PiloTREK

WE–200

2-wire compact 80 GHz non-contact radar level transmitters

User's and programming manual

1st edition

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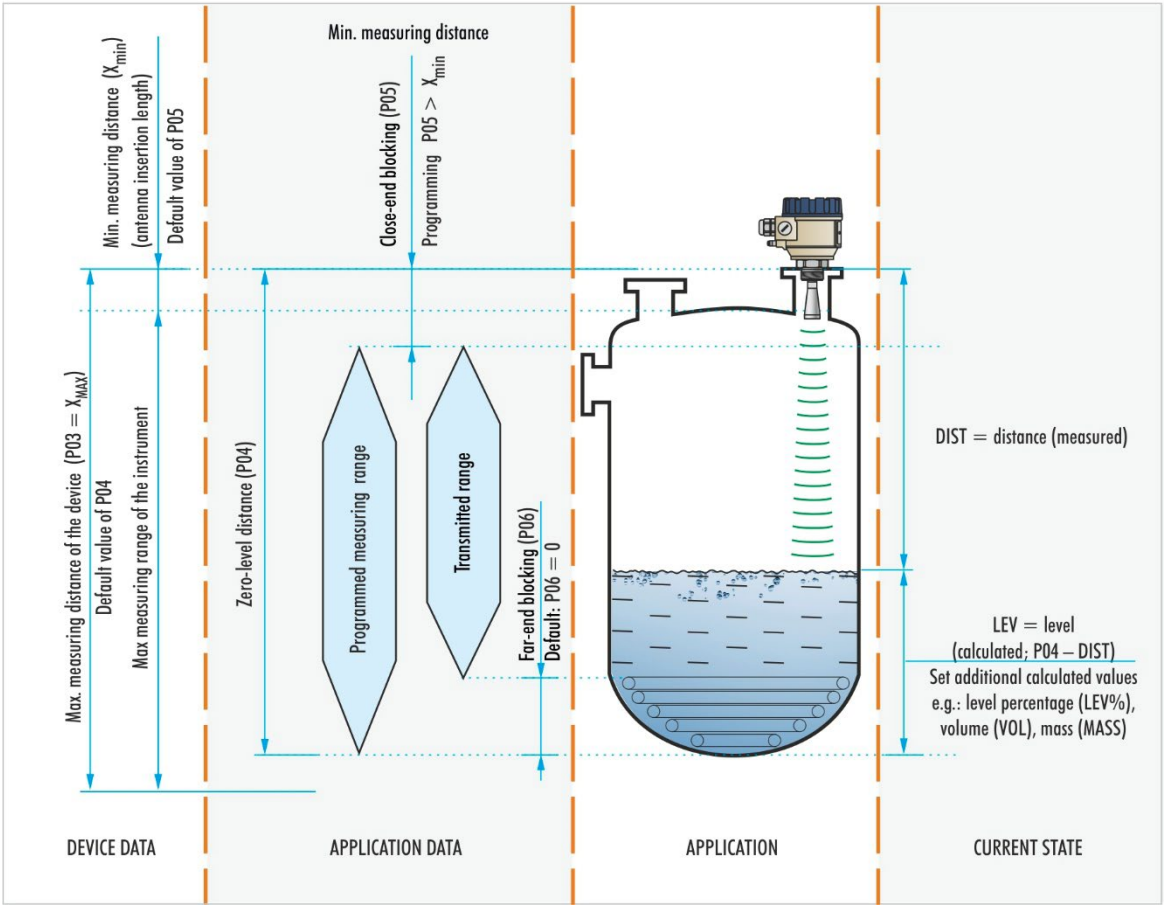
BASIC CONCEPTS AND ELEMENTS



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Thank you for purchasing a NIVELCO product.

1. INTRODUCTION

Application

The new PiloTREK WE–200 family of non-contact compact radar level transmitters uses the most advanced, next-generation measurement technology in industrial metrology, 80 GHz FMCW radar technology. The most fundamental advantages of 80 GHz radars over lower frequency radars (5...12 GHz, and 25 GHz) are the smaller antenna, better focusability, and smaller beam cone angle.
It uses the latest technology for measuring liquids, masses, emulsions, and other chemicals widely used in, for example, the water industry, food industry, energy industry, pharmaceutical industry, and chemical industry, which provides measurement results with millimeter accuracy.
It is also ideal for measuring substances susceptible to vapor formation and liquids with gas blankets. As no medium is required for millimeter wave propagation, it can also be used in a vacuum.
The instrument is HART® compatible and can be operated with NIVELCO EView2, PACT*ware*, MultiCONT universal process controller, or via Bluetooth® with MobileEView app.

Operating principle

The PiloTREK WE–200 is a continuous wave frequency modulated radar (FMCW) operating in the 80 GHz frequency band (W-band). Part of the energy of the frequency-modulated wave emitted by the transmitter's antenna is reflected from the measured surface, depending on the properties of the measured material. The distance to the reflecting surface is calculated with high accuracy by the electronics from the frequency shift of the reflected signal proportional to the propagation time and converted into a signal proportional to distance, level, or volume. The propagation velocity of the millimeter-wave signal in the air, gases, and vacuum is nearly constant regardless of temperature and pressure, so these factors do not significantly affect the accuracy of the measurement.

The signal strength of the reflected millimeter waves depends largely on the measured medium's relative dielectric constant (ε_r); therefore, the maximum measurement distance that can be achieved in practice may be reduced. A larger diameter antenna with a higher gain is recommended for measuring low dielectric constant media.

2. ORDER CODE (NOT ALL COMBINATIONS ARE AVAILABLE)

PiloTREK W ☐ ☐ - ☐ ☐ ☐ - ☐

VERSION	CODE
Transmitter	E
Transmitter + Display	G

ANTENNA / HOUSING	CODE
PP / Plastic, PBT	P
1.4571 / Plastic, PBT	M
1.4571 / Aluminum	S
1.4571 / Stainless steel	K
PVDF / Plastic	V
PVDF / Aluminum	B
PTFE / Plastic [1]	F

TYPE	CODE
80 GHz / Horn	2

MEASUREMENT RANGE	CODE
10 m (33 ft)	1
20 m (66 ft)	2
30 m (98.5 ft)	3

PROCESS CONNECTION	CODE
1" BSP [2]	2
1" NPT [2]	3
1½" BSP [3]	4
1½" NPT [3]	5
Ø75 mm (2½") / prepared for flange [4]	8
Prepared for welded flange [5]	S

OUTPUT / EX	CODE
4…20 mA + HART®	4
4…20 mA + HART® + Bluetooth®	B
4…20 mA + HART® + Relay	H
4…20 mA + HART® + BT® + Relay	R

[1] Up to 20 m (66 ft) measuring range.
[2] Only for 10 m (33 ft) measuring range.
[3] For 10 and 20 m (66 ft) measuring range.
[4] Only for 30 m (98.5 ft) measuring range, and encapsulated variants.
[5] 10 m (33 ft), 20 m (66 ft) types with 1½" antenna (from DN40), 30 m (98.5 ft) types with Ø75 mm (2½") antenna (from DN80).

Available accessories	Order code
Display unit	**SAP–300–0**
HART®–USB modem	**SAT–304–0**
HART®–USB/Bluetooth® modem	**SAT–504–☐**
HART®–USB/RS485 modem	**SAK–305–2**
HART®–USB/RS485 modem / Ex ia G	**SAK–305–6**
Process connections [6]	
DIN and ANSI flanges	**MFT–☐☐☐–☐**
DN40 Milch connection (DIN 11851)	
Seals [6]	
EPDM	
FFKM	

[6] The requirement for the above-mentioned technological connections and seals must be specified in the order.

3. TECHNICAL DATA

3.1. General

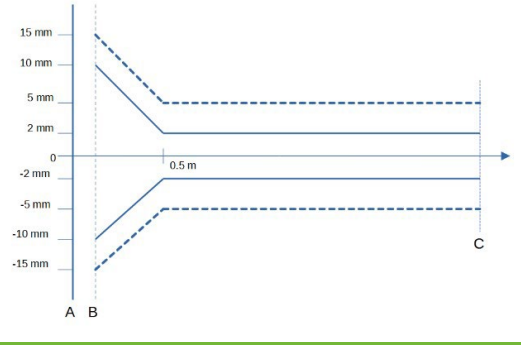
		With plastic housing W□P/M/V/F–2□□–□	With aluminum housing W□S/B–2□□–□	With stainless steel housing W□K–2□□–□
Measured and derived values		Measured value: distance; derived values: level, volume, weight, flow		
Signal frequency		77…81 GHz (W-band)		
Electronics housing		Plastic (PBT)	Painted cast aluminum	1.4571 (316Ti) stainless steel
Process temperature		–40…+100 °C (–40…+212 °F), PP encapsulation: –30…+80 °C (–22…+176 °F)		
Ambient temperature		–40…+70 °C (–40…+158 °F); with display unit: –20…+70 °C (–4…+158 °F)		
Measuring frequency		~ 1/s		
Resolution		0.1 mm		
Process pressure		Depends on type, see table (3.2)		
Supply voltage		12…36 V DC		
Output	Analog	4…20 mA; (3.9…20.5 mA); $R_{Lmax} = (U_S – 12\ V) / 0.02\ A$		
	Digital	HART® interface, HART® loop resistor ≥ 250 Ω		
	Relay (optional)	With changeover switch (SPDT) 30 V / 1 A DC; 42 V / 0.5 A AC		
	Display	SAP–300 LCD dot matrix		
Seal		FPM (Viton®) (optionally: EPDM, FFKM Perfluoroelastomer (Kalrez® 6375))		
Electrical protection		Class I overvoltage protection; (Class III [SELV])		
Ingress protection		IP67		
Electrical connection		2× M20×1.5 cable gland, cable diameter: Ø6…12 mm (Ø.24… Ø.47") (metal in the case of Ex variants, otherwise it is plastic) + inner thread 2× ½" NPT for protective tubing; Usable wire gauge: 0.5…1.5 mm² (AWG20…AWG15) (shielded cable is recommended)		
Weight		Plastic: 1…1.6 kg (2.2…3.5 lb)	Plastic: 1…1.6 kg (2.2…3.5 lb)	Plastic: 1…1.6 kg (2.2…3.5 lb)

3.2. Type-Specific Data

Antenna type	Encapsulated Antenna (W□P, W□V, W□F)				Stainless Steel Antenna (W□S, W□M, W□K)		
Antenna size	Ø1" W□□–212–□ W□□–213–□	Ø1½" W□□–2□4–□ W□□–2□5–□		Ø75 mm W□□–238–□	Ø1" W□□–212–□ W□□–213–□	Ø1½" W□□–2□4–□ W□□–2□5–□	
Antenna material	PP, PVDF, PTFE			PP/PVDF	1.4571 (316Ti) stainless steel		
Dead zone [7]	0 m (0 ft)						
Max. measuring distance [8]	10 m (33 ft)	10 m (33 ft)	20 m (66 ft)	30 m (98.5 ft)	10 m (33 ft)	10 m (33 ft)	20 m (66 ft)
Accuracy [9]	±5 mm (±0.2")	±5 mm (±0.2")	±2 mm (±0.079")	±2 mm (±0.079")	±5 mm (±0.2")	±5 mm (±0.2")	±2 mm (±0.079")
Antenna insertion length [10]	56 mm (2.2")	70 mm (2.76")		115 mm (4.53")	69 mm (2.72)	80 mm (3.15")	
Process pressure	–1…3 bar (–14.5…43.5 psi)				–1…25 bar (–14.5…362.6 psi)		
Beam angle (–3 dB)	12°	7°		4°	12°	7°	
Process connection	1" BSP / NPT	1½" BSP / NPT		flange	1" BSP / NPT	1½" BSP / NPT	

[7] From the tip of the antenna, if dielectric constant (ε_r) < 80.
[8] May be limited for media with low dielectric constants or non-vertical or non-planar surfaces.
[9] With an ideal reflecting surface, according to IEC 62828-1, an accuracy of ±2 mm (±0.079") is not guaranteed for Region 3 and Region 4 settings.
[10] From process connection.

3.3. Linearity error



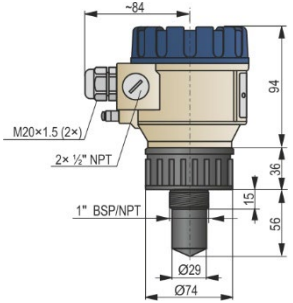
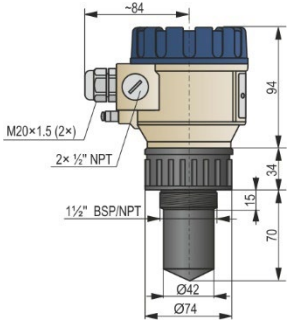
Legend:

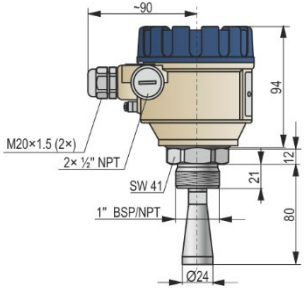
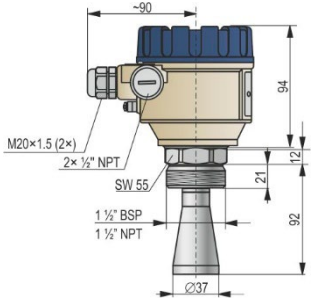
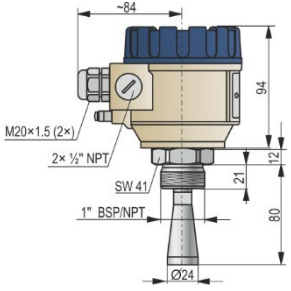
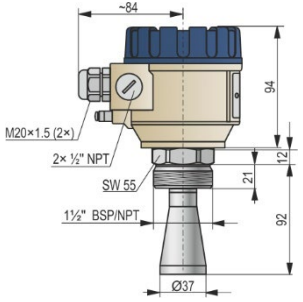
W□□–21□–□

W□□–22□–□ / W□□–238–□

A. Process connection plane of the device
B. The minimum measurement distance below which the radar cannot measure, due to the insertion length of the antenna (X_m)
C. Maximum measurement distance (X_M)

3.4. Dimensions

Encapsulated antenna (W□P, W□V, W□F)	
Ø1" **W□□–212–□** **W□□–213–□**	**Ø1½"** **W□□–2□4–□** **W□□–2□5–□**
	

Stainless steel antenna, aluminum housing (W□S)		Stainless steel antenna, plastic housing (WEM)	
Ø1" **W□S–212–□** **W□S–213–□**	**Ø1½"** **W□S–2□4–□** **W□S–2□5–□**	**Ø1"** **W□M–212–□** **W□M–213–□**	**Ø1½"** **W□M–2□4–□** **W□M–2□5–□**
			

3.5. Accessories

- Warranty card
- User and programming manual
- EU Declaration of Conformity
- Two M20×1.5 cable glands
- Flat seal (if applicable)
- SAP–300 display unit (if ordered)

3.6. Conditions for safe operation

Compliance with technological process conditions

- If the device is installed in a place subject to overvoltage, the device must be protected with at least class II surge protection!
- The device must be connected to the earth of the EP network via its earth screw.

