TECHNICAL INFORMATION

FLOWSIC600
Ultrasonic Gas Flow Meter

Ultrasonic Gas Flow Meter
for Custody Transfer
and Process Applications

MEPAFLOW600 CBM and Firmware V3.6.xx

SICK
Sensor Intelligence.

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Specified product characteristics and technical data do not serve as guarantee declarations.

Glossary

Abbreviations used in this manual

act.	actual (under operating/flowing conditions)
AGC	**A**utomatic **G**ain **C**ontrol
ANSI	**A**merican **N**ational **S**tandards **I**nstitute
ASCII	**A**merican **S**tandard **C**ode for **I**nformation **I**nterchange
ASME	**A**merican **S**ociety of **M**echanical **E**ngineers
ATEX	**At**mosphères **Ex**plosifs: Abbreviation for European standards that govern safety in potentially explosive atmospheres
AWG	**A**merican **W**ire **G**age
CBM	**C**ondition **B**ased **M**aintenance
CSA	**C**anadian **S**tandards **A**ssociation
DC	**D**irect **C**urrent
DIN	**D**eutsches **I**nstitut für **N**ormung
DN	**N**ominal **D**iameter (internal)
DSP	**D**igital **S**ignal **P**rocessor
EC	**E**uropean **C**ommunity
EMC	**E**lectro **M**agnetisc **C**compatibility
EN	**E**uro **N**orm (European Standard)
EVC	**E**lectronic **V**olume **C**orrector
Ex	Potentially **ex**plosive atmosphere
HART®	Communication interface
IEC	**I**nternational **E**lectrotechnical **C**ommission
IECEx	EC system for certification in accordance with standards for devices for use in potentially explosive atmospheres
LCD	**L**iquid **C**rystal **D**isplay
LED	**L**ight **E**mitting **D**iode
MDR	**M**anufacturer **D**ata **R**ecord
MEPAFLOW	**Me**nu-assisted **Pa**rameterization and Diagnosis for **FLOW**SIC600
NAMUR	**N**ormen**a**rbeitsgemeinschaft für **M**ess- **u**nd **R**egeltechnik in der chemischen Industrie (now "Interessengemeinschaft Prozessleittechnik der chemischen und pharmazeutischen Industrie"; ~ Association for Instrumentation and Control Standards in the Chemical Industry)
norm.	**norm**alized/corrected (under standard conditions)
OI	**O**perating **I**nstructions
OIML	**O**rganisation **I**nternationale de **M**etrologie **L**egale
PC	**P**ersonal **C**omputer
PTB	**P**hysikalisch **T**echnische **B**undesanstalt (~ Federal Metrology Office in Germany)
Reg. #	**Reg**ister number
RTU	**R**emote **T**erminal **U**nit
SNR	**S**ignal **N**oise **R**atio
SPU	**S**ignal **P**rocessing **U**nit
TI	**T**echnical **I**nformation
VDE	**V**erband **d**er **E**lektrotechnik Elektronik Informationstechnik (~ Association of German Electrical Engineers)

Warning Symbols

Hazard (general)

Hazard in potentially explosive atmospheres

Hazard by voltage

Warning Levels / Signal Words

WARNING
Risk or hazardous situation which *could* result in severe personal injury or death.

CAUTION
Hazard or unsafe practice which *could* result in personal injury or property damage.

NOTICE
Hazard which *could* result in property damage.

Information Symbols

Information about the use in potentially explosive atmospheres

Important technical information for this product

Important information on electric or electronic functions

Supplementary information

Link to information at another place

FLOWSIC600

1 Important Information

About this document
Scope of document
Safety instructions
Authorised staff
General safety instructions and protective measures
Dangers due to hot, corrosive and explosive gases and high pressure
Dangers due to heavy loads
Environmental information and instructions for disposal

1.1 About this document

This manual describes the FLOWSIC600 measuring system, which is used to determine the volumetric flow rate, volume and speed of sound in gases transported in pipelines. It provides general information on the measuring method employed, design and function of the entire system and its components, on planning, assembly, installation, calibration commissioning, maintenance and troubleshooting. A detailed description of the various system capabilities, options and settings which will assist in optimizing the meter configuration for a specific application is also included.

This manual covers standard applications which conform with the technical data specified. Additional information and assistance for special applications are available from your SICK representative. However, it is generally recommended that advantage be taken of qualified consulting services provided by SICK experts for your specific application.

This manual is a part of the FLOWSIC600 device documentation.

Documentation available via www.FLOWSIC600.com or from your local representative:

- FLOWSIC600 MODBUS specification document
- FLOWSIC600 HARTbus specification document
- FLOWSIC600 Technical Bulletin ENCODER Output

Documentation available from your local representative after training:

- FLOWSIC600 service manual
- FLOWSIC600 extraction tool operating instructions

1.2 Scope of document

This document applies to meters with firmware version 3.6.00 or higher and extended memory for the storage of e.g. hourly and daily mean values.

The software description in this document applies to MEPAFLOW600 CBM V1.3.00.

The following terms will be used for measurands:

Measurand	Basic abbreviations and units for FLOWSIC600			Abbreviations used for LCD-Display of SPU			MEPAFLOW600 CBM software		
Volume at flowing conditions	Vf	m³	acf	Vf	m³	cf	Vf	m³	acf
Volume at base conditions	Vb	Nm³	scf	Vb	m³	cf	Vb	Nm³	scf
Error volume at flowing conditions	Ef	m³	acf	Ef	m³	cf	Ef	m³	acf
Error volume at base conditions	Eb	Nm³	scf	Eb	m³	cf	Eb	Nm³	scf
Total volume at flowing conditions	Vo	m³	acf	Vo	m³	cf	Vo	m³	acf
Volume flow at flowing conditions	Qf	m³/h	acf/h	Qf	m³/h	cf/h	Qf	m³/h	acfh
Volume flow at base conditions	Qb	Nm³/h	scf/h	Qb	m³/h	cf/h	Qb	Nm³/h	scfh
Mass counter	M	t	lbs	M	t	lbs	M	t	lbs
Error Mass	Me	t	lbs	M	t	lbs	M	t	lbs
Mass flow at base conditions	Mf	t/h	lbs/h	M	t/h	lbs/h	M	t/h	lbs/h

1.3 Safety instructions

1.3.1 Intended use of the equipment

The FLOWSIC600 measuring system is used for measuring the actual volumetric flow rate of gases transported in pipelines. It can be used for measuring the actual corrected volume and the speed of sound in gases.

The measuring system shall only be used as specified by the manufacturer and as set forth below. Always observe the following information:

- Make sure the use of the equipment complies with the technical data, information about the permitted use, assembly and installation specifications and ambient as well as operating conditions. Relevant information is provided in the order documentation, type plate, certification documents and this manual.
- Any actions for the purpose of maintaining the value of the equipment, e.g. service and inspection, transport and storage etc., shall be performed as specified.
- Do not expose the equipment to mechanical stress, such as pigging.
- The flooding of the FLOWSIC600 with any liquid (e.g. for pressure or leakage tests) is deemed improper use. The consequences of such actions can not be foreseen or estimated. Improper use may result in failure of the ultrasonic transducers and consequently, failure of the entire flow meter.

Should it be necessary to flood the FLOWSIC600, please contact the manufacturer prior to doing so. In addition, the following instructions must be strictly adhered to:

WARNING:

► The pressure during flooding may not exceed more than 1,2 times the nominal pressure (when transducers are assembled).

1.4 Authorized staff

Persons responsible for safety shall ensure the following:

- Any work on the measuring system shall only be carried out by qualified staff and must be approved by skilled staff responsible for the plant.
  Due to their professional training, knowledge and vocational experience, as well as their knowledge of the relevant standards, regulations, health and safety regulations and equipment conditions, qualified persons shall be assigned by the person responsible for personal and plant safety to carry out such work. Qualified persons must be able to identify possible dangers and to take preventive action in due time. Skilled persons are defined in DIN VDE 0105 and IEC 364, or comparable standards.
- Skilled persons shall have precise knowledge of process-specific dangers, e.g. due to the effects of hot, toxic and pressurized gases, gas-liquid mixtures and other process media, and of the design and working principle of the measuring system and shall have received and be able to document appropriate training.
- In hazardous areas with potentially explosive atmospheres, wiring and installation shall only be carried out by staff trained according to EN /IEC 60079-14 and according to national regulations.

1.5 General safety instructions and protective measures

Using the equipment for any purpose other than that intended by the manufacturer, or improper operation may result in injuries and damage to the equipment. Read this section and the notes and warnings in the individual sections of this manual carefully and observe the instructions contained therein when carrying out any work on the FLOWSIC600 measuring system.

General instructions to be adhered to:

- Always comply with the statutory provisions and the associated technical rules and regulations relevant to the equipment when preparing for and carrying out any work on the measuring system. Pay particular attention to potentially hazardous aspects of the equipment, such as pressurized piping and explosion protection zones. Always observe the relevant regulations.
- Always consider local and equipment-specific conditions and process-specific dangers when carrying out any work on the equipment.
- Operating and service instructions and equipment documentation shall always be available on site. Always observe the safety instructions and notes on the prevention of injuries and damage given in these manuals.
- Ensure appropriate protective accessories are available in sufficient supply. Always use such protective accessories. Check that appropriate safety devices are fitted and working correctly.

1.6 Dangers due to hot, corrosive and explosive gases and high pressure

The FLOWSIC600 measuring system is directly integrated into gas-carrying pipelines.

The operating company is responsible for safe operation and for complying with additional national and company-specific regulations.

WARNING:

In plants with toxic and explosive gases, high pressure or high temperatures, the FLOWSIC600 measuring system shall only be installed or removed after the associated piping has been isolated and depressurized (i.e. vented to atmosphere).

The same applies to repair and service work which involves opening any pressurized component or the explosion-proof signal processing unit (SPU).

NOTICE:

Design, manufacture and inspection of the FLOWSIC600 measuring system is performed in compliance with the safety requirements set forth in the European Pressure Equipment Directive 97/23/EC.

1.7 Dangers due to heavy loads

The FLOWSIC600 measuring system must be safely attached to the carrying structure when being transported and installed.

WARNING:

- Only use lifting gear and equipment (e.g. lifting straps) which is suitable for the weight to be lifted. Max. load information can be found on the type plate of the lifting gear.
- The eye bolts attached to the meter body are suitable for the transport of the measuring device. However, additional loads (e.g. blind covers, filling for pressure tests or associated piping) must not be lifted and transported together with the measuring system without the use of additional support from the lifting gear.
- Never attach lifting gear to the signal processing unit or its mounting bracket and avoid contact between these parts and the lifting gear.

1.8 Environmental information and instructions for disposal

The FLOWSIC600 components are easily disassembled and do not contain toxic, radioactive or any other environmentally hazardous materials. The instrument consists primarily of steel, stainless steel, plastic and aluminium, and consequently there are few restrictions for disposal, except for the printed circuit boards, which must be disposed of as electronic scrap.

FLOWSIC600

2 Product Description

Features and applications
System components
Measuring principle
Path failure compensation
Output configurations
Operating states, meter states and signal output
Self-diagnosis with user warnings
Data handling in the FLOWSIC600
MEPAFLOW600 CBM

2.1 Features and applications

System features

The FLOWSIC600 measuring system is a compact gas meter used for ultrasonic volumetric gas flow measurement.

It is available in several different path configurations. Some configurations have a redundant measuring system which includes a second Signal Processing Unit (SPU) to allow for independent measurements on the secondary paths (→ 2.1.1 to → 2.1.3 and Key Code table in Section → pg. 206, 9.1.2).

Figure 1 FLOWSIC600

The main features of the FLOWSIC600 are:

- Hermetically sealed titanium Ultrasonic transducers integrated into the meter body
- Direct path design
- Intelligent self diagnosis with Condition Based Maintenance (CBM) functionality
- Counters, logbooks and configurable data logs on board
- MEPAFLOW600 CBM, a comprehensive user-interface which includes meter and data management
- No damage from over-ranging
- Measuring range up to 1:120
- Power consumption < 1W
- Meter diagnosis tool
- Worldwide service support

As a result, this measuring system is extremely robust and provides maximum accuracy, even under adverse operating conditions. Its compact design and concealed cabling provide protection from mechanical damage, thereby ensuring long-term stable measurement that is not sensitive to mechanical or electrical interference.

Applications

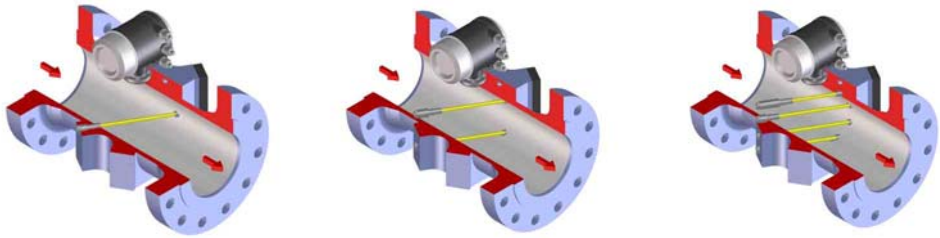
The FLOWSIC600 is ideally suited for a wide range of custody transfer and process measurement applications;

- Production, transportation and distribution of natural gas,
- Company-internal metering and billing,
- Power stations and other gas-consuming installations,
- Chemical and petrochemical industries,
- Compressed air distribution systems.

2.1.1 FLOWSIC600 1-path, FLOWSIC600 2-path, FLOWSIC600 4-path

These FLOWSIC600 meters can have 1, 2 or 4 ultrasonic measuring paths and are equipped with one set of electronics (SPU) (see outline drawings → pg. 257, 9.10).1 and 2-path meters are mainly used for process control and company internal billing. Meters with 4 paths can be used for fiscal gas metering in any segment of the natural gas market, including gathering, transportation, distribution and storage. National pattern approvals exist for several countries.

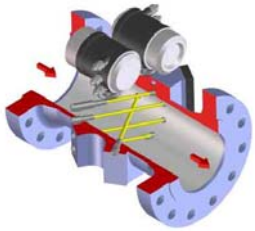
Figure 2 FLOWSIC600 1-path, 2-path and 4-path



2.1.2 FLOWSIC600 2plex (4 + 1 CBM Design)

The FLOWSIC600 2plex combines a fiscal and a diagnostic meter: the check meter with one pair of transducers, and the fiscal meter with four pairs of transducers. Both flow meters are incorporated into the same meter body, but metrologically independent. With their different path designs and the resulting difference in sensitivity the diagnostics of the FLOWSIC600 2plex can be compared in order to identify disturbances (caused by contamination, pulsation or noise) at an early stage and provide a warning long before the fiscal measurement will be impacted (see outline drawings → pg. 258, Figure 123).

Figure 3 FLOWSIC600 2plex



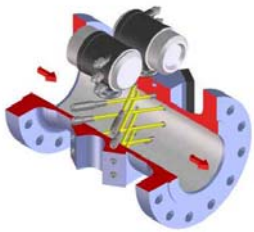
2.1.3 FLOWSIC600 Quatro

The redundant design of the FLOWSIC600 Quatro provides two 4-path fiscal meters for full redundancy with equal accuracy within one meter body. Each electronics operates 4 chordal pairs of transducers (within the same plane), and each determines the flow independently. This design significantly reduces costs for installations that traditionally utilized two separate meters with their associated piping.

The primary benefit of this design is that two different companies can utilize one meter body, but have totally electrically isolated metering systems. This permits each company to compute flow with equal accuracy, but be totally independent of each other. Additionally, should one of the electronics develop a problem or fail, the secondary unit will continue to provide accurate measurement data.

As an 8-path meter, the FLOWSIC600 Quatro can be used at flow test laboratories (see outline drawings → pg. 261, Figure 126).

Figure 4 FLOWSIC600 Quatro



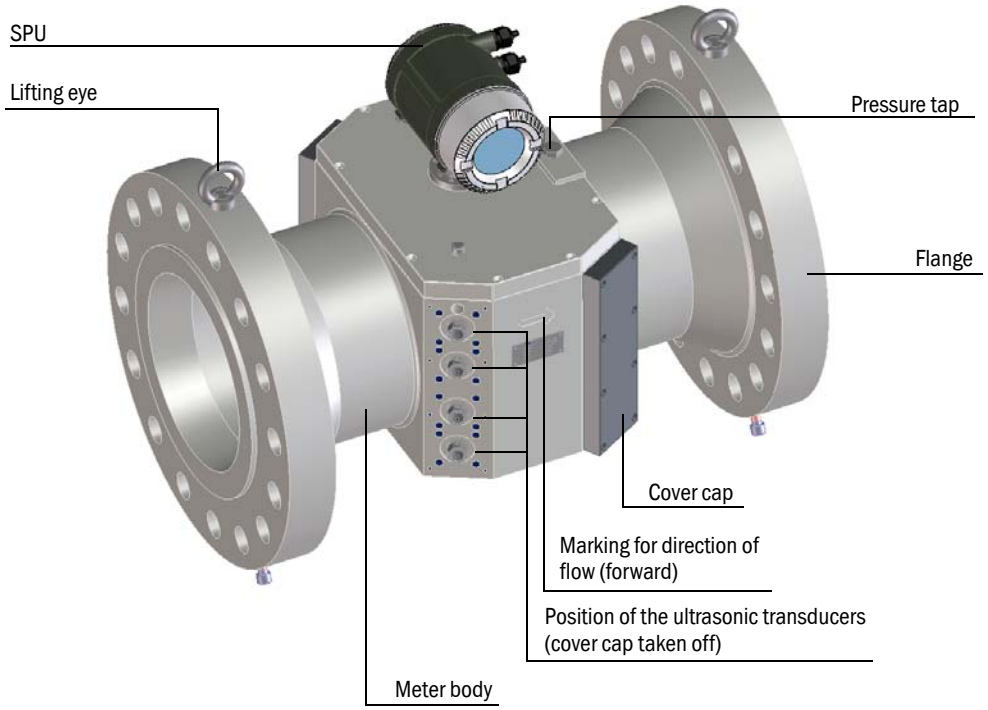
2.2 System components

The FLOWSIC600 measuring system consists of the following hardware components:

- Meter body
- Ultrasonic transducers
- Signal processing unit (SCU)

The MEPAFLOW600 CBM software is the user interface used to facilitate configuration and diagnosis (→ pg. 55, 2.9).

Figure 5 FLOWSIC600



2.2.1 Meter body

The meter body consists of a mid section for mounting the ultrasonic transducers, with flanges on either end. The meter body is made of a single-piece casting or forging, which is machined on precision equipment to ensure high reproducibility of the geometric parameters.

The internal diameter, design of the sealing surface, and standard dimensions of the flanges are in accordance with the specifications in the key code. The meter body material is chosen to suit customer requirements. Standard meter bodies are available in carbon steel, low temperature carbon steel and stainless steel.

The meter bodies can be delivered in several nominal sizes (→ pg. 208, 9.1.4).

2.2.2 Ultrasonic transducers

The FLOWSIC600 ultrasonic transducers are optimized to suit your application requirements. The high quality of the transducer design provides the basis for accurate and highly stable propagation time measurements with nanosecond precision. These transducers are of an intrinsically safe design ("ia", with Equipment Protection Level Ga).

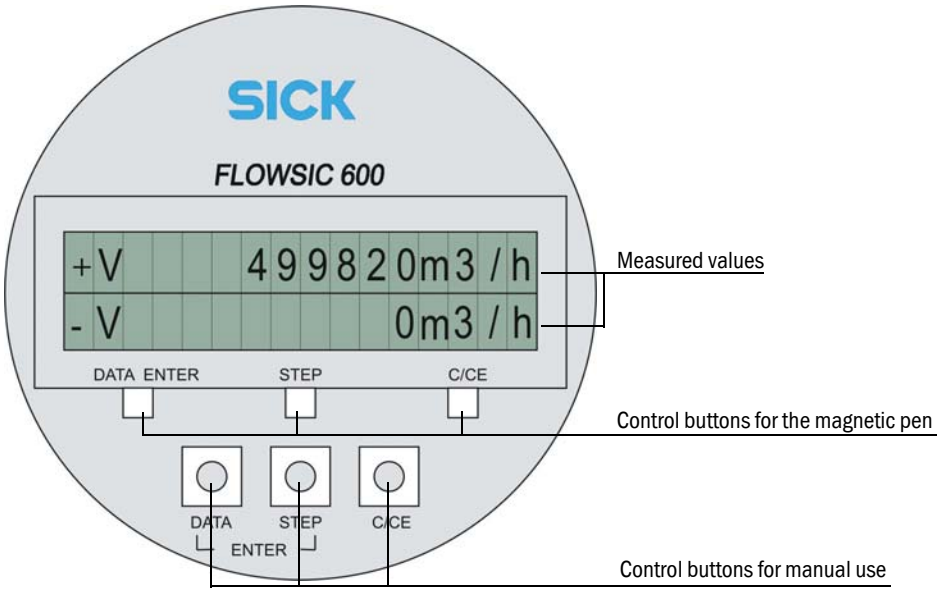
2.2.3 Signal processing unit

The Signal processing unit (SPU) contains all the electrical and electronic components for controlling the ultrasonic transducers. It generates transmission signals and analyzes the received signals to calculate the measuring values. The SPU also contains several interfaces for communication with a PC or standardized process control system.

The volume counters, log books (errors, warnings, parameter changes) and datalogs are stored in non-volatile data memory (FRAM) together with a time stamp (Logbooks → pg. 234, 9.4.) On system restart, the counter readings that were last saved are restored as the start values for the volume counters. The FRAM backup provides an unlimited number of writing cycles and protects the saved data for a minimum of 10 years.

The SPU is equipped with a front panel containing a two-line LCD to display current measured values, diagnostics and logbook information (→ Figure 6). An LED display is optionally available. The values to be displayed can be selected using a magnetic pen without removal of the window cover (for details on operation and menu structure → pg. 221, 9.3).

Figure 6 FLOWSIC600 front panel LCD



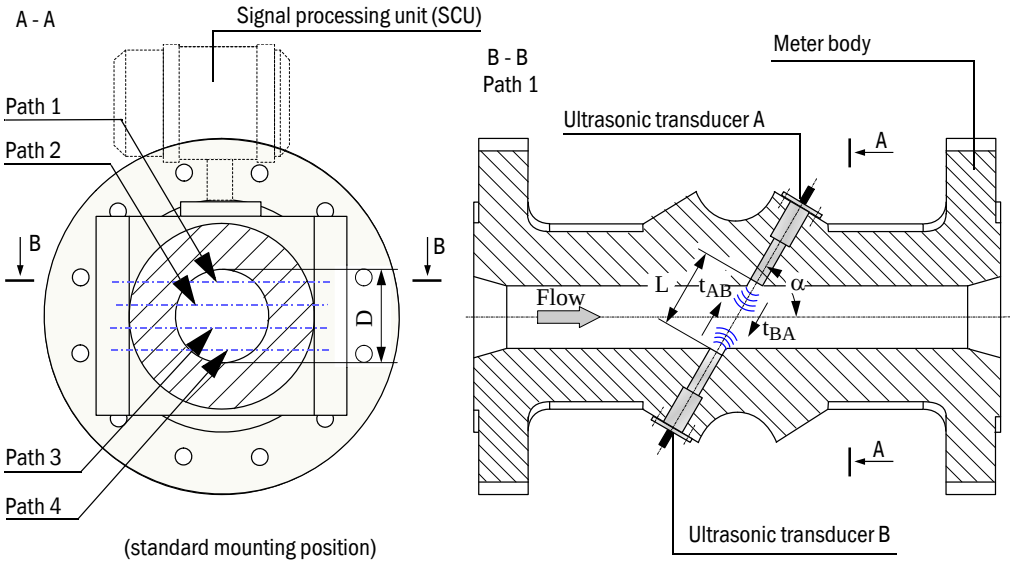
The power supply and interface terminals are located on the back of the SPU in a separate terminal section of the enclosure (→ pg. 108, 4.4.4).

The electronics are mounted in the SPU enclosure certified to EN / IEC 60079-1 with protection type "d" (flameproof enclosure). The transducer circuits are of an intrinsically safe design ("ia", with Equipment Protection Level Ga).

2.3 Measuring principle

The FLOWSIC600 operates by measuring the propagation delay of an ultrasonic pulse. The standard 4-path meter is equipped with four pairs of identical ultrasonic transducers. The transducer pairs are integrated in a meter body and arranged opposite one another at a defined angle to the flow axis, thereby forming a direct measuring path (→ Figure 7)

Figure 7 FLOWSIC600 measuring principle



The ultrasonic pulses cross the meter body from transducer to transducer. With no gas flowing, the pulses are emitted with the same speed (speed of sound) in both directions. When a gas is flowing through the meter body, the pulse in the direction of the gas flow is faster, while the pulse flowing against the flow is slower. This means that the transit time is shorter in the direction of flow (t_{AB}) and longer against the direction of flow (t_{BA}).

The ultrasonic transducers operate alternately as a transmitter and receiver. Each transducer is a piezoceramic element that is coupled with a diaphragm. To transmit signals, an alternating current is applied to the piezoceramic element so that it vibrates mechanically (piezoelectric effect). These vibrations are then transferred through the diaphragm to the gas. The vibrations are propagated as acoustic waves in the gas and strike the diaphragm on the opposite transducer after a propagation time that depends on the speed of sound and on the gas velocity. The waves are transferred to the piezoceramic element in the form of mechanical vibrations. They are then converted into an electrical signal by the inverse piezoelectric effect and used for further signal analysis.

The signals are then processed to calculate the transit times of the acoustic signals through the flowing medium. From the transit time the measurands can be calculated.

2.3.1 Determining the gas velocity

Measuring cycle

In the operating status "Measurement", the FLOWSIC600 determines the gas velocity on each path 10 times per second. One measuring cycle consists of a velocity measurement per path, the integration of the operating volume, several internal procedures and the update of the measured value output channels. This cycle takes about 100 ms.

Determining the transit time of the ultrasonic signals

A full analysis of the ultrasonic signals makes it possible to determine the point of time of signal reception, and thus the delay to the point of time of signal transmission. The signal propagation times in the flowing gas, t_{AB} and t_{BA}, are determined on the basis of this transit time.

Sound transit time in the direction of flow t_{AB}:

$$t_{AB} = \frac{L}{c + v_{Path} \cdot \cos \alpha}$$

Sound transit time against the direction of flow t_{BA}:

$$t_{BA} = \frac{L}{c - v_{Path} \cdot \cos \alpha}$$

L: Measuring path length
c: Speed of sound
v_{Path}: Path velocity
α: Angle between the longitudinal axis of the meter body and the path

Path velocity

The path velocity ($v_{Path\ i}$) is calculated from the difference between the two transit times:

$$v_{Path\ i} = \frac{L_i}{2 \bullet \cos \alpha_i} \cdot \left(\frac{1}{t_{AB\ i}} - \frac{1}{t_{BA\ i}} \right)$$

Path number 1 ... 4:
$v_{Path\ i}$: Measuring values in registers #7507 to #7510

α i: Register #7101 to #7104

L_i is the distance between the two transducer diaphragms.

This distance is calculated by subtracting the length of the transducers used (Reg. #7109 to #7116 "SensorLength i AB") from the distance between the transducer seats in the meter body (Reg. #7105 to #7108 "Length i").

$L_i = L_{Meter\ body\ i} - (L_{Transducer\ A\ i} + L_{Transducer\ B\ i})$

Mean path velocity

The most recent 100 measured results (path velocity and measurement status) are stored in a mean value memory. If no valid path velocity was determined due to a negative plausibility check, such condition is also stored in the mean value memory. The mean value memory is organized as FIFO memory. This means that the most recent entry always overwrites the oldest one. The mean path velocity $v_{avg\ i}$ comprises all valid measured values stored in the memory.

$$v_{avg\ i} = \frac{\sum v_{Path\ i}}{\text{all valid values}\ N_{valid}}$$

The percentage of invalid measurements within the last 100 measurements is used as a quality parameter (Reg. #3008 to #3011 "% Error i"). If the proportion of invalid measurements exceeds a certain threshold (Reg. #3514 "Limit%Error", manufacturer constant = 95%), the path is not used in the calculation of the flow velocity. In such cases, a replacement value may be determined for the faulty path in order to compensate for the failure (→ 2.4, p.28).

In MEPAFLOW600 CBM the reciprocal of the % Error (i.e. % Performance) is displayed.

Flow velocity (VOG)

The sum of the weighted average of the each of the four path velocities is the flow velocity through the meter body VA (Reg. #7004 "AvgVelGas").

v_A: Flow velocity
w_i: Weighting factor of a:
-measuring path
-Reg. #7120 to #7123 "Weight i"

$$v_A = \sum_{i=1}^{4} w_i \cdot v_{avg\ i}$$

If the diameter of the meter is not the same as the diameter of the pipe, then VA is calculated as follows:

v_A: Flow velocity
D_{pipe}: Pipe diameter (Reg. #7119)
Q_V: Uncorrected volume flow rate
→ pg. 24, 2.3.2

$$v_A = \frac{Q_V}{0.25 \cdot Pi + D_{pipe}^{\ 2} \cdot 3600}$$

2.3.2 Calculating the volumetric flow rate

The uncorrected volumetric flow rate Q_V^* is calculated from the flow velocity v_A and the open cross-sectional area in the meter body's measuring section:

D: Internal diameter of the meter body, Reg. #7100 "InnerDiameter"

$$Qv^* = v_A \cdot \frac{D^2 \cdot \pi}{4}$$

This intermediate result is still dependent on Reynolds number and the properties of the flow profile (asymmetry, swirl). It is corrected using the following formula:

$$Q_v = Q_v^* \cdot (1 + f\,[Q_v^*, p_{abs}, CC_{0...4}, PF, K_{0...5}])$$

Profile factor

$$PF = \frac{v_{avg2} + v_{avg3}}{v_{avg1} + v_{avg4}}$$

Fixed gas pressure: mean pressure in the operating range, register #7041 "Pressure(Fixed)".

Also → pg. 69, 3.2.2.2

$$p = \sqrt{p_{min} \cdot p_{max}} + 1bar$$

The sets of factors CC_0 to CC_4 and K_0 to K_5 are nominal size-dependent constants which were determined by the manufacturer and which are related to a particular FLOWSIC600.

Correcting the impact of pressure and temperature on the geometry of the meter body

The geometry parameters of the meter body are based on ambient temperature of 20 °C and 1 bar(a) and have been optimized to minimize deviations due to the influence of pressure and temperature. However, there is still an impact of pressure and temperature on the geometry of the meter body and thus on the measured value. This impact is corrected as follows:

Reg. #7040 "Temperature(fixed)" Reg. #7041 "Pressure(Fixed)" Reg. #7118 "ExpCorrTemperature Reg. #7117 "ExpCorrPressure"

$$Q_{v,\,corr} = Q_v \cdot (1 + K_T \cdot (T - 293.15) + K_p \cdot p)$$

The temperature coefficient K_T is material-specific and is $4.12 \cdot 10^{-5}\ K^{-1}$ for carbon steel and $5.23 \cdot 10^{-5}\ K^{-1}$ for stainless steel.

The pressure coefficient K_p was determined to be $6 \cdot 10^{-6}\ bar^{-1}$.

Correcting the characteristic "as found" calibration curve

The characteristic "as found" curve may be corrected using a factor dependent on the direction of flow ($AF_{forward}$, $AF_{reverse}$). In addition, a zero offset (ZO) may be entered. A meter functioning correctly should have a zero offset of 0.

$AF_{forw.}$: Reg. #7037 "AdjustFactorForward" Default: 1.0

$AF_{rev.}$: Reg. #7038 "AdjustFactorReverse" Default: 1.0

$$Q_{v,\,cal} = Q_{v,\,corr} \cdot AF_{forward}$$

$$Q_{v,\,cal} = Q_{v,\,corr} \cdot AF_{reverse}$$

The calculation of the factors is based on the weighted mean error (WME, equivalent to OIML recommendation no.137-1).

$$WME = \frac{\sum_{i=1}^{n} k_i \bullet E_i}{\sum_{i=1}^{n} k_i} \qquad \text{where } k_i = \frac{Q_i}{Q_{max}}$$

Q_i:	Tested flow rate
Q_{max}:	Tested maximum flow rate
E_i:	Mean error in % established at the tested flow rate

For $Q_i > 0.9\ Q_{max}$ a weighted factor of 0.4 should be used instead of 1 (OIML 137-1).

The corresponding factor is then calculated as follows:

$$AF = \frac{1}{1 + \frac{WME}{100}}$$

The result of the volumetric flow calculation is stored in register #7001 "VolumeFlow".
For further details on correction functions → §3 "Flow Calibration".

2.3.3 Calculating the actual volume

The operating volume is calculated from the operating volumetric flow rate $Q_{v,\ cal}$ by integration over time of the measuring intervals.

T_s: Measuring interval between two measurements

$$V_i = Q_{v,\ cal} \cdot T_s$$

The total aggregated volume is stored in the operating volume counters for both directions of flow. The operating volume counters can be reset if the Parameter write lock is UNLOCKED.

Reg.	Volume Counter	Abbreviation
#5010	Volume at flowing conditions (forward)	+ Vf
#5012	Volume at flowing conditions (reverse)	- Vf

While the system is in "Data invalid" status, the volumes determined are stored in separate error volume counters. These counters can be reset. Such a reset is recorded in the Custody logbook [1] together with date and time stamp.

Reg.	Volume Counter	Abbreviation
#5011	Error volume at flowing conditions (forward)	+ Ef
#5013	Error volume at flowing conditions (reverse)	- Ef

The resolution of aggregated volumes per volume unit [m³ or ft³] is defined in register #5014 "TotalizerResolution". When reading the volume counters (#5010 to #5013), the corresponding counter resolution must be considered.

$$V = \text{Volume register value } [m^3] \cdot \frac{\text{TotalizerResolution}[1/m^3]}{1000} [m^3]$$

Counter resolution (defaults)

Table 1

	Metric Units	
Nominal pipe size	**Register #5014 [1/m³]**	**Resulting resolution [m³]**
DN 50 (NPS 2)	10	0.01
DN 80 (NPS 3)		
DN 100 (NPS 4)		
DN 150 (NPS 6)	100	0.1
DN 200 (NPS 8)		
DN 250 (NPS 10)		
DN 300 (NPS 12)		
DN 350 (NPS 14)		
DN 400 (NPS 16)		
DN 450 (NPS 18)	1,000	1.0
DN 500 (NPS 20)		
DN 600 (NPS 24)		
NPS28 - NPS48	10,000	10

Calculation of total volume

Reg.	Volume counter	Abbreviation
#5016 (low bit) #5017 (high bit)	Total volume at flowing conditions (forward)[1]	+ Vo
#5018 (low bit) #5019 (high bit)	Total volume at flowing conditions (reverse)[1]	- Vo
#5085 (low bit) #5086 (high bit)	Total volume at base conditions (forward)[1]	+ VB
#5047 (low bit) #5048 (high bit)	Total volume at base conditions (reverse)[1]	- VB
#5045 (low bit) #5046 (high bit)	Total volume at flowing conditions (plus forward, minus reverse)[1]	Vo

[1] The 18 digit total volume counter values are stored in two long word registers of 9 digits each. The first 9 digits are stored in the "low" digit register, and the last 9 digits in the "high" digit register. The LCD displays only the "low" bits of the total volume counters.

The total volume counters +Vo and -Vo represent the sum of the respective volume counter plus the error volume counter:

$$|+Vo| = |+Vf| + |+Ef|$$

$$|-Vo| = |-Vf| + |-Ef|$$

The total volume counter Vo counts forward for volume flow in the positive direction and backwards for volume flow in the reverse direction:

$$Vo = |+Vf| + |+Ef| - |-Vf| - |-Ef|$$

Low flow cut off

If the current flow rate falls below a preset limit (register #7036 "LowFlowCutOff"), the calculated volumetric flow is set to zero. The current calculated flow velocity is not affected by this. The limit is set to 0.25 Q_{min} at the factory.

2.3.4 Determining the speed of sound

The actual speed of sound c in the gas under operating conditions is calculated from the sum of the two measured propagation times $t_{AB\,i}$ and $t_{BA\,i}$ of a path.

$$c_i = \frac{L_i}{2} \cdot \left(\frac{1}{t_{AB\,i}} + \frac{1}{t_{BA\,i}} \right)$$

$$c = \frac{1}{4} \sum_{i=1}^{4} c_i$$

A theoretical speed of sound can be derived from the gas composition, pressure and temperature values. This theoretical speed of sound and the measured speed of sound should be identical. The speed of sound thus provides an excellent diagnostic measure for system operation → pg. 169, 6.2.1.

2.4 Path failure compensation

NOTICE: **Type approval**

A 4-path FLOWSIC600 is able to compensate for the failure of one or more paths using a static or an adaptive compensation routine as described below. Path failure may be caused by a received ultrasonic signal which is invalid, i.e. the quality of the ultrasonic signal received will not allow the determination of a correct signal travel time and therefore correct gas velocity for this path.

- A 4-path FLOWSIC600 configured for custody transfer application (custody configuration) will indicate the compensation of one path failure with the meter status "Check Request". If two or more paths fail, the meter status "Data invalid" will be activated.
- A 4-path FLOWSIC600 configured for process applications will indicate the compensation of up to three path failures with the meter status "Check Request". If the remaining last path fails, the meter status "Data invalid" will be activated.

The measured value of the failed path is substituted with a calculated replacement value. This replacement value is calculated on the basis of the current valid values measured for other paths, and the relationship of gas velocities between the individual paths. The relationship between the paths for valid measurements is defined by the individual flow profile value in the installation. This relationship is continuously calculated and saved during undisturbed measurement operation of the meter.

Field studies have shown that it is useful to distinguish between two ranges (low velocity and high velocity). The relationship of gas velocities between the paths is stored separately for each of these two ranges.

Automatic determination and learning of path relationships

During normal operation, the individual path relationship P_{Path} is calculated continuously.

v_A: Mean area velocity
N: Number of measuring paths
w_i: Weighting factor of a: measuring path

(1) $$P_{Path\ i} = \frac{v_{Path\ i}}{v_A}$$

The mean area velocity is calculated as follows:

(2) $$v_A = \frac{1}{N} \sum_{i=1}^{N} w_i \cdot v_{Path\ i}$$

These relationships are used in an adaptive mean value calculation routine for each individual path. Statistical variation caused by turbulence is sufficiently suppressed with the help of this mean value calculation. This algorithm further allows the measuring system to adapt to different flow profiles caused by changes in operating conditions.

Due to the unique path relationships of each individual installation, every meter must determine the path relationships during the commissioning procedure (→ pg. 164, 5.8).

In order to ensure that the system is able to compensate for path failure at both high and low flow velocities, it is recommended that the FLOWSIC600 meter be run for 20 minutes at low gas velocities (< 8 m/s) (< 26.25 ft/s) first and then for 20 minutes at high gas velocities (> 8 m/s) (> 26.25 ft/s) during commissioning.

After starting the system, the average path relationship values are calculated on the basis of a minimum of 10,000 individual measurements. To collect that amount of data, the FLOWSIC600 requires approximately 20 minutes of error-free measurement on all paths.

Example:

The FLOWSIC600 makes 10 readings per second for each path, giving 6,000 readings in 10 minutes, and 10,200 in 17 minutes.

Because the path compensation procedure operates in a low (1 to 8 m/s or 3.28 to 26.24 ft/s) and a high (>8 m/s or >26.25 ft/s) gas velocity band separately, the FLOWSIC600 needs to measure 20 minutes within the low and 20 minutes within high velocity range.

When the average path relationships have been established based on the required minimum number of single readings, the path relationships are marked valid (the bit in Reg. #3003 "System Status" is set to "valid"), and the system is then able to compensate for path failure.

The variable mean value calculation is turned on at the same time. The default attenuation constant for this self-learning algorithm (Reg. #7206 "PathCompAverWeight") ensures that statistical variation is suppressed.

The path relationships for low (1-8 m/s or3.28 to 26.25 ft/s) and high flow velocities (> 8 m/s or >26.25 ft/s) are determined separately (see table below). This improves the result of the compensation because the path relationships are more stable at higher flow velocities. The path relationships are not learned if the flow velocity is below the value in Reg. #7208 "PathCompClassLo".

Parameter	**Default value (flow velocity, absolute value)**	**Notes**
Operation below "PathCompClassLo"	< 1 m/s	If the flow velocity is below the value specified in Reg. #7208 "PathCompClassLo", no automatic path relation adaptation occurs. In case of failure, the stored path relations for low flow velocities (1-8 m/s) are used.
Reg. #7208 "PathCompClassLo"	1 ... 8 m/s	If the flow velocity is above the value "PathCompClassLo", but below "PathCompClassHi", continuous calculation and adaptation of the path relations occurs. The results are saved in the "low flow" class registers #7289 - #7292 (path 1-4).
Reg. #7207 "PathCompClassHi"	> 8 m/s	If the flow velocity is above "PathCompClassHi", continuous calculation and adaptation of the path relations occurs. The results are saved in the "high flow" class registers #7285 - #7288 (path 1-4).

Adaptive compensation of one or more path failures

If the self-diagnosis routine implemented in the system detects a path failure, the velocity value for the failed path will not be used for the calculation of the mean area velocity v_A. If this occurs, the following formula will be used to calculate the mean area velocity based on the measured values applicable for the remaining paths and the stored adapted path relations.

bi: Status bit for path i
bi = 0: Path inactive (or failed)
bi = 1: Path active

$$v_A = \frac{\sum_{i=1}^{N} b_i \cdot w_i \cdot \frac{v_{Path\ i}}{P_{Path\ i}}}{\sum_{i=1}^{N} b_i \cdot w_i}$$

The system indicates that a path failure is being compensated with the "Check request" signal. An additional measurement uncertainty of up to 0.35% is tolerated in a four-path system when it is operating under the meter status "Check request". The volume measured for that period is stored in the normal volume counters for each flow direction.

Multiple path failure is compensated using the same principle, but the system then operates under the meter status "Data invalid". The volume measured for that period is stored in separate error volume counters for each flow direction. This enables gas quantities transported to be determined despite an increased measurement uncertainty.

Static compensation of one or more path failures

If the adaptive path compensation routine is turned off, static path relations as shown in the table below are used for path failure compensation. These default static values are based on the data of several installations.

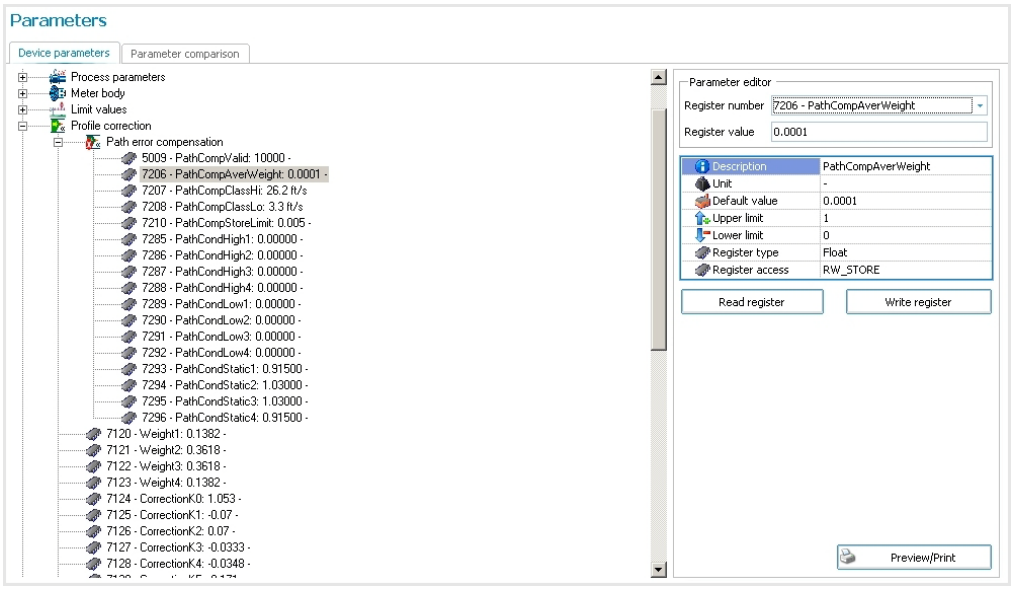
Number of paths	Path no.1	Path no.2	Path no.3	Path no.4
2	1.000	1.000		
4	0.915	1.030	1.030	0.915

The system indicates this status with the "Data invalid" signal. The volume measured for that period is stored in separate error volume counters for each flow direction. This enables gas quantities transported to be determined despite an increased measurement uncertainty.

Deactivation of the adaptive path failure compensation

If path failure compensation is not required, the calculation of the path relations can be suppressed by setting the attenuation constant (Reg. #7206 "PathCompAverWeight") to zero (→ Figure 8). In this case, only the static compensation described above will be active.

Figure 8 MEPAFLOW600 CBM, "Parameters" page, register #7206 (PathCompAverWeight)

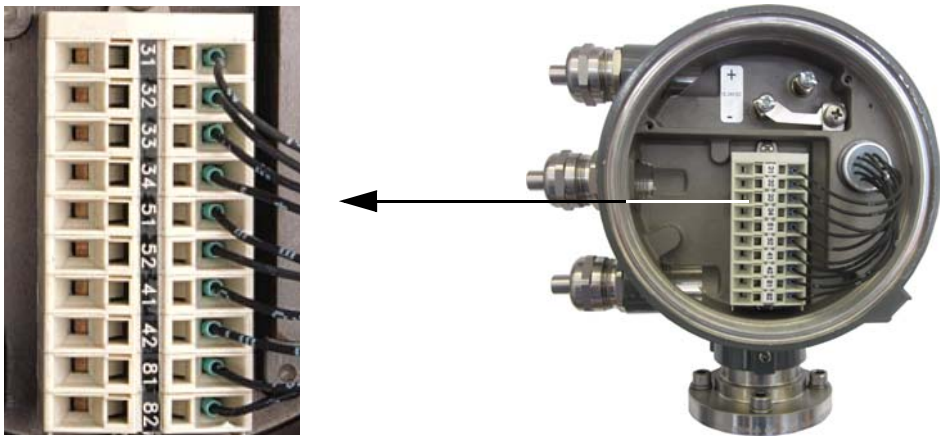


2.5 Output configurations

2.5.1 Hardware variants and signal outputs (I/O configuration)

The outputs of the FLOWSIC600 can be configured in several ways. Different output configurations require different hardware variants of the electronic unit (→ pg. 33, Table 3 and Table 4).

Figure 9 Terminals in the FLOWSIC600 signal processing unit (rear cover opened)



The following settings can be assigned to the four available physical outputs (the pure RS485 MODBUS communication port 33/34 is not considered to be an output). The settings can be configured on the "Parameters" page and in the "Field setup" wizard of the MEPAFLOW600 CBM software.

Digital output	Possible Settings
Output DO0 (31/32)	Pulse, warning, data invalid, flow direction, check request
	AO output 4 .. 20mA or 4 .. 20mA with serial HART®[1]
Communication (33/34)	Communication port RS485 MODBUS[2] (fixed)
Output DO1 (51/52)	Pulse, warning, data invalid, warning, flow direction, check request
Output DO2 (41/42)	Warning, data invalid, flow direction, check request
Output DO3 (81/82)	Communication port RS485 MODBUS[2]
	Warning, data invalid, flow direction, check request, ENCODER (NAMUR)[3]

1 For more detail on HART®, see document "HARTbus specification".
2 For more detail on RS485, see document "Short Manual MODBUS".
3 For more detail on the encoder option, see document "Technical Bulletin ENCODER output".

Table 2 Possible sources for analog output and impulse output

Reg.	Measurement output
#7001	Flow rate at flowing conditions (a.c.)
#7002	Flow rate at base conditions (s.c.)
#7003	Speed of sound (SOS) (averaged over paths)
#7004	Velocity of gas (VOG) (averaged over paths)
#7046	Molar mass
#7047	Mass flow

Table 3 Hardware variant / output configuration without integrated Electronic Volume Corrector (EVC)

Hardware variant/Output configuration[1]										
Analog board	**Standard**	1 (1/1)	2 (1/2)	3 (1/3)	4 (2/4)	5 (2/4)	6 (2/5)	7 (2/5)	9 (4/7)	0 (4/2)
	Low pressure	E (7/1)	F (7/2)	G (7/3)	H (8/4)	I (8/4)	J (8/5)	K (8/5)	L (9/7)	Q (9/2)
Output terminal	31/32	Pulse	Pulse	Status	Analog	Analog/ HART	Analog	Analog/ HART	Analog	Pulse
	33/34	RS485	RS485	RS485	RS485	RS485	RS485	RS485	RS485	RS485
	51/52	Pulse	Pulse	Pulse	Pulse	Pulse	Status	Status	Pulse	Pulse
	41/42	Status	Status	Status	Status	Status	Status	Status	Status	Status
	81/82	Status	RS485	Status	Status	Status	Status	Status	RS485	RS485

[1] X(Y/Z):
X = Code for hardware variant and output configuration within the new internal Key Code.
Y = Code for hardware variant within the Key Code (→ pg. 207, Figure 97).
Z = Code for output configuration.

Table 4 Hardware variant / output configuration with integrated Electronic Volume Corrector (EVC) continued

Hardware variant/Output configuration[1]					
Analog board	**Standard**	A (5/8)	B(5/9)	C(6/10)	D(6/11)
	Low pressure	M (A/8)	N (A/9)	O (B/10)	P (B/11)
Output terminal	31/32	EVC ext. PS	EVC ext. PS	EVC int. PS	EVC int. PS
	33/34	RS485	RS485	RS485	RS485
	51/52	Pulse	Pulse	Pulse	Pulse
	41/42	Status	Status	Status	Status
	81/82	Status	RS485	Status	RS485

1 X(Y/Z):
X = Code for hardware variant and output configuration within the new internal Key Code.
Y = Code for hardware variant within the Key Code (→ pg. 207, Figure 97).
Z = Code for output configuration.

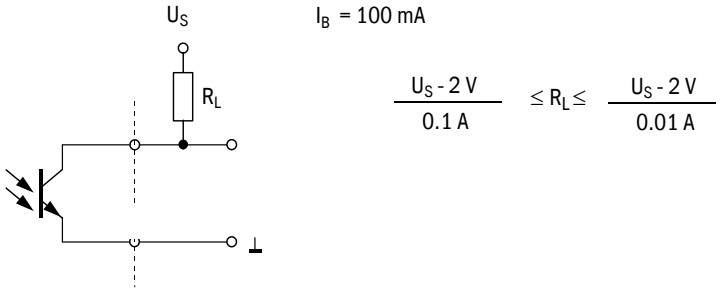
Wiring of digital outputs

The digital output (terminals 31/32, 51/52, 41/42, 81/82) can be wired as Open Collector or as NAMUR contact for connection to a NAMUR amplifier.

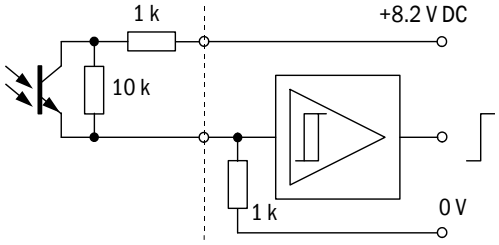
The outputs are wired to "NAMUR" on delivery, unless "Open Collector" was specified in the purchase order.

Figure 10 Wiring of digital outputs

Open Collector



NAMUR



NOTICE:

- An operating current range of 20 mA is recommended.
- I_{max} at the open collector connection must not exceed 100mA., otherwise the output may be destroyed.
- The maximum possible frequency of the impulse output depends on R_L and the cable length (cable capacitance).
- A higher frequency requires a lower R_L. For this case a low capacitance cable is recommended.

2.5.2 Optional integrated Electronic Volume Corrector (EVC)

The FLOWSIC600 (firmware V3.4.00 or higher) can be ordered with an integrated electronic volume corrector (EVC). On request and for extra charge, the EVC feature can be activated in the field. Please contact your local representative.

The FLOWSIC600 supports three different algorithms for gas volume correction. Alternatively the option "Fixed values" can be used.

Table 5 Algorithms for gas volume correction and alternative option "Fixed values"

SGERG88	Applicable up to a pressure of 100 bar (1450 psi).
MR113-3	Algorithm created in Russia and recommended for use in the Russian petroleum market for wet petroleum (flare gas) associated gas in a temperature range of –10 °C .. 230 °C at pressures up to 150 bar.
GERG91 mod	Recommended for correction of dry natural gas in Russia.
Alternative option "Fixed values"	Alternatively, the user can choose to calculate the molar mass using the measured SOS and the gas temperature taken as fixed or live value.

For detailed information on the EVC see document "FLOWSIC600 Technical Bulletin: EVC" (available from your local representative).

2.6 Operating modes, meter states and signal output

The FLOWSIC600 has two operating modes (→ pg. 37, 2.6.1):

- Operation
- Configuration Mode

In Operation Mode, the meter can have the following meter states (→ pg. 38, 2.6.2):

- Measurement valid
- Chck request
- Data invalid

2.6.1 Operation mode and configuration mode

The meter can be operated by the user in two modes: Operation Mode or Configuration Mode.

Operation Mode

In Operation Mode, the meter runs in one of the three aforementioned meter states, depending on the measuring conditions.

Configuration Mode

The Configuration Mode is used to modify parameters that directly influence the measurement and to test the system and output signals. Configuration Mode forces the meter into the meter status "Data invalid" and the digital output "Measurement valid" is deactivated. Invalid measured values may be produced. The system continues operation using the current sample rate and executes all calculations as in the Operation Mode. Frequency output and analog output may represent test values and do thus not necessarily indicate measured values. Any parameter modifications are applied immediately to the running calculations with the following exception: changes of the sample rate or of the configuration of the serial interface are applied after the meter is switched to Operation Mode.

If the meter is in Configuration Mode and there have been no activities either on the LCD display or via MEPAFLOW600 CBM for more than 15 minutes, the meter automatically switches to Operation Mode.

2.6.2 Meter states

2.6.2.1 Status: Measurement valid

The meter status "Measurement" is the standard meter status of the FLOWSIC600. Frequency outputs and current output are updated cyclically and indicate the actual volume and volume flow rate. In addition, the analog signal can indicate the actual flow rate, corrected volumetric flow rate, SOS (speed of sound) or VOG (velocity of gas). The digital output "Direction of flow" is updated in accordance with the direction of the volumetric flow. The digital output "Measurement valid" (active) represents the status of the measurement. Positive (forward) and negative (reverse) volumetric flow rates are integrated and saved in separate internal memory sections.

The MODBUS interface allows the query of all parameters and signals at any time without interfering with the function of the system.

Each measurement initiated by the system controller includes one full transit time measurement with, and one against the direction of flow on each path. The result of each measurement is written to a mean value memory to be used in further calculations. The size of this memory block and thus the device response delay can be modified through the parameter in register #3502 "AvgBlockSize". If no result can be calculated due to poor signal quality, this measurement is registered as an invalid attempt in the mean value memory. The mean value is formed in a variable averaging process including all valid measured values in the memory.

If the number of invalid measurements on a path exceeds a predefined limit (Reg. #3514 „Performance“), the measuring system activates the meter status "Check request".

2.6.2.2 Status: Check request

This meter status becomes active if one measuring path has failed and the adaptive path failure compensation has been activated (→ 2.4, p.28). The multi-path FLOWSIC600 system is able to compensate for this failure. Measurement is continued with reduced accuracy and the volume is still counted in the volume counters. If a path fails while the path failure compensation is not active, the measuring system will activate the "Data invalid" status.

Moreover the meter status "Check request" becomes active when the system alarms 2002 ("No HART communication to temperature transmitter"), 2003 ("No HART communication to pressure transmitter"), or 2004 ("Maximum pulse output frequency exceeded") become active (see Technical Informationtable → pg. 234, 9.4.1).

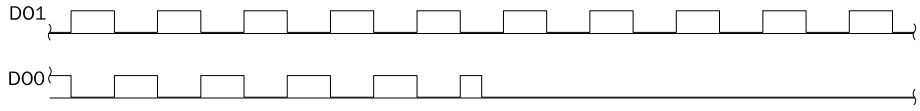
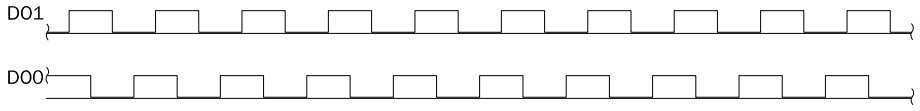
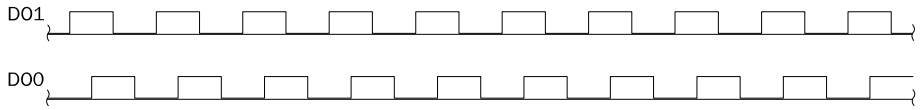
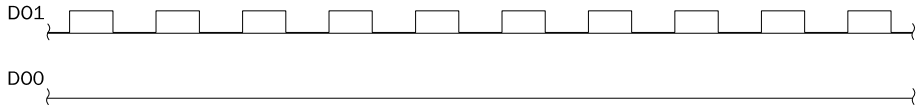
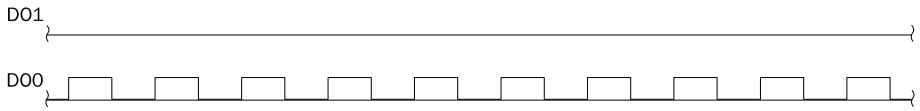
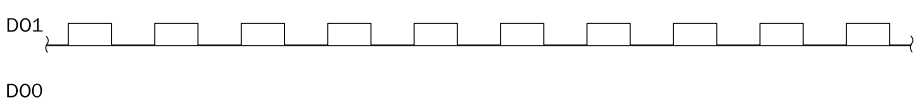
2.6.2.3 Status: Data invalid

If the quality of received signals is deficient in one or more measuring paths or the logbook is full or the measured value is out of the calibration range, the SPU must mark the measured value invalid and activate the meter status "Data invalid". The measured volume is counted in the error volume counter. However, the SPU will cyclically attempt to re-establish valid measurements. As soon as the signal quality and number of valid measurements meet the required criteria, the SPU will automatically change back to the "Measurement valid" or "Check request" status.

2.6.3 Output of pulse signals and status information

> ***NOTICE:*** **TYPE APPROVAL**
> Pulse output signals can be customized as shown in the following table.

Table 6 Pulse output

Output signal / LCD / port			Signal behavior			
			Measurement status	Check request status	Configuration Mode	Data invalid*
Pulse output signals	Inverted with error signal **					
	Phase shift 90 ° ***	Positive flow rate				
		Negative flow rate				
	Separate outputs for reach direction	Positive flow rate				
		Negative flow rate				
	Single pulse output ***					

* The meter can be configured to output a fixed frequency if the meter has the status "Data invalid". The frequency to be output in this case can be configured (0-6 kHz) in Reg. #3034 "ErrorFreq".

** Default setting on delivery.

*** Optional setting on customer request.

The default setting for "Check request", "Configuration" and "Data invalid" is "normally closed".

Table 7 Status output

Output signal / LCD / port	Signal behavior			
	Measurement status	**Check request status**	**Configuration Mode**	**Data invalid**
"Check request" Status signal	Status "active / inactive" * Measurement valid	Status "active / inactive" * Compensation of path failure	"undefined"	"undefined"
"Direction of flow" Status signal	Status "active / inactive" * Positive or negative direction of flow	Status "active / inactive" * Positive or negative direction of flow	"undefined"	"undefined"
"Warning"	Status "active / inactive" *	Status "active / inactive" *	"undefined"	"undefined"
LCD display	+V 123456 m³ -V 1234 m³	1234 m³ E Display flashing	FLOWSIC600 Configuration	+V 123456 m³ E -V 1234 m³ Display flashing
Serial port RS485	● Measured value, diagnosis information and parameters ● Measuring data logging, diagnosis and configuration through the MEPAFLOW600 CBM software ● Connection with external process control equipment through implemented MODBUS protocol (data polling)			

*The "active" or "inactive" state can be assigned to the electric switch status "normally open" or "normally closed" by configuration in the MEPAFLOW600 CBM software (adjust settings for Reg. #5101 on the "Parameters" page → pg. 137, 5.5.4.).

The output signal designation is described in the Technical Information → 2.5.1, p.32.

The LCD display can display measured values, parameters, messages and other information (see → pg. 214, 9.2).

A flashing letter in the upper right corner of the LCD display indicates that a logbook contains unacknowledged logbook entries. Depending on the type of entry this will be:

- "I" for Information
- "W" for Warning
- "E" for Error

After acknowledging all new entries, the letter stops flashing. For details see → pg. 176, 6.4.1.

2.7 Self-diagnosis with User Warnings

During normal operation, the ratios of sound and path velocities, amplification values, performance, and signal-to-noise ratios are continuously monitored. If these values exceed set limits (customized User Warning limits), a warning signal will be generated. This allows immediate measures to be taken to address a problem which could potentially impact measurement quality. A message in the Warning Logbook documents the time of the event and the specific User Warning limit which was exceeded.

- The "Warning" signal does not affect the functionality of the meter.
- All User Warning parameters - except for the parameter 'Min. VOG for warnings" - can be configured in the User Access Level "Operator" and without switching the meter to the Configuration Mode.

A User Warning becomes active only if a User Warning limit has been continuously exceeded for a certain time (specified in the parameter "Warning duration and averaging for warnings" in the Configuration tab of User Warnings).

During commissioning or operation, the User Warning limits can be adapted and activated or deactivated in the "User Warnings" window in MEPAFLOW600 CBM to suit individual application requirements (→ pg. 149, 5.7.1).

Figure 11 Button "User" in the MEPAFLOW600 CBM main system bar, "User Warnings" window

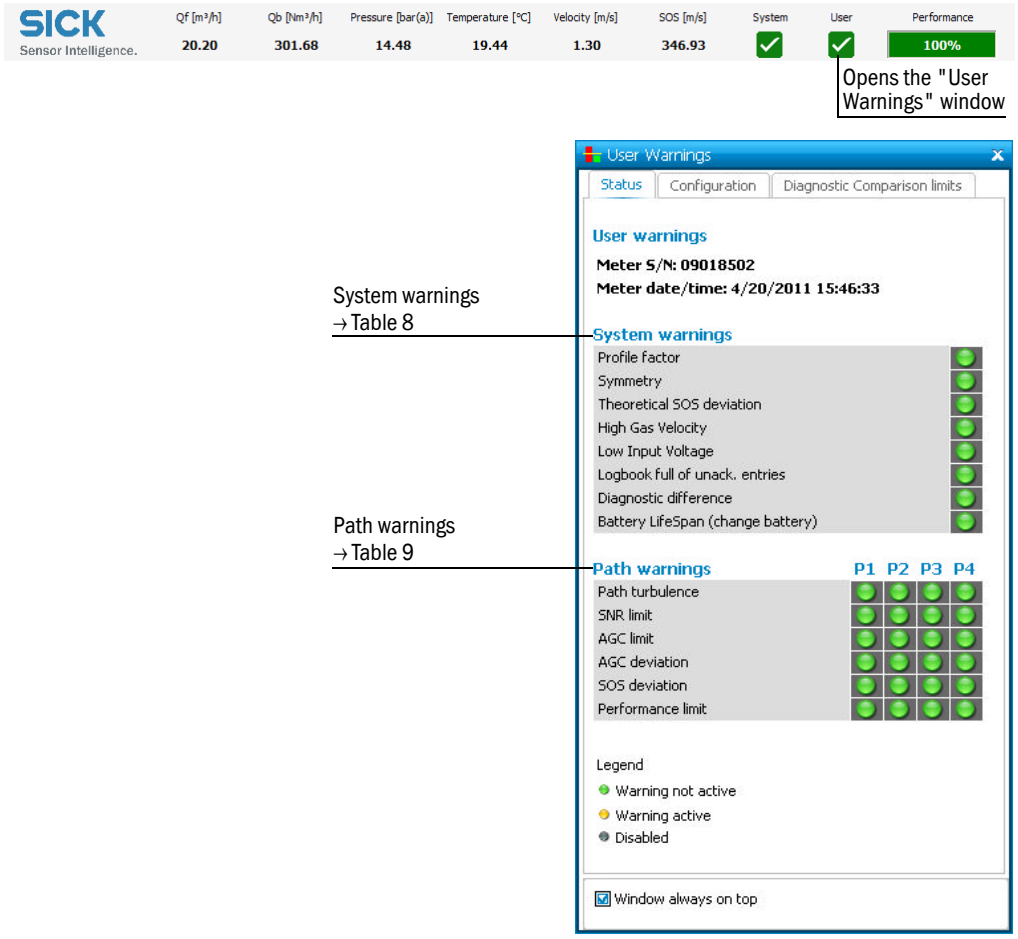


Table 8 System warnings in the User Warnings

Monitored measurement	Configurable User Warning Parameters	Default value	Notes	Default activation state[1]
Profile factor $= \frac{v2 + v3}{v1 + v4}$	Profile factor valid value[2]	1.11[3]	The profile factor represents the path velocity ratios of inner to outer paths. A change of the profile value may be caused by contamination, blockages or deposits in the line that change the shape of the flow profile.	Off
	Profile factor range[2]	5%[3]		
Symmetry $= \frac{v1 + v2}{v3 + v4}$	Symmetry valid value[2]	1.00[3]	The symmetry represents the path velocity ratios of upper to lower paths. A change of the symmetry value may be caused by contamination, blockages or deposits in the line that change the symmetry of the flow profile.	Off
	Symmetry range[2]	5%[3]		
Speed of sound (SOS) - deviation from theoretical SOS	Theoretical SOS deviation	0.3%	Optionally, a theoretical SOS calculated for the current gas composition, temperature and pressure can be written to the meter (e.g. from a flow computer). If the current measured SOS deviates from the theoretical SOS, a user warning is generated.	Off
High gas velocity	VOG limit	45 m/s	If the current Avg. Velocity of Gas exceeds the value "VOG limit", a User Warning is generated.	Off
Power supply (low input voltage)	Input voltage warning	12000mV	If the power supply voltage drops below the value "Input voltage warning", a User Warning is generated.	Off
Monitored event	**Configurable User Warning Parameters**		**Notes**	**Default activation state[1]**
A Logbook is full of unacknowledged entries	Logbook full of unack. entries		If one of the logbooks is full of unacknowledged entries, a User Warning is generated.	Off
Meter is in Configuration Mode	Warning at Configuration Mode		If the meter is in Configuration Mode, a User Warning is generated.	Off
Battery lifespan	Warning if battery lifespan is low		If the remaining battery lifespan is less than 15%, a User Warning is generated.	On

1 User Warnings must be activated to become effective on the warning output.

2 These User Warning limits are only monitored, as long as certain preconditions are met. The VOG must be above the value set in "Min. VOG for warnings" and the SOS must be relatively stable (change in %/s must be below the value set in "SOS profile rising").

3 The default value for these warning parameters can only be applied for a fully developed and symmetrical flow profile e.g. with a flow conditioner. The values should be adapted to the specific application

Table 9 Path warnings in the User Warnings

Monitored measurement	Configurable User Warning Parameters	Default value	Notes	Default activation state[1]
Turbulence[2] Variance of the average path velocity	Path turbulence	6%	A change in the path turbulence indicates changed flow conditions (e.g. a blocked flow conditioner). If the current turbulence value of any path exceeds the value "Path turbulence", a User Warning is generated.	Off
Signal-to-noise ratio (SNR)	SNR limit	13 dB	Interfering noise caused by fittings in the pipeline, valves that are not fully open, sources of noise near the measuring location, or defective ultrasonic transducers may affect the signal-to-noise-ratio. If the signal-to-noise ratio drops below the limit specified in "SNR limit", a User Warning is generated.	On
Signal amplification	AGC limit	93 dB	If the absolute value of the signal amplification exceeds the limit specified as "AGC limit", a User Warning is generated.	On
	AGC deviation	10 dB	The absolute difference between both path gain factors is monitored. If the AGCs of a path deviate more than permitted, this can indicate a malfunction in the ultrasonic transducers, electronic modules, transducer cables or parameter settings (signal models, control limits). If the value specified for the parameter "AGC deviation" is exceeded by a path, a User Warning is generated.	On
Speed of sound (SOS)[2]	SOS deviation	0.2%	The deviation between the current measured path SOS and the average value of the mean SOS calculated for all paths is monitored. The current gas velocity is used as a weighting factor, so that temperature stratification is disregarded at very low flow velocities. The SOS deviation indicates whether or not a path is measuring the correct transit time. If the SOS deviation of any path exceeds the value specified for the parameter "SOS deviation", a User Warning will be generated.	On
Performance	Performance limit	75%	The quality of the received signals is continuously monitored. If it drops below the limit specified in "Performance limit", a User Warning is generated.	Off

1 User Warnings must be activated to become effective on the warning output.

2 These User Warning limits are only monitored, as long as certain preconditions are met. The VOG must be above the value set in "Min. VOG for warnings" and the SOS must be relatively stable (change in %/s must be below the value set in "SOS profile rising").

Table 10 Warning preconditions

Configurable precondition	Default value	Notes
Warning Duration and averaging for warnings	30s	The User Warning status becomes active only if a User Warning has been continuously exceeded for the time specified in this parameter. All measurements monitored for the User Warnings are averaged over the time specified in this parameter.
Min. VOG for warnings	1 m/s (3.3 ft/s)	The monitoring of measurements for the User Warnings only takes effect, if the Avg. VOG is above the values specified in this parameter. **Caution:** This parameter also defines the lower limit of the gas velocity range classes for the Diagnostics Comparison Log . Changes to this parameter will clear all data from the Diagnostics Comparison Log. This parameter is the only User Warning parameter that can only be changed if the meter is in Configuration Mode and in the User Access Level "Service".
SOS profile rising	0%/s	The SOS deviation warning only takes effect if the the SOS gradient between all paths is below the limit specified in the parameter "SOS profilerising".

2.8 Data handling in the FLOWSIC600

2.8.1 Integrated volume counters

The FLOWSIC600 is equipped with integrated volume counters which can be displayed both on the LCD display and in MEPAFLOW600 CBM.

Integrated volume counters

Volume counter	Abbreviation
Volume at flowing conditions (forward)	+ Vf
Volume at flowing conditions (reverse)	- Vf
Error volume at flowing conditions (forward)[1]	+ Ef
Error volume at flowing conditions (reverse)[1]	- Ef
Total volume at flowing conditions (forward)	+ Vo
Total volume at flowing conditions (reverse)	- Vo
Total volume at flowing conditions (all)	Vo

Last hour/day registers

Volume counter	Abbreviation
Forward volume of last hour	Last hour forw.
Reverse volume of last hour	Last hour rev.
Forward volume of last day	Last day forw.
Reverse volume of last day	Last day rev.

Additional counters in meters with integrated Electronic Volume Corrector (EVC)

Volume counter	Abbreviation
Volume at base conditions (forward)	+ Vb
Volume at base conditions (reverse)	- Vb
Error volume at base conditions (forward)[1]	+ Eb
Error volume at base conditions (reverse)[1]	- Eb

Mass counters

Mass counter	Abbreviation
Mass counter (forward)	+ M
Mass counter (reverse)	- M
Mass total (forward)	M+
Mass total (reverse)	M-
Error Mass (forward)[1]	Me+
Error mass (reverse)[1]	Me-

[1] All error volume counters can be reset (User Access Level "Authorized operator", → pg. 233, 9.3.5). The value of the error volume counter at the time of reset is stored in a logbook entry.

2.8.2 Logbooks

Important system events are stored in three logbooks in the SPU memory of the meter.

Each logbook entry consists of a running index number, the event, a time stamp and the acknowledgement status. Entries in Custody logbook [1] and Warning logbook [2] also include the volume counter readings valid at that time. The events are logged continuously in order of occurrence into one of the three logbooks:

- Logbook 1 (Custody logbook [1], max. 1000 entries)
- Logbook 2 (Warning logbook [2], max. 500 entries)
- Logbook 3 (Parameter logbook [3], max. 250 entries)

Every logbook has its own index counter. Logbook entries are classified on the LCD display according to the event type.

Event types in logbooks

Display	Event type
E	Error
W	Warning
I	Information

A list of possible logbook entries can be found in the table ‘Overview of event entries‘ in the Appendix, see → pg. 234, 9.4.1.

Logbook overflow

NOTICE: **TYPE APPROVAL**

If a FLOWSIC600 is configured as a custody meter, the volume counters stop if Custody logbook [1] and/or Parameter Logbook [3] is full. The meter status "Data invalid" is activated. The measured values are now counted in the error volume counter.

If the FLOWSIC600 is not configured as a custody meter, all logbooks are per default configured to be overflowing. This means the index number continues increasing, and after the logbook has reached its maximum number of entries, each new entry overwrites the oldest entry.

If the logbook overflows, the oldest data will be lost. Regularly saving the logbook entries to the database via MEPAFLOW600 CBM (→ pg. 176, 6.4.1) and deletion of entries in the meter itself prevents data loss. If entries are deleted via MEPAFLOW600 CBM, the logbook index counter on the meter is reset.

Index counter overflow

The index number displayed in the LCD display runs up to 9999 and then overflows. In case of an index overflow, all logbook entries are deleted and all logbook index counters reset.

