Ultrasound Controller

D72 DP72 D128 G72

Manual

AQ Elteknik AB

Ultrasound Controller

D72 DP72 D128 G72

- **D72** **version RevE**
- **DP72** **version RevE**
- **D128** **version RevA**
- **G72** **version RevA**
- **Manual** **version 4.52**
- **Software** **version 4.5x**
- **Gsd file (for DP72)** **version 3.2**

January 2014

AQ Elteknik AB

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1. Manufacturer information

AQ Elteknik AB operates a policy of on-going development and reserves the right to make changes and improvements to any of the products described in this manual without prior notice.

Under no circumstances shall AQ Elteknik be held responsible for any loss or indirect damage howsoever caused. The contents of this document are provided as it is. AQ Elteknik AB reserves the right to revise this document or withdraw it at any time without prior notice.

Version

It is important that the manual version agree with the software version and hardware version of Ultrasound Controller. See page 3. Note that terminal numbers can be different on different versions.
This manual can be downloaded at www.aqelteknik.com

The software version and hardware version of Ultrasound Controller is shown briefly on the display when power is switched on.

Manufacturer Declaration of Conformity

Manufacturer: AQ Elteknik AB Sweden declares, that the product:

Ultrasound Controller marked with CE-label conforms with the following standards: EN 61000-6-2, EN 61000-6-4, EN55011 (Group 1, Class B).

Ultrasound Controller marked with  conforms to WEEE directive 2002/96/EC. The Ultrasound Controller also conforms to RoHS directive 2002/95/EC. When the Ultrasound Controller is to be discarded, send it back to AQ Elteknik AB for safe disposal.

Limited Warranty

AQ Elteknik AB warrants to the original end user that the Ultrasound Controller is free from any defects in materials or workmanship for a period of one year from the date of purchase. During the warranty period, should the Ultrasound Controller have indications of failure due to faulty workmanship or materials, AQ Elteknik AB will replace it with no charge. This warranty shall not apply if the Ultrasound Controller is modified, misused or subjected to abnormal working conditions.

Replacement as provided under this warranty is the only remedy of the purchaser. The purchaser pays freight to AQ Elteknik AB. AQ Elteknik AB shall in no event be held liable for indirect or consequential damages of any kind or character to the purchaser.

Warning

The Ultrasound Controller is intended to be used with the Air Sensor or the Level Switch, all of them manufactured by AQ Elteknik AB. AQ Elteknik AB takes no responsibility for any possible damage that could happen if any other sensor not manufactured by AQ Elteknik AB is connected to the Ultrasound Controller.

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Certificate of Quality and Function

AQ Elteknik AB guaranties that the Ultrasound Controller has passed function tests and quality tests.

2. Introduction

Ultrasound Controller

Ultrasound Controller uses ultrasound to make measurements. It can detect bubbles in flowing liquid or it can detect presence of liquid behind a container wall or it can measure continuous liquid level. The Ultrasound Controller has four different modes of operation:

Air Sensor mode: The Air Sensor monitors the presence of gas or particles in flowing liquid. The Air Sensor is very reliable and easy to use. Two Air Sensors can be connected to one Ultrasound Controller.

Level Switch mode: The Level Switch is a small sensor which attached to the outside of the container can sense the presence of liquid inside the container without making hole in the container. Four Level Switches can be connected to one Ultrasound Controller.

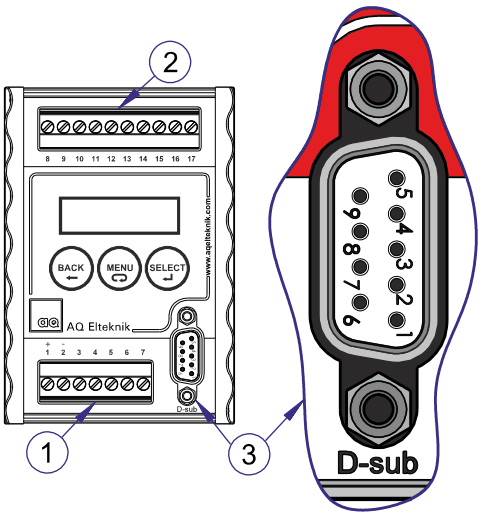
Level Sensor mode: Continuous liquid level is measured with a Level Switch attached under the container bottom (no hole in the container). High accuracy is achieved with a second Level Switch measuring liquid sound velocity. Two levels can be measured with one Ultrasound Controller.

Gel Sensor mode: The Level Switch attached to the outside of the container can sense the presence of gel inside the container without making hole in the container. Four single gel-levels can be measured with one Ultrasound Controller.

Installing the Ultrasound Controller D72 and G72

The Ultrasound Controller D72 should be protected from dust and water. It is made to be attached to a DIN-rail, to which it snaps easily and can be removed by pushing up and bending the top out. Usually it is installed in a cabinet. The green connector terminals can be removed by pulling the connector out.

The Ultrasound Controller should be installed in accordance with national regulations. A person with the required knowledge should perform the installation.



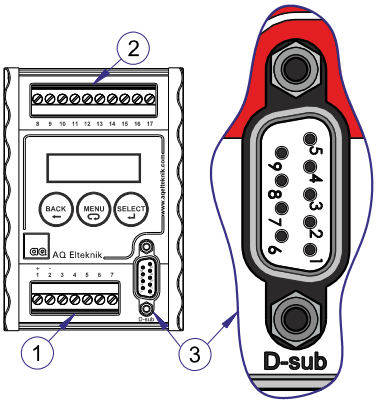
1 Terminal
2 Terminal (for Sensors)
3 D-sub

D72, G72 Terminal	Description
1	+ supply PLUS
2	– supply MINUS
3	Relay common
4	Relay 1
5	Relay 2
6	Relay 3
7	Relay 4
D-sub 1	Cable screen
D-sub 2	
D-sub 3	Reserved
D-sub 4	+ 4-20mA output B
D-sub 5	mA output MINUS
D-sub 6	
D-sub 7	
D-sub 8	Reserved
D-sub 9	+ 4-20mA output A

Installing the Ultrasound Controller DP72

The Ultrasound Controller DP72 should be protected from dust and water. It is made to be attached to a DIN-rail, to which it snaps easily and can be removed by pushing up and bending the top out. Usually it is installed in a cabinet. The green connector terminals can be removed by pulling the connector out.

The Ultrasound Controller should be installed in accordance with national regulations. A person with the required knowledge should perform the installation.



1 Terminal
2 Terminal (for Sensors)
3 D-sub

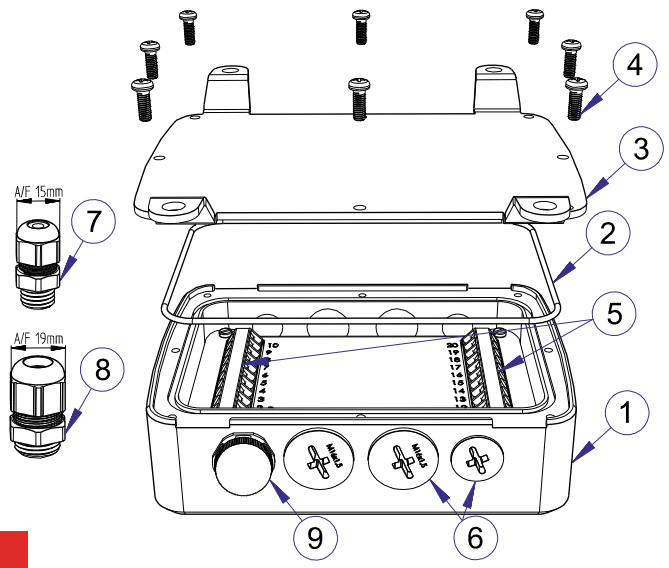
DP72 terminal	Description
1	+ supply PLUS
2	– supply MINUS
3	Relay common
4	Relay 1
5	Relay 2
6	Relay 3
7	Relay 4
D-sub 1	Cable screen
D-sub 2	
D-sub 3	Profibus B+
D-sub 4	+ 4-20mA output B
D-sub 5	mA output MINUS
D-sub 6	+5V output
D-sub 7	
D-sub 8	Profibus A-
D-sub 9	+ 4-20mA output A

Installing the Ultrasound Controller D128

The Ultrasound Controller D128 is protected according to IP65 and can be installed outside a protecting cabinet. The bottom plate must be removed in order to access the terminals to connect the cables (8 screws). Remove dummy coverings and insert cable glands as many as needed. There are 3 small and 4 big cable glands, see page 38. There should be only one cable in each cable gland to achieve IP65 protection. The pressure compensation element can be moved but must not be removed. Make sure the gasket is in place when screwing the bottom plate.

The Ultrasound Controller should be installed in accordance with national regulations. A person with the required knowledge should perform the installation.

D128 terminal	Description
1	+ supply PLUS
2	– supply MINUS
3	Relay common
4	Relay 1
5	Relay 2
6	Relay 3
7	Relay 4
8	mA output MINUS
9	+ 4-20mA output A
10	+ 4-20mA output B



1 Enclosure
2 Gasket
3 Bottom plate
4 Screws
5 Terminals
6 Dummy coverings
7,8 Cable glands (small and big)
9 Pressure compensation element

3. Navigating the menu system

Toggle between standby and power-on. (D128 only) 	Go back to previous menu-level or Cancel a Selected operation 	Scroll through the menu or Scroll through a list of parameter values 	Select a menu or Confirm the selection of a parameter-value 

Keep MENU button pressed to scroll continuous through parameter values. Press BACK button while pressing MENU button to scroll backwards.

Sensor MODE and the start-screen

When power is applied to the Ultrasound Controller it displays the software version on the LCD-display, followed by the start-screen. Depending on which mode is set; the corresponding start-screen will be shown. The Ultrasound Controller can be set to either Air Sensor mode, Level Switch mode, Level Sensor mode or Gel Sensor mode (Gel Sensor mode is not available in RevA-RevD). The mode determines the type of sensor that can be connected. When the Ultrasound Controller is powered on for the first time `Set sensor MODE` is displayed. Then press MENU button to scroll to the desired mode and press SELECT button. How to change sensor mode once it has been set is described in `ADVANCED SETTINGS`.

