NIVOTRACK

M-500/600, M-500 Ex

two-wire magnetostrictive level transmitters

User's and Programming manual

10th edition

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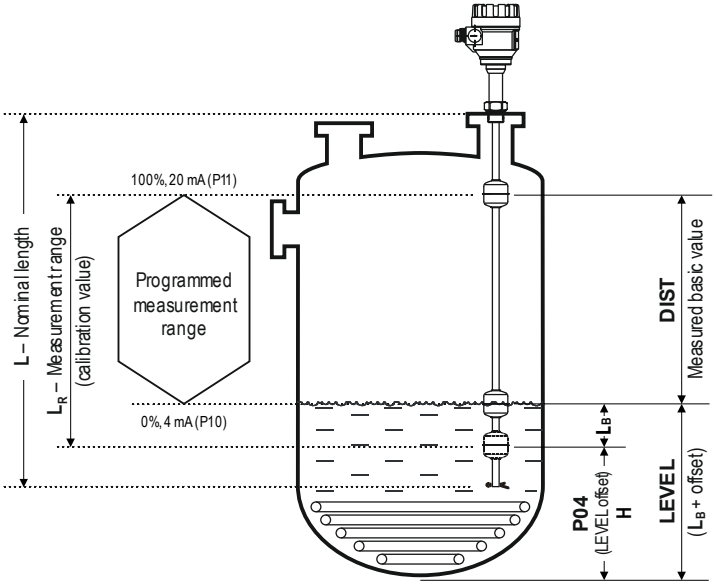
APPROVALS		Reference document number
	FM Canada, Certificate No.:FM16CA0037X	mba5052a0600s_01
	FM US, Certificate No.:FM16US0068X	mba5052a0600s_01
	BKI ATEX, Certificate No.:BKI16ATEX0012X/2	mba5052m0600p_10
	BKI IECEx, Certificate No.:IECEx BKI 12.0002 issue No.:1	mba5052a0600p_10
	Ex Russia, Certificate No.:RU C-HU.MF62.B.04454	mba5052o0600p_03
	Metrology OIML-R85, Certificate No.:TH-8592/3/2010	
	Metrology Romania, Certificate No.:9772/29.10.2013	

BASIC CONCEPT OF MEASUREMENT WITH NIVOTRACK



LEVEL = L – DIST + P04

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

1. INTRODUCTION

Application

NIVOTRACK M–500 / 600 series working on the magnetostrictive principle are suitable for high accuracy level measurement of storage tanks. Due to their high temperature and pressure rating these units can also be used for level gauging of technological tanks. The most suitable applications are with liquids free of solid particles and with low viscosity both in ordinary and hazardous locations.

Its high precision renders **NIVOTRACK** suitable for custody transfer measurement of valuable liquids such as fuels, solvents, alcohol distillates, etc. Plastic version of the series substantially expands the field of application by a wide range of aggressive materials.

Operating principle

The magnetostrictive transmitter is using the special feature of the magnetostrictive wire spanned in the rigid or flexible probe. A magnetic field excited in the magnetostrictive wire develops a wave in the wire. From the interference point with the magnetic disc placed in the float the wave travels back to the electronics with defined velocity. Measurement is based on measuring the flying time since it is proportional with the distance of the float from the electronics.

The above distance constitutes the basis for all output signals of the **NIVOTRACK**!
With the help of further mechanical data level and volume (tank content) can be calculated.

2. ORDER CODE

NIVOTRACK M ☐☐ – ☐☐☐ – ☐

TYPE	CODE
Transmitter	T
Transmitter + display	B
Transmitter PFA coated probe	E
Transmitter + display PFA coated probe	G
Transmitter mini	M
Transmitter mini + display	C

PROBE / PROCESS CONNECTION	CODE
Tube 1" BSP	A
Tube 2" BSP	C
Tube 1" NPT	D
Tube 2" NPT	G
Tube, w / o proc. conn.	U*
Flexible 2" BSP	K
Flexible 2" NPT	N
Flexible, w / o proc. conn.	Z
Rigid tube for NIVOFLIP, with clamp, without float	L
Rod 1½" TriClamp	J
Rod 2" TriClamp	M
Rod 2½" TriClamp	O
Rod 3" TriClamp	P
Rod 4" TriClamp	R

HOUSING	CODE
Aluminum	5
Plastic	6
Stainless steel	7

CODE	NOMINAL LENGTH		CODE
0	0 m	0 m	0
1	1 m	0.1 m	1
2	2 m	0.2 m	2
3	3 m	0.3 m	3
4	4 m	0.4 m	4
5	5 m	0.5 m	5
6	6 m	0.6 m	6
7	7 m	0.7 m	7
8	8 m	0.8 m	8
9	9 m	0.9 m	9
A	10 m		
B	11m		
C	12 m		
D	13 m		
E	14 m		
F	15 m		

OUTPUT / EX	CODE
4...20 mA / 0.1 mm	1
4...20 mA / 1 mm	2
4...20 mA + HART® / 0.1 mm	3
4...20 mA + HART® / 1 mm	4
4...20 mA / 0.1 mm / Ex ia	5
4...20 mA / 1 mm / Ex ia	6
4...20 mA + HART® / 0.1 mm / Ex ia	7
4...20 mA + HART® / 1 mm / Ex ia	8
4...20 mA + HART® / 0.1 mm / Ex ia / IP68	9
4...20 mA / 0.1 mm / Ex d	A
4...20 mA + HART® / 0.1 mm / Ex d	B
4...20 mA / 0.1 mm / Ex d + Ex ia	C
4...20 mA + HART® / 0.1 mm / Ex d + Ex ia	D
Dual compartment type:	
4...20 mA + HART® / 0.1 mm /XP Zona 1	E
4...20 mA / 0.1 mm /XP Zona 1	F
4...20 mA + HART® / 0.1 mm /XP IS Div 1	G
4...20 mA / 0.1 mm /XP IS Div 1	H
4...20 mA + HART® / 0.1 mm /NI Div 2	J
4...20 mA / 0.1 mm /NI Div 2	K

* Process connection to be ordered separately
(NOT ALL COMBINATIONS AVAILABLE!)

For certified level measurement for custody transfer only the HART® output with 0.1 mm resolution version including local display unit can be ordered.

ACCESSORIES TO BE ORDERED:

FLANGES: M F T – □ □ □ – □

STANDARDS / MATERIAL	CODE
DIN / carbon steel	1
DIN / 1.4571	2
DIN / PP	3
DIN / carbon steel + PTFE	4
ANSI / carbon steel	5
ANSI / 1.4571	6
ANSI / PP	7
ANSI / A38 + PTFE	8

DIMENSION DIN	ANSI	CODE
DN65	2½"	1
DN80	3"	2
DN100	4"	3
DN125	5"	4
DN150	6"	5
DN200	8"	6

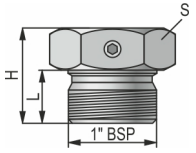
PRESSURE	CODE
PN16 / 150 psi	1
PN25 / 300 psi	2

INNER DESIGN	CODE
1" BSP	2
2" BSP	3
1" NPT	5
2" NPT	6
Sliding sleeve	A

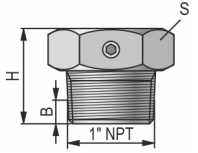
SLIDING SLEEVES:

TYPE	CONNECTION	S (mm)	H (mm)	L (mm)	B (mm)
MBH-105-2M-300-00	1" BSP	41	36	20	
MBK-105-2M-300-00	2" BSP	60	55	24	
MBL-105-2M-300-00	1" NPT	41	37		~10
MBN-105-2M-300-00	2" NPT	60	44.5		~11