The cable outside of the device must be secured and unencumbered!

The device operated from a power supply complying with Class 2 surge protection (SELV/PELV).

Compliance with local rules and regulations

The PiloTREK WE–200 is a Local Positioning Radar (LPR) and must be mounted in a fixed, antenna-down position. In addition, the following two restrictions on antenna placement and height from the ground must be observed:

- a separation distance of 4 km (2.48 miles) from radio astronomy sites operating in the frequency band 75…85 GHz, unless specifically authorized by the ruling national regulatory authority.
- At a distance of between 4 and 40 km (2.48 and 24.8 miles) from any radio astronomy site, the height of the radar above ground level must not exceed 15 m (49.2 ft).

3.7. Maintenance, repair, and storage conditions

PiloTREK WE–200 devices do not require regular maintenance. There may be occasions when the sensor head has to be cleaned of deposits. Cleaning must be done carefully without scratching or indenting the radiating surface.
All repairs, whether in-warranty or out-of-warranty must only be done by NIVELCO.
The device must be cleaned before it is returned for repair, all chemicals must be neutralized, and the device must be disinfected! In addition, the device must be accompanied by a form (DEVICE-RETURNING FORM, B0407/C) which can be downloaded from our website. In it, the person returning the device declares that the device is free from all contamination and hazardous substances.

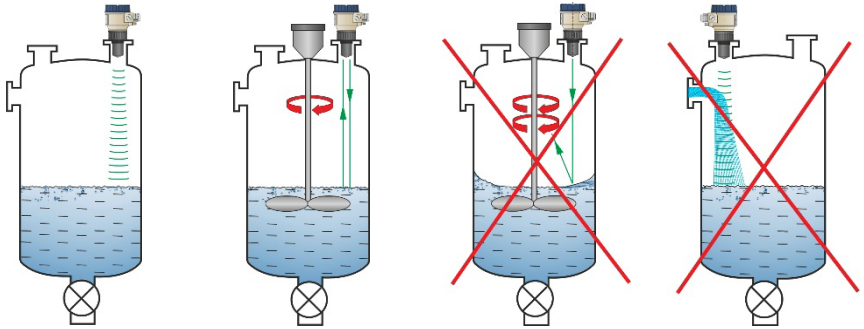
When not in use, the device must be stored within the ambient temperature specified in the technical data and at a maximum humidity of 98%.

3.8. Firmware update

The device's firmware is continuously maintained, considering user feedback and needs. If you want to update the firmware, use the built-in update communication port to upgrade to the latest version. To update, you need the NiFlash Light program; contact your distributor! In addition, the SAT–506–0 eLink communication adapter is required to upgrade the firmware.

4. INTEGRATION INTO THE TECHNOLOGICAL PROCESS

4.1. Level measurement applications



POSITIONING

The optimal location for PiloTREK (for a cylindrical tank) is at radius r = (0.3…0.5) R. It is always advisable to consider the radiation cone angle.

The liquid surface must be perpendicular to the axis of the device.

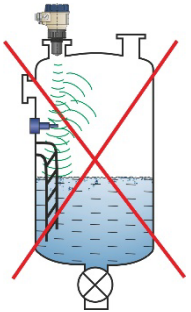
Under no circumstances place the device near the inlet opening! Improper placement may lead to malfunctions.

In the case of enclosed antenna designs, the possibility of antenna front surface humidity should be minimized.

OBSTACLES

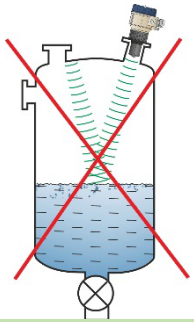
It is essential to avoid objects (pipes, ladders, structural elements, thermometers, etc.) entering the radiation cone.

CAUTION! If necessary, programming can block up to 4 interfering echoes in the PiloTREK WE–200 threshold settings by programming!



ALIGNMENT

The plane of the process connection must be parallel to the measured surface within ±2…3°.

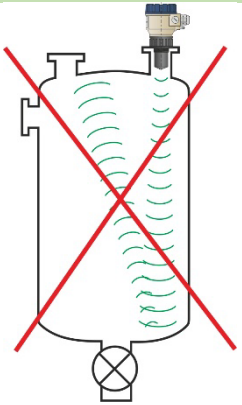


GASES / STEAM

In a closed (especially outdoors, exposed to direct sunlight) tank, vapors/gases above the liquid may reduce the millimeter-wave signal transmission.

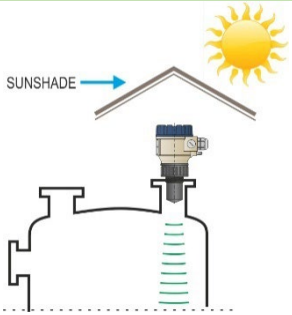
EMPTY TANK

Especially in the case of tanks with convex or conical bottoms or tanks with equipment (e.g., heating element, mixing paddle) at the bottom, the device may indicate an incorrect level when draining completely.
It is because the tank bottom or objects at the bottom of the tank scatter or reflect the millimeter waves emitted to a certain extent, or the lower signal level of the scattered radiation interferes with itself in the tank.
At least 100 mm (3.9") of liquid must cover these interfering devices or the convex or conical tank bottoms for a reliable measurement.



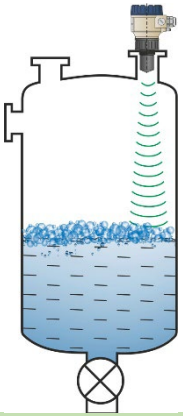
TEMPERATURE

The sensor must be protected from direct sunlight to avoid exceeding the highest permitted temperature.



FOAM

Foam on the measured surface may prevent millimeter-wave level measurement. The sensor should be mounted in a position below which the formation of foam is the smallest.

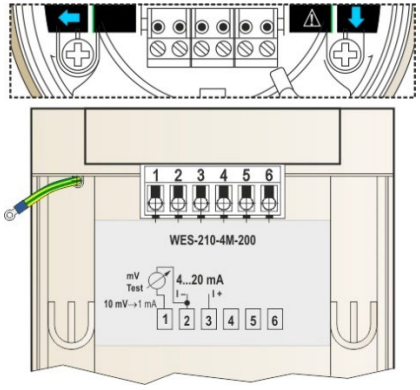


4.2. Flow measurement applications

- The instrument can be used for open channel flow measurement with the flumes and weirs described in Chapter 5.7.
- The distance of the sensor from the surface must be adjusted, taking into account the maximum level to be measured and the proximity linearization error curve in Chapter 3.2.
- The sensor must be positioned on the longitudinal axis of the restricting element at a location determined by the characteristics of the restricting element. This point is marked on NIVELCO Parshall flumes.
- Foam may form on top of the flowing liquid which may affect the measurements. The liquid's surface must be exposed in front of the sensor to obtain a good echo.
- The sensor must be fixed so that it cannot move.
- The correct construction of the upstream and downstream sections of the measurement channel is of utmost importance for the accuracy of the measurement.
- The accuracy of volume flow measurement based on the level change also depends on the size and design of the restrictive element (channel or weir) used and the surface quality of the flowing liquid (ripple, foam). Therefore, flow measurement accuracy is necessarily lower than the accuracy achievable with level measurement.
- The sensor must be protected from direct sunlight by a cover to prevent the sensor from exceeding the maximum permitted temperature.

4.3. Wiring

Wiring in regular, non-hazardous environments



1. Remove the cover of the device housing.
2. Insert the cable through the cable gland into the terminal block.
3. Strip approximately 80 mm (3.15") of the insulation of the cable and remove approximately 4 mm of the insulation of the wires. Cut the shielding of the signal cable.
4. Connect to points 2 and 3 of the terminal block according to the marked polarity.
5. Pull the cable back with about 10 mm (0.4") of the cable insulation remaining in the cable gland. Tighten the socket locking nuts with two wrenches.
6. Arrange the wiring in the housing.
7. Put the cover back on.

The insulation test with a test voltage of 500 V AC is prohibited due to the internal electronic overvoltage protection!

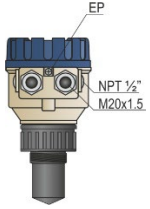
Connecting (grounding) to an equipotential network (EPH)

Earthing connector (EP) on the side of the device housing, maximum conductor cross-section: 4 mm² (AWG12).

The instrument housing must be earthed to a R < 1 Ω resistive earth.

The shield of the measuring cable must be grounded in the instrument room.

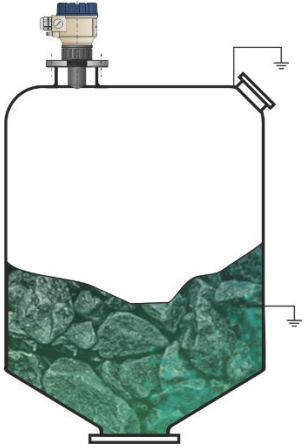
The measuring cable should not be routed near high-power cables, as shielding does not protect against switching harmonics.



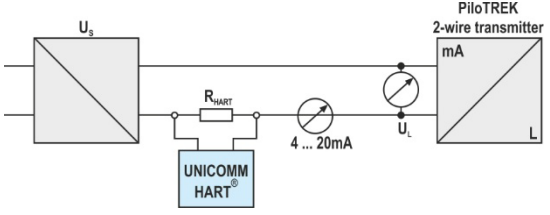
Electrostatic Discharge (ESD)

The device is protected against 4 kV ESD.

Warning! The internal protection of the instrument against ESD cannot protect the entire measuring system against electrostatic discharge.
In all cases, it is the user's responsibility to ensure the grounding of the tank and the measured material.

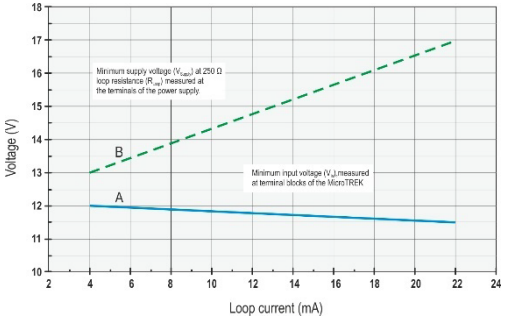


Designing a measuring network in a non-explosive environment



Power supply	
Nominal voltage	24 V DC
Maximum voltage (U_{in}):	36 V DC
Minimum voltage (U_{in}):	Depends on the load impedance. (See diagram)
Loop resistance, R_{loop}	R_{HART} + R_{cable} + $R_{ammeter}$
Minimum R_A	0 Ω
Maximum R_A	750 Ω
R_{HART} resistance for HART® communication	250 Ω (recommended)

Line "A": minimum voltage at the input terminals of the device
Line "B": minimum supply voltage (voltage across the device and the 250 Ω loop resistor)
Example for calculating the supply voltage:
The required minimum supply voltage at I_{min} = 4 mA:
$U_{supply\ min.}$ = $U_{input\ min.}$ + (I_{min} * loop resistance) = 11.5 V + (4 mA * 0.25 kΩ) = 12.5 V
the required minimum supply voltage at I_{max} = 22 mA:
$U_{supply\ min.}$ = $U_{input\ min.}$ + (I_{min} * loop resistance) = 11.5 V + (22 mA * 0.25 kΩ) = 18.5 V
Therefore, in the case of a loop resistance of 250 Ω, the 17 V supply voltage is just sufficient for the whole 4…20 mA in the measurement range.



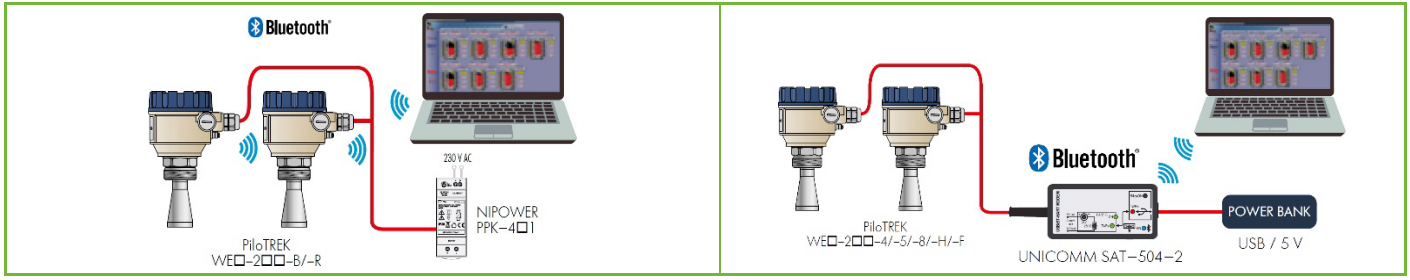
4.4. Available user interfaces

The device can be programmed using the following tools:

MultiCONT universal process controller	Ordered separately. Display
HART® USB modem (e.g. SAT–504)	Ordered separately. See Chapter 7 “EView2 user manual.”
SAP–300 display unit	Ordered separately. See Chapter 8 “Programming with SAP–300 display unit”

4.5. Bluetooth® communication

Devices with HART® communication can be connected via Bluetooth® to a computer or smartphone in the case of PiloTREK W□□–2□□–B / –R types, or in other cases using the SAT–504–2 HART®–USB/Bluetooth® modem.



4.6. BUS (HART®) communication

The device can be used in two modes:

- Current loop and HART®
- Multidrop, HART® protocol

The EView2 software and the MultiCONT universal process controller support the both modes. In accordance with the Rosemount Standard, HART® communication can be used between the PiloTREK as a “slave” and the HART® master as a point-to-point connection.

Communication can be implemented in two modes.

