NIVOSONAR
SenSonar

SM/SW-300 series remote control units
SI/SS/SID-300 series sensors

TWO-PART ULTRASONIC MEASUREMENT SYSTEMS

INSTALLATION
and
PROGRAMMING MANUAL

8th edition

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Thank you for choosing a NIVELCO instrument.
We are sure that you will be satisfied throughout its use.

1. INTRODUCTION

FIELDS OF APPLICATION

The Two-part Ultrasonic Measurement System of NIVELCO offers you an excellent tool for measuring:

- the level and volume of various liquids stored in tanks or reservoirs
- the flow volume of liquids in open channels
- the level of free flowing powders and bulk solids stored in tanks or silos.

The level measurement technology based on the „non-contacting ultrasonic principle" is especially suited for applications where, for any reason, no physical contact can be established to the surface of the material to be measured.

PRINCIPLE OF OPERATION

The ultrasonic level metering technology is based on the principle of measuring the period of time required for the ultrasound pulses to make a round trip from the sensor to the surface of the material and back. An ultrasonic sensor installed above the material to be measured emits an ultrasonic pulse train and receives the echoes reflected from its surface. The remote transmitter processes the received signal by selecting the echo reflected by the material surface and calculates from the time of flight, the distance of material surface.

TWO-PART ULTRASONIC MEASUREMENT SYSTEMS

The **Two-Part Measurement System** consists of **SenSonar Sensor(s)** based on the latest SenSonic™ transducer technology of NIVELCO and a highly sophisticated **NIVOSONAR Remote Control Unit**. This powerful system, is capable of measuring the level of practically any powder or bulk solid, even under most difficult circumstances such as dusting of powders caused by pneumatic filling etc.

QUEST+™

Due to its excellent signal processing feature the software QUEST+™ (**Qu**alified **E**cho **S**uppression **T**echnique **PLUS,** an improved version of the well proven QUEST™) the system provides solution for applications for which the Compact Transmitters are not „smart enough".

FEATURES

In addition to being able to perform very accurate and reliable distance measurements, the Two-Part Measurement System provides additional features such as programmable relays, galvanically isolated analogue output, RS485 computer interface for remote programming and data acquisition. The users can „customise" the information provided by the Remote Control Unit.

SenSonar Sensors

- Built-in temperature compensation on full range, excellent 5° focusing, „Echo-Quality" LED as well as a secondary surge protection are standard in most of the **SenSonar sensors**.
- **SenSonar sensors for liquids** are offered in various measuring ranges, such as 6 m, 10m, 15 m and 25 m, with Polypropylene PVDF or Teflon transducers as well as in intrinsically safe (EEx ia) versions - to meet the requirements of various liquid level measurement applications.
- **SenSonar sensors for free flowing solids** are offered in various measuring ranges, such as 15 m, 30 m, 60 m and 70 m also with Dust Ex Zone 10 approval and in a robust Aluminium housing with a special, closed cell foam face for highest performance. As an option, the sensors can be equipped with a rigid, vibration-proof aiming device - usually a necessary tool for applications involving free flowing solids.

2. TECHNICAL DATA

NIVOSONAR Remote Control Units (SM/SW-300 series)

Model	SMM	SMZ	SMW SWW	SMC/SMD SWC/SWD	SMH SWH
Mounting	Panel Mount		Wall Mount		
Connectable sensors	1		Up to 2		
Resolution	Up to 2 m: 1 mm; up to 5 m: 2 mm; up to 10 m: 5 mm; above 10 m: 10 mm				
Accuracy	0.25 % of range				
Ambient temperature range	0°C to 50°C		-20°C to 50°C		-25 to +50 °C
Analogue output	Electrically isolated; 0/4 to 20 mA; max. 500 Ohm with surge protection				
Relay output	SPDT, NO/NC; 250 V AC, 5 A at cos φ=1				
Electrical protection	Class II.				
Ex proof protection mark	[EEx ia], for use with EEx ia certified SenSonar Sensors				-
Enclosure	Front: IP40; rear: IP20	Front: IP54; rear: IP20	IP54	IP65	
Supply voltage	230 or 110 or 24 V AC, 50 to 60 Hz; or 24 V DC (specify it in the order)				
Power consumption	max. 10 VA		max. 12 VA		max. 25 VA
Weight	0.9 kg		2 kg		

SenSonar Sensors for Liquids (SI/SS-300 series)

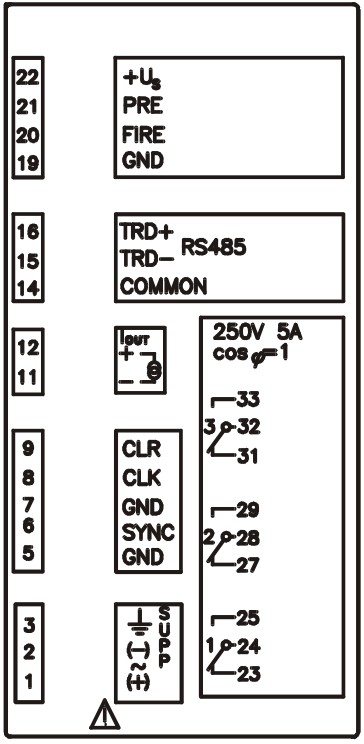
Model		SI-38	SS38	SI-36	SS-36	SI-34	SS-34	SI-32	SS-32
Range (Non Ex/EEx ia)		0.25 to 6/4 m		0.35 to 10/7 m		0.45 to 15/10 m		0.6 to 25/20 m	
Frequency		80 kHz		60 kHz		40 kHz		20 kHz	
Total beam angle at -3dB		5°						6°	
Transducer material		Polypropylene (PP) or PVDF							
Process temperature	Non Ex	**SSB**: -30°C to 90°C; **SIA**, **SIB**, **SSA**: -30°C to 80°C							
	EEx ia	**SSB**: -20°C to 80°C; **SIB**: -20°C to 75°C; **SIA**, **SSA**: -20°C to 70°C							
Ambient temperature		-30°C to 80°C							
Mechanical protection		**SI**: IP68; **SS**: IP65							
Housing material		**SI**: Same as transducer material; **SS**: Paint coated aluminium							
Pressure (absolute)		0.3 to 6 bar (0.03 to 0.6 MPa), without or with suitable flange							
Output signal/power supply		To/from **NIVOSONAR SM/SW-300** Remote Control Units							
Consumption		max. 24 VDC, 60 mA							
Electrical connections		**SI**: direct cable outlet **SS**: screw terminals in housing with 2 x Pg16							
Signal cable		4-wire shielded cable; wire cross section: 0.5 to 2.5 mm^2; max. 50nF, max. 20 Ohm							
Length of signal cable		Advised max. cable length: 300 m; recommended type: LIYCY 4 x 0.75 mm^2							
Electrical protection		Class III. with secondary lightning protection							
Ex rating		EEx ia IIB T6 for use with (EEx ia) certified **NIVOSONAR** Remote Control Units							
Weight		0.4 kg	1.5 kg	0.45kg	1.7 kg	1.4 kg	2.3 kg	2 kg	3.1 kg

SenSonar Sensors for Powders and Bulk Solids (SID-300 series)

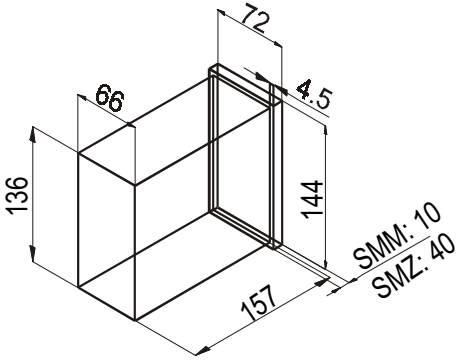
Model		SID-340	SID-330	SID-310	SID-310-H
Range		0.6 to 15 m	0.6 to 30 m	1.2 to 60 m	1.5 to 70 m
Frequency		40 kHz	30 kHz	15 kHz	15 kHz
Total beam angle (at -3dB)		5°			
Operating temperature		-30°C to +75°C			
Mechanical protection		IP65			
Mounting		1"			
Sensor material		Paint coated Aluminium with special, closed cell polystyrene foam face			
Pressure range (Absolute)		0.3 to 3 bar (0.03 to 0.3 MPa)			
Output signal		Special signals to **NIVOSONAR SM-300** remote control unit			
Power Supply		From **NIVOSONAR SM-300** Remote Control Unit			External; 24 V AC, -15%...+10%; max. 5 VA
Signal cable	Type	4-wire shielded	5-wire shielded		4-w shielded + 2-w power supply
	Quality	Wire cross section: 0.5 to 2.5 mm²; max. 50nF, max. 16 Ohm			
	Length	Advised max. cable length: 300 m; recommended type: LIYCY 4 x 0.75 mm², (+ 2 x 0.75 mm² for SID-31H)			
Electric protection		Class III. with secondary lightning protection			
Certificate for Ex versions		Dust Ex Zone 10			
Weight		1.9 kg	2.5 kg	5.1 kg	5.3 kg

3. DIMENSIONS

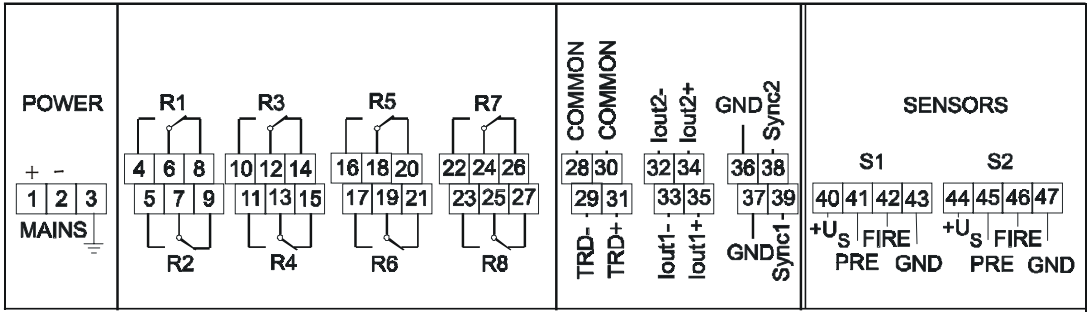
- **SMM and SMZ type, Panel Mount Remote Control Units**

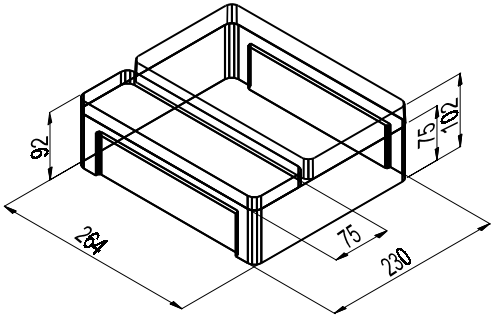


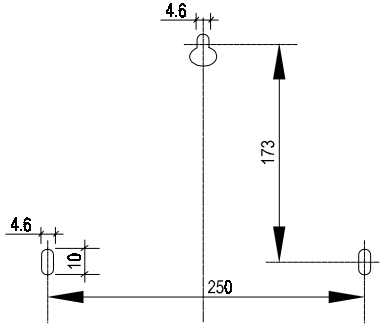
Cut-out dimensions: $68^{+0.7}$ x $138^{+1.0}$



- **SMW, SMC, SMD, SMH, SWW, SWC, SWD and SWH type, Wall Mount Remote Control Units**



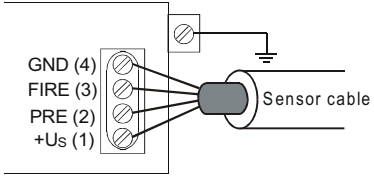




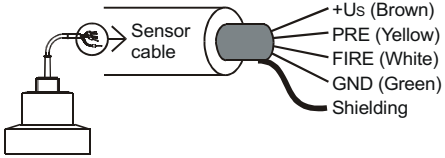
4. WIRING

Wiring between Sensor(s) and Remote Control Unit

SS-series Sensors

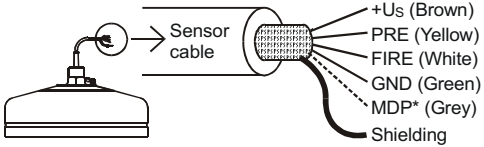


SI-series Sensors



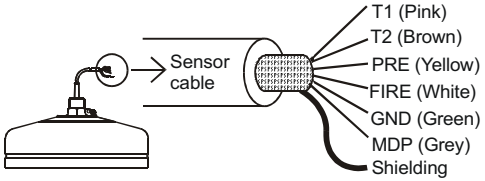
SID-series Sensors

SID-340
SID-330
SID-310

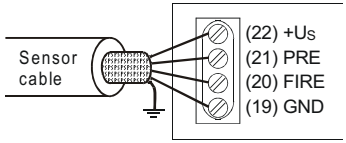


* Only in case of SID-31 and SID-33

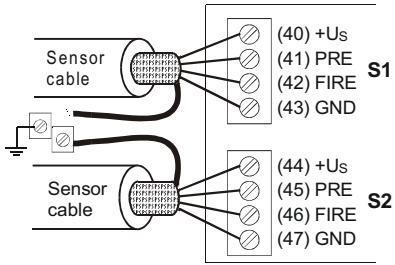
SID-310-H
External power supply version



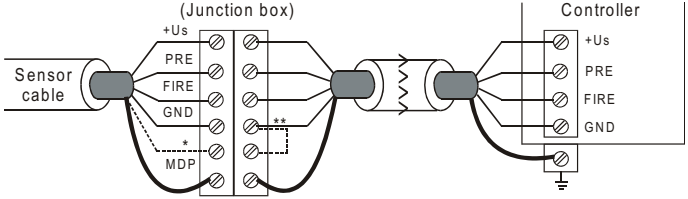
SMM, SMZ Remote control units



SMW, SMC, SMH Remote control units



Wiring, in case of extending the sensor signal cable



* Only in case of SID-330/310/310-H.
** Depending on measuring range, see table on the left.