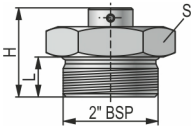
MBH



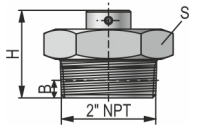
MBL



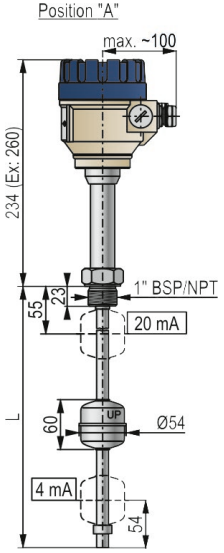
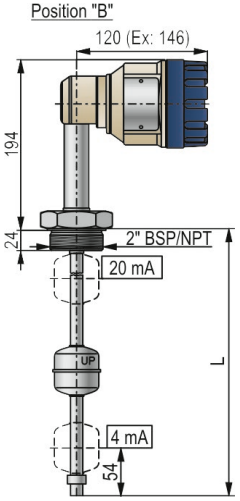
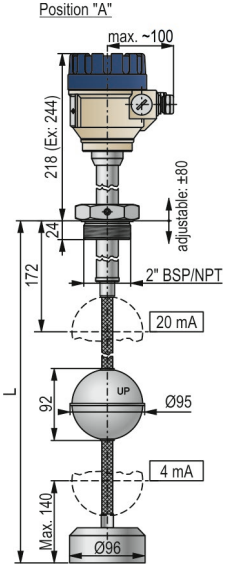
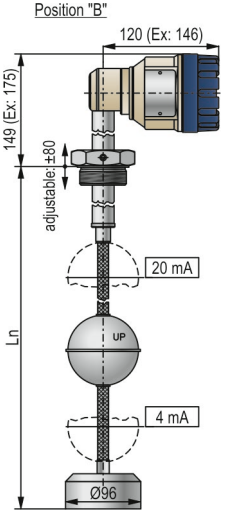
MBK

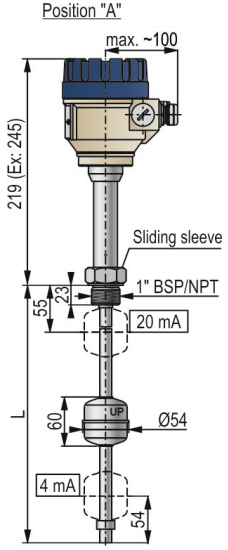
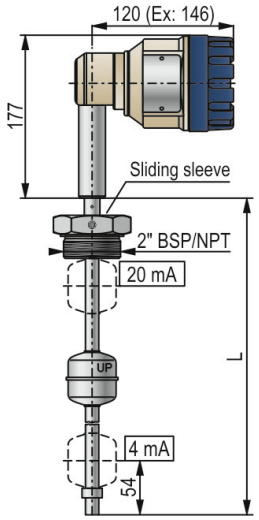
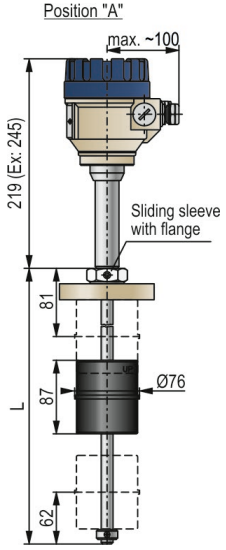
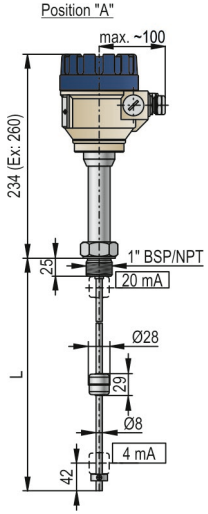


MBN



2.1. DIMENSIONS

RIGID TUBE TRANSMITTER WITH THREADED PROCESS CONNECTION **M□A, M□C, M□D, M□G**		*FLEXIBLE TUBE TRANSMITTER WITH SLIDING SLEEVE PROCESS CONNECTION* **M□K, M□N**	
			

RIGID TUBE TRANSMITTER WITHOUT PROCESS CONNECTION **MTU, MBU**		*PLASTIC COATED RIGID TUBE TRANSMITTER WITHOUT PROCESS CONNECTION* **MEU, MGU**	*MINI RIGID TUBE TRANSMITTER WITH THREADED PROCESS CONNECTION* **MM□, MC□**
Position "A"  	Position "B"  	Position "A"  	Position "A" 

3. TECHNICAL DATA

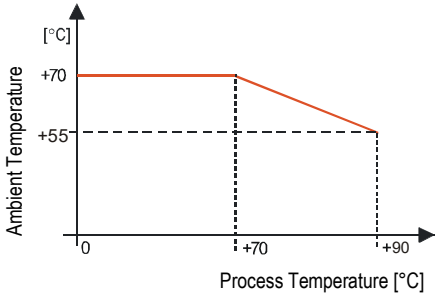
TYPE		RIGID TUBE VERSION M□A, M□C, M□D, M□G, MTU, MBU, MM□, MC□,	FLEXIBLE TUBE VERSION M□K, M□N	RIGID PLASTIC-COATED VERSION MEU, MGU
Measured process values		Level; distance, volume		
Nominal length (L)		0.5…4.5 m [1…14 ft] (MM□ and MC□ max. 1.5 m [4 ft])	2…15 m [6…49 ft]	0.5…3 m [1…9 ft]
Material of the probe		Stainless steel: DIN 1.4571		PFA-coated stainless steel
Max. process pressure*		25 bar (2.5 MPa [360 psi]) (MM□, MC□ max. 10 bar [145 psi])	16 bar (1.6 MPa) [230 psi]	3 bar (0.3 MPa) [44 psi]
Process temperature *		–40…+90 °C [–40…+194 °F] see temperature diagram and table 3.5		
Float diameter / material		∅54 x 60 mm [∅2 x 2.35"] cylindrical / 1.4404/Ti; ∅95 mm [∅4"] spherical / 1.4435; ∅124 mm [∅4.88"] spherical /1.4401; ∅28 x 29 mm [∅1 x 1.15"] / 1.4404		∅76 x 87 mm [∅3 x 3.45"] cylindrical / PVDF / PP
Medium density [SI]		with ∅54 mm cylindrical float: min. 0.8 g/cm³; with ∅54 mm cylindrical Ti float: min. 0.55 g/cm³; with ∅95 mm spherical float: min. 0.55 g/cm³; with ∅124 mm spherical float: min. 0.4 g/cm³		
Medium density [US]		with ∅2" cylindrical float: min. 0.462 oz/in³; with ∅2" cylindrical Ti float: min. 0.318 oz/in³, with ∅4" spherical float: min. 0.318 oz/in³, with ∅4.88" spherical float: min. 0.231 oz/in³		
Material of wetted parts		1.4571 (316Ti) stainless steel, float materials are detailed above		PFA + PVDF/PP
Ambient temperature		–40…+70 °C [–40…+160 °F] see: temperature table in Section 3.5		
Output	Analogue	4…20 mA (limit values: 3.9 and 20.5 mA)		
	Serial comm.	HART® interface (minimal loop resistance: 250 Ω)		
	Display	SAP–300 graphic display		
Damping time		0…99 s programmable		
Error indication		Current output: 3.8 mA or 22 mA		
Output load		$R_L = (U_S – 12.5\ V) / 0.02A$, U_S = power supply voltage		
Power supply		12.5…36 V DC		
Electrical protection		Class III		
Ingress protection		IP67/IP68, IP68 specification: 4 m water column for 4 hours		
Process connection		As per order codes		
Electrical connection		M20x1.5 cable gland for cable: ∅7…∅13 mm [∅0.28…∅0.51"], wire cross section: max. 1.5 mm² [AWG15]		
Housing		Painted aluminum (EN AC 42000) or plastic (VALOX 412) or stainless steel		
Mass		1.7 kg + probe: 0.6 kg/m [3.75 lb + m. probe: 0.4 lb/ft]	2.9 kg + probe: 0.3 kg/m [6.4 lb + m. probe: 0.2 lb/ft]	1.7 kg + probe: 0.7 kg/m [3.75 lb + m. probe: 0.45 lb/ft]

