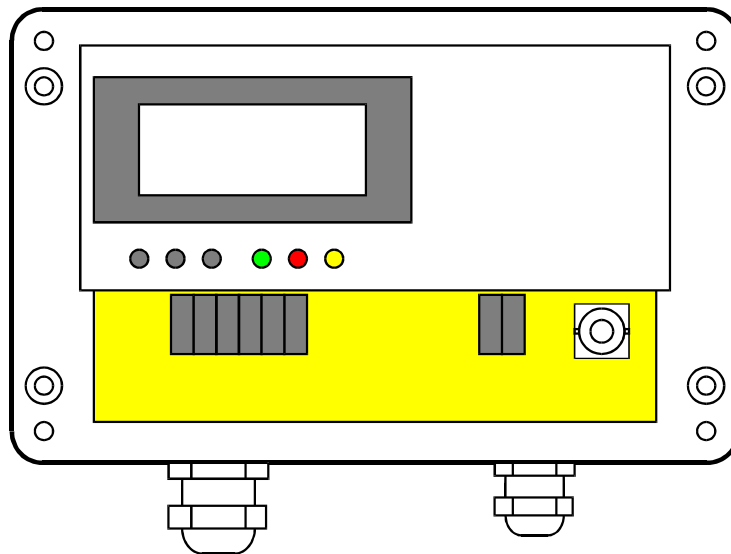




SONOMETER 05



User's Manual

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SONOMETER 05

Level Meter for Liquids

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1 Safety alerts and other symbols used



This safety alert symbol indicates an immediate hazardous situation. If not avoided it will result in serious injury or **damage to the equipment!** When you see this symbol, do not use the equipment further unless you have fully understood the nature of the hazard and have taken the required precautions.



This alert symbol indicates a potential hazard to the operation of the equipment. When you see this symbol, follow the prompts in this User's Manual to avoid the hazard. Call our service team if necessary.



This symbol indicates that you should call our **service team**.



This symbol indicates a **note** or detailed setting **tips**.



This symbol indicates enumeration.



Operator keys are printed in bold type and placed in pointed brackets.



Display text uses a special font on a grey background.

2 Safety instructions

The SONOMETER 05 and the ultrasonic sensors conform to the rules of the trade and comply with all applicable safety regulations.

The producer has taken every precaution to ensure safe working of the equipment. The user must take care that the equipment is set up and installed so that its safe use is not affected.

The equipment has been tested at the producer's works and is delivered in safe operating state.

This User's Manual contains information and warnings which must be complied with by the user to ensure the safe operation of the equipment.



The following safety instructions must be followed before starting the equipment and while using it:

- The equipment must only be started by authorised personnel and operated by instructed persons. All persons using the equipment must have read this User's Manual.
- Only the repair and maintenance operations described in the User's manual must be carried out and only specified parts must be used.
- Service work must only be carried out by the authorised service personnel of **SONOTEC Ultraschallsensorik Halle GmbH**.
- The equipment and all tools used for service or maintenance as well as all other equipment must be earthed as prescribed.
- The protective conductors must be continuous and not broken.
- The SONOMETER 05 must only be used in the specified temperature range from 0 to +60°C. Otherwise the equipment may not function properly and supply inaccurate results.
- The temperature resistance of the connecting cable must be adapted to the operating temperature of the measuring system.
- The casing of SONOMETER 05 must remain closed when the equipment is in use.
- The SONOMETER 05 must only be supplied with voltage from a source with a mains breaker. The SONOMETER 05 is not fused. Suitable fusing of the operating voltage (+24VDC/ 160 mA/T) should be provided by the user.
- The owner must make certain that the current on switched outputs does not exceed the rated limit of 0.5 A. This can be ensured, for example, by a fusible link.
- The SONOMETER 05 is splashwater-proof (IP65), but it should not be immersed in water.
- Use the special cable supplied with the SONOMETER 05 to connect the sensor and the unit. Connect the cable shield properly to frame earth via the cable socket on the SONOMETER 05.
- The sensors should be handled with care and screwed in only hand tight. If they are tightened fully, the contact face may be damaged. The sensor housing itself acts as a lever.
- Avoid electrostatic charge.

To prevent injury and damage to the equipment, follow the producer's instructions regarding starting and using the equipment, and maintenance. Maintenance and repairs not described in this User's Manual must only be carried out by authorised personnel.

The firm SONOTEC Ultraschallsensorik Halle GmbH is not liable for damage to a third party occasioned by using the equipment contrary to instructions.

Maintenance the equipment

The SONOMETER 05 and the sensor require no maintenance.

The sensor does not contain wearing parts.

3 Introduction

3.1 Overview

Liquid level meters of the SONOMETER series work on the ultrasonic pulse echo principle. This measuring method has several benefits:

- The ultrasonic sensors are attached to the outside of the vessel; they are not in exposed to the liquid in the tank.
- As measurement is made from outside, the liquid can be pressurised or be chemically toxic or aggressive. This has no effect on the measured data.
- The measuring method is particularly suitable for application in the pharmaceutical and the food industries.
- Foam on the liquid does not affect the accuracy of the measurement.
- The system can easily be fitted to existing vessels without expensive testing if the vessel is a pressure vessel.

The comfortable liquid level meter SONOMETER 05 has a large number of functions and can be used to advantage in complex measuring and control systems:

- A comprehensive measuring algorithm ensures high measuring accuracy and data reliability.
- The liquid level is directly shown on the display panel in metres or in percentages.
- The measured value is available in analogue format as a current value at than interface. The measured range can be adjusted as required.
- The parameters required for installation can comfortably be input via buttons. The parameter inputs are not lost if the power supply is interrupted.
- The SONOMETER 05 must be installed near the ultrasonic sensor. The distance between the ultrasonic sensor and the SONOMETER 05 should not exceed 10 m.

3.2 Systems components

The SONOMETER 05 system consists of the following components:

- the SONOMETER 05 evaluator
- ultrasonic sensors of E series
- fixing bracket on the vessel
- connecting cable between sensor and evaluator.

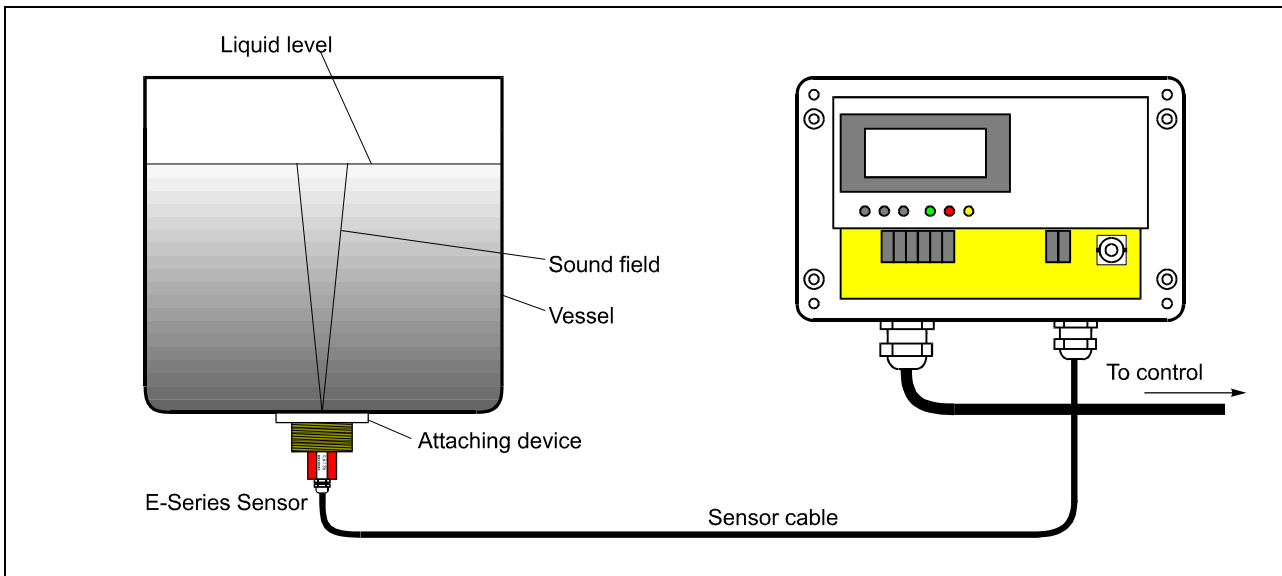


Figure 1: Overview of measuring system components

The selection of the suitable ultrasonic sensor and the appropriate bracket depends on

- the geometrical shape of the vessel,
- the material of which the vessel is made,
- the nature of the monitored liquid.

Our service staff will be glad to assist you in choosing the most suitable sensors and brackets. The following types are currently in the market:

Sensor type	Range	Measuring frequency	Attachment	Cable connection
E01	-20 ... +80°C	1 MHz	M30x1.5	10 m fixed cable
E02	-20 ... +80°C	1 MHz	M30x1.5	plugged connection
E03	hazard area -20 ... +80°C	1 MHz	M30x1.5	10 m fixed cable m
E04	-20 ... +80°C	2 MHz	M18x1	10 m fixed cable
E05	-20 ... +80°C	2 MHz	M18x1	plugged connection
E10	-20 ... +135°C	2 MHz	M18x1	10 m fixed cable
E11	-20 ... +135°C	1 MHz	M30x1.5	10 m fixed cable
E20	-20 ... +80°C	0.5 MHz	M45x1.5	10 m fixed cable
E21	-20 ... +80°C	0.5 MHz	M45x1.5	plugged connection
E22	hazard area -20 ... +80°C	0.5 MHz	M45x1.5	10 m fixed cable

Table 1: Overview of available sensors for SONOMETER 05

3.3 Principle of level metering

Pulse sent and echo received

The ultrasonic sensor of the SONOMETER 05 emits a brief acoustic signal. This pulse is transmitted through the vessel bottom in the liquid. The sound is reflected by the liquid level and is picked up as echo.

Transmission time measurement

In level metering, the time the ultrasonic pulse needs to travel to the liquid surface and back is of interest. This transmission time of the sound is measured by the SONOMETER 05. Adjacent the sound requires to propagate through the bottom of the vessel is deducted.

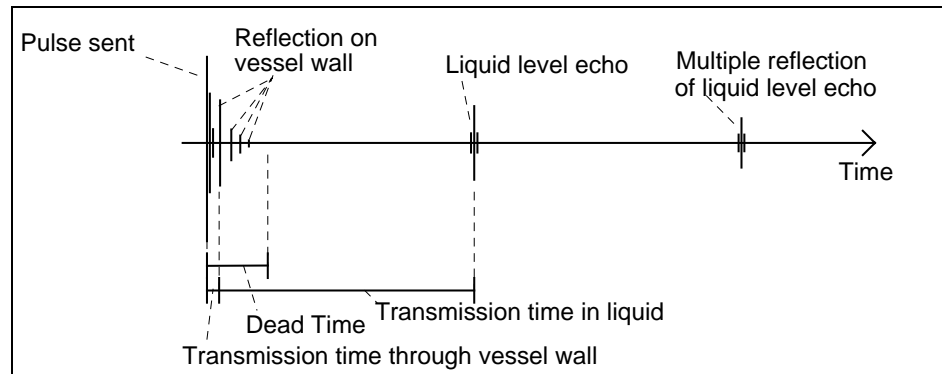


Figure 2: Echo detection in liquid level metering

Dead time

A part of the transmitted ultrasonic signal is multiply reflected on the inside wall of the vessel. The sensor picks up these reflections as early echo. These wall echoes must be eliminated. This is achieved by the dead time during which any echo is ignored.

This means that levels cannot be metered from zero.



Metering and evaluation of transmission time

A mean of the measured transmission times is calculated. A tolerance band (expected range) is placed around the calculated transmission time mean. Only measured values inside the expected range are included in the calculation of further mean values.

Filling level in metres

From the calculated mean transmission time, the level is calculated in units of metres on the basis of the speed of sound. The speed of sound depends on the kind of liquid, concentration and temperature. If the speed of sound changes substantially, come out a measured error.

Percentage level

The percentage level is the basis for all subsequent calculations and outputs. To convert the liquid level from units of metre in percentage the maximum liquid level must be specified that corresponds to a filling volume of 100%.

Output

The result can be output on the display panel in units of metres or in percentage.

The output of the current signal is also calculated on the basis of the percentage liquid level.

To adjust your control system you can set the time intervals in which the results are output. This regards the updating of the measured values on the display panel, the current outputs and the switching signals.

4 Installation

4.1 Sensor

4.1.1 Overview of attachments

There are various types of attaching the sensor to the vessel, depending on the sensor type used. Figure 3 to Figure 6 on the following pages contain the dimensional drawings of the sensors and their attachments.

The sensor is attached optionally by:

- rings welded to the outside of the vessel,
- bottomed rings welded into the wall of the vessel,
- plates glued or strapped to the outside of the vessel,

Adapter for special bolted joints (Varivent, milk pipe screw/bolted joints, clamp closure, etc.) are available on request.



If you are not sure which sensor type is best for your solution, please consult our service personnel, which will be glad to help (see Table 1 in chapter 3.2).

The ultrasonic sensor must be aligned vertically (max 2-3° off the vertical line are tolerated).

4.1.2 Preparing the coupling face

Inspect the condition of the coupling face

The quality of sound coupling is essential to the sensitivity of the measuring system. Therefore the following points should be noted.