- For connecting the Sensors to Remote Control Unit, use the type of cable described in the „Technical Data Table".
- Signal cables must not be led in common duct with high voltage lines.
- If signal cables of more than one sensor are led in common duct, make sure that they are individually shielded.
- SID-330/310/310-H sensors have an additional program wire (MDP), connect as follows:

Measuring range			MDP
SID-330	**SID-310**	**SID-310-H**	**program wire**
below 15 m	below 30 m	below 35 m	leave unconnected
over 15 m	over 30 m	over 35 m	connect to GND

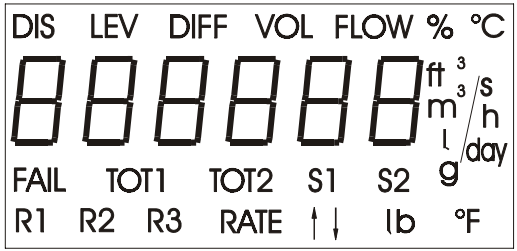
- The SYNC input of the Remote Control Units are TTL compatible.
  Active state: when the SYNC input is connected to the ground or the voltage on it is lower than 0.4V.
  Inactive state: when the SYNC input is left open/free or the voltage on it is higher than 2.4V (UMAX= 12V).

5. REMOTE CONTROL UNIT

5.1 Display

⇒ The symbol, for the quantity to be measured can be:

- **Distance** (DIS)
- **Level** (LEV)
- **Differential level** (DIFF LEV S1S2) - Only with Dual channel Remote Control Units
- **Average** (S1S2) - Only with Dual-channel Remote Control Units
- **Volume/weight** (VOL)
- **Volume flow** (FLOW)
- **Rate of level change** (RATE)
- **Level, volume or flow in percent** (%)
- **Temperature** (°C)
- **Volume flow totaliser** (TOT1)
- **Overall volume flow totaliser** (TOT2)



⇒ Various engineering units can be assigned to the displayed values.

⇒ **Relay Status** indication :
by „Relay symbols „ (R1,R2,R3) on the Display of **Panel Mount Remote Control Unit**
by „Relay LEDs" on the front panel of **Wall Mount Remote Control Unit**

Relay Status	Panel Mount Remote Control Unit	Wall Mount Remote Control Unit
De-energised	Relay symbol is off	LED is off
Energised	Relay symbol is on	LED is on
Relay under programming	Relay symbol is blinking	LED is blinking

⇒ The ∅ and ℇ arrows on the Display indicate the direction of level changes.

⇒ The symbol **FAIL** will blink if the Remote Control Unit detects an error.

5.2 Operating Modes

The Remote Control Unit has two basic operation modes:

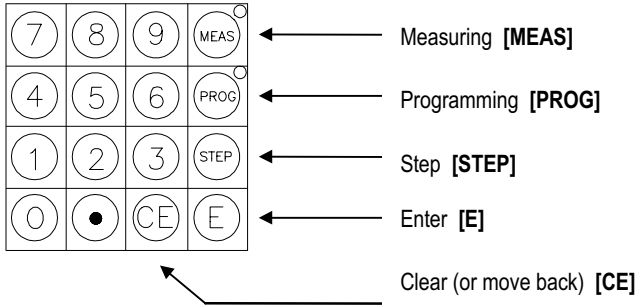
An illuminated LED on the **[MEAS]** key indicates *Measurement Mode*.

An illuminated LED on the **[PROG]** key indicates *Programming Mode*.

For selecting the desired Operating Mode, press the corresponding key.

The selection of Operating Mode will have no effect on the measuring process.

5.3 Keypad



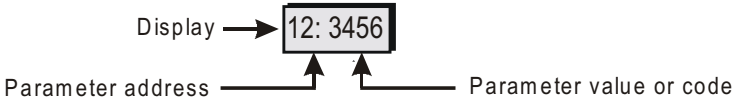
Function keys and their effect in **Measurement Mode**:

Key	Function	
[MEAS]	Scrolling between the 4 measurement values selected for displaying	
[PROG]	Entering the Programming Mode	
[STEP]	With SLM-208 scanner:	Advancing to the next sensor
	With dual channel Remote Control unit:	Changing the display between sensor 1 and sensor 2
[CE]	Will reset the TOT1 volume flow totaliser (only if TOT1 is on the Display)	

Function keys and their effect in **Programming Mode**:

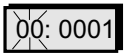
Key	Parameter address is blinking	Parameter value is blinking
[PROG]	-	- Returning to the previous confirmed entry
[STEP]	- Increasing the parameter address	- Increasing parameter value
[E]	- Confirming the entry and:	
	- changing to parameter value	- changing to parameter address
[CE]	- „Clear" if there were no **[STEP]** before, otherwise functioning as „down step"	
[MEAS]	- Returning to the Measurement Mode (When pressing this key, the unit will accept the last confirmed parameter but will not accept a parameter entry that was not confirmed)	

5.4 Programming

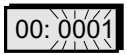


Entering the Programming Mode

Press the **[PROG]** key. The blinking numbers indicate the digits that can be modified:



Now, the parameter address can be modified or its value can be read. To modify the value of the parameter, press **[E]**:

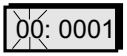


Now the value or code of the parameter can be modified.

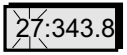
Parameter addresses will be indicated in this manual by **P00**, **P01**, **P02**...etc.
The value or code of a parameter will be indicated in this manual either directly by numbers (**P13= 12.34**) or as codes in letters (**P50= - - - x, P51= - xyz**). The number of letters represents the number of digits that can be entered.

Modifying the parameter address

If the parameter address is blinking:



⇒ A new, maximum 2 digit parameter address can be entered. For example.: press **[2]** and **[7]**:



The parameter 27 (**P27**) has been selected, and its value (343.8) is displayed. To modify the value/code of this parameter press **[E]**:

Now the value or code of the parameter can be modified (*see* „*Entering the parameter value*" *below*).

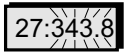
⇒ The required parameter address can also be reached by repeatedly pressing the **[STEP]** or **[CE]** keys**.**
The **[STEP]** key increases, the **[CE]** key decreases the parameter address.

Notes: After confirming the parameter address selection, the value of the parameter may not start blinking because:

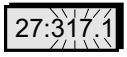
- *the parameter can not be modified (read-out parameter)*
- *or the **Access Lock** prevents the modification (see **P99**)*

Entering the parameter value:

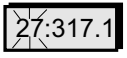
If the parameter value is blinking:



⇒ A new, maximum 4 digit value or code can be entered, e.g.: press **[3]** then **[1]** then **[7]** then **[.]** then **[1]**:



To confirm the modification and return to the parameter address press the key **[E]**:



Now other parameters can be selected and modified.

⇒ If you have changed over to the modification of the parameter value by mistake and have not made any changes, pressing key **[E]** leaves the value of the parameter unchanged and you will return to the parameter address.

⇒ If the parameter value has been modified incorrectly, but was not yet confirmed by **[E]**, pressing **[PROG]** gives back the former value of the parameter.

⇒ The parameter value can be deleted any time by pressing the key **[CE]**.

⇒ Similarly to the parameter address, the required parameter value can be reached by repeatedly pressing the key **[STEP]** for increasing or the key **[CE]** for decreasing the value. .

Notes:

a). The key **[CE]** would decrease the value only if the key **[STEP]** were pressed at least once before, otherwise it would function as a delete key.

b). The measurement will continue with the former settings, until the programming is ended by returning to the Measurement Mode by pressing the key **[MEAS].**

c). The Remote Control Unit may not accept the confirmation of a parameter value and not return to „Modifying the parameter address" because:

- the modified value is out of range
- or the particular combination of codes entered is not valid

6. DUAL-CHANNEL REMOTE CONTROL UNITS

The Dual-channel Remote Control Units (the type numbers **SM_/SW_-350 to 388**) can control two sensors handling them individually, as two independent measuring systems.

The Dual-channel Remote Control Units can also be used for special applications, where the two sensors constitute a single measuring system (e.g. differential level measurement, average calculation).

The Dual-channel Remote Control Unit has a single Display and Keypad. The differences of readout read-out and programming are described in the following paragraphs as compared to those of the single channel versions.

6.1 Parameter Sets

The Dual-channel Remote Control Units have two independent parameter sets (2 x **P00** - **P99**), one for sensor 1 and another for sensor 2. During programming, the symbol of the programmed sensor is displayed („**S1**" for sensor 1 and „**S2**" for sensor 2).

*Note: **P02**, **P07**, **P09**, **P62**, **P63** and **P99** are common parameters for both sensors (indicated on the display by „**S1S2**"), therefore you have to set them only for one sensors. Always the last entry will be valid.*

6.2 Measurement

The Dual-channel Remote Control Units drives the two sensors one after the other with fixed intervals. The measurement time required for each sensor depends on the measuring frequency:

Measuring frequency of sensor	Measuring time needed for one Sensor
80 kHz, 60 kHz, 40 kHz	2.4 seconds
20 kHz, 30 kHz	3.6 seconds
15 kHz	6 seconds

6.3 Display

*Manual Display Changing Mode (set: **P62= 0**)*

The display can be changed between the two sensors by pressing the key **[STEP]**. The symbol of the selected sensor is indicated on the Display („**S1**" or „**S2**").

*Automatic Display Changing Mode (set: **P62= 1**)*

The Display will alternate between the two sensors with an interval preset at the parameter **P63** (factory setting is 10 sec.).
In *Automatic Display Changing Mode* the display can be changed manually too.

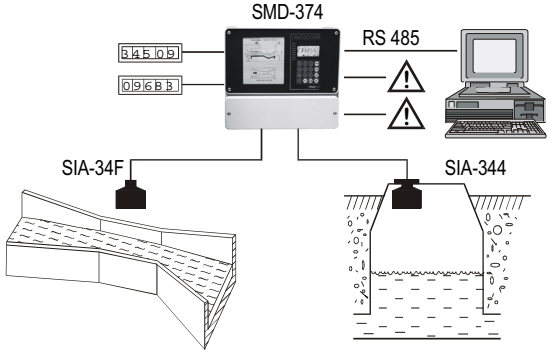
6.4 Programming

Only one sensor can be programmed at a time. Select the sensor to be programmed by the key **[STEP]** in Measurement Mode.

The sensor that is displayed when the Programming Mode is entered, is the one that can be programmed.

6.5 Open Channel Flow Metering

If the Dual-channel Remote Control Unit is set to the Open Channel Flow Metering Operation Mode (**P02= 1**), both of the channels (sensors) will also be able to perform level measurements beside their standard (Open Channel Flow Metering) function. However volume measurement can not be performed in Open Channel Flow Metering Operation Mode. Consequently, for example, one of the measuring channels can be used for flow metering in an open channel, while the other can measure the level in a tank or open reservoir.



6.6 Differential Level Metering

If Differential Level Metering Operation Mode is selected (**P02= 2**), the Dual-channel Remote Control Unit will also calculate the difference between the levels measured by the two sensors. This feature is commonly used for rake/screen control.

The *difference level* is indicated by „**LEV DIFF S1S2**" on the Display. The values to be displayed (level of sensor 1, level of sensor 2 and *difference level*) can be changed manually or automatically in the following sequence:

S1 → S2 → LEV DIFF S1S2

The *difference level* is always calculated according to the following formula:

LEV DIFF S1S2= LEV (S1) - LEV (S2)

Any of the analogue outputs can be assigned to *difference level* by selecting **yz = 08** in **P41**, while the other analogue output can be used for level metering. In addition relays can also be assigned to the *difference level* value; see **yz = 32**, **33**, **34**, **35** in **P51**.

6.7 Averaging

When this mode is selected (**P02: 3**), the Dual-channel Remote Control Unit will also calculate the average of the values provided by two sensors measuring the same target (measurement with two sensors in one large diameter storage silo)

The *average value* can be calculated and displayed in LEVEL, VOLUME or PERCENTAGE and it is indicated by „**LEV S1S2"** or „**VOL S1S2** or „**% S1S2**" on the Display.

The values to be displayed (level 1, level 2 and *average level*) can be changed manually or automatically in the following sequence:

S1 → S2 → AVARAGE

The analogue output can be assigned to any of the following:

- *average* LEVEL (**yz= 14**)
- *average* VOLUME (**yz= 15**)
- *average* in PERCENTAGE (**yz = 16**) in **P41**.

However relays can not be assigned to *average value*. They must be assigned to the each sensor individually.

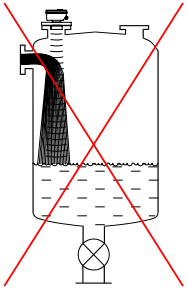
Note:
The average level, volume and average percentage are calculated according to the parameters (tank/silo sizes, percentage settings) set for the Measuring Channel 1 (S1).

7. LIQUID LEVEL MEASUREMENT

Installation

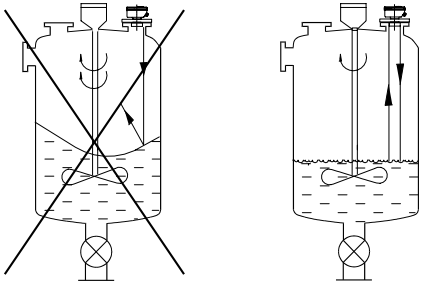
- PROTRUDING OBJECTS

Make sure that no objects (e.g. cooling pipes, ladders, bracing members, thermometers, etc.) or no tank/silo wall of ragged surface protrudes into the sensing cone of ultrasonic radiation beam.