Air Sensor mode

CALIBRATION
- Calibrate LIQUID AS 1
- Calibrate AIR AS 1
- Calibrate LIQUID AS 2
- Calibrate AIR AS 2

SHOW DATA
- Air Sensor 1
  - Calibration Data
  - Normal Measurement Data
  - Very Low Sensitivity Data
- Air Sensor 2
  - *same as above*
- AUXILIARY DATA

SETTINGS
- SET Air Sensor 1 parameters
  - SET TYPE
  - SET DIAMETER
  - SET SENSITIVITY
  - SET FILTER
- SET Air Sensor 2 parameters
  - *same as above*
- SET RELAY 1
- SET RELAY 2
- SET RELAY 3
- SET RELAY 4
- SET mA output A
- SET mA output B

HELP
- CONNECTOR Terminals 1-7
- CONNECTOR Terminals 8-17
- Information
- Software version

ADVANCED SETTINGS
- set sensor MODE
- SIMULATE
- RESTORE settings and calibrations
- PROFIBUS SETTING
  - BITRATE
  - ADDRESS
  - PARAMETER ACCESS
  - CONTROL

Level Switch mode

CALIBRATION
- CALIBRATE with AIR (empty)
  - Level Switch 1
  - Level Switch 2
  - Level Switch 3
  - Level Switch 4
  - LS1-LS4 together
- CALIBRATE with LIQUID (full)
  - *same as above*

SHOW DATA
- LevelSwitch 1
  - Echo DATA
  - WR DATA
  - Auxiliary data
- LevelSwitch 2 *same as above*
- LevelSwitch 3 *same as above*
- LevelSwitch 4 *same as above*
- Test LevelSwitch

SETTINGS
- SET parameters LevelSwitch 1
  - SET Type AND Technique
  - SET FILTER
  - SET ECHO-DISTANCE
  - SET Jacket
  - SET FREQUENCY
- SET parameters LevelSwitch 2
- SET parameters LevelSwitch 3
- SET parameters LevelSwitch 4
  - *same as above*
- SET RELAY 1
- SET RELAY 2
- SET RELAY 3
- SET RELAY 4

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ADVANCED SETTINGS
- Set sensor MODE
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- RESTORE settings and calibrations
- PROFIBUS SETTING
  - BITRATE
  - ADDRESS
  - PARAMETER ACCESS
  - CONTROL

Level Sensor mode

CALIBRATION
- CALIBRATE with AIR (low)
  - Level Sensor 1
  - Level Sensor 2
- CALIBRATE with LIQUID (high)
  - Level Sensor 1
  - Level Sensor 2

SHOW DATA
- Level Sensor 1
  - Level
  - Sound Velocity
  - Calibration Data
- Level Sensor 2
  - *same as above*

SETTINGS
- SET parameters Level Sensor 1
  - SET 100% Level
  - SET 0% Level
  - SET Liquid Sound VELOCITY
- SET Velocity Sensor EchoDISTANCE
  - SET Velocity Sensor HEIGHT
  - SET Velocity Sensor Control
  - SET Container Bottom-Thickness
  - SET Container Wall-Thickness
  - SET Container Wall-Thickness
- SET parameters Level Sensor 2
  - *same as above*
- SET mA output A
- SET mA output B
- SET RELAY 1
- SET RELAY 2
- SET RELAY 3
- SET RELAY 4

HELP
- CONNECTOR Terminals 1-7
- CONNECTOR Terminals 8-17
- Information
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ADVANCED SETTINGS
- set sensor MODE
- SIMULATE
- RESTORE settings and calibrations
- PROFIBUS SETTING
  - BITRATE
  - ADDRESS
  - PARAMETER ACCESS
  - CONTROL

Gel Sensor mode

CALIBRATION
- 1-4 together
- GelSensor 1
- GelSensor 2
- GelSensor 3
- GelSensor 4

SHOW DATA
- Gel Sensor Measured data
  - Gelconcentration %
  - Relativ Signal %
  - Relativ Attenuation dB/m
  - Signal dB
  - Liq WR sensor
- Gel Sensor Cal Data
  - Cal Liquid dB
  - Freq
  - Test Sensor dB

SETTINGS
- SET parameters Sensor 1
  - SET TYPE
  - SET ECHO DISTANCE
  - SET GEL-TYPE
  - SET GEL-THRESHOLD
  - SET FREQUENCY
  - SET WR THRESHOLD
  - SET RELAY1,2
  - SET RELAY3,4
  - SET mA output A
  - SET mA output B

HELP
- CONNECTOR Terminals 1-7
- CONNECTOR Terminals 8-17
- Information
- Software version

ADVANCED SETTINGS
- set sensor MODE
- RESTORE settings and calibrations
- PROFIBUS SETTING
  - BITRATE
  - ADDRESS
  - PARAMETER ACCESS
  - CONTROL

4. Air Sensor Mode

In Air Sensor mode the Air Sensor is used to measure the presence of bubbles in flowing liquid. One or two Air Sensors model SAC, PAC, FCS or FCP can be connected to one Ultrasound Controller.

Quick start guide

- Install Air Sensors according to instructions in the Air Sensor Manual.
- Connect cables, see page 6 or 7 and 10.
- Switch on external power supply.
- Read about navigating the menu system, page 8.
- Display show: SET sensor MODE. Press MENU button to scroll to Press SELECT for AirSensormode. Confirm by pressing SELECT button.
- Go to SETTINGS to set parameters, page 11.
- Fill Air Sensor 1 (AS1) with liquid. Select Calibrate LIQUID AS1 and Press SELECT button one second.
- Empty Air Sensor 1 (AS1) of liquid. Select Calibrate AIR AS1 and press SELECT button one second.
- Do the calibration in the same way for Air sensor 2 (AS2). The calibration order can be mixed for sensor and liquid/air.
- Go to SHOW DATA to check calibrated values, page 13.
- Ready.

Functional Description

Bubbles in the liquid flowing through the Air Sensor are monitored by the use of ultrasound. Inside the Air Sensor two low intensity beams of ultrasound are transmitted across the liquid-path in directions perpendicular to the liquid flow.

If a bubble moves into one of the ultrasound-beams the ultrasound will be partially deflected and the intensity of the ultrasound decreases. The controller constantly measures the intensity of the ultrasound and if the intensity becomes lower than the threshold it detects a bubble. Dense particles in the liquid can also deflect the ultrasound in a similar way and can therefore be detected.

The measurements of very low sensitivity and very very low sensitivity uses a different measurement technique. It measures how ultrasound vibrations in the Air Sensor walls are dampened by the presence of liquid inside.

The measurement accuracy depend on how well the Air Sensor is calibrated, the flow-rate, the type of liquid, how the Air Sensor is mounted and weather there is a single bubble or many bubbles and the Air Sensor size.

Orientation of the Air Sensor

If the Air Sensor is mounted horizontally orientation is important. Liquid flowing through the Air Sensor tends to pull bubbles towards the center of the tube but when flow rate decrease bubbles rises to the top. The Air Sensor is more sensitive to bubbles at the top if it is rotated so that the cable connector (and label) is facing up. If instead low bubble sensitivity is desirable rotate the Air Sensor so that the cable connector (and label) is facing down. This makes the Air Sensor less sensitive for bubbles at the top of the tube.

Setting lowest possible sensitivity for bubbles

If mounted horizontally rotate the Air Sensor so that the cable connector is facing down.

The FILTER setting determines the delay (response time) for detecting air. Consider what is the longest acceptable delay for detecting air that can be accepted and set FILTER accordingly: `delay 0,3s` or longer (don't set it to integrate). Bubbles that quickly come and go will then pass undetected.

Set the SENSITIVITY to `low`. SENSITIVITY can also be set to `very low` or `very very low`, but these settings are using a different measurement technique where the presence of liquid is detected regardless of bubbles. This technique is less reliable and is sensitive to temperature changes and works only on diameters > 16mm. Don't use it if there is more than +- 5C temperature variation during measurement and calibration. Try first SENSITIVITY `low` and FILTER `delay 0,3s` or longer. If there is still unwanted detections of bubbles, then change the setting of SENSITIVITY to `very low` or `very very low`.

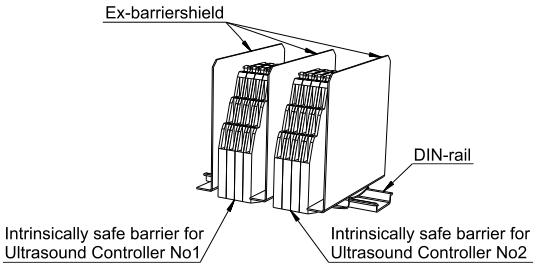
Connecting the Air Sensor

The cable from the Air Sensor should connect directly to the Ultrasound Controller. Maximum cable length depends on the Air Sensor, see Air Sensor manual. The cable screen must always be connected (screened cable must always be used). Any unscreened part of the cable should be no longer than 30mm. (The outer screen which exists only on FCS and FCP should not connect to the

Terminal number			**SAC, SAC Ex**	**PAC**	**FCP**	**FCS**	**FCS Ex**
D72 / DP72	**D128**		**cable color**	**cable color**	**cable color**	**cable color**	**cable color**
8	**11**	**Air Sensor 1**	Brown	Brown	Brown	Brown	White
9	**12**		White	White & JumperA	Screen of Brown cable & Screen of Green cable	Screen of Brown cable & Screen of Green cable	Screen of White cable & Screen of Yellow cable
10	**13**		Green	Green	Green	Green	Yellow
11	**14**		Yellow & Screen	Screen & JumperA	Screen of White cable	Screen of White cable & Screen of Yellow cable	Screen of Brown cable & Screen of Green cable
12	**15**			Yellow	White	White &	Brown & Green
13	**16**	**Air Sensor 2**	Brown	Brown	Brown	Brown	White
14	**17**		White	White & JumperB	Screen of Brown cable & Screen of Green cable	Screen of Brown cable & Screen of Green cable	Screen of White cable & Screen of Yellow cable
15	**18**		Green	Green	Green	Green	Yellow
16	**19**		Yellow & Screen	Screen & JumperB	Screen of White cable	Screen of White cable & Screen of Yellow cable	Screen of Brown cable & Screen of Green cable
17	**20**			Yellow	White	White &	Brown & Green

Ultrasound Controller but may be connected to ground via screened cable glands). PAC also needs a 50mm jumper cable. To minimize the risk of electric interference it is important that sources of interference like frequency inverters should use screened cables between inverter and motor.

In an ex-installation, shielding aluminum plates must be placed outside each group of zener barriers belonging to each Ultrasound Controller, order number: Ex-barriershield, see Air Sensor Ex manual.



SETTINGS

Through the SETTINGS- menu the parameters of the Air Sensor can be set.

Select SET TYPE to set the type of Air Sensor connected. This tells the Ultrasound Controller to make the correct adjustments for this Air Sensor type.

Select SET DIAMETER to set it to the diameter of the connected Air Sensor or as close as possible. This tells the Ultrasound Controller to make the correct adjustments for this Air Sensor diameter.

Select SET SENSITIVITY to set the sensitivity. This determines how sensitive the Air Sensor is for bubbles.

SENSITIVITY can be set to high, medium, low, very low and very very low.

At high sensitivity, a single bubble of approximately 2mm diameter can be detected.

At medium sensitivity, a single bubble of 3mm diameter can be detected.

At low sensitivity, a single bubble of approximately 10mm diameter can be detected. Low sensitivity is achieved by requiring both detectors inside the Air Sensor to detect bubbles at the same time. Many small bubbles together will be detected as if they were a single big bubble. Even tiny (microscopic almost invisible) bubbles can be detected if there are many of them.

High, medium and low sensitivity are the normal measurements.

At very low and very very low sensitivity a different measuring technique is used. This technique measures the presence of liquid or no liquid, making the Air Sensor very insensitive for bubbles. Very low sensitivity does not work well for Air Sensors with diameter < 22mm. Very low sensitivity measurements have temperature dependence and should not be used if there are temperature variations of more than ±5ºC.

Select SET FILTER to set the FILTER - time. It determines how the measurement-data is filtered. It can be set to either integrate 1ms – 3s or delay 300ms – 10s.

Integrate means integrating (adding) the duration of each bubble. When the integrated sum becomes higher than the FILTER–integrate - time, air will be indicated. When liquid is next time indicated, the integration-process starts over.

Delay means that air will be indicated only after air has been continuously detected for a time longer than FILTER–delay.

Long FILTER–delay and low SENSITIVITY is useful if some quantities of bubbles should be undetected.

Short FILTER–integrate and high SENSITIVITY is useful when almost every bubble should be detected.

Select SET RELAY to set how the relays should act. There are four relays each with one normally open contact (at power off and when sensor is not connected the relay is open). Each relay can be set independently. Choose between Closed with air or closed with liquid and choose

between Air Sensor 1 and Air Sensor 2. The duration of air being indicated is minimum 0,5 second even if the bubble is detected much shorter time (to make sure the indication of air is registered).