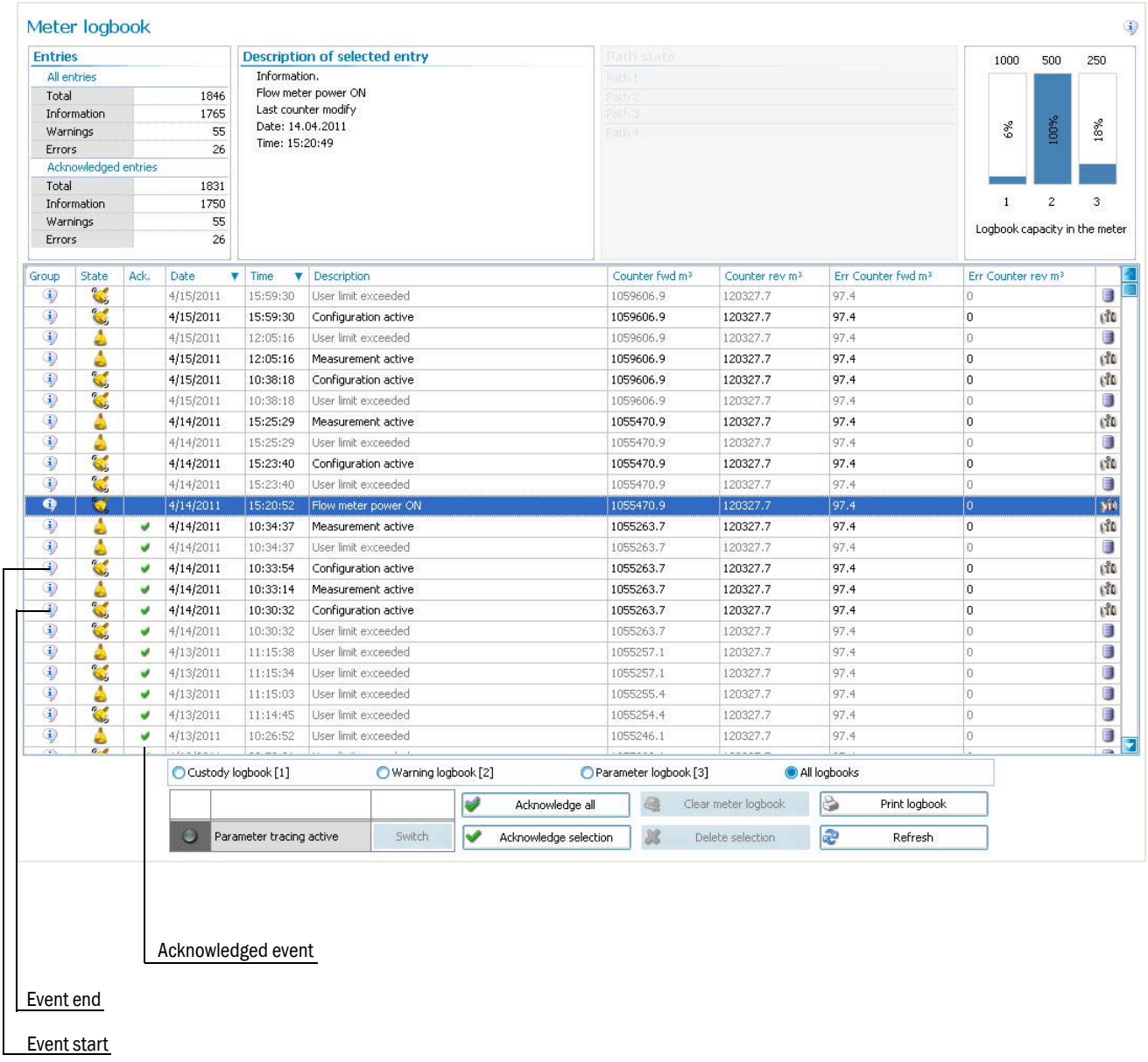
Acknowledging entries

Each entry can be acknowledged manually on the LCD display (→ pg. 222, 9.3.2) as well as in MEPAFLOW600 CBM (→ pg. 177, 6.4.1.2). It is possible to acknowledge individual entries or all entries at once.

Logbook entries In MEPAFLOW600 CBM

Logbook entries on the FLOWSIC600 can be downloaded, viewed, saved and exported with the MEPAFLOW600 CBM software. The "Meter logbook" page provides information on the number of registered events and the remaining memory space. See → pg. 176, 6.4.1 on handling the logbooks with MEPAFLOW600 CBM.

Figure 12 "Meter logbook" page in MEPAFLOW600 CBM



2.8.3 DataLogs[1]

For firmware version 3.4.03 and higher, the FLOWSIC600 provides two DataLogs (Hourly Log and Daily Log). They save averaged measured values and are stored in the SPU's non-volatile memory (FRAM). All data can be downloaded and exported to Excel files with MEPAFLOW600 CBM (→ pg. 179, 6.4.2.1.).

> The following sections describe the default configuration of the DataLogs. The DataLogs can be configured to best suit your application → pg. 156, 5.7.2.2.

2.8.3.1 Hourly Log

The Hourly Log logs hourly diagnostic values by default (dataset type "Diagnostic Values", see Technical Information→ pg. 50, Table 11) for the forward flow. As long as the flow is valid and the VOG is above Vmin all diagnostic and flow values are averaged over one hour and saved every full hour. The Hourly Log stores these values for more than a month (38 days) by default. They are then overwritten with new values.

2.8.3.2 Daily Log

The Daily Log logs the daily volume counter values by default (dataset type "Volume Counters" see Technical Information→ pg. 50, Table 12) for the forward flow. All flow values are averaged over one day and saved at the (configurable) Accounting Hour (see Technical Information→ 2.8.3.6). The Daily Log stores these values for approximately 2 years by default (1 year and 361 days). They are then overwritten with new values.

DataLog Storage Cycle

Hourly Log and Daily Log can be configured to save entries in a storage cycle of: 3 min, 5 min, 15 min, 30 min, 1 hour, 12 hours or 24 hours.

If a DataLog is set to a Storage cycle of 12 or 24 hours, the accounting hour takes effect.

2.8.3.3 DataLog storage behavior

Hourly Log and Daily Log can be configured for the following storage behavior:

- Overflow (Default)
- Stopping

> Storage Behavior "Stopping"
> If a DataLog is configured with the storage behavior "Stopping", a warning will be shown in the Meter Status Table when the DataLog is full. See → pg. 172, 6.2.3.

1 This feature may be deactivated. Please contact your SICK representative.

2.8.3.4 DataLog flow direction settings

Hourly Log and Daily Log can be configured with the following flow direction settings:

- Forward (Default)
- Reverse
- Bidirectional

The DataLog will only collect flow data for the flow direction for which it was configured. If the flow was below "Min. VOG for warnings" or flow in the opposite direction, the FlowTime will be 0%.

> A DataLog configured for bidirectional flow will average all flow data over the configured storage cycle, independently of the actual flow direction. If the flow direction changed in the middle of the storage cycle, AvgVOG may show as "0".

2.8.3.5 DataLog storage cycle

Hourly Log and Daily Log can be configured to save entries in a storage cycle of: 3 min, 5 min, 15 min, 30 min, 1 hour, 12 hours or 24 hours. If a DataLog is set to a Storage Cycle of 12 or 24 hours, then the accounting hour takes effect.

2.8.3.6 DataLog accounting hour

For all DataLogs configured for a storage cycle of 24 hours, the accounting hour sets the hour of the day, at which an entry is saved. For all DataLogs configured for a storage cycle of 12 hours, entries are saved at the time specified in the accounting hour and then again 12 hours later.

2.8.3.7 Distribution of FRAM capacity for DataLogs

The FRAM capacity for Hourly Log and Daily Log can be changed with the slider on the right side of the DataLogs Configuration tab (→ pg. 157, Figure 76).

2.8.3.8 Types of datasets stored in the DataLogs

Hourly Log and Daily Log can be configured to store one of the following type of dataset:

- Diagnostic Values (→ Table 11)
- Volume Counters (→ Table 12)
- Standard Volume Counters (→ Table 13)
- Mass Flow Counters (→ Table 14)

Table 11 Dataset type "Diagnostic Values"

		Unit	
Description	**Abbreviation**	**Metric**	**Imperial**
Date/Time when data was saved	Date / Time	Sec	Sec
Flow Time	FlowTime	%	%
Average VOG	AvgVOG	m/s	ft/s
Average SOS	AvgSOS	m/s	ft/s
Profile	Profile factor	-	-
Symmetry	Symmetry	-	-
Performance per path	Performance[1..4]	%	%
Turbulence per path	TurbulenceP [1..4]	%	%
Average VOG per path	AvgV [1..4]	m/s	ft/s
Average SOS per path	AvgC [1..4]	m/s	ft/s
SNR per path	SNRPath [1..4]	dB	dB
AGC per path	AGCPath [1..4]	dB	dB
VOG standard deviation	VOG_stdev	m/s	ft/s
Meter Status (→ pg. 179)	DLOG Status	-	-

- The dataset type "Diagnostic values" does not contain any diagnostic information for gas velocities below the value for Vmin ("LowFlowCutOff", Reg. #7036). The "Flow time" value shows, for the percentage of storage cycle time the flow was above Vmin and in the flow direction specified for the DataLog.
- All diagnostic information is flow-weighted.

Table 12 Dataset type "Volume Counters"

		Unit	
Description	**Abbreviation**	**Metric**	**Imperial**
Date/Time when data was saved	Date / Time	Sec	Sec
Flow Time	FlowTime	%	%
Total volume at flowing conditions (forward)	Vo forward	m³	acf
Total volume at flowing conditions (reverse)	Vo reverse	m³	acf
Volume at flowing conditions (forward)	Vf forward	m³	acf
Volume at flowing conditions (reverse)	Vf reverse	m³	acf
Averaged Performance	AvgPerformance	%	%
Meter Status (→ pg. 179)	DLOG Status	-	-

- The dataset type "Volume Counters" does not contain values for "Averaged performance" for gas velocities below the value for Vmin ("LowFlowCutOff", Reg. #7036).
- The "Flow time" value shows, the percentage of storage cycle time the flow was above Vmin and in the flow direction specified for the DataLog.
- The values for "Averaged performance" are flow-weighted.

Table 13 Dataset type "Standard Volume Counters"

		Unit	
Description	**Abbreviation**	**Metric**	**Imperial**
Date/Time when data was saved	Date / Time	Sec	Sec
Flow Time	FlowTime	%	%
Total volume at flowing conditions (forward)	Vo forward	m³	acf
Total volume at flowing conditions (reverse)	Vo reverse	m³	acf
Volume at flowing conditions (forward)	Vf forward	m³	acf
Volume at flowing conditions (reverse)	Vf reverse	m³	acf
Error Volume at base conditions (forward)	Eb forward	Nm³	scf
Error Volume at base conditions (reverse)	Eb reverse	Nm³	scf
Volume at base conditions (forward)	Vb forward	Nm³	scf
Volume at base conditions (reverse)	Vb reverse	Nm³	scf
Averaged Performance	AvgPerformance	%	%
Pressure	Pressure	bar(a)	psi(a)
Temperature	Temperature	°C	°F
Compressibility	Compressibility	-	-
Meter Status (→ pg. 179)	DLOG Status	-	-

- The dataset type "Standard Volume Counters" does not contain values for "Averaged performance", "Pressure", "Temperature" or "Compressibility" for gas velocities below the value for Vmin ("LowFlowCutOff", Reg. #7036).
- The "Flow time" value shows, the percentage of storage cycle time the flow was above Vmin and in the flow direction specified for the DataLog.
- The values for all diagnostic information (see above) are flow-weighted.

Table 14 Dataset type "Mass Flow Counters"

		Unit	
Description	**Abbreviation**	**Metric**	**Imperial**
Date/Time when data was saved	Date / Time	Sec	Sec
Total volume at flowing conditions (forward or reverse)	Vo forward or Vo reverse	m^3	acf
Error volume at flowing conditions (forward or reverse)	Ef forward or Ef reverse	m^3	acf
Total Volume at base conditions (forward or reverse)	VB Total forward or VB Total reverse	Nm^3	scf
Error volume at base conditions (forward or reverse)	Eb forward or Eb reverse	Nm^3	scf
Total Mass (forward or reverse)	Mass Total forward or Mass Total reverse	t	lbs
Error Mass (forward or reverse)	Me forward or Me reverse	t	lbs
Temperature	Temperature	°C	°F
Pressure	Pressure	bar(a)	psi(a)
Molecular weight	Molar mass	g/mol	lb/mol
Density	Density	kg/m^3	lb/ft^3
Last Volume during storage cycle (at flowing conditions)	Vo log cycle	m^3	acf
Last Volume during storage cycle (at base conditions)	VB log cycle	Nm^3	scf
Last mass during storage cycle	M Total log cycle	t	lbs
Meter Status (→ pg. 179)	Status	-	-

- The dataset type "Mass Flow Counters" does not contain values for "Pressure", "Temperature", "Molecular weight" or "Density" for gas velocities below the value for Vmin ("LowFlowCutOff", Reg. #7036).
- The "Flow time" value shows, the percentage of storage cycle time the flow was above Vmin and in the flow direction specified for the DataLog.
- The dataset type Mass Flow Counter cannot be configured for bidirectional use. If this dataset is necessary for a bidirectional application, it is recommended that it be used for the Hourly log and Daily Log, and configured accordingly.

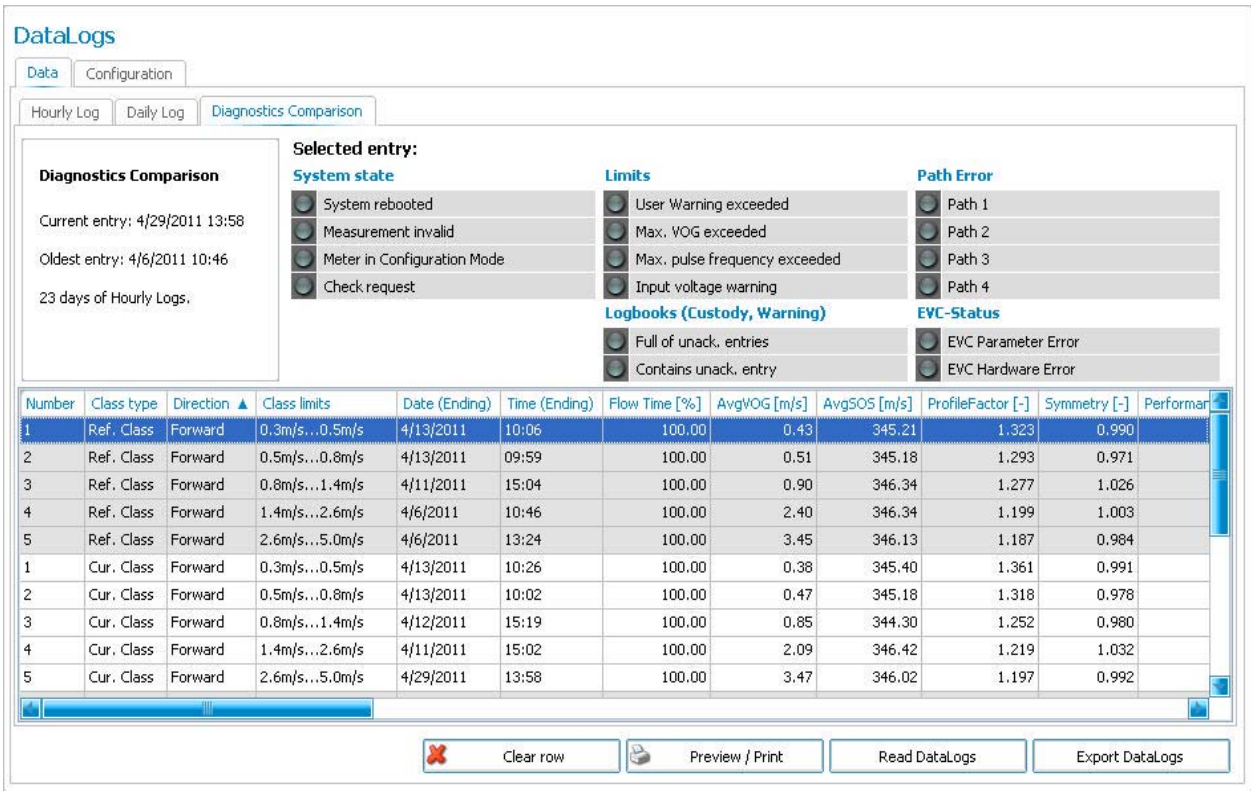
2.8.4 Diagnostics Comparison Log[1]

The Diagnostics Comparison Log provides a comparison between current diagnostic values (current fingerprint) and those of a reference time (reference fingerprint, for example, at time of commissioning). Since the diagnostic values (dataset type "Diagnostic Values", →Table 11) are velocity-dependent, it is necessary to use a velocity-adaptive comparison. Five gas velocity range classes are calculated from the velocity range of the meter. The current diagnosis values are stored in Current Classes 1 to 5, while the reference values are stored in Reference Classes 1 to 5.

Reference values are collected after the meter has been commissioned or after the classes have been cleared. Reference values are stored in the Reference Classes 1 to 5. If a Reference Class is filled with an entry, the next valid entry is stored into the same velocity range but in the corresponding Current Class (e.g. if Reference Class is filled, the next value from within this velocity range will be stored in Current Class 1). During operation, the Current Classes are continually overwritten with new entries. The Reference Classes stay unchanged until they are manually cleared.

Per default the Diagnostics Comparison Log operates bidirectional, saving separate data for both flow directions. The values are stored in the gas velocity classes 1 to 5, depending on the gas velocity.

Figure 13 Diagnostics Comparison Log



Number	Class type	Direction	Class limits	Date (Ending)	Time (Ending)	Flow Time [%]	AvgVOG [m/s]	AvgSOS [m/s]	ProfileFactor [-]	Symmetry [-]	Performar
1	Ref. Class	Forward	0.3m/s...0.5m/s	4/13/2011	10:06	100.00	0.43	345.21	1.323	0.990	
2	Ref. Class	Forward	0.5m/s...0.8m/s	4/13/2011	09:59	100.00	0.51	345.18	1.293	0.971	
3	Ref. Class	Forward	0.8m/s...1.4m/s	4/11/2011	15:04	100.00	0.90	346.34	1.277	1.026	
4	Ref. Class	Forward	1.4m/s...2.6m/s	4/6/2011	10:46	100.00	2.40	346.34	1.199	1.003	
5	Ref. Class	Forward	2.6m/s...5.0m/s	4/6/2011	13:24	100.00	3.45	346.13	1.187	0.984	
1	Cur. Class	Forward	0.3m/s...0.5m/s	4/13/2011	10:26	100.00	0.38	345.40	1.361	0.991	
2	Cur. Class	Forward	0.5m/s...0.8m/s	4/13/2011	10:02	100.00	0.47	345.18	1.318	0.978	
3	Cur. Class	Forward	0.8m/s...1.4m/s	4/12/2011	15:19	100.00	0.85	344.30	1.252	0.980	
4	Cur. Class	Forward	1.4m/s...2.6m/s	4/11/2011	15:02	100.00	2.09	346.42	1.219	1.032	
5	Cur. Class	Forward	2.6m/s...5.0m/s	4/29/2011	13:58	100.00	3.47	346.02	1.197	0.992	

1 This feature may be deactivated. Please contact your SICK representative.

2.8.4.1 Gas velocity class ranges

The gas velocity class ranges are optimized to cover the defined operation range of the meter. The lower limit of the gas velocity range classes is defined by the parameter "Min. VOG for warnings". The upper limit is defined by "VOG limit". Both parameters are configured in the User Warnings window (see "Configuration" tab → pg. 149, 5.7.1).

2.8.4.2 Diagnostics Comparison Report

From the data collected in the Diagnostics Comparison Log, the Diagnostics Comparison Report can be created using MEPAFLOW600 CBM (→ pg. 181, 6.4.3). It provides an overview of the velocity-dependent diagnostics and thus an easy health check. It contains:

- Basic meter data and meter operating data identifying the meter.
- Diagnostic Data Base provides information on the velocity range classes, the time when the reference classes where filled (the current classes will always be showing recent data), the Avg VOG in these classes and the standard deviation.
- Performance Change and Status give an easy, color-coded overview of Performance and Status recorded in the reference classes and the current classes.
- The Diagnostics section shows graphs documenting the changes on Flow Profile, Symmetry, Speed of Sound, Average Turbulence, Average SNR and Average AGC and the configured Diagnostics Comparison Limits (see below).

2.8.4.3 Diagnostics Comparison Limits

The Diagnostics Comparison limits can be activated in order to generate a warning when the difference between the diagnostic values in the reference classes and those in the current classes surpass the Diagnostics Comparison limit values. These limits can be activated and configured in the User Warnings window (→ pg. 161, 5.7.3.4).

2.9 MEPAFLOW600 CBM

This section provides a general overview of the diagnosis and configuration software for the FLOWSIC600: MEPAFLOW600 CBM V1.3. It describes the software installation (including system requirements).

Most data provided by the FLOWSIC600 (like readings, logbook entries and parameters) can be accessed via the LCD display of the meter (see → pg. 221, 9.3). However, the MEPAFLOW600 CBM software provides a more user friendly access to diagnostic, configuration and measurement data of the flow meter.

The procedure for connecting the FLOWSIC600 to a PC or laptop and the procedure of establishing a connection between FLOWSIC600 and MEPAFLOW600 CBM is described on → pg. 123, 5.2 and following. Further information on functionalities of MEPAFLOW600 CBM and its use in certain important procedures like commissioning or calibration are given in the corresponding chapters. Information on data handling with MEPAFLOW600 CBM is given on → pg. 58, 2.9.3.

2.9.1 Software installation

System requirements

- Microsoft Windows XP/Windows 7
- Min. 1 GHz CPU
- Min. 512 MB RAM
- USB- or serial interface
- Screen resolution min. 1024 x 768 pixel (optimal display resolution 1280 x 1024 pixel)

Compatibility

MEPAFLOW600 CBM can be used for all firmware and hardware versions of the FLOWSIC600. The availability of the software features depends on the firmware version of the connected FLOWSIC600.

Installation

A product CD containing the MEPAFLOW600 CBM software is included in delivery of the FLOWSIC600. Insert the product CD into your CD-ROM drive to install the software.

Download from www.flowsic600.com

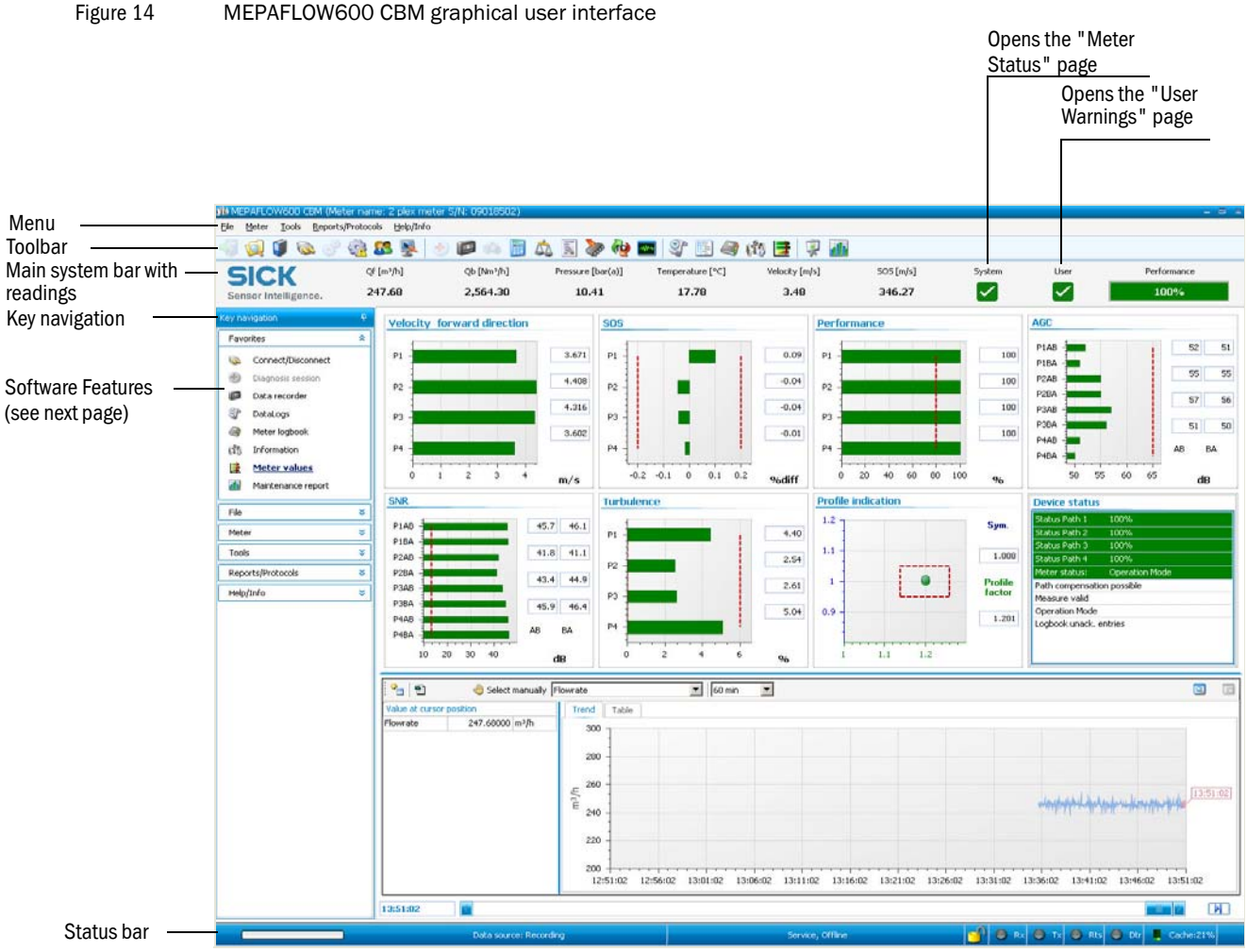
MEPAFLOW600 CBM can be downloaded free of charge from www.flowsic600.com website. Select the Software tab and follow the download instructions.

Administration rights are required for installing the MEPAFLOW600 CBM software. Ensure that the database path specified is one for which users of MEPAFLOW600 CBM have write access.

2.9.2 Overview

The MEPAFLOW600 CBM software supplies a menu-based user interface with many features for the diagnosis of the FLOWSIC600 system. It allows the access to all system parameters, displays diagnostic information in charts and graphs, generates reports (i.e. Maintenance reports) and data files (records, logs) which can be exported and can be used for data analysis. The MEPAFLOW600 CBM meter database allows online and offline management of parameters, reports, session files and logbooks.

Figure 14 MEPAFLOW600 CBM graphical user interface



Software features

Main readings bar	Description
Meter Status	Window displaying the current Meter Status.
User Warnings	Window for the display of the User Warnings and for the configuration of the User Warning Limits and the Diagnostic Comparison Limits.
Key navigation	**Description**
Connect/Disconnect	Assistant for establishing online and offline connections between MEPAFLOW600 CBM meter database and FLOWSIC600.
Diagnosis Session	Quick creation of session files for diagnostic purposes.
Data recorder	Tool for the recording and playback of current, future or cached readings.
DataLogs	Access to Hourly Log, Daily Log and Diagnostics Comparison data saved in the meter. Data can be exported to Excel. The Diagnostics Comparison Report can be printed or exported as PDF.
Meter logbook	Access to meter logbook and logbook entries saved to meter database.
Information	Overview of higher level meter information: Counter readings, identification and location of meter and display of readings (e.g. flow rate) in graph.
Meter values	Detailed diagnostic page with graphs for velocity of gas, speed of sound (SOS), path performance, AGC, signal-to-noise-ratio (SNR), turbulence, profile symmetry and user selectable readings (e.g. flow rate). Summary of device status.
Maintenance report	Assistant for the creation of Maintenance reports.
Meter explorer	Overview, access and management of the meter database saved on the PC. Includes all meter data and sessions with entries for all changes of parameters, changes of the operating mode, measurement records (including diagnosis sessions) and maintenance reports. Functions for export, import, creation and deletion of meter data.
Go to Operation Mode / Go to Configuration Mode	Operation Mode switches: "Operation Mode" for normal operation or "Configuration Mode" for writing information (i.e. parameters) to the meter.
Program settings	Access to program settings for the individual adjustment of the program appearance and setup (e.g. settings for file path, memory, unit system and layout).
Parameters	Access to all meter parameters. Assistant for comparing current parameter settings with previous ones.
Save cache	Saves the historical data from the PCs memory (cache) to a record.
SOS Calculator	A theoretical SOS can be calculated for a specific gas composition.
Meter calibration	The calibration wizard guides the user through the calibration procedure with automated processes to write the information to the meter and generate reports.
Field setup	The field setup wizard guides the user through the commissioning procedure.
Firmware update	Assistant for installing firmware updates.
I/O check	The I/O check wizard guides the user through a test of all meter outputs.
Path diagnosis	Access to path diagnosis and graphs of received signals.
Report manager	Overview, access and management of all reports stored in the meter database. The report manager enables the creation of Trend reports from saved records and maintenance reports.

2.9.3 Meter database

MEPAFLOW600 CBM stores all relevant changes to parameters, and all records and reports generated for the individual meter in a meter database. The meter database can be accessed from MEPAFLOW600 CBM via the "Connect / Disconnect" page, and then the "Meter explorer" (see → Figure 15) or the "Report manager".

The "Meter explorer" allows the import and export of meter database files and sessions (see below) as well as the creation of database entries for new meters.

Meter data

Data from the meters monitored by MEPAFLOW600 CBM is stored in Meter Data. For each meter, a meter data set and an entry is created in the meter database. A meter data set consists of a master data set and an unlimited number of session entries and event entries.

Master data set

The master data set is the set of data that identifies a particular meter in the meter database. This master data set can be created offline, which makes it possible to prepare for the commissioning of a meter before actually connecting to it.

Session

A session is the period of activity between connecting to and disconnecting from a meter. Sessions can pertain to online or offline connections. A session is opened upon connection (online or offline) to a meter. When the connection is closed, the session ends and the user has the opportunity to write a short description to explain what happened during the session. This description is saved in the session entry in the meter database together with the start and end time stamp of the session as well as the connection type (Direct, Modem, Ethernet or Offline).

Session entry

To document all relevant changes pertaining to the meters in the meter database, session entries are written and stored in a table in relation to the meter to which they apply. All session entries can be accessed and organized via the "Meter explorer" page. Session entries can be imported and exported to a session file via the "Meter explorer".

A session entry can contain an unlimited number of event entries and contains at least one parameter set.

A session entry is saved to the meter database at the end of the session only if any relevant events (changes or actions) took place during the session.

Session file

When a session is exported, a session file is generated which contains all data pertaining to the meter with which it was created and all event entries in relation to the session. The exported session file can be saved to the hard disk, transferred (e.g. via e-mail) or imported to another meter database.

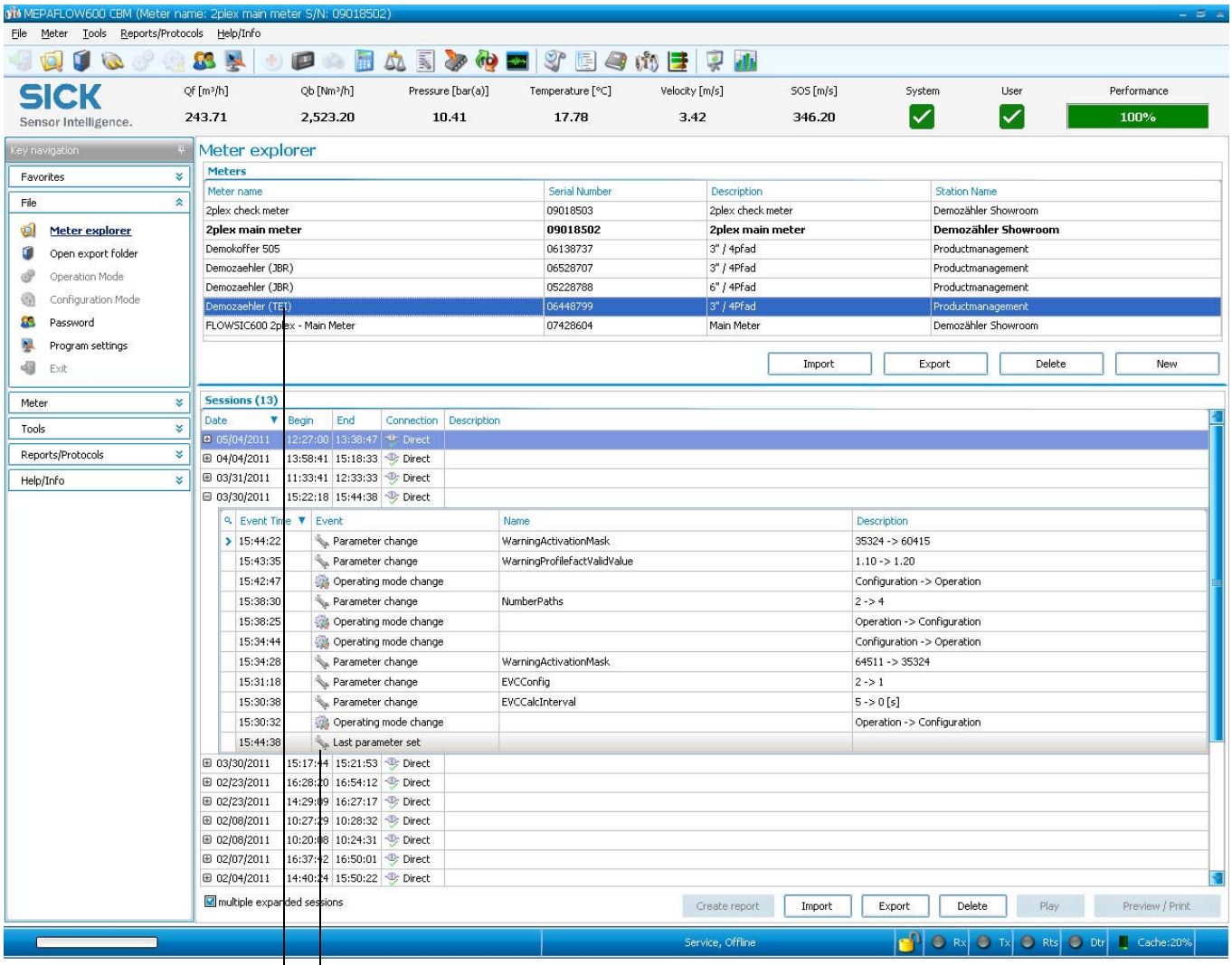
Event entry

An event entry is an entry that documents an important event that occurred during a session. It is saved within this session and can be viewed and accessed via the "Meter explorer" page. A session entry can contain the following event entries:

Event entry	Description
Time stamp (begin / end)	Time stamps are written at the beginning and end of each session.
Last parameter set	The parameter set documents the parameter settings at the end of the session. This entry is written when the session is opened, is kept up to date during the session and is closed when the session is ended.
Settings	Every change of any parameter is documented with the name of the parameter, its old value and its new value.
Operating mode change	Whenever the meter is switched from Configuration Mode to measurement mode or vice versa, the change is documented.
Unit switch Imperial Units / Metric Units	Every change made to the unit system settings is documented.
Diagnosis session	Every diagnosis session (→ 7.3, p.198) created by the user is saved in a separate session file and can be accessed (played, exported or deleted) from the Meter explorer *if the software is in an online or offline connection with the particular meter.*
Measurement record	Every measurement record (→ 2.9.4, p.61) created by the user is saved and can be accessed (played, exported or deleted) from the Meter explorer *if the software is in an online or offline connection with the particular meter.*
Maintenance report	Every maintenance report created by the user is saved and can be accessed (printed, exported or deleted) from the Meter explorer.
Error volume counter reset	Every reset of the error volume counters is documented.
Logbook reset	The clearing of data from a Logbook is documented
DataLog formatted	Changes to the DataLog format (→ pg. 48, 2.8.3), which result in the clearing of all data from the DataLog are documented.
DataLog cleared	The clearing of data from a DataLog (→ pg. 55, 2.9) is documented.
Firmware update	Firmware updates (see Service Manual) are documented.

Event entries contain the event type, the name of the event (relevant for records, reports and parameter changes), a time stamp and a description of the event.

Figure 15 "Meter explorer" with meter entries, session entries and event entries; one session is opened



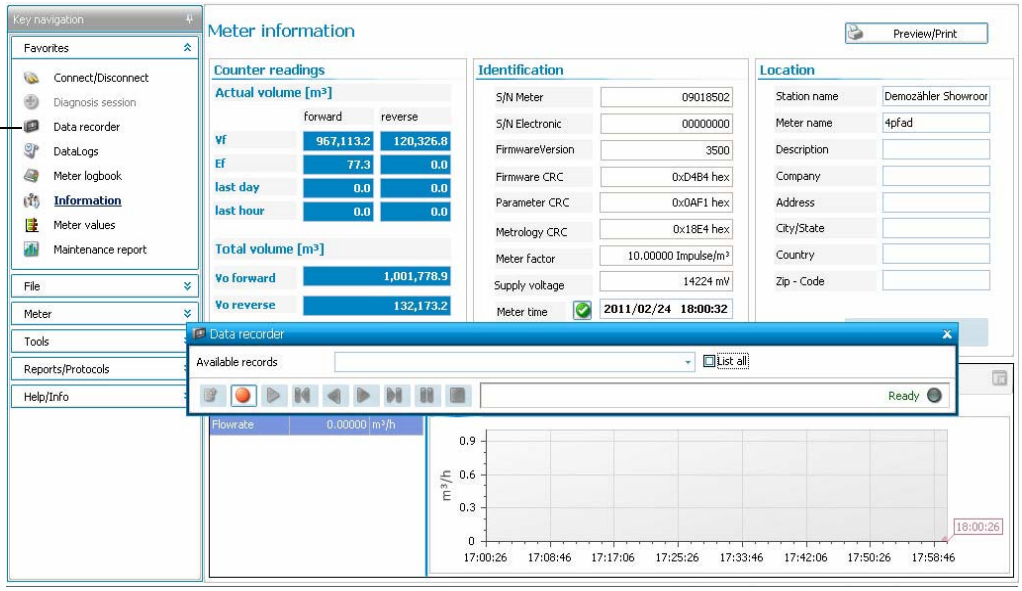
Event entry in opened session

Meter entries, selected meter is marked

2.9.4 Data recording with MEPAFLOW600 CBM

The Data recorder can be started from any page or wizard of MEPAFLOW600 CBM. It can be used to record measured data or playback previously recorded data. After it is started (menu "Tools / Data recorder"), it will float above any other content (→ Figure 16).

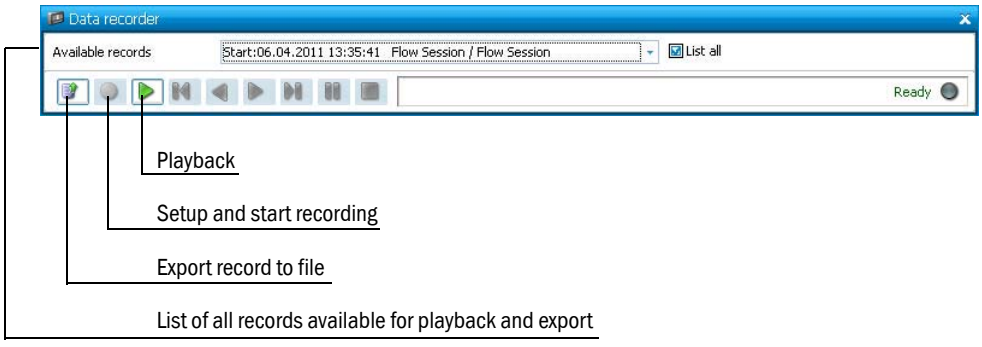
Figure 16 Data recorder floating above the "Meter information" page



Recording

The Data recorder can record live data, cached data or a combination of both according to the user's choice of options (→ Table 15). It can export or playback the record and offers playback functionality like stopping, pausing, or going backward and forward. It can also be set to record live data at some time in the future.

Figure 17 Data recorder with details



Recording options

Figure 18 "Data recorder setup" window

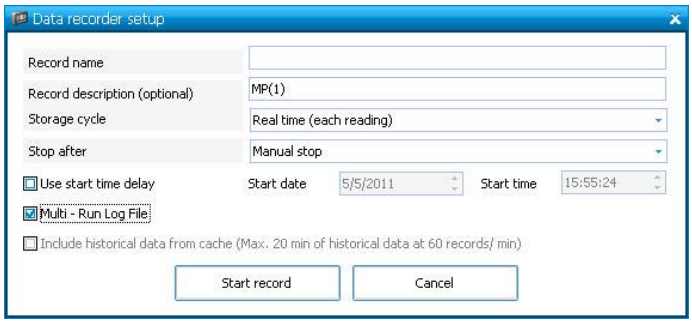


Table 15 Options available for recording

Option	Description
Record name Record description (optional)	Specify a record name and a record description (optional).
Storage cycle	Frequency for storing records (1 sec .. 1h, or real time)
Stop after	Recording stops after set time or after manual stop.
Multi - Run Log File	Valuable setting when running sequential tests. It enables a manual ‘stop and start‘ of the recording. Makes sequential logfile-naming simple.
Include data of history (cache)	Includes the data stored in the cache (historical data). See "Paths / Memory" tab in the "Program settings" to set the maximum period, for which the cache is saved.

- The "Data recorder" records all data except for the signal waveforms. To record the signal waveforms in addition to the other records, go to the "Path diagnosis" page, where the signal waveforms are displayed and click the "Record signal" button.
- A diagnosis session with all relevant data recorded (including the signal) can be created via the menu "Tools / Diagnosis Session".

Playback

The playback of a recording works similar to a video recorder. While the record is played, the charts and graphs show the recorded data.

- You can only playback records of a meter to which you are connected online or offline.
- The playback feeds the recorded data to the software‘s framework so that all charts and graphs display the recorded values, not the live data from a connected meter.

Export

The recorded data can be exported to an Excel file (.xls) for further processing.

FLOWSIC600

3 Flow Calibration

Short Guide to flow calibration
General notes
Preparation
Adjustment of the FLOWSIC600
Sealing
Flow recalibration

This chapter can be used as separate document to support the staff of flow test facilities when calibrating the meter. Experienced staff may use the Short Guide.

All information in this chapter relates to FLOWSIC600 devices marked 'II+' and the MEPAFLOW600 CBM software V1.2.00 or higher.

3.1 Short Guide to flow calibration

Verification and installation

- ► Check the meter for possible damages due to delivery.
- ► Cross-check the serial number on the main plate with the serial number in the Manufacturer Data Report (MDR) as well as the size. design pressure, design temperature, flow range and meter factor.
- ► Install the flow meter on the flow test facility (→ pg. 76, 3.3.2).
- ► Connect up the FLOWSIC600 (power supply cable, pulse outputs and RS485 MODBUS connections → pg. 77, 3.3.3).
- ► Remove the front cap and switch Parameter write lock to the unlock position (→ pg. 78, 3.3.5).
- ► Close the front cap and switch on the power supply.

Parameter setup

- ► Establish an online connection between FLOWSIC600 and MEPAFLOW600 CBM software (User Access Level: "Service"; Password: see Service Manual). (→ pg. 125, 5.3)
- ► Verify the key data on the "Meter information" page of MEPAFLOW600 CBM with the data of the Parameter report of the MDR (→ pg. 79, 3.3.6).
- ► Switch the meter into Configuration Mode.
- ► Open the "Meter calibration" wizard in MEPAFLOW600 CBM (select Tools / Meter calibration).
- ► Enter the pressure and temperature values on the wizard page 1 of 4 (→ pg. 79, 3.3.7).
- ► Check whether the meter is correctly set for the calibration (→ pg. 80, 3.3.8).
- ► Click "Write to meter".

Determination of adjust factors

- ► Provide a gas flow rate within the valid flow range in the test line.
- ► Check the performance of the meter and check the "Meter status" table (→ pg. 80, 3.3.8).
- ► Adjust the zero phase if necessary (→ pg. 84, 3.3.8.3).
- ► Prepare MEPAFLOW600 CBM data recording if required (→ pg. 86, 3.3.9).
- ► Carry out the flow verification. When finished, calculate the Weighted Mean Error (WME) and the adjust factor(s) and enter them in the meter (→ pg. 88, 3.4.1).

The MEPAFLOW600 CBM Calibration wizard supports the determination and setting of factors and coefficients (→ pg. 88, 3.4.1).

Verification

- ► Switch the meter to Operation Mode.
- ► Verify the adjustment for a sample of preset flow rates. Deviation between reference meter and meter under test should be within ±0.1% of the reference value.
- ► Switch the meter to Configuration Mode.
- ► Set the pressure, temperature and meter factor back to the customized values and write them to the meter.
- ► Switch the flow meter to Operation Mode and switch off the power.
- ► Remove the front cap and close the Parameter write lock (position: LOCKED) (→ pg. 78, 3.3.5)
- ► Close the front cap and switch on the power.

Documentation

- ► Reestablish the online connection between flow meter and MEPAFLOW600 CBM.
- ► Check in MEPAFLOW600 CBM that temperature, pressure and meter factor are at the customized values. Compare the meter factor with the value on the main plate.
- ► Check the "Meter status" window, ensuring that the Parameter write lock is LOCKED and no errors or warnings are active (→ pg. 78, 3.3.5)
- ► Create and print out a parameter report. If the Calibration wizard was used, print out the calibration report.

Sealing

- ► Carry out the sealing (→ pg. 92, 3.5 and → pg. 252, 9.9).

3.2 General notes

The FLOWSIC600 can be calibrated at a certified flow test stand (certified calibration facility), at ambient or high pressure, to reduce the measurement uncertainty and to reference it to the national standards.

The FLOWSIC600 offers three different adjustment methods, i.e. to calculate the adjust factor (also sometimes called "meter factor"):

- flow independent, constant value
- flow dependent using a polynomial approximation
- flow dependent using a linear interpolation of a data table

For all three cases the adjusted flow rate is calculated according to:

$$Q_{adjusted} = Q_{unadjusted} \cdot AF(Q)$$

Preconditions for calibration

- To use a FLOWSIC600 in fiscal metering applications, a national pattern approval certificate must exist where required. The FLOWSIC600 must meet the requirements set out in the pattern approval documents.
- The meter body must be approved for the maximum gas pressure it will be subjected to.
- The FLOWSIC600 must be installed according to Chapter 4.
- The FLOWSIC600 must be commissioned according to Chapter 5.

For a general description of calibration, please refer to ISO 17089.

3.2.1 Recommended test flow rates

The recommended number and position of test points are provided in OIML and AGA documents and are summarized in the table below. Alternatively they may be defined individually by the customer.

Test points according to OIML R137-1				Test points according to A.G.A. Report No.9	Test points according to MID Directive 2004/22/EC
Measuring range (turn down)					
1:20	1:30	1:50	> 1:50	All ranges	All ranges
-	-	-	Q_{min}		
-	-	2%	-	2.5%	Qmin
-	3%	-	3%	-	-
5%	5%	5%	5%	5%	5%
10%	10%	-	-	10%	10%
-	-	15%	15%	-	-
25%	25%	25%	25%	25%	25%
40%	40%	40%	40%	50%	40%
70%	70%	70%	70%	75%	70%
100%	100%	100%	100%	100%	100%

% values in table relate to Q_{max}

3.2.2 Operating pressure ranges

The minimum ($p_{e, min}$) and maximum ($p_{e, max}$) operating pressure must be representative of the operating pressure range.

WARNING:
The maximum operating pressure must not exceed the maximum pressure rating (Design Pressure PS) of the meter body.
The maximum permitted operating pressure (design pressure) is specified as "PS" on the type plate of the meter body (→ pg. 96, Figure 43).

The permitted operating pressure range of the meter is derived from the "Pressure(fixed)" parameter (Reg. #7041 "Pressure(fixed)").

Table 16 Pressure parameters

Variable	Reg. name	Description
p_{fix}	Reg. #7041 "Pressure(fixed)"	Absolute pressure value of the average working pressure
$p_{e, min}$	Reg. #7700 "pe.min"	Minimum operating pressure
$p_{e, max}$	Reg. #7701 "pe.max"	Maximum operating pressure

3.2.2.1 Flow calibration at atmospheric pressure (p_e, max < 4 bar(g))

If the maximum permitted operating pressure of a gas flow meter is < 4 bar, the flow calibration should be performed according to the specification "Flow Calibration Procedures, Ultrasonic Gas Flow Meter FLOWSIC600" (see product CD, document number: E_18475).

For a further increase in the measuring accuracy, the FLOWSIC600 provides Reynolds-number and velocity-related impact correction routines. These parameters, dependent on nominal size, are determined prior to the verification procedure and set as constants by the manufacturer. The Reynolds number range can be set using the "Pressure(fixed)" parameter (Reg. #7041).

For calibration with air at atmospheric pressure, switch the meter to "Air test" mode.

- ► Connect to the FLOWSIC600 with MEPAFLOW600 CBM (→ pg. 77, 3.3.4)
- ► Open the "Calibration wizard" (select Tools / Meter Calibration)
- ► Switch the meter to "Configuration Mode".
- ► Activate the check box "Ambient air flow test".
- ► Click "Write to meter".

"Air test" mode
The "Air test" mode sets the "Pressure(fixed)" parameter value internally to 1 bar. The meter then operates with the low pressure Reynolds numbers (low pressure curve). The words "Ambient Air Test Mode active" will appear in the status bar while the device is being calibrated.

Low frequency pulse rate during air test
If a high-pressure calibrated meter is to be tested under atmospheric pressure, a special low frequency pulse rate may be required. This can be specified as an alternative meter factor which is used during the air test only (Reg. #7060 "MeterFactorLF").

After calibration and adjustment, the FLOWSIC600 must be set to one of the following operating pressure ranges by setting the "Pressure(fixed)" parameter (Reg. #7041 → pg. 81, Figure 28).

Pressure(fixed)	Rated pressure range			
	$p_{e, min}$		$p_{e, max}$	
1 bar(a) (14.5 psi)	0 bar(g)	0 psi	0.1 bar(g)	1.4 psi
1.5 bar(a) (21.7 psi)	>0.1 bar(g)	1.4 psi	1.0 bar(g)	14.5 psi
3.2 bar(a) (46.4 psi)	>1.0 bar(g)	14.5 psi	4.0 bar(g)	58.0 psi

WARNING:
The maximum permitted operating pressure of a gas flow meter calibrated at atmospheric pressure must not exceed 4 bar(g).

3.2.2.2 **Flow calibration at high pressure (p_e, max > 4 bar(g))**

If the maximum permitted operating pressure of a gas flow meter is > 4 bar(g), the flow calibration should be performed according to the specification "Flow Calibration Procedures, Ultrasonic Gas Flow Meter FLOWSIC600" (see product CD, document number: E_18475). The FLOWSIC600 should be tested under the same conditions and using the same type of gas to be used during normal operation.

Determining the test pressure

Prior to the verification procedure, the parameter "Pressure(fixed)" must be set to the average pressure applied during testing. If the final operating pressure exceeds 50 bar, testing at 50 bar will be sufficient.

The maximum ratio of minimum and maximum operating pressure is:

$$\frac{p_{e, max}}{p_{e, min}} = \leq 4$$

Generally,

$$p_{fix} = \sqrt{p_{e, min} * p_{e, max}} + 1 \text{ bar}$$

where

$p_{e, min} = 0.5 * p_{fix}$

$p_{e, max} = 2 * p_{fix}$ if $p_{fix} \leq 0.5$ PS; otherwise PS

The corresponding operating pressure range is displayed on the FLOWSIC600 as calculated in accordance with these equations.

The test pressure which comes closest to the average at the application working pressure shall be entered as the "Pressure(fixed)" parameter. The meter shall then be adjusted with the weighted mean error established at this test pressure.

Enter the absolute pressure value of the average working pressure when setting the "Pressure(fixed)" parameter.

Testing at several test pressures

The applicable pressure range of a meter can be extended by testing the meter at several test pressures. In this case, the pressure parameters must be calculated as follows:

$$p_{fix} = \sqrt{p_{e,\,test,\,min} * p_{e,\,test,\,max}}$$

where

$p_{e,\,min} = 0.5 * p_{e,\,test,\,min}$

$p_{e,\,max} = 2 * p_{e,\,test,\,max}$

Then the pressure parameters in the meter must be configured as follows (in the exact order given):

- ► Connect to the FLOWSIC600 with MEPAFLOW600 CBM (→ pg. 77, 3.3.4)
- ► Open the "Parameters" page (select Meter / Parameters)
- ► Switch the meter to Configuration Mode (select File / Configuration Mode)
- ► Select the parameter Reg. #7041 "Pressure(fixed)"
- ► Enter the value calculated for pfix
- ► Click "Write to meter".
- ► Select the parameter Reg. #7700 "pe.min"
- ► Enter the value calculated for pe,min
- ► Click "Write to meter".
- ► Select the parameter Reg. #7701 "pe.max"
- ► Enter the value calculated for pe,max
- ► Click "Write to meter".
- ► Switch the meter back to Operation Mode (select Meter / Operation Mode)

NOTICE:

The calibration curve correction for the extended applicable pressure range must be applied by the flow computer. The current operating pressure must be applied by the flow computer.

3.2.3 Adjustment methods

The following adjustment methods are implemented in the FLOWSIC600 firmware and supported by the "Meter calibration" wizard in MEPAFLOW600 CBM:

- Adjustment with constant factor (→ pg. 71, 3.2.3.1)
- Adjustment using a polynomial correction (→ pg. 73, 3.2.3.2)
- Adjustment with piece wise linear error interpolation (→ pg. 74, 3.2.3.3)

> ***NOTICE:*** **Type approval**
> The method "correction with piece wise linear error interpolation" is not approved in every country for use in custody transfer applications. Cross-check with the type approval of the FLOWSIC600 for your country.

3.2.3.1 Adjustment with a constant factor

In general the "standard" calibration is carried out by calculating one adjust factor for the whole flow range of the meter.

See → »Calculating the volumetric flow rate« (pg. 24)

The Adjust factor is calculated from the weighted mean error (WME) or the flow weighted mean error (FWME) of the flow rates Q_i.

The WME is calculated by the test labs according to the equation:

$$WME = \frac{\sum_{i=1}^{n} k_i \bullet E_i}{\sum_{i=1}^{n} k_i} \qquad \text{where } k_i = \frac{Q_i}{Q_{max}}$$

Q_i:	Tested flow rate
Q_{max}:	Tested maximum flow rate
E_i:	Mean error in % established at the tested flow rate

For $Q_i > 0.9\ Q_{max}$ a weighted factor of 0.4 should be used instead of 1 (OIML 137-1).

If the meter is calibrated for bidirectional use, a second weighted mean error (WME) is determined using the values established separately for each direction of flow.

The new adjust factor is calculated as follows:

$$AF = \frac{1}{1 + \frac{WME}{100}}$$

The actual weighting of the error at higher flow rates may be different based on recommendations, or national regulations and/or type approvals.

The FWME is calculated by the test labs according to the equation:

$$FWME = \frac{\sum_{i=1}^{n} k_i \bullet E_i}{\sum_{i=1}^{n} k_i} \qquad \text{where } k_i = \frac{Q_i}{Q_{max}}$$

Q_i:	Tested flow rate
Q_{max}:	Tested maximum flow rate
E_i:	Mean error in % established at the tested flow rate

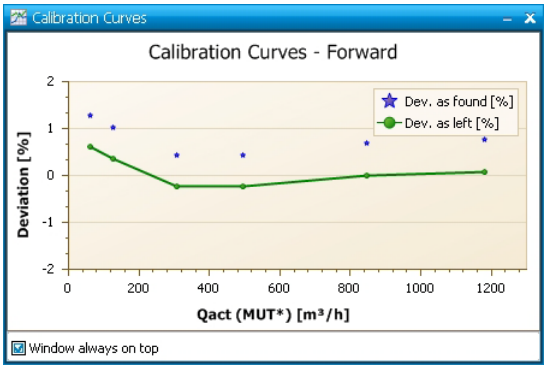
If the meter is calibrated for bidirectional use, a second weighted mean error (FWME) is determined using the values established separately for each direction of flow.

The new adjust factor is calculated as follows:

$$AF = \frac{1}{1 + \frac{FWME}{100}}$$

The error curve "Dev.as found" shows the deviation of the tested meter (FLOWSIC600) relative to the test stand (Reference meter(s)) without any correction of the FLOWSIC600 output behavior (→ Figure 19). The error curve "Dev. as left" shows the deviation of the FLOWSIC600 after correction with the Adjust factor.

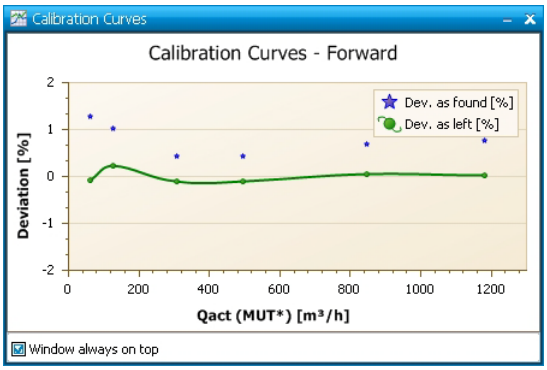
Figure 19 Calibration curve for adjustment with constant factor



3.2.3.2 Adjustment using a polynomial

Polynomial correction improves the linearity of the error curve and corrects the WME to a lower value. The difference between the polynomial curve and the test flow rates "Dev. as found" is the remaining error after adjustment, represented in the error curve ("Dev. as left"). The calculation procedure mathematically shifts the polynomial to the zero line (→ Figure 20).

Figure 20 Calibration curve for adjustment with polynomial



$$AF(Q) = \frac{1}{1 + \frac{E'(Q)}{100}}$$

The curve defined by the polynomial equation should be very close to the error curve for the meter under test (MUT) at each of the test flow rates. To optimize the curve, three different polynomial types are available:

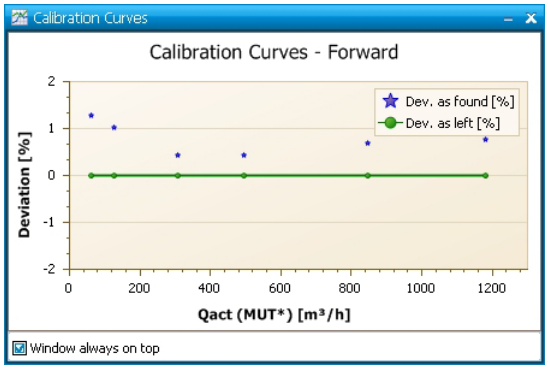
$E'(Q) = a_{-2}Q^{-2} + a_{-1}Q^{-1} + a_0 + a_1Q + a_2Q^2$	(1)	7 test flow rates
$E'(Q) = a_{-1}Q^{-1} + a_0 + a_1Q + a_2Q^2$	(2)	6 test flow rates
$E'(Q) = a_{-1}Q^{-1} + a_0 + a_1Q$	(3)	5 test flow rates

For adjustment with polynomial the above given minimum number of test flow rates must be determined.

3.2.3.3 Adjustment using piece wise linear error interpolation

With this method the flow rate error E(Q) (deviation as found from meter under test (MUT) related to the reference meter) will be corrected to zero (→ Figure 21). Of course, an exact correction to zero is only possible at the flow test points because only there the real deviation from the reference meter is known.

Figure 21 Graphical display of results of a piece wise corrected error curve



The MEPAFLOW600 CBM calibration wizard calculates the adjust factors AF(Q_i) for every flow test point in a way, that, when you multiply the adjust factor with the $Q_{act(MUT)}$, the result is the same value as the reading of the reference meter. After the adjustment the deviation as left is exactly zero. These 'test point' adjust factors are calculated as follows:

$$AF(Q_i) = \frac{1}{1 + \frac{E(Q_i)}{100\%}}$$

The 'test point' errors E(Q_i) are entered in the column "Dev. as found [%]" (→ pg. 89, Figure 38). The error values of the flow test points are stored in the meter in the form of K-factors according to:

$$K(Q_i) = 1 + \frac{E(Q_i)}{100\%} = \frac{1}{AF(Q_i)}$$

To correct the flow rate errors to zero between two adjacent flow test points i and i+1, a linear interpolation is used. During normal meter operation a flow rate dependent error of the meter is calculated according to:

$$E(Q) = Err_i + \frac{Err_{i+1} - Err_i}{Q_{i+1} - Q_i} \cdot (Q - Q_i)$$

Where $Q_i < Q < Q_{i+1}$ and i the index of the flow test point closest to the current flow rate.

During normal meter operation the error correction is carried out with a flow rate dependant adjust factor according to:

$$AF(Q) = \frac{1}{1 + \frac{E(Q)}{100\%}}$$

If the actual flow rate is less than the flow rate of the first data point, or greater than the flow rate of the last data point, the error characteristic will be fixed to the last value and not interpolated. The meter will indicated an "Adjust range error" (see "Meter status" window).

3.3 Preparation

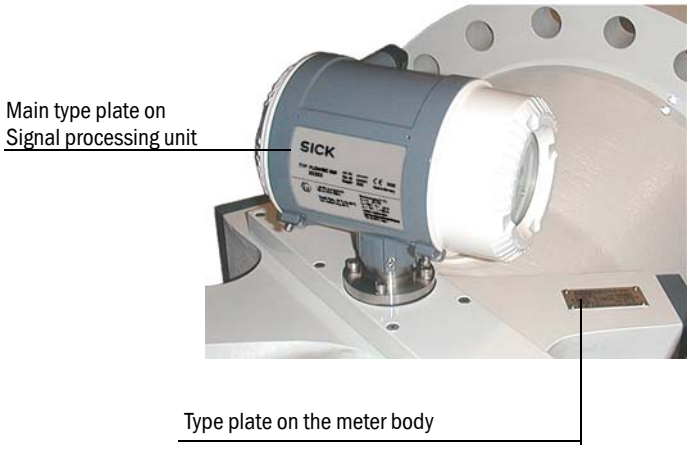
3.3.1 Identification and visual check

The FLOWSIC600 is delivered in a pre-assembled condition in a sturdy package. When unpacking the device, check for possible damage in transit. Pay particular attention to the interior of the meter body, any visible transducer components and the sealing surfaces on the flanges. Any damage must be documented and reported to the manufacturer immediately.

For identification use the information on the main type plate (→ Figure 22, example see → pg. 256, Figure 120). Cross-check the meter's serial number and the other information on the main plate with the data in the Manufacturer Data Record (MDR).

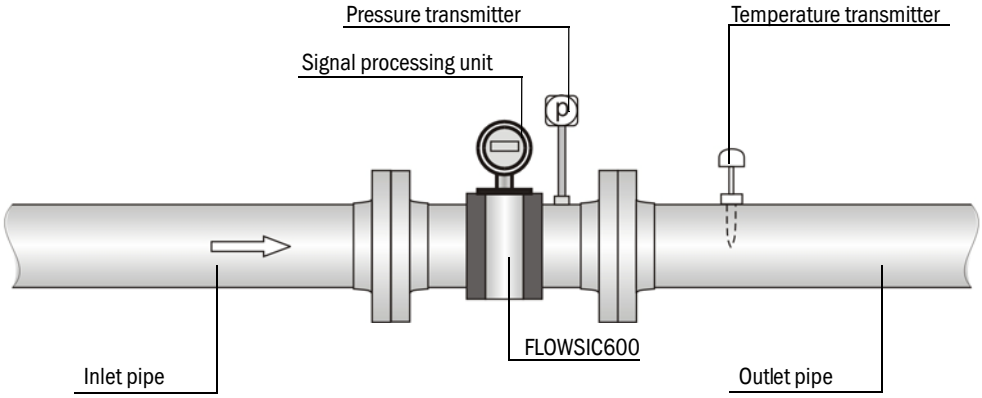
Information on nominal size (DN/NPS), design temperature (TS), design pressure (PS) and test pressure (PT) can be found on the type plate on the meter body (→ Figure 22, example see → pg. 256, Figure 121).

Figure 22 FLOWSIC600 type plates



3.3.2 Mechanical installation on the flow test stand

Figure 23 Installation of the FLOWSIC600 in the test pipeline



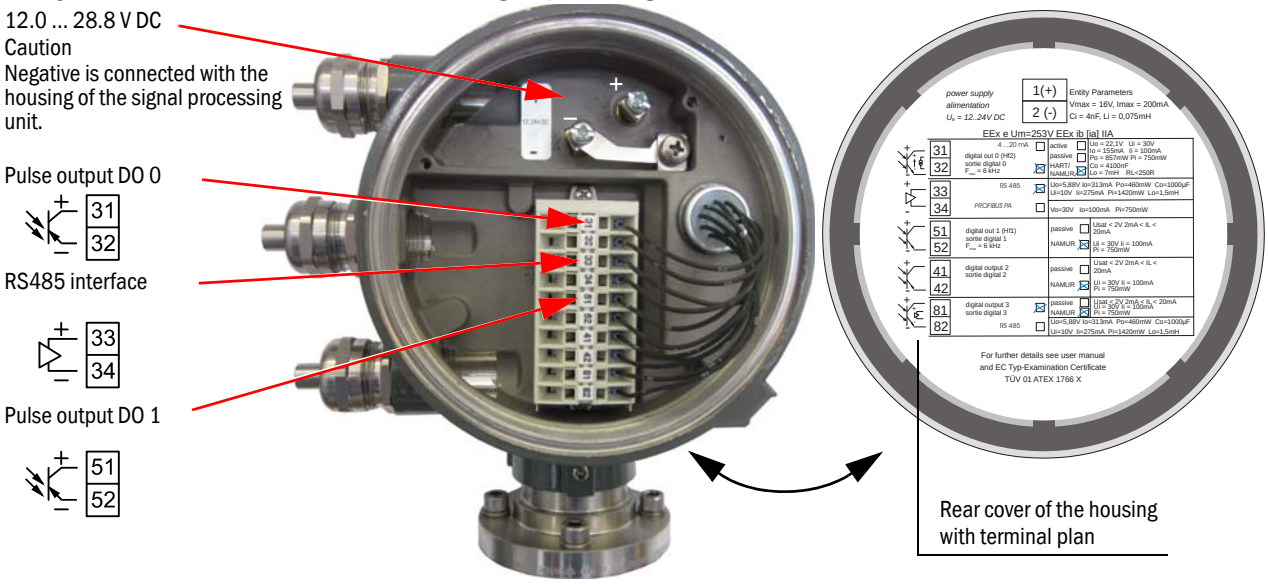
Detailed information about the installation in the pipeline and about necessary inlet and outlet pipes see → pg. 98, 4.2 and → pg. 101, 4.3.

The FLOWSIC600 can be calibrated without the inlet/outlet section used at the customer site. A PTB flow conditioner, which may be used at the customer site, has no influence on the measuring accuracy and the calibration result. Therefore it is not necessary, to use a flow conditioner during the calibration.

3.3.3 Electrical connection

After having removed the rear cover, the FLOWSIC600 must be connected electrically as shown in the Figure below. The default configuration is indicated in the terminal assignment plan inside the rear cover of the housing

Figure 24 Electrical connections in the signal processing unit



3.3.4 Connection to the FLOWSIC600 with MEPAFLOW600 CBM software

Connect to the FLOWSIC600 with a PC or laptop and MEPAFLOW600 CBM software (→ pg. 125, 5.3).

User access level: "Service"
Password: see Service Manual

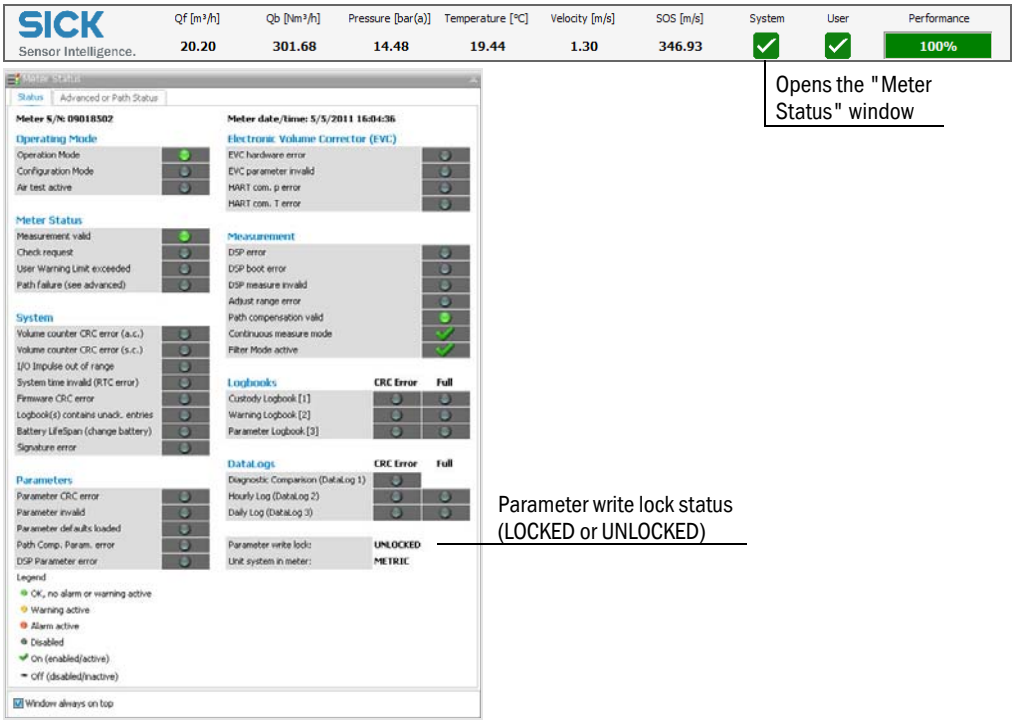
3.3.5 Parameter write lock

To calibrate the FLOWSIC600, the Parameter write lock has to be in the UNLOCKED position.

Check the setting of the Parameter write lock:

- ► Click the "System" button in the MEPAFLOW600 CBM main system bar (top right corner). The "Meter status" window is opened (→ Figure 25).

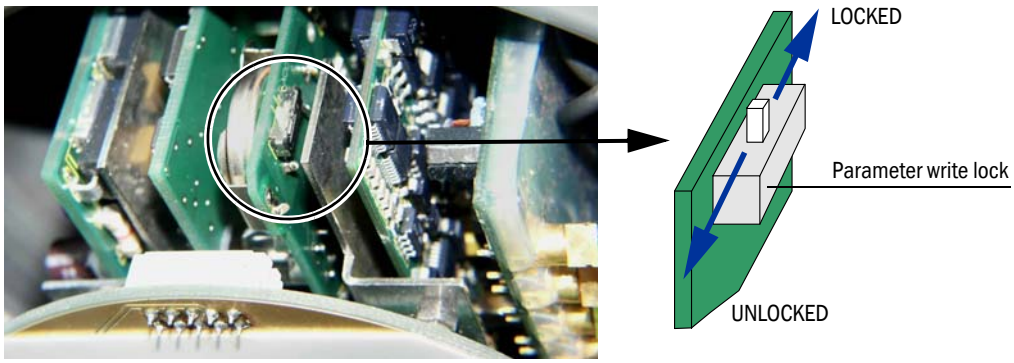
Figure 25 "Meter status" window



If the parameter write lock status is LOCKED, it must be manually unlocked to enable parameter changes (→ Figure 26):

- ► Disconnect the FLOWSIC600 from the power supply.
- ► Take off the front cap of the signal processing unit.
- ► Move the parameter write lock to the desired position.
- ► Mount the front cap again.
- ► Reconnect the power supply.

Figure 26 Parameter write lock



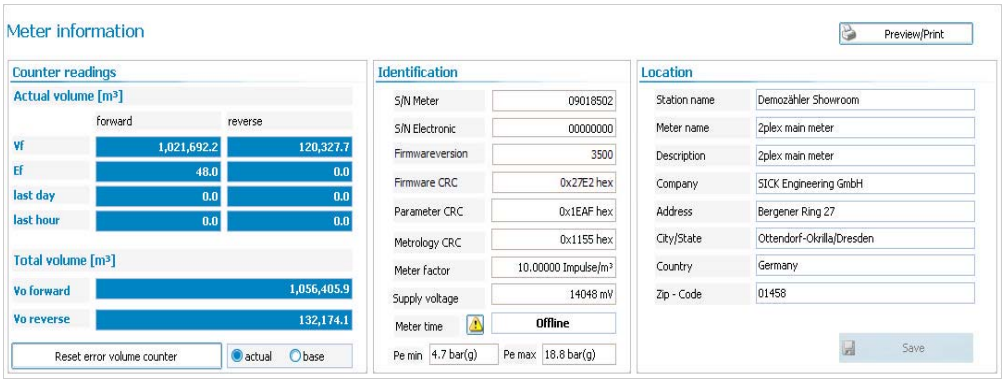
3.3.6 Identification of key data in the meter configuration

To ensure the validity of the flow meter configuration, the following data of the Parameters Report in the Manufacturers Data Report (MDR) has to be consistent with the information on the "Meter information" page (→ Figure 27) in MEPAFLOW600 CBM:

- Serial number of the meter,
- Firmware version,
- Meter factor,
- Firmware CRC.

► Open the "Meter information" page (select Meter / Information).

Figure 27 Identification information on the "Meter information" page in MEPAFLOW600 CBM



3.3.7 Setting the current gas condition

Before the calibration can be started, the process parameters "TemperatureFix" (Reg. #7040) and "PressureFix" (Reg. #7041) must be set to the average conditions during the calibration. These parameters can be edited in the "Meter calibration" wizard (→ Figure 28).

► Open the "Meter calibration" wizard in MEPAFLOW600 CBM (select Tools / Meter calibration).

► Enter p and T in the corresponding fields.

3.3.8 Functional check before flow calibration

Once the test facility is flowing at the initial flow rate, check the performance of the meter. The performance should be at least 75% on all paths. If the velocity of gas is greater than 30 m/s (100 ft/s), the performance values may be significantly lower.

- ► Check the "Meter Status" window for errors and warnings (→ Figure 25).

3.3.8.1 Correct meter factor for calibration

If during the calibration the pulse output supplies the readings for the meter under test, the meter factor must be checked for the maximum output frequency at Qmax and for the necessary resolution regarding Qmin.

Example:

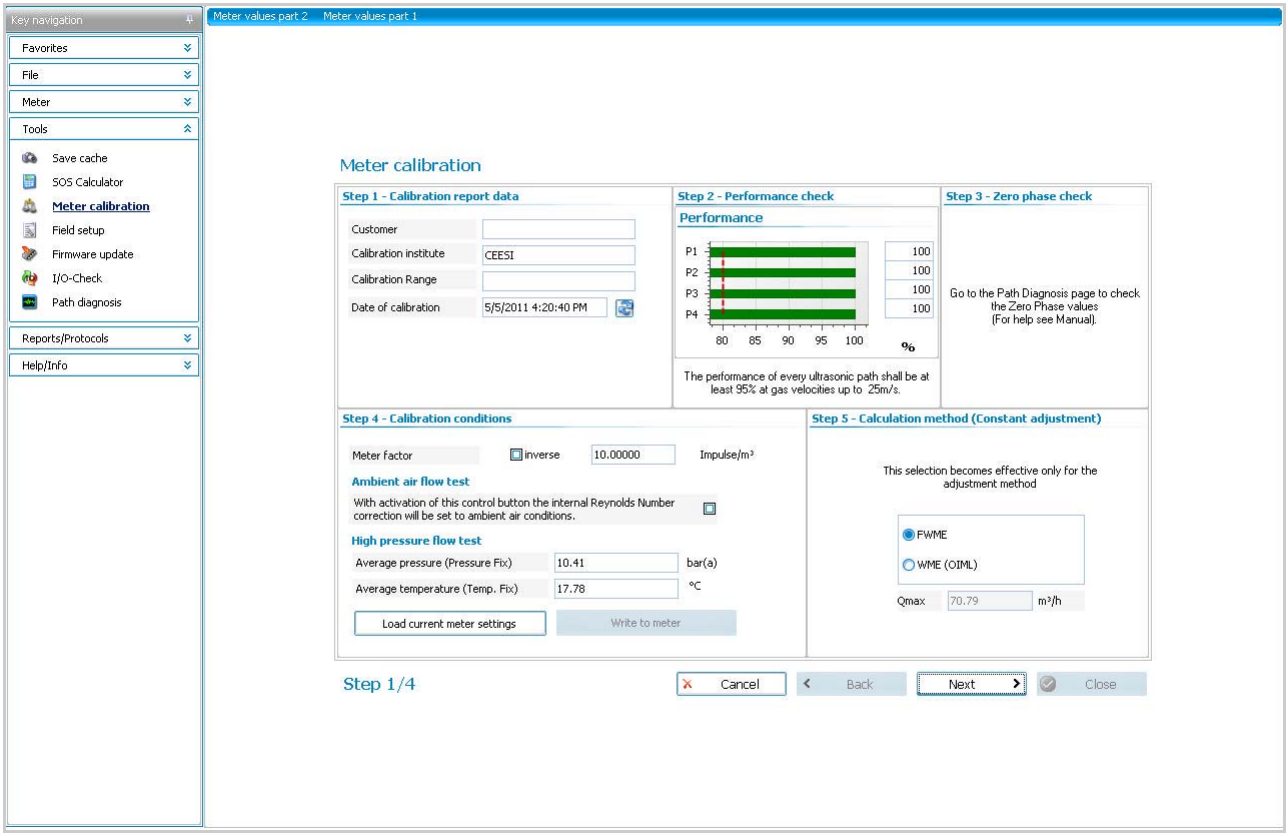
If Qmin = 20 m^3/h and the meter factor is set to 10 Imp./m^3 the FLOWSIC600 would provide only 3 pulses per minute. Apart from the insufficient resolution, it would take too long, to collect a representative number of pulses (compare → pg. 61, 2.9.4).