3.1. MEASUREMENT DATA (MSZ EN 60770-1:2011, MSZ EN 61298-1:2009, MSZ EN 61298-3:2009):

TYPE	M□□–□□□–2 M□□–□□□–4 M□□–□□□–6 M□□–□□□–8	M□□–□□□–1, M□□–□□□–A M□□–□□□-3, M□□–□□□–B M□□–□□□-5, M□□–□□□–C M□□–□□□-7, M□□–□□□–D
Resolution (of the displayed and the transmitted value on the HART® line)	1 mm	0.1 mm
Nonlinearity (of the displayed and the transmitted value on the HART® line)	±2 mm or ±0.02% F.S. whichever is greater Under reference conditions	±1 mm or ±0.01% F.S. whichever is greater Under reference conditions
Hysteresis (under reference conditions)	< ±1 mm	±0.25 mm
Zero span (in LEVEL measurement mode)	Anywhere within the active range	
Measurement range (reducing)*	Minimum range: 200 mm. Maximum range: see chapter 2.1 (Dimensions)	
Temperature error	0.04 mm / 10 °C (from –25…+50 °C)	
Current output resolution	2 uA	
Current output accuracy	10 uA	
Current output temperature error	200 ppm / °C	

** The detailed accuracy data is only valid under the default factory settings!*

For process temperatures above +70 °C (158 °F), the permissible ambient temperature is shown in the diagram below:



3.2. SPECIAL DATA FOR EX CERTIFIED MODELS

3.2.1. ATEX APPROVALS No.: BKI16ATEX0012X/2

Type	M□□–5/7□□–9Ex *	M□□–5/7□□–5 Ex M□□–5/7□□–6 Ex M□□–5/7□□–7 Ex M□□–5/7□□–8 Ex	M□□–5/7□□–C Ex M□□–5/7□□–D Ex	M□□–5/7□□–A Ex M□□–5/7□□–B Ex
Ex marking (ATEX)	Ex II 1 G Ex ia IIB T6…T5 Ga 0.5…15 m	Ex II 1 G Ex ia IIB T6…T5 Ga 0.5…15 m	Ex II 1/2 G Ex d ia IIB T6…T5 Ga/Gb 0.5…10 m	Ex II 2 G Ex d IIB T6…T5 Gb 0.5…10 m
Cable entry	–	M20x1.5 cable gland	Metal M20x1.5 cable gland with Ex d certification	
Cable outer diameter	–	Ø7…Ø13 mm	Ø9…Ø11 mm	
Ex power supply, Intrinsically safety data	U_{imax} = 30 V I_{imax} = 140 mA P_{imax} = 1 W C_i < 25 nF L_i < 210 μH	U_{imax} = 30 V I_{imax} = 140 mA P_{imax} = 1 W C_i < 15 nF L_i < 200 μH		Ui: 12.5…36 V DC I_{imax} = 140 mA

Attention! The M□□–5□□–9Ex type instrument is IP68-rated. The cover, cable gland, cable and the plug are glued and cannot be opened!

3.2.2. IECEx APPROVALS No.: IECEx BKI 12.0002 issue No.:2

Type	M□□-5/7□□-5 Ex M□□-5/7□□-6 Ex M□□-5/7□□-7 Ex M□□-5/7□□-8 Ex	M□□-5/7□□-C Ex M□□-5/7□□-D Ex	M□□-5/7□□-A Ex M□□-5/7□□-B Ex
Ex marking (IECEx)	Ex ia IIB T6…T5 Ga 0.5…15 m	Ex d ia IIB T6…T5 Ga 0.5…10 m	Ex d IIB T6…T5 Gb 0.5…10 m
Cable entry	M20x1.5 cable gland	Metal M20x1.5 cable gland Ex d certification	
Cable outer diameter	Ø7…Ø13 mm	Ø9…Ø11 mm	
Ex power supply, Intrinsically safety data	U_{imax} = 30 V I_{imax} = 140 mA P_{imax} = 1 W C_i < 15 nF L_i < 200 μH		Ui: 12.5…36 V DC I_{imax} = 140 mA

3.2.3. FM US APPROVALS No.: FM16US0068X (see 'Safety Manual')

The following data is for information purposes only. The FM certificate and the safety instructions can be found in the attached 'Safety Manual'.

TYPE	M□□–5□□–E M□□–5□□–F	M□□–5□□–G M□□–5□□–H	M□□–5□□–J M□□–5□□–K
Marking (FM US)	Class I, Zone 1, AEx db IIB T6…T5 Gb	Class I, Division 1, Groups C, D T6…T5	Class I, Division 2, Groups C, D T6…T5
Power supply	12.5…35 V DC	24…35 V DC (min. 22.5 V @ 20 mA)	12.5…35 V DC
Maximum current	22 mA		
U_m	250 V		

3.2.4. FM CANADA APPROVALS No.: FM16CA0037X (see 'Safety Manual')

The following data is for information purposes only. The FM certificate and the safety instructions can be found in the attached 'Safety Manual'.

TYPE	M□□–5□□–E M□□–5□□–F	M□□–5□□–G M□□–5□□–H	M□□–5□□–J M□□–5□□–K
Marking (FM CA)	Class I, Zone 1, Ex db IIB T6…T5 Gb	Class I, Division 1, Groups C, D T6…T5	Class I, Division 2, Groups C, D T6…T5
Power supply	12.5…35 V DC	24…35 V DC (min. 22.5 V @ 20 mA)	12.5…35 V DC
Maximum current	22 mA		
U_m	250 V		

3.3. ACCESSORIES

- Installation and Programming Manual
- Warranty Card,
- EU declaration of conformity,
- 2 cable glands (M20x1.5)
- 1 gasket (klingerit oilit) for BSP threads only

For M□K and M□N types only

- 1 pc weight
- 1 pc M10 nut
- 1 pc M10 spring washer
- 1 pc M10 washer
- 1 pc spacer (for float ∅52 mm only)

3.4. SPECIAL CONDITIONS FOR SAFE USE

Aluminum housing of the unit should be connected to the equipotential (grounding) system. For field connections, use cable rated +20 °C greater than Maximum Ambient Temperature and seal all threaded entries at enclosure with suitably rated sealing components.

In case of ⟨Ex⟩ II 1 G Ex ia IIB T6...T5 Ga protected equipment version with aluminum alloy enclosure, the aluminum-content of enclosure exceeds the limit, thus the equipment must be protected against impact and friction effects and may only be powered by a duly approved and certified Ex ia IIB intrinsically safe loop according to the technical data.

Regarding information on the dimensions of flameproof joints, please contact the Manufacturer.

The risk of electrostatic discharge shall be minimized at installation, especially plastic covered equipment with order code starting with MEU or MGU may be electrostatically charged, therefore:

- Medium to measure must be electrically conductive and with specific resistance not exceeding the value of 10^4 Ωm even on the most unfavorable places and under the most unfavorable conditions.
- Speed as well as way of filling and emptying should be chosen according to the medium.

For installation in environment with Maximum Ambient Temperature above +55 °C refer to Section 3.5. TEMPERATURE CLASSES AND TEMPERATURE LIMITS

3.5. TEMPERATURE CLASSES AND TEMPERATURE LIMITS

MAXIMUM ALLOWED AMBIENT TEMPERATURE OVER PROCESS TEMPERATURE:

TYPE	MAX. AMBIENT TEMPERATURE	MAX. PROCESS TEMPERATURE
M□A, M□C M□D, M□G	+70 °C	+80 °C
M□K, M□N		+70 °C
MEU, MGU		+80 °C
M□A, M□C, M□D, M□G	+55 °C	+90 °C
MEU, MGU		

LOWER TEMPERATURE LIMITS:

TYPE	EX PROTECTION TYPE		
	ia	d	d ia
MT□, ME□	–40 °C	–40 °C	–40 °C
MB□, MG□, MC□, MM□	–25 °C	–25 °C	–25 °C

3.6. MAINTENANCE AND REPAIR, STORAGE CONDITIONS

NIVOTRACK M–500 / 600 units do not require maintenance on a regular basis.

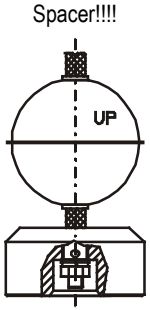
Repair during or after the guarantee period should only be carried out by NIVELCO. Devices for repair should be returned fully cleaned, and disinfected. Unused devices must be stored within the ambient temperature range specified in the technical data, and a maximum of 98% relative humidity.