Select SET mA output to set the assignment of the mA-outputs. There are two mA-outputs: A and B. They can be assigned to Air Sensor 1 or Air Sensor 2 and Normal Measurement Data or All Sensitivities

Normal Measurement Data Assigns a combination of the analog Ndata during the time LIQUID is indicated and 6mA when AIR is indicated.

20mA = Ndata =150%
16mA = Ndata =100%
8mA = Ndata = 0%
6mA = Air is detected
4mA = error

All Sensitivities Assigns bubble sizes to mA.

16mA = Liquid (no bubble)
14mA = small bubble
12mA = medium bubble
10mA = big bubble
8mA = very big bubble
6mA = very very big bubble
4mA = error.

AIR bubble indication time is always minimum 0,5 second.

Air Sensor start-screen

When power is applied, the Air Sensor start-screen is displayed showing something like this:

On the first line to the right is written AirSens meaning this is Air Sensor-mode. The first digit to the left indicates Air Sensor 1 and Air Sensor 2. Following the digit is diagnostic information about each Air Sensor:

--- No Air Sensor is connected and Air Sensor TYPE or DIAMETER is set to no Air Sensor

set Settings are missing

cal Waiting for calibration to be done

CalAir Waiting for calibration of Air to be done

CalLiq Waiting for calibration of Liquid to be done

err 1 Error, no Air Sensor is detected

err 2 Error, NAir too high, see troubleshooting

err 3 Error, VLthld too low, see troubleshooting

err 4 Error, NLiq too low, see troubleshooting

AIR Air or bubble is detected

LIQUID Liquid without bubble is detected.

(LIQUID is blinking if measurement data is higher than 200% suggesting a new calibration may be advisable)

On the second line to the right is written 1234 which shows the state of each of the four relays. A light digit on dark signifies a closed relay.

ADVANCED SETTINGS

Select Set sensor MODE to set either Air Sensor mode, Level Switch mode or Level Sensor mode. It determines which sensor can be connected. Changing sensor mode does not alter any settings or calibrations.

Select SIMULATE to simulate detection of air or liquid. Press SELECT button to toggle between simulation of AIR and LIQ. Press MENU button to change between Air Sensor 1 and 2.

Select RESTORE settings and calibrations to restore all settings and calibrations to factory-settings.

CALIBRATION

Calibration must be done both with air (with empty Air Sensor) and liquid (with full Air Sensor) and it can be done in any order. To calibrate liquid, make sure there is liquid inside the Air Sensor and select calibrate LIQUID (and press SELECT button one second). To calibrate air make sure the Air Sensor is empty and select calibrate AIR (and press SELECT button one second). During calibration of liquid, Ultrasound Controller adjusts the intensity of the ultrasound to become 100%. Each Air Sensor should be calibrated after installation. After the calibration it is advisable also to check the values in SHOW DATA (see below).

A new calibration of liquid may be required if the liquid properties has changed significantly since the last calibration. For the Air Sensor PAC or FCP a temperature change over 20ºC requires a new calibration of liquid.

SHOW DATA

During normal measurement the Air Sensor transmits beams of ultrasound and listens to the sound. Bubbles scatter the sound and thereby reduce the sound intensity and in this way the Air Sensor detects air. Each Air Sensor uses two beams to make two measurements, perpendicular to each other. During the very low sensitivity measurements the Air Sensor transmits beams of ultrasound and listens to how fast the vibrations within the walls of the Air Sensor disappears into the liquid inside the Air Sensor.

Select Calibration Data to show NLiq: normal measurement liquid signal, which is measured in dB. NLiq is measured and stored during calibration. NLiq over 45dB is normal, depending on type of Air Sensor. A faulty Air Sensor may show NLiq less than 30dB. If NLiq is low, err 4 will be shown, see troubleshooting. Also shown is NAir: normal measurement air signal relative to NLiq, which is measured in %. NAir is measured and stored during calibration. NAir should be 15% or less. Lower is better.

Select Normal Measurement Data to show Ndata: the current normal measurement signal relative to NLiq which is measured in %. With liquid in the Air Sensor, Ndata is expected to be near 100%. If it deviates too much from 100% (>120% or < 80%) it is advisable to calibrate the Air Sensor with liquid again. With air in the Air Sensor, Ndata should be 15% or less. The threshold of Ndata at which air bubbles are detected depends on the sensitivity setting and the type and size of Air Sensor (approximately at high sensitivity 44% and at low sensitivity 27%).

Select Very Low Sensitivity Data to show VLdata: very low sensitivity measurement data and VLthld: very low sensitivity calibrated and stored threshold. With air, VLdata becomes close to zero and with liquid, VLdata becomes higher than VLthld. VLthld depends on the type of Air Sensor. Air Sensors with diameter < 14mm can not use very low sensitivity. err 3 is displayed if VLthld becomes too low for reliable measurements, see troubleshooting.

Select AUXILIARY DATA to show unprocessed data from the Air Sensor. It can be used for troubleshooting when contacting AQ Elteknik AB.

HELP

Select HELP to show information about connecting the Ultrasound Controller.

Sound velocity in the Air Sensor

When there are two liquids with significant different sound velocity in the Air Sensor and these liquids are not well mixed, there can be a false indication of air. It happens because the sound is refracted when it travels from one liquid to the other. Setting longer filter times may filter out the false indication of air. Sound velocity of liquids lies in the range 900-2000m/s. If the sound velocity is outside this range the Air Sensor may not work.

Air Sensor TROUBLESHOOTING

Air or Liquid is indicated on the display but the relay does not change = RELAY setting is wrong.

Display shows:

cal, CalAir **or** CalLiq Calibration must be done.

set Settings of TYPE or DIAMETER is missing

err 1 = No Air Sensor is detected. The reason for this can be wrongly connected Air Sensor, or faulty Air Sensor.

err 2 = The relative signal with Air is too strong (at low, medium or high sensitivity). err 2 is shown if NAir is higher than 21-25%.

The reason for high NAir can be:

- Calibration of AIR has been done with liquid in the Air Sensor.
- Wrong settings of Air Sensor Type or Diameter.
- Electric interference.
- A faulty Air Sensor.
- Calibration of LIQUID has been done with liquid having lots of bubbles or particles attenuating the sound.

Electric interference will show itself as Ndata being unstable with Air in the Air Sensor. To minimize the risk of interference it is important that sources of interference like frequency **inverters** should use screened cables between inverter and motor. Also any unscreened part of the cable between the Air Sensor and Ultrasound Controller should be short. If ex-barriers are used, Ex-barriershields must be used especially if there is more than one Ultrasound Controller.

err 3 = There is not enough signal difference between air and liquid (at very low or very very low sensitivity). err 3 is shown if Very Low sensitivity threshold is not high enough for reliable measurement (VLthld <6). Air Sensor with diameter less than 22mm may have difficulty measuring at very low sensitivity. Change “SENSITIVITY” to low, medium or high instead.

err 4 = The absolute signal with Liquid is too weak (at low, medium or high sensitivity). err 4 is shown if the calibrated data with Liquid NLiq is lower than approximately 38dB for SAC and FCS or 35dB for FCS Ex or lower than 40dB for PAC or FCP.

The reason for this can be:

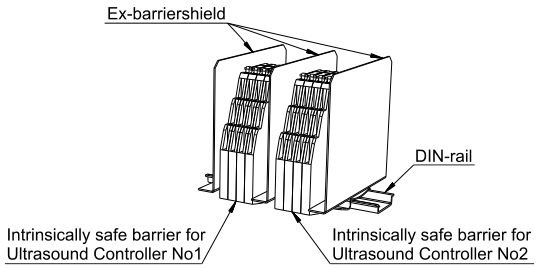
- Calibration of LIQUID has been done with air or liquid having lots of bubbles or particles attenuating the sound.
- Wrong settings of Air Sensor Type or Diameter.
- Wrong connected Air Sensor.
- A faulty Air Sensor

5. Level Switch Mode

In Level Switch Mode the Level Switch measures a single level from the side of the container. It measures the presence or no presence of liquid behind the container (or pipe) wall. The Level Switch senses through the wall AND no hole is needed. Four Level Switches can be connected to one Ultrasound Controller.

Quick start guide

- Install Level Switches according to instructions in the Level Switch Manual.
- Connect cables, see page 6 or 7 and 16.
- Switch on external power supply. You may have to press POWER to exit standby on D128.
- Read about navigating the menu system, page 8
- Go to SHOW DATA to check calibrated values, page13.SELECT for LevelSwitchmode. Confirm by pressing SELECT button.
- Display show: SET sensor MODE. Press MENU button to scroll to Press Go to SETTINGS to set parameters, page 18.
- Now calibrate Level Switch 1. Make sure liquid level is below the Level Switch. Select CALIBRATE with AIR (empty) then select Calibrate AIR Level Switch1 and press SELECT button one second.
- Make sure liquid level is above the Level Switch. Select CALIBRATE with LIQUID (full) then select Calibrate LIQUID Level Switch1 and press SELECT button one second.
- Do the calibration for all connected Level Switches. The calibration order air/liquid and Level Switch number can be mixed.
- Ready.



Connecting the Level Switch

The cable from the Level Switch should connect directly to the Ultrasound Controller. (Yellow and green cable are not used.) The cable screen must always be connected to Ultrasound Controller (screened cable must always be used). Any unscreened part of the cable should be no longer than 30mm. To minimize the risk of electric interference it is important that sources of interference like frequency inverters should use screened cables between inverter and motor.

In an ex-installation, shielding aluminum plates must be placed outside each group of zener barriers belonging to each Ultrasound Controller, order number: Ex-barriershield, see Level Switch Ex manual.

Ultrasound Controller Terminal		Level Switch Cable
D72 / DP72	**D128**	
8	11	Level Switch **1** Brown
9	12	Level Switch **1** White
10	13	Level Switch **2** Brown
11	14	Level Switch **1** Screen & Level Switch **2** Screen
12	15	Level Switch **2** White
13	16	Level Switch **3** Brown
14	17	Level Switch **3** White
15	18	Level Switch **4** Brown
16	19	Level Switch **3** Screen & Level Switch **4** Screen
17	20	Level Switch **4** White

Level Switch Type and Technique

There are two different measuring techniques Echo and WR (Wall Reverberate) and there are three different Level Switches: Level Switch KS, Level Switch LS and Level Switch RS.

Echo Technique

The Echo technique uses echo from a reflecting surface inside the container (usually the opposite container wall) to determine if there is liquid or not inside. Level Switch KS or Level Switch LS can be used but not Level Switch RS.

The ECHO-technique transmits short sounds and then measures the echo bouncing on the reflecting surface. When there is an echo, there is liquid inside and with no liquid there is no echo The liquid must not attenuate the sound too much. Small bubbles and particles in the liquid can cause attenuation and unmixed liquids having different sound velocities can cause refraction of the sound and thereby wrong indication of low level. It is important that the sound-beam from the sensor is reflected back to the sensor and not diverted in the wrong direction.

It is desirable that the ultrasound passes as easy as possible through the container wall. How well it passes depend on the wall material and thickness. Steel or glass wall should be in the range 1,2mm - 15 mm and plastic wall <15mm (PP<10mm). Plastic with fiberglass can be troublesome. Testing on the actual container is recommended. Any welding or other unevenness in the wall should be avoided as it can refract (bend) the sound-beam in an unwanted direction.