If necessary, the meter factor should be changed:

- ► Open the "Meter calibration" wizard in MEPAFLOW600 CBM (select Tools / Meter calibration).
- ► Switch the meter to Configuration Mode.
- ► Enter the correct value in the field "Meter factor"
- ► Click "Write to meter".

If a special low frequency pulse rate is required, an alternative meter factor may be specified which is then used during the air test only (Reg. #7060 "MeterFactorLF").

Figure 28 "Meter Calibration" wizard in MEPAFLOW600 CBM



3.3.8.2 Evaluation of the "ZeroPhase"

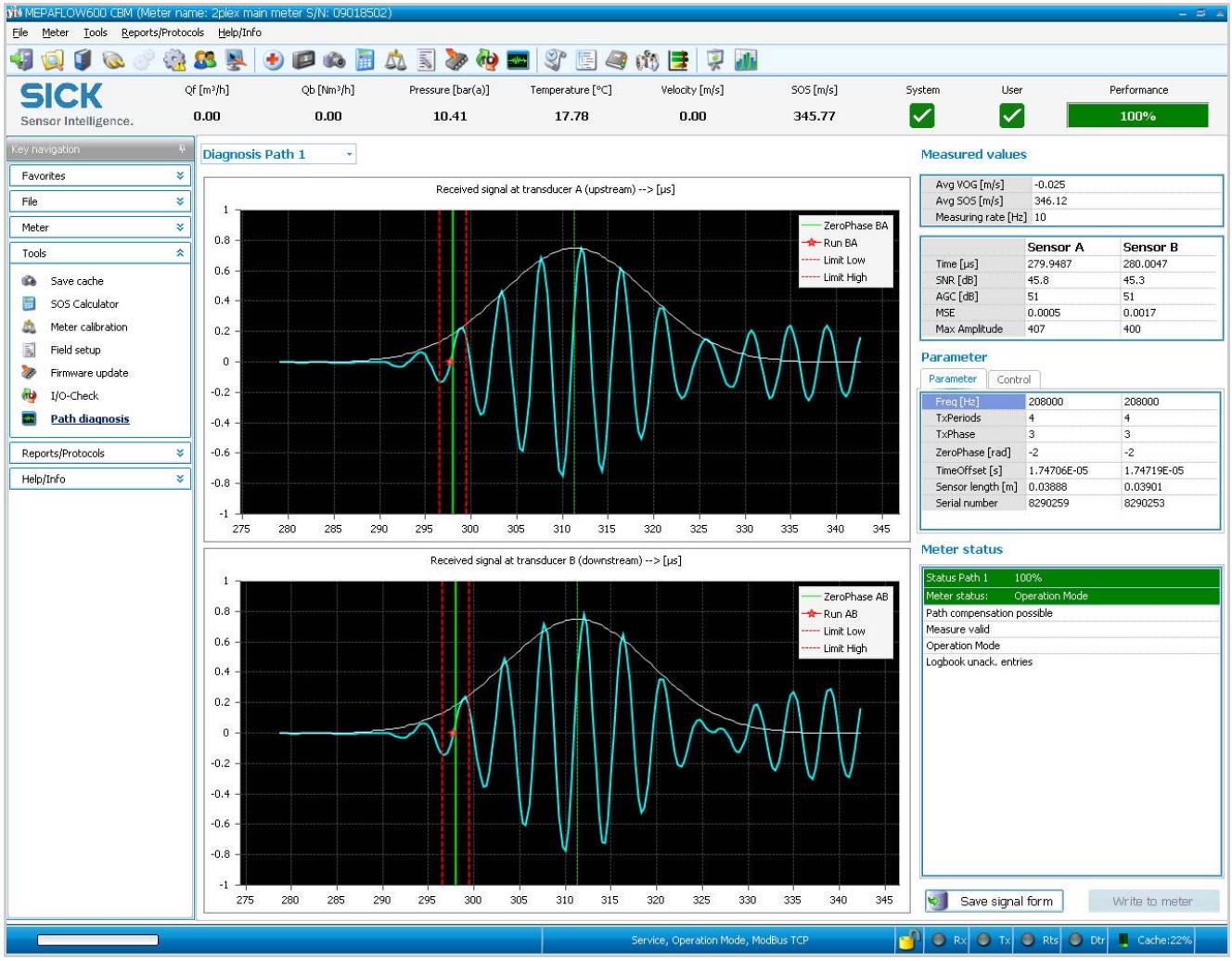
- ► Open the "Path Diagnosis" page (see → Figure 29)
- ► Check the "Zero Phase" parameters of both transducers on each path (path 1, 2, 3, 4)

Properly adjusted zero phases of the individual paths are the basis for accurate transit time measurement of the ultrasonic signals. The "Zero Phase" parameter of a path is properly adjusted, when the green cursor in the signal window is symmetrically within the two dotted red limit lines and the red asterisk is positioned exactly on the second positive zero crossing of the received ultrasonic signal. This adjustment is ideally performed with no flow.

Check box "Air test"

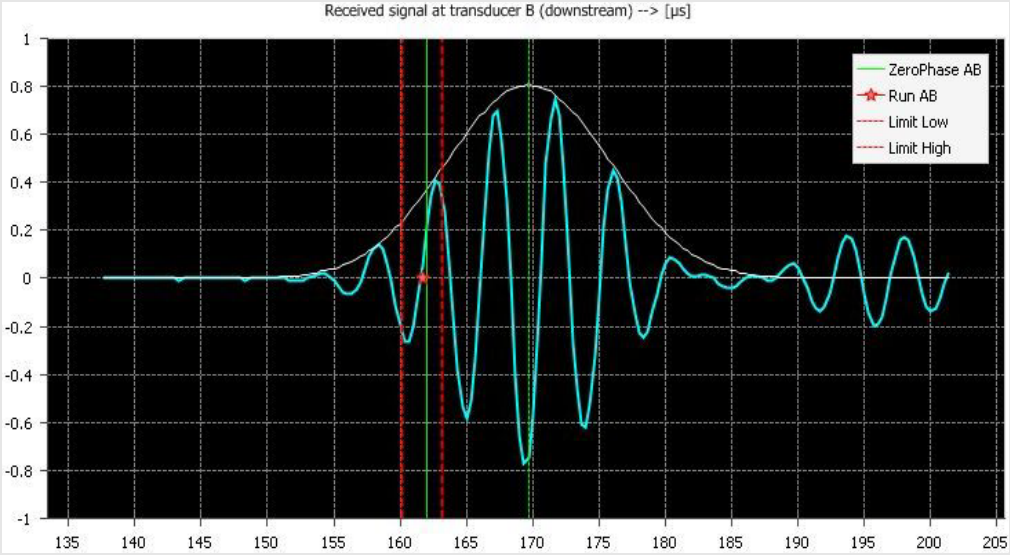
Activating this check box sets the Pressure (fix) parameter value internally to 1 bar. The meter then operates with the low pressure Reynolds numbers (low pressure curve).

Figure 29 "Path Diagnosis" wizard in MEPAFLOW600 CBM



If the zero phase values do not meet the aforementioned criteria, the zero phase needs to be adjusted according to Section → 3.3.8.3.

Figure 30 Signal window displaying ultrasonic signal on the "Path Diagnosis" page



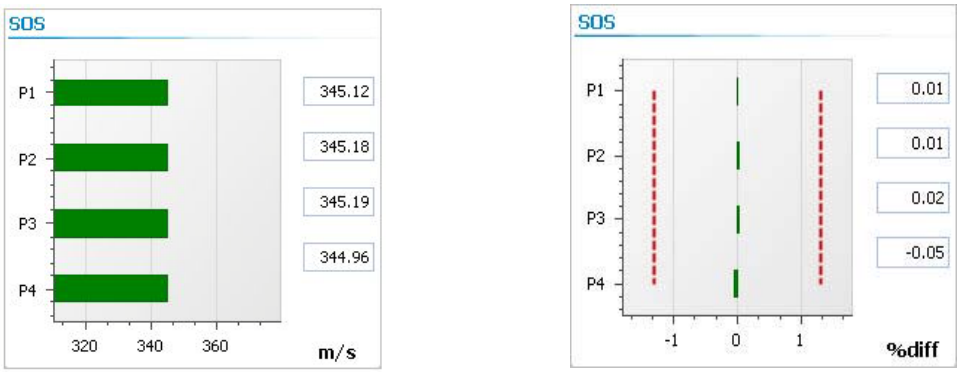
Additionally the validity of the settings can be verified by checking the time plausibility and the SOS:

- ► Open the "Meter status" window (→ Figure 25). If the indicator "Time plausibility" on tab "Advanced or path status" is on, the zero phase is incorrect.
- ► Open the "Meter values" page (select Meter / Meter values).
- ► Check that the measured SOS values are almost the same at all paths of the FLOWSIC600, and that they differ by less then 0.1% (→ Figure 31),
- ► Switch between display of absolute and difference SOS by clicking the right mouse button on the SOS graph and using the context-menu).

In the case of very low gas velocities (< 1 m/s or 3 ft/s), there may be more significant differences between the paths due to thermal stratification. In this case, the SOS on the upper paths (1 and 2) will be higher than on the lower paths.

- ► Check that the measured SOS deviates no more than 0,3% from a theoretical SOS, which is calculated from gas composition, pressure and temperature.

Figure 31 SOS per path on the "Meter values" page (left: absolute SOS, right: % difference to average)



3.3.8.3 Adjustment of the "Zero Phase" parameter

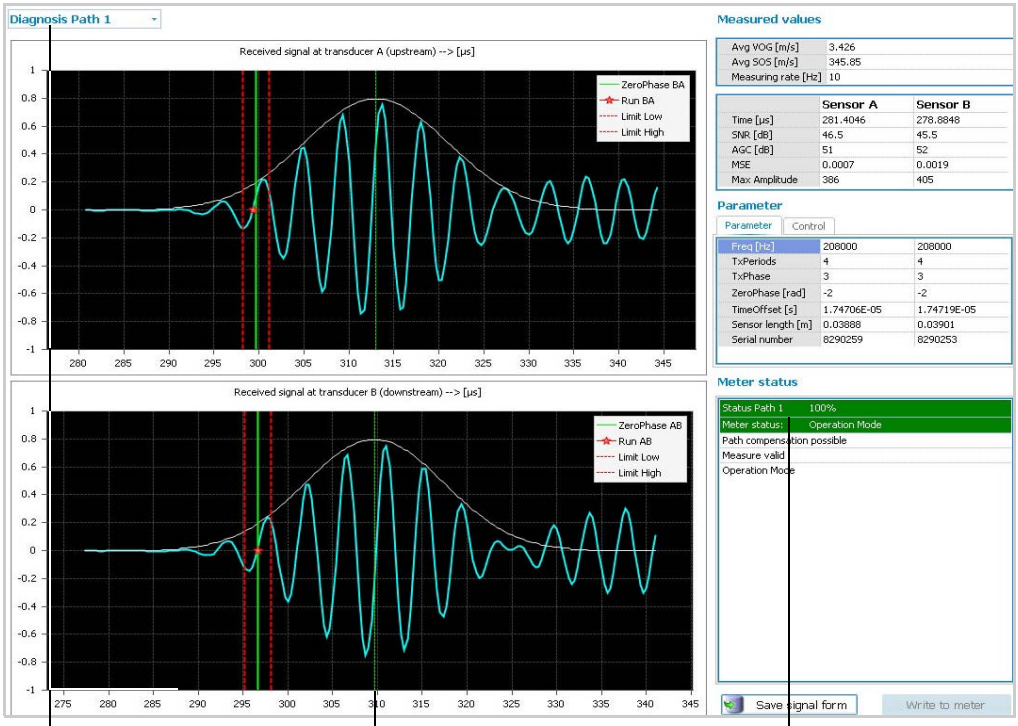
The zero phase should only be changed when the meter is at operating conditions.

- ► Open the "Path Diagnosis" page (→ Figure 32).
- ► Check the ultrasonic signals of both transducers for compliance with the following criteria:
  - – Symmetric signal shape with a signal-to-noise ratio (SNR) >20 dB
  - – No signal deformation or bias in the region where the amplitude converges to zero
  - – Adaptation mean square error (MSE) < 0.008.

Properly adjusted zero phases of the individual paths are the basis for accurate measurement of the ultrasonic signals‘ transit time.

The "Zero Phase" parameter of a path is properly adjusted, when the green cursor in the signal window is symmetrically within the two dotted red limit lines and the red asterisk is positioned exactly on the second positive zero crossing of the received ultrasonic signal (→ Figure 30).

Figure 32 "Path Diagnosis" page in MEPAFLOW600 CBM



If the zero phase values do not meet the aforementioned criteria, the zero phase needs to be adjusted.

The meter must be in the Configuration Mode with the Parameter write lock in the UNLOCKED position.

To shift the zero phase cursor to the proper position, the parameter "Zerophase[rad]" in the parameter table on the right hand needs to be adjusted.

- ► Click the arrows to raise or lower the zero phase in steps of 0.1 rad or type in a value.
- ► Begin by changing the zero phase value in steps of 0.5 rad.
- ► Then click "Write to meter" and check the reaction in the signal window.
- ► Continue until the green cursor is positioned near or exactly on the red asterisk. (The asterisk marks the second positive zero passage.)

The proper value of the zero phase can be calculated or determined empirically.

Examples for the effect on the phase lag:

- *Zero phase + 6.28 rad (=2π): Shifts the ZeroPhase BA (or AB) line by about one period to the right*
- *Zero phase - 3.14 rad (=-π): Shifts about half a period to the left*

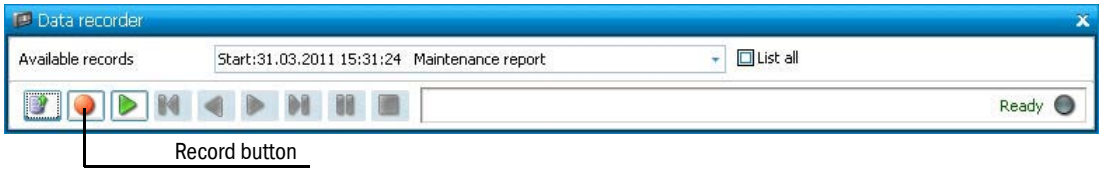
- ► After having adjusted the zero phase, check the SOS again (→ pg. 80, 3.3.8).

3.3.9 Data record during flow calibration (optional)

It is recommended that the measured values and diagnostic information are recorded during the flow calibration for documentation purposes and later use.

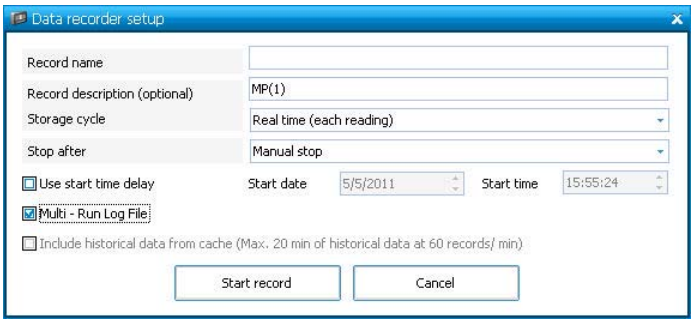
> The data recorder in MEPAFLOW600 CBM collects all important information and stores it in the meter database (→ pg. 58, 2.9.3).

Figure 33 Data recorder



- ► Open the data recorder (select Tools / Data recorder).
- ► Click the record button (→ Figure 33). The "Data recorder setup" window will appear (→ Figure 34).

Figure 34 "Data recorder setup" window



- ► Specify a record name
- ► Set the "Storage cycle" to "Real time (each reading)"
- ► Select a sufficient record duration for "Stop after"
- ► Check Multi-Run Log File. (This will allow changes to the Record description while retaining the same Record name for all records, e.g. "Measuring point Qmin", "Measuring point 0.1 Qmax", specific gas velocity etc.)
- ► Wait for stabilization of the first flow rate at which the meter will be calibrated.
- ► Click the "Start record" button. Now the Data recorder window will appear again (→ Figure 35). The data recorder indicates record count, remaining countdown time, and end time.

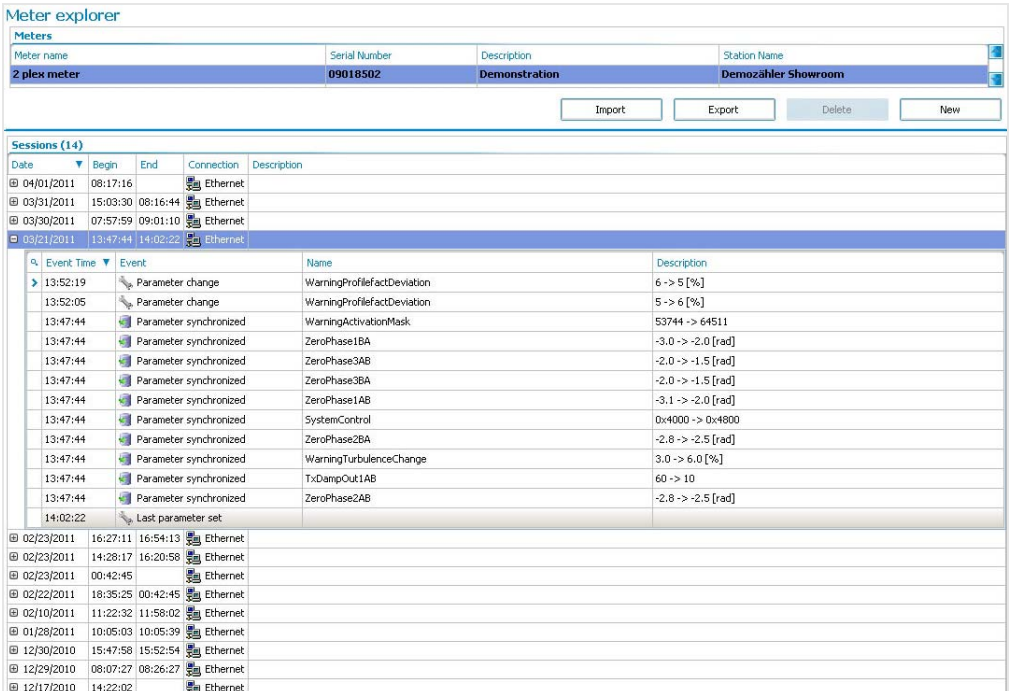
Figure 35 Data recording

- ► When the recording is finished, the next recording can be made, or recording stopped.
- ► Repeat for all records required.

The data recorded during the calibration are stored in the meter‘s database.

► Open the "Meter explorer" to see the "Measurement records" (→ Figure 36).

Figure 36 Meter explorer with stored calibration point records



After collecting data for all calibration points, the test results will be entered into the meter to adjust the meter‘s output.

3.4 Adjustment of the FLOWSIC600

The calibration facility runs flow tests and determines the deviations and uncertainties of the meter under test at least at 6 flow rates against the reference meter.

3.4.1 Determining adjust factors with the "Meter calibration" wizard

- ► Connect to the FLOWSIC600 with MEPAFLOW600 CBM (→ pg. 125, 5.3)
- ► Check performance, pressure, temperature and meter factor (→ pg. 75, 3.3ff)
- ► Open the "Meter calibration" wizard (select Tools / Meter calibration) (→ Figure 37)
- ► Switch the FLOWSIC600 to Configuration Mode
- ► Follow the instructions on screen and fill in all necessary fields.
- ► Click "Next".

Figure 37 "Meter calibration" wizard, step 1

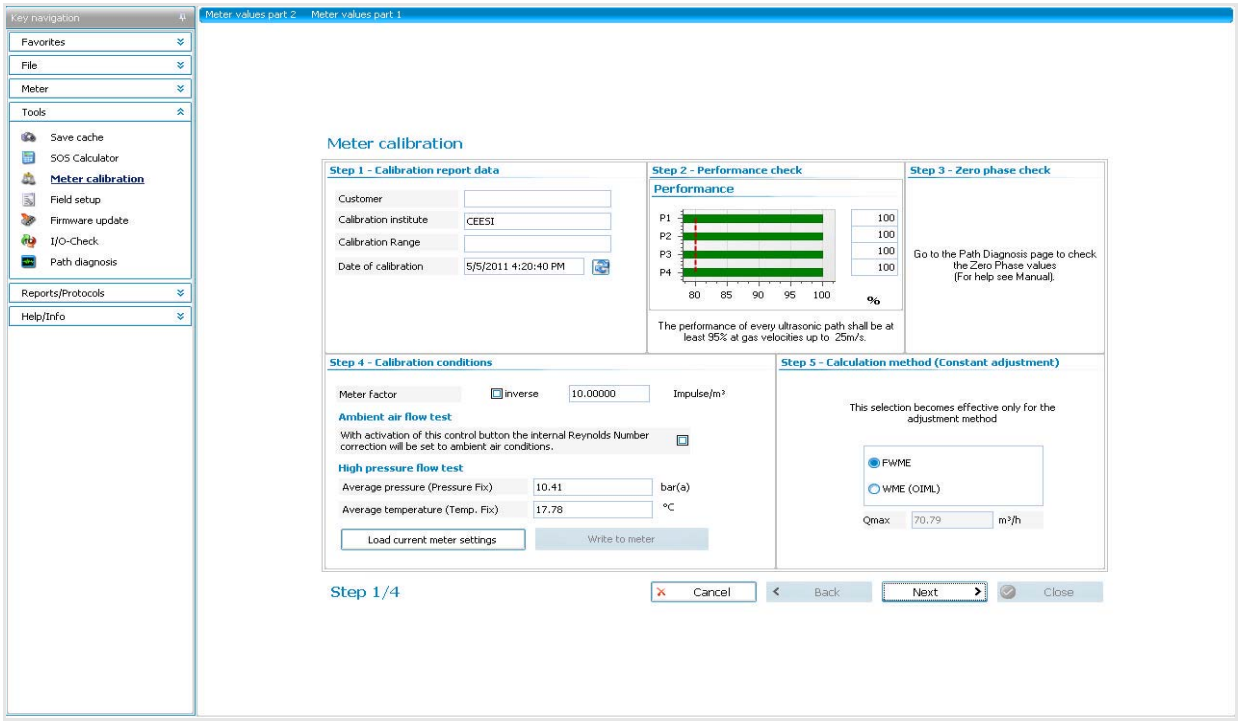
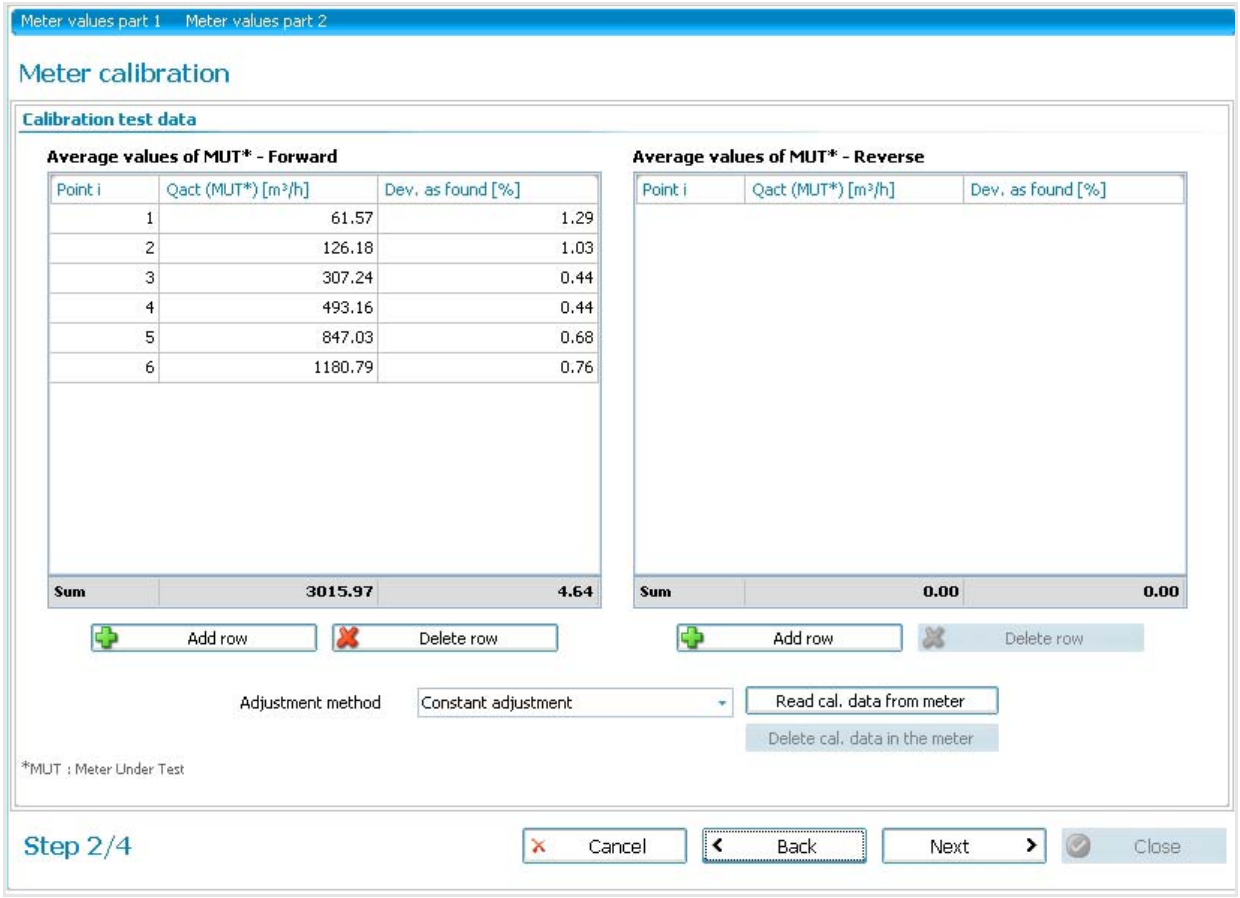


Figure 38 "Meter calibration" wizard, step 2



- ► Click "Add row" until you have a row for every flow test point.
- ► Enter all flow rates Qact for the Meter Under Test and the deviation as found into the table (→ Figure 38).

- The "Qact MUT" values are the flow rates of the flow calibration.
- "Dev. as found [%]" is the difference of the test meter relative to the reference (test stand).
- Qact and deviation must be entered for each flow rate.
- Only positive flows have to be entered, i.e. the reverse flow data points are not negative flows!

- ► Select the Adjustment method you want to apply.
- ► Click "Next".

Figure 39 "Calibration wizard", Step 4

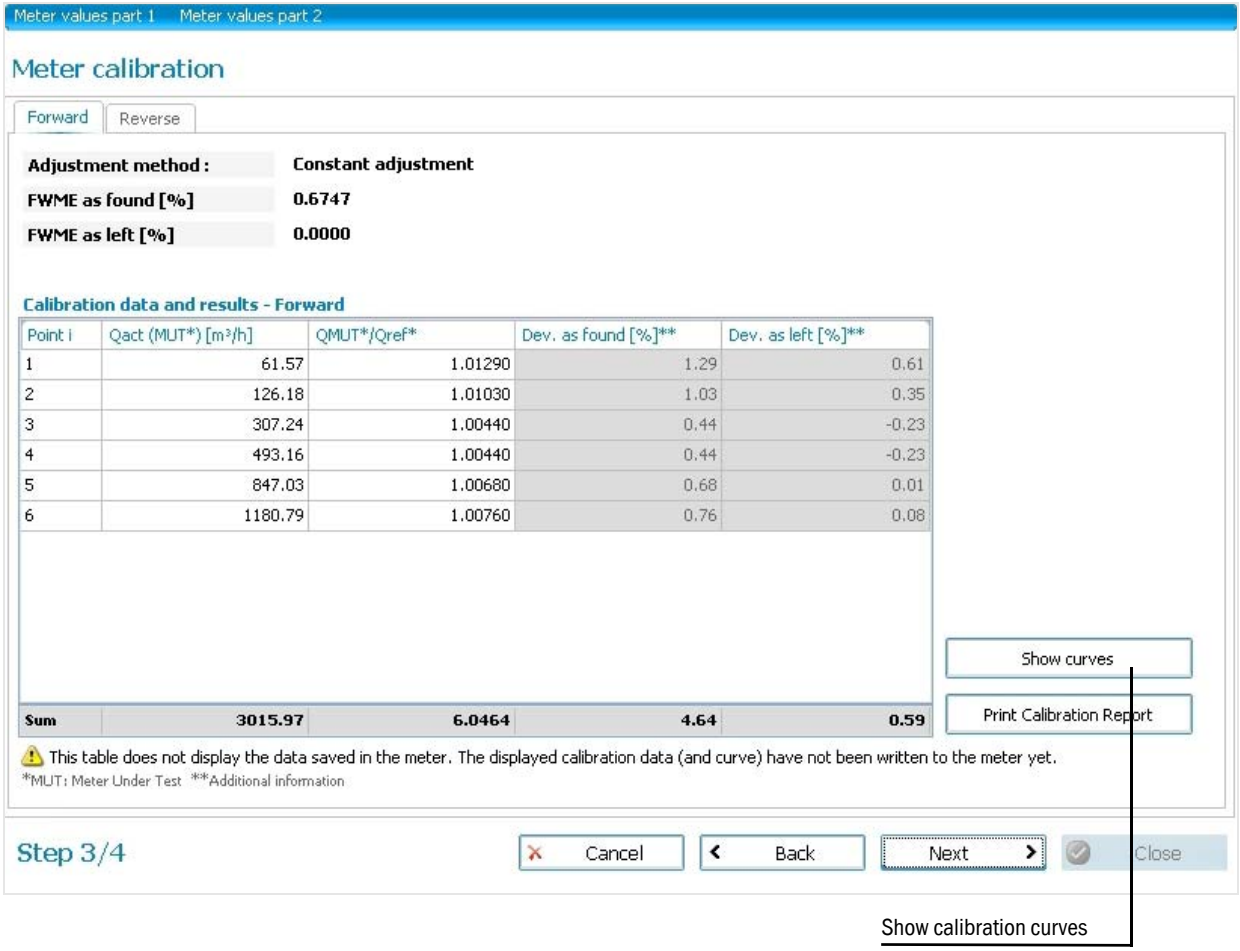
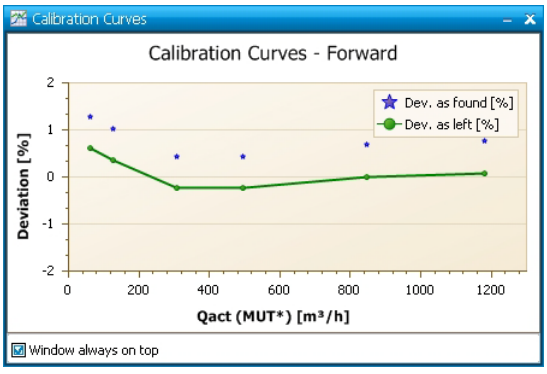


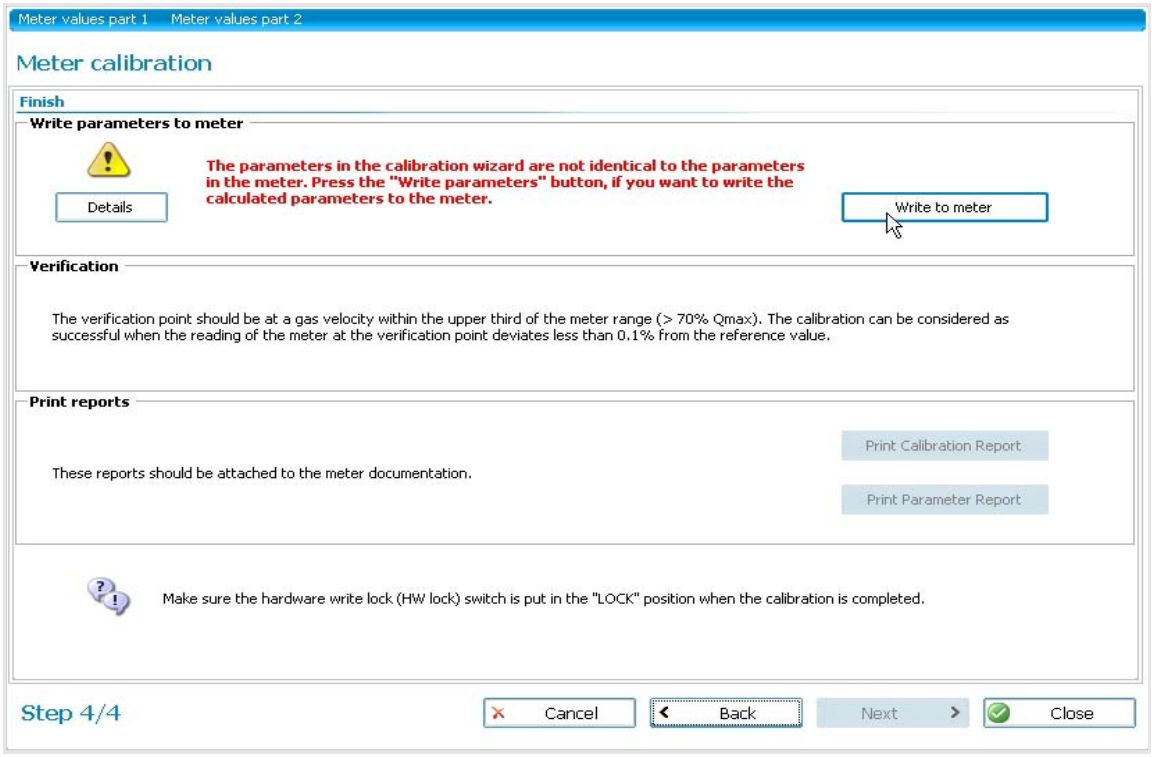
Figure 40 Calibration curve for adjustment with constant factor (example)



The calibration wizard calculates the WME (Weighted Mean Error) or the FMWE (Flow Weighted Mean Error) and the adjust factor (or polynomial coefficients).

- ► Use the tabs to change between the table for forward and reverse flow.
- ► Click "Show curves" to display the calibration curves.
- ► Click "Next".

Figure 41 "Meter calibration wizard, step 4



- ► If new adjust factors were calculated for the meter in step 2, click "Write to meter" (→ Figure 41).
- ► Switch the meter to Operation Mode.
- ► Follow the instructions on screen to verify the calibration.

Verification

Choose the test flow rate(s) between two flow rates the meter was tested at. For example, if the errors at Qmax and 0,7*Qmax have already been found, the correction should be tested at e.g. 0.8*Qmax. The volume measured by the meter should be within ±0.1% of the reference value. Verification for adjustment method "Constant factor":

- ► Verify at one test flow rate

Verification for adjustment method "Polynomial" or "Piece wise" :

- ► Verify at two test flow rates

- ► After the verification has been carried out successfully, go back to the first page of the calibration wizard (→ Figure 28)
- ► Set the pressure, temperature and meter factor values back to your customized values (see → 3.3.8).
- ► Switch the meter to Operation Mode.
- ► LOCK the Parameter write lock (→ pg. 78, Figure 26).
- ► Go to page 4 of the calibration wizard and print a "Calibration report" and a "Parameter report" (see examples in the Appendix).
- ► File both reports with the meter documentation.

3.5 Sealing

After completion of the calibration, carry out the following securing measures in accordance with the sealing plan (→ pg. 252, 9.9):

- ► Close the window cover of the SPU and seal it using the securing bracket and wire lead.
- ► Seal all transducer cover caps with at least two stickers.
- ► Attach the conformity label to the main type plate on the SPU (→ pg. 256, Figure 120).

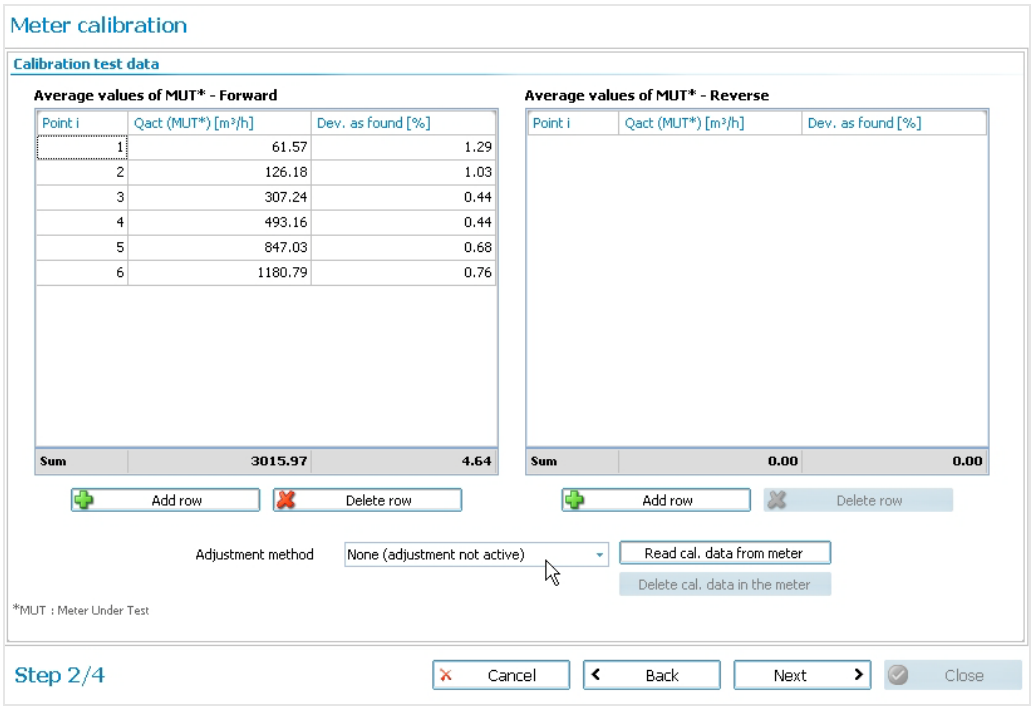
3.6 Flow recalibration

> ***NOTICE:***
> Special handling procedures for recalibration defined in standards, recommendations, national regulations and or type approvals must be considered.

To recalibrate the FLOWSIC600 at a flow test facility, apply the procedure as described in Section → pg. 75, 3.3 and → pg. 88, 3.4 by using the "Meter calibration" wizard in MEPAFLOW600 CBM.

- Check the remaining battery capacity and replace the battery if necessary (→ pg. 173, 6.2.4).
- Set the current gas conditions on page 1 of 4 (→ pg. 79, 3.3.7).
- Perform the functional check (→ pg. 80, 3.3.8).
- Go to page 2 of 4 of the "Meter calibration" wizard.→ Figure 42
- Select "None" as adjustment method. Now the flow meter does not use the adjust factors displayed on the right hand side. The factors are still displayed and not deleted so that they can be reactivated (see Note below).

Figure 42 "Meter calibration" wizard page 2 of 4, calibration factors "as found" (non flow calibrated flow meter)



- Now proceed with → 3.3.1 of this Chapter.

> If it becomes apparent after the flow tests, that the adjust factors do not have to be changed, do not write the parameter to the meter, but reactivate the previous adjust factors on page 2 of 4 in the wizard, by selecting the previously used adjustment method (other than "None").

FLOWSIC600

4 Installation

General notes
Installation
Mechanical installation
Electrical installation

4.1 General notes

4.1.1 Delivery

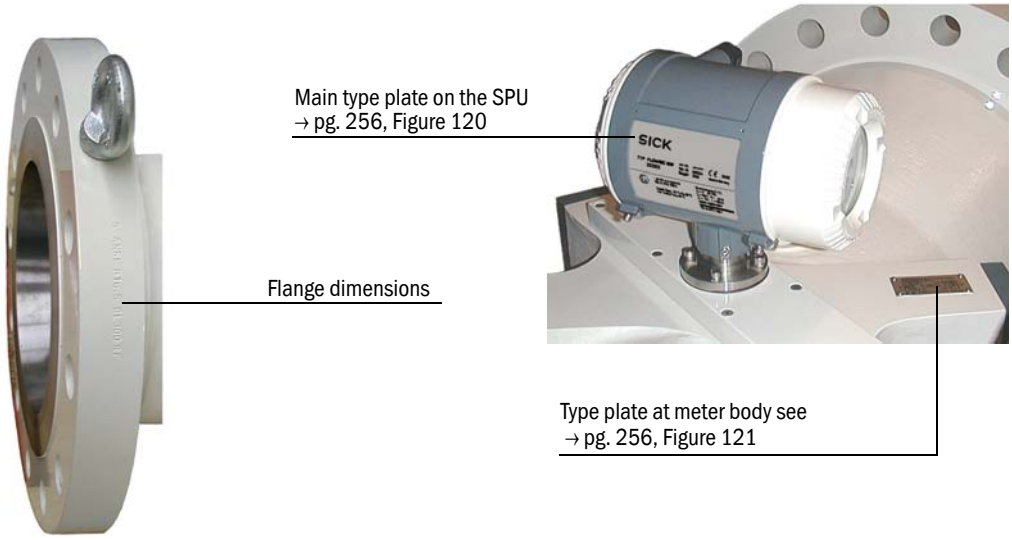
The FLOWSIC600 is delivered in a pre-assembled condition in a sturdy package. When unpacking the device, check for possible damage in transit. Pay particular attention to the interior of the meter body, any visible transducer components and the sealing surfaces on the flanges. Any damage must be documented and reported to the manufacturer immediately.

Also check the shipment to ensure all components are included. The standard meter shipment is comprised of:

- FLOWSIC600 measuring system (meter body with signal-processing unit and transducers)
- MEPAFLOW600 CBM operation, configuration and diagnosis software
- Operating Instructions,
- Manufacturer Data Report (MDR)

> ***NOTICE:***
> To guarantee safe and reliable operation of the measuring equipment, make sure the actual site conditions match the information provided on the labels on the meter body and SPU (see Figure 43).

Figure 43 FLOWSIC600 labels and marks



4.1.2 Transport and storage

WARNING:
Only use lifting gear and equipment (e.g. lifting straps) which is suitable for the weight to be lifted. Max. load information can be found on the type plate of the lifting gear. It is strongly recommended to use only the eye bolts when lifting the meter by itself. To lift the FLOWSIC600 please pay attention to Figure 44.

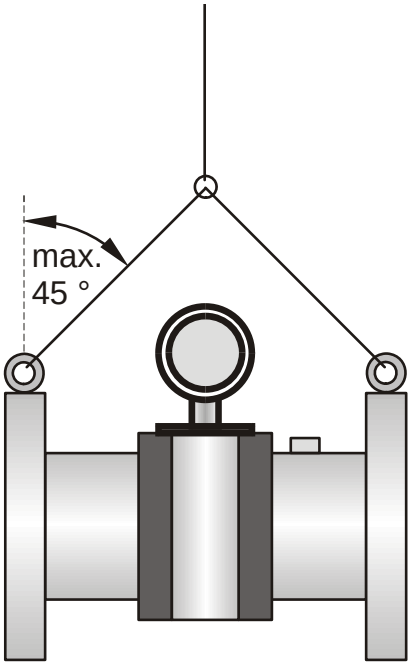
During FLOWSIC600 transport and storage operations, make sure that:

- The meter is firmly secured at all times
- Measures are taken to avoid mechanical damage
- Humidity and ambient temperature are within specified limits (→ pg. 209, Table 27).

If the device is to be stored outside for more than one day, sealing surfaces of the flanges and the interior of the meter body must be protected from corrosion, e.g. with Anticorit spray (not required for stainless steel meter bodies). The same measure shall be taken if the meter is to be stored in dry condition, but for more than a week.

NOTICE:
Due to natural temperature fluctuation in the course of a day, or if the meter is transported to a place with different temperature and humidity conditions, moisture may condense on any material. Carbon steel surfaces may corrode if left unprotected.

Figure 44 Lifting requirements



4.2 Installation

Generally, the installation arrangement is specified during the project planning phase, before installation of the system. Nominal size, material and type of flange should therefore be in accordance with the design of the measurement facility. It is particularly important that the meter inlet and outlet is of the same internal diameter as the adjacent piping.

Fastening bolts, nuts and flange seals used must be suited to the operational conditions, and comply with legal regulations and relevant standards.

The installation requirements were evaluated according to the flow disturbance sensitivity tests according to

- OIML R 137-1&2, 2012 "Gas meters", Annex B and
- ISO 17089-1, 2010, "Measurement of fluid flow in closed conduits - ultrasonic meters for gas - Part 1: Meters for custody transfer and allocation measurement.", 5.9.3 Installation requirements and flow profile considerations.

Any deviation from the planned design of the FLOWSIC600 and installation arrangement shall be agreed upon with the supplier and documented prior to installing the meter.

4.2.1 Measuring location

General requirements:

- The FLOWSIC600 can be installed in customary straight inlet and outlet pipes. The adjacent pipes must have the same nominal size as the meter body. The internal diameter can be obtained from the table (→ pg. 216, Table 29) based on the flange rating and the Standard. The max. permitted difference of the internal diameter of the inlet pipe from that of the meter body is 3%. Any welding beads and burs on the flanges of the inlet pipe shall be removed.
- The meter body may be installed in a horizontal or vertical position. In case of horizontal installation, the meter body shall be aligned so that the planes formed by the measuring paths are in a horizontal position. This minimizes dirt in the pipeline from entering the transducer ports. Vertical installation is only possible if the measuring system is used for dry, non-condensing gases. The gas flow must be free from any foreign material, dust and liquids. Otherwise, filters and traps shall be used.
- Do not mount equipment or fittings which may adversely affect the gas flow directly upstream the FLOWSIC600.
- Seals at the flange connections between meter body and pipeline must not protrude into the pipeline. Any protrusion into the flowing gas stream may change the flow profile and thus the measuring accuracy may be adversely affected.
- Pressure transmitter shall be connected to the pressure tap provided (→ pg. 19, Figure 5). The pressure tap can be a 1/8, 1/4 or 1/2 inch NPT (female) port, depending on meter size and customer requirements.
- For the leak-proof connection on the pressure line, a suitable thread sealing agent (e.g. PTFE tape) must be used when the pressure connection adapter is screwed in. After Installation and Commissioning the leak-tightness must be checked. All leaks must be repaired. Temperature probes shall be arranged as shown in → Figure 45 and → Figure 46.

4.2.2 Installation configurations

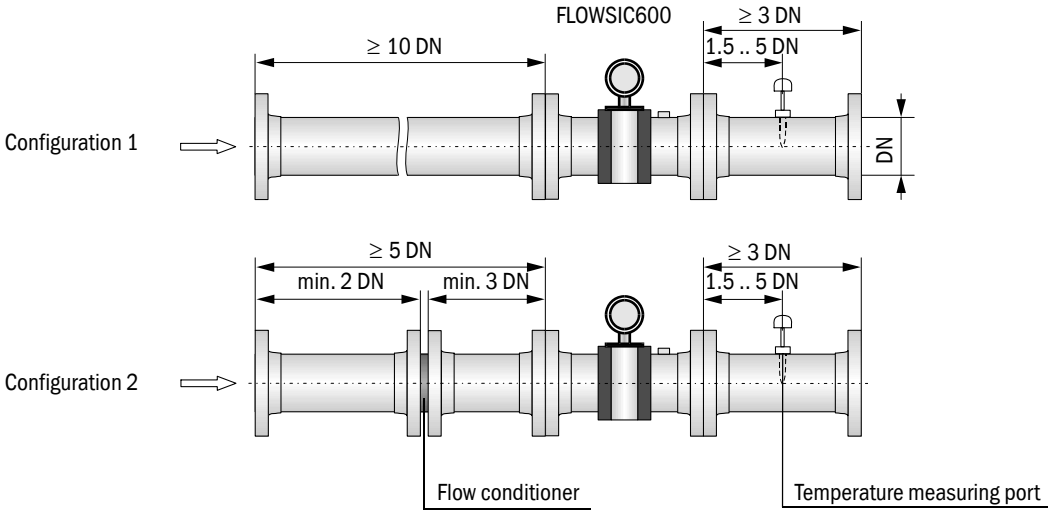
The choice of the installation configuration (see → Figure 45 and → Figure 46) depends on type and extent of the flow disturbance at the installation position.

Type of disturbance (distance upstream < 20 DN)	Possible installation configuration
None	Configuration 1 or 2
Elbow, reducer	
Double elbow out of plane, T piece	
Gas pressure controller with/ without noise abatement trim	Configuration 2
Diffuser	
Diffuser with swirling flow	

When configuration 2 (with flow conditioner) is used, the velocity of gas must not exceed 40 m/s (131 ft/s) in the pipe.

Unidirectional use

Figure 45 FLOWSIC600 installation in the pipeline for unidirectional use

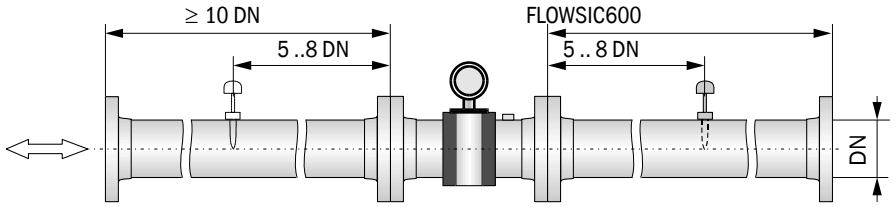


Bidirectional use

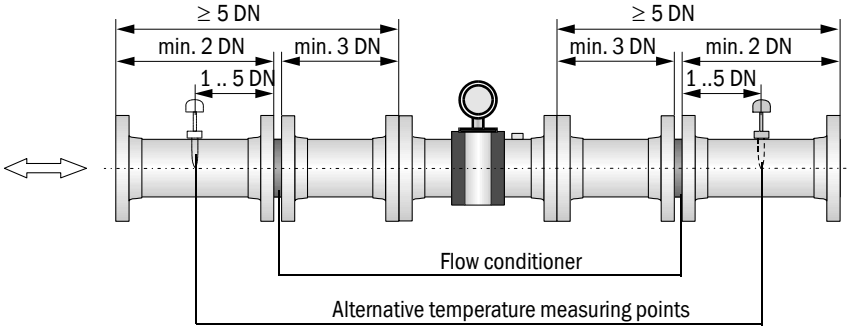
Two straight pipes are to be installed in the inlet and outlet sections if the meter is to be used bidirectionally. The temperature measuring point is to be located downstream of the FLOWSIC600, seen in the direction of predominant use. The temperature measuring point must not be installed more than 8 DN from the meter.

Figure 46 FLOWSIC600 installation in the pipeline for bidirectional use

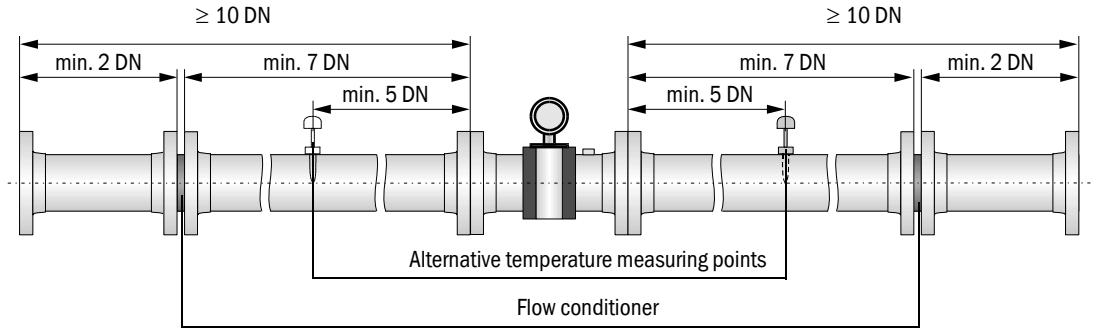
Configuration 1



Configuration 2a



Configuration 2b
Applicable for meters marked with an asterisk (*) in → Table 28, »Meter sizes according to metrological type approval«



4.3 Mechanical installation

Work on the pipelines to prepare for the installation of the gas flow meter is not included in the scope of delivery.

It is recommended to use the following tools, equipment and supplies for installation of the FLOWSIC600:

- Lifting gear or fork lift (with sufficient capacity to lift meter or meter-piping assembly)
- Box wrench with size suitable for flange installation
- Thread seal (e.g. PTFE tape) and flange gaskets
- Bolt lubricant,
- Leak detection spray

WARNING: DANGER

- Always observe the general safety regulations and safety instructions given in Section 1 when carrying out any installation work.
- The FLOWSIC600 must only be mounted on depressurized and vented pipelines.
- Take all necessary precautions to avoid local or plant-specific dangers.

4.3.1 Choosing flanges, seals and other parts

Use pipeline flanges, bolts, nuts, and seals that withstand the maximum operational pressure and temperature, as well as ambient and operational conditions (external and internal corrosion) for the flange connections. For installation lengths and flange dimensions, see MDR.

WARNING: DANGER

- Always strictly observe the safety instructions for the installation of pressure equipment including the connection of several pressure components set forth in the local or national relations and standards or Pressure Equipment Directive 97/23/EC.
- Installation staff must be familiar with the directives and standards applicable for pipeline construction.

4.3.2 Mounting the FLOWSIC600 in the piping

An arrow on the meter body indicates the main direction of flow. It is recommended to install the FLOWSIC600 as indicated by this arrow if the meter is to be used for unidirectional flow applications. If the meter is to be used in the bidirectional mode, the arrow indicates the positive direction of flow.

Installation work to be carried out

WARNING:

- The lifting eyes are designed for transporting the meter only. Do not lift the FLOWSIC600 using these eyes when additional loads (such as blind covers, filling for pressure tests or piping) are attached (also see → pg. 97, 4.1.2)
- Never attach lifting gear to the signal processing unit or its mounting bracket and avoid contact between these parts and the lifting gear.
- The FLOWSIC600 must not turn over or start to swing while being transported. Flange sealing surfaces, SPU housing and transducer cover caps may be damaged when the lifting gear is not attached properly.
- Take suitable measures to prevent damage to the meter when carrying out any other work (welding, painting) near the FLOWSIC600.

- ► Position the FLOWSIC600 at the desired location of the pipeline using the lifting gear. Only use the lifting eyes provided to lift and transport the device. If lifting straps are used, wrap them around the meter body.
- ► Check for correct seating and alignment of the flange gasket after installing the flange bolts, but prior to tightening.
- ► Align the FLOWSIC600 such that the offsets between inlet pipe, meter body and outlet pipe are minimized.
- ► Insert the remaining fastening bolts and tighten the nuts cross-wise. The tightening torque applied must not be lower than specified in the project planning.
- ► Mount the pressure sensing line between pressure tap and pressure transmitter.
- ► Fill the pipeline and check the installed FLOWSIC600 and piping connections for leaks.

***NOTICE:* Observe allowed pressure change**

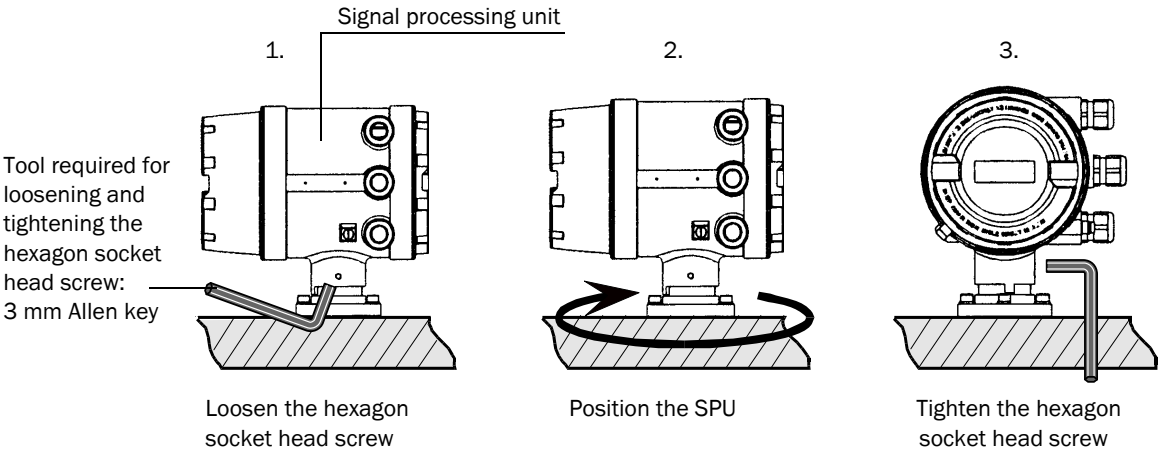
- ► The pressure change within the measuring section must not exceed 0.5 MPa/min in order to protect transducers and seals.

It is recommended to perform a leak test in accordance with the relevant regulations and standards after completion of the mechanical installation.

4.3.3 SPU alignment

The signal processing unit (SPU) can be turned so that the display can be easily read and that cable routing is facilitated (see → Figure 47). A stop on the housing prevents the SPU from being turned by more than 330° to prevent damage to the cables that come from the meter body.

Figure 47 Positioning the SPU.



NOTICE:
Do not forget to tighten the hexagon socket head screw after positioning the SPU.

4.4 Electrical installation

4.4.1 General information

Prerequisites

Wiring work (routing and connecting the power supply and signal cables), which is necessary when installing the FLOWSIC600, is not included in the scope of delivery. The mechanical installation described in Section → 4.3 must be completed first. Comply with the minimum cable specification requirements set out in Section → 4.4.2.

Cable routing

- ► Keep cables in conduits or laid on cable trays to provide protection from mechanical damage.
- ► Observe the permitted bending radiuses (generally, min. six times the cable diameter for multi-conductor cables).
- ► Keep all connections outside of conduits as short as possible.

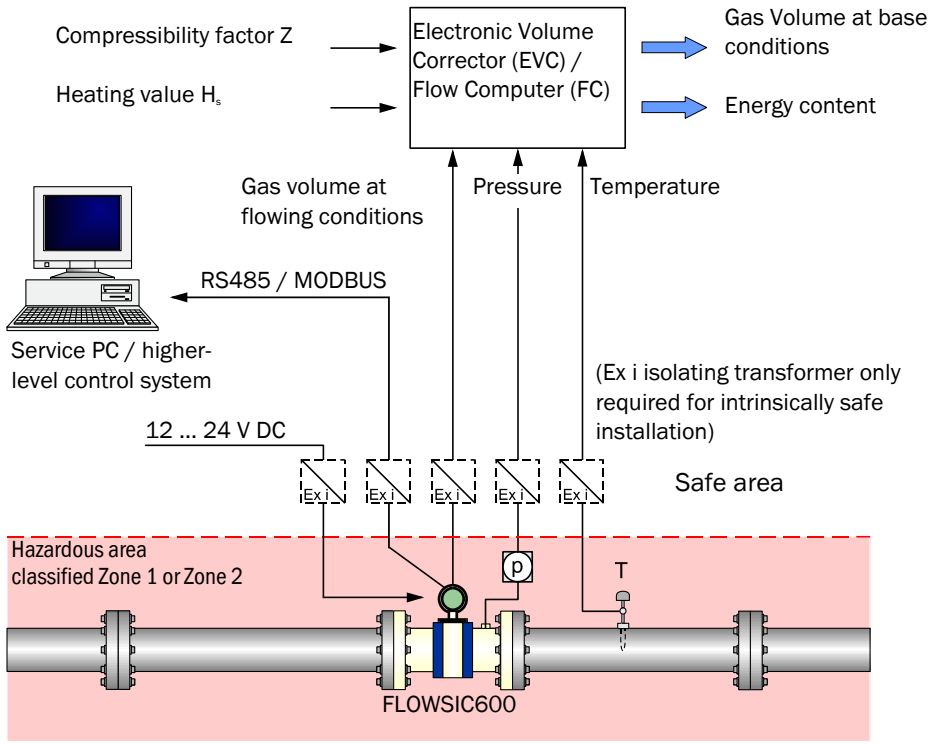
WARNING: DANGER

- ► Always observe the general safety regulations and safety instructions given in Section 1 when carrying out any installation work.
- ► Installation work shall only be carried out by trained staff and in accordance with the relevant regulations issued by the operating company.
- ► Take all necessary precautions to avoid local or plant-specific dangers.

General connection of the FLOWSIC600

Installation examples see → pg. 246, 9.7

Figure 48 FLOWSIC600 connection diagram



4.4.2 Cable specifications

WARNING:
The cables must fulfil the requirements for use in hazardous areas (e.g. set forth in EN /IEC 60079-14 or other relevant standards).

Power supply 12 ... 28.8 V DC

	Specification	Notes
Type of cable	Two conductors	Connect shielding (if present) to ground terminal
Min./ max. cross-sectional area	0.5 mm² / 2.5 mm² (20 - 12 AWG)	
Maximum cable length	Depending on loop resistance; Minimum input voltage on the FLOWSIC600 must be 12 V DC.	Peak current 150 mA
Cable diameter	6 ... 12 mm (1/4 to 1/2 inch)	Fixing range of the cable glands

Digital output / current output

	Specification	Notes
Type of cable	Twisted pair, shielded	Connect shielding at other end to ground terminal
Min./ max. cross-sectional area	2 x 0.5/1 mm² (2 x 20-18 AWG)	Do not connect unused conductor pairs and prevent them from accidental short-circuit
Maximum cable length	Loop resistance ≤ 250 Ω	
Cable diameter	6 ... 12 mm (1/4 to 1/2 inch)	Fixing range of the cable glands

Serial port (RS485)

	Specification	Notes
Type of cable	Twisted pair, shielded, impedance approx. 100...150Ω low cable capacitance: ≤ 100 pF/m	Connect shielding at other end to ground terminal
Min./ max. cross-sectional area	2 x 0.5/1 mm² (2 x 20-18 AWG)	
Maximum cable length	300 m at 0.5 mm² (1600 ft for 20 AWG) 500 m at 0,75 mm² (3300 ft for 20 AWG)	Do not connect unused conductor pairs and prevent them from accidental short-circuit
Cable diameter	6 ... 12 mm (1/4 to 1/2 inch)	Fixing range of the cable glands

NOTICE:
Only the lower fault current may be used with an internally fed analog output and use of HART communication.

4.4.3 Checking the cable loops

Check the cable loops to verify that the cables are connected correctly. Proceed as follows:

- ► Disconnect both ends of the cable of the loop to be tested. This is to prevent connected devices from interfering with the measurement.
- ► Test the entire cable loop between SPU and terminal device by measuring the loop resistance.
- ► If you want to test the insulation resistance as well, the cables must be disconnected from the electronic module before using the insulation resistance tester.

WARNING:
Applying test voltage to the cables before disconnecting them from the electronics module will seriously damage the electronics module.

- ► Reconnect all cables after the loop resistance test.

WARNING: Explosion Hazard

- In non-intrinsically safe installations, the terminal boxes may only be opened if the system is disconnected from the power supply.
- In non-intrinsically safe installations, the cables may only be disconnected if the system is disconnected from the power supply.
- The window cover must only be opened if the system is disconnected from the power supply and only 10 minutes or more after the system has been switched off, or the area is known to be non-hazardous.

NOTICE:
Incorrect cabling may cause failure of the FLOWSIC600. This will invalidate warranty claims. The manufacturer assumes no liability for consequential damage.

4.4.4 Terminal enclosure on the SPU

Opening the rear housing cover

- ► Loosen the securing clip using a 3 mm Allen key.
- ► Turn the rear housing cover counter-clockwise and take it off.

> ***NOTICE:*** **Lubricant**
> Only use LOCTITE 8156 as lubricant for front and rear housing cover.

A schematic wiring diagram is provided on the inside of the rear housing cover (see also → pg. 238, 9.5).

Figure 49 SPU housing

Figure 50 Terminal box on the rear of the SPU (see Section → 4.4.2 for North American wiring specification equivalents)

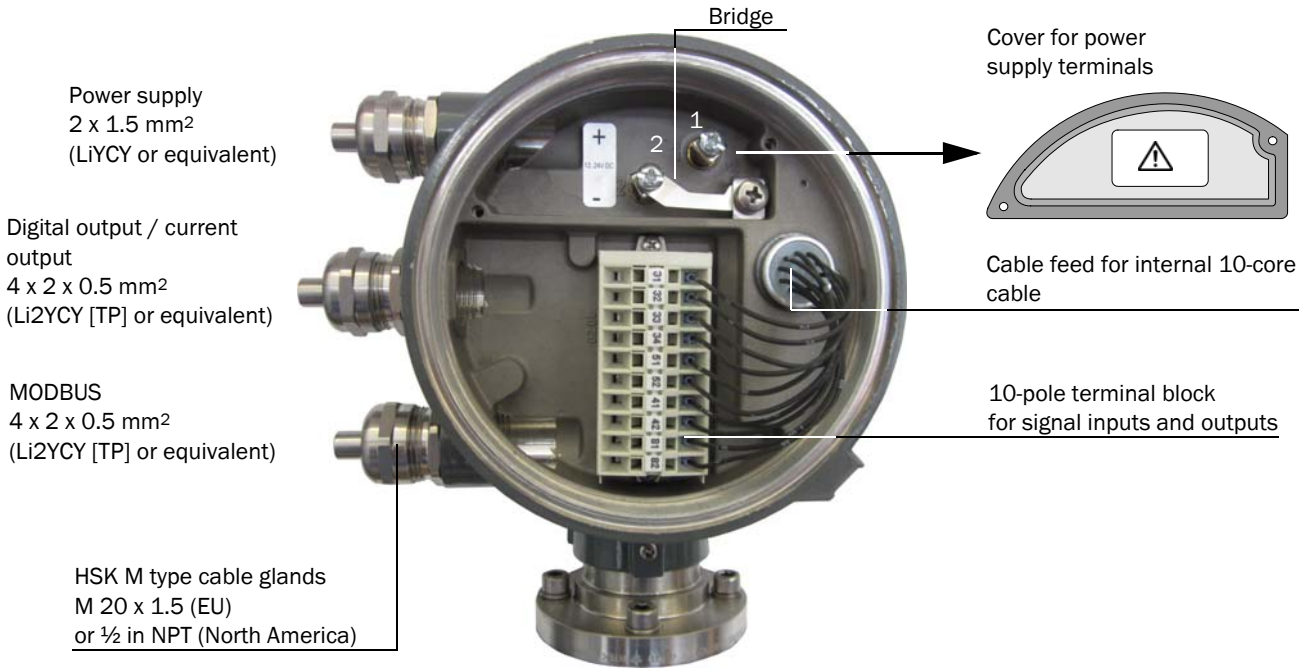
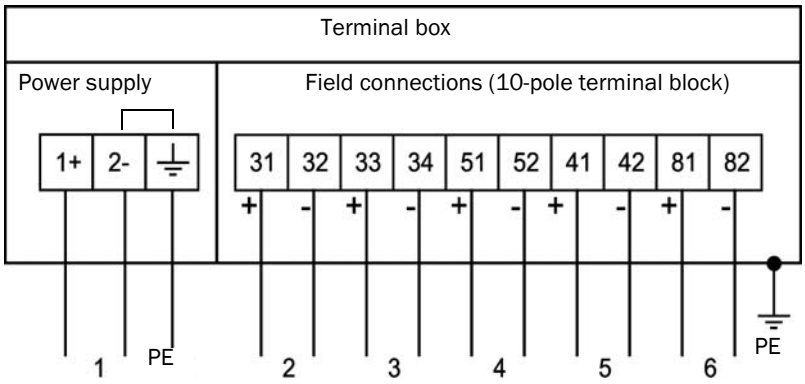


Figure 51 Terminal assignment for use in safe areas



***NOTICE:* Potential equalization**

PE: Potential Equalization terminal must be connected to earth ground.

***NOTICE:* Device-internal bridge**

Terminals 2 and PE are bridged internally, i.e. there is no insulation between PE and negative potential (→ Figure 50).

- ► This bridge is a firm part of the device and mandatory. It must not be removed or altered.
- ► Altering the bridge voids the manufacturer's warranty.

***NOTICE:* Termination of Modbus lines**

Begin and end of the Modbus lines must be terminated.

- Terminal 81/82: Always terminated
- Terminal 33/34: Switchable, terminated ex factory

For detailed information, see Service Manual FLOWSIC600, Section 4.4 "Serial interface RS485".

4.4.5 Operating the FLOWSIC600 in non-hazardous areas

Assign the terminals in the SPU terminal box (→ Figure 51) in accordance with the following table.

No.	Connection for	Function	Terminal	Value	Notes
1	Power supply		1+, 2-	12 ... 24 (+20%) V DC	
2	Digital output DO 0 (HF 2)	Passive	31, 32	f_{max} = 6 kHz, configurable pulse duration 0.05 s - 1 s Range: Variable number of pulses per volume unit "closed": 0 V ≤ $U_{CE\ L}$ ≤ 2 V, 2 mA ≤ $I_{CE\ L}$ ≤ 20 mA (L=Low) "open": 16 V ≤ $U_{CE\ H}$ ≤ 30 V, 0 mA ≤ $I_{CE\ H}$ ≤ 0.2 mA (H=High)	With NAMUR contact for connection to switching amplifier (according to EN 60947-5-6:2000)
3	Serial port	MODBUS (RS485)	33, 34	9600 Baud, 8 data bits, no parity, 1 stop bit	Baud rate to be set through software
4	Digital output DO 1 (HF 1)	Passive	51, 52	f_{max} = 6 kHz, configurable pulse duration 0.05 s - 1 s Range: Variable number of pulses per volume unit "closed": 0 V ≤ $U_{CE\ L}$ ≤ 2 V, 2 mA ≤ $I_{CE\ L}$ ≤ 20 mA (L=Low) "open": 16 V ≤ $U_{CE\ H}$ ≤ 30 V, 0 mA ≤ $I_{CE\ H}$ ≤ 0.2 mA (H=High)	With NAMUR contact for connection to switching amplifier (according to EN 60947-5-6:2000)
5	Digital output DO 2	Passive	41, 42	"closed": 0 V ≤ $U_{CE\ L}$ ≤ 2 V, 2 mA ≤ $I_{CE\ L}$ ≤ 20 mA (L=Low) "open": 16 V ≤ $U_{CE\ H}$ ≤ 30 V, 0 mA ≤ $I_{CE\ H}$ ≤ 0.2 mA (H=High) "Check request" (default)	
6	Digital output DO 3	Passive	81, 82	"closed": 0 V ≤ $U_{CE\ L}$ ≤ 2 V, 2 mA ≤ $I_{CE\ L}$ ≤ 20 mA (L=Low) "open": 16 V ≤ $U_{CE\ H}$ ≤ 30 V, 0 mA ≤ $I_{CE\ H}$ ≤ 0.2 mA (H=High) "Direction of flow" (default) (alternative "Warning")	
	Alternative assignment with second serial port (RS485)			9600 Baud, 8 data bits, no parity, 1 stop bit	Baud rate to be set through software

4.4.6 Requirements for use in hazardous areas with potentially explosive atmospheres[1]

Intended use

The FLOWSIC600 is suitable for use in hazardous areas classified as Zone 1 and Zone 2.

Certification in accordance with ATEX

II 1/2 G Ex de ib [ia] IIC T4
II 1/2 G Ex de ib [ia] IIA T4

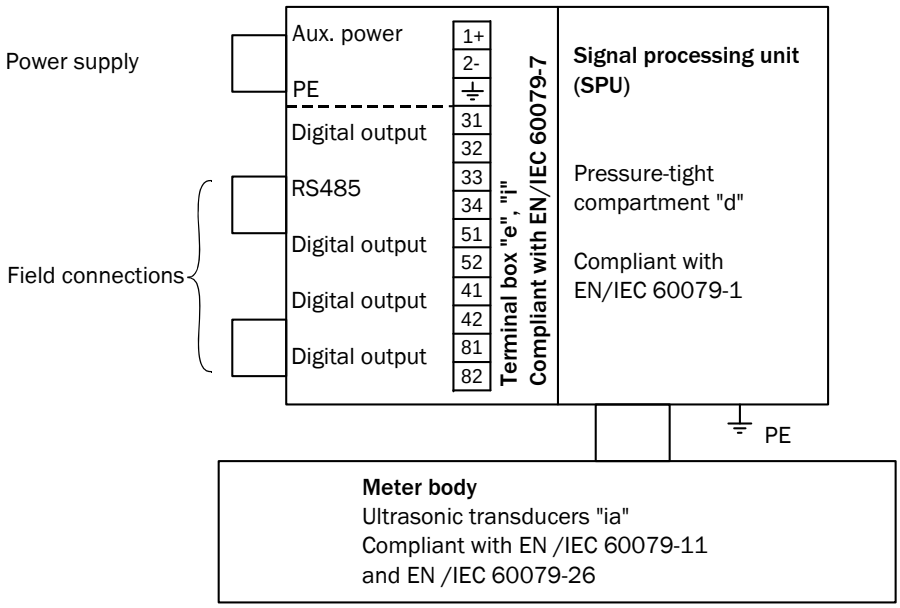
Permitted ambient temperature range -40 °C to +60 °C
EC TYPE Examination Certificate: TÜV 01 ATEX 1766, include 1. to 6. Supplement

IECEx Certification

Gb/Ga Ex de ib [ia Ga] IIC T4
Gb/Ga Ex de ib [ia Ga] IIC T4

Permitted ambient temperature range -40 °C to +60 °C, optionally - -50 °C to +70 °C
IECEx Certificate of Conformity: IECEx TUN 11.0001 X

Figure 52 FLOWIC600 components and their type of protection



1 For use in USA and Kanada, see control drawings → pg. 240, 9.6.

Operating conditions for the ultrasonic transducers

The FLOWSIC600 is designed for use in hazardous areas with potentially explosive atmospheres only under normal atmospheric conditions. The atmospheric conditions must be within the following ranges:

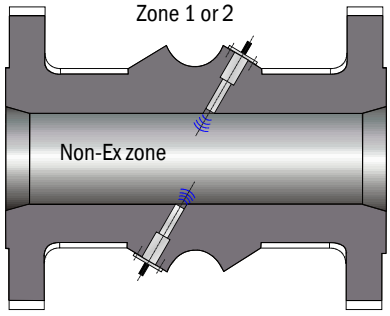
- Ambient pressure range 80 kPa (0.8 bar) to 110 kPa (1.1 bar)
- Air with normal oxygen content, typically 21% v/v

The ambient temperature must be within the range specified at the SPU type plate, e.g -40 °C to +60 °C.

