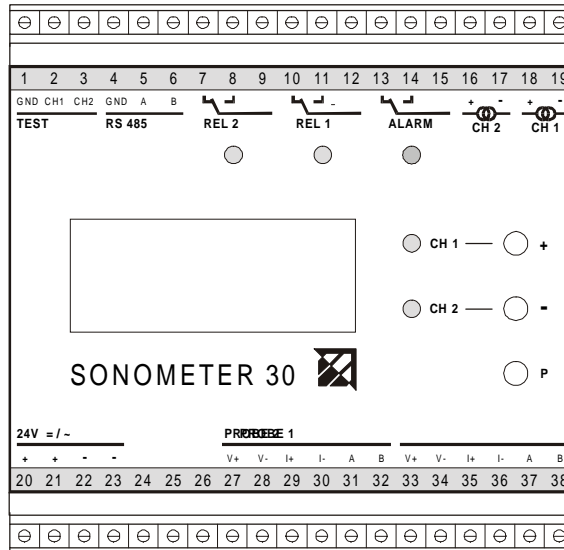


SONOMETER 30



Instruction Manual

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SONOMETER 30
Penetrating Pulse Technology
Liquid Level Measurement

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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 department**.



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 yellow background.

Symbol decals on the measuring system



This symbol indicates a general hazard. Caution! Follow the documentation. [See chapters 4.3 and 4.3.2!]



This symbol indicates the operational ground
See chapter 4.3.1.

2 Safety instructions

The SONOMETER 30 and the Penetrating Pulse Technology [ultrasonic] sensors comply with all applicable safety regulations. The equipment has been factory tested and every precaution has been taken to ensure the safe operation of the equipment. The user must take care that the equipment is set up and installed so that its safe use is not affected. This Instruction 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 performed by authorized service personnel.
- The equipment and all tools used for service must be grounded as prescribed.
- The protective conductors must be continuous and not broken.
- The SONOMETER 30 must only be used in the specified temperature range from -20 to +70°C, the sensor in the temperature range from -20 to +80°C.
- The temperature resistance of the connecting cable must be adapted to the operating temperature of the measuring system.
- In operation, the enclosures of both the unit and the sensor must remain closed.
- **Pull all plug connectors on the equipment before opening a housing.**
- All connections, in particular switched outputs, must be made with the supplied screw terminals. All terminal screws, including those on terminals not in use, must be tightened (touch guard/safe from finger-touch).
- The unit must only be supplied with voltage from a source through a breaker.
- The owner must make certain that the current on switched outputs does not exceed the rated limit of 5 amps. This can be ensured, for example, by a fusible link.
- The SONOMETER 30 must not be exposed to liquid.
- The cable between the SONOMETER 30 and the sensor must be shielded.
- The sensors should be handled with care and screwed in only hand tight. If they are tightened fully, the contact face may be damaged.
- Avoid electrostatic charge.

Maintenance, opening the equipment

The SONOMETER 30 and the Penetrating Pulse Technology sensor require no maintenance.

Opening the sensor housing is only necessary for installation. Interrupt the voltage supply before opening the housing. The sensor does not contain wearing parts.

*Service note:
Replace the fuse*

It may be necessary to open the housing of the SONOMETER 30 to replace the fuse.

Pull all plugs before opening the housing.

The voltage feed line (terminals 20-24) and the sensor feed (terminals 33/34 and 27/28, respectively) have fusible links.



These fuses must only be replaced by authorised service personnel. If a fuse blows, the cause must be identified.

Use type TE-5 fuse as a replacement:

- Install a 630 mA T fuse in the voltage supply line,
- Install a 100 mA T fuse in the line feeding the sensors.

Use only fuses of the specified rating.

Do not use a fuse of higher rating or jumper a fuse.

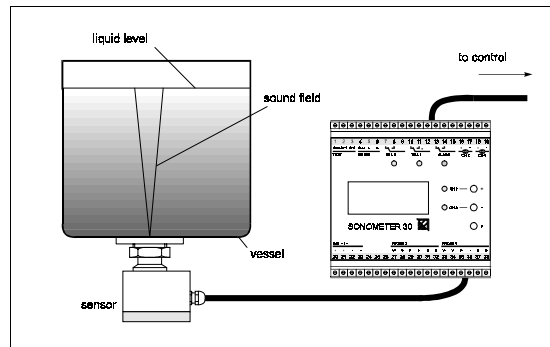
3 Introduction

3.1 Overview

Liquid level meters of the SONOMETER series work on the penetrating pulse echo principle.

This measuring method has several benefits:

- The 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 measurement.
- The measuring method is particularly suitable for applications in the pharmaceutical, food and beverage 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.



This versatile liquid level measuring system 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. The level indication can be scaled to any engineering units of level or volume.
- The measured value is available in an analog 4 to 20 ma current signal. The measured range can be adjusted as required.
- A large number of monitoring tasks for which the limits can be set freely can be performed simultaneously.
- The parameters required for installation can comfortably be input via buttons. The parameter inputs are not lost if the power supply is interrupted.
- Various operating states can be simulated with the SONOMETER 30, which is a substantial facilitation of the start-up or integration in your control system.
- A serial interface supports data exchange with computers. All parameters can be set and measured values obtained at this port. The port has bus capacity and supports the parallel connection of up to 32 series SONOMETER 30 / SONOCONTROL 20 units.
- The SONOMETER 30 is available as a single-channel or two-channel version. The second channel permits the metering the level in a second vessel or to increase the measuring accuracy of the first channel if the medium, its concentration or temperature change substantially.
- As a rule, the SONOMETER 30 is located in the control room. The distance to the sensor on the vessel can be up to 300 meters.

3.2 System components

The SONOMETER 30 system consists of the following components:

- the SONOMETER 30 evaluator
- one or two ultrasonic sensors of AE series
- fixing bracket on the vessel
- connecting cable between sensor and evaluator.

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	Frequency	Temp. Sensor	Mounting
AE01, Spec. 01	1 MHz	No	Screw-on module
AE01, Spec. 02	1 MHz	Yes	Screw-on module
AE01, Spec. 05	1 MHz	No	Screw thread M30x1.5
AE01, Spec. 06	1 MHz	Yes	Screw thread M30x1.5
AE20, Spec. 01	500 kHz	No	Screw-on module
AE20, Spec. 02	500 kHz	Yes	Screw-on module
AE20, Spec. 05	500 kHz	No	Screw thread M45x1.5
AE20, Spec. 06	500 kHz	Yes	Screw thread M45x1.5

3.3 Principle of Operation

Pulse sent and echo received

The ultrasonic sensor of the SONOMETER 30 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 30.

The measured transmission time is then adjusted. For example, the time the sound re-

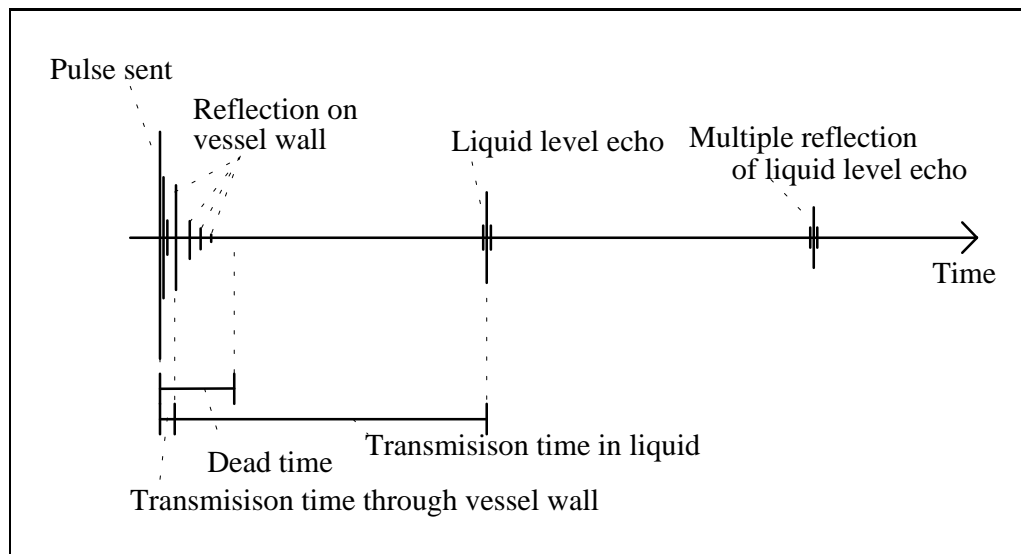


Figure 2: Echo detection in level metering

quires to propagate through the bottom of the vessel is deducted.

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 meters

From the calculated mean transmission time, the level in is calculated in units of meters 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, the calculation must be compensated.

Compensation with integrated temperature sensor

Compensation with temperature sensor

If the vessel always contains the same liquid, changes of the speed of sound due to temperature can be eliminated by a first approximation. This can be done with sensors with integrated temperature detector. However, inaccurate measured data are still possible because of the layers of different temperature in the liquid.

Compensation with reference measurement

Compensation with reference measurement

If the vessel is filled with another liquid, the concentration or chemical composition of the medium changes, the real speed of sound must be measured constantly. In applications of this type, the second measuring channel of the SONOMETER 30 can be used for reference measurement. In this case, the first channel uses the new sonic speed data.

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, knowledge of the vessel shape and its actual dimensions is required. Moreover, the maximum liquid level must be specified that corresponds to a filling volume of 100%.

Output

To calculate the filling volume, further vessel dimensions are required. The result can be output in units of litres, hectolitres or cubic metres.

The switching signals are generated by a comparison of the liquid level with the limit values (in percent)

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 (cf. Chapter 6.17).

4 Installation

4.1 Sensor

Sensor attachment



The sensor can be attached optionally with a screw-type module or thread. As counterpart of the sensor holders the following fixing devices are available:

- Ring for welding or gluing on the vessel,
- Mounting plate for attachment by strap retainers,
- Adapters for special screwed fasteners (Varivent, milk pipe screw connection, clamp closures, etc.).

Figures 3 and 4 on the following pages illustrate the various types of sensors and the method of their fixing.

If you are not sure which sensor type is best for your solution, please consult our service personnel, which will be glad to help.

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

Inspect state of attachment face

State of attachment 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 <10 µm. 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.

Install mounting compound between sensor and vessel

Install sensor with mounting compound

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. When the adhesive spreads evenly when the sensor is screwed in or pressed to the attachment face. Mounting compound and special adhesives are available from HiTECH Technologies.

AE01 / 01

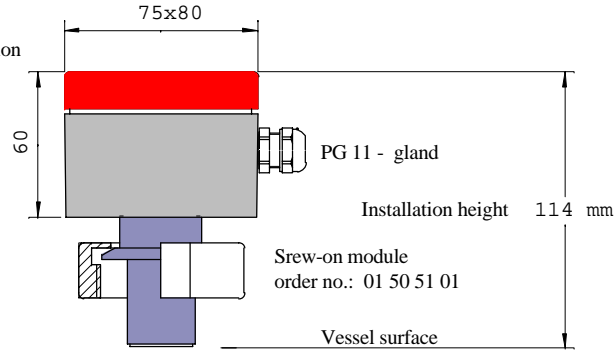
1 MHz / D20mm ; without temperature compensation

order no.: 01 41 10 01 01

AE01 / 02

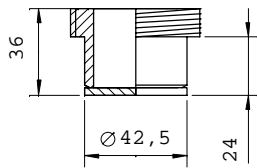
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order no.: 01 41 10 01 02