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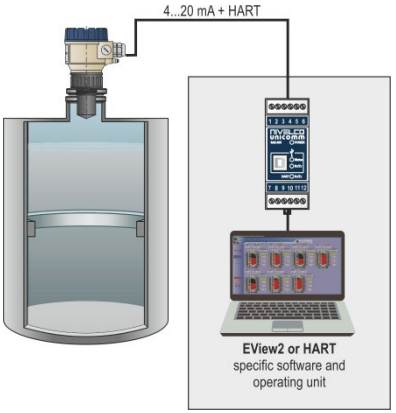
<tr>
<td> 
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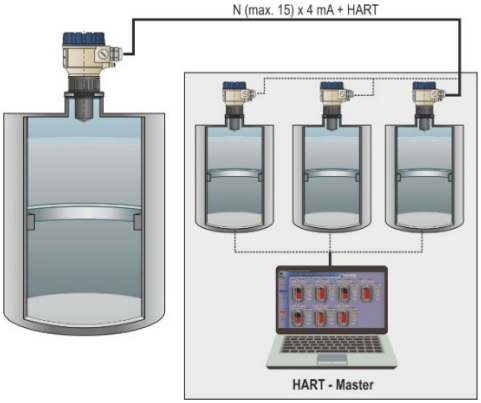
<td> 
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<tr>
<td>If the device is set to current transmission (4…20 mA, “0” HART short address) only one device can be used in the HART communication loop.</td>
<td>In the case of a multidrop operation (4 mA), several devices (up to 15) can be connected in a HART communication loop. The short address of the device must be other than 0.</td>
</tr>
</table>

4.7. Commissioning and setting up

NIVELCO supplies the PiloTREK 2-wire device with the specifications set by the customer, thus it is ready for operation immediately after installation and electrical connection. Measuring starts within 10 seconds from switching on.

Caution! The instrument starts with a current consumption of 3.5 mA after switching on! In this case, the instrument measures using the factory default settings. The factory default settings are suitable for checking functionality and simple measurement tasks but the device's full potential can only be used with the correct programming tailored to the requirements of the measured process. Therefore, to get to know the operational characteristics thoroughly and solve complex measuring tasks, it is necessary to read the chapters about programming.

5. PROGRAMMING

The HART interface of the **PiloTREK WE−200** lets the user to access and program all device parameters. The parameter set can be accessed in three ways:

- SAP–300 plug-in display unit. See Chapter 8 for manual and menu map.
- EView2 software. See Chapter 7 for manual.
- NIVELCO **MultiCONT** multi-channel process controller. See MultiCONT User Manual.

These methods differ in many aspects. This programming guide only discusses the method involving EView2. For detailed information, refer to the descriptions of the particular access methods or the user manuals.

Some rarely used parameters cannot be set directly from the graphical interface. Instead, they can be changed referring to the parameter number at the following path.

EView2
Advanced mode → Parameters

5.1. Configuring the measurement

P00: d c b a Unit system, default units, regional parameter **FACTORY DEFAULT: 0000**

If parameter P00 is changed, the device reverts the entire parameter set to the factory default values of the new unit system. Therefore, all parameters must be set again!

a	Mode
0	Normal
1	High-sensitivity

SAP–300	EView2	MultiCONT
BASIC SETUP → APPLICATION	*Application → Operating mode*	*App. parameters → P00 Application*

b	Unit (by "c")	
	Metric (EU)	Imperial (US)
0	m	ft
1	cm	inch
2	mm	inch

SAP–300	EView2	MultiCONT
BASIC SETUP → UNITS → ENGINEERING UNITS → DISTANCE UNITS	*Application → Engineering units*	*App. parameters → P00 Application*

c	Regio / Unit system	Regional parameter
0	EU / Metric	EU, United Kingdom, Albania, Andorra, Azerbaijan, Australia, Belarus, Bosnia and Herzegovina, Canada, Liechtenstein, Moldavia, Monaco, Montenegro, New Zealand, Northern Macedonia, Norway, San Marino, Saudi Arabia, Serbia, Switzerland, Turkey, Ukraine
1	US / Imperial	USA
2	Region 2 / Metric	Brazil, Japan, South Korea, Taiwan, Thailand
3	Region 2 / Imperial	
4[11]	Region 3 / Metric	India, Malaysia, South Africa
5[11]	Region 4 / Metric	Russia, Kazakhstan

[11] *The accuracy of ±2 mm is not guaranteed for Region 3 and Region 4 settings.*

SAP–300	EView2	MultiCONT
BASIC SETUP → UNITS → ENGINEERING SYSTEM	*Application → Calculation system*	*App. parameters → P00 Application*

d	Temperature unit
0	°C
1	°F

SAP–300	EView2	MultiCONT
BASIC SETUP → UNITS → ENGINEERING UNITS → TEMPERATURE UNITS	*Measurement configuration → Temperature*	*App. parameters → P00 Application*

P01: d c b a Output source **FACTORY DEFAULT: 1011**

P01ba defines the source of the primary output value (HART – PV), which also defines the value transmitted on the analog current output. The device automatically selects the measurement mode according to the selected output source. The device measures the level's distance. The other quantities are calculated based on the specified tank parameters and material characteristics.

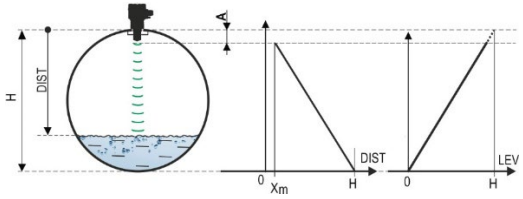
SV 'dc'	PV 'ba'	Output data / measuring mode	Parameters
10		Distance	–
11		Level	P04
12		Volume	P04, P40…45
13		Weight	P04, P32, P40…45
14[12]		Flow	P04, P40…45, P46
15		Empty Volume	P04, P40…45, P47
16		Level%	P04
17		Volume%	P04, P40…45
40		TEMP	–
41		TOT1	–
42		TOT2	–

[12] *Cannot be selected in Volume (12, 17), Weight (13), and Empty Volume (15) measuring modes.*

SAP–300	EView2	MultiCONT
MEASUREMENT CONFIGURATION → PV. Mode → SV. Mode	*Measurement configuration → Measurement mode*	*Parameters → P01 Outp. funct.*

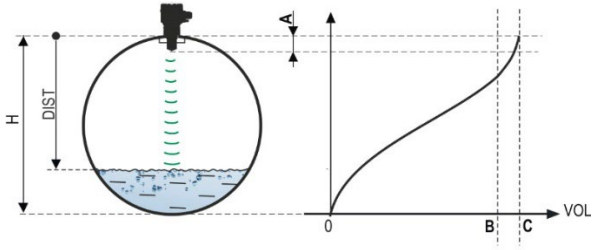
Distance measurement (DIST) / Level measurement (LEV)

DIST: Currently measured distance
A: Shortest measurable distance (P05)
H: Longest measurable distance, it is also the zero-level distance (P04)



Volume measurement (VOL)

DIST: Currently measured distance
A: Shortest measurable distance
H: Zero-level distance
B: Volume associated with the highest measurable level
C: Tank's total volume



P02: d c b a Output units **FACTORY DEFAULT: 2021**

The device calculates the volume, weight, and volume flow over a unit of time using a level-dependent (non-linear) function using **P40** or an output correction table (OCT). This parameter also determines the unit of measure for the "Output" column of the OCT table. The TOT value in flow measurement mode totalized (total) amount flowed. The distance, level, and temperature units can be selected in parameter P00.

a	Weight unit	
	Metric	US
0	kg	lb
1	ton	US ton
2	US ton	metric ton

SAP–300[13]	EView2	MultiCONT
BASIC SETUP → UNITS → ENGINEERING UNITS → MASS UNITS	*Measurement configuration → Mass Units*	*Parameters → P02 Output. unit.*

[13] *Appears only if an output variable (PV, SV, TV, QV) is weight!*

b	Volume	
	Metric	US
0	liter	gallon
1	hL	ft^3
2	m^3	barrel
3	million liter *(14)*	million gallon *(14)*

(14) Use is not recommended for flow measurement (in HART transmission it can only be interpreted in conjunction with reading an application-specific code). Except for MGD.

SAP–300(15)	EView2	MultiCONT
BASIC SETUP → UNITS → ENGINEERING UNITS → VOLUME UNITS	*Measurement configuration → Volume Units*	*Parameters → P02 Output. unit*

(15) Appears only if PV, SV, TV, or QV is set to FLOW!

c	Time
0	Second
1	Minute
2	Hour
3	Day

SAP–300(16)	EView2	MultiCONT
BASIC SETUP → UNITS → ENGINEERING UNITS → TIME UNITS	*Measurement configuration → Time Units*	*Parameters → P02 Output. unit*

(16) Appears only if PV, SV, TV, or QV is set to FLOW!

d	TOT	
	Metric	US
0	liter	gallon
1	hL	ft^3
2	m^3	barrel
3	million liters *(17)*	million gallons *(17)*

(17) Use is not recommended for flow measurement (in HART transmission it can only be interpreted in conjunction with reading an application-specific code). Except for MGD.

SAP–300(18)	EView2	MultiCONT
BASIC SETUP → UNITS → ENGINEERING UNITS → TOT UNITS	*Measurement configuration → TOT Units*	*Parameters → P02 Output. unit*

(18) Appears only if PV, SV, TV, or QV is set to FLOW!

P03: Maximum sensing distance **FACTORY DEFAULT: See X_{max} + 30 cm (1 ft).**

The maximum sensing distance measured from the process connection. The device evaluates level signals only within the specified distance. The maximum sensing distance is type-specific. See the **X_{max}** column (+30 cm [+1 ft]) of the type-specific measurement distance table below. Smaller values can be set. The minimum value is parameter P05 + 30 cm (1 ft). It is not necessary to set this parameter. The device automatically selects the detection distance based on the zero-level distance specified in P04, within the limits of P03.

Type-specific measuring distance	Minimum X_{min}[19]	Maximum X_{max}
W□□–212–□ / W□□–213–□[20]	0.056 m (2.2")	10 m (33 ft)
W□□–214–□ / W□□–215–□[20]	0.070 m (2.75")	10 m (33 ft)
W□□–224–□ / W□□–225–□[20]	0.070 m (2.75")	20 m (66 ft)
W□□–212–□ / W□□–213–□[21]	0.069 m (2.7")	10 m (33 ft)
W□□–214–□ / W□□–215–□[21]	0.080 m (3.15")	10 m (33 ft)
W□□–224–□ / W□□–225–□[21]	0.080 m (3.15")	20 m (66 ft)
W□□–238–□[20]	0.115 m (4.53")	30 m (98.5 ft)

[19] *From the plane of the process connection.*
[20] ***W□P, W□N, W□F** encapsulated antenna.*
[21] ***W□S, W□M, W□K** stainless steel antenna.*

SAP–300	EView2	MultiCONT
MEASUREMENT CONFIGURATION → → SENSING DIST.	*Measurement configuration → Sensing Distance*	*Parameters → P03 Sensing dist.*

P04: Zero-level distance (tank height – H) **FACTORY DEFAULT: See X_{max} in the table**

This parameter must always be set, except for distance measurement.

The zero-level distance (P04) is the distance between the sealing plane of the process connection and the designated zero level of the level measurement (e.g., the bottom of the tank). The device calculates the level value from the P04 value by subtracting the measured level distance. The device automatically sets the measuring distance within the maximum sensing distance (P03). The distance given here is denoted by 'H' in the figures and formulas. The maximum distance that can be measured (X_{max}) is in the measuring distance table above, depending on the selected type. The set zero-level distance can be greater than the maximum measuring distance but not exceeding 60 m (200 ft).

Since the level measured by the device is the calculated difference between the P04 set for the given application and the distance (DIST) measured by the device, it is important to specify the zero-level distance (H) accurately.

SAP–300	EView2	MultiCONT
CALCULATION → ZERO-LEVEL DISTANCE	*Measurement configuration → Zero-level distance*	*Parameters → P04 Sensing dist.*

P05: Close-end blocking (dead-zone) **FACTORY DEFAULT: See X_{min} in the table**

The dead-zone (starting from the process connection of the transmitter) is the range within which the device cannot measure due to its physical limitations (antenna insertion length). This is the minimum measuring distance of the device, and it is type-dependent. See the X_{min} column of the type-specific measuring distance table above.

Close-end blocking is the user-defined extension of the dead zone, within which the device does not consider any echoes. This, e.g., enables the exclusion of objects interfering with the measurement close to the sensor. Close-end blocking cannot be less than X_{min}.

SAP–300	EView2	MultiCONT
MEASUREMENT CONFIGURATION → → NEAR BLOCKING	*Measurement configuration → Minimum (P05)*	*Parameters → P05 Near blocking*

P06: Far-end blocking **FACTORY DEFAULT: 0.0**

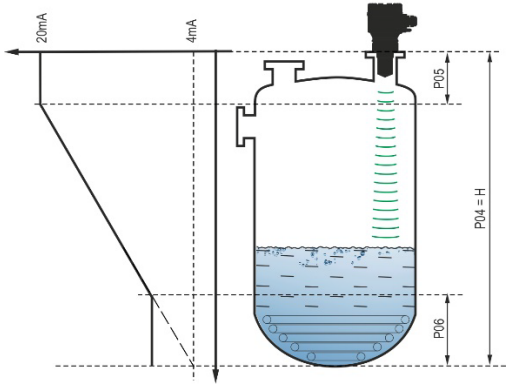
In parameter **P06**, we can specify a level value below which the output will no longer follow any further level decrease. Far-end blocking is used when objects at the bottom of the tank (mixer, heating coil, funnel, etc.) cause measurement uncertainty within this range, e.g., because interfering echoes cannot be safely distinguished from the echoes of the measured surface. If an echo falls within the far-end blocking range (LEV < P06), the device sends a special signal and keeps the level value defined here on the output (see figure). The “Echo in far-end blocking range” flag (see Chapter 6.1) indicates that the echo is in the far-end blocking zone. Regardless of this, the “VALID” flag is active, but the “HOLD” flag remains inactive.

Far-end blocking can be deactivated with **P06 = 0**. Min. value: 0 / max. value: P04 – P05 – 5 cm (2")

A.) Level or volume measurement

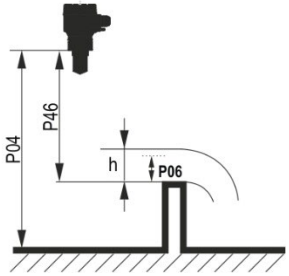
- *If the level drops below the value of P06:*

  It keeps a level value corresponding to P06 on the output and calculates the derived values from it.
- *If the level goes above the far-end blocking limit: In level or volume measurement mode, the programmed tank dimensions are valid, so far-end blocking does not affect the measured or calculated values.*



B.) Open-channel flow measurement

Far-end blocking is usually applied to those low-level values, below which exact volume flow cannot be calculated.