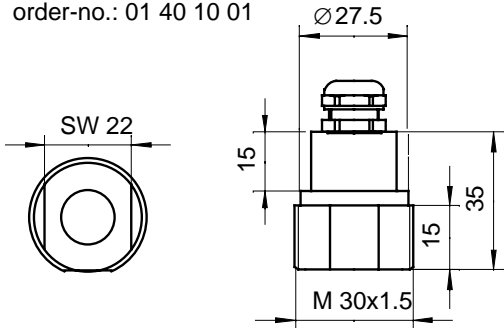
The face to which the sensor is attached on the outside of the vessel must be plane and smooth. Uneven attachment faces (e.g., on glass vessels) make sound contact more difficult and the results may not be correct in some cases. Unevenness of the attachment face can be compensated to some degree by applying a suitable mounting compound. Peak-to-valley height should be <math><10\ \mu\text{m}</math>. Paint or surface treatment are detrimental to good metering results.



There should be no peak or mark (e.g., chisel marks with lateral bulging, or similar). These can damage the sensor when it is installed.

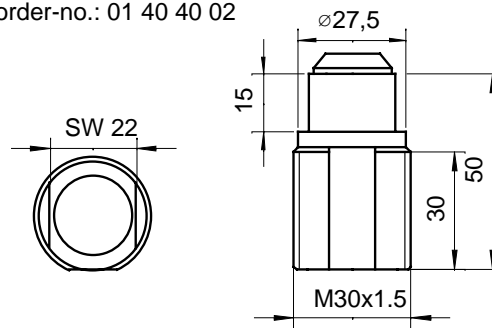
E01

1 MHz / D20mm
 material: POM
 incl. 10m fixed cable
 order-no.: 01 40 10 01



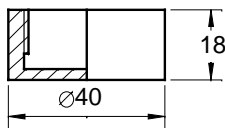
E02

1 MHz / D20mm
 material: POM
 plug-type connection: system LEMO 0E, IP68
 order-no.: 01 40 40 02



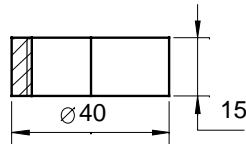
Attachment versions

material : 1.4571



Weld-in ring

order-no.: 01 50 01 21 02



Weld-on ring

order-no.: 01 50 01 11 02

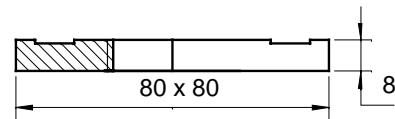
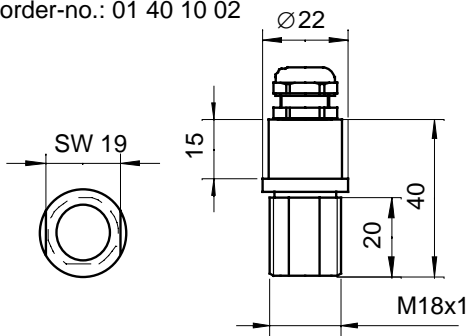


Plate for strap fastener,
 weld or glue
 order-no.: 01 50 02 21 02

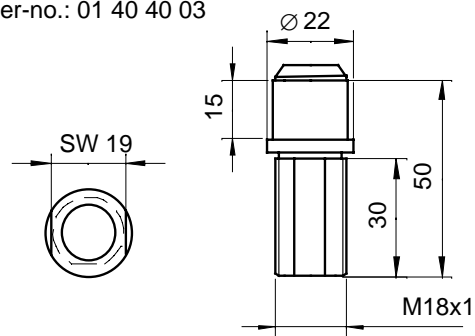
E04

2 MHz / D10mm
 material: POM
 incl. 10m fixed cable
 order-no.: 01 40 10 02



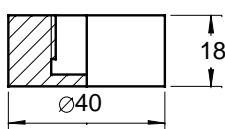
E05

2 MHz / D10mm
 material: POM
 plug-type connection: system LEMO 0E, IP68
 order-no.: 01 40 40 03



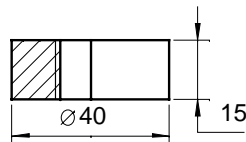
Attachment versions

material : 1.4571



Weld-in ring

order-no.: 01 50 01 21 01



Weld-on ring

order-no.: 01 50 01 11 01

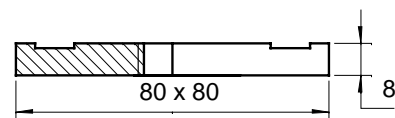
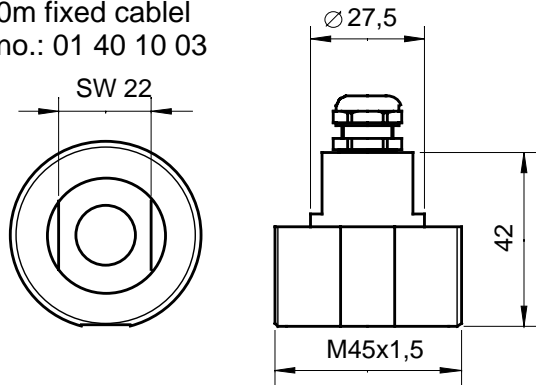


Plate for strap fastener,
 weld or glue
 order-no.: 01 50 02 21 01

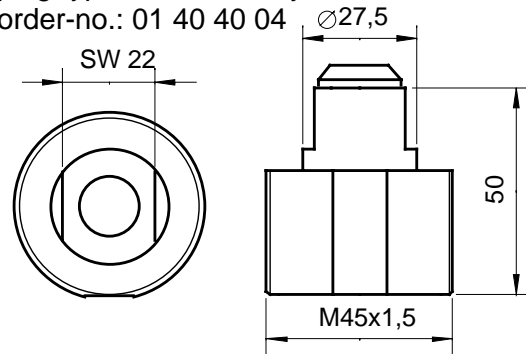
Figure 3: Dimensions of sensors E01, E02, E04, E05 and related attachment versions

E20

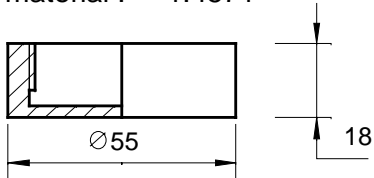
0,5 MHz / D35mm
 material: POM
 incl. 10m fixed cable
 order no.: 01 40 10 03

**E21**

0,5 MHz / D35mm
 material: POM
 plug-type connection system LEMO 0E, IP68
 order-no.: 01 40 40 04

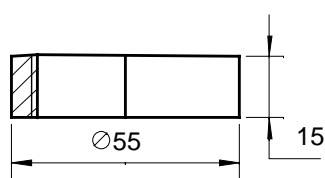
**Attachment versions**

material : 1.4571



Weld-in ring

order-no.: 01 50 01 21 03



Weld-on ring

order-no.: 01 50 01 11 02

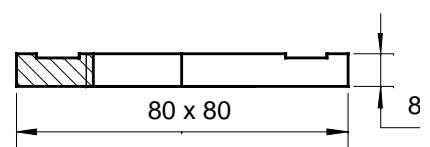


Plate for strap fastener,
 weld or glue

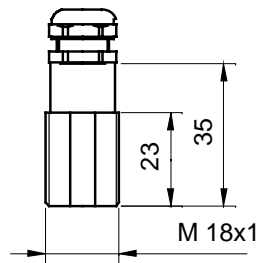
order-no.: 01 50 02 21 03

Figure 4: Dimensions of sensors E20, E21 and related attachment versions

E10

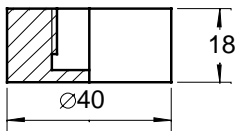
2 MHz / D10mm
 material: 1.4571
 incl. 10m fixed cable
 temperature range: -20°C bis 135°C

order-no.: 01 40 20 01



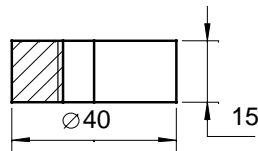
Attachment versions

material : 1.4571



Weld-in ring

order no.: 01 50 01 21 01



Weld-on ring

order-no.: 01 50 01 11 01

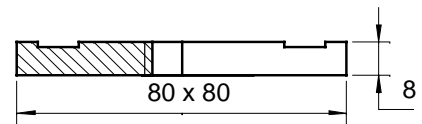


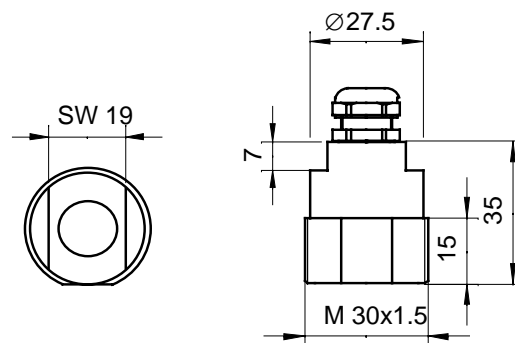
Plate for strap fastener,
weld or glue

order-no.: 01 50 02 21 01

E11

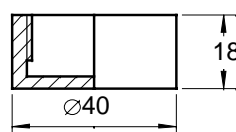
1 MHz / D20mm
 material: 1.4571
 incl. 10m fixed cable
 temperature range: -20°C bis 135°C

order-no.: 01 40 20 02



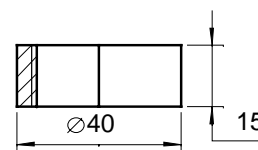
Attachment versions

material : 1.4571



Weld-in ring

order-no.: 01 50 01 21 02



Weld-on ring

order-no.: 01 50 01 11 02

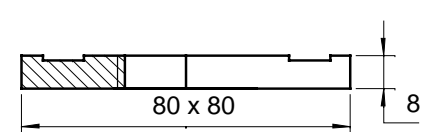


Plate for strap fastener,
weld or glue

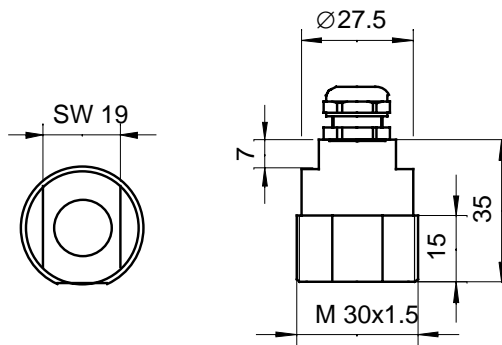
order-no.: 01 50 02 21 02

Figure 5: Dimensions of sensors E10, E11 and related attachment versions

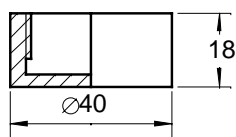
E03

1 MHz / D20mm
 material: 1.4571
 incl. 10m fixed cable
 temperature range: -20°C bis 80°C
 EEx m II T6

order-no.: 01 40 30 01

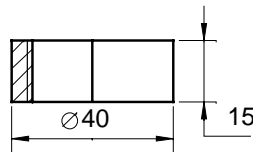
**Attachment versions**

material : 1.4571



Weld-in ring

order-no.: 01 50 01 21 02



Weld-on ring

order-no.: 01 50 01 11 02

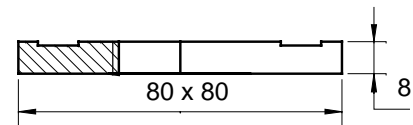


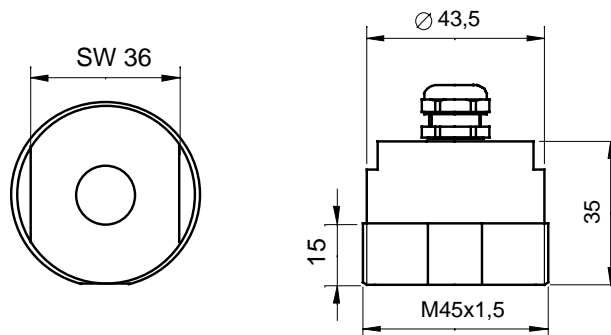
Plate for strip fastener,
weld or glue

order-no.: 01 50 02 21 02

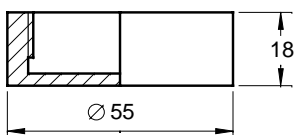
E22

0,5 MHz / D35mm
 material: 1.4571
 incl. 10m fixed cable
 temperature range: -20°C bis 80°C
 EEx m II T6

order-no.: 01 40 30 02

**Attachment versions**

material : 1.4571



Weld-in ring

order-no.: 01 50 01 21 03



Weld-on ring

order-no.: 01 50 01 11 02

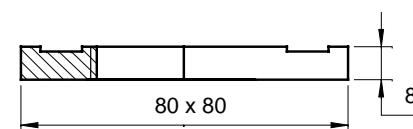


Plate for strap fastener,
weld or glue

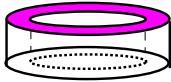
order-no.: 01 50 02 21 03

Figure 6: Dimensions of sensors E03, E22 and related attachment versions

4.1.3 Installing the attachments

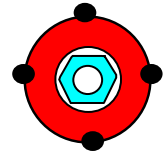
Ring fastener

The ring fastener can be glued or spot welded with max. 4 spots.



Welding-on:

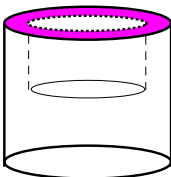
Spot-weld the ring with maximum 4 spots to ensure that the vessel walls are not distorted and the coupling surface out of plane. Remember that the sensor should stand vertically on the reflecting surface.



