Operating Instructions

Radar sensor for continuous level measurement of liquids

VEGAPULS 61

Modbus and Levelmaster protocol

Document ID: 41361

Contents

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Safety instructions for Ex areas

Take note of the Ex specific safety instructions for Ex applications. These instructions are attached as documents to each instrument with Ex approval and are part of the operating instructions.

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1 About this document

1.1 Function

This operating instructions provides all the information you need for mounting, connection and setup as well as important instructions for maintenance, fault rectification, the exchange of parts and the safety of the user. Please read this information before putting the instrument into operation and keep this manual accessible in the immediate vicinity of the device.

1.2 Target group

This operating instructions manual is directed to trained personnel. The contents of this manual must be made available to the qualified personnel and implemented.

1.3 Symbols used

Document ID
This symbol on the front page of this instruction refers to the Document ID. By entering the Document ID on www.vega.com you will reach the document download.

Information, tip, note
This symbol indicates helpful additional information.

Caution: If this warning is ignored, faults or malfunctions can result.
Warning: If this warning is ignored, injury to persons and/or serious damage to the instrument can result.
Danger: If this warning is ignored, serious injury to persons and/or destruction of the instrument can result.

Ex applications
This symbol indicates special instructions for Ex applications.

• **List**
The dot set in front indicates a list with no implied sequence.

→ **Action**
This arrow indicates a single action.

1 **Sequence of actions**
Numbers set in front indicate successive steps in a procedure.

Battery disposal
This symbol indicates special information about the disposal of batteries and accumulators.

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2 For your safety

2.1 Authorised personnel

All operations described in this documentation must be carried out only by trained, qualified personnel authorised by the plant operator.

During work on and with the device, the required personal protective equipment must always be worn.

2.2 Appropriate use

VEGAPULS 61 is a sensor for continuous level measurement.

You can find detailed information about the area of application in chapter "*Product description*".

Operational reliability is ensured only if the instrument is properly used according to the specifications in the operating instructions manual as well as possible supplementary instructions.

2.3 Warning about incorrect use

Inappropriate or incorrect use of this product can give rise to application-specific hazards, e.g. vessel overfill through incorrect mounting or adjustment. Damage to property and persons or environmental contamination can result. Also, the protective characteristics of the instrument can be impaired.

2.4 General safety instructions

This is a state-of-the-art instrument complying with all prevailing regulations and directives. The instrument must only be operated in a technically flawless and reliable condition. The operator is responsible for the trouble-free operation of the instrument. When measuring aggressive or corrosive media that can cause a dangerous situation if the instrument malfunctions, the operator has to implement suitable measures to make sure the instrument is functioning properly.

During the entire duration of use, the user is obliged to determine the compliance of the necessary occupational safety measures with the current valid rules and regulations and also take note of new regulations.

The safety instructions in this operating instructions manual, the national installation standards as well as the valid safety regulations and accident prevention rules must be observed by the user.

For safety and warranty reasons, any invasive work on the device beyond that described in the operating instructions manual may be carried out only by personnel authorised by the manufacturer. Arbitrary conversions or modifications are explicitly forbidden. For safety reasons, only the accessory specified by the manufacturer must be used.

To avoid any danger, the safety approval markings and safety tips on the device must also be observed and their meaning read in this operating instructions manual.

Depending on the instrument version, the emitting frequencies are in the C, K or W band range. The low emission power is far below the internationally approved limit values. When used correctly, the device poses no danger to health.

2.5 EU conformity

The device fulfils the legal requirements of the applicable EU directives. By affixing the CE marking, we confirm the conformity of the instrument with these directives.

You can find the EU conformity declaration on our website under www.vega.com/downloads.

Electromagnetic compatibility
Instruments with plastic housing are designed for use in an industrial environment. Nevertheless, electromagnetic interference from electrical conductors and radiated emissions must be taken into account, as is usual with class A instruments according to EN 61326-1. If the instrument is used in a different environment, the electromagnetic compatibility to other instruments must be ensured by suitable measures.

2.6 NAMUR recommendations

NAMUR is the automation technology user association in the process industry in Germany. The published NAMUR recommendations are accepted as the standard in field instrumentation.

The device fulfils the requirements of the following NAMUR recommendations:

- NE 21 – Electromagnetic compatibility of equipment
- NE 53 – Compatibility of field devices and display/adjustment components
- NE 107 - Self-monitoring and diagnosis of field devices

For further information see www.namur.de.

2.7 Radio license for Europe

The instrument was tested according to the latest issue of the following harmonized standards:

- EN 302372 - Tank Level Probing Radar

It is hence approved for use inside closed vessels in countries of the EU.

Use is also approved in EFTA countries, provided the respective standards have been implemented.

For operation inside of closed vessels, points a to f in annex E of EN 302372 must be fulfilled.

2.8 Radio license for USA

This approval is only valid for USA. Hence the following text is only available in the English language.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

● This device may not cause interference, and
● This device must accept any interference, including interference that may cause undesired operation of the device

This device is approved for unrestricted use only inside closed, stationary vessels made of metal, concrete and reinforced fiberglass.

For operation outside of closed vessels, the following conditions must be fulfilled:

● This device shall be installed and maintained to ensure a vertically downward orientation of the transmit antenna's main beam. Furthermore, the use of any mechanism that does not allow the main beam of the transmitter to be mounted vertically downward is prohibited.
● Operation of the instrument with encapsulated horn antenna ø 40 mm is only permitted within closed vessels.
● This device shall be installed only at fixed locations. The LPR device shall not operate while being moved or while inside a moving container.

● Hand-held applications are prohibited.
● Marketing to residential consumers is prohibited.

Changes or modifications not expressly approved by the manufacturer could void the user's authority to operate this equipment.

2.9 Radio license for Canada

This approval is only valid for Canada. Hence the following texts are only available in the English/French language.

This device complies with Industry Canada's license-exempt RSS standards. Operation is subject to the following conditions:

● This device may not cause interference, and
● This device must accept any interference, including interference that may cause undesired operation of the device

This device has been approved for both closed containers and open-air environments with the following limitations:

● Closed Containers: For installations utilizing a tilt during installation: This device is limited to installation in a completely enclosed container made of metal, concrete or reinforced fiberglass to prevent RF emissions, which can otherwise interfere with aeronautical navigation, the maximum approved tilt angle is 10°.
● Open Air Environment: For operation outside of closed vessels, the following condition must be fulfilled: This device shall be installed and maintained to ensure a vertically downward orientation of the transmit antenna's main beam. Furthermore, the use of any mechanism that does not allow the main beam of the transmitter to be mounted vertically downward is prohibited.
● Operation of the instrument with encapsulated horn antenna ø 40 mm is only permitted within closed vessels.

The installation of the LPR/TLPR device shall be done by trained installers, in strict compliance with the manufacture's instructions.

This device shall be installed only at fixed locations. The LPR device shall not operate while being moved or while inside a moving container.

Hand-held applications are prohibited.

Marketing to residential consumers is prohibited.

The use of this device is on a "no-interference, no-protection" basis. That ist, the user shall accept operatings of high-powered radaar in the same frequency band which may interfere with or damage this device.

