VF05

**VF05 2-WIRE GUIDED (TDR)
LEVEL TRANSMITTERS**

USER AND PROGRAMMING MANUAL

LEVEL MEASUREMENT TECHNICAL CONCEPTS

Factory default value of the minimum measuring distance (dead zone) X_m

Factory default value of the maximum measuring distance X_M

Maximum measuring range of the instrument

Programmed value of the maximum measuring distance (H) of the application

Programmed measuring range of the applications

Upper dead zone programmed to a higher value than factory default

DIST= measured distance

LEV= level (calculates; H−DIST)
VOL= volume (calculated from DIST LEV)

lower dead zone remote blocking not measurable

CONTENTS

1. INTRODUCTION

Application

The VF05 two-wire guided microwave level transmitter is used to measure the distance, level, and volume of liquids, solids, and granules. The device can be used in storage and reaction tanks, rigid pipelines of suitable diameter, and level reference vessels. The device is HART capable, it can be programmed using HyView software or PACTWARE.

Operating Principle

The VF05 two-wire guided-microwave level transmitter measurement method is based on TDR (Time Domain Reflectometry) analysis of the electromagnetic pulse traveling along the probe. The device sends nanosecond-wide, low-power pulses along an electrically conductive rod, cable, or coaxial supply line at a known rate of light propagation speed. If the electromagnetic pulse propagating along the conductor reaches a medium boundary with a different (ε_r) dielectric constant (the surface of the measured medium or the phase boundary of two liquids), some of the energy is reflected from there. The larger and sharper the (ε_r) dielectric constant change at the boundary of the media, the better the efficiency of the reflection (e.g., 80% of the energy is reflected from a flat air-water boundary) is.

The pulse is detected and processed by the device as a voltage signal. Since the propagation speed is known, the distance of the reflecting surface can be determined by measuring the travel time of the pulse. The travel time is the time between the start of the pulse and the arrival of the reflected pulse, and the distance traveled is twice the distance to and from the target. The device calculates the distance from the measured time into an electric signal proportional to the distance, an output current of 4…20 mA, and provides a HART**®** output signal and displays it on the display. Other derived quantities (volume, weight, etc.) can also be obtained from the distance data using the device software. The advantage of the described measurement technology compared to other level measurement methods is that the dust, foam, steam, boiling, and surface turbulence have no disturbing effect.

2. ORDER CODES

VF05 ☐ ☐ **-** ☐ ☐ ☐ **-** ☐   **2-wire guided microwave level transmitter**

Version / Temperature	Code
Transmitter	T
High-temperature transmitter	H
Transmitter + display	B
High-temperature transmitter + display	P

Probe / Process connection		Code
Coaxial	1" BSP	A
	1" NPT	B
	1½" BSP	C
	1½" NPT	H
Rod	1" BSP	R
	1" NPT	P
	1½" BSP	S
	1½" NPT	Z
Dual rod	1½" BSP	D
	1½" NPT	E
4 mm cable	1" BSP	K
	1" NPT	L
	1½" BSP	V
	1½" NPT	W
8 mm cable	1½" BSP	N
	1½" NPT	J
4 mm dual cable	1½" BSP	T
	1½" NPT	U
4 mm FEP-coated cable	1" BSP	F
	1" NPT	G
	DN40 TriClamp	X
	DN40 Milch	Y
Fully PFA-coated rod / DN50		Q
4 mm fully FEP-coated cable / DN50		M
Fully PP-coated rod / DN50		I
Fully PFA-coated rod / 1½" TriClamp		O

Housing	Code
Aluminum	7
Stainless steel	9

Probe length (x 10m)	Code
0 m	0
10 m	1
20 m	2
30 m	3

Probe length (x 1m)	Code
0 m	0
1 m	1
2 m	2
3 m	3
4 m	4
5 m	5
6 m	6
7 m	7
8 m	8
9 m	9

Probe length (x 0.1m)	Code
0 m	0
0.1 m	1
0.2 m	2
0.3 m	3
0.4 m	4
0.5 m	5
0.6 m	6
0.7 m	7
0.8 m	8
0.9 m	9

Output	Code
4…20 mA + HART	4

Note max probe lengths differ: -
Max cable length is 30m
Max length of Rod & Dual rod (both Ø8mm) is 3m
Max length of Rod (Ø14mm) & Coaxial is 6m

3. TECHNICAL DATA

GENERAL

		With aluminum housing VF05□□–7□□–4, 5, 6, 8		With stainless steel housing VF05□□–9□□–4, 5, 6, 8
Input data	Measured values	Distance between the reference point and the plane of the reflection (surface of the material); derived values: level, volume or weight		
	Measuring range	Depends on the probe and the measured medium (refer to technical data and probes table)		
Probe types and technical data		Coaxial, dual cable, cable, dual rod, and rod probes (for technical data refer to the Technical Data of Probes table)		
Housing		Cast aluminum with epoxy finish		Stainless steel
Process temperature		–30…+200 °C (–22…+392 °F) (for technical data refer to – MEDIUM TEMPERATURE table – Page 7)		
Process pressure		–1…40 bar (–0.1…4 MPa [–14…580 psig]) (for technical data refer to – MEDIUM PRESSURE DIAGRAM – Page 7)		
Ambient temperature		–30…+60 °C (–22…+140 °F), with display: –20…+60 °C (–4…+140 °F)		
Seal		FPM (Viton®), for high temperatures, optional FFKM Perfluoroelastomer (Kalrez® 6375), EPDM		
Ingress protection		IP67		
Supply voltage		13…36 V DC, nominal 24 V DC, built-in transient overvoltage protection		
Output data	Output signal	Analog: 4…20 mA; (3.9…20.5 mA) passive output; error signal 3.8 or 22 mA		
		BUS: serial, HART® interface, termination resistor maximum 750 Ω		
		Display: VGF-DISPLAY LCD dot-matrix		
	Accuracy [2]	Liquids: ±5 mm (±0.2"). If probe length is ≥ 10 m (L ≥ 33 feet); ±0.05% of probe length		
		Solids: ±20 mm (±0.8"). If probe length is ≥ 10 m (L ≥ 33 feet); ±0.2% of probe length		
Wiring		2× M20x1.5 metal cable gland; cable diameter: Ø7…13 mm (Ø0.3…0.5"), or M20x1.5 plastic cable gland; cable diameter: Ø6…12 mm (Ø0.23…0.47") maximum wire cross section: 0.5…1.5 mm² (AWG20…AWG15) (shielded cable recommended) + internal thread 2× ½" NPT for the cable's damping tube		
Electrical protection		Class III		
Weight (housing)		1.3 kg (2.9 lbs)	2.2 kg (4.9 lbs)	3.9 kg (8.6 lbs)

[1] With ideal reflective surfaces and constant temperatures.

TECHNICAL DATA OF PROBES

Type	VF05□K–□□□□–□ VF05□L–□□□□–□ VF05□V–□□□□–□ VF05□W–□□□□–□	VF05□R–□□□□–□ VF05□P–□□□□–□	VF05□S–□□□□–□ VF05□Z–□□□□–□	VF05□N–□□□□–□ VF05□J–□□□□–□	VF05□T–□□□□–□ VF05□U–□□□□–□	VF05□D–□□□□–□ VF05□E–□□□□–□	VF05□A–□□□□–□ VF05□B–□□□□–□ VF05□C–□□□□–□ VF05□H–□□□□–□
Version	4 mm cable (0.15")	Rod		8 mm cable (0.3")	4mm dual cable (0.15")	Dual rod	Coaxial
Maximum measuring range	30 m (100 feet)	3 m (10 feet)	6 m (20 feet)	30 m (100 feet)		3 m (10 feet)	6 m (20 feet)
Minimum measuring range εr = 80 / 2.4	0.25 m / 0.35 m (9.84" / 13.8")				0.15 m / 0.3 m (0.5 feet / 1 feet)		0 m (0 feet)
Min. distance to objects	⌀600 mm (⌀2 feet)				⌀200 mm (Ø 0.65 feet)		⌀0 mm (0 feet)
Minimum εr of medium	2.1				1.8		1.4
Process connection	1" BSP / 1" NPT / 1½" BSP / 1½" NPT	1" BSP / 1" NPT	1½" BSP / 1½" NPT				1" BSP / 1" NPT / 1½" BSP / 1½" NPT
Material of probe	316 (1.4401)	316Ti (1.4571)		316 (1.4401)		316Ti (1.4571)	
Nominal diameter of probe	4 mm (0.15")	8 mm (0.3")	14 mm (0.55")	8 mm (0.3")	4 mm (0.15")	8 mm (0.3")	28 mm (1.1")
Weight	0.12 kg/m (0.08 lb/feet)	0.4 kg/m (0.25 lb/feet)	1.2 kg/m (0.8 lb/feet)	0.4 kg/m (0.25 lb/feet)	0.24 kg/m (0.16 lb/feet)	0.8 kg/m (0.5 lb/feet)	1.3 kg/m (0.85 lb/feet)
Separator material	–				PFA, welded onto cable	PTFE-GF25 if length is >1.5 m (5 feet)	PTFE, if length is >1.5 m (5 feet)
Tensioning weight dimensions	Ø25 x 100 mm (Ø1 x 4")	–		Ø40 x 260 mm (Ø1.5 x 10")	Ø40 x 80 mm (Ø1.5 x 3")	–	
Material of tensioning weight	316Ti (1.4571)	–		316Ti (1.4571)	316Ti (1.4571)	–	

Type	VF05□F–□□□□–□ VF05□G–□□□□–□	VF05TX–□□□□–□	VF05TY–□□□□–□	VF05TM–□□□□–□	VF05TQ–□□□□–□	VF05TI-□□□□-□
Version	4 mm (0.15") FEP-coated cable			4 mm (0.15") fully FEP-coated cable	Fully PFA-coated rod	Fully PP-coated rod
Maximum measuring range	30 m (100 feet)				3 m (10 feet)	
Minimal measuring range ε_r = 80 / 2,4	0.25 m / 0.35 m (9.84" / 13.8")					
Free space requirement	$\varnothing$600 mm ($\varnothing$2 feet)					
Minimal ε_r of medium	2.1					
Process connection	1" BSP 1" NPT	DN 40 Triclamp	DN 40 Milch	DN 50		
Material of probe	316 (1.4401) / FEP				316Ti (1.4571) / PFA	316Ti (1.4571) / PP
Nominal diameter of probe	6 mm (0.23")				12 mm (0.5")	16 mm (0.62")
Mass	0.16 kg/m (0.1 lb/feet)				0.5 kg/m (0.33 lb/feet)	0.6 kg/m (0.4 lb/feet)
Coating of fillet and tension weight	–			PFA		PP
Tensioning weight dimensions	Ø25 x 100 mm (Ø1 x 4")			–		
Material of tensioning weight	316Ti (1.4571)			–		
Maximum medium temperature	+150 °C (+302 °F)					+60 °C (+140 °F)