Gluing:

Apply metal epoxy adhesive to the underside of the ring and press the contact face to the coupling face. Remember that the sensor should stand vertically on the reflecting surface.

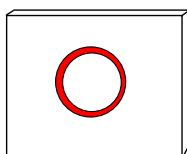
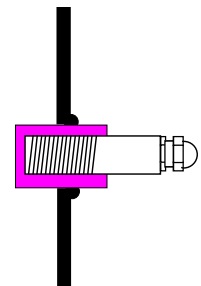
Remove all adhesive carefully from the coupling face and the female thread of the bracket. Observe the curing time.



Weld-in type ring fastener

An opening suiting the ring must be available in the vessel wall allowing the ring to be welded vertically to the vessel diameter.

The deviation from the vertical line must not exceed 2-3°.



Mounting plate

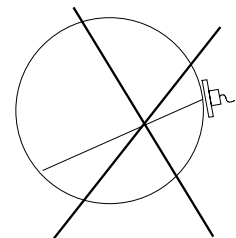
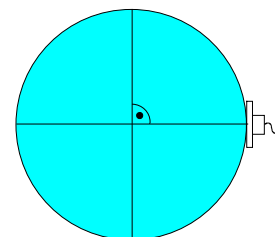
The mounting plate can be glued or strapped to the outside wall of the vessel.

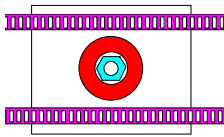
Gluing:

Apply metal epoxy adhesive to the underside of the plate and press the plate in contact with the coupling face. Make sure of proper seating.

Remove all adhesive carefully from the coupling face and the female thread of the bracket.

Install the sensor only when the glue has cured.





Strap fastening

Cut two fastening straps to the required length (vessel circumference + 20 cm).

Push one end of the strap in the eye of the turnbuckle from above (appr. 5 cm) and bend it over.

Place the strap around the vessel. The bent end of the strap should contact the vessel wall.

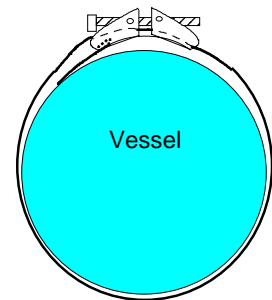
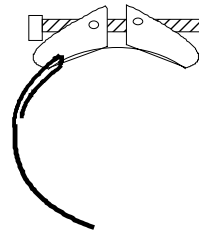
Slip the other end of the strap underneath the screw and through the turnbuckle until it projects on the other side.

Slip the mounting plate between the fastening strap and the vessel wall at the prepared place and tighten the strap until the plate is held.

Install the second strap and place it around the plate in the same manner.

Align the mounting plate accurately to ensure that the sensor will stand vertically on the liquid surface.

Pull the straps through the turnbuckle as far as possible with your hands. Then tighten both straps uniformly by turning the screws. Make certain of proper seating. Some additional tightening may be required later either by turning the screw or pulling the strap and turning the screw.



4.1.4 Screwing in the sensor

Install mounting compound between sensor and vessel!

To ensure good sonar contact, apply a mounting compound between the sensor and the vessel. Use special adhesive if you want a permanent bond.

Apply a finger nail size bead of the adhesive to the tip of the sensor. The adhesive spreads evenly when the sensor is screwed in or pressed to the attachment face. Mounting compound and special adhesives are available from SONOTEC Ultraschallsensorik.

Tighten sensor only hand-tight!



At this point, screw the sensor only **hand-tight**. Remember that the ultrasonic transducers have an ultra-precision plastic coat at their fronts.

4.2 SONOMETER 05

The measuring electronic circuitry is installed in a splashwater-proof housing (IP 65 degree of protection). The controls and the cable connections are accessible after unscrewing the housing cover. The fastening holes are outside the sealed space and do not affect the protection degree of the unit.

Generally, the unit should only be opened for connection or for start-up.

The permitted temperature range from 0°C to +60°C must not be exceeded.

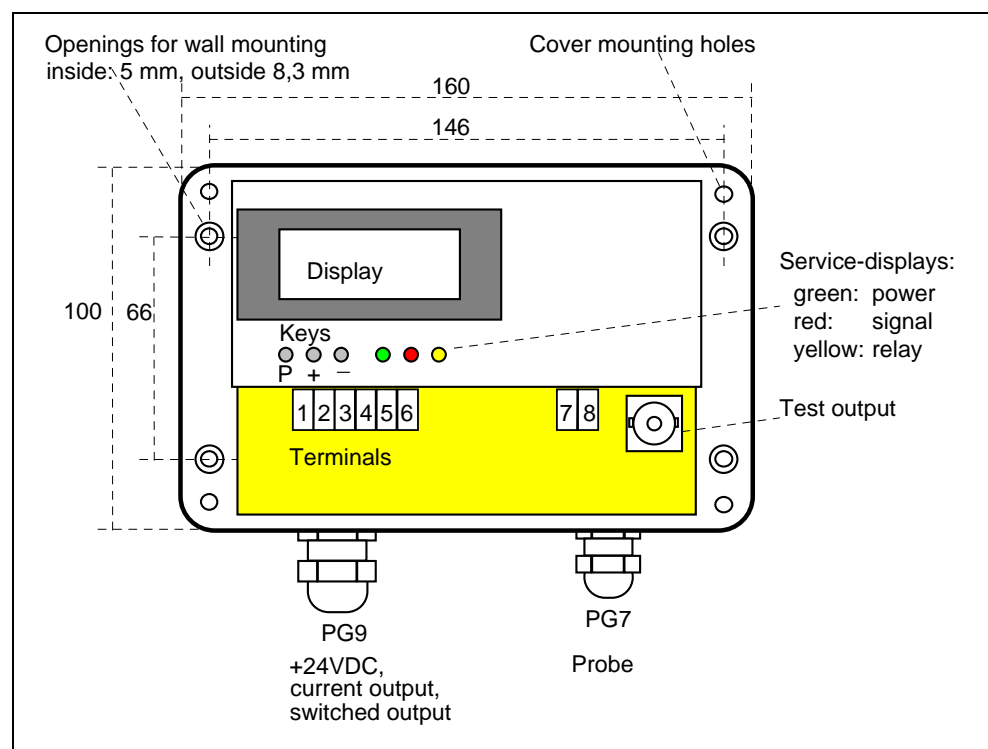
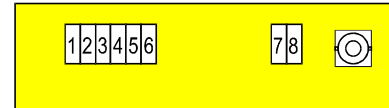


Figure 7:
SONOMETER 05
Controls and
connections

4.3 Connections

4.3.1 Terminal pin configurations

Pins connect the sensor to the unit, supply operating voltage and also the control system.



Pin	Supply
1	Operating voltage +18 ... 30 VDC / 150mA
2	Earth (connected to housing earth)
3	Current output +
4	Current output - (connected to housing earth)
5	Terminal 1 switched contact
6	Terminal 2 switched contact
7	Ultrasonic sensor
8	Ultrasonic sensor, shield (connected to housing earth)

Table 2:
SONOMETER 05
terminal pin
configuration

Pins 2, 4, 8 are connected internally and to housing earth.



Provide equipotential bonding between housing earth and vessel earth externally by a separate earth wire. Otherwise there is risk of destruction of the internal earth link if different potentials occur.

4.3.2 Connecting the ultrasonic sensor

PG7 (in the right side of housing)



Connect the sensor only with the double-screened cable supplied with the SONOMETER 05 unit. The maximum length between the SONOMETER 10 and the sensor is 10 m. Longer sensor cables can be used in special cases. Please consult our Service department. The cable can be shortened as required.

Connect the outer shield firmly with the housing earth by means of the cable screw union on the SONOMETER 05. Prepare the cable end as illustrated in Figure 8.

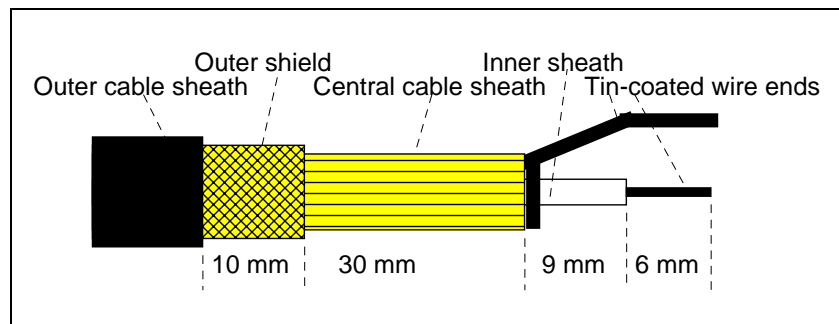


Figure 8:
Preparing the sensor
cable

To connect the sensor cable to the SONOMETER 05, proceed as follows:

- *only for plug-connected sensors:* Push the sensor cable plug fully into the bush on the sensor. It should latch audibly.
- Slacken metal nut **(a)** of the PG7 cable screwed connections on the right part of the housing of on the SONOMETER 05 and pull the nut over the cable (see Figure 9).
- Also pull plastic insert **(b)** over the cable.
- Bend back outer shield **(d)** and place it over rubber ring **(c)** of plastic insert **(b)**.

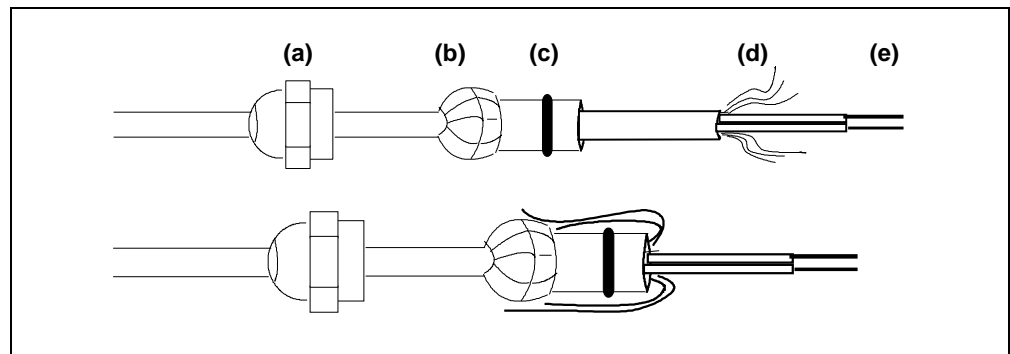


Figure 9:
Connection the sensor
cable

- Install two cable ends **(e)** through PG7 and connect them to pins 7 and 8. Pull the pins can be removed from the electronic assembly for ease of connection.
- Fully press the plastic insert with the shield in the cable bush so that the plastic insert presses the cable shield against the metal gland.
- Install the metal nut and tighten it with a wrench.

4.3.3 Connecting the operating voltage, current output and switching contact

PG9 (in the left side of housing)

A shielded multiple cable (2 ... 6 conductors) with maximal outer diameter of 7.5 mm is necessary to connect:

- Power supply,
- Current output,
- Switched output,

The shield must be connected with housing earth by means of the cable gland (the same as sensor cable, see 4.3.2).

Operating voltage

Table 3: Connecting the operating voltage

Pin	Supply
1	Operating voltage +18 ... 30 VDC / 150mA
2	Earth (connected to housing earth)

The unit has integrated polarity reversal protection.



Please note that pin 2 (operating voltage earth) is connected to frame earth. **The operating voltage is not isolated!** The SONOMETER 05 must only be supplied by a power source that can be separated from the mains supply.

The unit is not fused. The operating voltage of the SONOMETER 05 must be fused externally, e.g., with fuse link 160 mA/T.



Efficient protection of the unit from transient voltage (e.g., lighting) must be provided.

After switching on the operating voltage, the SONOMETER 05 needs about 1 second to be ready for service. On the display panel take place a notice (level or error).

Current output wiring



The current output provides a 0..20 mA and 4..20 mA signal, respectively, that is proportional to the liquid level in the set range. The current output is **not potential free**.

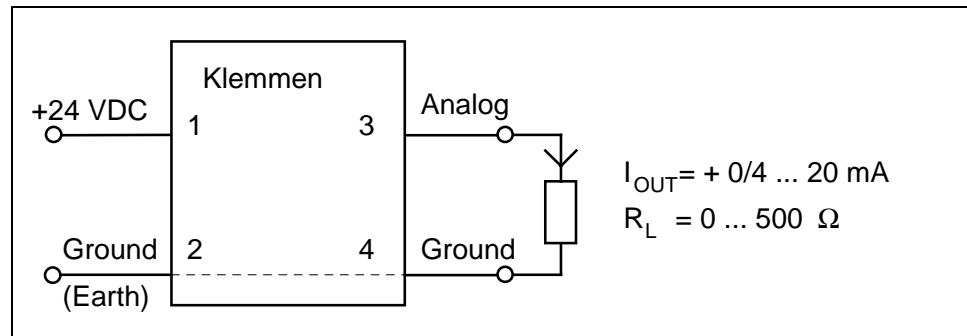


Figure 10:
Current output wiring

It provides a correct signal of the output load in the range 0..500 Ω (at current values between 0/4 ... 20 mA). An output that is not required must not be wired.



If a load resistance of 500 Ω is added, a voltage-proportional signal in the range of 0/2 ... 10 V can be obtained.