However, devices found to interfere with primary licensing operations will be required to be removed at the user's expense.

The installer/user of this device shall ensure that it is at least 10 km from the Dominion Astrophysical Radio Observatory (DRAO) near Penticton, British Columbia. The coordinates of the DRAO are latitude 49°19′15″ N and longitude 119°37′12″W. For devices not meeting this 10 km separation (e.g., those in the Okanagan Valley, British Columbia,) the installer/user must coordinate with, and obtain the written concurrence of, the Director of the DRAO before the equipment can be installed or operated. The Director of the DRAO may be contacted at 250-497-2300 (tel.)or 250-497-2355 (fax). (Alternatively, the Manager, Regulatory Standards, Industry Canada, may be contacted.)

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux conditions suivantes :

● L'appareil ne doit pas produire de brouillage; et
● L'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Cet appareil est homologué pour une utilisation dans les cuves fermées et les environnements ouverts avec les restrictions suivantes :

● Cuves fermées : Pour les installations impliquant une inclinaison lors de l'installation : cet appareil ne doit être installé que dans une cuve totalement fermée en en métal, en béton ou en matière plastiqe renforcée de fibres de verre, pour empêcher les émissions RF susceptibles d'interférer avec la navigation aéronautique. L'angle d'inclinaison maximum autorisé est de 10°.
● Environnement ouvert : Pour l'utilisation hors des cuves fermées, la condition suivante doit être remplie : L'appareil doit être installé et entretenu de manière à garantir une orientation verticale vers le bas du faisceau principal de l'antenne émettrice. De plus, l'utilisation de tout mécanisme ne permettant pas l'orientation verticale vers le bas du faisceau principal de l'émetteur est interdite
● Il est uniquement autorisé d'exploiter l'appareil avec capsulé antenne cône ø 40 mm dans des boîtiers fermés.

L'installation d'un dispositif LPR ou TLPR doit être effectuée par des installateurs qualifiés, en pleine conformité avec les instructions du fabricant.

Cet appareil ne doit être installé qu'à des emplacements fixes. L'appareil LPR ne doit pas être utilisé pendant qu'il est en train d'être déplacé ou se trouve dans un conteneur en mouvement.

Les applications portables sont interdites.

La vente à des particuliers est interdite.

Ce dispositif ne peut être exploité qu'en régime de non-brouillage et de non-protection, c'est-à-dire que l'utilisateur doit accepter que des radars de haute puissance de la même bande de fréquences puissent brouiller ce dispositif ou même l'endommager. D'autre part, les capteurs de niveau qui perturbent une exploitation autorisée par licence de fonctionnement principal doivent être enlevés aux frais de leur utilisateur.

La personne qui installe/utilise ce capteur de niveau doit s'assurer qu'il se trouve à au moins 10 km de l'Observatoire fédéral de radio-astrophysique (OFR) de Penticton en Colombie-Britannique. Les coordonnées de l'OFR sont : latitude N 49° 19′ 15″, longitude O 119° 37′ 12″. La personne qui installe/utilise un dispositif ne pouvant respecter cette distance de 10 km (p. ex. dans la vallée de l'Okanagan [Colombie-Britannique]) doit se concerter avec le directeur de l'OFR afin d'obtenir de sa part une autorisation écrite avant que l'équipement ne puisse être installé ou mis en marche. Le directeur de l'OFR peut être contacté au 250-497-2300 (tél.) ou au 250-497-2355 (fax). (Le Directeur des Normes réglementaires d'Industrie Canada peut également être contacté).

2.10 Installation and operation in the USA and Canada

This information is only valid for USA and Canada. Hence the following text is only available in the English language.

Installations in the US shall comply with the relevant requirements of the National Electrical Code (ANSI/NFPA 70).

Installations in Canada shall comply with the relevant requirements of the Canadian Electrical Code.

2.11 Environmental instructions

Protection of the environment is one of our most important duties. That is why we have introduced an environment management system with the goal of continuously improving company environmental protection. The environment management system is certified according to DIN EN ISO 14001.

Please help us fulfil this obligation by observing the environmental instructions in this manual:

● Chapter "*Packaging, transport and storage*"
● Chapter "*Disposal*"

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3 Product description

3.1 Configuration

Type label
The type label contains the most important data for identification and use of the instrument:

Fig. 1: Layout of the type label (example)

1 Instrument type
2 Product code
3 Approvals
4 Power supply and signal output, electronics
5 Protection rating
6 Measuring range
7 Process and ambient temperature, process pressure
8 Material wetted parts
9 Hardware and software version
10 Order number
11 Serial number of the instrument
12 Data matrix code for VEGA Tools app
13 Symbol of the device protection class
14 ID numbers, instrument documentation
15 Reminder to observe the instrument documentation

Serial number - Instrument search
The type label contains the serial number of the instrument. With it you can find the following instrument data on our homepage:

● Product code (HTML)
● Delivery date (HTML)
● Order-specific instrument features (HTML)
● Operating instructions and quick setup guide at the time of shipment (PDF)
● Order-specific sensor data for an electronics exchange (XML)
● Test certificate (PDF) - optional

Go to "*www.vega.com*", "*Search*". Enter the serial number.

Alternatively, you can access the data via your smartphone:

● Download the VEGA Tools app from the "*Apple App Store*" or the "*Google Play Store*"
● Scan the Data Matrix code on the type label of the instrument or
● Enter the serial number manually in the app

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Electronics design

The instrument contains two different electronics in its housing chambers:

- The Modbus electronics for power supply and communication with the Modbus-RTU
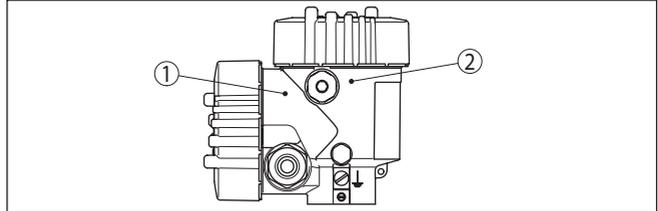- The sensor electronics for the actual measuring tasks

Fig. 2: Position of Modbus and sensor electronics

1 Modbus electronics
2 Sensor electronics

Scope of this operating instructions

This operating instructions manual applies to the following instrument versions:

- Hardware from 2.1.0
- Software from 4.5.3

Versions of the sensor electronics

The instrument is available in two different sensor electronics versions. The selection depends on the application area, see chapter "*Principle of operation*".

This version can be determined via the product code on the type label as well as on the electronics.

- Standard electronics type PS60HK.-
- Electronics with increased sensitivity type PS60HS.-

Scope of delivery

The scope of delivery encompasses:

- Radar sensor
- Mounting strap with fixing material (optional)
- Documentation
  - Quick setup guide VEGAPULS 61
  - Instructions for optional instrument features
  - Ex-specific "*Safety instructions*" (with Ex versions)
  - If necessary, further certificates

> **Information:**
> The optional instrument features are described in the operating instructions manual. The respective scope of delivery results from the order specification.

3.2 Principle of operation

Application area

The VEGAPULS 61 is a radar sensor for continuous level measurement of liquids under simple process conditions.