MEDIUM TEMPERATURE		
	Type	**FLANGE TEMPERATURE**
Base model		–30…+90 °C (–22…+194 °F)
High-temperature HH□ or HP□ transmitter		–30…+200 °C (–22…+392 °F)

MEDIUM PRESSURE DIAGRAM

DIMENSIONS

VF05TK–□□□□–□ VF05TL–□□□□–□ VF05TV–□□□□–□ VF05TW–□□□□–□	VF05TR–□□□□–□ VF05TP–□□□□–□	VF05TS–□□□□–□ VF05TZ–□□□□–□	VF05TN–□□□□–□ VF05TJ–□□□□–□	VF05TT–□□□□–□ VF05TU–□□□□–□	VF05TD–□□□□–□ VF05TE–□□□□–□	VF05TA–□□□□–□ VF05TB–□□□□–□ VF05TC–□□□□–□ VF05TH–□□□□–□
VF05TF–□□□□–□ VF05TG–□□□□–□	VF05TX–□□□□–□	VF05TY–□□□□–□	VF05TM–□□□□–□	VF05TQ–□□□□–□	VF05TI–□□□□–□	

3.1. EXPLOSION PROTECTION, DESIGNATION, LIMIT VALUES

Licensing in progress.

3.2. ACCESSORIES

- Hyview software
- User and Programming manual
- 2× M20x1.5 cable gland
- VGF-DISPLAY display unit (option)

3.3. CONDITIONS FOR SAFE USE

- The metal housing of the device must be connected to the equipotential (EP) network.
- The aluminum content of the cast aluminum housing exceeds the limit value, so the equipment must be protected against impact and friction.

3.4. MAINTENANCE AND REPAIR

VF05 does not require maintenance on a regular basis. In some very rare instances, however, the probe may need cleaning to remove deposited material. This must be carried out gently, without damaging the probe. Repairs during or after the warranty period are carried out exclusively at the Manufacturer. The equipment sent back for repair should be cleaned or disinfected by the User.

4. INSTALLING

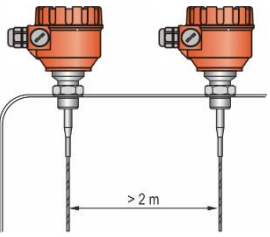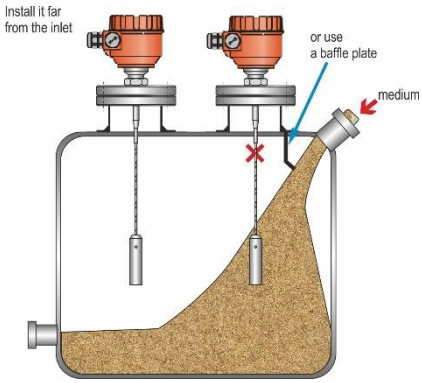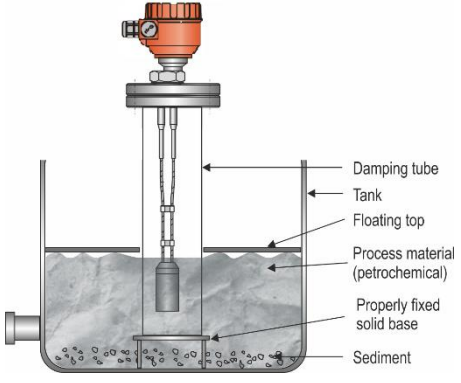## 4.1. HANDLING AND STORAGE

⚠️	Lift the instrument using both hands, or if necessary, use a hoist. Do not lift the instrument by the probe. It is a critically sensitive part.	Protect the instrument from mechanical impacts and falling. The electronics is a sensitive and fragile unit.
	Do not bend coaxial and rod probes. The device must be supported in the marked places. 	The cable probe must not be looped, broken, or frayed. The minimum bending diameter is 0.4 m (16"). All these may cause a measurement error.
	Storage temperature: 	
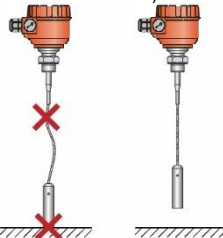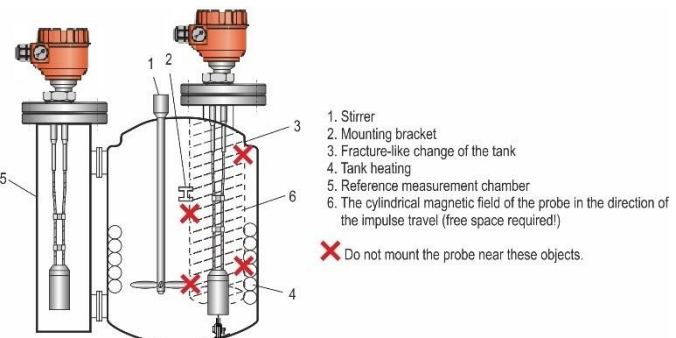
4.2. MOUNTING ON CONTAINERS

4.2.1. *General mounting instructions*

The size and position of the connector on the top of the tank (and the distance from the wall), the internal anti-reflection fittings, the rough joints, the welds and the shape and design of the top and bottom of the tank are very important for the correct operation of the device. Any factor that affects the formation of the electromagnetic field of the probe also significantly impairs the measurement accuracy. The coaxial probe is an exception because it has no external electromagnetic field.

Threaded process connection	Lifter height	Lifter intrusion into the tank
The easiest way to mount onto the tank is with a device screwed into a 1 "BSP, 1" NPT, 1½ "BSP or 1½" NPT threaded hole. 	⚠️ Do not use a lifter longer than the probe diameter for individual probes and dusty applications. h ≤ Ød, where h = lifter height Ød = lifter diameter ***Consult HYCONTROL if the above condition cannot be met!***	⚠️ ❌ ***The lifter must not extend into the tank, as the protruding part interferes with the measurement!***

Mounting two devices	Effects of material influx	Using a protective tube
If two devices have to be mounted on one tank, they must be spaced at least 2 m (6.5 ft) apart to eliminate interference and measurement inaccuracies resulting from the interaction of the two electromagnetic fields. Devices equipped with coaxial probes are not subject to the above warning because there is no electromagnetic field outside the probe's outer sheath. 	⚠️ Do not place the lifter near the material inlet pipe connector. Material flowing onto the sensor probe causes incorrect level indication. If there is not enough space, it is recommended to install a baffle plate. 	The floating lid is a common solution for petrochemicals. In such cases, the use of a damping tube is recommended.

Straightness and contact of measuring probes with other fittings and distance from the bottom of the tank.	Using a stirrer
After installation, the cable probes and the associated tensile weight must be straight, tensioned, and away from other fittings (e.g., mixer). They must not come into contact with the tank wall, bottom, or other objects. The installation space requirements of the different measuring probes must be taken into account according to the data of the measuring probes (see Technical Data). 	There is no radiation cone along the probe. When measuring liquids, the use of a reference chamber or damping tube is recommended, since it provides mechanical and electromagnetic protection for accurate measurement. 1. Stirrer 2. Mounting bracket 3. Fracture-like change of the tank 4. Tank heating 5. Reference measurement chamber 6. The cylindrical magnetic field of the probe in the direction of the impulse travel (free space required!) ❌ Do not mount the probe near these objects.

⚠️ **Protect the device from direct sunlight!**
Attaching the probe to the bottom of the tank.
Flexible cable probes can be anchored to the bottom of the tank with a fastener or loop.

Installing and shortening the cable probes
If necessary, the probe can be shortened, but only for liquid applications.
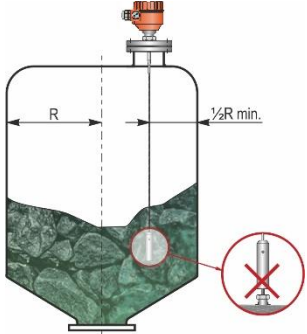
Steps:
1. Loosen the grub screws (hexagon) with an Allen key. (ISO 2936)!
2. Pull the cable out of the tension weight and cut to the desired size!
3. Insert the cable back into the weight as shown and tighten the screws!
4. Modify the configuration parameters to the new length, the reference point being the upper edge of the weight!
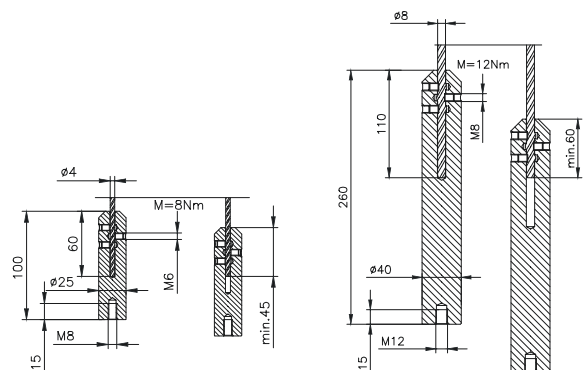
4.2.2. *Installing the Device for Measuring Solids*

False measured value	Coning and strong tensile force on the probe	
The probe may not touch the lifter pipe		⚠ Strong tensile force. The rope must not be anchored when measuring solids. The device is mounted at a distance of half the radius of the tank from the top of the tank with a minimum lift nozzle height. It prevents excessive mechanical stress when emptying the tank.

The tensile force of the probe rope depends on the height and shape of the tank, the fragmentation of the material, the density, and the speed of discharge.

The following table gives the tensile load values for the different materials (approximate data in tons).

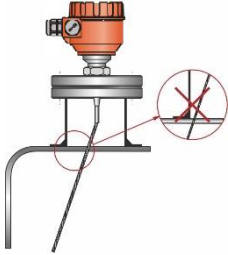| Probe type	Material	Probe length		
		6 m (20 ft)	12 m (40 ft)	24 m (80 ft)
Single cable, Ø8 mm (Ø0.31"), max. load: 3.0 T	Cement	0.6 T	1.2 T	2.4 T
	Ash	0.3 T	0.6 T	1.2 T

The measured process material can accumulate on the probe and lifter, which weakens the energy of the measuring pulse.

Avoid creating cavities that increase deposition.

Observe the load capacity of the tank top, which must ensure the maximum tensile force of the probe.