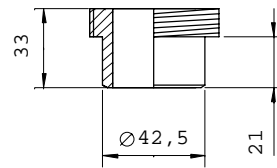
Attachment versions

material : 1.4571



Weld - in ring

order no.: 01 50 51 21 01



Weld - on ring

order no.: 01 50 51 11 01

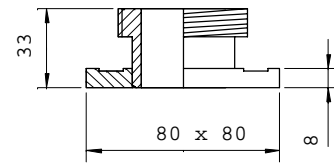


Plate for strap fastener,
weld or glue

order no.: 01 50 52 21 01

AE01 / 05

1 MHz / D20mm ; without temperature compensation

M30x1,5

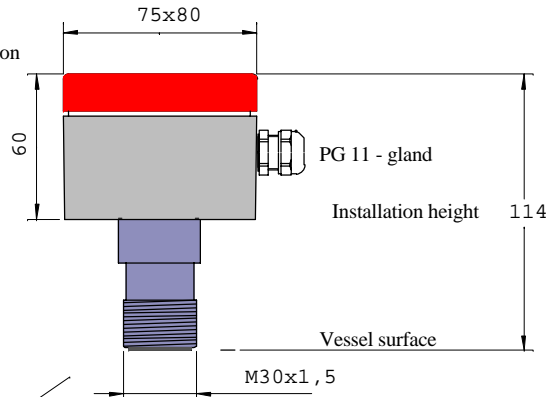
order no.: 01 41 10 01 05

AE01 / 06

1 MHz / D20mm ; with temperature compensation

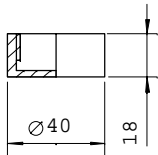
M30x1,5

order no.: 01 41 10 01 06



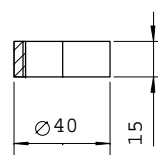
Attachment versions

material : 1.4571



Weld - in ring

order no.: 01 50 01 21 02



Weld - on ring

order no.: 01 50 01 11 02

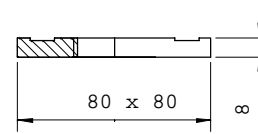


Plate for strap fastener ,
weld or glue

order no.: 01 50 02 21 02

Figure 3: Dimensions of series AE01 sensors and attachment versions

AE20 / 01

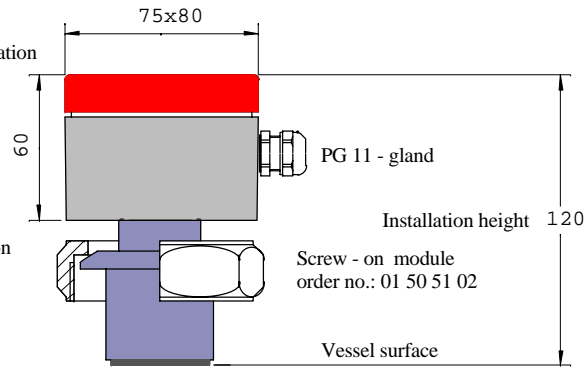
0,5 MHz / D35mm ; without temperature compensation

order no.: 01 41 10 02 01

AE20 / 02

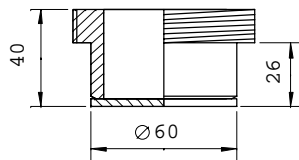
0,5 MHz / D35mm ; with temperature compensation

order no.: 01 41 10 02 02



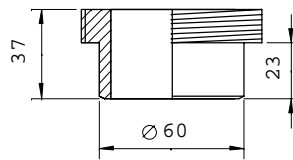
Attachment versions

material : 1.4571



weld - in ring

order no.: 01 50 51 21 02



weld - on ring

order no.: 01 50 51 11 02

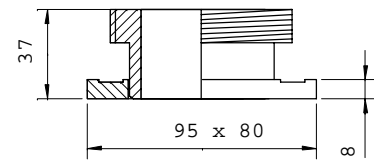


Plate for strap fastener ,
weld or glue

order no.: 01 50 52 21 02

AE20 / 05

0,5 MHz / D35mm ; without temperature compensation

M45x1,5

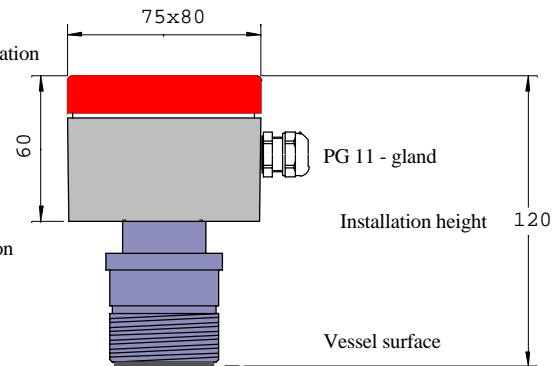
order no.: 01 41 10 02 05

AE20 / 06

0,5 MHz / D35mm ; with temperature compensation

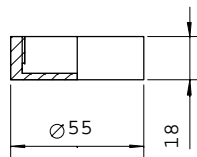
M45x1,5

order no.: 01 41 10 02 06



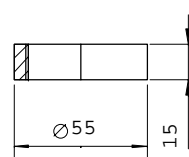
Attachment versions

material : 1.4571



weld - in ring

order no.: 01 50 01 21 03



weld - on ring

order no.: 01 50 01 11 03

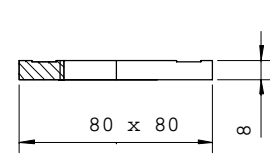


Plate for strap fastener ,
weld or glue

order no.: 01 50 02 21 04

Figure 4: Dimensions of series AE20 sensors and attachment versions

Install sensor only hand-tight



If the sensor is attached by means of screw-type module, install the sensor in the receiver and screw the cap hand-tight. The sensor can be aligned to some degree by tightening the cap, i.e., deviation caused during installation of the retainer can be compensated. The direction in which the cable exits can be selected freely by turning the sensor.

If you use a sensor with screw thread, no mechanical adjustment is possible. Like sensor with screw-type module, install the sensor only hand-tight. Note that the front of the ultrasonic transducers are covered with a high-precision plastic coat.

Operating temperature

Operating temperature

The specified maximum operating temperature of the sensors must not be exceeded, not even for a short moment.

The sensor consists of the ultrasonic transducer and the electronic control circuits. The ultrasonic transducer, which has direct contact with the vessel, is designed for a maximum temperature of 135°C. The electronic circuitry in the sensor housing can tolerate temperatures from -20°C to 80°C. Self-heating due to operation remains low (up to 10 K). The permitted ambient temperature range of the sensors is essentially determined by the local conditions, i.e., by the possibility to carry off heat.

Here are two examples:

*Example 1:
Sensor attached to vessel, no convection possible*

(1) The sensor is attached to a heated vessel. The vessel is completely covered with heat insulation. As in these conditions heat cannot be transported, the sensor heats to the temperature of the vessel. In this case the maximum vessel temperature is 70°C, viz. the highest permitted temperature of the electronic circuitry less the degree of self-heating.

*Example 2:
Sensor attached to vessel, with good convection*

(2) The sensor is used on a vessel without thermal insulation. Convection is not obstructed. In this situation a temperature gradient develops in the sensor, i.e., the temperature of the sensor housing is lower than that of the vessel. The maximum vessel temperature can be 135°C provided the temperature of the electronic circuits remains within the a.m. range. The actual temperature measured depends on a variety of factors and cannot be predicted reliably at this point.



CAUTION: There is risk of burns if the temperature of the sensor housing is above 70°C!

4.2 SONOMETER 30

The SONOMETER 30 is installed in a control cubicle. It is mounted to a standard 35mm supporting rail.

The SONOMETER 30 must be protected from the ingress of moisture. The degree of protection of the housing /the terminals is IP20/ IP00.

The permitted temperature range from 20°C to 70°C must not be exceeded.

4.3 Connections

Device overview

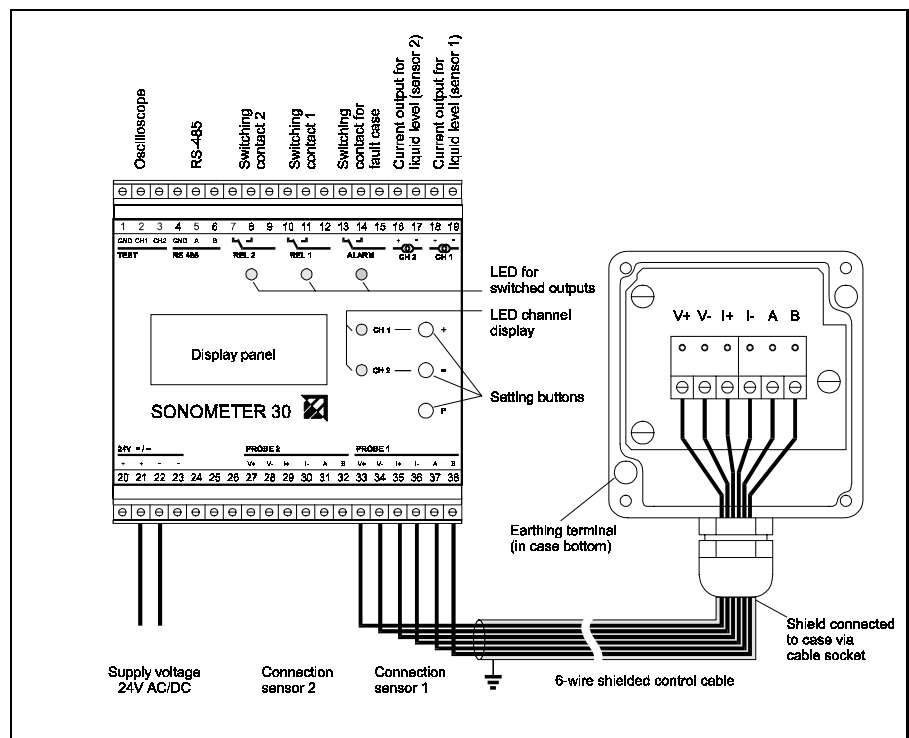


Figure 3: Controls and connections

4.3.1 Connecting the ultrasonic sensors

The ultrasonic sensors of the AE series consist of an ultrasonic transducer and the electronic circuitry. Power is supplied and the electronic circuits controlled by the SONOMETER 30.

Use shielded control cable LiYCY 6x0.5

Connect the sensors to the SONOMETER 30 with a 6-wire shielded control cable. We recommend shielded control wire type LiYCY 6x0.5. The cable can be 300 m long. The resistance of each wire must not exceed 10 ohms for the chosen length of cable. This means that conductors of smaller cross section area can be used if the cable length is short. Assuming round wire cross section and outside cable diameter of 5 – 10 mm, the IP65 degree of protection of the sensor is ensured.

Attaching the cable to the sensor

The shield is connected to the housing and earthed when the cable is installed in the cable bush. To attach the cable, proceed as follows:

- Open the sensor housing
- Strip approx. 60 mm of the cable
- Unscrew the cap on the cable bush
- Pull out the cable bush insert
- Pull the cable through the cap and the insert
- Terminate six wires with wire end ferrules
- Bend back the shield over the O-ring in the insert, cf. Figure 6.

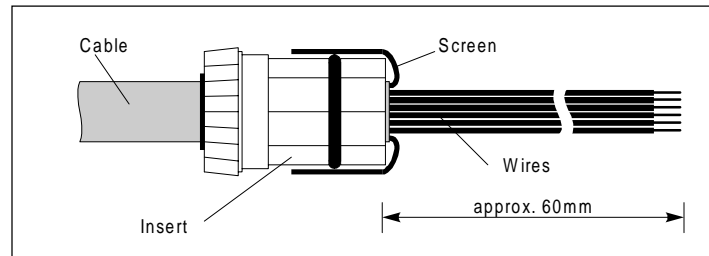


Figure 6: Attaching the cable to the sensor

- Install the wires through the cable bush and fully press in the insert, this causes the shield to be pressed to the inside of the cable bush
- Screw the cap tight, this fixes the cable and makes it insensitive to tensile stress
- Connect the terminals
- Close the housing cover



The installation will be easier if you pull the screw terminals off the electronic circuits when making the connections.

Ground sensor if vessel is not of metal.

On metal vessels, the sensor is earthed by its housing. If the vessel is made of non-conducting material, you should earth it by means of the earth-terminal screw on the bottom of the sensor housing.

4.3.2 Connecting the SONOMETER 30

The connections of the SONOMETER 30 to the ultrasonic sensor and the subsequent control are made by screw terminals located on the top and bottom of the enclosure, see table 2.



To make installation of the connecting lines easier, the screw terminals can be pulled off.

Top plug connector

Pin	Meaning
1	Ground for oscilloscope
2	Channel 1 test output for visual inspection with oscilloscope
3 *)	Channel 2 test output for visual inspection with oscilloscope
4	Ground for serial interface RS-485
5	A line RS-485 (bi-directional)
6	B line RS-485 (bi-directional)
7	Break contact for switching signal 2
8	Make contact for switching signal 2
9	Common connection for switching signal 2
10	Break contact for switching signal 1
11	Make contact for switching s1
12	Common connection for switching 1
13	Break contact for switching signal in case of fault
14	Make contact for switching signal in case of fault
15	Common connection for switching signal in case of fault
16 *)	Positive connection of current signal for channel 2
17 *)	Negative connection of current signal for channel 2
18	Positive connection of current signal for channel 1
19	Negative connection of current signal for channel 1

Table 2: Terminal pin configuration

Bottom plug connector

Pin	Meaning
20	First pole for 24V AC/DC feed voltage
21	Internal connection with pin 20
22	Second pole for 24V AC/DC feed voltage
23	Internal connection with pin 22
24	Reserved, not to be contacted
25	Reserved, not to be contacted
26	Reserved, not to be contacted
27 *)	Positive operating voltage, sensor 2
28 *)	Negative operating voltage, sensor 2
29 *)	Positive connection for current control loop, sensor 2
30 *)	Negative connection for current control loop, sensor 2
31 *)	A line for sensor 2
32 *)	B line for sensor 2
33	Positive operating voltage, sensor 1
34	Negative operating voltage, sensor 1
35	Positive connection for current control loop, sensor 1
36	Negative connection for current control loop, sensor 1
37	A line for sensor 1
38	B line for sensor 1

Connections marked with an asterisk (*) are only available if your SONOM-ETER 30 is a 2-channel unit (spec. 2xx).