Note: Please note that if the current value output is **larger than 20 mA** (e. g. when the vessel is overfull) the specified range of the output load **cannot be guaranteed**. It may be necessary to reduce the load to below 500 Ω .

Please, note further that the current signal refers to the percentage liquid level in the tank or the volume value are taken, not to the level in metres; see chapter 6 for a description of parameter sets.

Switched output wiring

The switched output give a control signal for the correct work of the device. So you can see error functions and can acted accordingly.

The switched output is implemented by a relay and is potentialfree. When the relay contact makes, the „relay“ yellow LED lights.

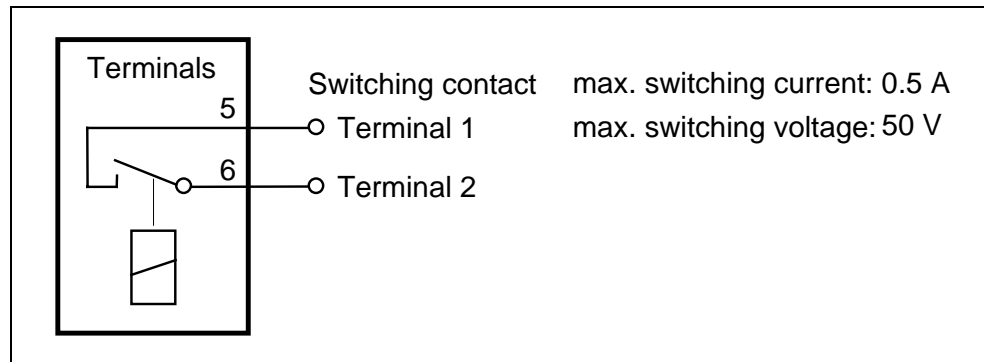


Figure 11:
Switched outputs
SONOMETER 05



Please make external provision that the maximum switching current of 0.5A on the relay cannot be exceeded.

CAUTION! The maximum rated voltage of the switched output to earth is 50 V!

The switched output may be configured by setting of parameter P 50 as shown in Table 4:

P 50	Relay
0	always breaks contact
1	always makes contact (<i>condition: power supply is switched on</i>)
2	breaks contact if a device fault occurred
3	breaks contact if a device fault occurred or no echo detected

Table 4: Configuration of
the switched output

A device fault is defined by one of the following conditions:

- no operating voltage,
- cable to control system is interrupted,
- no sensor connected or the sensor cable is interrupted,
- an internal device fault has occurred (software or hardware fault).

4.3.4 Test output

Connect the oscilloscope to the test output for a visual assessment of the echo pattern. Connect the oscilloscope ($R_E = 1\text{ M}\Omega$) to the test output with a test head or other suitable measuring line.

The following oscilloscope settings are recommended:

- Triggering: AC / negative flank / level: -400 mV
- Y co-ordinate: 200 mV/DIV
- Time base: 100 μs /DIV ... 5 ms/DIV depending on measuring range

On principle, the following picture will be obtained if the working method is correct:

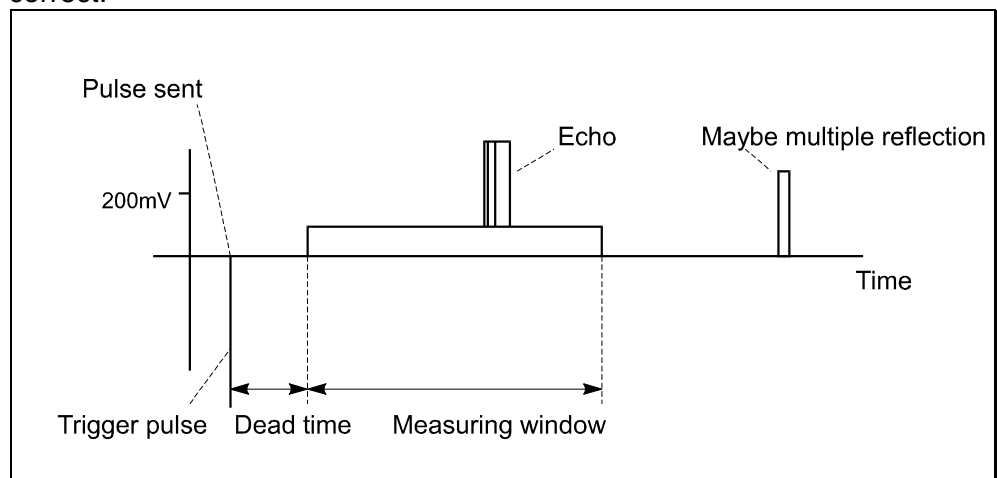


Figure 12:
Visual inspection with
the test output using
an oscilloscope

4.4 Installation in hazard area

If sensors and assessment electronic circuitry are to be installed in hazard area, both must conform to current hazard requirements. Basically two versions are possible:

(a) Sensor in hazard area, SONOMETER 05 not in hazard area

In this case sensors with certified hazard capability are used. These sensors have a permanently installed connection cable.

The SONOMETER 05 is not located within the hazard area and requires no particular protection. Advantageously the unit can be parameterised in service without any extra precautions.

Prerequisites



As a rule, this version is only possible where hazard and non-hazard areas are separated from each other by suitable structures.

The sensor cable between the sensor and the SONOMETER 05 must not be longer than 10m. Longer sensor cables are available in special cases, for which our Service department staff should be consulted.

(b) Sensor and SONOMETER 05 in hazard area

In this case sensors with certified hazard capability are used. These sensors have a permanently installed connection cable.

The SONOMETER 05 is installed in a flameproof enclosure in the hazard area. The connecting cables are installed in pressure-resistant compression glands.

Prerequisites

The housing must be opened for parameterising the unit. Hazard protection does not exist at this moment. The unit cannot be started unless the safety inspector of the firm gives the go-ahead.

Available components

The use of the SONOMETER 05 and the sensors in hazard areas are subject to international provisions for start-up, maintenance and repair of electrical equipment. In agreement with CENELEC standards EN 50 014 to 50 020 / 50 028 / 50 039 the following components are available for service in hazard environments:

EEx d IIB T5

Certified cast aluminium housing type EJB-1 or EJB-2 in flameproof enclosure for the SONOMETER 05 or other components (e.g. power supply unit)

EEx m II T6

Certified sensors type E03 and E22 with permanently installed cable in encapsulated design.

EEx d IIC T6

Certified compression glands and blanking plug M20 in flameproof enclosure.

The supply comprises the hazard certificates for the components.

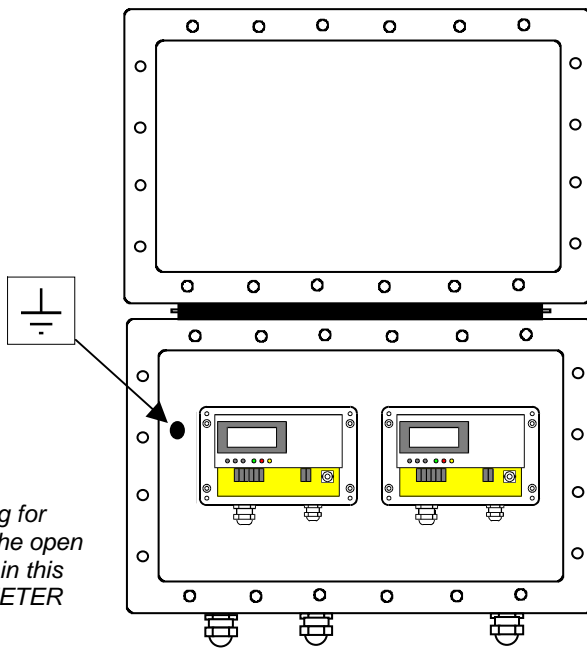


Figure 13: Protective housing for hazard service. The open housing contains in this case 2 x SONOMETER 05 (units open)

The aluminium housing is made and supplied as required by the configuration. The EJB-1 housing accommodates one SONOMETER, the EJB-2 housing accommodates two SONOMETER or one SONOMETER with power supply unit. The units are securely attached to the bottom of the housing when delivered.

On the reverse side of the housing bottom, there are 4 M8 threaded holes to which a plate can be attached. The plate must be accessible from behind. If the housing is to be mounted on a wall, it must at first be fastened with screws to the plate.

The housing cover is connected to the base housing by a hinge. The cover can be opened upwards when installed.

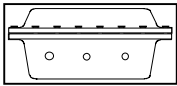
The cover can be opened through more than 180 degrees to a far-back position and stays open. **Still, the cover should be secured in position to prevent accidental closing. Risk of injury and damage!**

Apply corrosion-inhibiting paste evenly to the sealing faces of the housing cover and the base before installing the screws. Apply the paste also to all screw plugs. The paste protects against corrosion and has a sealing effect.



	Protective housing type EJB-1	Protective housing type EJB-2
Outside dimensions (L x W x H)	296 x 198 x 197 mm	418 x 218 x 208 mm
Inside dimensions (L x W x H)	240 x 140 x 145 mm	360 x 160 x 150 mm
Weight of housing (without unit)	8.5 kg	14.2 kg
Distance of holes in a mounting plate for attaching the housing		

Table 5: Dimensions of protective housings EJB-1 and EJB-2



Depending on the configuration, the housing has a certain number of compression glands. Two gland types are used for different cable diameters.

Cable type	Outer sheath diameter of cable	Inside diameter of compression gland
Sensor cable	3.0 ... 8.0 mm	85 mm
Control lines or mains cable	7.5 ... 11.9 mm	120 mm

Table 6: Types of compression glands



Make absolutely certain that the cables are installed through the compression gland of suitable size. Otherwise the hazard protection is not ensured.

Install certified blanking plugs on all compression glands that are not needed.

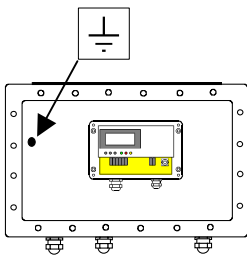
Install the cables in accordance with local provisions. In particular, observe VDE 0165.

Properly earth the housing and the components in the housing.

Earthing screws:

The external earthing screw (M6) is located at the edge of the side opposite the hinge.

The earthing screw (M6) in the housing is located on the housing bottom, to the left of the component(s) already installed.



Connecting the cables through the compression glands

- Remove compression screw **(a)** of the compression gland on the housing and take out neoprene seal **(b)**.
- Slide the compression screw and the neoprene seal over the shielded cable as illustrated in Figure 14.

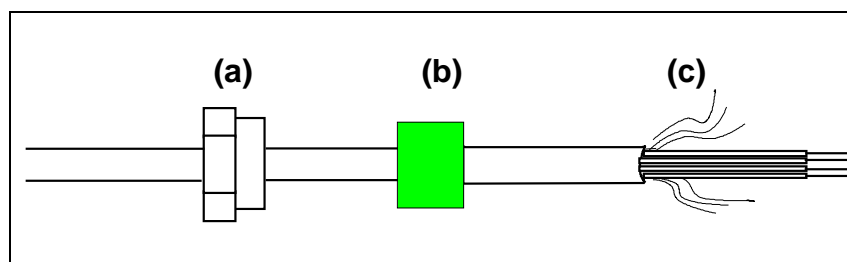


Figure 14:
Connecting the cable by
compression gland

- Slide the compression screw and the neoprene seal over the cable.
- Open the outer shield of cable **(c)**.
- Install the cable through the gland into the housing.
- Connect the cable to the SONOMETER 05 as described in chapters 4.3.2 and 4.3.3. Connect the outer shields of the sensor cable as well as the multiple-wire cable to the housing through the PG cable glands on the SONOMETER 05.

- Finally slide the neoprene seal in the gland of the housing and tighten the compression screw with a wrench. The cable must be clamped tight to satisfy the flameproof function.

**Use of E03 and E22 sensors in hazard areas**

Hazard protection exists when the coupling surface of the sensors is protected mechanically. This means the sensor must not be powered electrically unless it has been firmly attached to the vessel by mechanical means.

The sensor cable must be installed so that it is protected against physical damage.

**Start-up with type EJB flameproof enclosure**

If a mixture of explosive gases exist, the enclosure must not be opened. The company safety inspector's go-ahead is required to install the flameproof enclosure and the housing of the SONOMETER 05. For details, see chapter 5.

After completing parameterisation, close the SONOMETER 05 housing and close the flameproof enclosure tightly with an allen wrench.

5 Start-up

5.1 Installation and wiring check

!

Before feeding operating voltage, make sure of the correct installation of the sensor and of the SONOMETER 05.

If a power supply unit is used, the installation instructions should be observed.

5.2 SONOMETER 05 operating modes

When operating voltage is supplied, the SONOMETER is running in regular measuring mode which is identified by the notification a level or a error code.

In programming mode the parameter settings can be polled and edited.

5.3 Functions of buttons

Button functions in measuring mode

There are three hidden buttons in the front plate. In measuring mode, only the <P> button has a function assigned to it. It changes to programming mode.

Button functions in programming mode

In programming mode, the buttons perform a second function:

- Button <P>: Selects a parameter, confirms entries
- Button <+>: Increments the selected parameter
- Button <->: Decrements the selected parameter

5.4 SONOMETER 05 parameter setting

1. Starting the programming mode

Enabling the programming mode:

CodE

Pressing button <P> once for about 2 seconds starts the programming mode. The word **CodE** is shown on the display panel.