4.3. WIRING

Wiring in non-explosive environments

1. Take the device's lid off.
2. Put the cable through the cable gland (½" NPT) to the terminal block.
3. Remove the outer insulation for ~80 mm (~3.15") from the cable so the wires can be accessed, then strip the wires for 4 mm. Strip the shielding from the signal cable.
4. Connect the cable to terminal 2 and 3 (polarity is irrelevant).
5. Retract the cable so the cable's outer insulation runs through the cable gland for about 10 mm (0.4"). Then tighten the cable gland's nuts with two wrenches.
6. Organize the wires in the compartment.
7. Put the lid back on.

Do not perform insulation tests with a test voltage of 500 V AC on the device due to the internal electronic surge protection!

Connecting (grounding) to equipotential network (EPH)

Threaded earth connection (EP) on the side of the housing, maximum wire cross section: 4 mm² (AWG12). The housing of the device must be earthed to a ground with a resistance of $R < 1\ \Omega$.

The shield of the test lead must be earthed at the instrument panel. Do not run the test lead near high-current cables, as shielding does not provide protection against switching harmonics.

Electrostatic discharge (E.S.D.)

⚠ The device is protected against 4 kV ESD.

Warning: The electrostatic discharge protection of the measuring system cannot be solved by the internal ESD protection.

In all cases, it is the user's responsibility to ensure that the tank, measured material, and probe are grounded.

⚠ **Risk of injury!**
The probe may accumulate an electrostatic charge during regular operation, so discharge it to the ground by touching it (tank side) when installing!
Ground the inlet and the measured medium!

Design of the measuring network in non-explosive environments

Power supply

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

Line A: minimum voltage on the device's input terminals
Line B: minimum supply voltage (voltage drop on the device and the 250 Ω loop resistance)

An example for calculating the supply voltage:
The minimum supply voltage at I_{min} = 4 mA current:
$U_{supply\ min.}$ = $U_{in\ min.}$ + (I_{min} * loop resistance) = 12 V + (4 mA * 0.25 kΩ) = 13 V

The minimum supply voltage at I_{max} = 22 mA current:
$U_{supply\ min.}$ = $U_{in\ min.}$ + (I_{min} * loop resistance) = 11.5 V + (22 mA * 0.25 kΩ) = 17 V

Therefore, if the loop resistance is 250 Ω, 17 V is just enough for the entire 4…20 mA measuring range.

### 4.3.1.   *BUS (HART®) communication*

The output of the device can be used in two ways: 1. Current loop output and HART®   2. Passive, HART® protocol
The HyView program supports the use of both modes.
According to the Rosemount Standard, HART® communication can be used as a point-to-point connection between VF05 as a "slave" and a HART® "master".
There are two modes of communication:
•   If the device (HART® short address 0) is set to current loop transmission (4…20 mA), only one device can be in the HART® communication loop
•   For multidrop operation (4mA), several devices (max. 15) can be connected to one HART® communication loop. In this case, a short address other than 0 must be set for the device.
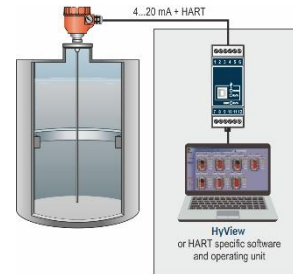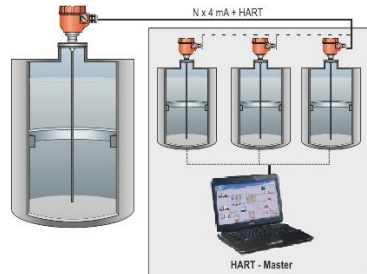
4.4. SWITCHING ON AND COMMISSIONING

The VF05 two-wire device is supplied by HYCONTROL with the technical specifications requested by the customer, so it is ready for operation immediately after installation and wiring up.
Measuring starts less than 20 seconds after switching on. **Attention! The initial current consumption of the device is 3.5 mA right after switching on!** If there is a change in the installation data due to shortening a cable probe, the set parameters must be changed according to the application before starting the measurement.

4.5. AVAILABLE USER INTERFACES

The instrument can be programmed by using the following devices / accessories:

VGF-DISPLAY display unit	Ordered separately. See "5.2. Programming with the VGF-DISPLAY display unit."
Hyview software (PC needed)	Available as download
HART® Microlink USB modem	Ordered separately. See "5.1. Programming with HyView"

5. PROGRAMMING

There are two ways to program the VF05.
- **Programming with the HyView software**
- **Programming with the VGF-DISPLAY display unit**

5.1. PROGRAMMING WITH HYVIEW

5.1.1. *Installing and Running HyView*

If necessary, install the "HyView HART Configuration Software" (hereafter HyView).
Electrical connections: Connect the transmitter to a PC using a HART® USB modem (sold separately).
Start the program and search for the transmitter in the program.

5.1.2. *Programming and Configuring the Device*

Select the device from the list of found devices to configure and program and open the device's "Device Programming" window.

All the necessary parameters and function settings can be performed with HyView. The table below summarizes the parameters and their location and path.
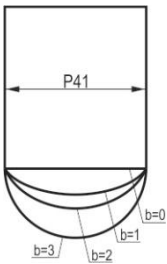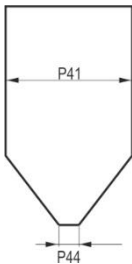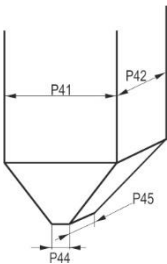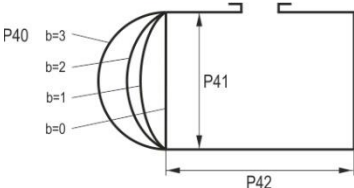
5.1.2.1 Parameters
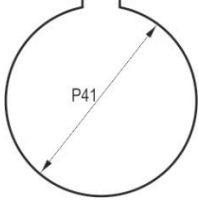
Table 1.

Name (number), function	Adjustable value range / Default value	Description
Zero-level distance (P04), Set container height	0...60 m (0…200 ft) **As per order**	It provides the basis for level measurement calculations. The distance between the plane of the lower sealing surface of the mechanical connector (the lower plane of the flange in the case of a flanged version) and the reference point at the bottom of the tank. Its value must be set in a distance unit (Unit - P00b). Note: There is no measurement beyond the set zero distance if the output is configured for distance or level measurement. **HyView setting:** "Device Settings" > "Measurement configuration" > "Zero-level dist." **VGF-DISPLAY:** `MAIN MENU / CALCULATION / ZERO-LEVEL DISTANCE`
Minimum measuring distance (P05), Dead zone **Warning!** **Critical parameter!**	Minimum measuring distance… probe length (P03) **"Minimum measuring distance" according to the Probe data table**	The dead zone is the distance between the plane of the lower sealing surface of the mechanical connection (the lower plane of the flange in the case of the flanged version) and the highest level in the tank. Signals generated within the dead zone are not processed. The current loop output does not follow the dead zone level signal. Its value must be set in distance units (Length unit – P00b). **HyView setting:** "Device Settings" > "Measurement configuration" > "Minimum". **VGF-DISPLAY:** `MAIN MENU / MEASUREMENT CONFIG / MIN. MEAS. DIST.`
Maximum measuring range limit (P06), Remote blocking	0 (limiter off) or the minimum measuring distance. The distance between (P05) + 5 cm and the probe length (P03) 0 (off)	The maximum value of the measuring range of the device can be limited with this parameter. Signals received beyond the set distance will not be processed. Its value is calculated from the plane of the lower sealing surface of the mechanical connector (in the case of a flanged version, from the lower plane of the flange). Remote blocking can be turned off by setting the parameter to 0. In this case, the device will give a valid result along the entire length of the sensor. **HyView setting:** "Device Settings" > "Measurement optimalization" > "Far end (P06)". **VGF-DISPLAY:** `MAIN MENU / MEASUREMENT CONFIG / MAX. MEAS. DIST.`
Damping time (P20) Time constant	0…999 sec. **10 sec**	The "Damping time" is used to reduce undesired fluctuations (e.g.: rippling) in the display of the measured data. If the level changes abruptly, the new value will be set to within 1% accuracy (exponential setting). Unit of measure: seconds. **HyView setting:** "Device Settings" > "Measurement optimalization" > "Damping time" **VGF-DISPLAY:** `MAIN MENU / MEAS. OPTIMIZATION / DAMPING TIME`
Probe length (P03)	0.1…30 m (0.33…100 ft) **Default probe length as per order + 0.1 m (+ 0.33 ft)**	The set value is the nominal probe length + 100 mm (+ 0.33 ft). This value should only be changed if the probe length is changed or the probe is replaced. Its value must be set in distance unit (Length unit - P00b). For special applications, the length of the probe may be greater than the height of the tank but may not exceed 30 m (100 ft). **HyView setting:** "Device Settings" > "Measurement configuration" > "Probe length settings" **VGF-DISPLAY:** `MAIN MENU / MEASUREMENT CONFIG / PROBE LENGTH`
Fixed output current (P08), Setting constant output current	3.8…22 mA **4**	When the current output is set to "Fixed" mode (P12b = 1), the constant current set here is set. The PV current transmission does not work, and at the same time, it overrides any current output fault indication. **HyView setting:** "Device Settings" > "Outputs" > "Fix output current (P8)" **VGF-DISPLAY:** `MAIN MENU / OUTPUT SETUP / ANALOG OUTPUT / MANUAL VALUE`
System of measurement units, units of measurement:		Path of parameters: "Settings" / Application" tab
Unit system (P00c), Unit system settings	Selectable values: − Metric (EU), European unit system − Imperial (US), US unit system **Metric (EU)**	The units that can actually be used (length, volume, weight) change according to the unit system set according to this parameter. When setting or changing units, the unit system must be selected first and only then can the actual unit to be used be set (according to the previously narrowed list). **HyView setting:** "Device Settings" > "Application" > "Calculation system" **VGF-DISPLAY:** `MAIN MENU / BASIC SETUP / UNITS / ENGINEERING SYSTEM`