The ultrasound beam behaves similar to a light-beam, the direction of the echo depend on from what angle it hits the reflecting surface. Obstructing object in the path between sensor and the reflecting surface should be avoided. The sound beam is approximately 1cm in diameter. A tube in the center of the container can give an echo but it is weaker than the echo from the opposite container wall. In case there are obstructing objects inside the container, perhaps the Level Switch RS with the WR-technique is a better choice.

On small containers, disturbing background echoes becomes stronger in relation to the echo. Level Switch LS and KS should therefore not be used on containers smaller than 44mm diameter.

WR Technique

The WR technique measures vibrations in the container wall to determine if there is liquid or not behind the wall. Level Switch RS should be used (and in some cases also Level Switch KS can be used)

The WR-technique transmits sound and then measures how quickly vibrations in the container wall disappear. Vibrations in the wall disappear more quickly with liquid inside. The WR-technique works well with most liquids since the sound does not have to travel through the liquid. But the WR-technique is dependent on the material and thickness of the wall. Steel or glass wall 1,2mm - 15 mm or plastic wall < 15mm (PP<10mm) should be ok. Plastic with fiberglass could be troublesome and testing on the actual container is recommended. WR technique has temperature dependence and should not be used if temperature when full or empty differ more than 15ºC from temperature during calibration.

On plastic walls it is also possible to use Level Switch KS with the WR-technique however there can be temperature dependence. Level Switch KS can also be used with the WR-technique on a container with jacket to sense the presence of liquid in the inner container (if the gap between the jacket and the container is filled with liquid).

The WR-technique measures very small signal changes and is sensitive to small movements of the Level Switch. The Level Switch must therefore preferably be glued. The WR-technique can also be sensitive to liquid drops remaining on the inside of the wall and sensitive to temperature changes.

The advantage of the WR-technique is it is independent of liquid properties and that there is no need for a reflecting surface.

Mounting the Level Switch

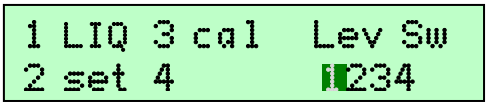
How to mount the Level Switch on the container is described in Level Switch manual.

Level Switch start-screen

When power is applied, the Level Switch start-screen is displayed showing Lev Sw on first line to the right signifying this is Level Switch start-screen. . On the second line to the right is written 1234 which shows the state of each of the four relays. A dark background signifies a closed relay.

To the left are four small digits signifying Level Switch 1 2 3 and 4 with three-letter-text following each digit showing information about each Level Switch:

AIR	air is detected
LIQ	liquid is detected
cal	Waiting for calibration of Air and/or Liquid
set	parameters need to be set
--	Level Switch disconnected
err	error – see troubleshooting
	Level Switch is not existing



Example: Level Switch 1 detecting liquid, Level Switch 2 connected but not set, Level Switch 3 need to be calibrated, Level Switch 4 not existing, Relay1 closed.

SETTINGS

Through the SETTINGS-menu the parameters of the Level Switch can be set.

Select SET Type AND Technique to set it to either Type LS and Technique ECHO or Type RS and Technique WR or No Level Switch. All other settings are for special cases only.

Select SET DISTANCE to reflecting wall to set it between 46mm (minimum) and 600mm (maximum). This parameter is needed only if the “ECHO” technique is chosen and should be set to actual distance ±10%.

Select SET FILTER to set the filter-time between 0,5s 1s 2s or 4s. It determines how fast the Level Switch detects air or liquid.

Select SET Jacket to set the distance in mm between jacket and container. Set it only if container has a jacket.

Select **“SET FREQUENCY”:** to set the measurement frequency. If set to Auto, the best frequency (1=1,1MHz, 2=1,5MHz, 3=2MHz or 4=2,2MHz) is automatically selected. Changing the “FREQUENCY” does not change the calibration.

Select SET RELAY to set how the relays should act. Each relay have one normally open contact (at power off and when sensor is not connected the relay is open).). There are four relays and each relay can be controlled independently by any Level Switch. Choose between Closed with air or closed with liquid. It is also possible to set one relay to be controlled by two Level Switches. **Example (pump filling a container):** LS1 is placed high and LS2 is placed low on a container. The relay is set to: Open LS1 Liq, Closed LS2 Air. When liquid level drops below

LS2, the relay closes (starting the pump to fill the container). When liquid level rises to LS1, the relay opens (stopping the pump).

Example (pump emptying container): LS1 is placed high and LS2 is placed low on a container. The relay is set to: Open LS2 Air, Closed LS1 Liq. When liquid level rises to LS1, the relay closes (starting the pump to empty the container). When liquid level drops to LS2, the relay opens (stopping the pump).

Container with jacket

In a container with a jacket the small space between the container and the jacket is filled with liquid to regulate the temperature of the inner container. This is a special case when a Level Switch KS can use the Technique set to WR and Jacket set to the distance between the jacket and container walls. Measurements will then be made on the inner container using the WR technique. The space between the jacket and container must be filled with liquid.

CALIBRATION

Select CALIBRATION to calibrate the Level Switch. Each Level Switch must be calibrated after installation. Calibration must be done both for liquid and for air. The order or the time between the calibration of air and liquid is of no importance.

A new calibration has to be done if the Level Switch is moved and should be done if the temperature or the liquid properties has changed significantly since the last calibration. To see how well the Level Switch behaves at different temperatures or with a different liquid the measurement data can be checked.

SHOW DATA

Select Echo DATA to show Edata: echo measurement data (echo strength) relative to ELiq. During calibration it is set to be 100% with liquid. Efrq: shows the frequency (1, 2, 3 or 4). On the second line threshold Ethd: is displayed. If Edata is higher than Ethd then liquid is detected. ELiq shows calibrated echo strength with liquid (0,7dB units). Maximum is 100 and a value of 40 is a weak echo. Eliq depends on the sensor and the container. Ethd is best if it is less than 40%. If higher than 60% the difference between echo strength with liquid and air is too low.

Select WR DATA to show measurement data of the WR-technique. This screen shows first Wdata: WR measurement data. Wdata is approximately zero when there is air. With Liquid it becomes approximately twice Wthld. Wfrq: shows the frequency that has been chosen either manually or automatically (1, 2, 3 or 4). The best frequency depends on the container wall thickness. On the second line is Wthd: WR threshold which is the value of Wdata at which indication changes between Air and Liquid. If Wdata is higher than Wthd then liquid is indicated. Wthd is set during calibration to half the value of Wdata with Liquid. Wss: approximate signal (set at calibration) in 0,3dB units.

Select Auxiliary data to show unprocessed data from the Level Switch.

Select Test Level Switch to show test-data for the Level Switch when it is not attached to a container. A value is shown for each Level Switch. If the Level Switch is correctly connected a value between 0 and 70 should be shown. If by pressing on the inner side of the Level Switch with your finger this value increases then the Level Switch is working. A Level Switch wrongly connected or unconnected shows a value higher than 100.

ADVANCED SETTINGS

Select Set sensor MODE to set either Air Sensor mode or Level Switch mode or Level Sensor mode. It determines which sensor can be connected. Changing sensor mode does not alter any settings or calibrations.

Select SIMULATE to simulate detection of air or liquid. Press SELECT button to toggle between simulation of Air and Liq. Press MENU button to change between Level Switch 1, 2, 3 and 4.

Select RESTORE settings and calibrations to restore all settings and calibrations to factory-settings.

HELP

Select HELP to show information about connecting the Ultrasound Controller.

Sound velocity and the Level Switch

When ECHO Technique is used and there are two liquids with significant different sound velocity in the container and these liquids are not well mixed, then there can be a false indication of air because the sound is refracted at the surface between the two liquids. Sound velocity of liquids lies usually within 900-2000m/s. A sound velocity outside this range may be compensated by increasing or decreasing DISTANCE to reflecting wall.

Measurement Reliability

Measurement reliability is good but many factors determine the reliability (wall material, wall thickness, liquid properties, temperature and glue). Therefore it is always advisable to make tests under varying conditions and temperatures. Best is to test and evaluate both Level Switch RS and Level Switch KS before deciding.

Level Switch TROUBLESHOOTING

Display shows:

-- = The Level Switch is not connected or there is a short circuit.

cal = Calibration has not been done. It must be calibrated both for Air and Liquid before cal disappears.

set = "Echo" technique is chosen and the DISTANCE to reflecting wall is not set.

The relay does not change but the display changes between Air and Liquid. Wrong setting of RELAY.

err = Measurement cannot be done. During calibration there was not enough difference between the signal with air and with liquid: For Echo technique Echo threshold Ethd must be < 50% and for WR technique WR threshold Wthd must be > 5. The reason for **err** can be:

- Calibration was made for Air but there was Liquid in the container or calibration was made for Liquid but there was Air in the container.
- The Level Switch is not attached correctly to the container. There is a tiny air-gap between the Level Switch and the container.
- If ECHO technique is chosen and the "DISTANCE to reflecting wall" is wrong.
- If ECHO technique is chosen and the echo is reflected in a direction where it does not reach the Level Switch.
- If ECHO technique is chosen and the something is between the Level Switch and the reflecting wall.
- The liquid does not let through enough sound. Try Level Switch RS instead of Level Switch LS.
- The container wall does not let through enough sound. Try a different FREQUENCY or set it to Auto.
- Wrong connection or faulty Level Switch. Select Test Level Switch: to test the level switch and its connection.

Electric interference can show itself as Edata being unstable with Air or Wdata being unstable with liquid. To minimize the risk of interference it is important that sources of interference (like frequency inverters) should use screened cables to the motor. Also any unscreened part of the cable between the Level Switch and Ultrasound Controller should be short. If ex-barriers are used, Ex-barriershields must be used especially if there is more than one Ultrasound Controller.

6. Level Sensor Mode

In Level Sensor mode a level sensor is attached at the bottom of the container and measures the continuous liquid level. The level sensor is attached outside the container and senses through the bottom (no hole is needed).

A velocity sensor can also be attached, measuring sound velocity.

Two levels sensors and two velocity sensors can be connected to one Ultrasound Controller.

Quick start guide

- Install sensors according to instructions on page 23 and instructions in the Level Switch Manual.
- Connect cables, see page 6 or 7 and 23
- Switch on external power supply.
- Read about navigating the menu system, page 8
- Display show: SET sensor MODE. Press MENU button to scroll to Press SELECT for LevelSensormode. Confirm by pressing SELECT button. (To change mode again, see page 26)
- Go to SETTINGS to set parameters, page 24.
- Calibrate level sensor 1: Fill container to at least 70%. Select Calibrate LIQUID Level Sensor 1 and Press SELECT button one second.
- Empty container. Select Calibrate AIR Level Sensor 1 and Press SELECT button one second.
- Do the calibration for level sensor 2 also. The calibration order air/liquid can be mixed.
- Go to SHOW DATA to check calibrated values, page 25.
- Ready.

Functional Description

The level sensor is attached under the container. It sends ultrasound through the bottom and through the liquid, towards the surface where the sound bounces back to the level sensor. Ultrasound Controller measures the time for the echo and calculates the level.

Measurement accuracy is dependent on liquid sound velocity which can vary with liquid and temperature. A velocity sensor can be attached on the containers vertical wall sending ultrasound through the wall and through the liquid. Ultrasound Controller measures the echo that bounces on the opposite container wall (or other reflecting surface inside the container). The velocity sensor can also make level measurement. It can tell whether there is liquid or air behind the wall and this can be used for increased reliability, see SETTINGS.

In order to measure properly the echo should be as loud as possible. The echo is attenuated by travelling through the bottom and travelling through the liquid. Small bubbles and particles in the liquid causes further attenuation. The echo can disappear completely if it does not bounce back to the level sensor. Unmixed liquids having different sound velocities can cause refraction of the sound beam so it does not bounce back to the level sensor. How quiet the echo has become can be checked in SHOW DATA.