4. INSTALLATION

4.1. MOUNTING

- When choosing the installation place please ensure proper space for later calibrations, verification or maintenance service.
- Waving, vortex or vibration effects have negative influence on the measurement accuracy. To avoid these effects, the mounting placement should be as far as possible from the sources of these disturbing effects for instance from openings of filling or emptying. These effects can be attenuated in applications with rigid tube probes by the use of stilling pipe along the whole probe. Please consult with a NIVELCO distributor!
- To ensure consistent and durable operation the measurement medium should be free of suspended solid materials, which could stick between the float and the probe. • The unit should be protected against direct heat radiation.
- Prior to the installation the mounting dimensions of the unit and the tank as well as the calculations should be checked carefully.
- Prior to the installation a preliminary operation check is suggested.
- If necessary to change the default factory settings the programming should be performed in accordance to the description in the 5th chapter.
- The units are offering a wide variety of process connections according to the available order codes. The tank opening should be fit for the selected level transmitter by means of the insertion hole is bigger than the float diameter. If this is not possible the float has to be removed from the probe and when the unit is mounted into the tank the float can be mounted from inside of the vessel. The “UP” marking on the float ensures that the float is mounted back in the correct position. See the drawing! Prior to finishing the mounting the spacer needed to assemble back between the float and the counterweight.

- In case of MEU and MGU types the probe length can be adjusted. Nevertheless the probe length outside the tank should not be greater than 200 mm.
  In case of M□K and M□N types with flexible probe are supplied with a counterweight at the end of the probe for straightening the cable probe and fixing it in the right position. The weight and the fastening nut are included with the instrument. When lowering down the flexible probe (with the weight at the end) to the bottom of the tank, special care has to be taken to avoid twisting and kinking of the coil. Do not coil the cable less than 60 cm in diameter. Dropping or twitching of the cable probe may damage the unit. To avoid the float to falling down and hitting the weight the float should be placed to the bottom position next to the weight. The weight should not contact with the tank bottom. The proper straightening of the cable probe can be checked by the analogue output or by the display. If the float is at the bottom position, I_{OUT} should be equal to 4 mA or the displayed measurement value should be 0 mm.



ATTENTION!

In order to avoid damaging the probe, do not put it to torsion when installing or removing the unit. Therefore, special care has to be taken when the process connection is being screwed into or out of the flange. The best is to hold the rigid part of the probe with a suitable tool as long as the process connection is tightened to its place. Sliding sleeve must not be loosened during operation.

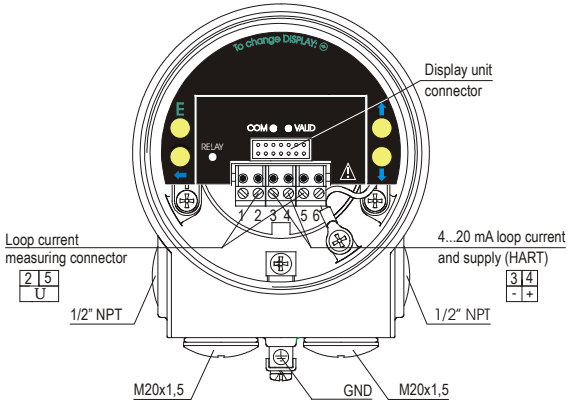
4.2. WIRING

This transmitter is designed to operate on 12.5…36 V DC power only (for Ex transmitters: 12.5…30 V DC).

The measured voltage on the terminals of the unit should be at least 12.5 V. Using transmitter with HART a terminal resistance with a minimum value of 250 Ω should be applied.

The power supply should be interconnected with the unit with twisted, shielded cable that can be pulled through the cable conduit. The cable can be connected to the terminal strip after removing the cover and the display unit.

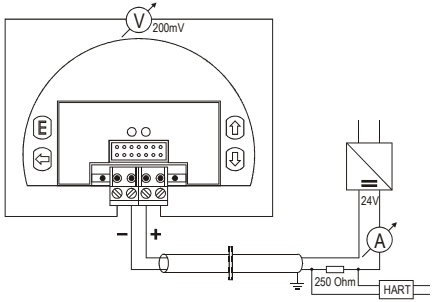
CAUTION: the enclosure of the transmitter should be grounded. Grounding resistance should be < 2 Ω. Shielding of the interconnecting cable should be grounded at the control room side. To avoid disturbing noises the interconnecting cable must not be led near to high voltage cables. Especially critical are inductive couplings of AC harmonics against which the protection of shielding is not effective.



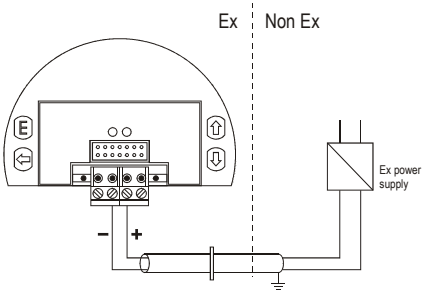
The unit may be damaged by electrostatic discharge (ESD), via its terminal thus used commonly precautions should be applied to avoid electrostatic discharge e.g. touching a properly grounded point before removing the cover of the enclosure.

Possible electrostatic discharge may damage the unit. Thus, the internal electric connection points must not be touched by hand.

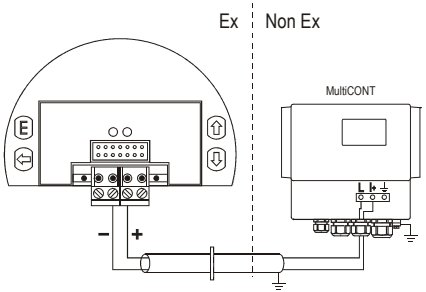
4.2.1. Wiring of Ex certified units



With HART



Standard



With MULTICONT

4.3. LOOP CURRENT CHECKING

After removing the cover and the display module the actual loop current can be measured with an accuracy of 0.5% by connecting a voltmeter (in the range of 200 mV) to the points indicated on the drawing above.

The loop current measuring connectors are designed for checking the proper installation only, they cannot be used as a permanent secondary voltage output. Testing and installation under explosive atmosphere requires approved test equipment and trained personnel!

5. PROGRAMMING

NIVOTRACK transmitters can be programmed by two basic ways.

- **Programming with SAP-300 display unit**, (see chapter 5.2).
- Accessing all the configurable parameters allows full modification of the operation (measurement configuration, zero point offset, output assignments, measurement optimization, entering dimensions of 11 kind of tanks into parameters, 99-point linearization table).

NIVOTRACK MB☐–5☐☐ and MG☐–5☐☐ types do not include the SAP–300 display unit.

The **NIVOTRACK** transmitters are fully operational without the SAP–300 display unit, the SAP-300 module is needed only for parameter configuration and / or displaying measurement values.

The device measures during the programming procedure in accordance to the previous parameter set. The new, modified parameter set becomes valid after returning into Measurement Mode!

If the transmitter is left in Programming Mode by mistake, it will automatically return to Measurement Mode after 30 minutes and modifications will be unsaved.

FACTORY SETTINGS

The **NIVOTRACK M-500 / 600** type transmitters will be delivered with the following Factory default values:

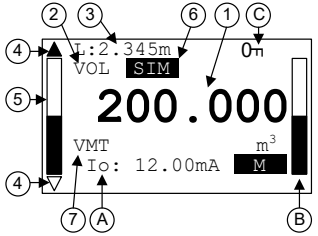
⇒ Measurement mode: level (LEV). Displayed value shows level.
⇒ Current output and bar graph on the right side are proportional to the level.
⇒ 4 mA and 0% are assigned to minimal level (lowest position of the float).
⇒ 20 mA and 100% are assigned to maximal level (highest position of the float).
⇒ Error indication by the current output: holds last value of the output.
⇒ Level tracking time constant: 0 sec.

The transmitter measures the distance (DIST) from the highest position of the float as primary value. This distance can be processed, displayed in the following units: m, cm, mm, feet, or inch. Since the measurement range of the device is given, the electronics calculate the actual level (LEV). If the mechanical dimensions of the proper mounting position of the device – distance between the lowest position of the float and the bottom of the tank – are also known, then the measured level can be more accurate by this data. The calculated level is used for volume (VOL), or mass (MASS) calculation, and this is the input value of the 99-point linearization process (VMT).