Name (number), function	Adjustable value range	Description
	Default value	
Distance unit (P00b), Length unit	Selectable values Metric (EU): – m – cm – mm – custom unit Imperial (US): – inch – ft **m**	The unit of measurement for the transmitter when the distance and level are set. If "custom unit" is selected, the unit uses the unit of length as the distance unit based on the value specified in "User Unit." **HyView setting:** "Device Settings" > "Application" > "Engineering units" **VGF-DISPLAY:** `MAIN MENU / BASIC SETUP / UNITS / ENGINEERING UNITS / DISTANCE UNITS`
Output unit, volume (P02b) Volume unit	Selectable values Metric (EU): – liter – hl – m³ – million liters Imperial (US): – gallon – ft³ – barrel – million gallons **liter**	The unit of the transmitted number when set to volume measurement. The device converts the measured level into volume by calculation. It is done by using a level-dependent (non-linear) function. It also gives the unit of measure for the "Output" column in the VM table (OC). **HyView setting:** "Device Settings" > "Measurement configuration" > "Volume units" **VGF-DISPLAY:** `MAIN MENU / BASIC SETUP / UNITS / ENGINEERING UNITS / VOLUME UNITS` **IT IS ONLY DISPLAYED IF THE PV IS VOLUME!**
Output unit, Weight (P02a) Weight unit	Selectable values Metric (EU): – kg – ton – US ton Imperial (US): – lb – US ton – metric ton **kg**	The unit of the transmitter number if the device is set for weight measurement. The device converts the measured level into weight. It is done by using a level-dependent (non-linear) function. It also gives the unit of measure for the "Output" column in the VM table (OC). **HyView setting:** "Device Settings" > "Measurement configuration" > "Mass units" **VGF-DISPLAY:** `MAIN MENU / BASIC SETUP / UNITS / ENGINEERING UNITS / MASS UNITS` **IT IS ONLY DISPLAYED IF THE PV IS MASS!**
Operating mode (P00a), Measured medium property	Selectable values: – Liquid – Granular solid – Two interfacing liquids **Liquid medium**	The basic characteristic of the measured medium is set here. The measuring capabilities of the device vary significantly depending on this characteristic of the medium (see specification). **HyView setting:** "Device Settings" > "Application" > "Operating mode" **VGF-DISPLAY:** `MAIN MENU / BASIC SETUP / APPLICATION`
Unit system (P00d), Temperature unit	Selectable values: – °C – °F **°C**	The unit of temperature measurement is selected here. **HyView setting:** "Device Settings" > "Measurement configuration" > "Temperature" **VGF-DISPLAY:** `MAIN MENU / BASIC SETUP / UNITS / ENGINEERING UNITS / TEMPERATURE UNITS`
Output function (P01ab), Application mode	Selectable values Metric (EU): – Distance – Level – Volume – Mass – Ullage volume **LEVEL**	Set the physical quantity for the transmitted meter. The device measures distance. The other quantities are calculated based on the specified tank parameters and material characteristics. **HyView setting:** "Device Settings" > "Measurement configuration" > "Measurement mode (PV source)" **VGF-DISPLAY:** `MAIN MENU / MEASUREMENT CONFIG / PV. MODE`
Custom Unit multiplier (P07) User defined unit (Length unit)	0.001…100 **1.000**	The distance in "custom unit" is the distance in meters multiplied by P07 to get. The corresponding setting field only appears or is active if "custom unit" is selected in the unit system. The reference of the multiplier is meter, the value of the conversion factor must always be given in relation to it. For example, if the conversion factor is 10, then the new unit is 10 m (33 ft) or if the conversion factor is 0.1, the new unit is 0.1 m. **HyView setting:** "Device Settings" > "Application" > "Conversion factor" **VGF-DISPLAY:** no adjustment available
Select echo (P25)	Selectable values: – Highest amplitude – First – Second – Last **Highest amplitude**	In problematic cases, it is possible to choose between the echoes created during the measurement in order to ensure a stable measurement and transmission. **HyView setting:** "Device Settings" > "Measurement optimalization" > "Selection of Echo…" **VGF-DISPLAY:** no adjustment available
Filling speed (P26)	0.1…900m/h (0.33…2950 ft/h) **900m/h (2950 ft/h)**	The maximum rate of rise in the tank during filling. Entering it correctly increases the reliability of the measurement during charging. **HyView setting:** "Device Settings" > "Measurement optimalization" > "Level elevation rate …" **VGF-DISPLAY:** no adjustment available
Emptying speed (P27)	0.1…900m/h (0.33…2950 ft/h) **900m/h (2950 ft/h)**	The maximum rate of dropping in the tank during emptying. Entering it correctly makes the measurement more reliable during emptying.

Name (number), function	Adjustable value range	Description
	Default value	
		HyView setting: "Device Settings" > "Measurement optimalization" > "Level descent rate …" **VGF-DISPLAY:** no adjustment available
Current output, current output signal settings:		Path to parameters: "Device settings" / Outputs" tab
Current loop output (P12b), Set mode	Selectable values: – Auto – Manual **Auto**	Selects the current loop output mode when transmitting current. In "Auto" mode, the output current changes proportionally to the PV (4… 20 mA). In the case of "Manual," the constant current set in the parameter P08 is forced to the current output mainly for testing purposes. **HyView setting:** "Device Settings" > "Outputs" > "Current generator mode" **VGF-DISPLAY:** `MAIN MENU / OUTPUT SETUP / ANALOG OUTPUT / CURRENT MODE`
Current loop output (P12a), Value of output current if there is an error (error current)	Selectable values: – Hold – 3.8 mA – 22 mA **Hold**	This parameter determines the state that the current loop output draws in the event of a fault. For "Hold," it keeps the last measured value (4… 20 mA), for "3.8 mA" and "22 mA" it keeps the indicated value until the fault is present. **HyView setting:** "Device Settings" > "Outputs" > "Current output -> Error indication by the current output" **VGF-DISPLAY:** `MAIN MENU / OUTPUT SETUP / ANALOG OUTPUT / ERROR MODE`
Value assigned to 4 mA (P10)	Selectable values: In accordance with the PV adjustment range, usually minimum value **0.000 m (0.000 ft)**	PV value assigned to 4 mA in current transmission mode (usually the lower limit of the measuring range for level measurement). **HyView setting:** "Device Settings" > "Outputs" > "Assignment of 4 mA - PV" **VGF-DISPLAY:** `MAIN MENU / OUTPUT SETUP / ANALOG OUTPUT / 4mA VALUE`
Value assigned to 20 mA (P11)	Selectable values: In accordance with the PV adjustment range, usually maximum value **6.000 m (20.000 ft)**	PV value assigned to 20 mA in current transmission mode (usually the upper limit of the measuring range for level measurement). **HyView setting:** "Device Settings" > "Outputs" > "Assignment of 22 mA - PV" **VGF-DISPLAY:** `MAIN MENU / OUTPUT SETUP / ANALOG OUTPUT / 22mA VALUE`
Echo loss handling (P28b), Error signal delay	Selectable values: No delay – 10 sec – 20 sec – 30 sec – 1 min – 2 min – 5 min – 15 min **0** (no delay)	This parameter determines the time elapsed between the occurrence of the fault and the error signal (e. g.: fault current). The output is held at the time of the delay, based on the last valid measured data. The function is only available for current output with an error signal set to the lower (3.8 mA) or the upper (22 mA) error current. **HyView setting:** "Device Settings" > "Measurement optimalization" > "Error delay" **VGF-DISPLAY:** no adjustment available
Special, identifying data		Path to parameters: "Device programming window (Advanced mode) / Special" tab
HART short address (P19), Device address	0…15 **0**	Unique device address based on which the device can be identified and managed via the HART bus. • 0: analog output active (current loop transmission active, 4…20 mA) • 1…15: analog output inactive (no current loop transmission, constant 4 mA), Multidrop **HyView setting:** "Device Settings" > "Device identification" > "Device short address" **VGF-DISPLAY:** `MAIN MENU / OUTPUT SETUP / SERIAL OUTPUT / ADDRESS`
RELAY mode (P13a), RELAY output modes	Selectable values: – OFF – PV – On Error **OFF**	The operating mode of the RELAY with optional level switching functions can be set with this parameter. The function is Off by default. When set to "PV," the RELAY operates based on the trigger and release values set according to the PV. The "On Error" setting allows a switched (relay contact) fault indication to the process controller. **HyView setting:** "Device Settings" > "Outputs" > "Relay mode" **VGF-DISPLAY:** `MAIN MENU / OUTPUT SETUP / RELAY OUTPUT / RELAY MODE`
RELAY mode (P13b), RELAY functions	Selectable values: – Hysteresis – Window comparator **Hysteresis**	The basic switching methodology of the RELAY set to "PV" mode can be set. **HyView setting:** "Device Settings" > "Outputs" > "Relay function" **VGF-DISPLAY:** `MAIN MENU / OUTPUT SETUP / RELAY OUTPUT / RELAY FUNCTION`
RELAY mode (P13c), RELAY inverted mode	Selectable values: – Not inverted – Inverted **Not inverted**	If the setting is non-inverted, the RELAY closes its contacts when the trigger value is reached, otherwise (inversion) opens these contacts. **HyView setting:** "Device Settings" > "Outputs" > "Relay inverted" **VGF-DISPLAY:** `MAIN MENU / OUTPUT SETUP / RELAY OUTPUT / INVERTING`
RELAY trigger value (P14)	Value can be adjusted in accordance with PV setting interval **1.000 m (3.300 feet) (level)**	The measured PV value at which reaching the upper limit (upper switching value) is signaled on the RELAY output. **HyView setting:** "Device Settings" > "Outputs" > "Energized value" **VGF-DISPLAY:** `MAIN MENU / OUTPUT SETUP / RELAY OUTPUT / ENERGIZED VALUE`
RELAY release value (P15)	Value can be adjusted in accordance with PV setting interval	The measured PV value at which reaching the lower limit (lower switching value) is signaled on the RELAY output.