Once the FLOWSIC600 is installed in the pipeline, the meter body becomes a part of the pipeline. The wall of the pipeline and the meter body is then deemed a zone-separating barrier. The figure below helps in understanding the different situations for a possible application and shows what operating conditions apply.

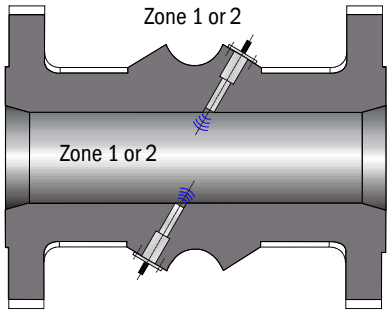
Figure 53 Ex-Zones

Case 1:



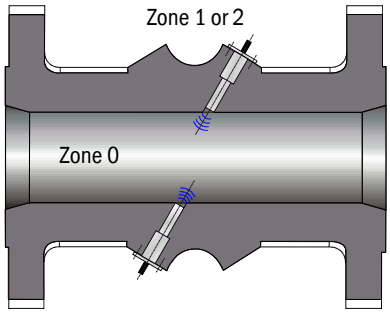
- The pipeline contains a non-explosive mixture. The gas mixture may be combustible.
- Gas pressure and gas temperature may be within the range specified by the tag on the meter body.

Case 2:



- The area inside the pipeline is classified as hazardous area Zone 1 or 2.
- Gas pressure must be in the range from 80 kPa to 110 kPa (normal atmospheric condition)
- Gas temperature must be within the permitted ambient temperature range specified by the type plate on the SPU

Case 3:



- The area inside the pipeline is dlassified as hazardous area Zone 0.
- Gas pressure must be in the range from 80 kPa to 110 kPa (normal atmospheric condition)
- Gas temperature must in the range from -20 °C to 60 °C.

Additional requirements for operation of ultrasonic transducer in Zone 0 classified areas

The FLOWSIC600 is marked with a minimum rating of II 1/2 G Ex [ia] or Gb/Ga Ex [ia Ga].

Operation of ultrasonic sensors in Zone 0

The ultrasonic transducers are suitable for operation in Zone 0 at atmospheric conditions, i.e. ambient temperature -20 °C to 60 °C and ambient pressure 0.8 bar to 1.1 bar(a). If ultrasonic transducers with titanium housing are to be used in Zone 0, it must be assured that the medium does not transport solid parts (like dust or other particles) which could cause an ignition hazard. Otherwise, transducers made from stainless steel must be used.

After installation and following every de-installation and reinstallation of the ultrasonic transducers, the seal effect must be appropriately checked. During operation, the leak-tightness must be periodically checked and the seals replaced if necessary. After de-installation and before every reinstallation the seals must be replaced according to the original assembly. Seals can be ordered from SICK (part number and serial number from type plate at SPU).

NOTICE:

The rise in the ambient temperature outside the pipeline due to a hot pipeline must be taken into account.

The user must ensure that the ambient temperature around the electronics housing does not exceed the maximum permitted ambient temperature marked on the type plate of the FLOWSIC600.

General requirements for installation

- The documentation for hazardous area classification (zone classification) according to EN/IEC60079-10 must be available.
- The equipment must be verified as suitable for use in the classified area.
- Additional requirements must be observed for use of transducers in Zone 0 as described above.
- After installation an initial test run of the complete equipment and the plant according to EN/IEC60079-17 must be performed before regular operation is started.

Requirements regarding cabling

- Cables must fulfill the requirements set forth in EN/IEC60079-14.
- Cables that are subject to exceptional thermal, mechanical or chemical stress must be specially protected, e.g. by laying them in protective tubing.
- Cables that are not installed fire proof must be flame retardant according to IEC 60332-1.
- Cables for Ex e must comply with EN/IEC 60079-14 section 11.
- Observe the clamping range of the cable glands for cable selection.
- Use Ex e II respectively Ex i II certified cable glands with adequate ingress protection rating as alternate replacement only.
- For intrinsically safe wiring and an ambient temperature range between -20 °C to +60 °C, the existing metal cable glands may be replaced with light-blue plastic cable glands (available on request).
- Replace the existing cable glands with suitable cable glands if installation with armored cables is intended.
- When delivered, the cable glands are secured by default with a sealing plug. If the cable glands are not used, only sealing plugs with EX e II approval must be used.
- Conduit systems must comply with EN/IEC 60079-14, section 9.4 and 10.5. In addition, compliance with national and other relevant regulations is required
- "Conduits" according to IEC 60614-2-1 and IEC60614-2-5 are not suitable.
- Conduits must be protected against vibration.
- Use a suitable thread sealant, as detailed in EN/IEC60079-14, section 9.4.
- Protect stranded wires against fraying with ferrules.
- Keep clearance and creepage distances for the connected wires in accordance with EN/IEC60079 and EN/IEC 60079-11 respectively.
- Connect unused wires to ground or safeguard so that a short circuit with other conductive parts is excluded.
- Carry out potential equalization in accordance with EN/IEC6079-14
- The meter body and the electronic housing must be connected to the potential equalization.
- Where the FLOWSIC600 is installed in a grounded metal duct, no additional grounding is required for the meter body. The electronics housing must nevertheless be separately grounded.

Connection of the FLOWSIC600 with associated equipment

The terminal compartment of the FLOWSIC600 complies with the requirements of EN/ IEC60079-7 and
EN/IEC 60079-11, respectively.

The FLOWSIC600 provides non-intrinsically safe wiring as well as intrinsically safe wiring with the interconnected associated equipment in the following manner:

1 Power supply connection and all other field connections as non-intrinsically safe wiring

2 Power supply connection and all other field connection as intrinsically safe wiring to Exi certified equipment in a Zone 1 or Zone 2 classified hazardous area or to [Exi] certified associated equipment in the safe area.

3 Power supply connection as non-intrinsically safe wiring and all other filed connection as intrinsically safe wiring.

A combination of intrinsically safe and non-intrinsically safe wiring for the field connections is not permitted.

Maximum voltage in the safe area must not exceed 253 V (Um = 253V).

For intrinsically safe wiring:

- The safety-relevant data in the EC Type Examination Certificate and the IECEx Certificate of Conformity must be observed.
- Intrinsic safety for each circuit must be assessed in accordance with EN/IEC60079-14 section 12.
- The safety-relevant parameters of interconnected equipment must comply with the following values: Uo < Ui, Io < Ii, Po < Pi, Ci + Ccable < Co, Li + Lcable < Lo

The interconnection of two or more intrinsically safe outputs may require an additional assessment of intrinsic safety in accordance with EN /IEC60079-11.

Ensure that the cover on the power supply connection is properly sealed for regular operation.

For intrinsically safe wiring, the rear cover can be removed and connecting and disconnecting is permitted while the circuits are live and as long as the safe separation between the circuits has been kept.

WARNING: Explosion Hazard

- Do not open the enclosure while energized.
- Wait 10 minutes after power has been removed before opening the window cover.
- Do not open the cover of the terminal compartment while energized unless wiring is intrinsically safe.
- Do not remove the cover of the power supply while energized unless wiring is intrinsically safe.
- Do not connect or disconnect while circuits are live unless the area is known to be non-hazardous or wiring is intrinsically safe.
- Do not use the equipment if damaged (includes cables or terminals).

Terminal assignment

The terminal assignment in the SPU terminal box (see → pg. 109, Figure 51) is the same as for the installation of the FLOWSIC600 in non-hazardous areas (see table → pg. 110, 4.4.5).

> ***NOTICE:***
> For measurement reasons, the equipotential bonding must, as far as possible, be identical to the pipeline potential or protective ground/earth. Additional grounding with the protective conductor via the terminals is not permitted!

The connections of the ultrasonic transducers are intrinsically safe and are safely separated from one another and from other non-intrinsically safe circuits. The transducers may be connected and disconnected during operation as long as the safe separation of circuits has been preserved in every respect. In order to ensure this, the respective transducer connection cable should be disconnected at both ends (disconnect the electronics side first, and then if necessary, the transducer side unless the MCX connector is suitably fixed to prevent any uncontrolled movement). Operation using sensors or cables not part of the original delivery or with sensors/components from other manufacturers is not permitted.

> ***NOTICE:***
> Replace backup battery with PANASONIC type BR2032,
> Sick part no. 7048533. It may only be replaced by trained staff.

Specific requirements for installation and use in North America

The FLOWSIC600 is intended for use in hazardous areas classified as Class I Division 1 and Class I Zone 1 as follows:

- Cl. I, Div. 1, Groups B, C and D, T4 resp. Cl. I, Zone 1, Group IIB + Hydrogene, T4
- Cl. I, Div. 1 Group D, T4 resp. Cl. I, Zone 1, Group IIA, T4

Further, the FLOWSIC600 is suitable for use in hazardous areas classified as Class I Division 2 and Class I Zone 2 as follows:

- Cl. I, Div. 2, Groups A, B, C and D, T4 resp. Cl. I, Zone 2, Group IIC, T4
- Cl. I, Div. 2 Group D, T4 resp. Cl. I, Zone 2, Group IIA, T4

Installation

- Install in the US in accordance with the NEC.
- Install in Canada in accordance with CEC part 1.

For further details see drawing no. 781.00.02 (→ pg. 240, 9.6).

Notes for safe operation in hazardous areas

WARNING:
Always observe the temperature specifications for use in hazardous areas.

Approval of the ultrasonic transducers in zone 0 is only valid for operation under atmospheric conditions.

- Explosion protection: II 1/2G Ex de ib [ia] IIC T4 or II 2G Ex de ib [ia] IIA T4
- Ambient temperature range is from -40 °C to +60 °C.
- If terminals are assigned with intrinsically safe circuits, it is recommended that the metal cable glands be replaced with the light-blue plastic ones
- The type of protection for the field connections and power supply connection is determined by the external circuits that are connected (for options see "Connection options" above).
- Safety-relevant data for intrinsically safe circuits is provided in the EC Type Examination Certificate and the IEC Certificate of Conformity.
- Ensure that the cover on the power supply connection is properly sealed. In intrinsically safe installations, the terminal box can be opened and cables connected and disconnected while the system is live. In this case the safe separation of the circuits from each other must be observed.
- If the meter body is insulated, the insulation thickness must not exceed 100 mm. The SPU housing must not be insulated.
- The standard paint of the FL600 meter body consists of a double layer: Epoxy and Acrylic RAL9002. This combination is the ideal protection of the meter body against corrosion. The layer thickness is less than 0.2 mm.

WARNING: Explosion Hazard
The ultrasonic probes are preferably made from titanium.

► Should zone 0 or zone 1 have been defined in the pipeline, operation is allowed only when ignition hazards caused by impact or friction can be excluded.

WARNING: Ignition hazard through electrostatic discharges
Ignition hazards through electrostatic discharges exist when gas flow meters with special paint and a layer thickness >0.2 mm are used in applications with ignition group IIC in accordance with ATEX and IECEx.

► For installation, the risk of electrostatic charging of the surface must be reduced to a minimum.

► Use appropriate caution when performing maintenance and cleaning work. For example, the surfaces should only be cleaned with a damp cloth.

► A warning sign fitted at the factory identifies this type of device:

Safety-relevant data of inputs and outputs for ATEX certified FLOWSIC600 only

<table>
<tr><td>Power circuit</td><td colspan="8">Intrinsically safe Ex ia/ib IIA/IIB/ IIC</td><td>Non-intrinsically safe</td></tr>
<tr><td>Power supply</td><td colspan="8">U_I = 20 V, P_I = 2,6 W</td><td>12...24 V DC</td></tr>
<tr><td rowspan="4">Active current output
Terminals 31/32</td><td colspan="8">U_0 = 22.1V</td><td rowspan="4">U_B = 18 V
U_B = 35 mA</td></tr>
<tr><td>I_0</td><td>P_0</td><td colspan="2">Ex ia/ib IIA</td><td colspan="2">Ex ia/ib IIB</td><td colspan="2">Ex ia/ib IIC</td></tr>
<tr><td>[mA]</td><td>[mW]</td><td>C_0 [µF]</td><td>L_0 [mH]</td><td>C_0 [µF]</td><td>L_0 [mH]</td><td>C_0 [nF]</td><td>L_0 [mH]</td></tr>
<tr><td>Hardware variant
1-5,7/9, A</td><td>155</td><td>857</td><td>4.1</td><td>7</td><td></td><td></td><td>163</td><td>1</td></tr>
<tr><td>Hardware variant 6, B</td><td>87</td><td>481</td><td>2</td><td>7</td><td>0.5</td><td>4</td><td>77</td><td>1</td></tr>
<tr><td></td><td colspan="8">Characteristic curve: linear
or for connection to certified intrinsically safe circuits with the following maximum values:
U_I = 30 V
I_I = 100 mA
P_I = 750 mW
Internal capacity: C_I = 4 nF
Internal inductance: negligible</td></tr>
<tr><td>Digital output
Terminals 51/52
Terminals 41/42
Terminals 81/82</td><td colspan="8">For connection to certified intrinsically safe circuits with the following maximum values:
U_I = 30 V
I_I = 100 mA
P_I = 750 mW
Internal capacity: C_I = 4 nF
Internal inductance: negligible</td><td>U_B = 30 V
I_B = 100 mA</td></tr>
<tr><td>RS485
Terminals 33/34
Terminals 81/82</td><td colspan="8">Characteristic curve: linear
U_0 = 5.88 V
I_0 = 313 mA
P_0 = 460 mW
C_0 = 1000 µF for IIA resp. 43 µF for IIC
L_0 = 1.5mH for IIA resp. 0.2 mH for IIC
or for connection to certified intrinsically safe circuits with the following maximum values:
U_I = 10 V
I_I = 275 mA
P_I = 1420 mW
Internal capacity: C_I = 4 nF
Internal inductance: negligible</td><td>U_B = 5V
I_B = 175 mA</td></tr>
<tr><td>Ultrasonic transducer connections
(for connecting SICK ultrasonic transducers only)</td><td colspan="3">Ex ia/ib IIA</td><td colspan="3">Ex ia/ib IIB</td><td colspan="2">Ex ia/ib IIC</td><td></td></tr>
<tr><td></td><td colspan="3">Characteristic curve: linear
Max. transmission voltage: U_0 = ±60.8 V
Short-circuit current: I_0 = ±92 mA
P_0 = 1399 mW
Internal capacity C_i = negligible
Internal inductance: L_i = 20.6 mH</td><td colspan="3">U_0 = ±51.2 V
I_0 = ±77 mA
P_0 = 986 mW
negligible
L_i = 15.5 mH</td><td colspan="2">U_0 = ±38.9 V
I_0 = ±59 mA
P_0 = 574 mW
negligible
L_i = 6.7 mH</td><td></td></tr>
</table>

WARNING:

U_m = 235 V: For intrinsically safe installation, maximum voltage in the non-hazardous area must not exceed 253 V

Safety-relevant data of inputs and outputs for IECEx certified FLOWSIC600 only

<table>
<tr><td>Power circuit</td><td colspan="8">Intrinsically safe Ex ia/ib IIA/IIB/ IIC</td><td>Non-intrinsically safe</td></tr>
<tr><td>Power supply</td><td colspan="8">U_I = 20 V, P_I = 2,6 W</td><td>12 ... 24 V DC</td></tr>
<tr><td rowspan="4">Active current output
Terminals 31/32</td><td colspan="8">U_O = 22.1V</td><td rowspan="4">U_B = 18 V
U_B = 35 mA</td></tr>
<tr><td>I_O</td><td>P_O</td><td colspan="2">Ex ia/ib IIA</td><td colspan="2">Ex ia/ib IIB</td><td colspan="2">Ex ia/ib IIC</td></tr>
<tr><td>[mA]</td><td>[mW]</td><td>C_O [µF]</td><td>L_O [mH]</td><td>C_O [µF]</td><td>L_O [mH]</td><td>C_O [nF]</td><td>L_O [mH]</td></tr>
<tr><td>All hardware variants</td><td>87</td><td>481</td><td>2</td><td>7</td><td>0.5</td><td>4</td><td>77</td><td>1</td></tr>
<tr><td></td><td colspan="8">Characteristic curve: linear
or for connection to certified intrinsically safe circuits with the following maximum values:
U_I = 30 V
I_I = 100 mA
P_I = 750 mW
Internal capacity: C_I = 4 nF
Internal inductance: negligible</td></tr>
<tr><td>Digital output
Terminals 51/52
Terminals 41/42
Terminals 81/82</td><td colspan="8">For connection to certified intrinsically safe circuits with the following maximum values:
U_I = 30 V
I_I = 100 mA
P_I = 750 mW
Internal capacity: C_I = 4 nF
Internal inductance: negligible</td><td>U_B = 30 V
I_B = 100 mA</td></tr>
<tr><td>RS485
Terminals 33/34
Terminals 81/82</td><td colspan="8">Characteristic curve: linear
U_O = 5.88 V
I_O = 313 mA
P_O = 460 mW
C_O = 1000 µF for IIA resp. 43 µF for IIC
L_O = 1.5mH for IIA resp. 0.2 mH for IIC
or for connection to certified intrinsically safe circuits with the following maximum values:
U_I = 10 V
I_I = 275 mA
P_I = 1420 mW
Internal capacity: C_I = 4 nF
Internal inductance: negligible</td><td>U_B = 5V
I_B = 175 mA</td></tr>
<tr><td rowspan="2">Ultrasonic transducer connections
(for connecting SICK ultrasonic transducers only)</td><td colspan="4">Ex ia/ib IIA</td><td colspan="2">Ex ia/ib IIB</td><td colspan="2">Ex ia/ib IIC</td><td></td></tr>
<tr><td colspan="4">Characteristic curve: linear
Max. transmission voltage: U_O = ±60.8 V
Short-circuit current: I_O = ±92 mA
P_O = 388 mW
Internal capacity C_i = negligible
Internal inductance: L_i = 20.6 mH</td><td colspan="2">U_O = ±51.2 V
I_O = ±77 mA
P_O = 372 mW
negligible
L_i = 15.5 mH</td><td colspan="2">U_O = ±38.9 V
I_O = ±59 mA
P_O = 248 mW
negligible
L_i = 6.7 mH</td><td></td></tr>
</table>

WARNING:
U_m = 235 V: For intrinsically safe installation, maximum voltage in the non-hazardous area must not exceed 253 V

FLOWSIC600

5 Commissioning

5.1 General notes

Before commissioning, all activities described in the chapter →»Installation« must be completed. It is recommended to use a laptop/PC with MEPAFLOW600 CBM software installed for the commissioning (→ pg. 125, 5.3). The commissioning should be documented with a Commissioning Protocol. The document "FLOWSIC600 Commissioning Protocol" is content of the FLOWSIC600 shipping on paper and on the product CD.

The FLOWSIC600 is 'wet' or 'dry' calibrated when delivered to the end user. The 'dry' calibration consists of the 3-D measurement of the meter body, zero-flow and speed of sound test, and other system specific inspections/tests which belong to the manufacturing and quality assurance process. The 'wet' calibration is performed at a flow calibration test stand (calibration test facility).

All parameters, determined by the aforementioned tests, as well as design specific data are preset and stored in the FLOWSIC600 in a non-volatile memory before delivery. The design-specific data, which is known before manufacturing the device, will not be changed during commissioning. This is of special importance if the FLOWSIC600 is officially sealed after an authorized flow calibration. Generally, the parameters are protected by a password. Additionally a Parameter write lock in the SPU prevents custody relevant parameter changes.

> ***NOTICE:*** **Type approval**
> If the FLOWSIC600 is to be used for custody transfer applications, each change of parameters and of the Parameter write lock has to be agreed to by the applicable national authorities.

In all other cases the output parameters of the FLOWSIC600 can be adapted on site by trained staff.

Commissioning the FLOWSIC600 involves the following steps, regardless of whether the device is installed at a test facility or at the final measuring location:

- Connecting the FLOWSIC600 to a PC or Laptop (→ pg. 123, 5.2)
- Connecting to the FLOWSIC600 with MEPAFLOW600 CBM (→ pg. 125, 5.3)
- Identification (→ pg. 131, 5.4)
- Field setup (→ pg. 133, 5.5)
- Function test → pg. 146, 5.6,
- Optional additional setup (→ pg. 149, 5.7)
- Activation of path compensation (→ pg. 164, 5.8)
- Sealing (→ pg. 165, 5.9),
- Documentation (→ pg. 165, 5.10)

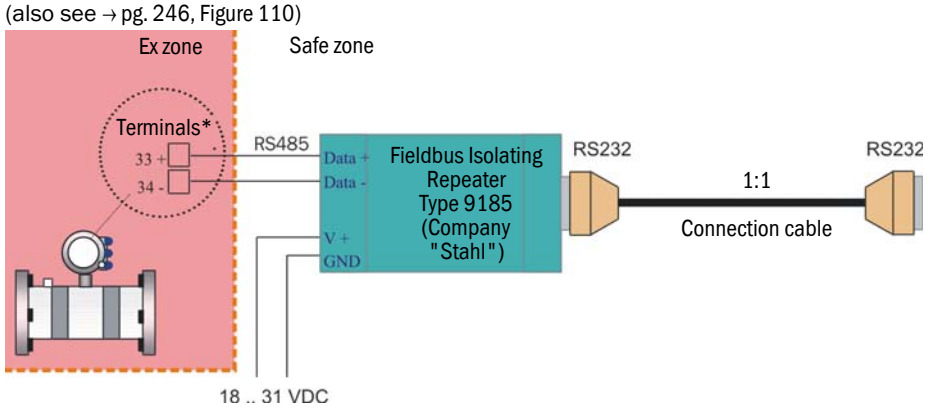
5.2 Connecting the FLOWSIC600 to a PC or laptop

5.2.1 Connecting the FLOWSIC600 via RS485 / RS232 cable

Interface sets for the connection of the FLOWSIC600 with a PC via serial or USB-interface can be ordered from SICK. See → pg. 124, Table 17.

The FLOWSIC600 serial interface conforms with the RS485 standard. An RS485 /RS232 cable and a 1:1 interface cable (pin 2 – pin 2 and pin 3 – pin 3) are required for data transfer to PC or laptop (see → Figure 54). Because MEPAFLOW600 CBM, the operation and diagnosis software for the FLOWSIC600, does not support RTS/CTS data transfer, the adapter must be able to distinguish between transmission and reception mode automatically. We, therefore, recommend the use of a serial interface set available from SICK.

Figure 54 Wiring example of "MEPA interface set RS485 / RS232" intrinsically safe for DIN rail mounting (also see → pg. 246, Figure 110)



*Possible terminals for the RS485 connection are:

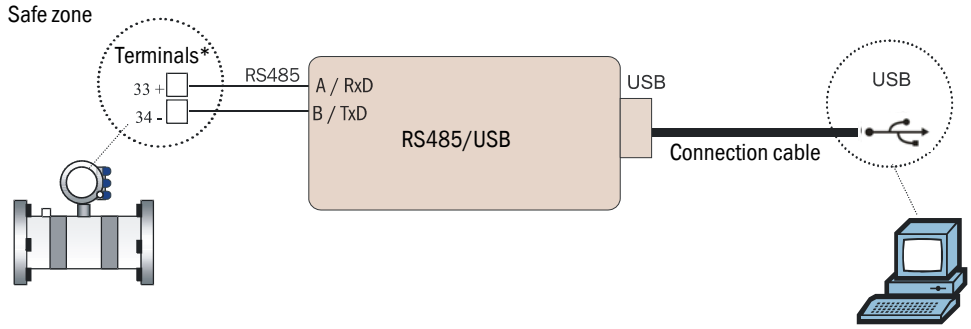
- 33 (+) and 34 (-)
- 81 (+) and 82 (-)

If necessary, the RS485 ports can be assigned to a specific bus address (Reg. #5020 "DeviceBusaddress"). The service port always has the bus address "1".

5.2.2 Connecting the FLOWSIC600 via RS485/USB converter

If the PC/laptop does not offer a RS232 serial interface, a USB interface can be used. An appropriate USB converter is necessary to transform the signal for the RS485 device interface. The USB converter available through SICK contains a CD-ROM with a software driver which must be installed before an online connection between the FLOWSIC600 and the MEPAFLOW600 CBM software can be established.

Figure 55 Wiring example of "MEPA interface set RS485/USB" (Converter, Cable, Terminal plug, CD-ROM with software driver), non-intrinsically safe (see also Fig. 104)



*Possible terminals for the RS485 connection are:

- 33 (+) and 34 (-)
- 81 (+) and 82 (-)

If necessary, the RS485 ports can be assigned to a specific bus address (Reg. #5020 "DeviceBusaddress"). The service port always has the bus address "1".

Table 17 Interface sets for the connection of the FLOWSIC600 to a network

Description	Part Number
"MEPA interface set RS485 / RS232" intrinsically safe for DIN rail mounting	2033410
"MEPA interface set RS485/USB" (Converter, cable, terminal plug, CD-ROM with software driver), non-intrinsically safe	6030669

5.3 Connecting to the FLOWSIC600 with MEPAFLOW600 CBM

5.3.1 Starting MEPAFLOW600 CBM

The MEPAFLOW600 CBM software is provided on the product CD shipped with the meter. It can also be downloaded from www.flowsic600.com. See → pg. 55, 2.9.1 for more details on the installation.

► After successful installation, start the MEPAFLOW600 CBM by selecting the "MEPAFLOW600 CBM" entry in the program group "SICK", created during installation, or by double-clicking on the desktop icon.

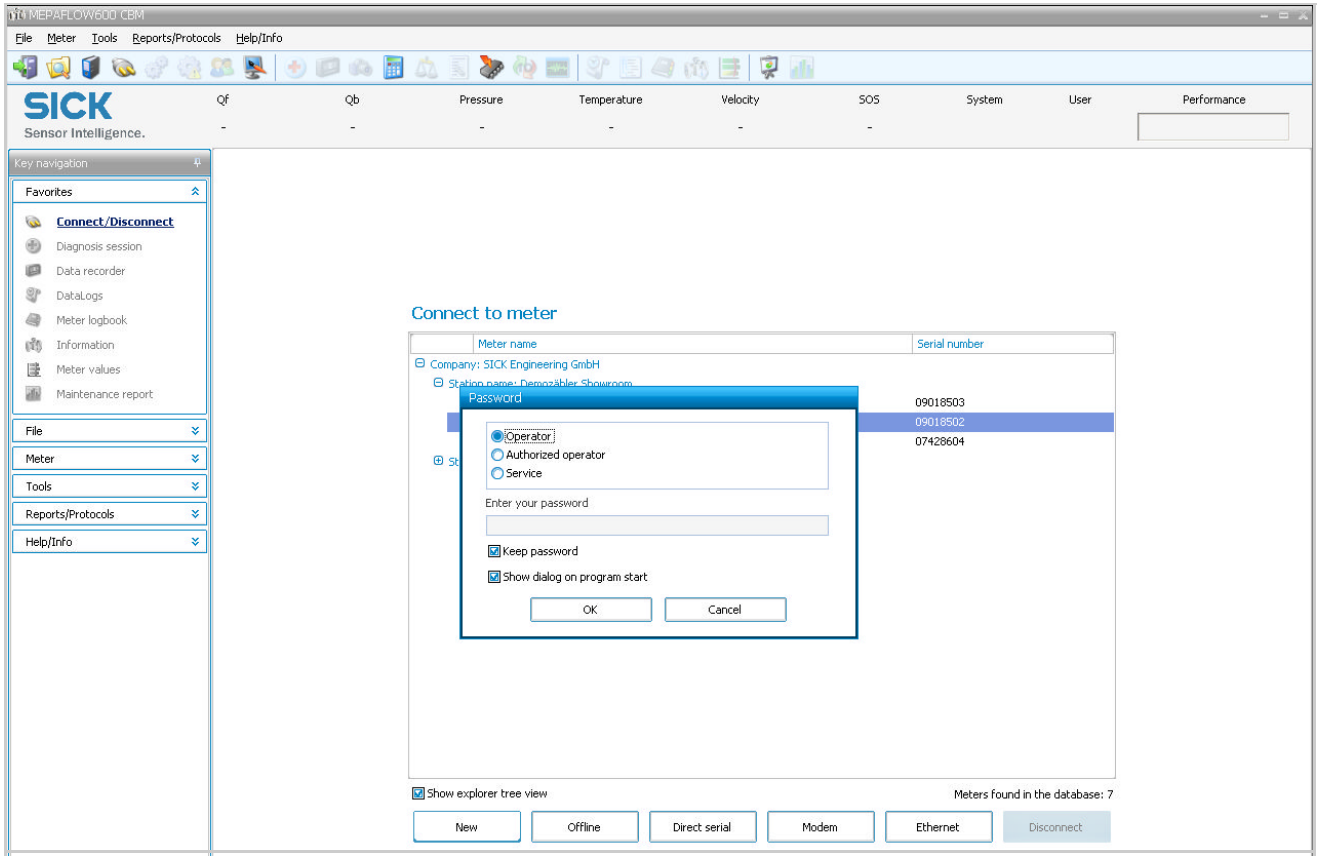
5.3.2 Choosing a User Access Level

► After starting MEPAFLOW600 CBM, the "Connect / Disconnect" page appears with the "Password" dialog window. (→ Figure 56)

► Choose a User access level, activate the corresponding radio button, enter the password and click the "OK" button.

User access level	Password
Operator	No password required
Authorized operator	"sickoptic"
Service	See Service Manual

Figure 56 MEPAFLOW600 CBM "Connect / Disconnect" page with "Password" dialog window



5.3.3 Creating a new meter entry in the meter database

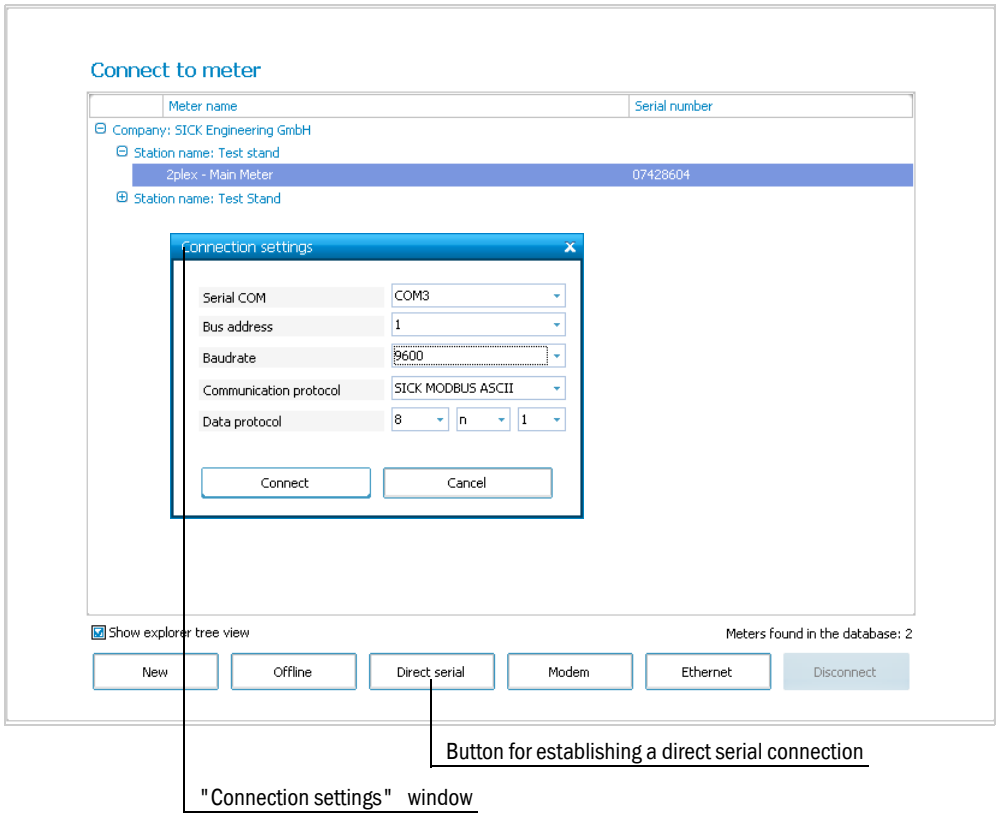
New meter entries can be created, whether the corresponding meter is connected to the PC or not. If the meter is connected, MEPAFLOW600 CBM loads all available parameters from the meter. If the meter is not connected, an initial master data set is created from the information the user enters (→ pg. 58, 2.9.3).

- ► Open the "Connect / Disconnect" page (Figure 56).
- ► Click "New". Then follow the instructions on screen.

5.3.4 Online connection: Direct serial

- Choose a meter and click the "Direct serial" button to establish a serial connection to a meter which is connected to the PC (→ Figure 57).
- Specify the appropriate connection settings in the "Connection settings" window (→ Figure 57) and click the "Connect" button to establish an online connection to the meter. If the connection fails, see → pg. 199, 7.4 for troubleshooting.

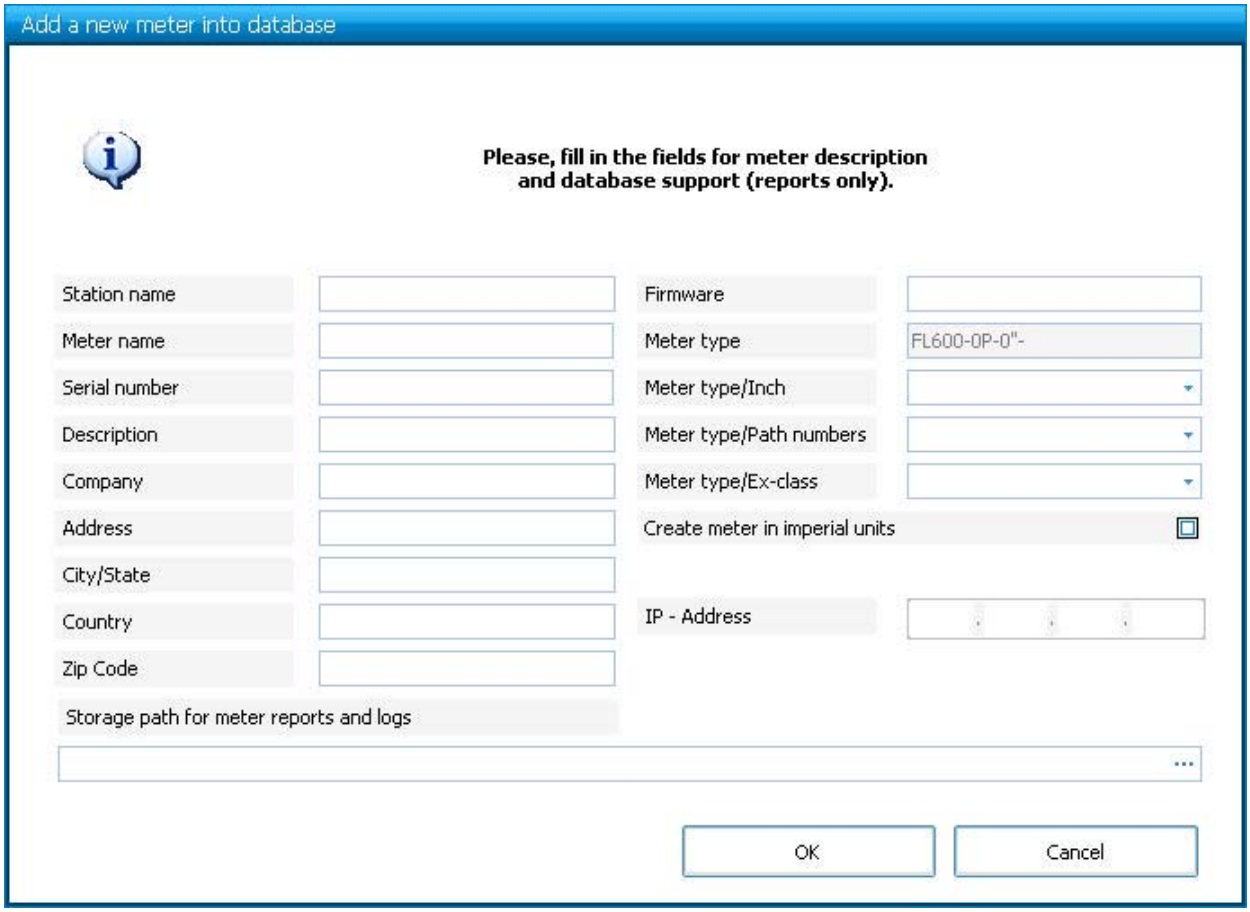
Figure 57 Connection settings



The parameters shown in the "Connection Settings" window in → Figure 57 are the default values with which the FLOWSIC600 RS485 interface is configured. The serial COM port must be individually selected.

- ► Edit the fields for the meter identification in the "Add new meter into database" dialog. The serial number, firmware version and meter type are automatically read from the meter → Figure 58.
- ► After the connection has been established, MEPAFLOW600 CBM displays the start page (can be specified in the Program settings) and the current readings from the meter.

Figure 58 Adding new meter to database



5.3.5 Online connection: Ethernet

The FLOWSIC600 can be connected to a network via Ethernet with an adapter. This adapter translates the meter MODBUS communication (ASCII or RTU) to MODBUS TCP. MEPAFLOW600 CBM supports the MODBUS TCP protocol.

Requirements

- The Ethernet connection requires firmware V3.3.05 or higher. It provides the required generic MODBUS protocol on the interface for the MODBUS TCP adapter.
- The FLOWSIC600 must be connected to a MODBUS ASCII/ MODBUS RTU to MODBUS TCP adapter, which is connected to a network via Ethernet and receives a - preferably permanent - IP address.
- The PC with MEPAFLOW600 CBM V1.0.47 or higher installed must be connected to the network and have uninhibited access to this IP address.

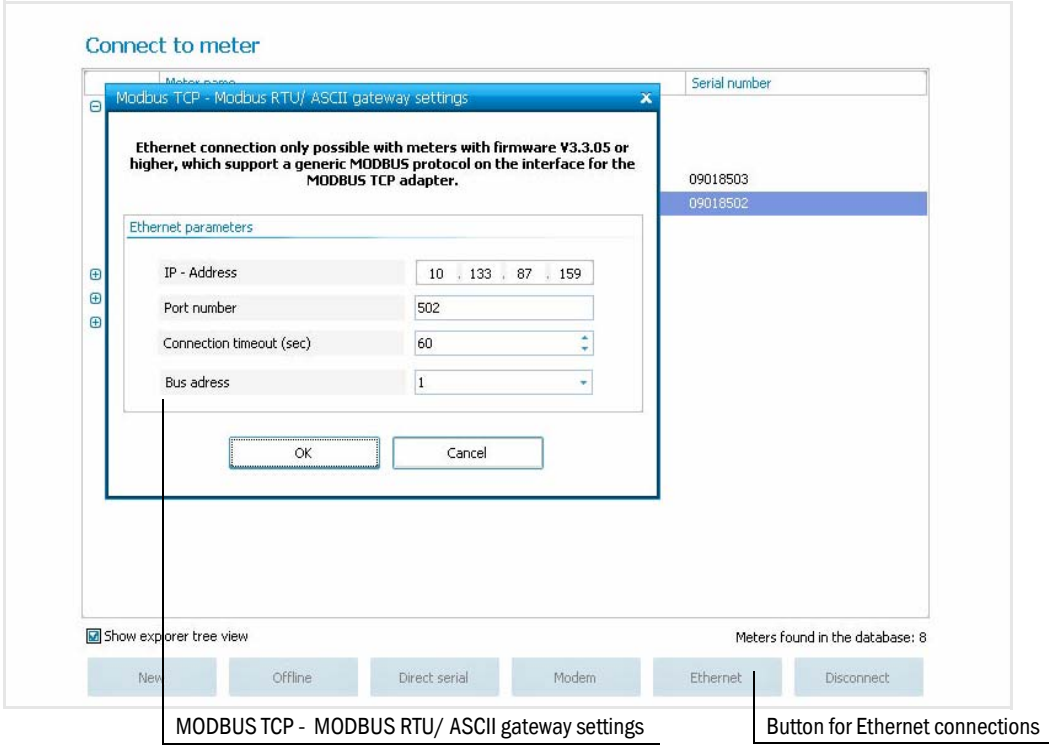
Preparations for online connections via Ethernet

- ► Make sure one of the serial ports (terminals 33/34 or 81/82) of the FLOWSIC600 is configured to use Generic MODBUS RTU or Generic MODBUS ASCII (NOT a SICK MODBUS protocol).
- ► Make sure the serial port is configured so that the highest baud rate is used (56000 baud).
- ► Connect a MODBUS RTU/MODBUS ASCII to MODBUS TCP adapter to the serial port according to the manual of the adapter.
- ► Connect the adapter cable to your network.
- ► Make sure the network assigns a permanent IP address to the adapter.
- ► Configure the adapter to the network settings (IP address / protocol / baudrate / gateway etc.) that you want to use (refer to adapter manual).
- ► Make sure the PC with MEPAFLOW600 CBM has access to the adapter‘s IP address.
- ► Make sure you know the MODBUS bus address of the meter.

In case of problems with the network setup, refer to your network administrator.

- ► Click the "Ethernet" button to establish a connection via Ethernet.
- ► Specify the IP address of the MODBUS TCP adapter and the bus address of the meter in the dialog "MODBUS TCP - MODBUS RTU/ASCII gateway settings" (→ Figure 59).
- ► Click "OK" to establish an online connection to the meter.

Figure 59 "MODBUS TCP - MODBUS RTU/ASCII gateway settings" dialog for online connections via Ethernet



Tested MODBUS TCP to MODBUS ASCII/RTU adapter

The connection between FLOWSIC600 and MEPAFLOW600 CBM has been tested with the "MODBUS TCP to MODBUS ASCII/RTU Converter", Model MES1b by B&B Electronics. This adapter is shipped with a software, which searches the network for connectable devices and supplies the user with the IP addresses found.

Table 18 Interface sets for the connection of the FLOWSIC600 to a network

Description	Part Number
MODBUS TCP to MODBUS ASCII/RTU Converter	6044004

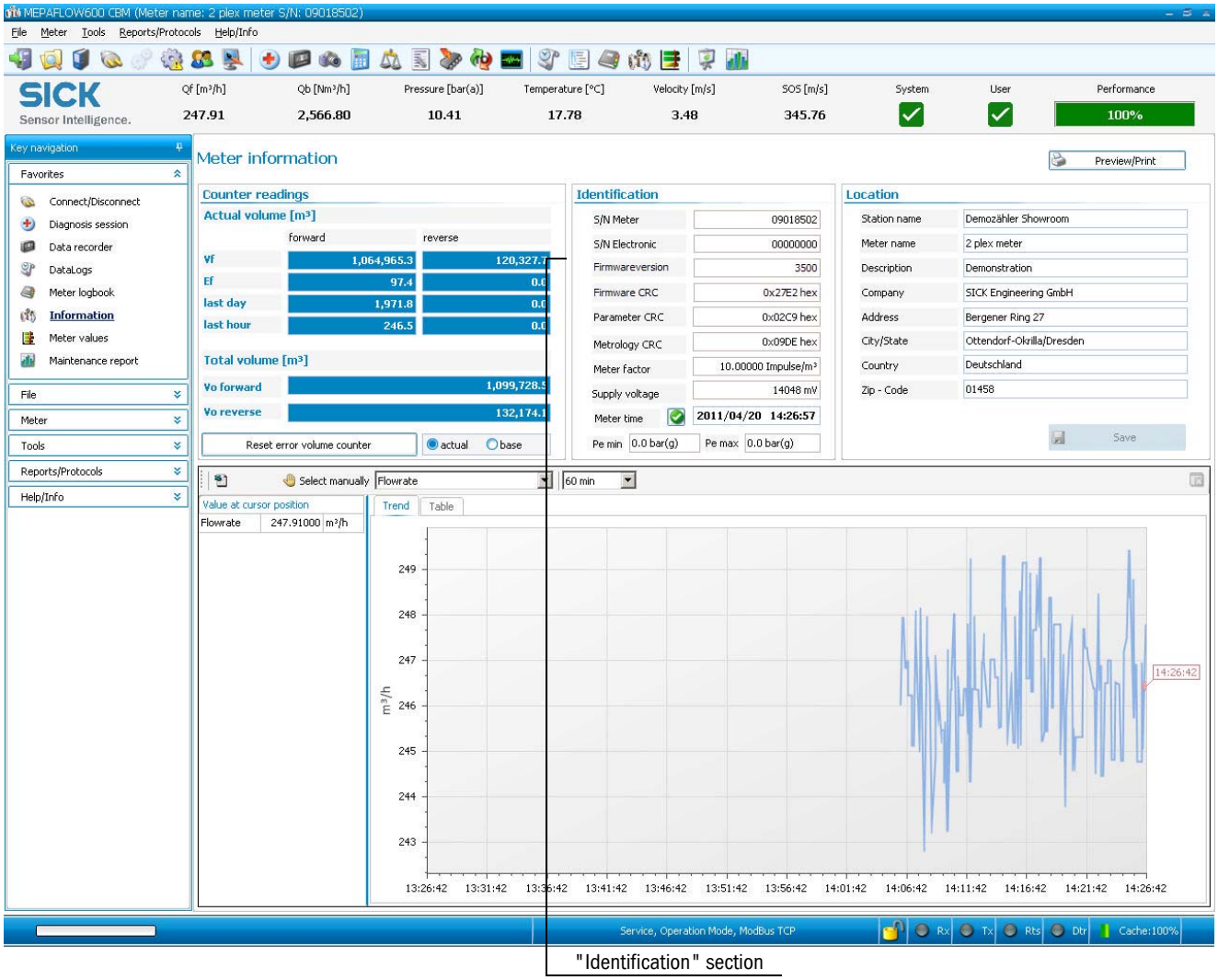
5.4 Identification

5.4.1 Checking identification, operation / design data and firmware version

Before commissioning, cross-check the data representing the flow meter with the data in the test protocols which are contained in the Manufacturer Data Report (MDR). This can be done on the LCD display (→ pg. 221, 9.3) or - much easier - with MEPAFLOW600 CBM software:

► Open the "Meter information" page and compare the data in the "Identification" section (→ Figure 60) with the data in the check reports of the MDR or, when the meter has been calibrated, with the calibration and parameter report.

Figure 60 "Meter Information" page



5.4.1.1 Firmware

The FLOWSIC600 firmware is stored on a non-volatile memory (FLASH PROM). The program code for the signal processor and system micro-controller are identified by a version number (Reg. #5002 "FirmwareVersion") and a check sum (Reg. #5005 "ProgramCRC") and can be verified as mentioned above.

> ***NOTICE:*** **Type approval**
> If the FLOWSIC600 is used for fiscal metering, the approved firmware versions and the associated check sums are documented in the national pattern approval certificates.

5.5 Field setup

The MEPAFLOW600 CBM software "Field setup" wizard guides the user through the parameter configuration during the commissioning of the FLOWSIC600. The wizard consists of 8 pages. For checking the configuration of the SPU outputs refer to the "Instrument Data Sheet" of the FLOWSIC600, which is included in the Manufacturer Data Record (MDR) (example see → Figure 61).

The parameter changes performed in the Field setup wizard require the User Access Level "Authorized operator" (see → pg. 125, 5.3.2).

- ► To start the Field setup, choose "Tools / Field Setup" from the menu.
- ► Follow the instructions on screen step by step.

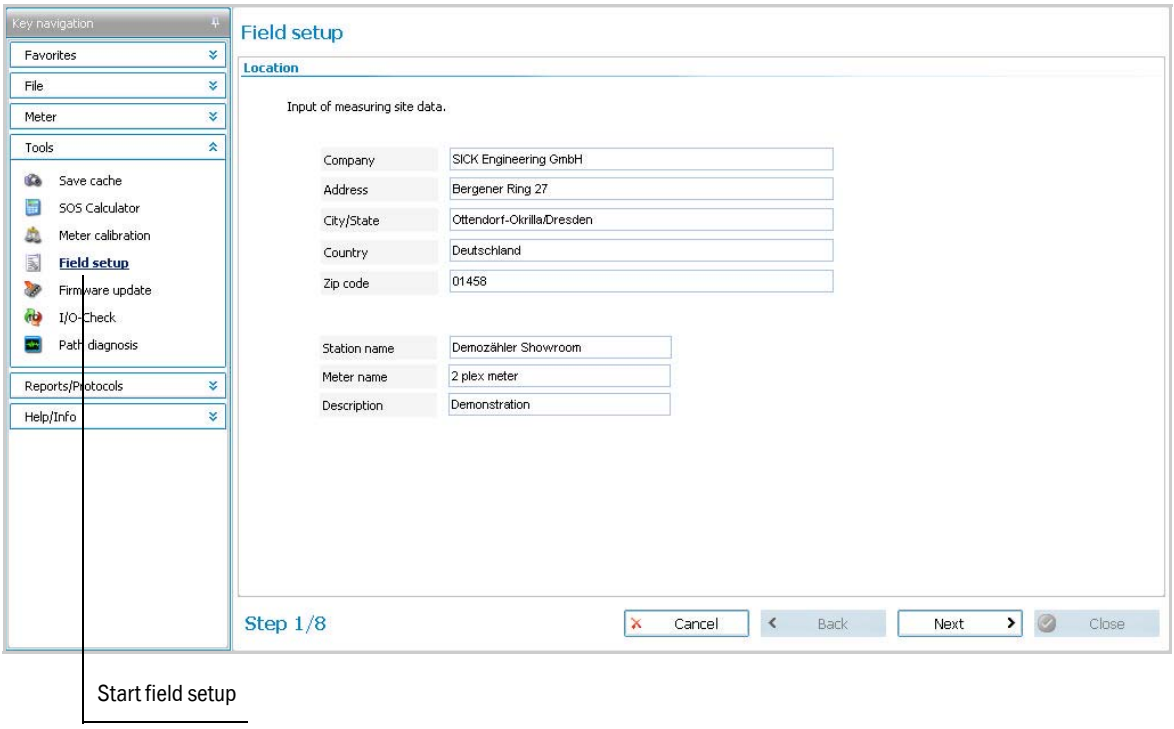
Figure 61 Example of an "Instrument Data Sheet" as contained in the MDR

1	**GENERAL**			54	**TRANSMITTER (Integral)**			
2	**Meter-No.: 3889**			56 *	Power supply / Power consumption		12 .. 28,8 V DC	< 1W
3	Type		FL600	57 *	Enclosure classification		IP 67	
4	Meter size		06" / DN150	58 *	Cable entry		M20 x 1,5 (3x)	
5 *	Article number			° 59	Hazardous Area Class.		II 1/2G Eex de ib [ia] IIA T4	
6 *	TAG number							
7 *								
8 *	Order number		01/11-2	60	SPU housing material		Aluminium	
9	**METER BODY**			° 61	Ambient temperature (range)	℃	-40 ... 60	
10	Inner pipe diameter	mm	147,00	62	Display		LCD	
11	Overal length (A)	mm	450,00	63	Display language		Russian	
12	Overal height (B)	mm	490,00	64	Engineering units		Metric	
13	Weight	kg	130	65	**Output and Signal Configuration - Signal processing unit**			
14	Flow range	m³/h	32 ... 2500	66	*DO0/AO0 Terminals 31/32 (HF-Pulse)*		Volume a.c., no pulses when data invalid	
15	Number of meas. paths		4	67	Signal configuration		NAMUR / normally open	
16	Linearity		+/- 0.5% of MV 0.1 .. 1 Qmax	68				
17 *	Repeatability		< 0,1%	69				
18	Flange design code		DIN/EN 1092-1	70				
19	Flange class		PN100	71				
20	Flange face		Form B2	72	*MOD Terminals 33/34 (RS 485)*		SICK Modbus ASCII	
21	Body material		1.0566 / ASTM A350 Gr. LF2	73	*DO1 Terminals 51/52 (HF-Pulse)*		Volume a.c.	
22	Transducers exchangeable under pressure		No	74	meter factor	1/m³	2.880	
23 *	Transducer cover		Aluminium	75	Signal configuration		NAMUR / normally open	
° 24	Design temperature	℃	-46 ... 100	76	max. Output		8,2 V / 0,8...6,5 mA	
° 25	Design pressure	bar (g)	94	77	*DO2 Terminals 41/42 (Status)*		Status Warning	
26	Material certificate		3.1 EN 10204	78	Signal configuration		NAMUR / normally open	
27 *	Enclosure classification		IP 67	79	max. Output		8,2 V / 0,8...6,5 mA	
28 *	Surface coating / painting		two layers: Epoxy + Acrylic RAL9002	80	*DO3 Terminals 81/82 (RS 485)*		SICK Modbus ASCII	
29 *	Pressure tapping		1/4" NPT female	81				
30	**Sensors**			82				
31				83	**COMMUNICATION**			
32 *	Sensor material		Titan 3.7165	84	Interface		2x RS 485	

5.5.1 Location information and unit system (Field setup page 1 of 8)

This data helps to identify the meter in the MEPAFLOW600 CBM meter database.

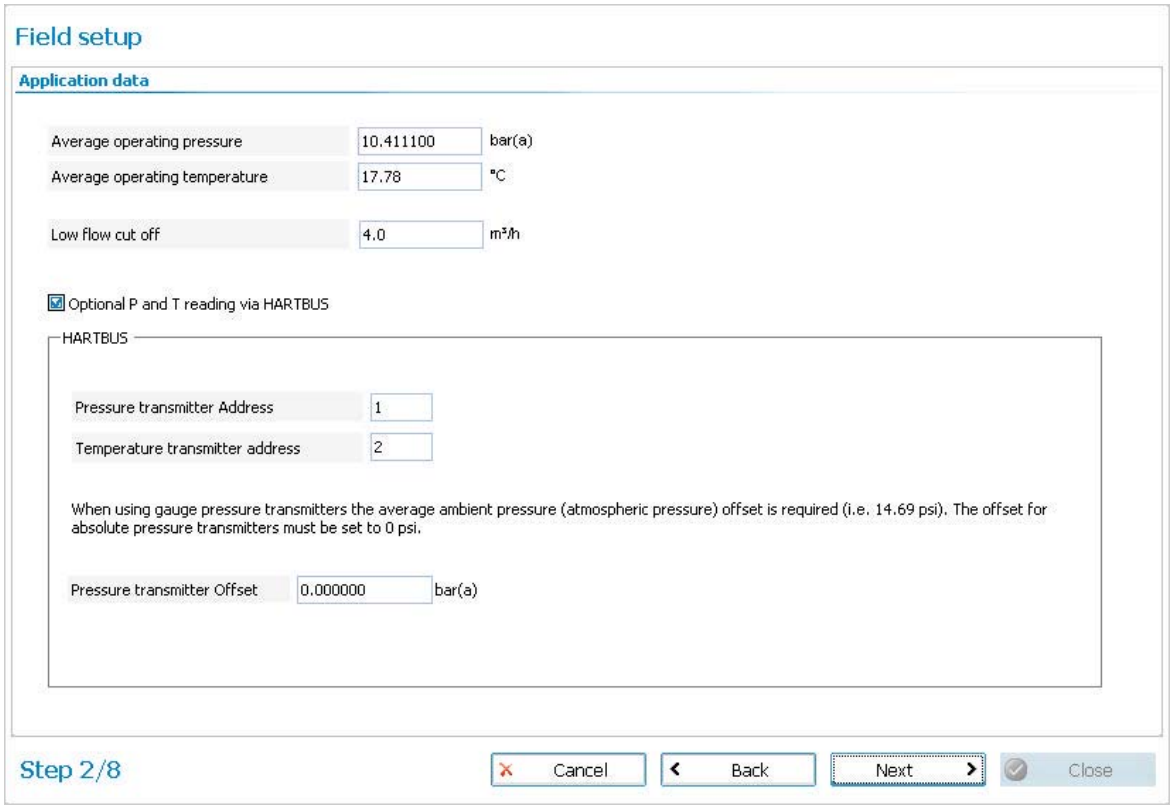
Figure 62 Field setup wizard page 1 of 8: Location information



5.5.2 Application data (Field setup page 2 of 8)

The pressure and temperature values which have to be entered at this page are stored as the parameters PressureFix and TemperatureFix.

Figure 63 Field setup page 2 of 8: Application data



These values are used to correct the influence of geometric changes of the meter body due to temperature and pressure on site (in relation to the conditions during the dry calibration / wet calibration). These values are also used when the FLOWSIC600 operates with the integrated volume corrector using constant temperature and pressure correction of the volume.

The pressure value is to be determined as described on → pg. 69, 3.2.2.2. The "Low flow cut off" is usually set to 25% of Qmin.

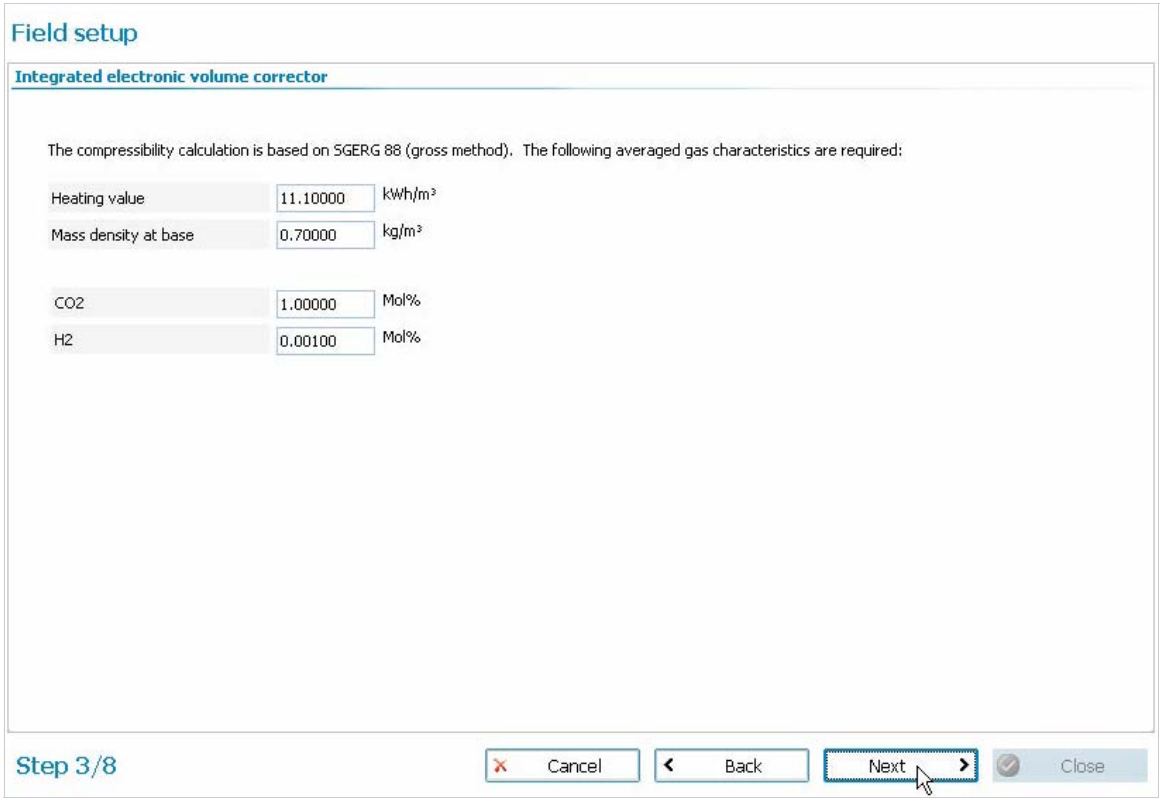
HART® option
If the option HART® protocol was ordered, you can activate the check box "Optional p and T reading via HARTBUS". In this case the FLOWSIC600 operates with HART® communication in Master-Mode.

5.5.3 Integrated electronic volume corrector (EVC) (Field setup page 3 of 8)

EVC option
If the meter was ordered with the option "Integrated electronic volume corrector (EVC)" (→ pg. 36, 2.5.2), the integrated electronic volume corrector has to be activated as described in the "Technical Bulletin: Electronic Volume Correction (EVC)"

In the field setup only the necessary EVC parameters for the GERG88 correction algorithm are available.

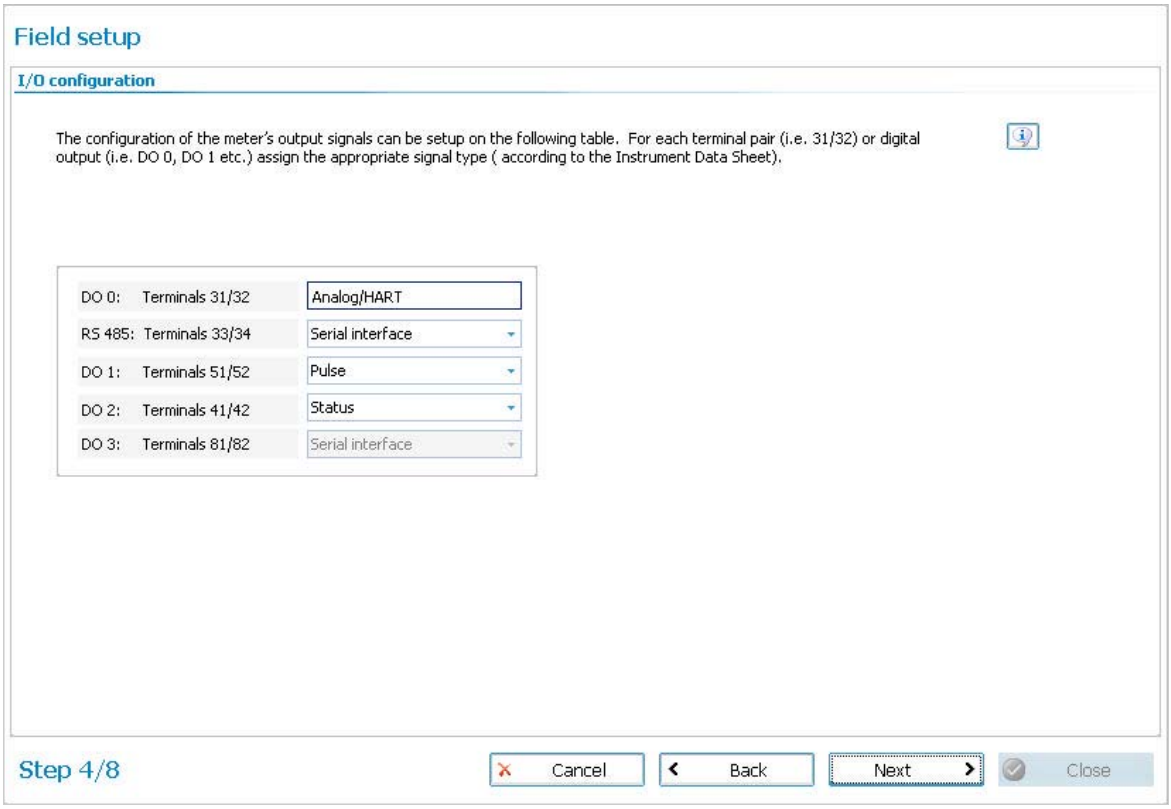
Figure 64 Field setup page 3 of 8: Integrated electronic volume corrector



5.5.4 I / O configuration - output configuration (Field setup page 4 of 8)

The output configuration has to be set based on the information provided in the Instrument Data Sheet.

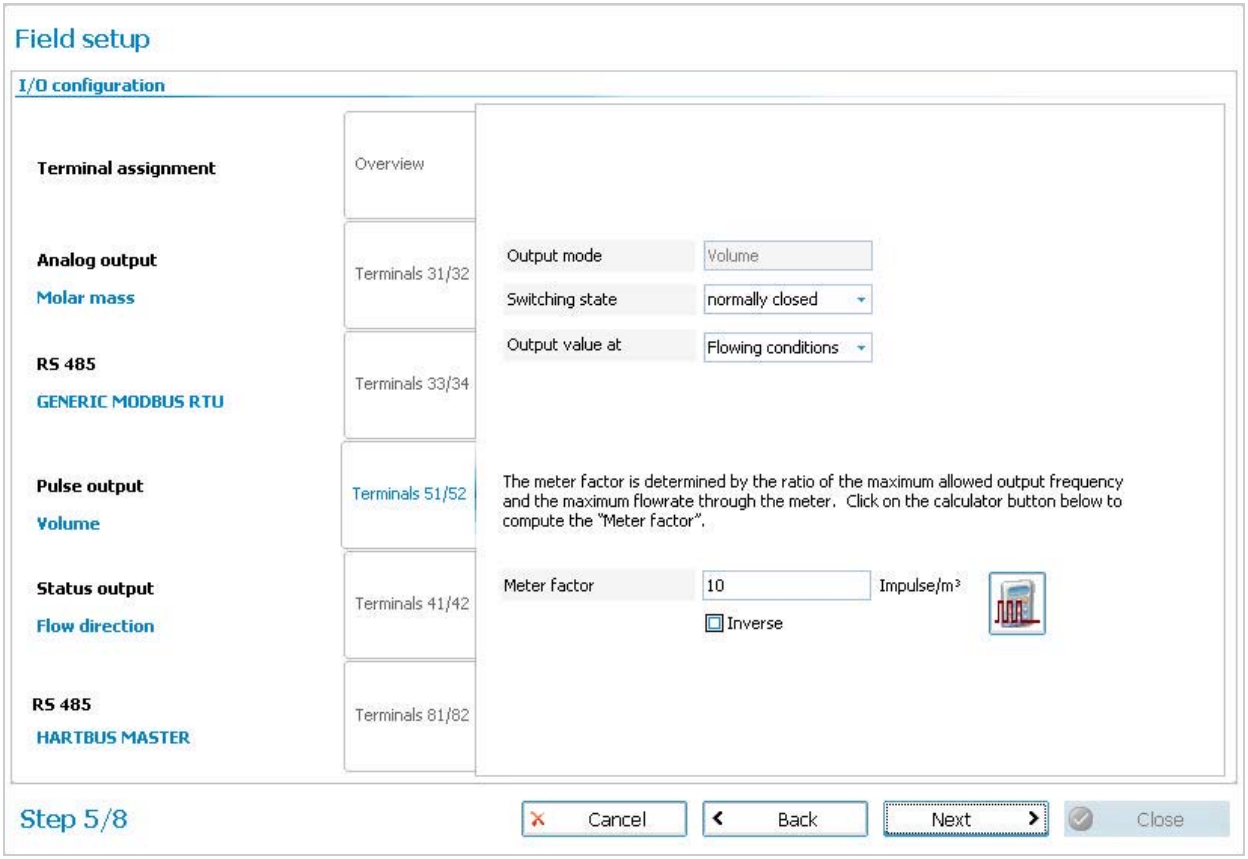
Figure 65 Field setup page 4 of 8: I / O configuration



5.5.5 I / O configuration - terminal assignment (Field setup page 5 of 8)

The terminal assignment contains five tabs for the individual terminals and one for the overview. In these tabs, the outputs can be specifically configured. For detailed information on the output signal and for support functions use the information buttons (when displayed). For the pulse output, use the built in Meter Factor calculator.

Figure 66 Field setup page 5 of 8: I / O configuration - Terminal assignment, tab for terminals 31/32



Meter factor

The meter factor specified on the main type plate must be identical to the meter factor in the meter‘s firmware, which is displayed on the terminal assignment page, when a pulse output is selected (the meter factor can also be found on the "Meter parameter" page at Reg. #7027 "Meter Factor"). The meter factor is set at the factory according to the customer‘s specification. If this doesn‘t exist, the meter factor is set to a standard value such that the maximum pulse output frequency is approximately 2 kHz at the maximum flow rate (see → pg. 208, 9.1.4).

If the meter factor has to be modified to the current application during the commissioning, any change must be agreed with the authorities, if the meter is used for fiscal purposes. In this case, the main type plate has to be exchanged with a new one containing the new meter factor. Contact your SICK representative to obtain a new type plate.

The new meter factor can be calculated according to the following formula:

f_{max} : max. pulse frequency [Hz]
Q_{max} : max. volumetric flow [m^3/h], [ft^3/h]

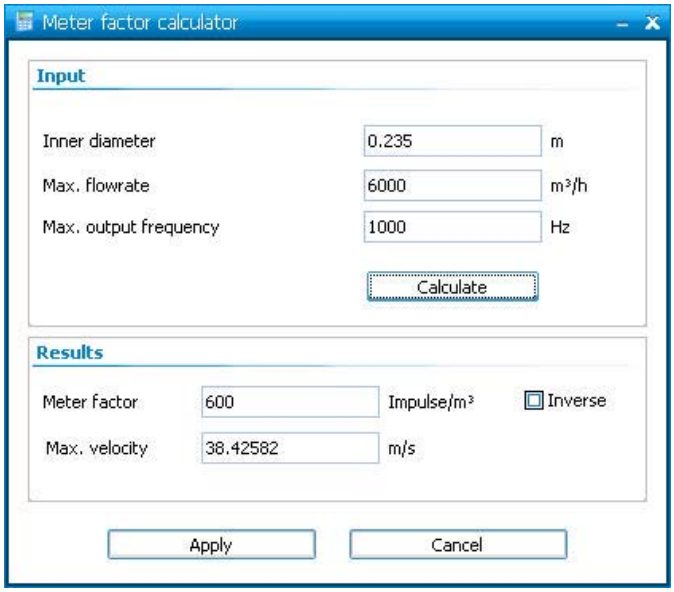
$$\text{Meter factor} = \frac{f_{max} \bullet 3600}{Q_{max}} \quad \left[\frac{\text{Pulse}}{\text{Volume unit}}\right]$$

- In North America "K-Factor" is used. The K-Factor is the inverse of the meter value and can be set by clicking the button "Inverse" in the meter factor calculator.

For assistance in calculating the meter factor, use the integrated "Meter factor calculator" (→ Figure 67).

► Click the button "Meter factor calculator" (→ Figure 66).

Figure 67 Meter factor calculator

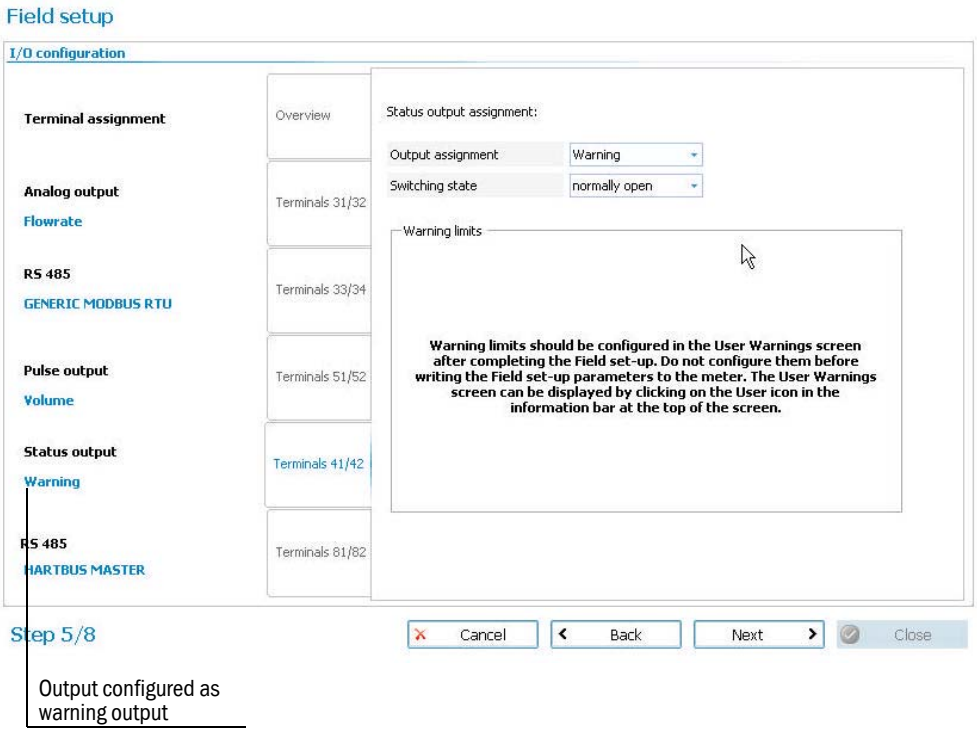


Warning limits

If a status output was configured as "Warning" output in Step 4 (→ pg. 138, 5.5.5), clicking on the tab for this output will display the settings for the switching state.

The User Warning Limits can be configured and activated after the completion of the Field Setup Wizard (→ pg. 149, 5.7.1).

Figure 68 Status output, configured for "Warning"



Analog output

To adapt the FLOWSIC600 to the different application conditions the analog output has to be configured. The adjustment of the analog output requires the change of various parameters.

The output current I_{out} is calculated as follows:

$$I_{out} = 4\ mA + \frac{Q - AORangeLow}{(AORangeHigh - AORangeLow)} \bullet 16\ mA$$

Q:	Actual volume flow rate (other possible sources: normalized volume flow rate, mass flow rate, molar mass)
AORangeHigh:	Upper range limit (has to be set)
AORangeLow:	Lower range limit (has to be set)

5.5.6 LCD display setup (Field setup page 6 of 8)

- ► Assign the language to be used in the menu of the LCD display.
- ► Choose from the dropdown menu, what measurands and readings are to be displayed on the two page standard display.

