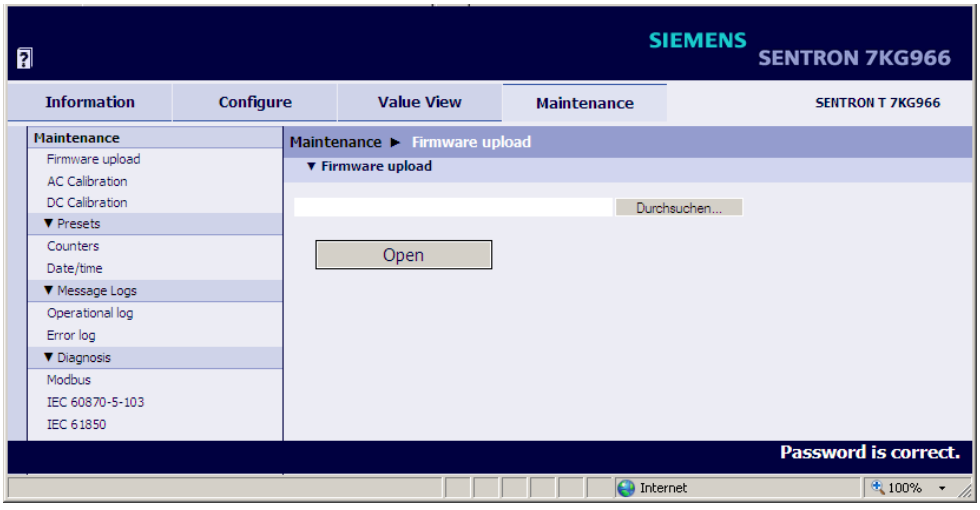


Fig. 7-44 Maintenance Tab, Firmware Upload - Open Input/output Window

✧ Click the **Browse...** button.

The **Choose file** dialog opens.

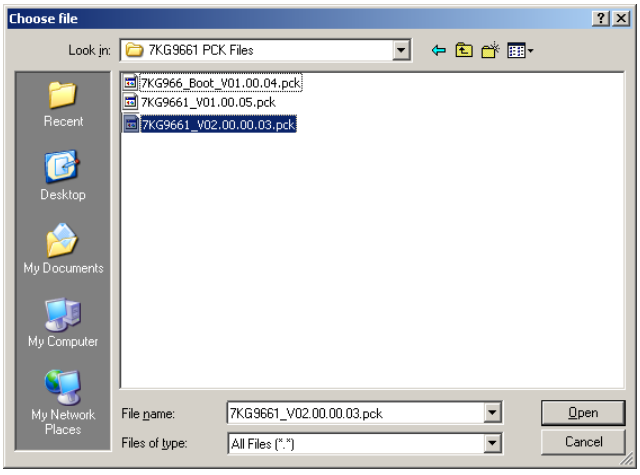


Fig. 7-45 Choose File Dialog

✧ Select the desired update (extension .pck) in the directory.

✧ Click the **Open** button.

The selected path is inserted in the input/output window, figure 7-44, into the **Browse...** field.

✧ Click the **Open** button.

✧ After approx. 2 s, the message **Action was successful!** is displayed in the input/output window.

Device firmware, default set of parameters, text libraries, HTML files or parts thereof are uploaded within one minute.

The device then restarts automatically.

NOTE

Do not switch off the supply voltage during the upload process as this can lead to data loss.

7.5.2 Calibration

The chapter 10 gives a detailed description of the calibration of the measuring ranges of AC voltage, AC current, voltage in the neutral conductor (V_N) and of the DC analog outputs. It explains the

- measurement setup and the
- calibration procedure.

7.5.3 Presettings

7.5.3.1 Counters (Energy Counters)

To display and reset the energy counters, proceed as follows:

✧ In the navigation window, click the **Presets** menu and then **Counters**.
The **Counters** input/output window opens.

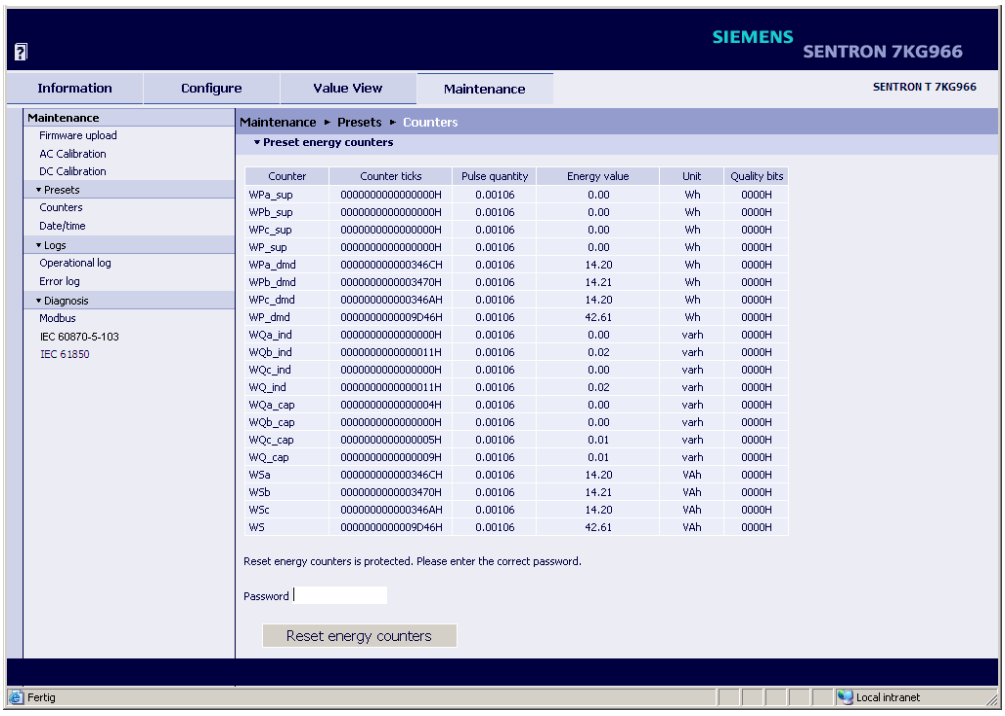


Fig. 7-46 Maintenance Tab, Preset Counters

✧ Enter the maintenance password into the **Password** field.

✧ Click the **Reset energy counters** button.
The **Counter ticks**, the calculated **Energy value** and the corresponding **Quality bits** are reset for all energy counters.

7.5.3.2 Date/Time

To set the date and time, proceed as follows:

✧ In the navigation window, click the **Presets** menu and then **Date/time**.
The **Date/time** input/output window opens.

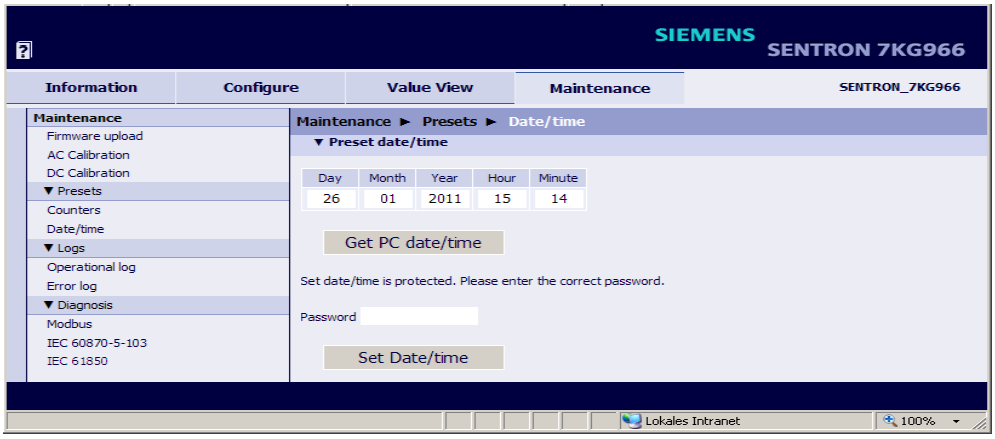


Fig. 7-47 Maintenance Tab, Preset Date/time

You can either get the date and time from the connected PC or adjust it manually.

Get PC Date and Time

✧ In the input/output window, click the **Get PC date/time** button.
The PC time is displayed in the fields of the input/output window and applied in the device.

Setting the Date and Time Manually (24-hour format)

✧ In the input/output window enter the desired time into the fields **Day** (format dd), **Month** (format mm), **Year** (format yyyy), **Hour** (format hh) and **Minute** (format mm).

✧ Enter the maintenance password into the **Password** field.

✧ Click the **Set Date/time** button.
The time you have entered is displayed in the fields of the input/output window and applied in the device.

7.5.4 Message Logs

7.5.4.1 Operational Log

To view and clear the **Operational log** (max. 128), proceed as follows:

NOTE

The last 128 operational indications are displayed, older indications are automatically deleted.

✧ In the navigation window, click the **Message Logs** menu and then the **Operational log** menu item.
The **Operational log** input/output window opens.

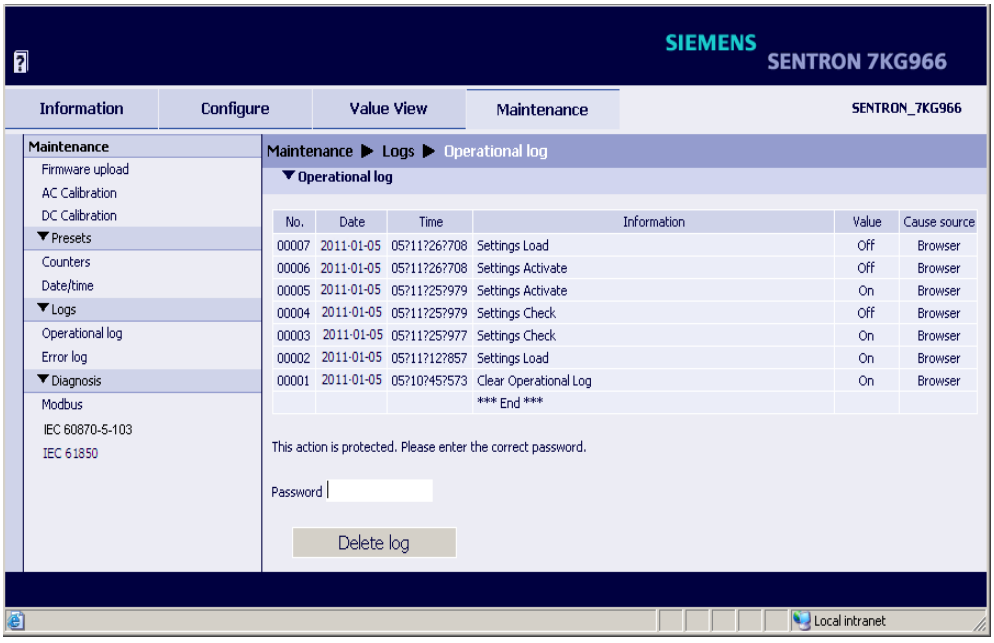


Fig. 7-48 Maintenance Tab, Delete Log

✧ Enter the maintenance password into the **Password** field.

✧ Click the **Delete log** button in the input/output window.
All operational indications in the input/output window are deleted without backup. The indication no. 0001 appears in the log list: "Clear Operational Log".

NOTE

If you need the operational indications, for example for subsequent analysis, save or print them out as described in chapter 7.2.5.2.

7.5.4.2 Error Logs

NOTE

Error messages are service information that you quote to the service department upon request in case of an error.

To view and clear the **Error log** (max. 128), proceed as follows:

✧ In the navigation window, click the **Message Logs** menu and then **Error log**.

The **Error log** input/output window opens.

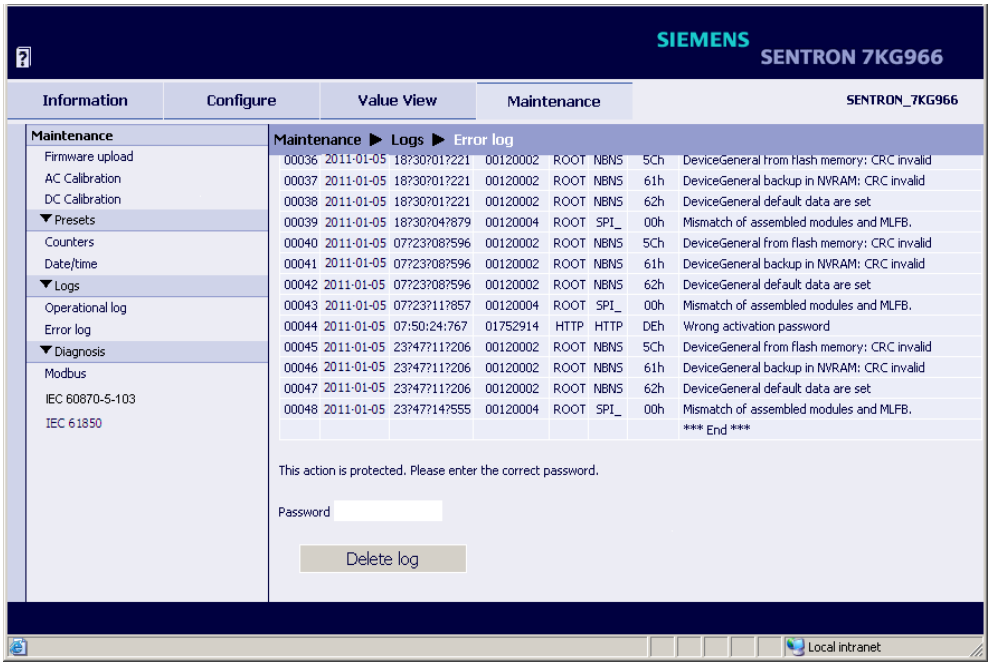


Fig. 7-49 Maintenance Tab, Delete Error Log

✧ Enter the maintenance password into the **Password** field.

✧ Click the **Delete log** button in the input/output window.

All error messages in the input/output window are deleted without backup. The indication no. 0001 appears in the log list: ***Error Log Cleared***.

NOTE

If you need the error messages, for example for subsequent analysis, save or print them out as described in chapter 7.2.5.2.

7.5.5 Diagnosis

7.5.5.1 Diagnosis Modbus

NOTE

The data for diagnosing Modbus TCP and/or Modbus RTU are only displayed if you have selected these bus protocols on the **Configure** tab → **Administrative** menu → **Ethernet communication** and **Communication serial** menu items.

For protocols that are not selected, the **Diagnosis Modbus** input/output window shows the entry **-none-**.

✧ In the navigation window, click the **Diagnosis** menu and then **Modbus**.

The **Modbus** input/output window opens and the **Modbus TCP** and **Modbus RTU** protocols are displayed. For Modbus TCP the **Standard server** and the **User-port server** are analyzed, for Modbus RTU the **Serial interface** and the **Serial server** are analyzed.

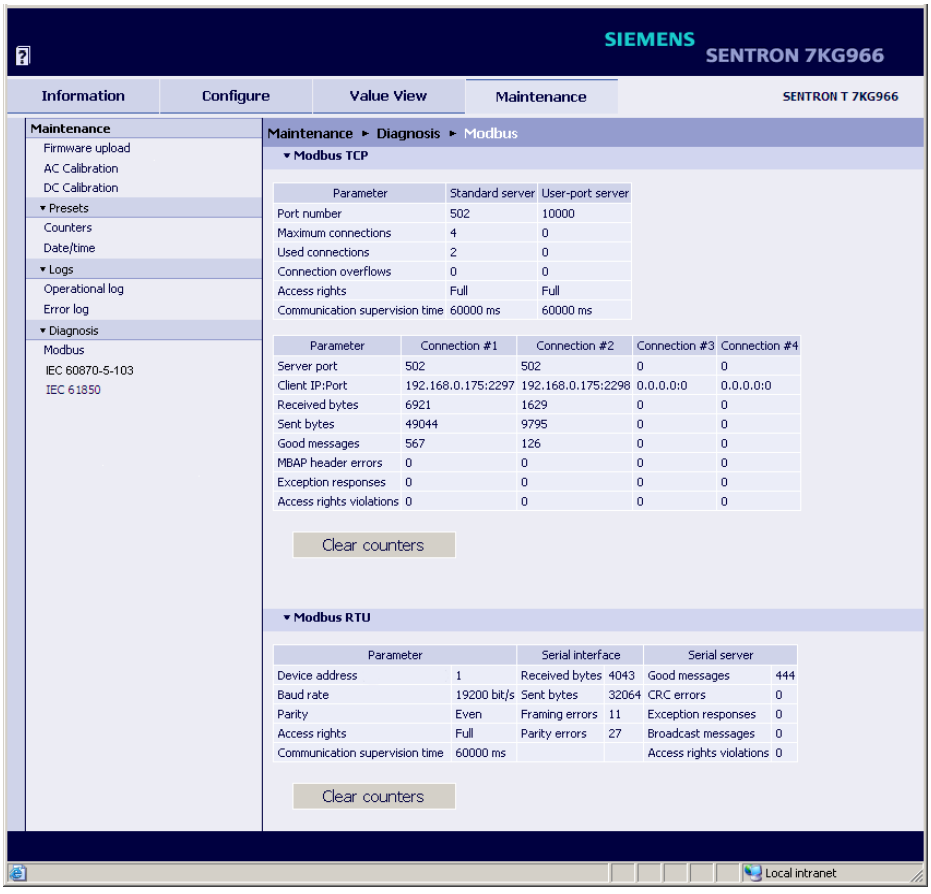


Fig. 7-50 Maintenance Tab, Diagnosis Modbus Input/output Window with Protocols Modbus TCP and Modbus RTU

✧ To clear the counters for Modbus TCP, click the **Clear counters** button in the **Modbus TCP** section of the input/output window.

All counters in the Modbus TCP section are reset to zero.

✧ To clear the counters for Modbus RTU, click the **Clear counters** button in the Modbus RTU section of the input/output window.

All counters in the Modbus RTU section are reset to zero.

NOTE

The chapter 9.2.8 gives more details about diagnosing Modbus.

7.5.5.2 Diagnosis IEC 60870-5-103

NOTE

The diagnostics data of IEC 60870-5-103 are only displayed if this bus protocol has been selected on the **Configure** tab → **Administrative** menu → **Communication serial** menu item.

If no protocol is selected, the **Diagnosis IEC 60870-5-103** input/output window shows the entry **-none-**.

✧ In the navigation window open the **Diagnosis** menu and click the **IEC 60870-5-103** menu item.

The **IEC 60870-5-103** input/output window opens and the protocol is displayed. The **serial interface** and the **serial server** are then analyzed.

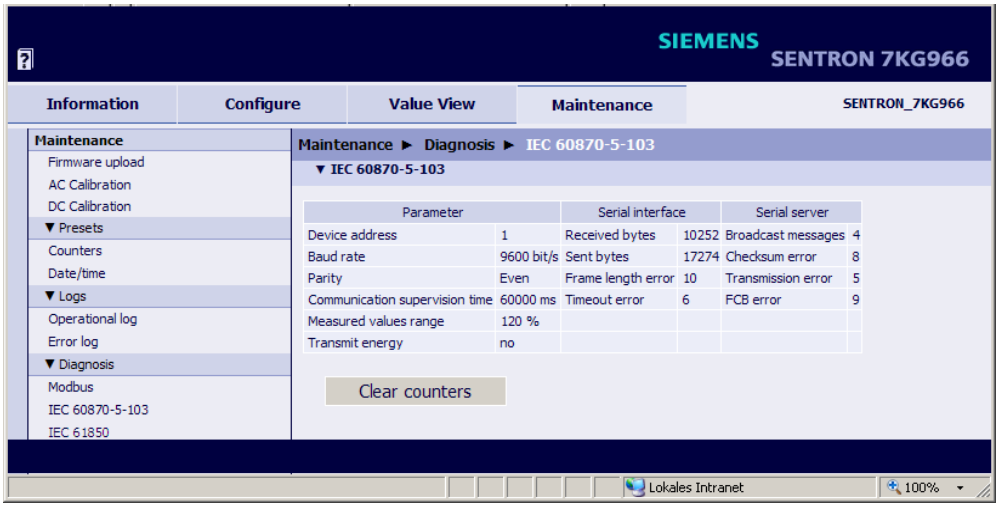


Fig. 7-51 Maintenance Tab, Diagnosis IEC 60870-5-103 Input/output Window

✧ To clear the counters for IEC 60870-5-103, click the **Clear counters** button.

All counters are reset to zero.

NOTE

The chapter 9.3.5 provides more details on diagnosing IEC 60870-5-103.

7.5.5.3 Diagnosis IEC 61850

NOTE

The diagnostics data of IEC 61850 are only displayed if this bus protocol has been selected on the **Configure** tab → **Administrative** menu → **Communication Ethernet** menu item.

If no protocol is selected, the **Diagnosis IEC 61850** input/output window shows the entry **-none-**.

✧ In the navigation window open the **Diagnosis** menu and click the **IEC 61850** menu item.

The **IEC 61850** input/output window opens and the protocol is displayed. The Ethernet interface is then analyzed.

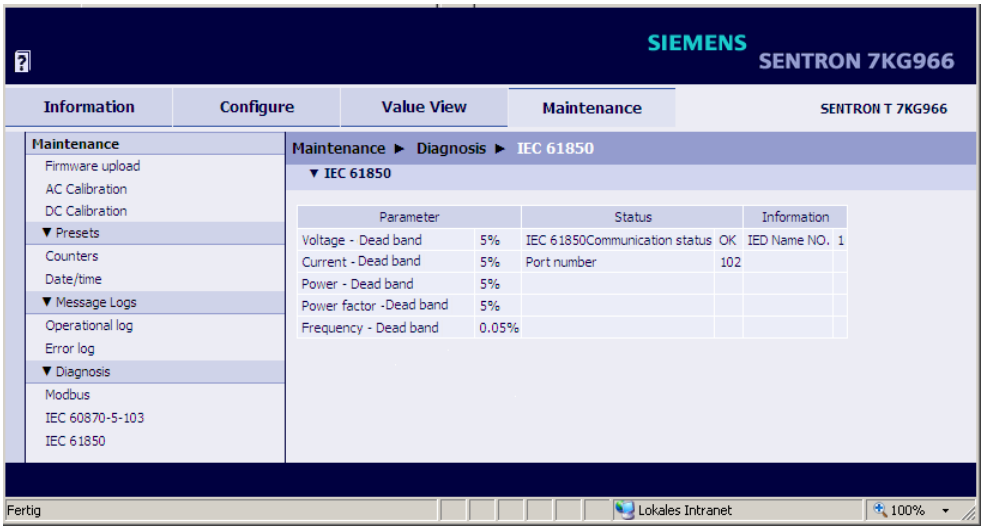


Fig. 7-52 Maintenance Tab, Diagnosis IEC 61850 Input/output Window

NOTE

The chapter 9.4.6 provides more details on diagnosing IEC 61850.

7.6 Parameterization and Analysis Example

7.6.1 Task

- ✧ Set the parameters via the Ethernet interface using the default IP address set upon delivery of the device.
- ✧ Configure SENTRON T according to the topology.
- ✧ Parameterize the indication of a limit violation for V_{ab} > 11 kV with 10 % hysteresis and name the indication.
- ✧ Parameterize a binary output that is switched on for the duration of the limit violation.
- ✧ Parameterize the DC analog output K2/3 for the measured value V_{ab} and an output current range from 0 mA to 20 mA.
- ✧ Communicate via serial communication using device address 1, with a baud rate of 19.2 kbit/s, even parity, full access rights and a monitoring time of 1 min.
- ✧ Parameterize the Ethernet communication according to the network configuration specified by the plant operator.
- ✧ Assign an arbitrary name and specify the time/date format as YYYY-MM-DD and the time in 24-hour format.
- ✧ Activate the device configuration you have created as the active set of parameters.
- ✧ Carry out the measurements and record the limit violations.

7.6.2 Initial Situation

Topology

- 4-wire system
- Rated input voltage (ph-ph): AC 10 kV
- Rated input current: AC 100 A
- Rated frequency: 50 Hz
- Connection: any load via transformers
- Voltage transformer: 10 000 V : 100 V
- Current transformer: 100 A : 1 A
- Communication via Ethernet and RS485 interfaces

Network Configuration

- Default IP address: 192.168.0.55
- User IP address: 192.168.1.40 (customer-specific)
- Subnet mask: 255.255.255.0
- Default gateway: 192.168.1.1

Features of 7KG9661-xFA10-1AA0

- 3 inputs for alternating current measurements
- 4 inputs for alternating voltage measurements
- 4 DC analog outputs
- 2 binary outputs
- Standard interface: Ethernet with Modbus TCP
- Serial interface: RS485 with Modbus RTU
- 4 LEDs for displaying operating states

Connection Diagram

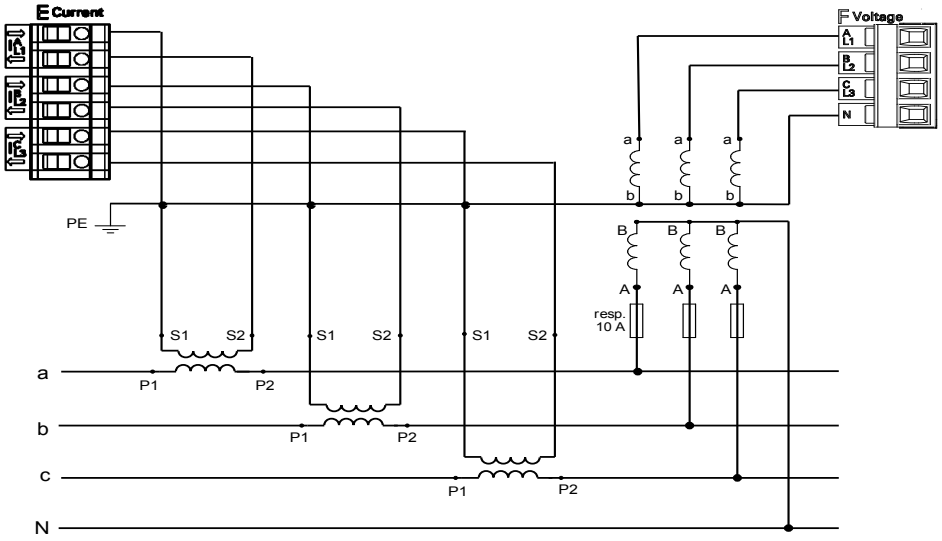


Fig. 7-53 Connection Diagram

Device Terminals Used for Measurements and Communication

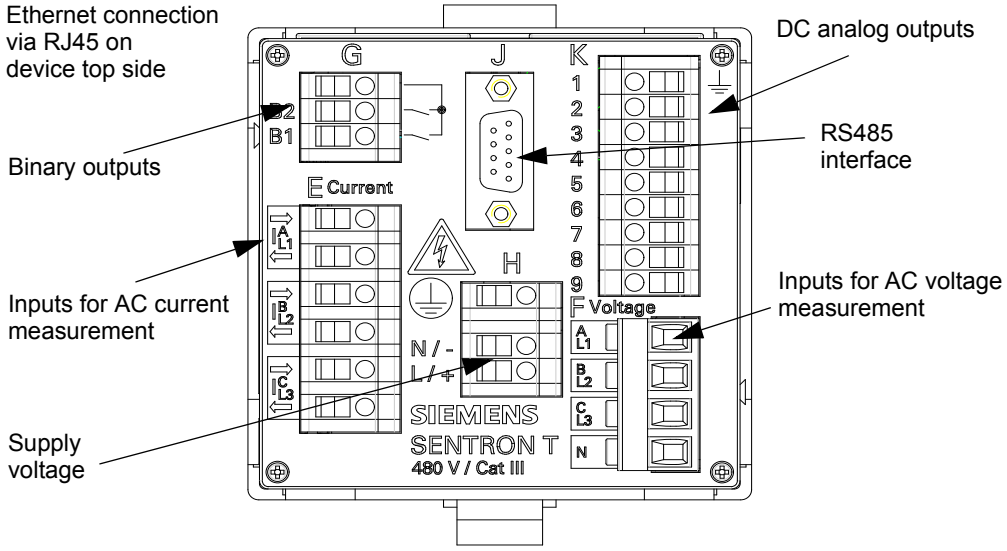


Fig. 7-54 Terminals Used at the Device

7.6.3 Parameterization as Defined by the Task

Precondition

SENTRON T is electrically connected to the system and commissioned as described in chapter 5.7. Rated voltages and currents at the measuring inputs are switched off.

Parameterization

- ✧ Start the User Interface as described in chapter 7.2.1 (initial startup) or chapter 7.2.5 (start during operation). Use the factory-preset IP address for this purpose.
- ✧ In the **Configure** tab, set the parameters under **AC measurement** (see chapter 7.3.3.1.1) according to the topology specifications as follows:

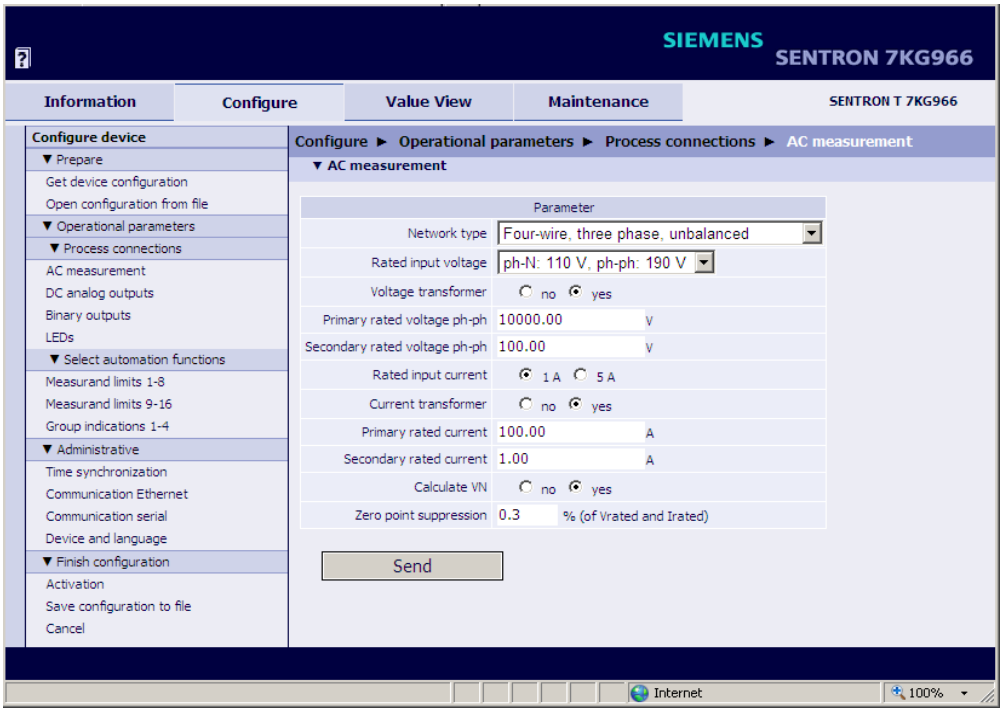


Fig. 7-55 Configure Tab, Example of AC Measurement Settings

NOTE

If Ethernet communication with **Bus protocol IEC 61850** is active and you change **Net work type** the device will reset.