Name (number), function	Adjustable value range / Default value	Description
	5.000 m (16.400 ft) (level)	**HyView setting:** "Device Settings" > "Outputs" > "De-Energized value" **VGF-DISPLAY:** `MAIN MENU / OUTPUT SETUP / RELAY OUTPUT / DEENERGIZED VALUE`
RELAY delay (P16)	0…999 sec	In the event that the PV measured value has reached the lower or upper switching value or an error signal has occurred in the event of an error, the RELAY is activated and a change is visible on the relay output after this time delay.
	0 sec	**HyView setting:** "Device Settings" > "Outputs" > "Relay delay time" **VGF-DISPLAY:** `MAIN MENU / OUTPUT SETUP / RELAY OUTPUT / DELAY`
Tank type (P40a), Tank shapes for volume measurement	Selectable values: – Output Conversion table (OCT) – Standing cylindrical tank with dome bottom – Standing cylindrical tank with conical bottom – Standing rectangular tank with or without chute – Lying cylindrical tank – Spherical tank **Standing cylindrical tank with dome bottom**	Selecting a typical basic container shape for volume measurement. The tank dimensions can be set using parameters P41… P45 (see figures below). If OCT is set, the tank shape must be specified in tabular form. **HyView setting:** "Device settings" > "Tank/Silo parameters" > "Tank shape" **VGF-DISPLAY:** `MAIN MENU / CALCULATION / TANK SHAPE` **IT IS ONLY DISPLAYED IF THE PV IS VOLUME!**
Tank type (P40b), Tank properties for volume measurement, tank bottom shape	Selectable values: – 0 (flat) – 1 – 2 – 3 **0 (flat)**	Assigning typical tank bottom designs to a specific tank type for accurate volume calculation. The exact form for the setting code is shown in the figure below. **HyView setting:** "Device settings" > "Tank/Silo parameters" > "Bottom shape" **VGF-DISPLAY:** no adjustment available

Standing cylindrical tank with dome bottom	Standing cylindrical tank with conical bottom	Standing rectangular tank	Lying cylindrical tank	Spherical tank

Tank dimensions (P41…P45), for volume measurement	0…999 999	Typical dimensions in units of length for the tank type set in parameter P40 for volume calculation.
	0	**HyView setting:** "Device settings" > "Tank/Silo parameters" > "Bottom shape" **VGF-DISPLAY:** no adjustment available
Specific gravity (P32), for weight measurement	0.01…100	If the device is set to weight measurement, the specific gravity of the material (medium) stored in the tank must be entered here for weight calculation. The value to be set is the ratio (without unit) to the density of the water. **HyView setting:** "Device settings" > "Measurement optimalization" > "Specific gravity" **VGF-DISPLAY:** no adjustment available
Threshold offset (P34), interference sensitivity setting	-4095…+4095	Modifies the acceptance threshold set on the echo chart. It can be used it to increase (positive value) or decrease (negative value) the device's ability to suppress the interference signal relative to the default setting. When set to 0, there is no change from the original setting. **HyView setting:** "Device settings" > "Measurement optimalization" > "Threshold offset"
	0	**VGF-DISPLAY:** `MAIN MENU / MEAS. OPTIMIZATION / THRESHOLD OFFSET`

User defined multiplier (P22), Correction factor (measured/actual)	0.7…10	Adjusts the transmitted quantity by distance. If the value measured by the device differs from the value under real conditions, this multiplier can be used to adjust the result. The output value is multiplied by the number set here. The default multiplier is 1, which does not change the output.
	1	**HyView setting:** "Device settings" > "Measurement optimalization" > "Velocity user correction factor" **VGF-DISPLAY:** no adjustment available
Gross tank volume (P47)	0…999 999	If the output (PV source) is set to "Ullage volume" transmission, the total volume can be specified 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 volume of the medium. Its unit is PV.
	0	**HyView setting**: "Device settings" > "Tank/Silo parameters" > "Total tank volume" **VGF-DISPLAY:** no adjustment available

5.1.2.2 Setting Up and Filling the OC (Output Conversion) Table

This feature is required to create a level / volume conversion table of up to twenty points. Each new value entered must be greater than the previous one.
The length and volume units can be changed later without changing the data in the table (length unit, volume unit).
The two units on the right and left of the table are given by the length unit and volume unit settings, i.e., these two units must be used to complete the table (length unit and volume unit).

Important: Volume can only be measured if a conversion table is created!
To fill or adjust the device level / volume table, go to the "Device Setup"> "OC-table" tab in HyView.
Here you can fill or modify the table.
The difference is that if the "Measurement mode PV source" parameter is set to "Volume" or "Ullage Volume", the OC table is active.
When the appropriate changes have been made to the table or it has been filled in correctly, click the "Send" button under the "Get" button on the right on this page ("OC-table" tab) to download the table.

5.1.2.3 Device status window

To turn on the "Device status window" in HyView, right-click on the device line in the "Device list" list in the main window and select "Show Device Status Window" in the popup window.

5.1.2.4 Device "Echo Diagram" (Oscilloscope Function)

Open the "Echo Diagram" window to display the device echo diagram.
The "Device Echo map" window will appear. The diagram shows the reflection curve measured by the device.
Press the "Refresh" button in the bottom row of the window (or press the F4 button while in the window) to refresh the chart or read the data. After a successful reading, a curve corresponding to the image below will appear on the graph (see Figure 1).
If there was an evaluable level signal, it will also appear on the graph ("Selected peak" bubble window) along with other additional information. In addition, you can use this window to set any "Threshold" level.

5.1.2.5 Level Threshold

The level threshold of the device can be changed in the echo diagram window, i.e., the value of "Threshold."
This may be necessary if the device does not find the level signal (e.g., the set level threshold is too high or too low and the gain is already at the highest level).
To change the "Threshold" value, access the "Threshold settings"> "Threshold edit enable" function from the pop-up menu triggered by a right-click. The corner points of the threshold curve on the echo diagram can then be adjusted with the mouse. Pressing the "Apply Threshold" button on the left help panel will apply the set threshold value. To refresh the chart, press the "Refresh" button (or press the F4 button in the window).
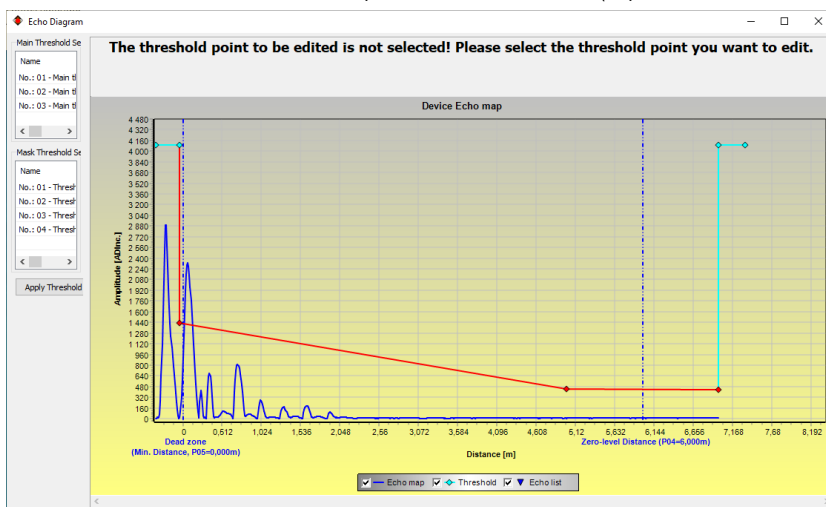
Attention! The "Cursor On" function does not give an exact value, it only recalculates the value of the given point based on the graphical representation.

5.1.3. *Programming Example 1 (Using HyView):*

Changing the actual tank height (10.000 m [33.000 ft]).
To the probe (cable) length L_2 (9.000 m [29.500 ft]) configured by the manufacturer, and saving the new parameter.

Step	Operation	Entered data / value
1	Open the "Device Setup" window for that device in HyView	The program will read and display the device settings
2	Select "Measurement configuration"	
3	Click on "Zero-level dist." (Zero-Level Distance)	The data in the field: 10.000 [m] ([33.000 [ft])
4	Enter the new value	9.000 [m] (29.500 [ft])
5	Press the button labeled "Send" in the lower right row of the window to download the new value to the device	
6	Press the "X" close button to exit the device settings window	

Programming Example 2 (Using HyView*):*

Setting custom scale: Select the "Level" measurement mode as the current loop output parameter to set the scale from the bottom of the tank.
Set the current range from 4…20 mA with 22 mA as error signal.
Select the appropriate minimum and maximum values for the measurement scale.

Step	Operation	Entered data / value
1	Open the "Device Setup" window for that device in HyView	The program will read and display the device settings
2	Select "Measurement configuration	
3	Within the "Measurement mode PV" section, select the new setting value (Level) from the drop-down list	This field will read "Level"
4	Select "Outputs"	
5	Select "Error indication …" drop-down list.	The field will say "Hold"
6	Select "New setting" from the drop-down list	The field will say "22 mA"
7	Select the data field named "Assignment of 4 mA - PV".	The field will say "0.000 [m]" ("0.000 [ft]")
8	Enter the new value. This gives the level corresponding to a minimum output of 4 mA.	The field will say "1.000 [m]" ("3.300 [ft]")
9	Select the data field named "Assignment of 20 mA - PV"	The field will say "6.000 [m]" ("20 [ft]") (default: 6.000 [m])
10	Switch to 8,600 m. This gives the level corresponding to the maximum output of 20 mA (and sets the maximum output to the upper limit of the dead zone).	The field will say "8.600 [m]" ("28,2 [ft]")
11	Press the button labeled "Send" in the lower right row of the window to download the new values to the device.	
12	Press the "X" close button to exit the device settings window.	

Creating a volume table – (HyView OC-table (OCT))

A conversion table has to be created using HyView to measure volume.

The volume values in the table are assigned to the measured levels. For asymmetrical and irregularly shaped containers, the accuracy of the volume measurement depends on the number of pairs of values associated. The maximum number of pairs is 20. The volume is determined by linear interpolation between two value pairs. The conversion table is usually used for volume measurement, but can also be used for weight or flow measurement.

The following example shows five-point programming.

Here's how to create a user-defined "level-to-volume" conversion table (using HyView).

Step	Operation	Entered data / selected value
1	Open the "Device Setup" window for the device in HyView.	
2	Go to "Application" and select "Calculation system".	Metric (EU), Imperial (US), Optional Unit
3	Select length (Engineering Unit).	m (ft)
4	Go to "Measurement configuration" and select volume from the "Measurement mode (PV source)" list.	Volume
5	Select the volume unit in "Volume Units".	m³ (ft³)
6	Go to "Measuring distances" Enter the tank height into "Zero-level dist." (click in the field and enter the value).	6.00 m (20 ft)
7	Go to "Probe length" and enter s value for probe length	5.80 m (19 ft)
8	Go to the "Minimum (P5)" field and enter the dead zone value (forbidden distance)	0.40 m (1.3 ft)
9	Press the button labeled "Send" in the lower right row of the window to download the new values to the device.	Please wait while the download process is complete
10	Go to "OC-Table" Fill in the table called "OCT list" with the appropriate values. A maximum of 20 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 Ctrl + Insert, or by selecting "Add new item" in the right mouse button popup menu. Lines can be deleted by pressing Ctrl + D.	See the following table (Table 2)
11	To download the spreadsheet to your device, press the "Send" button on the right side of the tab (OC-table) below the "Get" button.	