5.1. THE SAP–300 DISPLAY UNIT

5.1.1. The SAP–300 module

The SAP–300 is a 64 × 128 dot-matrix LCD display which can be plugged into the transmitter. (Universal – usable in other **NIVELCO** devices as well – provided that the system software supports SAP-300.)



Warning!
The SAP–300 module is based on LCD technology, so please make sure it is not exposed to permanent heat or direct sunlight, in order to avoid damage of the display unit. If the instrument cannot be protected against direct sunlight or high temperature that is beyond the standard operating temperature range of the SAP–300, please do not leave the SAP display in the instrument.
Displaying with the SAP–300 module

Elements of the display:

1. Primary value (PV), as per BASIC SETUP / PV. MODE.

2. Mode of primary value calculation, as per BASIC SETUP / PV. MODE.

3. Type and value of the initial value for primary value calculation:

- In case of level measurement: distance
- In case of volume or mass calculation: level

4. Trend direction arrows. The empty triangle shows when the measured value is small, the filled triangle shows large-scale change. The measured value is constant if none of the arrows are shown.

5. Measured value in relation to measurement range (Sensor range) in a bar graph.

6. Indication of primary value simulation. In this case the display and output will show the values of the simulation and not the measured value.

7. Indication of the Volume/Mass calculation table (**V**olume/**M**ass **T**able – VMT)

During active simulation the critical measurement errors will be displayed to give information to the user.

A., Calculated value of the output current. After the dimension, the mode of current output is indicated by inverse inscription:

M Manual mode (see: chapter 5.3.2.1)

H HART address is not 0, so output current has become overwritten to 4 mA (see: chapter 5.3.2.1)

E! Analogue transmission reacts to a programmed failure condition if an upper or lower fault current is programmed (see: chapter 5.3.2.4)

B., Output range (4…20 mA) indicated in a bar graph.

C., Indication of Menu Lock:

- If key symbol is visible, the unit is protected with a password. When entering the menu, the instrument asks for the correct password.
- If REM message is visible, the instrument is in remote programming mode and the menu cannot be accessed.

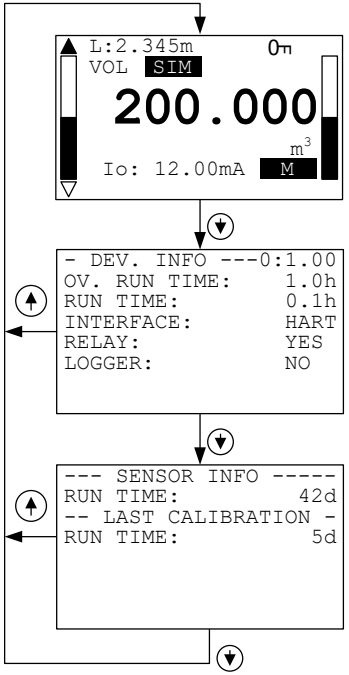
Errors occurred during the measurement can be seen at the bottom line of the display.

Information displays:

Press Ⓓ button to cycle between the information displays.

1. The general information display (DEV. INFO): overall running time (OV. RUN TIME), run time after power on (RUN TIME), type of interface (INTERFACE), relay (RELAY) and logger (LOGGER) indication.
2. Sensor information display

The informative display switches back to main screen after 30 seconds. By pressing the Ⓤ button the user can get back to main screen at any time. Pressing the Ⓔ button in any of the displays the user can enter to menu. After exiting the menu always the main screen will be shown.



5.2. PROGRAMMING WITH THE SAP–300 DISPLAY UNIT

When entering the menu the instrument makes a copy of the actual parameters, all changes are done to this duplicated parameter set. During programming the instrument keeps measuring and transmitting with the current (and intact) parameter set. After exiting the menu the instrument replaces the original parameters with the new parameter set and will measure according the new parameters. This means that the change of the parameters does not become immediately effective when pressing the Ⓔ button! Entering the menu can be done by pressing the Ⓔ button while exiting the menu can be done by pressing the ⓔ button.

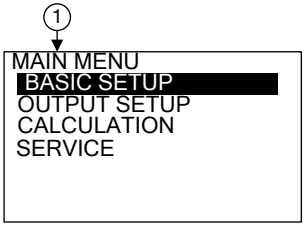
If the instrument is left in programming mode after 30 mins it will automatically return to measuring mode. If the SAP display is removed during programming the instrument immediately returns to measuring mode.
As programming with SAP–300 (manual programming) and HART (remote mode) programming is not possible at the same time use only one programming method at a time. Measured values can be read out through HART at any time.

5.2.1. Elements of the programming interface

The parameters of the instrument are grouped according to their functions. The programming interface consists of lists, dialog windows, edit windows and report windows.

Lists

Navigation between the lines of a list can be done by pressing ⓤ / ⓓ buttons. Pressing the Ⓔ button activates a list item. Selected list item is marked with inverse color. Exit from a list by pressing the ⓔ button.

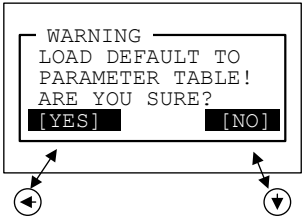


Menu list

Menu list is a specialized list. Its characteristic is that upon selecting a list item we directly get into another list, and these lists are opening from each other in different levels. The menu header (1) helps to navigate. Entering the menu can be done by pressing the Ⓔ button. Navigation between the menu items can be done by pressing the ⓤ / ⓓ buttons. Enter to the selected menu by pressing the Ⓔ button. The selected list item is marked with inverse color. Exit from a submenu with ⓔ button. Pressing the ⓔ button in the main menu will exit programming mode and the instrument will return to measuring mode.

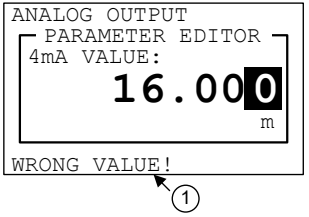
Dialog window

The system sends messages or warnings using dialog windows. These usually can be acknowledged by pressing the ◄ button or the user can choose between two options (usually YES or NO) by pressing ◄ / ▼ buttons. In some cases to correct an error one of the parameters has to be changed.



Edit window

An edit window is used for modifying a numeric parameter value. The selected character can be changed using the ▲ / ▼ buttons. The cursor can be moved to left, using the ◄ button. The direction of the cursor movement through the digits is right to left. Changed value can be validated by pressing the E button. The software checks if the entered value is appropriate, exiting the edit window is only possible after entering a correct value. If the entered value is uninterpretable the software sends an error message in the bottom line (1) of the display. The display gives the same error message, independently of the measured value and the measurement principle.



Edit window – button combinations

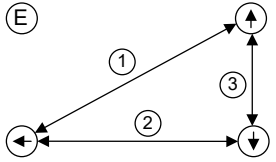
In the edit window the following button combinations are available:

Recalling the parameters to the state before editing (◄ + ▲, pressed for 3 secs);

Recalling default parameters (◄ + ▼, pressed for 3 secs);

Inserting (currently) measured value to the edit window (▲ + ▼, pressed for 3 secs)

Only for certain parameters!



5.2.2. Menu structure

Main menu

BASIC SETUP	Parameter group of the basic measurement parameters
OUTPUT SETUP	Parameter group of the output parameters
CALCULATION	Calculations
SERVICE	Service functions, calibration, test and simulation

5.3. PROGRAMMABLE FEATURES DESCRIPTION

5.3.1. Basic measurement settings

5.3.1.1 Units

Default measuring unit:

Parameter: P00: c, where a: 0, 1. Default value: EU
Menu path: BASIC SETUP / UNITS/ENGINEERING SYSTEM (for USA versions: US)
Description: This should be configured as the first step of the programming. Here you can choose the default unit system:

- EU European unit system
- US Anglo-Saxon unit system

Dimension of the default measuring unit:

Parameter: P00: b, and P02: b Default value: mm, m^3, t
Menu path: BASIC SETUP / UNITS/ENGINEERING UNITS (for USA versions: inch, ft^3, t)
Description: The dimension of the unit can be specified in this menu:

- BASIC UNITS (mm, cm, m, ft, inch)
- VOLUME UNITS (m^3, l)
- MASS UNITS (t, t)

If the unit is changed, after a warning message the device resets all the parameters.