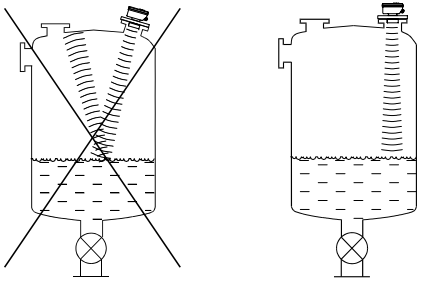
- AGITATORS AND STIRRERS

The effects of revolving agitators and stirrers are reliably eliminated by the QUEST+™ software. Ultrasonic measurement is not recommended in applications where due to a high rpm of the central stirrer a conical liquid surface may be formed.



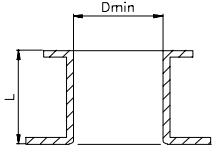
- ALIGNEMENT

Since the surface of liquids is always horizontal, the ultrasonic device must be mounted with a maximum deviation of ±1° from the horizontal.



- STAND-OFF PIPE

The structure of the stand off pipe should be rigid, the inner rim where the ultrasonic beam leaves the pipe should be rounded.



L[mm]	$D_{minimum}$[mm]			
	SS/SI-38	SS/SI-36	SS/SI-34	SS/SI-32
500	125	150	200	300
300	100	125	175	200
200	85	100	150	175

- FOAM

In case of foam above the liquid, exceeding 1-2 cm, ultrasonic devices with lower measuring frequency (40, 20 kHz) are recommended. Eventually a location should be found, where foaming is the smallest (the device should be located as far as possible from liquid inflow) or a stilling pipe or well should be used.

- FUME/VAPOUR

In case of closed tanks containing chemicals or other liquids creating fume/gases above the liquid surface especially for outdoor tanks exposed to the sun, a strong reduction of the nominal measuring range of the ultrasonic device is to be considered during device selection.
Devices with lower measuring frequency (40, 20 kHz) are recommended depending on the range.

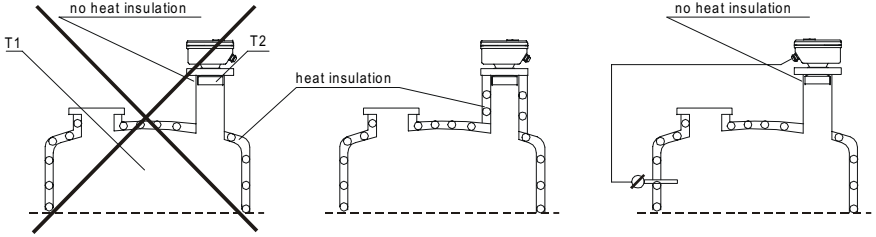
- WIND

An intensive moving of the air (gas) in the vicinity of the ultrasonic cone is to be avoided. A strong draft of wind may "blow away" the ultrasound.

Devices with lower measuring frequency (40, 20 kHz) are recommended.

- TEMPERATURE

All SenSonar Sensors are internally temperature compensated.
However constant temperature should be ensured along the axis of ultrasonic for improving the accuracy.



If the constant temperature cannot be ensured but improved accuracy is required the use of an external temperature sensor (such as PT100 of NIVELCO) will be recommended.
For outdoor applications, usually good result can be achieved by simply installing a shade over the sensor device.

- GENERAL

SenSonar Sensors with a 1" mounting neck, must never be mounted directly to thin metallic roofs, brackets. Always use the SAA-106 Damping Gland supplied by NIVELCO.

8. OPEN CHANNEL FLOW MEASUREMENT

Set-up parameters

- Select the sensor model (**P01)** and the appropriate operation mode (**P02**),.
- Select the measurement data (max. 4) to be displayed (**P03**).
- **In case of Dual-channel (Wall-Mount) Remote Control Unit:** assign the relays to sensors (**P09**).

Measurement parameters

- If required, define a minimum *Head of flow* to specify where the flow calculation should be cut-off (**P15**)
- Select the measuring principle of flow and specify the engineering unit (**P16**)
- Specify the flume/weir dimensions or flow parameters (**P17** - **P19**).
- Do not forget to set the zero-level for flow metering (**P17)**.
- If level measurement is also requested also set **P13**.
- Adjust the best filtering time for the application (**P60**).

Installation

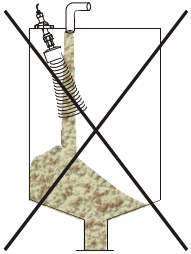
- For improving the accuracy install the sensor as close to the expected water level as it is allowed by the dead-zone of sensor.
- Install the sensor accurately upstream in a place defined by the characteristics of overflow and metering channel along the longitudinal axis of the flume or weir.
- In Parshall flume supplied by NIVELCO the location of sensor is marked.
- In some applications the liquid may foam rendering the level and therefore the flow measurement impossible. In some applications a so-called “anti-foam frame” - with a properly reflecting surface in its interior - have successfully been used.
- Make sure that distance from water level to the sensor, which relates to “zero-flow” is constant. Therefore it is recommended to fasten the elements of the channel rigidly to the holding assembly or to the tower of transmitter or sensor.
- From the point of view of measurement accuracy the length of channel sections preceding and following the measuring flume and their method of joining to the measuring channel section are of critical importance.
- Despite the most careful installation it may happen that the accuracy of flow metering will not be as good as that of the distance measurement.
- Protect the sensor with a shelter from over-heating by direct sunshine.

9. FREE FLOWING SOLIDS LEVEL METERING

Installation

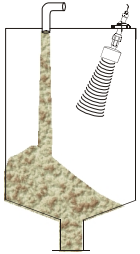
- PROTRUDING OBJECTS

Measurement during filling is only possible if the sensing cone of the device dose not cross the path of the in flowing material.
Make sure that no object or no tank/silo wall of ragged surface protrudes into the sensing cone of ultrasonic radiation beam.



- MATERIAL INFLOW

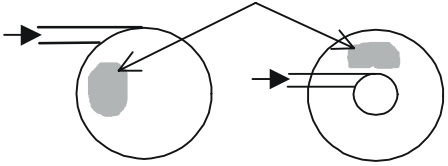
Install the device as far away from the filling point(s) as possible, while assuring that the transducer is aimed at the silo outlet.



- PNEUMATIC FILLING FROM THE SIDE

Mount the sensor at a place where the speed of the filled-in material reaches its lowest value.

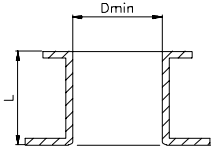
Recommended area of mounting (top view of silo)



- STAND-OFF PIPE

The hereby presented dimensions are strongly recommended when using the „stand-off pipe „

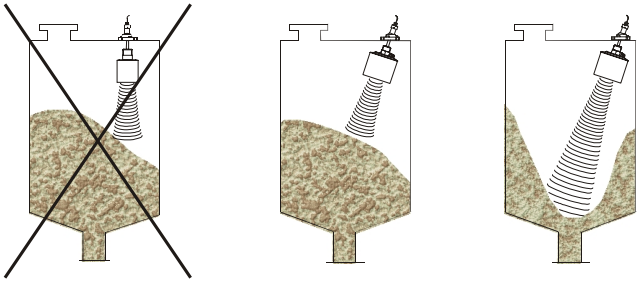
The structure of the „stand-off pipe „ should be rigid, the inner rim where the ultrasonic beam leaves the pipe should be rounded.



L[mm]	$D_{minimum}$[mm]		
	SID-340	SID-330	SID-310
500	200	300	500
300	175	200	400
200	150	175	325

Aiming

To avoid problems caused by surface unevenness, in most cases aiming (tilting) of the device is required, which can easily be carried out with the SAA-102 Aiming Device of NIVELCO. Aiming is best carried out, when the tank/silo is almost empty. In most cases, the sensor should be aimed towards the silo outlet. On applications where the material does not form a sufficient angle of repose; or, typically in tall and narrow silos (diameter : height = 1 : 5 or narrower, e.g. ∅3x18 m) aiming is not required: the sensor should face straight downwards.



General

- SURFACE

Surface unevenness as well as surface quality has an influence on the measurement. To avoid problems caused by the above, an aiming of the device is required.

- DUST

Dust in general reduces the measuring range of the ultrasonic device. This reduction is also dependent on the diameter of the tank/silo. The appropriate system and measuring range should be selected carefully.

- WIND

An intensive moving of the air in the vicinity of the ultrasonic cone is to be avoided. A strong draft of wind may „blow away" the ultrasound. If used outdoors, it is recommended to prevent a strong wind by „shielding" the unit.

- GENERAL

SenSonar Sensors with a 1" mounting neck, must never be mounted directly to thin metallic roofs, brackets. Always use the SAA-106 Damping Gland supplied by NIVELCO.

10. PROGRAMMING

Notes:

1. ***SW-300*** *Remote Control Units do not use all the parameters used by* ***SM-300*** *series.*
2. ***SW-300*** *Remote Control Units are limited in use to the following sensors:* ***SI-36***, ***SI-34***.

10.1 Basic configuration

P01: - - - x Sensor model

x	Sensor model	Used with SW-300
0	Not used	Not used
1	SI/SS-38	NA
2	SI/SS-36	YES (SI-36)
3	SI/SS-34	YES (SI-34)
4	SID-34	NA
5	SID-33	NA
6	SI/SS-32	NA
7	SID-31	NA
8	SID-31H	NA

P02: - - - x Main operating mode (common parameter for dual channel versions)

x	Operating (measurement) mode
0	Level (volume)
1	Open channel flow (level)
2	Differential (level)
3	Average (level, volume)

ADDITIONAL SETUP PARAMETERS FOR DUAL CHANNEL REMOTE CONTROL UNITS

P07: - - - x Sensor assignment (common parameter for Dual-channel Remote Control Units)

x	Active channels	Display indication
1	Sensor 1	**S1**
2	Sensor 2	**S2**
3	Sensor 1 & Sensor 2 (dual channel mode)	**S1S2**

P09: - - xy Relay assignment (common parameter for Dual-channel Remote Control Units)

x	Number of relays assigned to sensor S2
y	Number of relays assigned to sensor S1

Example for the relay assignment: **xy= 42**

R#1	R#2	R#3	R#4	R#5	R#6	R#7	R#8
S1	S1	S2	S2	S2	S2	-	-

x= 4: relays (#3, #4,…, #6) are assigned to **S2**
y= 2: relays (#1, #2) are assigned to **S1**.

ADDITIONAL SETUP PARAMETERS FOR US AND CANADIAN SOFTWARE VERSIONS

P90: vxyz Units

V	VOLUME indication
0	Ft^3
1	Gallon

y	Display / calculations
0	feet
1	inch (max. 650 inch)

x	Gallons
0	US Gallon
1	Imperial Gallon

z	Temperature indication
0	°C
1	°F

10.2 Display configuration

P03: vxyz Display mode

Select maximum 4 measurement data to be displayed.
When the Remote Control Unit is in Measurement Mode, use the key **[MEAS]** to scroll.

Read out sequence: v - x - y - z.

v,x,y,z	Displayed measurement data	Eng. Unit
0	There is no data displayed (jumps to the next one)	-
1	Distance (**DIS)**	m
2	Level (**LEV**)	m
3	Volume (**VOL**) or Volume Flow (**Flow**) according to P02	m^3 or P16
4	Percentage of Level, Volume or Flow (**%**) according to P04	%
5	Level changing rate (**RATE**)	m/h
6	Temperature (**°C**)	°C
7	Volume Flow totaliser (**TOT1**) if P02= 1	m^3
8	Overall Volume Flow totaliser **(TOT2)** if P02= 1	m^3

ADDITIONAL DISPLAY CONFIGURATION FOR PERCENTAGE

P04: - - - x Percentage assignment

x	Percentage calculation	Eng. Unit
0	Level	%
1	Volume or Flow (according to P02)	%

P05: 0% value for displaying percentage (not for the analogue output !)
P06: 100% value for displaying percentage (not for the analogue output !)

Programming of the analogue output must be carried out in **P41**.

ADDITIONAL DISPLAY CONFIGURATION FOR DUAL-CHANNEL REMOTE CONTROL UNIT

P62: - - - x Display changing mode (common parameter for Dual-channel Remote Control Units)

x	Display changing mode
0	Manual, with the **[STEP]** key
1	Automatic

P63: (sec) Display changing interval (common parameter for Dual-channel Remote Control Units)

The *Display changing interval* can be set between 10 sec and 1000 sec.

Factory default setting: 10 sec.

10.3 Configuring the calculation

P13: (m) Maximum measuring distance

Distance between tank bottom and sensor face.
Accuracy of *Level* is dependent on the accuracy of the setting of this parameter:

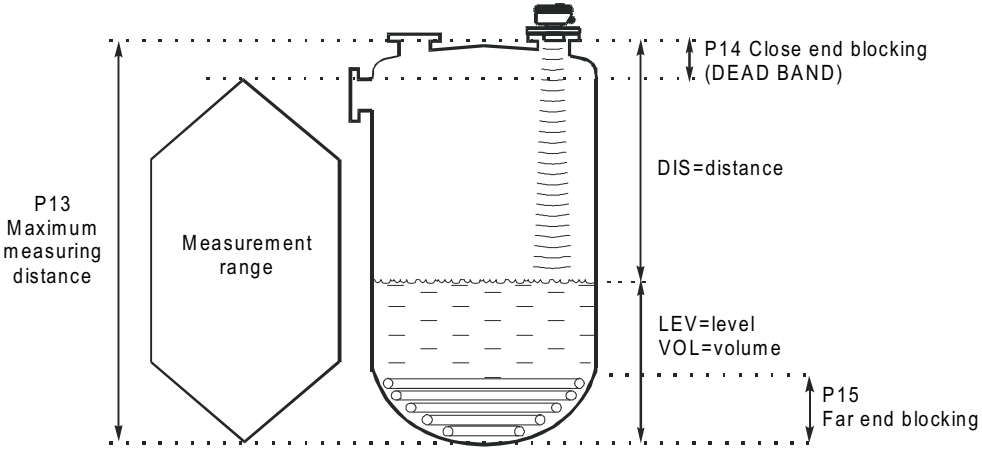
LEV= P13 - DIS

To set the *maximum measuring distance* accurately, measure the distance of the empty tank with the Remote Control Unit, read the displayed *Distance* value and write it into the parameter P13. (This will be important only if accurate liquid level measurement is required.)