✧ On the **Configure** tab, set the parameters under **DC analog outputs** (see chapter 7.3.3.1.2) for analog output terminal K2/3 as follows:

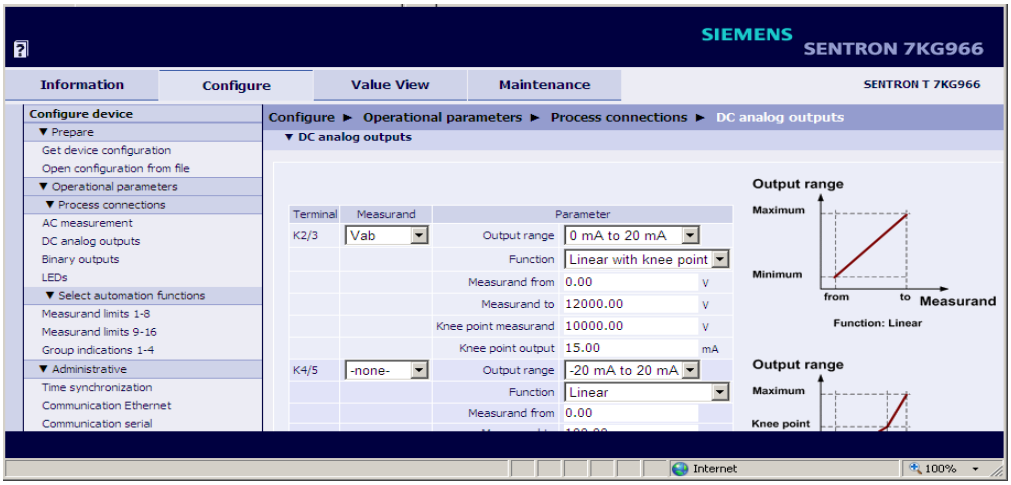


Fig. 7-56 Configure Tab, Model Configuration of DC Analog Outputs

✧ Configure a limit violation indication on the **Configure** tab, **Measurand limits 1-8** item (see chapter 7.3.3.2) as follows:

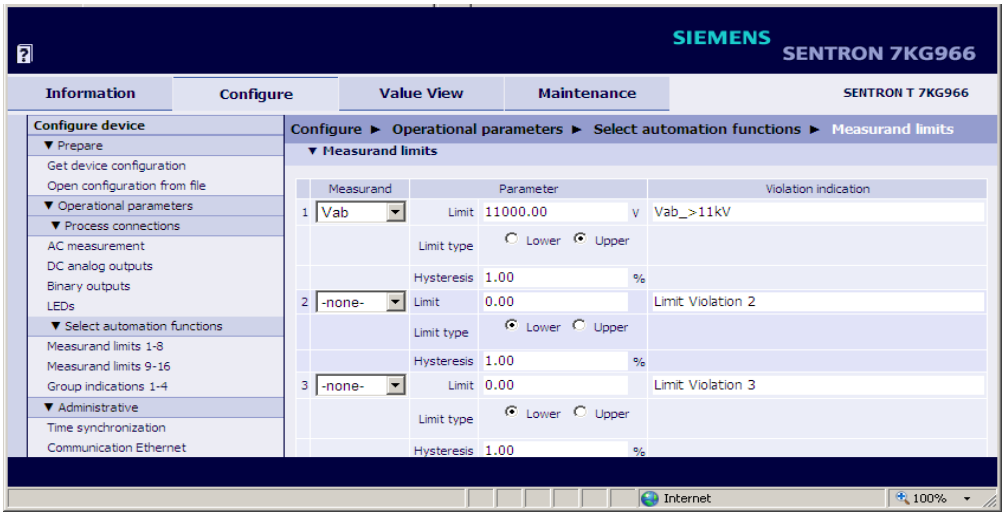


Fig. 7-57 Configure Tab, Example of a Limit Parameterization

✧ Configure binary output terminal G1/3 on the **Configure** tab, **Binary outputs** item (see chapter 7.3.3.1.3) as follows:

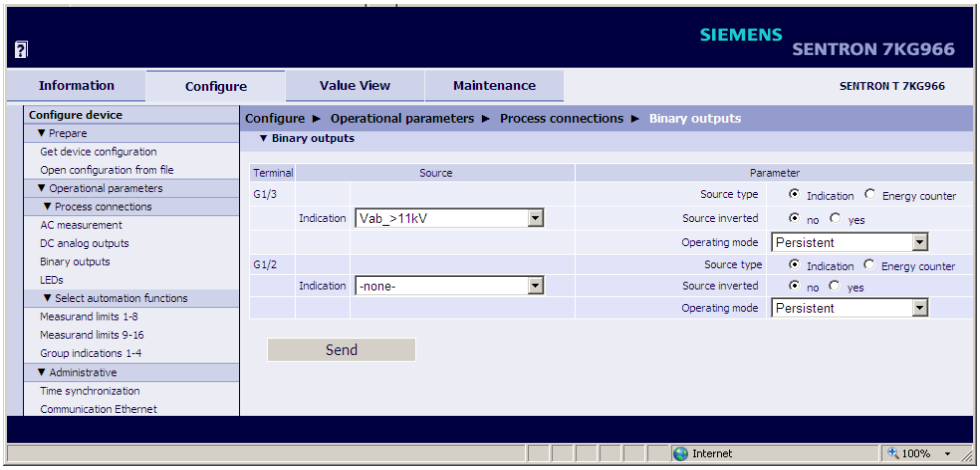


Fig. 7-58 Configure Tab, Example of Binary Outputs

✧ On the **Configure** tab set the parameters under **Communication serial** (see chapter 7.3.4.3) as follows:

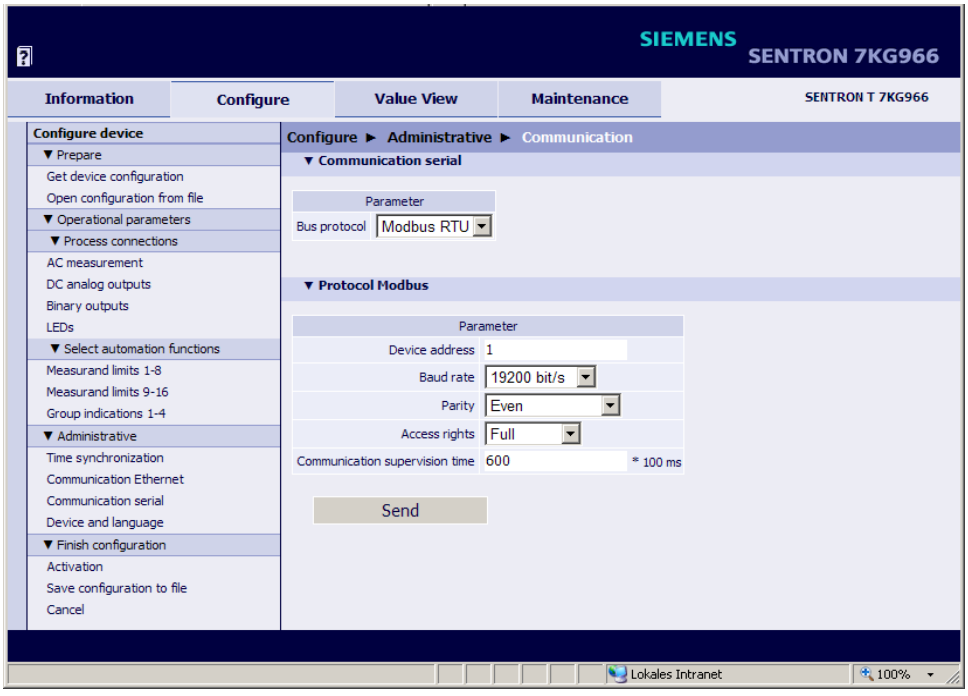


Fig. 7-59 Configure Tab, Example of Serial Communication Settings

✧ On the **Configure** tab set the parameters under **Communication Ethernet** (see chapter 7.3.4.2) according to the configuration specified by the plant operator, for example as follows

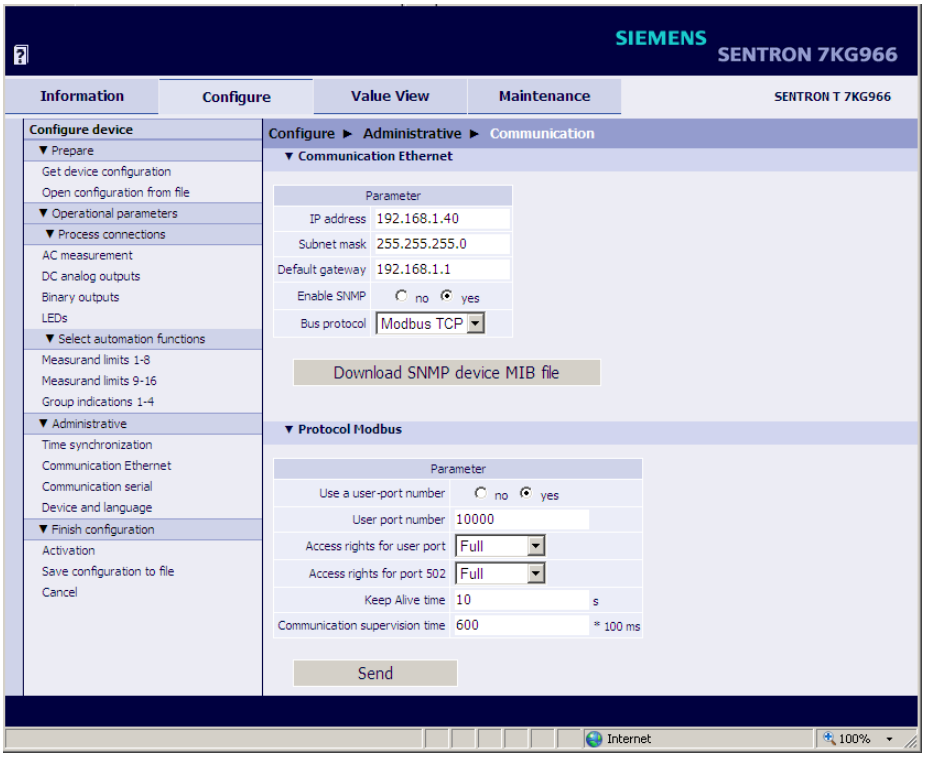


Fig. 7-60 Configure Tab, Example of Ethernet Communication Settings

✧ On the **Configure** tab, **Device and language** item assign a device name and the format for the date and time display on the HTML pages as described in chapter 7.3.4.4.

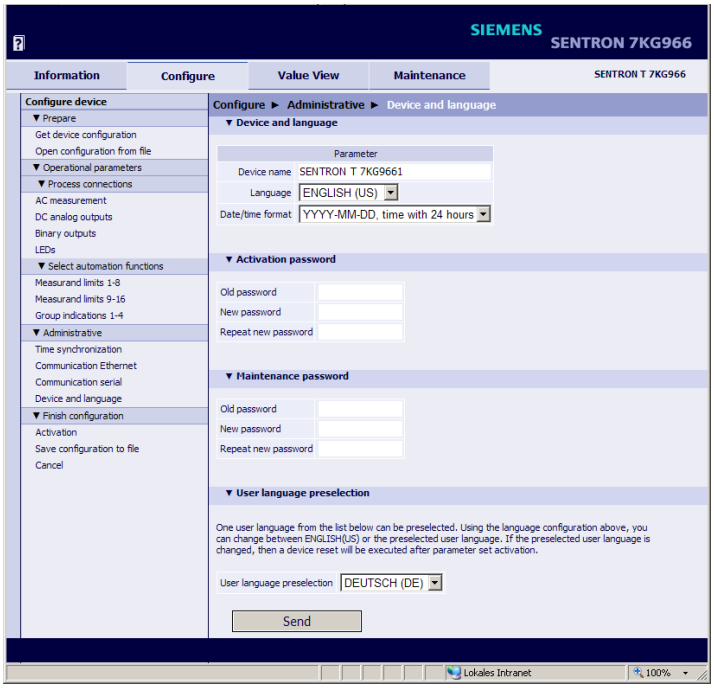


Fig. 7-61 Configure Tab, Example of Device and Language Settings

- ✧ Go to the **Configure** tab, **Save configuration to file** menu item to save your device configuration as the active set of parameters as described in “Save Configuration to File”.
- ✧ Enable the active set of parameters in the device as described in “Activating the Set of Parameters”.

NOTE

After changing the network settings and subsequent parameter activation the device will reset.

7.6.4 Performing the Measurement

- ✧ Switch on the rated voltages and rated currents at the measuring inputs E and F of SENTRON T observing the safety NOTEs given in chapter 5.7.
- ✧ Open the **Value view** tab to read the measured values in the navigation window under **AC operational values** and **AC power and energy** described in chapter 7.4.
- ✧ On the **Value view** tab read the DC analog outputs under **DC analog outputs** in the navigation window according to chapter 7.4.

  The User Interface displays the voltage V_{ba} at DC analog output K2/3 of the device and error information detected at this output.
- ✧ On the **Value view** tab read, the status of binary output G1/3 under **Binary outputs** in the navigation window according to chapter 7.4.

  The User Interface displays the status of binary output G1/3 which corresponds to the parameterized indication Vab_>11kV.
- ✧ On the **Value view** tab read the limit violation indication configured for the voltage V_{ba} by opening the **Measurand limits** item in the navigation window according to chapter 7.4.

  If the parameterized limit of the voltage V_{ab} is exceeded, a corresponding limit violation indication is displayed in the table.

NOTE

Measured values and indications are refreshed after 5 s on the **Value view** tab.

8 Time Synchronization

8.1 General

During operation, SENTRON T needs the date and time for all time-relevant processes. The term **time** is used throughout this section to refer to both the date and the time.

The time synchronization in the SENTRON T is necessary to guarantee a common time basis for the communication with peripheral devices and time stamping of the process data.

SENTRON T supports both external and internal time synchronization. The type of time synchronization is specified during the parameterization (see chapter 7.3.4.1). The external time synchronization from an NTP server is preferred.

8.2 Internal Time Keeping

8.2.1 Time Format

The internal time is kept in UTC (Universal Time Coordinated) from 01.01.2000, 00:00 to 31.12.2099, 23:59.

To display the local time e.g. on the HTML pages of the user, you can configure a local time correction factor and the automatic adjustment to daylight saving time during parameterization (see chapter 7.3.4.1).

8.2.2 Status Bits

FAIL Status Bit

The **FAIL** status bit implemented in the SENTRON T signals with "0" that the time is **valid** and with "1" that the time is **invalid**.

The status of the FAIL bit corresponds to the "Clock error" operational indication, see chapter 14.

The following table lists the time stamps of events or indications for the displayed operational and error logs according to status bit set/not set using the example of *date 2010-09-26, time 13:49.35246*:

Tabelle 8-1 FAIL Status Bit for Time Synchronization via NTP Server

FAIL	Output
0	2010-09-26 13:49.35:246
1	2010-09-26 13?49?35?246

DST Status Bit

With "1", the **DST** status bit implemented in the SENTRON T signals that the local daylight saving time is active. The operational indication "Daylight saving time" is displayed.

8.3 External Time Synchronization via Ethernet NTP

General

To synchronize the time via an external source, SENTRON T is equipped with an SNTP client (SNTP = Simple Network Time Protocol) that can be connected to 2 NTP servers (NTP = Network Time Protocol), the primary and the secondary (redundant) NTP server.

The chapter 7.3.4.1 describes how to set the parameters of the 2 servers.

NTP is used for external time synchronization via Ethernet. The SNTP client sends a time request to the NTP server once a minute. The time synchronization error is ±5 ms referred to UTC time of the NTP server.

The time stamp of the NTP server has a 64-bit format. Counting is accomplished in seconds and fractions of seconds.

NOTE

The time format is described in detail in the RFC 5905 (Request for Comments 5905 for NTP).

Time Synchronization Procedure

The device was set to external time synchronization (**Ethernet NTP**) during the parameterization. After switching on or resetting the device, the FAIL bit is first set to "1" (=invalid) and the device sends a time request to the NTP server. After receiving the time information from the NTP server via Ethernet, the FAIL bit is set to "0" (=valid) and the internal timer (RTC) is updated. The SNTP client repeats the time request to the NTP server cyclically once every minute.

If the primary NTP server fails (for example, no response to a request twice or one of the criteria at "Redundant NTP server" satisfied) and if the secondary NTP server is operational (always polled in parallel), the device switches to the secondary NTP server. The FAIL bit remains = 0. In this case, the operational indication "Primary NTP Server Error" is displayed, see chapter 14.

If the secondary NTP server is also invalid, the FAIL bit will be set to 1 after the programmable timer **Error indication after** (see Figure 7-34) has expired, and the "Clock Error" indication is output.

Redundant NTP Servers

The time synchronization supports a primary and a secondary NTP server. Different IP addresses are set for the two NTP servers, see chapter 7.3.4.1.

SENTRON T cyclically polls both NTP servers once every minute, but during normal operation it is synchronized by the primary NTP server. The device automatically switches to the secondary NTP server if one of the following criteria are met:

- No response from the primary NTP server to two successive requests
- The "Alarm" indication is set in the time information of the primary NTP server.
- The primary NTP server responds with zero.
- The message runtime in the network is > 5 ms.
- The stratum of the primary NTP server is 0 (unknown) or > 3.

Switching to the secondary NTP server is prevented if:

- The secondary server does not provide better time information (see criteria that initiate the switch from primary to secondary NTP server; "Secondary NTP Server Error" indication was already output) or
- The secondary server has recently been available for less than 10 minutes.

In these cases, SENTRON T is not synchronized anymore. The device uses the internal clock (on milliseconds time basis) and the last valid drift. After the programmable delay time, the device reports "Clock Error", see chapter 14.

Switching Back from the Secondary to the Primary NTP Server

While the device is synchronized by the secondary NTP server, it continues to cyclically poll the primary NTP server. The device will only switch back to the primary NTP server if it receives correct time information and if none of the criteria for **Redundant NTP Servers** are fulfilled anymore.

NOTE

The chapter 7.3.4.1, Time Synchronization via Ethernet NTP gives a detailed description of how to parameterize the time. chapter 9.2.6.2 and chapter 9.2.7.2 provide information on the data format.

8.4 External Time Synchronization via Fieldbus

The external time synchronization via fieldbus is used if the device is connected to the systems control via protocol **Modbus RTU** or IEC 60870-5-103 using the RS485 interface.

The time information can also be transmitted from the systems control via **Modbus TCP** or **IEC 61850** using Ethernet interface. When using the Ethernet connection, Siemens recommend, however, to synchronize the device from an NTP server, see chapter 8.3.

When using the external time synchronization via fieldbus, the client should send a message containing the time information to the device in 1-minute cycles, see chapter 9.2.7.2.

The time synchronization error using the **Modbus RTU** or **IEC 60870-5-103** protocol is ±20 ms max.

NOTE

The chapter 7.3.4.1, Time Synchronization via Fieldbus gives a detailed description of how to parameterize the time. chapter 9.2.6.2 and chapter 9.2.7.2 provide information on the data format.

8.5 Internal Time Synchronization via RTC

Besides external time synchronization, the internal time synchronization is also possible using the battery-buffered RTC (Real Time Clock). SENTRON T features a quartz oscillator for this purpose.

The time offset of internal time synchronization is 86 ms/day maximum. Due to the reduced accuracy, RTC should only be used in case of failure or unavailability of the external time synchronization.

NOTE

The chapter 7.3.4.1, Internal Time Synchronization gives a detailed description of how to parameterize the time. chapter 9.2.6.2 and chapter 9.2.7.2 provide information on the data format.

9 Communication

9.1 Communication Features

SENTRON T supports the communication via Ethernet. Device versions equipped with a serial interface also support communication via RS485.

Simultaneous communication via the Ethernet port and in parallel via the serial interface is possible with the corresponding parameterization. In this case it is possible, for example, to parameterize and read out data via the Ethernet port while the protocol traffic runs with a client via the serial interface.

NOTE

Siemens recommends not using SENTRON T in Ethernet systems with high utilization (GOOSE, other Ethernet data traffic) without a connected external Ethernet switch. Since none of the devices is equipped with an internal Ethernet switch, high network utilization might result in overloading of the data traffic in the device and thus in malfunctions, even if the data traffic is intended for other devices in the network.

This always applies as soon as a network cable is connected, even if the selected protocol is not an Ethernet protocol (e.g. Modbus RTU, serial transmission).

9.1.1 Ethernet Communication (SENTRON T 7KG966x)

Via the Ethernet interface the following are supported:

- Parameterization, analysis and diagnosis with HTML pages
- DHCP (Dynamic Host Configuration Protocol) to assign the network configuration (IP address etc.) to clients in an Ethernet network with DHCP server
- Time synchronization via NTP
- Data exchange with connected devices via Modbus TCP or IEC 61850

Data of the Ethernet Interface when Using the Modbus TCP Protocol

- IP address: 192.168.0.00
- Subnet mask: 255.255.255.0
- Default gateway: 192.168.0.1
- SNMP: Yes
- User port number: 10000
- Access rights: for user port and port 502 full access rights
- Keep Alive time: 10 s
- Communication supervision time: 1 min

Data of the Ethernet Interface when Using the IEC 61850 Protocol

- IP address: 192.168.0.00
- Subnet mask: 255.255.255.0
- Default gateway: 192.168.0.1
- SNMP: Yes

9.1.1.1 TCP/IP Protocol Stack

7KG966 supports the following TCP/IP services:

- TCP/IP IPv4
- DHCP client (Dynamic Host Configuration Protocol)
- NTP (Network Time Protocol)
- HTTP server

9.1.1.2 IP Address

To enable the device to communicate within the Ethernet network, you have to establish a network configuration consisting of IP address, subnet mask and standard gateway.

The device comes delivered with a default IP address that can be restored at any time by pressing the IP-Addr. push-button. Each device also has a unique MAC address.

The default IP address and the default subnet mask are imprinted on the side panel, see Figure 9-1:

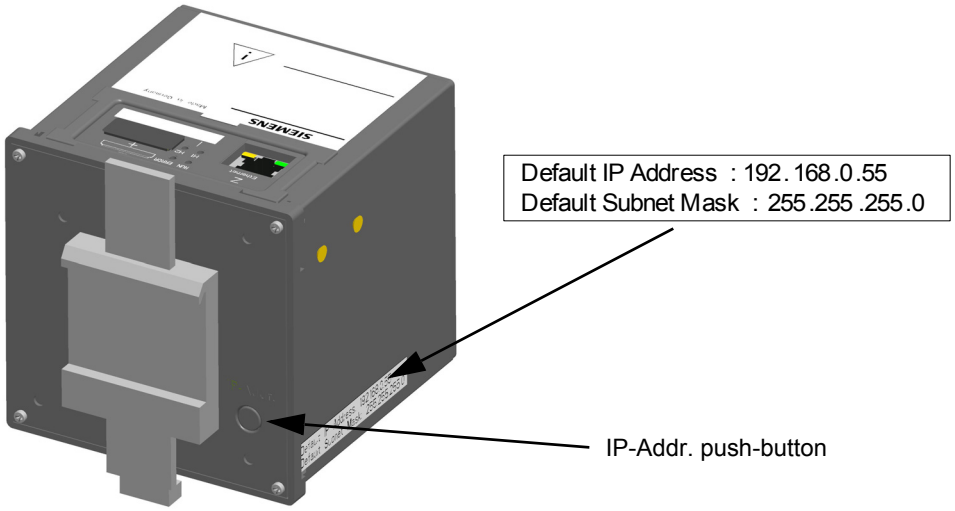


Fig. 9-1 DIN Rail Side with IP-Addr. Push-button

Default IP Address and IP-Addr. Push-button

The IP-Addr. push-button is located in the lower right corner of the DIN rail side (see Figure 9-1). When pressed (> 3 s), this button activates the factory-set default IP address. After pressing the IP-Addr. push-button, the device restarts and the IP address and subnet mask are temporarily activated in the default IP network configuration. The customer-specific IP configuration is not overwritten.

The network configuration settings can be displayed and edited on an HTML page during the parameterization (see chapter 7.3.4.2). After a renewed restart the parameterized network configuration is used again.

Check for Twice Assigned IP Address

Serious problems can occur if the same IP address is assigned more than once in a communication network.

For this reason, an ARP request is sent to the own IP address during start-up of the device. If no response is received from the communication network within 2 s, it is assumed that the IP address is not yet used in the network.

Otherwise, the LEDs (see chapter 12.3) signal that the IP address is already assigned and the device is not connected to the network. In this case, you have to specify a different IP address.

NOTE

If the device is directly connected to a PC (without Ethernet switch), the PC will need a longer period to be able to detect the connection and therefore to receive the ARP telegram. In this case it may not be detected when PC and device have the same IP address.

Reception of the Network Configuration from the DHCP Server

The network configuration can also be obtained from an external server. Using the DHCP protocol, the device is integrated into an already existing network.

If the IP address 0.0.0.0 is configured (see chapter 7.3.4.2), the device sends a query to the external DHCP server requesting the network configuration immediately after booting. Having received the network configuration, the device launches the Ethernet services.

If no DHCP server is available, you have to disconnect the device from the network and start it using the default IP address (see chapter 5.7.3) and assign a permanent IP address.

9.1.1.3 Ethernet Interface

SENTRON T is equipped with an Ethernet interface. The data are exchanged via the RJ45 Ethernet plug connector located on the top side of the device.

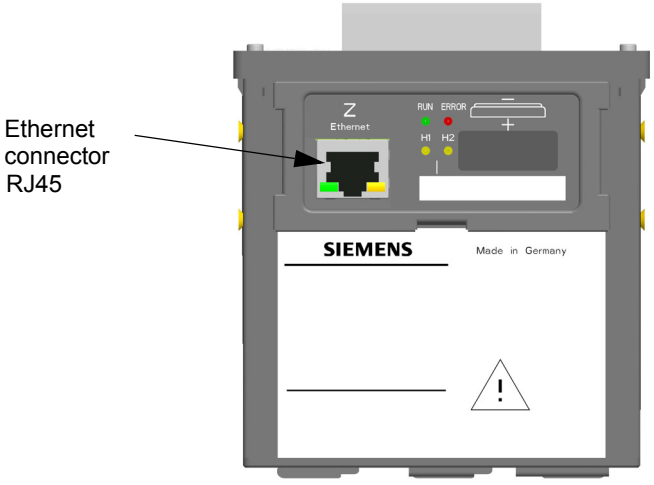


Fig. 9-2 RJ45 Ethernet Plug Connector

The Ethernet interface is characterized by the following parameters:

- Transmission rate: 10/100 Mbit/s
- Protocol: IEEE802.3
- Connection: 100Base-T (RJ45), pin assignment according to DIN EN 50173, automatic patch/crossover cable recognition
- Connecting cable: 100 Ω to 150 Ω STP, CAT5 (shielded twisted-pair cable), max. 100 m if well installed

9.1.2 Serial Communication (SENTRON T 7KG9661)

Devices equipped with an RS485 interface can communicate serially with peripheral devices using the Modbus RTU or IEC 60870-5-103 fieldbus protocol. The serial interface supports the following actions:

- Transmission of measured data, metered values and indications
- Time synchronization.

Data of the RS485 Interface when Using the Modbus RTU Protocol

The RS485 interface comes with the following parameters set by the manufacturer:

- Bus protocol: Modbus RTU
- Device address: 1
- Baud rate: 19 200 bit/s
- Parity: even

You can modify these parameters during the parameterization, see chapter 7.3.4.3.

The connection is a 9 pin D-sub connector plug.

Data of the RS485 Interface when Using the IEC 60870-5-103 Protocol

The RS485 interface comes with the following parameters set by the manufacturer:

- Bus protocol: IEC 60870-5-103
- Device address: 1
- Baud rate: 9600 bit/s
- Parity: even (fixed)
- Measured value range: 120 %
- Send counters telegram: no
- Communication supervision time: 600 ms

The parameters, except for the parity, can be changed during the parameterization, see chapter 7.3.4.3.

The connection is a 9 pin D-sub connector plug.

Location of the RS485 Interface on the Device

The RS485 interface of 7KG966-xxA10-xAA0 and 7KG966-xxA30-xAA0 is located on the terminal side.

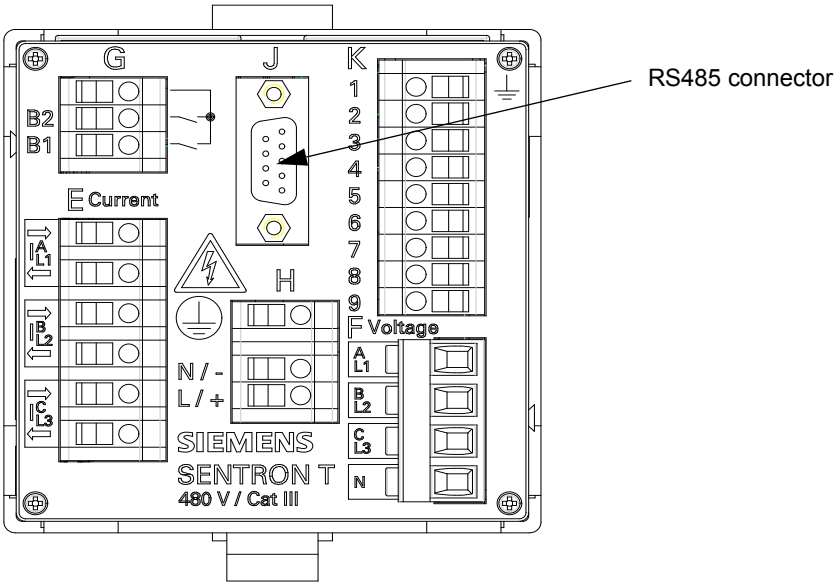


Fig. 9-3 Position of the RS485 Plug Connector of 7KG966-xFA10-xAA0/-xFA30-xAA0

NOTE

The pin assignment of the RS485 plug connector is described in chapter 13.1.3.

9.2 Modbus

When communicating via Ethernet, the Modbus TCP protocol is used; communication via RS485 relies on the Modbus RTU protocol. The Modbus specification with a detailed explanation of the Modbus protocol is provided in:

- Modbus over Serial Line
  Specification & Implementation Guide
  http://www.modbus.org
- Modbus Application Protocol Specification
  http://www.modbus.org
- Modbus Messaging on TCP/IP Implementation Guide
  http://www.modbus.org

9.2.1 Modbus Functions

NOTE

The Modbus functions are the same for Modbus TCP (Ethernet) and Modbus RTU (serial).