5.3.1.2 PV mode

Parameter: P01: b a Default value: DIST
Menu path: BASIC SETUP / PV MODE
Description: This mode determines the primary value and the displayed value. It also determines the value which will be proportional to the output current.

- DISTANCE
- LEVEL
- VOLUME
- MASS

5.3.1.3 Damping time

Parameter:	P20	Default value:	0 sec
Menu path:	BASIC SETUP / DAMPING TIME		
Description:	Damping time is used to damp the unwanted fluctuations of the output and display. If the measured value changes rapidly the new value will settle with 1% accuracy after this set time. (damping according to an exponential function).		

5.3.1.4 Application

Parameter:	P0: a, where a: 0, 1.	Default value:	NORMAL
Menu path:	BASIC SETUP / APPLICATION		
Description:	Application mode, refers to the mounting position of the devices, and affects the function of error indications. • NORMAL Device sensor is in the tank. Every error indication in normal mode. • BYPASS Device sensor is outside the tank in a measuring tube The „SIGNAL IN N.D.B." and „SIGNAL IN F.D.B." error indication are inactive.		

5.3.1.5 Installation mode (ONLY USD (UpSide Down) – „Reverse installation position" devices)

Parameter:	P0: d, where d: 0, 1.	Default value:	NORMAL
Menu path:	BASIC SETUP / MOUNTING MODE		
Description:	It reverses the reference points of the level calculation in accordance with the mounting position. • NORMAL Device housing on top, sensor on bottom (normal position) • UPSIDE DOWN Device housing on bottom, sensor on top (reverse position)		

5.3.2. Analogue Output

5.3.2.1 Output current mode

Parameter: P12: b, where a: 0, 1. Default value: AUTO
Menu path: OUTPUT SETUP / ANALOG OUTPUT / CURRENT MODE
Description: Transmission mode of the current output [AUTO, MANUAL]

- AUTO The output current is calculated from the measured value, output is active.
- MANUAL The output current is fixed at a constant (set) value (see 5.3.2.5). In this mode the setting of the error current is irrelevant. The set (current) value overwrites the 4 mA output of HART multidrop mode!

5.3.2.2 Output current value 4 mA

Parameter: P10 Default value: 0
Menu path: OUTPUT SETUP / ANALOG OUTPUT / 4 mA VALUE
Description: Measured value assigned to 4 mA.
The transmitted value is in accordance to the primary value (PV) (P01: a). Assignment can be done that the change in measured value and the change in the output value are the same (normal), or opposite directional (inverse operation). For example: 1 m level is 4 mA, 10 m level is 20 mA, or 1 m level is 20 mA and 10 m level is 4 mA.

5.3.2.3 Output current value 20 mA

Parameter: P11 Default value:
Menu path: OUTPUT SETUP / ANALOG OUTPUT / 20 mA VALUE Active measurement range
Description: Measured value assigned to 20mA.
The transmitted value is in accordance to the primary value (PV) (P01: a). Assignment can be done that the change in measured value and the change in the output value are the same (normal), or opposite directional (inverse operation). For example: 1 m level is 4 mA, 10 m level is 20 mA, or 1 m level is 20 mA and 10 m level is 4 mA.

5.3.2.4 Output current error mode

Parameter: P12: a, where a: 0, 1, 2 — Default value: HOLD
Menu path: OUTPUT SETUP / ANALOG OUTPUT / ERROR MODE
Description: Error indication by the current output

- HOLD Error indication has no effect on the output current.
- 3.8 mA Error indication: the output current gets 3.8 mA.
- 22 mA Error indication: the output current gets 22 mA.

Warning This error indication is active unless the failure is fixed, or until the failure terminates.

5.3.2.5 Fixed output current

Parameter: P08 — Default value: 4 mA
Menu path: OUTPUT SETUP / ANALOG OUTPUT / MANUAL VALUE
Description: Parameter for setting the fixed output current
Values between 3.8 and 20.5 can be entered. The output current will be set to the entered value and analogue transmission will be suspended (see: 5.3.2.1). This error indication overrides all other error indication.

5.3.3. Digital Output

5.3.3.1 HART polling address (if there is a HART option in the device)

Parameter: P19 — Default value: 0
Menu path: OUTPUT SETUP / SERIAL OUTPUT / ADDRESS
Description: HART polling address (only HART capable types)
The polling address can be set between 0 and 15. For a single instrument the polling address is 0 and the output is 4…20 mA (analogue output). If multiple units are used in HART Multidrop mode (max. 15) the polling addresses should differ from 0 (1 – 15), in this case the output current will be fixed at 4 mA.

5.3.4. Calculation

5.3.4.1 Zero point offset (Distance between the lowest position of the float and the bottom of the tank)

Parameter:	P04	Default value:	0
Menu path:	CALCULATION / LEVEL OFFSET		
Description:	This Parameter is used for zero point offset. In level measurement mode the zero level is meant at the lowest position of the float. Due to the construction of the device, it cannot able to measure the level through the whole height of the tank, because it may not reach the bottom of the tank. In this Parameter the distance between the lowest position of the float and the bottom of the tank can be entered. The offset value will be a negative value (the value of the Parameter is always the distance between the lowest position of the float and the zero point offset of the measurement) this negative number should be entered into the Parameter if the measurement range needs to be decreased virtually. The absolute value of this number shall be less than the active measurement range. Factory default Parameter value shall be used if there is no need to use zero point offset. (See: Basic concept of Measurement on the 2nd page). Wrong configuration of the zero point offset can result negative level display. Negative level is not right or normal. However there is no error indication on negative level display, it cannot be used for 4…20 mA programming or volume / mass calculations.		

5.3.4.2 Calculation mode

Parameter: P47: a, where a: 0,1. Default value: 0
Menu path: CALCULATION / V/M CALC. MODE
Description: Calculation of the volume and mass can be performed with two ways:

- TANK FUNCTION/SHAPE – volume and mass calculation with a tank shape formula. Entering this menu point table is automatically OFF.
- V/M TABLE – volume and mass calculation with a table. Entering this menu point table is automatically ON.

5.3.4.3 Tank function / shape

Parameter: P40: a, where a: 0,1, 2, 3, 4. Default value: 0
Menu path: CALCULATION / V/M CALC. MODE / TANK FUNCTION/SHAPE
Description:

- Standing cylindrical tank
- Standing cylindrical tank with conical bottom
- Standing rectangular tank with or without chute
- Lying cylindrical tank
- Spherical tank

5.3.4.4 Tank bottom shape

Parameter: P40: b, where a: 0,1, 2, 3. Default value: 0
Menu path: CALCULATION / V/M CALC. MODE / TANK FUNCTION/SHAPE
Description: This menu only appears, if it has an importance on the selected type!

- SHAPE1
- SHAPE2
- SHAPE3
- SHAPE4

5.3.4.5 Tank dimensions

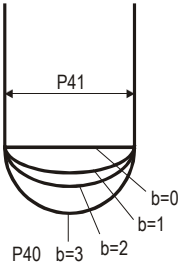
Parameter: P41-P45 Default value: 0

Menu path: CALCULATION / V/M CALC. MODE / TANK FUNCTION/SHAPE

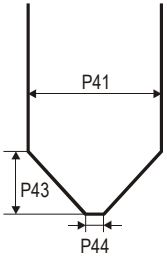
Description:

- DIM1 (P41)
- DIM2 (P42)
- DIM3 (P43)
- DIM4 (P44)
- DIM5 (P45)

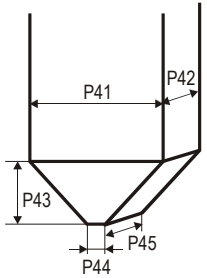
Standing cylindrical tank with hemispherical bottom a = 0