- *If the level in the flume drops below the blocking value:*
  - The current loop output holds the value corresponding to Q = 0.
  - For 0-value transmission via HART "No Flow" or for displaying 0.

- *If the level in the flume rises above the blocking value:*

  Flow value is calculated using the parameters specified in the program, so remote blocking does not affect measured values.

SAP–300	EView2	MultiCONT
MEASUREMENT CONFIGURATION → → FAR BLOCKING	*Measurement optimalization → Far end (P06)*	*Parameters → P06 Far blocking*

5.2. Current loop output

P08: Manual output current value **FACTORY DEFAULT: 4.0**

If the analog current loop output mode (**P12b**) is set to "Manual," the output current takes the value specified here, and the analog transmission switches off. A value between 3.8...20.5 mA is specified in this parameter. Caution! The device automatically switches to "Manual" current output mode when a new value is set in parameter P08. When 0 is entered, the device switches to "Automatic" current transmission mode (P12b = 0) and resets the value of parameter P08 to the factory setting.

In HART multi-drop mode (see parameter P19), the current loop output is fixed at 4 mA, as per standard, and the manual output current value (P08) does not apply.

SAP–300	EView2	MultiCONT
OUTPUT SETUP → ANALOG OUTPUT → → FIX CURRENT VALUE	*Current output → Fix output current (P08)*	*Parameters → P08 Fix current*

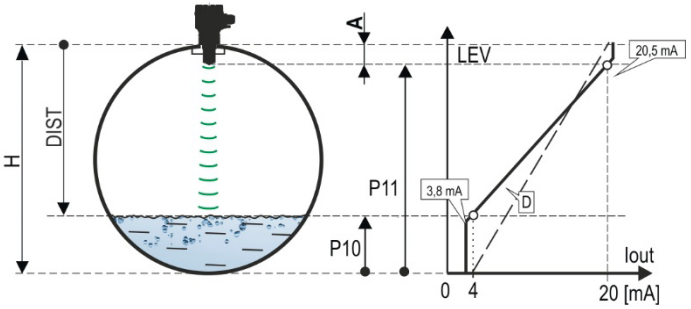
P10: The value of the transmitted quantity assigned to 4 mA output current **FACTORY DEFAULT: 0.0**

In the case of "Automatic" mode of the analog current output, it is the PV value assigned to 4 mA (usually the lower limit of the measuring range in the case of level measurement). The device scales the (HART – PV, see P01) output value to the analog current output 4...20 mA range using the values specified in parameters P10 and P11.

SAP–300	EView2	MultiCONT
OUTPUT SETUP → ANALOG OUTPUT → → PV VALUE OF 4 mA	*Current output → Assignment of 4 mA - PV*	*Parameters → P10 PV assign 4 mA*

P11: The value of the transmitted quantity assigned to 20 mA output current **FACTORY DEFAULT: X_{max}** (See table of **P03**)

In the case of "Automatic" (current transmission) mode of the analog current output, it is the PV assigned to 20 mA (usually the upper limit of the measurement range in the case of level measurement). The device scales the (HART – PV, see P01) output value to the analog current output 4…20 mA range using the values specified in parameters P10 and P11. The values can be assigned inversely. (For example, 4 mA to 1 m [3.3 ft] level and 20 mA to 10 m [33 ft] level, or vice versa 20 mA to 1 m [3.3 ft] level and 4 mA to 10 m [33 ft] level.)



A: Shortest measurable distance
D: ***P10, P11*** diagram valid for factory default settings

SAP–300	EView2	MultiCONT
OUTPUT SETUP → ANALOG OUTPUT → → PV VALUE OF 20 mA	*Outputs → Current output → → Assignment of 20 mA - PV*	*Parameters → P11 PV assign 20 mA*

P12: - c b a Analog current loop output mode **FACTORY DEFAULT: 0000**

Error current mode: the device indicates the error state on the current output according to the setting below. The error indication set as below persists until the error is cleared.

a	Error current mode
0	HOLD (holding last valid value)
1	3.8 mA
2	22 mA

SAP–300	EView2	MultiCONT
OUTPUT SETUP → ANALOG OUTPUT → → ERROR MODE	*Current output → Error indication by the current output*	*Parameters → P12 current output*

Analog current output mode:

b	Analog current output mode	Description
0	Automatic (current transmission)	The value of the output current is calculated from the measured value using the parameters P10 and P11. The output of the transmitter is active.
1	Manual	The value of the output current is not calculated from the measured value. Instead, a fixed output current (P08) is sent to the output. In this mode, the setting of the fault current mode is irrelevant. **Multi-drop HART communication mode 4 mA (P19) override!**

SAP–300	EView2	MultiCONT
OUTPUT SETUP → ANALOG OUTPUT → → CURRENT MODE	*Outputs → Current generator mode*	*Parameters → P12 current output*

Startup mode: when switching on or restarting after a power failure the current is transmitted until the device starts measuring. It is recommended to set it to the fault current of the system. For periodic applications, e.g., battery operation, selecting the "Fast" recovery mode is recommended to shorten the measurement cycle time.

c	Initial current	Resume time [s]
0	< 3.8 mA (Normal)	12…16[22]
1	> 22 mA (Fast)	3…4[22]

[22] *Depending on the radar parameters. Note that it also depends on the conditions of use and how long after resuming operation the instrument will find an echo that can be evaluated.*

SAP–300	EView2	MultiCONT
BASIC SETUP → STARTUP CURRENT	*Outputs → Startup current*	*Parameters → P12 current output*

5.3. Relay output (optional)

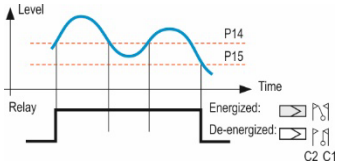
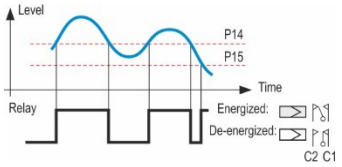
P13: - c b a Relay function **FACTORY DEFAULT: 0001**

a	Operating mode	Description
0	By PV (P14-P15-P16)	The operating mode of the RELAY optionally built into the device can be set with this parameter. If it is set to "by PV," the RELAY operates based on the triggering (P14) and releasing (P15) values set.
1	"No ECHO" (echo loss): C1 = "On" (release)	

2	"No ECHO" (echo loss): C2 = "On" (energize)	The "No ECHO" setting enables a switched (relay contact) error signal to the process controller. **Caution! When the device is de-energized, the relay releases, so C1 is ON.**
3	FLOW impulse (P17)	
4	C1 error (release)	
9	OFF	

SAP–300	EView2	MultiCONT
OUTPUT SETUP → RELAY OUTPUT → → RELAY MODE	*Outputs → Relay output → Relay mode*	*Parameters → P13 Relay function*

Operating mode: only relevant for operation by PV (P13a = 0)

b	Function		Programmable parameters	Description
0	Hysteresis		**P14, P15** At least 20 mm (0.787") hysteresis required between **P14** and **P15.** **P14 > P15** – normal operation **P14 < P15** – inverted operation	The basic switching method of the RELAY set to "PV" mode can be adjusted.
1	Window comparator		**P14, P15** At least 20 mm (0.787") hysteresis required between **P14** and **P15.** **P14 > P15** – normal operation **P14 < P15** – inverted operation	

SAP–300	EView2	MultiCONT
OUTPUT SETUP → RELAY OUTPUT → RELAY FUNCTION	*Outputs → Relay Function*	*Parameters → P13 Relay function*

FLOW impulse constant's (P17) unit (if P13:a = 3):

c	Metric (EU)	Imperial (US)
0	m^3	ft^3
1	liter	US gallon
2	liter	GB gallon

SAP–300	EView2	MultiCONT
OUTPUT SETUP → RELAY OUTPUT → → VOLUME/PULSE UNIT	*Outputs → Relay output → Relay parameters → → Pulse constant unit*	*Parameters → P13 Relay function*

P14: Relay parameter – Relay on value **FACTORY DEFAULT: 0**

The measured PV value at which reaching the upper limit value is indicated on the RELAY output.
Adjustable value range: Value is adjustable according to PV setting range.

SAP–300	EView2	MultiCONT
OUTPUT SETUP → RELAY OUTPUT → → ENERGIZED VALUE	*Outputs → Relay output → Relay parameters → Energized value*	*Parameters → P14 Relay on value*

P15: Relay parameter – Relay off value **FACTORY DEFAULT: 0**

The measured PV value at which reaching the lower limit value is indicated on the RELAY output.
Adjustable value range: Value is adjustable according to PV setting range.

SAP–300	EView2	MultiCONT
OUTPUT SETUP → RELAY OUTPUT → DEENERGIZED VALUE	*Outputs → Relay output → Relay parameters → De-Energized value*	*Parameters → P15 Relay off value*

P16: Relay parameter – Relay delay **FACTORY DEFAULT: 0**

If the PV measurement value has reached the lower or upper switching value or an error has occurred in the case of an error signal, the actual RELAY operation is activated after this time, or after this time, a change is visible on the output.

Adjustable value range: 0…999 s.

SAP–300	EView2	MultiCONT
OUTPUT SETUP → RELAY OUTPUT → DELAY	*Outputs → Relay delay time*	*Parameters → P16 Relay delay*

P17: Relay parameter – Flow parameter value **FACTORY DEFAULT: 1**

In the case of FLOW, the relay gives a pulse per volume unit specified here. The volume unit is set in parameter P13:c. The pulse width is 100 ms.

The guaranteed maximum pulse density: < 3 seconds.

SAP–300	EView2	MultiCONT
OUTPUT SETUP → RELAY OUTPUT → VOLUME/PULSE VALUE	*Outputs → Relay output → Relay parameters → Pulse constant*	*Parameters → P17 Flow pulse*

5.4. Digital communication

P19: HART short address (device address) **FACTORY DEFAULT: 0**

A unique device address by which the device is identified and managed via HART.

a	Description
0	Analog current loop output is active (current transmission via 4…20 mA)
1…15	Analog current loop inactive (no current transmission, fixed 4 mA), multi-drop

SAP–300	EView2	MultiCONT
OUTPUT SETUP → DIGITAL OUTPUT → → ADDRESS	*Device Identification → HART Device Short Address*	*Parameters → P19 Polling addr.*

5.5. Measurement optimization

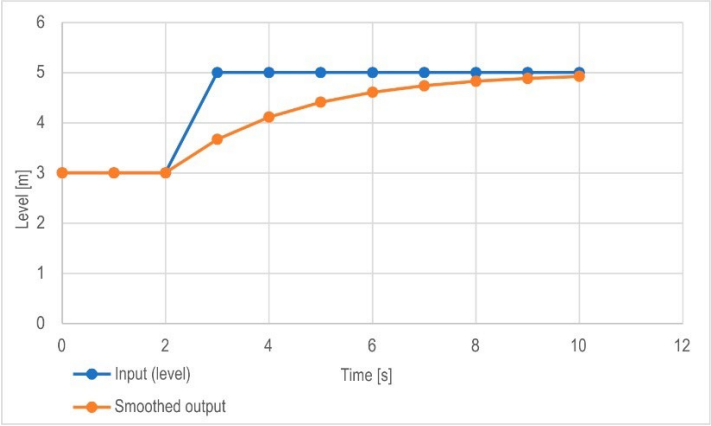
P20: Damping Time **FACTORY DEFAULT: 40**

Damping time reduces unwanted fluctuations in displaying the measured data (e.g., ripples). If the level jumps, the transmitted value reaches 98% of the jump at this time. Unit: second (s). Value range: 0...999 s.

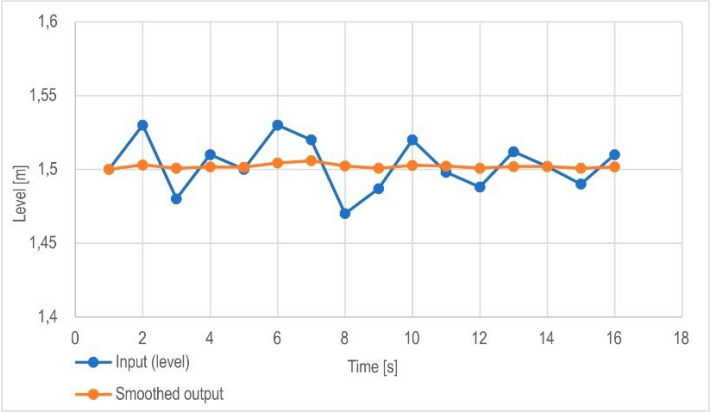
	For testing	Recommended
Barely or non-volatile/waving media	0 s	2 s
Highly volatile / strongly waving liquid	> 6 s	> 10 s

SAP–300	EView2	MultiCONT
MEAS. OPTIMIZATION → DAMPING TIME	*Measurement optimalization → Damping time*	*Parameters → P20 Damping time*

Damping example 1.
Damping time = 10 s
Level change (level) = 2 m (6.6 ft)



Damping example 2.
Damping time = 40 s
Level change = 2…3 cm
(0.39"…0.79") ripple
If a higher degree of undulation is expected in the measured liquid column, it is recommended to set a higher damping time. This way, the fluctuation of the value of the transmitted level can be reduced.



P22: User slope correction factor (actual/measured) **FACTORY DEFAULT: 1.0**

It corrects the transmitted quantity according to the distance. If the value measured by the device differs from the value under real conditions, this multiplier can be used to refine the result. The output value is multiplied by the number set here. By default, the multiplier (1) does not modify the output.

Value range: 0.7…10

SAP–300	EView2	MultiCONT
CALCULATION→ USER SLOPE MULTIPLIER	*Measurement optimalization → Velocity user correction factor*	*Parameters → P22 User slope corr*

P25: - - - a Echo selection **FACTORY DEFAULT: 00**

The parameter P25a sets the echo selection strategy. Automatic operating mode is suitable for most applications. For special application requirements, a specific echo selection can be set as required.

a	Echo selection within measuring window
0	Automatic
1	First
2	Second
3	Largest
4	Last

SAP–300	EView2	MultiCONT
MEAS. OPTIMIZATION → ECHO SELECTION	*Measurement optimalization → Echo selection → → Selection of Echo…*	*Parameters → P25 Echo Selection*

P26/P27: Level tracking speed **FACTORY DEFAULT: 600 m/h (1 970 ft / h)**

The level tracking speed is the fastest level change speed that the device can continuously track. The device will only follow a level change slower than the set value. If the device senses a level signal change faster than this value, it assumes it is the result of a measurement error (e.g., condensation), it will not accept it, and the outputs will show the last valid value. Suppose this resulted from an incorrect measurement, and the result of the next measurement is plausible based on the set maximum speed. Then hold is canceled, and the actual measured level takes effect. If the rapid change in level was actually real, the device recalculates with each measurement whether the currently measured level is within the range determined by the product of the tracking speed and the elapsed time. If it is within the range, it cancels the hold, and the output adjusts to the new value according to the set damping parameter. Setting the level tracking speed is important when technological processes, especially during filling or discharging, produce interfering factors (e.g., ripples, foaming) that affect measurement stability. The set level tracking speed must be higher than the maximum filling/discharging speed prescribed by the technology. By entering it correctly, measurements during filling and discharging become more reliable. **Caution! In tanks with a conical or pyramidal bottom, the level change rate at the bottom of the tank increases significantly due to the shape of the tank.**

In this parameter pair, the filling and discharging speed can be set separately:

- P26 – Level rising rate (filling speed)
- P27 – Level descent rate (emptying speed)

The parameter's unit of measure: metric: [m/h]; US: [ft/h].