Either Level Switch KS or Level Switch LS can be used as level sensor and velocity sensor. Level Switch RS cannot be used for Level Sensor.

Connecting the level sensor

The cable from the level sensor and velocity sensor should connect directly to the Ultrasound Controller. (Yellow and green cable are not used.) The cable screen must always be connected to Ultrasound Controller (and screened cable must always be used). Any unscreened part of the cable should be no longer than 30mm. To minimize the risk of electric interference it is important that sources of interference like frequency inverters should use screened cables between inverter and motor. In an ex-installation, shielding aluminum plates must be placed outside each group of zener barriers belonging to each Ultrasound Controller, order number: Ex-barriershield, see Level Switch Ex manual.

Ultrasound Controller Terminal		Cable	GSF90
D72 / DP72	D128		
8	11	Level Sensor 1 Brown	1 Brown
9	12	Level Sensor 1 White	1 White
10	13	Velocity sensor 1 Brown	1 Green
11	14	Level sensor 1 Screen & Velocity sensor 1 Screen	Screen
12	15	Velocity sensor 1 White	1 Yellow
13	16	Level sensor 2 Brown	2 Brown
14	17	Level sensor 2 White	1 White
15	18	Velocity sensor 2 Brown	2 Green
16	19	Level sensor 2 Screen & Velocity sensor 2 Screen	Screen
17	20	Velocity sensor 2 White	2 Yellow

Mounting the Level Sensor

The level sensor (= Level Switch) is mounted under the container. It is important the ultrasound pass as easy as possible through the container bottom. How well it passes depend on the wall material and thickness. Steel or glass bottom 1,2mm - 6 mm are ok. Plastic bottom < 15mm (PP<10mm) is ok. Plastic with fiberglass < 8mm is ok. Testing on the actual container is recommended.

When the bottom is very thick, vibrations within the wall makes accurate measurements of low levels difficult. Minimum level that can be measured depends on the bottom thickness and its material. As the sound passes through the bottom it makes the bottom vibrate and these vibrations take time to decay especially if the bottom is thick. On a 3mm thick stainless-steel-bottom liquid levels down to 30mm can be measured.

If the bottom thickness can be chosen, a thickness with resonance at 2MHz is preferred since at this frequency the sensor has maximum gain. For stainless steel this is approximately 1,5mm, 3mm or 4,5mm. The ultrasound beam is narrow (angle less than 10˚) so the level sensor must be aimed in such a way that the echo from the surface is properly returned back to the level sensor. See below what to do with a non-horizontal container bottom.

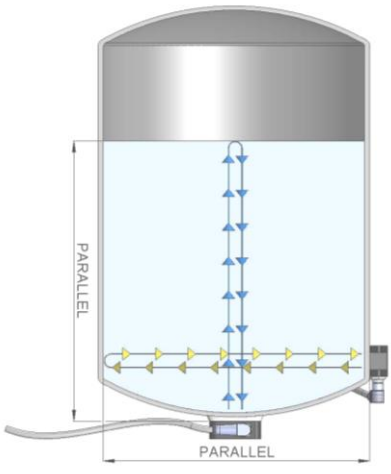
The velocity sensor (= Level Switch) is mounted on the container wall near the bottom.

See Level Switch manual how to glue the level sensor.

In the GSF90 level and velocity sensors are combined.

Installing the level sensor on a non-horizontal bottom

If the bottom is not horizontal or has uneven thickness, a lot of silicone can be used to glue the level sensor inclined. In this case the level sensor should be connected to Ultrasound Controller and be active measuring while it is being glued so that it can be adjusted for loudest echo. Loudest echo may not be at exactly



horizontal position. The deviation from horizontal bottom for stainless steel must be less than 10˚. Fill the container above half and place the level sensor with silicone in a position expected to be good and calibrate liquid. If there is no error go to Level Sensor measured data. The echo strength is shown in dB. Adjust the angle of the level sensor for maximum echo strength. Then calibrate liquid again and check the angle of the level sensor. Then hold it there for 24hours.

Mounting the velocity sensor

A velocity sensor (= Level Switch) must be mounted so it can measure the echo bouncing at the opposite container wall. Preferably it is mounted quite low on the container since it needs liquid to measure the velocity. How well sound passes through the wall depend on the material and thickness, see above.

See Level Switch manual how to glue the velocity sensor.

Container top

When the container is full with liquid all the way up to the top the ultrasound will bounce on the top. If the inside of the top is not horizontal and flat just above the level sensor the echo may bounce in wrong direction.

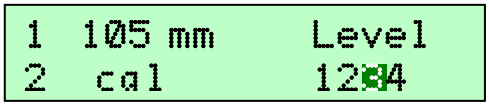
Level Sensor start-screen

When power is applied, the Level Sensor start-screen is displayed showing LevlSens on first line to the right signifying this is Level Sensor start-screen. On the second line to the right is written 1234 which shows the state of each of the four relays. A light digit on dark signifies a closed relay.

To the left, the digit 1 signifies Level Sensor 1, followed by the measured level in %. If no measurement can be done there is text with information instead. On the second line, the digit 2 signifies Level Sensor 2.

cal	calibration needs to be done of air or liquid
set	parameters need to be set
---	not active
err	error – see troubleshooting
> xx	level is over xx mm (over 100%)
< xx	level is below xx mm

Example: Level Sensor 1 105mm
Level Sensor 2 need to be calibrated



SETTINGS

Through the SETTINGS-menu the parameters of the Level Sensor can be set.

Select SET 100% Level to set the level which correspond to 100% level. A level over 170% will not be measured at all.

Select SET 0% Level to set the level xx which correspond to 0% level. Any level below 0% will be shown as <xx.

Select SET Liquid Sound Velocity This parameter is used only if sound velocity measurement cannot be done because of no velocity sensor. It should be set to the value of the liquid.

Select SET Velocity Sensor EchoDISTANCE to set distance (in mm), from the velocity sensor to the reflecting surface, but it is only the distance through liquid. Set it to . . . . . if no velocity sensor is used to make velocity measurements.

Select SET Velocity Sensor HEIGHT to set the height (in mm) above the bottom where the velocity sensor is placed. If this value is set, the level measurements of the velocity sensor are used to limit the level sensor measurement. Set it to ". . . . . ." if the velocity sensor should be used only for velocity measurements.

Select SET Velocity Sensor Control to set how the Velocity Sensors Air/Liq-measurement is used. Set to Level unaffected it is not used. Set to Limit level it limits the level measurements. Set to make zero level it makes level zero below Velocity Sensor.

Select SET Container Bottom-Thickness it is used to add sound travelling time through the bottom.

Select SET Container Wall-Thickness it is used to add sound travelling time through the wall.

Select SET RELAY to set how the relays should act. Each relay have one normally open contact (at power off the relay is open).

CALIBRATION

Select CALIBRATION to calibrate. Each level sensor must be calibrated after installation. Calibration should be done for air (empty container) and for liquid with either minimum 70% full container or minimum 150mm. Do not fill completely if the container top does not reflect the echo well. During calibration Ultrasound Controller measures different frequencies and selects the one producing the strongest echo. Calibration should also be done for air (with liquid level below the velocity sensor) but only necessary if a velocity sensor is used. If possible calibrate with the liquid that is going to be used or a similar one.

A new calibration has to be done if the level sensor or the velocity sensor is moved.

If there is a velocity sensor the calibration measures the sound velocity and this measurement will be used when the liquid level is below the velocity sensor.

It is important to check (in SHOW DATA) that the echo is at least 10dB above the threshold.

SHOW DATA

Select Level Sensor x measured data to show level mm, echo strength dB, average good echo %Echo and threshold Thld dB. It is important to check the value of echo strength and threshold to make sure the echo strength is above threshold. Echo strength below threshold will not be accepted. Threshold is determined by the amount of background noise.

Select Velocity Sensor x measured data: to show sound velocity m/s, echo strength dB and echo strength divided by calibrated liquid echo strength %.

Select Level Sensor x calibrated data to show calibrated signal strength dB and calibrated frequency MHz.

Select Velocity Sensor x calibrated data to show calibrated velocity m/s, calibrated signal strength dB, calibrated frequency MHz and calibrated threshold for detecting liquid %. Calibrated threshold must not be too high, less than 50% is good.

ADVANCED SETTINGS

Select Set sensor MODE to set either Air Sensor mode, Level Switch mode or Level Sensor mode. It determines which sensor can be connected. Changing sensor mode does not alter any settings or calibrations.

Select RESTORE settings and calibrations to restore all settings and calibrations to factory-settings.

HELP

Select HELP to show information about connecting the Ultrasound Controller.

Level Sensor TROUBLESHOOTING

Display shows:

set = Settings is missing

cal = Calibration of air and/or liquid must to be done.

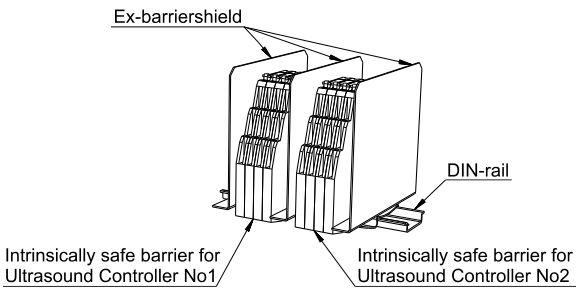
set = Some setting is missing.

err = Measurement cannot be done due to an error that was measured during calibration: Either level sensor or velocity sensor echo is too weak or the velocity sensor echo with air is too strong.

OVER = Measured level is between 100% and 170%.

The echo strength, threshold and %echo should be checked: If the echo is weak compared to threshold there can be problem measuring the level. Make sure the echo is reflected properly back to the level sensor. The bottom thickness and material also influences the echo strength, see Mounting the Level Sensor.

Electric interference can cause trouble because it can increase the threshold. To minimize the risk of electric interference it is important that sources of interference like frequency inverters should use screened cables for the motor. Also any unscreened part of the cable between the Level Switches and Ultrasound Controller should be short. If ex-barriers are used, Ex-barriershields must be used.



In order for Ultrasound Controller to measure the level well it needs echoes from the surface. Due to various reasons however the echoes can become too weak to be able to be detected. An indication of how well the echoes are detected is %Echo, which is 100% with good echo but becomes less with weak echo. Also echo strength dB and threshold Thld dB indicates how strong the echo is compared to background noise. In an empty container there is no echo but %Echo may still show more than 0% because noises are misinterpreted as echoes.

For reliable measurement strong echo is good. Some reasons for weak echo:

- Container is empty. - This is ok there should be no echo then.
- Bottom is thick. – If possible make bottom thinner. Also consider ideal thickness for resonance at 2 MHz.
- Bottom thickness is such that resonance is not at 2MHz. – If it is possible make bottom thickness so resonance is at 1,9 - 2,2 MHz (d = n * λ / 2 = n * v / 4000000 λ = wavelength at 2MHz d = bottom thickness n = 1,2,3… v = sound velocity m/s) (stainless steel: d = n * 1,41mm).
- Liquid level is very low. – The echo is veiled by echoes within the bottom. Measuring very low level is difficult due to short echoes inside the bottom.
- Bubbles or particles scatter the echo.
- Level is outside the range (170%). – Set the range.
- Container is full and the inside surface of the top of the container is shaped in such a way that echoes are reflected in wrong direction. – Make a small portion of the inside surface flat just above the level sensor.
- Level sensor is aimed in wrong direction. – Aim the level sensor in the right direction.
- The container is inclined and thereby the level sensor becomes aimed in wrong direction. – Unincline the container or aim the level sensor.
- The liquid is rotating and the centrifugal force makes the surface parabolic thereby reflecting echo in wrong direction. – Try finding better position for the level sensor, maybe in the middle of the container.