The Modbus server of SENTRON T supports the following Modbus functions:

Table 9-1 Supported Modbus Functions

Function Number	Function Name	Description
03 (03H)	Read Holding Registers	Reading one or more holding registers from the Modbus server Up to 125 registers can be read with one message.
06 (06H)	Write Single Register	Writing a holding register Function 16 is used for writing multiple holding register using one Modbus message.
16 (10H)	Write Multiple Registers	Writing one or more holding registers Up to 123 registers can be written with one message.

9.2.2 Exception Responses

NOTE

The exception responses for Modbus TCP (Ethernet) and Modbus RTU (serial) are the same.

The Modbus server performs a series of consistency checks of the Modbus client requests, and if errors (e.g. request to read a nonexistent register) are detected, it generates Modbus exception codes which are signaled to the Modbus client in exception responses messages.

The messages contain the following codes:

Exception Code 01 ILLEGAL_FUNCTION

- The Modbus client uses a function that is not supported by the Modbus server of the SENTRON T (the supported Modbus functions are listed in chapter 9.2.1).

Exception Code 02 ILLEGAL_DATA_ADDRESS

- An attempt is made to read out or write to a nonexistent Modbus register (see chapter 9.2.7, Modbus mapping for valid registers).
- An attempt is made to read out or write to too many registers. A Modbus message enables reading out 125 holding registers and writing to 123 holding registers maximum.
- The Modbus clients tries to write to a register in the Modbus server for which only read access is allowed according to the Modbus mapping (see chapter 9.2.7).

Exception Code 03 ILLEGAL_DATA_VALUE

- The Redundanz client addresses a register that does not allow access to partial data because it is part of a data type with a complex data structure distributed across several registers and can be read or written only as a whole.
- The Modbus client attempts to write to the Modbus server for which the access rights are set to "read only".

Exception Code 04 SERVER_FAILURE

- Error during the time format conversion in the Modbus server because a faulty date/time format was received via Modbus (for example month format > 12).

9.2.3 Modbus TCP (SENTRON T 7KG966x)

Properties of the Modbus TCP

- Connection-oriented Ethernet protocol based on TCP/IP
- Use of IP addresses for addressing individual components connected to the bus (bus nodes)
- The Modbus TCP protocol has the TCP port number 502 reserved on the server side. It is possible to use a parameterized port number.
- All data types in the Modbus TCP messages which are larger than 1 byte, are stored in the Big-endian format, that is the most significant byte (MSB) is stored at the lowest register address and is transmitted first.
- Communication sequence:
  - The client sends a request to the server to start a data transfer from the server to the client.
  - The server sends the requested data back to the client or an exception code if the requested data are not available.
- The Modbus TCP data packet has a maximum size of 260 bytes:
  - 253 bytes max. for data and
  - 7 bytes for the Modbus TCP header

Parameterization

The following parameters can be set for the Modbus TCP bus protocol, see also chapter 7.3.4.2:

Table 9-2 Modbus TCP Settings

Parameter	Default Setting	Settings
IP address	192.168.0.55	any, 0.0.0.0 for DHCP
Subnet mask	255.255.255.0	any
Default gateway	192.168.0.1	any
Bus protocol	Modbus TCP	-
Use a user-port number	no	no yes
User-port number (only if *Use a user-port number* **yes** has been parameterized)	10000	10000 to 65535
Access rights for user port 502	Full	Full Read only
Access rights for user port (only if *Use a user-port number* **yes** has been parameterized)	Full	Full Read only
Keep Alive time	10 s	0 s = switch off 1 s to 65 535 s
Communication supervision time	600 * 100 ms	0 s = none 100 ms to 6 553 400 ms

Number of Connections

Up to four TCP connections are possible:

- Without user port number: 4 connections via standard port 502
- With user port number: 2 connections via standard port 502 and 2 connections via the user port

9.2.4 Modbus RTU (SENTRON T 7KG9661)

Properties of the Modbus RTU

- Client-server protocol
- All clients have a unique address in the range from 1 to 247.
- Packets with the address = 0 are forwarded to all clients (broadcast).
- The individual data bytes in the messages are transmitted asynchronously with 11 bits.
  - 1 start bit,
  - 8 data bits,
  - 1 parity bit and 1 stop bit or
  - No parity bit and 2 stop bits
- Single messages are separated by bus silent intervals of at least 3.5 character times and end with a CRC code for error detection.
- RS485 is used as bus physics.
- The Modbus RTU data packet has a maximum size of 256 bytes.
  - 1 byte server address
  - 253 bytes for data
  - 2 bytes for CRC

The following parameters can be set for the Modbus RTU bus protocol:

Table 9-3 Modbus RTU Settings

Parameter	Default Setting	Setting Range
Device address	1	1 to 247
Baud rate	19 200 bit/s	1200 bit/s, 2400 bit/s 4800 bit/s, 9600 bit/s 19 200 bit/s, 38 400 bit/s 57 600 bit/s, 115 200 bit/s
Parity	Even	no/1 stop bit even odd no/2 stop bits
Access rights	Full	Full Read only
Communication supervision time	600 * 100 ms	0 s = none 100 ms to 6 553 400 ms

9.2.5 Register Assignment

Only holding registers are used for SENTRON T. All measured values, indications and metered values are stored in these holding registers.

Each Modbus register set has an individual 6-digit identification number.

The holding register set has the identification number 4xxxxx and begins with the register number "1" (400001).

NOTE

The following descriptions only quote the last 4 digits of the holding register numbers, for example **0052** for 400052.

9.2.6 Data Types

NOTE

The Modbus data types for Modbus TCP (Ethernet) and Modbus RTU (serial) are the same.

The following data types are used for storing variables in the Modbus registers.

- Measured value
- Date/time
- Indication (read only)
- Controllable indications (read and write)
- Counter

NOTE

The following convention applies when storing variables to the Modbus holding register that consist of more complex data types (that is variables that are larger than a holding register, for example 32-bit measured values):

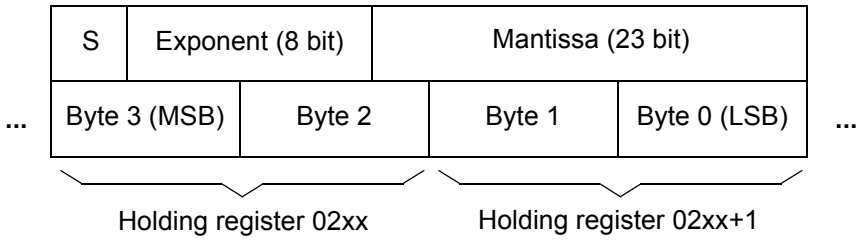
The register with the lowest address contains the most significant byte (MSB), the register with the highest address contains the least significant byte (LSB).

9.2.6.1 Data Type - Measured Value

The *Measured Value* data type is transferred into 2 holding registers in 32-bit floating-point format (single precision) according to IEEE standard 754.

Structure of the Format

The 32-bit floating-point format consists of a sign bit (S), exponent and mantissa:



Value Range

The 32-bit floating-point format has the value range: $\pm 10^{38}$.

Value of the Measured Values

The value of a measured value is obtained as follows:

Exponent = 0: Resulting value = 0

Exponent = 255, mantissa = 0: Resulting value = $(-1)^{<sign>} * +Inf$

Exponent = 255, mantissa not equal to 0: Resulting value = NaN

0 < Exponent < 255: Resulting value = $(-1)^{<sign>} * 2^{(<exponent> - 127)} * 1, <mantissa>$

Status and Quality Information

SENTRON T uses floating-point values with the exponent 255 (Inf, NaN) to display status information of the measured values:

Table 9-4 Floating-point Values

Floating-point Value (hexadecimal)		State	Remark
7F800000H	+Inf	Overflow	Measured value overflow (> 1.2 V_{rated}, > 2 I_{rated})
7F800001H	NaN	invalid	For example, frequency not measured because mains voltage too small (< 15 % V_{rated})
7F800002H	NaN	not calculated	Measured value is not calculated, for instance because it does not exist in the selected network type.

Accuracy of the Floating-point Numbers

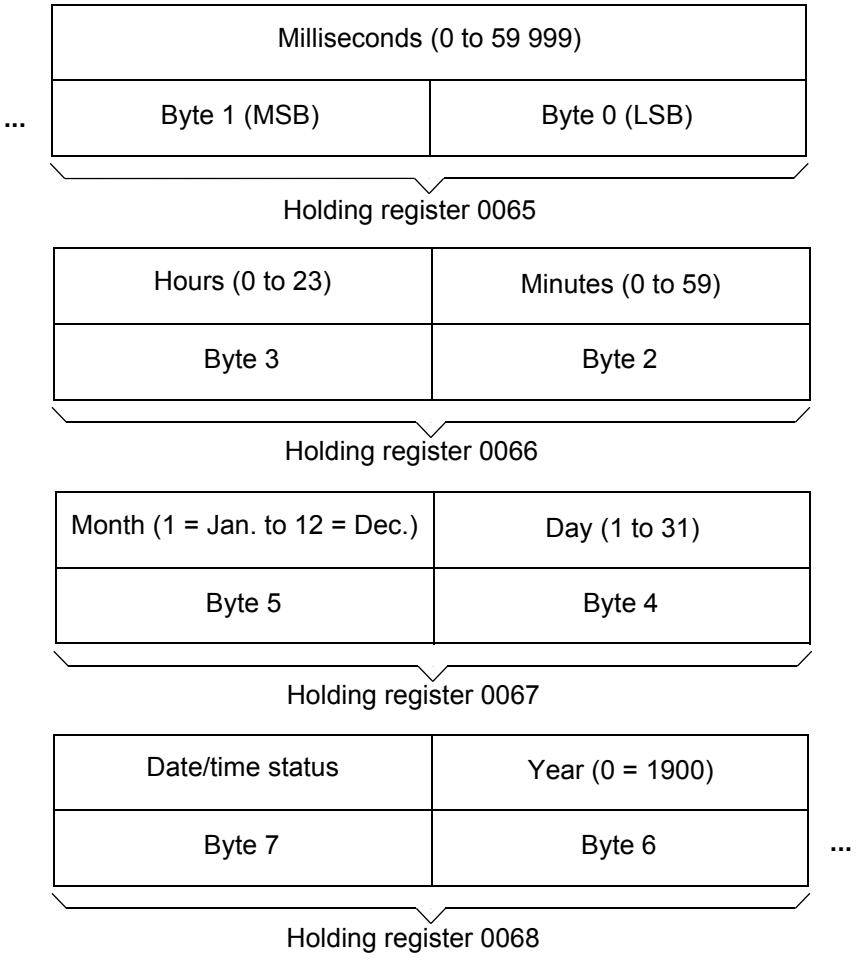
The 32-bit floating-point numbers have a 23-bit mantissa. Integer numbers can be represented in the following ranges without loss of accuracy:

- Binary:±(1)111 1111 1111 1111 1111 1111
- Hexadecimal:±FF FF FF
- Decimal:±16777216

32-bit floating-point numbers are accurate to about 7 decimal digits. An accuracy of 4 decimal digits (0.2 measuring error) is required for measuring alternating current quantities.

9.2.6.2 Data Type - Date/Time

The *Date/Time* data type is used to transmit the local time. The following format is used:



Date/time Status

10H set: Daylight saving time active

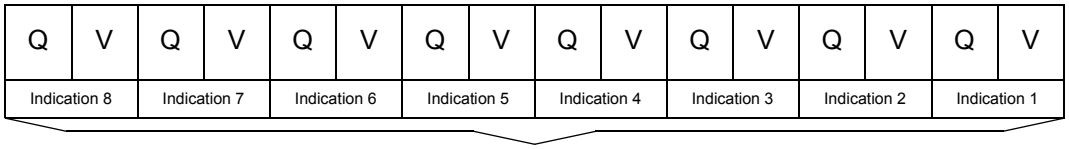
20H set: Date/time error (equivalent to FAIL bit in Table 8-1).

NOTE

For the time synchronization via Ethernet, Siemens recommends the use of NTP, see chapter 8.

9.2.6.3 Data Type - Indications (Read Only)

The *Indications* data type is represented by two bits in holding registers:



e.g. Holding register 0101

Where:

- Q: status/quality bit: 0 = OK, 1 = invalid
- V: Value bit: 0 = OFF, 1 = ON

Status or Quality Bit "Q"

An indication is invalid if the result of a calculation is based on an invalid measured value, for example the calculated limit value of an invalid measured value. If the indication is invalid, the quality bit is set to "1". The value bit can be ignored in this case.

Example: The system frequency is invalid if the voltage is smaller than 15 % of the rated voltage when measuring the frequency. Any limit violation indication based on this value is also invalid.

For indications that are always valid, for example the internal device indication *Device OK*, "0" is transmitted as the quality bit.

Value Bit "V"

The value bit indicates whether an indication is ON (=1) or OFF (=0).

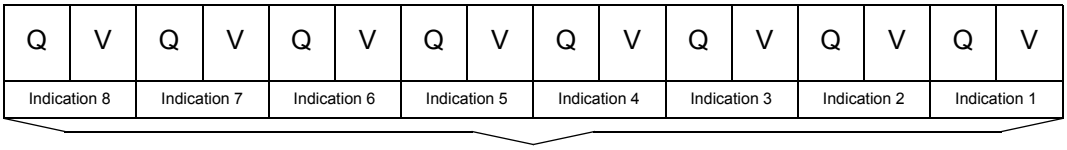
9.2.6.4 Data Type - Controllable Indications (Read/Write)

The *Controllable Indications* data type is needed for:

- The binary outputs of the SENTRON T
- Processing internal device commands (e.g. resetting the energy counters).

The holding register is used for read and write access in this context.

Use as Read Register



Holding register 0141

Where:

- Q: status/quality bit: 0 = OK, 1 = invalid
- V: Value bit: 0 = OFF, 1 = ON

See also chapter 9.2.6.3.

Use as Write Register

This data format enables up to 8 commands to be transmitted via the holding register for which the ON/OFF bits are set to either 0/1 or to 1/0. If these bits are set to 0/0 or 1/1, no evaluation will be performed.

9.2.6.5 Data Type - Counter

General

With the *Counter* data type, units of energy are transmitted as counter pulses.

To calculate the primary value, the conversion factor 'Energy per counter pulse' is output as the Measured Value data type in addition to the counter pulses (see chapter 9.2.6.1). The primary value is calculated as follows:

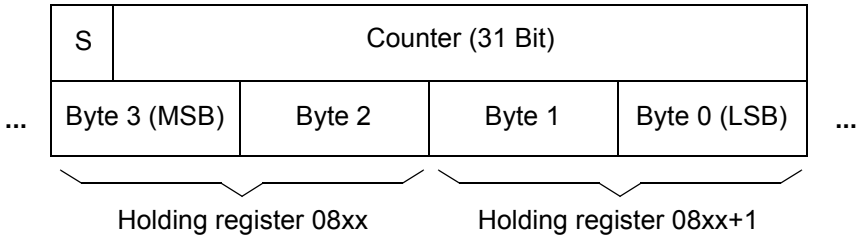
Primary value = number of counter pulses * energy per counter pulse

The following information is sent to each counter using the Modbus protocol:

- Counter pulses as 32-bit values (with sign)
- Separate status indications for "invalid" and "overflow" for each counter
- Energy per counter pulse in floating-point format for measured values (see chapter 9.2.7.12)

Counter Pulses

32-bit integers with sign allow a maximum of ±2 147 483 647 counter pulses before the counter overflows. The *Counter* data type is structured as follows:



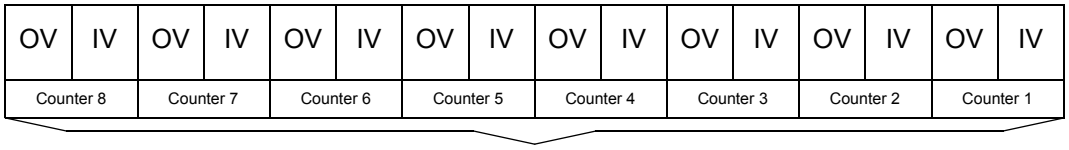
Bit S (Sign)

Reserved for negative metered values

Quality Information

The two following quality bits are stored for each counter in separate holding registers:

- **Overflow OV**: The internal counter pulse exceeds 31 bits. The Overflow bit is reset once the counter has been reset.
- **Invalid IV**: The counter value is invalid due to a reset/device start. The bit is deleted 1 min after the device start.



Holding register 08xx

Energy per Counter Pulse

The energy per counter pulse is identical for all energy metered values calculated from the measured AC quantities so that only one value is transmitted for all energy counters. The energy per counter pulse is determined by the AC network configuration.

At the rated value 60 000 counter pulses per hour are recorded for V_{rated} and I_{rated}. A counter overflow occurs about four years after the counters were reset when V_{rated} and I_{rated} are measured continuously.

9.2.7 Data in the Modbus Registers (Data Mapping)

NOTE

The data for Modbus TCP (Ethernet) and Modbus RTU (serial) in the Modbus registers are the same.

The indications, measured values etc. are stored in Holding registers. The following register groups exist. They are described in the following sections:

- Register 0001 to 0049: Device identification (read only)
- Register 0065 to 0068: Date and time (read and write)
- Register 0071 to 0089: Version information (read only)
- Register 0101 to 0102 : Device status (read only)
- Register 0111 to 0112: Indications concerning limit violations (read only)
- Register 0113: Group indications
- Register 0121 to 0122: Error messages of the DC analog outputs (read only)
- Register 0131: Status of the binary outputs (read only)
- Register 0141: Messages of the communication (read and write)
- Register 0201 to 0280: Measured values (read only)
- Register 0601 to 0608: DC analog outputs (read only)
- Register 0801 to 0846: Energy counters (read only)

9.2.7.1 Register 0001 to 0049: Device Identification

These registers are write protected. A write attempt will be rejected with exception code 03 (ILLEGAL_DATA_VALUE).

Table 9-5 Register 0001 to 0049: Device Identification

Register	Type of Information	Remark
0001 to 0008	Device type (string, max. 16 characters)	"SENTRON T"
0009 to 0024	Device ordering code (string, max. 32 characters)	Example: "7KG96611FA101AA0"
0025 to 0040	Device name from the configuration (string, max. 32 characters)	Example: "SENTRON T #1"
0041 to 0049	Device serial number (string, max. 16 characters)	Example: "BF0704034576"

9.2.7.2 Register 0065 to 0068: Date and Time

The date and time can be transmitted in 64-bit format or in 32-bit format.

64-bit Format

The 4 registers 0065 to 0068 (time and date) are transmitted in one message.

32-bit Format

The registers are transmitted in two messages. The first message contains the registers 0067 and 0068 (date), the second message contains the registers 0065 and 0066 (time).

The time synchronization only takes effect when the time has been completely transmitted.

Data type: Date/time

Table 9-6 Register 0065 to 0068: Date and Time

Register	Type of Information	Remark
0065	Milliseconds	see chapter 9.2.6.2
0066	Hours/minutes	
0067	Month/day	
0068	Time status/year	

9.2.7.3 Register 0071 to 0089: Version Information

These registers are write protected. A write attempt will be rejected with exception code 03 (ILLEGAL_DATA_VALUE).

Table 9-7 Register 0071 to 0089: Version Information

Register	Type of Information	Remark
0071 to 0076	Boot version	e.g. „V01.10.01“
0077 to 0082	Firmware version	e.g. „V01.10.01“
0083 to 0089	Parameter set version	e.g. „V01.10.01“

9.2.7.4 Register 0101 to 0102: Device Status

This register is write protected. A write attempt will be rejected with exception code 03 (ILLEGAL_DATA_VALUE).

Data type: indication

Table 9-8 Register 0101 to 0102: Device Status

Register	Type of Information	Remark
$0101/2^0$	Device ready	1 = Device ready
$0101/2^2$	Battery failure	0 = Battery OK, 1 = Battery failure (exchange battery)
$0101/2^4$	Reserved	= 0
$0101/2^6$	Reserved	= 0
$0101/2^8$	Settings Load	1 = Load settings
$0101/2^{10}$	Settings Check	1 = Check settings
$0101/2^{12}$	Settings Activate	1 = Activate settings
$0101/2^{14}$	Reserved	= 0
$0102/2^0$	Direction of rotation	0 = Anti-clockwise 1 = Clockwise
$0102/2^2$ to $0102/2^{14}$	Reserved	= 0

NOTE

Registers between 0103 and 0141 that are not shown can be read too during requests and return the value 0.

9.2.7.5 Register 0111 and 0112: Limit Violation Indications

These registers are write protected. A write attempt will be rejected with exception code 03 (ILLEGAL_DATA_VALUE).

Data type: indication

Table 9-9 Register 0111 and 0112: Limit Violation Indications

Register	Type of Information	Remark
$0111/2^0$	Limit Violation 1	An indication is output (= 1) if a measured value has exceeded or fallen below a configured limit value, see chapter 7.3.3.2.
$0111/2^2$	Limit Violation 2	
$0111/2^4$	Limit Violation 3	
$0111/2^6$	Limit Violation 4	
$0111/2^8$	Limit Violation 5	
$0111/2^{10}$	Limit Violation 6	
$0111/2^{12}$	Limit Violation 7	
$0111/2^{14}$	Limit Violation 8	
$0112/2^0$	Limit Violation 9	An indication is output (= 1) if a measured value has exceeded or fallen below a configured limit value, see chapter 7.3.3.2.
$0112/2^2$	Limit Violation 10	
$0112/2^4$	Limit Violation 11	
$0112/2^6$	Limit Violation 12	
$0112/2^8$	Limit Violation 13	
$0112/2^{10}$	Limit Violation 14	
$0112/2^{12}$	Limit Violation 15	
$0112/2^{14}$	Limit Violation 16	

9.2.7.6 Register 0113: Group Indications

These registers are write protected. A write attempt will be rejected with exception code 03 (ILLEGAL_DATA_VALUE).

Data type: indication

Table 9-10 Register 0113: Group Indications

Register	Type of Information	Remark
0113/2^0	Group indication 1	Up to 4 single point indications can be linked logically and combined to a group indication. A total of 4 group indications can be parameterized
0113/2^2	Group indication 2	
0113/2^4	Group indication 3	
0113/2^6	Group indication 3	
0113/2^8	Reserved	= 0
0113/2^{10}	Reserved	= 0
0113/2^{12}	Reserved	= 0
0113/2^{14}	Reserved	= 0

9.2.7.7 Register 0121 and 0122: Error Messages - DC Analog Outputs

These registers are write protected. A write attempt will be rejected with exception code 03 (ILLEGAL_DATA_VALUE).

Data type: indication

Table 9-11 Register 0121 and 0122: Error Messages - DC Analog Outputs

Register	Type of Information	Remark
$0121/2^0$	Analog Output 1 - Load Error	DC analog output 1 at terminal block K, terminals K2/3
$0121/2^2$	Analog Output 1 - reserved	
$0121/2^4$	Analog Output 1 - Overtemp.	
$0121/2^6$	Analog Output 1 - Error	
$0121/2^8$	Analog Output 2 - Load Error	DC analog output 2 at terminal block K, terminals K4/5
$0121/2^{10}$	Analog Output 2 - reserved	
$0121/2^{12}$	Analog Output 2 - Overtemp.	
$0121/2^{14}$	Analog Output 2 - Error	
$0122/2^0$	Analog Output 3 - Load Error	DC analog output 3 at terminal block K, terminals K6/7
$0122/2^2$	Analog Output 3 - reserved	
$0122/2^4$	Analog Output 3 - Overtemp.	
$0122/2^6$	Analog Output 3 - Error	
$0122/2^8$	Analog Output 4 - Load Error	DC analog output 4 at terminal block K, terminals K8/9
$0122/2^{10}$	Analog Output 4 - reserved	
$0122/2^{12}$	Analog Output 4 - Overtemp.	
$0122/2^{14}$	Analog Output 4 - Error	

9.2.7.8 Register 0131: Status of the Binary Outputs

This register is write protected. A write attempt will be rejected with exception code 03 (ILLEGAL_DATA_VALUE).

Data type: indication

Table 9-12 Register 0131: Status of the Binary Outputs

Register	Type of Information	Remark
$0131/2^0$	Binary Output B1	Binary output B1 at terminal block G
$0131/2^2$	Binary Output B2	Binary output B2 at terminal block G
$0131/2^4$ to $0131/2^{14}$	Reserved	= 0

9.2.7.9 Register 0141: Indications of the Communication

Data type: controllable indications

Table 9-13 Register 0141: Indications of the Communication

Register	Type of Information	Remark
$0141/2^0$	Indication 1 from Remote	For controlling the binary outputs via the communication
$0141/2^2$	Indication 2 from Remote	
$0141/2^4$ to $0141/2^{12}$	Reserved	= 0
$0141/2^{14}$	Reset Energy	0 → 1: Resets the energy counters

9.2.7.10 Registers 0201 to 0280: Measured Values

These registers are write protected. A write attempt will be rejected with exception code 03 (ILLEGAL_DATA_VALUE).

Data type: Measured value

Table 9-14 Registers 0201 to 0280: Measured Values

Register	Type of Information	Remark	Unit
0201	Va	Voltage a-N	V
0203	Vb	Voltage b-N	V
0205	Vc	Voltage c-N	V
0207	VN	Voltage neutral conductor	V
0209	Ia	Current a	A
0211	Ib	Current b	A
0213	Ic	Current c	A
0215	IN	Current neutral conductor	A
0217	Vab	Voltage a-b	V
0219	Vbc	Voltage b-c	V
0221	Vca	Voltage c-a	V
0223	Vavg	Mean value of voltage (P-N)	V
0225	Iavg	Mean value of currents	A
0227	Pa	Active power a	W
0229	Pb	Active power b	W
0231	Pc	Active power c	W
0233	P	Active power	W
0235	Qa	Reactive power a	var
0237	Qb	Reactive power b	var
0239	Qc	Reactive power c	var
0241	Q	Reactive Power	var
0243	Sa	Apparent power a	VA
0245	Sb	Apparent power b	VA

Table 9-14 Registers 0201 to 0280: Measured Values (cont.)

Register	Type of Information	Remark	Unit
0247	Sc	Apparent power c	VA
0249	S	Apparent power	VA
0251	cos ϕ (a)	Active power factor a	-
0253	cos ϕ (b)	Active power factor b	-
0255	cos ϕ (c)	Active power factor c	-
0257	cos ϕ	Active power factor	-
0259	PFa	Power factor a	-
0261	PFb	Power factor b	-
0263	PFc	Power factor c	-
0265	PF	Power factor	-
0267	ϕa	Phase angle a	° (degree)
0269	ϕb	Phase angle b	° (degree)
0271	ϕc	Phase angle c	° (degree)
0273	ϕ	Phase angle	° (degree)
0275	f	Power frequency	Hz
0277	Vunbal	Unbalanced voltage	%
0279	Iunbal	Unbalanced current	%

9.2.7.11 Registers 0601 to 0608: DC Analog Outputs

These registers are write protected. A write attempt will be rejected with exception code 03 (ILLEGAL_DATA_VALUE).

Data type: Measured value

Table 9-15 Registers 0601 to 0608: DC Analog Outputs

Register	Type of Information	Remark	Unit
0601	Analog Output 1	DC analog output 1 at terminal block K, terminals K2/3	mA or V
0603	Analog Output 2	DC analog output 2 at terminal block K, terminals K4/5	mA or V
0605	Analog Output 3	DC analog output 3 at terminal block K, terminals K6/7	mA or V
0607	Analog Output 4	DC analog output 4 at terminal block K, terminals K8/9	mA or V

9.2.7.12 Registers 0801 to 0846: Energy Counters

These registers are write protected. A write attempt will be rejected with exception code 03 (ILLEGAL_DATA_VALUE).

9.2.7.12.1 Register 0801: Energy per Counter Pulse

Data type: Measured value

Table 9-16 Register 0801: Energy per Counter Pulse

Register	Type of Information	Remark	Unit
0801	PulseQuantity	Conversion factor of counter pulses into energy values	Wh per pulse, varh per pulse or VAh per pulse

9.2.7.12.2 Registers 0803 to 0806: Counter Value Status

Data type: Counter (quality information)

Table 9-17 Registers 0803 to 0806: Counter Value Status

Register	Type of Information	Remark	Unit
0803/2^0	Status 1	Status of counters WPa_Demand	-
0803/2^2	Status 2	Status of counters WPb_Demand	-
0803/2^4	Status 3	Status of counters WPc_Demand	-
0803/2^6	Status 4	Status of counters WP_Demand	-
0803/2^8	Status 5	Status of counters WPa_Supply	-
0803/2^{10}	Status 6	Status of counters WPb_Supply	-
0803/2^{12}	Status 7	Status of counters WPc_Supply	-
0803/2^{14}	Status 8	Status of counters WP_Supply	-
0804/2^0	Status 9	Status of counters WQa_inductive	-
0804/2^2	Status 10	Status of counters WQb_inductive	-
0804/2^4	Status 11	Status of counters WQc_inductive	-
0804/2^6	Status 12	Status of counters WQ_inductive	-
0804/2^8	Status 13	Status of counters WQa_capacitive	-
0804/2^{10}	Status 14	Status of counters WQb_capacitive	-
0804/2^{12}	Status 15	Status of counters WQc_capacitive	-
0804/2^{14}	Status 16	Status of counters WQ_capacitive	-
0805/2^0	Status 17	Status of counters WSa	-
0805/2^2	Status 18	Status of counters WSb	-
0805/2^4	Status 19	Status of counters WSc	-
0805/2^6	Status 20	Status of counters WS	-
0805/2^8 to 0805/2^{15}	Reserved	= 0	-
0806	Reserved	= 0	-

9.2.7.12.3 Registers 0807 to 0846: Counter Pulses

Data type: Counter

Table 9-18 Registers 0807 to 0846: Counter Pulses

Register	Type of Information	Remark	Unit
0807	WPa_dmd	Active energy based on active power Pa Demand	Pulse
0809	WPb_dmd	Active energy based on active power Pb Demand	Pulse
0811	WPc_dmd	Active energy based on active power Pc Demand	Pulse
0813	WP_dmd	Active energy based on active power P Demand	Pulse
0815	WPa_sup	Active energy based on active power Pa Supply	Pulse
0817	WPb_sup	Active energy based on active power Pb Supply	Pulse
0819	WPc_sup	Active energy based on active power Pc Supply	Pulse
0821	WP_sup	Active energy based on active power P Supply	Pulse
0823	WQa_ind	Reactive energy based on reactive power Qa inductive	Pulse
0825	WQb_ind	Reactive energy based on reactive power Qb inductive	Pulse
0827	WQc_ind	Reactive energy based on reactive power Qc inductive	Pulse
0829	WQ_ind	Reactive energy based on reactive power Q inductive	Pulse
0831	WQa_cap	Reactive energy based on reactive power Qa capacitive	Pulse
0833	WQb_cap	Reactive energy based on reactive power Qb capacitive	Pulse
0835	WQc_cap	Reactive energy based on reactive power Qc capacitive	Pulse
0837	WQ_cap	Reactive energy based on reactive power Q capacitive	Pulse

Table 9-18 Registers 0807 to 0846: Counter Pulses (cont.)