Table 2. (Input table)

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 (17.65 ft³)
3	0.75 m (2.5 ft)	1.0 m³ (35 ft³)
4	1.00 m (3.3 ft)	1.5 m³ (52.9 ft³)
5	5.60 m (18.5 ft)	16.8 m³ (593.3 ft³)

Note: The level can be measured effectively between 0.20 m (0.66 ft) and 5.60 m (18.5 ft). When the level of the measured material falls below the end of the measuring probe, the device will still indicate 0.20 m, because the level meter can only display between 0.20 m (0.66 ft) and 5.60 m (18.5 ft) according to the probe length (which is now 5.8 m [19 ft]).
The size of the dead zone depends on the equipment and the type of probe.

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

Step	Operation	Entered data / Selected value
1	Go to "Outputs" and set "Current generator mode" to "Auto" (default)	Auto
2	Set the error status to the appropriate mode in "Error indication …" (default).	Hold
3	Select the "Assignment of 4 mA - PV (P10)" field and enter the min. volume value for the 4 mA output current.	0.5 m³ (17.65 feet³)
4	Go to the "Assignment of 20 mA– PV (P11)" field and enter the max. 20 mA output current value.	16.8 m³ (593.3 feet³)
5	Press the button labeled "Send" in the lower right row of the window to load the new values into the device	
6	Press the "X" close button to exit the device settings window.	

5.2. PROGRAMMING WITH THE VGF-DISPLAY: DISPLAY UNIT

The most important parameters of VF05 can also be set with the VGF-DISPLAY: display unit.
By default, the display shows the primary measurement result (from which the output current is calculated).
In addition to the measured value displayed in large numbers, a bar graph representing the value of the output current is also shown on the right.
Programming is done using a text menu. You can use the Ⓔ / ⓐ / ⓓ / ⓔ buttons to navigate the menu.

5.2.1. *VGF-DISPLAY: Display Unit*

Display   64 × 128 dot matrix LCD, signs, units and bar graph
Ambient temperature   –20…+60 °C (–4…+140 °F)
Housing material   PBT fiberglass, plastic (DuPont®)

The plug-in module containing the VGF-DISPLAY: LCD display (universal - can also be used in other HYCONTROL devices, provided the device software supports VGF-DISPLAY:).

Warning!
The VGF-DISPLAY: uses an LCD, do not expose the VGF-DISPLAY: to prolonged exposure to strong heat or sunlight as the display may be damaged.

    If the VF05 cannot be protected against solar radiation not possible or it is used outside the operating temperature range of the VGF-DISPLAY:, do not leave the VGF-DISPLAY: in the VF05!

5.2.2. *The Behavior of the VF05 while Programmed Manually*

By default, VF05 displays the main measurement data on the VGF-DISPLAY: display (hereafter referred to as display).
Enter the programming menu by pressing the Ⓔ button. Use the ⓐ / ⓓ buttons to navigate through the menu items.
Enter the selected menu item with the Ⓔ button. Return to the previous menu level with the ⓔ key.
The buttons only work if the VGF-DISPLAY: is present!
The device continues measuring while the menu is accessed. Changes made in the menu take effect when you exit the menu.
If you do not exit the VF05 menu, the device will automatically return to the measurement display state after 30 minutes. In this case, any changes made in the menu will be ignored.
If the VGF-DISPLAY: is pulled out of the VF05, the VF05 will automatically exit the menu and ignore any changes made in the menu.
Since programming with VGF-DISPLAY (manual programming) and remote programming on HART (REMOTE MODE) create a conflict, only one mode can be used at a time.
Manual programming has priority overt HART!
During manual programming, the device sends a "device is busy" signal to the HART master (HART Response code: 32 – Device is busy).
In remote programming mode, **REM** is displayed on the top right of the display. In this case, manual programming of the device is disabled, the menu cannot be accessed.
If no VGF-DISPLAY: is connected, the LEDs will be visible, the flashes of the COM LED will indicate HART communication, and the VALID LED will indicate if the data measured by the device is valid.

5.2.3. Manual Programming

Press the Ⓔ button to modify the parameter under the cursor in the submenu.

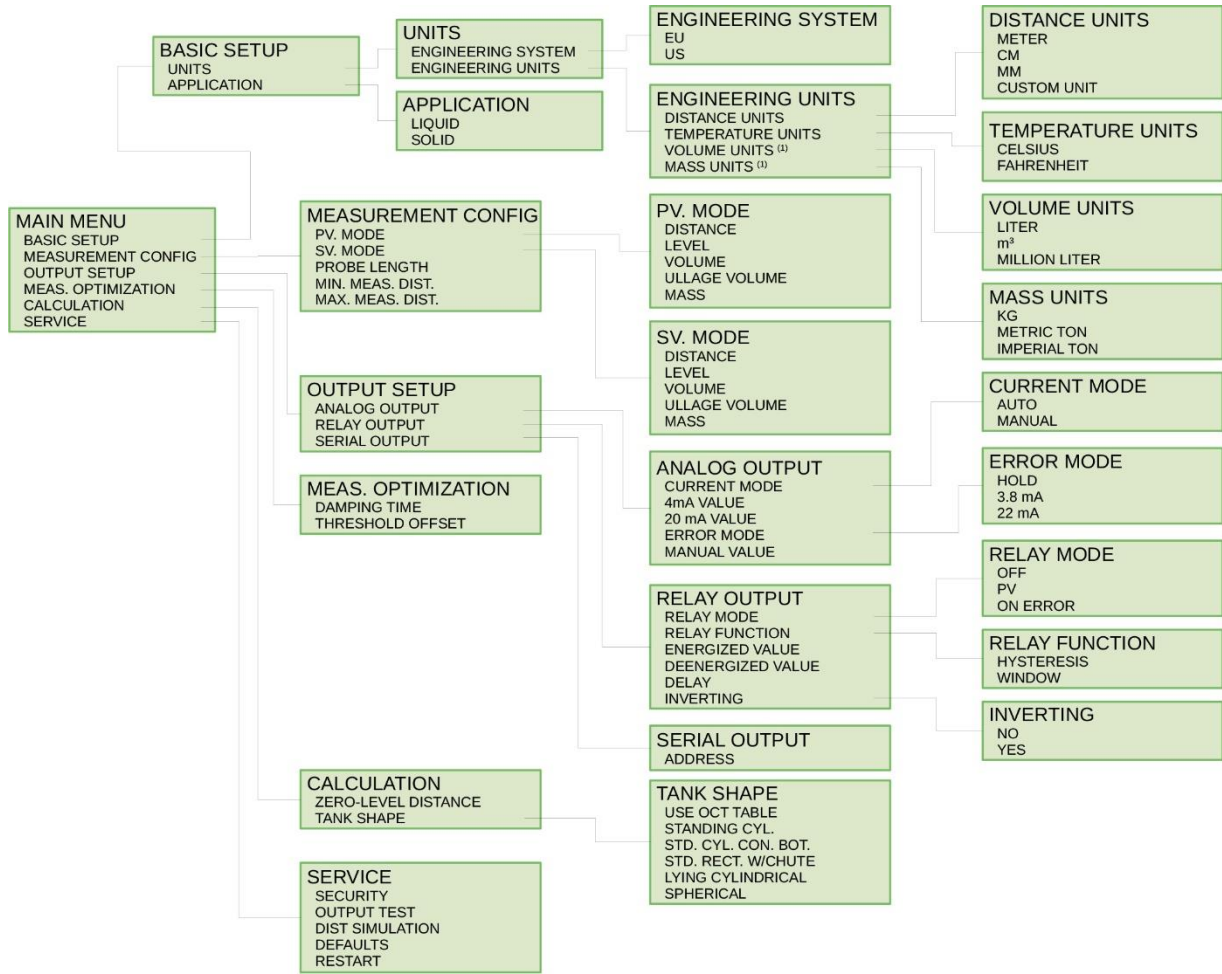|		
There are two modes:	Text list:	Navigated is same as in the menu. The Ⓔ button executes the selection, and the ⓔ button cancels it.
	Editable number field:	Serves to edit numeric values. Editing is aided by an (inverted) cursor. The number under the cursor can be changed with the / buttons (no overflow). The cursor can be moved left with the ⓔ arrow (max. 9 character-positions, including the decimal point). When the end of the field is reached, the cursor returns to the first position on the right. Editing is concluded by pressing the Ⓔ button. In this case, VF05 will check the entered value and if it is not correct, "WRONG VALUE!" is displayed in the bottom row.

BASIC SETUP
- UNITS
- APPLICATION

UNITS
- ENGINEERING SYSTEM
- ENGINEERING UNITS

APPLICATION
- LIQUID
- SOLID

ENGINEERING SYSTEM
- EU
- US

ENGINEERING UNITS
- DISTANCE UNITS
- TEMPERATURE UNITS
- VOLUME UNITS [1]
- MASS UNITS [1]

DISTANCE UNITS
- METER
- CM
- MM
- CUSTOM UNIT

TEMPERATURE UNITS
- CELSIUS
- FAHRENHEIT

VOLUME UNITS
- LITER
- m³
- MILLION LITER

MASS UNITS
- KG
- METRIC TON
- IMPERIAL TON

MAIN MENU
- BASIC SETUP
- MEASUREMENT CONFIG
- OUTPUT SETUP
- MEAS. OPTIMIZATION
- CALCULATION
- SERVICE

MEASUREMENT CONFIG
- PV. MODE
- SV. MODE
- PROBE LENGTH
- MIN. MEAS. DIST.
- MAX. MEAS. DIST.

PV. MODE
- DISTANCE
- LEVEL
- VOLUME
- ULLAGE VOLUME
- MASS

SV. MODE
- DISTANCE
- LEVEL
- VOLUME
- ULLAGE VOLUME
- MASS

OUTPUT SETUP
- ANALOG OUTPUT
- RELAY OUTPUT
- SERIAL OUTPUT

ANALOG OUTPUT
- CURRENT MODE
- 4mA VALUE
- 20 mA VALUE
- ERROR MODE
- MANUAL VALUE

CURRENT MODE
- AUTO
- MANUAL

ERROR MODE
- HOLD
- 3.8 mA
- 22 mA

MEAS. OPTIMIZATION
- DAMPING TIME
- THRESHOLD OFFSET

RELAY OUTPUT
- RELAY MODE
- RELAY FUNCTION
- ENERGIZED VALUE
- DEENERGIZED VALUE
- DELAY
- INVERTING

RELAY MODE
- OFF
- PV
- ON ERROR

RELAY FUNCTION
- HYSTERESIS
- WINDOW

INVERTING
- NO
- YES

SERIAL OUTPUT
- ADDRESS

CALCULATION
- ZERO-LEVEL DISTANCE
- TANK SHAPE

TANK SHAPE
- USE OCT TABLE
- STANDING CYL.
- STD. CYL. CON. BOT.
- STD. RECT. W/CHUTE
- LYING CYLINDRICAL
- SPHERICAL

SERVICE
- SECURITY
- OUTPUT TEST
- DIST SIMULATION
- DEFAULTS
- RESTART

Menu hierarchy

5.3. PROPERTIES OF VF05 TWO-WIRE MICROWAVE LEVEL TRANSMITTER

This chapter discusses the following topics:
- How does the transmitter measure the level, what factors play a role?
- Setting up and illustrating the measuring scale of the device in five possible ways.
- The role of gain adjustment in measurement.
- What is a "Threshold line" and how can it be changed?