7. Gel Sensor Mode

Gel Sensor Mode can measure the presence and concentration of gel media, used in chromatography systems. It can measure single levels of gel and gel concentration behind the container wall. The Gel Sensor senses through the wall (no hole is needed). Four single levels can be measured with one Ultrasound Controller. Level Switch KS (or Level Switch QS containing four sensors) can be used as gel sensors.

GSF90 is a gel sensor to be installed inside the column. It uses a higher frequency (4MHz) and must be connected to G72 or GP72. Up to four GSF90 can be connected to one G72 or GP72.

(Gel Sensor Mode is not available in versions: < 4.40)

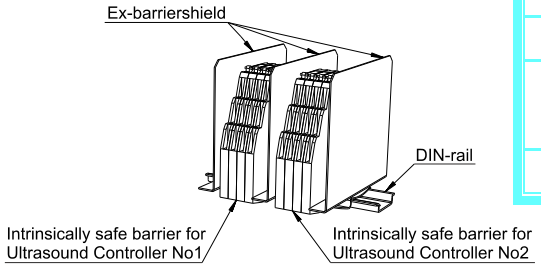
Quick start guide

- Install Gel Sensors (Level Switches) according to instructions in the Level Switch Manual.
- Connect cables, see Connecting the Gel Sensor.
- Switch on external power supply. You may have to press POWER to activate D128.
- You may read about navigating the menu system, page 8
- Display show: `SET sensor MODE`. Press MENU button to scroll to `Press SELECT for Gel Sensor mode`. Confirm by pressing SELECT button.
- Go to `SETTINGS` to set parameters, page 31
- Calibrate Gel Sensors with liquid. Make sure liquid level is above and gel level is below the Gel Sensors. Select `Calibrate Liquid 1- 4 together` and press SELECT button one second.
- Go to `SHOW DATA` to check values, page 32
- Ready to use.

Connecting the Gel Sensor

The cable from the Gel Sensor should connect directly to the Ultrasound Controller. The cable screen must always be connected to Ultrasound Controller (and screened cable must always be used). Any unscreened part of the cable should be no longer than 30mm. To minimize the risk of electric interference it is important that sources of interference like frequency inverters should use screened cables between inverter and motor.

Ultrasound Controller		Cable color	Cable color
D72 DP72	**D128**	**Level Switch KS**	**Level Switch QS**
8	**11**	Gel Sensor **1** Brown	Black (Brown)
9	**12**	Gel Sensor **1** White	Grey
10	**13**	Gel Sensor **2** Brown	Blue (White)
11	**14**	Cable screen & Yellow & Green & Ground	Cable screen & Ground
12	**15**	Gel Sensor **2** White	
13	**16**	Gel Sensor **3** Brown	White (Blue)
14	**17**	Gel Sensor **3** White	Grey (jumper)
15	**18**	Gel Sensor **4** Brown	Brown (Black)
16	**19**	Cable screen & Yellow & Green & Ground	Cable screen & Ground
17	**20**	Gel Sensor **4** White	



In an ex-installation, shielding aluminum plates must be placed outside each group of zener barriers belonging to each Ultrasound Controller.

order number: Ex-barriershield, see Level Switch Ex manual.

Ultrasound Controller		Cable color
G72 GP72		**GSF90**
8		Gel Sensor **1** Yellow
9		Gel Sensor **1** Green
10		Gel Sensor **2** Yellow
11		Cable screen & Brown & White & Ground
12		Gel Sensor **2** Green
13		Gel Sensor **3** Yellow
14		Gel Sensor **3** Green
15		Gel Sensor **4** Yellow
16		Cable screen & Brown & White & Ground
17		Gel Sensor **4** Green

Measuring Gel

Gel media used in chromatography systems consists of small particles which scatters the ultrasound causing attenuation. Ultrasound attenuation is a reliable method to measure gel concentration. For attenuation <60dB/m, ultrasound attenuation per meter is fairly proportional to gel concentration. The amount depends on ultrasound frequency and gel type. The actual measured attenuation is also proportional to echo travel distance.

During calibration the relative signal level, `Relativ Signal`, is adjusted to 100% and relative attenuation, `RelativAtt`, is adjusted to 0dB/m, then gelconcentration, `Gelconc`, becomes 0%. Normally calibration is done with pure liquid without gel. When gel concentration increases, attenuation increases and the signal level drops.

Unfortunately not only gel causes attenuation, unsolved dense matter also causes attenuation. GEL-THRESHOLD should therefore be set so that wrong detection of gel is avoided or calibration should be done with the liquid containing unsolved dense matter. Look at Gelconc %, when different liquids exist in the container and see what happens. Gelconc % and RelativAtt can not become negative so attenuation lower than the calibrated attenuation can only be seen in as Relativ Signal being higher than 100%.

Liquids having different sound velocities and being not well mixed, causes refraction and thereby attenuation. This happens for example if a liquid is switched from one kind to another like water switched to alcohol.

Low liquid level (Air) causes high attenuation and can not be distinguished from gel. However by simultaneously measuring air/liquid with the WR-technique, wrong detection of gel when there is air can be avoided.

In SHOW DATA measurement data can be checked.

Measurement technique

Either Level Switch KS or Level Switch QS or Gel Sensor GSF90 can be used as Gel Sensor. However GSF90 must use G72 or GP72 which both uses 4MHz ultrasound. Gel is measured by measuring sound attenuation using echo-technique. Air level can also be measured using Liq WR sensor technique.

The echo-technique measures echoes from a reflecting surface inside the container, usually the opposite container wall or the pin on GSF90. Sound pulses are transmitted and comes back as echoes after bouncing off the reflecting surface.

It is important the ultrasound can pass as easy as possible into and through the container wall. How well it passes depend on the wall material and thickness and how the Level Switch is attached. Steel or glass wall should be in the range 1,3mm - 15 mm and plastic wall <30mm (PP<10mm). Testing on the actual container is recommended. Any welding-joint in the wall should be avoided as it can refract the sound-beam.

The ultrasound beam behaves similar to a light-beam, the direction of the echo depend on from what angle it hits the reflecting surface. The sound beam is approximately 1cm in diameter. Obstructing objects in the path between sensor and the reflecting surface may cause the beam to divert. It is possible to use objects other than the opposite container wall as a reflecting surface.

On small containers (less than 60mm, depending on wall material), sound travelling along the container wall can cause problem, when measuring high attenuations.

The Liq WR sensor measurement is done independent of the gel-measurement. It can detect the presence of air which would otherwise give a false indication of gel. The Liq WR sensor measures vibrations in the container wall (sensor wall in GSF90) to determine if there is air or not behind the wall. The Liq WR sensor transmits sound and then measures how quickly vibrations in the container wall disappear. Vibrations in the wall disappear more slowly with air. The Liq WR sensor is dependent on the material and thickness of the wall. Plastic wall < 30mm (PP<10mm) works well. Liq WR sensor may have temperature dependence and should be avoided on glass wall if temperature varies more than +-5ºC during measurements and should not be used at all on steel wall. The Liq WR sensor measures small signal changes and is sensitive to small movements of the Level Switch, therefore gluing is preferred when Liq WR measurement is used.

Mounting the Level Switch

How to mount the Level Switch on the container is described in Level Switch manual.

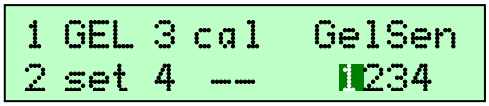
Gel Sensor start-screen

When power is applied, the Gel Sensor start-screen is displayed showing GelSen on first line to the right signifying this is Gel Sensor start-screen. On the second line to the right is written 1234 which shows the state of each of the four relays. A light digit on dark signifies a closed relay.

To the left are four small digits signifying Gel Sensor 1 2 3 and 4 with three-letter-text following each digit showing information about each Gel Sensor:

GEL	gel is detected
LIQ	no gel is detected
AIR	air is detected
	Gel Sensor is not existing
cal	Waiting for calibration of Air and/or Liquid
set	parameters need to be set
--	Gel Sensor disconnected
err	error – see troubleshooting

Example: Gel Sensor 1 detecting GEL, Gel Sensor 2 connected but all parameters are not set, Gel Sensor 3 need to be calibrated, Gel Sensor 4 Gel Sensor disconnected, Relay1 closed.



SETTINGS

Through the SETTINGS-menu the parameters of the Gel Sensor can be set.

Select SET Type to set it to the number of connected sensors, or to Level Switch QS which has 4 sensors in an array. For GSF90 set it to the number of connected sensors.

Select SET ECHO-DISTANCE to set the distance between the Level Switch and opposite reflecting surface inside the container. For GSF90 set it to 90mm.

Select SET GEL-TYPE to set the the amount of attenuation of the gel.

Select SET GEL-THRESHOLD to set the gel concentration to be detected. Gel-threshold is independent of container size.

Select SET FREQUENCY to set the measurement frequency. Calibration for different frequencies are stored during calibration. FREQUENCY can be changed after calibration. If container is made of plastic use 2,2 MHz. If container is made of glass or stainless steel then 2,2MHz may give weak echo, then try a lower frequency. (The wall thickness determines how well different frequencies penetrates the wall). GSF90 must be used with G72/GP72 at 4 MHz. Only G72 and GP72 can use 4 MHz.

Select Liquid Sensor SET WR THRESHOLD to set threshold of the Liq WR sensor. Can be set to half the value of Liq WR sensor dB with Air. It should be used only when the wall is made of plastic or GSF90. (For GSF90 set it to 3,7dB) If not used set it to disabled.

Select SET RELAY to set how the relays act. Each relay have one normally open contact (at power off the relay is open). There are four relays relay1 is controlled by GS1 and relay2 is controlled by GS2. Relay3 and relay4 are either controlled by GS1 and GS2, if GS3 do not exist or controlled by GS3 and GS4, if GS3 exist. Relay can be set to closed or open with gel. Unless Liq WR sensor is disabled, detection of air overrides the detection of gel. Relay can also be set to be closed or open with error / air (error=disconnected sensor). Relay can also be set to be closed or

open with weak signal. Weak signal is when the echo signal is weak, below -50dB and then there is a risk that actual gel concentration is higher than the measured concentration.

Select SET mA output A or SET mA output B to set the 4-20mA outputs. 1,5mA/GelDetectn means each gel sensor that detects gel adds 1,5mA to the output. Relative attenu. 1mA=-4dB/m means the relative attenuation of 1 is output 1mA for each 4dB attenuation. Gelconcentration 1mA=1% to output gelconcentration.

CALIBRATION

Make sure there is liquid and not gel behind the Level Switches. Select CALIBRATION and select 1-4 together (or select a single sensor) then hold SELECT button pressed one second to calibrate the Gel Sensors.

The sensors must be calibrated after installation. If the KS or QS sensors have been moved it is recommended to calibrate again. Changing the ECHO-DISTANCE also require new calibration.

To see how well the Gel Sensor behaves with different liquids the relative signal can be checked in SHOW DATA. Look at the values in Relativ Signal % and Gelconc. Check how different liquids affect the signal.

If Liquid Sensor WR is not disabled check also Liq WR sensor dB. It is the signal from the Liquid Sensor WR which is set to zero during calibration. With air in the container check the value of Liq WR sensor dB. The Liquid Sensor WR THRESHOLD should be set to about half of this value.