SAP–300	EView2	MultiCONT
MEAS. OPTIMIZATION → LEVEL TRACK SPEED → FILLING SPEED → → EMPTYING SPEED	*Measurement optimalization → Level → → Level elevation rate (filling speed) Level descent rate (emptying speed)*	*Parameters → P26 Filling speed Parameters → P27 Emptying speed*

P28 - - b a Measurement loss handling **FACTORY DEFAULT: 0010**

Echo loss handling:

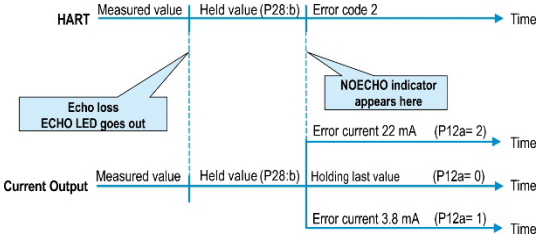
a	Echo loss ("no-Echo") handling
0	Hold for the period in the P28b decade.
1	Hold (indefinitely)
2	Filling simulation (at detected speed)
3	Filling simulation (at P26/P27 maximum speed)
4	Tank empty (DIST = maximum / LEV = 0)
5	Tank full (DIST minimum / LEV = maximum)

SAP–300	EView2	MultiCONT
MEAS. OPTIMIZATION → ECHO LOSS HANDLING → OUTPUT MODE	*Measurement optimalization → Measurement loss management → Echo loss handling*	*Parameters → P28 ECHO loss.*

Error indication delay:
This parameter defines the time elapsed between the occurrence of the error and the issued error signal (error current). During the delay, the output is holding the last valid measured value. The function is available for current output only if the error signal is set to a lower (3.8 mA) or upper (22 mA) error current.

When the error is gone, the device returns to measuring mode after the set delay.

b	Error indication delay	Notes
0	No delay	During a short echo loss, the last value is held in transmission for a period set in **P28:b.** After that, it is transmitted via HART on bit **0** of **DSE**[23] according to **P12:a** on the current loop output.
1	10 s	
2	20 s	
3	30 s	
4	1 min	
5	2 min	
6	5 min	
7	15 min	



[23] ***DSE – "Device Specific Error"*** *indicator bits (HART). See Chapter 6 Troubleshooting.*

SAP–300	EView2	MultiCONT
MEAS. OPTIMIZATION → ECHO LOSS HANDLING → OUTPUT HOLD TIME	*Measurement optimalization → Measurement loss management → Error delay*	*Parameters → P28 ECHO loss.*

P32: Specific density of the measured medium **FACTORY DEFAULT: 1.0**

If the device is set to weight transmission, the specific density of the material (medium) stored in the tank must be entered here for the weight calculation. The value is a relative ratio number (without a unit) compared to the density of water, i.e., 1 g/cm^3.
Value range: 0.01…10

SAP–300	EView2	MultiCONT
CALCULATION → SPECIFIC GRAVITY	*Measurement optimalization → Specific gravity*	*Parameters → P32 Spec. gravity.*

P34: Threshold offset **FACTORY DEFAULT: 0**

It is used for simple relative modification of the acceptance threshold value set in the Echo diagram, the value range of which is –4000…+4000. It can increase (positive value) or decrease (negative value) the device's noise suppression ability compared to the default setting. If the value is 0, there is no change compared to the set threshold value. (See Chapter 7.4 Threshold mask).

SAP–300	EView2	MultiCONT
MEAS. OPTIMIZATION → THRESHOLD OFFSET	*Measurement optimalization → Threshold offset*	*Parameters → P34 Thresh. offs.*

5.6. Volume measurement

P40: 0 - b a Output value calculation method **FACTORY DEFAULT: 0000**

A selection of typical tank shapes for volume measurement. The tank dimensions can be set using parameters P41...P45 (see figures below). In the case of the OCT setting, the tank shape must be specified in a table.

ba	Tank shape	Parameters
- -	Output Conversion Table (OCT)	See Chapter 5.8
b0	Vertical cylindrical tank with a convex bottom	**P40+(b), P41**
01	Vertical cylindrical tank with a conical bottom	**P41, P43, P44**
02	Vertical rectangular tank with a pyramidal bottom	**P41, P42, P43, P44, P45**
03	Horizontal cylindrical tank	**P40(b), P41, P42**
04	Spherical tank	**P41**

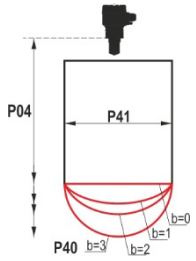
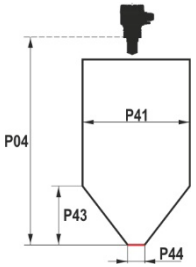
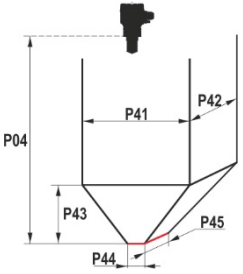
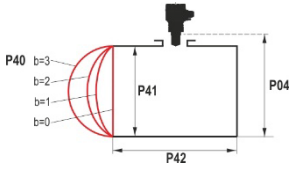
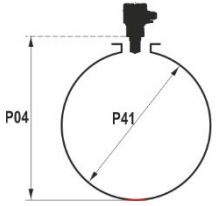
SAP–300	EView2	MultiCONT
CALCULATION → TANK SHAPE	*Tank/Silo parameters → Tank shape*	*Parameters → P40 Tank type.*

b	Tank bottom shape	
0	Planar	Associating typical tank bottom shapes for the specific tank type to calculate the volume accurately. The exact form of the setting code can be seen in the drawings under parameters P41…45.
1	Slightly convex	
2	Strongly convex	
3	Hemispherical	

SAP–300	EView2	MultiCONT
CALCULATION → TANK SHAPE	*Tank/Silo parameters → Bottom shape*	*Parameters → P40 Tank type.*

P41-45: - - - - Tank dimensions

These are the size parameters for the tank shape selected in parameter P40 according to the dimensions shown in the drawings below. **For proper operation, it is important to specify these dimensions accurately.**

Vertical cylindrical tank with a convex bottom	Vertical cylindrical tank with a conical bottom	Vertical rectangular tank with a pyramidal bottom	Horizontal cylindrical tank	Spherical tank
				

P47: - - - a Total tank volume — FACTORY DEFAULT: 0.0

The total tank volume is required for empty volume calculation (see parameter P01).
If one of the outputs (PV, SV, TV, or QV) is set to transmit "Ullage volume," then the total volume can be entered in this parameter to calculate the actual transmitted value. In this case, the transmitted data is the difference between the total volume and the actual medium volume. Its unit is the volume unit set in the P01b decade.
Value range: 0...999,999.

SAP–300	EView2	MultiCONT
CALCULATION → TANK SHAPE	*Tank/Silo parameters → Total tank volume*	*Parameters → P47 Total volume*

5.7. Open-channel flow measurement

P40: 0 - b a Volume flow measurement options **FACTORY DEFAULT: 0000**

ba	Flume, formula, data						Parameters
- -	NIVELCO Parshall flumes	Output Conversion Table, See Chapter 5.8					
		Type	**Calculation formula**	**Q_{min} [l/s]**	**Q_{max} [l/s]**	**"P" [cm]**	
00		GPA-1P1	Q [l/s] = $60.87*h^{1,552}$	0.26	5.38	30	**P46**
01		GPA-1P2	Q [l/s] = $119.7*h^{1,553}$	0.52	13.3	34	**P46**
02		GPA-1P3	Q [l/s] = $178.4*h^{1,555}$	0.78	49	39	**P46**
03		GPA-1P4	Q [l/s] = $353.9*h^{1,558}$	1.52	164	53	**P46**
04		GPA-1P5	Q [l/s] = $521.4*h^{1,558}$	2.25	360	75	**P46**
05		GPA-1P6	Q [l/s] = $674.6*h^{1,556}$	2.91	570	120	**P46**
06		GPA-1P7	Q [l/s] = $1014.9*h^{1,56}$	4.4	890	130	**P46**
07		GPA-1P8	Q [l/s] = $1368*h^{1,5638}$	5.8	1208	135	**P46**
08		GPA-1P9	Q [l/s] = $2080.5*h^{1,5689}$	8.7	1850	150	**P46**
09	Generic Parshall flume						**P46**, **P42**
10	Palmer-Bowlus (D/2)						**P46**, **P41**
11	Palmer-Bowlus (D/3)						**P46**, **P41**
12	Palmer-Bowlus (rectangular)						**P46**, **P41**, **P42**
13	Khafagi-Venturi						**P46**, **P42**
14	Weir						**P46**, **P42**
15	Rectangular or Bazin weir						**P46**, **P41**, **P42**
16	Trapezoidal weir						**P46**, **P41**, **P42**
17	Special trapezoidal (4:1) weir						**P46**, **P42**
18	V-shaped weir						**P46**, **P42**
19	Thomson (90°) weir						**P46**
20	Circular weir						**P46**, **P41**
21	Generic formula: Q[l/s] = **P41**$*h^{P42}$, h [m]						**P46**, **P41**, **P42**
22	Generic formula: Q[l/s] = **P41**$*h^{P42}$, h [P00:cb]						**P46**, **P41**, **P42**

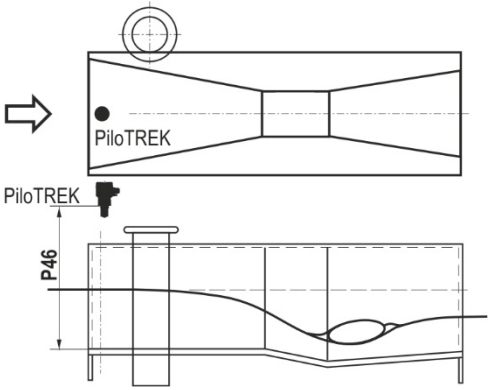
ba	Flume, formula, data	Parameters
30	4" Palmer-Bowlus (D/2)	**P46**
31	6" Palmer-Bowlus (D/2)	**P46**
32	8" Palmer-Bowlus (D/2)	**P46**
33	10" Palmer-Bowlus (D/2)	**P46**
34	12" Palmer-Bowlus (D/2)	**P46**
35	15" Palmer-Bowlus (D/2)	**P46**
36	18" Palmer-Bowlus (D/2)	**P46**
37	21" Palmer-Bowlus (D/2)	**P46**
38	24" Palmer-Bowlus (D/2)	**P46**

SAP–300	EView2	MultiCONT
CALCULATION → FLOW MEASUREMENT	*Flow measurement → Open channel flow measurement methods*	*Parameters → P40 Tank type.*

P41-45: Flume / weir dimensions **FACTORY DEFAULT: 0**

P40=00
.
.
.
.
08

NIVELCO Parshall flume (GPA1-P1 through GPA-1P9)
See details in the manual of the Parshall flume.



P40=09

Generic Parshall flume

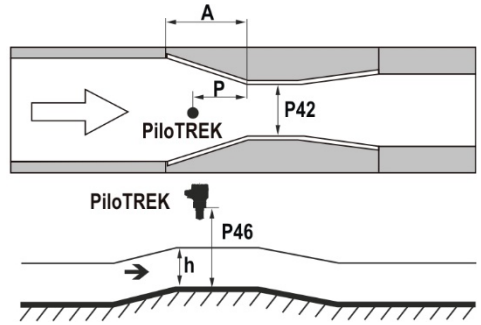
0,305 < **P42** (throat width) < 2,44

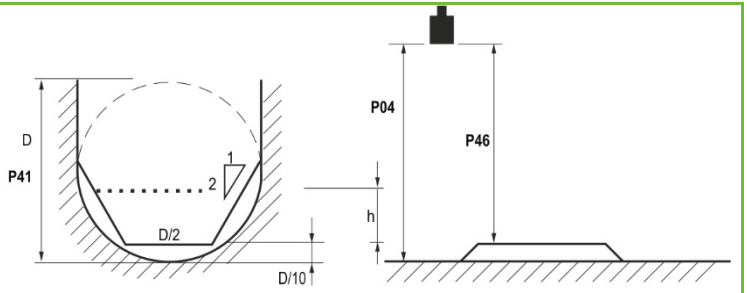
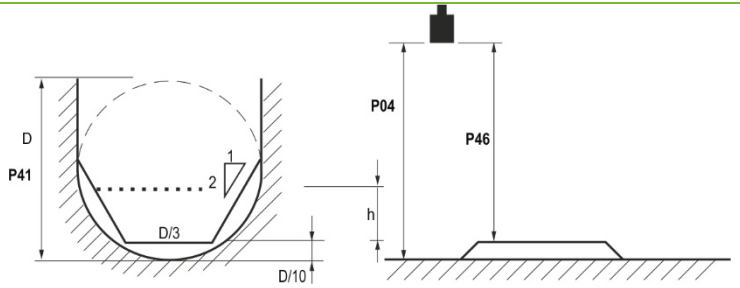
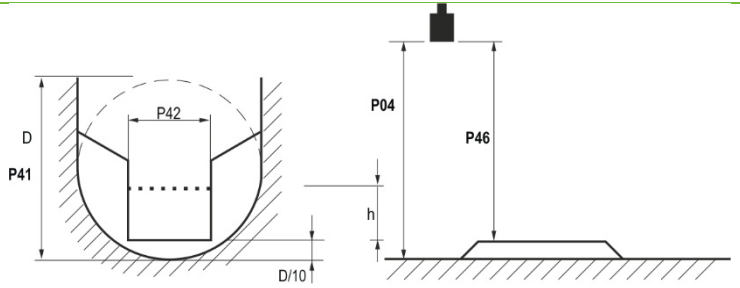
$$Q[l/s] = 372 \cdot \mathbf{P42} \cdot (h/0{,}305)^{1{,}569\,\mathbf{P42}^{0{,}026}}$$