Dependent on the application range, different versions are used:

- Level measurement of aggressive liquids in small vessels: **encapsulated antenna system**
- Flow measurement in open flumes or gauge measurement of bodies of water: **Plastic horn antenna**
- Products with an $ε_r$ value ≥ 1.8: **Standard electronics**
- Products with an $ε_r$ value ≥ 1.5, < 1.8; applications with very poor reflective properties: **Electronics with increased sensitivity**

The actual values that can be reached depend on the measurement conditions, the antenna system or the standpipe or bypass.

Functional principle

The antenna of the radar sensor emits short radar pulses with a duration of approx. 1 ns. These pulses are reflected by the product and received by the antenna as echoes. The transit time of the radar pulses from emission to reception is proportional to the distance and hence to the level. The determined level is converted into an appropriate output signal and outputted as measured value.

3.3 Packaging, transport and storage

Packaging

Your instrument was protected by packaging during transport. Its capacity to handle normal loads during transport is assured by a test based on ISO 4180.

The packaging of standard instruments consists of environment-friendly, recyclable cardboard. For special versions, PE foam or PE foil is also used. Dispose of the packaging material via specialised recycling companies.

Transport

Transport must be carried out in due consideration of the notes on the transport packaging. Nonobservance of these instructions can cause damage to the device.

Transport inspection

The delivery must be checked for completeness and possible transit damage immediately at receipt. Ascertained transit damage or concealed defects must be appropriately dealt with.

Storage

Up to the time of installation, the packages must be left closed and stored according to the orientation and storage markings on the outside.

Unless otherwise indicated, the packages must be stored only under the following conditions:

- Not in the open
- Dry and dust free
- Not exposed to corrosive media
- Protected against solar radiation
- Avoiding mechanical shock and vibration

Storage and transport temperature

- Storage and transport temperature see chapter "*Supplement - Technical data - Ambient conditions*"
- Relative humidity 20 … 85 %

Lifting and carrying

With instrument weights of more than 18 kg (39.68 lbs) suitable and approved equipment must be used for lifting and carrying.

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3.4 Accessories and replacement parts

PLICSCOM

The display and adjustment module PLICSCOM is used for measured value indication, adjustment and diagnosis. It can be inserted into the sensor or the external display and adjustment unit and removed at any time.

The integrated Bluetooth module (optional) enables wireless adjustment via standard adjustment devices:

● Smartphone/tablet (iOS or Android operating system)
● PC/notebook with Bluetooth USB adapter (Windows operating system)

You can find further information in the operating instructions "*Display and adjustment module PLICSCOM*" (Document-ID 36433).

VEGACONNECT

The interface adapter VEGACONNECT enables the connection of communication-capable instruments to the USB interface of a PC. For parameter adjustment of these instruments, the adjustment software PACTware with VEGA-DTM is required.

You can find further information in the operating instructions "*Interface adapter VEGACONNECT*" (Document-ID 32628).

Protective cover

The protective cover protects the sensor housing against soiling and intense heat from solar radiation.

You will find additional information in the supplementary instructions manual "*Protective cover*" (Document-ID 34296).

Flanges

Screwed flanges are available in different versions according to the following standards: DIN 2501, EN 1092-1, BS 10, ASME B 16.5, JIS B 2210-1984, GOST 12821-80.

You can find additional information in the supplementary instructions manual "*Flanges according to DIN-EN-ASME-JIS*".

Electronics module

Electronics module "VEGAPULS series 60" is a replacement part for radar sensors of VEGAPULS series 60. A different version is available for each type of signal output.

You can find further information in the operating instructions "*Electronics module VEGAPULS series 60*" (Document-ID 36801).

Supplementary electronics for Modbus

The supplementary electronics is a replacement part for sensors with signal output Modbus.

You can find further information in the operating instructions "*Supplementary electronics for Modbus*" (Document-ID 41864).

Antenna impedance cone

The antenna impedance cone is a replacement part used for optimum transmission of microwaves and for sealing against the process.

You find further information in the operating instructions "*Antenna impedance cone VEGAPULS 62 and 68*" (Document-ID 31381).

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4 Mounting

4.1 General instructions

Screwing in

On devices with a threaded fitting, the hexagon on the process fitting must be tightened with a suitable wrench.

See chapter "*Dimensions*" for wrench size.

⚠ **Warning:**
The housing or the electrical connection may not be used for screwing in! Tightening can cause damage, e. g. to the rotation mechanism of the housing.

Protection against moisture

Protect your instrument against moisture ingress through the following measures:

● Use a suitable connection cable (see chapter "*Connecting to power supply*")
● Tighten the cable gland or plug connector
● When mounting horizontally, turn the housing so that the cable gland or plug connector point downward
● Lead the connection cable downward in front of the cable entry or plug connector.

This applies mainly to outdoor installations, in areas where high humidity is expected (e.g. through cleaning processes) and on cooled or heated vessels.

To maintain the housing protection, make sure that the housing lid is closed during operation and locked, if necessary.

Make sure that the degree of contamination specified in chapter "*Technical data*" meets the existing ambient conditions.

Suitability for the process conditions

Make sure before mounting that all parts of the instrument exposed to the process are suitable for the existing process conditions.

These are mainly:

● Active measuring component
● Process fitting
● Process seal

Process conditions in particular are:

● Process pressure
● Process temperature
● Chemical properties of the medium
● Abrasion and mechanical influences

You can find detailed information on the process conditions in chapter "*Technical data*" as well as on the type label.

Suitability for the ambient conditions

The instrument is suitable for standard and extended ambient conditions acc. to IEC/EN 61010-1.

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4.2   Collar or adapter flange

For mounting the instrument on a socket, a combi compression flange for DN 80 (ASME 3" or JIS 80) is also available for retro fitting. Optionally, the instrument can be also equipped with an adapter flange from DN 100 (ASME 4" or JIS 100).

With the housing versions plastic, aluminium single chamber and stainless steel, the collar flange can be placed directly over the housing. With the aluminium double chamber housing, retroactive mounting in this way is not possible - the mounting type must be specified with the order.

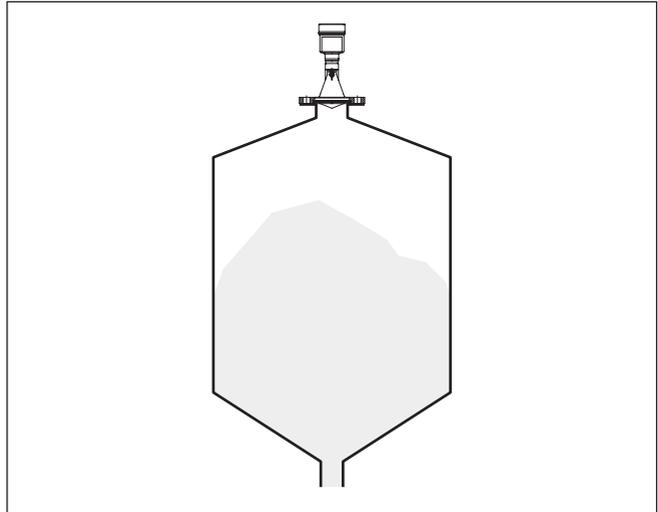You can find drawings of these mounting options in chapter "*Dimensions*".