Standing cylindrical tank with conical bottom a = 1 ; b = 0

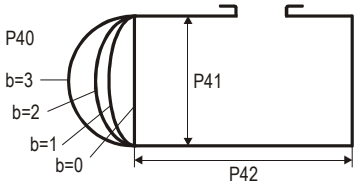


Standing rectangular tank with or without chute a = 2 ; b = 1

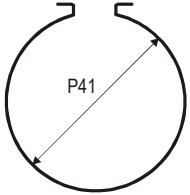


If no chute: P43, P44 and P45 = 0

Lying cylindrical tank a = 3



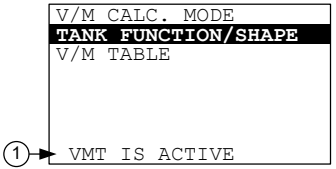
Spherical tank a = 4 ; b = 0



5.3.4.6 Volume and Mass Table (VMT)

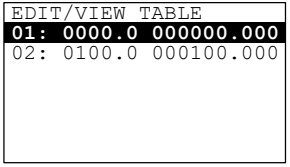
Parameter: -
Menu path: CALCULATION / V/M CALC. MODE / V/M TABLE
Description:
- View/Edit table
- Add item
- Delete item

If none of the formulas match perfectly to the characteristics of the needed tank, there is a possibility to use table calculation mode. The device can handle a 99-point table on this purpose and counts values between the neighboring point pairs with linear interpolation.
The input (left) side of the table contains the level data, the output (right) side contains the volume or mass data.
The first point pair of the table should be 0.0. If a long table wanted to be shortened, 0.0 point pair should be entered into the last item of the table. The device modifies the unused point pairs automatically in the background into 0.0. The status (ON or OFF) of the table is shown on a warning message (1) on the bottom line of the display.



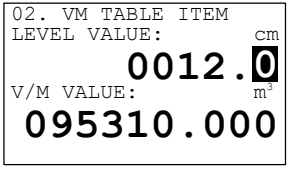
All modifications are done on a temporary table. This temporary table becomes valid after exiting. Modifications during the programming procedure have no effect on the measurement and the transmitting.

Entering the point pairs can be done in arbitrary order, because the device sorts according to ascending order. Both sides of the table have to be strictly monotonic increasing. In case of any error, warning message (see: chapter 6) will appear. When entering again the table inscription indicates the first wrong line.

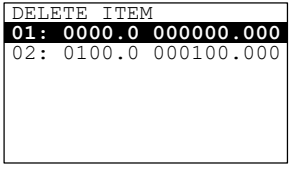


View table:
In VIEW/EDIT TABLE menu point items of the ordered table can be checked. For moving in the list use the ⓥ and ⓐ buttons, for editing the selected item use the Ⓔ button. Exiting from the list can be done by pressing the ⓒ button.

Edit table:
Adding a point pair (ADD ITEM) to the list or pressing Ⓔ button on an existing item, an edit screen will appear. In this edit screen there are two editing filed. Both editing field work as same as editing a Parameter. Getting from the first field to the second field press the Ⓔ button. Pressing Ⓔ button in the second field it will return to the previous menu point. Exiting from the last field, the device performs the ordering of the table.



Delete item
Moving in the list can be done with ⓥ and ⓐ buttons, for deleting an item press the Ⓔ button on the selected item. Exiting from the list can be done by pressing the ⓒ button. The table has to contain at least 2 items.



5.3.5. Service functions

5.3.5.1 Security codes

User codes

Menu path: SERVICE / SECURITY / USER LOCK
Description: Setting or unlocking the user security code.
The instrument can be protected against unauthorized programming with a 4-digit PIN (Personal Identification Number) code. If either of the digits differs from 0 the code is active. If zero is specified, then the secret code has been deleted!
In case of Active code, this code is requested at menu entry.

Service code

Menu path: SERVICE / SECURITY / SERVICE LOCK
Description: Setting of the service code.
Only for trained personnel!

5.3.5.2 Current output test

Parameter: P80
Menu path: SERVICE / OUTPUT TEST / ANALOG OUTPUT
Description: Loop current test (mA)
Entering this Parameter the current value which is proportional to the actual measurement value will appear on the display and the output. In loop current test mode, values between 3.9 and 20.5 can be entered. The output current will be set to the entered value. The measured current on the output should be equal to the set value.
In test mode a dialog window warns the user of the fixed output current until the user exits the warning message window.
Exiting can be done by pressing the ⊖ button.

5.3.5.3 Distance simulation

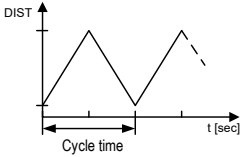
This function facilitates the user to be able to check the calculations (tank formula, table), outputs, and the additional processing instruments connected to the output. **NIVOTRACK** transmitters can perform simulation on the value of a constant or a variable. To start simulation the instrument must return to Measurement mode. In Measurement mode if simulation is in progress, an inverse SIM caption appears on the display.

Simulation mode

Parameter: P84: a, where a: 0,1, 2, 3. Default value: OFF
Menu path: SERVICE / DIST SIMULATION / MODE
Description:

Simulation mode:

OFF	No simulation
FIX VALUE	Value of the simulated distance is set according to the lowest value of the simulation.
TRIANGLE WAVE	Value of the simulated distance changes linearly between the lowest and highest values with an adjustable cycle time.
SQUARE WAVE	The simulated value jumps between the lowest and highest values with an adjustable cycle time.



Simulation cycle

Parameter: P85 Default value: 60 sec
Menu path: SERVICE / DIST. SIMULATION / TIME
Description: Cycle time of the simulation

Bottom value of the simulation

Parameter: P86 Default value: 0 mm
Menu path: SERVICE / DIST. SIMULATION / BOTTOM VALUE
Description: Lowest value of the simulation

Upper value of the simulation

Parameter: P87 Default value: Programmed measurement range
Menu path: SERVICE / SIMULATION / UPPER VALUE
Description: Highest value of the simulation

5.3.5.4 Load default values

Menu path: SERVICE / DEFAULTS / LOAD DEFAULT

Description: This command loads all default values of the instrument.
After loading the default values the parameters can freely be changed, the effect of the changes does not affect the measurement until the user exits programming mode and returns to measurement mode. Before loading the defaults the software asks for a confirmation warning the user that all user parameters will be lost!

5.3.5.5 Service distance offset

Parameter: P05 Default value: 0 mm

Menu path: SERVICE / SERVICE DIST OFFSET

Description: There is a possibility to display auxiliary service information on the bottom line of the screen. This information is useful when verifying measurement is performed with a hand-instrument and zero point of this device is not the same as the highest position of the float. In this case a distance should be entered into this Parameter which is the distance between the highest position of the float (which is the zero point of the measurement range) and the zero point of the verifying instrument.
This Parameter has no effect on level measurement or on volume and mass calculation, it only appears on the screen. If the value of this Parameter is not zero, „SDIST=x.xxx" format display appears on the bottom line of the measurement screen.