Attaching the sensor cable to the SONOMETER 30

- Where the cable enters the control cabinet, connect the cable shield to the equipotential bonding. Avoid earthing connection by a long line as this renders the shield ineffective. There is no need to connect a shield to the SONOMETER 30.
- Strip the cable and install end ferrules.
- Connect the cable from the cable to the terminals of SONOMETER 30 as shown in table 2. This ensures that the terminals V+, V-, I+, I-, A and B on SONOMETER 30 are connected to the terminals of the same designation in the sensor.

Operating voltage circuit wiring

The supply voltage poles cannot be mistaken. Make the connections of the operating voltage as follows:

- Terminal 20/21: first pin 24 V AC/DC, max. 500 mA
- Terminal 22/23: second pin 24 V AC/DC, max. 500 mA



Terminals 20 and 21 as well as 22 and 23 are internally wired. A second unit can easily be supplied with operating voltage.



Max. range for supply voltage: 19 ... 30 V AC/DC

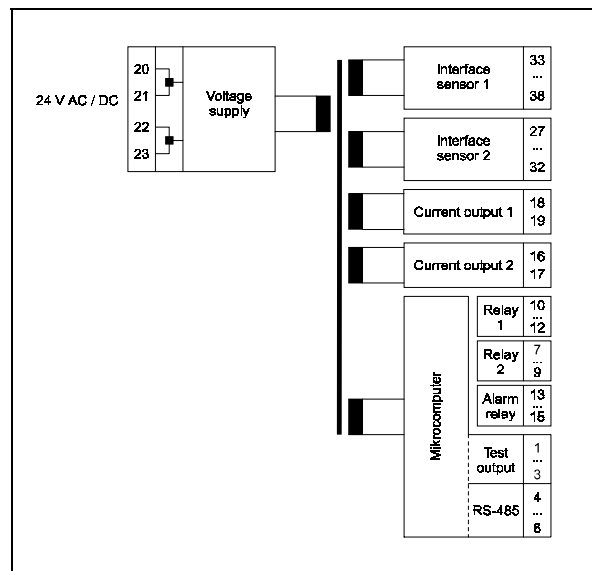


Figure 7: Galvanic isolation in the SONOMETER 30

To ensure high resistance to electromagnetic interference (EMI), signals are transmitted differentially. Besides, all function blocks in SONOMETER 30 are supplied with electrically isolated operating voltage. This avoids wrong connection due to potential difference.



Please note that the electric isolation of the assemblies is limited to an isolation strength of 50V. **The galvanic isolation must not be used to disconnect the mains supply.** Disconnect the mains supply by means of an externally connected power supply unit. Figure 10 contains an illustration of the assemblies with isolated supply voltage and the appropriate terminal connections.



Protect the unit effectively from transient interference (e.g., lightning).

The SONOMETER 30 is ready for operation approximately 3 seconds after starting the operating voltage.

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 of **floating** type.

It provides a correct signal of the output load in the range 0..500 ohms (at current values between 0/4 ... 20 mA). If a load resistance of 500 ohms is added, a voltage-proportional signal in the range of 0/2 ... 10 V can be obtained. An output that is not required must not be wired.

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 ohms.

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.

Current output 1 (terminals 18 and 19) is permanently assigned to the measuring results of sensor 1; current output 2 (terminals 16 and 17) is permanently assigned to the measuring results of sensor 2 (only with SONOMETER 30, spec. 2xx).



CAUTION! The maximum rated voltage of the current outputs to earth is 50 V!

Switched output wiring

All switched outputs are designed as relay contacts (changeover contacts), which ensures galvanic isolation from the SONOMETER 30. The maximum switching current is 5 A. There is no limitation of the switching current in the SONOMETER 30. Suitable external provision should be made by the owner of the unit.

Table 3:
Maximum switching
voltage by equipment
specification

Equipment specification	Max. switching voltage/current
xx1 and xx2	50V / 5A
xx3 and higher	250V / 5A

Test output

Connect the oscilloscope to the test output for a visual assessment of the echo pattern. Connect the oscilloscope ($R = 1 \text{ Meg. Ohm}$) 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:

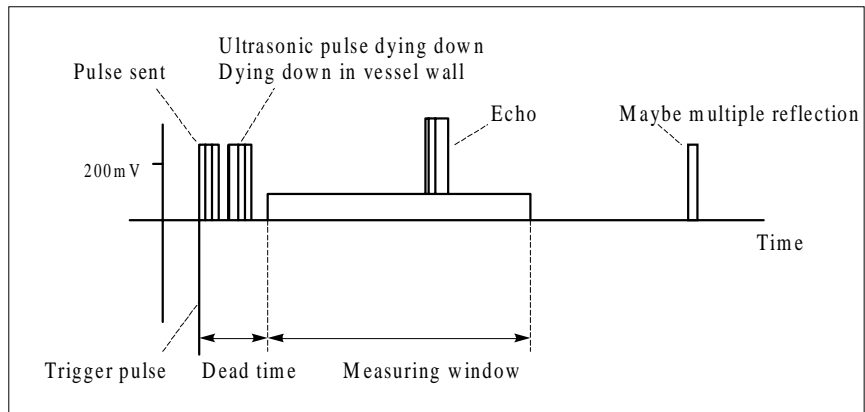


Figure 8:
Visual inspection of the
test output using an
oscilloscope

5 Start-up

5.1 Installation and wiring check

Before feeding operating voltage, make sure of the correct installation of the sensor (firm seating of all fastening elements, the cable attachment and the housing cover).

Inspect the wiring on the sensor, the SONOMETER 30 and other units, if any. Ensure, in particular, that all plug-type terminals on the SONOMETER 30 are installed at the correct places.

Make sure that the sensor is earthed. If the vessel is made of non-conducting material, a separate ground cable must be installed. The cable shield of the probe cable must be connected to the equipotential bonding of the control room.

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

5.2 SONOMETER 30 operating modes

When operating voltage is supplied, the SONOMETER 30 is running in regular measuring mode.

In programming mode the parameter settings can be displayed and edited. There are two ways to go from measuring mode to programming mode:

1. Programming by means of 3 hidden buttons and the display panel on the front plate of the SONOMETER 30.
2. Programming by the serial interface RS-485. During serial communication the word **r 485** is shown on the display panel.

5.3 Functions of buttons

There are three hidden buttons in the right-hand part of the front plate. These buttons have the following functions in measuring mode:

- Button <P>: Changes to programming mode
- Button <+>: Switches the display to measuring channel 1
- Button <->: Switches the display to measuring channel 2

Switching from one measuring channel to the other is only possible on 2-channel versions of the SONOMETER 30 (specification 2xx).

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

*Button functions in
measuring code*

*Button functions in
programming mode*

5.4 SONOMETER 30 parameter setting

1. Starting the programming mode

Enabling the programming mode: CodE

Code number input:

0000

Normal programming mode:

0345

Advanced programming mode:

1799

Wrong code number:

FEHL



Parameter Selection menu:

P xx

Parameter display:

xxxx

Button <+>:

Increments value

Button <->:

Decrements value

Button <P>:

Next parameter

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.

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

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.

2. Parameter Selection menu

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

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.

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

Save parameters:

0 No save

1 Save

End End of programming mode

Rapid toggle between:
measuring mode ↔
programming mode

Warning:
Parameter not saved!

F 09



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 6.42). 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.

Please note the following:

- 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 program 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.
- As long as the programming mode remains enabled, communication via the RS485 interface is not possible.

*If in programming mode you want to go from one programming level to another programming level, save the parameter entries at first (see chapter 6.13), cancel the programming mode and then start it again by pressing button **<P>**.*

5.5 Measured value acquisition

Before the SONOMETER 30 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 gate



(2) An internal time window is generated in the SONOMETER 30. 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.

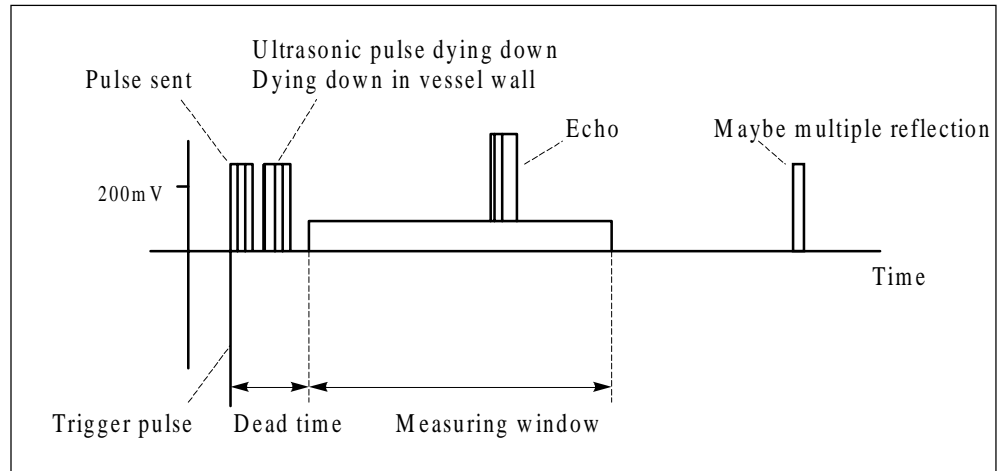


Figure 9: Echo detection in liquid level metering

- If no echo pulses can be seen as illustrated in figure 9, 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 30 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:

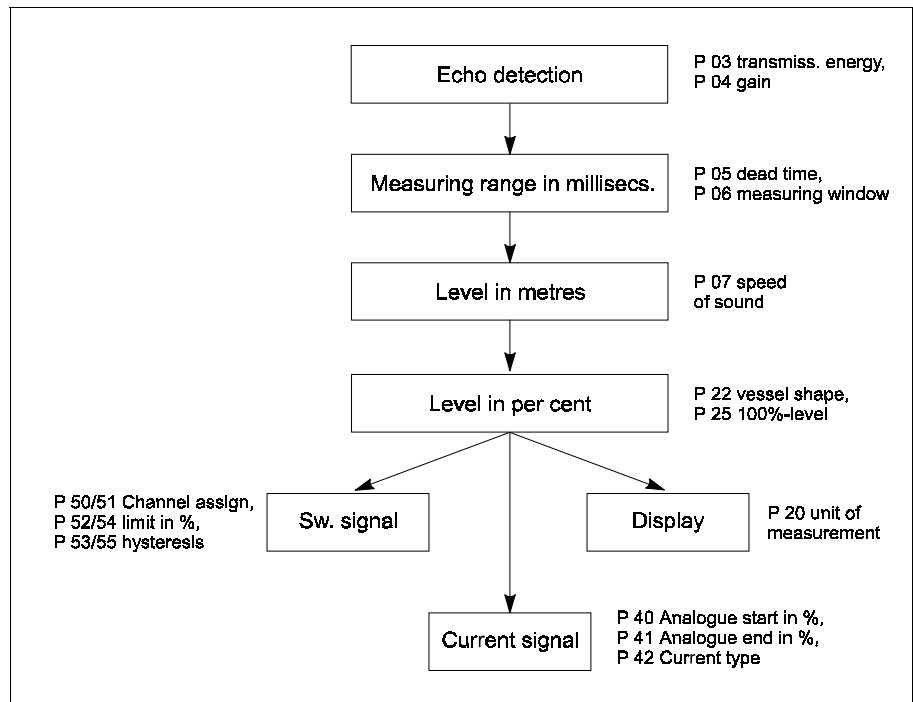


Figure 10: Fundamental parameters at start-up

Detection of echo in case of adverse sonic conditions

Transmission time related gain

Further parameters for measured value processing

- The parameters P 08 „Expected range“ and P 09 „Noise suppression“ improve the behaviour of the SONOMETER 30 in case of adverse acoustic conditions. They can smoothen the result.
- 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 dead time, 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.
- Conversion to percentage level of vessel volume*
- The percentage level is calculated by means of parameter P 25 (100% level in metres) and parameter P 22 (shape of vessel). All outputs relate to the percentage filling of the vessel.
- The percentage level is proportional to the volume of the vessel. This requires input of the dimension data of the vessel (P 23-P 31).*
- If the measured value proportional to the level is sufficient, enter the maximum level (in metres) as the 100% level in P 25 and specify the vessel as a sphere (P 22 = 2, this is default setting).*
- Display panel information*
- The SONOMETER 30 can show the measured values in several units (e. g., metres, litres, cubic metres). The unit is selected with P 20.
- Current signal*
- 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.
- Besides, current values can be defined which are output if a fault is detected in the device or a measured value is wrong.
- Switching signal*
- The 2 independent switching contacts are assigned to the measuring channels with parameter P 50 and parameter P 51. The switching point is entered as a percentage value via parameters P 52/ P 54, a hysteresis can be programmed with P 53/ P 55.
- The separate ALARM switching contact can be blocked or assigned to the measuring channels with parameter P 56.
- Temperature compensation*
- The calculation of the speed of sound as a function of the temperature is released with P 60. The measure of temperature dependence is entered via parameters P 61-P 63. This function will only work if sensors with integrated temperature detectors are used.
- Device address*
- If the serial port of the SONOMETER 30 is used, you should assign a device address with parameter P 90.
- Copying parameters to the other channel*
- If you are using a 2-channel SONOMETER 30 (specification 2xx) in which both sensors perform similar measuring tasks, you can enable a copy function with parameter P 98 and copy all parameters from the current channel to the other channel.
- Saving parameters*
- The entered parameters are permanently saved with parameter P 99.