Pressing button <P> again causes the code **0000** to be shown on the display panel. This is a prompt for you to input a code number.

Code number input:

0000

The programming mode is divided in two different levels. The selection is made by the input of a code number at the beginning of the programming mode. Press buttons <+> and <-> until you can enter one of the following code numbers:

Normal programming mode:
0345

- Normal programming mode: Enter code number: 0345
On this level you can program all parameters which are important for the start-up of the SONOMETER 05 unit.

Advanced programming mode:
1799

- Advanced programming mode: Enter code number: 1799
This level has several functions that are not available to the user in normal programming mode (see chapter 7: Advanced Programming mode). These functions should only be used by instructed persons.

Wrong code number:
FEHL

If you enter a wrong code number, the prompt FEHL is shown on the display panel and the system exits the programming mode.

If the correct code number is entered, press <P> to confirm the entry. The system then goes to the Parameter Selection menu.



Entry of the code number is not necessary if the user exited the previous programming procedure without saving parameters. In this case, pressing button <P> directly starts the programming mode. If you want to re-enable the code number to protect from unauthorised access save the data before exiting the parameter setting function.

Parameter Selection menu:
P xx

2. Parameter Selection menu

On the display panel P xx is shown. The number xx indicates the current parameter number.

Parameter display:
xxxx

You can set a parameter number by pressing buttons <+> or <->. The required parameter value is confirmed by a press of button <P> and will be shown on the display panel.

If you select a parameter that has not been implemented or is not available on the current programming level, the system goes to the next possible parameter.

Button <+>:
Increments value

Button <->:
Decrements value

Button <P>:
Next parameter

3. Setting a parameter

The parameter value on display can be changed within permitted limits by pressing button <+> or <->. Confirm the new setting by pressing <P> and the system returns to the Parameter Selection menu, (P xx is shown on the display panel); the parameter number indicates the next higher parameter.

Exit programming mode by selecting
P 99

4. Cancelling the programming mode

You can select, view or change the parameters in any sequence. The programming mode is cancelled by calling the last parameter, P 99 (Saving parameters, see chapter 6.26). After making and confirming the entry, the programming mode is cancelled. The word End is shown on the display panel and the system returns to the measuring mode.

Save parameters:

No save
0

Save
1

End of programming mode
End

Please note the following:

*Rapid toggle between:
measuring mode ↔
programming mode*

*Warning:
Parameter not saved!*

F 09



- Normally, any entry in programming mode is carried out immediately. The measuring procedure is continued without limitation in the background.
- If the programming mode was cancelled **without saving** the parameter entries, the code-protected **access remains disabled**. In this case pressing button <P> returns you to the programming mode directly. This is a convenient way to toggle between programming mode and measuring method.
- If the programming mode fails to detect any activity for 16 minutes, it returns to the measuring mode automatically. To remind the user that the parameter entries will not be saved when the program is exited and the code-number protection has not been re-enabled, the code **F 09** is shown on the display panel.

If in programming mode you want to go from one programming level to another programming level, save the parameter entries at first (see chapter 6.26), cancel the programming mode and then start it again by pressing button <P>.

5.5 Measured value acquisition

Before the SONOMETER 05 can be used for measurement, it must be adjusted to the concrete conditions (vessel and medium). Two fundamental settings are required for the acquisition of measured values:

*Set transmission
energy/gain*



(1) The amplitude of the ultrasonic pulse is attenuated as it propagates through the liquid in the vessel. Hence, the pulse must be electronically amplified when received.

The transmission energy of the ultrasonic pulse and the gain must be set so that the pulse can penetrate the medium and is detected clearly by the receiver.

*Set dead time
and measuring
window*



(2) An internal time window is generated in the SONOMETER 05. The first echo detected in this time window is measured.

Notably the dying down of the transmitted pulse must be kept out of the time window. The time to the start of the measuring window is referred to as dead time. Any echoes detected in this time are ignored.

The dead time should be defined to ensure that the reflected ultrasonic noise has died down at the beginning of the measuring window.

Proceed as follows:

- Connect the oscilloscope to the test output of the appropriate channel.
- Fill the vessel 100 % with liquid.

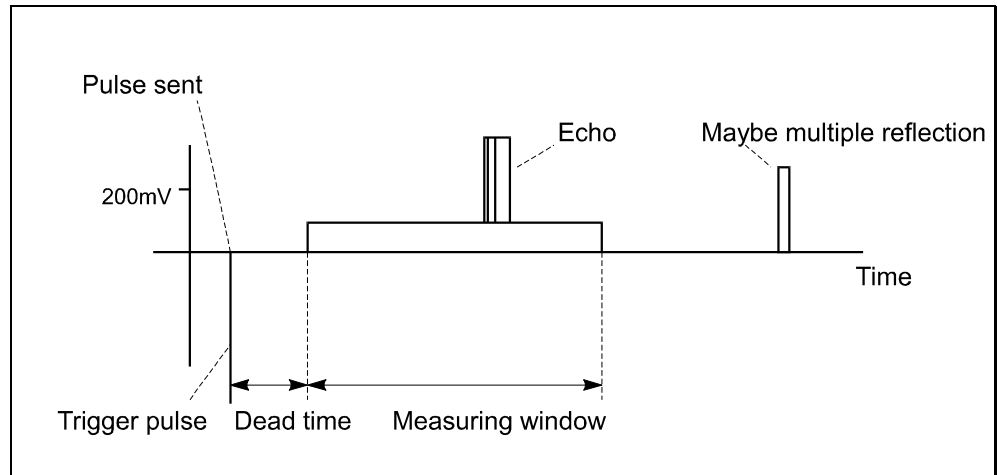


Figure 15: Echo detection in liquid level metering

- If no echo pulses can be seen as illustrated in Figure 15, increase the transmission energy (P 03) and/or the gain (P 04) until ultrasonic signals are received continually. Please note that the liquid may be turbulent, e. g., caused by a stirrer or from filling.
- Shift the beginning of the measuring window by changing the value for the dead time (P 05). If you decrement the value, the measuring window will shift to the left on the oscilloscope, if you increment it, the measuring window shifts to the right.
- The end of the measuring window (P 06) should be set to indicate the maximum filling level. This point in time is marked by the level echo at the moment of maximum filling. The measuring window should not be longer than required.

5.6 Measured value processing

After setting the echo detection the SONOMETER 05 is adjusted to your process conditions.

The required changes of parameters are discussed with reference to an example in chapter 6 of this Manual.

Basic procedure of measured value processing:

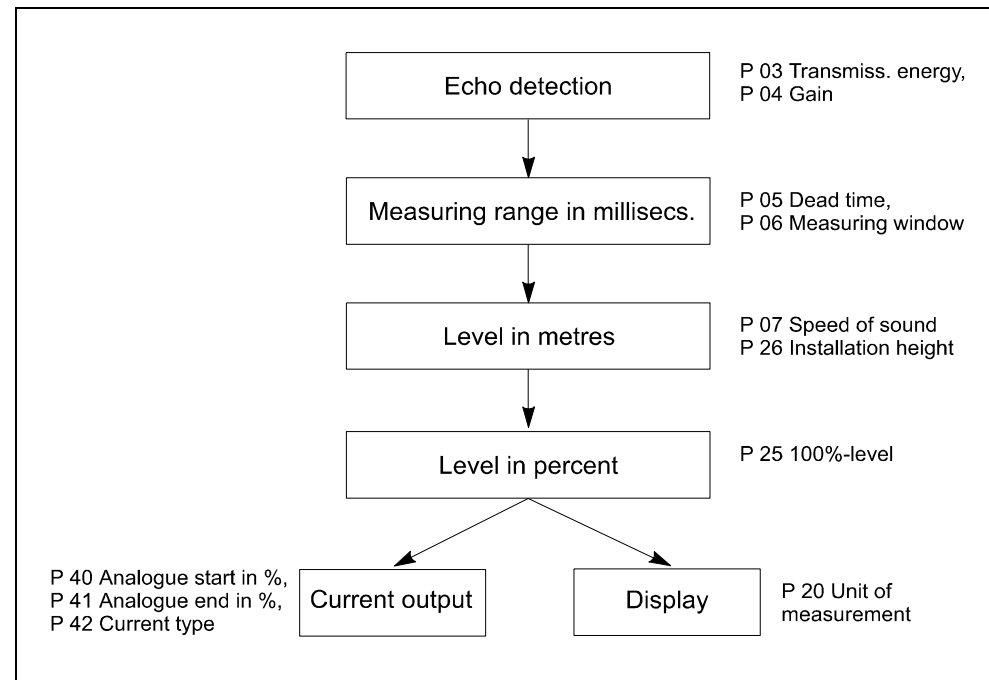


Figure 16: Fundamental parameters at start-up

Further parameters for measured value processing

Detection of echo in case of adverse sonic conditions

- The parameters P 08 „Expected range“ and P 09 „Noise suppression“ improve the behaviour of the SONOMETER 05 in case of adverse acoustic conditions. They can smoothen the result.

Transmission time related gain

- It may happen that the transmission energy and the gain required for a full vessel are too high for making the measurement on a vessel with a less than complete filling. To reduce the deadtime, it is possible to correct the transmission energy and the gain with the parameters P 12 ... P 16 as required by the echo to return.

Calculation of liquid level

- The time the signal needs to penetrate the wall of the vessel (P 10, wall time) is deducted from the measured total transmission time of the ultrasonic pulse.
- The liquid level in units of metres is calculated from the echo time with consideration of the speed of sound (P 07) in the liquid with which the vessel is filled.
- The percentage level is calculated by means of parameter P 25 (100% level in metres). All outputs relate to the percentage filling of the vessel.

-
- | | |
|----------------------------------|--|
| <i>Display panel information</i> | <ul style="list-style-type: none">• The SONOMETER 05 can show the measured values in several units (e. g., metres, litres, cubic metres). The unit is selected with P 20. |
| <i>Current signal</i> | <ul style="list-style-type: none">• Parameters P 40 and P 41 define the percentage values for the start point and the end point, respectively, of the current signal. P 42 specifies whether the smallest current is 0 mA or 4 mA. <p>Besides, current values can be defined which are output if a fault is detected in the device or a measured value is wrong.</p> |
| <i>Switching signal</i> | <ul style="list-style-type: none">• The switched output (to give a control signal for the correct work) may be configured with parameter P 50. |
| <i>Saving parameters</i> | <ul style="list-style-type: none">• The entered parameters are permanently saved with parameter P 99. |

6 SONOMETER 05 parameters

Param.-No.	Designation	Settings
CODE	Normal programm. mode access code	0345
P 03	Transmission energy	Step 1 ... 20
P 04	Gain	Step 1 ... 3
P 05	Dead time	0.001 ... 20 ms
P 06	Measuring window	0.001 ... 30 ms
P 07	Speed of sound	250 ... 8000 m/s
P 08	Expected range	0.8 ... 100 %
P 09	Noise suppression	0.05 ... 1000 s
P 10	Wall time	0 ... 200 µs
P 11	Sensor frequency	250 kHz / 500 kHz / 1 MHz / 2 MHz
P 12	TCG-enable, number of reference points	OFF, 1 ... 10
P 13	TCG: select reference point	1 ... 10
P 14	TCG: time for current reference point	0.001 ... 30 ms
P 15	TCG: trans. energy for current ref. point	Step 1 ... 20
P 16	TCG: gain for current reference point	Step 1 ... 3
P 20	Unit of measurement for display output	0: m / 1: % / 2: ms
P 21	Output intervall	0.05 ... 1000 s
P 25	100% level	0.001 ... 40 m
P 26	Installation height	-9.99 ... 9.999 m
P 40	Beginning of current output	0.0 ... 100 %
P 41	End of current output	0.0 ... 100 %
P 42	Current output range	0-20 / 4-20 mA
P 43	Current for wrong measuring	0.0 ... 22 mA / OFF
P 44	Current in case of device fault	0.0 ... 22 mA / OFF
P 50	Configuration of switched output	0 ... 3 (0:off/ 1:on./ 2:alarm by error/ 3:alarm by error+no echo)
P 92	Software version	yyxx: read only
P 99	Saving parameters	0: no saving / 1: saving permanently

Table 7: Parameter overview

6.1 Parameter P 03: Transmission energy

Settings

0001 ... **0020**: Transmission energy steps

This parameter specifies the energy content of the emitted ultrasonic pulse. The higher the transmission energy, the higher the energy content of the emitted ultrasonic pulse.

6.2 Parameter P 04: Gain

Settings

0001 ... **0003**: Gain step

The electronic circuitry amplifies the reflected ultrasonic pulse (echo) and then converts it into a digital signal (triggering). This parameter sets the strength of gain.

The setting should preferably be made with visual inspection by an oscilloscope connected to the test output (see chapter 4.3.4).

If echo signals are detected, a little arrow appears in the top left corner of the display panel.

6.3 Parameter P 05: Dead time

Settings

0.001 ... 20.00: Dead time in [ms]

Part of the transmitted ultrasonic pulse is reflected several times by the walls of the vessel. The purpose of the dead time is to eliminate undesired reflections received in the time window. Level echoes received in the time window are also ignored. Equation 1 allows a sufficiently accurate estimation of the minimum level that can be measured.

$$F_{\min} [\text{mm}] \approx \frac{1}{2} * v_1 [\text{m/s}] * T_{\text{dead}} [\text{ms}]$$

T_{dead} : Dead time,
 F_{\min} : Minimum measurable level,
 v_1 : Speed of sound in the measured liquid

*Equation 1:
 Estimation of the
 bottom limit for*

To have visual control of setting the dead time, the use of an oscilloscope on the test output of the SONOMETER 05 is urgently recommended (see chapter 4.3.4).