Fig. 3: Flange mounting of the radar sensor

4.3   Mounting preparations, mounting strap

The mounting strap enables simple mounting on the vessel wall or silo top. It is suitable for wall, ceiling or boom mounting. Especially in open vessels this is a very easy and effective way to align the sensor to the bulk solid surface.

The strap is supplied unassembled and must be screwed to the sensor before setup with three hexagon socket screws M5 x 10 and spring washers. Max. torque, see chapter "*Technical data*". Required tools: Allen wrench size 4.

There are two ways to screw the strap onto the sensor. Depending on the selected version, the sensors can be swivelled in the strap as follows:

● Single chamber housing
   – Angle of inclination 180°, infinitely variable
   – Angle of inclination in three steps 0°, 90° and 180°

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- Double chamber housing
  - Angle of inclination 90°, infinitely variable
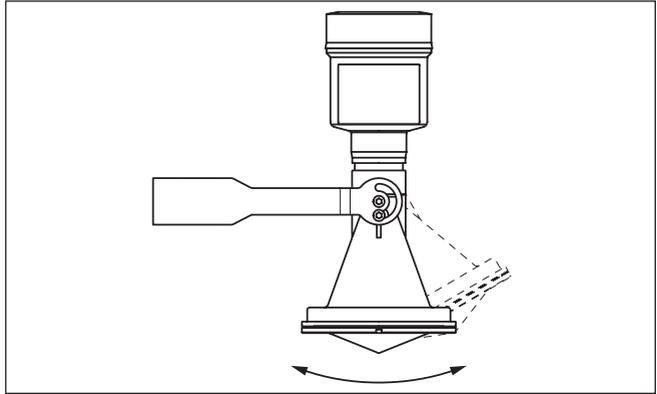 - Angle of inclination in two steps 0° and 90°

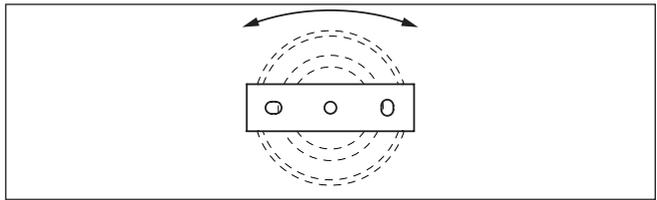*Fig. 4: Adjustment of the angle of inclination*

Fig. 5: Turning by fastening in the centre

4.4   Mounting instructions

Tight installation of the plastic horn antenna

For tight installation of the version with plastic horn antenna with compression or adapter flange, the following conditions must be fulfilled:

1. Use suitable flat seal, e.g. of EPDM with Shore hardness 25 or 50
2. Make sure the number of flange screws corresponds to the number of flange holes
3. Tighten all screws with the torque stated in the technical data

Polarisation

The emitted radar impulses of the radar sensor are electromagnetic waves. The polarisation is the direction of the electrical wave component. By turning the instrument in the connection flange or mounting boss, the polarisation can be used to reduce the effects of false echoes.

The position of the polarisation is marked on the process fitting of the instrument.
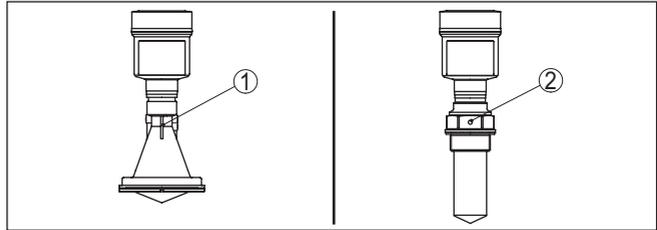
Fig. 6: Position of the polarisation

1   Marking with version with plastic horn antenna
2   Marking with version with encapsulated antenna system

Installation position

When mounting the sensor, keep a distance of at least 200 mm (7.874 in) to the vessel wall. If the sensor is installed in the center of dished or round vessel tops, multiple echoes can arise. These can, however, be suppressed by an appropriate adjustment (see chapter "*Setup*").

If you cannot maintain this distance, you should carry out a false signal suppression during setup. This applies particularly if buildup on the vessel wall is expected. In such cases, we recommend repeating the false signal suppression at a later date with existing buildup.
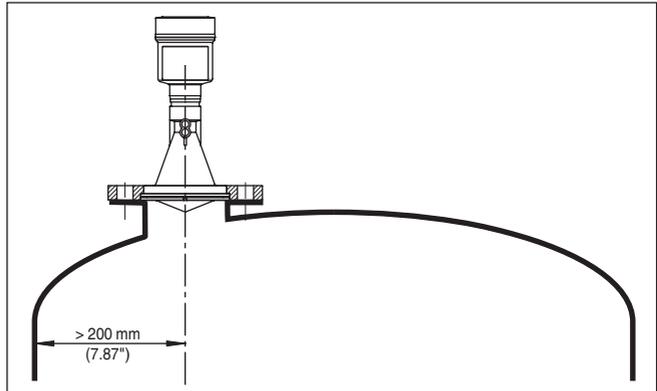
Fig. 7: Mounting of the radar sensor on round vessel tops

In vessels with conical bottom it can be advantageous to mount the sensor in the centre of the vessel, as measurement is then possible down to the bottom.
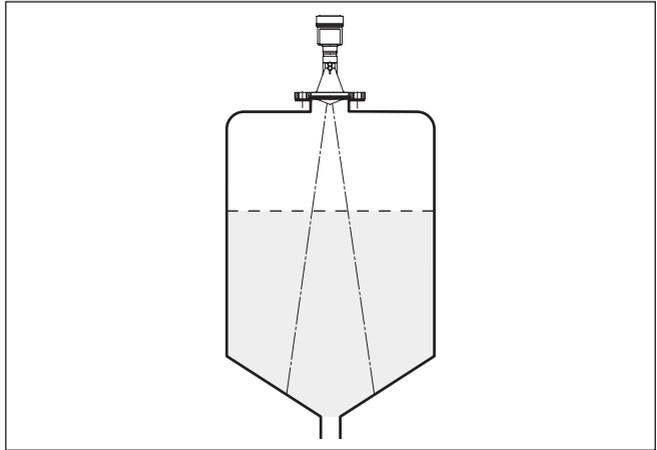
Fig. 8: Mounting of the radar sensor on vessels with conical bottom

Inflowing medium

Do not mount the instruments in or above the filling stream. Make sure that you detect the product surface, not the inflowing product.
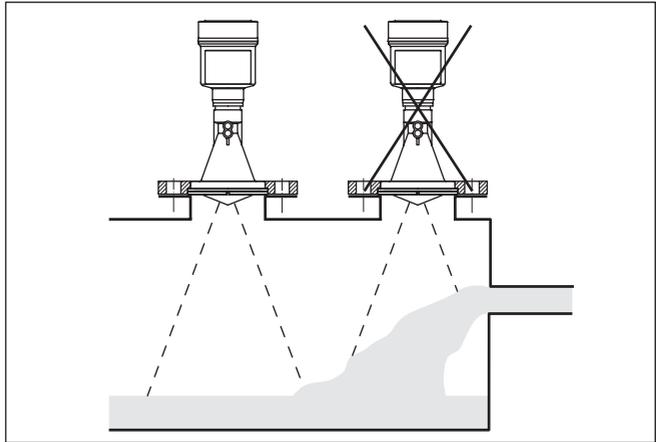
Fig. 9: Mounting of the radar sensor with inflowing medium