6 SONOMETER 30 parameters

Param.- No.	Spec. 1xx	Spec. 2xx	Designation	Settings
CODE	x	x	Normal programm. mode access code	0345
P 02		x	Channel selection	CH1 / CH2
P 03	x	x	Transmission energy	Step 1 ... 9
P 04	x	x	Gain	Step 1 ... 67
P 05	x	x	Dead time	0.001 ... 20.00 ms
P 06	x	x	Measuring window	0.001 ... 30.00 ms
P 07	x	x	Speed of sound	250 ... 8000 m/s
P 08	x	x	Expected range	0.8 ... 100 %
P 09	x	x	Noise suppression	0.100 ... 2000 s
P 10	x	x	Wall time	0 ... 200 µs
P 12	x	x	TCG-enable, number of ref. points	OFF, 1 ... 10
P 13	x	x	TCG: select reference point	1 ... 10
P 14	x	x	TCG: time for current ref. point	0.001 ... 30.00 ms
P 15	x	x	TCG: trans. energy for curr. ref. point	Step 1 ... 9
P 16	x	x	TCG: gain for curr. ref. point	Step 1 ... 67
P 20	x	x	Unit of measurement for display output	0: m/ 1: %/ 2: l/ 3: hl/ 4: m³/ 5: ms/ 6: °C/7: m/s
P 21	x	x	Output intervall	0.100 ... 2000 s
P 22	x	x	Shape of vessel (standard shapes)	0:st.cyl./ 1:ly.cyl./ 2:rect./ 3:user def./ 4:ref.
P 23	x	x	Dimension 1	0.000 ... 20.00 m
P 24	x	x	Dimension 2	0.000 ... 20.00 m
P 25	x	x	100% level	0.001 ... 40.00 m
P 26	x	x	Mounting height of sensor	-9.990 ... 9.999 m
P 27	x	x	User def. shape: number of ref. points	2 ... 30
P 28	x	x	User def. shape: select reference point	1 ... 30
P 29	x	x	User def. shape: level at curr. ref. pt.	0.000 ... 20.00 m
P 30	x	x	User def. shape: volume at curr. ref. pt.	000.0 ... 120.0 %
P 31	x	x	User def. shape: reference volume	0.001 ... 9999 m³
P 40	x	x	Beginning of current output	000.0 ... 100.0 %
P 41	x	x	End of current output	000.0 ... 100.0 %
P 42	x	x	Current output range	0-20 / 4-20 mA
P 43	x	x	Current for wrong reading	00.0 ... 22.0 mA / OFF
P 44	x	x	Current in case of device fault	00.0 ... 22.0 mA / OFF
P 50	x	x	Configuration of switched output 1	OFF / On / CH1 / CH2
P 51	x	x	Configuration of switched output 2	OFF / On / CH1 / CH2
P 52	x	x	Level limit of switched output 1	000.0 ... 120.0 %
P 53	x	x	Hysteresis of switched output 1	000.0 ... 50.0 %
P 54	x	x	Level limit of switched output 2	000.0 ... 120.0 %
P 55	x	x	Hysteresis of switched output 2	000.0 ... 50.0 %
P 56	x	x	Configuration of alarm switched output	OFF / On / CH1 / CH2 / CH1+CH2
P 60	x	x	Enable temperature compensation	0: OFF / 1: water / 2: other
P 61	x	x	Speed of sound at apex	250 ... 8000 m/s
P 62	x	x	Temperature at apex	-50 ... 150°C
P 63	x	x	Linear drift of speed of sound	-9.990 ... 9.999 m/sK
P 90	x	x	Device address RS485	1 ... 32
P 92	x	x	Software version	yyxx: read only
P 98		x	Copying parameter sets	0: no function / 1:copying to other channel
P 99	x	x	Saving parameters	0: no saving / 1: saving permanently

Table 4: Parameter overview

6.1 Parameter P 02: Channel selection

This parameter is only available in devices with two measuring channels (specification: 2xx).

This parameter selects the measuring channel in programming mode. All further entries of parameters relate to the channel selected here. The green LED for CH1 and CH2, respectively, lights to indicated the selected channel.

- Switching to channel 1: <+> ? CH 1 ?<P>, green LED CH1 lights
- Switching to channel 2: <-> ? CH 2 ?<P>, green LED CH2 lights

The channel can also be selected in measuring mode before starting the programming mode.

6.2 Parameter P 03: Transmission energy

Settings

0001 ... 0009: 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.

6.3 Parameter P 04: Gain

Settings

0001 ... 0067: Gain steps

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 made with visual inspection by an oscilloscope connected to the test output (see chapter 4.3.2).

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

One step changes the gain power approximately by 1 dB. The unit dB is a logarithmic, relative unit of measurement. For example, 20 dB are equal to factor 10; 6 dB to factor 2.

6.4 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.

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

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

1: Estimation of the bottom limit for measurement

To have visual control of setting the dead time, the use of an oscilloscope on the test output of the SONOMETER 30 is urgently recommended (see chapter 4.3.2).

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.

6.5 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

6.6 Parameter P 07: Speed of sound

Settings

0250 ... 8000: Speed of sound in [m/s] at 20°C

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

Table 5: Speed of sound in selected liquids (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

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

1. Please set the following parameters to the specified values:
 - P 07 = 1483 (speed of sound = 1,483 m/s)
 - P 11 = Wall time (see chapter 6.9)
 - P 20 = 0 (display values in unit of „m“)
 - P 26 = 0 (installation height = 0 m)
2. Fill the vessel with liquid and measure the level by another method (distance between liquid surface and sensor surface).
3. Cancel the programming mode and take the level reading (in m).
4. 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:

$$v_1 [\text{m / s}] = \frac{F_{\text{Meas}} [\text{m}]}{F_{\text{Displ}} [\text{m}]} * 1483$$

v_1 : 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

6.7 Parameter P 08: Expected range

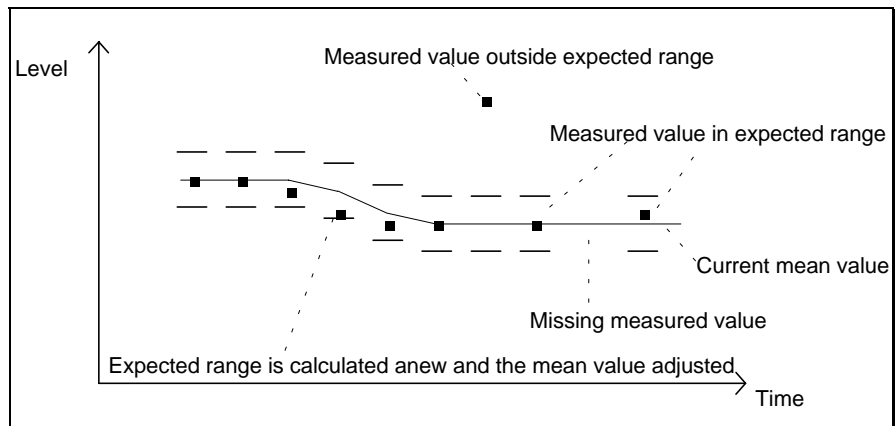
Settings

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

The SONOMETER 30 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 11: Assessment of level data with reference to expected range



Example

The parameter P 08 in the SONOMETER 30 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.

6.8 Parameter P 09: Noise suppression

Settings

0.100 ... 2000: Noise suppression time in [s]

The number setting indicates the period in which the SONOMETER 30 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 9 = 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.

6.9 Parameter P 10: Wall time

Settings

0001 ... 0100: 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 fro) 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 6: Wall time in μ s as a function of vessel material and wall thickness of the vessel

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.

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

The transmission energy 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 gain adjustment and keep the transmission energy constant at one step across the entire measuring range. This accelerates the measuring process.

The dead time is made up 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.

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 30 when echo noise or multiple echo is detected.

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: Transmission energy =3 / gain=35. 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: Transmission energy=1 / gain=10. 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 transmission energy is calculated. At a level of 2.25 m (echo time = 3 ms) the following settings are required: Transmission energy=1 / gain=20. The echo is also stable at transmission energy=3 / gain=20.

Echo time	Level	Transmission energy	Gain
0.1 ms	75 mm	1	10
3 ms	2.25 m	1 or 3	20
10 ms	7,5 m	3	35

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

<i>P 03 (transmission energy at start)</i>	<i>Step 1</i>
<i>P 04 (gain at start)</i>	<i>Step 10</i>
<i>P 05 (dead time)</i>	<i>0.100 ms</i>
<i>P 13 (select 1st TCG reference point)</i>	<i>1</i>
<i>P 14 (timing of 1st TCG reference point)</i>	<i>3.000 ms</i>
<i>P 15 (transmission energy of 1st TCG reference point)</i>	<i>Step 3</i>
<i>P 16 (gain of 1st TCG reference point)</i>	<i>Step 20</i>
<i>P 13 (select 2nd TCG reference point)</i>	<i>2</i>
<i>P 14 (timing of 2nd TCG reference point)</i>	<i>10.00 ms</i>
<i>P 15 (transmission energy of 2nd TCG reference point)</i>	<i>Step 3</i>
<i>P 16 (gain of 2nd TCG reference point)</i>	<i>Step 35</i>
<i>P 12 (number of reference points and enable TCG)</i>	<i>2</i>

Figure 12 illustrates the adjustment of transmission energy and gain in the above example.

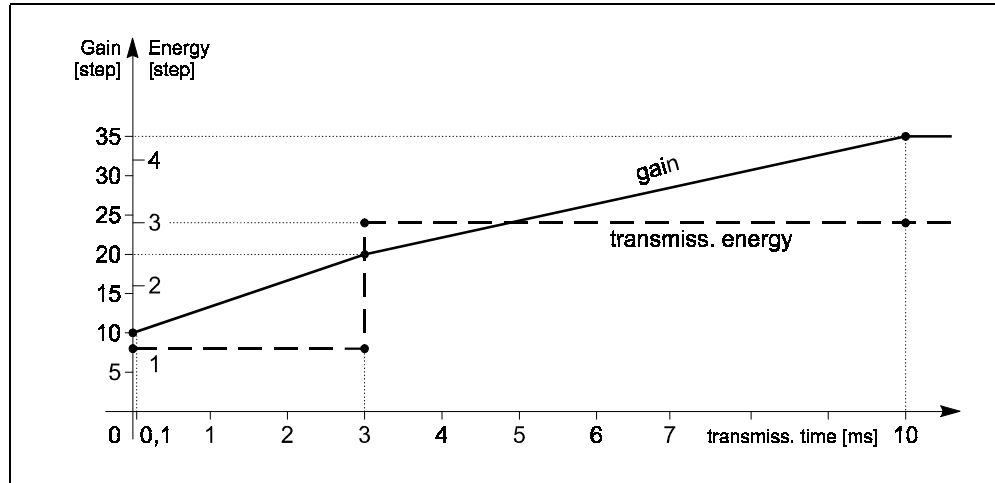


Figure 12: time controlled gain

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

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

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

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 30. 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.