Default table for maximum measuring range:

Sensor model	Max. (m)	Max. "EEx ia" (m)
SI/SS-38	6	4
SI/SS-36	10	7
SI/SS-34	15	12
SID-34	15	-
SID-33	30	-
SI/SS-32	25	20
SID-31	60	-
SID-31H	70	-

Note: EEx ia sensors have a limited range, see User's Manual of SenSonar Sensors.



P14: (m) ***Close-end-blocking***

The Remote Control Unit will not accept any echo within the blocking distance set here.

Automatic Close end blocking (Automatic Dead Band control)
By using the factory default value, the unit will automatically set the smallest possible Close-end-blocking distance.

Manual Close-end-blocking
By entering a value, higher than the factory default, the minimum measuring range will be extended and fixed to the specified value.

Manual Close-end-blocking would be used for example to block out the echo originating from the bottom rim of a stand-of pipe or from any object protruding into the ultrasonic cone.

To return to automatic blocking, re-enter the factory default value.

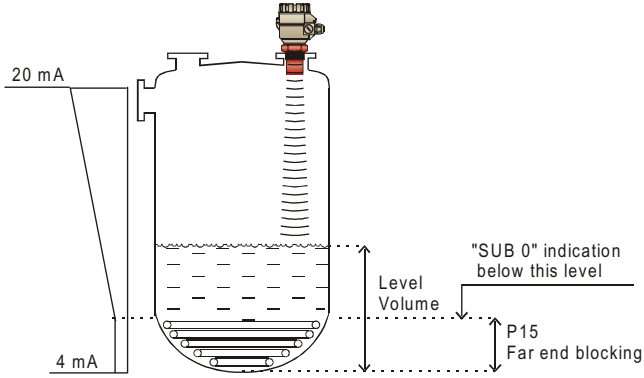
Default table for minimum measuring ranges (Automatic Dead Band control):

Sensor model	Min. (m)
SI/SS-38	0.25
SI/SS-36	0.35
SI/SS-34	0.45
SID-34	0.6
SID-33	0.6
SI/SS-32	0.6
SID-31	1.2
SID-31H	1.5

P15: (m) Far-end-blocking

A). Level measurement

Far end blocking is used to neglect incorrect level/volume readings and output actions below a pre-set level. In the far-end of the measuring range, for example tanks with heaters or other interfering objects (sludge, cone of silo etc.) may cause faulty readings.



If the medium level falls below the blocked out range:

The controller will act as follows:

- Display will indicate „**Sub 0**" *
- Current output will hold the last value

** „Sub 0" is not indicated when the device is displaying DISTANCE.*

If the medium level is above the blocked out range:

The calculation of level and volume will be based on the programmed tank dimensions, therefore the measurement values will not be influenced in any way, by the far end blocking value.

B). Open channel flow metering

Far end blocking will be used to neglect incorrect volume flow readings and output actions below a pre-set level, if accurate volume flow calculation is not possible any more.

If the liquid level in the flume/weir falls below the blocked out range:

The Remote Control Unit will act as follows:

- Indicate „**No Flo**" on the Display
- Hold last valid data on the current output.

If the level in the flume/weir is above the blocked out range:

The calculation of volume flow will be based on the programmed flume/weir data, therefore the measurement values will not be influenced in any way, by the far end blocking value.

10.4 Configuring the volume and weight measurements

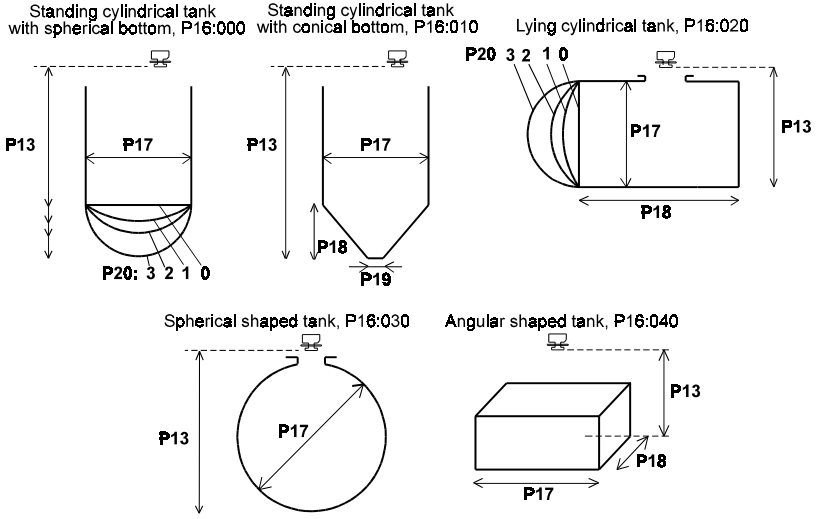
P16: - xyz Tank/silo shape

xy	Tank shape	Also to be set
00	Standing cylindrical tank with hemispherical bottom	P17, P20
01	Standing cylindrical tank with conical bottom	P17, P18, P19
02	Lying cylindrical tank	P17, P18, P20
03	Spherical shape	P17
04	Angular shape	P17, P18

Z	Engineering unit
0	m^3

*Note: If the shape of tank/silo is other than the ones listed above, use the 32-point linearisation curve (**P31**, **P32**) to „create" a customised volume calculation.*

P17-20: Tank/silo dimensions



P28: (kg/dm^3) Specific gravity

If you want to indicate the weight instead of volume on the display, enter the specific gravity in „kg/dm^3" .

A **[t]** indicated on the Display beside the measurement value refers to *metric ton*.

Factory default setting: „0.00" means calculation of volume in „m^3".

If you will use the 32-point linearisation curve and want to enter the data in *metric tons*, enter „1" for this parameter.

10.5 Volume Flow configuration

P16: - xyz Principle of flow metering

See flume/weir figures on following pages.

xy	Principle of flow metering					Also to be set:
	Nivelco Parshall Flumes					
	Type	Calculation formula	Qmin [l/s]	Qmax [l/s]	"P" [cm]	
00	GPA-1P1	Q[l/s]= 60.87*$h^{1.552}$	0.26	5.38	30	P17
01	GPA-1P2	Q[l/s]= 119.7*$h^{1.553}$	0.52	13.3	34	P17
02	GPA-1P3	Q[l/s]= 178.4*$h^{1.555}$	0.78	49	39	P17
03	GPA-1P4	Q[l/s]= 353.9*$h^{1.558}$	1.52	164	53	P17
04	GPA-1P5	Q[l/s]= 521.4*$h^{1.558}$	2.25	360	75	P17
05	GPA-1P6	Q[l/s]= 674.6*$h^{1.556}$	2.91	570	120	P17
06	GPA-1P7	Q[l/s]= 1014.9*$h^{1.556}$	4.4	890	130	P17
07	GPA-1P8	Q[l/s]= 1368*$h^{1.5638}$	5.8	1208	135	P17
08	GPA-1P9	Q[l/s]= 2080.5*$h^{1.5689}$	8.7	1850	150	P17
09	General PARSHALL					P17, P19
10	PALMER-BOWLUS (D/2)					P17, P18
11	PALMER-BOWLUS (D/3)					P17, P18
12	PALMER-BOWLUS (Rectangular)					P17, P18, P19
13	Khafagi Venturi					P17, P19
19	Bottom-step weir					P17, P18
20	Suppressed rectangular or BAZIN weir					P17, P18, P19
21	Trapezoidal weir					P17, P18, P19
22	Special trapezoidal (4:1) weir					P17, P19
23	V-notch weir					P17, P18
24	THOMSON (90°-notch) weir					P17
25	Circular weir					P17, P19
30	General flow formula: Q[l/s]= 1000*P19*h^{P18}, h [m]					P17, P18, P19

z	Engineering unit
0	l/s
1	m^3/s
2	l/h
3	m^3/h
4	l/day
5	m^3/day

*Note: If the flume or weir is other than the ones above, use the 32- point linearisation curve (**P31**, **P32**) to "create" a customised flow calculation.*

P84: (m) Head of flow (h)

Level of headwater is displayed here, on which *Flow calculation* is based.

P17-20: Flume/weir dimensions

P17 is *always* the *zero-point of flow*. For further parameters see the following Figures.

P16= 00 08 — **Nivelco Parshall flumes (GPA1P1 to GPA-1P9)**

P16= 09 — **General Parshall flume**

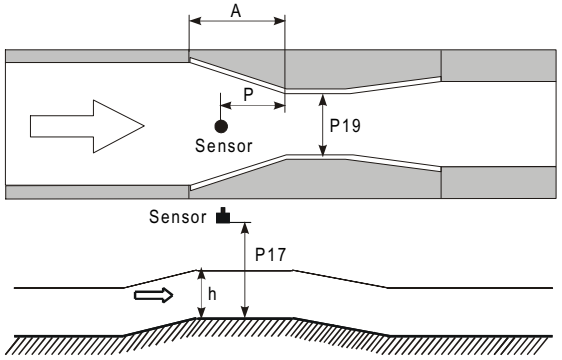
0.305 < P19 [m] <2.44

$Q[m^3/s] = 0.372*P19*(h/0.305)^{1.569*P19^{0.026}}$

2.5 <P19[m]
$Q[m^3/s] = K*P19*h$

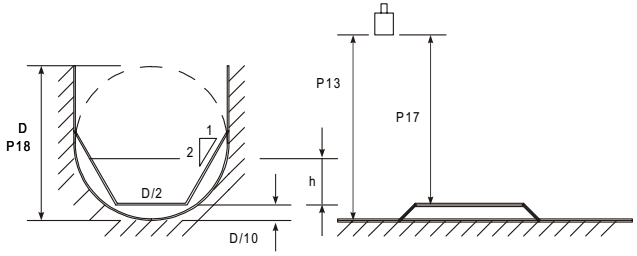
P= 2/3A

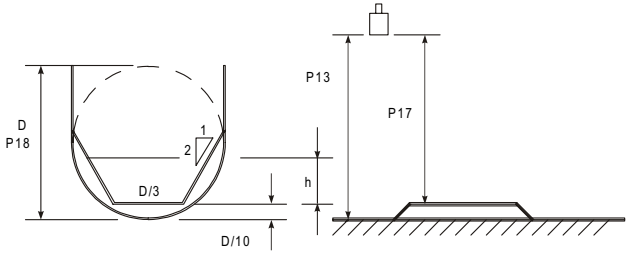
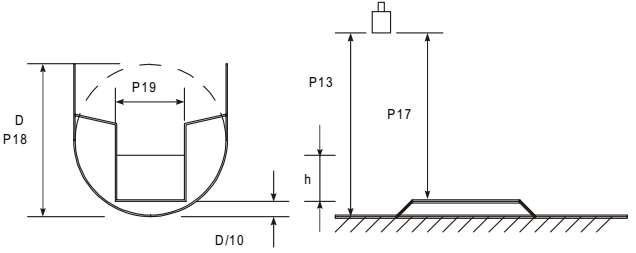
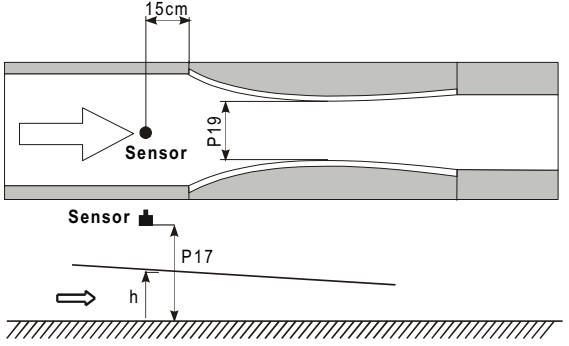
P19	K
3.05	2.450
4.57	2.400
6.10	2.370
7.62	2.350
9.14	2.340
15.24	2.320

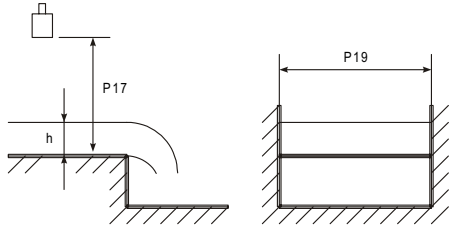
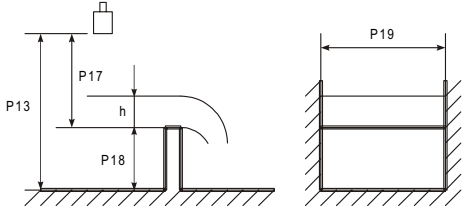
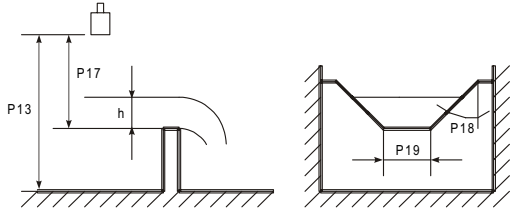
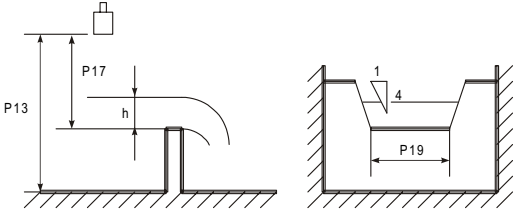