Register	Type of Information	Remark	Unit
0839	WSa	Apparent energy based on apparent power Sa	Pulse
0841	WSb	Apparent energy based on apparent power Sb	Pulse
0843	WSc	Apparent energy based on apparent power Sc	Pulse
0845	WS	Apparent energy based on apparent power S	Pulse

9.2.8 Modbus Diagnosis

The diagnostics function for Modbus TCP and Modbus RTU, see chapter 7.5.5.1, enables analyzing the parameters and the communication and resetting diagnostics counters.

9.2.8.1 Modbus TCP Diagnosis

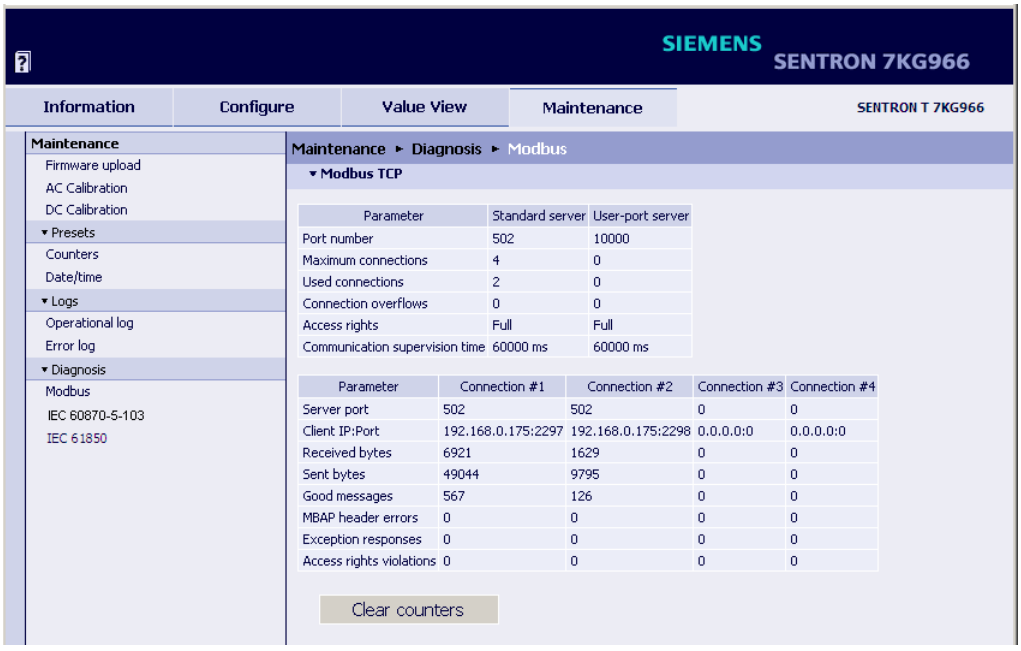


Fig. 9-4 Modbus TCP Diagnosis

Parameter for Standard Server and User-port Server

- Port number: Standard port 502 and configured user port
- Number of connections: For user port number 502: 4 connections via standard port 502

  For other user port numbers: 2 connections via standard port 502 and 2 connections via the user port
- Used connections: Number of connections that are actually used
- Connection overflow: Counter of the attempts to establish more connections than allowed;

  Number of allowed connection attempts:

  For user port number 502: ≥ 5 connection attempts via standard port 502

  For other user port numbers: ≥ 3 connection attempts via standard port 502 and/or ≥ 3 connection attempts via user port
- Status of the access rights: Factory setting: Full
- Monitoring time of the communication: Factory setting: 60 000 ms

Parameter of Connections

- Server port: Server port number of the current connection in the respective column; if "0" is displayed, the connection is inactive or down
- Client IP:Port: Last or current IP address and port number of the client
- Received bytes: Total number of bytes received by the TCP port
- Sent bytes: Total number of bytes sent to the TCP port
- Good messages: Total number of messages received that were detected as valid Modbus messages
- MBAP header error: Error in the MBAP header: incorrect protocol ID or implausible length of data
- Exception responses: Counters of the transmitted exception response messages (see chapter 9.2.2)
- Access rights violations: Total number of write accesses received if the parameter **Access rights for port xxx** is set to **Read only** of the associated TCP port (e.g. 502) in the **Communication Ethernet** input/output window (see see chapter 7.3.4.2)

9.2.8.2 Modbus RTU Diagnosis

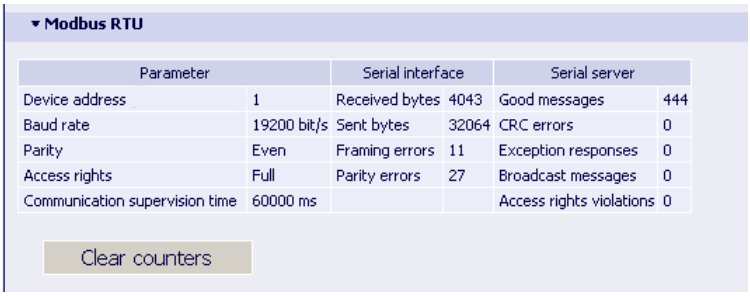


Fig. 9-5 Modbus RTU Diagnosis

Parameter

The following parameters are displayed with Modbus RTU:

- Device address: Default setting: 1
- Baud rate: Default setting: 19 200 bit/s
- Parity: Default setting: Even
- Access rights: Default setting: Full
- Communication supervision time: Default setting: 60 000 ms

Serial Interface

- Bytes received: Total number of bytes received by the RS485 interface
- Bytes sent: Total number of bytes sent to the RS485 interface
- Frame error: Number of detected frame errors (invalid stop bit, e.g. if the baud rate is wrong)
- Parity error: Number of detected parity errors (wrong parity)

Serial Server

- Correct messages: Total number of messages received that were detected as valid Modbus messages
- CRC error: Total number of messages received in which CRC errors were detected
- Exception responses: Counters of the transmitted exception response messages (see chapter 9.2.2)
- Broadcast messages: Total number of the broadcast messages received with the server address 0
- Access rights violations: Total number of write accesses received if the parameter **Access rights** is set to **Read only** in the **Communication serial** input/output window (see see chapter 7.3.4.3)

9.3 IEC 60870-5-103 (SENTRON T 7KG9661)

The IEC 60870-5-103 protocol is also used for communication via the RS485 interface. The IEC 60870-5-103 specification with a detailed explanation of the protocol is given in International Standard IEC 60870-5-103.

9.3.1 Function Ranges

9.3.1.1 Basic Application Functions

Table 9-19 Basic Application Functions

IEC 60870-5-103 Function	Supported by SENTRON T	Remark
Station Initialization	Yes	Station initialization is necessary: • After device start-up (power-up or reset) or • After no telegram was received by the device for the period of 5 minutes which is addressed to this slave or is a broadcast telegram
General Interrogation	Yes	Events which are contained in general interrogation.
Clock Synchronization	Yes	Using the individual IEC 60870-5-103 device address or the broadcast address.
Command Transmission	Yes	Reset energy value/remote control
Test Mode	No	-
Blocking of Monitoring Direction	No	-
Transmission of Disturbance Data	No	-
Generic Services	No	-

9.3.1.2 Standard ASDUs in Monitoring Direction

Table 9-20 Standard ASDUs in Monitoring Direction

#	Designation	Supported by SENTRON T	Remark
ASDU 1	Time-tagged message	Yes	All available events and binary information with time stamp.
ASDU 2	Time-tagged message with relative time	No	-
ASDU 3	Measurands I	No	-
ASDU 4	Time-tagged measurands with relative time	No	-
ASDU 5	Identification	Yes	Manufacturer (8 ASCII characters): „SIEMENS “ (8^{th} character = space)
ASDU 6	Time synchronization	Yes	-
ASDU 8	General interrogation termination	Yes	-
ASDU 9	Measurands II	Yes	Refer to chapter 9.3.2.2, “Telegrams for Measured Values”
ASDU 10	Generic data	No	-
ASDU 11	Generic identification	No	-
ASDU 23	List of disturbance data	No	-
ASDU 26	Ready for transmission of disturbance data	No	-
ASDU 27	Ready for transmission of channel	No	-
ASDU 28	Ready for transmission of tags	No	-
ASDU 29	Transmission of tags	No	-
ASDU 30	Transmission of disturbance values	No	-
ASDU 31	End of transmission	No	-

9.3.1.3 Standard ASDUs in Control Direction

Table 9-21 Standard ASDUs in Control Direction

#	Designation	Supported by SENTRON T	Remark
ASDU 6	Time synchronization	Yes	-
ASDU 7	General interrogation	Yes	-
ASDU 10	Generic data	No	-
ASDU 20	General command	Yes	-
ASDU 21	Generic command	No	-
ASDU 24	Order for disturbance data transmission	No	-
ASDU 25	ACK for disturbance data transmission	No	-

9.3.1.4 Private ASDU in Monitoring Direction

Table 9-22 Private ASDU in Monitoring Direction

#	Designation	Supported by SENTRON T	Remark
ASDU 205 *	Counters	Yes	Energy counters

* Definition acc. to SIPROTEC for energy and pulse counters

NOTE

Information about ASDU 205 see: http://siemens.siprotec.com; pdf document: Additional information for users of the IEC 60870-5-103

9.3.2 Data Mapping and Telegrams for Measured Values

9.3.2.1 Data Mapping for Measured Values

The 7KG966 device supports transmission of measured values via the communication protocol IEC 60870-5-103 (see Table 9-23). All measured values are transferred as per-unit values. The column "100 % corresponds to" in the Table • shows the relation between the 100 % per-unit value and the corresponding measured value.

Explanations to the "100 % corresponds to" Values: AC Voltages and AC Currents

All 100 % values correspond to the associated selected nominal operating values (AC 1 A or AC 5 A for currents and AC 110 V, AC 190 V, AC 400 V or AC 690 V (max. 600 V for UL) for voltages V_{ph-ph}).

The following special cases apply to the frequency, the active power factor and the DC analog outputs:

Explanations to the "100 % corresponds to" Value: Frequency

The device automatically recognizes the line frequency (either 50 Hz or 60 Hz). Via IEC 60870-5-103 protocol the deviation of the line frequency is transmitted.

Examples for 50 Hz nominal frequency:

- Line frequency = 50 Hz → IEC 60870-5-103 value = 0 %
- Line frequency = 55 Hz → IEC 60870-5-103 value = 100 %
- Line frequency = 49 Hz → IEC 60870-5-103 value = -20 %

Explanations to the "100 % corresponds to" Values: Active Power Factor cos ϕ

The active power factor cos ϕ has a sign.

- negative cos ϕ: capacitive
- positive cos ϕ: inductive

Explanations to the "100 % corresponds to" Values: DC Analog Outputs

For the DC analog outputs, 100 % correspond to the following values depending on the parameterization:

- 20 mA
- 10 V

Table 9-23 Measured Value Mapping

#	Value	Measured Quantity	100 % Corresponds to	Function Type	Information Number	Compatibility	Data Unit	Position
1	Va	Voltage (A-N)	$V_{ph-N\ (nom.)}$	130	148	Yes	9	4
2	Vb	Voltage (B-N)	$V_{ph-N\ (nom.)}$	130	148	Yes	9	5
3	Vc	Voltage (C-N)	$V_{ph-N\ (nom.)}$	130	148	Yes	9	6

Table 9-23 Measured Value Mapping (cont.)

#	Value	Measured Quantity	100 % Corresponds to	Function Type	Information Number	Compatibility	Data Unit	Position
4	Vab	Voltage (A-B)	$V_{ph-ph\ (nom.)}$	130	151	No	9	1
5	Vbc	Voltage (B-C)	$V_{ph-ph\ (nom.)}$	130	151	No	9	2
6	Vca	Voltage (C-A)	$V_{ph-ph\ (nom.)}$	130	151	No	9	3
7	Vavg	Average Voltage	$V_{ph-N\ (nom.)}$	130	151	No	9	4
8	VN	Neutral Voltage	$V_{ph-N\ (nom.)}$	130	150	No	9	7
9	Ia	Current (A)	$I_{(nom.)}$	130	148	Yes	9	1
10	Ib	Current (B)	$I_{(nom.)}$	130	148	Yes	9	2
11	Ic	Current (C)	$I_{(nom.)}$	130	148	Yes	9	3
12	Iavg	Average Current	$I_{(nom.)}$	130	151	No	9	9
13	IN	Neutral Current	$I_{(nom.)}$	130	151	No	9	10
14	Pa	Real Power (A)	$I_{(nom.)} * V_{ph-N\ (nom.)}$	130	150	No	9	1
15	Pb	Real Power (B)	$I_{(nom.)} * V_{ph-N\ (nom.)}$	130	152	No	9	1
16	Pc	Real Power (C)	$I_{(nom.)} * V_{ph-N\ (nom.)}$	130	152	No	9	2
17	P	Real Power	$3 * I_{(nom.)} * V_{ph-N\ (nom.)}$	130	148	Yes	9	7
18	Qa	Reactive Power (A)	$I_{(nom.)} * V_{ph-N\ (nom.)}$	130	150	No	9	2
19	Qb	Reactive Power (B)	$I_{(nom.)} * V_{ph-N\ (nom.)}$	130	152	No	9	3
20	Qc	Reactive Power (C)	$I_{(nom.)} * V_{ph-N\ (nom.)}$	130	152	No	9	4
21	Q	Reactive Power	$3 * I_{(nom.)} * V_{ph-N\ (nom.)}$	130	148	Yes	9	8
22	Sa	Apparent Power (A)	$I_{(nom.)} * V_{ph-N\ (nom.)}$	130	150	No	9	3
23	Sb	Apparent Power (B)	$I_{(nom.)} * V_{ph-N\ (nom.)}$	130	152	No	9	5

Table 9-23 Measured Value Mapping (cont.)

#	Value	Measured Quantity	100 % Corresponds to	Function Type	Information Number	Compatibility	Data Unit	Position
24	Sc	Apparent Power (C)	$I_{(nom.)} * V_{ph-N\ (nom.)}$	130	152	No	9	6
25	S	Apparent Power	$3 * I_{(nom.)} * V_{ph-N\ (nom.)}$	130	151	Yes	9	5
26	cos ϕ (a)	Active Power Factor cos ϕ (A)	1	130	150	No	9	4
27	cos ϕ (b)	Active Power Factor cos ϕ (B)	1	130	152	No	9	7
28	cos ϕ (c)	Active Power Factor cos ϕ (C)	1	130	152	No	9	8
29	cos ϕ	Active Power Factor cos ϕ	1	130	151	No	9	6
30	PFa	Power Factor (A)	1	130	150	No	9	5
31	PFb	Power Factor (B)	1	130	152	No	9	9
32	PFc	Power Factor (C)	1	130	152	No	9	10
33	PF	Power Factor	1	130	151	No	9	7
34	ϕa	Phase Angle (A)	180°	130	150	No	9	6
35	ϕb	Phase Angle (B)	180°	130	152	No	9	11
36	ϕc	Phase Angle (C)	180°	130	152	No	9	12
37	ϕ	Phase Angle	180°	130	151	No	9	8
38	f	System Frequency	5 Hz deviation	130	148	Yes	9	9
39	Vunbal	Unbalanced voltage	100 %	130	151	No	9	11
40	Iunbal	Unbalanced current	100 %	130	151	No	9	12

9.3.2.2 Telegrams for Measured Values

The measured values of the SENTRON T device are transmitted via IEC 60870-5-103 using five different telegrams. Depending on the selected **Network type** (see chapter 7.3.3), specific AC measured values are sent.

Function Type FUN

Each telegram from the slave device to the master device contains a function type the function type FUN:

FUN = 130: AC measurement - AC measurands and associated indications

FUN = 131: DC measurement - DC analog output and binary output

Information Number INF

INF = 148

INF = 150

INF = 151

INF = 152

Five different measurands telegrams are defined as follows:

Compatible Measurands II

Data Unit (ASDU) = 9
Identifier (max. 9 elements)
Cause of Transmission (COT)
Common Address of ASDU
Function Type (FUN) = 130
Information Number (INF) = 148
Current (Ia)
Current (Ib)
Current (Ic)
Voltage (Va)
Voltage (Vb)
Voltage (Vc)
Real Power (P)
Reactive Power (Q)
System Frequency (f)

Private Measurands 1-phase Additional

Data Unit (ASDU) = 9
Identifier (max. 7 elements)
Cause of Transmission (COT)
Address of ASDU
Function Type (FUN) = 130
Information Number (INF) = 150
Real Power (Pa)
Reactive Power (Qa)
Apparent Power (Sa)
Active power factor cos ϕ (a)
Power Factor (PFa)
Phase Angle (ϕa)
Neutral voltage (VN)

Private Measurands 3-phase, First Additional

Data Unit (ASDU) = 9
Identifier (max. 12 elements)
Cause of Transmission (COT)
Address of ASDU
Function Type (FUN) = 130
Information Number (INF) = 151
Voltage (Vab)
Voltage (Vbc)
Voltage (Vca)
Average Voltage (Vavg)
Apparent Power (S)
Active power factor cos ϕ
Power Factor (PF)
Phase Angle (ϕ)
Average Current (I)
Neutral Current (In)
Voltage unbalance (Vunbal)
Current unbalance (Iunbal)

Private Measurands 3-phase, Second Additional

Data Unit (ASDU) = 9
Identifier (max. 12 elements)
Cause of Transmission (COT)
Address of ASDU
Function Type (FUN) = 130
Information Number (INF) = 152
Real Power (Pb)
Real Power (Pc)
Reactive Power (Qb)
Reactive Power (Qc)
Apparent Power (Sb)
Apparent Power (Sc)
cos ϕ (b)
cos ϕ (c)
Power Factor (PFb)
Power Factor (PFc)
Phase Angle (ϕb)
Phase Angle (ϕc)

DC Analog Outputs

Data Unit (ASDU) = 9
Identifier (max. 4 elements)
Cause of Transmission (COT)
Common Address of ASDU
Function Type (FUN) = 131
Information Number (INF) = 150
Analog Output 1
Analog Output 2
Analog Output 3
Analog Output 4

9.3.2.3 Transmitted Telegrams in the Various Network Types

Depending on the selected **Network type**, two or four of the telegrams for AC measurands are sent to the IEC 60870-5-103 master.

Table 9-24 Transmitted Telegrams vs. Network Type

	Network Type					
	Single-phase Network	3-wire 3-phase			4-wire 3-phase	
		Balanced	Unbalanced 3I	Unbalanced 2I	Bal-anced	Unbal-anced
Compatible Measurands II	X*	X**	X**	X**	X	X
Private Measurands 1-phase additional	X	-	-	-	-	X
Private Measurands 3-phase, 1st additional	-	X	X	X	X	X
Private Measurands 3-phase, 2nd additional	-	-	-	-	-	X
DC Analog Outputs	X	X	X	X	X	X

* The values for 3N as well as phases b and c in the “Compatible Measurands II” telegram which are not available for this network type are indicated as invalid.

** For 3-wire network configuration following quantities of measurand II are not valid: Van, Vbn, Vcn. Therefore, the relevant measurand invalid bit in “Compatible Measurand II” - ASDU 9 will be set.

All telegrams are transferred sequentially. The IEC 60870-5-103 slave sends the next following telegram in the order shown in Table 9-24 and the measurands telegram.

When the last AC measurands telegram or the DC measurands telegram is sent, it starts with "Compatible Measurands II".

The IEC 60870-5-103 Master can retrieve either only one telegram, a part of the telegram or all telegrams supported by the device.

On every class 2 request from the IEC 60870-5-103 master, the current measured values are transmitted. It is the task of the communication master to compare the values of the current and previous request if necessary.

9.3.3 Data Mapping for Commands and Events

The following table contains all available commands and events as well as the information of the modules:

Table 9-25 Commands and Events

#	Designation	Description	Type of Information	Function Type	Information Number	Compatibility	Data Unit	General Interrogation
1	Indication 1 from Remote	Assign to binary output 1 or 2	Event	135	32	No	1	Yes
2	Indication 1 from Remote	Assign to binary output 1 or 2	Command	135	32	No	20	-
3	Indication 2 from Remote	Assign to binary output 1 or 2	Event	135	33	No	1	Yes
4	Indication 2 from Remote	Assign to binary output 1 or 2	Command	135	33	No	20	-
5	BO1	Binary output 1	Event	135	34	No	1	Yes
6	BO2	Binary output 2	Event	135	35	No	1	Yes
7	Limit Violation 1	Limit value 1	Event	135	49	No	1	Yes
8	Limit Violation 2	Limit value 2	Event	135	50	No	1	Yes
9	Limit Violation 3	Limit value 3	Event	135	51	No	1	Yes
10	Limit Violation 4	Limit value 4	Event	135	52	No	1	Yes
11	Limit Violation 5	Limit value 5	Event	135	53	No	1	Yes
12	Limit Violation 6	Limit value 6	Event	135	54	No	1	Yes
13	Limit Violation 7	Limit value 7	Event	135	55	No	1	Yes
14	Limit Violation 8	Limit value 8	Event	135	56	No	1	Yes
15	Limit Violation 9	Limit value 9	Event	135	57	No	1	Yes
16	Limit Violation 10	Limit value 10	Event	135	58	No	1	Yes
17	Limit Violation 11	Limit value 11	Event	135	59	No	1	Yes

Table 9-25 Commands and Events (cont.)

#	Designation	Description	Type of Information	Function Type	Information Number	Compatibility	Data Unit	General Interrogation
18	Limit Violation 12	Limit value 12	Event	135	60	No	1	Yes
19	Limit Violation 13	Limit value 13	Event	135	61	No	1	Yes
20	Limit Violation 14	Limit value 14	Event	135	62	No	1	Yes
21	Limit Violation 15	Limit value 15	Event	135	63	No	1	Yes
22	Limit Violation 16	Limit value 16	Event	135	64	No	1	Yes
23	Battery fault	Battery fault	Event	135	65	No	1	Yes
24	Device OK	Device OK	Event	135	66	No	1	Yes
25	Reset Energy	Reset energy	Event	135	67	No	1	Yes
26	Reset Energy	Reset energy	Command	135	67	No	20	-
27	Time Synchroni-zation Error	Time synchroni-zation error	Event	135	68	No	1	Yes
28	Settings Load	Parameter load	Event	135	69	No	1	Yes
29	Analog Output 1 - Load Error	Analog output 1, overload	Event	135	70	No	1	Yes
30	Analog Output 1 - Overtemp.	Analog output 1, temperature error	Event	135	71	No	1	Yes
31	Analog Output 1 - Error	Analog output 1, sum error	Event	135	72	No	1	Yes
32	Analog Output 2 - Load Error	Analog output 2, overload	Event	135	73	No	1	Yes
33	Analog Output 2 - Overtemp.	Analog output 2, temperature error	Event	135	74	No	1	Yes
34	Analog Output 2 - Error	Analog output 2, sum error	Event	135	75	No	1	Yes

Table 9-25 Commands and Events (cont.)

#	Designation	Description	Type of Information	Function Type	Information Number	Compatibility	Data Unit	General Interrogation
35	Analog Output 3 - Load Error	Analog output 3, overload	Event	135	76	No	1	Yes
36	Analog Output 3 - Overtemp.	Analog output 3, temperature error	Event	135	77	No	1	Yes
37	Analog Output 3 - Error	Analog output 3, sum error	Event	135	78	No	1	Yes
38	Analog Output 4 - Load Error	Analog output 4, overload	Event	135	79	No	1	Yes
39	Analog Output 4 - Overtemp.	Analog output 4, temperature error	Event	135	80	No	1	Yes
40	Analog Output 4 - Error	Analog output 4, sum error	Event	135	81	No	1	Yes
41	DirectionRotation	Direction of rotation	Event	135	82	No	1	Yes
42	GI1	Group indication 1	Event	135	83	No	1	Yes
43	GI2	Group indication 2	Event	135	84	No	1	Yes
44	GI3	Group indication 3	Event	135	85	No	1	Yes
45	GI4	Group indication 4	Event	135	86	No	1	Yes

9.3.4 Data Mapping for Counters

Metering values (e.g. kWh) are not defined in the IEC standard and there are no compatible data units available which are suitable for the transmission of metered values. The private data unit 205 has been defined for the transmission of metered values using Class 1 data format.

Only one metering value per data unit is transmitted. There exists a cyclic interval for transmitting the counters which is set fixed to 1 min in SENTRON T.

Table 9-26 Counters

#	Value	Unit	Function Type	Information Number	Compati-bility	Data Unit
1	WPa_sup	Wh	133	51	No	205
2	WPb_sup	Wh	133	52	No	205
3	WPc_sup	Wh	133	53	No	205
4	WP_sup	Wh	133	54	No	205
5	WPa_dmd	Wh	133	55	No	205
6	WPb_dmd	Wh	133	56	No	205
7	WPc_dmd	Wh	133	57	No	205
8	WP_dmd	Wh	133	58	No	205
9	WQa_ind	varh	133	59	No	205
10	WQb_ind	varh	133	60	No	205
11	WQc_ind	varh	133	61	No	205
12	WQ_ind	varh	133	62	No	205
13	WQa_cap	varh	133	63	No	205
14	WQb_cap	varh	133	64	No	205
15	WQc_cap	varh	133	65	No	205
16	WQ_cap	varh	133	66	No	205
17	WSa	VAh	133	67	No	205
18	WSb	VAh	133	68	No	205
19	WSc	VAh	133	69	No	205
20	WS	VAh	133	70	No	205

9.3.5 Diagnosis IEC 60870-5-103

The diagnostics function for IEC 60870-5-103, see chapter 7.5.5.2, enables analyzing the parameters and the communication and resetting diagnostics counters.

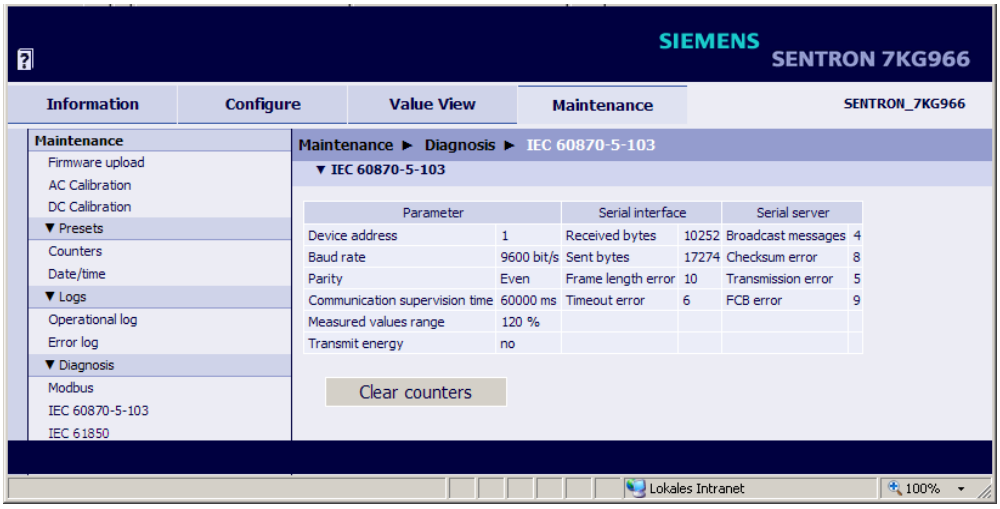


Fig. 9-6 Diagnosis IEC 60870-5-103

Parameters

The following parameters are displayed with IEC 60870-5-103:

- Device address: Default setting: 1
- Baud rate: Default setting: 9600 bit/s
- Parity: Even (fixed)
- Communication supervision time: Default setting: 60 000 ms
- Measured value range: 120 %
- Send counters telegram: No

Serial Interface

The following parameters are displayed for the serial interface:

- Received bytes: Total numbers of bytes received by serial interface
- Sent bytes: Total numbers of bytes sent to the serial interface
- Frame length error: Total numbers of incoming frame exceeded buffer size (invalid stop bit, e.g. if the baud rate is wrong)
- Time-out error: Total numbers of intercharacter time-out occurred

Serial Server

The following parameters are displayed for the serial server:

- Broadcast messages: Total numbers of received broadcast telegrams with server address zero
- Checksum error: Total numbers of invalid checksum
- Transmission error: Total numbers of error returned from target transmit routine
- FCB error: Total numbers of received invalid frame count bit (FCB)

9.4 IEC 61850 (SENTRON T 7KG9662)

NOTE

Applies to firmware version V02.00.04 and higher.

The IEC 61850 protocol is also used for communication via the Ethernet interface. The IEC 61850 specification with a detailed explanation of the protocol is given in “International Standard IEC 61850”.