5.3.1. *Level Measurement – Level reflection, Threshold Line and Automatic Gain Adjustment*

After connecting the power supply, the device will start operating:
1. It measures the reflected signals above the threshold line with the gain amplitude determined by the voltage amplitude and adjusted by cyclic repetition.
2. Determines the signal with the maximum amplitude that corresponds to the level reflection.

The following figure is a snapshot of the HyView - "Echo Chart" function, typically for a measured material. -The ADC values of the radar digitizer are located on the vertical axis. The ADC value of 4095 corresponds to a radar signal with an amplitude of 3.3V. The distance on the horizontal axis.
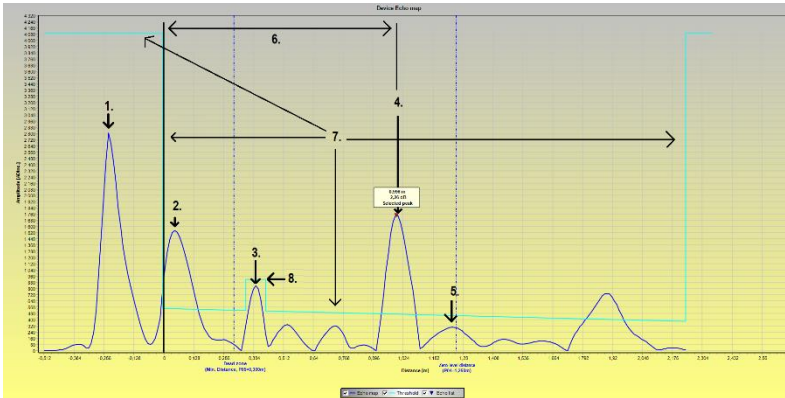
|	
1	Radar reference pulse emitted (transmitter signal or ping)
2	Flange reflection / flange pulse (does not occur with coaxial probe)
3	Non-material level reflection (parasitic, such as stirrer)
4	Reflection of measured medium's level
5	Zero level distance (in this case coincides with the echo of the probe end)
6	Measured distance
7	Main threshold line. For setting up, refer to **"5.1.2.5 Setting the Threshold"**
8	Threshold mask (to mask disturbances that cross the main threshold line) For setting up, refer to **"5.1.2.5 Setting the Threshold"**

5.3.2. *To illustrate the five possible configurations, the following fluid level measurement settings are assumed*

- To illustrate the five possible configurations, the following fluid level measurement settings are assumed:

(HyView->"Device Settings"->"Application"->"Operating mode: Liquid level measurement")
(HyView->"Device Settings"->"Measurement Configuration"->"PV source: Level")

- Thus, the HART "PV" of the transmitter, its primary digital output, will be a level value. The level is calculated from the parameter values below:
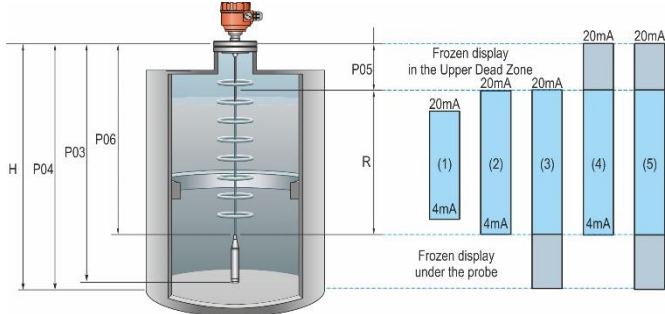
P03 – Probe length
P04 – Zero-level distance
P05 – Min. distance/Near blocking
P06 – Max. dist./Far blocking
Other markings in the figure:
R – Measuring range
H – Tank height

⚠️ **NOTE:** The reference point for distance measurement "0" is the sealing flange of the device (bottom of hexagon), the lower surface of the flange for flanged devices. If max. distance is set to 0, the probe length is the maximum measuring distance. The 4…20 mA current output of the level transmitter can be assigned to the measured value, HART "PV" with two parameters:

P10: Lower level value: HyView->"Device Settings"->"Outputs"->"Assignment of 4-mA")

P11: Upper level value: HyView->"Device Settings"->"Outputs"->"Assignment of 20-mA")

The cases outlined on the right side of the figure above:

1. The "current output" range is shorter than the max. possible measuring range: The 4 and 20 mA adjusters are located inside the near and far dead zone on the probe, within the limits
2. The range of the 'current output' is equal to the measuring range:
Assignment of 4-mA (P10): = "0 level" distance – maximum measuring distance.
Assignment of 20-mA (P11): = "0 level" distance – minimum measuring distance.
3. The "current output" range is longer than the measuring range:
Assignment of 4-mA (P10): = shorter than "0 level" distance – maximum measuring distance.
Assignment of 20-mA (P11): = "0 level" distance – minimum measuring distance.
4. The "current output" range is longer than the measuring range:
Assignment of 4-mA (P10): = "0 level" distance – maximum measuring distance.
Assignment of 20-mA (P11): = distance longer than "level 0" – minimum measuring distance.
5. The "current output" range is longer than the measuring range:
Assignment of 4-mA (P10): = shorter than "0 level" distance – maximum measuring distance.
Assignment of 20-mA (P11): = distance longer than "level 0" – minimum measuring distance.

### 5.3.3. *Echo Loss Handling*

The reflected signal usually disappears when the level is in the upper dead zone or near the bottom of the tank.

The zones used to handle signal loss (unreasonably many signals in Zone 1), which can be adjusted with parameters, are shown in the figure below.

During "HyView" polling, the "Device status" function window must be used to monitor the measurement status of the device on a PC (to activate the function, see section 5.1.2.3).

It can also be tracked on an VGF-DISPLAY: display.

Indications: "Echo lost": echo is lost, "E": tank is empty, "F": tank is full, "Echo in near blocking" in the nearby zone, "Echo in far blocking" in the remote zone.
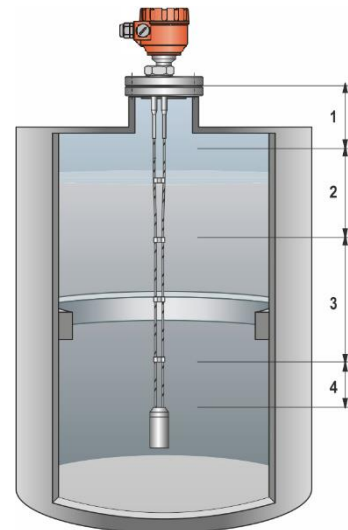
Zone 1: Detection delay
Calibration setting. It filters out unwanted interferences. It has been **replaced by the threshold mask**, which can be edited in the Echo diagram.
It is not recommended! Since, unlike the threshold mask, the instrument does not detect any reflections in this section of the probe, regardless of the amplitude! If the level is in this zone, it can only be inferred from the previous level that the tank is full.

Zone 2: Close-end blocking: P05
The distance measurement works within the minimum measuring distance, up to the detection delay. If the level is closer when switched on, the minimum measuring distance (or the values calculated from it) is returned, "F" is displayed as full and "Echo in near blocking" is displayed. For Eview 2 polling, "Echo in near blocking" is also passed. The same is true if the echo of the level is transferred to this range from the actual measurement zone.

Zone 3: Actual measuring zone

By default, the device searches for the largest reflected signal along the length of the probe. If the pulse is lost, the display freezes at the last value measured in this zone and the transmitted values freeze. The display will say "Echo lost".

Zone 4: Maximum measuring distance (Far-end blocking): P06

If the signal is lost (or within this range), the device returns the maximum measuring distance or the values calculated from it. The display shows "E" for empty, "Echo in far blocking." "Echo in far blocking" can also be detected during HyView polling.

5.3.1.1. Gain and Voltage Amplitude

Based on the principle of measurement, the TDR guided radar emits a radar pulse and then "waits" for its reflections in time: it registers them as a time-varying voltage. The it calculates the distance from the time and the propagation speed of the radar signal. The eternal question is which reflection comes from the target we are looking for.

This is decided by a complex algorithm running on the transmitter microcontroller. It is important to configure it well.

Ideally, such a reflection with the largest voltage amplitude comes from the level of the material in the container. However, reflections from many other objects and the background noise of the electronics also interfere with the measurement. It is easy for the extent and amplitude of the reflections from the disturbances to rival its level.

– For strong, high-amplitude signals, the "Threshold" line is used to help differentiate between level echo and interference.
– In case of a weak signal, the amplification also helps, it highlights the signal from the noise, which is easier to measure.
– The automatic gain switching has its own limits

Signal gain example (automatic by default):
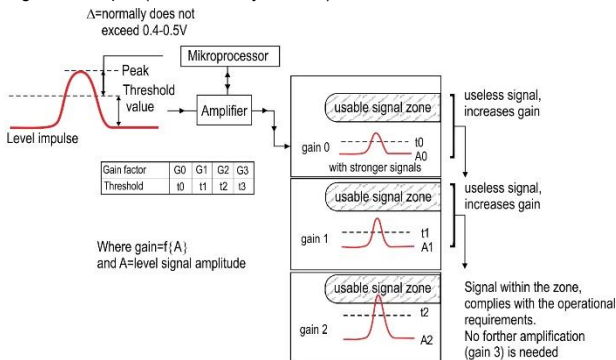
Gain factor

The gain is automatically set by default to make the measured signal as ideal as possible.

In addition, a custom value or gain range can be set with parameter **P24**.

The amplitude of the signal is proportional to the dielectric factor (ε_r) of the measured substance.

For small amplitudes, gain must be used.

The applicable gain depends on the dielectric constant (ε_r) and the type of probe.