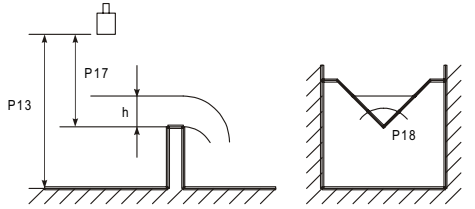
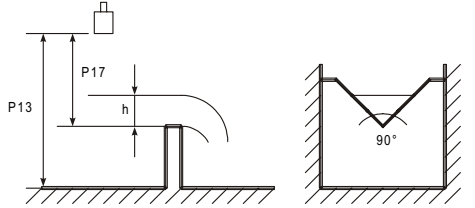
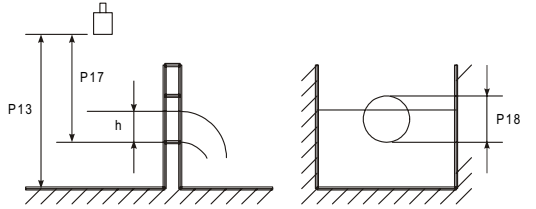
P16= 10 — **Palmer-Bowlus (D/2) flume**

$Q[m^3/s] = f(h1/P18)*P18^{2.5}$, where h1[m]= h+(P18/10)
P18[m]



P16= 11	**Palmer-Bowlus (D/3) flume** Q[m^3/s]= f(h1/P18)*$P18^{2.5}$, where h1[m]= h+(P18/10) P18[m]	
P16= 12	**Palmer-Bowlus (Rectangular) flume** Q[m^3/s]= C*P19*$h^{1.5}$, where C= f(P18/P19) P18[m], P19[m]	
P16= 13	**Khafagi Venturi flume** Q[m^3/s]= P19*1.744*$h^{1.5}$ + 0.091*$h^{2.5}$ P19[m]	

P16= 19	**Bottom step weir** 0.0005 < Q[m^3/s] < 1 0.3 < P19[m] < 15 0.1 < h[m] < 10 Q[m^3/s]= 5.073*P19*$h^{1.5}$ Accuracy: ±10%	
P16= 20	**Suppressed rectangular or BAZIN weir** 0.001 < Q[m^3/s] < 5 0.15 < P18[m] < 0.8 0.15 < P19[m] < 3 0.015 < h[m] < 0.8 Q[m^3/s]= 1.77738*[1+(0.1378*h/P18)]*P19*$(h+0.001)^{1.5}$ Accuracy: ±1%	
P16= 21	**Trapezoidal weir** 0.0032 < Q[m^3/s] < 82 20 < P18[°] < 100 0.5 < P19[m] < 15 0.1 < h[m] < 2 Q[m^3/s]= 1.772*P19*$h^{1.5}$+1.320*tg(P18/2)*$h^{2.47}$ Accuracy: ±5%	
P16= 22	**Special Trapezoidal (4:1) weir** 0.0018 < Q[m^3/s] < 50 0.3 < P19[m] < 10 0.1 < h[m] < 2 Q[m^3/s]= 1.866*P19*$h^{1.5}$ Accuracy: ±3%	

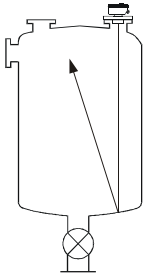
P16= 23	**V-notch weir** 0.0002 < Q[m^3/s] < 1 20 < P18[°] < 100 0.05 < h[m] < 1 Q[m^3/s]= 1.320*tg(P18/2)*$h^{2.47}$ Accuracy: ±1%	
P16= 24	**THOMSON (90°-notch) weir** 0.0002 < Q[m^3/s] < 1 0.05 < h[m] < 1 Q[m^3/s]= 1.320*$h^{2.47}$ Accuracy: ±1%	
P16= 25	**Circular weir** 0.0003 < Q[m^3/s] < 25 0.02 < h[m] < 2 Q[m^3/s]= m*b*$D^{2.5}$ where b=f(h/P18) m= 0.555+0.418h/P18+(P18/(0.11*h)) Accuracy: ±5%	

10.6 Parameters for measurement optimisation

P12 - - - x Compensation of side reflection in case of emptied tanks

This parameter should be used only in case the Remote Controller displays echo-loss in case of *empty tanks*.

If the sensor is mounted *off the vertical axis* in tanks with a conical or spherical bottom, ultrasonic reflection according to the drawing may be experienced in case the tank is emptied.



x	Compensation
0	OFF
1	ON

P21: - - xy Target tracking speed

xy	Tracking speed
00	Standard
01	Fast
11	Special

Standard: For most of the applications
Fast: For fast changing level
Special: Only for special applications
Note: Measuring range will be reduced to 50% of the nominal measuring range of the sensor.

P22 - - - x Echo-loss error indication

x	Echo-loss error indication
0	Delayed
1	None
2	Immediate

Delayed: For the time of echo-loss, display and analogue output will hold last value.
If the echo-loss prevails for 10 sec plus the time period set in P60, the reading on the display will change to "no Echo" and the outputs will change to the "Error Indication Mode" preset in P41.

None: For the time of echo-loss, display and analogue output will hold last value.

Immediate: In case of echo-loss, the display will immediately change to „no Echo" and the outputs will change to the "Error Indication Mode" preset in P41.

P23: - - - x Echo-loss indication during filling

x	Echo-loss indication during filling
0	Standard
1	Output shift

Standard: Indication, as specified in **P22**.

Output shift: For the time of an echo-loss during the filling process, the reading on the display and analogue output will shift towards the "full" silo state with a level elevation rate (filling speed) preset in **P24.**
Output shift mode is only active if **P22= 1** is also set.

P24: (m/h) Level elevation rate (filling speed)
P25: (m/h) Level descent rate (discharging speed)

Use these parameters to provide additional protection in applications involving dust during the filling process (powders, dusting granules).

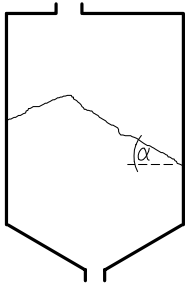
These parameters must be adjusted to the real-time filling and discharging rate of the tanks/silo.

For all other applications, use the factory default setting: 9999 m/h.

P26: - - - x Angle of repose (repose formation)

This parameter provides information for the QUEST+ software for optimising the echo-search pattern.

x	Estimated angle of repose
0	No angle of repose (default)
1	Below 15° (α)
2	Over 15° (α)



In case of free flowing solid applications:

*On powders, use the **x= 1** setting, regardless of the actual angle of repose.*
*The optimal setting can be verified with the help of the parameter **P81**:*
Ideal setting of P26 is at which the value in P81 becomes the highest.

1). Set **P26** for **x= 1**, confirm it with **[E]** and change over to Measurement mode then return to Programming mode.

2). Observe the change of echo amplitude in **P81** and record an average value.

3). Perform the above with the **P26 x= 2** setting. (You may try it in the **P26 x= 0** setting, but probably you will obtain the lowest value.)

4). Finally set **P26 (x)** to the value at which **P81** was recorded the highest.

P27: (m/s) Sound velocity (343.8 m/s at 20°C)

The base of sound velocity correction is the flight time of sound at 20°C.

Use this parameter if the sound velocity of the medium (gases) above the measured surface is other than that of in air, and is only recommended for applications in which this medium is close to homogeneous. If it is not, the accuracy of the measurement can be improved using the LEVEL-LEVEL calibration mode of the 32-point linearisation curve (**P31**, **P32)**.

For sound velocities in various gases see Section 11.

P33: - - - x Echo selection

Some applications involve multiple echoes within the measuring window.

X	Echo selection
0	First echo in window (factory default)
1	Largest echo in window

P60: - - - x Filtering time

Use this parameter to reduce unwanted fluctuation of Display and outputs.
Liquid level measurement:

x	Time constant (sec)	None/moderate fume or waves	Heavy/dense fume Turbulent waves
0	no filter	Recommended only for testing	
1	10	recommended	not recommended
2	30	recommended	recommended
3	100	applicable	recommended
4	300	applicable	applicable
5	1000	applicable	applicable

Powders and bulk solids level measurement:

x	Time constant (sec)	None, or moderate dusting	Heavy dusting
0	no filter	Recommended only for testing	
1	10	applicable	not recommended
2	30	recommended	applicable
3	100	recommended	recommended
4	300	applicable	recommended
5	1000	applicable	applicable

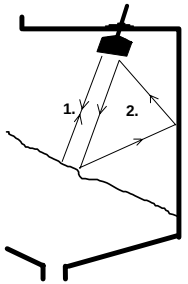
P34: (m) Manual echo selection

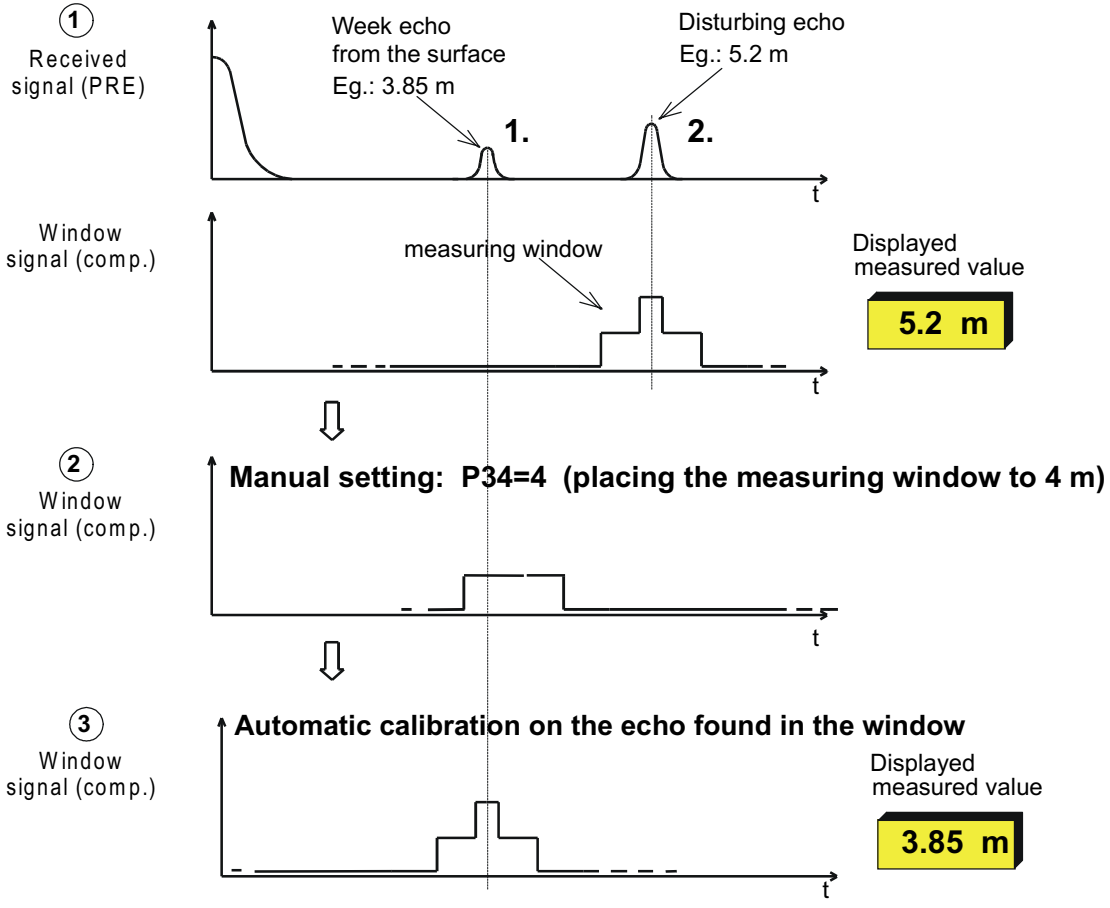
This parameter is used if the Remote Control Unit unambiguously selects a wrong echo; for example the echo reflected from the surface is much weaker than the interfering one(s) (*see the enclosed Figures*).

Determine the *distance* of the right echo visually or measure it with a tool, and enter this approximate value in **P34**.

The software will :

- move the window to the entered distance
- calibrate itself onto the echo found there
- neglect all signals outside the window.




1
Received signal (PRE)
Week echo from the surface Eg.: 3.85 m
Disturbing echo Eg.: 5.2 m
1.
2.
t
Window signal (comp.)
measuring window
Displayed measured value
5.2 m
t
2
Window signal (comp.)
Manual setting: P34=4 (placing the measuring window to 4 m)
t
3
Window signal (comp.)
Automatic calibration on the echo found in the window
Displayed measured value
3.85 m
t

10.7 Configuring the analogue output

The 0/4 to 20 mA values of the analogue output can be scaled anywhere within the measurement range.

Measurement range= P13 - P14

The analogue output can be assigned to any measurement value, independently from the Display configuration. However, if the percentage is selected for the analogue output, it will refer to the same percentage value (Level, Volume or Flow) selected for the display in **P04.**

P41: vxyz Analogue output mode

Error indication (see also P22 and P23)

v	Error indication (according to NAMUR)
0	Hold last value
1	over 21 mA
2	3.6 mA

Output range setting

x	Output range
0	0 to 20 mA
1	4 to 20 mA

Assigning a function to the analogue output

yz	Output function
00	Not used (factory default)
01	Distance (**DIS)**
02	Level (**LEV**)
03	Volume (**VOL**) or Volume Flow (**Flow**); according to P02
04	Percentage (**%**) of level, volume or flow; according to P04
05	Level changing rate (**RATE**)
06	Temperature (**°C**)
07	Resetable volume flow totaliser (**TOT1**); only if P02= 1
08	Differential level (**LEV DIFF S1S2**); only if P02= 2

yz	Output function
14	Average in level; only if P02= 3
15	Average in volume; only if P02= 3
16	Average in percentage; only if P02= 3

P42: Measuring value assigned to 0/4 mA value of the analogue output
P43: Measuring value assigned to 20 mA value of the analogue output

The Remote Control Unit automatically interprets the values set for 0/4 mA and 20 mA in the engineering unit specified in the analogue output assignment. This engineering unit also appears on the Display while setting these parameters.
If the value in **P42** is larger than the value in **P43**, the scale will be inverted automatically.