5.3.5.6 Restart

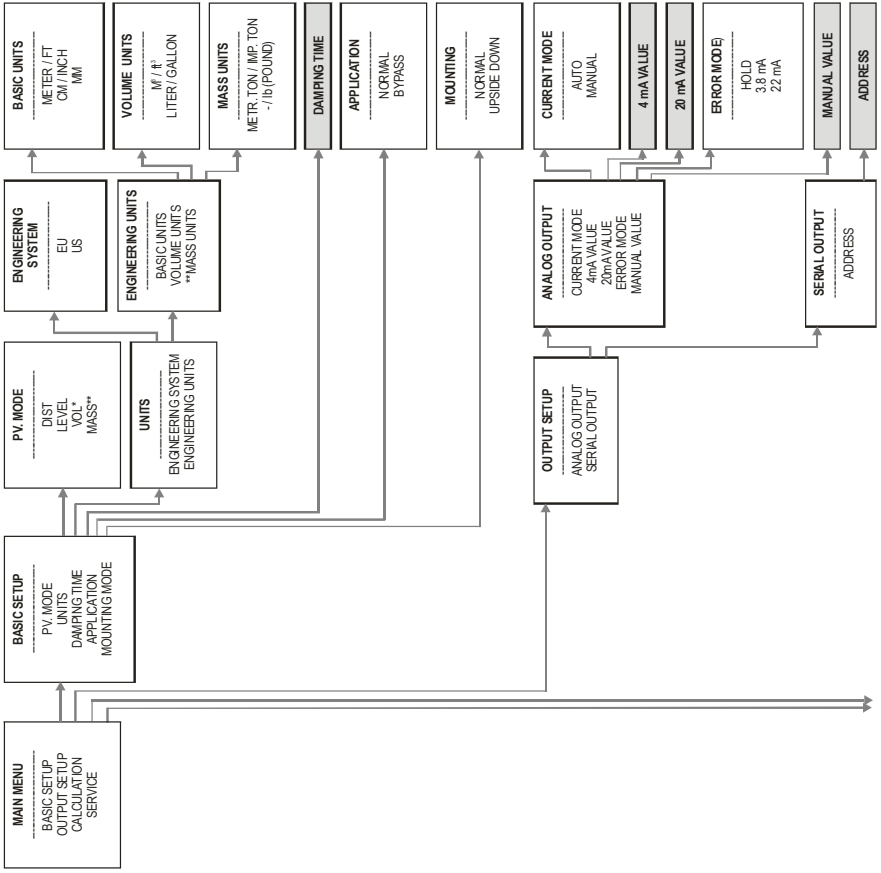
Menu path: SERVICE / RESTART

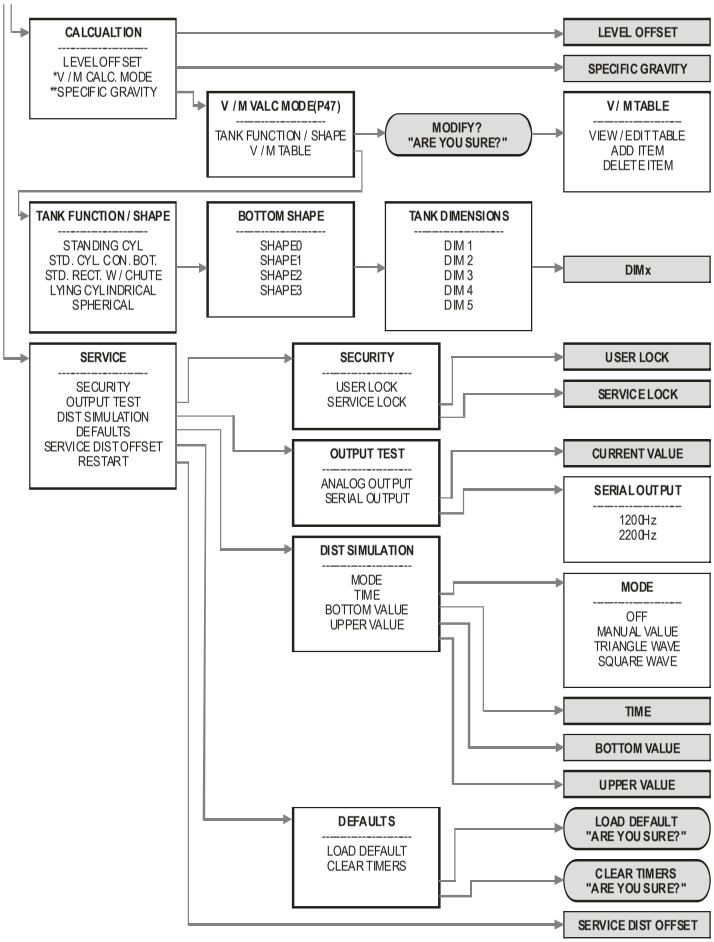
Description: Restarts the instrument (Cold boot) (Reloads parameters from the non-volatile memory)

6. ERROR CODES

MESSAGE ON THE SCREEN	ERROR DESCRIPTION	PROCEDURE	CODE
MEMORY ERROR	Memory error in the electronics	Contact the service!	1
NO INPUT SIGNAL	Probe error	Contact the service!	2
EE COM. ERROR	Hardware error (EEPROM communication error)	Contact the service!	3
MATH. OVERLOAD	Display overflow	Check the programming!	4
SIGNAL IN N.D.B.	Probe or calibration error (Signal is in near dead band)	Contact the service!	5
SIGNAL IN F.D.B.	Probe or calibration error (Signal is in far dead band)	Check the mounting specifications.	7
VMT SIZE ERROR	Linearization error: Less than two items are in the table.	Check the content of the VMT! See: 5.3.4.6.	12
VMT INPUT ERROR	Linearization table error: monotonicity error in the input (level) side of the table.	Check the content of the VMT! See: 5.3.4.6.	13
VMT OUTPUT ERROR	Linearization table error: monotonicity error in the output (volume or mass) side of the table.	Check the content of the VMT! See: 5.3.4.6.	14
VMT INPUT OV.RNG.	Linearization table error: The measured level is greater than the highest level of the table's input side.	Check the content of the VMT! See 5.3.4.6. Device performs extrapolation according to the last point pairs!	15
EE CHK ERROR	Parameter checksum error.	Check the programming! For regenerating the checksum, modify a Parameter and return to Measurement mode. If this error still remains, contact the service!	16
INTEGRITY ERROR	Parameter consistency error. (Automatically fixed internal error.) Only WARNING	Check the programming!	17
AC COM. ERROR	Hardware error	Contact the service!	18
CALIBRATION ERROR	Sensor calibration error	Contact the service!	

7. MENU MAP


MAIN MENU
BASIC SETUP
OUTPUT SETUP
CALCULATION
SERVICE
BASIC SETUP
P.V. MODE
UNITS
DAMPING TIME
APPLICATION
MOUNTING MODE
P.V. MODE
DIST
LEVEL
VOL*
MASS**
UNITS
ENGINEERING SYSTEM
ENGINEERING UNITS
ENGINEERING SYSTEM
EU
US
ENGINEERING UNITS
BASIC UNITS
VOLUME UNITS
**MASS UNITS
BASIC UNITS
METER / FT
CM / INCH
MM
VOLUME UNITS
M³ / ft³
LITER / GALLON
MASS UNITS
METR. TON / IMP. TON
-/ lb (POUND)
DAMPING TIME
APPLICATION
NORMAL
BYPASS
MOUNTING
NORMAL
UPSIDE DOWN
OUTPUT SETUP
ANALOG OUTPUT
SERIAL OUTPUT
ANALOG OUTPUT
CURRENT MODE
4mA VALUE
20mA VALUE
ERROR MODE
MANUAL VALUE
CURRENT MODE
AUTO
MANUAL
4 mA VALUE
20 mA VALUE
ERROR MODE
HOLD
3.8 mA
22 mA
SERIAL OUTPUT
ADDRESS
MANUAL VALUE
ADDRESS


CALCUALTION
LEVEL OFFSET
*V / M CALC. MODE
**SPECIFIC GRAVITY
LEVEL OFFSET
SPECIFIC GRAVITY
V / M VALC MODE(P47)
TANK FUNCTION / SHAPE
V / M TABLE
MODIFY?
"ARE YOU SURE?"
V / M TABLE
VIEW / EDIT TABLE
ADD ITEM
DELETE ITEM
TANK FUNCTION / SHAPE
STANDING CYL.
STD. CYL. CON. BOT.
STD. RECT. W / CHUTE
LYING CYLINDRICAL
SPHERICAL
BOTTOM SHAPE
SHAPE0
SHAPE1
SHAPE2
SHAPE3
TANK DIMENSIONS
DIM 1
DIM 2
DIM 3
DIM 4
DIM 5
DIMx
SERVICE
SECURITY
OUTPUT TEST
DIST SIMULATION
DEFAULTS
SERVICE DIST OFFSET
RESTART
SECURITY
USER LOCK
SERVICE LOCK
USER LOCK
SERVICE LOCK
OUTPUT TEST
ANALOG OUTPUT
SERIAL OUTPUT
CURRENT VALUE
SERIAL OUTPUT
1200Hz
2200Hz
DIST SIMULATION
MODE
TIME
BOTTOM VALUE
UPPER VALUE
MODE
OFF
MANUAL VALUE
TRIANGLE WAVE
SQUARE WAVE
TIME
BOTTOM VALUE
UPPER VALUE
DEFAULTS
LOAD DEFAULT
CLEAR TIMERS
LOAD DEFAULT
"ARE YOU SURE?"
CLEAR TIMERS
"ARE YOU SURE?"
SERVICE DIST OFFSET