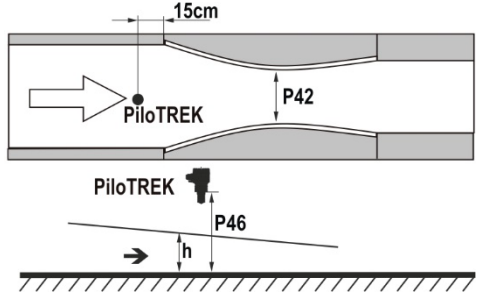
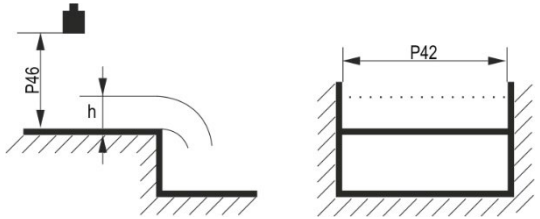
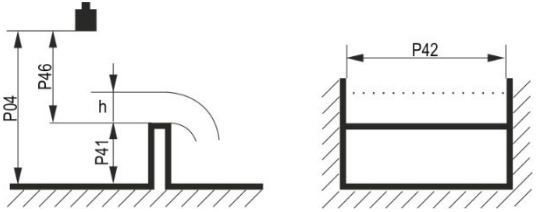
2,5 < P42
Q [l/s] = K*P42*h^{1,6}

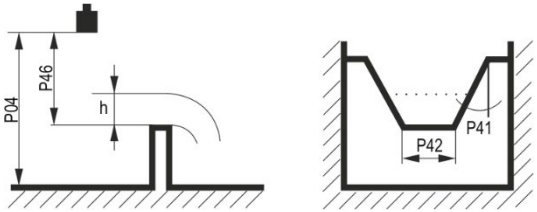
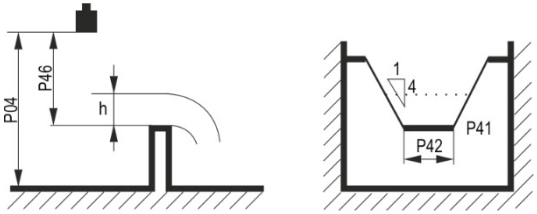
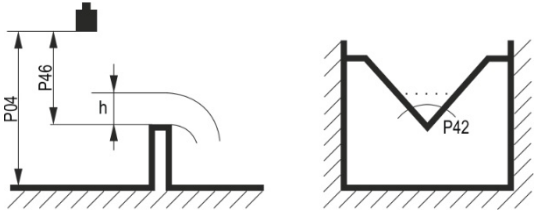
P = 2/3*A

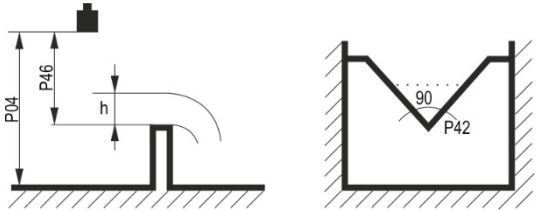
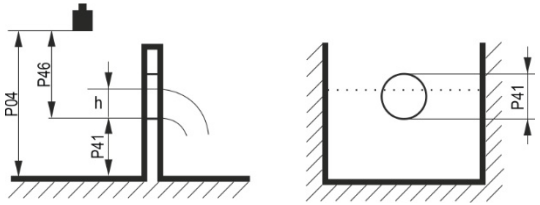
P42 [m]	K
3,05	2,450
4,57	2,400
6,10	2,370
7,62	2,350
9,14	2,340
15,24	2,320

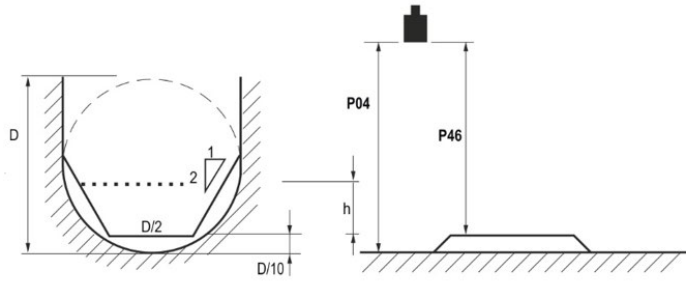


P40= 10	**Palmer-Bowlus (D/2) flume** Q [m^3/s] = f(h1/**P41**) * **P41**^{2,5}, where h1[m] = h+(**P41**/10) **P41** [m]	
P40= 11	**Palmer-Bowlus (D/3) flume** Q [m^3/s] = f(h1/**P41**) * **P41**^{2,5}, where h1[m]= h+(**P41**/10) **P41** [m]	
P40= 12	**Palmer-Bowlus (rectangular) flume** Q [m^3/s] = C*__P42__*h^{1,5}, where C = f(**P41**/**P42**) **P41 [m], P42 [m]**	

P40= 13	**Khafagi-Venturi flume** $Q\ [m^3/s] = 1{,}744 \cdot \mathbf{P42} \cdot h^{1,5} + 0{,}091 \cdot h^{2,5}$ **P42 [m]** h [m]	
P40= 14	**Weir** $0{,}0005 < Q\ [m^3/s] < 1$ **0,3 < P42 [m] < 15** $0{,}1 < h\ [m] < 10$ **$Q\ [m^3/s] = 5{,}073 \cdot P42 \cdot h^{1,5}$** **Accuracy: ±10%**	
P40= 15	**Rectangular or Bazin weir** $0{,}001 < Q\ [m^3/s] < 5$ **0,15 < P41 [m] < 0,8** **0,15 < P42 [m] < 3** $0{,}015 < h\ [m] < 0{,}8$ **$Q\ [m^3/s] = 1{,}77738(1+0{,}1378h/P41) \cdot P42 \cdot (h+0{,}0012)^{1,5}$** **Accuracy**: ±1%	

P40= 16	**Trapezoid weir** 0,0032 < Q [m^3/s] < 82 **20 < P41[°] < 100** **0,5 < P42 [m] < 15** 0,1 < h [m] < 2 **Q [m^3/s] = 1,772 · P42 · $h^{1,5}$ + 1,320 ·tg(P41/2) · $h^{2,47}$** **Accuracy: ±5%**	
P40= 17	**Special trapezoid (4:1) weir** 0,0018 < Q [m^3/s] < 50 **0,3 < P42 [m] < 10** 0,1 < h [m] < 2 **Q [m^3/s] = 1,866 · P42 · $h^{1,5}$** **Accuracy: ±3%**	
P40= 18	**V-shaped weir** 0,0002 < Q [m^3/s] < 1 **20 < P42[°] < 100** 0,05 < h [m] < 1 **Q[m^3/s] = 1,320 · tg(P42/2) · $h^{2,47}$** **Accuracy: ±3%**	

P40= 19	**THOMSON (90°) weir** 0,0002 < Q [m^3/s] < 1 0,05 < h [m] < 1 Q [m^3/s] = 1,320 · $h^{2,47}$ **Accuracy: ±3%**	
P40= 20	**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/D)** **m = 0,555+0,041 · h/P41+(P41/(0,11 · h))** **Accuracy: ±5%**	
P40=21	**Generic formula:** **Q [l/s] = P41*h^{P42}** **h [m]**	
P40=22	**Generic formula:** Q [l/s] = P41*h^{P42} 'h' will be substituted in the unit set in P00c and P00b.	

P40=30...38	**Palmer-Bowlus standard D/2 flume (4"… 24")** Refer to flume's user manual for details. **P46 [P00c, P00b]**	

P46: - - - a Distance associated with h=0 when measuring flow **FACTORY DEFAULT: VARIES BY TYPE**

P46 is the distance between the sensor's process connection and the liquid's surface, which can be measured at the limit of the start of the flow (Q = 0); see figures. Minimum value: P05 + 5 cm (2"). Maximum value: P03.

5.8. Output Conversion Table – OCT programming

P40: d - [] [] OCT operation **FACTORY DEFAULT: 0**

d	Output data Measurement mode	Reference
0	Output Conversion Table OFF	See Chapter 5.8
1	Output Conversion Table ON	

An output signal of any characteristic can be assigned to the level values measured by the device. The unit of the output signal is the unit set in parameter P00 or P02 of the output data type assigned to the "HART - PV" output in parameter P01. The characteristic can be specified with a maximum of 100 points. Between the points, the device calculates the output signal from the measured level by linear interpolation and after the last point by linear extrapolation. The OCT can be used to assign the measured level to an arbitrary output signal. Its typical application is the calculation of level to volume for tanks that are not included in the tank shape list (e.g., dented) and specifying individual channel characteristics in the case of open channel flow measurement.

SAP–300	EView2	MultiCONT
CALCULATION → OCT TABLE	*OC-Table → Linearization (See Chapter 7.5)*	*Parameters → P40 Tank type.*

Conditions for correct programming of data pairs

- The table must start with L(1)= 0 and R(1)= is the output quantity assigned to it.
- Column “L” may not contain identical values.
- Columns “L” and “R” can only have increasing values from top to bottom.
- If the table contains less than 100 points, column “L”, in the row following the last valuable data pair, must be 0.

i	**L** (left column) MEASURED LEVEL	**R** (right column) OUTPUT VALUE
1	**0**	**R(1)**
2	**L(2)**	**R(2)**
	L(i)	**R(i)**
nn	**L(nn)**	**R(nn)**
nn+1	**0**	
100		

SAP–300	**EView2**	**MultiCONT**
CALCULATION → OCT TABLE	*OC-Table → OCT list (See Chapter 7.5)*	*Parameters → P40 Tank type.*

5.9. Service diagnostic parameters (read only)

P60:	**- - - -**	**Number of operating hours since issuing [h]**
P61:	**- - - -**	**The number of operating hours since the last power-on [h]**
P62:	**- - - -**	**The number of operating hours of the relay (closed time of contact C2) [h]**
P63:	**- - - -**	**The number of switching cycles of the relay**
P64:	**- - - -**	**The current temperature of the device's electronics [°C / °F]**
P65:	**- - - -**	**The highest temperature of the device ever measured [°C / °F]**
P66:	**- - - -**	**The lowest temperature of the device ever measured [°C / °F]**
P70:	**- - - -**	**Number of detected peaks (current)**
P71:	**- - - -**	**Magnitude of selected echo (raw value)**
P72	**- - - -**	**The amplitude of the selected echo [dB]**
P73:		**The distance of the selected echo [m]**
P74:		**Echo lost/shot ratio**

5.10. Flow measurement control parameters (read only)

P76: - - - - Measuring height of the flow measurement ('h' value)

Measuring height required for flow measurement. This value is the “h” value in the flow calculation formula. (See P46)

P77: - - - - TOT1 totalizer (can be cleared)

P78: - - - - TOT2 totalizer

5.11. Output control parameters (read only)

P79: - - - - Current generator re-measured output current [µA]

P80: - - - - Current generator calculated output current [mA]

P81: - - - - Relay output status

5.12. Hardware / Software versions (read only)

P94/95: - - - - Software code 2 / 3 (SLAVE MCUs)

P96: - - - - Software code 3 (MAIN MCU)

P97/98: - - - - Hardware identification code

6. TROUBLESHOOTING

6.1. Status and error indication in HART® communication

Status and error indication in HART communication: The response code, according to the HART standard, is two 16-bit words after the "Response code" bytes, respectively "Errors and Warnings" and "Status."

Bit №	Device Specific Error/Warning flags	Meaning, possible reason, solution
0	No echo (*Warning*)	The device cannot detect the surface to be measured, so there is no echo or there are too many echoes due to interference. Ensure proper installation! If the problem persists, contact the dealership.
1	EEPROM is not detected (*Error*)	The parameter memory of the device is compromised. Contact dealership.
2	EEPROM checksum error detected (*Error*)	Some data stored in the device's parameter memory has been corrupted. Factory default settings are restored by the device. If the device's parameter memory fails frequently, contact the dealership.
3	OCT input side integrity error (*Error*)	The data in the left (L) column of the Output Conversion Table (OCT) is not incremental. Correct it.
4	OCT output side integrity error (*Error*)	The data in the right (R) column of the Output Conversion Table (OCT) is not incremental. Correct it.
5	OCT item count is <2 (*Error*)	Too few points are entered into the Output Conversion Table (OCT). At least two ($i \geq 2$) points (elements) must be entered.
6	Input level over the OCT input side (overload) (*Warning*)	The measured level, as the input value of the OCT, points out of the range entered in the left (L) column of the OCT. Enhance the range.
7	EEPROM reinitiated (EEPROM layout damaged or missing) (*Error*)	The data structure stored in the device's parameter memory is corrupted. The device restored the factory default settings. If the device's parameter memory fails frequently, contact the dealership!
8	—	—
9	Echo in near blocking range (Warning)	The measured surface is too close, within the device's minimum measuring range (X_{min}). Set the close-end blocking (P05) to a smaller value, or change the technology to ensure that the surface to be measured does not come so close to the sensor of the device.
10	Echo in far blocking range (Warning)	The measured surface is too far, outside the device's maximum measuring range (X_{max}). Set the far-end blocking (P05) to a larger value, or change the technology to ensure that the surface to be measured does not get so far from the sensor of the device.
11	—	—

Bit №	Device Specific Error/Warning flags	Meaning, possible reason, solution
12	One or more slave controller(s) failure! (Error)	One of the device's auxiliary controllers has failed. The probability of a firmware error is high. Performing a complete firmware update with NiFlash (including synchronization) may solve the problem. If unsuccessful, contact the dealership.
13	Relay failure (Error)	If the device has an optional relay, it is faulty. Contact the dealership.
14	Parameter table integrity error (Error)	The value of one or more parameters is not consistent with the associated parameters. Correct the parameter value.
15	Sensor failure (Error)	The radar sensor is faulty. There can be several reasons for this, e.g., the data connection with the radar sensor unit is inadequate or insufficient energy available for the measurement. The terminal voltage of the device must be above the prescribed minimum in all circumstances! Check the voltage conditions of the loop by measurement and change it as necessary so that the electrical conditions for the terminals of the device are met. Contact the dealership if the power supply voltage level is correct and the error persists.