Parameter P 15: Transmission energy for current TCG reference point

0001 ... 0009: Transmission energy step for current TCG reference point

Parameter P 15 defines the transmission energy to be used between the current reference point and the next following reference point. If there is no next following reference point, this transmission energy is used for the rest of the measuring window.

For setting, refer to parameter P 03 in chapter 6.2.

6.14 Parameter P 16: Gain for current TCG reference point

0001 ... 0067: Gain step for current TCG reference point

These parameters define the gain of the current TCG reference point. The gain 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 04 in chapter 6.3.

6.15 Parameter P 20: Unit of measurement for display output

0000:	Level in [m]
0001:	Level in [%]
0002:	Filled volume in [l]
0003:	Filled volume in [hl]
0004:	Filled volume in [m ³]
0005:	Echo time in [ms]
0006:	Sensor temperature in [°C] (only meaningful if sensors with temperature detector are used)
0007:	Compensated speed of sound in [m/s] (only meaningful if sensors with temperature detector are used or for reference measurement)

Note that to obtain a correct reading of level in % or filled volume the vessel geometry data must have been specified in parameters P 22 - P 31.

6.16 Parameter P 21: Output interval

0.100 ... 2000: 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.

6.17 Parameter P 22: Shape of vessel

- 0: Upright cylinder with /without conical end
- 1: Lying cylinder
- 2: Rectangular vessel
- 3: User defined shape (specify reference points)

rEF: Reference measurement (only possible on channel 2)

These parameters are required for the conversion of the level data to filled volume data according to the geometrical shape of the vessel. Depending on the shape, the following parameter groups are of relevance:

Standard vessel

- P 23: Dimension 1
- P 24: Dimension 2
- P 25: 100% level
- P 26: Height at which sensor is mounted

User defined vessel shape

- P 26: Height at which sensor is mounted
- P 27: Number of reference points
- P 28: Reference point selection
- P 29: Level in [m] at selected reference point
- P 30: Filled volume in [%] at selected reference point
- P 31: Filled volume at 100 % in [m³]

Reference measurement

- P 23: Dimension 1 (i. a. vessel diameter)

The location of each of the above dimensions can be seen from the following illustrations.

Vessel shape 0:

Upright cylinder with or without conical end (Figure 13 to Figure 16)

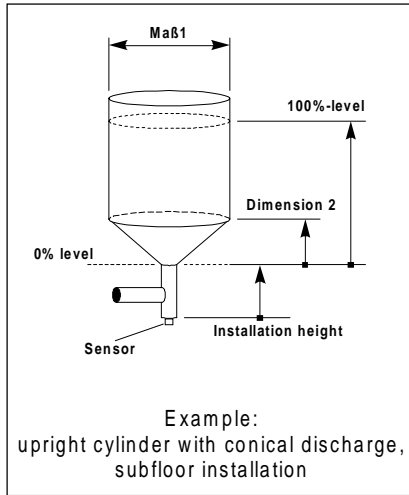


Figure 13: Upright cylinder with discharge cone; sensor at connection

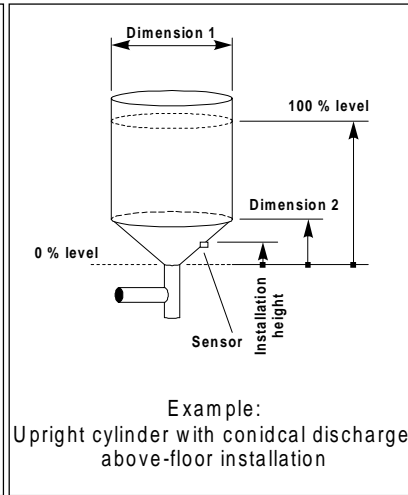


Figure 14: Upright cylinder with discharge cone; sensor in discharge cone

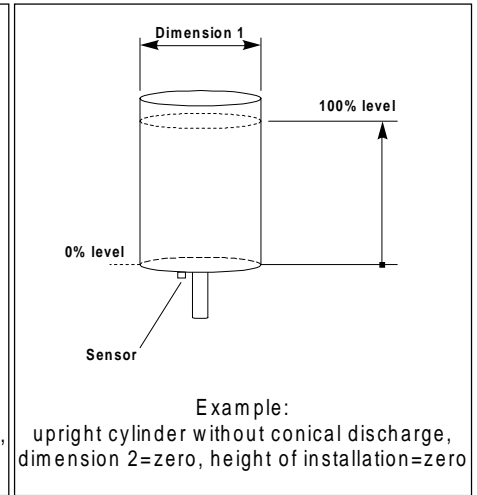


Figure 15: Upright cylinder without discharge cone; sensor mounted in vessel bottom

Vessel shape 1:

Horizontal cylinder (Figure 16)

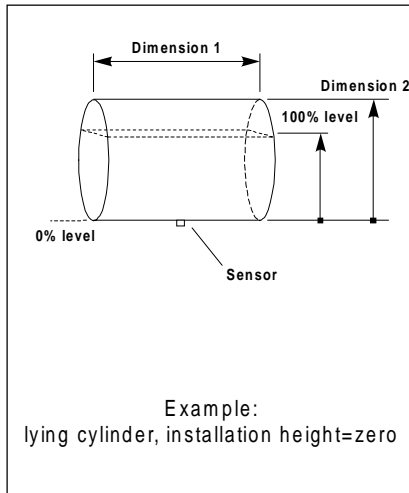


Figure 16: Horizontal cylinder, sensor mounted in vessel bottom

Vessel shape 2:

Rectangular vessel (Figure 17 and figure 18)

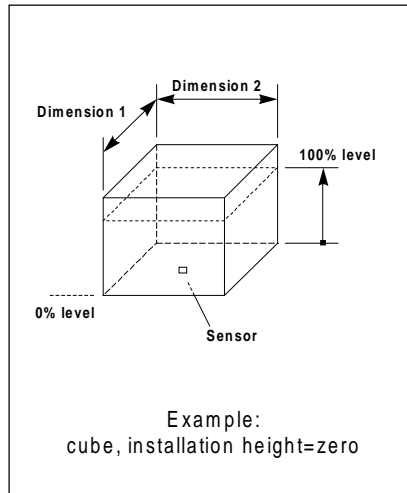


Figure 17: Rectangular vessel; sensor mounted in vessel bottom

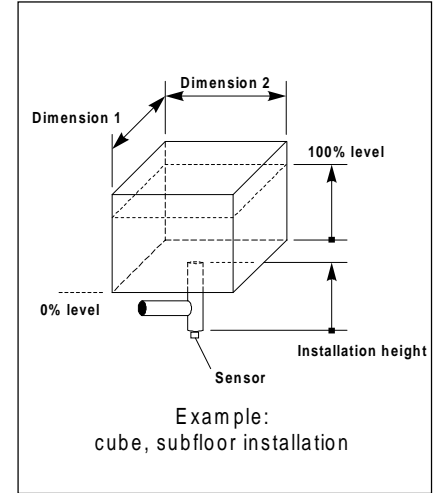


Figure 18: Rectangular vessel; sensor mounted in discharge connection

Vessel shape 3:

User defined shape (Figure 19)

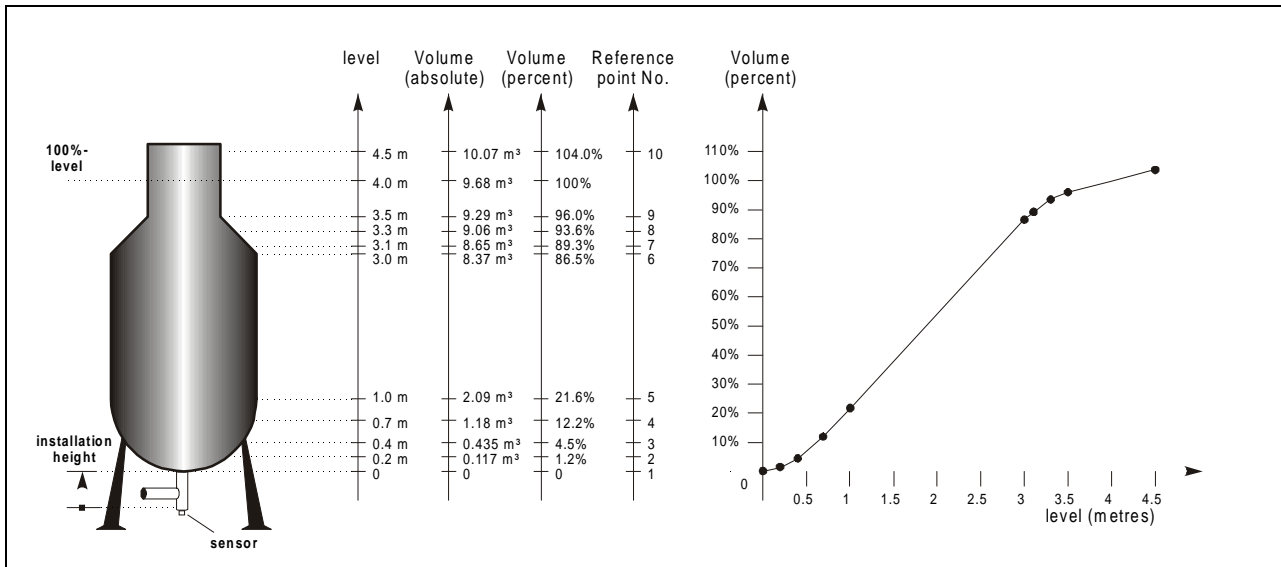


Figure 19: User defined vessel shape
Enter filling curve with reference points (parameters P27 - P 31)

Reference measurement

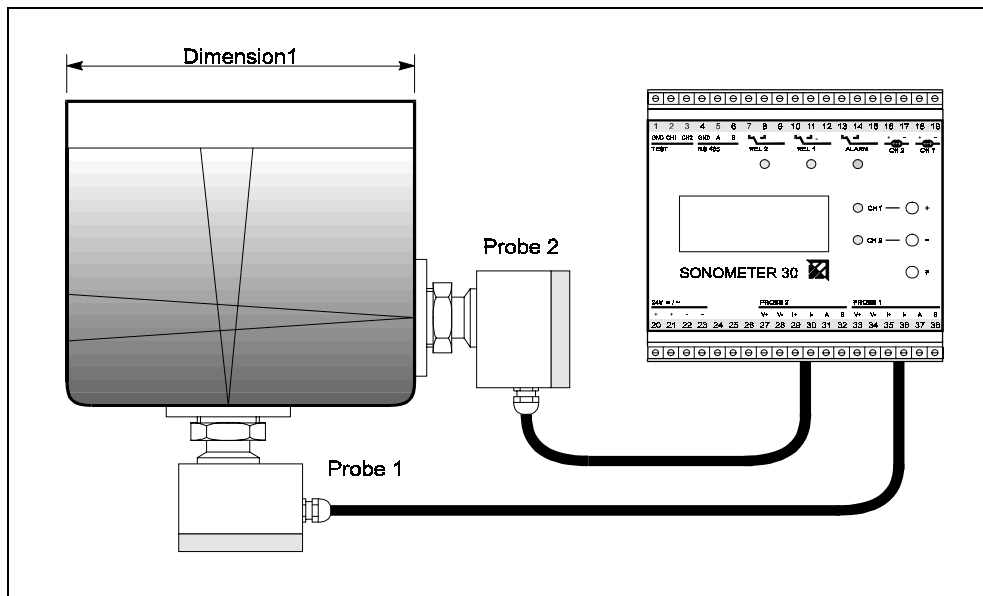


Figure 20: Using a second channel as reference path

For reference measurement you need a meter with 2 measuring channels (specification: 2xx).

In reference measuring mode, the second channel measures the speed of sound. The measured speed is used by the first channel to calculate the level. The sensor in the second channel must be mounted to ensure that the sound signal travels horizontally through the vessel. The vessel diameter is specified as dimension 1 in channel 2.

6.18 Parameter P 23 / P 24: Dimension 1 / Dimension 2

0.000 ... 20.00: Dimension 1 or dimension 2 in [m]

6.19 Parameter P 25: 100% level

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

6.20 Parameter P 26: Mounting height of sensor

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

6.21 To note if vessel is of user defined shape

Select the user defined vessel shape if your vessel does not fit completely or even nearly into any of the above shapes.

The geometrical shape of the vessel is not important. The characteristic of filling the vessel is indicated by reference points. Each reference point represents a pair of values consisting of the liquid level in units of metres and the appropriate filled volume (in percent). You can enter 2 ... 30 reference points. A linear rise of the filled volume is assumed between any two reference points.