Figure 69 Field setup page 6 of 8: LCD display setup with dropdown menu

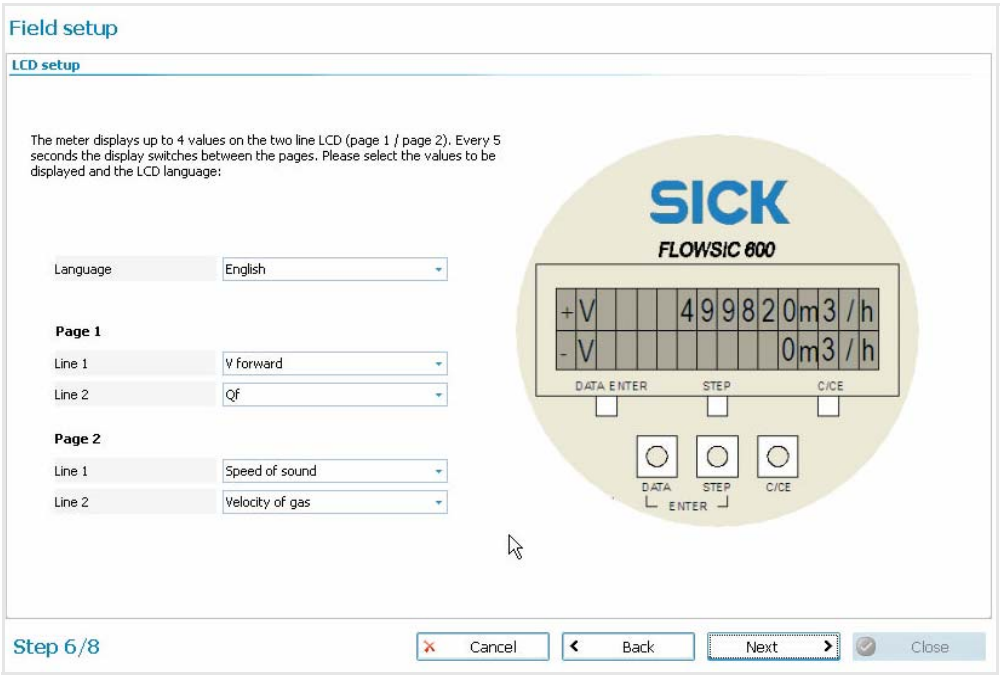


Table 19 Possible sources for lines on LCD

Reg. #	Measurement output	Abbreviation in MEPAFLOW600 CBM	Abbreviations on LCD
7002	Volume flow at base conditions[1]	Qb	+/- Qb
7001	Volume flow at flowing conditions[1]	Qf	+/- Qf
5010	Volume counter forward[1]	V forward	+ Vf
5012	Volume counter reverse[1]	V reverse	- Vf
5011	Error volume counter forward[1]	E forward	+ Ef
5013	Error volume counter reverse[1]	E reverse	- Ef
7004	Velocity of gas	VOG	VOG
7003	Speed of sound	SOS	SOS
7022	Pressure (from external source)	p	p
7021	Temperature (from external source)	T	T
3029	Frequency	FO	FO
7035	Analog output	AO	AO
3020	Input Voltage	Uin	Uin
5016	Forward Volume Total [1]	Vfo forward	+ Vo
5018	Reverse Volume Total [1]	Vfo reverse	- Vo
5041	Volume at base conditions forward[1]	Vb forward	+ Vb
5043	Volume at base conditions reverse[1]	Vb reverse	- Vb
5042	Error volume at base conditions forward[1]	Eb forward	+ Eb
5044	Error volume at base conditions reverse[1]	Eb reverse	- Eb
5045	Total volume at flowing conditions (plus forward, minus reverse volume)[1]	Vo	Vo
5079	Total mass counter forward[1]	M forward	+ M
5081	Total mass counter reverse[1]	M reverse	- M
7047	Mass flow	M flow	+/- Mf
5085	Total volume at base conditions forward[1]	Vo forward	+ VB
5047	Total volume at base conditions reverse[1]	Vo reverse	- VB
7065	Volume flow at base conditions as m^3/d	Qb (m^3/d)	+/- Qb
-	None	empty row	-

[1] The 18 digit total volume counter values are stored in two long word registers of 9 digits each. The first 9 digits are stored in the "low" digit register, and the last 9 digits in the "high" digit register. The LCD displays only the "low" bits of the total volume counters.

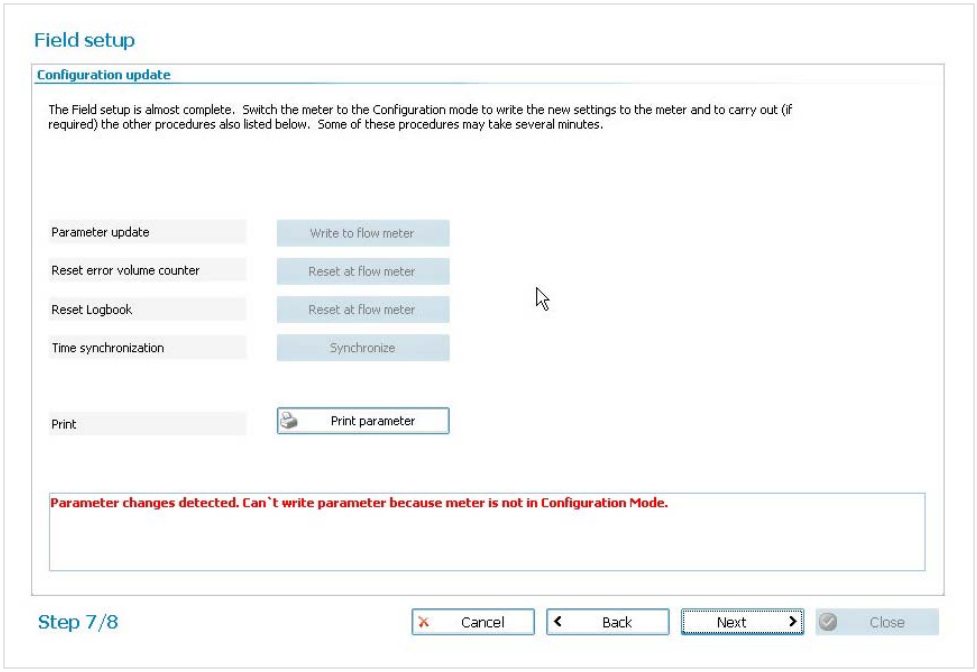
See → pg. 221, 9.3 for more information on the LCD display.

5.5.7 Configuration update (Field setup page 7 of 8)

User Access Level: "Authorized Operator" or "Service"

- Switch the meter into the Configuration Mode.
- To write the configuration and parameter settings specified on pages 2 to 6 of the "Field setup" wizard to the meter, use the "Write to flow meter" button. The summary field displays information about the actions just carried out (successful or unsuccessful writing of parameters).
- To reset the error volume counters and the logbooks - which is recommended after commissioning the meter - use the "Reset at flow meter" buttons.
- The time synchronization function makes it possible to write your PC time to the meter and thus synchronize the meter with your local time settings. Be careful with this function. Read → pg. 172, 6.2.3 before using it.
- Switch the meter back to Operation Mode
- Print a parameter report to document any changes made.
- Before creating the final maintenance report according to Section → 5.5.8, activate the path compensation according to → pg. 164, 5.8.

Figure 70 Field setup page 7 of 8: Configuration update



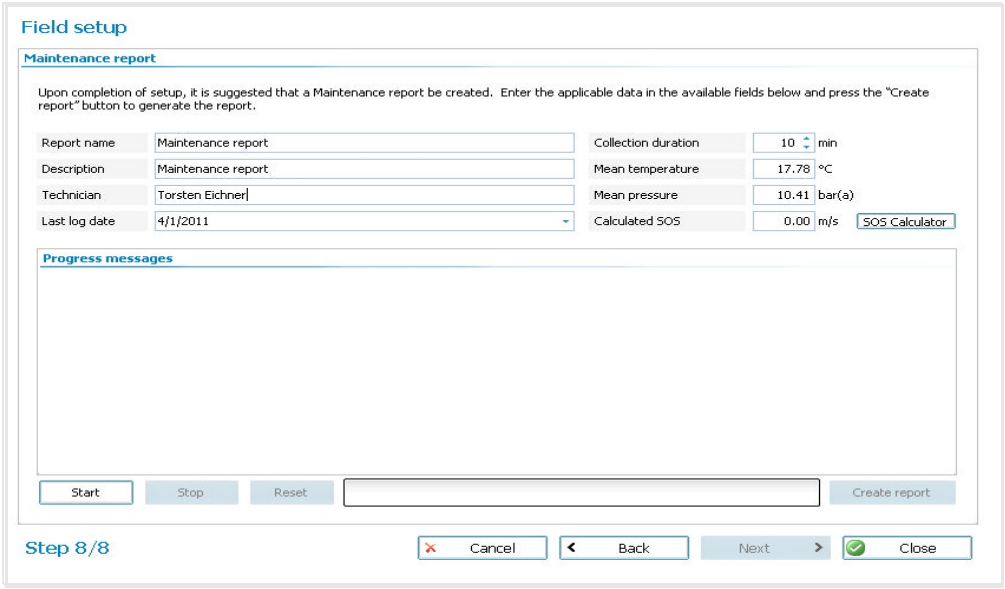
5.5.8 Maintenance report (Field setup page 8 of 8)

Create the Maintenance report.

- ► Enter the information (Description, Technician) in the fields provided.
- ► Specify the collection duration (e.g. 3 min.), Specify the collection duration (e.g. 3 min), a timespan, over which live meter data is to be collected to document the meter‘s state after the field setup. (Live data collection starts after clicking the "Start" button.)
- ► Enter the current pressure, temperature and SOS. If the SOS is unknown, use the Speed of sound Calculator (SOS calculator) to calculate the SOS for the gas composition. The gas composition must be current and representative (more details → pg. 169, 6.2.1).
- ► Click the "Start" button to start live data collection. Diagnosis data, measured values and status information will be collected over the specified time span.
- ► Once the data collection has been completed and the "Create report" button becomes available, click on it. The Maintenance report will be created and displayed.
- ► Print it and store a copy in the Manufacturer Data Report (MDR) shipped with the meter.
- ► Close the preview window.
- ► Click the button "Close" in the Field Setup

The Field Setup is now complete.

Figure 71 Field setup page 8 of 8: Maintenance report



After creation, the Maintenance Report is automatically stored in the MEPAFLOW600 CBM meter database. It is accessible via the "Meter explorer" and the "Report manager". The Maintenance report can also be exported to Excel using the direct link provided when the Maintenance report is displayed.

5.5.9 Disconnecting from the meter and closing the session

When disconnecting from the meter, a session is stored in the MEPAFLOW600 CBM meter database. It contains the following data:

- a complete parameter set from the meter at disconnection
- all parameter changes made during Field setup (entries can be viewed in the Meter Explorer)
- all logbook data (if downloaded)
- the Maintenance Report created on page 8 of the Field setup

This data can be accessed later with the "Meter Explorer", even when you are not directly connected to the meter.

To disconnect from the meter and to close the session, proceed as follows:

► Go to "Connect / Disconnect" page (select "File / Connect/Disconnect" from menu).
► Click "Disconnect". The "Session description" window opens.
► Describe the activities carried out during the session (e.g. "Field Setup").
► Click OK.

5.6 Function test

The major system parameters are configured at the factory. The default settings should allow error free operation of the FLOWSIC600. Nevertheless, correct meter operation should be verified on site when the meter is installed and is subject to actual operating conditions.

5.6.1 Function test on FLOWSIC600 with LCD front panel

The FLOWSIC600 is functioning correctly, if the standard display shows two pages of measurands and current readings and the pages alternate every 5 seconds. (For operation and menu structure of the SPU with LCD see → pg. 221, 9.3)

If a current error or warning is active, the display will be interrupted by an error message every 2 seconds. As soon as the cause of the error/warning has been rectified, the FLOWSIC600 automatically returns to the standard display.

If the logbooks contain unacknowledged errors, warnings or information, the corresponding letter is displayed in the upper right hand corner and flashes. The letter stops flashing, once the message has been acknowledged in the logbook. It disappears when the entries have been cleared from the logbook.

Detailed information on errors is available in the logbook (see → pg. 176, 6.4.1 und → pg. 234, 9.4 of this Manual). See chapter → »Troubleshooting«.

You are advised to check the plausibility of the measured and diagnosis values, even if the device is functioning properly (see chapter → »Maintenance«).

5.6.2 Function test on FLOWSIC600 with LED front panel

The FLOWSIC600 is functioning correctly when the green status LEDs for each measuring path installed start flashing periodically approximately 30 seconds after the power supply is switched on.

If the yellow LED flashes, the FLOWSIC600 works in the operation state ''Check request'' with an insignificantly reduced accuracy (e.g. if one path fails).

If the yellow LED lights up permanently, the measurement is invalid. In this case, the error must be diagnosed (see Chapter 8 of this Manual).

5.6.3 Function test with MEPAFLOW600 CBM

Performance check

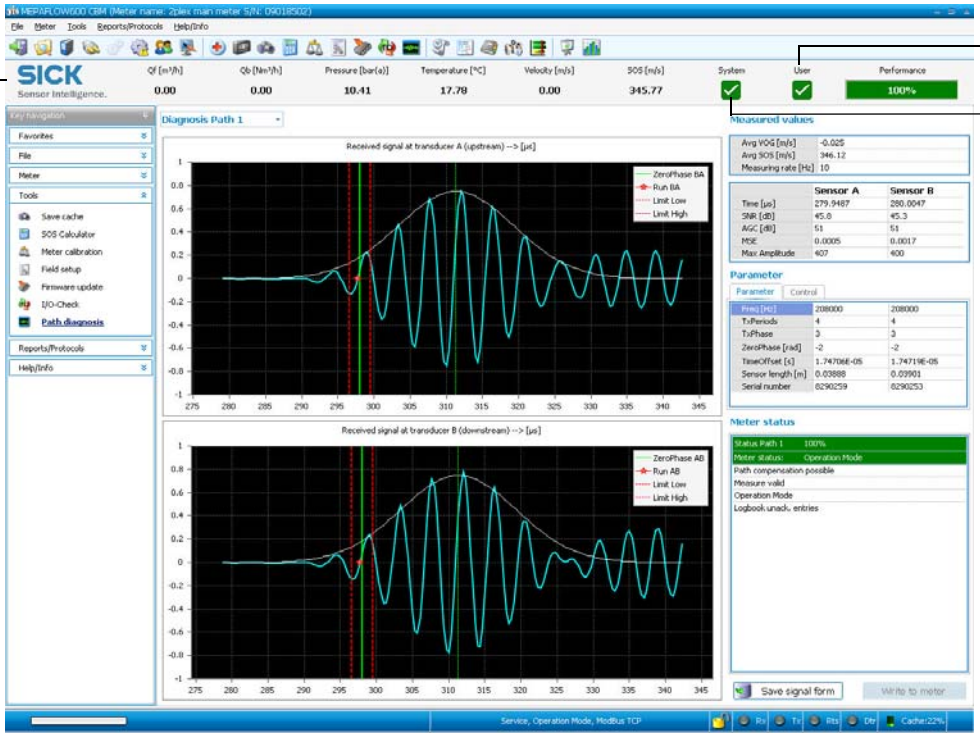
- ► Once the facility is flowing at the initial flow rate, go to the "Meter values" page to check the performance of the meter. The performance value should be at least 75% on all paths. If the velocity of gas is greater than 30 m/s (100 ft/s), the performance values may be significantly lower.
- ► Check the Main system bar for system alarms (the symbol on the button "System" should be green) and warnings (the symbol on the button "User" should be green) (→ Figure 72). If there is a yellow or a red symbol, proceed as described on → pg. 188, 7.1.

Zero phase check

- ► Use the "Path Diagnosis" wizard (→ Figure 72) to check the "Zero Phase" parameters of both transducers on each path (path 1, 2, 3, 4).

Properly adjusted zero phases of the individual paths are the basis for accurate transit time measurement of the ultrasonic signals. The "Zero Phase" parameter of a path is properly adjusted, when the green cursor in the signal window is symmetrically within the two dotted red limit lines and the red asterisk is positioned exactly on the second positive zero crossing of the received ultrasonic signal (→ Figure 73).

Figure 72 "Path Diagnosis" wizard in MEPAFLOW600 CBM

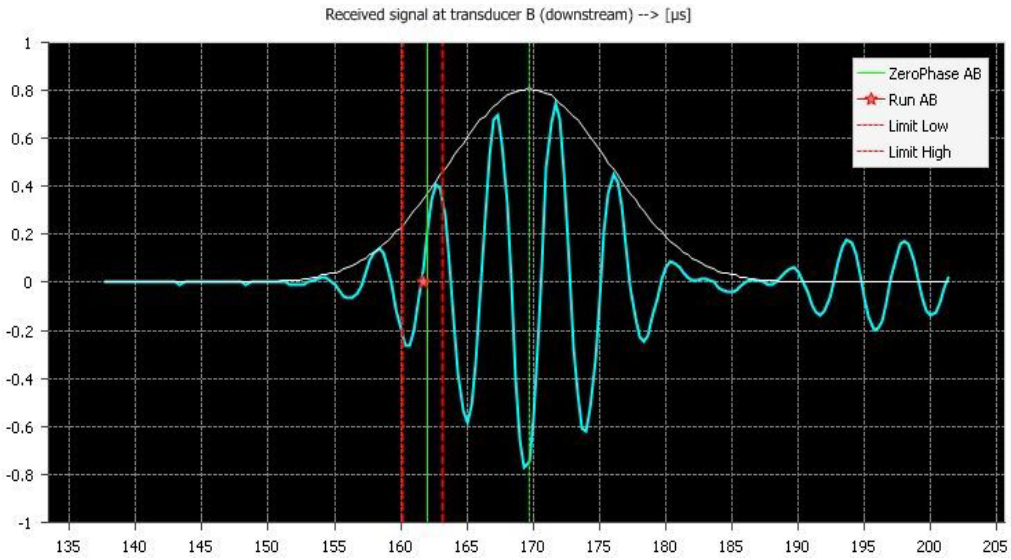


If the zero phase values do not meet the aforementioned criteria, the zero phase needs to be adjusted according to → pg. 84, 3.3.8.3.

In addition, the validity of the settings should be verified:

► Open the "Meter status" window and go to the tab "Advanced or Path Status" (→ pg. 164, Figure 78). If a lamp for "Time plausibility" is on, it indicates an incorrect zero phase.

Figure 73 Signal window displaying ultrasonic signal in the "Path Diagnosis" page



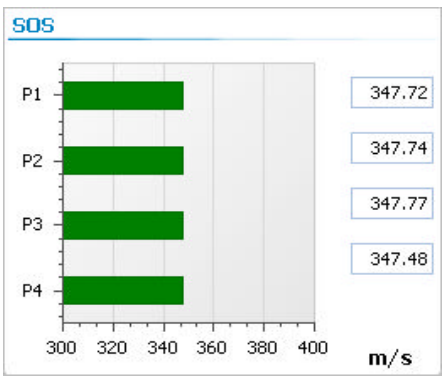
► Go to the "Meter values" page to check that the measured SOS values are almost the same at all paths of the FLOWSIC600, and that they differ by less then 0.1% (→ Figure 74).

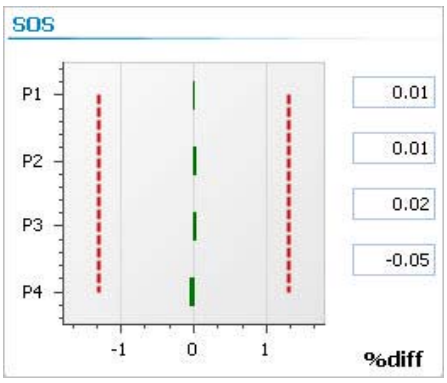
► Switch between display of absolute and difference SOS by clicking the right mouse button on the SOS graph and using the context-menu.

In the case of very low gas velocities (< 1 m/s or 3 ft/s), there may be more significant differences between the paths due to thermal stratification. In this case, the SOS on the upper paths (1 and 2) will be higher than the lower paths.

► Check that the measured SOS deviates no more than 0,3% from a theoretical SOS, which is calculated from gas composition, pressure and temperature (→ pg. 169, 6.2.1).

Figure 74 SOS per path on the "Meter values" page (left: absolute SOS , right: difference to average)





5.7 Optional advanced setup

5.7.1 Configuration and activation of User Warnings

When normal operating conditions have been reached, the User Warnings can be configured to best suit the specific application.

- The User Warnings are preconfigured when the meter is shipped from the factory (see "Default activation state" and "Default value" in the following tables→ pg. 151, Table 20).
- If there is no need to change the User Warnings, or if you are not sure about consequences of changes, keep the values as they are or discuss with a SICK representative.

To configure the User Warning limits, proceed as follows:

- ► Use MEPAFLOW600 CBM to connect to the meter (→ pg. 125, 5.3).
- ► Open the "User Warnings" assistant from the main system bar by clicking the "User" button (→ Figure 75).
- ► Go to the "Configuration" tab (→ Figure 75, right side).
- ► Use →Table 20, →Table 21 and →Table 22 to plan the configuration of User Warnings to best suit the specific application.
- ► Activate or deactivate User Warnings with the check box on the right.
- ► Edit parameter values in the fields.
- ► Click the "Write to meter" button.

All User Warning parameters - except for the parameter ‘Min. VOG for warnings" - can be configured in the User Access Level "Operator" and without switching the meter to the Configuration Mode.

Figure 75 Button "User" in the main system bar, "User Warnings" assistant with "Status" and "Configuration" tab

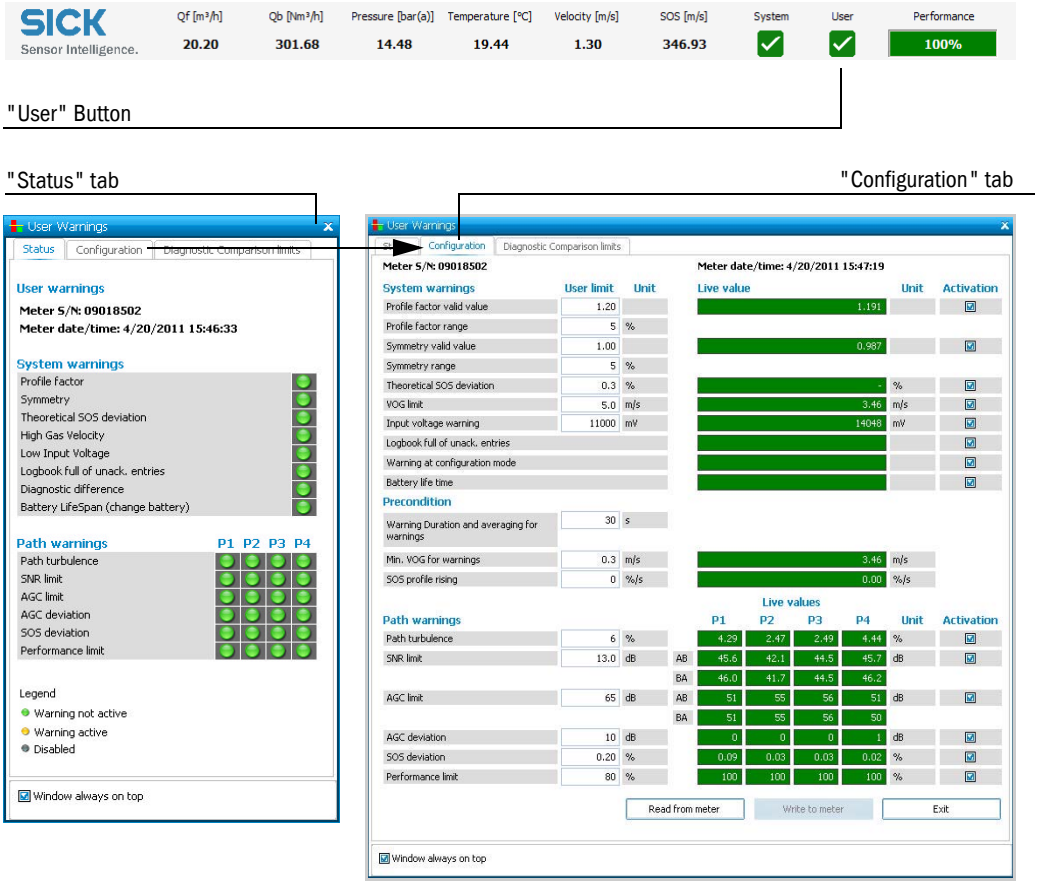


Table 20 System warnings

Monitored measurement	Configurable User Warning parameters	Default value	Notes	Default activation state[1]
Profile factor[2] $= \frac{v2 + v3}{v1 + v4}$	Profile factor valid value	1.11	The profile factor represents the path velocity ratios of inner to outer paths. A User Warning is generated when the profile factor value calculated from the current path velocities (v1..v4) deviates from the "Profile factor valid value" by more than the allowed "Profile factor range". The usage of a flow conditioner improves and stabilizes the flow profile and results in well-defined values for profile factor and symmetry, so that the default values may be applied. In installations without flow conditioner, the values for the parameters "Profile factor valid value" and "Profile factor range" may significantly differ from the defaults. A change of the symmetry value may be caused by contamination, blockage or deposits in the line that change the symmetry of the flow profile. ► When the application is operating under normal conditions, try to observe, how the Profile factor changes within the operating range (VOG between Qmin and Qmax). ► From these observations useful values can be concluded for "Profile factor valid value" and "Profile factor range".	Off
	Profile factor range	5%		
Symmetry[1] $= \frac{v1 + v2}{v3 + v4}$	Symmetry valid value	1.00	The symmetry represents the path velocity ratios of upper to lower paths. If the symmetry value calculated from the current path velocities (v1..v4) deviates from the "Symmetry valid value" more than allowed by the "Symmetry range", a User Warning is generated. The usage of a flow conditioner improves and stabilizes the flow profile and results in well-defined values for profile factor and symmetry, so that the default values may be applied. In installations without flow conditioner, the values for the parameters "Symmetry valid value" and "Symmetry range" may significantly differ from the defaults. A change of the symmetry value may be caused by contamination, blockage or deposits in the line that change the symmetry of the flow profile. ► When the application is operating under normal conditions, try to observe, how the Symmetry changes within the operating range (VOG between Qmin and Qmax). ► From these observations useful values can be concluded for "Symmetry valid value" and "Symmetry range".	Off
	Symmetry range	5%		

Table 20 System warnings

Monitored event	Configurable User Warning parameters	Default value	Notes	Default activation state[1]
High gas velocity	VOG limit	45 m/s	If the current average Velocity of Gas exceeds the value "VOG limit", a User Warning is generated. **Caution:** This parameter (Reg. #7201 "MaxVelGas") also defines the upper limit of the gas velocity range classes for the Diagnostics Comparison Log. Changes to this parameter will clear all data from the Diagnostics Comparison Log. ► Configure "VOG limit" to suit the specific application.	Off
Power supply (low input voltage)	Input voltage warning	12000mV	If the power supply voltage drops below the value "Input voltage warning" (e.g. in applications with autarkic power supply by solar panels) a User Warning is generated.	Off
A Logbook is full of unackn. entries	Logbook full of unack. entries		If one of the logbooks is full of unacknowledged entries, a User Warning is generated.	Off
Meter is in Configuration Mode	Warning at Configuration Mode		If the meter is in Configuration Mode, a User Warning is generated.	Off
Battery lifespan	Warning if battery lifespan is low		If the remaining battery lifespan is less than 15%, a User Warning is generated.	On

1 User Warnings must be activated to become effective on the warning output.

2 These user warning limits are only monitored, as long as certain preconditions are met (see → Table 22).

Table 21 Path warnings

Monitored measurement	Configurable User Warning parameters	Default value	Notes	Default activation state[1]
Turbulence[2] $= \frac{\sqrt{\delta^2(V_{pathi})}}{V_{path}}$	Path turbulence	6%	A change in the path turbulence indicates changed flow conditions (e.g. a blocked flow conditioner). If the current turbulence value of any path exceeds the value "Path turbulence", a User Warning is generated. The usage of a flow conditioner improves and stabilizes the flow profile and results in well-defined values for the turbulence, so that the default value may be applied. In installations without flow conditioner, the value for the parameter "Path turbulence" may significantly differ from the defaults. ► When the application is operating under normal conditions, try to observe, how the Profile factor changes within the operating range (VOG between Qmin and Qmax). ► From these observations reasonable values can be estimated for "Path turbulance" and "Profile factor range".	Off
Signal-to-noise ratio (SNR)	SNR limit	13 dB	Interfering noise caused by fittings in the pipeline, valves that are not fully open, sources of noise near the measuring location, or defective ultrasonic transducers may affect the SNR. Other possible sources of interference include electrical noise caused by bad contact of the connectors or sources of acoustic interference, such as control valves or very high flow velocities. Typically the SNR is greater than 20dB. It depends on the nominal diameter of the meter body and the current process pressure. If the SNR drops below the limit specified in "SNR limit", a User Warning is generated. ► Configure the "SNR limit" to be 6dB below what is observed in the application under normal operating conditions.	On
Signal amplification	AGC limit	93 dB	If the absolute value of the reception gain exceeds the limit specified as "AGC limit", a User Warning is generated. Caution: The current signal amplification largely depends on the current process pressure (inversely proportional in initial approximation, that is, if the pressure doubles, the required reception sensitivity will be halved). ► Configure the "AGC limit" to be 6dB below what is observed in the application at the lowest operating pressure.	On
	AGC deviation	10 dB	The absolute difference between both path gain factors is monitored. If the AGCs of a path deviate more than permitted, this can indicate a malfunction in the ultrasonic transducers, electronic modules, transducer cables or parameter settings (signal models, control limits). If the value specified for the parameter "AGC deviation" is exceeded by a path, a User Warning is generated. Caution: High flow velocities may also increase the difference in gain. ► Considering the application conditions, the "AGC deviation" may be set to a lower value.	On

Table 21 Path warnings

Speed of sound (SOS)[2]	SOS deviation	0.2%	The deviation between the current measured path SOS and the average value of the mean SOS calculated for all paths is monitored. The current flowing gas velocity is used as a weighting factor, so that temperature stratification is disregarded at very low flow velocities. The SOS deviation indicates whether or not a path is measuring the correct transit time. If the SOS deviation of any path exceeds the value specified for the parameter "SOS deviation", a User Warning will be generated. Note: When setting the parameter, take into account plausible conditions for normal operation (in particular temperature stratification which can occur at low flow rates). ► Considering the application conditions, the "SOS deviation" may be set to a lower value.	On
Performance	Performance limit	7%	The quality of the received signals is continuously monitored. If it drops below the limit specified in "Performance limit", a User Warning is generated. ► Considering the application conditions, the "Performance limit" may be set higher than the default.	Off

1 User Warnings must be activated to become effective on the warning output.

2 These User Warning limits are only monitored, as long as certain preconditions are met (→ Table 22).

Table 22 Warning preconditions

Configurable precondition	Default value	Notes
Warning Duration and averaging for warnings	30s	The User Warning status becomes active only if a User Warning has been continuously exceeded for the time specified in this parameter. All measurements monitored for the User Warnings are averaged over the time specified in this parameter. ► Configure this parameter to suit the specific application.
Min. VOG for warnings	1 m/s (3.3 ft/s)	The monitoring of measurements for the User Warnings only becomes effective, if the average VOG is above the value specified in this parameter. **Caution:** ● It is not recommended to change the settings for this parameter! ● This parameter defines the parameter Reg. #7208"PathCompClassLo" which plays an important role for the path failure compensation (→ pg. 28, 2.4). ● This parameter also defines the lower limit of the gas velocity range classes for the Diagnostics Comparison Log (→ pg. 159, 5.7.3). Changes to this parameter will clear all data from the Diagnostics Comparison Log and restart it. ● This parameter is the only User Warning parameter that can only be changed if the meter is in Configuration Mode and in the User Access Level "Service". ► If necessary, configure this parameter to suit the specific application.
SOS profile rising	0%/s	To improve the sensitivity of the SOS deviation warning, the influence of thermal stratification (e.g. caused by sun radiation on the pipe at low flow velocities) has to be considered. SOS deviation warning only becomes effective if the the SOS gradient between all paths is below the limit specified in the parameter "SOS profilerising". ► If necessary, configure this parameter to suit the specific application.

5.7.2 Configuration of DataLogs

5.7.2.1 Using the DataLogs

Starting with firmware version 3.4.00, the FLOWSIC600 provides two DataLogs (Hourly Log and Daily Log). They save averaged measured values and are stored in the SPU‘s non-volatile memory (FRAM). All data can be downloaded and exported to Excel files with MEPAFLOW600 CBM (→ pg. 53, 2.8.4.).

Valid flow for DataLog logging

Gas flow values are averaged for the DataLog entry only if VOG is above the "Min. VOG for warnings" (→ pg. 149, 5.7.1) and the flow is in the direction for which the DataLog was configured. The Flow Time saved for every entry indicates about how long the gas flow was valid for DataLog Logging during the storage cycle. For example:

- If the flow was above "Min. VOG for warnings" and in the forward direction (for a forward configured Hourly Log) for half an hour, the corresponding Hourly Log data will show a Flow Time of 50%.
- If the flow was above "Min. VOG for warnings" but in the reverse direction (for a forward configured Hourly Log) for an hour, the corresponding Hourly Log data will show a Flow Time of 0%.
- If the Flow Time is 0%, all diagnosis related values are shown as 0 (Temperature is 0 Kelvin). Meter Status and Volume Counter values are shown as usual.

5.7.2.2 **Configuration of DataLogs**

The following parameters can be configured on the Configuration tab of the DataLogs page (→ Figure 76) to best suit the specific application (for more details see → pg. 49, 2.8.3.8 and following):

- Type of dataset,
- Storage cycle,
- Storage behavior,
- Active flow direction,
- Accounting hour
- Distribution of FRAM capacity.

Changes to the parameters "Type of dataset", "Storage behavior" or "Direction" will erase all entries from the DataLog which is changed.

► If configuring these parameters after commissioning, first download and export all entries according to → 2.8.4, to prevent loss of data.

When the meter is shipped, the DataLogs are preconfigured.

Table 23 Standard DataLogs configuration when meter is shipped *

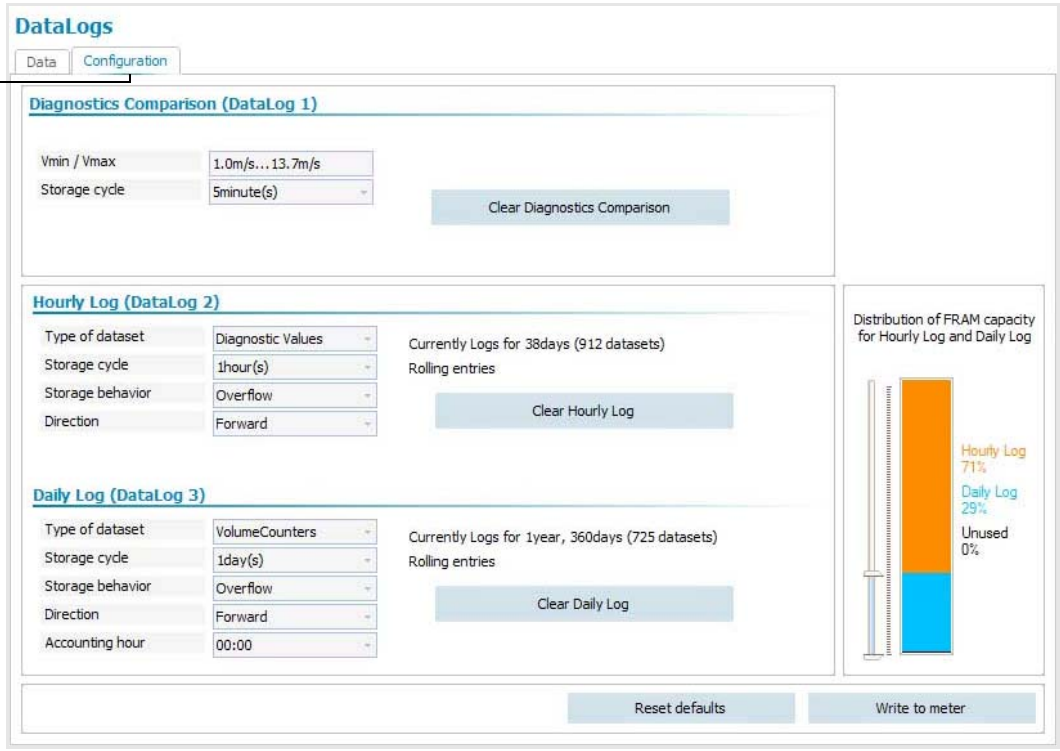
Configuration parameter	Hourly log	Daily log	Diagnostics comparison log
Type of Dataset	Diagnostic values	Volume counters	Diagnostic values
Storage cycle	1 hour	1 day	5 min
Storage behavior	Overflow	Overflow	not applicable
Active flow direction	Forward	Forward	Bidirectional
Accounting hour	not applicable	0 (midnight)	not applicable
Max. number of entries	Entries for approx. 38 days	Entries for approx. 2 years	20 entries

* Depending on location, the DataLogs for the specific FLOWSIC600 may be preconfigured to fit the requirements e.g. of API, MID or PTB. These settings may differ from the defaults described here.

Complete the following steps to configure the DataLogs:

- ► Go to the DataLogs page (select Meter / DataLogs from menu).
- ► Choose the Configuration tab (see → Figure 76).
- ► Switch the meter into Configuration Mode (choose "File / Configuration Mode" from the menu).
- ► Use the drop down lists to select the parameter settings.
- ► Click the "Write to meter" button.

Figure 76 DataLogs Configuration tab



5.7.2.3 Disabling DataLogs

To disable a DataLog complete the following steps:

- ► Go to the DataLogs page (select Meter / DataLogs from menu).
- ► Choose the Configuration tab (see → Figure 76).
- ► Switch the meter into Configuration Mode (choose "File / Configuration Mode" from the menu).
- ► Set the parameter "Storage cycle" to "disabled" for any DataLog that should be disabled.
- ► Click the "Write to meter" button.

5.7.2.4 Enabling (starting) DataLogs

To enable (start) a disabled DataLog, complete the steps described under → pg. 158, 5.7.2.5 (Resetting DataLog Parameters to Defaults).

5.7.2.5 Resetting DataLog parameters to defaults

Before resetting DataLog Parameters to Defaults
In MEPAFLOW600 CBM from V1.1.00, DataLog entries are not saved in the meter database. Before clearing entries from DataLogs, download and export the entries into Excel (→ pg. 178, 6.4.2).

Complete the following steps to reset the DataLog parameters to the defaults:

- ► Go to the DataLogs page (select Meter / DataLogs from menu).
- ► Choose the "Configuration" tab (see → Figure 76).
- ► Switch the meter into Configuration Mode (choose "File / Configuration Mode" from the menu).
- ► Click "Reset defaults".

Defaults
The default settings are described in → 2.8.3.1 and → 2.8.3.2.

5.7.3 Configuring and using the Diagnostics Comparison Log

The Diagnostics Comparison Log can be used to get information on changes in the meter's health (more information → pg. 53, 2.8.4): The Diagnostic Comparison Report, created from the data of the Diagnostics Comparison Log, facilitates an easy and quick information about changes in the meter health between two different points of time (e.g. commissioning and now) (→ pg. 181, 6.4.3 Diagnostic Comparison Report Check).

5.7.3.1 Using the Diagnostics Comparison Log

The Diagnostics Comparison Log provides a comparison between current diagnostic values (dataset type "Diagnostic Values", → pg. 50, Table 11) and those of a reference time (e.g. at time of commissioning). The current diagnosis values are stored in Current Classes 1 to 5, while the reference values are stored in Reference Classes 1 to 5.

To prepare the Diagnostics Comparison Log for the future use, complete the following steps when the FLOWSIC600 is running under normal operating conditions:

- ► Go to the "DataLogs" page (choose "Meter / DataLogs" from the menu) → pg. 157, Figure 76.
- ► In the "DataLog" selection dialog, activate the check box for "Diagnostics Comparison" [DataLog1], to download the Diagnostics Comparison data from the meter.
- ► Click "Export Datalogs" and export the Diagnostics Comparison Data to an Excel File for future reference.
- ► Clear all Diagnostics Comparison Log data that may have been collected from the meter during calibration:
  - ► Choose the "Configuration" tab (see → Figure 76).
  - ► Switch the meter into Configuration Mode (select File/Configuration Mode from menu).
  - ► Click the "Clear Diagnostics Comparison" button and confirm the confirmation dialog with "Yes".
  - ► Switch the meter into Operation Mode.
- ► If possible, operate the meter in the Velocity Range Classes 1 to 5 (also see → pg. 160, 5.7.3.2) to fill the Reference Classes with data representing the correct operation of your installation.

Filling the velocity range classes with valid flow data

- Only stable gas flow conditions will be used to calculate the averaged data in the Diagnostics Comparison Log. Therefore the set gas velocities should be well within the class limits and should stay relatively stable for the time set as storage cycle (default is 5 minutes).
- The parameter DataLogClassStdev (Reg. #3050) sets the allowed standard deviation for the definition of the gas flow conditions as stable → 2.8.3.8.

When the reference classes are filled with data representing the usual operation of the installation, the current classes will be continuously updated, showing the current state of the meter. Use the Diagnostics Comparison Report → pg. 181, 6.4.3, to detect changes in the meter between the diagnostic values in the reference classes and those in the current classes.

5.7.3.2 Configuring the general conditions for the Diagnostics Comparison Log

The gas velocity class ranges are calculated to optimally cover the operation range of the meter. The lower limit of the gas velocity range classes is defined by the parameter "Min. VOG for warnings". The upper limit is defined by "VOG limit".

- ► View the Diagnostics Comparison data tab, to find the velocity class limits calculated for the meter. → Figure 13, S. 53 shows an example of a Diagnostics Comparison Log filled with entries.
- ► If necessary, configure "Min. VOG for warnings" and "VOG limit" to fit the application range of your specific FLOWSIC600 on the configuration tab of the User Warnings window (→ pg. 149, 5.7.1).

- Changes to the parameters "Min. VOG for warnings" or "VOG limit" will clear all data from the Diagnostics Comparison Log!
- Note that the parameter "Min. VOG for warnings", Reg. #7208 "PathCompClassLow", plays an important role in path compensation (→ pg. 28, 2.4).
- Note that the parameter "VOG limit" also defines the limit for User Warnings.

5.7.3.3 Configuring the Diagnostics Comparison Log

Complete the following steps to configure the Diagnostics Comparison Log:

- ► Go to the DataLogs page (choose "Meter / DataLogs" from the menu).
- ► Choose the Configuration tab (see → Figure 76).
- ► Switch the meter into Configuration Mode (select File/Configuration Mode from menu).
- ► Use the drop down lists behind the arrows to select the parameter settings.
- ► Click the "Write to meter" button.

5.7.3.4 Configuration of the Diagnostics Comparison limits

The Diagnostics Comparison limits can be activated to make the meter generate a warning when the difference between the diagnostic values in the reference classes and those in the current classes exceed the Diagnostics Comparison limit values.

These limits can be activated and configured in the User Warnings window:

- ► Use MEPAFLOW600 CBM to connect to the meter (→ pg. 125, 5.3).
- ► Open the "User Warnings" window from the main system bar by clicking the "User" button (→ Figure 77).
- ► Go to the "Diagnostic Comparison limits" tab (→ Figure 77).
- ► Use → Table 24 to plan the optimum configuration of the Diagnostics Comparison limits to best suit your application.
- ► Activate or deactivate the Diagnostic Comparison limits with the check box on the right.
- ► Edit parameter values in the fields.
- ► Click the "Write to meter" button.

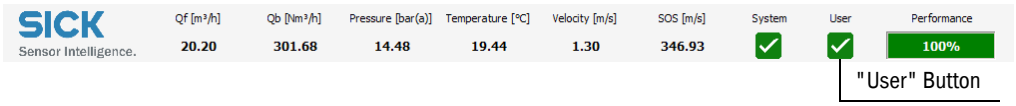
All Diagnostics Comparison limit parameters can be configured in the User Access Level "Authorized Operator" and without switching the meter to the Configuration Mode.

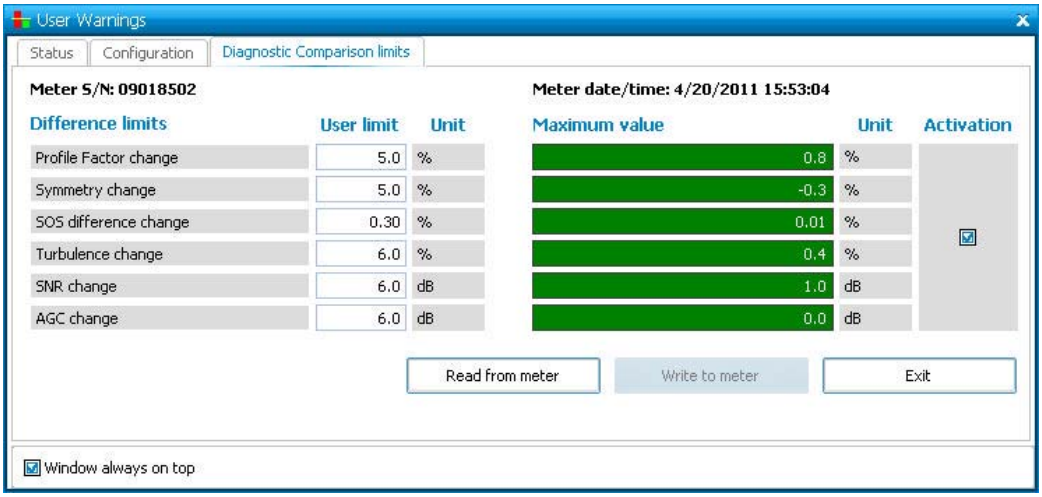
Table 24 Diagnostics Comparison limits

Monitored difference between reference values and current values	Configurable difference limit	Default value	Notes	Default activation state[1]
Profile factor	Profile Factor change	10%	A change of the profile factor value may be caused by contamination, blockage or deposits in the line that change the symmetry of the flow profile. ► We recommend to use the default value.	Off
Symmetry	Symmetry change	10%	A change of the symmetry value may be caused by contamination, blockage or deposits in the line that change the symmetry of the flow profile. ► We recommend to use the default value.	
SOS differences between paths	SOS difference change	1%	The SOS deviation indicates whether or not a path is measuring the correct transit time. ► We recommend to use the default value.	
Turbulence	Turbulence change	50%	A change of the turbulence value may be caused by contamination, blockage or deposits in the line that change the symmetry of the flow profile. ► We recommend to use the default value.	
SNR (Signal-to-noise ratio)	SNR change	20dB	Interfering noise caused by fittings in the pipeline, valves that are not fully open, sources of noise near the measuring location, or defective ultrasonic transducers may affect the signal-to-noise-ratio. ► We recommend to use the default value.	
AGC (Signal amplification)	AGC change	10dB	If the AGCs of a path deviate more than allowed, this can indicate a malfunction in the ultrasonic transducers, electronic modules, transducer cables or parameter settings (signal models, control limits). ► We recommend to use the default value.	

1 User Warnings must be activated to become effective on the warning output.

Figure 77 "User Warnings" window with "Diagnostics Comparison limit" tab





5.8 Activation of path compensation

If the status bit "Path compensation valid" is "active", then the FLOWSIC600 is able to compensate a path failure- (see also → pg. 28, 2.4).

The meter automatically sets this bit to "active" after operating for about 20 minutes with error free measurement at all paths at a gas velocity between 1 to 8m/s (3.3 to 26.2 ft/s) and also about 20 minutes at a gas velocity higher than 8m/s (26.2 ft/s).

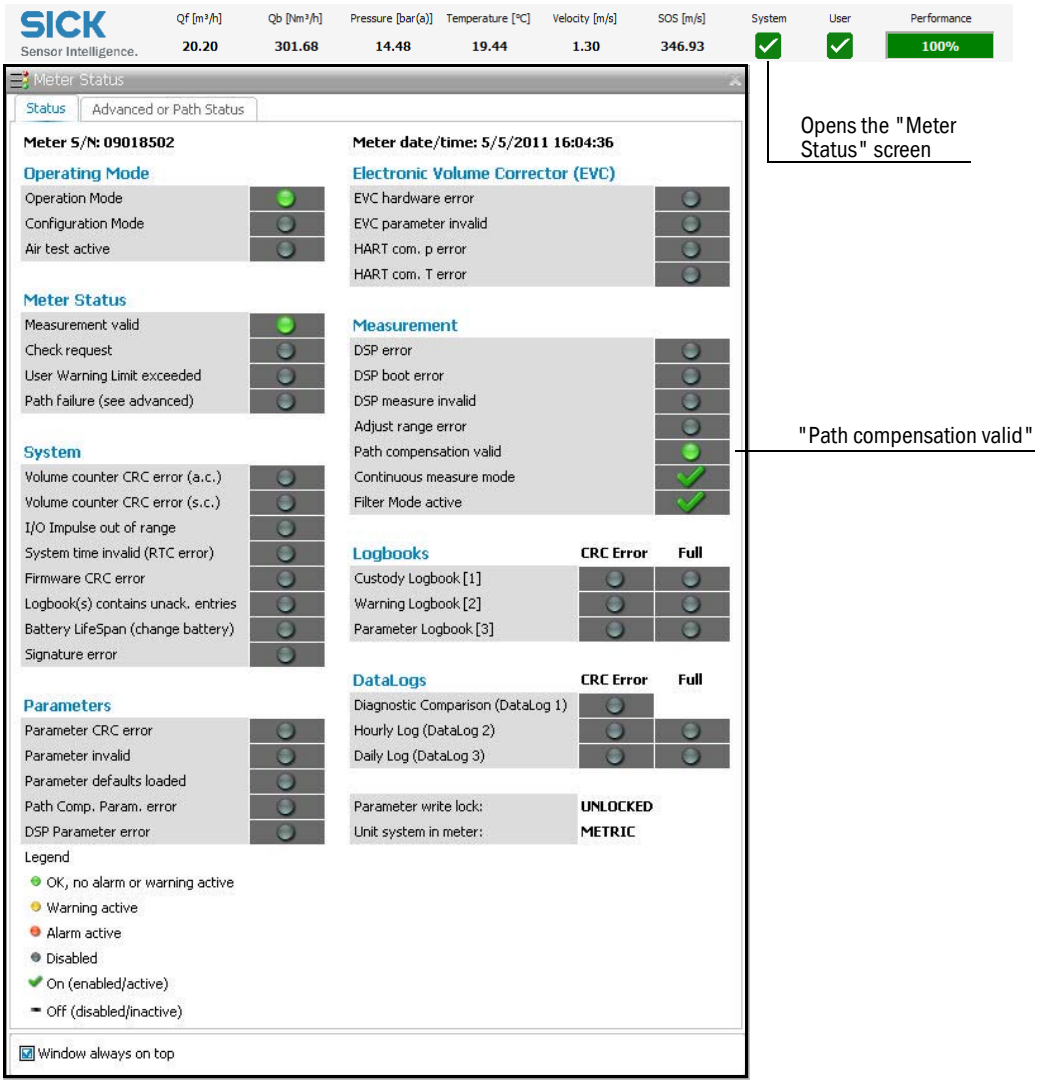
The status bit "Path compensation valid" is displayed on the "Meter status" page (→ pg. 164, Figure 78).

Determination of path relationships during commissioning

Due to the unique path relationships of each individual installation, every meter must determine the path relationships during the commissioning procedure.

In order to ensure that the system is able to compensate for path failure at both high and low flow velocities, it is recommended that the FLOWSIC600 meter be run for 20 minutes at low gas velocities (< 8 m/s or < 26.2 ft/s) first and then for 20 minutes at high gas velocities (> 8 m/s or > 26.2 ft/s) during commissioning.

Figure 78 "Meter status" page with active "Path compensation valid" status bit



5.9 Sealing

After having completed the commissioning, seal the signal processing unit (if required) in accordance with the sealing plan (→ pg. 252, 9.9).

5.10 Documentation

The commissioning should be documented with a Commissioning Protocol. The document "FLOWSIC600 Commissioning Protocol" is content of the FLOWSIC600 shipping on paper and on the product CD.

► File the completed Commissioning Protocol with the Manufacturer Data Record (MDR)

FLOWSIC600

6 Maintenance

General
Routine checks
Maintenance report
Optional data download
Optional adaptation of the User Warnings

6.1 General

The FLOWSIC600 does not contain mechanically moving parts. The meter body and ultrasonic transducers are the only components that come into contact with the gaseous media. Titanium and high-quality stainless steel ensure that these components are resistant to corrosion, provided that the meter is installed and operated in accordance with the relevant specifications. This means that the FLOWSIC600 is a low-maintenance system. User Warning Limits can be configured to provide early warnings for possible issues with contamination or blockage. Maintenance is limited mainly to routine checks to determine the plausibility of the measured values and diagnostic results produced by the system.

It is recommended that Maintenance Reports be created and filed on a regular basis (→ pg. 174, 6.3). This creates a basis of comparable data over time and helps when a problem requires diagnosis.

The operating conditions (gas composition, pressure, temperature, flow velocity) of the individual Maintenance Reports should be comparable or documented separately and taken into account when the data is analyzed.

Routine checks:

→ »Comparing theoretical and measured Speed of Sound (SOS)« (pg. 169)
→ »Checking the meter health« (pg. 171)
→ »Time synchronization« (pg. 172)
→ »Battery lifespan / capacity« (pg. 173)

Documentation:

→ »Maintenance report« (pg. 174)

Optional data download:

→ »Logbook check« (pg. 176)
→ »DataLogs check« (pg. 178)
→ »Diagnostics Comparison Report Check« (pg. 181)
→ »Trend report« (pg. 183)
→ »Backup of MEPAFLOW600 CBM meter database« (pg. 185)

Optional advanced configurations:

→ »Optional adaptation of the User Warnings« (pg. 185)

6.2 Routine checks

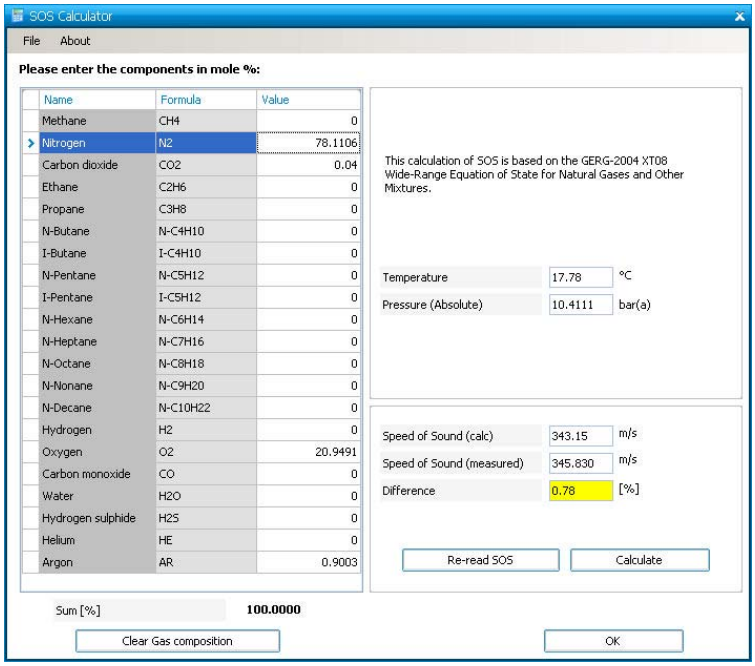
The information displayed on the front panel LCD display of the FLOWSIC600 meter can be checked to ensure that the system is functioning properly. The MEPAFLOW600 CBM software provides a more user friendly way for doing routine checks.

6.2.1 Comparing theoretical and measured Speed of Sound (SOS)

One of the most important criteria for the correct operation of an ultrasonic gas meter is the consistency between the theoretical SOS, calculated for the actual gas composition, temperature and pressure, and the SOS measured by the ultrasonic gas meter.

The Speed of Sound Calculator (SOS Calculator) available in MEPAFLOW600 CBM calculates a theoretical SOS for a specific gas composition at a specified temperature and pressure (→ Figure 79). The calculation of thermodynamic properties is based on the "GERG-2004 XT08 Wide-Range Equation of State for Natural Gases and other Mixtures". The algorithms that are implemented in the SOS calculator were developed by the Ruhr-University Bochum (Germany).

Figure 79 Speed of Sound Calculator with loaded gas composition file



- ► Use MEPAFLOW600 CBM to connect to the meter (→ pg. 125, 5.3).
- ► Start the SOS calculator from the Maintenance Report or choose "Tools / SOS Calculator" from the menu (→ pg. 174, Figure 83).

- ► Enter the gas composition and specify temperature and pressure for your specific application.
- ► Click the "Calculate" button.
- ► If the SOS calculator was started from the Maintenance Report, the calculated value is automatically copied to the corresponding field in the wizard and to the report.
- ► Compare the theoretical SOS with the SOS measured by the FLOWSIC600 (see Figure 80, main system bar).

The deviation between both should be less than 0.1%. If the deviation exceeds 0.3%, check the plausibility of temperature, pressure and gas composition. Otherwise proceed according to → pg. 169, 6.2.1.

It is possible to set up a user warning to continuously monitor for a deviation between a theoretical SOS (written to the meter e.g. by a flow computer) and the current measured SOS. See -> Section Commissioning, Optional setup of user warnings.

6.2.2 Checking the meter health

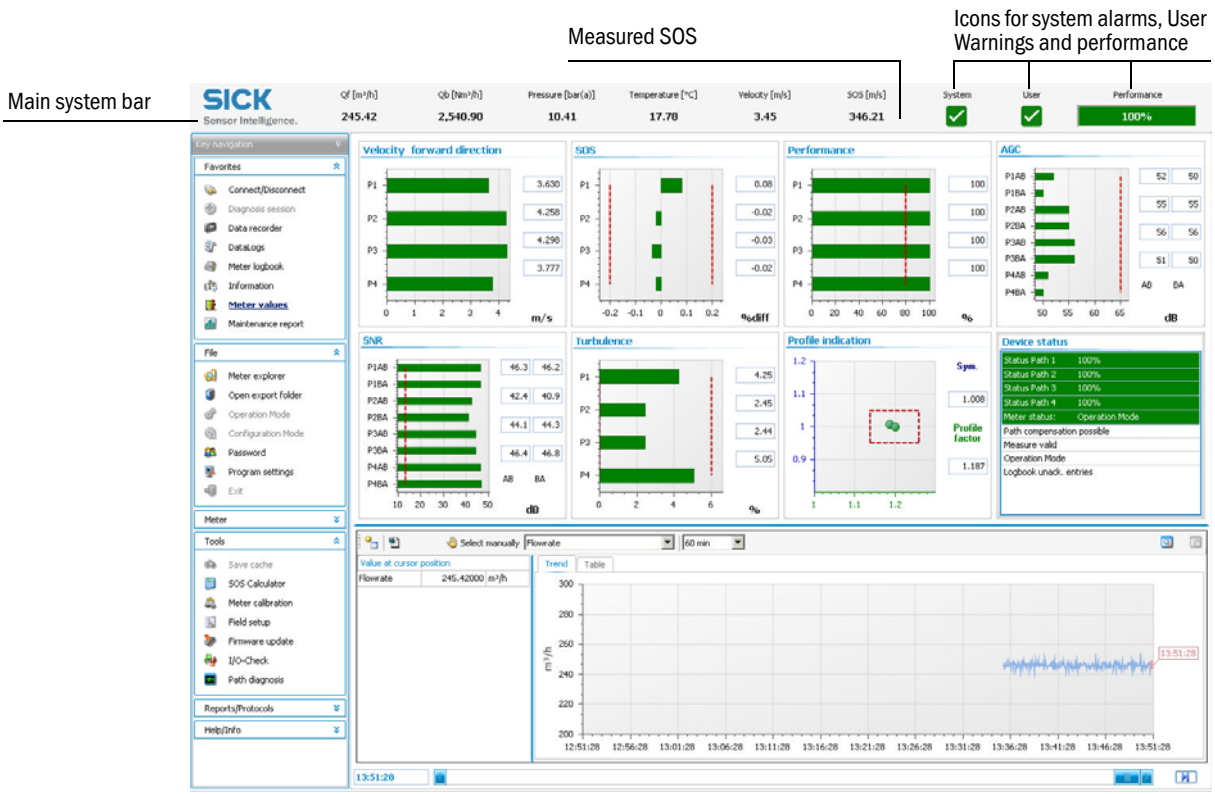
The FLOWSIC600 monitors its own meter health with User Warnings and system alarms. If the outputs are configured to indicate alarms and / or User Warnings, it is not necessary to manually check the meter health.

To get visual feedback about the meter‘s health, the "Main system bar" in MEPAFLOW600 CBM provides a compact overview:

- ► Use MEPAFLOW600 CBM to connect to the meter (→ pg. 125, 5.3).
- ► Check the main system bar for any yellow or red icon (→ Figure 80). A red or yellow icon indicates a potential problem with the meter.

If any of the icons in the main system bar are yellow or red, proceed with checking the "Meter Status" (→ pg. 189, 7.2.1) and the "User Warnings" (→ pg. 191, 7.2.2).

Figure 80 Main system bar



6.2.3 Time synchronization

All entries in logbooks or datalogs saved in the meter‘s memory (FRAM) are written with a time stamp containing the meter time. The meter time can be synchronized with a master clock (e.g. PC clock) via MODBUS or with MEPAFLOW600 CBM.

A synchronization causes a logbook entry in the Custody logbook [1] only if the time change is greater than 3% of the time elapsed since the last synchronization.

Synchronization via MODBUS

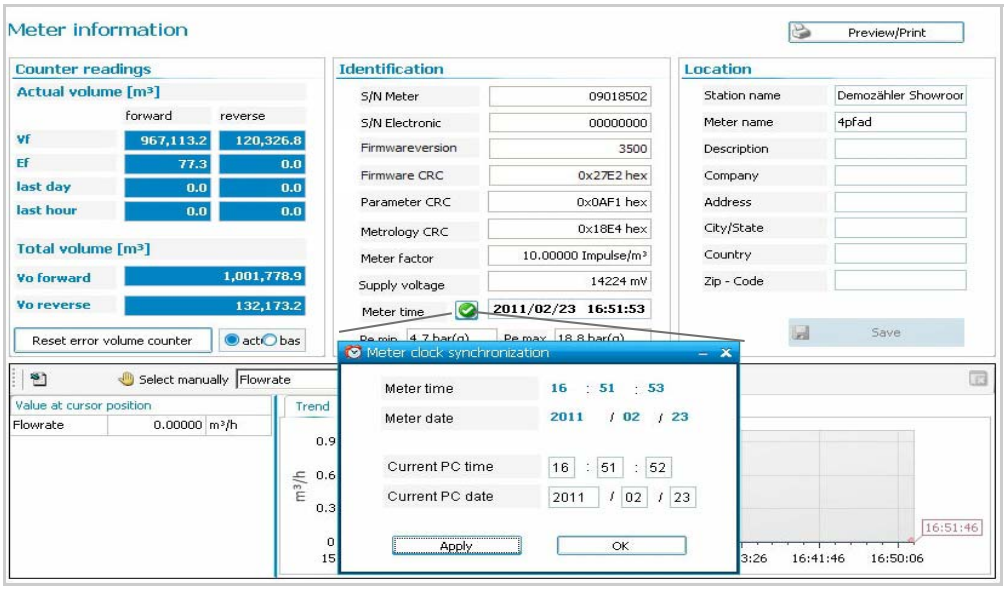
The date and the time of the FLOWSIC600 can be set separately by an external write. Each operation for date and time causes a separate entry in the Custody logbook [1].

Alternatively the synchronization function can be used. To use this method, the date (Reg. #5007 "Date") and the time register (Reg. #5008 "Time") must be written sequentially within 2 seconds. The date register must be written first. The write operation can be accomplished by the MODBUS without setting the FLOWSIC600 into Configuration Mode.

Time synchronization via MEPAFLOW600 CBM

MEPAFLOW600 CBM offers a synchronization function via a button in the "Meter Information" screen (→ Figure 81). The button is marked with a yellow sign calling attention to the synchronization if the time difference between the meter clock and the PC clock is greater than 30 seconds.

Figure 81 Synchronization button and meter clock synchronization window



6.2.4 Battery lifespan / capacity

The Real Time Clock (RTC) of the FLOWSIC600 is buffered by a battery. The manufacturer states that the battery life span is at least ten years. The remaining battery capacity can be viewed on the LCD in the first menu level (→ pg. 222, 9.3.2).

Figure 82 Display of remaining battery capacity on the LCD display

Because the FLOWSIC600 has no regular maintenance cycle, the system alarm "Battery lifetime" is generated when the remaining battery life is less than 15%. This alarm forces the operator to change the battery (→ pg. 189, 7.2.1). A logbook entry is also generated. Optionally, the user can choose an additional user warning for the battery lifespan (→ pg. 150, Figure 75).

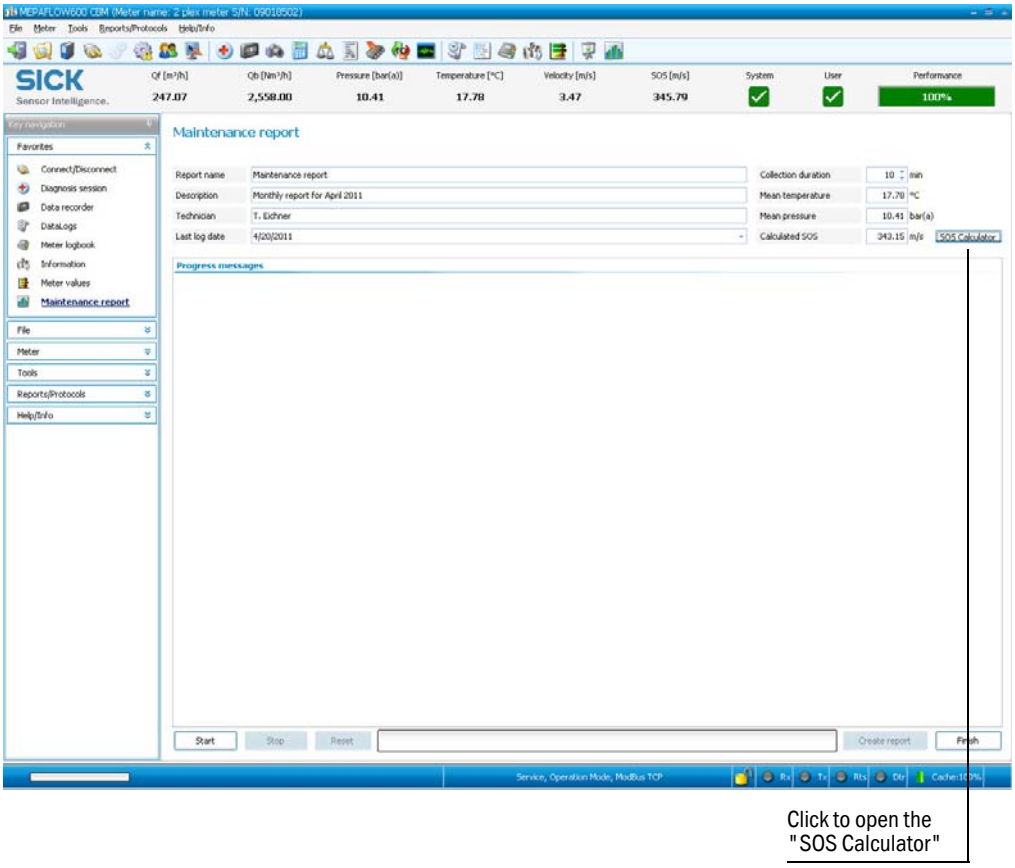
NOTICE:
The battery may only be changed by trained staff. See → pg. 197, 7.2.4 for troubleshooting.

6.3 Maintenance report

It is recommended that Maintenance Reports be generated and filed on a regular basis. This creates a basis of comparable data over time and helps when a problem has to be diagnosed.

> The operating conditions (gas composition, pressure, temperature, flow velocity) of the individual Maintenance Reports should be similar or documented separately and taken into account when the data is analyzed.

Figure 83 "Maintenance report" wizard



To create a maintenance report, follow the described procedure:

- ► Choose "Favorites / Maintenance report" from the menu to open the Maintenance report wizard (→ Figure 83).
- ► Enter the information (Description, Technician) in the fields provided.

- Specify the "Collection duration", a timespan, over which live meter data is to be collected to document the meter‘s state (default: 1 minute).
- Enter the current pressure, temperature and SOS. Use the SOS Calculator to calculate the SOS for the gas composition (→ pg. 169, 6.2.1). The gas composition must be current and representative.
- Click the "Start" button to start live data collection. Diagnosis data, measured values and status information will be collected over the specified time span and will be saved in the meter database.
- Click the "Create report" button. The Maintenance report will be generated and displayed.
- Print it and file the copy in the Manufacturer Data Report (MDR) shipped with the meter.

The Maintenance report and the record are stored in the MEPAFLOW600 CBM meter database and accessible via the "Meter explorer" and the "Report Manager". Maintenance reports can be exported to an Excel file. If Maintenance reports have been regularly collected, a Trend report can be created (→ pg. 183, 6.4.4).

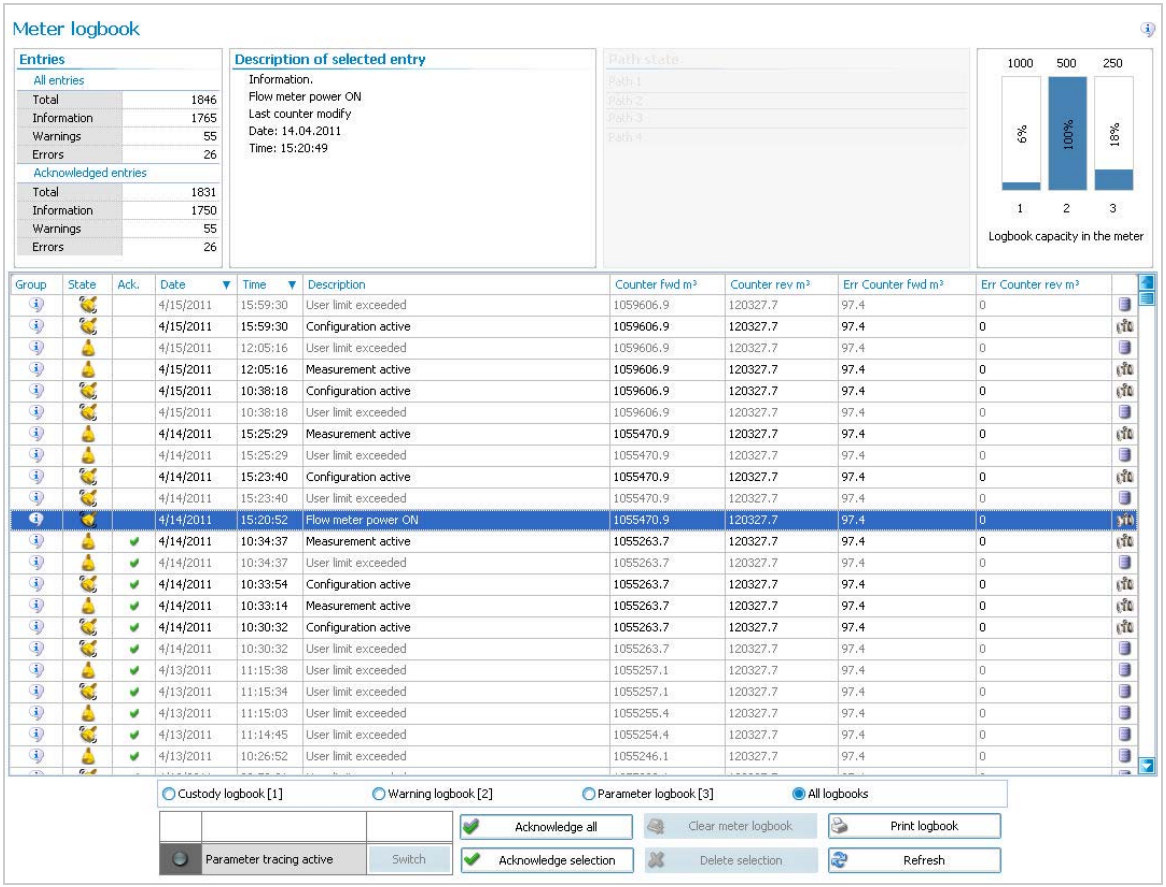
6.4 Optional data download

6.4.1 Logbook check

To prevent an overflow of the logbooks and possible data loss, logbook entries can be saved to the meter database with the MEPAFLOW600 CMB software. The entries on the meter can then be deleted.

The "Meter logbook" page shows all logbook entries on the meter and in the MEPAFLOW600 CBM database. It provides details on each entry and information on the number of registered events and the remaining memory space.

Figure 84 "Meter logbook" page in MEPAFLOW600 CBM



6.4.1.1 Downloading and saving logbook entries to the MEPAFLOW600 CBM meter database

To download and save logbook entries to the MEPAFLOW600 CBM meter database, proceed as follows:

- ► Use MEPAFLOW600 CBM to connect to the meter (→ pg. 125, 5.3).
- ► Choose "Meter / Meter Logbook" from the menu to open the Logbook page.
- ► In the dialog "Logbook selection", select the desired logbooks and click "OK".

The logbook entries are now downloaded to the MEPAFLOW600 CBM database. They can be viewed offline without connection to the meter or share them with others (export the device or the session).

6.4.1.2 Acknowledging logbook entries on the meter

To acknowledge logbook entries on the meter, proceed as follows:

- ► Download and save the logbook entries from the meter according to → 6.4.1.1.
- ► Select the logbook in which entries are to be acknowledged or select "All logbooks" to acknowledge entries in all logbooks at once.
- ► Mark the entries to be acknowledged.
- ► Click the "Acknowledge selection" button to acknowledge the selected entries only or click the "Acknowledge all" button in order to acknowledge all entries in the selected logbook(s).

6.4.1.3 Clearing logbooks on the meter

If the logbooks are configured with the storage behavior "rolling", it is not necessary to clear the logbooks on the meter. When the logbook is full, new entries will overwrite the oldest entries.

If a logbook is configured with the storage behavior "blocking" (e.g. with custody configuration), a full Custody logbook [1] will activate the meter status "Data invalid". In this case it is recommended to clear the logbooks.

NOTICE:

The following preconditions must be met to clear logbooks on the meter:

- The Parameter write lock must be in the "UNLOCKED" position (→ pg. 78, 3.3.5)
- The user must be in the User Access Level "Service" (password see Service Manual).
- The meter must be in Configuration Mode.

To clear the logbooks on the meter, proceed as follows:

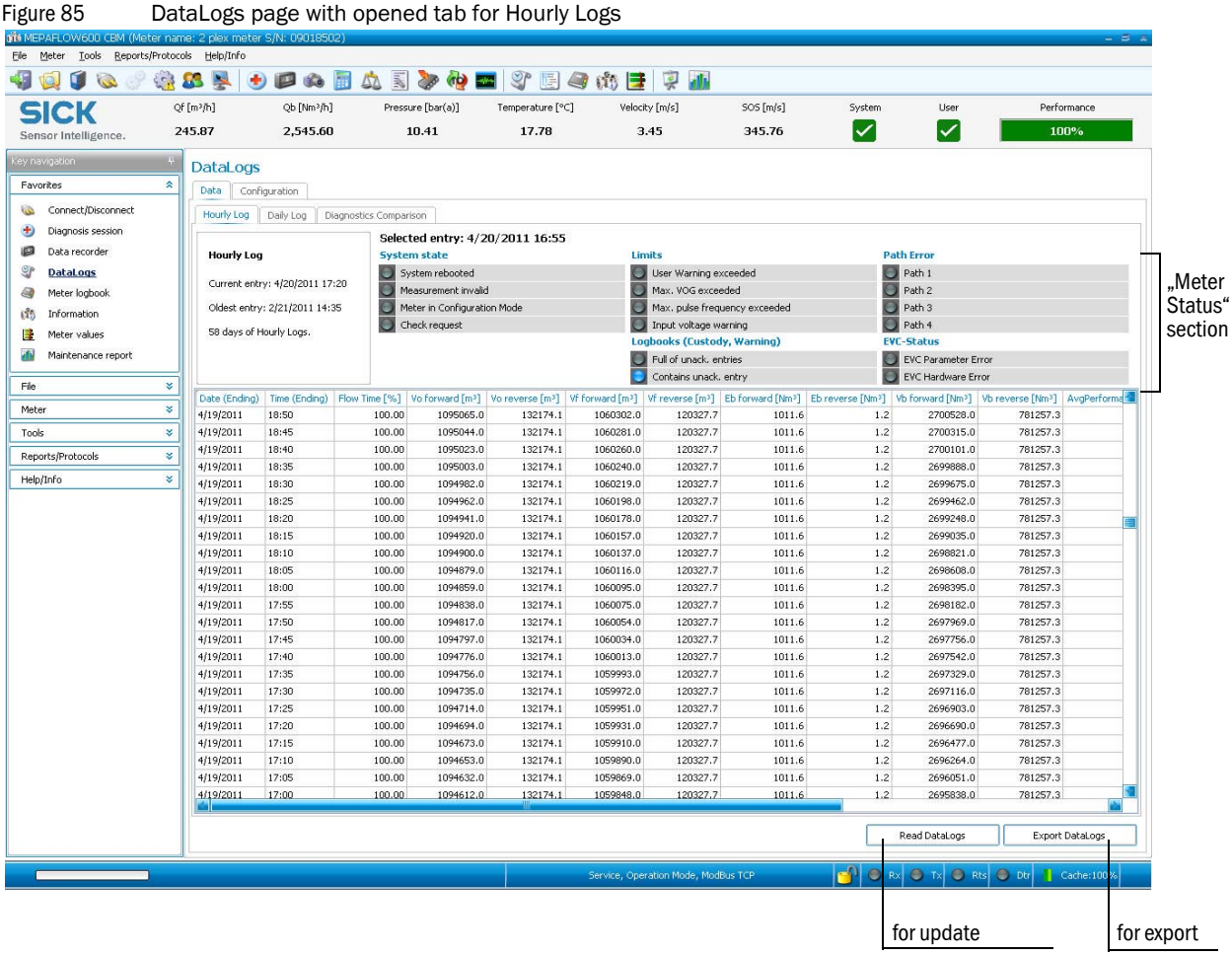
- ► Choose the User Access Level "Service" (→ pg. 125, 5.3.2).
- ► Download and save the logbook entries from the meter according to → 6.4.1.1.
- ► Select the logbook to be cleared or select "All logbooks" to clear all.
- ► Switch the meter to Configuration Mode (choose "File / Configuration Mode" from the menu).
- ► Click the "Clear meter logbook" button and confirm the warning with "OK".
- ► Switch the meter to Operation Mode.
- ► If the Parameter write lock was unlocked prior to clearing the meter logbook, follow all necessary procedures to bring the meter to back to its original state.