Bit №	Device-Specific Status flags (DSS)	Explanation
0-2	PV value type (DIST, LEV, VOL, MASS, FLOW, LEV%, VOL%, …)	The type of the primary transmitted value (PV) by P01a.
3	Manual programming is active (Status)	The device is in manual programming mode. (Only on devices (WG☐) featuring a display.)
4	Remote programming is active (Status)	The device is in remote programming mode.
5	Simulation is active (Warning)	The device is in simulation mode. Caution! The output value is independent of the measured value.
6	User password is set (Status)	Password protection is active.
7	Relay energized (Status)	Relay is energized.
8	User lock is active (Status)	User lock is active. The parameters are protected by a password set by the user.
9	Factory lock is active (Status)	Factory lock is active. The factory default settings and calibration data are locked.
10	SAP display is connected (Status)	A display is connected to the device. (Only on devices (WG☐) featuring a display.)
11	Diagnostic mode is active (Status)	The device is in diagnostic mode.
12	HOLD (Warning)	The transmitted value is on hold.
13	Calibration mode is active (Status)	The device is in calibration mode.
14	Valid (Status)	The transmitted value is refreshed and valid.
15	HS communication mode is active (Status)	The device is in high-speed communication mode.

6.2. Typical application errors

Error	Possible cause	Solution
The transmitted value takes a value from a close range (most often around 0.2 m).	Condensation or dirt on the antenna.	Clean the antenna or use a threshold mask to block the interfering echo.
The measured value does not change despite the level change.	This typically happens when echo loss occurs. In most cases, this is: – during foaming of the medium – dirt on the antenna – excessive waves – incorrect max. (P03) measurement setting – it can happen in cases of echo below the threshold curve.	Remove dirt from the antenna. Check the surface of the medium to be measured, if necessary, take measures to reduce foaming or ripples! Check threshold settings. See Chapter 7.3! Check the P03 maximum measuring distance setting.

7. EView2 INSTRUCTIONS

If necessary, install the EView2 HART configuration software (hereafter EView2) as described in Chapter 3 of the program's manual. The software can be downloaded from www.nivelco.com.
Electrical connections: Start the program and search for the transmitter with the program (for more information, see also EView2 user manual, Chapter 4).
From the devices found during the detection, select the device you want to configure or program and open the "device programming" window of the device (Chapters 4.4 and 4.5 of the EView2 user manual). All the necessary parameters and function settings can be changed with EView2.
This chapter only describes the specific functions related to PiloTREKs and two programming examples.

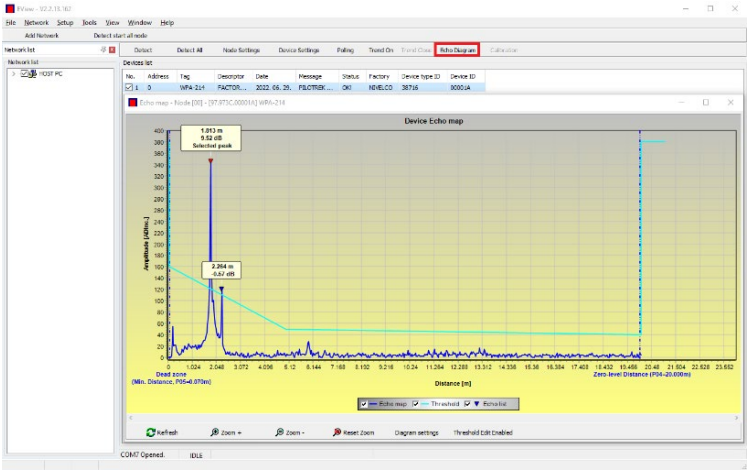
7.1. Device Status Window

To invoke the "Device Status Window" in EView2, right-click on the device line in the "Device List" in the main window and select the "Show Device Status Window" menu item in the popup window. This window shows the status and error messages of the PiloTREK. (See Chapter 6.1) The "Device Status Window" can also be summoned in the "Polling" window by activating the corresponding check box.

7.2. Echo Diagram (oscilloscope function)

Click the “Echo Diagram” button in EView2 to display the device's Echo Diagram. A window called “Echo map” will appear. This diagram shows the reflection curve measured by the device. In addition, this window can be used to adjust the threshold level. To update the chart or read the data, press the “Refresh” button on the bottom line of the window (or press the F4 key).

After a successful reading, an echo graph similar to the attached “Echo Diagram” appears. The displayed information content can be selected in the legend. The “Echo list” displays the location and data of the echo peaks evaluated by the device, of which the selected level signal is marked with the inscription “Selected peak.”



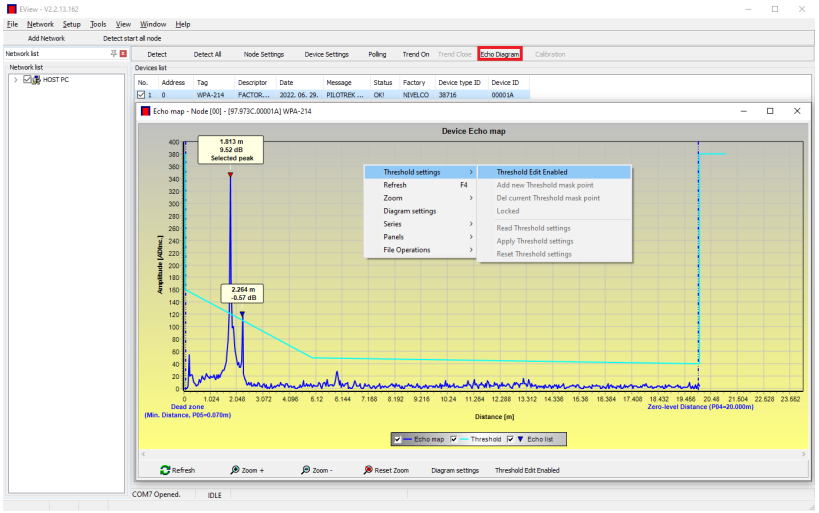
7.3. Threshold settings

The function is intended for advanced users. Incorrect setting may render the device unable to measure!

The purpose of the threshold value and the threshold line is to mask unwanted echoes from the measurement. Echo peaks below the threshold level are not taken into account in the evaluation. Setting the threshold may be necessary if the device selects the wrong echo peak as the level, for example because there is an interfering object in the path of the ultrasound during the measurement. Before changing the threshold curve, it is recommended to minimize interfering echoes by selecting the correct installation location of the device.

The threshold can be edited in the Echo diagram window of the EView2 software. In addition, the height of the entire threshold can be adjusted in a simplified way with the P34 “Threshold offset” parameter among the measurement optimization parameters. The main threshold line is used to trace the general shape of the echo curve. Threshold highlights, also known as threshold masks, are available to mask interfering echo peaks protruding from the curve.

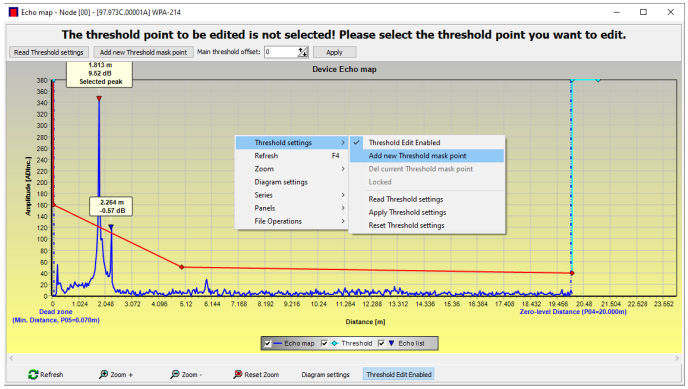
The threshold editing mode can be activated either by selecting “Threshold Edit Enable” in the bottom menu bar or by selecting “Threshold settings” → “Threshold Edit Enable” in the context menu that appears when clicking the right mouse button. In this case, the threshold editing function bar appears in the upper half of the window, and the editable points are marked red on the threshold curve. If no editable point is selected, the “Threshold offset” can be set in the function bar, so the height of the basic threshold curve consisting of three points is the same. If an editable point is selected by clicking the left mouse button, its position can also be altered separately.

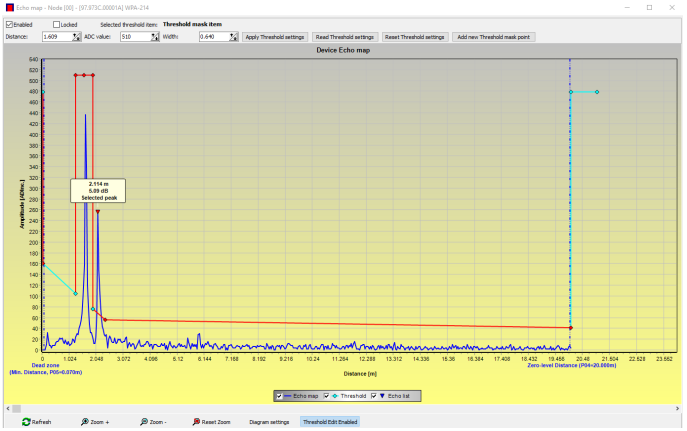


Threshold points can also be moved with the mouse by clicking and holding the left mouse button over the selected point. The changes only take effect in the device after pressing the “Apply Threshold settings” button, which can also be found in the threshold editing function bar or the context menu. To display the evaluation corresponding to the new threshold, refresh the chart with the “Refresh” button in the bottom menu bar (or the F4 function key).

7.4. Threshold mask

The “Threshold Mask” function masks an echo peak that interferes with the measurement. To do this, after pressing the “Add new threshold mask” button in the threshold editing function bar, click the left mouse button in the diagram over the position where you want to place the threshold highlight, or if using the context menu, click with the right mouse button on the desired position, then select the “Add new threshold mask” function. The position and width of the threshold mask can also be adjusted afterwards in the threshold editing function bar by selecting the center point of the highlight as described above. In the case of graphic editing, its position and height can be adjusted by dragging the center point, and its width can be adjusted by dragging the corner point. A total of 4 threshold highlights can be defined. If there are more interfering echoes than 4, it is better to choose another mounting position.





Caution! The “Cursor On” function does not provide an exact value. It only calculates the value of a given point based on the graphical representation.

The threshold highlight can be deleted by selecting its center point, or turning the “Enabled” switch off in the threshold editing function bar, or selecting the “Del current threshold mask” function in the context menu. Until the changes are applied to the device with the “Apply Threshold settings” function, it uses the previous (current) threshold settings, which can be read with the “Read Threshold settings” function. The factory default settings can be restored with the “Reset Threshold Settings” function.

7.5. The output conversion table (OCT) – (EView2 OC-Table)

The output conversion table (OCT) is active if table correction is selected in parameter P40. See Chapters 5.7, 5.8, and 5.9. The OCT is filled in using the EView2 software. The conversion table is usually used for volume measurement but can also be used for weight or flow measurement.
This table assigns different output values to the measured levels. The value on the left is always the measured level (relative to the zero-level distance (P04) setting), and the value on the right is the output value for the particular level. The unit associated with the output value is determined by the setting of the "Output source" (P01, HART - PV) and "Output units" (P02) parameters.
The output value is determined by linear interpolation between two value pairs, so the accuracy of the conversion depends on the density of the associated value pairs. After the last pair of points, the output value is calculated by linear extrapolation. The maximum number of pairs is 100.
More information:

- Each new level value entered must be greater than the previous one.
- The length and volume units can be changed later on without changing the data in the table (length unit, volume unit). Take heed that the units in the table are always interpreted by the device according to the currently set units of measure. Therefore, the OCT must always be filled in with values corresponding to the set units.
- Caution! When using the conversion table, the setting of the current output (P10/P11) is also interpreted according to the value range (and measurement unit) defined on the left side of the table. Accordingly, the appropriate setting of the P10/P11 parameters is recommended after uploading the table.
- If the conversion table is filled in incorrectly, the output (transmitted) value will not be correct either!

A user-defined conversion table (e.g., "level - volume") can be created using EView2 as follows:
To fill in or set the output conversion (OC) table of the device, go to the "Device Settings" → "OC-Table" tab in EView2. Upload or modify the table according to "EView2 Instructions for Use – Chapter 6.4." If the appropriate changes have been made in the table and it has been filled in correctly, press the "Send" button on this page ("OC-Table" tab) on the right side under the "Get" button to download the table to the device.

In the following example, five-point programming is presented, example: “Level - Volume” conversion

Step	Action	Entered data / chosen value
1	In EView2, open the “Device Settings” window of the given device.	
2	Go to the point called “Application” and select the unit system (“Calculation system”).	Metric (EU)
3	Select a length unit (Engineering Unit).	m
4	Go to “Measurement configuration” and select “Measurement mode (PV source): volume transmission” from the list.	Volume
5	Select a volume unit in the “Volume Units” section.	m^3
6	Go to “Measuring distances” and enter the tank height in the field named “Zero-level dist.” (Click on the field and enter the value).	6.00 m
9	Press the “Send” button in the lower right corner of the window to download the new values to the device.	Wait until the download process is complete.
10	Go to the point called “OC-Table.” Fill in the table called “OCT list” with the appropriate values. A maximum of 100 points can be entered. Each level and volume point must be entered. Each subsequent point must be larger than the previous one. New lines can be created by pressing the “Ctrl + Insert” key combination or selecting “Add new item” in the popup menu of the right mouse button. A line can be deleted by pressing the “Ctrl + D” keys together.	See the following table (Example for completing OCT)
11	To download the table to the device, press the “Send” button located on this page (“OC-Table” tab) on the right side under the “Get” button.	

Example of filling out the OCT

Point	Level (Source column)	Volume (Output column)
1	0.0 m (0.0 ft)	0.0 m³ (0.0 ft³)
2	0.20 m (0.66 ft)	0.5 m³ (17.6 ft³)
3	0.75 m (2.46 ft)	1.0 m³ (35.3 ft³)
4	1.00 m (3.30 ft)	1.5 m³ (53 ft³)
5	5.60 m (18.37 ft)	16.8 m³ (593.3 ft³)

Additional procedure for displaying 4…20 mA current output (using EView2)

Step	Action	Entered data / value
1	Go to “Outputs” and set “Current generator mode” to “Auto” (default setting)	Auto
2	In the “Error indication ...” field, set the error status to the appropriate mode (default setting).	Hold-
3	Select “Assignment of 4 mA – PV (P10)” and enter the volume value corresponding to the output current value of 4 mA.	0.5 m³ (17.6 ft³)
4	Select “Assignment of 20 mA – PV (P11)” and enter the volume value corresponding to the output current value of 20 mA.	16.80 m³ (593.3 ft³)
5	Press the “Send” button in the lower right line of the window to download the new values to the device.	
6	Press the “X” close button to exit the device settings window.	