SENTRON T supports 6 input configurations (see chapter 4.1.3):

- 1-phase system
- 3-wire network - balanced (1I)
- 3-wire network - unbalanced (3I)
- 3-wire network - unbalanced (2I)
- 4-wire network - balanced (1I)
- 4-wire network - unbalanced (3I)

9.4.1 Logic Node: Measurement

1-phase System

Table 9-27 1-phase System

inst		**1**
desc		**Measurand**
lnClass		**MMXU**
lnName		**IED_LD1/MMXU1**
clcMth		**TRUE_RMS**
Data Objects	**CDC**	**Measurand**
Hz	MV	f
PhV	WYE	Van
A	WYE	Ia
W	WYE	Pa
VAr	WYE	Qa
VA	WYE	Sa
PF	WYE	PFa

3-wire Network - Balanced (1l)

Table 9-28 3-wire Network - Balanced (1l)

inst		**2**
desc		**Measurand**
lnClass		**MMXU**
lnName		**IED_LD1/MMXU2**
clcMth		**TRUE_RMS**
Data Objects	**CDC**	**Measurand**
TotW	MV	P
TotVAr	MV	Q
TotVA	MV	S
TotPF	MV	PF
Hz	MV	f
PPV	DEL	Vab
		Vbc
		Vca
PhV	WYE	Vavg
A	WYE	Ia

3-wire Network - Unbalanced (3I)

Table 9-29 3-wire Network - Unbalanced (3I)

inst		**3**
desc		**Measurand**
lnClass		**MMXU**
lnName		**IED_LD1/MMXU3**
clcMth		**TRUE_RMS**
Data Objects	**CDC**	**Measurand**
TotW	MV	P
TotVAr	MV	Q
TotVA	MV	S
TotPF	MV	PF
Hz	MV	f
PPV	DEL	Vab
		Vbc
		Vca
PhV	WYE	Vavg
A	WYE	Ia
		Ib
		Ic
		In
		Iavg

3-wire Network - Unbalanced (2I)

Table 9-30 3-wire Network - Unbalanced (2I)

inst		**4**
desc		**Measurand**
lnClass		**MMXU**
lnName		**IED_LD1/MMXU4**
clcMth		**TRUE_RMS**
Data Objects	**CDC**	**Measurand**
TotW	MV	P
TotVAr	MV	Q
TotVA	MV	S
TotPF	MV	PF
Hz	MV	f
PPV	DEL	Vab
		Vbc
		Vca
PhV	WYE	Vavg
A	WYE	Ia
		Ib
		Ic
		Iavg

4-wire Network - Balanced (1I)

Table 9-31 4-wire Network - Balanced (1I)

inst		**5**
desc		**Measurand**
lnClass		**MMXU**
lnName		**IED_LD1/MMXU5**
clcMth		**TRUE_RMS**
Data Objects	**CDC**	**Measurand**
TotW	MV	P
TotVAr	MV	Q
TotVA	MV	S
TotPF	MV	PF
Hz	MV	f
PhV	WYE	Van
PhV	WYE	Vavg
A	WYE	Ia

4-wire Network - Unbalanced (3I)

Table 9-32 4-wire Network - Unbalanced (3I)

inst		**6**
desc		**Measurand**
lnClass		**MMXU**
lnName		**IED_LD1/MMXU6**
clcMth		**TRUE_RMS**
Data Objects	**CDC**	**Measurand**
TotW	MV	P
TotVAr	MV	Q
TotVA	MV	S
TotPF	MV	PF
Hz	MV	f
PPV	DEL	Vab
		Vbc
		Vca
PhV	WYE	Van
		Vbn
		Vcn
		Vn
		Vavg
A	WYE	Ia
		Ib
		Ic
		In
		Iavg

Table 9-32 4-wire Network - Unbalanced (3I) (cont.)

W	WYE	Pa
		Pb
		Pc
VAr	WYE	Qa
		Qb
		Qc
VA	WYE	Sa
		Sb
		Sc
PF	WYE	PFa
		PFb
		PFc

9.4.2 Logic Node: Metering

NOTE

Metered values are only available in the 3-wire and 4-wire network.

Table 9-33 3-wire and 4-wire Network

inst		**1**
desc		**Measurand**
InClass		**MMTR**
InName		**IED_LD1/MMTR**
Data Objects	**CDC**	**Counter**
TotVAh	BCR	WS
SupWh	BCR	WP_Supply
SupVArh	BCR	WQ_Inductive
DmdWh	BCR	WP_Demand
DmdVArh	BCR	WQ_Capacitive

9.4.3 General I/O Processes

Table 9-34 Limit Violations/Group Indications

inst		**1**
desc		**Indications**
InClass		**GGIO**
InName		**IED_LD1/GGIO1**
Data Objects	**CDC**	
Status information		
Alm1~16	SPS	Limit violations 1 to 16
Alm17~20	SPS	Group indications 1 to 4

Table 9-35 Indications

inst		**2**
desc		**Indications**
InClass		**GGIO**
InName		**IED_LD1/GGIO2**
Data Objects	**CDC**	
Status information		
Ind1	SPS	Indication 1 from remote
Ind2	SPS	Indication 2 from remote
Alm1	SPS	Reset Energy
Alm2	SPS	Parameter load
Alm3	SPS	Time synchronization error
Alm4	SPS	Rotation

Table 9-36 Analog Output Errors

inst		**3**
desc		**Indications**
InClass		**GGIO**
InName		**IED_LD1/GGIO3**
Data Objects	**CDC**	
Status information		
Alm1	SPS	Analog output 1 - overload
Alm2	SPS	Analog output 1 - temp error
Alm3	SPS	Analog output 1 - sum error
Alm4	SPS	Analog output 2 - overload
Alm5	SPS	Analog output 2 - temp error
Alm6	SPS	Analog output 2 - sum error
Alm7	SPS	Analog output 3 - overload
Alm8	SPS	Analog output 3 - temp error
Alm9	SPS	Analog output 3 - sum error
Alm10	SPS	Analog output 4 - overload
Alm11	SPS	Analog output 4 - temp error
Alm12	SPS	Analog output 4 - sum error

Table 9-37 Battery

inst		**1**
desc		**Battery status**
InClass		**ZBAT**
InName		**IED_LD1/ZBAT1**
Data objekts	**CDC**	
Status information		
Vol	MV	Battery voltage (not available, invalid)
BatLo	SPS	Battery failure (undervoltage or battery is missing)

9.4.4 PICS - ACSI Conformance Statement

(PICS = Protocol Implementation Conformance Statement)

ACSI Basic Conformance Statement

Table 9-38 Basic Conformance Statement

		Client/ Subscriber	Server/ Publisher
Client-Server roles			
B11	**Server** side (of TWO-PARTY-APPLICATION-ASSOCIATION)	-	Y
B12	**Client** side of (TWO-PARTY-APPLICATION-ASSOCIATION)	N	-
SCSMs supported			
B21	**SCSM**: IEC 6185-8-1 used	N	Y
B22	**SCSM**: IEC 6185-9-1 used	N	N
B23	**SCSM**: IEC 6185-9-2 used	N	N
B24	**SCSM**: other	N/A	N/A
Generic substation event model (GSE)			
B31	**Publisher** side	-	N
B32	**Subscriber** side	N	_
Transmission of sampled value model (SVC)			
B41	**Publisher** side	-	N
B42	**Subscriber** side	N	_

Y = supported; N or empty: not supported

ACSI Models Conformance Statement

Table 9-39 ACSI Models Conformance Statement

		Client/ Subscriber	Server/ Publisher
If Server or Client side (B11/12) supported			
M1	**Logical device**	N	Y
M2	**Logical node**	N	Y
M3	**Data**	N	Y
M4	**Data set**	N	Y
M5	**Substitution**	N	N
M6	**Setting group control**	N	N
Reporting			
M7	**Buffered report control**	N	Y
M7-1	Sequence-number	N	Y
M7-2	Report-time-stamp	N	Y
M7-3	Reason-for-inclusion	N	Y
M7-4	Data-set-name	N	Y
M7-5	Data-reference	N	Y
M7-6	Buffer-overflow	N	Y
M7-7	EntryID	N	Y
M7-8	BufTim	N	Y
M7-9	IntgPd	N	Y
M7-10	GI	N	Y
M7-11	Conf-revision	N	Y
M8	**Unbuffered report control**	N	Y
M8-1	Sequence-number	N	Y
M8-2	Report-time-stamp	N	Y
M8-3	Reason-for-inclusion	N	Y

Table 9-39 ACSI Models Conformance Statement (cont.)

		Client/ Subscriber	Server/ Publisher
M8-4	Data-set-name	N	Y
M8-5	Data-reference	N	Y
M8-6	BufTim	N	Y
M8-7	IntgPd	N	Y
M8-8	GI	N	Y
M8-9	Conf-revision	N	Y
Logging		N	N
M9	**Log control**	N	N
M9-1	IntgPd	N	N
M10	**Log**	N	N
M11	**Control**	N	N
If GSE (B31/32) is supported			
M12	**GOOSE**	N	N
M13	**GSSE**	N	N
If SVC (41/42) is supported			
M14	**Multicast SVC**	N	N
M15	**Unicast SVC**	N	N
If Server or Client side (B11/12) supported			
M16	Time	N	N
M17	File Transfer	N	N

Y = supported; N or empty: not supported

ACSI Service Conformance Statement

Table 9-40 ACSI Service Conformance Statement

	Services	AA: TP/MC	Client (C)	Server (S)	Comments
Server					
S1	ServerDirectory	TP	N	Y	
Application association					
S2	Associate		N	Y	
S3	Abort		N	Y	
S4	Release		N	Y	
Logical device					
S5	LogicalDeviceDirectory	TP	N	Y	
Logical node					
S6	LogicalNodeDirectory	TP	N	Y	
S7	GetAllDataValues	TP	N	Y	
Data					
S8	GetDataValues	TP	N	Y	
S9	SetDataValues	TP	N	N	
S10	GetDataDirectory	TP	N	Y	
S11	GetDataDefinition	TP	N	Y	
Data set					
S12	GetDataSetValues	TP	N	Y	
S13	SetDataSetValues	TP	N	N	
S14	CreateDataSet	TP	N	N	

Table 9-40 ACSI Service Conformance Statement (cont.)

	Services	AA: TP/MC	Client (C)	Server (S)	Comments
S15	DeleteDataSet	TP	N	N	
S16	GetDataSetDirectory	TP	N	Y	
Substitution					
S17	SetDataValues	TP	N	N	
Setting group control					
S18	SelectActiveSG	TP	N	N	
S19	SelectEditSG	TP	N	N	
S20	SetSGValues	TP	N	N	
S21	ConfirmEditSGValues	TP	N	N	
S22	GetSGValues	TP	N	N	
S23	GetSGCBValues	TP	N	N	
Reporting					
Buffered report control block (BRCB)					
S24	Report	TP	N	Y	
S24-1	data-change (dchg)		N	Y	
S24-2	qchg-change (qchg)		N	Y	
S24-3	data-update (dupd)		N	N	
S25	GetBRCBValues	TP	N	Y	
S26	SetBRCBValues	TP	N	Y	
Unbuffered report control block (URCB)					
S27	Report	TP	N	Y	
S27-1	data-change (dchg)		N	Y	
S27-2	qchg-change (qchg)		N	Y	

Table 9-40 ACSI Service Conformance Statement (cont.)

	Services	AA: TP/MC	Client (C)	Server (S)	Comments
S27-3	data-update (dupd)		N	N	
S28	GetURCBValues	TP	N	Y	
S29	SetURCBValues	TP	N	Y	
Logging					
Log control block					
S30	GetLCBValues				
S31	SetLCBValues				
Log					
S32	QueryLogByTime	TP	N	N	
S33	QueryLogByEntry	TP	N	N	
S34	GetLogStatusValues	TP	N	N	
Generic substation event model (GSE)					
GOOSE-CONTROL-BLOCK					
S35	SendGOOSEMessage	MC	N	N	
S36	GetReference	TP	N	N	
S37	GetGOOSEElementNumber	TP	N	N	
S38	GetGoCBValues	TP	N	N	
S39	SetGoCBValues	TP	N	N	
GSSE-CONTROL-BLOCK					
S40	SendGSSEMessage	MC	N	N	
S41	GetReference	TP	N	N	
S42	GetGSSEElementNumber	TP	N	N	
S43	GetGsCBValues	TP	N	N	
S44	SetGsCBValues	TP	N	N	

Table 9-40 ACSI Service Conformance Statement (cont.)

	Services	AA: TP/MC	Client (C)	Server (S)	Comments
Transmission of sampled value model (SVC)					
	Multicast SVC				
S45	SendMSVMessage	MC	N	N	
S46	GetMSVCBValues	TP	N	N	
S47	SetMSVCBValues	TP	N	N	
	Unicast SVC				
S48	SendUSVMessage	TP	N	N	
S49	GetUSVCBValues	TP	N	N	
S50	SetUSVCBValues	TP	N	N	
Control					
S51	Select		N	N	
S52	SelectWithValue	TP	N	N	
S53	Cancel	TP	N	N	
S54	Operate	TP	N	N	
S55	Command-Termination	TP	N	N	
S56	TimeActivated-Operate	TP	N	N	
File transfer					
S57	GetFile	TP	N	N	
S58	SetFile	TP	N	N	
S59	DeleteFile	TP	N	N	
S60	GetFileAttributeValues	TP	N	N	
Time					
T1	Time resolution of internal clock			10 (1 ms)	nearest negative power of 2 in seconds

Table 9-40 ACSI Service Conformance Statement (cont.)

	Services	AA: TP/MC	Client (C)	Server (S)	Comments
T2	Time accuracy of internal clock			Y	T0 (10 ms)
				Y	T1 (1 ms)
				N	T2 (100 µs)
				N	T3 (25 µs)
				N	T4 (4 µs)
				N	T5 (1 µs)
T3	Supported TimeStamp resolution	-		10 (1 ms)	nearest negative power of 2 in seconds

Y = supported; N or empty: not supported

9.4.5 PIXIT

(PIXIT = Protocol Implementation Extra Information for Testing)

PIXIT for Association Model

Table 9-41 PIXIT for Association Model

Description	Value/Clarification		Example
Maximum number of clients that can set-up an association simultaneously	5		
TCP_KEEPALIVE value	10 seconds		
Lost connection detection time	10 seconds		
Is authentication supported	No		
What association parameters are necessary for successful association	Transport selector	Yes	0001
	Session selector	Yes	0001
	Presentation selector	Yes	00000001
	AP Title	No	Any
	AP Qualifier	No	Any
What is the maximum and minimum MMS PDU size	Max MMS PDU size	20 000	
	Min MMS PDU size		
What is the maximum startup time after a power supply interrupt	30 seconds		

PIXIT for Server Model

Table 9-42 PIXIT for Server Model

Description	Value/Clarification		
Which analogue value (MX) quality bits are supported (can be set by server)	Validity	Yes	Good
		Yes	Invalid
		No	Reserved
		No	Questionable
		Yes	Overflow
		No	OutofRange
		No	BadReference
		No	Oscillatory
		Yes	Failure
		No	OldData
		No	Inconsistent
		No	Inaccurate
	Source	Yes	Process
		No	Substituted
		No	Test
		No	OperatorBlocked

Table 9-42 PIXIT for Server Model (cont.)

Description	Value/Clarification		
Which status value (ST) quality bits are supported (can be set by server)	Valitity	Yes	Good
		Yes	Invalid
		No	Reserved
		No	Questionable
		No	BadReference
		No	Oscillatory
		Yes	Failure
		No	OldData
		No	Inconsistent
		No	Inaccurate
	Source	Yes	Process
		No	Substituted
		No	Test
		No	OperatorBlocked
What is the maximum number of data values in one GetDataValues request	Not restricted; depends on the max. MMS PDU size given above.		
What is the maximum number of data values in one SetDataValues request	N/A		

PIXIT for Data Set Model

Table 9-43 PIXIT for Data Set Model

Description	Value/Clarification
What is the maximum number of data elements in one data set (compare ICD setting)	N/A, data sets are fix
How many persistent data sets can be created by one or more clients	N/A, data sets are fix
How many non-persistent data sets can be created by one or more clients	N/A, data sets are fix

PIXIT for Reporting Model

Table 9-44 PIXIT for Reporting Model

Description	Value/Clarification	
The supported trigger conditions are (compare PICS)	integrity	Yes
	data change	Yes
	quality change	Yes
	data update	No
	general interrogation	Yes
The supported optional fields are	sequence-number	Yes
	report-time-stamp	Yes
	reason-for-inclusion	Yes
	data-set-name	Yes
	data-reference	Yes
	buffer-overflow	Yes
	entryID	Yes
	conf-rev	Yes
	segmentation	Yes
Can the server send segmented reports	Yes	
Mechanism on second internal data change notification of the same analogue data value within buffer period (Compare IEC 61850-7-2 §14.2.2.9)	Send report immediately	
Multi client URCB approach (compare IEC 61850-7-2 §14.2.1)	Each URCB is visible to all clients	
What is the format of EntryID	First 2 Byte : Integer Last 6 Bytes: BTime6 time stamp	
What is the buffer size for each BRCB or how many reports can be buffered	No fixed size, depends on total number of BRCBs	
Pre-configured RCB attributes that cannot be changed online when RptEna = FALSE (see also the ICD report settings)		

Table 9-44 PIXIT for Reporting Model (cont.)

Description	Value/Clarification	
May the reported data set contain: - structured data objects? - data attributes? - timestamp data attributes?	 Yes Yes Yes, will not be included in a dchg report	
What is the scan cycle for binary events? Is this fixed, configurable	60 ms Fixed	
additional items:		
Dynamic BRCB reservation after an abort of the client/server association	Reservation of the BRCB has been fixed with TISSUE 453. A Value of -1 for ResTms is not supported	

PIXIT for Time and Time Sychronization Model

Table 9-45 PIXIT for Time and Time Syncronization Model

Description	Value/Clarification	
What quality bits are supported	LeapSecondsKnown	No
	ClockFailure	Yes
	ClockNotSynchronized	Yes
Describe the behavior when the time synchronization signal/messages are lost	After a waiting period, time quality is set to ClockNotSynchronized and ClockFailure	
When is the time quality bit "Clock failure" set?	At faulty internal clock or failure of the synchronization source (SNTP, field bus) or RTC failure	
When is the time quality bit "Clock not synchronised" set?	After a waiting period, time quality is set to ClockNotSynchronized and ClockFailure	
Is the timestamp of a binary event adjusted to the configured scan cycle?	No	
Does the device support time zone and daylight saving?	Yes	

Table 9-45 PIXIT for Time and Time Syncronization Model (cont.)

Description	Value/Clarification	
Which attibutes of the NTP response packet are validated?	Leap indicator not equal to 3?	Yes
	Mode is equal to SERVER	No
	OriginateTimestamp is equal to value sent by the SNTP client as TransmitTimestamp	No
	RX/TX timestamp fields are checked for reasonableness	Yes
	SNTP version 3 and/or 4	No
	Other (describe)	No

TICS

Table 9-46 TICS

Topic	Tissue No.	Link	Description	Impact of Interoper.	Imple-mented
Object Model	120	http://www.tissues.iec61850.com/tissue.mspx?issueid=120	Type - Mod.stVal and Mod.ctlVal	-	Y
	146	http://www.tissues.iec61850.com/tissue.mspx?issueid=146	CtxInt	-	Y
	173	http://www.tissues.iec61850.com/tissue.mspx?issueid=173	Ctl modelling harmonization	-	N/A
	234	http://www.tissues.iec61850.com/tissue.mspx?issueid=234	New type CtxInt	x	Y
Services	377	http://www.tissues.iec61850.com/tissue.mspx?issueid=377	DeleteDataSet response	-	N/A
	276	http://www.tissues.iec61850.com/tissue.mspx?issueid=276	File Services Negative Re-sponses	-	N/A
	183	http://www.tissues.iec61850.com/tissue.mspx?issueid=183	GetNameList error hand-ling	x	Y
	165	http://www.tissues.iec61850.com/tissue.mspx?issueid=165	Improper Error Response for GetDataSetValues	x	Y
	116	http://www.tissues.iec61850.com/tissue.mspx?issueid=116	GetNameList with empty response?	x	Y
Reporting	474	http://www.tissues.iec61850.com/tissue.mspx?issueid=474	GI for URCB	-	Y
	453	http://www.tissues.iec61850.com/tissue.mspx?issueid=453	Reporting & Logging model revision	x	Y
	438	http://www.tissues.iec61850.com/tissue.mspx?issueid=438	EntryTime base should be GMT	-	Y
	349	http://www.tissues.iec61850.com/tissue.mspx?issueid=349	BRCB TimeOfEntry has two definitions	x	Y
	348	http://www.tissues.iec61850.com/tissue.mspx?issueid=348	URCB class and report	x	Y
	344	http://www.tissues.iec61850.com/tissue.mspx?issueid=344	TimeOfEntry misspelled	-	Y
	335	http://www.tissues.iec61850.com/tissue.mspx?issueid=335	Clearing of Bufovfl	x	Y
	332	http://www.tissues.iec61850.com/tissue.mspx?issueid=332	Ambiguity in use of trigger options	x	Y
	329	http://www.tissues.iec61850.com/tissue.mspx?issueid=329	Reporting and BufOvl	x	Y
	322	http://www.tissues.iec61850.com/tissue.mspx?issueid=322	Write Configuration attribu-te of BRCBs	-	Y
	301	http://www.tissues.iec61850.com/tissue.mspx?issueid=301	SqNum in Buffered Reports	-	Y
	300	http://www.tissues.iec61850.com/tissue.mspx?issueid=300	Attribute Resv in BRCB	x	Y

Table 9-46 TICS (cont.)

Topic	Tissue No.	Link	Description	Impact of Interoper.	Imple-mented
Reporting (cont.)	298	http://www.tissues.iec61850.com/tissue.mspx?issueid=298	Type of SqNum	x	Y
	297	http://www.tissues.iec61850.com/tissue.mspx?issueid=297	Sequence number	x	Y
	278	http://www.tissues.iec61850.com/tissue.mspx?issueid=278	EntryId not valid for a server	x	Y
	275	http://www.tissues.iec61850.com/tissue.mspx?issueid=275	Confusing statement on GI usage	x	Y
	191	http://www.tissues.iec61850.com/tissue.mspx?issueid=191	BRCB: Integrity and buffe-ring reports	x	Y
	190	http://www.tissues.iec61850.com/tissue.mspx?issueid=190	BRCB: EntryId and Time-OfEntry	x	Y
	177	http://www.tissues.iec61850.com/tissue.mspx?issueid=177	Ignoring OptFlds bits for URCB	-	Y
	52	http://www.tissues.iec61850.com/tissue.mspx?issueid=52	Ambiguity GOOSE SqNum	x	N/A
	49	http://www.tissues.iec61850.com/tissue.mspx?issueid=49	BRCB TimeOfEntry?	x	Y
Control model	46	http://www.tissues.iec61850.com/tissue.mspx?issueid=46	Synchro check cancel	x	N/A
	44	http://www.tissues.iec61850.com/tissue.mspx?issueid=44	AddCause - Object not sel	x	N/A
	30	http://www.tissues.iec61850.com/tissue.mspx?issueid=30	control parameter T	x	N/A

Services Which are Not Supported

- Substitution model
- Setting group control model
- Logging model
- Generic substation event model
- Control model
- File transfer model

9.4.6 Diagnosis IEC 61850

The diagnosis for IEC 61850, see chapter 7.5.5.3, allows the analysis of parameters and communication.

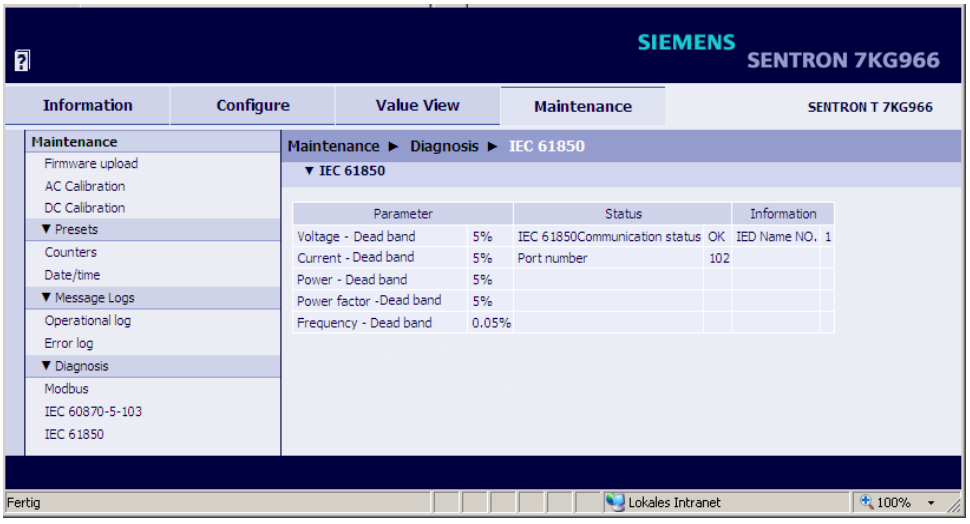


Fig. 9-7 Diagnosis IEC 61850

Parameters

With IEC 61850, the following parameters are displayed:

- Voltage - Deadband: Default: 5 %
- Current - Deadband: Default: 5 %
- Power - Deadband: Default: 5 %
- Power factor - Deadband Default: 5 %
- Frequency - Deadband Default: 0.05 %

Statuses

With IEC 61850, the following statuses are displayed:

IEC 61850 Communication status: Status of communication: OK or Fail

Port number: Set port number, e.g. 102

Information

IED Name NO.: Default: 00000

10 Calibration

10.1 General

Calibration Due to Internal Requirements

The device comes calibrated from the factory and does not have to be calibrated again throughout its entire operation period. The calibration is only carried out if this is necessary due to internal requirements.

Calibration Device

To test the SENTRON T, a calibration device is necessary that generates the AC voltages, AC currents and phase angles with a tolerance of max. 0.1 % of the rated value that is fed in.

If the testing devices are galvanically separated, you have to connect the terminal N to the protective grounding terminal ⏚ at terminal block F - Voltage.

NOTE

Measured values are entered or displayed with a decimal point separating the integral and the fractional parts, for example 400.34 V.

NOTE

You have to observe the specifications and execution instructions of the accident prevention regulation BGV A3. Use appropriate electric tools.

10.2 Calibrating the AC Voltage Measuring Range

Measurement Setup

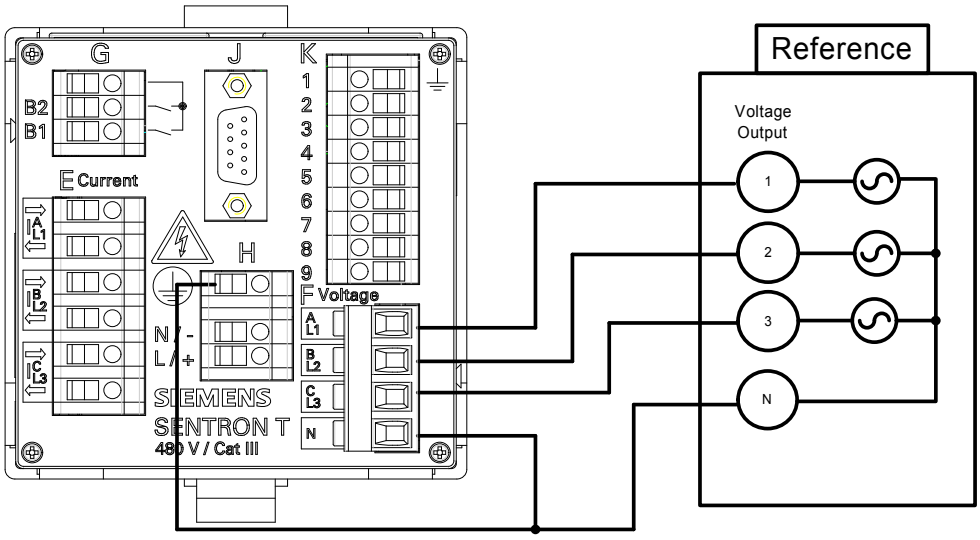


Fig. 10-1 Measurement Setup for Calibrating the AC Voltage Measuring Range

Calibration is only possible with symmetrical phases (3 x 120°), see figure 10-1.

Measuring Ranges

You can perform the calibration for the following AC voltage measuring ranges:

- AC 63.5 V
- AC 110 V
- AC 230 V
- AC 400 V

Calibration

To calibrate the AC voltage measuring ranges, proceed as follows:

✧ Set up the measurement as shown in figure 10-1, depending on the device variant.

DANGER

Danger by high contact voltages when attaching the measuring lines to the terminal blocks

Non-observance will lead to death or serious injury.

- Work may only be carried out by trained personnel (see Preface) who are familiar with and observe the safety requirements and precautions.
- Work may never be carried out if there is any dangerous voltage present.
- Deenergize the device.
- **Circuit breaker:** A suitable isolating device shall be connected upstream in order to permit disconnection of the device from the power supply. The circuit breaker must be mounted close to the device, be easily accessible to the user and marked as a circuit breaker for the device.
- Secure the supply voltage with an approved (UL/IEC) fuse: 1.6 A, type C.
- If a melting fuse is used, a suitable approved (UL/IEC) fuse holder has to be used.

✧ On the rear plate of the device connect a DC or AC power supply at the terminal block H acc. to chapter 5.3.2.

✧ Start the device as described in chapter 5.7.

✧ Adjust the following parameters in the **Configure** tab → **AC measurement** (red marking):

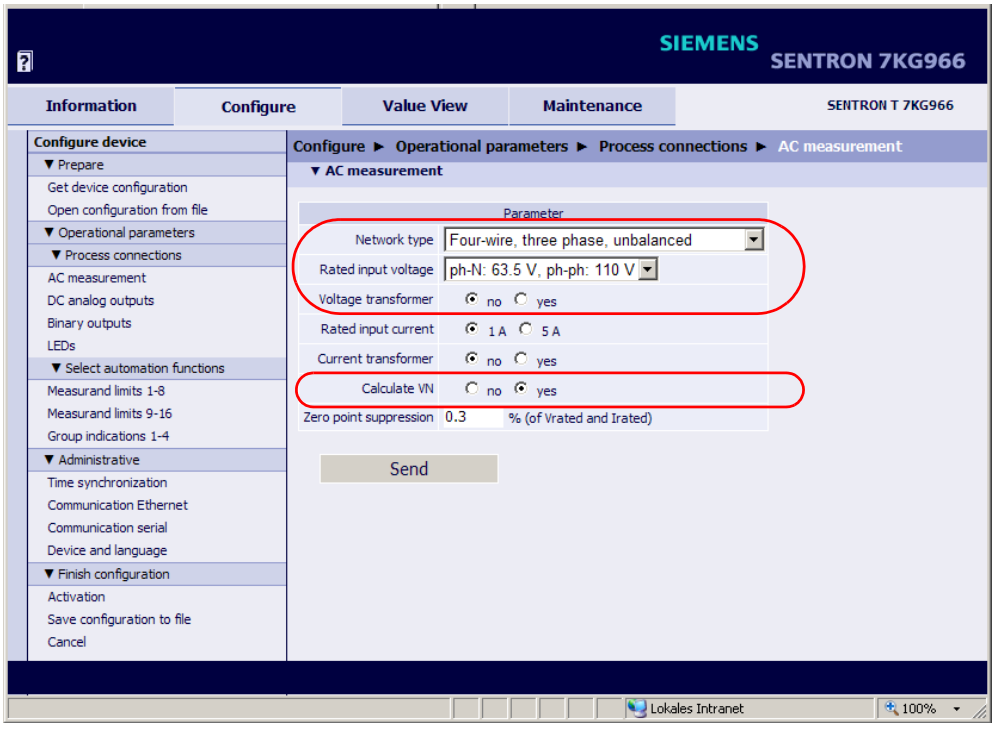


Fig. 10-2 Settings for the Calibrating of an AC Voltage Measuring Range

NOTE

When calibrating the AC voltage measuring range, **Calculate VN** must be set to **yes**, see also chapter 7.3.3.1.1 and figure 7-20.