Check Signal Strength. With liquid and no gel it should be minimum 35dB. The reason for a low signal strength can be a tiny air-gap between the Level Switch and the container, wrong angled Level Switch, wrong settings, liquid that attenuates the sound, glass or steel wall with thickness that do not let through the selected frequency very well (try a lower frequency).

SHOW DATA

Select Measured data to show measured data. All four Gel Sensors are shown together. Pressing MENU button scrolls through: Gelconc. %, Relativ Signal %, RelativAtt. dB/m, Signal dB and Liq WR sensor dB.

Gelconc. %, is the measured gel concentration.

Reltiv Signal %, is measured sound signal strength in percent of calibrated sound signal strength.

RelativAtt. dB/m, is the measured sound attenuation per meter. It is set to zero at calibration and it is independent of echo-distance.

Signal dB is the measured sound signal strength (dB) where 85dB is maximum and 0dB is minimum. When signal level is below 20dB, then echo is so weak that there is risk that the measured gel-concentration is lower than actual gel-concentration.

Liq WR sensor dB is the signal from the WR-measurement and it is relative to signal at calibration (dB). It is near 0dB with liquid and depending on the container wall around 3dB with air.

Select Calibrated Data to show calibrated data. All four Gel Sensors are shown together. Pressing MENU button scrolls through: Cal Liq dB, Freq and Test Sensor dB

Cal Liq dB is the measured sound signal strength during calibration with liquid (dB). The higher the better. Lower than 35dB is considered to be too weak signal.

Freq is the chosen frequency: 1=1,3MHz, 2=1,5MHz, 3=1,7MHz, 4=2MHz, 5=2,2MHz or 6=4MHz. Use as high as possible (except 4MHz). Steel or glass wall thickness may make it necessary to change to a lower frequency in order to get high enough signal strength.

Test Sensor dB shows Liquid Sensor WR signal. It can be used to test a Gel Sensor not attached to a container. If the Gel Sensor is correctly connected a value between 0 and 30 should be shown. Pressing on the inner side of the Gel Sensor with a thumb the value increases showing the Level Switch is working. A bad Level Switch, wrong or not connected will show a value 60 or more.

ADVANCED SETTINGS

Select Set sensor MODE to set either Air Sensor mode, Level Switch mode, Level Sensor mode or Gel Sensor mode. Changing sensor mode does not alter settings and calibrations.

Select RESTORE settings and calibrations to restore all settings and calibrations to factory-settings.

HELP

Select HELP to show information about connecting the Ultrasound Controller.

Measurement Reliability

Many factors determine the reliability (wall material, wall thickness, liquid properties, temperature and glue). Therefore it is always advisable to make tests under varying conditions and temperatures.

The reliability of Liquid Sensor WR depend on the container wall. On a plastic wall 10-30mm it works well. On GSF90 it works well. On a glass wall and polypropylene wall it has temperature dependence and should not be used if there is more than +- 7°C variation during measurement. On steel wall it is not recommended.

Gel Sensor TROUBLESHOOTING

Display shows:

-- = The Gel Sensor is not connected or there is a short circuit.

cal = Calibration has not been done. It must be calibrated with Liquid.

set = Some settings is missing.

If the relay does not change but the display changes between Liquid, Air and Gel. Wrong setting of RELAY.

err = During calibration the signal was weak:

- Calibration was made without liquid or with gel.
- The Level Switch is not attached correctly to the container. There is a tiny air-gap between the Level Switch and the container.
- The “DISTANCE to reflecting wall” is wrong.
- The echo is reflected in a direction where it does not reach the Level Switch.
- Something obstructing between the Level Switch and the reflecting wall.
- The container wall does not let through enough sound. Try a different FREQUENCY.
- Wrong connection or faulty Level Switch. Select Test Gel Sensor then test the Level Switch and its connection.

Electric interference can show itself as the attenuation and gel concentration not being able to get high enough with gel. To minimize the risk of interference it is important that sources of interference (like frequency inverters) should use screened cables between inverter and motor. Also any unscreened part of the cable between the Level Switch and Ultrasound Controller should be short. If ex-barriers are used, Ex-barriershields must be used especially if there is more than one Ultrasound Controller.

8. Profibus DP

Connecting Profibus

The Ultrasound Controller DP72,GP72 supports Profibus DP-V0 with communication speeds up to 1,5Mbit/s. The Profibus cable connects to DP72,GP72 via a 9-pin D-sub connector see table.

To terminate the Profibus cable, put 390Ω between pin6 and pin8 and 220Ω between pin6 and pin5 and 390Ω between pin3 and pin5.

The Profibus-interface in DP72,GP72 is not isolated from power supply.

The gsd-file: DP720B0E.gsd is needed for configuration of the Profibus master. It can be downloaded at www.aqelteknik.se. The version of the gsd-file is written in the beginning of the gsd-file (the gsd-file can be viewed with a text editor). It must be the correct version. See page 3 for correct version.

PROFIBUS Parameters

The PROFIBUS SETTING: is accessible through ADVANCED SETTINGS menu.

Select BITRATE: to set the bitrate. Auto automatically selects bitrate. (Maximum bitrate is 1,5Mbit/s).

Select ADDRESS: to set the address (0-125). Every unit must have different address.

Select PARAMETER ACCESS. If set to Profibus only then all parameters, (except PROFIBUS Parameters) will be set by the Profibus master only. If set to Menu only, then all parameters can be set via the menu and not via Profibus master.

Select CONTROL: to enable or disable Profibus communication.

Profibus Status-symbol

The current status of the Profibus communication is shown with a Profibus status-symbol on the start screen at the bottom right corner of the display:

□ = Profibus enabled but no communication is detected.

▒ = Profibus is not enabled.

▮ = Profibus communication is detected but not to me or data cannot be interpreted.

P = Parameter or configuration telegram is received.

> < (alternating) = Data exchange telegrams are received and responded to.

X = Ready for data exchange but no telegram is received.

T = Telegrams are received.

Request Data

The master sends one byte Request Data to DP72, which respond with 16 bytes Response Data (1-16).

Request data should normally be zero. A nonzero request data is used to start calibration. The master sends a calibration command by changing the Request Data bit1-4 from being all zero to being nonzero (the data depends on which sensors are to be calibrated, see the Profibus data exchange table below). Bit 0 selects calibrate Air or Liquid. After the master has sent the data,

Request Data should be set to zero again to prepare for a future calibration command. DP72 performs calibration immediately when it receives the command. Calibration can also be done by pressing the buttons on DP72. Calibration takes about 1-3 seconds and during this time DP72 will discard any new calibration commands.

Response Data

Most of the Response Data is the same data as shown in SHOW DATA menu and the start screen. The format is 8 bit unsigned. Chapter SHOW DATA gives more information about it.

Air Sensor: Response Data 1 and 2 bit 0 shows the Filtered Air/Liquid-data for the selected sensitivity. Filtered Air/Liquid-data for all sensitivities are available in Response Data 3 and 4 and can be used to show different bubble sizes or change sensitivity without changing any settings**.** The indication of Air is always minimum 0,5s even if a bubble passes quickly through the Air Sensor.

Level Sensor: For Response Data 3 and 4 the value 255 corresponds to 100%.

Request Data table

Request Data	Air Sensor Mode	Level Switch Mode	Level Sensor Mode
1	bit0: 0= Air 1= Liquid bit1: 1= calibrate AS 1 bit2: 1= calibrate AS 2 bit3: 0 bit4: 0 bit5: 0 bit6: 0 bit7: 0	bit0: 0= Air 1= Liquid bit1: 1= calibrate LS 1 bit2: 1= calibrate LS 2 bit3: 1= calibrate LS 3 bit4: 1= calibrate LS 4 bit5: 0 bit6: 0 bit7: 0	bit0: 0= Air 1= Liquid bit1: 1= calibrate Level 1 bit2: 1= calibrate Level 2 bit3: 0 bit4: 0 bit5: 0 bit6: 0 bit7: 0

[1] depends on selected sensitivity (Normal or Very Low)
[2] depends on selected Technique (Echo or WR)

Ndata = Normal measurement data
Efrq = Echo frequency
VLdata = Very Low sensitivity measurement data
NLiq = Normal sensitivity calibrated liquid data dB
NAir = Normal sensitivity calibrated air data
VLthld = Very Low sensitivity calibrated threshold
Ethd = Echo threshold
Wfrq = WR frequency
Edata = Echo measurement data
Wdata = WR measurement data
ELiq = Echo calibrated liquid data * 0,3dB
Wss = WR signal * 0,7dB
Wthd = WR threshold

TROUBLESHOOTING

If the Profibus status-symbol shows □ all the time: There is no communication detected. Profibus cable is not connected or Profibus Master is inactive.

If the Profibus status-symbol shows ▮ all the time: There is communication detected but it could be wrong bitrate or wrong address or wrong cable polarity.

If the Profibus status-symbol shows **P** continuously it means the Profibus master repeatedly sends parameter or configuration telegrams but DP72 do not accept them. Something is wrong with the parameter or configuration telegram probably caused by wrong version of the gsd-file.

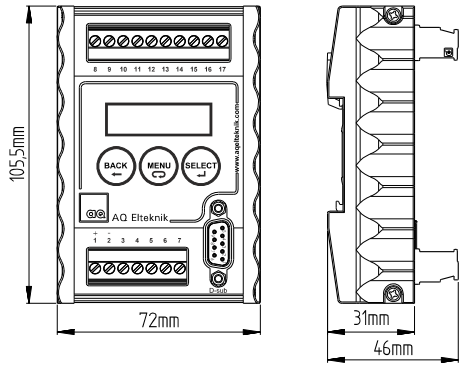
If no Profibus status-symbol is shown at all: Profibus is not enabled.