7.6. Programming example 1 – configuring level measurement (using EView2)

Configuring level measurement in a 9 m (29.5 ft) tank (example). Level measurement is the factory default mode, it is sufficient to enter only the actual tank height (P04 = 9.0 m [29.5 ft]). The max. measuring length of the WP−200 radar configured by the manufacturer is 10.0 m (33 ft), so it covers the required 9 m (29.5 ft).

Step	Action	Entered data / value
1	Open the “Device Settings” window corresponding to the given device in EView2.	The program reads and displays the device settings.
2	Select “Measurement configuration.”	
3	Click on “Zero-level dist.” (Zero-level distance) field.	Data in the field: 10.000 [m] (33.000 [ft])
4	Enter the new value.	9,000 [m] (29.500 [ft])
5	Press the “Send” button in the lower right corner of the window to download the new value to the device.	The device will work according to the new settings after the download is complete.
6	Press the “X” close button to exit the device settings window.	

7.7. Programming example 2 – configuring the current loop output (using EView2)

Custom scale setting: Example: 4 mA indicates the 1 m level [3.3 ft], 20 mA indicates the full tank, for example 8 m (26.2 ft) maximum level, upper error current.
Set current range 4…20 mA with 22 mA error indication.
Choose a suitable minimum and maximum value for the scale of the measurement.

Step	Action	Entered data / value
1	In EView2, open the "Device Settings" window corresponding to the given device.	The program reads the device settings and displays them.
4	Select "Outputs"	
5	Select the "Error indication …" drop-down list.	The field will read "Hold"
6	Select the new setting value (22 mA) in the drop-down list.	The field will read "22 mA"
7	Select the "Assignment of 4 mA – PV" data field.	The field will read "0.000 [m]" (0.000 [ft])
8	Enter the new value. This sets the level corresponding to the 4-mA minimum output (1 m).	The field will read "1.000 [m]" (3.300 [ft])
9	Select the "Assignment of 20 mA – PV" data field.	The field will show the maximum measuring distance by default.
10	Switch to 8.000 m (26.20 ft). This sets the level corresponding to the 20-mA maximum output (8 m [26.2 ft]).	The field will read "8.000 [m]" (26.20 [ft])
11	Press the "Send" button in the lower right line of the window to download the new values to the device.	After the download is complete, the device will use the new settings.
12	Press the "X" close button to exit the device settings window.	

8. PROGRAMMING WITH SAP–300 DISPLAY UNIT

The main parameters of PiloTREK can also be set using the SAP–300 display unit. By default, the display shows the primary measurement result (from which the output current is calculated). In addition to the measurement value displayed in large figures, a bar graph representing the output current value is also shown on the right.

Programming is done via a text menu. Use the Ⓔ / ⊕ / ⊖ / ⊖ keys to navigate through the menu.

8.1. SAP–300 display unit

Display:	64 × 128 dot matrix LCD, with symbols, units, and column diagram
Ambient temperature:	–20…+65 °C (–4…+149 °F)
Housing material:	PBT fiberglass-reinforced plastic (DuPont®)

The SAP–300 is a plug-in module with an LCD (universal – can be used in other NIVELCO devices, provided that the device's software supports SAP–300).

Caution!

The SAP–300 is based on LCD technology, do not expose the SAP–300 to prolonged heat or sunlight as the display may be damaged.

If it is not possible to protect the PiloTREK from sunlight or if the PiloTREK is to be used outside the operating temperature range of the SAP–300, do not leave the SAP–300 in the PiloTREK!

8.2. The PiloTREK during programming

By default, the PiloTREK displays the main measurement data on the SAP–300 display (hereafter referred to as the display).

To enter the programming menu, press the Ⓔ button. Use the ⊕ / ⊖ buttons to navigate between the menu items.

You can also enter the selected menu item by pressing the Ⓔ button. To return to the previous menu level, press the ⊖ button.

The buttons only work when the SAP-300 is present!

While using the menu, the instrument continues measuring without interruption. Any setting changes made in the menu will take effect when you exit the menu. If the PiloTREK menu is not exited, the PiloTREK will automatically return to the measurement display state after 30 minutes. Any changes made in the menu will then be ignored.

If the SAP–300 is unplugged from PiloTREK, PiloTREK will automatically exit the menu and ignore any changes made to the menu.

Since programming with the SAP–300 (manual programming) and remote programming via HART (REMOTE MODE) create a competing situation, only one mode can be used at a time.

Manual programming has priority!
During manual programming, the device sends a "device busy" signal to the HART master (HART Response code: 32 - Device is busy).
In remote programming mode, REM appears on the top right of the display. In this case, manual programming of the device is disabled, and the menu cannot be accessed.

If no SAP–300 is connected, the LEDs will become visible, the COM LED will flash to indicate HART communication, and the VALID LED will indicate if the data measured by the device is valid.

8.3. Manual programming

While on a submenu item, pressing the Ⓔ button will change the parameter or access an additional submenu.

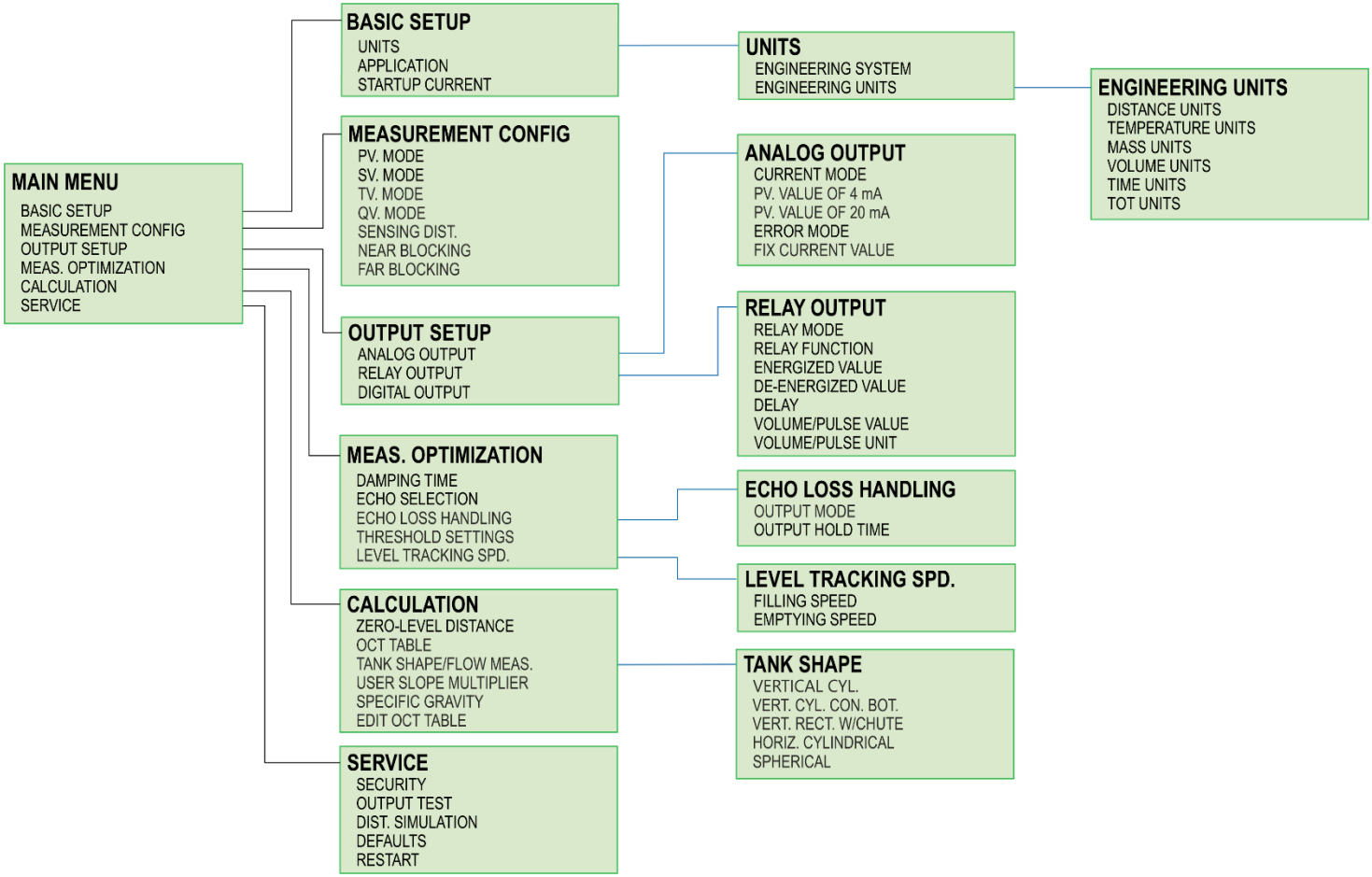
There are two modes:

Text list: It can be navigated like the menu list.

Accept selection by pressing Ⓔ, and discard it by pressing the ◄ button.

Editable number field: It is used to edit numeric values. Editing is assisted by a cursor (inverse character).

The number on the cursor position can be changed with the ▲ / ▼ keys (no over-, under-, or underflow between characters). The cursor can be moved to the left with the ◄ arrow key (max. 9 characters space, including the decimal point). When you reach the end of the field, the cursor returns to the first position on the right. The modification is completed by pressing the Ⓔ button. PiloTREK will then check the value entered, and if it is not correct, the message "WRONG VALUE!" will appear on the bottom line.


MAIN MENU
BASIC SETUP
MEASUREMENT CONFIG
OUTPUT SETUP
MEAS. OPTIMIZATION
CALCULATION
SERVICE
BASIC SETUP
UNITS
APPLICATION
STARTUP CURRENT
MEASUREMENT CONFIG
PV. MODE
SV. MODE
TV. MODE
QV. MODE
SENSING DIST.
NEAR BLOCKING
FAR BLOCKING
OUTPUT SETUP
ANALOG OUTPUT
RELAY OUTPUT
DIGITAL OUTPUT
MEAS. OPTIMIZATION
DAMPING TIME
ECHO SELECTION
ECHO LOSS HANDLING
THRESHOLD SETTINGS
LEVEL TRACKING SPD.
CALCULATION
ZERO-LEVEL DISTANCE
OCT TABLE
TANK SHAPE/FLOW MEAS.
USER SLOPE MULTIPLIER
SPECIFIC GRAVITY
EDIT OCT TABLE
SERVICE
SECURITY
OUTPUT TEST
DIST. SIMULATION
DEFAULTS
RESTART
UNITS
ENGINEERING SYSTEM
ENGINEERING UNITS
ENGINEERING UNITS
DISTANCE UNITS
TEMPERATURE UNITS
MASS UNITS
VOLUME UNITS
TIME UNITS
TOT UNITS
ANALOG OUTPUT
CURRENT MODE
PV. VALUE OF 4 mA
PV. VALUE OF 20 mA
ERROR MODE
FIX CURRENT VALUE
RELAY OUTPUT
RELAY MODE
RELAY FUNCTION
ENERGIZED VALUE
DE-ENERGIZED VALUE
DELAY
VOLUME/PULSE VALUE
VOLUME/PULSE UNIT
ECHO LOSS HANDLING
OUTPUT MODE
OUTPUT HOLD TIME
LEVEL TRACKING SPD.
FILLING SPEED
EMPTYING SPEED
TANK SHAPE
VERTICAL CYL.
VERT. CYL. CON. BOT.
VERT. RECT. W/CHUTE
HORIZ. CYLINDRICAL
SPHERICAL

9. PARAMETER LIST

Pr.	Page	Name	Value d	c	b	a
P00	17	Unit system, default unit, region parameter				
P01	19	Output source				
P02	19	Output units				
P03	21	Maximum sensing distance				
P04	21	Zero-level distance (tank height – H)				
P05	23	Close-end blocking (dead-zone)				
P06	23	Far-end blocking				
P07		—				
P08	25	Manual output current value				
P09		—				
P10	25	Output value assigned to 4 mA				
P11	25	Output value assigned to 20 mA				
P12	26	Analog current loop output's mode				
P13	27	Relay output				
P14	29	Relay parameter – Trigger value				
P15	29	Relay parameter – Release value				
P16	30	Relay parameter – Delay				
P17	30	Relay parameter – Flow parameter value				
P18		—				
P19	30	HART address				
P20	30	Damping Time				
P21		—				
P22	32	User Slope Correction Factor				
P23		—				
P24		—				
P25	32	Echo selection				
P26	33	Level rise speed (filling speed)				
P27	33	Level drop speed (discharging speed)				
P28	33	Measurement loss management				
P29		—				
P30		—				
P31		—				
P32	34	Density of the measured medium				
P34	34	Threshold offset				
P40	35	Tank shape				
P41	39	Tank dimensions / Volume flow options				
P42	39	Tank dimensions / Flume – weir dimensions				
P43	39	Tank dimensions / Flume – weir dimensions				
P44	39	Tank dimensions / Flume – weir dimensions				
P45	39	Tank dimensions / Flume – weir dimensions				
P46	44	The distance to the surface without flow				
P47	36	Total tank volume				

Pr.	Page	Name	Pr.	Page	Name
P60	45	Number of operating hours since issuing [h]	**P80**	46	Current generator calculated output current [mA]
P61	45	The number of operating hours since the last power-on [h]	**P81**	46	Status of relay outputs
P62	45	The number of operating hours of the signal detector (closed time of contact C2) [h]	**P82**		—
P63	45	The number of switching cycles of the relay	**P83**		—
P64	45	The current temperature of the electronics [°C / °F]	**P84**		—
P65	45	The highest temperature of the device ever measured [°C / °F]	**P85**		—
P66	45	The lowest temperature of the device ever measured [°C / °F]	**P86**		—
P67		—	**P87**		—
P68		—	**P88**		—
P69		—	**P89**		—
P70	45	Number of detected peaks (current)	**P90**		—
P71	45	Magnitude of selected echo [raw value]	**P91**		—
P72	45	Amplitude of selected echo [dB]	**P92**		—
P73	45	Distance of selected echo [m]	**P93**		—
P74	45	Echo lost / shot rate	**P94**	46	Software identifier (RADAR)
P75			**P95**	46	Software identifier (COPROC)
P76	46	Measuring height of the flow measurement (read only) (LEV)	**P96**	46	Software identifier (MAIN MCU)
P77	46	TOT1 totalizer (clearable)	**P97**	46	Special config mode (read only)
P78	46	TOT2 totalizer	**P98**	46	Hardware code (read only)
P79	46	Current generator re-measured output current [µA]	**P99**		

wes200en23p01
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