6.4.2 DataLogs check

Starting with firmware version 3.4.00, the FLOWSIC600 provides two DataLogs (Hourly Log and Daily Log). They save averaged measured values and are stored in the SPU's non-volatile memory (FRAM). All data can be downloaded and exported to Excel files with MEPAFLOW600 CBM (→ pg. 152, on configuring the DataLogs.).

Full support for the DataLogs is provided by MEPAFLOW600 CBM V1.1.00 or higher.

Figure 85 DataLogs page with opened tab for Hourly Logs



6.4.2.1 Downloading and exporting of DataLog data

To download and export the data from your FLOWSIC600, complete the following steps:

- ► Use MEPAFLOW600 CBM to connect to the meter (→ pg. 125, 5.3).
- ► Go to the DataLogs page (choose "Meter / DataLogs" from the menu).
- ► In the dialog "DataLog selection", select those DataLogs that you want to view and/or export and click "OK".
- ► Now the DataLogs page is displayed with the data from the meter (→ pg. 53, 2.8.4).
- ► If you select a DataLog entry, its time stamp and the meter status (see below) is shown in the middle section.
- ► To update the data from the meter, use the button "Read DataLogs".
- ► To export DataLog data to an Excel file (.xls), use the button "Export DataLogs".

For more options and configuration, → pg. 159, 5.7.3.

Meter status

In every DataLog entry, a condensed meter status information is saved. It shows all meter status information that became active during the storage cycle - even if it was for the shortest period of time.

If a meter status information bit is shown active in a DataLog entry, the logbooks will contain a corresponding entry with more information.

- ► Always check the logbooks, if you require more information about the meter status information in the DataLogs.

Flow weighted diagnostic information in DataLog data

The datasets (→ pg. 49, 2.8.3.8) do not contain any diagnostic information for gas velocities below the value for the parameter Vmin (Reg. #7036 "LowFlowCutOff"). The "Flow time" value shows, for what percentage of the duration of the storage cycle the flow was above Vmin and in the flow direction specified for the DataLog.

All diagnostic information is flow-weighted.

6.4.2.2 Clearing entries from DataLogs

If the DataLogs are configured with the storage behavior "rolling", it is not necessary to clear the entries from the DataLogs on the meter. When the DataLog is full, new entries will overwrite the oldest entries.

If a DataLog is configured with the storage behavior "blocking", the DataLog will stop saving new entries when it is full and a yellow light will indicate the full DataLog on the meter status table (→ pg. 189, 7.2.1). In this case it is recommended to clear the entries from the DataLogs.

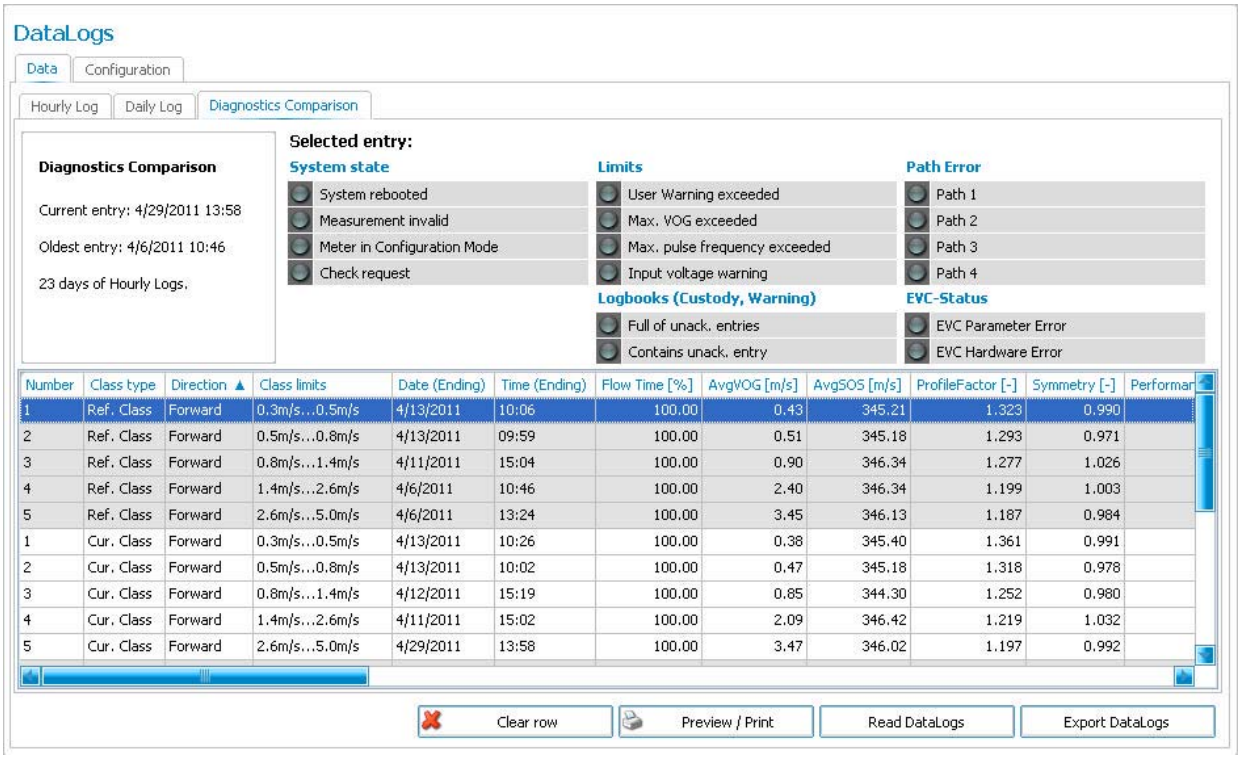
To clear all entries from a DataLog, complete the following steps:

- ► Go to the DataLogs page (select Meter / DataLogs from menu).
- ► Choose the Configuration tab (see → pg. 157, Figure 76).
- ► Switch the meter into Configuration Mode (choose "File / Configuration Mode" from the menu).
- ► Click the "Clear" button for the DataLogs from which you want to clear entries.
- ► Switch the meter into Operation Mode.

6.4.3 Diagnostics Comparison Report Check

To compare the current diagnostic values (current fingerprint) of the meter with the reference diagnostic values (reference fingerprint, e.g. stored at commissioning), the Diagnostics Comparison Report provides graphs and color coded information on diagnostics.

Figure 86 Diagnostics Comparison Log table



Number	Class type	Direction	Class limits	Date (Ending)	Time (Ending)	Flow Time [%]	AvgVOG [m/s]	AvgSOS [m/s]	ProfileFactor [-]	Symmetry [-]	Performar
1	Ref. Class	Forward	0.3m/s...0.5m/s	4/13/2011	10:06	100.00	0.43	345.21	1.323	0.990	
2	Ref. Class	Forward	0.5m/s...0.8m/s	4/13/2011	09:59	100.00	0.51	345.18	1.293	0.971	
3	Ref. Class	Forward	0.8m/s...1.4m/s	4/11/2011	15:04	100.00	0.90	346.34	1.277	1.026	
4	Ref. Class	Forward	1.4m/s...2.6m/s	4/6/2011	10:46	100.00	2.40	346.34	1.199	1.003	
5	Ref. Class	Forward	2.6m/s...5.0m/s	4/6/2011	13:24	100.00	3.45	346.13	1.187	0.984	
1	Cur. Class	Forward	0.3m/s...0.5m/s	4/13/2011	10:26	100.00	0.38	345.40	1.361	0.991	
2	Cur. Class	Forward	0.5m/s...0.8m/s	4/13/2011	10:02	100.00	0.47	345.18	1.318	0.978	
3	Cur. Class	Forward	0.8m/s...1.4m/s	4/12/2011	15:19	100.00	0.85	344.30	1.252	0.980	
4	Cur. Class	Forward	1.4m/s...2.6m/s	4/11/2011	15:02	100.00	2.09	346.42	1.219	1.032	
5	Cur. Class	Forward	2.6m/s...5.0m/s	4/29/2011	13:58	100.00	3.47	346.02	1.197	0.992	

To print a Diagnostics Comparison Report, complete the following steps:

- ► Download the Diagnostics Comparison Log from your FLOWSIC600 according to → 6.4.2.1.
- ► Go to the Diagnostics Comparison data tab (→ Figure 86).
- ► Click the button "Preview/Print".
- ► In the "Preview / Print options", enter your name and select the flow direction for which you want to view the report.
- ► Click "Preview / Print".
- ► In the print preview, either print the report or export it to a PDF file.

Figure 87 Diagnostics Comparison Report, no relevant changes between reference and current fingerprint

FLOWSIC600- Diagnostic Comparison Report

SICK Sensor Intelligence.

Meter name:	2plex main meter	Address:	Bergener Ring 27
Serial number:	09018502	City/State:	Ottendorf-Okrilla/Dresden
Station name:	Demozähler Showroom	Zip code:	01458
Technician:		Country:	Germany

Meter Operating Data

Internal meter ID:	0.14200 [m]	Firmware version:	3500	Report date (PC):	5/9/2011	(mm/dd/yyyy)
Internal pipe ID:	0.15870 [m]	Firmware CRC:	0xF2CC	Report time (PC):	01:10:27	(hh:mm:ss)
Path number:	4	Parameter CRC:	0x0569	Meter date	5/9/2011	(mm/dd/yyyy)
Meter factor:	10 [Impulse/m³]	Metrology CRC:	0x0FC8	Meter time	13:10:28	(hh:mm:ss)
Adjust method:	0-None	Adjust CRC	0x1FB0	Average time	1	min

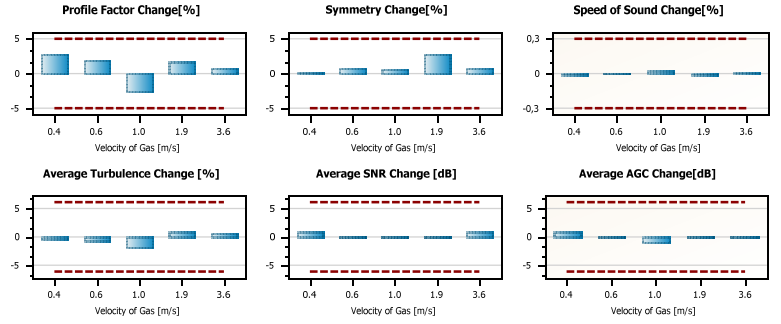
Diagnostic Data Base

		Reference			Current		
Class	Range	Avg VOG [m/s]	StdDev [m/s]	Date/Time	Avg VOG [m/s]	StdDev [m/s]	Date/Time
I	0.3m/s...0.5m/s	0.43	0.00000	4/13/2011 10:06:00	0.38	0.00000	4/13/2011 10:26:00
II	0.5m/s...0.8m/s	0.51	0.00000	4/13/2011 09:59:00	0.47	0.00000	4/13/2011 10:02:00
III	0.8m/s...1.4m/s	0.90	0.00000	4/11/2011 15:04:00	1.33	0.00000	5/4/2011 16:13:00
IV	1.4m/s...2.6m/s	2.40	0.00000	4/6/2011 10:46:00	2.09	0.00000	4/11/2011 15:02:00
V	2.6m/s...5.0m/s	3.45	0.00000	4/6/2011 13:24:00	3.47	0.00000	4/29/2011 13:58:00

Performance Change and Status (Forward)

			Performance				Status													
	Class	Date/Time (End)	Path 1 %	Path 2 %	Path 3 %	Path 4 %	warm boot	data invalid	configuration	check request	error path 1	error path 2	error path 3	error path 4	user warning	limit min. Vin	limit max. VOG	limit max. freq.	logbook full	logbook unack.	not used	not used
Reference	I	4/13/2011 10:06:00	100	100	100	100	0	0	0	0	0	0	0	0	1	0	0	0	0	1		
	II	4/13/2011 09:59:00	100	100	100	100	0	0	0	0	0	0	0	0	1	0	0	0	0	1		
	III	4/11/2011 15:04:00	100	100	100	100	0	0	0	0	0	0	0	0	1	0	0	0	0	1		
	IV	4/6/2011 10:46:00	100	100	100	100	0	0	0	0	0	0	0	0	0	0	0	0	0	1		
	V	4/6/2011 13:24:00	100	100	100	100	0	0	0	0	0	0	0	0	0	0	0	0	0	1		
Current	I	4/13/2011 10:26:00	100	100	100	100	0	0	0	0	0	0	0	0	1	0	0	0	0	1		
	II	4/13/2011 10:02:00	100	100	100	100	0	0	0	0	0	0	0	0	1	0	0	0	0	1		
	III	5/4/2011 16:13:00	100	100	100	100	0	0	0	0	0	0	0	0	0	0	0	0	0	1		
	IV	4/11/2011 15:02:00	100	100	100	100	0	0	0	0	0	0	0	0	1	0	0	0	0	1		
	V	4/29/2011 13:58:00	100	100	100	100	0	0	1	0	0	0	0	0	1	0	0	0	0	1		

Diagnostics



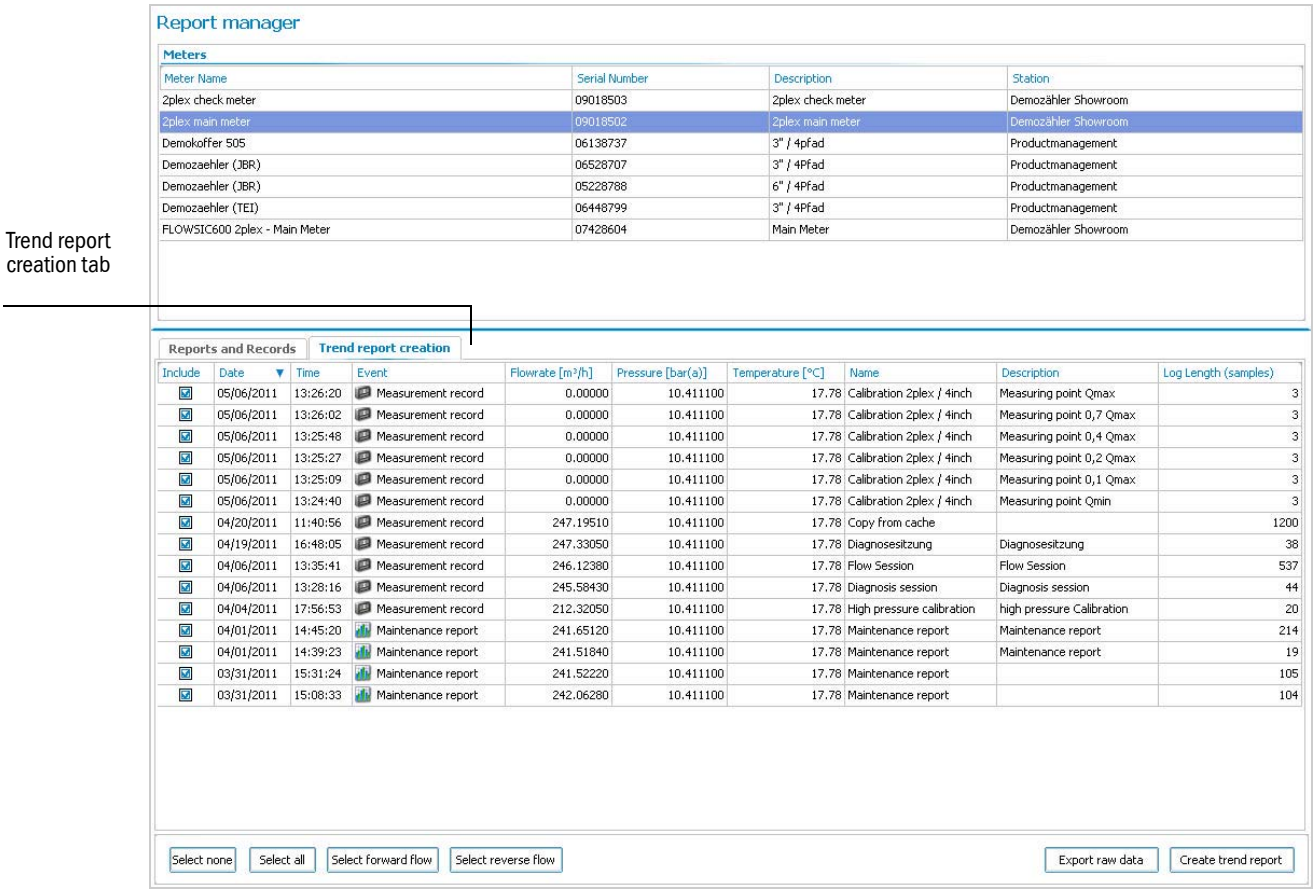
Diagnostics state of 5/9/2011 13:10:28 <online>
Printed on 5/9/2011 13:10:28

Page 1 of 1

6.4.4 Trend report

If Maintenance Reports have been created on a regular basis, a trend analysis of diagnostic indicators can help to find gradual changes in the state of the meter that occur over a long term period (→ Figure 89).

Figure 88 "Trend report creation" tab



To create a Trend Report, follow the described procedure:

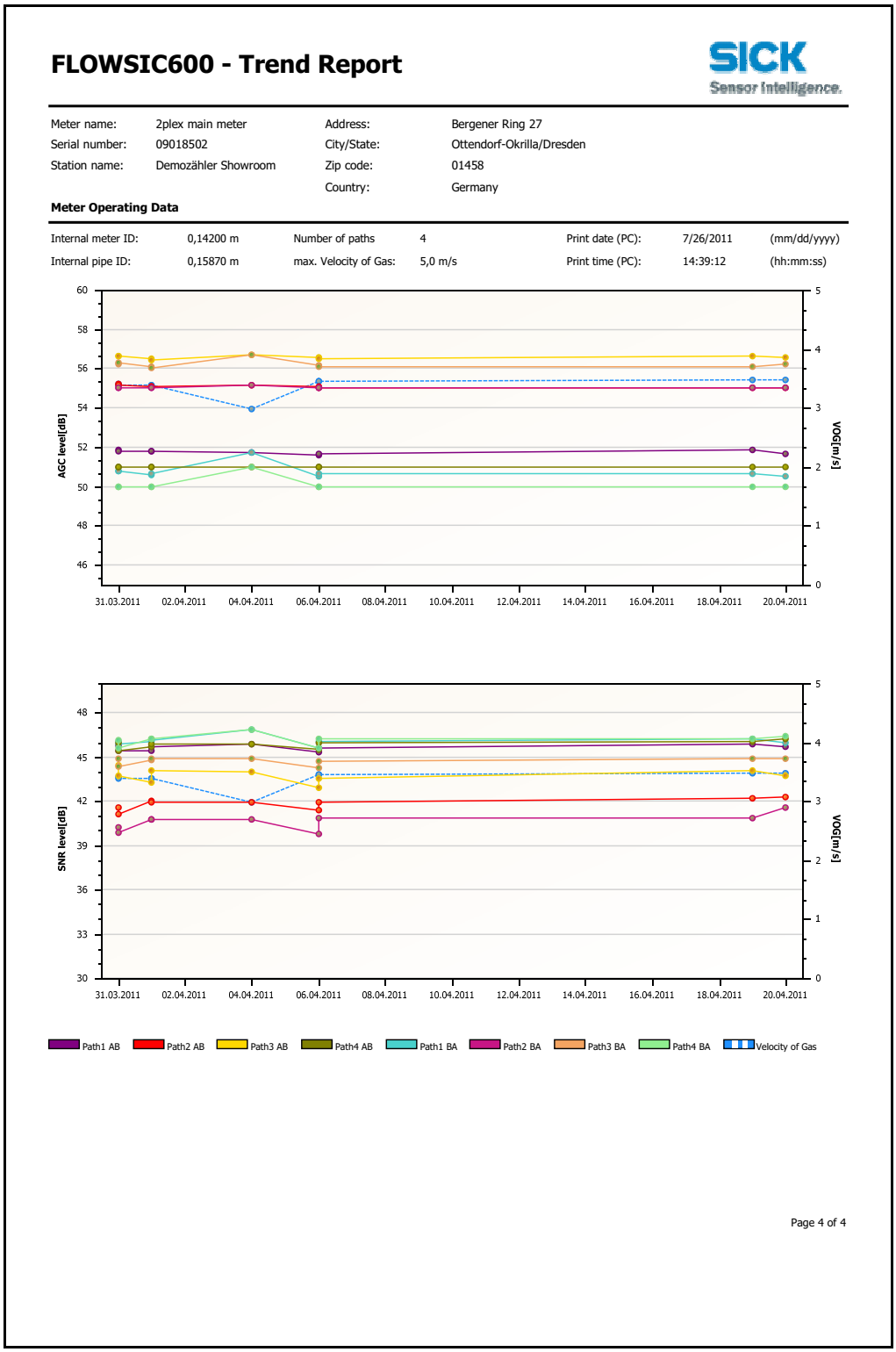
- ► Choose "Reports/Protocols / Report Manager" from the menu to open the Report Manager (Figure 88).
- ► Go to the "Trend report creation" tab.
- ► Select all reports and records that you want to include in the trend analysis.

> Select only reports and records that were created under comparable operating conditions concerning flow rate, pressure and temperature.

- ► Click "Create trend report" or "Export raw data".

> The "Export raw data" command exports the average values of each record to an Excel file.

Figure 89 Trend report, example page



FLOWSIC600 - Trend Report

SICK Sensor Intelligence.

Meter name:	2plex main meter	Address:	Bergener Ring 27
Serial number:	09018502	City/State:	Ottendorf-Okrilla/Dresden
Station name:	Demozähler Showroom	Zip code:	01458
		Country:	Germany

Meter Operating Data

Internal meter ID:	0,14200 m	Number of paths	4	Print date (PC):	7/26/2011 (mm/dd/yyyy)
Internal pipe ID:	0,15870 m	max. Velocity of Gas:	5,0 m/s	Print time (PC):	14:39:12 (hh:mm:ss)

Page 4 of 4

6.4.5 Backup of MEPAFLOW600 CBM meter database

To ensure that a computer problem will not result in data loss, a frequent backup of the MEPAFLOW600 CBM database file (→ pg. 58, 2.9.3) is highly recommended. This file includes the MEPAFLOW600 CBM meter database.

The database file "DATABASE.FDB" is created during the installation process and stored in the file path you specified for the software installation. Default storage path is: "C:\programs\SICK\MEPAFLOW600 CBM".

A copy of this file should be created on a regular basis and should be stored in a safe place (e.g. a CD-ROM).

To restore a backup after a system crash, repeat the installation routine and then overwrite the newly created "DATABASE.FDB" with the backup.

6.5 Optional adaptation of the User Warnings

When a history of diagnostic values has been established e.g. by the regular saving of Maintenance Reports, the User Warnings Limits (→ pg. 149, 5.7.1) and the Diagnostics Comparison Limits (→ pg. 159, 5.7.3) can be further optimized.

Please contact your local SICK representative if you need help with this.

FLOWSIC600

7 Troubleshooting

General troubleshooting
Indication of meter states, system alarms and warnings
Generation of diagnosis session
Meter connection troubleshooting

This chapter provides solutions for problems highlighted by routine tests during maintenance (→ pg. 169, 6.2) or the function tests after commissioning (→ pg. 146, 5.6).

If the cause of the problem cannot be localized, it is recommended to use the MEPAFLOW600 CBM software to record the current parameter set and diagnosis values in a diagnosis session file (→ pg. 198, 7.3) and send this to a local SICK representative.

7.1 General troubleshooting

Problem	Possible causes	Actions
● No display ● No pulse frequency ● No active status signal	Faulty power supply	► Check the input voltage at terminals 1 and 2. ► Check cables and terminal connections. **Caution** Take the relevant safety precautions!
	Defective device	► Create a diagnosis session according to → pg. 198, 7.3 and contact your local SICK representative.

7.2 Indication of meter states, system alarms and warnings

The FLOWSIC600 gives information about alarms and warnings in the following ways:

- The LCD display indicates active system alarms or warnings. If a current error or warning is active, the display will flash and a message will be displayed with a message number in the upper right corner (→ pg. 234, 9.4.1 for more details on LCD error messages).
- A status output can be configured to indicate if the meter status "Data invalid", the meter status "Check request" or the "Warning" status become active.
- The pulse output can be configured to indicate if the meter is in Configuration Mode or if the meter status "Data invalid" becomes active.
- The meter status registers can be read via MODBUS (see document "FLOWSIC600 Modbus Specification").
- The MEPAFLOW600 CBM software can be used to check the meter health. System alarms and User Warnings are indicated in the Main system bar.

It is recommended to use MEPAFLOW600 CBM to get further information on the meter‘s health:

► If the meter indicates "Data invalid" or "Check request" follow → pg. 189, 7.2.1.

► If the meter indicates "Warning", follow → pg. 191, 7.2.2.

► To do a more detailed check of the meter health (→ pg. 195, 7.2.3).

7.2.1 Checking the "Meter Status" window

The "Meter status" window in MEPAFLOW600 CBM displays an overview about the meter's status and operation.

- ► Use MEPAFLOW600 CBM to connect to the meter (→ pg. 125, 5.3).
- ► Click on the "System" button in the main system bar to open the "Meter status" window (→ Figure 90).
- ► Check the general "Meter Status" section (marked in Figure 90) for yellow or red lights.

Meter status light	Causes	Actions
Green light "Measurement valid"		Measurement is valid, meter is operating correctly.
Red light "Measurement valid"	Measurement is invalid and / or the meter is in Configuration Mode. The measured volume is counted in the error volume counter.[1]	► If the meter is in Configuration Mode, choose "File / Operation Mode" from the menu to switch it to Operation Mode. ► Otherwise proceed according to → pg. 198, 7.3.
Yellow light "Check request"	One or more paths have failed or another problem affects the measurement accuracy.[1]	► Proceed according to → pg. 198, 7.3.
Yellow light "User Warning Limit exceeded".	A User Warning Limit was exceeded.[2]	► Check the User Warnings according to → pg. 191, 7.2.2.
Red light "Path failure"	One or more paths have failed.	► Proceed according to → pg. 198, 7.3.

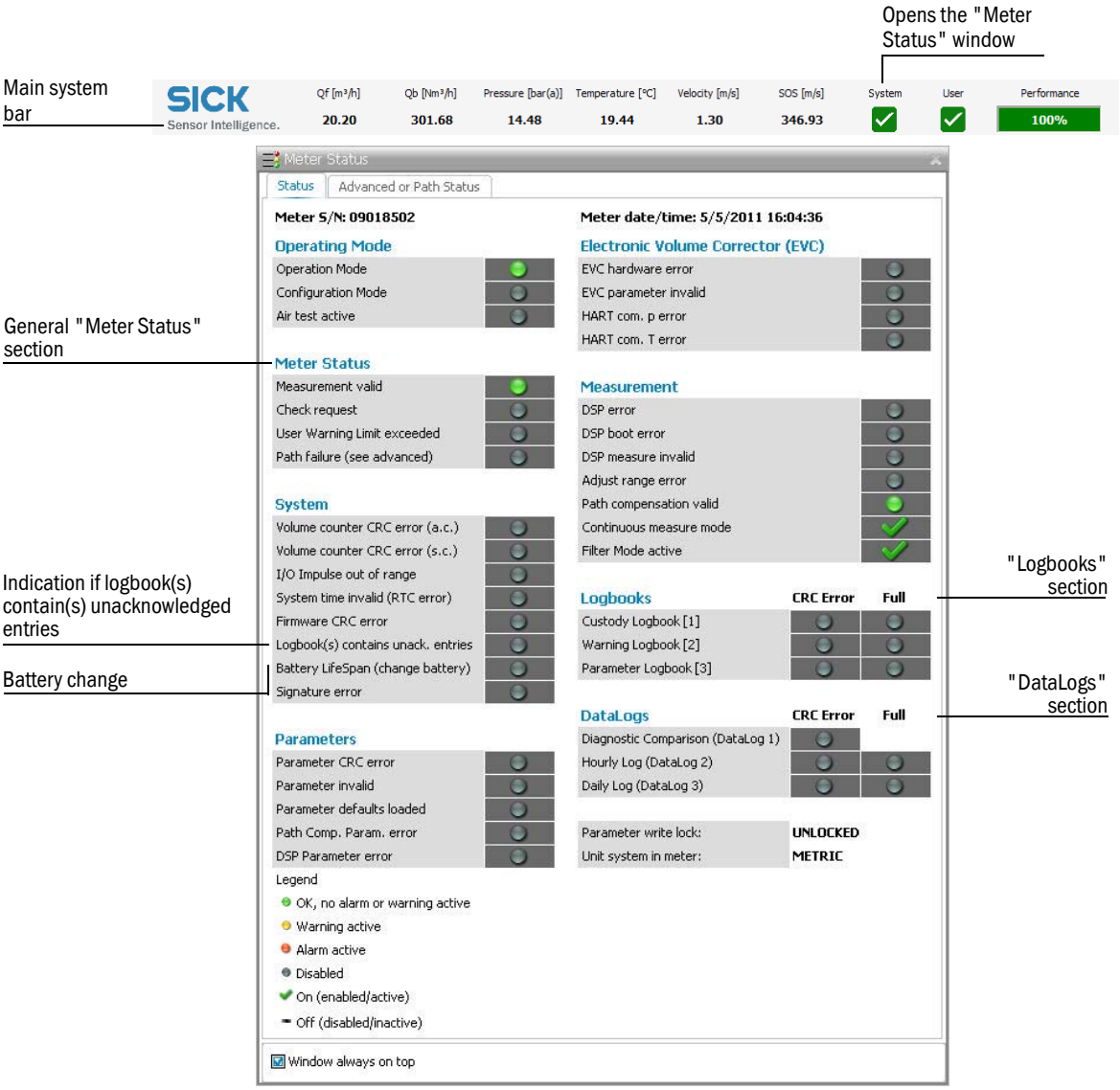
1 See → pg. 38, 2.6.2 for more details on meter states.

2 See → pg. 41, 2.7 "Technical Information" for more details on User Warnings.

- ► If there are no yellow or red lights in the general "Meter Status" section you can check the following other sections (also marked in Figure 90) for yellow or red lights.

Meter status light	Causes	Actions
Yellow light "Logbook contains unack. entries"	Logbook contains unacknowledged entries.	► Download and check all logbook entries according to → pg. 176, 6.4.1.1.
Red light for any Logbook "full"	The logbook in question is configured to "blocking" and is full of entries.	► Download and check all logbook entries according to → pg. 176, 6.4.1.1. ► Clear the meter logbook according to → pg. 177, 6.4.1.3. ► Consider reconfiguring the logbook to "rolling" (Parameter Page). If your meter is configured according to PTB requirements a full Custody Logbook [1] will activate the meter status "Data invalid". ► Download and check all logbook entries according to → pg. 176, 6.4.1.1. ► Clear the meter logbook according to → pg. 177, 6.4.1.3.
Yellow light for any DataLog "full"	The DataLog in question is configured to "blocking" and is full of entries.	► Check the DataLog according to → pg. 179, 6.4.2.2whether the DataLog is to be configured as "rolling" (→ pg. 156, 5.7.2.2).
Yellow light "Battery Lifespan (change battery)"	After 8.5 years this warning is activated to force the user to change the battery.	► See → pg. 197, 7.2.4 for more details. ► Contact trained staff or your SICK representative. ► Trained staff: Change the battery according to the procedure described in the Service Manual

Figure 90 Main system bar with "System" button and opened "Meter Status" window



7.2.2 Checking the "User Warnings" window

The "User Warnings" window displays an overview about the User Warning status.

- ► Use MEPAFLOW600 CBM to connect to the meter (→ pg. 125, 5.3).
- ► Click on the "User" button in the main system bar of the MEPAFLOW600 CBM screen to open the "User Warnings" window (→ Figure 91).
- ► Check the window for yellow lights and proceed according to → pg. 192, Table 25 .

Figure 91 Main system bar with button "User" and opened "User Warnings" window

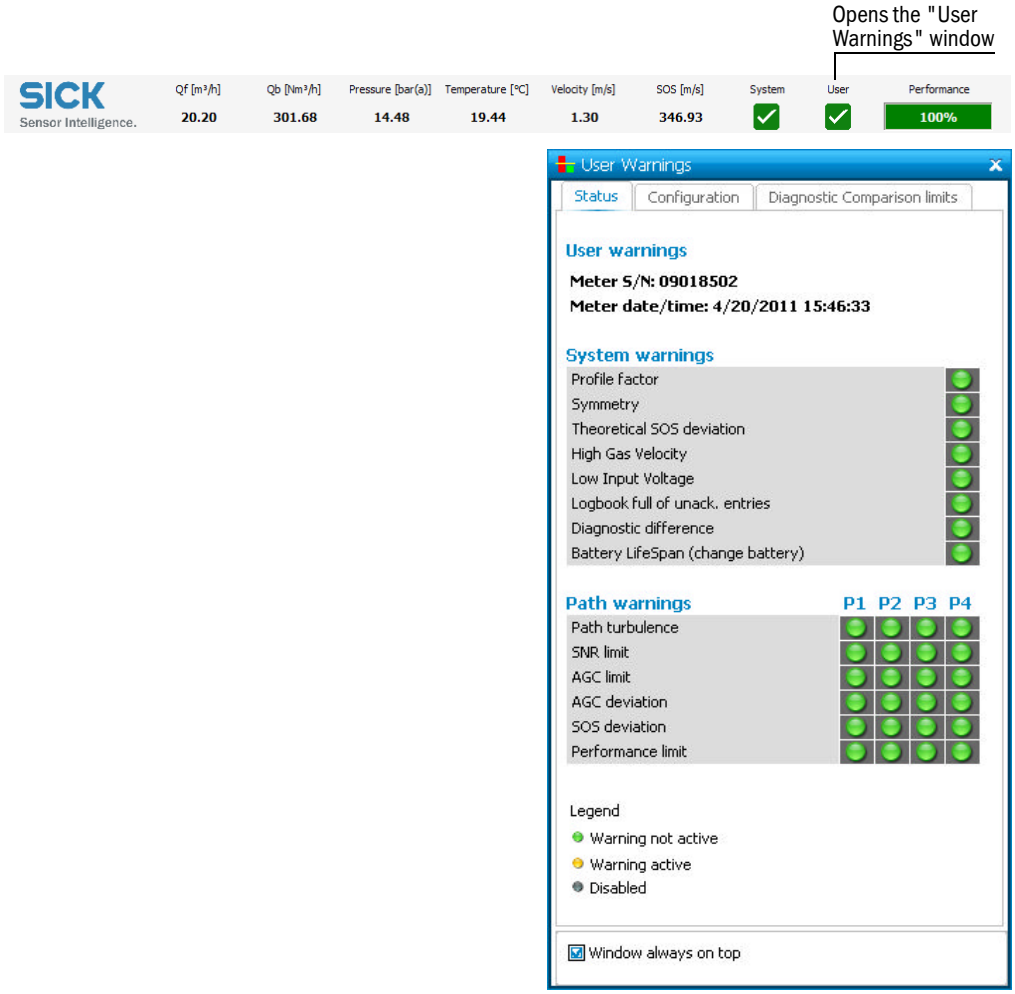


Table 25 Interpretation of active User Warning status

Yellow light for...	Possible causes	Actions
Profile factor[1]	A change of the symmetry value may be caused by contamination, blockage or deposits in the line that change the symmetry of the flow profile.	► Compare the current value with previous measurements (e.g. Maintenance Report from commissioning) and check whether the User Warning limit is configured correctly (→ pg. 149, 5.7.1). ► Create a Diagnosis Session according to → pg. 198, 7.3 and contact your trained staff.
Symmetry[1]	A change of the symmetry value may be caused by contamination, blockage or deposits in the line that change the symmetry of the flow profile.	► Compare the current value with previous measurements (e.g. Maintenance Report from commissioning) and check whether the User Warning limit is configured correctly (→ pg. 149, 5.7.1). ► Create a Diagnosis Session according to → pg. 198, 7.3 and contact your trained staff.
Theoretical (SOS) deviation	A deviation of the measured Speed of Sound (SOS) from the theoretical SOS may be caused by: – asynchronous determination of the measured and the theoretical SOS due to fluctuations in gas composition and analysis time lag, – malfunction of the pressure measurement, – malfunction of the temperature measurement, – malfunction of the gas composition measurement, – malfunction of the meter, – or deposits on the transducer(s) or meter body which change the path length.	► Check the theoretical SOS for plausibility using the SOS calculator -> see Maintenance/ Routine Checks / Comparing theoretical and measured Speed of Sound (SOS) ► Check the updating cycle between meter and the device transmitting the theoretical SOS ► Check the pressure and the temperature measurement for plausibility or errors ► Create a Diagnosis Session according to → pg. 198, 7.3 and contact your trained staff.
High gas velocity	The current average Velocity of Gas exceeds the value "VOG limit".	► The VOG limit should be configured to suit your application.
Low input voltage (power supply)	The power supply voltage is below the value "Input voltage warning" and may indicate a potential problem of the power supply (e.g. low battery status of solar powered system).	► Check the power system

[1] These User Warning limits are only monitored, as long as certain preconditions are met (→ pg. 154, Table 22).

Interpretation of active User Warning status (continued)

Yellow light for...	Possible causes	Actions
Battery lifespan (change battery)	The remaining battery lifespan is less than 15%	► Check when the battery was last replaced. Replace battery within one year (battery age is 8.5 years)
Path turbulence[1]	A change in the path turbulence indicates changed flow conditions (e.g. a blocked flow conditioner).	► Compare the current value with previous measurements (e.g. Maintenance Report from commissioning) and compare the conditions. ► Check whether the User Warning limit is configured correctly (→ pg. 149, 5.7.1). ► Create a Diagnosis Session according to → pg. 198, 7.3 and contact your trained staff.
SNR limit (Signal-to-noise ratio)	Interfering noise caused by fittings in the pipeline, valves that are not fully open, sources of noise near the measuring location, or defective ultrasonic transducers may affect the signal-to-noise-ratio. Other possible sources of interference include electrical noise caused by bad contact of the connectors or sources of acoustic interference, such as control valves or very high flow velocities. These values are generally site-specific and do not change as long as the conditions remain the same. A reduction in the signal-to-noise ratio while the AGC level stays unchanged, hints at sources of acoustic interference (e.g. pressure regulator) near the point of measurement.	► Compare the current value with previous measurements (e.g. Maintenance Report from commissioning) and check whether the User Warning limit is configured correctly (→ pg. 149, 5.7.1). ► Check the AGC level. ► Create a Diagnosis Session according to → pg. 198, 7.3 and contact your trained staff.
AGC limit (signal amplification)	The signal amplification (AGC level) set by the meter largely depends on the current process pressure. The reception sensitivity is inversely proportional to the process pressure: if the pressure doubles, the sensitivity will be 6dB smaller. Under normal conditions, this value is very stable over time. Significant fluctuations in the AGC level indicate a low-quality received signal. A significant increase under comparable process conditions is usually caused by dirt on the ultrasonic transducers.	► Compare the current value with previous measurements (e.g. Maintenance Report from commissioning) and check whether the User Warning limit is configured correctly (→ pg. 149, 5.7.1). ► Create a Diagnosis Session according to → pg. 198, 7.3 and contact your trained staff.

[1] These User Warning limits are only monitored, as long as certain preconditions are met (→ pg. 154, Table 22).

Interpretation of active User Warning status (continued)

Yellow light for...	Possible causes	Actions
AGC deviation (signal amplification)	The difference between the two ultrasonic transducers on each of the measuring paths is small, although it can increase at higher velocities. If the AGCs of a path deviate more than allowed, this can indicate a malfunction in the ultrasonic transducers, electronic modules, transducer cables or parameter settings (signal models, control limits).	► Check, whether the difference in gain is increased by a high flow velocity. ► Compare the current value with previous measurements (e.g. Maintenance Report from commissioning) and check whether the User Warning limit is configured correctly (→ pg. 149, 5.7.1). ► Create a Diagnosis Session according to → pg. 198, 7.3 and contact your trained staff.
SOS deviation[1]	The SOS deviation indicates whether or not a path is measuring the correct transit time. The measured speed of sound should be stable. Sudden changes in the measured value may be indicative of signal detection problems (which can affect transit time measurements) or changes in the gas composition. The speed of sound in the individual paths should also be approximately identical (see graph on→ pg. 171, Figure 80).	► Check, whether a low flow rate may be causing temperature stratification. ► Use the SOS Calculator, to calculate the theoretical SOS (→ pg. 169, 6.2.1). ► Compare the current value with previous measurements (e.g. Maintenance Report from commissioning) and check whether the User Warning limit is configured correctly (→ pg. 149, 5.7.1). ► Create a Diagnosis Session according to → pg. 198, 7.3 and contact your trained staff.
Performance limit	The performance is the percentage of valid received ultrasonic signals for each path. That means, if 5 of 100 transmitted signals do not meet the acceptance criteria for a signal analysis, then the performance of this path is only 95%. The performance of each path should be very close to 100% (check on the "Meter Values" page → pg. 171, Figure 80). Due to signal attenuation on the way from the transmitting to the receiving sensor or due to acoustic noise, also caused by very high gas velocity, the performance can be significantly lower. The minimum performance at which reliable gas velocity values are supplied is 5%. When the performance falls below 5%, the path fails and will be substituted by a replacement value (more details → pg. 28, 2.4). Significant discrepancies in the values under comparable conditions (pressure, temperature, flow velocity, gas composition) indicate that changes have occurred in the device or piping (e.g. disturbance caused by a valve that is not fully open).	► A change in performance at comparable process conditions can indicate a potential transducer problem (e.g. contamination). A visual inspection of the ultrasonic signals and the transducer itself is required. ► Create a Diagnosis Session according to → pg. 198, 7.3 and contact your trained staff.

[1] These User Warning limits are only monitored, as long as certain preconditions are met (→ pg. 154, Table 22).

7.2.3 Checking the diagnostic meter values

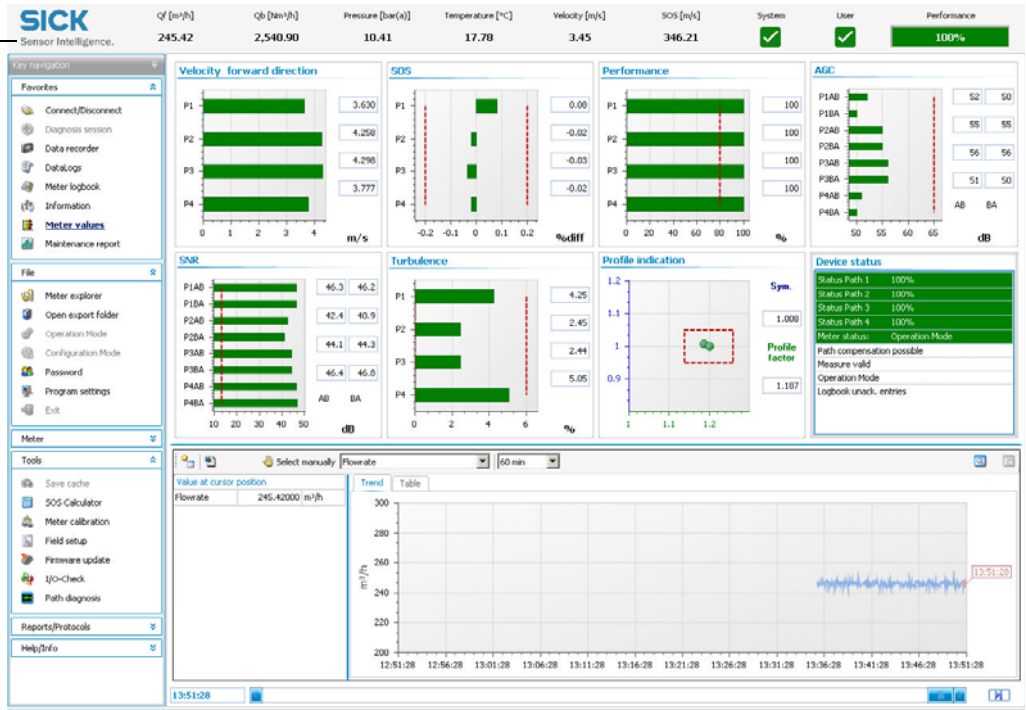
The "Meter values" page displays detailed diagnostic information:

- ► Use MEPAFLOW600 CBM to connect to the meter (→ pg. 125, 5.3).
- ► Choose "Meter / Meter values" from the menu to call up the "Meter values" page (→ Figure 92).
- ► Check the "Meter values" page for any yellow or red graphs or yellow or red indicators in the Main system bar. Yellow or red indicates a potential problem.

If any of the graphs or any of the icons in the main system bar are yellow or red, proceed with checking the "Meter Status" (→ pg. 189, 7.2.1) and the "User Warnings" (→ pg. 191, 7.2.2).

Figure 92 "Meter values" page

Main system bar



Problem	Possible causes	Actions
Implausible sepeed of sound	Gas composition, pressure or temperature measurement is incorrect	Check gas composition, pressure and temperature. Create a Diagnosis Session according to → pg. 198, 7.3 and contact your trained staff or your local SICK representative.
Different speed of sound in the individual paths	Faulty transducer or electronic module	Create a Diagnosis Session according to → pg. 198, 7.3 and contact your trained staff or your local SICK representative. Trained staff: Replace the transducer(s) (see Service Manual, Chapter 7). Note: Temperature-induced stratification can result in differences between the individual paths, especially with very low flow (higher temperatures generate higher speeds of sound). Even if the plant is being filled or if it is shut down, different speeds of sound may occur in the individual paths as a result of stratification.
Lower signal-to-noise ratio and reception sensitivity Increased number of rejected measurements in individual paths	Damaged transducer	Create a Diagnosis Session according to → pg. 198, 7.3 and contact your trained staff or your local SICK representative. Trained staff: Replace the transducer(s) (see Service Manual, Chapter 7).
	Additional sources of noise due to a valve that is not fully open, fittings, noise sources near the device	Check the measurement plausibility and number of rejected measurements and, if necessary, eliminate noise sources. Create a Diagnosis Session according to → pg. 198, 7.3 and contact your trained staff or your local SICK representative.
Increased receiver sensitivity (AGC)	Different gas composition or process pressure	No action required on the device
	Transducer(s) are dirty	Create a Diagnosis Session according to → pg. 198, 7.3 and contact your trained staff or your local SICK representative. Trained staff: Clean the transducer(s) (see Service Manual, Chapter 7)
Increased number of rejected measurements in all paths	Additional noise sources	Eliminate noise sources
	Gas velocity outside the measuring range	

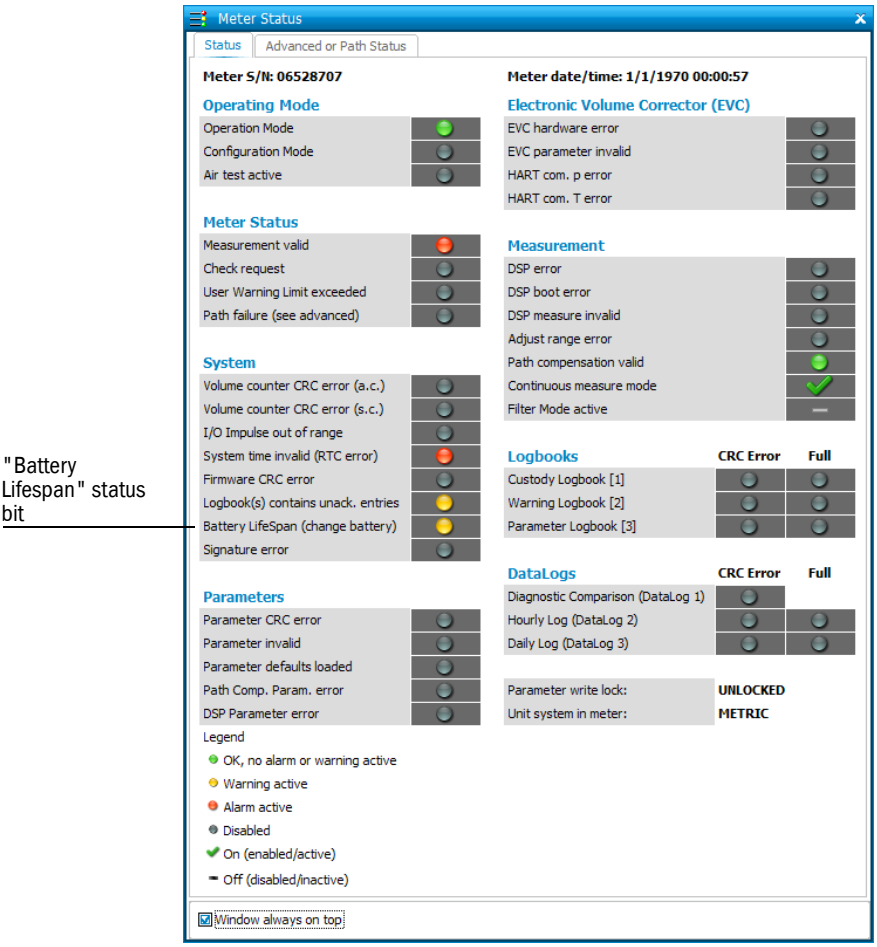
7.2.4 Battery lifespan / capacity

Because the FLOWSIC600 has no regular maintenance cycle, a user warning will be automatically generated if the remaining battery life is less than 15%. After 8.5 years, a warning is generated which forces the operator to change the battery. The battery may only be changed by trained staff. The procedure for changing the battery is described in the Service Manual. For further information on warning settings → pg. 149, 5.7.

Figure 93 Flashing message on the LCD display, prompts to change the battery

```
INFORMATION 1030
LifeSpan Battery
```

Figure 94 "Battery Lifespan" status bit in "Meter Status" window

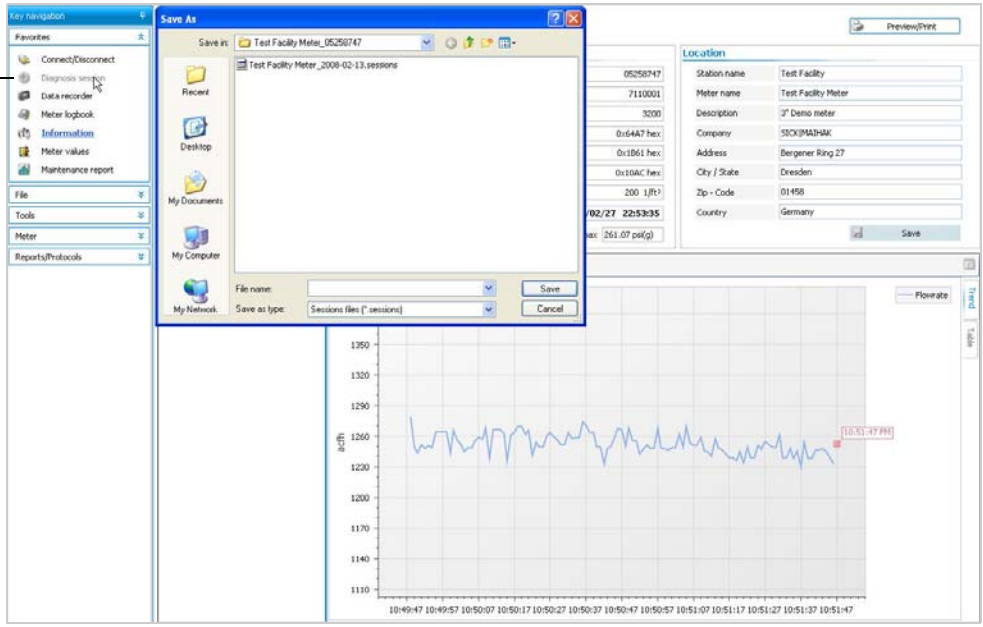


7.3 Generation of a Diagnosis session

If it becomes necessary to generate a Diagnosis session for remote support, follow the procedure described below:

- ► Start the MEPAFLOW600 CBM software and establish an online connection to the meter (see → pg. 125, 5.3 for all necessary preparations).
- ► Choose "Tools / Diagnosis session" from the menu or click the "Diagnosis session" item in the Key navigation (→ Figure 95)

Figure 95 "Diagnosis session" generation



- ► Specify a file name. (The file path is set according to the program settings. If necessary, specify a different path.)
- ► Click the "Save" button.
- ► MEPAFLOW600 CBM will now download the logbooks from the meter and generate a Diagnosis session with all relevant data. The entire process usually takes about three minutes. If the logbooks contain a lot of entries, the process may take longer.
- ► Email the Diagnosis session file to your SICK representative for support.

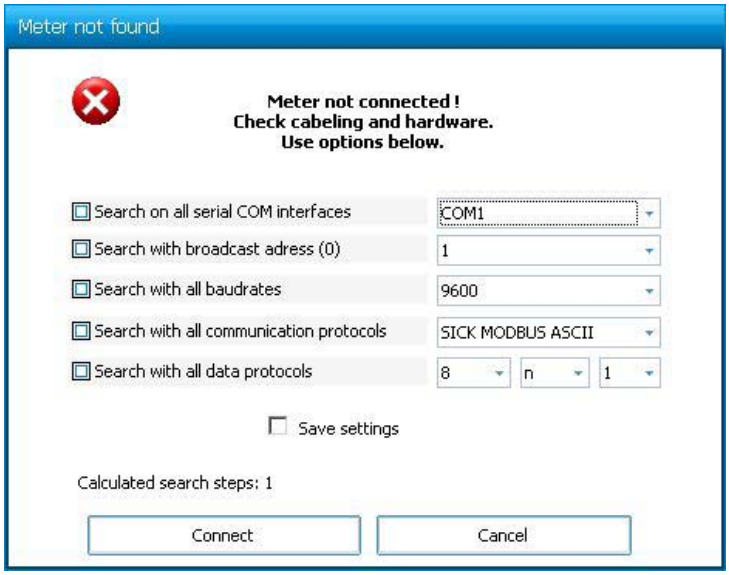
7.4 Meter connection troubleshooting

Meter not found at initial connection/connection lost during session

- ► Check all cables and the hardware. Check also the correct installation of the adapters (see → pg. 123, 5.2.1 and → pg. 124, 5.2.2).
- ► Attempt to re-establish connection via "Connect to Meter" window.
- ► Use the options in the window displayed to make MEPAFLOW600 CBM search with wider options (→ Figure 96), especially if parameters (e.g. the baud rate) may have been changed.

If necessary, the RS485 ports can be assigned to a specific bus address (Reg. #5020 "DeviceBusaddress"). The service port always has the bus address "1".

Figure 96 "Meter not found" dialog for the specification of wider search options.



FLOWSIC600

8 List of Parts

Tools and accessories
Spare parts

8.1 Tools and accessories

Designation	Part number
Transducer extraction tool	7041772
Special key for extractable ultrasonic transducers up to 16"	7041872
Special key for extractable ultrasonic transducers from 18"	4047937
Coax connection tool NL200	4047938
LCD control set (magnetic pen, adhesive straps)	2032787
MEPA interface set RS485 / RS232 (Adam, power supply, cable)	7041773
MEPA interface set RS485 / RS232, intrinsically safe for DIN mounting rail (Type: STAHL 9185)	2033410
MEPA interface set RS485 / USB Nientech (converter, cable, plug, software)	6030669
MODBUS TCP to MODBUS ASCII/RTU Converter	6044004

8.2 Spare parts

SPU housing and electronic module

Designation	Part number
Power supply terminal box cover	7041671
Set of clips (for SPU housing rear cover and front panel)	2031000
SICK LCD front panel	7041660
SICK LED front panel	7041659
Connection block for hardware variant 1, 2, 4, 5, 7, 8, 9, A (ATEX/CSA)	2040275
Connection block for hardware variant 1,2,4,5,7,8,9,A (IECEx)	2062870
Connection block for hardware variant 6, B (ATEX/CSA/IECEx)	2056878
Fuse board with parts needed for assembly	2041502
Electronic block IIA/D 135 kHz (power, SPU, I/O, analog)	2040382
Electronic block IIC/BCD 135 kHz (analog board and shunt board)	2040383
Electronic block IIA/D H 135 kHz (analogue board and shunt board)	2040384
Electronic block IIC/BCD H 135 kHz (analogue board and shunt board)	2040385
Electronic block IIA/D A 135 kHz (analog board and shunt board)	2046414
Electronic block IIC/BCD A 135 kHz (analog board and shunt board)	2046413
Electronic block IIA/D H 200 kHz (analog board and shunt board)	2040386
Electronic block IIC/BCD 200 kHz (analogue board and shunt board)	2040387
Electronic block IIA/D H 200 kHz (analog board and shunt board)	2040388
Electronic block IIC/BCD H 200 kHz (analogue board and shunt board)	2040389
Electronic block IIA/D A 200 kHz (analog board and shunt board)	2046354
Electronic block IIC/BCD A 200 kHz (analog board and shunt board)	2046353
Buffer battery	7048533

Ultrasonic transducers and gaskets

Designation	Part number
Transducer pair, type S1 (200 kHz, 100 bar, 85 °C, titanium, P18)	7042400
Transducer pair, type S2 (200 kHz, 100 bar, 120 °C, titanium, P18)	7041787
Transducer pair, type 22 (200 kHz, 250 bar, 120 °C, titanium, P18)	2039997
Transducer pair, type S6 (200 kHz, 100 bar, 120 °C, titanium, P10)	7042607
Transducer pair, type 26 (200 kHz, 250 bar, 120 °C, titanium, P10)	2039441
Transducer pair, type S7 (135 kHz, 16 bar, 180 °C, titanium, P18)	2040392
Transducer pair, type S8 (135 kHz, 100 bar, 180 °C, titanium, P18)	2034125
Transducer pair, type 28 (135 kHz, 250 bar, 180 °C, titanium, P18)	2032538
Transducer pair, type M6 (200 kHz, 10 bar, 120 °C, titanium/+layer, P10)	2032592
Transducer pair, type L8 (135 kHz, 250 bar, 180 °C, titanium, P18)	2040394
Transducer pair, type 46 (200 kHz, 450 bar, 150 °C, titanium, P14)	2040391
Transducer pair, type K4 (135 kHz, 63 bar, -196°C, stainless steel, P14)	2062720
Transducer pair, type N8 (135 kHz, 63 bar, 180°C, stainless steel, P18)	2048186
O ring 15 * 2.0 (Viton, natural gas resistant, -25 ... +200 °C)	7045173
O ring 15 * 2.0 (Viton, LT170-TT, natural gas resistant, -40 ... +200 °C)	5314393
O ring 15 * 2.0 (Celrez, FFKM-900, -10 ...+260 °C)	5315517
O ring 11.5 * 1.5 (Viton, natural gas resistant, -25 ... +200 °C)	5313739
O ring 11.5 * 1.5 (Viton, V747-75, -25 ... +200 °C)	5314241
O ring 11.5 * 1.5 (Celrez, FFKM-900, -10 ...+260 °C)	5314490
O ring 7.5 * 1.5 (Viton, natural gas resistant, -25 ... +200 °C)	7044129
O ring 7 * 2.0 (Viton, LT170-TT, natural gas resistant, -40 ... 200 °C)	5315493

Other

Designation	Part number
Sealing plug 1/4" NPT, stainless steel, for pressure connection	7045206
Sealing plug 1/8" NPT, stainless steel, for pressure connection	2039447
Retaining bolt M16*1.5 ID 10mm	4039880
Retaining bolt M22*1.5 ID 14mm	4040076
Retaining bolt M27*2 ID 18mm	7041294
Tooth washer I8.2 (for transducer P10)	5321752
Tooth washer I10.5 (for transducer P14)	7045916
Spring washer B12 (for transducer P18)	7045991
Serrated lock washer I 8.2	5313705
Sealing cord for cap, 2.0-EPDM (yard ware)	5308767

FLOWSIC600

9 Appendix

Conformities and technical data
Characteristic properties and dimensions of the meter body
Operation and menu structure of the SPU with LCD display
Logbooks
SPU terminal assignment
Connection diagrams for operating the FLOWSIC600 in hazardous areas in accordance with North American Guidelines (NEC, CEC)
Wiring examples
Reports created with MEPAFLOW600 CBM
Sealing plan
Outline drawings

9.1 Conformities and technical data

9.1.1 CE certificate

The FLOWSIC600 has been developed, manufactured and tested in accordance with the following EC directives:

- Pressure Equipment Directive 97/23/EC
- Directive 94/9/EC (ATEX)
- EMC Directive 2004/108/EC
- MID Directive 2004/22/EC

Conformity with above directives has been verified and the device has been marked with the CE label. The specific designation of the pressure equipment demanded according to the Pressure Equipment Directive 97/23/EC under part 3.3 and 3.4 can be found in the MDR of the FLOWSIC600.

9.1.2 Standard compatibility and type approval

The FLOWSIC600 conforms to the following norms, standards or recommendations:

- EN 60079-0, EN 60079-1, EN 60079-7, EN 60079-11, EN 60079-26
- OIML R 137-1, 2006, "Gas meters, Part 1: Requirements"
- OIML D 11, 2004, "General requirements for electronic measuring instruments"
- A.G.A Report No. 9, 2007, "Measurement of Gas by Multipath Ultrasonic Meters"
- API 21.1 "Flow Measurement Using Electronic Metering Systems"
- ISO 17089-1, 2010, "Measurement of fluid flow in closed conduits - ultrasonic meters for gas - Part 1: Meters for custody transfer and allocation measurement."
- BS 7965, 2009, "Guide to the selection, installation, operation and calibration of diagonal path transit time ultrasonic flow meters for industrial gas applications.

2“ Type approval for commercial or custody transfer has been granted by the relevant authorities, e.g.:

- Germany: PTB (Physikalisch-Technische Bundesanstalt), code number 7.421 / 03.05
- Netherlands: NMI (Netherlands Meetinstituut), code number B35
- Canada: Measurement Canada, Approval No. AG-0521
- Switzerland: Metrologie und Akkreditierung Switzerland, Appr. No. CH-G4-04404-00
- Europe: MID Approval, DE-08-MI002-PTB005
- GOST

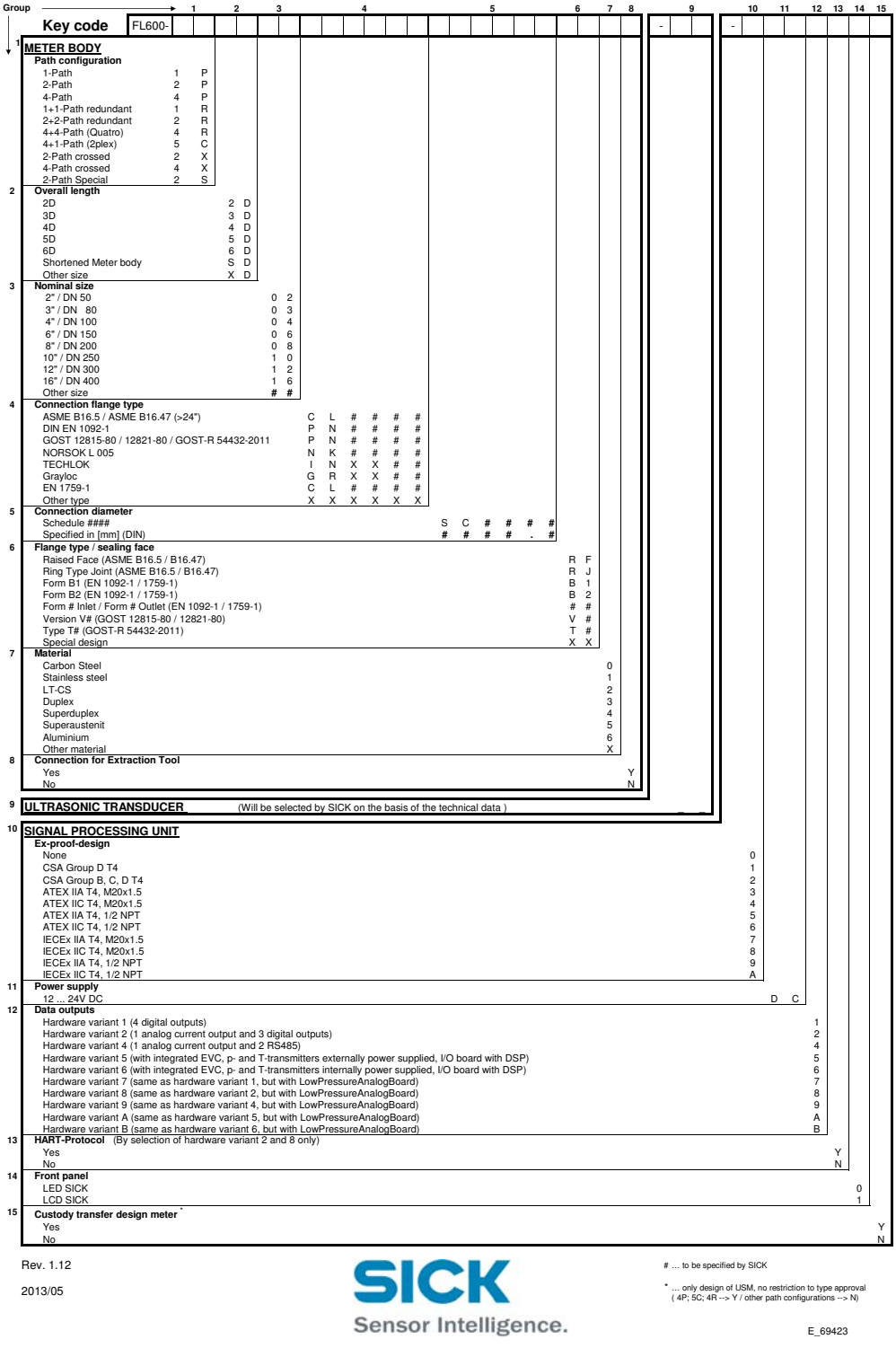
9.1.3 WELMEC compliance

The interfaces and the software of the FLOWSIC600 have been designed non-reactive in terms of the Eichordnung, Anlage 7 "Messgeräte für Gas" (calibration regulations, Annex 7 "Gas Meters") and the requirements of the WELMEC regulation 7.2, and documented completely in document "Interface description".

The test results were archived in a traceable manner and can be provided on request.

Figure 97 Common key code (for short description of meter design, indicated on Type Plate* and Instrument Data Sheet**)

Type Code FLOWSIC600



* See → pg. 256, Figure 121

** The Instrument Data Sheet is included in the Manufacturer Data Report (MDR).

9.1.4 Technical data

Type approval
The information in this section may differ from the type approval which is valid for the FLOWSIC600 in your country.
Please use your national type approval for the FLOWSIC600.

Table 26 Common meter sizes and flow rates

TYPE APPROVAL

Nominal Size		Actual flow rate [m³/h]			Actual flow rate [ft³/h]		Max. Velocity*	
		Q_{min}	Q_t	Q_{max}[1]	Q_{min}	Q_{max} [1]	[m/sec]	[ft/sec]
DN 50	(NPS 2)	4	13	400	140	14,000	65	213
DN 80	(NPS 3)	8	32	1000	280	35,000	65	213
DN 100	(NPS 4)	13	50	1,600	460	56,000	60	197
DN 150	(NPS 6)	20	80	3000	710	106,000	50	164
DN 200	(NPS 8)	32	130	4500	1,130	159,000	45	148
DN 250	(NPS 10)	50	240	7000	1,770	247,000	40	131
DN 300	(NPS 12)	65	375	8000	2,300	282,000	33	108
DN 350	(NPS 14)	80	375	10000	2,830	353,000	33	108
DN 400	(NPS 16)	120	600	14000	4,240	494,000	33	108
DN 450	(NPS 18)	130	650	17000	4,600	600,000	33	108
DN 500	(NPS 20)	200	975	20000	7,070	707,000	33	108
DN 600	(NPS 24)	320	1500	32000	11,300	1,131,000	33	108
DN 700	(NPS 28)	400	2000	40000	14,100	1,414,000	30	98
DN 750	(NPS 30)	400	2000	45000	14,100	1,590,000	30	98
DN 800	(NPS 32)	400	2400	50000	14,100	1,767,000	30	98
DN 900	(NPS 36)	650	3750	66000	23,000	2,333,000	30	98
DN 1000	(NPS 40)	650	5000	80000	23,000	2,828,000	30	98
DN 1050	(NPS 42)	1300	6000	85,000	46,000	3,004,000	30	98
DN 1100	(NPS 44)	1400	6500	90000	49,500	3,181,000	28	92
DN 1200	(NPS 48)	1600	7000	100000	56,600	3,535,000	27	89

1 Q_{max} can be limited by the working pressure and attenuation of the gas medium

*When a configuration with flow conditioner is used, the velocity of gas must not exceed 40 m/s (131 ft/s) in the pipe.

Table 27 Technical data

Meter characteristics and measuring parameters		
Measured variables	Flow rate, volume at flowing and base conditions, gas velocity, speed of sound	
Number of measuring paths	2, 4, 4+1, 4+4	
Measuring Principle	Ultrasonic transit time difference measurement	
Measured medium	Natural gas, N_2, O_2, air, C_2H_4, vapor, process gases	
Measuring ranges	Actual flow rate.	4 ... 400 m³/h / 1,600 ... 100,000 m³/h
	Measuring ranges depending on nominal pipe size	
Repeatability	< 0.1 % of reading	
Accuracy		Error limits
	2-path version [1]	≤ ± 1 %
	4-path version [2]	≤ ± 0.5% Dry calibrated
	4-path version [2]	≤ ± 0.2% After flow calibration and adjustment with constant factor
	4-path version [2]	≤ ± 0.1% After flow calibration and adjustment with polynominal or piece-wise correction
	[1] Within range Q_t ... Q_{max} with straight inlet/outlet section of 20D/3D or with flow straightener 10D/3D [2] Within range Q_t ... Q_{max} with uninterrupted inlet/outlet section 10D/3D or with flow straightener 5D/3D	
Diagnostics functions	Integrated device diagnosis and extended diagnosis use software MEPAFLO600 CBM	
Gas temperature	–40 °C ... +180 °C On request: –194 °C ... +280 °C	
Operating pressure	0 bar (g) ... 250 bar (g) On request: Up to 450 bar (g)	
Nominal pipe size	2" ... 48" (DN 50 ... DN 1200)	
Ambient conditions		
Ambient temperature	ATEX, CSA	–40 °C ... +60 °C
	IECEx	–40 °C ... +70 °C
	Optional IECEx	–50 °C ... +70 °C
Storage temperature	–40 °C ... +70 °C	
Ambient humidity	≤ 95% relative humidity	
Approvals		
Conformities	AGA Report No. 9 API 21.1 OIML D11 OIML R137-1 ISO 17089-1 BS 7965 Type approvals: MID, Measurement Canada, GOST ...	
Ex approvals	IECEx	Gb/Ga Ex d e ib [ia Ga] IIA T4 Gb/Ga Ex d e ib [ia Ga] IIC T4 Ultrasonic transducer, intrinsically safe
	ATEX	II 1/2G Ex de ib [ia] IIA T4 II 1/2G Ex de ib [ia] IIC T4 Ultrasonic transducer, intrinsically safe
	NEC/CEC (US/CA)	Class I, Division 1, Groups B, C, D T4 Class I, Division 2, Groups A, B, C, D T4 Class I, Division 1, Group D T4 Class I, Division 2, Group D T4 Ultrasonic transducer, intrinsically safe
Electrical safety	CE	
IP classification	IP 65 / IP 66 / IP 67	

Outputs and interfaces	
Analog output	1 output (optional): 4 ... 20 mA, 200 Ω Active/passive, electrically isolated
Digital outputs	Up to 3 outputs: 30 V, 10 mA Passive, electrically isolated, open collector or acc. to NAMUR (EN 50227), f_{max} = 6 kHz (scalable)
Interfaces	RS-485 (2x, for configuration, measured value output and diagnosis)
Bus protocol	MODBUS ASCII MODBUS RTU HART
Operation	Via meter display and software MEPAFLOW600 CBM
Installation	
Dimensions (W x H x D)	See dimension drawings
Weight	Depending on device version
Material in contact with media	Low-temperature carbon steel, stainless steel, Duplex steel
Electrical connection	
Voltage	12 ... 28.8 V DDC For active current output: 15 ... 28.8 V DDC
Power input	≤ 1 W
General	
Scope of delivery	The scope of delivery is dependent on the application and the customer specifications.