The setting of the dead time should be made on the full vessel so that all reflections detected immediately after sending the pulse are in the time window of the dead time.

6.4 Parameter P 06: Measuring window

Settings

0.001 ... 30.00: Measuring window in [ms]

The measuring window should be set according to the maximum level. The measuring window should not be longer than required.

The end of the measuring window can be defined by means of Equation 2.

$$T_{\text{MW}} [\text{ms}] \approx \frac{F_{\max} [\text{m}]}{v_1 [\text{m/s}]} * 2400 \approx 1,6 * F_{\max} [\text{m}] \quad (\text{for water})$$

T_{MW} : Measuring window,
 F_{\max} : Maximum possible level,
 v_1 : Speed of sound in the measured liquid

*Equation 2:
 Calculation of the
 measuring window*

--

6.5 Parameter P 07: Speed of sound

Settings

0250 ... 8000: Speed of sound in [m/s]

The speed of sound depends on the measured liquid and the temperature. The table below contains speed of sound data for selected liquids at 20°C.

Liquid	Speed of sound
Water	1,483 m/s
Ethyl alcohol	1,180 m/s
Acetone	1,200 m/s
Diesel oil (light)	1,250 m/s
Transformer oil	1,425 m/s

Table 8: Speed of sound in selected liquids (20°C)



If the speed of sound is not known, proceed as follows:

- Please set the following parameters to the specified values:
 - P 07 = 1483 (speed of sound = 1,483 m/s)
 - P 10 = Wall time (see chapter 6.8)
 - P 20 = 0 (display values in unit of „m“)
 - P 26 = 0 (installation height = 0 m)
- Fill the vessel with liquid and measure the level by another method (distance between liquid surface and sensor surface).
- Cancel the programming mode and take the level reading (in m).
- If the level reading is low, increase the speed of sound setting, if it is high, reduce the speed of sound setting. You can use the following equation:

$$v_l [\text{m/s}] = \frac{F_{\text{Meas}} [\text{m}]}{F_{\text{Displ}} [\text{m}]} * 1483$$

v_l : Calculated speed of sound of the measured liquid

F_{Meas} : Level measured by alternative method

F_{Displ} : Level shown on the display panel

Equation 3: Adjusting the speed of sound

6.6 Parameter P 08: Expected range

Settings

0.8 ... 100.0: Expected range in [%] of the currently measured level

The SONOMETER 05 calculates a mean of all measured values. The mean value is calculated only of measured values within the expected range. The expected range is calculated again after every measuring cycle and adapted to the current liquid level.

Where signal conditions are favourable, the expected range should be programmed to be as small as possible. This makes the level measurement most accurate. If wrong level data are supplied repeatedly, the expected range should be made larger.

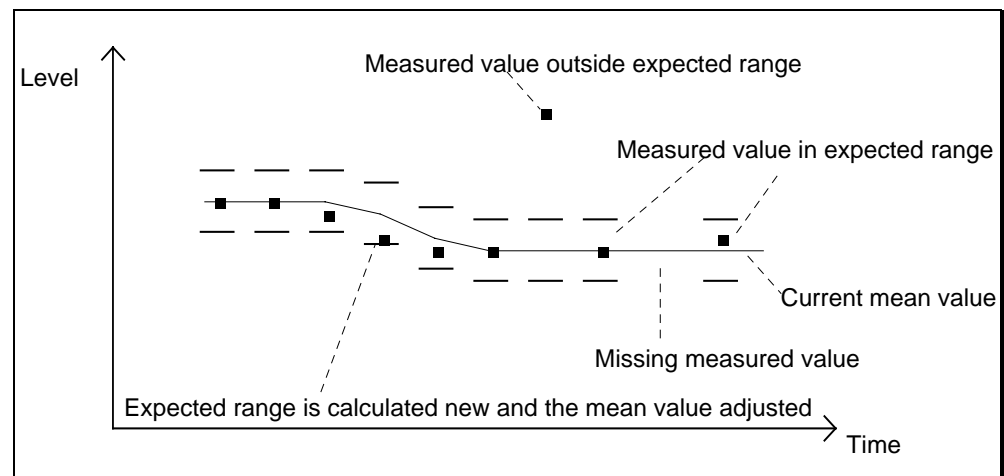


Figure 17: Assessment of level data with reference to expected range

Example

The parameter P 08 in the SONOMETER 05 is set to step 6.2 %. The surface of the liquid in the tank is in motion and waves are forming. It is possible that the first level echo was deflected and not picked up whereas multiple reflections were detected much later. The definition of 6.2 % expected range, which is in the range of the last correct measured value, this measured value is not used for the calculation of the mean. The interference is completely ignored for the output.

6.7 Parameter P 09: Noise suppression

Settings

0.050 ... 1000: Noise suppression time in [s]

The number setting indicates the period in which the SONOMETER 05 gathers measured values or tolerates wrong measured values before switching to wrong measurement (**no E** on the display panel). This parameter should be set to as small a value as possible where conditions are good.

Example

In the case on hand it cannot be excluded that air bubbles form when liquid enters the vessel. Air bubbles form regularly after every 10 minutes for a period of 1 minute. Readings are not possible during this time.

Recommended setting: P 09 = 100 s

This means that the correct value is held for a maximum period of 100 s during which no reading can be taken. As soon as the trouble factor disappears, the unit resumes regular measuring mode.

6.8 Parameter P 10: Wall time

Settings

0000 ... 0200: Wall time in [μ s]

This parameter defines the wall time of the ultrasonic pulse in the wall of the vessel. This is a function of the wall thickness and the material of the vessel.

The table below contains the wall time (i. e. the distance to and from) of the sound in different materials.

Material	Wall thickness				
	1 mm	2 mm	5 mm	10 mm	20 mm
Aluminium	0	1	2	3	6
Copper/brass	0	1	2	4	8
Steel	0	1	2	3	7
Glass	0	1	2	3	7
PE / PVC	1	2	5	10	21
Plexiglass	1	2	4	7	15

Table 9: Wall time in μ s as a function of vessel material and wall thickness of the vessel

6.9 Parameter P 11: Sensor frequency

Settings

250 ... 2000: Sensor frequency in [kHz]

The various sensor types operate in different frequency ranges. For the correct frequency, please refer to the sensor label. The frequency is the left of the two numbers in MHz. The sensor in Figure 29 is a 0.5 MHz = 500 kHz sensor (note: 1 MHz = 1,000 kHz).

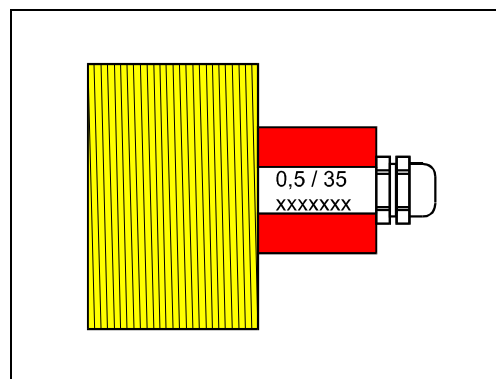


Figure 18: Frequency label on sensor

6.10 More information on time controlled gain (TCG)

As the ultrasonic pulse propagates in the liquid, its intensity decays. To make an echo clearly detectable, a large filled volume usually requires more transmission energy or gain than a small filled volume. With the TCG function the transmission energy and the echo time of the ultrasonic pulse can be adjusted to optimum level. This permits to reduce the dead time (i.e., the lowest level for measurement) without impairing the measuring accuracy of large filled volumes.

Division in time intervals

For this, the measuring range can be divided in up to 10 time intervals of any width. Each interval is marked by a reference point. A reference point is a point on the time scale to which specific values of transmission energy and gain are assigned. The reference point for time point 0 is set by parameters P 03 and P 04.

Transmission energy

The transmission energy is adjusted in linear fashion in the time interval between the reference points.

Gain

The gain is constant in each time interval. The values defined for the last reference point are adopted and not changed for the rest of the measuring range.



In most cases it is sufficient to work only with transmission adjustment and keep the gain constant at one step across the entire measuring range. This simplifies the setting of parameters.

Dead time

The dead time is made up automatically as a function of the current echo time reading. It follows the echo at a time difference equal to double the expected range (parameter P 08). The dead time is never smaller than the dead time set in parameter P 05.

Only the combined action of transmission energy, gain and dead time is visible at the test output. When the unit is started up, at first the required values for the maximum and minimum levels are determined with parameters P 03/P 04/P 05 are determined. Next, the reference point parameters are defined and programmed on this basis. Then the TCG function is enabled and its operation checked.

Echo search

While TCG is enabled, an echo search of the whole measuring range is made in regular intervals. This avoids latching and "cogging" of the SONOMETER 05 when echo noise or multiple echo is detected.

Example

If the echo is lost by fault, the whole measuring range is searched for echoes until the fault is over.

The programming of the TCG function will now be explained by way of an example:

The vessel is filled to a level of 7.5m; this is equal to 100% filling of the vessel. At the speed of sound of 1,500 m/s the echo time is 10 ms. With disabled TCG the following values are measured at which echo become stable gain = 3 / Transmission energy = 15. A dead time of 0.5 ms was recorded. The corresponding minimum filling is 375 mm.

If the liquid level is low, the following settings already supply stable echo: gain = 2 / transmission energy = 3. The dead time is reduced to 0.1 ms. This corresponds to a minimum filling of 75 mm.

Finally, an intermediate value for the switchover point of the gain is calculated. At a level of 2.25 m (echo time = 3 ms) the following settings are required: gain = 2 / transmission energy = 10. The echo is also stable at gain = 3 / transmission energy = 10.

Echo time	Level	Gain	Transmission energy
0.1 ms	75 mm	2	3
3 ms	2.25 m	3	10
10 ms	7.5 m	3	15

The situation as described requires 2 TCG reference points. The following defined parameters are entered:

P 03 (transmission energy at start)	Step 3
P 04 (gain at start)	Step 2
P 05 (dead time)	0.100 ms
P 13 (select 1 st TCG reference point)	1
P 14 (timing of 1 st TCG reference point)	3.000 ms
P 15 (transmission energy of 1 st TCG reference point)	Step 10
P 16 (gain of 1 st TCG reference point)	Step 3
P 13 (select 2nd TCG reference point)	2
P 14 (timing of 2nd TCG reference point)	10.00 ms
P 15 (transmission energy of 2nd TCG reference point)	Step 15
P 16 (gain of 2nd TCG reference point)	Step 3
P 12 (number of reference points and enable TCG)	2

Figure 19 illustrates the adjustment of transmission energy and gain in the above example.

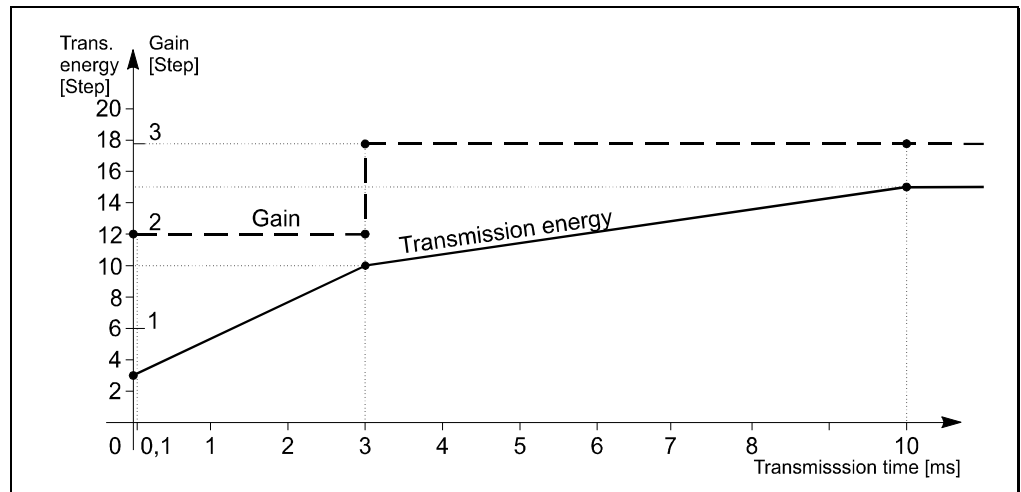


Figure 19:
Time controlled gain

6.11 Parameter P 12: Enable / reference point number for TCG

Settings

OFF: Time controlled function off

0001 ... 0010: Number of reference points for TCG

This parameter disables / enables the time controlled gain. You enable the function by specifying the number of reference points to be defined. Only the number of reference points specified here is accepted as the valid number and is used for calculation.



Start with entering all reference point data and then enable the TCG.

6.12 Parameter P 13: Select TCG reference point

Settings

0001 ... 0010: Select the current TCG reference point

Here the number of the TCG reference point is specified to which the settings of parameters P 14 to P 16 relate. To view or edit further reference points, call P 13 every time and enter the number of the reference point you want to view or edit.

6.13 Parameter P 14: Time for current TCG reference point

Settings

0.001 ... 30.00: Timing of current reference point in [ms]

This parameter defines the time position of the current reference point in the measuring range of the SONOMETER 05. At first select the required reference point with parameter P 13.