Level and percentage volume must increase from one reference point to the next. The distance between any two reference points need not be the same.

The first reference point is always numbered 1. The percentage volume of the last specified reference point must be larger than or equal to 100% (max. 120%). Finally, the vessel volume that corresponds to 100% filling must be specified. This value is specified in units of cubic metres.

To enter a pair of reference point values with parameters P 29 and P 30 the required reference point must first be selected with parameter P 28. Enter the liquid level and percentage volume of the current reference point and then call parameter P 28 again to select the next reference point for which you want to specify values.

A plausibility check of the entries is made when cancel the programming mode.

6.22 Parameter P 27: Number of reference points

0002 ... 0030: Number of reference points for user defined vessel shape

This parameter indicates the number of reference points describing the volume procedure of the vessel. Only the number of reference points specified here is accepted as the valid number and is used for calculation.

6.23 Parameter P 28: Select reference point

0001 ... 0030: Selects the current reference point for the user defined vessel shape

Here the number of the reference point is specified to which the entries in parameters P 29 and P 30 relate. To view or edit other reference points, always call P 28 at first and enter the number of the reference point you want to view or edit.

6.24 Parameter P 29: Level at current reference point

0.000 ... 20.00: Level in [m]

Here you enter the level at which the percentage volume entered at P 30 is reached.

6.25 Parameter P 30: Volume at current reference point

0.000 ... 120.0: Volume in [%]

Here you enter the percentage volume relating to level P 29.

6.26 Parameter P 31: Reference volume

0.001 ... 9999: Volume in [m³]

This parameter provides the link between the percentage volume of a reference point and the absolute volume.

The specified number is a cubic metre value corresponding to 100% filling of the vessel.

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

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.

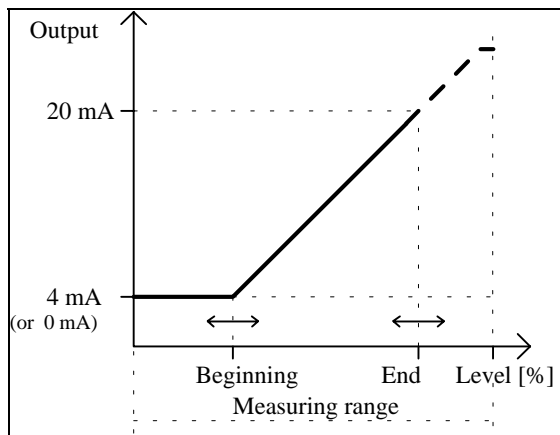


Figure 21: Current output characteristic:
Beginning < End:
Positive rise of current as level increases

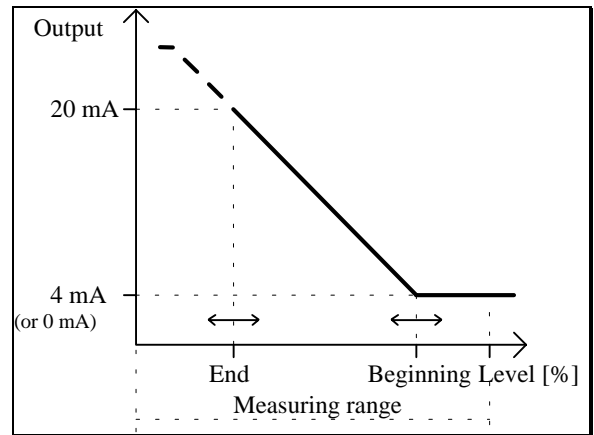


Figure 22: Current output characteristic:
Beginning > End:
Negative rise of current as level increases

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.

6.28 Parameter P 42: Current output range

- 0-20: Current output in range 0 ... 20 mA
- 4-20: Current output in range 4 ... 20 mA

6.29 Parameter P 43: Current for wrong reading

000.0 ... 022.0: Current in [mA]

OFF: Last current value output remains on display panel

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 reading.

For output of value currents higher than 20 mA see chapter 4.3.2.

6.30 Parameter P 44: Current in case of device fault

Settings

000.0 ... 022.0: Current in [mA]

OFF: Last current value output remains on display panel

Here you can define the current which the SONOMETER 30 puts out if no reading of the liquid level can be taken. If a device fault has occurred, the fault current output presupposes that the SONOMETER 30 was not stopped.

For setting, please read the information regarding parameter P 43 in chapter 6.30.

6.31 Parameter P 50 / P 51: Configuration of switched output 1 / 2

SONOMETER 30, spec.: 1xx, 1-channel

Spec.: 1xx

OFF: Switched output permanently disabled

On: Switched output permanently enabled

A C1: Switched output is set to channel 1 as required by the level measured

SONOMETER 30, spec.: 2xx, 2-channel

Spec.: 2xx

OFF: Switched output permanently disabled

On: Switched output permanently enabled

A C1: Switched output is set to channel 1 as required by the level measured

A C2: Switched output is set to channel 2 as required by the level measured

6.32 Parameter P 52 / P 54: Level limit of switched output 1 / 2

000.0 ... 120.0: Level limit of switching contact in [%]

6.33 Parameter P 53 / P 55: Hysteresis of switched output 1 / 2

000.0 ... 050.0: Hysteresis in [%]

The switching contact is **switched on** if a level higher than or equal to the set limit is detected in the assigned channel (parameters P 52 / P 54).

The switching contact is **switched off** if a level smaller than the limit less the hysteresis is detected in the assigned channel.

Switch on : Level [%] ? limit [%]

Switch off: Level [%] < limit [%] - hysteresis [%]

6.34 Parameter P 56: Configuration of alarm switched output

The ALARM switched output provides outputs of fault messages and works on the closed-circuit current principle. The switching contact also generates a fault message, for example, when the feeding voltage fails.

SONOMETER 30, Spec.: 1xx, 1-channel

- OFF: ALARM relay permanently disabled,
red LED lighting
- On: ALARM relay permanently enabled,
red LED not lighting
- A C1: ALARM relay drops (fault message) if no reading is possible
in channel 1

SONOMETER 30, Spec.: 2xx, 2-channel

- OFF: ALARM relay permanently disabled,
red LED lighting
- On: ALARM relay permanently enabled,
red LED not lighting
- A C1: ALARM relay drops (fault message) if no reading is possible
in channel 1
- A C2: ALARM relay drops (fault message) if no reading is possible
in channel 2
- C1u2: ALARM relay drops (fault message) if no reading is possible
in channel 1 or channel 2

No fault message

- Relay picked up
- Red LED in the front plate not lighting

Fault message:

- Relay dropped
Red LED lighting (operating voltage is available)

6.35 Parameter P 60: Enable temperature compensation

The speed of sound depends on the temperature to some degree. If the temperature fluctuates, wrong readings are likely.

Sensors with integrated temperature detector compensate the reading error. They ensure that the speed of sound is calculated for the actual temperature of the liquid. This is done with reference to a temperature coefficient.

The temperature as measured and the speed of sound derived from the temperature reading can be shown on the display panel in measuring mode (see chapter 6.16, parameter P 20).

As regards temperature coefficients, there are two fundamentally different groups of liquids:

Water and water-related liquids, aqueous solutions

- The dependence of the speed of sound on the temperature has the shape of a parable.

Two parameters must be entered as co-ordinates of the apex of the parabolic characteristic. The other pair of values is provided by parameter P 07 (speed of sound), which invariably relates to a temperature of 20°C.

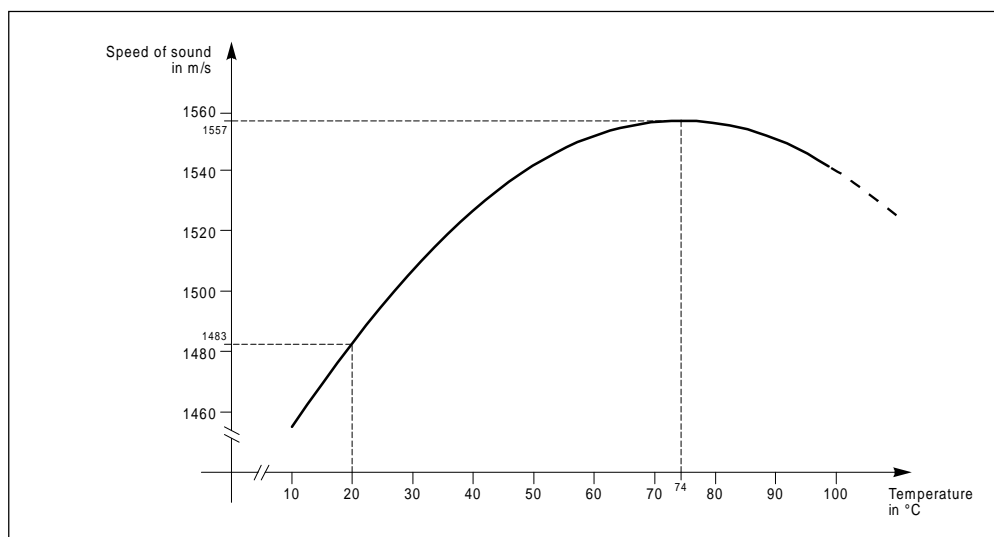


Figure 23: Temperature dependence of the speed of sound in water

Other liquids

Other liquids (e .e. hydrocarbons, oils, ...)

- Linear dependence of speed of sound on temperature

Tables with values for a multitude of different liquids are available. Please ask our service team for the parameters you require.

- OFF: Temperature compensation disabled,
speed of sound equal to setting of parameter P 07
- 1: Water-like liquid (parabolic temperature dependence)
- 2: Other liquid (linear temperature dependence)

6.36 Parameter P 61: Speed of sound at apex

The following parameter applies only to water-like liquids: parameter

P 60 = 1.

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

It may happen that the speed of sound is at its maximum at 20°C. The speed of sound in parameter (P 07) always relates to a temperature of 20°C. In such a case simply enter a second pair of values for speed of sound and temperature at P 61 and P 62 even if that is not the maximum speed of sound. The SONO-METER 30 automatically detects it and selects the appropriate instruction for calculation.

6.37 Parameter P 62: Temperature at apex

The following parameter applies only to water-like liquids: parameter

P 60 = 1.

-50 ° ... 150 °: Temperature at apex of characteristic in [°C]

6.38 Parameter P 63: Linear drift of speed of sound

Other liquids

This parameter applies to all liquids that are unlike water: parameter

P 60 = 2.

-9.990 ... 9.999: Drift of the speed of sound in [m/s per K]

6.39 Parameter P 90: Device address

0001 ... 0032: Device address for serial port

Up to 32 devices can be connected in parallel to the RS-485 bus. It is a condition, however, that every device has a different device address.

6.40 Parameter P 92: Software version

Read only

xx.yy : Software version xx: Main version
 yy: Sub-version

The software in SONOMETER 30 is continually updated to adjust it to practical requirements. Besides, user-defined adjustments to the software are also possible. This parameter shows you the current version of the software you are using. The main version is separated from the subordinate version by decimal point. If you require service, please specify the software version number in your request.

6.41 Function P 98: Copying parameter sets

- 0: Function disabled
- 1: The parameters of the current enabled channel are copied to the other channel.

This function is only available in units with 2 measuring channels (specification: 2xx).

Function P 98 is a convenient way to copy the set of parameters from one channel to the other. Parameters for adjusting the control currents and the alarm relay cannot be copied.

Do not forget to save the parameters (see chapter 6.43).

6.42 Function P 99: Saving parameters

This function is enabled after the Parameter Selection menu by showing the word SAFE on the display panel. When this is confirmed, the following functions can be enabled:

Settings

- 0:
 - The parameters are not saved, edited parameters will be lost by a failure of the voltage supply. As a reminder F 09 flashes.
 - To set new parameters you need not enter a code number.
- 1:
 - The parameters are saved permanently. They will not be lost even if the voltage supply fails.
 - Access to the parameter data is only possible after entering the code number.

When you have completed confirmed all entries, the software quits the programming mode and the word End is shown on the display panel.

7 Advanced Programing mode

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8 Serial port

The SONOMETER 30 has a serial port for setting parameters and poll measured data.

If the serial port is enabled, the SONOMETER 30 switches to programming mode. Parameter setting via the keypad and the serial port are therefore exclusive of each other. If, for example, parameters are set via the serial port, the SONOMETER 30 will not respond to the press of a button and the information r485 is shown on the display panel to indicate the current status. Only when communication ends, the previous information will again appear on the display panel.