Criteria applicable to meter when used in accordance with metrological type approval

Table 28 Meter sizes according to metrological type approval

Meter size	Meter size	Measuring range (Qmin [m³/h])					Max. flow rate Qmax [m³/h]	Meter factor [pulses/ m³]
		≥1:100	1:80	1:50	1:30	1:20		
DN 80 (3")	G100					8	160	45000
	G160				8	13	250	28800
	G250			8	13	20	400	18000
	G400*		8	13	20	32	650	11100
DN 100 (4")	G160					13	250	28800
	G250				13	20	400	18000
	G400			13	20	32	650	11100
	G650*		13	20	32	50	1000	7200
DN 150 (6")	G250					20	400	18000
	G400				20	32	650	11100
	G650			20	32	50	1000	7200
	G1000		20	32	50	80	1600	4500
	G1000E		32				2200	3272
	G1600*	20	32	50	80	130	2500	2880
DN 200 (8")	G400					32	650	11100
	G650				32	50	1000	7200
	G1000			32	50	80	1600	4500
	G1600		32	50	80	130	2500	2880
	G1600E	32	40				3600	2000
	G2500*	32		80	130	200	4000	1800
DN 250 (10")	G1000				50	80	1600	4500
	G1600			50	80	130	2500	2880
	G2500		50	80	130	200	4000	1800
	G2500E	50					5000	1285
	G4000*	50	80	130	200	320	6500	1110
DN 300 (12")	G1600				80	130	2500	2880
	G2500			80	130	200	4000	1800
	G4000	65	80	130	200	320	6500	1110
	G4000 E	65					7800	920
DN 350 (14")	G1600				80		2500	2880
	G2500			80	130	200	4000	1800
	G4000		80	130	200	320	6500	1110
	G4000 E	80					7800	920

Meter size	Meter size	Measuring range (Qmin [m³/h])					Max. flow rate Qmax [m³/h]	Meter factor [pulses/ m³]
		≥1:100	1:80	1:50	1:30	1:20		
DN 400 (16")	G2500				130	200	4000	1800
	G4000			130	200	320	6500	1110
	G6500		120	200	320	500	10000	720
	G6500 E	120					12000	600
DN 450 (18")	G4000			130	200	320	6500	1110
	G6500		130	200	320	500	10000	720
	G10000	130					16000	450
DN 500 (20")	G4000				200	320	6500	1110
	G6500			200	320	500	10000	720
	G10000		200	320	500	800	16000	450
	G10000 E	200					20000	360
DN 550 (22")	G6500			200	320	500	10000	720
	G10000		200	320	500	800	16000	450
	G16000	200					25000	288
DN 600 (24")	G6500				320	500	10000	720
	G10000			320	500	800	16000	450
	G16000		320	500	800	1300	25000	288
	G16000 E	320					32000	225
DN 650 (26")	G6500				320	500	10000	720
	G10000			320	500	800	16000	450
	G16000		320	500	800	1300	25000	288
	G16000E	320					32000	225
DN 700 (28")	G6500					500	10000	720
	G10000				500		16000	450
	G16000			500			25000	288
	G25000	400	500				40000	180
DN 750 (30")	G6500					500	10000	720
	G10000				500		16000	450
	G16000			500			25000	288
	G25000	400	500				40000	180
DN 800 (32")	G10000				500	800	16000	450
	G16000			500			25000	288
	G25000	400	500				40000	180
DN 850 (34“)	G16000				800		25000	288
	G25000			800			40000	180
	G40000	650	800				65000	111
DN 900 (36")	G16000				800		25000	288
	G25000			800			40000	180
	G40000	650	800				65000	111

Meter size	Meter size	Measuring range (Qmin [m³/h])					Max. flow rate Qmax [m³/h]	Meter factor [pulses/ m³]
		≥1:100	1:80	1:50	1:30	1:20		
DN950 (38“)	G16000					1300	25000	288
	G25000				1300		40000	180
	G40000		800	1300			65000	111
DN 1000 (40")	G16000					1300	25000	288
	G25000				1300		40000	180
	G40000	650	800	1300			65000	111

- Any flow rates given above are also valid in the bidirectional mode.
- G-classes marked with an asterisk (*) must only be used in configuration No. 2 (see → pg. 99, 4.2.2).
- G-classes marked with an (E) have an extended max. flow rate (max. flow velocity v_{max} = 36 m/s) related to commonly established turbine meter G-classes.
- The transition flow Q_t is based on the flow range the meter is designed for according to the main plate. It is:
  - for a flow range of 1:20 Q_t=0.20 Q_{max} and
  - for a flow range of 1:30 Q_t=0.15 Q_{max} and
  - for a flow range of ≥ 1:50 Q_t=0.10 Q_{max}
- Higher values for Q_{min} and lower values for Q_{max} are admissible provided that Q_{min} 0.05 Q_{max}.
- Another meter factor is admissible if the frequency at the pulse output is selected <6 kHz for 1.2 Q_{max}.

9.2 Characteristic properties and dimensions of the meter body

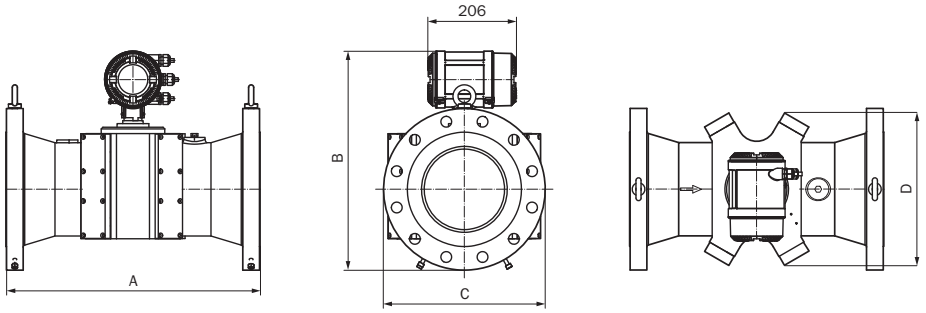
Standard materials for meter body

Material			Pressure-Temperature-Rating		Min. application temp.
			Flanges acc. to ASME B16.5 and ASME B16.47	Flanges acc. to EN 1092-1	
Carbon steel	Casting	1.1120 (A216 Gr. WCC)	Table 2-1.2 of ASME B16.5	Rating for Material Group 3E1	- 25 °C
LT carbon steel	Casting	1.6220 (ASTM A352 Gr. LCC)	Table 2-1.2 of ASME B16.5	Rating for Material Group 7EO	- 46 °C
	Forging	1.0571 (1.0566)/ASTM A350 Gr. LF2	Table 2-1.2 of ASME B16.5	Rating for Material Group 8E3	
Stainless steel	Casting	1.4408 (ASTM A351 Gr. CF8M)	Table 2-2.2 of ASME B16.5	Rating for Material Group 14EO	- 196 °C
	Forging	1.4401 (1.4404)/ASTM A182 Gr. F316 (F316L)	Table 2-2.2 of ASME B16.5	Rating for Material Group 14EO	
Duplex	Casting	1.4470 (ASTM A995 Gr.4A	Table 2-2.2 of ASME B16.5	Rating for Material Group 16EO	- 46 °C
	Forging	1.4462/ASTM A182 Gr. F51	Table 2-2.2 of ASME B16.5	Rating for Material Group 16EO	

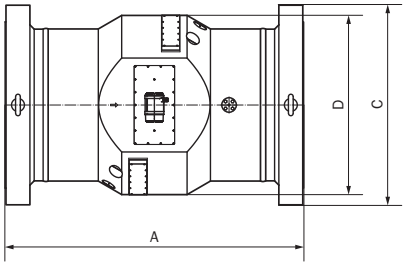
Weights and dimensions

Figure 98 Dimensioned drawing

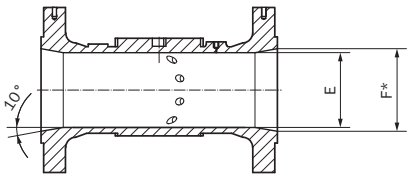
Models for nominal sizes of 3"/DN 80 up to 14"/DN 350 (cast)



Models for nominal sizes from 16"/DN 400 (forged)



Longitudinal section for nominal sizes up to 48"/DN 1200



* Dimension F must be specified by the customer, as it depends on the internal pipe diameter at the installation location.(see→ pg. 220, Table 30 or type-code)

Table 29 Meter dimensions

Nominal pipe size	Connec-tion flange	Standard	Weight	Length (A)	Height (B)	Flange diameter (C)	Width of measuring section (D)	Internal diameter (E)
			[kg]	[mm]	[mm]	[mm]	[mm]	[mm]
3"	cl. 150	ANSI B16.5	37	240	344	190	180	73
	cl. 300		38		354	210		
	cl. 600		42		354	210		
	cl. 900		84	400	395	240		
DN80	PN 16	DIN 2633	37	240	349	200		
	PN 63	DIN 2636	40		356	215		
	PN 100	DIN 2637	43		364	230		
4"	cl. 150	ANSI B16.5	44	300	375	230	240	95
	cl. 300		55		388	255		
	cl. 600		66		398	275		
	cl. 900		99	500	408	290		
DN100	PN 16	DIN 2633	40	300	372	220		
	PN 63	DIN 2636	52		405	250		
	PN 100	DIN 2637	61		410	265		
6"	cl. 150	ANSI B16.5	100	450	445	280	300	142
	cl. 300		110		465	320		
	cl. 600		140		483	355		
	cl. 900		220	750	496	380		
DN150	PN 16	DIN 2633	90	450	448	285		
	PN 63	DIN 2636	110		478	345		
	PN 100	DIN 2637	130		483	355		
8"	cl. 150	ANSI B16.5	150	600	498	345	350	190
	cl. 300		180		516	380		
	cl. 600		210		536	420		
	cl. 900		300		562	470		
DN200	PN 16	DIN 2633	140		498	340		
	PN 63	DIN 2636	190		535	415		
	PN 100	DIN 2637	210		543	430		
10"	cl. 150	ANSI B16.5	240	750	548	405	410	235
	cl. 300		250		568	445		
	cl. 600		330		600	510		
	cl. 900		470		625	545		
DN250	PN 16	DIN 2633	220		547	405		
	PN 63	DIN 2636	270		580	470		
	PN 100	DIN 2637	320		597	505		
12"	cl. 150	ANSI B16.5	350	900	586	485	470	270
	cl. 300		400		605	520		
	cl. 600		490		625	560		
	cl. 900		720		685	610		
DN300	PN 16	DIN 2633	325		575	460		
	PN 63	DIN 2636	425		610	530		
	PN 100	DIN 2637	525		638	585		

Table 29 Meter dimensions

Nominal pipe size	Connection flange	Standard	Weight	Length (A)	Height (B)	Flange diameter (C)	Width of measuring section (D)	Internal diameter (E)
			[kg]	[mm]	[mm]	[mm]	[mm]	[mm]
14"	cl. 150	ANSI B16.5	475	1050	642	535	540	315
	cl. 300		600		667	585		
	cl. 600		675		677	605		
	cl. 900		850		700	640		
DN80	PN 16	DIN 2633	475		635	520		
	PN 63	DIN 2636	625		675	600		
	PN 100	DIN 2637	750		705	655		
The length 3D is also available for all size 16" meters and larger.								
16"	cl. 150	ANSI B16.5	475	762	700	595	570	360
	cl. 300		550		728	650		
	cl. 600		640		745	685		
	cl. 900		1025	800	755	705		
DN400	PN 16	DIN 2633	370	762	693	580		
	PN 63	DIN 2636	600		738	670		
18"	cl. 150	ANSI B16.5	660	820	754	635	620	405
	cl. 300		760		792	710		
	cl. 600		960		820	745		
	cl. 900		1300	900	830	785		
DN450	PN 16	Data on request						
20"	cl. 150	ANSI B16.5	750	902	815	700	670	450
	cl. 300		930		853	775		
	cl. 600		1080		872	815		
	cl. 900		1500	1000	892	855		
DN500	PN 16	DIN 2633	700	902	823	715		
22"	cl. 150	Data on request						
	cl. 300							
	cl. 600							
	cl. 900							
DN550	PN 16							
24"	cl. 150	ANSI B16.5	1090	991	927	815	760	540
	cl. 300		1390	991	978	915		
	cl. 600		1615	991	990	940		
	cl. 900		2450	1200	1040	1040		
DN600	PN 16	DIN 2633	1015	991	940	840		
26"	cl. 150	ASME B16.47	1475	1050	965	870	828	585
	cl. 300		1825		1016	972		
	cl. 600		2100		1038	1016		
	cl. 900		2500	1250	1073	1086		
DN650	PN16	Data on request						
28"	cl. 150	ASME B16.47	1950	1100	1027	927	862	630
	cl. 300		2225		1080	1035		
	cl. 600		2450		1100	1073		
	cl. 900		3000	1300	1150	1169		
DN700	PN16	Data on request						

Table 29 Meter dimensions

Nominal pipe size	Connec-tion flange	Standard	Weight	Length (A)	Height (B)	Flange diameter (C)	Width of measuring section (D)	Internal diameter (E)
			[kg]	[mm]	[mm]	[mm]	[mm]	[mm]
30"	cl. 150	ASME B16.47	2195	1150	1080	985	902	675
	cl. 300		2545		1135	1092		
	cl. 600		2820		1154	1130		
	cl. 900		3350	1350	1205	1232		
DN750	PN16	Data on request						
32"	cl. 150	ASME B16.47	2485	1200	1145	1061	979	720
	cl. 300		2835		1190	1150		
	cl. 600		3110		1212	1194		
	cl. 900		3800	1400	1272	1315		
DN800	PN 16	Data on request						
34"	cl. 150	Data on request						
	cl. 300							
	cl. 600							
	cl. 900							
DN850	PN 16							
36"	cl. 150	ASME B16.47	3125	1250	1250	1169	1082	810
	cl. 300		3525		1300	1270		
	cl. 600		3850		1323	1315		
	cl. 900		5225	1450	1396	1461		
DN900	PN 16	Data on request						
38"	cl. 150	ASME B16.47	3800	1300	1310	1238	1160	855
	cl. 300		3725	1300	1275	1169		
	cl. 600		4300	1300	1325	1270		
	cl. 900		-	-	1421	1461		
DN950	PN 16	Data on request						
40"	cl. 150	ASME B16.47	3825	1350	1359	1289	1213	900
	cl. 300		4125		1334	1239		
	cl. 600		4675		1375	1321		
	cl. 900		Data on request		1470	1512		
DN1000	PN 16	Data on request						
42"	cl. 150	ASME B16.47	4675	1450	1415	1346	1261	945
	cl. 300		4650		1386	1289		
	cl. 600		5450		1444	1404		
	cl. 900		Data on request		1523	1562		
DN1050	PN 16	Data on request						
44"	cl. 150	Data on request						
	cl. 300							
	cl. 600							
	cl. 900							
DN1100	PN 16							
46"	cl. 150	Data on request						
	cl. 300							
	cl. 600							
	cl. 900							
DIN1150	PN 16							

Table 29 Meter dimensions

Nominal pipe size	Connec-tion flange	Standard	Weight	Length (A)	Height (B)	Flange diameter (C)	Width of measuring section (D)	Internal diameter (E)
			[kg]	[mm]	[mm]	[mm]	[mm]	[mm]
48"	cl. 150	ASME B16.47	6400	1600	1574	1511	1416	1080
	cl. 300		6475		1552	1467		
	cl. 600		7850		1615	1594		
	cl. 900		12100	1900	1711	1785		
DN1200	PN 16	Data on request						

- Weight indications are to be considered as guide values.
- Weight indications are estimated for carbon steel.

Table 30 Inner pipe diameter

Nominal pipe size	Pipe dimensions in accordance with ANSI B36.10M - 1985					DIN 2633	DIN 2636	DIN 2637
	SC20	SC30	SC40	SC60	SC80	PN16	PN64	PN100
2"			52.5		49.3			
DN 50						54.5	54.5	54.5
3"			77.9		73.7			
DN 80						82.5	81.5	80.9
4"			102.3		97.2			
DN 100						107.1	106.3	104.3
6"			154.1		146.3			
DN 150						159.3	157.1	154.1
8"	206.4	205	202.7	198.5	193.7			
DN 200						206.5	204.9	199.1
10"	260.4	257.5	254.5	247.7	242.9			
DN 250						260.4	255.4	248.0
12"	311.2	307.1	303.2	295.3	288.9			
DN 300						309.7	301.9	295.5
14"	339.8	336.6	333.3	325.4	317.5			
DN 350						339.6	343.0	336.0
16"	390.6	387.4	381.0	373.1	363.5			
DN 400						390.4	378	
18"	441.4	434.9	428.7	419.1	409.5			
DN 450								
20"	489.0	482.6	477.8	466.8	455.6			
DN 500						492.0		
24"	590.6	581.1	574.6	560.4	547.7			
DN 600						592.4		

9.3 Operation and menu structure of the SPU with LCD display

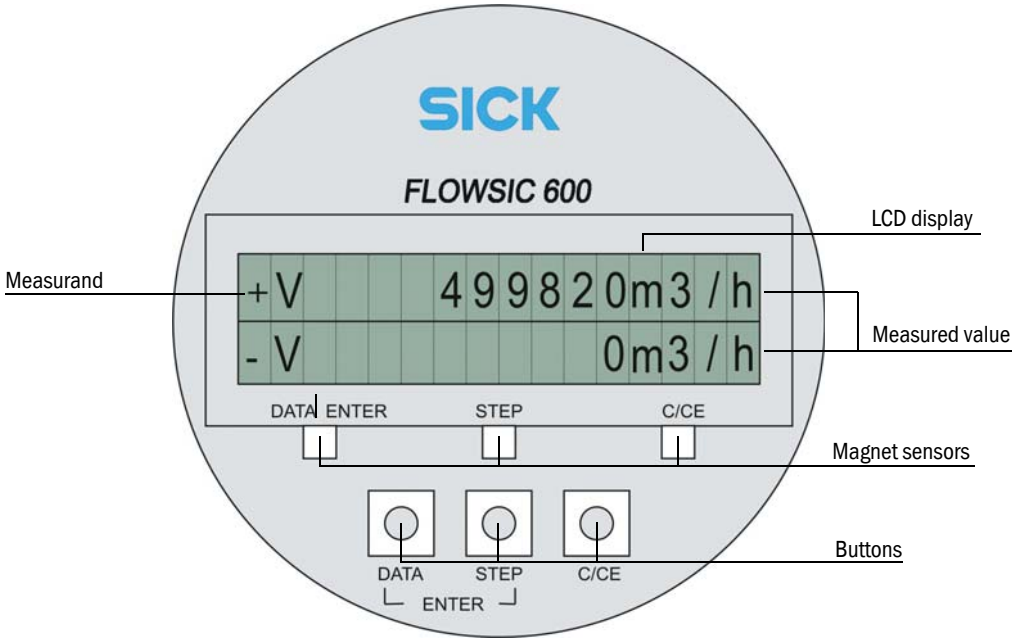
9.3.1 Operation

The current measured values, counter readings, and diagnostic information can be displayed on the two-line LCD display on the front panel of the SPU. The information display can be navigated by using a magnetic pen, while the front cap is kept closed, or using the buttons while the front cap is open (see → Figure 99).

WARNING: Explosion Hazard
Do not open the window cover unless the area is known to be non-hazardous.

WARNING:
EMC and protection from accidental contact cannot be guaranteed if the cover is opened.

Figure 99 Front panel with LCD display



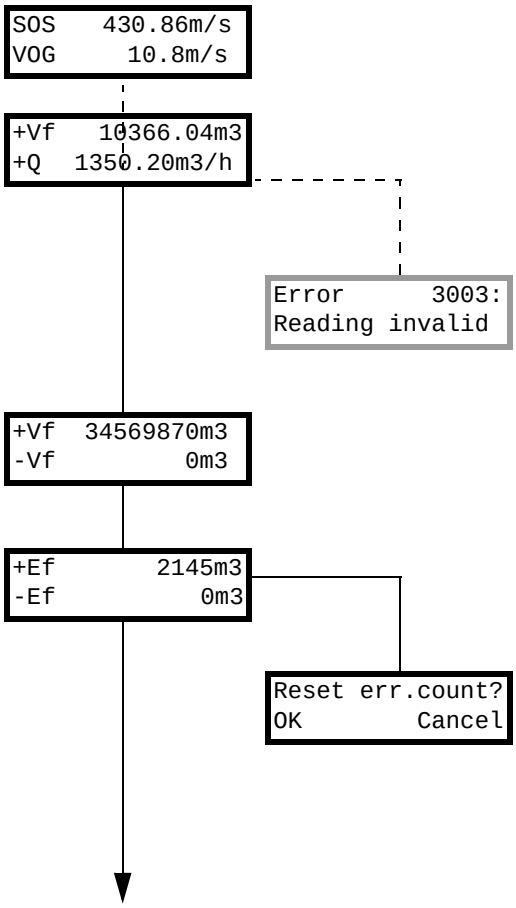
Button	Magnetic sensor	Function	Description
C/CE	C/CE	Menu level up	Use the C/CE button to return from any menu to the upper level; continue pressing to return to the initial display
STEP	STEP	Step forward	Use the STEP button to step forward in the menu
DATA	DATA ENTER	Step backward	Use the DATA button to step backward in the menu
STEP + DATA pressed together or DATA pressed longer than 2 seconds	DATA ENTER pressed longer than 2 seconds	ENTER	Use the ENTER function to select a menu level, acknowledge logbook entries, reset the error volume counters or edit any modifiable parameter (after unlocking the Parameter write lock)

9.3.2 Menu structure on the LCD display

The menu structure on the LCD display consists of a standard display (displaying readings, important errors or warnings, the device state and a submenu for the reset of the error volume counters) and the main menu. The main menu provides topically structured information and allows operations like changing parameters, acknowledging logged events. Navigate standard display and main menu using the buttons or the magnetic sensors as described below.

Parameters can be edited in "Configuration" mode only.

Graphical representation	Description
	Vertical lines represent connections between menu items on the same menu level. Use the STEP button to step forward and the DATA button to step backward
	Horizontal lines represent connections between different menu levels. Use the ENTER function to enter a lower-level menu and the C/CE button to go back to a higher-level menu.
	Dashed horizontal or vertical lines represent connections between alternating displays pages
	Boxes with a thick border represent the display of a menu item
	Boxes with a grey border represent a flashing display (e.g. if a current warning or an unacknowledged logbook entry is displayed)



Notes

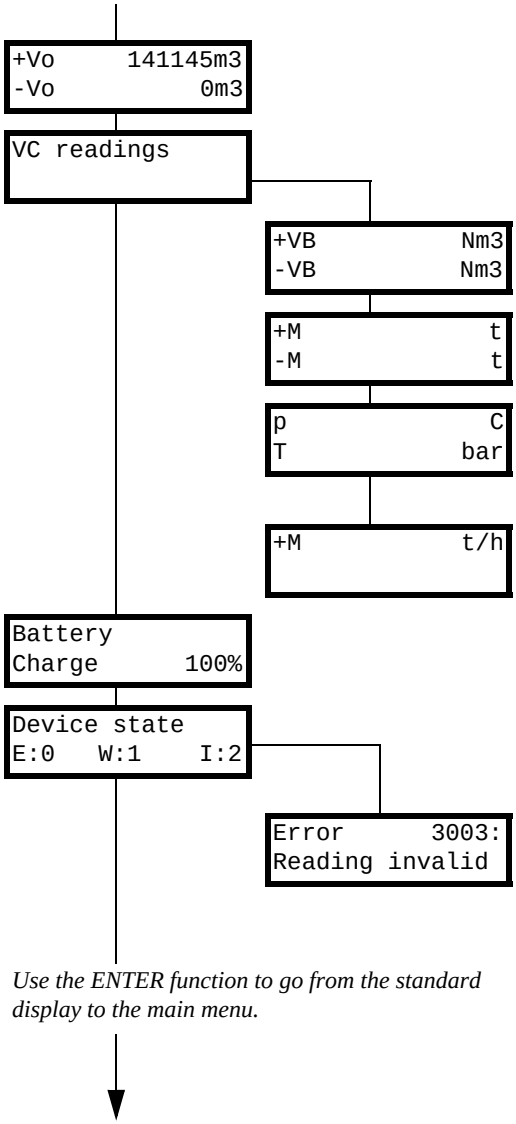
The standard display shows two pages with a configurable display of measurands and current readings. By default Speed of Sound (SOS), Velocity of Gas (VOG), the Volume at Flowing Conditions forward (+Vf) and the Volumetric flow rate at Flowing Conditions forward (+Qf) are displayed. The pages alternate every 5 seconds. If the logbooks contain unacknowledged **E**rrors, **W**arnings or **I**nformation, the corresponding letter is displayed in the upper right hand corner and flashes.

If an error or a warning is active, the display will flash. A message with a message number will be displayed in the upper right corner. For further explanation see Section → 9.4.1.

Display of the current operating volume counter readings forward (+Vf) and reverse (-Vf). Volume counter readings can be displayed for volume at flowing (Vf) or at base (Vb) conditions.

Display of the current error volume counter readings forward (+Ef) and reverse (-Ef). Use the ENTER function to erase the error counter.

Confirmation dialog for the erasure of the error counter. Use the ENTER function to confirm erasure or the C/CE button to cancel the dialog. This event will be recorded with a time stamp in Logbook1.



Notes

Display of the Total volume counter at flowing conditions forward (+Vo) and reverse (-Vo).

EVC readings menu. Enter the menu with the ENTER function to view the EVC readings.

Display of the Total volume counter at base conditions forward (+VB) and reverse (-VB).

Display of the Mass counter forward (+M) and reverse (-M).

Display of the live values of pressure (p) and temperature (T) as written from a sensor or as found in Reg. #7040 "Temperature (fixed)" and Reg. #7041 "Pressure (fixed)".

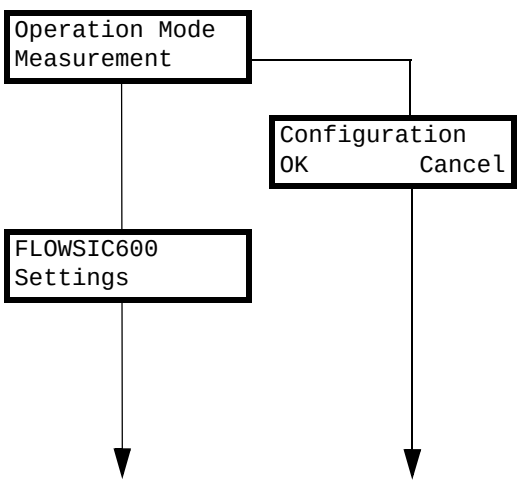
Display of the Mass Flow (Mf).

Display of battery charge.

Display of the current device state. The number of active **E**rrors, **W**arnings and **I**nformation is displayed. To view the messages enter the menu with the ENTER function.

Currently active error, warning or information. The number of the message is displayed in the first line (1xxx=Information, 2xxx=Warning, 3xxx=Error). See table in Section → 9.4.1. Use the STEP and the DATA button to navigate through the messages.

Use the ENTER function to go from the standard display to the main menu.



Notes

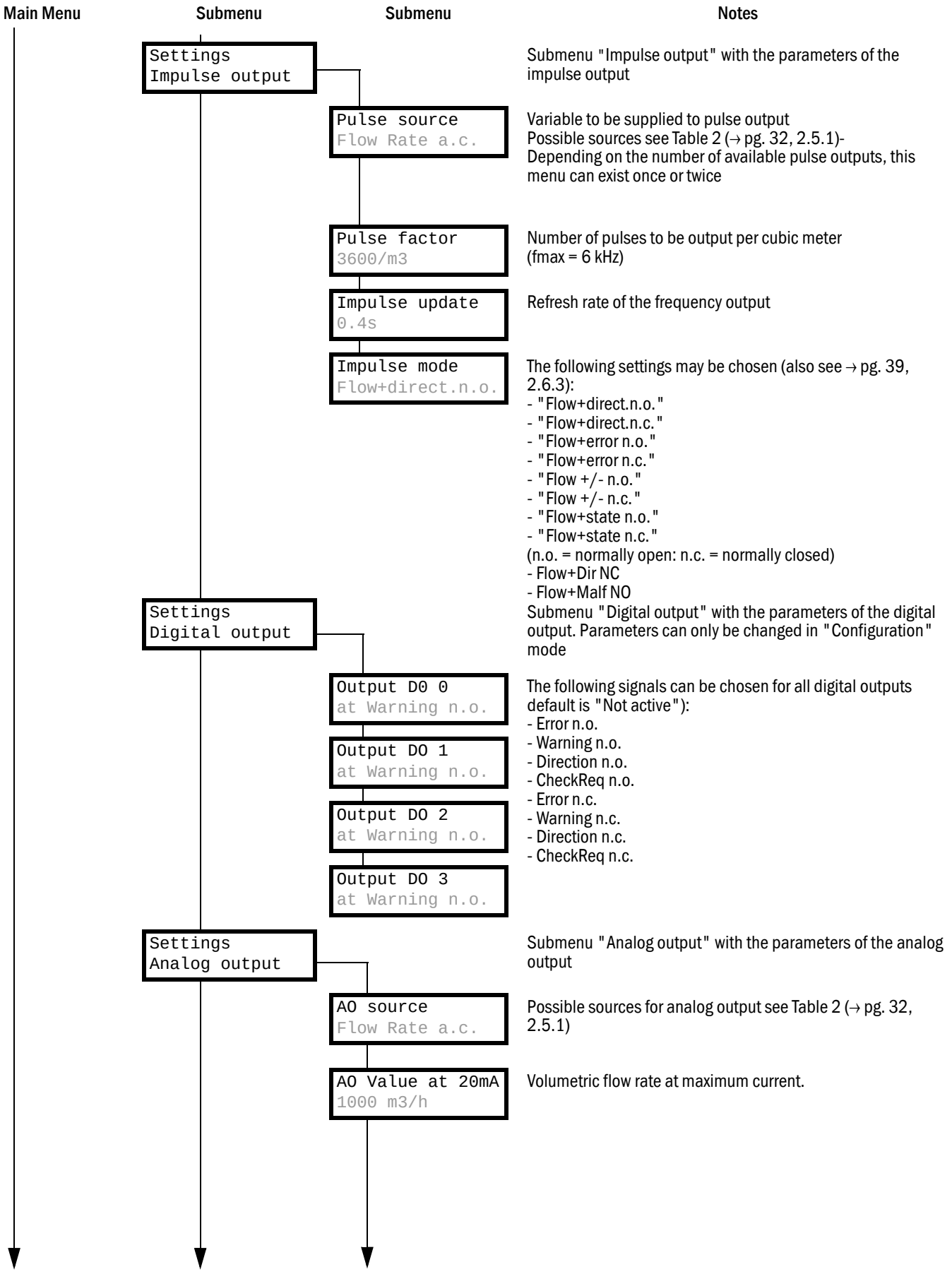
The main menu provides menus and submenus for topically structured information and user operations.

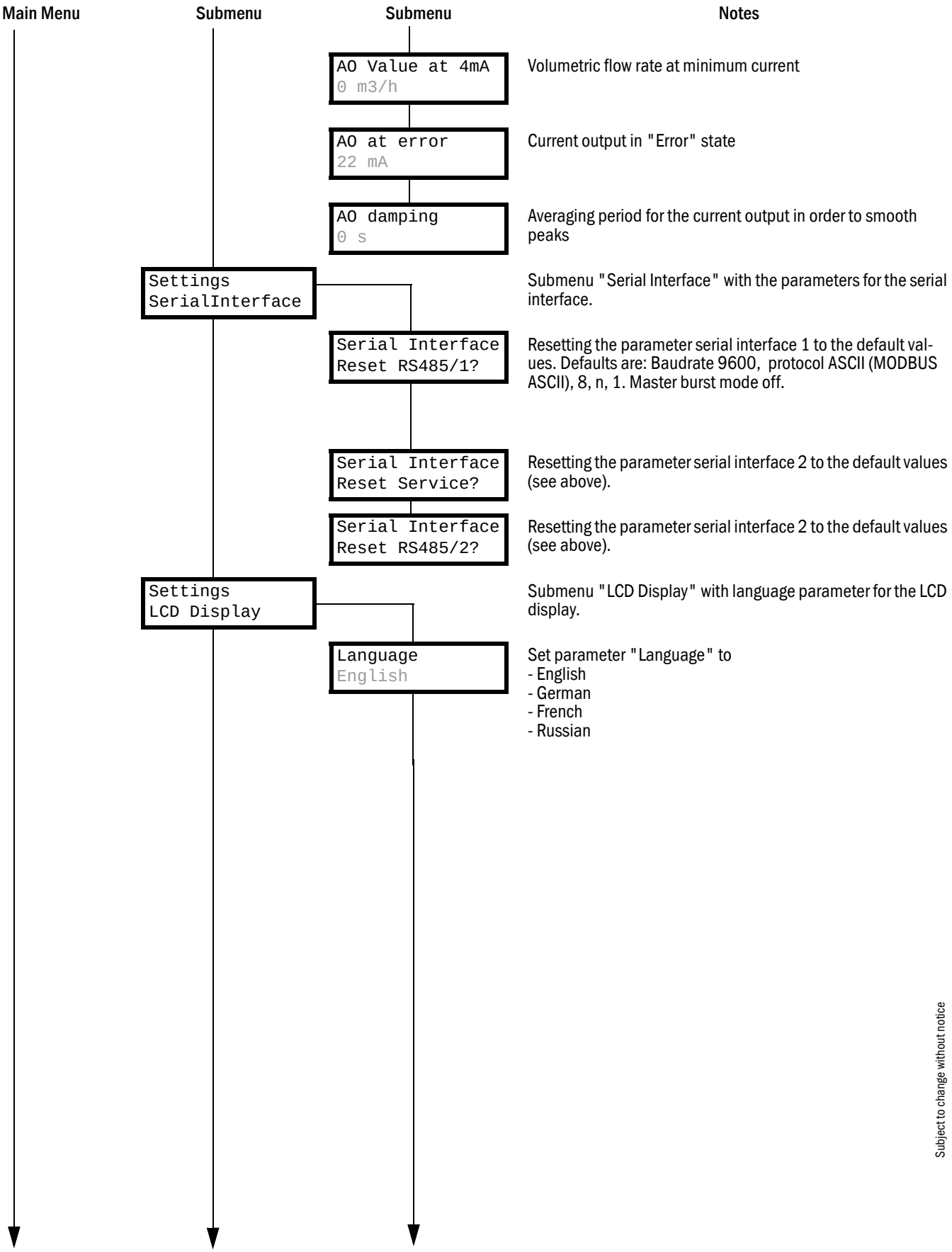
Display of the current operating mode ("Operation" or "Configuration"). Use the ENTER function to switch the mode.

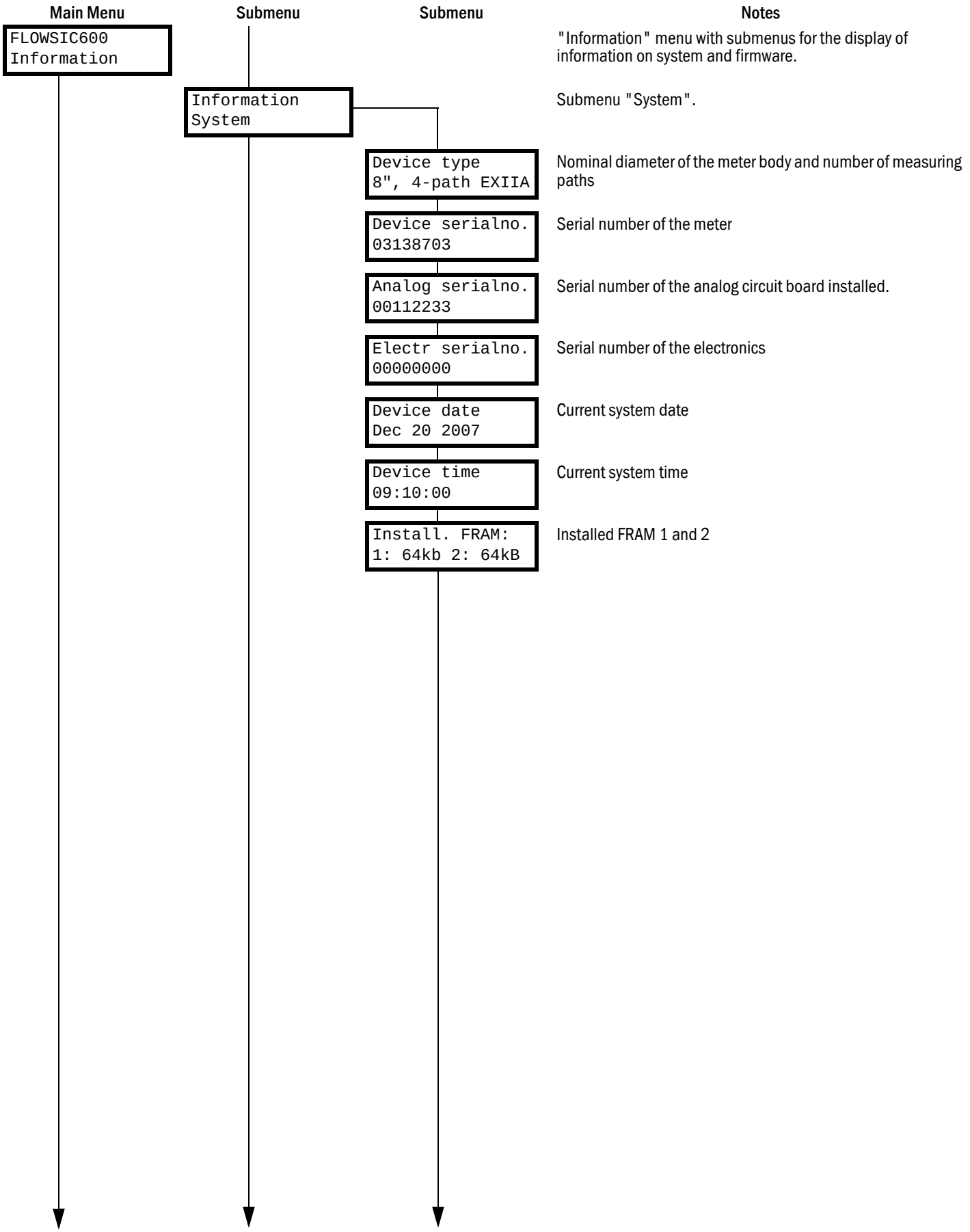
Confirmation dialog for switching to the indicated operating mode. Use the ENTER function to confirm or the C/CE button to cancel the dialog. Event is logged in Logbook1.

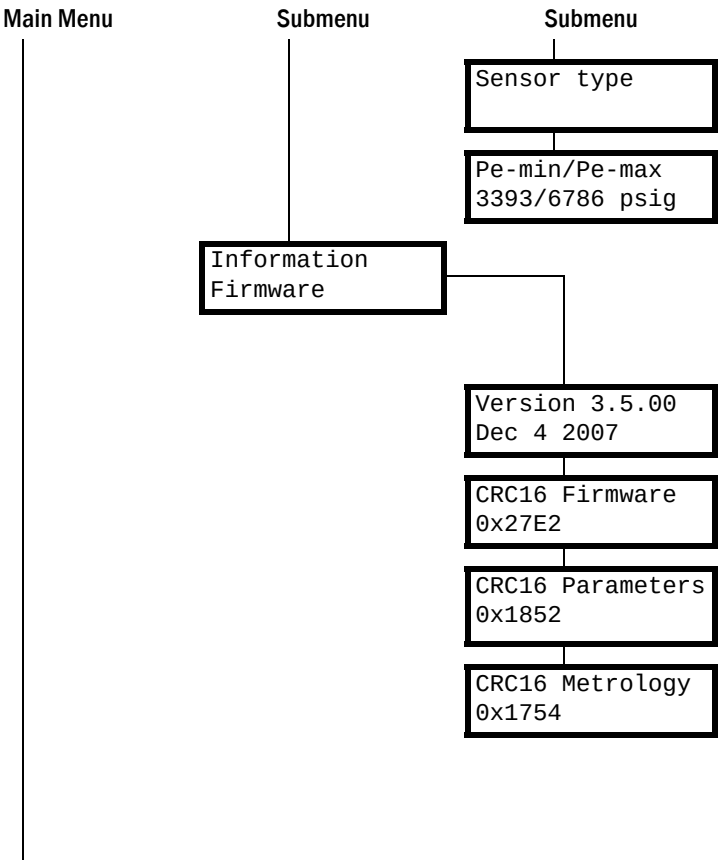
"Parameter change" menu with submenus for editing the system configuration at commissioning and parameterization. Parameters can only be changed in "Configuration" mode.

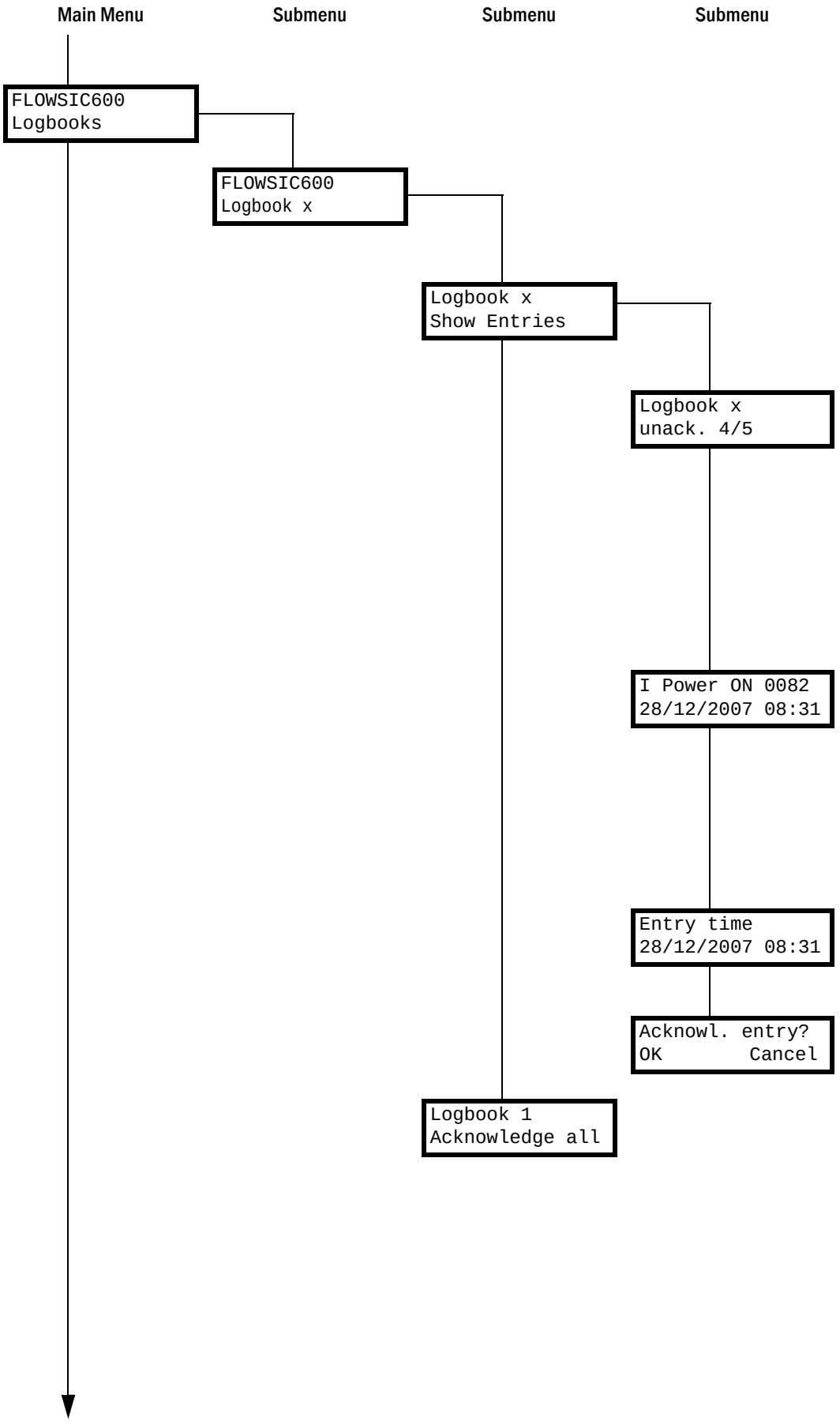
Main Menu	Submenu	Submenu	Notes
	Setting? Calibration		Submenu "Calibration" with the basic parameters for the calibration of the meter according to the field conditions.
		Adjust forward 1.0000	Display of the forward adjustment /correction factor.
		Adjust reverse 1.0000	Display of the reverse adjustment/correction factor.
		Pressure fix 20.00 bar	The parameters pe_min and pe_max are calculated from the entered average working pressure
		Testmode (1 bar) Airtest OFF	Turn the "Test" mode ON or OFF

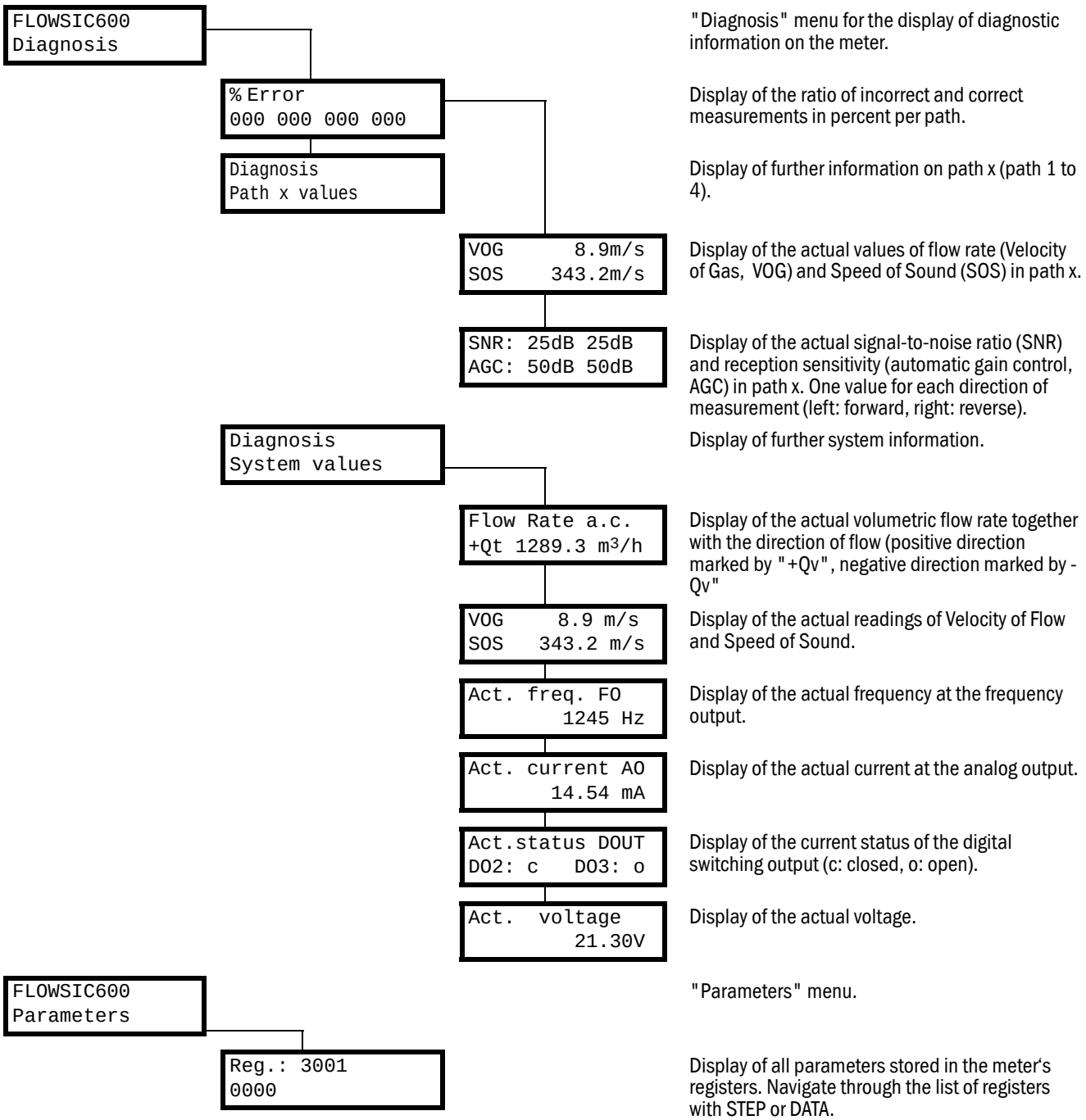


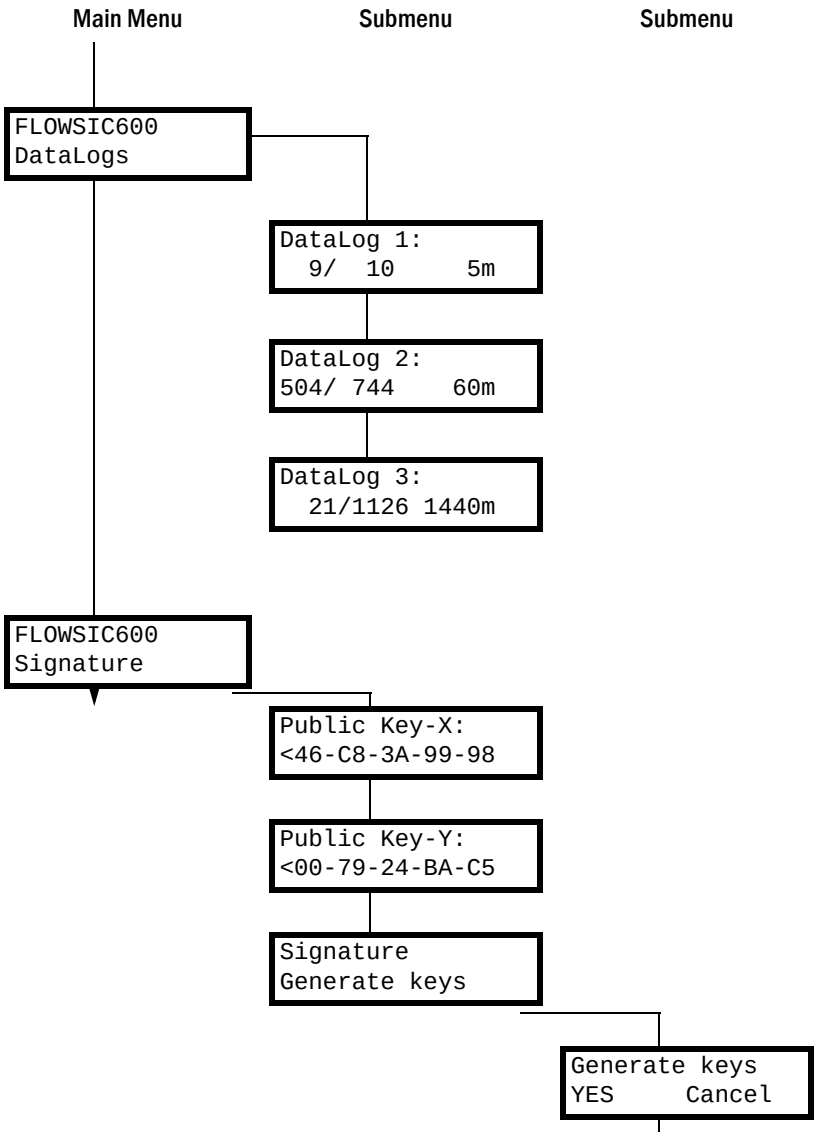












9.3.3 Display of measured values

The default values to be displayed on the two line LCD can be assigned using MEPAFLOW600 CBM. The values can be assigned to the desired page and line of the standard display. The two display pages alternate every 5 seconds.

9.3.4 Data editing in Configuration Mode

In configuration parameters which are relevant to the commissioning or operation of the meter can be modified. If the Parameter write lock is LOCKED, it must be set to the "UNLOCKED" before parameter modification.

Navigate to the parameter and use the ENTER function to begin editing.

Options depending on the type of data:

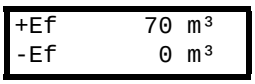
- Integer:0, 1, 2, 3, 4, 5, 6, 7, 8, 9, sign
- Floating point:0, 1, 2, 3, 4, 5, 6, 7, 8, 9, space, decimal point, sign
- List of registers:List of all registers (which are plausible for this parameter)

Example: Switching the meter to Configuration Mode and editing a parameter, e.g. the impulse factor.

Action	Buttons	Display
Standard display	-	+V 34569870 m3 -V 0 m3
Enter menu	ENTER	Operation Mode Operation
Edit parameter "Operation Mode"	ENTER	Configuration? OK Cancel
Confirm change to "Maintenance Mode"	ENTER –> Change mode	Configuration? Success!
Scroll through the menu structure to the parameter you want to edit	(ENTER, STEP, DATA)	
In this example, the impulse factor is edited		Impulse factor 115/m3
Select the parameter	ENTER	Impulse factor 115
Move cursor to the digit that you want to change	1 * STEP	Impulse factor 11
Put in edit mode	2 * DATA	Impulse factor 115
Enter desired value	x * DATA	Impulse factor 110
Confirm new value	ENTER	Impulse factor 110/m3
Return to standard display	3 x CE/C	+V 34569870 m3 -V 0 m3

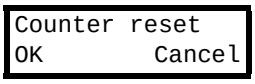
9.3.5 Resetting the error volume counters

To reset the error volume counters, password level "authorized operator" is required.



Select the error volume display. Use the ENTER function to enter the dialog for resetting the error volume counters.

<ENTER>



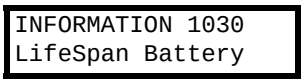
Confirm the reset with the ENTER function. The error volume counter will be reset to zero. The reset will be recorded in the logbook. Press C/CE to cancel the reset.

<ENTER>

9.3.6 Acknowledging a battery replacement

Description of a battery replacement, see Service Manual

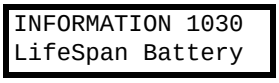
After a battery replacement the following message flashes on the LCD-display:



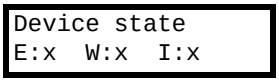
Since date and time of the FLOWSIC600 are invalid after switching the meter back on, they have to be set to valid values. We recommend to use the clock synchronization function of MEPAFLOW600 CBM (click the "Attention" Icon in the "Identification" box on the "Information" page).

After setting date and time, the LCD message can be acknowledged. The acknowledgment sets the life span cycle of the new battery to zero. Complete the following step at the LCD-display:

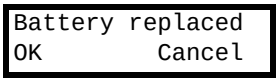
Press DATA.



Apply the ENTER function two times



Apply the ENTER function



(This message becomes visible for just one second.)

WARNING: Explosion Hazard

- Do not replace the battery unless power has been removed or the area is known to be non-hazardous.
- Substitution of components may impair intrinsic safety.
- Replacement battery must be of type Panasonic BR 2032.

9.4 Logbooks

1 Classification of logbook entries

The entries are distinguished into three classes and identified by the initial character in the first line.

- "I"information
- "W"warning
- "E"error/ malfunction

2 Type of occurrence

- "+"point of time identifying the beginning of a status
- "-"point of time identifying the end of a status

9.4.1 Overview of event entries in meter logbooks

Message No. on LCD	Details	Logbook	LCD Text
Custody logbook [1]			
3002	NO DSP communication	1	E+System 0001 NO DSP-Communic.
			E-System 0001 NO DSP-Communic.
3003	Measurement invalid	1	E+DSP 0001 Reading invalid
			E-DSP 0001 Reading invalid
3004	Firmware CRC invalid	1	E+Firmware 0001 CRC invalid
			E-Firmware 0001 CRC invalid
3005	Parameter CRC invalid	1	E+Parameter 0001 CRC invalid
			E-Parameter 0001 CRC invalid
3006	Parameter out of range	1	E+Parameter 0001 #XXXX range error
			E-Parameter 0001 #XXXX range error
3007	Failure during storage of path compensation parameter	1	E+PathComp. 0001 Storage error
			E+PathComp. 0001 Storage error
3008	Meter clock time invalid	1	E+System 0001 ClockTime inval.
			E-System 0001 ClockTime inval.

Message No. on LCD	Details	Logbook	LCD Text
3009	Custody logbook [1] overflow	1	E+Logbook 1 0001 Overflow
			E-Logbook 1 0001 Overflow
3011	CRC volume counter (a.c) invalid	1	E+Count.ac 0001 CRC invalid
			E-Count.ac 0001 CRC invalid
3012	CRC volume counter (n.c) invalid	1	E+Count.sc 0001 CRC invalid
			E-Count.sc 0001 CRC invalid
3013	Transit time mode activated	1	E+System 0001 TransitTimeMode
			E-System 0001 TransitTimeMode
3014	No signature key	1	E+System 0001 No signature key
			E-System 0001 No signature key
2001	Path failure	1	W+PathError 0001 Path 1 2 3 4
			W-PathError 0001 All paths OK
2002	No HART communication to temperature transmitter	1	W+HART T 0001 No communication
			W-HART T 0001 No communication
2003	No HART communication to pressure transmitter	1	W+HART P 0001 No communication
			W-HART P 0001 No communication
2004	Maximum pulse output frequency exceeded (6kHz)	1	W+PulseOut 0001 6000 Hz exceeded
			W-PulseOut 0001 6000 Hz exceeded
2005	EVC parameter invalid	1	W+EVC 0001 EVC para.invalid
			W+EVC 0001 EVC para.invalid
2006	EVC hardware error	1	W+EVC 0001 EVC module error
			W+EVC 0001 EVC module error
1001	Flow meter power ON	1	I Power ON 0001 dd/mm/yy mm:ss
1002	Meter clock adjusted	1	I Set Time 0001 dd/mm/yy mm:ss

Message No. on LCD	Details	Logbook	LCD Text
1003	Configuration Mode active	1	I+Meas.Mode 0001 Configurat. ON 1
			I-Meas.Mode 0001 Measurement ON 1
1004	Firmware changed	1	I Update FW 0001 3104 -> 3200
1007	Custody logbook [1] erased and initialized	1	I Logbook 1 0001 Reset and Init
1014	Overflow volume counter (a.c.)	1	I Count.ac 0001 Overflow
1015	Overflow volume counter (s.c.)	1	I Count.sc 0001 Overflow
1016	Error volume counter cleared	1	I Reset E 0001 01/01/07 10:47
1017	All volume counters cleared	1	I Reset V 0001 01/01/07 10:47
1027	Initialization error → Default parameter loaded	1	I+InitError 0001 DefaultParaLoad
			I-InitError 0001 DefaultParaLoad
1029	Air test mode activated	1	I+Airtest 0001 Active
			I-Airtest 0001 Not active
Warning logbook [2]			
1008	Warning logbook [2] erased and initialized	2	I Logbook 2 0001 Reset and Init
1010	Warning logbook [2] overflow	2	I+Logbook 2 0001 Overflow
			I-Logbook 2 0001 Overflow
1018	DataLog 1 cleared	2	I DataLog 1 0001 Reset
1019	DataLog 2 cleared	2	I DataLog 2 0001 Reset
1020	DataLog 3 cleared	2	I DataLog 3 0001 Reset
1021	DataLog 1 overflow	2	I+DataLog 1 0001 Overflow
			I-DataLog 1 0001 Overflow
1022	DataLog 2 overflow	2	I+DataLog 2 0001 Overflow
			I-DataLog 2 0001 Overflow

Message No. on LCD	Details	Logbook	LCD Text
1023	DataLog 3 overflow	2	I+DataLog 3 0001 Overflow
			I-DataLog 3 0001 Overflow
1024	DatenLog 1 CRC error	2	I+DataLog 1 0001 CRC invalid
			I-DataLog 1 0001 CRC invalid
1025	DatenLog 2 CRC error	2	I+DataLog 2 0001 CRC invalid
			I-DataLog 2 0001 CRC invalid
1026	DataLog 3 CRC error	2	I+DataLog 3 0001 CRC invalid
			I-DataLog 3 0001 CRC invalid
1028	Customer limit exceeded	2	I+Userlimit 0001 Limit XXXXXXXXXX
			I-Userlimit 0001 Limits OK
Parameter logbook [3]			
1005	Parameter changed	3	I Parameter 0001 Change Reg3001
1006	All parameters to default (Reset)	3	I Parameter 0001 Reset all
1009	Parameter logbook [3] erased and initialized	3	I Logbook 3 0001 Reset and Init
1011	Parameter logbook [3] overflow	3	I+Logbook 3 0001 Overflow
			I Logbook 3 0001 Overflow

9.4.2 Acknowledging a logbook entry on the LCD display

```
I Power ON 001
28/12/2007 12:13
```

<ENTER>

```
Entry time
28/12/2007 12:13
```

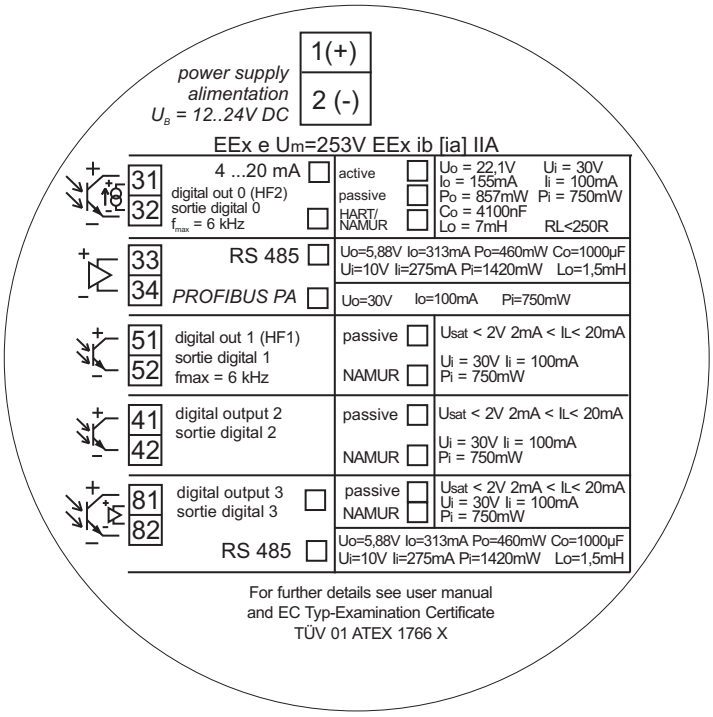
Press STEP or DATA to select an entry which has not yet been acknowledged (display is flashing). Activate the ENTER function to display the corresponding time stamp of the event. The display is still flashing. Activate the ENTER function again in order to acknowledge the entry (display will stop flashing). Return to the list of logbook entries by pressing C/CE.

It is recommended that MEPAFLOW600 CBM be used for the acknowledgment of logbook entries due to the user-friendly access it provides.

9.5 SPU terminal assignment

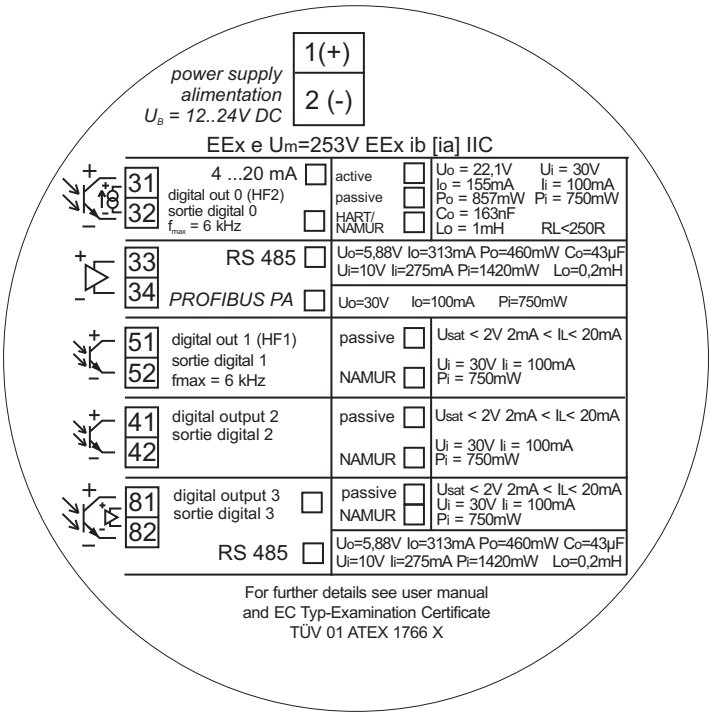
Connection in accordance with ATEX IIA

Figure 100 Terminal assignment in accordance with ATEX IIA



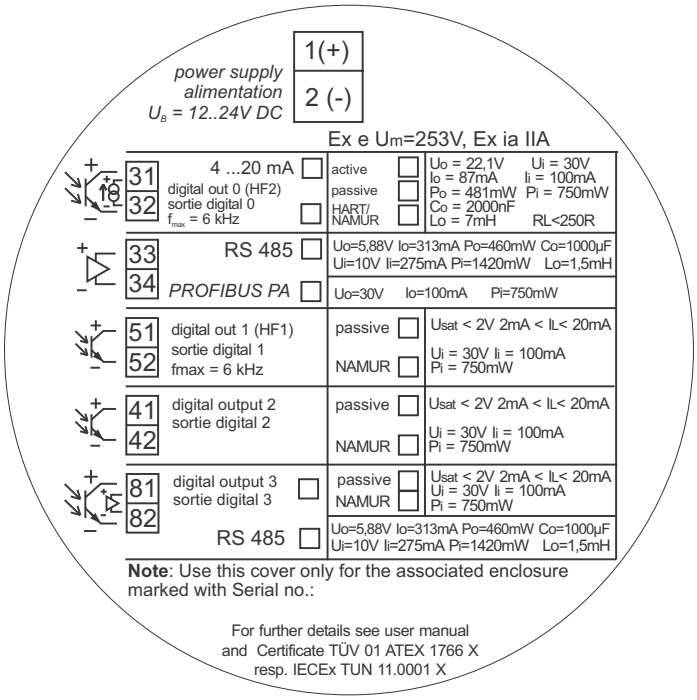
Connection in accordance with ATEX IIC

Figure 101 Terminal assignment in accordance with ATEX IIC



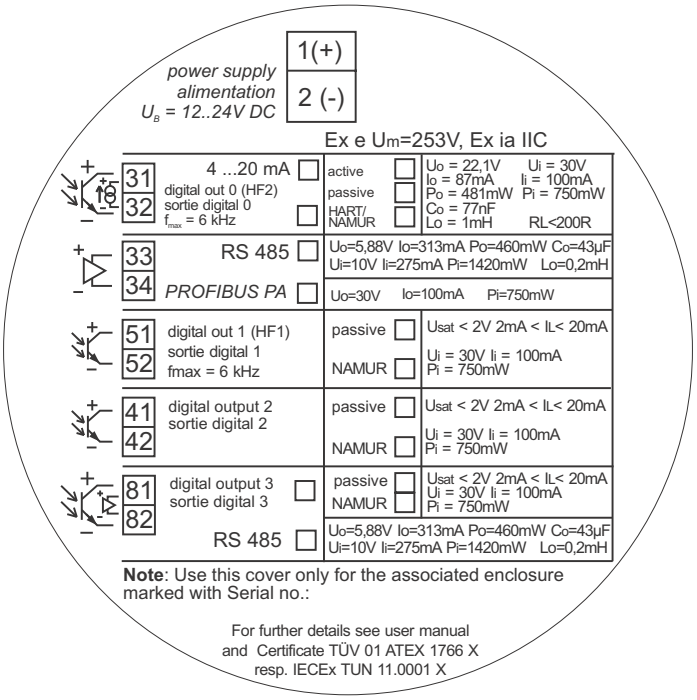
Connection in accordance with ATEX /IECEx IIA

Figure 102 Terminal assignment in accordance with ATEX IIA



Connection in accordance with ATEX /IECEx IIC

Figure 103 Terminal assignment in accordance with ATEX IIC



For CSA SPU Assignment → S. 243, »Control drawing 781.00.02 (page 4)« and following.