Socket with encapsulated antenna system

The socket piece should be dimensioned in such a way that the antenna end protrudes at least 10 mm (0.4 in) out of the socket.
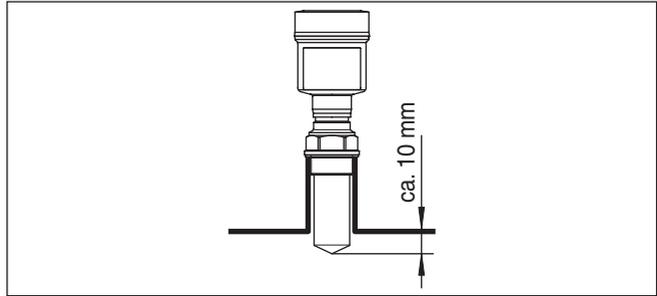
Fig. 10: Recommended socket mounting

If the reflective properties of the medium are good, you can mount VEGAPULS 61 on sockets which are higher than the length of the antenna. You will find recommended values for socket heights in the following illustration. The socket end should be smooth and burr-free, if possible also rounded. After installation you must carry out a false signal suppression.
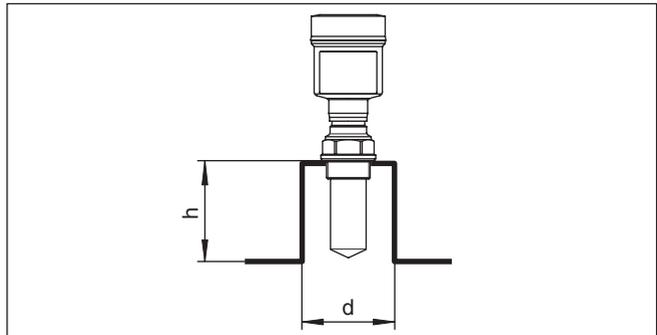
Fig. 11: Deviating socket dimensions

The below chart specifies the max. socket length h depending on the diameter d.

| Socket diameter d		Socket length h	
40 mm	1½"	≤ 100 mm	≤ 3.9 in
50 mm	2"	≤ 150 mm	≤ 5.9 in
80 mm	3"	≤ 200 mm	≤ 7.9 in
100 mm	4"	≤ 300 mm	≤ 11.8 in
150 mm	6"	≤ 400 mm	≤ 15.8 in

Socket with plastic horn antenna

A corresponding collar flange for DN 80 (ASME 3" or JIS 80) as well as a suitable adapter flange are available for mounting VEGAPULS 61.

With the housing versions plastic, aluminium single chamber and stainless steel, the collar flange can be placed directly over the housing. With the aluminium double chamber housing, retroactive mount-

ing in this way is not possible - the mounting type must be specified with the order.

Information:
ℹ The mounting socket should be as short as possible and its end rounded. This reduces false echoes from the vessel mounting socket.
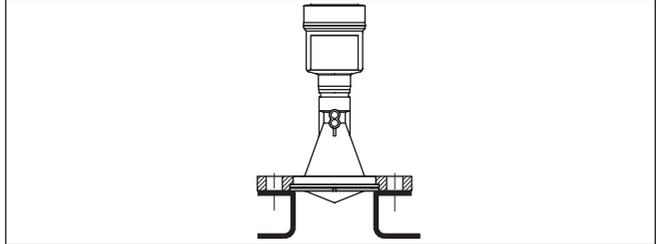
Fig. 12: Recommended socket mounting

If the medium has good reflective properties, VEGAPULS 61 can also be mounted on a longer socket piece. Recommended values for socket heights are specified in the following illustration. You must carry out a false echo storage afterwards.
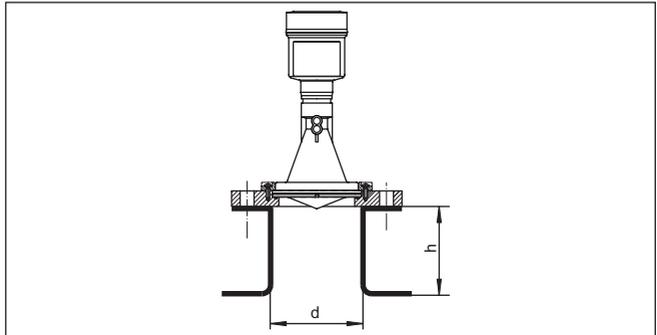
The below charts specify the max. socket length h depending on the diameter d.

Socket diameter d		Socket length h	
80 mm	3"	≤ 300 mm	≤ 11.8 in
100 mm	4"	≤ 400 mm	≤ 15.8 in
150 mm	6"	≤ 500 mm	≤ 19.7 in

Socket diameter d	Socket length h
3"	≤ 11.8 in
4"	≤ 15.8 in
6"	≤ 19.7 in

Sensor orientation

In liquids, direct the sensor as perpendicular as possible to the product surface to achieve optimum measurement results.

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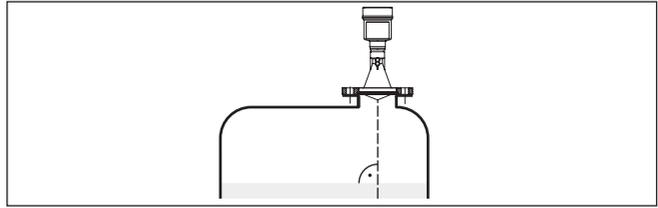
Fig. 14: Alignment in liquids

Vessel installations

The mounting location of the radar sensor should be a place where no other equipment or fixtures cross the path of the radar signals.

Vessel installations, such as e.g. ladders, limit switches, heating spirals, struts, etc., can cause false echoes and impair the useful echo. Make sure when planning your measuring point that the radar sensor has a "clear view" to the measured product.

In case of existing vessel installations, a false signal suppression should be carried out during setup.

If large vessel installations such as struts or supports cause false echoes, these can be attenuated through supplementary measures. Small, inclined sheet metal baffles above the installations scatter the radar signals and prevent direct interfering reflections.

Fig. 15: Cover flat, large-area profiles with deflectors

Agitators

If there are agitators in the vessel, a false signal suppression should be carried out with the agitators in motion. This ensures that the interfering reflections from the agitators are saved with the blades in different positions.
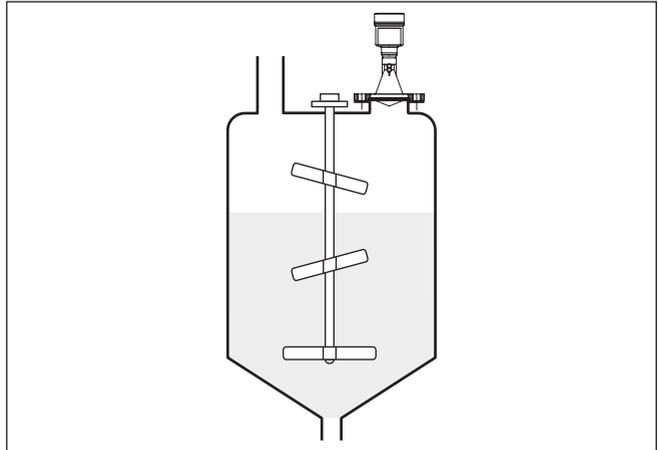
Fig. 16: Agitators

Foam generation

Through the action of filling, stirring and other processes in the vessel, compact foam can form on the product surface, damping the emitted signals considerably.