✧ Switch on the reference voltage AC 63.5 V at the measurement setup.

✧ Click the **Maintenance** tab on the User Interface.

The **Maintenance** tab opens.

✧ Click the **AC Calibration** element in the navigation window.

The **AC Calibration** input/output window opens.

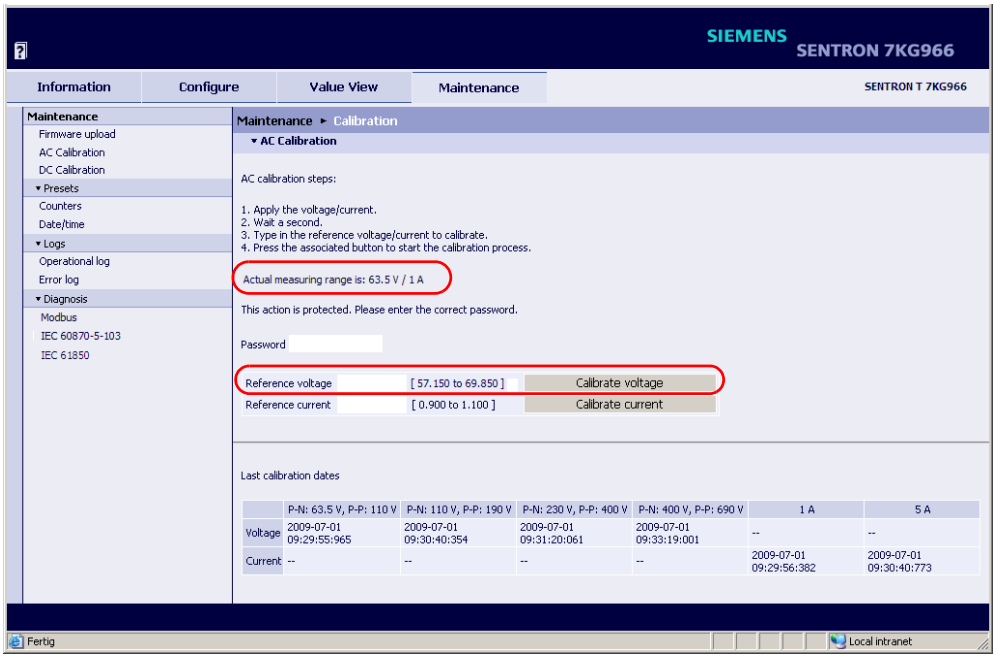


Fig. 10-3 Calibrating the AC Voltage Measuring Range

✧ Check which measuring range is presently used in the input/output window at **Actual measuring range is: 63.5 V / 1 A**.

✧ Enter the maintenance password into the **Password** field.

✧ Enter the reference voltage 63.5 V that is generated by the measurement setup into the **Reference voltage** field.

✧ Click the **Calibrate voltage** button.

The device executes the calibration and the lower field of the input/output window automatically displays the updated calibration date.

✧ Check the calibrating values in the **Value View** tab→ **AC operational values**.

✧ Carry out the calibration for the voltage measurement ranges AC 110 V, AC 230 V and AC 400 V in accordance of the described work steps.

10.3 Calibrating the AC Current Measuring Range

Measurement Setup

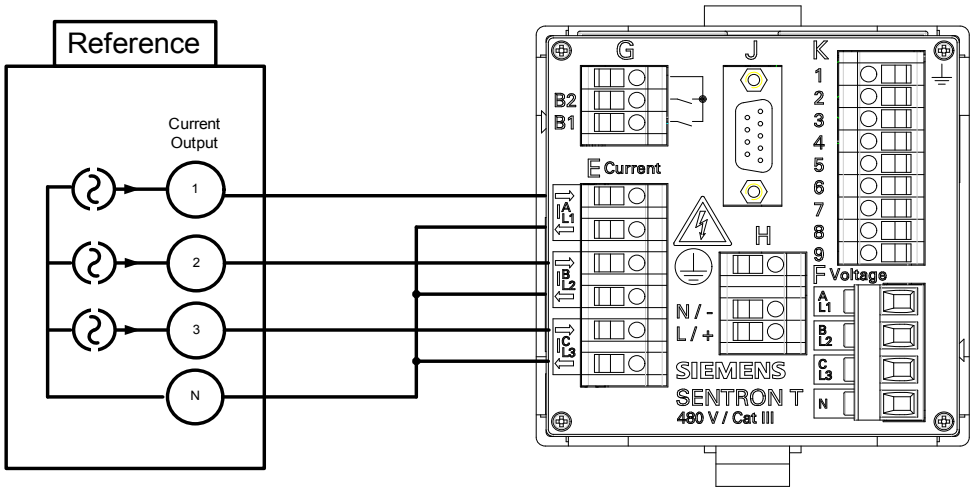


Fig. 10-4 Measurement Setup for Calibrating the AC Current Measuring Range

NOTE

Calibration is only possible with symmetrical phases (3 x 120°), see figure 10-4.

NOTE

If you use a testing instrument of the type OMICRON as a reference, then you must connect the connection N of the current output with the protective ground terminal ⏚ of the SENTRON T.

Measuring Ranges

You can perform the calibration for the following AC current measuring ranges

- AC 1 A
- AC 5 A

Calibration

To calibrate the AC current measuring ranges, proceed as follows:

✧ Set up the measurement as shown in figure 10-4.

DANGER

Danger by high contact voltages when attaching the measuring lines to the terminal blocks

Non-observance will lead to death or serious injury.

- Work may only be carried out by trained personnel (see Preface) who are familiar with and observe the safety requirements and precautions.
- Work may never be carried out if there is any dangerous voltage present.
- Deenergize the device.
- **Circuit breaker:** A suitable isolating device shall be connected upstream in order to permit disconnection of the device from the power supply. The circuit breaker must be mounted close to the device, be easily accessible to the user and marked as a circuit breaker for the device.
- Secure the supply voltage with an approved (UL/IEC) fuse: 1.6 A, type C.
- If a melting fuse is used, a suitable approved (UL/IEC) fuse holder has to be used.

✧ On the rear plate of the device connect a DC or AC power supply at the terminal block H acc. to chapter 5.3.2.

✧ Start the device as described in chapter 5.7.

✧ Adjust the following parameters in the **Configure** tab → **AC measurement** (red marking):

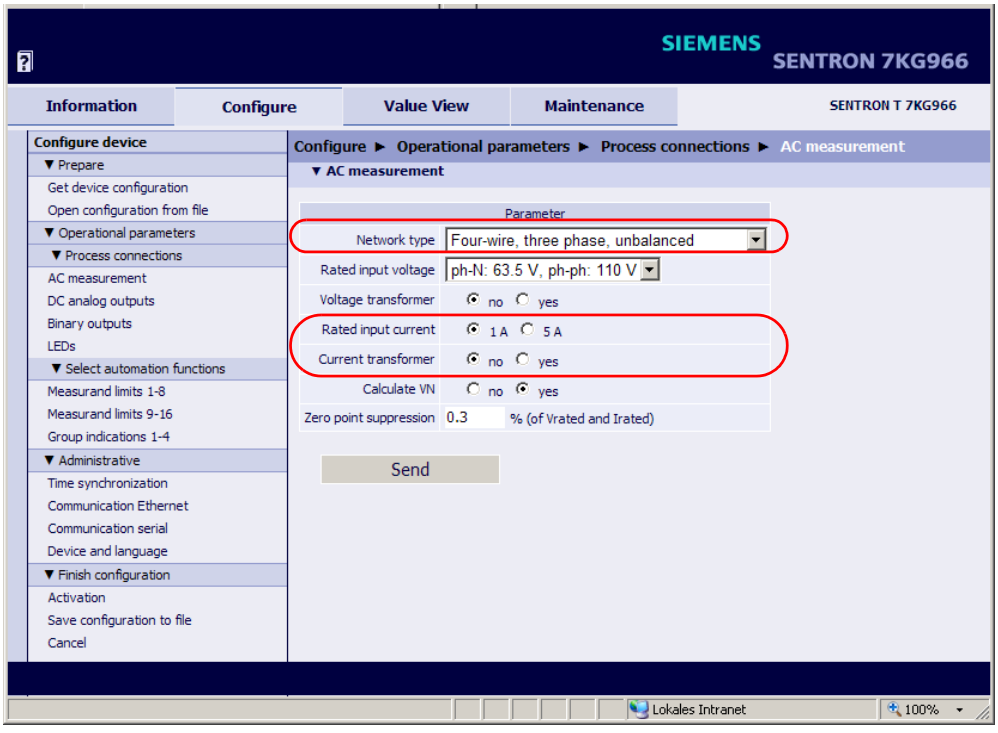


Fig. 10-5 Settings for the Calibrating of an AC Current Measuring Range

✧ Switch on the reference current AC 1 A at the measurement setup.

✧ Click the **Maintenance** tab on the User Interface.

The **Maintenance** tab opens.

✧ Click the **AC Calibration** element in the navigation window.

The **AC Calibration** input/output window opens.

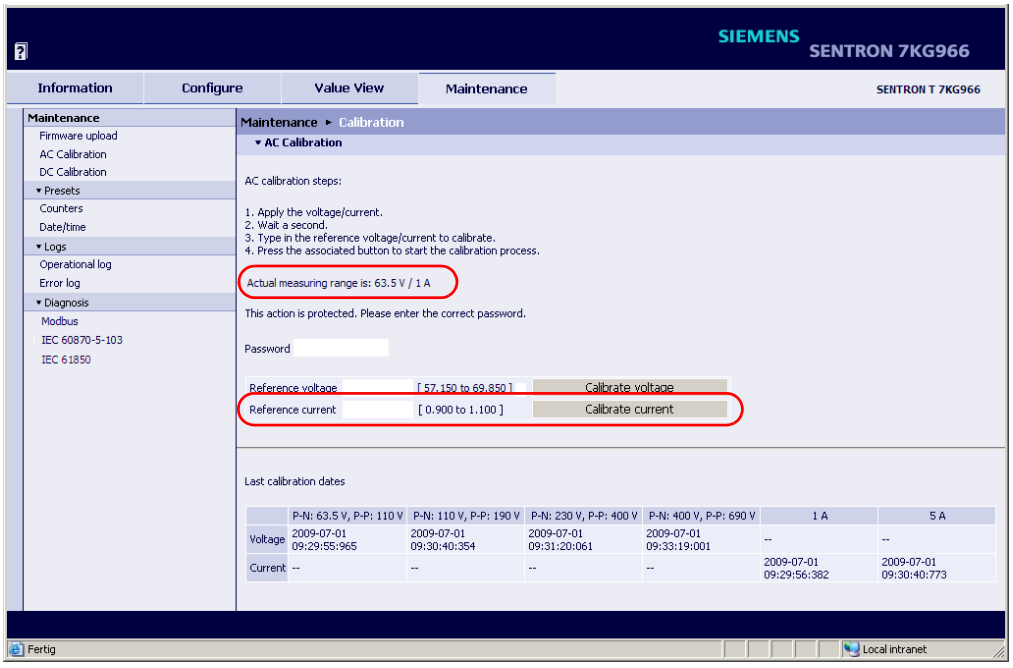


Fig. 10-6 Calibrating the AC Current Measuring Range

✧ Check which measuring range is presently used in the input/output window at **Actual measuring range is: 63.5 V/1 A**.

✧ Enter the maintenance password into the **Password** field.

✧ Enter the reference current 1.0 A that is generated by the measurement setup into the **Reference current** field.

✧ Click the **Calibrate current** button.

The device executes the calibration and the lower field of the input/output window automatically displays the updated calibration date.

✧ Check the calibrating values in the **Value View** tab→ **AC operational values**.

✧ Carry out the calibration for the current measurement range AC 5 A in accordance of the described work steps.

10.4 Calibrating the Measuring Voltage Input of Neutral Conductor VN

10.4.1 Calibrating SENTRON T 7KG966x-1xAx0-xAA0 (Potential Divider Voltage Measurement)

Measurement Setup

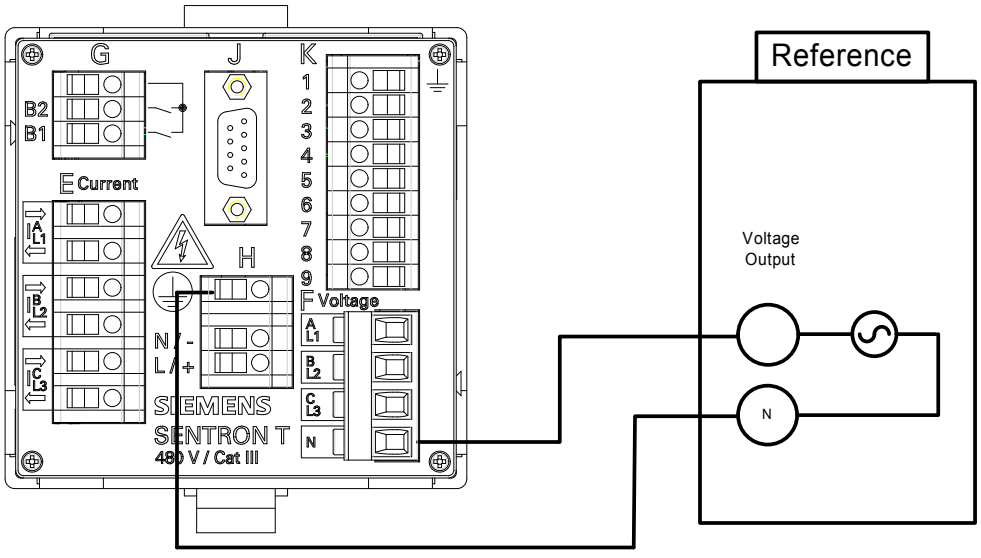


Fig. 10-7 Measurement Setup for Calibrating VN

Measuring Ranges

You can perform the calibration for the following AC voltage measuring ranges:

- AC 63.5 V
- AC 110 V
- AC 230 V
- AC 400 V

Calibration

To calibrate the AC voltage measuring ranges, proceed as follows:

✧ Set up the measurement as shown in figure 10-7 or figure 10-10, acc. to device version.

DANGER

Danger by high contact voltages when attaching the measuring lines to the terminal blocks

Non-observance will lead to death or serious injury.

- Work may only be carried out by trained personnel (see Preface) who are familiar with and observe the safety requirements and precautions.
- Work may never be carried out if there is any dangerous voltage present.
- Deenergize the device.
- **Circuit breaker:** A suitable isolating device shall be connected upstream in order to permit disconnection of the device from the power supply. The circuit breaker must be mounted close to the device, be easily accessible to the user and marked as a circuit breaker for the device.
- Secure the supply voltage with an approved (UL/IEC) fuse: 1.6 A, type C.
- If a melting fuse is used, a suitable approved (UL/IEC) fuse holder has to be used.

✧ On the rear plate of the device connect a DC or AC power supply at the terminal block H acc. to chapter 5.3.2.

✧ Start the device as described in chapter 5.7.

✧ Adjust the following parameters in the **Configure** tab → **AC measurement** (red marking):

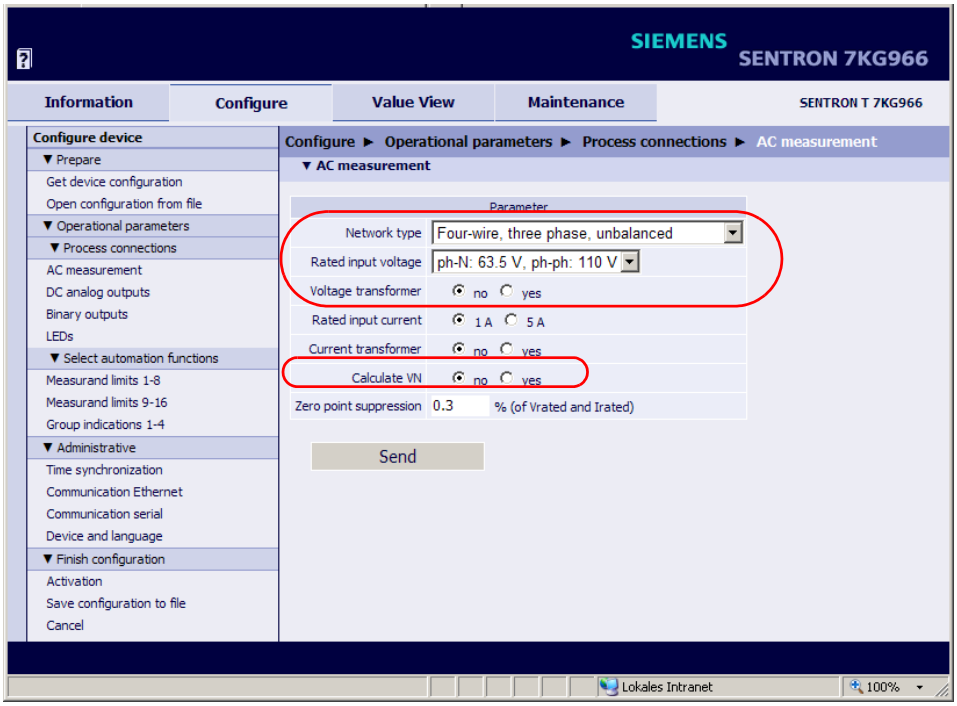


Fig. 10-8 Settings for the Calibrating of VN

NOTE

This calibration is only possible if **no** is selected in the **Configure** tab → **AC measurement** → **Calculate VN** option field, see chapter 7.3.3.1.1.

✧ Switch on the reference voltage AC 63.5 V at the measurement setup.

✧ Click the **Maintenance** tab on the User Interface.

The **Maintenance** tab opens.

✧ Click the **AC Calibration** element in the navigation window.

The **AC Calibration** input/output window opens.

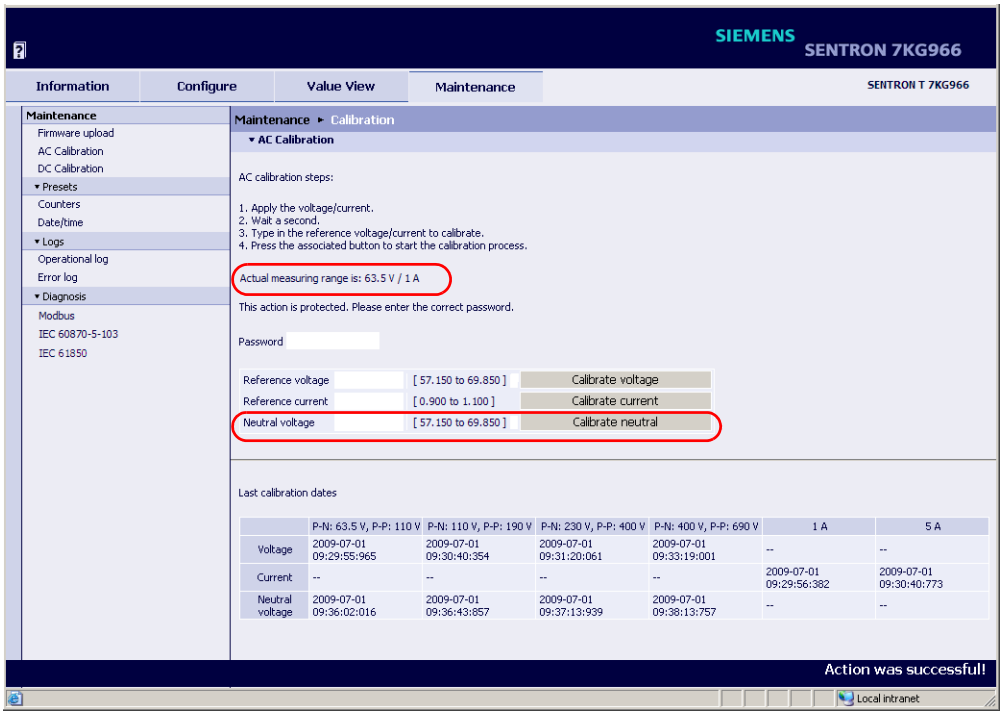


Fig. 10-9 Calibrating the Neutral Voltage in the Neutral Conductor.

✧ Check which measuring range is presently used in the input/output window at **Actual measuring range is: 63.5 V / 1 A**.

✧ Enter the maintenance password into the **Password** field.

✧ Enter the reference voltage 63.5 V that is generated by the measurement setup into the **Neutral voltage** field.

✧ Click the **Calibrate neutral** button.

The device executes the calibration and the lower field of the input/output window automatically displays the updated calibration date.

✧ Check the calibrating values in the **Value View** tab→ **AC operational values**.

✧ Carry out the calibration for the voltage measurement ranges AC 110 V, AC 230 V and AC 400 V in accordance of the described work steps.

10.4.2 Calibrating SENTRON T 7KG966x-2xAx0-xAA0 (Galvanic Isolated Voltage Measurement)

Measurement Setup

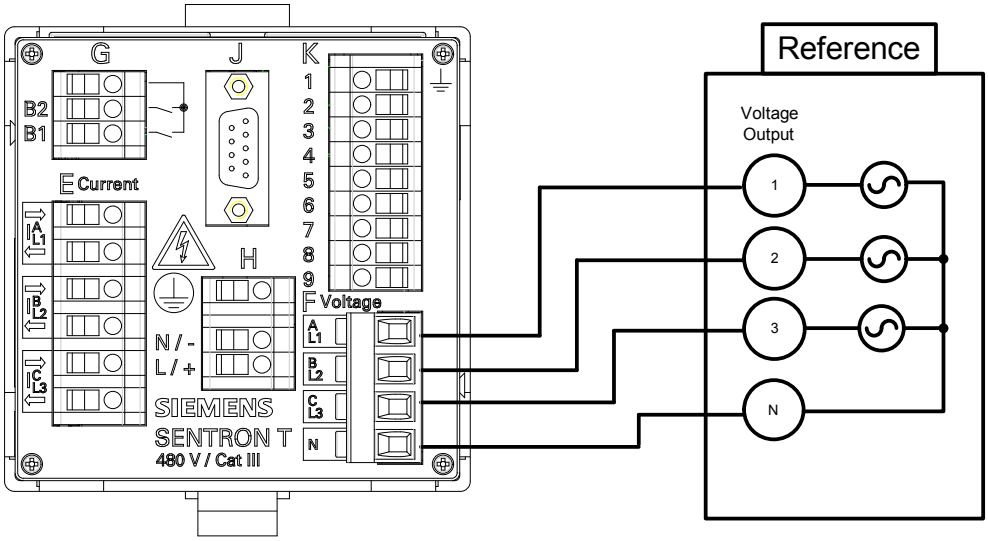


Fig. 10-10 Measurement Setup for Calibrating VN

NOTE

With this device variant, the 3 voltages Va, Vb and Vc must be fed in cophasally (3 x 0°) at terminal block F.

Measuring Ranges

You can perform the calibration for the following AC voltage measuring ranges:

- AC 63.5 V
- AC 110 V
- AC 230 V
- AC 400 V

Calibration

To calibrate the AC voltage measuring ranges, proceed as follows:

✧ Set up the measurement as shown in figure 10-10.

✧ Perform the calibration according to section 10.4.1.

10.5 Calibrating the Phase Angel

Measurement Setup

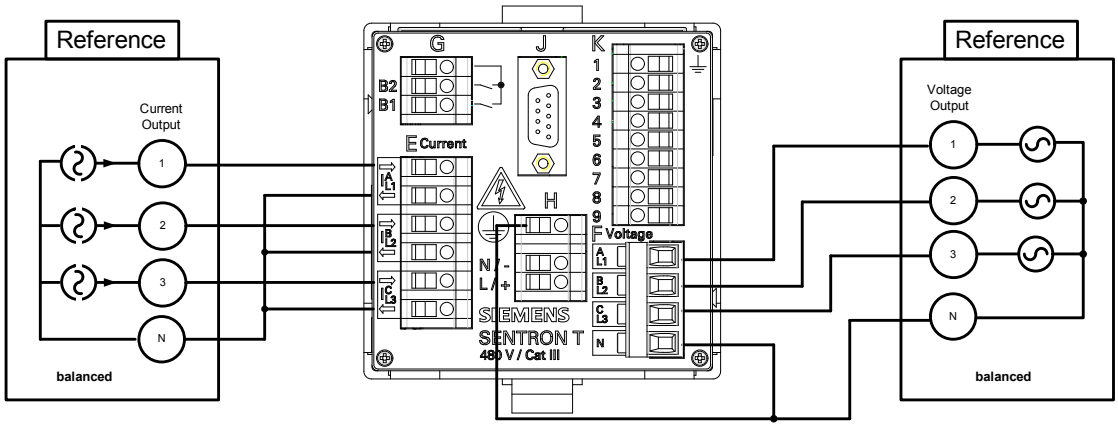


Fig. 10-11 Measurement Setup for Phase Angle

NOTE

If you use a testing instrument of the type OMICRON as a reference, then you must connect the connection N of the current output with the protective ground terminal ⏚ of the SENTRON T.

Measuring Ranges

You can perform the calibration the phase angles for the following AC voltage measuring ranges:

- AC 63.5 V
- AC 110 V
- AC 230 V
- AC 400 V

Settings the Phase Angles Referency Voltage to Referency Current

- Va to Ia = 0°
- Vb to Ib = 0°
- Vc to Ic = 0°

Calibration

To calibrate the phase angle, proceed as follows:

✧ Set up the measurement as shown in figure 10-11.

DANGER

Danger by high contact voltages when attaching the measuring lines to the terminal blocks

Non-observance will lead to death or serious injury.

- Work may only be carried out by trained personnel (see Preface) who are familiar with and observe the safety requirements and precautions.
- Work may never be carried out if there is any dangerous voltage present.
- Deenergize the device.
- **Circuit breaker:** A suitable isolating device shall be connected upstream in order to permit disconnection of the device from the power supply. The circuit breaker must be mounted close to the device, be easily accessible to the user and marked as a circuit breaker for the device.
- Secure the supply voltage with an approved (UL/IEC) fuse: 1.6 A, type C.
- If a melting fuse is used, a suitable approved (UL/IEC) fuse holder has to be used.

✧ On the rear plate of the device connect a DC or AC power supply at the terminal block H acc. to chapter 5.3.2.

✧ Start the device as described in chapter 5.7.

✧ Adjust the following parameters in the **Configure** tab → **AC measurement** (red marking):

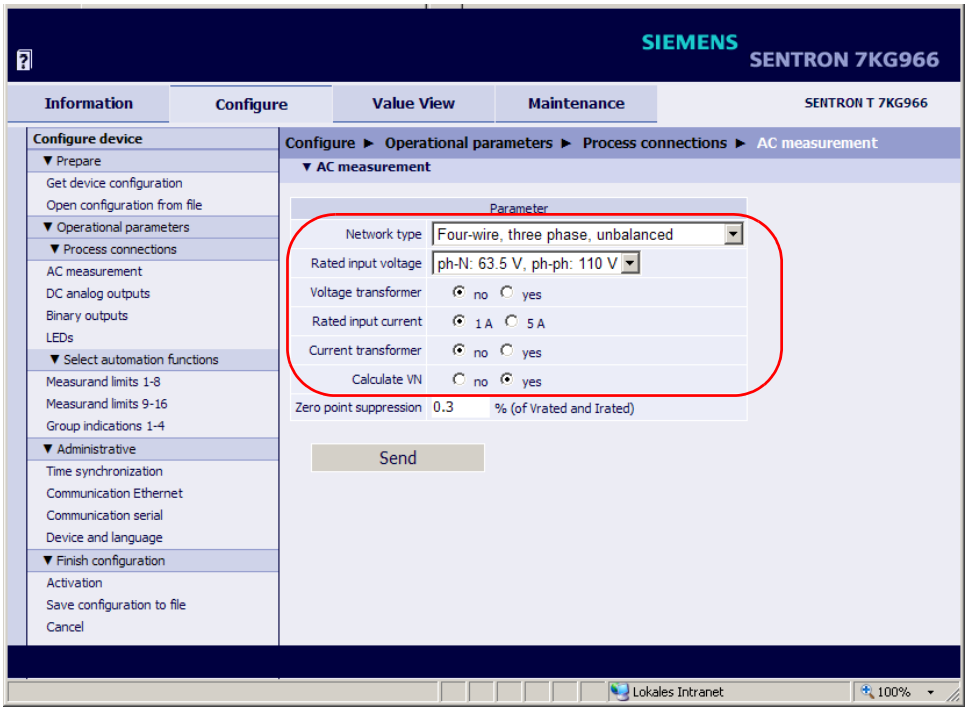


Fig. 10-12 Settings for the Calibrating of the Phase Angles

NOTE

This calibration is only possible if **no** is selected in the **Configure** tab → **AC measurement** → **Calculate VN** option field, see chapter 7.3.3.1.1.

- ✧ Switch on the reference current 1.0 A and the reference voltage AC 63.5 V at the measurement setup.
- ✧ Click the **Maintenance** tab on the User Interface.

  The **Maintenance** tab opens.
- ✧ Click the **AC Calibration** element in the navigation window.

  The **AC Calibration** input/output window opens.

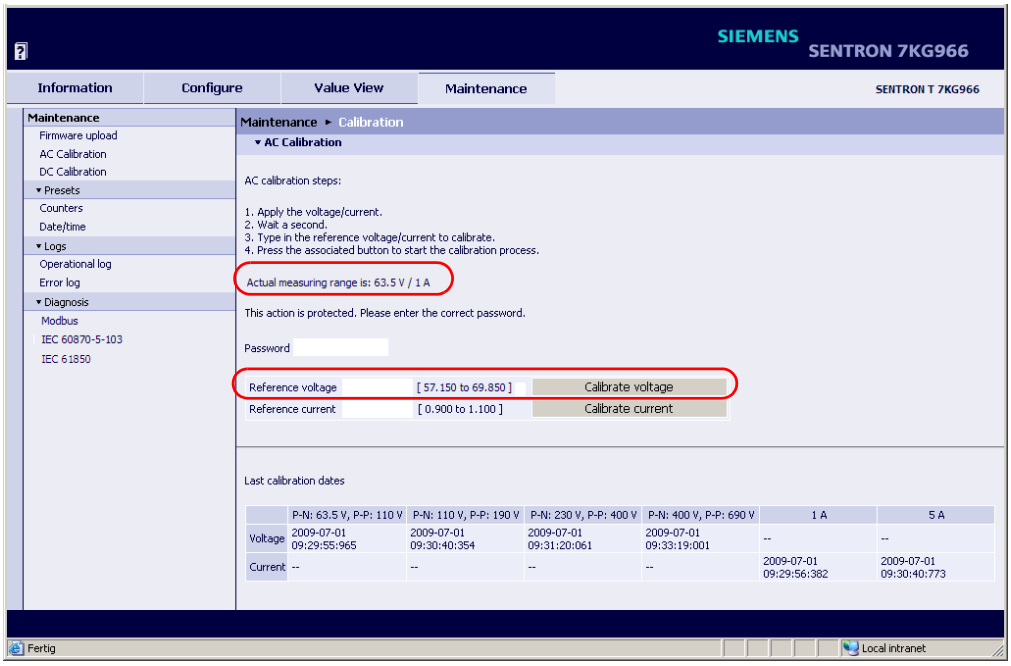


Fig. 10-13 Calibrating the Phase Angle by Calibrating the AC Voltage

- ✧ Check which measuring range is presently used in the input/output window at: **Actual measuring range is: 63.5 V / 1 A**.
- ✧ Enter the maintenance password into the **Password** field.
- ✧ Enter the reference voltage 63.5 V that is generated by the measurement setup into the **Reference voltage** field.
- ✧ Click the **Calibrate voltage** button.