10.8 Relay configuration

P50: - - - x Relay selecting parameter

Enter the serial number of the relay that you wish to program.
Flashing symbol of relay indicates that it is under programming.
The following set of parameters (**P51**-**P54**) will be assigned to the relay selected hear.
To program another relay, return to this parameter and enter its serial number.

P51: - xyz Relay function

Relays can be assigned to several functions. The relay set-points can be entered in various measurement units, independently from the display configuration. However, if the percentage is selected, it will refer to the same percentage unit (Level, Volume or Flow) as selected for the display in **P04.**

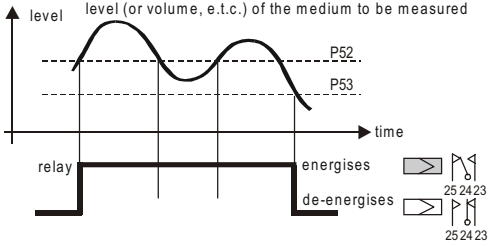
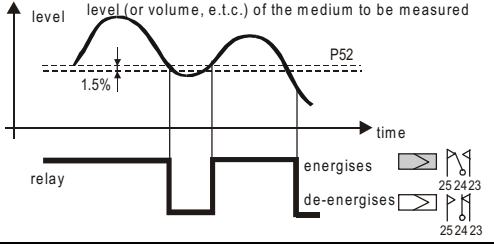
Select the measurement quantity in **x** (it can be different for each relay) and assign the function in **yz**.
The required set-point values (**P52**-**P54**) are automatically interpreted and Displayed in the engineering unit of the selected measurement quantity.

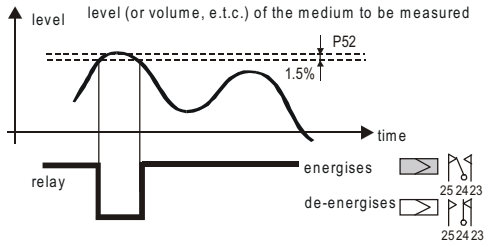
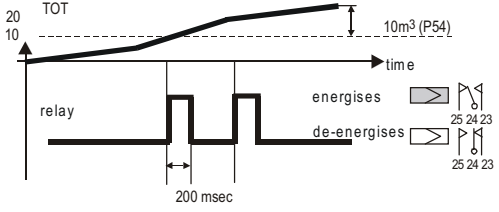
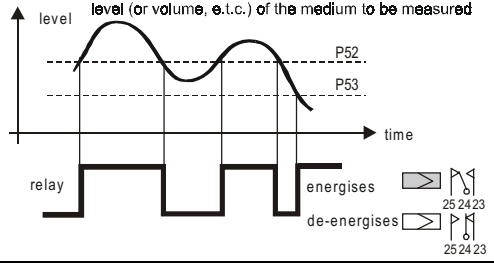
Examples:

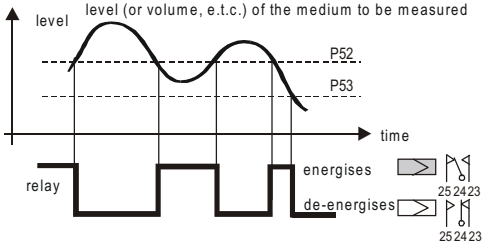
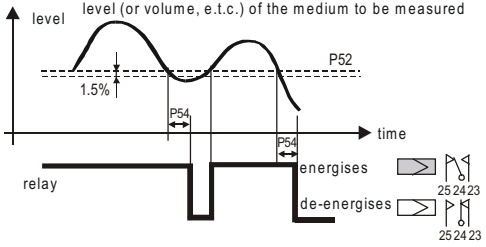
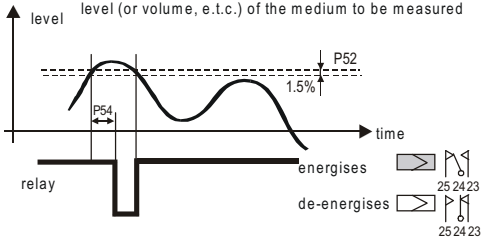
x= 0 (LEV) → Interpretation of **yz** (m)
x= 1 (VOL) → Interpretation of **yz** (m^3)
= 1 (Flow) → Interpretation of **yz** (according to **P16**)
x= 2 (%) → Interpretation of **yz** (according to **P04)**

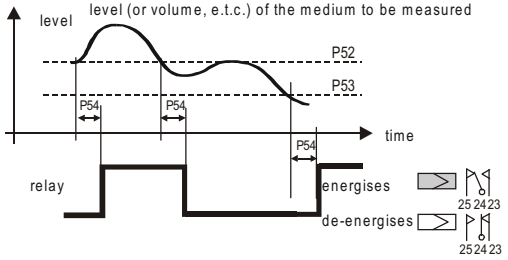
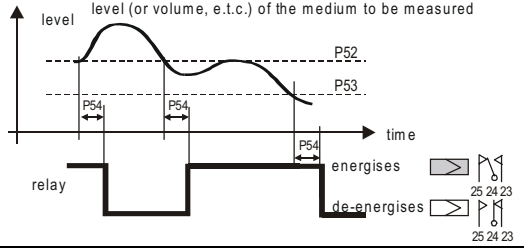
There are some functions that do not require a measurement quantity selection: for functions denoted by * beside **yz**, the parameter **x** is irrelevant!

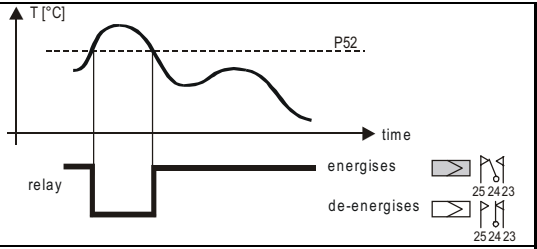
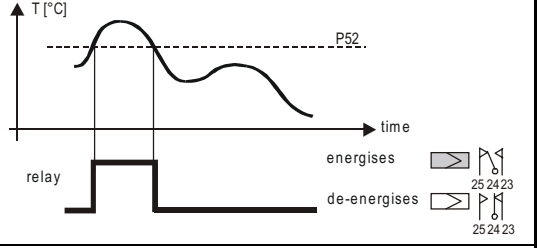
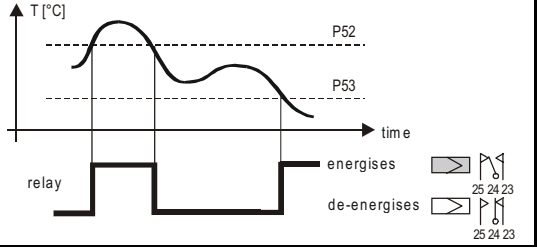
x	Measurement quantity of relay function
0	Level (**LEV**)
1	Volume (**VOL**) or Volume Flow (**Flow**); according to P02
2	Percentage (**%**) of Level, Volume or Flow; according to P04

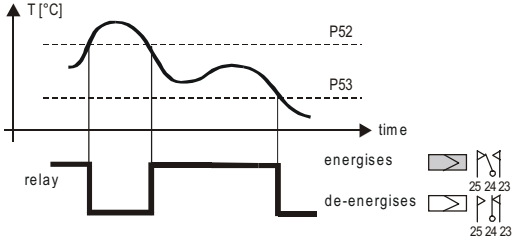
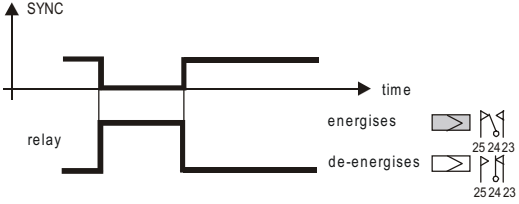
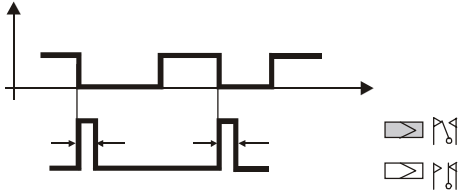
yz	Relay function		Also set:
00	Not used (factory default)		-
01	DIFFERENTIAL LEVEL CONTROL (PUMP CONTROL) Relay is energised at preset value in P52, de-energises at preset value in P53		P52, P53
02	FAIL-SAFE LOW ALARM with 1,5% fixed hysteresis Relay is de-energised below preset value in P52		P52

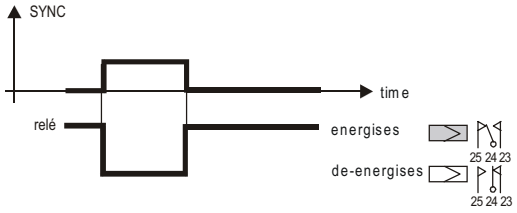
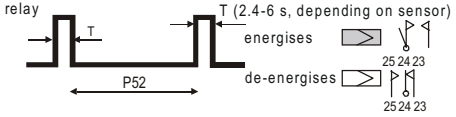
<table>
<tr>
<td>03</td>
<td>FAIL-SAFE HIGH ALARM with 1,5% fixed hysteresis
Relay is de-energised above preset value in P52</td>
<td> 
</td>
<td>P52</td>
</tr>
<tr>
<td>*04
(x= 0)</td>
<td>COUNTER mode for flow metering
A 200 msec pulse is generated
at every 1, 10, 100 or 1000 m^3
<table>
<tr><th>P54</th><th>Quantity for pulse</th></tr>
<tr><td>0</td><td>1m^3</td></tr>
<tr><td>1</td><td>10m^3</td></tr>
<tr><td>2</td><td>100m^3</td></tr>
<tr><td>3</td><td>1000m^3</td></tr>
</table></td>
<td> 
</td>
<td>P54</td>
</tr>
<tr>
<td>05</td>
<td>WINDOW COMPARATOR
Relay is de-energised within and energised outside the range preset in P52-P53</td>
<td> 
</td>
<td>P52, P53</td>
</tr>
</table>

06	WINDOW COMPARATOR Relay is de-energised outside and energised within the range preset in P52-P53		P52, P53
07	FAIL-SAFE LOW ALARM WITH TIME DELAY Same as **02**, but with a time delay preset in P54 in seconds		P52, P53, P54
08	FAIL SAFE HIGH ALARM WITH TIME DELAY Same as **03**, but with a time delay preset in P54 in seconds		P52, P54

09	WINDOW COMPARATOR WITH TIME DELAY Same as **05**, but with a time delay preset in P54 in seconds		P52, P53, P54
10	WINDOW COMPARATOR WITH TIME DELAY Same as **06**, but with a time delay preset in P54 in seconds		P52, P53, P54
***11** **(x= 0)**	ERROR INDICATION Relay is de-energised at any error		-
***12** **(x= 0)**	ERROR INDICATION Relay is energised at any error		-
***13** **(x= 0)**	PRESET ERROR INDICATION Relay is de-energised at the event of an error type preset in P54. See „Error codes" in Section 10.17		P54
***14** **(x= 0)**	PRESET ERROR INDICATION Relay is energised at the event of an error type preset in P54. See „Error codes" in Section 10.17		P54

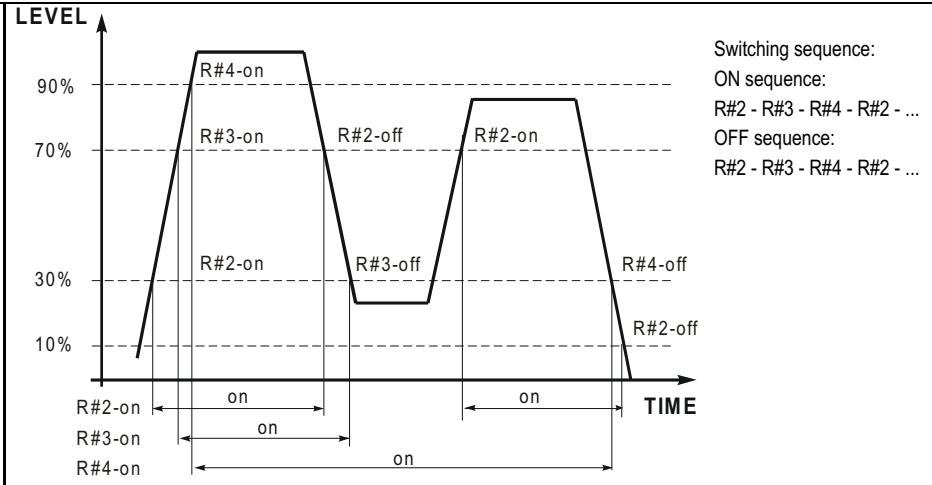
***15** **(x= 0)**	TEMPERATURE LIMIT SWITCH Relay is de-energised above a temperature preset in P52		P52
***17** **(x= 0)**	TEMPERATURE LIMIT SWITCH Relay is energised above a temperature preset in P52		P52
***19** **(x= 0)**	TEMPERATURE RANGE CONTROL Relay is de-energised within temperature range preset in P52-P53		P52, P53