If foams are causing measurement errors, the biggest possible radar antennas, the electronics with increased sensitivity or low frequency radar sensors (C band) should be used.

As an alternative, sensors with guided microwave can be used. These are unaffected by foam generation and are best suited for such applications.

4.5 Measurement setup - Pipes

Measurement in a surge pipe

By using a surge pipe in the vessel, the influence of vessel installations and turbulence can be excluded. Under these prerequisites, the measurement of products with low dielectric values (ε_r value ≤ 1.6) is possible.

Note the following illustrations and instructions for measurement in a surge pipe.

ℹ Information:
Measurement in a surge pipe is not recommended for extremely adhesive products.

Configuration surge pipe
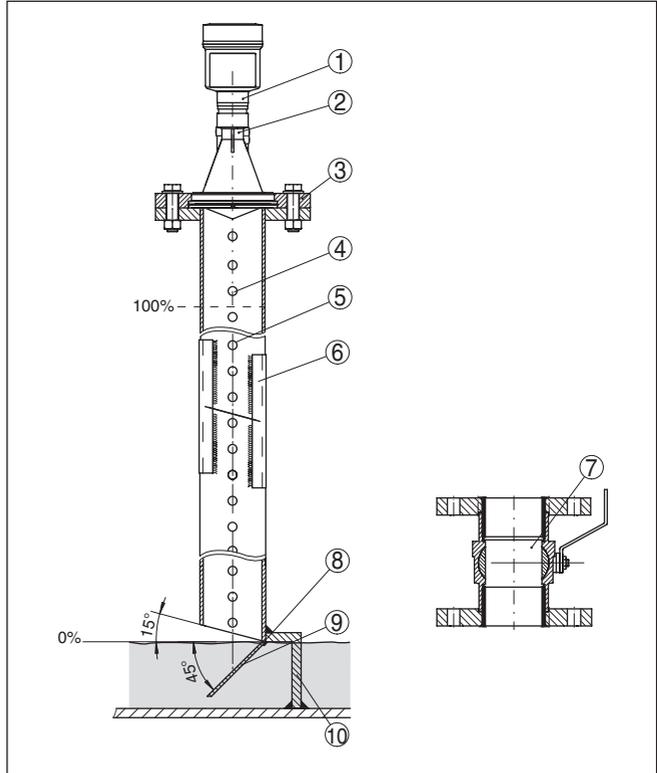
Fig. 17: Configuration surge pipe VEGAPULS 61

1 Radar sensor
2 Polarisation marking
3 Thread or flange on the instrument
4 Vent hole
5 Holes
6 Welding connection through U-profile
7 Ball valve with complete opening
8 Surge pipe end
9 Reflector sheet
10 Fastening of the surge pipe

Surge pipe extension
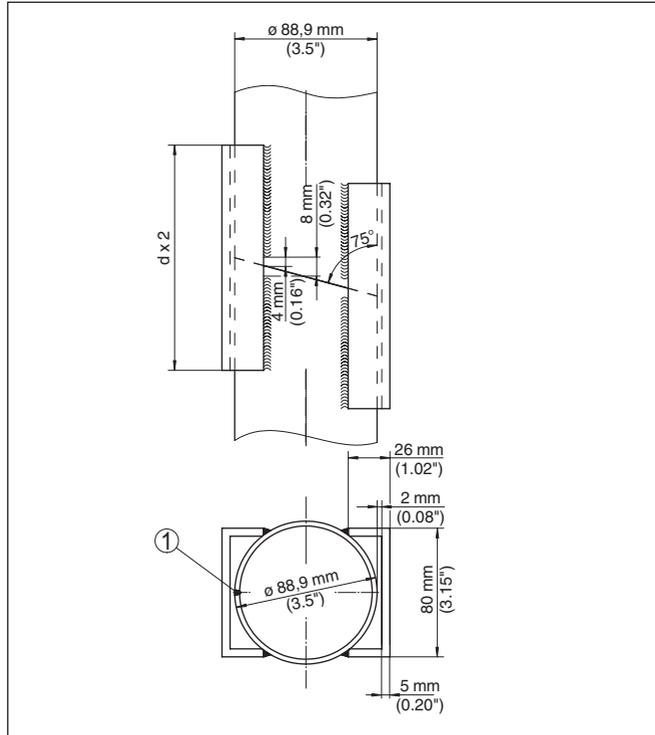
Fig. 18: Welding connection with surge pipe extension for different example diameters

1 Position of the welded joint with longitudinally welded pipes

Instructions and requirements, surge pipe

Instructions of orientation of the polarisation:
● Note marking of the polarisation on the sensor
● With threaded versions, the marking is on the hexagon, with flange versions between two flange holes
● The marking must be in one plane with the holes in the surge pipe

Instructions for the measurement:
● The 100 % point must be below the upper vent hole and the antenna edge
● The 0 % point is the end of the surge pipe
● During parameter adjustment, select "*Application standpipe*" and enter the tube diameter to compensate for errors due to running time shift
● A false signal suppression with the installed sensor is recommended but not mandatory
● The measurement through a ball valve with unrestricted channel is possible

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Constructive requirements:
● Material metal, smooth inner surface
● Preferably pultruded or straight beaded stainless steel tube
● Welded joint should be straight and lie in one axis with the holes
● Flanges are welded to the tube according to the orientation of the polarisation
● When using a ball valves, align the transitions on the inside and fix accurately
● Gap size with junctions ≤ 0.1 mm
● Surge pipes must extend all the way down to the requested min. level, as measurement is only possible within the tube
● Diameter of holes ≤ 5 mm, any number OK, on one side or completely through
● The antenna diameter of the sensor should correspond to the inner diameter of the tube
● Diameter should be constant over the complete length

Instructions for surge pipe extension:
● The ends of the extension tubes must be bevelled and exactly aligned
● Welded connection via external U profiles according to illustration above. Length of the U profiles should be at least double the tube diameter
● Do not weld through the pipe wall. The surge pipe must remain smooth inside. Roughness and beads on the inside caused by unintentional penetration should be removed since they cause strong false echoes and encourage buildup
● An extension via welding neck flanges or pipe collars is not recommended.

Measurement in the bypass tube

An alternative to measurement in a surge pipe is measurement in a bypass tube outside of the vessel.