  The device executes the calibration and the lower field of the input/output window automatically displays the updated calibration date.
- ✧ Check the calibrating values in the **Value View** tab → **AC operational values**.
- ✧ Carry out the calibration for the voltage measurement ranges AC 110 V, AC 230 V and AC 400 V in accordance of the described work steps.

10.6 Calibrating the DC Analog Outputs

Measurement Setup

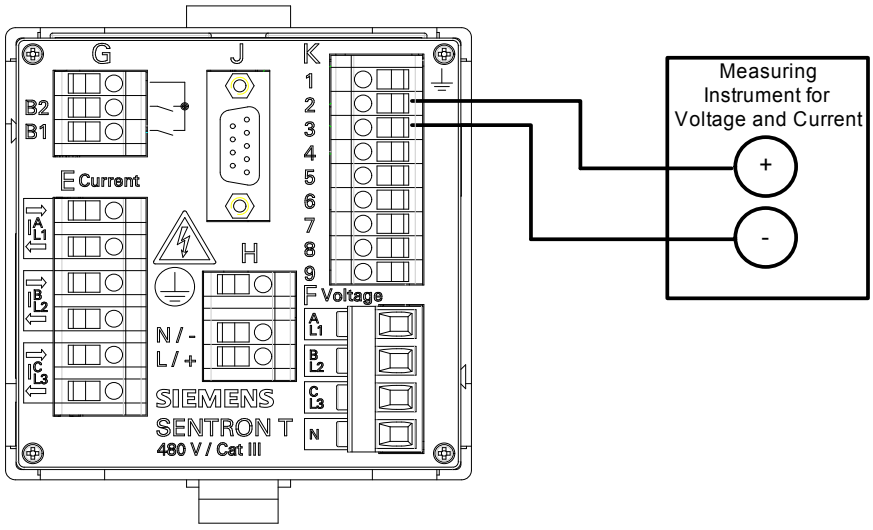


Fig. 10-14 Measurement Setup for Calibrating the DC Analog Outputs

Measuring Ranges

You can calibrate the 4 DC analog outputs for the following current/voltage ranges:

- Calibration of current output; valid for these ranges:
  DC 0 mA to +20 mA and DC -20 mA to +20 mA
- Calibration of voltage output; valid for these ranges:
  DC 0 V to +10 V and DC -10 V to +10 V

NOTE

The calibration of the DC analog outputs always refers to present parameterization of the outputs If, for example, the DC analog output K2/3 is set to the current range DC -20 mA to DC +20 mA, this range is calibrated. The calibration is then also valid for the range from DC 0 mA to DC +20 mA.

If a different current or voltage range is to be calibrated at DC analog output K2/3, you must first parameterize that output (see chapter 7.3.3.1.2).

Calibration (example DC analog output K2/3, current range DC -20 mA to DC +20 mA)

To calibrate the DC analog outputs, proceed as follows:

✧ Set up the measurement as shown in figure 10-14.

DANGER

Danger by high contact voltages when attaching the measuring lines to the terminal blocks

Non-observance will lead to death or serious injury.

- Work may only be carried out by trained personnel (see Preface) who are familiar with and observe the safety requirements and precautions.
- Work may never be carried out if there is any dangerous voltage present.
- Deenergize the device.
- **Circuit breaker:** A suitable isolating device shall be connected upstream in order to permit disconnection of the device from the power supply. The circuit breaker must be mounted close to the device, be easily accessible to the user and marked as a circuit breaker for the device.
- Secure the supply voltage with an approved (UL/IEC) fuse: 1.6 A, type C.
- If a melting fuse is used, a suitable approved (UL/IEC) fuse holder has to be used.

✧ On the rear plate of the device connect a DC or AC power supply at the terminal block H acc. to chapter 5.3.2.

✧ Start the device as described in chapter 5.7.

✧ Switch on the measuring device at the measurement setup.

✧ Adjust the following parameters in the **Configure** tab → **DC analog outputs** (red marking):

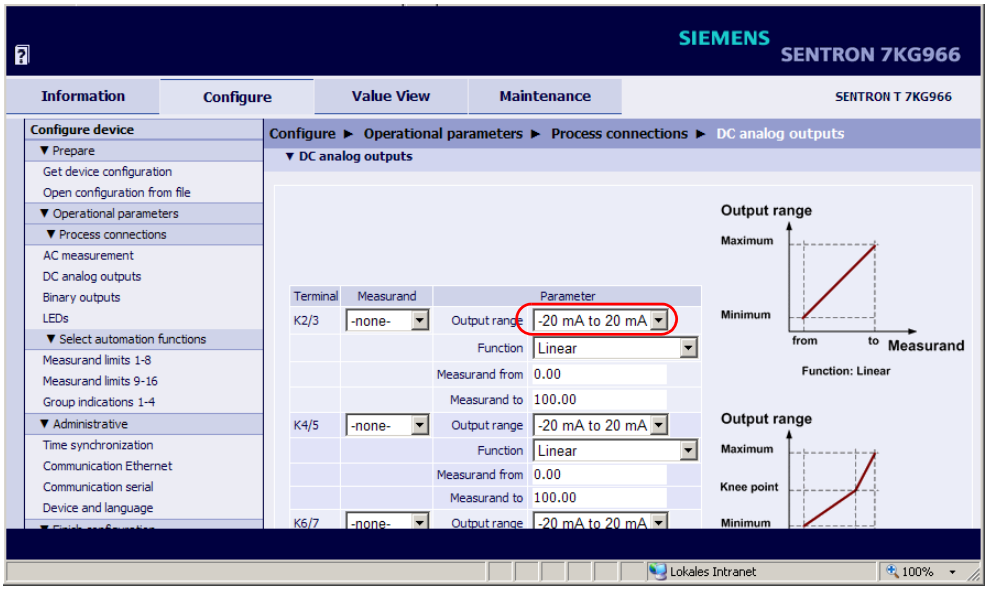


Fig. 10-15 Settings for the Calibrating of the DC Analog Outputs

✧ Click the **Maintenance** tab on the User Interface.

The **Maintenance** tab opens.

✧ Click the **DC Calibration** element in the navigation window.

The **DC Calibration** input/output window opens.

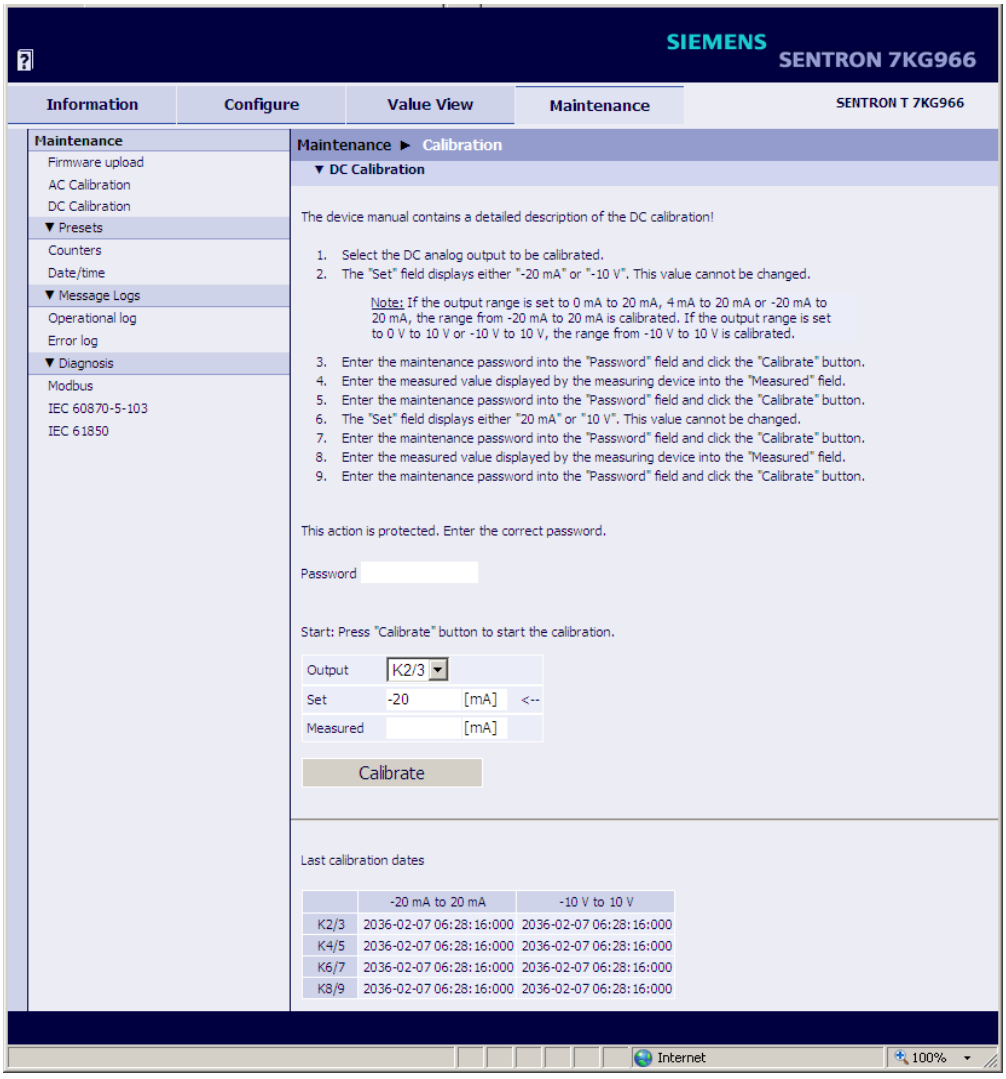


Fig. 10-16 Calibrating the DC Analog Outputs

- ✧ Select the DC analog output to be calibrated (e.g. K2/3) in the **Output** list box of the input/output window.
  The **Set** field displays **-20 mA** (DC analog output = current output). This value cannot be changed.
  You do not carry out any entries in the **Measured** field.
- ✧ Enter the maintenance password into the **Password** field.
- ✧ Click the **Calibrate** button.
- ✧ Enter the measured value displayed by the measuring device (e.g. **-19.45** for -19.45 mA) into the **Measured** field without unit; up to 4 decimal places are possible.
- ✧ Enter the maintenance password into the **Password** field.

✧ Click the **Calibrate** button.

The **Set** field displays **20 mA** (DC analog output = current output). This value cannot be changed.

You do not carry out any entries in the **Measured** field.

✧ Enter the maintenance password into the **Password** field.

✧ Click the **Calibrate** button.

✧ Enter the measured value displayed by the measuring device (e.g. **20.405** for 20.405 mA) into the **Measured** field without unit; up to 4 decimal places are possible.

✧ Enter the maintenance password into the **Password** field.

✧ Click the **Calibrate** button.

The device performs the calibration of the DC analog outputs, and the lower field of the input/output window automatically displays the updated calibration date.

Last calibration dates

	-20 mA to 20 mA	-10 V to 10 V
K2/3	2009-07-01 09:49:27:920	2009-07-01 09:43:02:281
K4/5	2009-07-01 09:48:44:264	2009-07-01 09:43:44:597
K6/7	2009-07-01 09:47:56:722	2009-07-01 09:44:28:872
K8/9	2009-07-01 09:47:12:248	2009-07-01 09:45:19:149

Fig. 10-17 Calibration Result (Detail)

✧ Proceed analogously to calibrate the other DC analog outputs you have selected.

11 Maintenance, Storage, Transport

11.1 Maintenance

Except for a battery replacement, the SENTRON T is maintenance-free.

Wipe the device using a clean, dry and soft cloth if necessary. Do not use solvents.

The Product Information enclosed with the device (ordering code E50417-B1050-C493) describes how to replace the battery.

11.2 Storage

Store the device in a dry and clean location. Store the device within a temperature range from -25 °C to +70 °C (-13 °F to +158 °F).

The relative humidity must not lead to condensation or ice formation.

To avoid premature aging of the electrolytic capacitors, store the device within the recommended temperature range of +10 °C to +35 °C (+50 °F to +95 °F).

Siemens furthermore recommends connecting the device to supply voltage once a year for 1 to 2 days in order to form the inserted electrolytic condensers. This procedure should also be carried out before operating the device.

NOTE

In this context, pay attention to the commissioning notes in chapter 5.7.

The Lithium-batteries in our equipment are subject to Special Provision 188 of the UN Recommendations on the Transport of Dangerous Goods Model Regulations and Special Provision A45 of the IATA Dangerous Goods Regulation and the ICAO Technical Instructions. This is only valid for the original battery or original spare batteries.

11.3 Transport

If devices are to be shipped elsewhere, you can reuse the transport packaging. When using different packaging, you must ensure that the transport requirements according to ISO 2248 are adhered to. The storage packing of the individual devices is not adequade for transport purposes.

12 Failures and LED Indications

12.1 General Inspection

Visual Inspection

If function failures occur, first check the device visually. Observe the following points when inspecting the device visually:

- Correct installation of the device as described in chapter 5.2 at the intended location
- Compliance with the ambient conditions specified in chapter 13.1.4 of the technical data
- Correct connection of supply voltage and grounding conductors according to chapter 5.3
- Correct connection of measuring and communication lines according to chapter 5.7.1

Function Checks

Additionally, check the following aspects:

- Correct functioning of peripheral devices (e.g. connected PC, series-connected current transformers)
- Compliance with the system requirements specified in chapter 5.4
- Compliance with the access rights according to chapter 5.5
- Compliance with the commissioning sequence of the device according to chapter 5.7
- Evaluation of the LED failure indications, see chapter 12.3.

12.2 Commissioning during Failures

12.2.1 Automatic Start of the Boot Loader

If a firmware update has failed or the device startup was unsuccessful, Internet Explorer will automatically open the HTML page **7KG966 Boot Loader**, see Figure 12-1.

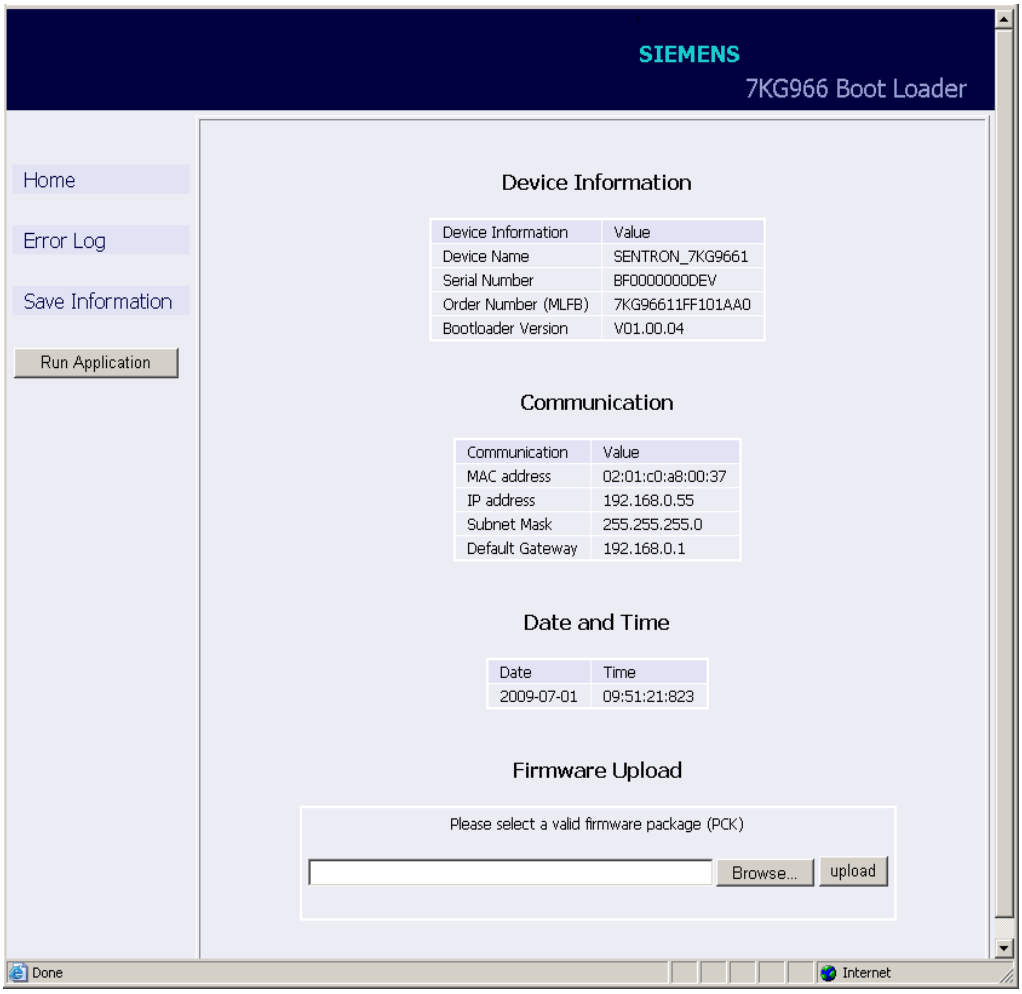


Fig. 12-1 Boot Loader

Starting User Interface <u>without</u> Loading a New/Different Firmware

✧ Click the **Run Application** button. The following message appears:

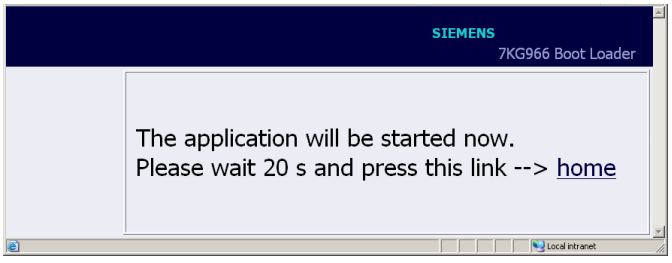


Fig. 12-2 Boot Loader Message of Run Application

✧ Wait for at least 20 s and then click the **home** link.

The User Interface opens.

Starting User Interface with Loading a New/Different Firmware

✧ Click the **Browse...** button.

The **Choose file** dialog box opens.

✧ In the **Choose file** dialog box select the current firmware update (file extension .pck) in the **Look in:** list box and click the **Open** button.

The path appears in the **Browse...** field.

✧ Click the **upload** button.

The firmware is uploaded from the device to the PC and the following information is displayed in the Boot Loader window:

Fig. 12-3 Information in the Boot Loader

✧ Wait for at least 30 s and then click the **home** link.

The User Interface opens.

12.2.2 Manual Start of the Boot Loader

If it is necessary to start the Boot Loader manually, proceed as follows:

✧ If the SENTRON T is still energized by the supply voltage, switch off the supply voltage.

✧ Press the IP-Addr. push-button at the SENTRON T (see chapter 5.7.3), and holding the IP-Addr. push-button down, switch on the supply voltage.

✧ Hold the IP-Addr. push-button down until the LEDs ERROR (red) and H2 (yellow) on the device top side are lit (LEDs RUN (green) and H1 (yellow) are off).

✧ Release the IP-Addr. push-button.

SENTRON T starts the Boot Loader with the **7KG966 Boot Loader** HTML page (see figure 12-1).

12.3 Indications Signaled by LEDs

SENTRON T automatically monitors the functions of its hardware, software, and firmware components. The LEDs on the top side of the housing indicate the current device status.

Designation of the LEDs

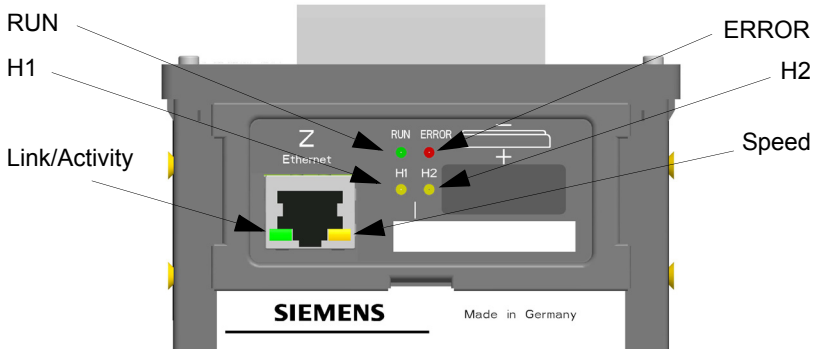


Fig. 12-4 Designation of the LEDs

Meaning of the LEDs

LED (green, red, yellow): on

LED (green, red, yellow): flashes

LEDs H1/H2/ERROR: as set by the user

LED: off

LED Speed (yellow):

off: 10 Mbit/s

on: 100 Mbit/s

LED Link/Activity (green):

LED on: Ethernet link is up

LED flashing: Ethernet link is up and data is transferred

LED off: no Ethernet partners connected

Table 12-1 Indications Signaled by LEDs

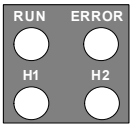
LED	Meaning
	Device switched off

Table 12-1 Indications Signaled by LEDs (cont.)

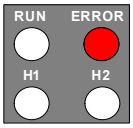
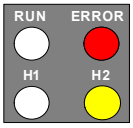
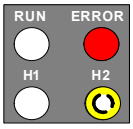
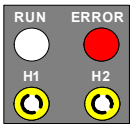
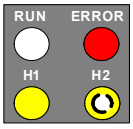
LED	Meaning
	No firmware loaded
Boot Loader	
	IP-Addr. push-button pressed during power-on
	Boot loader started after IP-Addr. push-button was pressed during power-on
	DHCP active (H1 switches off after receiving the IP address via DHCP)
	Default IP address by pressing IP-Addr. push-button

Table 12-1 Indications Signaled by LEDs (cont.)

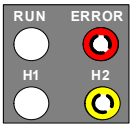
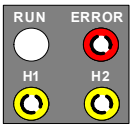
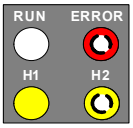
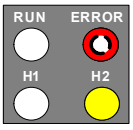
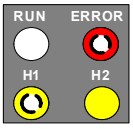
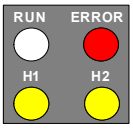
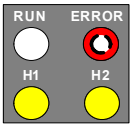
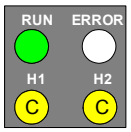
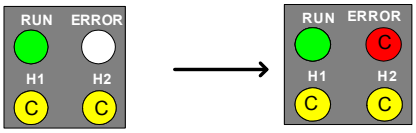
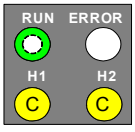
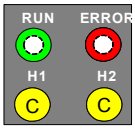
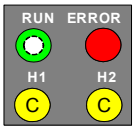
LED	Meaning
	Boot loader started; no process application exists
	DHCP active (LED H1 switches off after receiving the IP address via DHCP)
	Default IP address by pressing the IP-Addr. push-button
	Boot loader was started because an error occurred in the process application.
	DHCP active (LED H1 switches off after reception of the IP address via DHCP)
	Boot loader started, process application is being loaded.
	Double IP address is detected

Table 12-1 Indications Signaled by LEDs (cont.)

LED	Meaning
Process Application	
	Normal mode: IP address has been configured or received from DHCP.
	Parameterization of the ERROR LED: The ERROR LED can be assigned all indications.
	DHCP: LED RUN (green) is lit after the IP address was received by the DHCP server.
	Default IP address is applied by pressing the IP-Addr. push-button.
	Double IP address is detected.

12.4 Troubleshooting and Repair

General Troubleshooting

The user is not authorized to troubleshoot the defective device beyond the measures described in chapter 12.1 and chapter 12.3 or make repairs himself. Special electronic modules are inserted in the SENTRON T which can only be replaced by the manufacturer according to the guidelines for Electrostatic sensitive devices (ESD).

If you suspect any damage on the device, Siemens recommends sending the entire device to the manufacturer. For this purpose, it is best to use the original transport packaging or similar packaging.

Troubleshooting Based on Error Messages

NOTE

Error messages are service information that you quote to the service department upon request in case of an error.

The error messages can be saved as described in chapter 7.2.5.2, section **File download** → **Save**.

The error messages can be printed as described in chapter 7.2.5.2, section **File download** → **Open**.

13 Technical Data

13.1 General Device Data

13.1.1 Power Supply

Direct Voltage

Rated input voltages	24 V to 250 V
Admissible input voltage tolerance	±20 %
Permitted ripple of the input voltage at 24 V, 48 V, 60 V, 110 V, 220 V, 250 V15 %	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	5 W

Alternating Voltage

Rated input voltages	110 V to 230 V
System frequency at AC	45 Hz to 65 Hz
Admissible input voltage tolerance	±20 %
Permitted 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

13.1.2 Inputs and Outputs

Inputs for Alternating Voltage Measurements (Connector Block F)

Rated input AC voltages (parameterizable)	
Phase-N/PE	63.5 V 110 V 230 V 400 V (max. 347 V for UL) Operat. measurem. uncertainly acc. to IEC 60688: ±0.1 %
Phase-phase	110 V 190 V 400 V 690 V (max. 600 V for UL) Operat. measurem. uncertainly acc. to IEC 60688: ±0.1 %
Maximum input AC voltage (depending on the parameterization)	1.2 x rated input AC voltage
Maximum input AC voltage	
Phase-N/PE	480 V (max. 347 V for UL)
Phase-phase	831 V (max. 600 V for UL)
Input impedances	
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 information about the voltage measurement inputs	
Power consumption per input for V_{rated} 400 V	38 mW
Permissible power frequency	45 Hz to 65 Hz
Measuring error (with calibration) at 23 °C ± 1 °C 50 Hz or 60 Hz	typically 0.1 % at rated input AC voltage acc. to IEC 60668
Continuous overload capacity	1.5 x rated input AC voltage Phase-N: max. 347 V for UL Phase-phase: max. 600 V for UL
Surge overload capacity	2 x rated input voltage according to IEC 60255-27 Phase-N: max. 347 V for UL Phase-phase: max. 600 V for UL

Inputs for Alternating Current Measurements (Connector Block E)

Input AC currents	
Rated input current range	1 A 5 A Operat. measurem. uncertainly acc. to IEC 60688: ±0.1 %
Max. input current	2 x rated input AC current
Power consumption per input	
at 1 A	1 mVA
at 5 A	2.5 mVA
Further information about the current measurement inputs	
Permissible power frequency	45 Hz to 65 Hz
Max. rated input voltage	150 V
Measuring error (with calibration) at 23 °C ± 1 °C 50 Hz or 60 Hz	Typically 0.1 % at rated input current
Thermal stability	10 A continuous 100 A for max. 1 s according to IEC 60688

Binary Outputs (Connector Block G)

Maximum switching 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	35 Ω
Admissible switching frequency	10 Hz
Number of switching cycles	Unlimited

DC Analog Outputs (Connector 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 impedance)
Short-circuit current	±24 mA, short-circuit proof
No-load voltage	15 V, idling-proof
Measuring error (with calibration) at 23 °C ± 1 °C	Max. 0.2 % at rated current
Response time	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
Minimum load impedance	1 kΩ
Short-circuit current	±24 mA, short-circuit proof
Measuring error (with calibration) at 23 °C ± 1 °C	Max. 0.1 % at rated voltage
Response time	120 ms at 50 Hz 100 ms at 60 Hz

13.1.3 Communication Interfaces

Ethernet (Connector Z)

Ethernet, electrical	Operation	With device internal software
	Connection	Device top side RJ45 connector socket 100BaseT acc. to IEEE802.3 LED yellow: 10/100 Mbit/s (off/on) LED green: connection/no connection (on/off)
	Protocols	Modbus TCP IEC 61850 Server
	Voltage strength	DC 700 V
	Transmission rate	10/100 Mbit/s
	Cable for 100Base-T	100 Ω to 150 Ω STP, CAT5
	Maximum cable length 100Base-T	100 m, if well installed

Serial Interface (Connector J)

RS485	Connection	Terminal side, 9 pin D-sub socket	
	Protocol	Modbus RTU	IEC 60870-5-103
	Baud rate (adjustable)	Min. 1200 bit/s Max. 115 200 bit/s; Default setting 19 200 bit/s	Min. 9600 bit/s Max. 38 400 bit/s; Default setting 9600 bit/s
	Maximum distance of transmission	Max. 1 km (depending on data 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	
	Measured value range	-	120 % or 240 %
	Bus termination	Not integrated, bus termination using plugs with integrated bus terminating resistors (see figure 13-1)	

Recommended Termination of the RS485 Interface (Connector J)

The RS485 bus requires at least the bus termination shown in the figure below, with pullup/pulldown resistors:

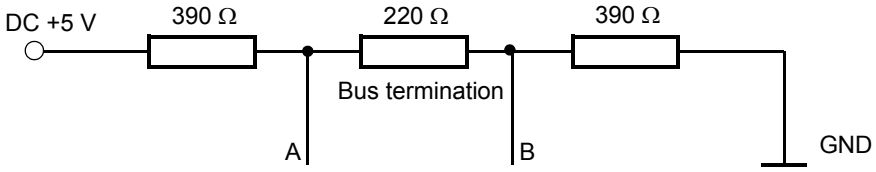


Fig. 13-1 Termination of the RS485 Interface

The bus termination must be respectively carried out at the first and last RS485 device interface of the bus. No terminating resistor may be used at all other devices in this line.

Siemens recommends the use of a bus termination plug with integrated (activatable) resistors in accordance with figure 13-1, for example plugs with 35°-cable outlet type 6ES7972-0BA42-0XA0 (see chapter 2.2). Use a 2-wired, twisted and shielded cable (see chapter 2.2). In case of outdoor mounting Siemens recommends a rodent protection. You can find current installation material at SIEMENS IS in the "Catalogue for Industrial Communication", chapter "PROFIBUS", see also:
http://www.automation.siemens.com/mcms/automation/en/industrial-communications/Pages/Default.aspx.