Stage	Gain factor
1	1.00
2	2.111
3	4.4
4	8.927

Threshold line

The threshold line is used to filter out interference. The principle of operation is as follows:
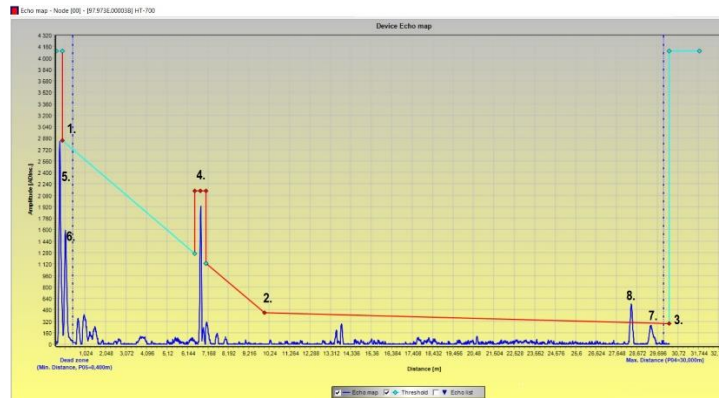
- Reflections in the area below the line: noise and disturbance signals must not be selected as the echo peak of the measured level.
- However, as soon as the level reaches the interference, the amplitude of the signal from the disturbance and the signal from the level add up. It crosses the threshold and is selected as the level indicator.

The factory default threshold can be used for most average measurement tasks, but may need to be modified depending on the particular installation and application:

- Measuring mediums with very low dielectric constant (ε_r), like oil.
- In case of multiple interference reflections or due to unfavorable installation conditions.
- To avoid measuring for deposits on the probe.

For tank connection with impedance coupling other than factory setting

The figure below shows a radar echo diagram and a threshold line with threshold extension:

The **Main threshold is defined by** "1.", "2.", "3."

- Adjustment is only permitted in justified cases: e.g.: elevated baseline, signal level, strong noise conditions close to the level transmitter!
- Signals in the area below the two extremes and below the line are not selected.
- The main threshold line can be changed in the Echo diagram by clicking Threshold settings / Threshold edit enabled in the pop-up context menu after pressing the right mouse button.
- Drag the dots on the graph with the left mouse button; the start, center, and end point have to be set to detect the minor noises in the waveform. The peak of the level echo must be above it at all distances. It must be below the baseline of the signal and the noise.

Four Threshold masks are intended to mask larger-amplitude or infrequent protruding interferences. An example of this is the dot marked "**4".**" in the figure.
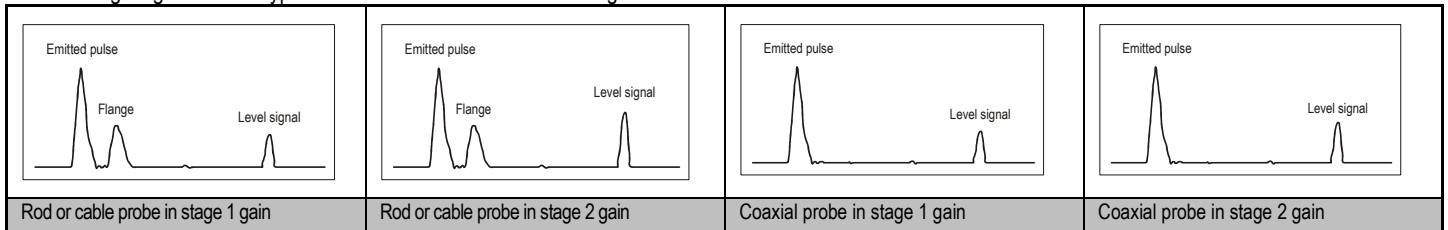
- Threshold extensions can also be modified on the Echo chart by clicking Threshold settings / Threshold edit enabled in the pop-up context menu after pressing the right mouse button.
- In the right-click context menu, you can add a new threshold line addition by clicking Threshold settings / Add Threshold mask point. Where the mouse pointer is on the echo diagram.
- It can be deleted with the Threshold settings / Del current Threshold mask point in the context menu by right-clicking on any of its points.
- The middle of the three points can be moved to the desired location by grabbing them with the left mouse button. It is advisable to leave at least 25 "ADC values" at the top of the fault, but not too much. As soon as the level reaches the interference signal, the amplitude of the level and the amplitude of the interference signal add up, the threshold line addition must be lower to determine the distance.
- The width of the threshold line completion can be adjusted by grasping its extreme points in a similar manner. -The width of the peaks usually fluctuates less than their height, however, it is recommended to leave a little on them as well.
    - Deposits may form on the probe. the propagation speed of the radar signal in them slows down. Thus, over time, the distance shifts. Adding a threshold line positioned wider and wider may alleviated the problem. Although the peak of the level is selected, its distance will not be corrected.

Further points in the diagram:

"5.": radar reference signal (transmitter signal or ping).

"6.": flange impulse (does not occur with a coaxial probe).

"7.": reflection from the probe's end of weight.

"8.": the echo peak of the level.

5.3.4. *Typical Signal Forms*

The following diagrams show typical waveforms recorded in Echo diagram mode.

| Rod or cable probe in stage 1 gain | Rod or cable probe in stage 2 gain | Coaxial probe in stage 1 gain | Coaxial probe in stage 2 gain |

There is no flange reflection in the coaxial probe diagram because the mechanical design does not cause an impedance change along the probe at the flange.
The amplitude of the signal reflected from the surface of the measured substance increases as the level increases and decreases as the level decreases.

Note for the measurement of solids: for most solids measurements, the measurement is made at a gain factor of 3 (except for powders and granules with a high dielectric constant (ε_r), such as carbon dust).

If there are difficulties with the level measurement between the device's gain factor 1 and 3 at a certain point in the level measurement, there is usually some interfering object (protruding part, etc.) in the tank in the path of the electromagnetic measuring pulse. Thus, the device gives a false level value when it detects the largest signal reflected there.

5.4. TROUBLESHOOTING

Event	Fault	Solution
Error messages		
"Tank full" state *, display freezes at maximum or minimum value	Not a fault. The level has reached (and may have exceeded) the entered max. limit value. It then prints the maximum (for level) or the minimum (for distance).	There is none. The measurement will be normal within the programmed limits.
"Tank empty" state * display freezes at maximum or minimum value	Not a fault. The level has dropped to the lower dead zone so there is no further signal detected. It then displays the maximum (for distance) or minimum (for level).	There is none. The measurement will be normal within the programmed limits.
"Tank full" and "Level lost" state *, display freezes at maximum or minimum value	Not a fault. The level has risen to the upper dead zone so there is no further signal detected.	Empty the tank below the upper level and check functioning!
"Level lost" state *, display freezes	The device has lost the signal it is looking for, but has not yet found the reflected signal. This can occur if the signal has dropped below the threshold and parasitic signals from the flange or tank failure do not allow the true signal to be found.	Ensure that the level in the tank drops below the maximum and check the measurement. If no signal is detected, change the threshold value manually as described in "**Threshold line**." Use the oscilloscope chart and threshold setting functions (0).
"Reference not found" state *	Occurs when there is a problem with the time base of the measurement card circuit.	Contact HYCONTROL!
"Level lost" and "Reference not found" state *, display freezes	The probe has been subjected to electrostatic discharge (ESD).	The device starts searching for the measuring signal again and displays the result. If the display remains frozen, the device may be damaged due to an ESD discharge and will need to be replaced. Contact HYCONTROL!
"Flange not found" state *	The instrument is incorrectly programmed for a cable or rod probe while a coaxial probe is installed. But it is possible that a long tank stub will cause a large amount of flange attenuation.	Contact HYCONTROL to address the fault.

Event	Fault	Solution
"Delay out of limits" state *, display freezes	The transmitted measurement signal cannot be detected. The device will not operate as long as this error persists.	The device may need to be replaced. Contact HYCONTROL!
"Negative voltage error" *	Occurs when there is a problem with the time base of the measurement card circuit.	Contact HYCONTROL!
"VC01 voltage error" *		
"VC02 voltage error" *		
"Reprogramming FPGA" *		

* The device is connected to the HyView software and listed in the "Device Status" window (or the "Markers" window) with active polling.

Event	Fault	Solution
General operation		
The device is not accurate for measuring materials with high dielectric constants (ε_r). There is a constant offset when measuring.	The tank height setting is incorrect.	Check the tank height and the parameters. If the device has been replaced, check that the factory parameters are the same as the original! Contact HYCONTROL to access the factory menu!
The device indicates an inaccurate level value.	The device does not detect the actual measurement signal.	Check for the presence of components that interfere with the interior of the tank. If the received signal is close to the tank connection, increase the ratio of the detection delay to the dead zone equally, or increase the threshold over the entire measuring range if the full measuring range is important. In all cases, use the oscilloscope function of HyView to visualize the phenomena. The threshold should be set to obscure interference, but with sufficient margin to detect the useful signal. The reflected pulse image (same as the start signal) may be too large if the probe touches the tank wall or neck (see 1.3.5). Disconnect!
The device does not measure accurately when there are two or more layers in the tank.	The device may not be properly programmed for this application and will measure the interface layer instead of the level.	Make sure that "2 liquids, 1 level" is set to "2 liquids, 1 level" in the "Application" tab of the "Device Programming" window. Also check that the top layer is at least 100 mm (0.33 ft) from the measured material. Contact HYCONTROL for the correct setting.

Event	Fault	Solution
Electrical connection and communication output		
Current output value < 4 mA	No power supply	Check the power supply.
	Device is not connected properly.	Check the connection between the device and the power supply.
	The output current setting is incorrect.	Perform the calibration if you have permission to do so, or contact HYCONTROL.
Display says the current output value is 22 mA	There is an error.	This occurs when 4 – 20 mA / error 22 mA are programmed. Check the status of the device during polling in the "Device status" window (or in the Markers diagram) or the status menu (4.0) on the HART® communicator.
	The device is booting.	Wait 50 seconds! If the current jumps between 4 and 20 mA and immediately goes back to 22 mA, contact HYCONTROL.
The status of the current output is not the same as the value on the display on the HyView or HART® communicator.	The output current setting is incorrect.	Check the current loop and connections. Set the output as described in the User Manual and try to change the threshold using HyView - Oscilloscope diagram / Threshold settings or the HHC communicator.
Data transmission via the digital interface does not work. The machine is in the process of being set up, wait 50 seconds and try again.	The communication parameters are not set correctly on the computer.	Check the computer settings (address / device number).
	Bad connection to interface	Check the connection.
	Device current < 4 mA.	If the problem persists, contact HYCONTROL.
	Device current = 22 mA	