The specified timing must be longer from one reference point to the next. The intervals need not be the same.

6.14 Parameter P 15: Transmission energy for current TCG reference point

Settings

0001 ... 0020: Transmission energy step for current TCG reference point

These parameters define the transmission energy of the current TCG reference point. The transmission energy is calculated as a linear measure between the current reference point and the neighbouring reference points and is adjusted continually as required by the current echo time.

For setting, refer to parameter P 03 in chapter 6.1.

6.15 Parameter P 16: Gain for current TCG reference point

Settings

0001 ... 0003: Gain step for current TCG reference point

Parameter P 16 defines the gain to be used between the current reference point and the next following reference point. If there is no next following reference point, this gain is used for the rest of the measuring window.

For setting, refer to parameter P 04 in chapter 6.2.

6.16 Parameter P 20: Unit of measurement for display output

Settings

0000: Level in [m]

0001: Level in [%]

0002: Echo time in [ms]

Note that to obtain a correct reading of level in % the value for 100% level must have been specified in parameters P 25 (see chapter 6.18).

6.17 Parameter P 21: Output interval

Settings

0.050 ... 1000: Output interval in [s]

The output interval defines the time intervals at which the current level reading is output via the current outputs, the switching contacts and the display panel.



Please note that the time process of acquiring measured values is essentially influenced by parameter P 09 (noise suppression). The output interval merely influences the time behaviour of the output.

This parameter should be edited if

- the rate at which the digits on the display panel change is to be reduced,
- the rate at which the connected consumers are switched on or off by the switched outputs is to be reduced (pumps, etc.),
- the rate at which a higher-level control samples the level via the current output is to be increased.

6.18 Parameter P 25: 100% level

Settings

0.001 ... 40.00: Level at 100 % in [m]

For the calculation of the level in metres in a percentage level the level which correspond with 100 % must have been specified. See also the examples in Figure 20 to Figure 22.

6.19 Parameter P 26: Installation height of sensor

Settings

-9.990 ... +9.999: Sensor installation height in [m]

Depending of the location of sensor on the vessel the value for parameter 26 must be positive or negative. See the following examples:

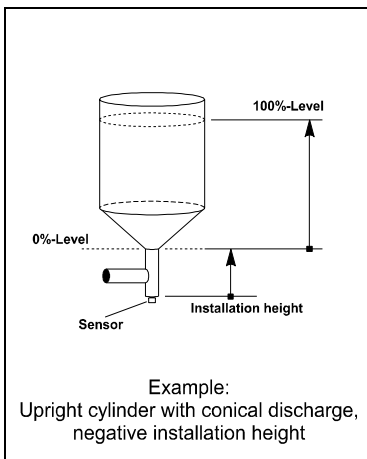


Figure 20: Upright cylinder with discharge cone;
Sensor at connection

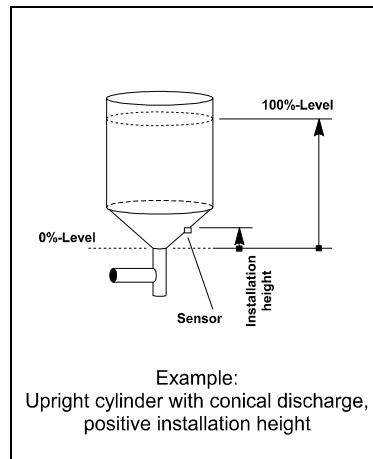


Figure 21: Upright cylinder with discharge cone;
Sensor in discharge cone

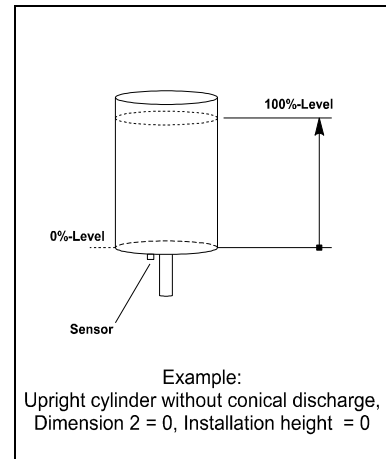


Figure 22: Upright cylinder without discharge cone;
Sensor mounted at vessel bottom

6.20 Parameter P 40 / P41: Beginning and end of current output

Settings

000.0 ... 100.0: Level in [%] for beginning and end of current output

These parameters define the level range for the current output. Between the values specified as beginning and end a current signal in the range from 0 ... 20 mA or 4 ... 20 mA proportional to the level in the vessel is output. Depending on whether the value marking the beginning is larger or smaller than the parameter setting marking the end, the current output characteristic shows a positive or negative rise.

This makes it possible by selecting a suitable entry for parameters P 40 and P 41 to shift the characteristic, create a zoom function or invert the current output characteristic.

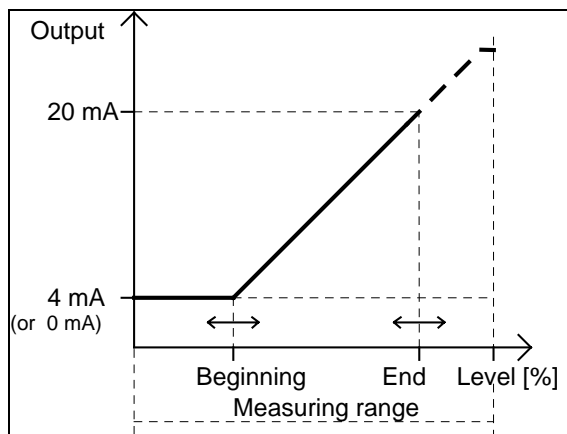


Figure 23: Current output characteristic:
Beginning < End:
Positive rise of current as level increases

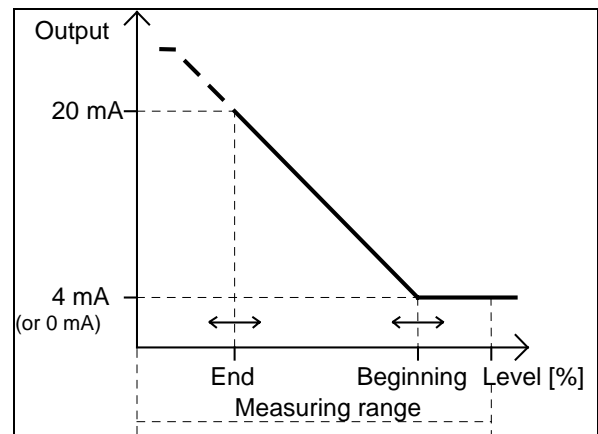


Figure 24: Current output characteristic:
Beginning > End:
Negative rise of current as level increases

!

Note: Limitation of current starts at about 22 ... 24 mA. Current values higher than 20mA reliable indicate overfilling. Please note that the electrical specification of the current output to the maximum burden can only be guaranteed in the range from 0 ... 20 mA.

6.21 Parameter P 42: Current output range

Settings

0-20: Current output in range 0 ... 20 mA

4-20: Current output in range 4 ... 20 mA

6.22 Parameter P 43: Current for wrong measuring

Settings

000.0 ... 022.0: Current in [mA]

OFF: Last current value output remains on current output

Here you can set the current which is output if a reading is wrong (on the display panel, e. g., no E). This value is unrelated to the range setting of the current output (Parameter P 42, 0/4 ... 20 mA).

If a value larger than 22.0 mA is specified, the word: OFF is shown on the display panel. In this case the current value will not change in case of a wrong measuring.

For output of value currents higher than 20 mA see chapter 0.

6.23 Parameter P 44: Current in case of device fault

Settings

000.0 ... 022.0: Current in [mA]

OFF: Last current value output remains on current output

Here you can define the current which the SONOMETER 05 puts out in case of device fault, presupposes that the SONOMETER 05 was not stopped.

For setting, please read the information regarding parameter P 43 in chapter 6.22.

6.24 Parameter P 50: Configuration of switched output

Settings

0: The switching contact is permanently open.

1: The switching contact is permanently close.

2: The switching contact is open only by device error.

3: The switching contact is open by device error and in case of wrong echo detection.

With this configuration you can determind the behavior of the switched output depending on the working state of the device.

See also Table 4: Configuration of the switched output in chapter 4.3.3.

7 Advanced Programming mode

The parameters and functions described in chapter 6 are sufficient for a convenient start-up of the SONOMETER 05. In addition to these, there are more functions for specific applications which increase the safety of the measuring system or make service work easier.

To start the Advanced Programming mode, a special code number must be entered.

All parameters and functions in chapter 6 are also available in the Advanced Programming mode. Therefore only the modifications will be described in the paragraphs below.

Param.-No.	Designation	Settings
CODE	Advanced programming mode access code	1799
P 32	Liquid level simulation	0.0 ... 120% / OFF
P 45	Current output simulation	0.0 ... 22 mA / OFF
P 46	Calibration value for current output (end)	0 ... 3000
P 47	Calibration value for current output (zero)	0 ... 1000
P 70	Enable / interval for sensor contact verification	OFF, 5 ... 1000 s
P 71	Transmission energy for sensor contact verification	step 1 ... 20
P 72	Gain for sensor contact verification	step 1 ... 3
P 73	Gate beginning for sensor contact verification	0.001 ... 30 ms
P 74	Gate width for sensor contact verification	0.001 ... 30 ms
P 91	Asynchronous base interval	45 ... 55 ms

Table 10:
Extra parameters in
Advanced Programming
mode

7.1 Parameter P 32: Simulation of liquid level

Settings

0.000 ... **120.0**: Simulation value in [%]

OFF: Simulation disabled

The liquid level simulation is a useful feature (e.g. to test lower-level controls) All output functions, such as

- displays outputs,
- setting the switched outputs,
- outputs via current interface,
(Exception: if simulation of current output is enabled,
see chapter 7.2, parameter P 45),
- polling via serial interface

relate to the input of the percentage simulation value, provided the simulation function is enabled.

Remember that the real liquid level will only be measured when the simulation is disabled. To disable the simulation, enter a parameter value > 120.0; the display panel will show: **OFF**.

When you simulate a level, the echo time [ms] and the level [m] cannot be shown on the display panel.



7.2 Parameter P 45: Simulation of current output

Settings

000.0 ... **022.0**: Simulation value for current output in [mA]

OFF: Simulation of current output disabled

To adjust the current output or start a lower-level control, any current value can be output unrelated to the liquid level and any other device setting can be output.

!

Remember that a correct, level-related current value output will only be available when the simulation is disabled. To disable the simulation, enter a parameter value > 22.0; the display panel will show: **OFF**.

For current value output larger than 20 mA, please see the note in chapter 4.3.3.

7.3 Parameter P 46/ P47: Adjustment of current output

Settings

0000 ... **3000**: Adjustment value for current output (end)

0000 ... **1000**: Adjustment value for current output (zero)

Generally the current output adjustment will be made when the device is delivered to your place. This parameters permit you to recalibrate the current output. Please proceed as follows:

1. Connect a current meter (terminals 3/4)
2. Set parameter P 45 to **020.0**.
3. The current should be 20.00 mA \pm 0.01 mA.
4. Change parameter P 46 until 20.00 mA \pm 0.01 mA is output.
5. Set parameter P 45 to **000.1**.
6. The current should be 0.100 mA \pm 0.01 mA.
7. Change parameter P 47 until 0.100 mA \pm 0.01 mA is output.
8. Reset the current simulation P 45 to **OFF**.
9. Save the parameters (P 99=1).
10. Disconnect the current meter and connect the lower-level control.

7.4 Parameter P 70: Enable / interval for sensor contact verification

Settings

OFF: Sensor contact verification disabled

0005 ... 1000: Time interval for sensor contact verification in [s]

The SONOMETER 05 can verify the attachment of the sensors to the vessel in regular intervals.

Parameter P 70 disables the sensor contact verification (OFF) or sets steps of a time interval between two tests in the range from 5 s to 1000 s (approx. 16 min).

Operating principle of attachment verification

Functional principle of the contact verification

To verify that the sensor is in contact with the vessel, the signal reflected by the wall after the transmission of the pulse is evaluated. For this purpose, a second gate is generated in the dying down area of the pulse. The test gate has its own transmission energy, gain and gate times.

Parameters P 71 to P 74 define the test gate. If one of these parameters is selected in programming mode, the SONOMETER 05 internally changes from the measuring gate to the test gate. The setting of the test gate should preferably be made with an oscilloscope connected to the test output. The arrow on the display panel (see chapter 6.2) and the switched output also indicate the test gate during parameter setting.

Please try which setting of parameters provides the best verification of the sensor contact with the vessel full and completely drained.

Interruption of measurement during attachment verification

!

Interruption of the measurement process during contact verification

Measurement is interrupted for the duration of the sensor contact verification test. The test duration is 250 ms ... 500 ms. To run applications which do not tolerate even a brief interruption of the measuring process, the contact verification function should therefore be disabled. In this case, the sensor contact should be verified during the regular inspection.

The parameters of the sensor contact verification can be set and therefore adjusted to the shortest possible duration. Please observe the information in the following paragraphs.

7.5 Parameter P 71: Transmission energy for sensor contact verification

Settings

0001 ... 0020: Steps of the transmission energy for sensor contact verification

If possible, parameter P 71 should be set to the same value as parameter P 03, this reduces the time required to verify the sensor attachment. Also see chapter 6.1.