Configuration bypass
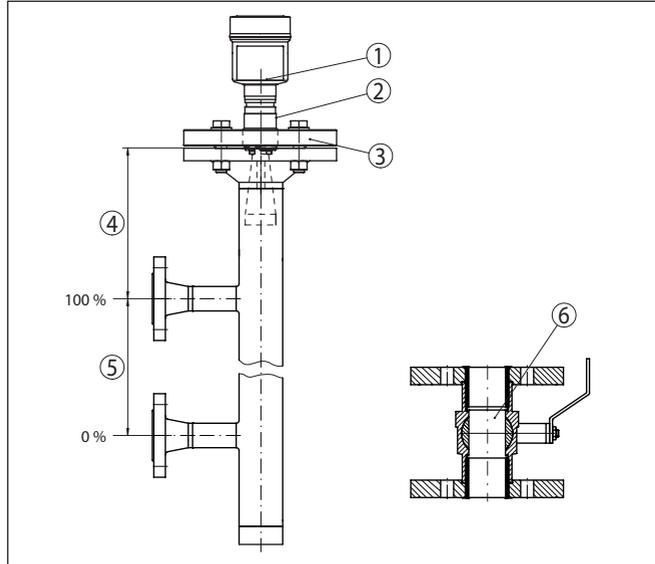
Fig. 19: Configuration bypass

1 Radar sensor
2 Polarisation marking
3 Instrument flange
4 Distance sensor reference plane to upper tube connection
5 Distance of the tube connections
6 Ball valve with complete opening

Instructions and requirements, bypass

Instructions of orientation of the polarisation:

● Note marking of the polarisation on the sensor
● With threaded versions, the marking is on the hexagon, with flange versions between two flange holes
● The marking must be in one plane with the tube connections to the vessel

Instructions for the measurement:

● The 100 % point may not be above the upper tube connection to the vessel
● The 0 % point may not be below the lower tube connection to the vessel
● Min. distance, sensor reference plane to upper edge of upper tube connection > 300 mm
● During parameter adjustment, select "*Application standpipe*" and enter the tube diameter to compensate for errors due to running time shift
● A false signal suppression with the installed sensor is recommended but not mandatory
● The measurement through a ball valve with unrestricted channel is possible

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Constructional requirements on the bypass pipe:
● Material metal, smooth inner surface
● In case of an extremely rough tube inner surface, use an inserted tube (tube in tube) or a radar sensor with tube antenna
● Flanges are welded to the tube according to the orientation of the polarisation
● Gap size with junctions ≤ 0.1 mm, for example, when using a ball valve or intermediate flanges with single pipe sections
● The antenna diameter of the sensor should correspond to the inner diameter of the tube
● Diameter should be constant over the complete length

4.6 Measurement setup - Flow

Flow measurement with rectangular overfall

The short examples give you introductory information on flow measurement. Detailed planning information is available from flume manufacturers and in special literature.
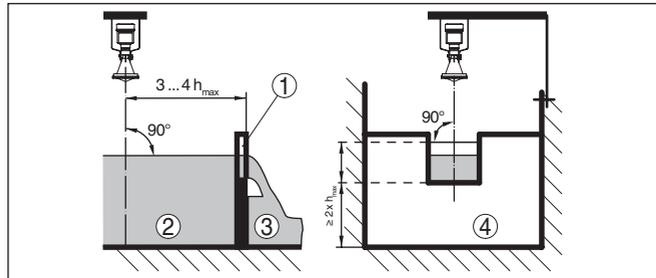
Fig. 20: Flow measurement with rectangular overfall: $d_{min.}$ = min. distance of the sensor (see chapter "Technical data"); $h_{max.}$ = max. filling of the rectangular spillway

1 Overflow orifice (side view)
2 Headwater
3 Tailwater
4 Overfall orifice (view from tailwater)

In general, the following points must be observed:

● Install the sensor on the headwater side
● Installation in the centre of the flume and vertical to the liquid surface
● Distance to the overfall orifice
● Distance of orifice opening above ground
● Min. distance of the orifice opening to tailwater
● Min. distance of the sensor to max. storage level

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Flow measurement with Khafagi Venturi flume
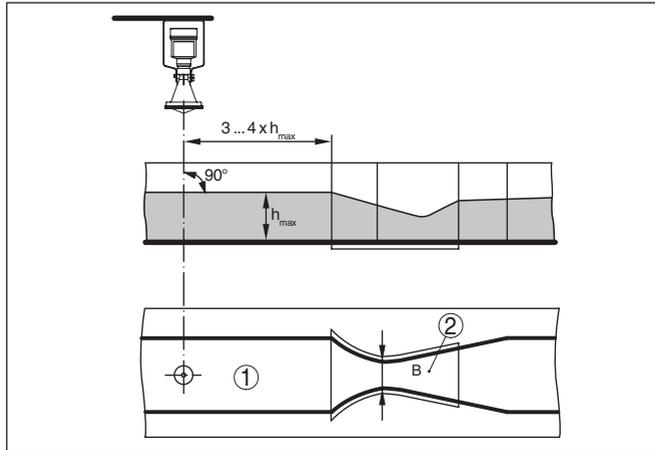
Fig. 21: Flow measurement with Khafagi-Venturi flume: $h_{max.}$ = max. filling of the flume; B = tightest constriction in the flume

1 Position sensor
2 Venturi flume

In general, the following points must be observed:

- Installation of the sensor at the inlet side
- Installation in the centre of the flume and vertical to the liquid surface
- Distance to the Venturi flume
- Min. distance of the sensor to max. storage level

5 Connecting to power supply and bus system

5.1 Preparing the connection

Safety instructions

Always keep in mind the following safety instructions:

● Carry out electrical connection by trained, qualified personnel authorised by the plant operator
● If overvoltage surges are expected, overvoltage arresters should be installed

⚠ **Warning:**
Connect only in the complete absence of line voltage.

Voltage supply

The instrument requires an operating voltage of 8 … 30 V DC. Operating voltage and digital bus signal are carried on separate two-wire connection cables.

Connection cable

The instrument is connected with standard two-wire, twisted cable suitable for RS 485. If electromagnetic interference is expected which is above the test values of EN 61326 for industrial areas, screened cable should be used.

Make sure that the cable used has the required temperature resistance and fire safety for max. occurring ambient temperature

Use cable with round cross section for instruments with housing and cable gland. Use a cable gland suitable for the cable diameter to ensure the seal effect of the cable gland (IP protection rating).

Make sure that the entire installation is carried out according to the Fieldbus specification. In particular, make sure that the bus is terminated with suitable terminating resistors.

Cable glands

Metric threads
In the case of instrument housings with metric thread, the cable glands are screwed in at the factory. They are sealed with plastic plugs as transport protection.

You have to remove these plugs before electrical connection.

NPT thread
In the case of instrument housings with self-sealing NPT threads, it is not possible to have the cable entries screwed in at the factory. The free openings for the cable glands are therefore covered with red dust protection caps as transport protection.

Prior to setup you have to replace these protective caps with approved cable glands or close the openings with suitable blind plugs.

On plastic housings, the NPT cable gland or the Conduit steel tube must be screwed into the threaded insert without grease.

Max. torque for all housings, see chapter "*Technical data*".

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Cable screening and grounding

Make sure that the cable screen and grounding are carried out according to Fieldbus specification. We recommend to connect the cable screening to ground potential on both ends.