9.6 Connection diagrams for operating the FLOWSIC600 in hazardous areas in accordance with North American Requirements (NEC, CEC)

Figure 104 Control drawing 781.00.02 (page 1)

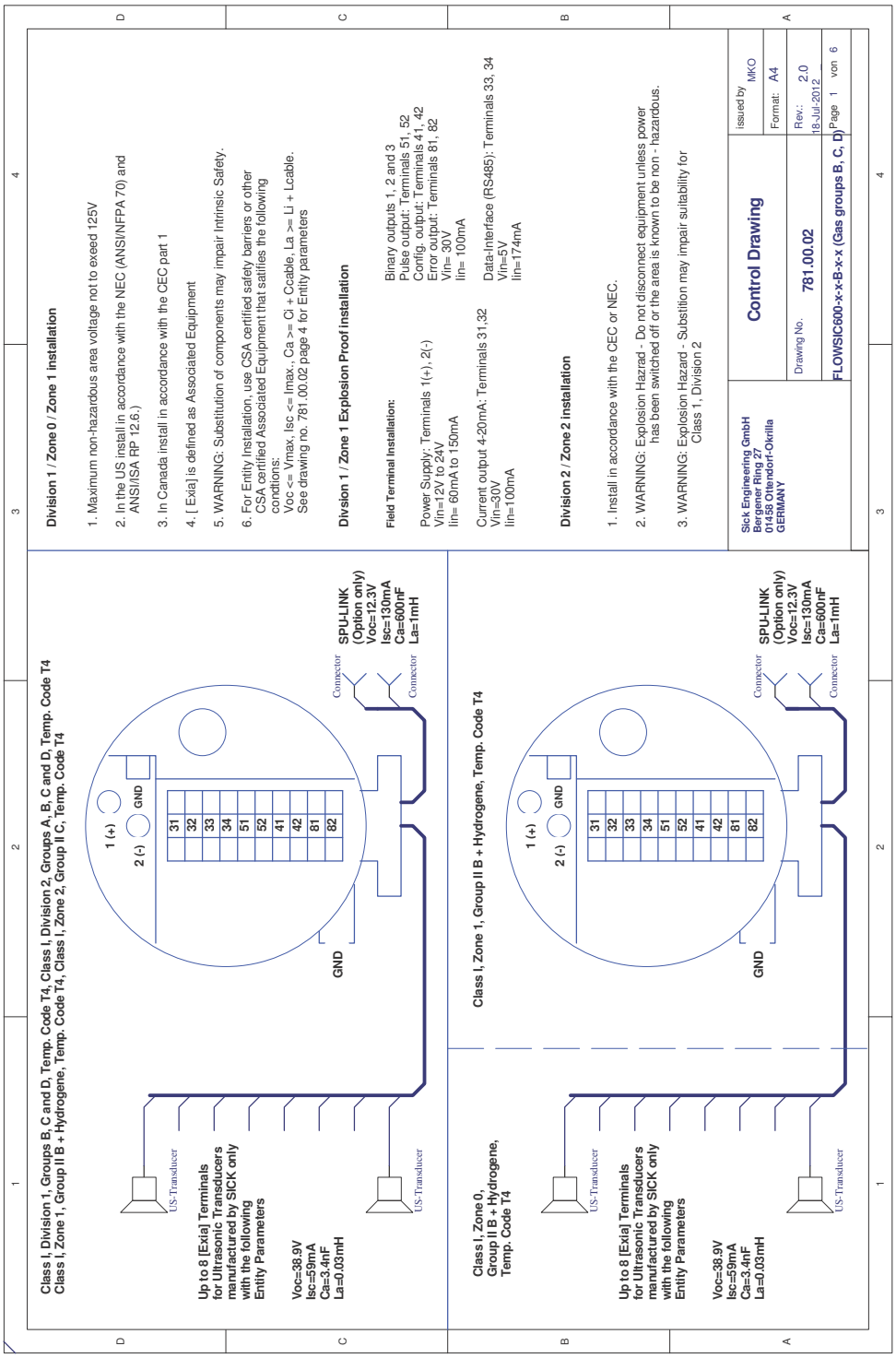


Figure 105 Control drawing 781.00.02 (page 2)

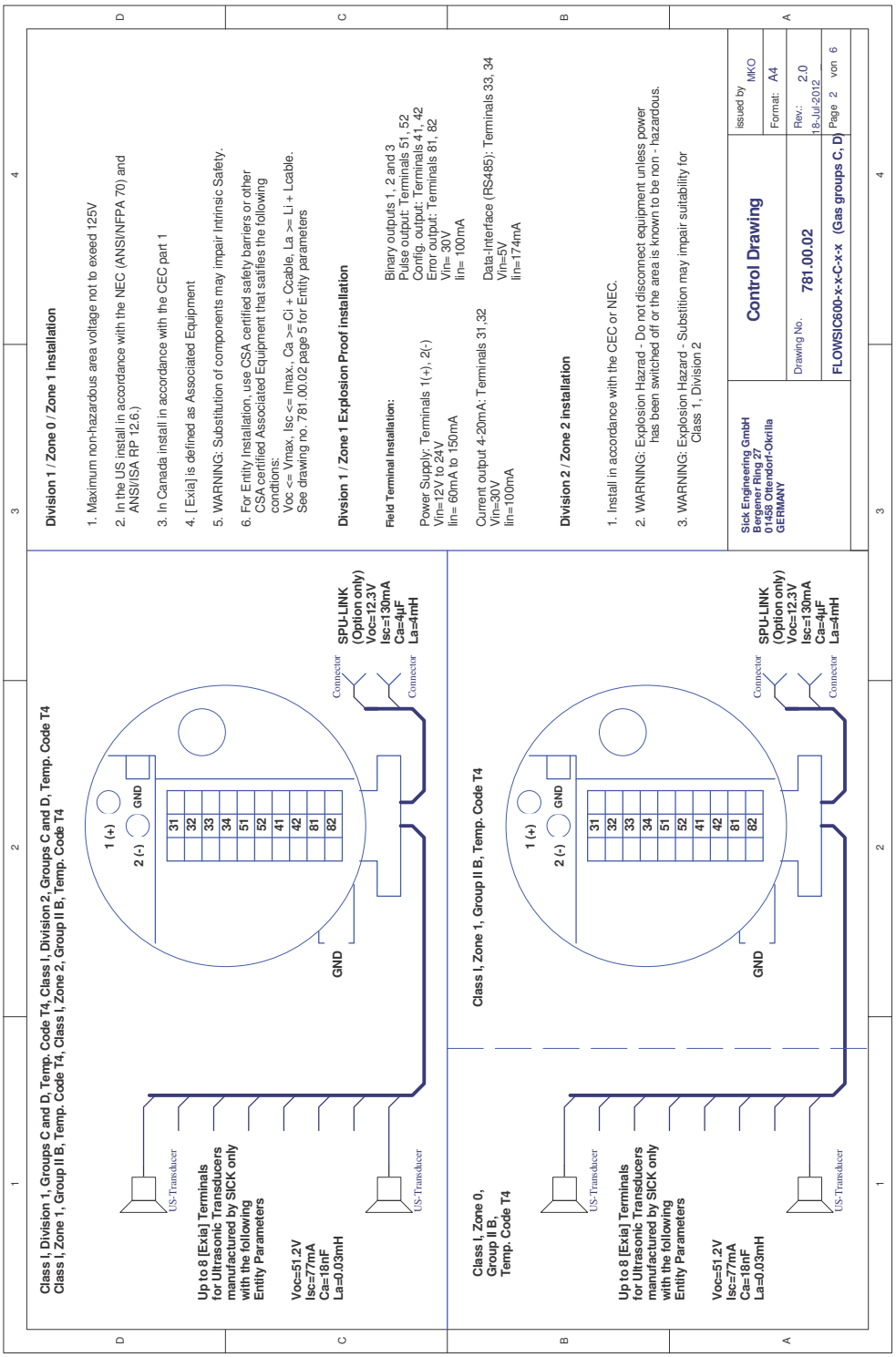


Figure 106 Control drawing 781.00.02 (page 3)

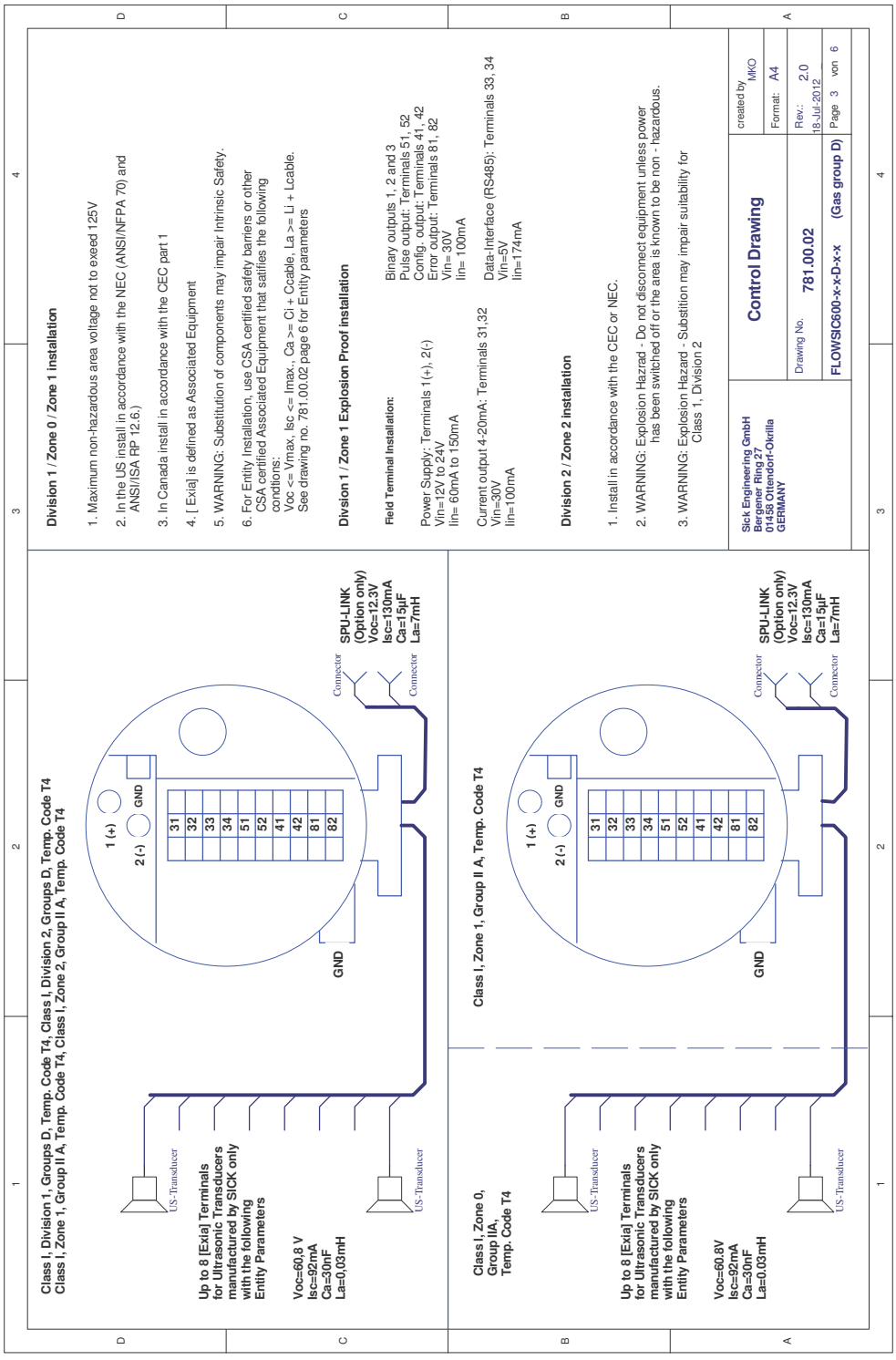


Figure 107 Control drawing 781.00.02 (page 4)

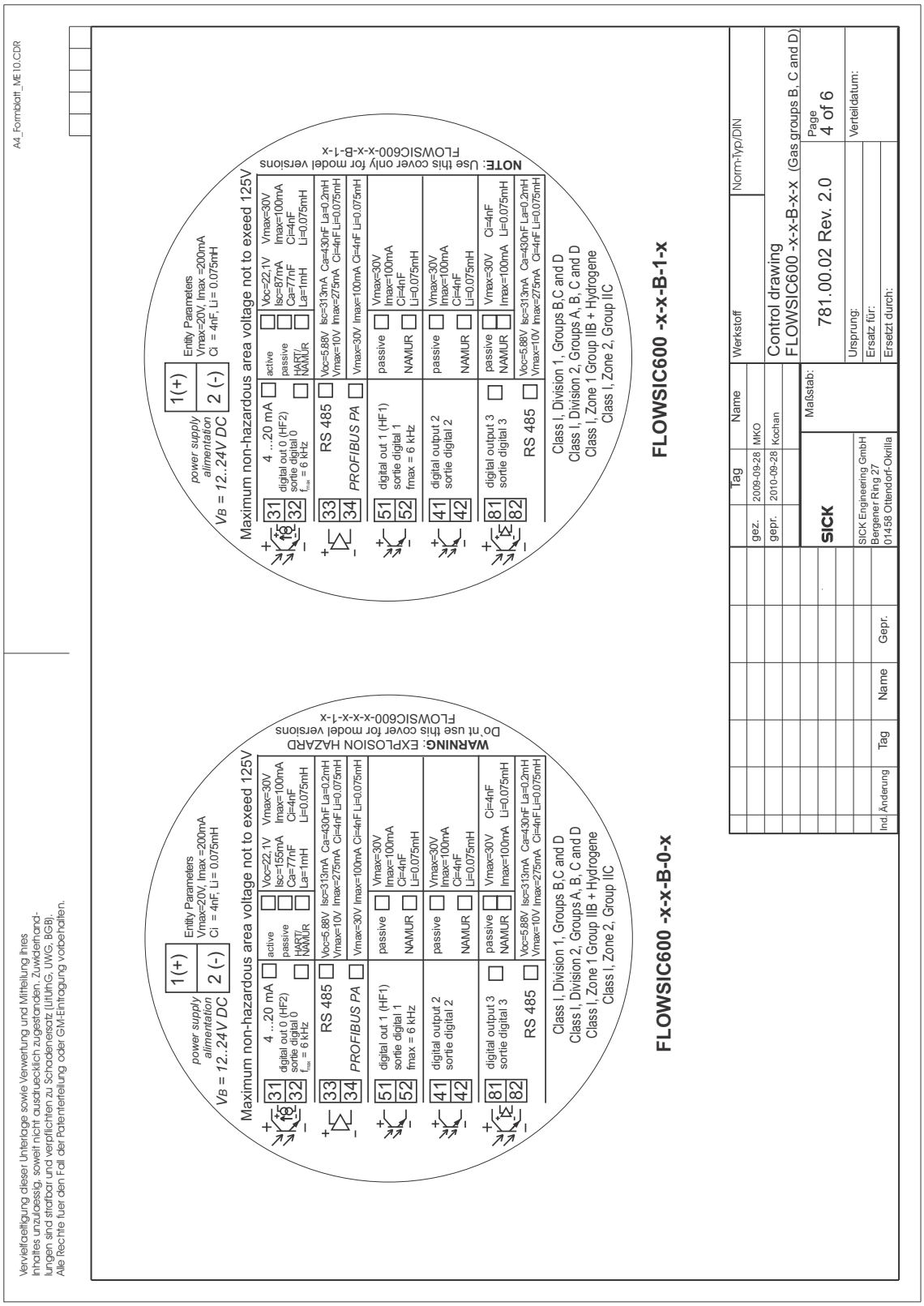


Figure 108 Control drawing 781.00.02 (page 5)

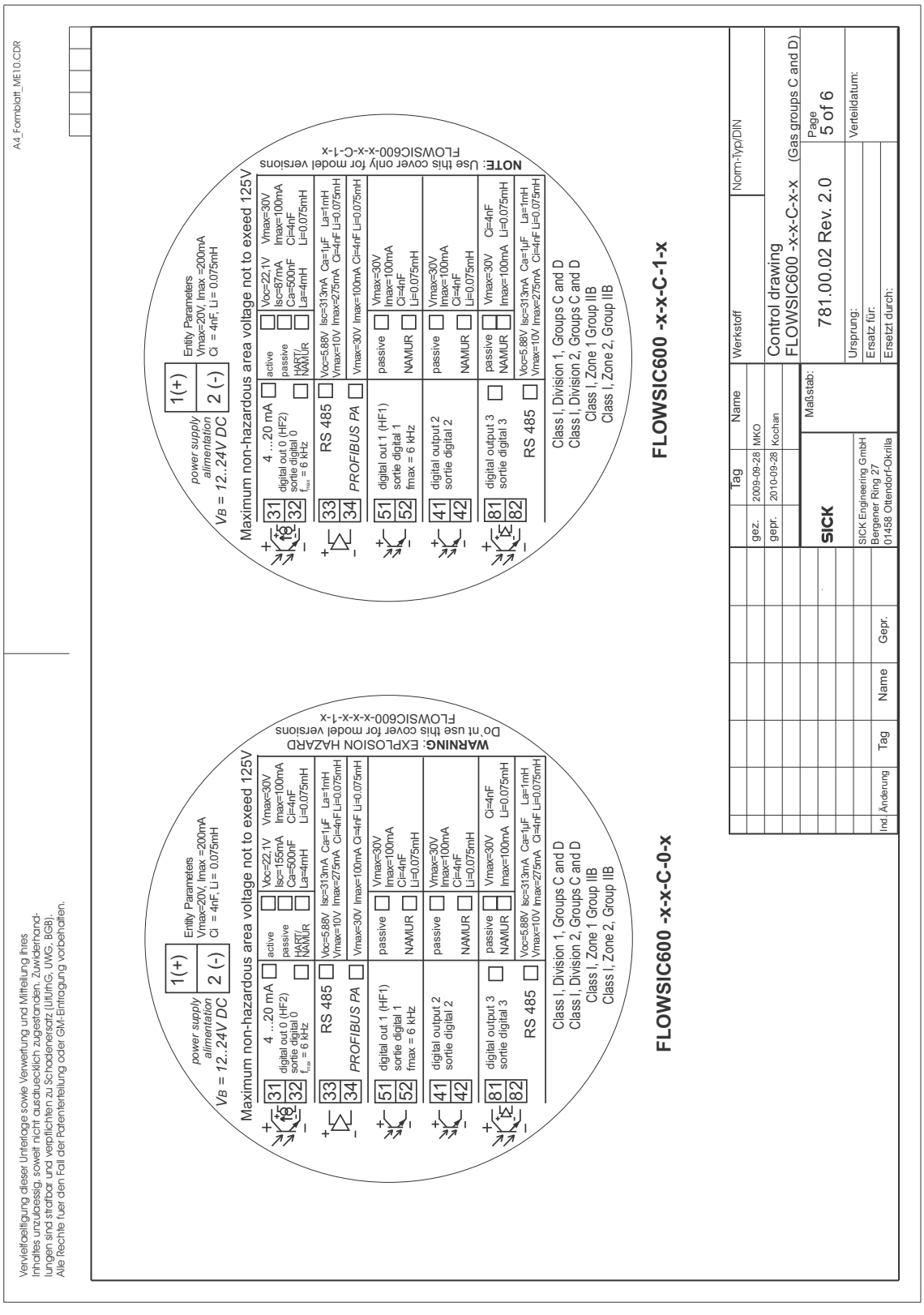
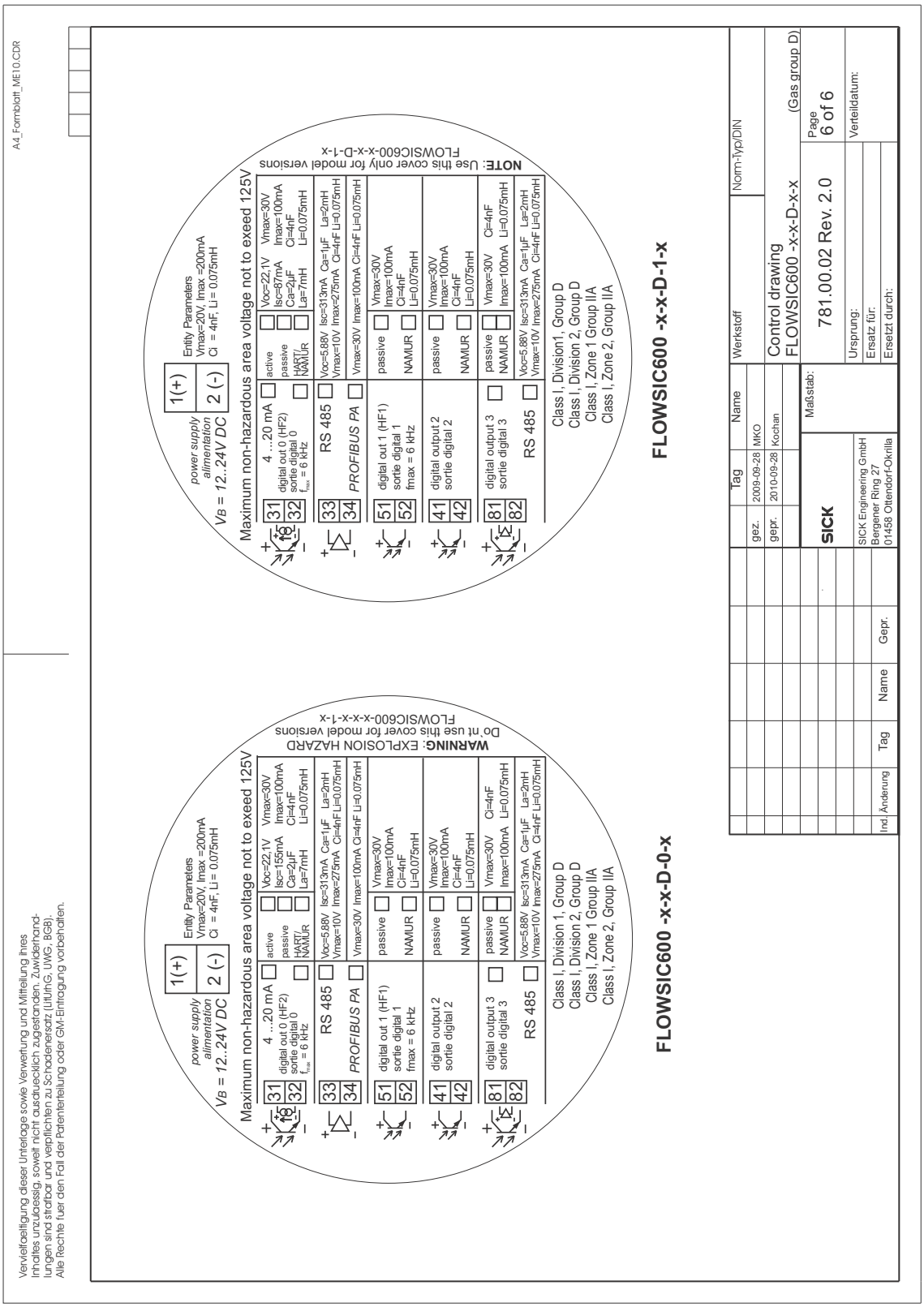


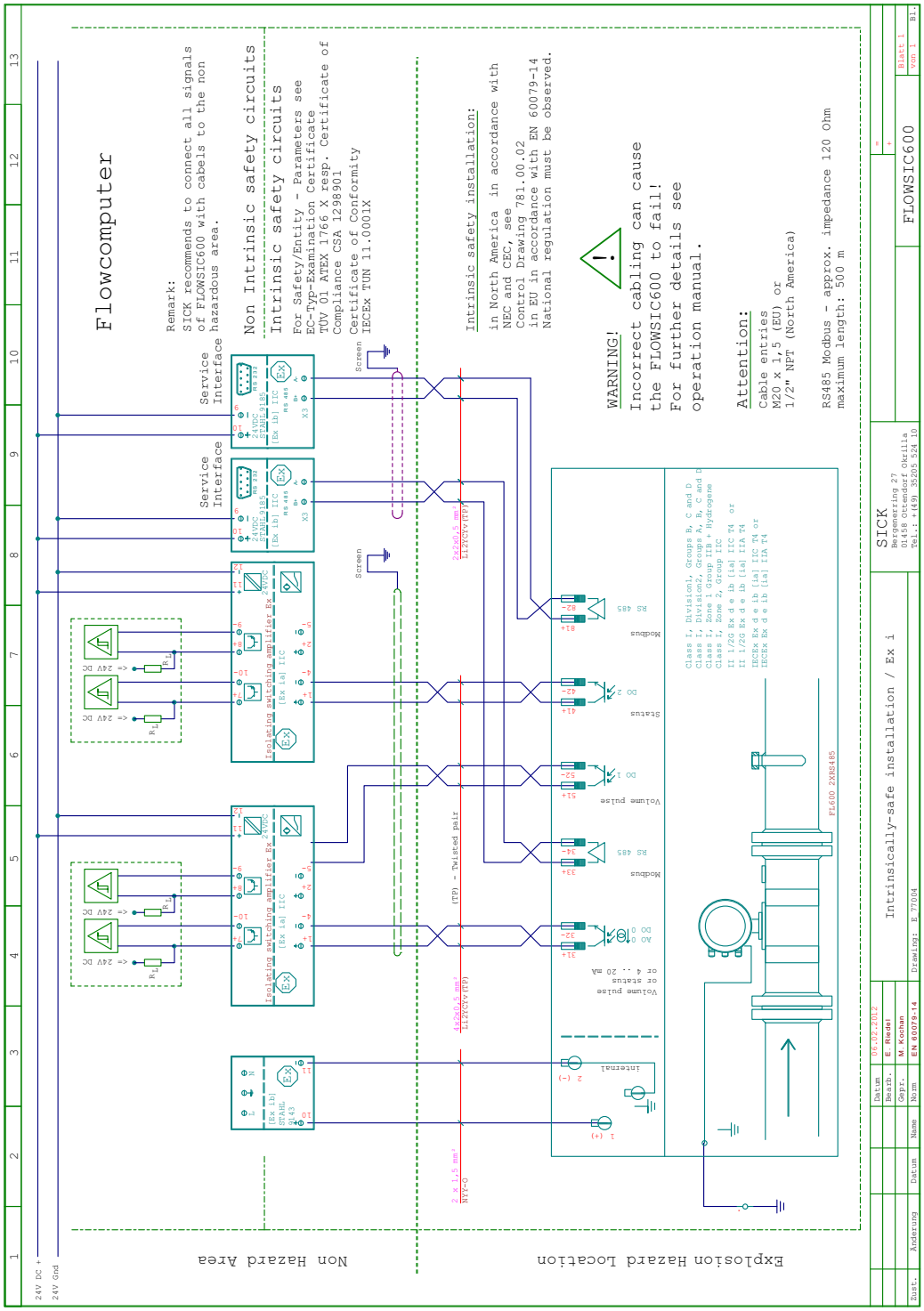
Figure 109 Control drawing 781.00.02 (page 6)



9.7 Wiring examples

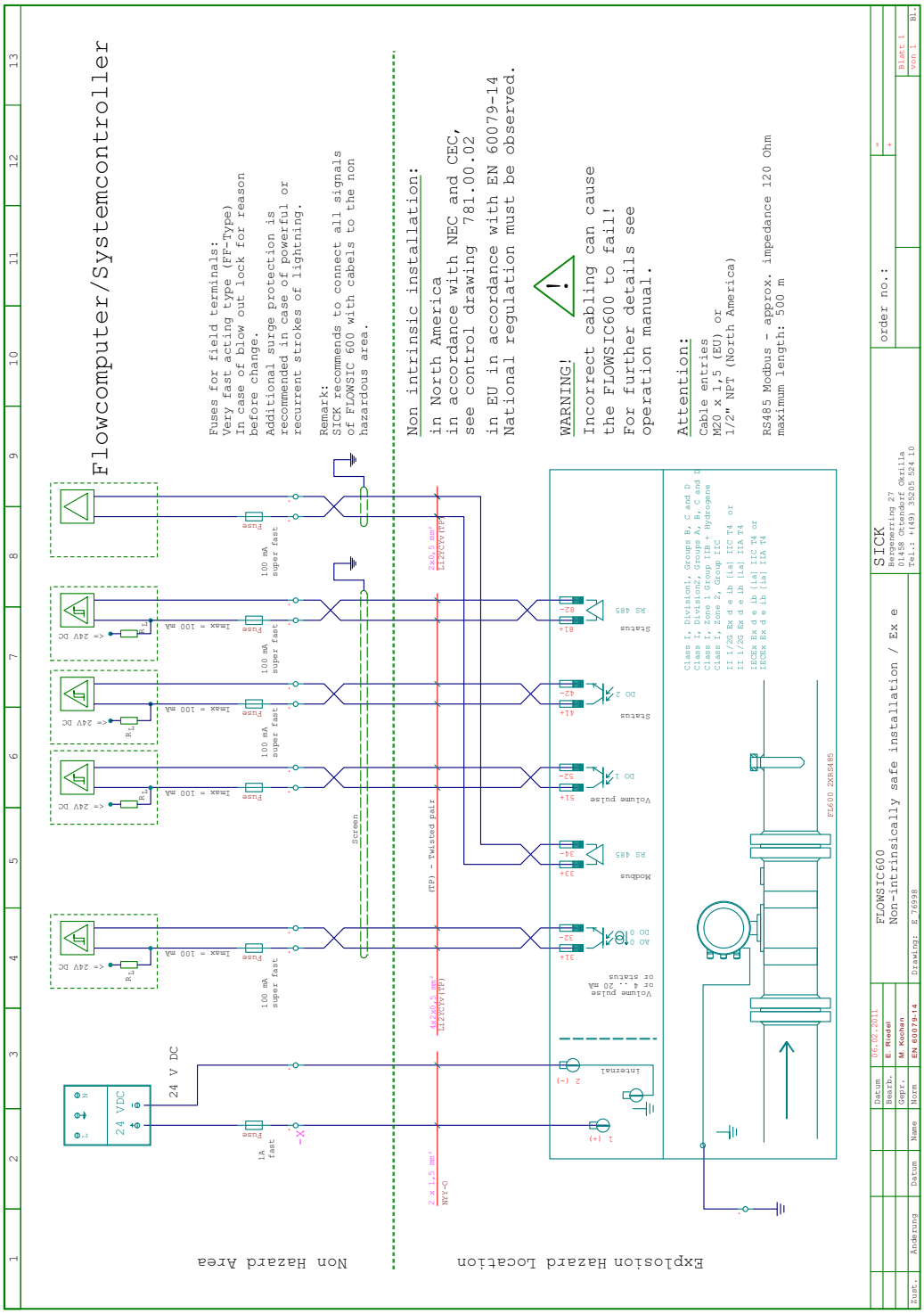
9.7.1 Intrinsically safe installation

Figure 110 FLOWSIC600 intrinsically safe installation



9.7.2 Non-intrinsically safe installation

Figure 111 FLOWSIC600 non-intrinsically safe installation



9.8 Reports created with MEPAFLOW600 CBM

Maintenance report

Figure 112 Maintenance report created with MEPAFLOW600 CBM (example page 1)

FLOWSIC600 - Maintenance Report: ID_20110401144520

SICK Sensor Intelligence.

Station Name:	Demozähler Showroom	Address:	Bergener Ring 27	Meter Date:	01.04.2011	(dd.mm.yyyy)
S/N Meter:	09018502	City/State:	Ottendorf-Okrilla/Dresden	Meter Time:	14:45:19	(hh:mm:ss)
S/N Electronics:	00000000	Country:	Germany	Log Length:	214	(Samples)
S/N Analog board:	06390217	Zip Code:	01458	Last Test Date:	01.04.2011	(dd.mm.yyyy)
Meter Name:	2plex main meter	Technician:	Torsten Eichner			

Meter Operating Avg. Pressure: 10.41 bar(a) Avg. Temperature: 17.78 °C Calculated SOS:

Internal Meter ID:	0.14200 m	Firmware Version:	3500	Average SOS:	345.51 m/s
Internal Pipe ID:	0.15870 m	Firmware CRC:	0xD4B4	SOS Difference:	
Path Number:	4	Parameter CRC:	0x1EAF	Profile Factor:	1.190
Meter Factor:	10 Impulse/m³	Metrology CRC:	0x1155	Symmetry:	0.985
Meter Factor inv.:	0.100000 m³/Impulse	Adjust CRC:	0x129E	Flow Rate:	241.65 m³/h
Signal Stacking:	no	Adjust method:	Adjust factor	Flow Rate Base:	2501.91 Nm³/h

Meter Diagnostics (Paths & Transducers)

VOG [m/s]	Average	Maximum	Minimum
Path 1	3.519	3.663	3.371
Path 2	4.238	4.373	4.082
Path 3	4.256	4.366	4.119
Path 4	3.618	3.901	3.385
Average	3.393	3.440	3.350

SOS [m/s]	Average	Maximum	Minimum
Path 1	345.82	345.88	345.76
Path 2	345.39	345.42	345.34
Path 3	345.37	345.42	345.31
Path 4	345.45	345.53	345.37
Average	345.51	345.53	345.48

	AGC [dB]	SNR [dB]
Path 1 AB	51.8	45.7
Path 1 BA	50.7	46.1
Path 2 AB	55.1	42.0
Path 2 BA	55.0	40.7
Path 3 AB	56.5	44.1
Path 3 BA	56.1	44.9
Path 4 AB	51.0	45.9
Path 4 BA	50.0	46.2
Avg AB	53.6	44.4
Avg BA	52.9	44.5

	Perform. Avg [%]	Turbulence Avg [%]	Velocity Ratio	ACC Diff. AB - BA
Path 1	100	4.2	1.037	1.136
Path 2	100	2.4	1.249	0.117
Path 3	100	2.6	1.254	0.397
Path 4	100	5.2	1.066	1.000
Average	100	3.6	1.152	0.662

Counter Readings			
Volume [m³]	Normal	Error	Total
Forward	1021692.2	48.0	1056405.9
Reverse	120327.7	0.0	132174.1

User warnings

System warnings

Profile factor	
Symmetry	
Theoretical SOS deviation	
High Gas Velocity	
Low Input Voltage	
Logbook full of unack. entries	
Diagnostic difference	

Path warnings

	P1	P2	P3	P4
Path turbulence				
SNR limit				
AGC limit				
AGC deviation				
SOS deviation				
Performance limit				

Legend
- Warning not active
- Warning active
- Disabled

Meter Status

Operating Mode

Operation Mode	
Configuration Mode	
Air test activ	

Meter Status

Measurement valid	
Check request	
User Warning Limit exceeded	
Path failure	

System

Volume counter CRC error (a.c.)	
Volume counter CRC error (s.c.)	
I/O Impulse out of range	
System time invalid (RTC error)	
Firmware CRC error	
Logbook(s) contains unack. entries	
Battery LifeSpan (change battery)	
Signature error	

Parameters

Parameter CRC error	
Parameter invalid	
Parameter defaults loaded	
Path Comp. Param. error	
DSP Parameter error	

Legend
- OK, no alarm or warning active
- Warning active
- Alarm active
- Disabled
- On (enabled/active)
- Off (disabled/inactive)

Electronic Volume Corrector (EVC)

EVC hardware error	
EVC parameter invalid	
HART com p. error	
HART com. T error	

Measurement

DSP error	
DSP boot error	
DSP measure invalid	
Adjust range error	
Path compensation valid	
Continuous measure mode	
Filter mode active	

Logbooks

	CRC Error	Full
Custody Logbook [1]		
Warning Logbook [2]		
Parameter Logbook [3]		

DataLogs

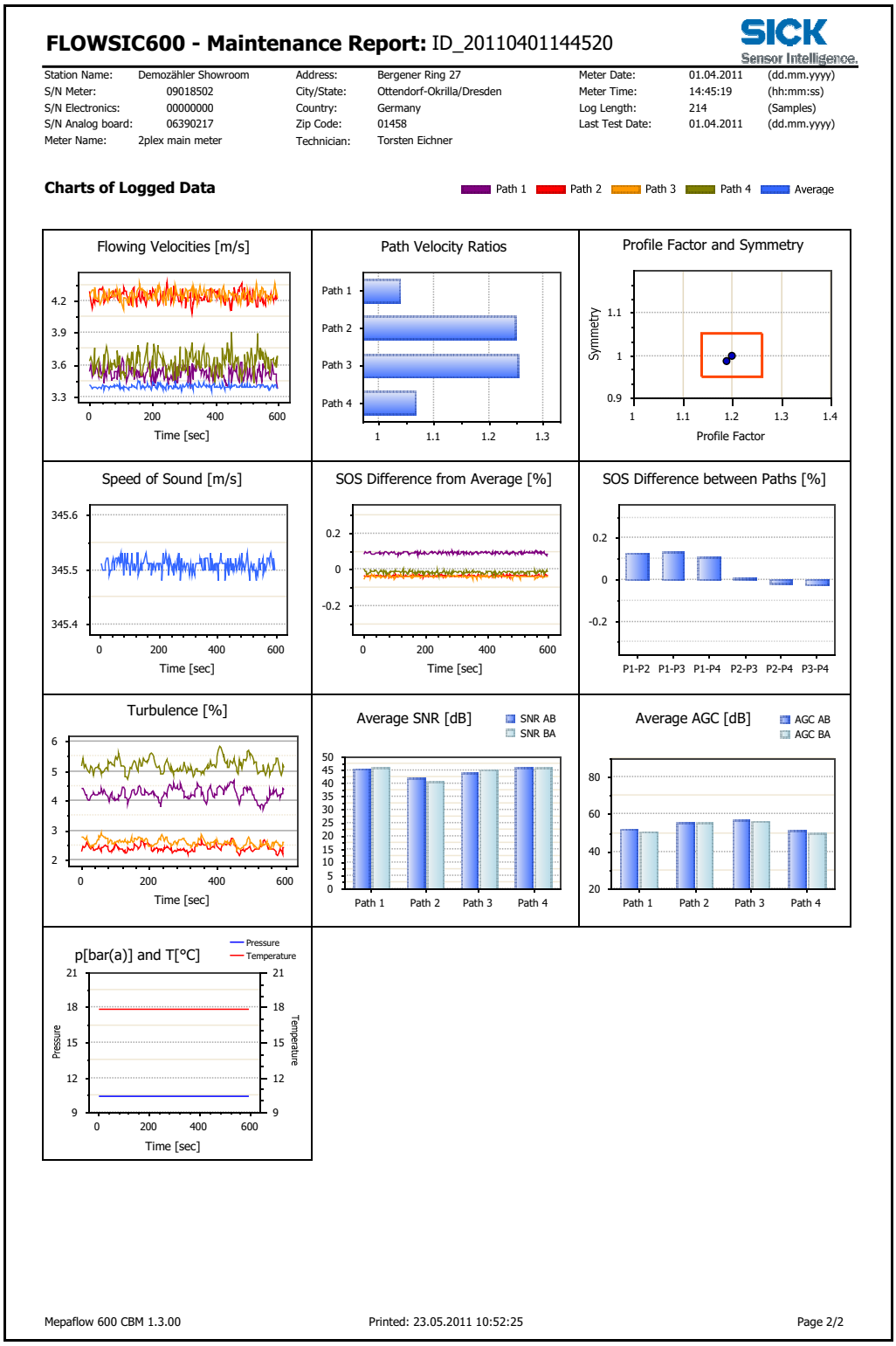
	CRC Error	Full
Diagnostic Comparison (DataLog1)		
Hourly Log (DataLog2)		
Daily Log (DataLog 3)		

Parameter write lock:	UNLOCKED
Unit system in meter	METRIC

Tested By: _____ Witness: _____ Date: _____

Mepaflow 600 CBM 1.3.00 Printed: 23.05.2011 10:52:25 Page 1/2

Figure 113 Maintenance report created with MEPAFLOW600 CBM (example page 2)



9.8.1 Custody Parameter Report

Figure 114 Custody parameter report created with MEPAFLOW600 CBM (example)

FLOWSIC600-Custody Parameter Report

SICK Sensor Intelligence.

Meter name	**4pfad**	S/N Meter	**09018502**
Description		S/N Electronic	**00000000**
Station name	**Demozähler Showroom**	S/N Analog board	**06390217**
Company		Meter type	**FL600 - 4P - 6 inch - ATEX IIA T4 - S2 sensors**
Address		Meter factor	**10** Impulse/m³

Pe min	**4.7** bar(g)	Firmware version	**3500**	Unit system	**Metric**
Pe max	**18.8** bar(g)	Metrology CRC	**0x007E**	Firmware CRC	**0xD4B4**
Pressure fix.	**10.4111** bar(a)	Adjust CRC	**0x129E**	Parameter CRC	**0x0AF1**
Temperature fix.	**17.78** °C				

Serial Numbers of Sensors

	Path 1	Path 2	Path 3	Path 4
Transducer A	**08290259**	**08290324**	**08290292**	**08290297**
Transducer B	**08290253**	**08290262**	**08290263**	**08290264**

Meter adjustment

Adjust mode **1-Adjust factor** LowFlowCutOff **4.0** m³/h

Forward direction

Adjust mode - Linear
Factor forward **1.00240**

Adjust mode - Polynom

Adjust A-2	0.000000E+000
Adjust A-1	-6.990760E-001
Adjust A0	9.980881E-001
Adjust A1	-4.148707E-006
Adjust A2	0.000000E+000

Calibration Data

Point i	Qact[m³/h]	QMUT/Qref*	Deviation as found[%]**	Deviation as left[%]**
1	1.03	0.99590	-0.41	-0.17
2	2.83	1.00000	0.00	0.24
3	7.07	0.99680	-0.32	-0.08
4	11.31	0.99600	-0.40	-0.16
5	19.81	0.99800	-0.20	0.04
6	28.32	0.99800	-0.20	0.04
7	-	-	-	-
8	-	-	-	-
9	-	-	-	-
10	-	-	-	-
11	-	-	-	-
12	-	-	-	-

Reverse direction

Adjust mode - Linear
Factor reverse **1.00000**

Adjust mode - Polynom

Adjust A-2	0.000000E+000
Adjust A-1	0.000000E+000
Adjust A0	1.000000E+000
Adjust A1	0.000000E+000
Adjust A2	0.000000E+000

Calibration Data

Point i	Qact[m³/h]	QMUT/Qref*	Deviation as found[%]**	Deviation as left[%]**
1	-	-	-	-
2	-	-	-	-
3	-	-	-	-
4	-	-	-	-
5	-	-	-	-
6	-	-	-	-
7	-	-	-	-
8	-	-	-	-
9	-	-	-	-
10	-	-	-	-
11	-	-	-	-
12	-	-	-	-

*MUT Meter Under Test **Additional information

Interface

Modbus ID 1

MODBUS (1) - Terminal 33/34		Service (2) - internal		Extended (3) - Terminal 81/82	
Baudrate	57600	Baudrate	9600	Baudrate	9600
Responce delay	0 ms	Responce delay	0 ms	Responce delay	0 ms
Protocol	GENERIC_MODBUS_RTU	Protocol	SICK_MODBUS_ASCII	Protocol	SICK_MODBUS_ASCII

Parameter state of 2/23/2011 15:36:31 <online>
Printed on 2/23/2011 15:36:32 Page 1 of 1

9.8.2 Calibration Report

Figure 115 Calibration report created with MEPAFLOW600 CBM (example)

FLOWSIC600 - Calibration Report 1/2

SICK Sensor Intelligence.

Device	Ultrasonic meter	**S/N Meter**	09018502
Type	FLOWSIC600	**S/N Electronics**	00000000
Nominal Diameter	0.15870 m	**Meter Type**	FL600 - 4P - 6 inch - ATEX IIA T4 - S2 Sensors
Calibration Range		**Firmware version**	V3500
Manufacturer	SICK Engineering GmbH	**Firmware CRC**	0xD4B4
Customer	ABCDEF	**Parameter CRC**	0x0AF1
Calibration Institute	ABCDEF	**Metrology CRC**	0x007E
Date of calibration	2/23/2011 2:34:54 PM	**Adjust CRC**	0x129E

Calibration data and results - Forward

Adjust method	Constant factor	**Pressure (Pressure Fix)**	10.41 bar(a)
Flow direction	Forward	**Temperature (Temp. Fix)**	17.78 °C
FWME as found [%]	-0.2392	**Meter factor**	10 Impulse/m³
FWME as left [%]	0.0000		

Point i	Qact (MUT*)[m³/h]	QMUT*/Qref*	Dev. as found[%]**	Dev. as left[%]**
1	1.03	0.99590	-0.41	-0.17
2	2.83	1.00000	0.00	0.24
3	7.07	0.99680	-0.32	-0.08
4	11.31	0.99600	-0.40	-0.16
5	19.81	0.99800	-0.20	0.04
6	28.32	0.99800	-0.20	0.04
Sum	**70.37**	**5.98470**	**-1.53**	**-0.09**

*MUT: Meter Under Test **Additional information

Parameter state of 2/23/2011 15:35:59 <online>
Printed on 2/23/2011 15:35:59

Page 1 of 2

9.9 Sealing plan

Figure 116 Sealing plan, part 1 (cast version)

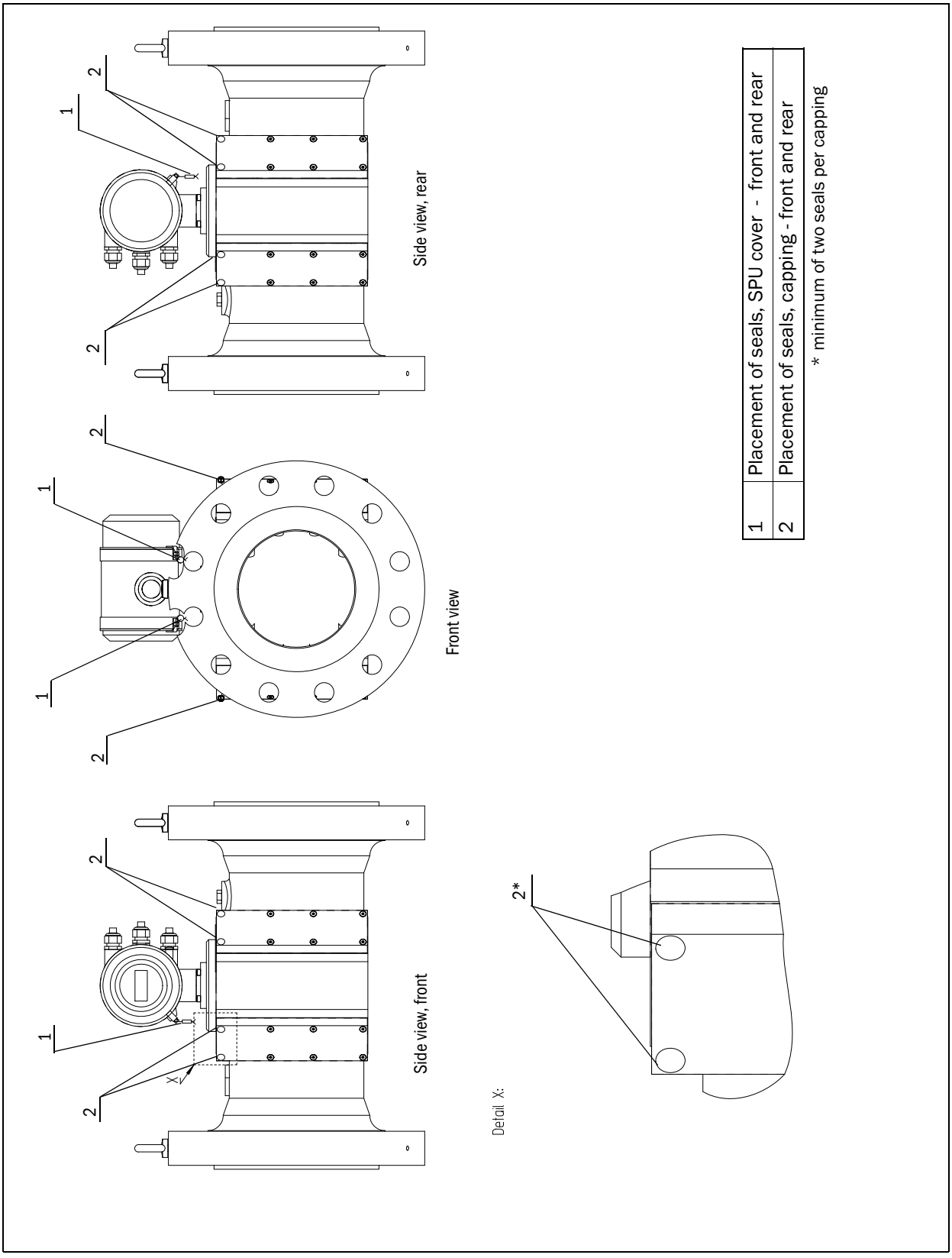


Figure 117 Sealing plan, part 2 (cast version)

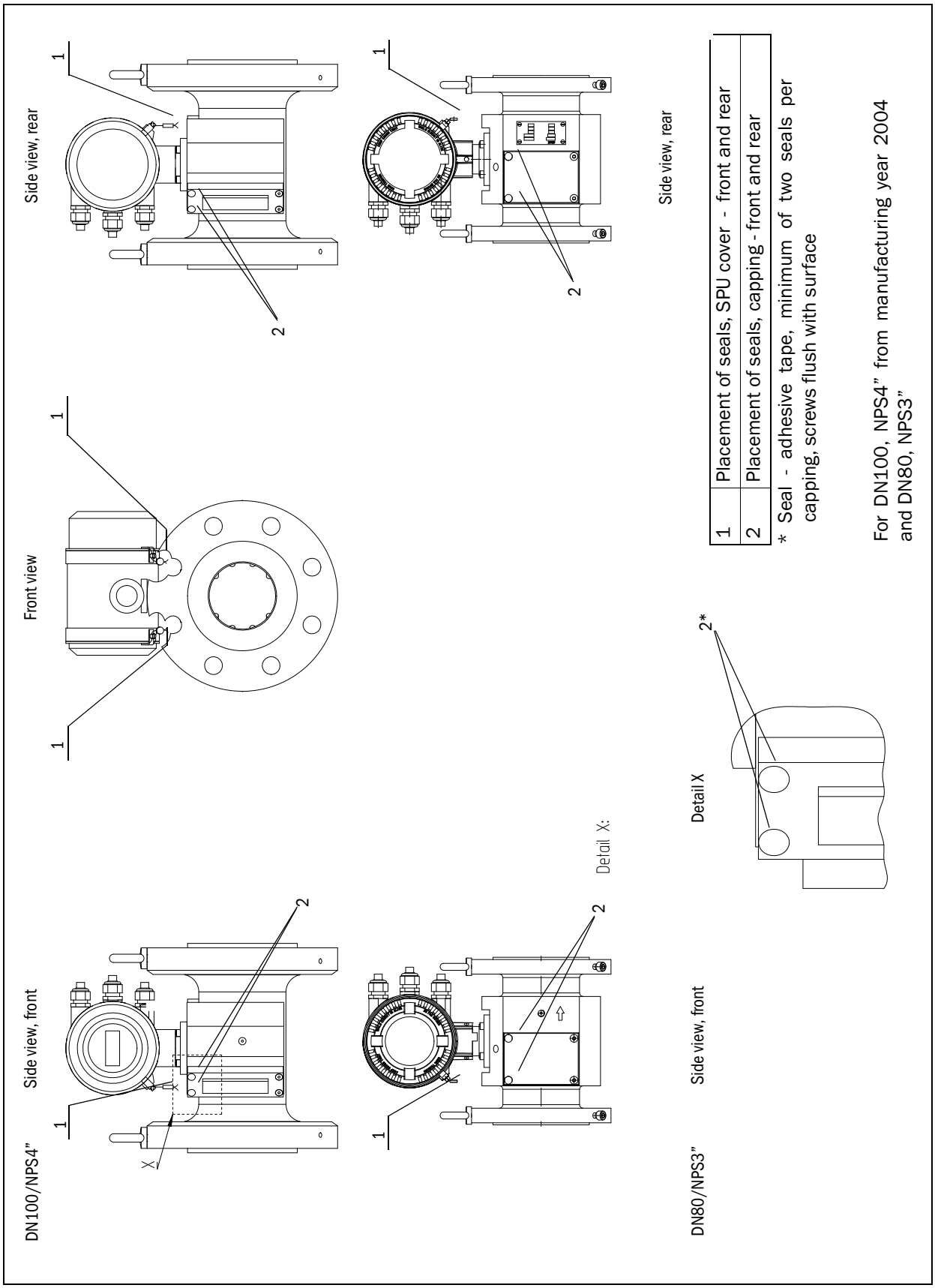


Figure 118 Sealing plan, part 3 (forged version)

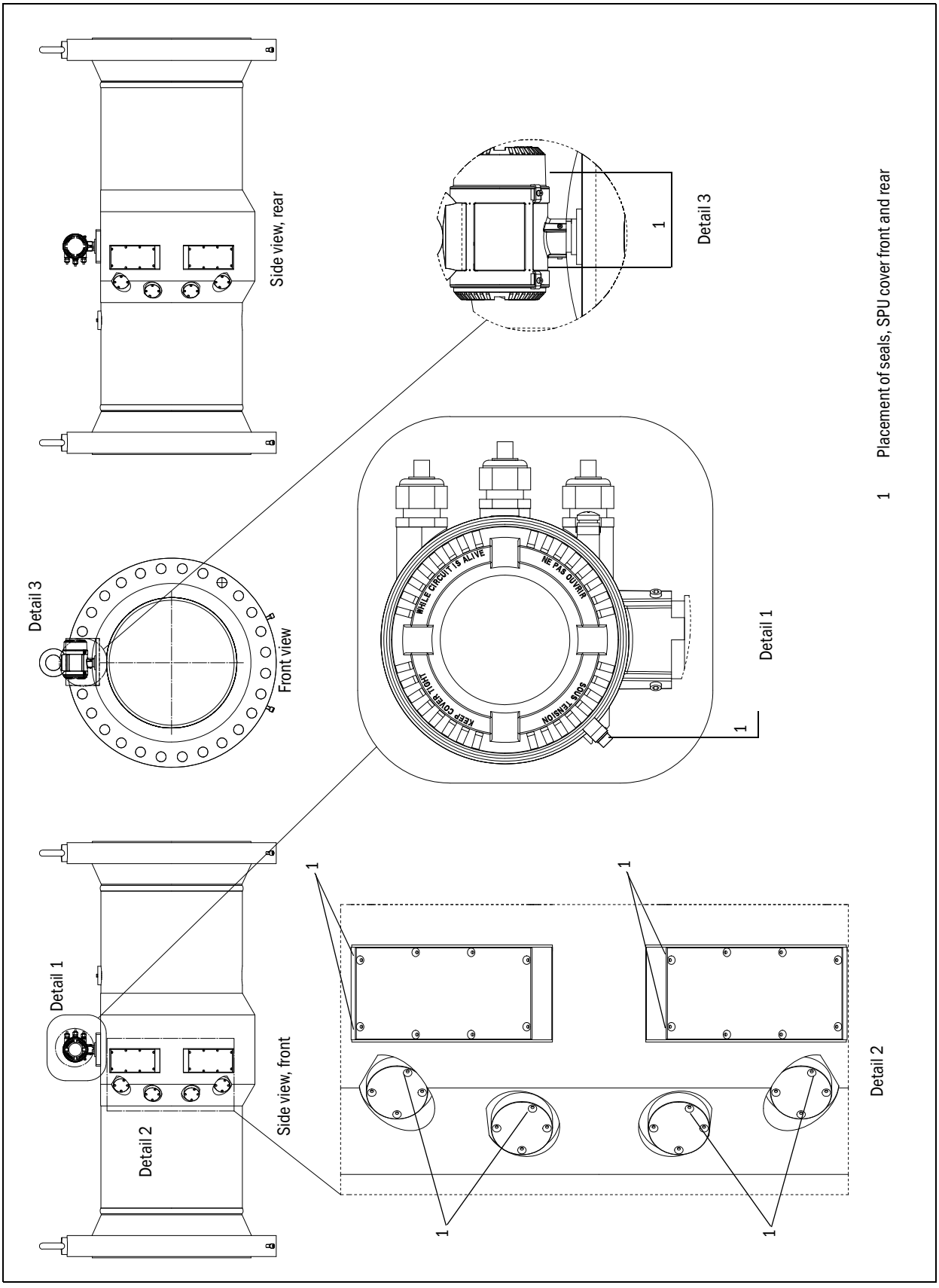
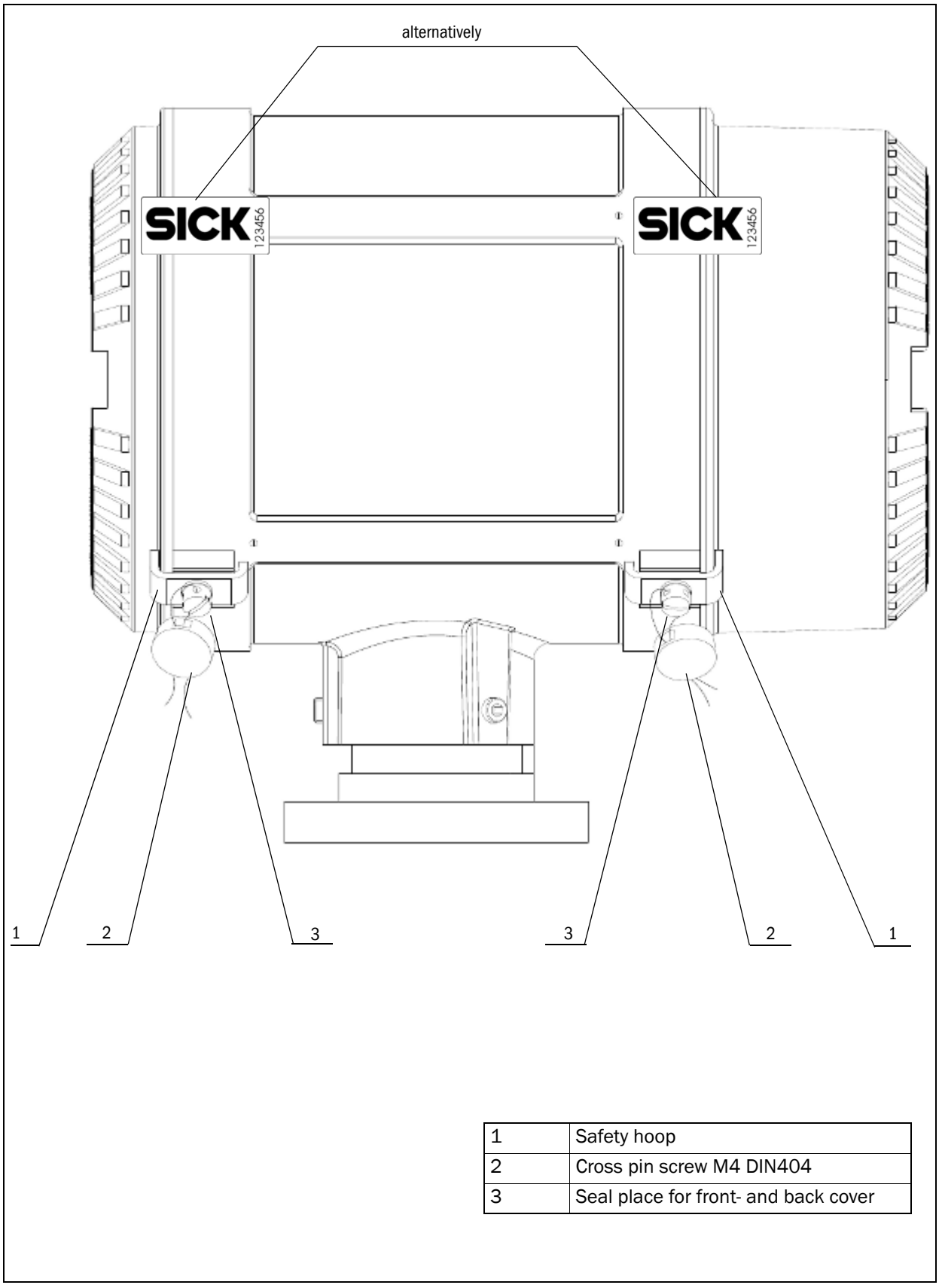
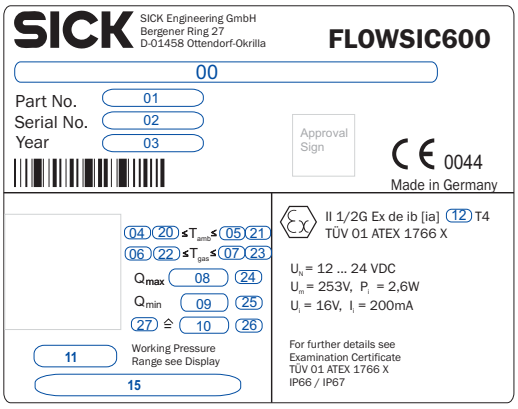


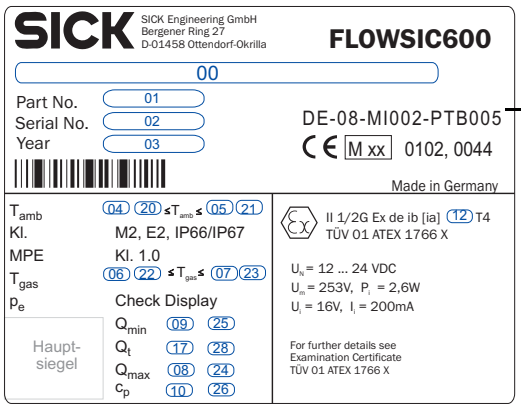
Figure 119 Sealing plan, part 4



1	Safety hoop
2	Cross pin screw M4 DIN404
3	Seal place for front- and back cover

Figure 120 Examples: Main type plates on the signal processing unit (right: including conformity label)

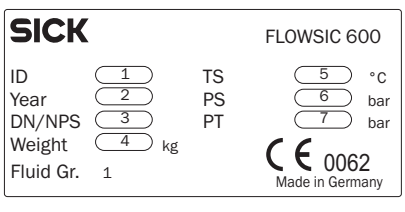




Conformity label

Variable	Bezeichnung	Bezeichnung
00	Typschlüssel	Device type
01	Artikelnummer	Part Number
02	Seriennummer	Serial Number
03	Baujahr	Year
04	Min. Umgebungstemperatur	Min. Ambient Temperature
05	Max Umgebungstemperatur	Max Ambient Temperature
06	Min. Mediumstemperatur	Min. Gas Temperature
07	Max. Mediumstemperatur	Max. Gas Temperature
08	Max. Durchfluss	Max. Flow rate
09	Min. Durchfluss	Min. Flow rate
10	Impulswertigkeit	K-Factor
11	Baugröße	Size
12	Gasgruppe Ex	Gas group Ex
13	Modellnummer	Model Number
14	-	Type approval
15	Verwendung	use
16	-	Year short (YY)
17	Trenndurchfluss	transition flow rate
18	-	-
19	-	-
20	Einheit zu (04)	unit to (04)
21	Einheit zu (05)	unit to (05)
22	Einheit zu (06)	unit to (06)
23	Einheit zu (07)	unit to (07)
24	Einheit zu (08)	unit to (08)
25	Einheit zu (09)	unit to (09)
26	Einheit zu (10)	unit to (10)
27	unit Vol	unit Vol
28	Einheit zu (17)	unit to (17)

Figure 121 Example: Type plate on the meter body



Variable	Bezeichnung	Description
1	Messaufnehmer Identifikation	Meter Body Identifikation
2	Datum	Date
3	Nominale Nennweite mm/inch	Nominal Pipe Size mm/inch
4	Gewicht	Weight
5	Einsatztemperaturbereich min/max	Temperature Range min/max
6	Max. Betriebsüberdruck	Max. Operating Overpressure
7	Prüfüberdruck	Test Overpressure

9.10 Outline drawings

Figure 122 Outline drawing FLOWSIC600 1-path

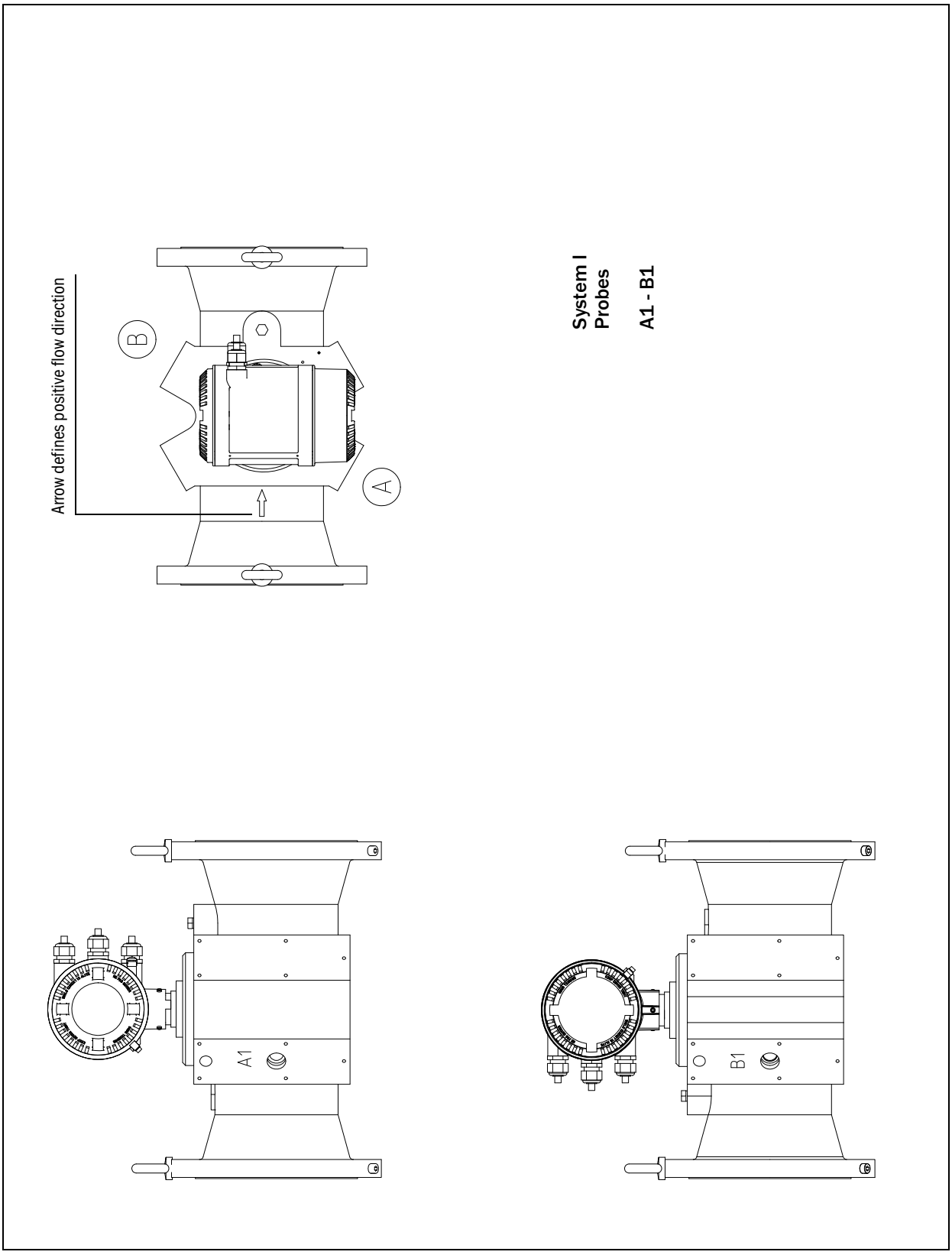


Figure 123 Outline drawing FLOWSIC600 2-path

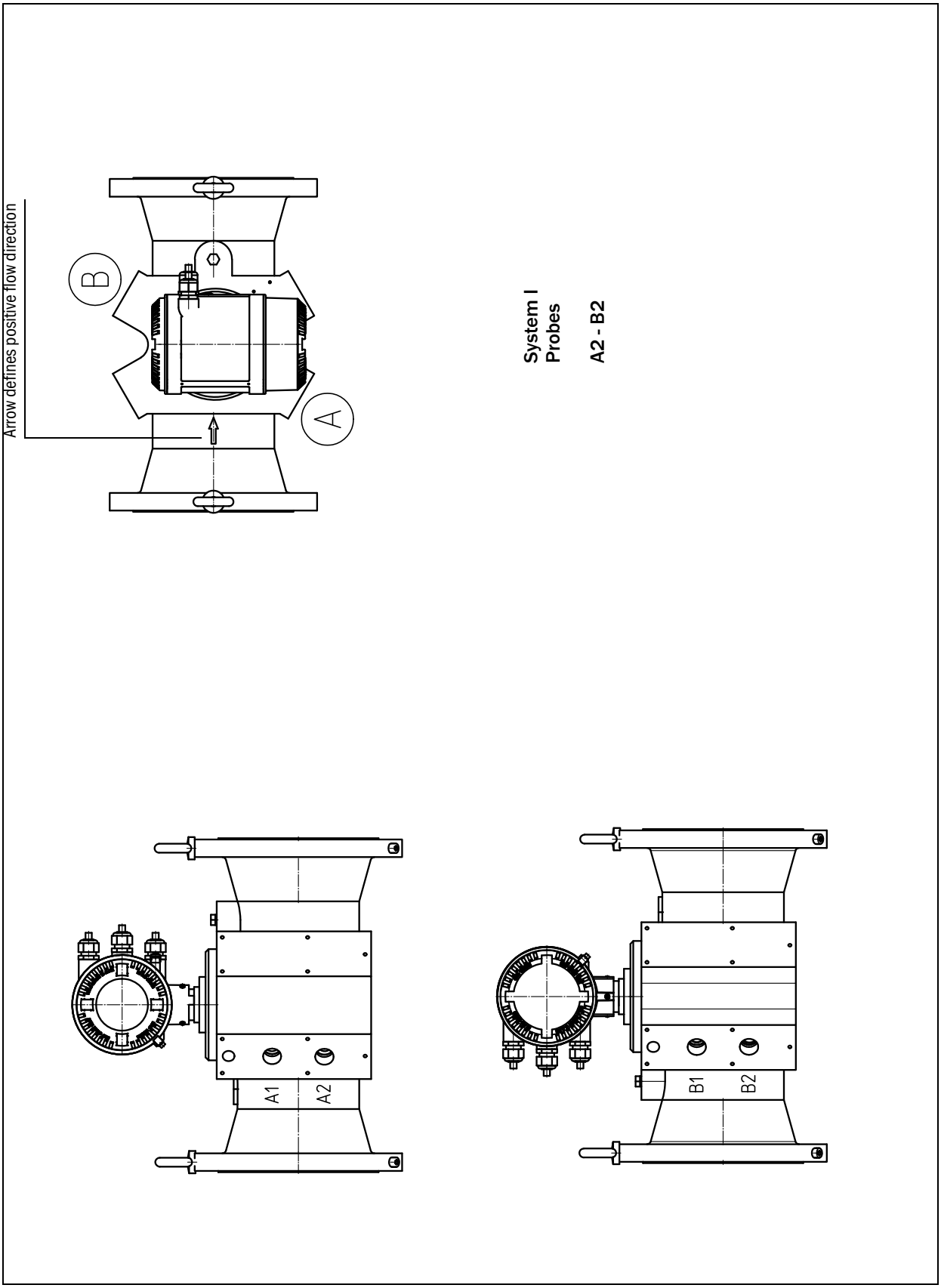


Figure 124 Outline drawing FLOWSIC600 4-path

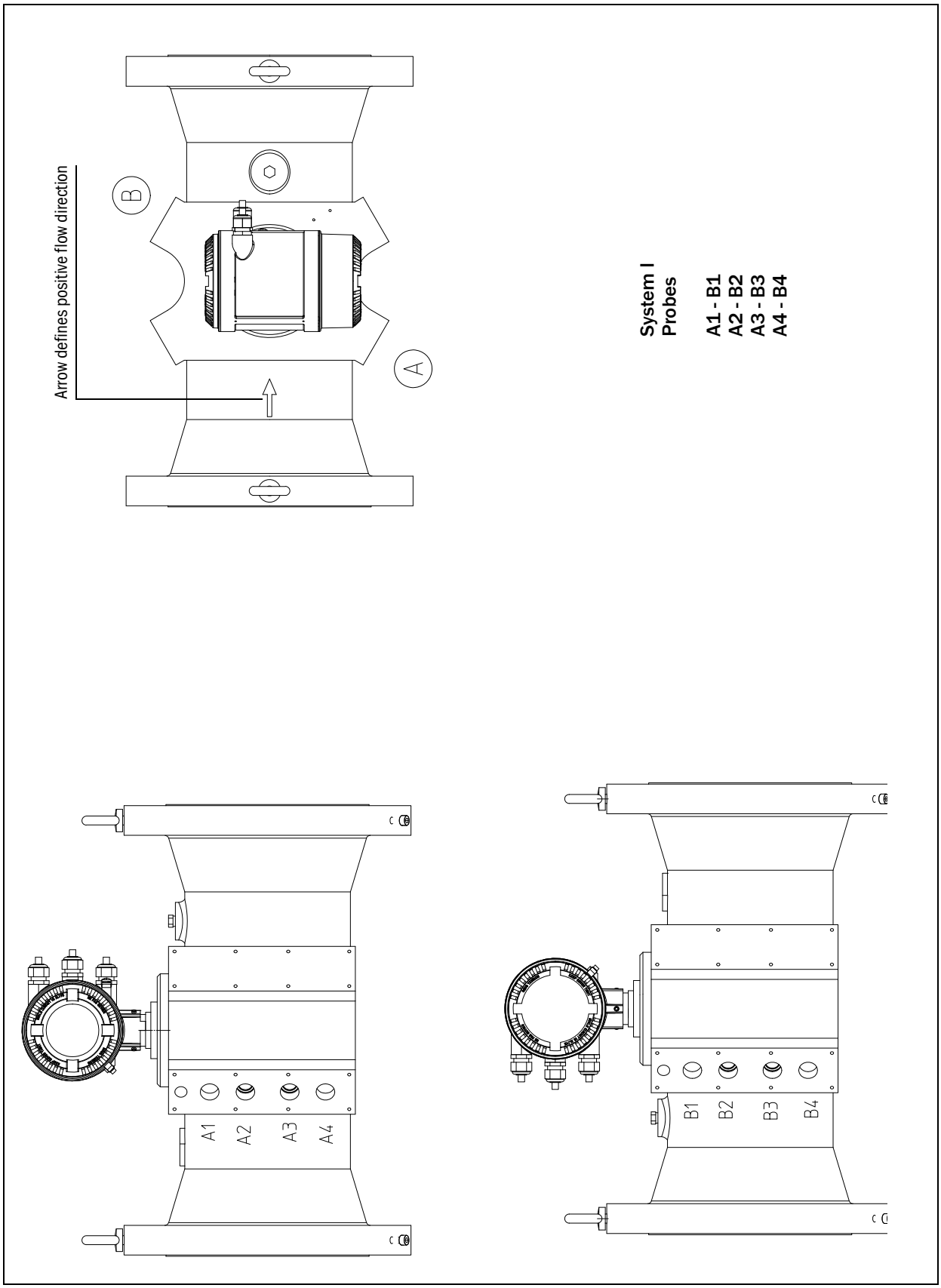


Figure 125 Outline drawing FLOWSIC600 2plex

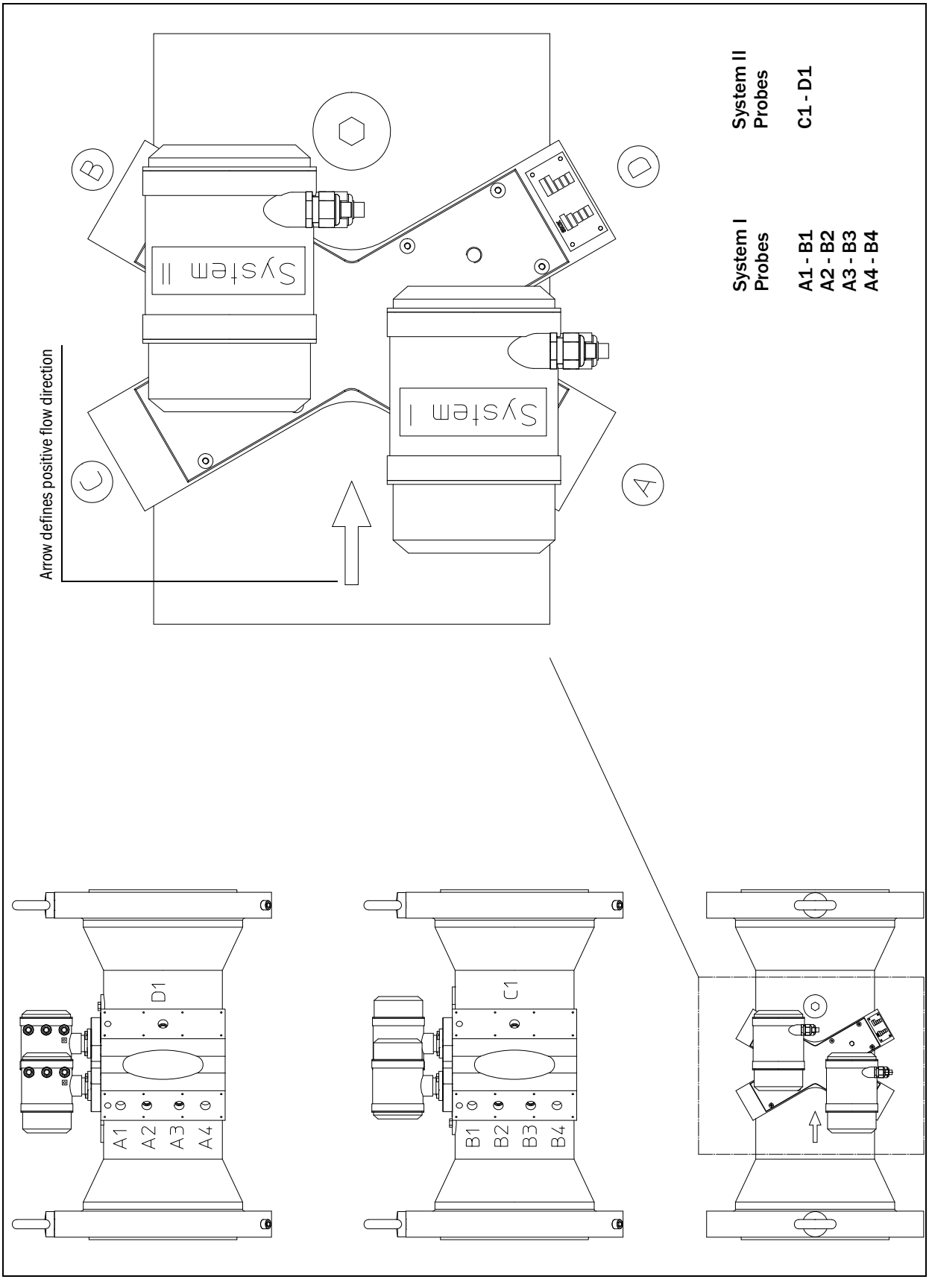
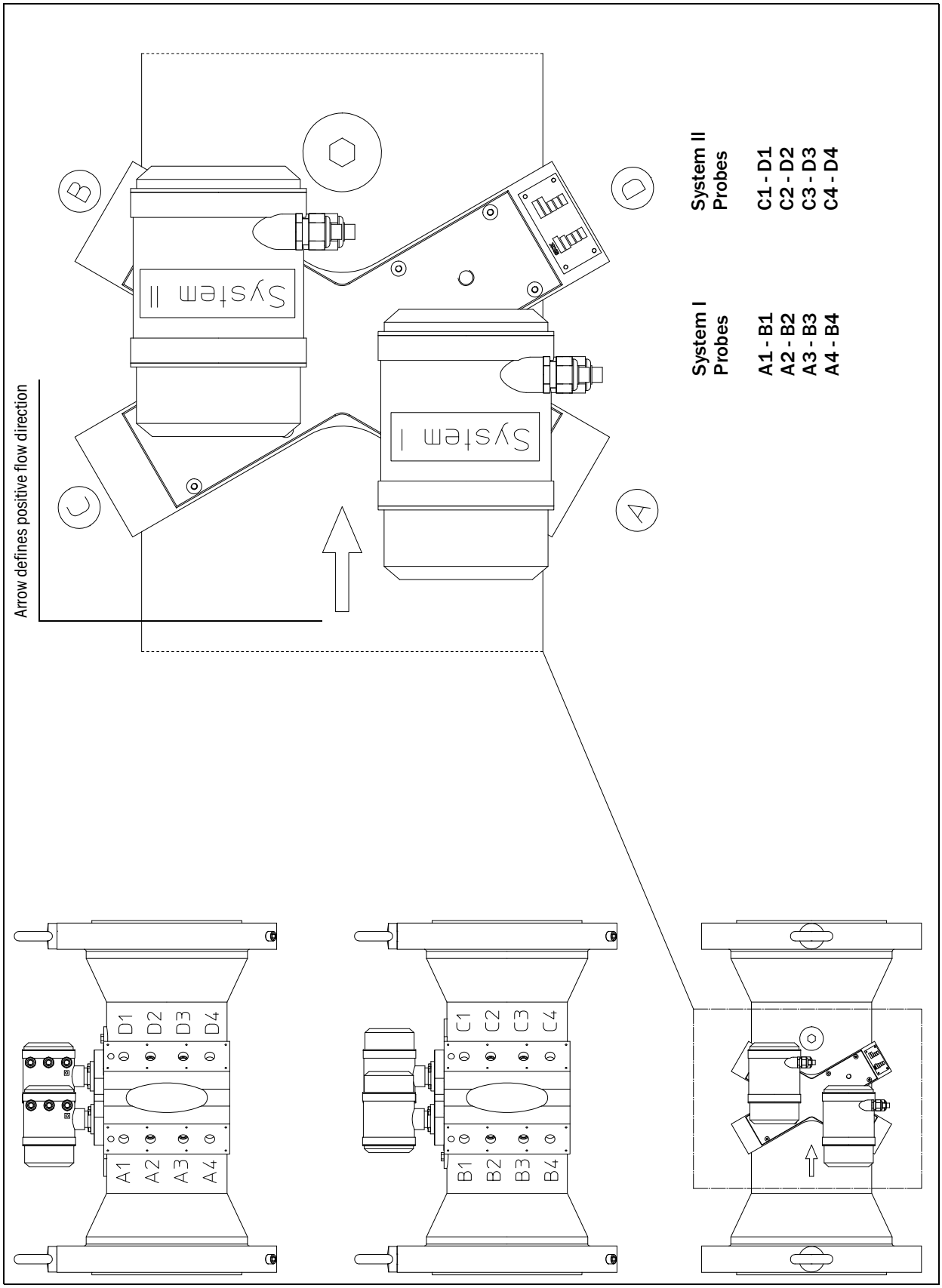


Figure 126 Outline drawing FLOWSIC600 Quatro



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