7.6 Parameter P 72: Gain for sensor contact verification

Settings

0001 ... **0003**: Gain step for sensor contact verification

Before setting this parameter, read the information regarding parameter P 04 in chapter 6.2.

7.7 Parameter P 73 / P 74: Gate beginning / gate width for sensor contact verification

Settings

0.001 ... **30.00**: Gate beginning in [ms]

0.001 ... **30.00**: Gate width in [ms]

The sum from gate beginning and gate width cannot be bigger as 32.00 ms. Die gate width will be limit by the SONOMETER 05

When defining the start of the test gate, make certain that no signal is reflected when the sensor is not attached. The door should only be wide enough to ensure that no reflected “useful” signal is received.

7.8 Parameter P 91: Base interval

Settings

45.0 ... **55.0**:Base interval in [ms]

If several SONOMETER 05 are connected to one vessel it may happen that the units interfere with each other. In this case each unit should use a different cycle rate. Therefore specify a different value for parameter P 91 for each SONOMETER 05.

Although this will not eliminate the reciprocal ultrasonic interference, the noise suppression functions (see chapters 6.6 and 6.7) however provide efficient protection from wrong readings.

8 Troubleshooting

8.1 Troubleshooting

If your SONOMETER 05 does not give the correct level reading, the fault must be located. As a first step, find out if the problem is sonic or electrical. Please work through the following checklist.

- Is the SONOMETER 05 supplied with 24 V DC operating voltage?
- Is the sensor connected properly?
- Is the sensor making full contact with the mounting compound?
- Is the sensor set up vertically/aligned to the sound-reflecting surface?
- Is there liquid in the vessel?
- Is the dead time setting correct?
- Does noise by sound reflection on the vessel wall interfere with the measuring process in the gate?
- Do baffles interfere with the sound path?
- Does the liquid contain too many foreign objects or bubbles?
- Is there strong turbulence?
- Is the setting of the transmission energy and/or the gain low?
- Has the liquid changed in the course of operation?
- Has the temperature or the concentration of the liquid changed substantially?
- Is equipotential bonding ensured between the vessel and the housing?
- Are both shields of the sensor cable properly connected to earth?

If the SONOMETER 05 detects a device fault, an appropriate message is displayed on the display panel. The evaluation is different for faults and warnings. For details, see the respective passages of this manual.



Call our service team if you have a problem. We will be glad to assist you to ensure smooth service of your SONOMETER 05.

8.2 Device faults

Device faults either affect or prevent measurement. If a fault is detected, the alarm-switched output is active and a fault message is shown on the display panel (see also chapter 6.24). If several faults are detected at the same time, the most serious fault is shown. If echo is lost (shown as **no E** on the display panel, the current for wrong reading (chapter 6.22), is shown, in other cases current in case of device fault (chapter 6.23) is shown. If both occur together, the device fault current flows.

The fault code on the display panel can be polled via the serial port.

A condition for the output of fault messages is that the SONOMETER 05 was not stopped.

no

The sensor does not receive an echo from the sound-reflecting surface.

The following causes are especially likely:

- Liquid level outside the measuring range,
- Transmission energy and/or gain not strong enough,
- Gate time and/or measuring window settings wrong,
- Sensor has failed and/or cable is broken,
- Strong motion on liquid surface for a period exceeding the noise suppression setting.

F

The hash total by the program memory is wrong. This is a particularly grave fault. The SONOMETER 05 would cease to operate properly and was therefore stopped. If this fault occurs, please call our service team.

F

The hash total by the non-volatile parameter memory is wrong. You can make a total reset by pressing the selection key and a new start of the device. Please contact our service team for repair of defective assemblies.

F

The device software is not compatible with the device hardware. Please inform our service team.

F

The device software contains a wrong software version. Please inform our service team.

F

The main memory in the device is defective. As the saved parameter settings are no longer secure, the measuring process is discontinued and device stopped. Please contact our service team.

F

The internal working memory of the microcomputer is defective. The device was stopped. Please inform our service team.

F

A difference between the (working) parameter set and the contents of the non-volatile parameter memory has been found. Please verify your parameter settings and save them again. If the same fault occurs again, the computer hardware is defective. Please consult our service team.

F

The acoustic attachment of the sensor to the vessel is interrupted or impaired. Inspect the sensor contact or the settings of parameters P 71 to P 74.



Detection of fault F 10 must be permitted by parameter P 70.

F

The sensor detects a signal although no signal should actually be present at this time. The cause can be a to high electro-magnetical field. Please contact our service team.



Detection of fault F 11 must be permitted by parameter P 70.

- F** The entry data of transmission time related gain lack plausibility. A possible cause may be that the values for the times of the permitted reference points (P 14) are not growing steadily. Please also inspect if the setting of the number of permitted reference points (P 12) is correct.

8.3 Warnings

Warnings inform the user that the measuring process is not proceeding along the optimum line. Warnings are caused by parameters that are not the best. The measuring result will not be affected.

The warning code can be polled serially.

- F** The parameters have not been saved permanently. You quit the programming mode with P 99 = 0 or the SONOMETER 05 automatically returned to the measuring mode after not detecting any button activity or receiving a serial instruction for 16 minutes.
The warning F 09 is indicated periodically by „flashing“ for a brief moment.

- F** Overflow or underflow of the number range.

- F** The unit set with parameter P 20 lacks plausibility. Examples: Output of a sound transmission time while the simulation of the percentage level is enabled.

- F** The SONOMETER 05 cannot calculate the measured value because you result absurd value, e. g. the calculated percentage value exceeds 500% limit.

9 Default settings

The devices are delivered with the following default settings:

Param. No.	Designation	Reset values
P 03	Transmission energy	Step 10
P 04	Gain	Step 2
P 05	Dead time	0.2 ms
P 06	Measuring window	30 ms
P 07	Speed of sound	1483 m/s
P 08	Expected range	6.2 %
P 09	Noise suppression	0.5 s
P 10	Wall time	2 µs
P 12	TCG enable, number of reference points	OFF
P 13	TCG: select reference point	1
P 14	TCG: reference point timing	0.2 ... 2.0 ms (0.2 ms-steps)
P 15	TCG: reference point energy	1 ... 10 (steps 1)
P 16	TCG: reference point gain	Step 2
P 20	Unit of measurement for display	0, i.e. metres
P 21	Output interval	0.5 s
P 25	100% level	2.000 m
P 26	Sensor mounting height	0 m
P 32	Liquid level simulation	OFF
P 40	Current output beginning	0.0 %
P 41	Current output end	100 %
P 42	Current output range	0-20 mA
P 43	Current on wrong reading	OFF
P 44	Current on device fault	OFF
P 45	Simulation of current output	OFF
P 46	Adjustment of current output (end)	Adjust. value, after reset: 0
P 47	Adjustment of current output (zero)	Adjust. value, after reset: 0
P 50	Configuration Switched output	3, i.e. open by no echo or fault
P 70	Enable / interval for sensor contact verification	OFF
P 71	Transmiss. energy for sensor contact verification	Step 1
P 72	Gain for sensor contact verification	Step 2
P 73	Gate beginning for sensor contact verification	0.025 ms
P 74	Gate width for sensor contact verification	0.1 ms
P 91	Asynchronous base interval	50 ms
P 92	Software version	xx.yy
P 99	Save parameters	0

Table 11: Default settings



The above default settings will also be adopted after a total reset. A total reset can be made by pressing all three buttons when the device is switched off, then the device is switched on and the buttons are held pressed until the display panel goes blank. Remember that a total reset also rests all calibrated values. Parameter P 46/ P47 must be compensated again (see chapter 7.3).

10 Technical data

SONOMETER 05: Ultrasonic liquid level meter

Measuring principle	Echo time measurement in pulse-echo mode
Sensors: measuring frequency/ form of construction	500 kHz: E20, E21, E22 1 MHz: E01, E02, E03, E11 2 MHz: E04, E05, E10
Attachment of sensors	Without exposure to measured liquid, attached to outside of vessel, or directly in the liquid
Length of sensor cable	10 m, bigger length on enquiry
Parameter setting	Digital setting by buttons via display panel Unauthorised access control by code number
Measuring range	Maximum transmission time: 32 ms (approx. 23 m with water)
Resolution	1% of measuring range, maximum 1 mm (with defined measuring conditions)
Frequency of measuring sequence	approx. 20 Hz
Display	Digital display for measured-value output (level in m, or %) and parameter setting
Current outputs	Current output 0/4-20 mA for measured-value, no electrically isolated
Switched outputs	Switched output for fault output <ul style="list-style-type: none"> • Maximum switching voltage: 50 V • Maximum switching current: 100 mA • Relay, electrically isolated
Voltage supply	+18 ... 30 VDC/ 150 mA, protected against polarity reversal, approx. 1 s response time after start of operating voltage
Housing	SONOMETER 05: Aluminium, L x W x H: 160 x 100 x 80 mm, IP65 Sensors: Plastic: E01, E02, E04, E05, E20, E21, Stainless steel: E03, E10, E11, E22
Connections	SONOMETER 05: IP65 cable gland, internal: plug-in screw terminals Sensors: permanently installed connecting cable: E01, E03, E04, E10, E11, E20, E22, water-tight plug connector: E02, E05, E21

Connections	SONOMETER 05: IP65-cable glands, internal plug-type screw terminals Sensors: fixed cable: E01, E03, E04, E10, E11, E20, E22 waterproof connector: E02, E05, E21
Mounting	SONOMETER 05: wall-mounted Sensors: Mounting ring / mounting plate / fastening strap on vessel: <ul style="list-style-type: none"> • Screw thread M18x1: E04, E05, E10 • Screw thread M30x1.5: E01, E02, E03, E11 • Screw thread M45x1.5: E20, E21, E22
Temperature range	SONOMETER 05: 0 ... +60 °C Sensors: -20 ... +80°C: E01, E02, E03, E04, E05, E20, E21, E22 -20 ... +135°C: E10, E11
Hazard protection	SONOMETER 05: installed in housing EJB-1 or EJB-2, type of protection acc. to EEx d IIB T5 Sensors: Type of protection acc. to EEx m II T6 for E03, E22
Insulation resistance	Double basic insulation according to EN 61010-1 between all circuits
CE conformity	EC directives and other legislation 89/336/EEC and 92/31/EEC (Electromagnetic Compatibility), 73/23/EEC and 93/68/EU (Low Voltage Directive) <ul style="list-style-type: none"> • EMC, noise radiation emission: DIN EN 50081, Part 1 (VDE 0839, Part 81-2) DIN EN 55011 • EMC, noise immunity: DIN EN 50082, Part 2 (VDE 0839, Part 82-2): EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-6; Test result: b • Low Voltage Directive: EN 61010-1, EN 61010-1/A2
Scope of supply	SONOMETER 05, E series ultrasonic sensor incl. probe cable, user's manual
Accessories	Sensor fasteners, mounting compound

Table 12:
Technical data

Param.- No.	Designation	Settings	Your Settings
P 03	Transmission energy	Step 1 ... 20	
P 04	Gain	Step 1 ... 3	
P 05	Dead time	0.001 ... 20 ms	
P 06	Measuring window	0.001 ... 30 ms	
P 07	Speed of sound	250 ... 8000 m/s	
P 08	Expected range	0.8 ... 100 %	
P 09	Noise suppression	0.05 ... 1000 s	
P 10	Wall time	0 ... 200 μ s	
P 11	Sensor frequency	1 MHz	
P 12	TCG-enable, number of ref. points	OFF, 1 ... 10	
P 13	TCG: select reference point	1 ... 10	
P 14	TCG: time for current reference point	0.001 ... 30 ms	
P 15	TCG: transmission energy for current reference point	Step 1 ... 20	
P 16	TCG: gain for current reference point	Step 1 ... 3	
P 20	Unit of measurement for display output	0: m/ 1: %/ 2: ms	
P 21	Output interval	0.05 ... 1000 s	
P 25	100% level	0.001 ... 40 m	
P 26	Installation height of sensor	-9.990 ... 9.999 m	
P 32	Liquid level simulation	0.0 ... 120% / OFF	

Place of Measurement:
Others:

Date:

Param.-No.	Designation	Settings	Your Settings
P 40	Beginning of current output	0.0 ... 100 %	
P 41	End of current output	0.0 ... 100 %	
P 42	Current output range	0-20 / 4-20 mA	
P 43	Current for wrong measuring	0.0 ... 22 mA / OFF	
P 44	Current in case of device fault	0.0 ... 22 mA / OFF	
P 45	Current output simulation	0.0 ... 22 mA / OFF	
P 46	Calibration value for current output (end)	0 ... 3000	
P 47	Calibration value for current output (zero)	0 ... 1000	
P 50	Configuration switched outputs	0 ... 3: 0: off/ 1: on 2: Fault 3: no Echo+Fault	
P 70	Enable / interval for sensor contact verification	OFF, 5 ... 1000 s	
P 71	Transmission energy for sensor contact verification	step 1 ... 20	
P 72	Gain for sensor contact verification	step 1 ... 3	
P 73	Gate beginning for sensor contact verification	0.001 ... 30 ms	
P 74	Gate width for sensor contact verification	0.001 ... 30 ms	
P 91	Asynchronous base interval	0 ... 1.5 ms	
P 92	Software version	yyxx: read only	
P 99	Save parameters	0: no save / 1: save	

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