***21** **(x= 0)**	TEMPERATURE RANGE CONTROL Relay is energised within temperature range preset in P52-P53		P52, P53
***23** **(x= 0)**	LEVEL CHANGING RATE LIMIT SWITCH Relay will be de-energised if the preset value in P52 is exceeded		P52
***24** **(x= 0)**	LEVEL CHANGING RATE LIMIT SWITCH Relay will be energised if the preset value in P52 is exceeded		P52
***26** **(x= 0)**	SYNCHRONISING INPUT DETECTION Relay is energised during the active status of SYNC input		
***27** **(x= 0)**	SYNCHRONISING INPUT DETECTION Relay generates a 200 msec pulse each time the SYNC input is activated		

***28** **(x= 0)**	SYNCHRONISING INPUT DETECTION Relay is de-energised during SYNC input is activated		
***29** **(x= 0)**	TIMER RELAY Relay is energised for the period of a measuring cycle (2.4-6) sec depending on the sensor); the interval can be preset in P52 between 0.01 and 650 hours		P52
***30** **(x= 0)**	VOLUME FLOW LIMIT SWITCH Relay is de-energised upon TOT1 counter reaching the value preset in P54		P54
***31** **(x= 0)**	VOLUME FLOW LIMIT SWITCH Relay is energised upon TOT1 counter reaching the value preset in P54		P54
***32** **(x= 0)**	LEVEL ALARM FOR DIFFERENTIAL LEVEL METERING Relay will be energised if the differential level (LEV DIFF S1S2) is higher or equal to the level preset in P52 (LEV S1- LEV S2 ≥ P52)		P52
***33** **(x= 0)**	LEVEL ALARM FOR DIFFERENTIAL LEVEL METERING Relay will be de-energised if the differential level (LEV DIFF S1S2) is higher or equal to the level preset in P52 (LEV S1-LEV S2 ≥ P52)		P52
***34** **(x= 0)**	LEVEL ALARM FOR DIFFERENTIAL LEVEL METERING Relay will be energised if the differential level (LEV DIFF S1S2) is below zero (LEV S1-LEV S2 < 0)		-
***35** **(x= 0)**	LEVEL ALARM FOR DIFFERENTIAL LEVEL METERING Relay will be de-energise if the differential level (LEV DIFF S1S2) is below zero (LEV S1-LEV S2 < 0)		-

- The "measurement quantity" is not interpreted, set **x= 0**

36	ALTERNATING PUMP CONTROL The alternating pump control will prevent pumps work more than other pumps in cases when the liquid level varies mostly around the switching points of a particular pump. The *alternating pump control* function will apply to relays that are set to **P51: 236**. In case of *alternating pump control*, the relays (and the connected pumps) are not assigned to a fixed liquid level (R1-ON at 20 %, R1-OFF at 30%), but are sequentially selected by the remote control unit ("Relay last switched off" -ON at 20%). Relay ON/OFF value pairs must be entered under the switching point parameters of the relays (**P52** and **P53**). Based on the operation principle of *alternating pump control*, the relay ON/OFF value pairs are <u>not</u> assigned to the relay for which they have been entered. Any relay can use the specified switching points. <u>Programming example:</u> • Select a relay for *alternating pump control* at P50 • Set the alternating pump control operation mode P51= 236 • Enter a switching point *List of required ON/OFF switching points:* [1] ON= 30%, OFF= 10% [2] ON= 70%, OFF= 30% [3] ON= 90%, OFF= 70% *Enter the ON/OFF switching points to any of the relays you have selected for alternating pump control.* *Each ON/OFF pair must be entered under one of the relays (P52=ON / P53= OFF):* R#2: P52= 30%, P53= 10% R#3: P52= 70%, P53= 30% R#4: P52= 90%, P53= 70%	



P52-54: Relay parameters

The unit automatically interprets the set-point values in the engineering unit of the chosen measurement quantity.

P55: vxyz Relay copying parameter

vx is the serial number of the relay parameters of which are to be copied
yz is the serial number of the relay to which the parameters are to be copied.

For example: **P55= 0102** -> settings of R#1 are copied to R#2.

10.9 Linearisation curve of 32-point

P31: - - - x Linearisation mode

The 32-point linearisation curve can be used for the following:

Level linearisation

Select this mode to obtain *level to level* conversion.

Using this mode, the left column of the Linearisation Table will contain the level values measured by the Remote Control Unit and the right column the corresponding calibrated level values.

Volume and flow calculation will be based on the linearisation values.

Volume or flow linearisation

Select this mode to obtain *level to volume* or *level to flow* conversion.

Using this mode, the left column of the linearisation table will contain the level values measured by the Remote Control Unit and the right column the corresponding calibrated volume or flow values.

x	Linearisation mode	Data entry mode	Origin of data	
			left column (**L**) [m]	right column (**r**) [m], [m³], [P16 „Z"]
0	Not used	-	-	-
1	Level	MANUAL	Measured level	Calibrated level
2		S-AUTO		
3	Volume or flow	MANUAL		Calibrated volume or flow
4	*	S-AUTO		

Note: * Do not forget to program **P17**.

Data-pairs of the linearisation table are handled in a 2x32 matrix, consisting of a „**left column**", a „**right column**" and 32 rows for the 32 data-pairs.

MANUAL data entry

The previously recorded (calibrated) data are entered manually in the left and right columns of the Linearisation Table.

SEMI-AUTOMATIC data entry

The left column of the Linearisation Table is created by copying the value currently measured by the Remote Control Unit into the table, while the right column is filled up manually with the corresponding calibrated data.

P32: - - xy Linearisation table

Enter address of data pair to be modified or viewed and press **[E]**.
If you enter **xy= 00**, the Display will jump to the next empty data-pair.

xy	Address of the data-pair
00	Jumps to the next empty data-pair
01 - 32	Jumps to the data-pair of the given address

ENTERING OR VIEWING OF LINEARISATION TABLE DATA-PAIRS

⇒ For parameter **P32**, either enter the address of the data-pair to be modified/viewed; or, enter **[00]** to jump to the next empty data-pair.
Note: The value before the „three-dot" colon on the Display is the address of the selected data-pair, the value after it is the value of the left column.

⇒ Use **[STEP]** and **[CE]** keys to increase/decrease the address of data-pair.
After reaching the 32nd data-pair, the Remote Control Unit will jump back to the 1st data-pair.

Dimensions Left column: always [m]
Right column: [m] for level, [m³] for volume and [P16 „Z"] for flow.

⇒ **Manual data entry**: Press **[E]** when correct address of data-pair is blinking.
The appearing symbol "**L**" stands for „left-column value".
Simply overwrite the old value and press **[E]** to move over to the right column.

Semi-automatic data entry: Press **[E]** when correct address of data-pair is blinking. The appearing symbol "**L**" stands for „left-column value".
Use the **[STEP]** key to switch over between the value in the table and the blinking value currently measured by the Remote Control Unit. To copy the blinking value into the table, press **[E]** when this blinking value is on the Display. Simultaneously this will move to the right column.

⇒ To move over from the left column to the right column, press **[E]**:
The appearing symbol "**r**" stands for „right-column value".
Simply overwrite old value and press **[E]** to move to the next data-pair.

⇒ To exit the linearisation table any time, press **[PROG]**.

CONDITIONS OF CORRECT OPERATION

Model of table:

left column (L)	right column (r)
L(1)= 0	**r**(1)
L(i)	**r**(i)
-	-
L(j)	**r**(j)

⇒ The table must always start with: L(1)= 0 and r(1)= corresponding value.

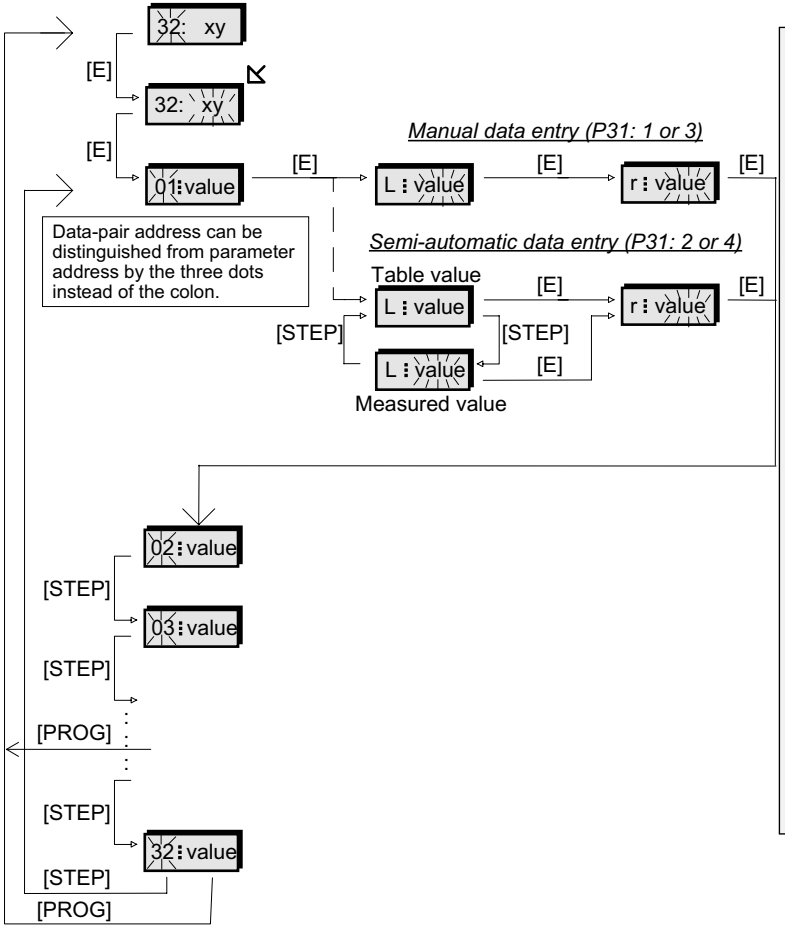
⇒ Conditions of ending the table: j= 32 or **L**(j)= 0

If the Linearisation Table contains less than 32 valid data-pairs, a 0 must stand in the left column, after the last valid data. In this case the Remote Control Unit will ignore the following data.

⇒ If **P31** was not set to 0 before returning to Measurement mode (**[MEAS]**), the table will be checked for incorrect data and data-pairs will be put into increasing order according to the left column.

⇒ Error codes will be displayed (see Error Codes in Section 10.19) if one of the above conditions are not met.

See the flow chart on next page.



Linearisation table

N°	Data position		N°	Data position	
	left (**L**)	right (**r**)		left (**L**)	right (**r**)
1			17		
2			18		
3			19		
4			20		
5			21		
6			22		
7			23		
8			24		
9			25		
10			26		
11			27		
12			28		
13			29		
14			30		
15			31		
16			32		

10.10 Communication

P97: - - xy Communication set-up

x	Baud rate of RS485
y	Baud rate of RS232

Code	Baud rate
0	1200
1	1400
2	4800
3	9600
4	19200

P00: vxyz Remote Control Unit address (for RS485) / Parameter sets

When RS485 is not used, **vx** must be **00**.

When RS485 is used, **vx** specifies the address of the Remote Control Unit, and must be between **01** and **99** (see the RS485 Interface User's Manual).

yz is the operating parameter set. When specifying the RS485 address, the values displayed under **yz** must be re-entered.

Example:

Value of **P00** before specifying an address for the Remote Control Unit: **P00: 0001**

Address of Remote Control Unit for RS485 communication: **19**

New value of **P00: 1901**

P87: RS485 test

Upon entering this parameter (**[87] [E] [E]**), the Remote Control Unit will send "NIVELCO DIST= xx.xx [m]" to the RS232 and RS485 ports, each time the Display is updated.

For further information (see the RS485 Interface User's Manual).

10.11 Using SLM-308 Scanner

The number of sensors connected to the SLM-308 Scanner should be entered at **P61.** The SLM-308 Scanner can be programmed for *manual* or *automatic* scanning at **P62**.

In automatic scanning mode the sensors carry out measurements one after the other with a fixed interval. The Display always indicates the scanned sensor.

Measurement time required for a Sensor is between 5 and 12 sec. Depending on the type of SenSonar Sensors.

P61: - - - x Number of sensors connected to the SLM-308 Scanner

Maximum 8 sensors, the factory default value of this parameter is: 0

P62: - - - x Scanning Mode

The Scanning Mode of sensors is to be set here. The Display will always show the measurement values of the scanned sensor.

X	Scanning Mode
0	Manual, with the **[STEP]** key
1	Automatic

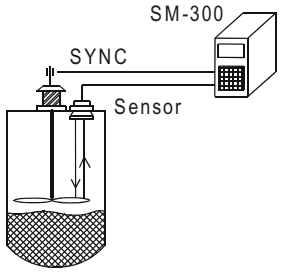
Further information on the SLM-208 scanner can be found in the user's manual: „SLM-308 scanning device".

10.12 Using the „SYNC" Synchronising Input

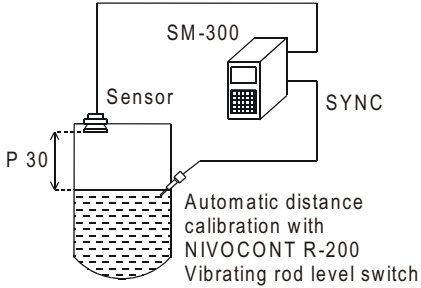
P29: - - - x Synchronising Input Mode

x	SYNC Input Mode	SYNC Contact Input
0	Not used (factory default)	-
1	Remote synchronisation	level sensitive
2	Remote distance calibration	falling edge (1→0)
3	Remote reset of the TOT1 counter	falling edge (1→0)
4	Remote [STEP]	Falling edge (1→0)

Remote synchronisation:
The unit does not emit FIRE signals until the TTL compatible „SYNC" input is pulled down to 0V. During this time, display will indicate "HOLD". This feature can be used to synchronise a fast moving agitator with the Remote Control Unit. By sensing the axis position of the agitator and leading this signal as a voltage to the „SYNC" input of the Remote Control Unit, the unit will not take measurements when the paddles of the agitator is in the range of the sensor beam, *see the Figure below.*



Remote distance calibration:
Each time the TTL compatible „SYNC" input is pulled down to 0V by the level switch, the measuring window will jump to the reference distance, determined by the level switch and will calibrate itself on the echo found within the window. The reference distance must be set in **P30**. This configuration is used in high accuracy or unstable applications where the unit re-calibrates itself each time the level passes the set value, see the Figure below.