The 9 pin D-sub socket of the RS485 interface is connected as follows:

Pin No.	Assignment	Pin No.	Assignment
1	Shield	6	DC +5 V Supply voltage for terminating resistors (max. 100 mA)
2	Not assigned	7	RTS Direction control (if required for an external conversion)
3	A RS485 connection pin A	8	B RS485 connection pin B
4	Not assigned	9	Not assigned
5	GND (towards DC +5 V)		

13.1.4 Environmental Data

Temperature data		
	Operating temperature	-25 °C to +70 °C -13 °F to +158 °F
	Temperature during transport	-25 °C to +70 °C -13 °F to +158 °F
	Temperatur during storage	-25 °C to +70 °C -13 °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

13.1.5 General Data

Battery	Type	PANASONIC CR2032 or VARTA 6032 101 501
	Voltage	3 V
	Capacity	230 mAh
	Typical life	10 years In operation with continuous supply voltage
		2 months within 10 years; In operation where supply voltage is not applied continuously
Protection class acc. to IEC 60529	DIN rail side	IP20
	Terminal side (terminals)	IP20
	Top side	IP20

13.2 Test Data

Reference Conditions for Determining the Test Data

Input current	Rated current ± 1 %
Input voltage	Rated voltage ± 1 %
Frequency	45 Hz to 65 Hz
Curve shape	Sine, total harmonic distortion ≤ 5 %
Ambient temperature	23 °C ± 1 °C
Supply voltage	V_{HN} ± 1 %
Warm-up time	≥ 15 min
Interfering fields	None

13.2.1 Electrical Tests

Standards

Standards:	IEC 60688 and IEC 60255 IEEE Std C37.90, see individual functions VDE 0435 For more standards see also individual functions

Insulation Test according to IEC 61010-1

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	480 V	Surge voltage 9.76 kV	Cat. III
Supply voltage	Reinforced	300 V	DC 3.125 kV	Cat. III
Binary outputs	Reinforced	300 V	AC 3.536 kV	Cat. III
DC analog outputs	Function	< 50 V	DC 700 V	Cat. III
Ethernet interface	Function	< 50 V	DC 700 V	Cat. III
RS485 interface	Function	< 50 V	DC 700 V	Cat. III

EMC Tests for Immunity (Type Tests)

Standards:		IEC 60255-6 and -22, (product standards) IEC/EN 61000-6-2 VDE 0435 For more standards see also individual functions
1 MHz test, Class III, IEC 60255-22-1, IEC 61000-4-18, IEEE C37.90.1		2.5 kV (peak); 1 MHz; τ = 15 µs; 400 Surges per s; Test duration 2 s; R_i = 200 Ω
Electrostatic discharge, Class III IEC 60255-22-2, IEC 61000-4-2		4 kV contact discharge; 8 kV air discharge, both polarities; 150 pF; R_i = 330 Ω
Radio frequency electromagnetic field, amplitude-modulated, Class III IEC 61000-4-3, IEC 60255-22-3		10 V/m; 80 MHz to 2.7 GHz; 80 % AM; 1 kHz
Fast transient bursts, Class III IEC 61000-4-4, IEC 60255-22-4, IEEE C37.90.1		2 kV; 5 ns/50 ns; 5 kHz; Burst length = 15 ms; Repetition rate 300 ms; Both polarities; R_i = 50 Ω; Test duration 1 min
High energy surge voltages (SURGE), Installation Class III IEC 61000-4-5, IEC 60255-22-5		Impulse: 1.2 µs/50 µs
	Auxiliary voltage	Common mode: 2 kV; 12 Ω; 9 µF Diff. mode:1 kV; 2 Ω; 18 µF
	Measuring inputs, binary inputs and relay outputs	Common mode: 2 kV; 42 Ω; 0.5 µF Diff. mode: 1 kV; 42 Ω; 0,5 µF
HF on lines, amplitude-modulated, Class III IEC 61000-4-6, IEC 60255-22-6		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

EMC Test for Noise Emission (Type Test)

Standard:	IEC/EN 61000-6-4
Radio noise voltage to lines, only auxiliary voltage IEC-CISPR 11	150 kHz to 30 MHz Limit Class B
Interference field strength IEC-CISPR 11	30 MHz to 1000 MHz Limit Class B

13.2.2 Mechanical Stress Tests

Vibration and Shock Stress during Stationary Operation

Standards:	IEC 60255-21 and IEC 60068
Oscillation IEC 60255-21-1, Class II; 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 60255-21-2, Class I; IEC 60068-2-27 test Ea	Semi-sinusoidal 5 g acceleration, duration 11 ms, each 3 shocks in both directions of the 3 axes
Seismic Vibration IEC 60255-21-3, Class II; 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 1 octave/min 1 cycle in 3 orthogonal axes

Vibration and Shock Stress during Transport

Standards:	IEC 60255-21 and IEC 60068
Oscillation IEC 60255-21-1, Class 2; 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 axes
Shock IEC 60255-21-2, Class 1; IEC 60068-2-27 test Ea	Semi-sinusoidal 15 g acceleration, duration 11 ms, each 3 shocks (in both directions of the 3 axes)
Continuous Shock IEC 60255-21-2, Class 1; IEC 60068-2-29 test Eb	Semi-sinusoidal 10 g acceleration, duration 16 ms, each 1000 shocks (in both directions of the 3 axes)
Free fall IEC 60068-2-32 test Ed	1 m

13.2.3 Climatic Stress Tests

Standards: IEC 60068 and IEEEC37.90
Cold: IEC 60068-2-1 test Ad IEEE C37.90-2
Dry heat during operation, storage and transport: IEC 60068-2-2 test Bd
Damp heat: IEC 60068-2-3 test Ca
Change of temperature: IEC 60068-2-14 test Na and Nb
Individual gastest, 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

13.2.4 Safety Standards

Standards: EN 61010
EN 61010-1

13.3 Dimensions

Mass	approx. 0.5 kg
Dimension (W x H x D)	96 mm x 96 mm x 100 mm 3.78 inch x 3.78 inch x 3.94 inch

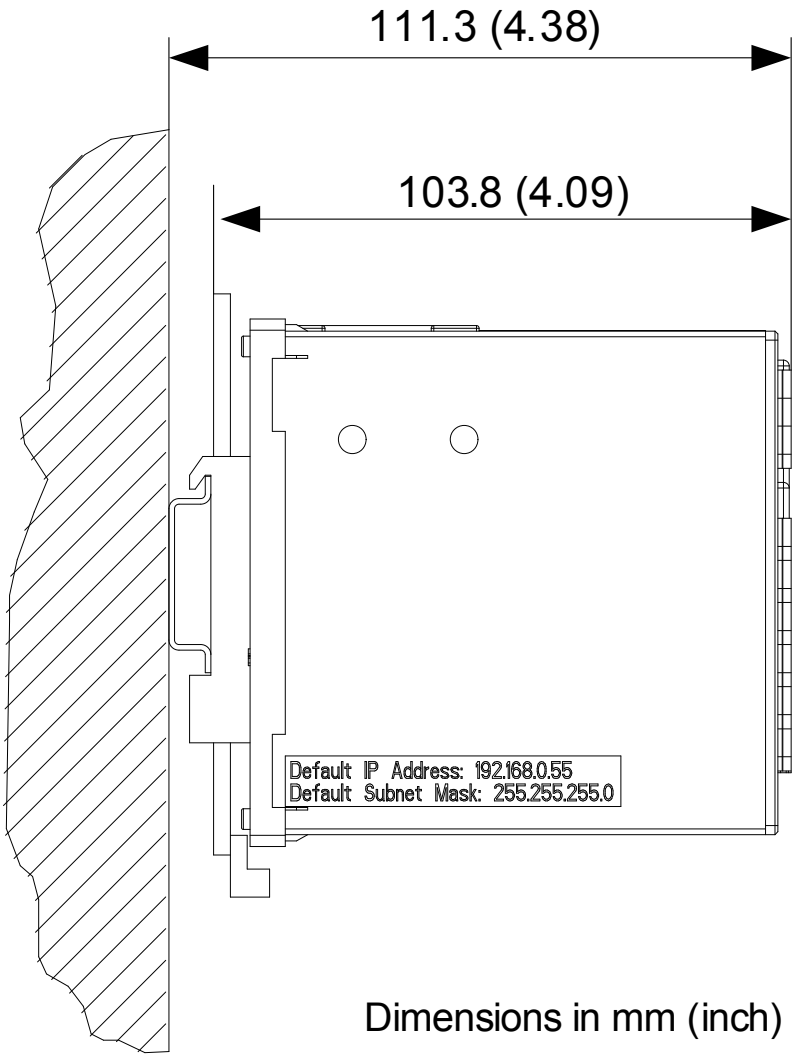


Fig. 13-2 Dimensional drawing of the SENTRON T

14 Operational Indications

Indication	Description	Notes
Device OK	The device startup was successful.	Indication on: Device ready
Start Up	Device startup or device restart	Indication on: Device startup successful
Battery Failure	Battery voltage < 2.7 V or no battery inserted	Indication on: Battery failure
Clear operational log	The operational indications were deleted.	Indication on: Operational indications deleted
Time Synchronization Error	Error during the time synchronization from the NTP server or fieldbus	Indication off: At least one time message was received during the set timer ("**Error indication after**"). The time stamp is set when the first valid time information or time synchronization is received. Indication on: No time message was received during the set timer ("**Error indication after**"). The time stamp is set after the "**Error indication after**" timer has expired and no synchronization message was received. Parameter range: see chapter 7.3.4.1 Error sources with RTC: - no valid time after device startup Error sources with NTP or fieldbus: - „**Error indication after**" timer expires and no synchronization message was received
	Error during internal time synchronization	Indication on: RTC time invalid Indication off: After setting the clock via HTML (see chapter 7.3.4.1) During battery failure at device startup
Time Set	The time was set.	Indication on: Time set Only when setting the clock via HTML
Default IP Address	The IP-Addr. push-button has been pressed for more than 3 s.	Indication on: IP-Addr. push-button was pressed The device restarts and applies the default IP address.

Indication	Description	Notes
Primary NTP Server Error	Faulty or no response from the primary NTP server	Indication on: Error Indication off: Valid time messages has been received for a period of 10 min Only for time synchronization via Ethernet NTP (see chapter 7.3.4.1)
Secondary NTP Server Error	Faulty or no response from the secondary NTP server	Indication on: Error Indication off: Valid time messages has been received for a period of 10 min Only for time synchronization via Ethernet NTP (see chapter 7.3.4.1)
Daylight Saving Time	Switching between daylight saving time/standard time	Indication on: Daylight saving time Indication off: Standard time
Ethernet Link Error	Ethernet connection error	Indication on: Error Indication off: Ethernet link recognized
Modbus TCP OK (Modbus TCP Server)	At least one Modbus TCP link has received Modbus messages.	Indication on: At least one Modbus message was received during the set monitoring time. The time stamp is set when the first valid message is received. Indication off: No Modbus message was received during the set monitoring time. See chapter 7.3.4.2
Modbus Serial OK (Modbus RTU Slave)	The Modbus serial communication has received a valid Modbus message.	Indication on: At least one serial message was received during the set monitoring time. The time stamp is set when the first valid message is received. Indication off: No serial message was received during the set monitoring time. See chapter 7.3.4.3
IEC 60870-5-103 OK	Communication via protocol IEC 60870-5-103 is correct.	Indication on: At least one serial message was received during the set monitoring time. The time stamp is set when the first valid message is received. Indication off: No serial message was received during the set monitoring time. See chapter 7.3.4.3
IEC 61850 OK	Communication via protocol IEC 61850 is correct.	Indication on: At least one message was received during the set monitoring time. The time stamp is set when the first valid message is received. Indication off: No message was received during the set monitoring time. See chapter 7.3.4.2

Indication	Description	Notes
Settings Load	Starting to change the parameters of the passive set of parameters.	Indication on: Start of changes Indication off: Changes complete
Settings Check	The passive set of parameters is to be activated; the internal parameter check is running.	Indication on: Check started Indication off: Check complete
Settings Activate	The passive set of parameters is enabled and the device works with these parameters.	Indication on: Activation started Indication off: Activation complete
Analog Output x - Load Error	Load connection error Voltage mode: insufficient load impedance (< 1 kΩ) or short-circuit Current mode: connected load > 400 Ω (incl. line impedance) or open loop	Indication on: Error is present Indication off: Error eliminated Indications from the DC analog outputs; x = 1, 2, 3, 4 In the voltage mode effective from an initial voltage of ±2 V on In the current mode effective from an output current of ±4 mA on
Analog Output x - Overtemp.	Overtemperature The temperature supervision of the output drivers has picked up (device is outside the specified temperature range).	Indication on: Error is present Indication off: Error eliminated Indications from the DC analog outputs; x = 1, 2, 3, 4
Analog Output x - Error	Group indication of the two Analog Output x single error indication	
Limit Violation x	Indication that a parameterized limiting value has been violated	Indication on: The limit of the monitored measured value has been violated or no measured value is parameterized as input of the limiting value. Indication off: The limit of the monitored measured value is not violated. Message invalid: The monitored measured value is invalid (e.g. frequency at V < 15 % of V_{rated}). x = 1 to 16
Indication 1 from Remote	Status of the indications that can be set to control the LEDs and the binary outputs via the communication.	Indication on: ON Indication off: OFF Message invalid: Not yet updated via the communication or again invalid via the communication
Indication 2 from Remote		
Binary Output 1	Status of binary outputs ON/OFF	Indication on: ON Indication off: OFF Only if not output as counter output (for counter output = 0)
Binary Output 2		

Indication	Description	Notes
Reset Energy	The energy counters were reset.	Indication on: Energy counters reset
Rotation Voltage Clockwise	Indication of rotation voltage	Indication ON: Phase sequence Va-Vb-Vc, rotation clockwise Indication OFF: Phase sequence Va-Vc-Vb, (2 phases interchanged); rotation anti-clockwise Indication invalid: Direction of rotation can not calculated (e.g. no voltage applied)
Group indication x	Up to 4 single-point indications can be linked logically and combined to a group indication.	A total of 4 group indications (x = 1 to 4) can be parameterized.

15 Operating Parameters

15.1 Process Connections

The following process connections are available:

- AC Measurement
- DC Analog Outputs
- Binary Outputs
- LEDs

15.1.1 AC Measurement

Parameter	Default Settings	Setting Range
Network type	Four-wire, three phase, unbalanced	Single-phase network Three-wire, three phase balanced Three-wire, three phase, unbalanced (2 * I) Three-wire, three phase, unbalanced (3 * I) Four-wire, three phase, balanced Four-wire, three phase, unbalanced
Rated input voltage	ph-N: AC 400 V (max. 347 V for UL), ph-ph: AC 690 V (max. 600 V for UL)	ph-N: AC 63.5 V, ph-ph: AC 110 V ph-N: AC 110 V, ph-ph: AC 190 V ph-N: AC 230 V, ph-ph: AC 400 V ph-N: AC 400 V (max. 347 V for UL) ph-ph: AC 690 V (max. 600 V for UL)
Voltage transformer	no	yes no
Primary rated voltage ph-ph	AC 10 000 V	AC 100.0 V to AC 1 000 000.0 V
Secondary rated voltage ph-ph	AC 100 V	AC 1.0 V to AC 600.0 V
Rated input current	AC 5 A	AC 1 A AC 5 A
Current transformer	no	yes no
Primary rated current	AC 1 000 A	AC 1.0 A to AC 100 000 A
Secondary rated current	AC 1 A	AC 0.001 A to AC 10.0 A
Calculate Vn *)	yes	yes no
Zero point suppression	0.3 % (from Vrated, Irated)	0.0 % to 10.0 %

*) This option field is only visible in the device variants SENTRON T 7KG966x-1xAx0-xAA0.

15.1.2 DC Analog Outputs

Parameter	Default Settings	Setting Range
Measurand	none	-none- Va; Vb; Vc Vab; Vbc; Vca Ia; Ib; Ic VN; Vavg IN, Iavg Pa; Pb; Pc; P Qa; Qb; Qc; Q Sa; Sb; Sc; S cos ϕ (a); cos ϕ (b); cos ϕ (c); cos ϕ PFa; PFb; PFc; PF ϕa; ϕb; ϕc; ϕ f Vunbal Iunbal
Output range	-20 mA to 20 mA	0 mA to 20 mA 4 mA to 20 mA -20 mA to +20 mA 0 V to 10 V -10 V to +10 V
Function	Linear	Linear; Linear with knee point Square
Measurand from [1)] (unit according to measured value)	0.00	-1 000 000 000.0 to 1 000 000 000.0
Measurand to [1)] (unit according to measured value)	100.00	-1 000 000 000.0 to 1 000 000 000.0
Knee-point measurand[1)] (unit according to measured value)	0.00	-1 000 000 000.0 to 1 000 000 000.0
Knee-point output (unit according to measured value)	0.00	-20 mA to +20 mA or -10 V to +10 V

1) "Measured value from" ≤ "Knee-point measured value" ≤ "Measured value to"

15.1.3 Binary Outputs

Parameter	Default Settings	Setting Range
Source type	Indication	Indication Energy counter
Indication [1)]	-none-	-none- Device OK Battery Failure Settings Load Settings Check Settings Activate Modbus TCP OK Ethernet Link Error Modbus Serial OK Time Synchronization Error Primary NTP Server Error Secondary NTP Server Error Daylight Saving Time Default IP Address IEC 60870-5-103 OK IEC 61850 OK Analog Output x - Load Error Analog Output x Overtemp. Analog Output x Error Limit Violation y Indication 1 from Remote Indication 2 from Remote Rotation Voltage Clockwise Group Indication x
Energy counter [2)]	-none-	WPa_sup WPb_sup WPc_sup WP_sup WPa_dmd WPb_dmd WPc_dmd WP_dmd WQa_ind WQb_ind WQc_ind WQ_ind WQa_cap WQb_cap WQc_cap WQ_cap WSa WSb WSc WS
Source inverted [1)]	no	no yes

Operating mode [1]	Persistent	Persistent Persistent with fail safe Pulse Pulse with retrigger
Energy increase per pulse [2]	1.0 Wh	0.1 Wh/VAh/varh to 1 000 000 Wh/VAh/varh
Output time pulse operating mode [3]	20 * 10 ms = 200 ms	50 ms to 3 600 000 ms

x = 1 to 4

y = 1 to 16, user-defined name, if assigned (see chapter 15.2)

[1] only if source type = indication

[2] only if source type = energy counter

[3] only if pulse output or source type = energy counter

15.1.4 LEDs

LED	Default Setting	Setting Range
RUN	Device ready	Not settable
ERROR (Error signalization and signalization according to parameterization) H1 H2	-none-	-none- Device OK Battery Failure Settings Load Settings Check Settings Activate Modbus TCP OK Ethernet Link Error Modbus Serial OK Time Synchronization Error Primary NTP Server Error Secondary NTP Server Error Daylight Saving Time Default IP Address IEC 60870-5-103 OK IEC 61850 OK Analog Output x - Load Error Analog Output x Overtemp. Analog Output x Error Limit Violation y Indication 1 from Remote Indication 2 from Remote Rotation Voltage Clockwise Group Indication x
Indication inverted	no	no yes

x = 1 to 4

y = 1 to 16, user-defined name, if assigned (see chapter 15.2)

15.2 Automation Functions

The following automation functions are available:

- Limit violation 1-8
- Limit violation 9-16
- Group indication 1-4

Limit Violation 1-8 and 9-16

Parameter	Default Setting	Setting Range
Measurand	-none-	-none- Va; Vb; Vc Vab; Vbc; Vca Ia; Ib; Ic VN; Vavg IN; Iavg Pa; Pb; Pc; P Qa; Qb; Qc; Q Sa; Sb; Sc; S cos ϕ (a); cos ϕ (b); cos ϕ (c); cos ϕ PFa; PFb; PFc; PF ϕa; ϕb; ϕc; ϕ f Vunbal Iunbal
Limit	0.00	-1 000 000 000 to 1 000 000 000 (unit)
Limit type	Lower	Lower Upper
Hysteresis (%)	1.0	0.0 to 10.0
Violation indication	Limit Violation x (x = 1 to 16)	The name of the limit value indication is customizable.

x = 1 to 16

Group Indications 1-4

Parameter	Default Setting	Setting Range
Source	-none-	-none- Device OK Battery Failure Settings Load Settings Check Settings Activate Modbus TCP OK Ethernet Link Error Modbus Serial OK Time Synchronization Error Primary NTP Server Error Secondary NTP Server Error Daylight Saving Time Default IP Address IEC 60870-5-103 OK IEC 61850 OK Analog Output x - Load Error Analog Output x Overtemp. Analog Output x Error Limit Violation y Indication 1 from Remote Indication 2 from Remote Rotation Voltage Clockwise Group Indication x
Source inverted	no	no yes
Logic operation	NONE	NONE OR AND
Group indication name	Group Indication x	Any

x = 1 to 4

y = 1 to 16

15.3 Administrative

The following administrative settings are available:

- Time Synchronization
- Ethernet Communication
- Communication Serial
- Device and Language

15.3.1 Time Synchronization

Parameter	Default Settings	Setting Range
Source time synchronization	Internal	Internal Ethernet NTP Fieldbus
Time zone offset to UTC	+00:00	-12 to +13 (hours) (in increments of 0.5 h)
Daylight Saving Time switchover	yes	no yes
DST offset to UTC	+01:00	0 to + 2 (hours) (in increments of 0.5 h)
Start of DST	March Last week Sunday 02:00 AM	January to December First week Second week Third week Fourth week Last week Sunday to Saturday 0:00 to 23:00 (full hour)
End of DST	October Last week Sunday 03:00 AM	January to December First week Second week Third week Fourth week Last week Sunday to Saturday 0:00 to 23:00 (full hour)
Additional Parameters if the Source is Ethernet NTP		
Primary NTP server IP Address	192.168.0.254	Any
Secondary NTP server IP Address	192.168.0.253	Any No polling of the NTP server if 0.0.0.0 was entered
Error indication after	10 min	2 min to 120 min
Additional Parameters if Source is Fieldbus		
Error indication after	10 min	2 min to 120 min

15.3.2 Ethernet Communication

Parameter	Default Settings	Setting Range
IP Address [1)]	192.168.0.55	Any 0.0.0.0 = DHCP
Subnet mask [1)]	255.255.255.0	Any
Default gateway [1)]	192.168.0.1	Any
Enable SNMP	no	no yes
Bus protocol	Modbus TCP	Modbus TCP IEC 61850 -none-
Bus Protocol Modbus TCP		
Use a user-port number [2)]	no	no yes
User-port number [2)] (can only be set when *Use a user-port number* is parameterized with *yes*)	10000	10000 to 65535
Access rights for user port (can only be set when *Use a user-port number* is parameterized with *yes*)	Full	Full Read only
Access rights for user port 502	Full	Full Read only
Keep Alive time	10 s	0 s = switch off 1 s to 65 535 s
Communication supervision time	600 * 100 ms	0 s = none 100 ms to 6 553 400 ms
Bus Protocol IEC 61850		
IED Name NO.	0	0 to 65534
Voltage - Deadband	5 %	0 % to 5 %, in 1-% steps
Current - Deadband	5 %	0 % to 5 %, in 1-% steps
Power - Deadband	5 %	0 % to 5 %, in 1-% steps
Power factor - Deadband	0.05	0 % 2 % to 5 %, in 1-% steps
Frequency - Deadband	0.05	0 % 0.02 % 0.05 %

1) After the parameter changes have been enabled, the device resets.

2) After enabling the parameter changes, any currently active Modbus TCP connections will be closed. The Modbus TCP client must later re-open these connections.

15.3.3 Communication Serial

Parameter	Default Settings	Setting Range
Bus protocol	Modbus RTU	-none- Modbus RTU IEC 60870-5-103
Bus Protocol Modbus RTU		
Device address	1	1 to 247
Baud rate	19 200 bit/s	1200 bit/s, 2400 bit/s 4800 bit/s, 9600 bit/s 19 200 bit/s, 38 400 bit/s 57 600 bit/s, 115 200 bit/s
Parity	Even	None, 1 stop bit Even Odd None, 2 stop bit
Access rights	Full	Full Read only
Communication supervision time	600 * 100 ms	0 s = none 100 ms to 6 553 400 ms
Bus Protocol IEC 60870-5-103		
Device address	1	1 to 254
Baud rate	9600 bit/s	9600 bit/s 19 200 bit/s 38 400 bit/s
Measured value range	120 % corresponds to a measured value range from -4096 to +4095 (-120 % to +120 %)	120 % 240 % corresponds to a measured value range from -4096 to +4095 (-120 % to +120 % or -240 % to +240 %)
Transmit energy	no	yes (every minute) no
Communication supervision time	600 * 100 ms	0 s = no 100 ms to 6 553 400 ms

NOTE

For the serial communication via IEC 60870-5-103, the parity is permanently set to **even**.

15.3.4 Device and Language

Parameter	Default Settings	Setting Range
Device name	SENTRON 7KG966	Max. 32 characters
Language	ENGLISH (US)	ENGLISH (US) User language acc. to preselection of user language: DEUTSCH (DE) or FRANCAIS (FR)
Date/time format	YYYY-MM-DD, Time with 24 hours	YYYY-MM-DD, Time with 24 hours YYYY-MM-DD, Time with 12 h AM/PM DD-MM-YYYY, Time with 24 hours DD-MM-YYYY, Time with 12 h AM/PM MM/DD/YYYY, Time with 24 hours MM/DD/YYYY, Time with 12 h AM/PM
Activation password	000000	Any 6 to 14 characters
Maintenance password	311299	Any 6 to 14 characters
User language preselection	DEUTSCH (DE)	DEUTSCH (DE) FRANCAIS (FR)

Glossary

A

AC	**A**lternating **C**urrent
ADC	**A**nalog-**d**igital **C**onverter
ARP	**A**ddress **R**esolution **P**rotocol: Network protocol
ASDU	**A**pplication **S**ervice **D**ata **U**nit

B

Big-Endian format	The most significant byte is stored first, that is at the memory location with the lowest address.
Boot Application	Starting a device with the firmware required for the microcontroller
Broadcast message	Message in the network where data packets are transmitted to all devices on the network from one point

C

CDC	**C**ommon **D**ata **C**lass (IEC 61850)
Client	Device in the communication network that sends data requests or commands to the server devices and receives responses from them
CRC error	**C**yclic **R**edundancy **C**heck: The cyclic redundancy check is a method of determining a test value for data (e.g. for data transmission in computer networks) with the purpose to detect errors during the transmission or duplication of data.

D

DC	**D**irect **C**urrent
DHCP	**D**ynamic **H**ost **C**onfiguration **P**rotocol enables the network configuration to be assigned to the devices by a DHCP server
DSP	**D**igital **S**ignal **P**rocessor
DST	**D**aylight **S**aving **T**ime

E

Ethernet	Cable-based data network technology for local data networks

F

FW	**F**irm**w**are: Program code for execution in a microcontroller

G

Gateway	Enables networks based on different protocols to communicate with each other

H

Holding register	Area for representing data in Modbus communication

I

ICD-Datei	**I**ED **C**ability **D**escription: Contains the standardized description of the device configuration
IEC	**I**nternational **E**lectrotechnical **C**ommission, standards organization; Communication standard for substations and protection equipment
IEC 60870-5-103	Type of protocol to the data transmission via serial networks (e.g. RS485)
IED	**I**ntelligent **E**lectronic **D**evice
Indication off	The status of the indication changes from ON to OFF, that is the indication is deleted.
Indication on	The status of the indication changes from OFF to ON, that is the indication is currently present.
+Inf	Stands for *Infinity* and denotes a counter overflow. Extremely large number or infinitely positive number
IP	**I**nternet **P**rotocol
IP address	Addresses in computer networks based on the Internet protocol

J

JavaScript	Script language mainly used by Web browsers

K

KeepAlive	KeepAlive on TCP level is a feature intended to verify the availability and functioning of the communication partner (client) and to maintain a TCP network link if the network is inactive. The server sends KeepAlive messages (TCP packets without data) to the client in regular intervals (KeepAlive time) while the network is inactive, and the client responds to these messages. If the client does not respond to a KeepAlive message, the server assumes that the link is down or the client is inactive and closes the TCP link.

L

LED	**L**ight-**E**mitting **D**iode
Limit violation	A value exceeding or falling under a parameterized limiting value.
LSB	**L**east **S**ignificant **B**it

M

MAC-Address	**M**edia **A**ccess **C**ontrol address: Hardware address that clearly identifies the device on the network.
MBAP	**M**od**b**us **A**pplication **P**rotocol
MBAP Header	Header of a Modbus TCP message consisting of these 4 parts: Transaction identifier (2 bytes), protocol identifier (2 bytes), length (2 bytes), unit identifier (1 byte).
MIB	Management Information Base: Information which can be retrieved or modified via the SNMP network management protocol
Modbus	The Modbus protocol is a communication protocol based on a client-server architecture.
Modbus RTU	Modbus **R**emote **T**erminal **U**nit: Modbus protocol type for transmitting data over serial networks (e.g. RS485)
Modbus TCP	Modbus **T**ransmission **C**ontrol **P**rotocol: Modbus protocol type for transmitting data as TCP/IP packets; TCP port 502 is reserved for Modbus TCP.
MSB	**M**ost **S**ignificant **B**it

N

NaN	**N**ot **a** **N**umber means "invalid": Result of an invalid computing operation
NTP	**N**etwork **T**ime **P**rotocol: Standard for synchronizing clocks in computer systems using packet-based communication networks

P

PIXIT	**P**rotocol **I**mplementation **Ex**tra Information for **T**esting

R

Response time	Time the output needs to react to a signal change at the device input. Time measured from an instant change at the AC input until the corresponding change of a DC output quantity has reached 90% of its final value.
RJ45	Ethernet plug connector
RS485	Interface standard for digital, wire-based, differential, serial data transmission
RTC	**R**eal-**T**ime **C**lock
RTU	See Modbus **R**emote **T**erminal **U**nit

S

Server	Sends data upon request by the client
SNMP	**S**imple **N**etwork **M**anagement **P**rotocol: Serves for monitoring and controlling network elements of a central station
SNTP	**S**imple **N**etwork **T**ime **P**rotocol: Simplified version of the NTP
SW	**S**oft**w**are: Program executed on a computer
STP	**S**hielded **t**wisted-**p**air is the cable for 100Base-T (Ethernet)

Stratum	Each NTP server is synchronized by a high-precision time standard or by another NTP server. The stratum is the position of the NTP server in the hierarchy of NTP servers polled by the device. The best stratum is 1, each further level in the NTP server hierarchy increases the stratum by 1.
Subnet mask	Bit mask in the network protocol that defines how many IP addresses the computer network encompasses. Together with the IP address of a device, the subnet mask defines which IP addresses the device searches in its own network and which IP addresses it tries to reach via routers in other networks.

T

TCP/IP	**T**ransmission **C**ontrol **P**rotocol/**I**nternet **P**rotocol: Family of network protocols

U

UTC	**U**niversal **T**ime **C**oordinated: Universal time standard referred to the time at the prime meridian

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