Conversely, i. e., if parameters are being set via the keypad, the SONOMETER 30 will only respond to attempts to establish a link via the serial port after the keypad entries have been completed.

8.1 Hardware specification

The SONOMETER 30 is equipped with a RS-485 interface. Up to 32 devices can be connected in parallel to the data lines form a bus. Each device is assigned an address, a number from 01 to 32.

Data is transferred in semi-duplex mode, i. e., data is sent and received by the same line. Only one subscriber can transmit data, while the other devices are receiving. The figure below illustrates the working principle for a RS-485 bus with SONOMETER 30 devices: Like terminals of all units must be connected with each other.

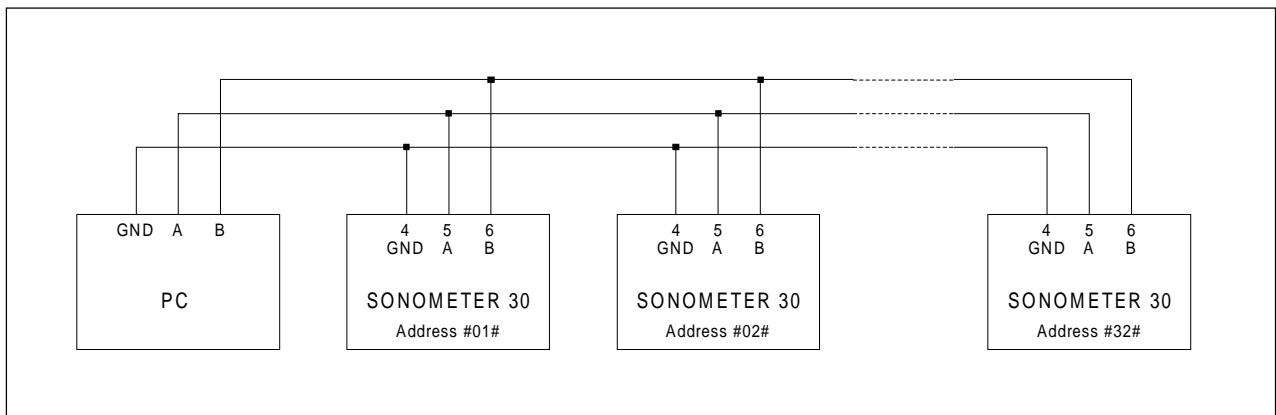


Figure 24: RS-485 wiring principle

RS232 ↔ RS485-
converter

Communication via the serial port follows the master-slave principle. The master, usually your PC, a terminal device, or a similar device, always works as the transmitter and controls the data exchange. It functions as a receiver only to receive data.

The SONOMETER 30 is the slave performing the instructions it receives from the master. For this purpose, the serial port of the SONOMETER 30 always works as a receiver. It transmits data only if instructed and returns to receive mode after it.

If a PC is to function as the master, an RS-485 interface must usually be installed. The required RS-485 plug-in module (mostly with electrical isolation) are available commercially.

As an alternative, an adapter can be used that fits the RS-485 standard to the standard RS-232 port of your PC. The RS-232 port of a PC usually has separate lines for reception and transmission. Both lines are brought together in the adapter. For this multiplexing mode to operate smoothly, information on the direction of the data flow, i. e., transmission or reception, is required. Most suppliers of RS232-RS485 adapters use the RS-232 control lines RTS or DTR. For details, please see the user instructions of your adapter.

Port configuration

Please configure your serial port as follows:
Baud rate 9600 Bit/s, 8 data bits, 1 stop bit, no parity.

8.2 Log

Communication with the SONOMETER 30 proceeds in the form of instructions which consist of ASCII characters. Each instruction is concluded by a carriage return character (symbol: <CR>, value: 13^{dec.} = 0D^{hex.}). The SONOMETER 30 accepts only capital letters, digits and several special characters. The instruction format is the following:

#ADDRESS# INSTRUCTION WORD=VALUE<CR>

- ADDRESS is the device address (see chapter 6.40) of the respective device, it is preceded and followed by the “#” lozenge sign.
- If you want to address all devices at the same time, you can specify “ALL” between the two lozenge signs. This works only with so-called set instructions (see below).
- INSTRUCTION WORD indicates the key word for the respective parameter, see chapter 8.3, Set of instructions for serial port.
- The equal sign separates the instruction word from the instruction value. It must always be entered.
- VALUE stands for a number of question mark “?”. This is the difference between instructions which *set* a parameter to a certain numerical value and instructions which *inquire* for the number value of a parameter.

If an inquiry instruction is sent, the respective SONOMETER 30 replies to the inquiry. The reply uses the same format as the instruction, i.e., it consist of the address, the instruction word and the numerical value.



1. There are two instruction for which the use of the equal sign and the VALUE and is forbidden. These instructions are "EXIT" to quit the communication with the SONOMETER 30 and "SAVE" to permanently save the date input .
2. On the other hand, there are instruction words that are only allowed in inquiry instructions or only in setting instructions. The former group, for example, comprises measured values or device type, the latter the access code and the reset instructions.
3. Serial parameter setting supports only integers. Therefore smaller units than those shown on the display panels must be used.
4. Instructions that are unknown or do not conform to the format are ignored. As the SONOMETER 30 can only transmit as a slave on the instruction of the master, it **cannot output any fault messages** on its own.

Establishing a link,
entering the code
number

Parameter setting by the serial port is very similar to the parameter input via the keypad. All parameters relate to the current channel.

At first, the link with the SONOMETER 30 is established by means of a CODE instruction. The code is of the same value as the code number entered via the keypad. Again, the parameters are set on two levels. If the code is valid, the keypad of the SONOMETER 30 will be blocked until you quit the serial communication by entering EXIT or the system does not detect any instructions for approximately 16 minutes. You can also go from one programming level to the other with the CODE instruction.

8.3 Set of instructions for serial port

Parameter P 01: Access code

a) To establish a link

Instruction word: CODE

Instruction class: Set

Value range: 0345 for normal parameter setting
1799 for Advanced Programming mode

b) To go to another parameter setting level

Instruction word: CODE

Instruction class: Set

Value range: 0345 for normal parameter setting
1799 for Advanced Programming mode

c) Quit serial communication

Instruction word: EXIT

Instruction class: non-parameterised instruction

Parameter P 02: Channel

Instruction word: CH

Instruction class: Set and inquire

Value range: 1..2

Parameter P 03: Transmission energy

Instruction word: ENERGY

Instruction class: Set and inquire

Value range: 1..9 [in steps]

Parameter P 04: Gain

Instruction word: GAIN

Instruction class: Set and inquire

Value range: 1..67 [in steps]

Parameter P 05: Dead time

Instruction word: DEADTIME

Instruction class: Set and inquire

Value range: 1..20000 [μ s]**Parameter P 06: Measuring window**

Instruction word: MEASWIND

Instruction class: Set and inquire

Value range: 1..30000 [μ s]**Parameter P 07: Speed of sound**

Instruction word: VEL

Instruction class: Set and inquire

Value range: 250..8000 [m/s]

Parameter P 08: Expected range

Instruction word: AVRTOL

Instruction class: Set and inquire

Value range: 0..7 [In steps], with the following meaning:

Step	Expected range	Step	Expected range	Step	Expected range
0	0.8 %	3	6.2 %	6	50 %
1	1.6 %	4	12.5 %	7	100 %
2	3.1 %	5	25 %		

Parameter P 09: Noise suppression

Instruction word: ERRDELAY

Instruction class: Set and inquire

Value range: 0..13 [In steps], with the following meaning:

Step	Noise suppression	Step	Noise suppression	Step	Noise suppression
0	0.1 s	5	5 s	10	200 s
1	0.2 s	6	10 s	11	500 s
2	0.5 s	7	20 s	12	1000 s
3	1 s	8	50 s	13	2000 s
4	2 s	9	100 s		

Parameter P 10: Wall time

Instruction word: WALLTIME

Instruction class: Set and inquire

Value range: 0..200 [μ s]**Parameter P 11: Compensation of control current for sensor**

Instruction word: CALGAIN

Parameter setting level: Advanced Programming mode only

Instruction class: Set and inquire

Value range: 100..255

Parameter P 12: Enable / number of reference points for time controlled gain (TCG)

Instruction word: TCGCOUNT

Instruction class: Set and inquire

Value range: 0 (disabled), 1..10

Parameter P 13: Select TCG reference point

Instruction word: TCGSELECT
Instruction class: Set and inquire
Value range: 1..10

Parameter P 14: Time for current TCG reference point

Instruction word: TCGTIME
Instruction class: Set and inquire
Value range: 1..30000 [µs]

Parameter P 15: Transmission energy for current TCG reference point

Instruction word: TCGENERGY
Instruction class: Set and inquire
Value range: 1..9 [In steps]

Parameter P 16: Gain for current TCG reference point

Instruction word: TCGGAIN
Instruction class: Set and inquire
Value range: 1..67 [In steps]

Parameter P 20: Unit of measurement for display output

Instruction word: UNIT
Instruction class: Set and inquire
Value range: 0..7, with the following meaning:

No.	Unit	No.	Unit
0	Level in metres	4	Volume in cubic metres
1	Volume in percent	5	Transmission time in milliseconds
2	Volume in litres	6	Sensor temperature in °C
3	Volume in hectolitres	7	Compensated speed of sound in m/s

Parameter P 21: Output interval

Instruction word: OUTPER
Instruction class: Set and inquire
Value range: 0..13 [In steps], with the following meaning:

Step	Output interval	Step	Output interval	Step	Output interval
0	0.1 s	5	5 s	10	200 s
1	0.2 s	6	10 s	11	500 s
2	0.5 s	7	20 s	12	1000 s
3	1 s	8	50 s	13	2000 s
4	2 s	9	100 s		

Parameter P 22: Shape of vessel

Instruction word: FORM
Instruction class: Set and inquire
Value range: with spec. 1xx: 0..3; with spec. 2xx, channel 1: 0..3, channel 2: 0..4;
with the following meaning:

No.	Vessel shape	No.	Vessel shape
0	Upright cylinder with/without discharge cone	2	Cube tank
1	Lying cylinder	3	User defined vessel shape
		4	Reference measurement

Parameter P 23: Dimension 1 and

Parameter P 24: Dimension 2

Instruction word: DIST1, DIST2
Instruction class: Set and inquire
Value range: 0..20000 [mm]

Parameter P 25: 100% level

Instruction word: MAXLEVEL

Instruction class: Set and inquire

Value range: 1..40000 [mm]

Parameter P 26: Mounting height of sensor

Instruction word: MOUNTLEVEL

Instruction class: Set and inquire

Value range: -9990..9999 [mm]

Parameter P 27: Number of reference points with vessel of user defined shape

Instruction word: RPCOUNT

Instruction class: Set and inquire

Value range: 2..30

Parameter P 28: Select reference point

Instruction word: RPSELECT

Instruction class: Set and inquire

Value range: 1..30

Parameter P 29: Level at current reference point

Instruction word: RPLEVEL

Instruction class: Set and inquire

Value range: 0..20000 [mm]

Parameter P 30: Volume at current reference point

Instruction word: RPVOLUME

Instruction class: Set and inquire

Value range: 0..12000 [a hundred times percentage value]

Parameter P 31: Reference volume

Instruction word: REFVOLUME

Instruction class: Set and inquire

Value range: 0.001..9999 [cubic metres]

Note: This is the only parameter which supports floating decimal point function. The value range comprises 1 litre to 9999 cubic metres. The number of digits is limited to **four**. Every change to the next higher power of 10 causes a shift of the floating point to the right deleting one decimal digit. Hence four ranges are available: (I) 0.001 .. 9.999, (II) 10.00 .. 99.99, (III) 100.0 .. 999.9 and (IV) 1000 .. 9999.

Parameter P 32: Simulation of level

Instruction word: SETLEVEL

Setting level: Advanced Programming mode only

Instruction class: Set and inquire

Value range: 0..12000 and 12001 [a hundred times percentage value];
12001 means Simulation OFF

Parameter P 40: Beginning of current output

Instruction word: ANLSTART

Instruction class: Set and inquire

Value range: 0..10000 [a hundred times percentage value]

Parameter P 41: End of current output

Instruction word: ANLEND

Instruction class: Set and inquire

Value range: 0..10000 [a hundred times percentage value]

Parameter P 42: Current output range

Instruction word: OFFSCURR

Instruction class: Set and inquire

Value range: 0,1; with the following meaning 0: 0..20mA, 1: 4..20mA

Parameter P 43: Current for wrong reading

Instruction word: ERRCURR

Instruction class: Set and inquire

Value range: 0..220 and 221 [ten times the milliampere value];
221 means OFF, if a fault occurs, the last current value is held;
current value is guaranteed up to 20 mA only.