Remote reset of the TOT1 counter:
Each time if the SYNC input is pulled down to 0V the TOT1 counter will be reset.

Remote [STEP]:
When used with an SLM-308 scanning device. The "SYNC" input will serve to advance the scanning using an external signal. See 10.11 for more information on the operation of the scanning system.

P30: (m) Distance for Remote Distance Calibration

*Used only when **P29= 2**.*

10.13 Application related informational parameters

P74: (°C) Present temperature of transducer or the external thermometer
P75: (°C) Maximum temperature of transducer the external thermometer
P76: (°C) Minimum temperature of transducer or the external thermometer

„Pt Error" will be displayed in case of temperature circuit breakage.

P77: (xx-y) Sensor gain

This parameter provides information on the operating conditions of the sensor. The amplification factor (gain) of the sensor is displayed here.

xx - For all SenSonar sensors except SID-330/310/310-H : 0 (min.) - (16 (max.)

y - For SID-33/31/31H type SenSonar sensors: 0 (min.) - 7 (max.

Note: During the aiming of an SID-330/310/310-H sensor, try to find a position, where the amplification is the smallest, in order to have sufficient amount of reserve for the filling procedure.

P78: Number of echoes

The number of echoes „seen" by the system is displayed here.

P79: Echo map

After entering this parameter, use the **[STEP]** key to read out the echo data.

The first value is always the distance of the echo, the next value is the amplitude of the echo. The amplitude is a relative number between 0 and 255. If there is no echo detected by the Remote Control Unit, „no Echo" will be displayed.

key	display	comment
[PROG]	00:xxxx	
⇩		
[7] [9]	79:xxxx	
⇩		
[E]	79: 1.5	Distance of the first echo (1.5 m)
⇩		
[STEP]	79: 200	Amplitude of the first echo
⇩		
[STEP]	79: 1.9	Distance of the second echo (1.9 m)
⇩		
[STEP]	79: 95	The second amplitude is less then half of the first echo's
⇩		
[E]	79:xxxx	Quit

P80: (m) Window position

The distance of the measurement window is displayed here.
If there is no echo detected, the Remote Control Unit will display „no Echo"

P81: Amplitude of the echo in the window (0-255)

The relative amplitude of the echo in the measurement window is displayed.

P82: (m) Blocking distance

The currently established close-end blocking distance is displayed.
Provides useful information if automatic blocking was selected in **P14**.

P83: Signal/noise ratio

This parameter gives information on the measurement conditions.
The signal/noise ratio is a value between 0 and 100:

Ratio	Measurement conditions
Over 70	Excellent
Between 70 and 30	Good
Under 30	Unreliable

10.14 Test/service parameters

*Note: The tested outputs adapt the preset test values at the moment these are confirmed by **[E]**. The test is cancelled when the test parameter is exited.*

P70: (h) Overall operating hours of the unit

Indication varies according to the elapsed time:

Operating hours	Indication form
Under 1000h	123.4
Between 1000 and 10000h	1234
Over 10000h	1.23:4 meaning 1.23 x10^4

P71: (h) Time elapsed after last switch-on

Indication same as in **P70**.

P72: (h) Operating hours of the relay set in parameter P50

Indication same as in **P70**.

P73: Switching cycle number of the relay set in parameter P50

Indication same as in **P70**.

P84: (m) Head of flow (h)

Level of headwater is displayed here, on which *Flow calculation* is based.

P85: (mA) Analogue output test

The value of this parameter is the value of the Remote Control Unit's analogue output.

To test the analogue output, simply set a value between 0 and 22 (0...22 mA). On pressing **[E]**, the Remote Control Unit will drive the analogue output with the set value. Observe the result with an appropriate DC current meter.

P86: - - xy Relay test

Drive the selected relay into the preset state and check the switching action by: listening to the switching of the relay or by observing the change over in the relay symbol or with the help of a resistance measurement.

x is the serial number of the tested relay, **x**=0 means all relays at same time.

y	Relay state
0	De-energised
1	Energised

P88: LCD test: all symbols will appear

P89: - - - x Compatibility parameter

When used together with a NIVOSONAR S-200 series ultrasonic sensor, this parameter must be set.

x	Sensor
0	SenSonar ***S-300***
1	NIVOSONAR ***S-200***

P96: vxyz Hardware code
P98: vxyz Software code

v is the last digit of the manufacturing date (199**v**)
x is the production serial number
yz is for the software version

10.15 Simulation Mode

P92: - - - x Simulation Mode

This function enables the user to test the correct programming of the Remote Control Unit's outputs. Without any sensor connected, the Remote Control Unit can simulate a continuos change of level, according to the preset simulation parameters. The simulation levels must be *within* the maximum measuring distance set in **P13** and the „close end blocking value" in **P14**.

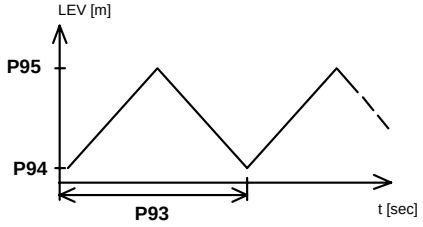
To start the Simulation, *return to Measurement Mode* after setting the simulation parameters. While the Remote Control Unit is in Simulation Mode, both red LEDs are alighted on the **[PROG]** and **[MEAS]** keys. To stop the simulation, set: **P92= 0**.

X	Simulation type
0	No simulation (factory default)
1	The level changes continuously up and down between the level values set in P94-P95 with a cycle time set in P93
2	Static level simulation: the level will be the value set in P94

P93: (sec) Cycle time for the simulation

P94: (m) Simulated low level value

P95: (m) Simulated high level value



10.16 Access Lock

P99: vxyz Access Lock by a Secret Code

The purpose of this feature is to provide protection against accidental (or intentional) re-programming of parameters.

The Secret Code can be a numeric value other than **0000**. Setting a Secret Code will automatically be activated when the Remote Control Unit is returned to Measurement Mode. If the Secret Code is activated, the parameters can only be viewed, this is indicated by a flashing colon (ꟻ .

In order to program a Remote Control Unit locked by a secret code, you should first enter the Secret Code in **P99**. The Secret Code is re-activated when the Remote Control Unit is returned to Measurement Mode.

To delete the Secret Code, enter the Secret Code in **P99**. After confirming it with **[E]** re-enter the parameter **P99** and enter **0000**.
[vxyz (Secret Code) **]** → **[E]** → **[E]** → **[0000]** → **[E]** ⇒ **Secret Code deleted**

10.17 Deleting TOT1 Volume Flow Totaliser

1. Move the Display to TOT1 (use the **[MEAS]** key in Measurement Mode)
2. press **[CE]:** „CLEAR" is displayed (the value in TOT1 is ready to be cleared)
3. press **[CE]** again to confirm deleting (TOT1 is now deleted)

You can quit the deleting procedure by pressing **[MEAS]** after the first **[CE]** and as a result TOT1 will be returned on the Display.

10.18 Performing Measurements with Parameter Sets

A „Parameter Set" is a configuration of programmable parameters (**P00** - **P99**).
The Remote Control Unit can manage up to four parameter different sets:

- The ***factory default set (0)*** contains the factory parameter settings. This set can be used to „reset" the Remote Control Unit and it can not be erased.
- The ***operating set (1)*** is the set upon which the measurements are based. This is the set that will be modified during a programming.
- Each time the Programming Mode is entered, a „backup copy" is created from the operating set. The „backup copy"(always contains the last operating set) is stored in the ***old set (2)***.

The „backup copy" enables the programmer to recall the former operating parameter set if the new settings where not successful.

- The Remote Control Unit also has a ***user set (3)*** for storing various parameter settings. The programmer can create a user set by copying (by **P69**) the operating set into the ***user set***. To use a user set for measurement simply copy it back (by **P00**) into the operating set and the unit operation restarts according to the user set.

E.g. applications where the tank can be filled with various mediums depending on technology, and each medium requires its own parameter settings (wave filtering, repose, filling/emptying rate etc.), or you simply want to compare the effects of various parameter settings in order to obtain the optimal one..

P00: - - - x Loading a parameter set

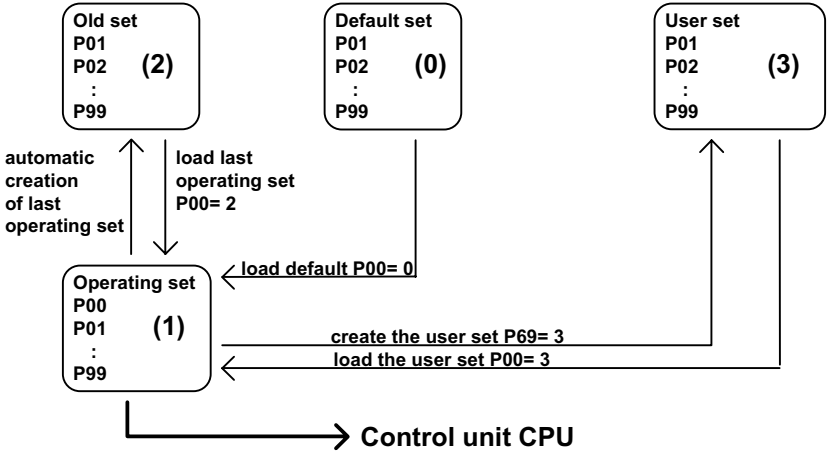
When confirming the entered value with **[E]**, the selected parameter set is copied to the ***operating set*** and the Remote Control Unit automatically restarts its operation according to the selected new parameter set.

X	Parameter set
0	Factory default set
1	Operating set
2	Old set
3	User set

Note: The Remote Control Unit always starts to operate with the parameter set it was working with before disconnection. See the following Figures.

P69: - - - x Creating the User Set

Simply enter the code of the user set: **x= 3** and confirm it with **[E]**.



10.19 Error Codes

The following Error Messages can occur:

Error Code	Error description	Causes and actions to be done
1	Memory error	Contact local agent
2 or **no Echo**	Echo loss	a). Sensor does not see the target b). Cable between sensor and Remote Control Unit is broken
4	Overflow	Check settings
5	Code referring to sensor error or improper installation/mounting	Verify sensor for correct operation and check for correct mounting according to Users Manual
6	The measurement is at the reliability threshold (only with **SID-31/33** sensor)	Re-aim the sensor or try to find a better location
7	No signal received within the measuring range specified in P13 and P14.	Review programming, also look for installation mistake
11	Linearisation table error: L(1)≠ 0	See the Section „Linearisation"
12	Linearisation table error: L(1) and L(2) are both zero (no valid data-pairs)	See the Section „Linearisation"
13	Linearisation table error: there are two same L(i) data in the table	See the Section „Linearisation"
14	Linearisation table error: the r(i) values are not monotone increasing	See the Section „Linearisation"
15	Linearisation table error: measured Level is higher than the last Volume or Flow data-pair	See the Section „Linearisation"
E	The checksum of the program in the EEPROM is wrong	Contact local agent
x.x	Difference level or Averaging mode error: the first digit specifies the sensor (S1 or S2), the second digit denotes the actual error code	See „Difference level" or „Averaging mode"

11. SOUND VELOCITIES IN VARIOUS GASES

The following table contains the sound velocity of various gases measured on **20°C**.

Gases		Sound Velocity (m/s)
Acetaldehyde	C_2H_4O	252.8
Acetylene	C_2H_2	340.8
Ammonia	NH_3	429.9
Argon	Ar	319.1
Bensol	C_6H_6	183.4
Carbon dioxide	CO_2	268.3
Carbon monoxide	CO	349.2
Carbon tetrachloride	CCl_4	150.2
Chlorine	Cl_2	212.7
Dimethyl ether	CH_3OCH_3	213.4
Ethane	C_2H_6	327.4
Ethanol	C_2H_3OH	267.3
Ethylene	C_2H_4	329.4
Helium	He	994.5
Hydrogen sulphide	H_2S	321.1
Methane	CH_4	445.5
Methanol	CH_3OH	347
Neon	Ne	449.6
Nitrogen	N_2	349.1
Nitrogen monoxide	NO	346
Oxygen	O_2	328.6
Propane	C_3H_8	246.5
Sulphur hexafluoride	SF_6	137.8

Par.	Page	Description	
P00	40	Load a parameter set	
P01	15	Sensor model	
P02	15	Operating mode	
P03	16	Display mode	
P04	16	Percentage Display assignm.	
P05	16	0% value	
P06	16	100% value	
P07	15	Sensor assignment (dual ch.)	
P08	-	N.A.	
P09	15	Relay assignment (dual ch.)	
P10	-	N.A.	
P11	-	N.A.	
P12	23	Compensation for side reflection	
P13	17	Maximum measuring distance	
P14	18	Close end blocking	
P15	18	Far end blocking	
P16	19/20	Volume / Flow configuration	
P17	19/20	Volume / Flow dimension	
P18	19/20	Volume / Flow dimension	
P19	19/20	Volume / Flow dimension	
P20	19/20	Volume / Flow dimension	
P21	23	Target tracking speed	
P22	23	Echo-loss indication	
P23	23	Echo-loss ind. during filling	
P24	23	Level elevation rate	

Par.	Page	Description	
P25	23	Level descent rate	
P26	24	Angle of repose	
P27	24	Sound velocity	
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