Response Data table

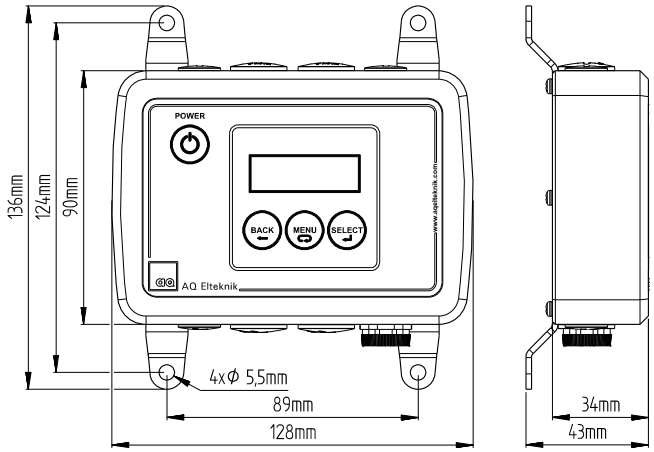
Response Data	Air Sensor Mode	Level Switch Mode	Level Sensor Mode
1	Air Sensor 1 bit0: 0= Air 1= Liquid bit1: not used bit2: not used bit3: 1= no sensor bit4: 1= calibration not been done bit5: 1= error bit6: 1= error very low sensitivity bit7: 1= calibration in progress	Level Switch 1 bit0: 0= Air 1= Liquid bit1: Efrq or Wfrq bit0[2] bit2: Efrq or Wfrq bit1[2] bit3: Efrq or Wfrq bit2[2] bit4: 1= no sensor bit5: 1= error echo bit6: 1= error WR bit7: 1= calibration in progress	Level Sensor 1 bit0: velocity sensor 0=Air 1=Liq bit1: - bit2: 1= calibration missing bit3: 1= error bit4: 1= no echo bit5: 1= OVER (>100%) bit6: - bit7: -
2	Air Sensor 2 (same as above)	Level Switch 2 (same as above)	Level Sensor 2 (same as above)
3	Air Sensor 1 0=Air 1=Liquid bit0: Very Very low bit1: Very low sensitivity bit2: Low sensitivity bit3: Medium sensitivity bit4: High sensitivity bit5-7 not used	Level Switch 3 (same as above)	Level Sensor 1 **Measured Level** % (255=100%)
4	Air Sensor 2 (same as above)	Level Switch 4 (same as above)	Level Sensor 2 **Measured Level** %
5	Air Sensor 1a **Ndata** % or **VLdata**[1]	Level Switch 1 **Edata** % or **Wdata**[2]	Level Sensor 1 **Measured Level** mm High 8bits
6	Air Sensor 1b **Ndata** % or **VLdata**[1]	Level Switch 2 **Edata** % or **Wdata**[2]	Level Sensor 1 **Measured Level** mm Low 8bits
7	Air Sensor 2a **Ndata** % or **VLdata**[1]	Level Switch 3 **Edata** % or **Wdata**[2]	Level Sensor 2 **Measured Level** mm High 8bits
8	Air Sensor 2b **Ndata** % or **VLdata**[1]	Level Switch 4 **Edata** % or **Wdata**[2]	Level Sensor 2 **Measured Level** mm Low 8bits
9	Air Sensor 1a NLiq	Level Switch 1 **ELiq** or **Wss**[2]	Level Sensor 1 **Sound velocity** m/s High 8bits
10	Air Sensor 1b NLiq	Level Switch 2 **ELiq** or **Wss**[2]	Level Sensor 1 **Sound velocity** m/s Low 8bits
11	Air Sensor 2a NLiq	Level Switch 3 **ELiq** or **Wss**[2]	Level Sensor 2 **Sound velocity** m/s High 8bits
12	Air Sensor 2b NLiq	Level Switch 4 **ELiq** or **Wss**[2]	Level Sensor 2 **Sound velocity** m/s Low 8bits
13	Air Sensor 1a **NAir** % or **VLthld**[1]	Level Switch 1 **Ethd** % or **Wthd**[2]	Level Sensor 1 **Velocity sensor threshold** %
14	Air Sensor 1b **NAir** % or **VLthld**[1]	Level Switch 2 **Ethd** % or **Wthd**[2]	Level Sensor 2 **Velocity sensor threshold** %
15	Air Sensor 2a **NAir** % or **VLthld**[1]	Level Switch 3 **Ethd** % or **Wthd**[2]	Level Sensor 1 **Echo strength** dB
16	Air Sensor 2b **NAir** % or **VLthld**[1]	Level Switch 3 **Ethd** % or **Wthd**[2]	Level Sensor 2 **Echo strength** dB

9. Technical specifications Ultrasound Controller

Hardware version	See page 3
Software version	See page 3
Weight	210g (D72,DP72,G72,GP72), 370g (D128)
Operating temperature	0°C to 50°C
Supply voltage	24V ± 3V DC
Current consumption max	200mA
Relay 1-4	potential free contacts (open when power is off) Maximum load: 30V DC/AC 500mA All four relays are connected to a single common (terminal 3)
mA output	4-20mA (active output) maximum voltage drop on connected load 10V
Protection class	IP30 (D72,DP72,G72,GP72) IP65 (D128)
Ambient Humidity	0% - 90%
Material	Aluminum, PA, PC, POM
Measurement frequency	1,1 – 2,2 MHz
Average output power	10 mW
Profibus DP	In DP72 and GP72 only
Gsd file for DP72	DP720B0E.gsd version see page 3
Cable glands in D128	M12: cable Ø3,5mm - Ø7mm M16: cable Ø4,1mm - Ø10mm



D72, DP72,G72,GP72



D128

10. Parameter settings

Air Sensor

MODE

	Possible values
	Not set ☼
	Air Sensor
	Level Switch
	Level Sensor

TYPE

Air Sensor 1	Air Sensor 2	Possible values
		No Air Sensor ☼
		SAC
		SAC Ex
		PAC or FCP
		FCS
		FCS Ex

DIAMETER

Air Sensor 1	Air Sensor 2	Possible values
		No Air Sensor ☼
		2mm
		3mm
		4mm
		4,5mm
		6mm
		8mm
		10mm
		12mm
		14mm
		16mm
		18mm
		20mm
		22mm
		26mm
		30mm
		35mm
		38mm
		46mm
		51mm
		58mm
		64mm
		70mm

SENSITIVITY

Air Sensor 1	Air Sensor 2	Possible values
		very very low
		very low
		low
		medium ☼
		high

FILTER

Air Sensor 1	Air Sensor 2	Possible values
		integrate 1ms
		integrate 3ms
		integrate 10ms
		integrate 30ms ☼
		integrate 0,1s
		integrate 0,3s
		integrate 1s
		integrate 3s
		delay 0,3s
		delay 1s
		delay 3s
		delay 10s

Air Sensor RELAY

RELAY 1	RELAY 2	RELAY 3	RELAY 4	Possible values
				not assigned ☼
				Open AS1 Liq, Closed AS1 Air
				Open AS1 Air, Closed AS1 Liq
				Open AS2 Liq, Closed AS2 Air
				Open AS2 Air, Closed AS2 Liq

Air Sensor mA output

mA output A	mA output B	Possible values
		not assigned ☼
		AS1 At Selected Sensitivity
		AS2 At Selected Sensitivity
		AS1 All Sensitivities
		AS2 All Sensitivities
		AS1 Normal Measurement Data
		AS2 Normal Measurement Data

Level Switch

TECHNIQUE of measurements

Level Switch 1	2	3	4	Possible values
				No Level Switch ☼
				Type **LS**, Technique **EHCO**
				Type **RS**, Technique **WR**
				Type **LS**, Technique **WR**

FILTER

Level Switch 1	2	3	4	Possible values
				0,5s
				1s ☼
				2s
				4s
				8s
				12s
				16s

ECHO-DISTANCE

Level Switch 1	2	3	4	(Technique ECHO only) Possible values
				. . . . . ☼
				32mm
				38mm
				42mm
				46mm
				49mm
				53mm
				58mm
				65mm
				75mm
				85mm
				100mm
				115mm
				135mm
				165mm
				200mm
				250mm
				300mm
				350mm
				400mm
				500mm
				600mm

Jacket

Level Switch 1	2	3	4	(Technique WR special) Possible values
				no Jacket ☼
				..... mm
				..... mm
				..... mm
				..... mm

FREQUENCY

Level Switch 1	2	3	4	Possible values
				Auto ☼
				1 - 1,3 MHz
				2 - 1,5 MHz
				3 - 1,7 MHz
				4 - 2,0 MHz
				5 - 2,2 MHz

Level Switch

RELAY 1	RELAY 2	RELAY 3	RELAY 4	Possible values
				not assigned ☼
				Open LS1 Air, Closed LS1 Liq
				Open LS1 Liq, Closed LS1 Air
				Open LS2 Air, Closed LS2 Liq
				Open LS2 Liq, Closed LS2 Air
				Open LS3 Air, Closed LS3 Liq
				Open LS3 Liq, Closed LS3 Air
				Open LS4 Air, Closed LS4 Liq
				Open LS4 Liq, Closed LS4 Air
				Open LS2 Air, Closed LS1 Liq
				Open LS1 Liq, Closed LS2 Air
				Open LS2 Air, Closed LS3 Liq
				Open LS3 Liq, Closed LS2 Air
				Open LS3 Air, Closed LS4 Liq
				Open LS4 Liq, Closed LS3 Air

PROFIBUS SETTING

BITRATE	
	Auto ☼
	9,6 kbit/s
	19,2 kbit/s
	45,45 kbit/s
	93,75 kbit/s
	187,5 kbit/s
	500 kbit/s
	1500 kbit/s

Level Sensor

100% Level

Level Sensor 1	Level Sensor 2	Possible values
		..... mm
		..... mm

0% Level

Level Sensor 1	Level Sensor 2	Possible values
		..... mm
		..... mm

Liquid Sound VELOCITY

Velocity Sensor 1	Velocity Sensor 2	Possible values
		..... m/s
		..... m/s

Velocity Sensor Echo DISTANCE

Velocity Sensor 1	Velocity Sensor 2	Possible values
		..... mm
		..... mm

Velocity Sensor HEIGHT

Velocity Sensor 1	Velocity Sensor 2	Possible values
		..... mm
		..... mm

Velocity Sensor Control

Velocity Sensor 1	Velocity Sensor 2	Possible values
		Velocity only
		Limits
		Zero below

Container Bottom-THICKNESS

Level Sensor 1	Level Sensor 2	Possible values
		..... mm
		..... mm

Container Wall-THICKNESS

Velocity Sensor 1	Velocity Sensor 2	Possible values
		..... mm
		..... mm

Container Wall-THICKNESS

Velocity Sensor 1	Velocity Sensor 2	Possible values
		..... mm
		..... mm

RELAY

RELAY 1	RELAY 2	RELAY 3	RELAY 4	CONNECTION to
				Level Sensor 1
				Level Sensor 2

RELAY

RELAY				ON Level / OFF Level
1				1 ON ..... mm
1				1 OFF ..... mm
	2			2 ON ..... mm
	2			2 OFF ..... mm
		3		3 ON ..... mm
		3		3 OFF ..... mm
			4	4 ON ..... mm
			4	4 OFF ..... mm

PROFIBUS SETTING

ADDRESS	
	1-125

PROFIBUS SETTING

CONTROL	
	DISABLE ☼
	ENABLE

PROFIBUS SETTING

RAMETER ACCI	
	Profibus only ☼
	Menu only

☼ indicates default setting

Gel Sensor

TYPE

	Possible values
	No Gel Sensor
	GS1 GS2 GS3 GS4
	GS1 GS2 GS3
	GS1 GS2 GS3
	GS1
	Level Switch QS

ECHO-DISTANCE

..... mm

GEL-TYPE

	Possible values
	not set ☼
	1%=5dB/m
	1%=7dB/m (DEAE)
	1%=10dB/m
	1%=15dB/m
	1%=20dB/m
	1%=25dB/m
	1%=30dB/m
	1%=35dB/m
	1%=40dB/m (Tungsten)
	1%=45dB/m

GEL-THRESHOLD

	Possible values
	not set ☼
	0,6% gel
	0,8% gel
	1,0% gel
	1,2% gel
	1,4% gel
	1,7% gel
	2% gel
	2,3% gel
	2,6% gel
	3% gel
	3,5% gel
	4% gel
	5% gel

FREQUENCY

	Possible values
	Auto ☼
	1 - 1,3 MHz
	2 - 1,5 MHz
	3 - 1,7 MHz
	4 - 2,0 MHz
	5 - 2,2 MHz
	6 - 4,5 MHz

WR-THRESHOLD

	Possible values
	disabled ☼
	0,7 dB
	1,0 dB
	1,3 dB
	1,7 dB
	2,0 dB
	2,3 dB
	2,7 dB
	3,3 dB

RELAY

	Possible values
	not set ☼
	Open: Gel
	Closed: Gel
	Open: Err/Air
	Closed: Err/Air
	Weak Echo
	Weak Echo

mA output

	Possible values
	disabled ☼
	1,5mA / Geldetection
	Attenuation GS1
	Attenuation GS2
	Attenuation GS3
	Attenuation GS4
	Gelconcentration GS1
	Gelconcentration GS2
	Gelconcentration GS3
	Gelconcentration GS4