Parameter P 44: Current in case of device fault

Instruction word: FAILCURR

Instruction class: Set and inquire

Value range: 0..220 and 221 [ten times the milliampere value];
221 means OFF, if a fault occurs, the last current value is held;
current value is guaranteed up to 20 mA only.

Parameter P 45: Simulation of current output

Instruction word: TESTCURR

Setting level: Advanced Programming mode only

Instruction class: Set and inquire

Value range: 0..220 and 221 [ten times the milliampere value];
221 means simulation OFF, if a fault occurs, the last current value is held;
current value is guaranteed up to 20 mA only .

Parameter P 46: Adjustment of current output

Instruction word: CALCURR

Setting level: Advanced Programming mode only

Instruction class: Set and inquire

Value range: 0..3000

Parameter P 50: Configuration of switched output 1 and

Parameter P 51: Configuration of switched output 2

Instruction word: REL1, REL2

Instruction class: Set and inquire

Value range: 0..2 with specification 1xx, 0..3 with specification 2xx,
with the following meaning:

No.	Configuration	No.	Configuration
0	permanently disabled	2	switches according to channel 1 level
1	permanently enabled	3	switches according to channel 2 level

Parameter P 52: Level limit of switched output 1 and

Parameter P 54: Level limit of switched output 2

Instruction word: SWLEVEL1, SWLEVEL2

Instruction class: Set and inquire

Value range: 0..12000 [a hundred times percentage value]

Parameter P 53: Hysteresis of switched output 1 and

Parameter P 55: Hysteresis of switched output 2

Instruction word: HYST1, HYST2

Instruction class: Set and inquire

Value range: 0..5000 [a hundred times percentage value]

Parameter P 56: Alarm switched output configuration

Instruction word: ALARMREL

Instruction class: Set and inquire

Value range: 0..2 for specification 1xx, 0..4 for specification 2xx, with the following meaning:

No. Configuration	No. Configuration
0 permanently disabled	3 Switches only if fault in channel 2
1 permanently enabled	4 Switches if fault in channel 1 or channel 2
2 Switches only if fault in channel 1	

Parameter P 60: Enable temperature compensation

Instruction word: TEMPMEAS

Instruction class: Set and inquire

Value range: 0..2, with the following meaning:

No. Compensation	No. Compensation
0 disabled	2 for all other media
1 for water and water-like media	

Parameter P 61: Speed of sound at apex

Instruction word: MAXVEL

Instruction class: Set and inquire

Value range: 250..8000 [m/s]

Parameter P 62: Temperature at apex

Instruction word: TEMPMAXVEL

Instruction class: Set and inquire

Value range: 2230..4230 [ten times the Kelvin value]

Here are a few examples:

-50°C = 223 K corresponds to 2230; 0°C = 273 K corresponds to 2730,
 20°C = 293 K corresponds to 2930, 100°C = 373 K corresponds to 3730;
 150°C = 423 K corresponds to 4230

Parameter P 63: Linear drift of speed of sound

Instruction word: VELDRIFT

Instruction class: Set and inquire

Value range: -9999..9999 [mm/s pro Kelvin]

Parameter P 70: Release / interval for sensor contact verification

Instruction word: SELFTTEST

Setting level: Advanced Programming mode only

Instruction class: Set and inquire

Value range: 0..6 [In steps], with the following meaning:

Step	Time interval	Step	Time interval
0	disabled	4	100 s
1	5 s	5	500 s
2	10 s	6	1000 s
3	50 s		

Parameter P 71: Transmission energy for sensor contact verification

Instruction word: TESTENERGY

Setting level: Advanced Programming mode only

Instruction class: Set and inquire

Value range: 1..9 [In steps]

Parameter P 72: Gain for sensor contact verification

Instruction word: TESTGAIN

Setting level: Advanced Programming mode only

Instruction class: Set and inquire

Value range: 1..67 [In steps]

Parameter P 73: Gate beginning for sensor contact verification

Instruction word: TESTBEG

Setting level: Advanced Programming mode only

Instruction class: Set and inquire

Value range: 1..30000 [μ s]**Parameter P 74: Gate width for sensor contact verification**

Instruction word: TESTWID

Setting level: Advanced Programming mode only

Instruction class: Set and inquire

Value range: 1..30000 [μ s]**Parameter P 90: Device address**

This parameter can only be set via the keyboard, it is a precondition for communication via the serial interface.

Parameter P 91: Asynchronous cycle rate

Instruction word: ASYNCH

Setting level: Advanced Programming mode only

Instruction class: Set and inquire

Value range: 0..15 [In steps], with the following meaning:

Step	Offset from base interval	Step	Offset from base interval	Step	Offset from base interval
0	0 μ s	6	600 μ s	12	1.2 ms
1	100 μ s	7	700 μ s	13	1.3 ms
2	200 μ s	8	800 μ s	14	1.4 ms
3	300 μ s	9	900 μ s	15	1.5 ms
4	400 μ s	10	1,0 ms		
5	500 μ s	11	1,1 ms		

Parameter P 92: Software-Version

Instruction word: VERSION

Instruction class: Inquire

Feedback value: xxyy (as decimal number without decimal point); with the following meaning:

xx: principal version, yy: sub-version

Function P 98: Copy parameter sets

Instruction word: COPYALL

Instruction class: Set

Value range: 0.1; this function is only implemented in specification 2xx devices.

with the following meaning:

0: no activity

1: all parameters of the current channel are copied in the other channel (except calibrated values P11 / P46).

Function P 99: Save parameters

Instruction word: SAVE

Instruction class: non-parametrised instruction

No value range defined

Parameter P 101: Device configuration

Instruction word: IDENT

Instruction class: Inquiry

The device type can be inquired with this instruction.

Value range: 2: SONOMETER 30 specification 1xx
3: SONOMETER 30 specification 2xx

Parameter P 102: Release or block measuring procedure

Instruction word: ENABLE

Parameter setting level: Advanced Programming mode only

Instruction class: Set and inquire

Value range: 0.1; with the following meaning:

- 0: Blocks the measuring procedure, the sensors carry out no more measuring function. No fault message is generated. The current outputs constantly supply the last current value. This instruction is particularly of interest for applications with several SONOMETER 30 units on one vessel (redundant configuration). Normally, the units would interfere with each other (acoustic cross-talk).
- 1: Release measuring procedure, normal operating state. An explicit release of the measuring procedure is only required after a previous blockage.

Parameter P 103: Reset

Instruction word: RESET

Setting level: Advanced Programming mode only

Instruction class: Set

Value range: 0.1; with the following meaning

- 0: no activity
- 1: The SONOMETER 30 makes the reset of the internal microcomputer. The parameter entries in the memory are not erased, parameters not saved will be lost.

Parameter P 104: Total reset

Instruction word: TOTALRESET

Setting level: Advanced Programming mode only

Instruction class: Set

Value range: 0.1; with the following meaning

- 0: no activity
- 1: The SONOMETER 30 makes the reset of the internal microcomputer. All parameters (including calibrated values) are lost and are replaced by default values. (see chapter 10).

Parameter P 105: Inquire status

Instruction word: STATE

Instruction class: Inquire

For the correct interpretation of the returned number a binary evaluation of all bits must be made. They have the following meanings:

- Bit 0: Echo flag CH1: An echo of the pulse just transmitted has been detected in channel 1.
- Bit 1: Echo flag CH2: An echo of the pulse just transmitted has been detected in channel 2.
- Bit 2: Measured value flag CH1: Indicates that a value transmission time mean result is available for channel 1.
- Bit 3: Measured value flag CH2: Indicates that a value transmission time mean result is available for channel 2.
- Bit 4: Alarm relay switching state: Indicates if the alarm relay has or has not picked up.
- Bit 5: Relay 1 switching state: Indicates if relay 1 has picked up.
- Bit 6: Relay 2 switching state: Indicates if relay 2 has picked up.
- Bit 7: always 0

Parameter P 106: Inquire measured value (percentage level)

Instruction word: MEASDAT

Instruction class: Inquire

Feedback value: 0..12000 [a hundred times percentage value]

Note: If the level simulation is enabled, the value set there is returned.

Parameter P 107: Inquire temperature value

Instruction word: TEMPDAT

Instruction class: Inquire

Feedback value: ten times the Kelvin value. For examples of conversion to centigrade, see parameter P 62.

Parameter P 108: Inquire compensated speed of sound

Instruction word: REALVEL

Instruction class: Inquire

Feedback value: Speed of sound in m/s on which the measuring process is currently based.

Parameter P 109: Inquire fault

Instruction word: ERROR

Instruction class: Inquire

Feedback value: 0..255, see chapter9.2.

The number xx of the fault is output and shown as F xx on the display panel. If several faults are detected at the same time, the number of the most serious fault is displayed. If this is repaired, the fault that is next less serious, is shown, and so on, until all faults have been shown. If the SONOMETER 30 works properly, the feedback is zero.

Parameter P 110: Inquire warnings

Instruction word: WARNING

Instruction class: Inquire

Feedback value: 0..255, see chapter 9.3.

This parameter has the same function as parameter P 109.

9 Troubleshooting

9.1 Troubleshooting

If your SONOMETER 30 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 30 supplied with 24 V AC/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 30 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 30.



9.2 Device faults

Device faults either affect or prevent measurement. If a fault is detected, the alarm relay drops, the appropriate LED lights and a fault message is shown on the display panel. 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 6.30), is shown, in other cases current in case of device fault (chapter 6.31) 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.

In the 2-channel SONOMETER 30 the fault code of the current channel is displayed or output via the serial port.

A condition for the output of fault messages is that the SONOMETER 30 was not stopped.

- noE 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 beginning 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.
- F01 The hash total by the program memory is wrong. This is a particularly grave fault. The SONOMETER 30 would cease to operate properly and was therefore stopped. If this fault occurs, please call our service team.
- F02 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.
- F03 The device software is not compatible with the device hardware. Please inform our service team.
- The device software contains a wrong software version. Please inform our service team.
- F05 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.
- F06 The internal working memory of the microcomputer is defective. The device was stopped. Please inform our service team.
- F07 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.
- F08 The sensor enable circuitry is defective. Please call our service team to repair the defect.
- F10 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.*
- F11 The sensor detects a signal although no signal should actually be present at this time. The cause is a defect in the sensor and/or in the SONOMETER 30. Please contact our service team.
-  *Detection of fault F 11 must be permitted by parameter P 70.*

F12 The sensor detects no signal. Possible causes include a broken cable, a defect in the electronic circuitry of the sensor. If a wiring check is inconclusive, please inform our service team.

F20 You have enabled temperature measurement (parameter P 60) but the SONOMETER 30 receives no temperature signal. Either the connected sensor has no temperature detector or the temperature detector is defective.

F22 The temperature detector in the sensor has detected a temperature outside the permitted range from -20°C to 135°C.

F31 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.

F32 The entry data for the vessel lack plausibility. Please verify the parameter values under the aspect of the following possible causes:

Upright cylinder (type 0): Dimension 1 (diameter) is zero.

Horizontal cylinder (type 1): Dimension 1 (length) and/or dimension 2 (diameter) is zero. It is also possible that the 100% level is higher than the diameter of the vessel.

Cube-shape vessel (type 2): Dimension 1 (length) and/or dimension 2 (width) is zero.

User defined shape of vessel (type 3): The level does not rise steadily from one reference point to the next (even values are also not acceptable). The same may be the case with the percentage volume. The last valid reference point (specified by parameter P 27) contains a volume less than 100%.

9.3 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.

- F09 The parameters have not been saved permanently. You quit the programming mode with P 99 = 0 or the SONOMETER 30 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.
- F21 You have selected the temperature for the display panel (parameter P 20) but not enabled the temperature reading (parameter P 60).
- F30 Overflow or underflow of the number range. The number cannot be represented by the 4-digit display. Go to the next higher volume unit or select another unit (parameter P 20).
- F33 The unit set with parameter P 20 lacks plausibility. Examples: Output of a volume unit in channel 2 while it serves as reference measurement; or output of a sound transmission time while the simulation of the percentage level is enabled.
- F34 The SONOMETER 30 cannot calculate the measured value because the vessel data entered do not consider the level reading. This may have several causes, e. g.:
the calculated percentage value exceeds 500% limit;
lying cylinder: the level is higher than the cylinder diameter;
user defined shape of vessel: the liquid level exceeds the level defined by the highest reference point.

10 Default settings

The devices are delivered with the following default settings:

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