In systems with potential equalisation, connect the cable screening directly to ground potential at the power supply unit and the sensor. The cable screening in the sensor must be connected directly to the internal ground terminal. The ground terminal outside on the housing must be connected to the potential equalisation (low impedance).

5.2 Connecting

Connection technology

The voltage supply and signal output are connected via the spring-loaded terminals in the housing.

Connection to the display and adjustment module or to the interface adapter is carried out via contact pins in the housing.

ℹ Information:
The terminal block is pluggable and can be removed from the electronics. To do this, lift the terminal block with a small screwdriver and pull it out. When reinserting the terminal block, you should hear it snap in.

Connection procedure

Proceed as follows:

1. Unscrew the housing lid
2. Loosen compression nut of the cable gland and remove blind plug
3. Remove approx. 10 cm (4 in) of the cable mantle (signal output), strip approx. 1 cm (0.4 in) insulation from the ends of the individual wires
4. Insert the cable into the sensor through the cable entry

Fig. 22: Connection steps 5 and 6

5. Insert the wire ends into the terminals according to the wiring plan

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Information:

Solid cores as well as flexible cores with wire end sleeves are inserted directly into the terminal openings. In case of flexible cores without end sleeves, press the terminal from above with a small screwdriver, the terminal opening is then free. When the screwdriver is released, the terminal closes again.

6. Check the hold of the wires in the terminals by lightly pulling on them

7. Connect the cable screening to the internal ground terminal, connect the outer ground terminal to potential equalisation in case of power supply via low voltage

8. Connect the lead cable for voltage supply in the same way according to the wiring plan, in addition connect the ground conductor to the inner ground terminal when powered with mains voltage.

9. Tighten the compression nut of the cable glands. The seal ring must completely encircle the cables

10. Screw the housing lid back on

The electrical connection is finished.

Information:

The terminal blocks are pluggable and can be removed from the housing insert. To do this, lift the terminal block with a small screwdriver and pull it out. When inserting the terminal block again, you should hear it snap in.

5.3 Wiring plan

Overview
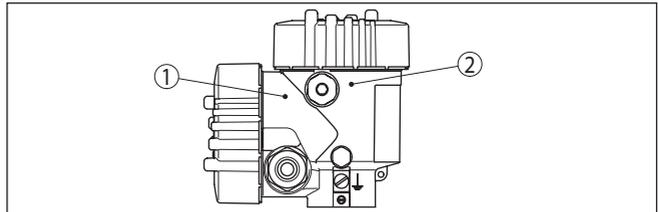
Fig. 23: Position of connection compartment (Modbus electronics) and electronics compartment (sensor electronics)

1   Connection compartment
2   Electronics compartment

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Electronics compartment
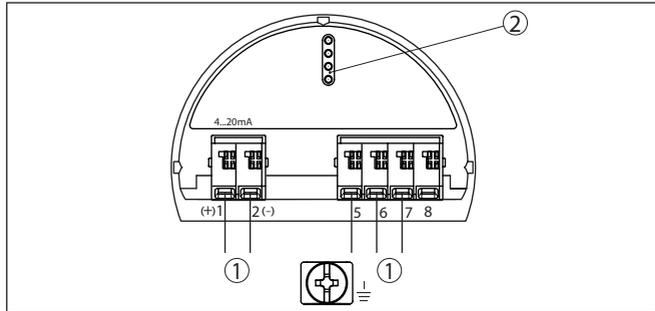
Fig. 24: Electronics compartment - double chamber housing

1 Internal connection to the connection compartment
2 For display and adjustment module or interface adapter

Connection compartment
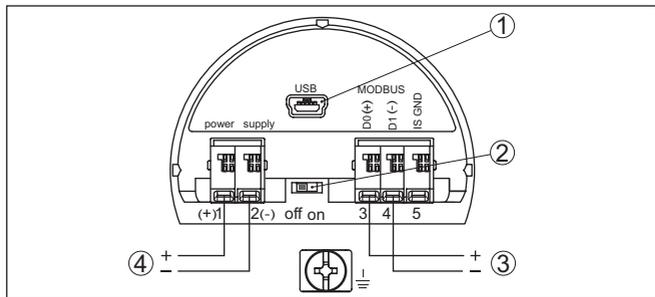
Fig. 25: Connection compartment

1 USB interface
2 Slide switch for integrated termination resistor (120 Ω)
3 Modbus signal
4 Voltage supply

Terminal	Function	Polarity
1	Voltage supply	+
2	Voltage supply	-
3	Modbus signal D0	+
4	Modbus signal D1	-
5	Function ground when installing according to CSA (Canadian Standards Association)	

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5.4 Double chamber housing with VEGADIS-Adapter

Electronics compartment
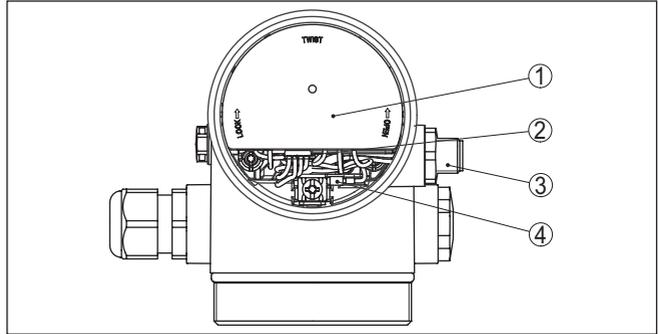
Fig. 26: View to the electronics compartment with VEGADIS adapter for connection of the external display and adjustment unit

1 VEGADIS adapter
2 Internal plug connection
3 Plug connector M12 x 1

Assignment of the plug connector
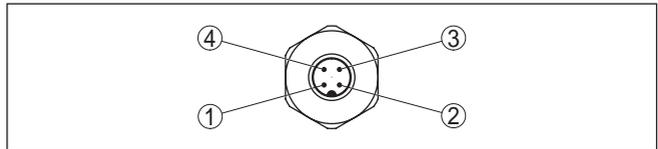
Fig. 27: View to the plug connector M12 x 1

1 Pin 1
2 Pin 2
3 Pin 3
4 Pin 4

Contact pin	Colour, connection cable in the sensor	Terminal, electronics module
Pin 1	Brown	5
Pin 2	White	6
Pin 3	Blue	7
Pin 4	Black	8

5.5 Switch-on phase

After VEGAPULS 61 is connected to the bus system, the instrument carries out a self-test for approx. 30 seconds. The following steps are carried out:

- Internal check of the electronics
- Indication of a status message, e.g. "*F 105 Determine measured value*" on the display or PC
- Status byte goes briefly to fault value

Then the actual measured value is output to the signal cable. The value takes into account settings that have already been carried out, e.g. default setting.

6 Set up the sensor with the display and adjustment module

6.1 Adjustment volume

The display and adjustment module is only used for parameter adjustment of the sensor, i.e. for adaptation to the measurement task.

The parameter adjustment of the Modbus interface is carried out via a PC with PACTware. You can find the procedure in chapter "*Set up sensor and Modbus interface with PACTware*".

6.2 Insert display and adjustment module

The display and adjustment module can be inserted into the sensor and removed again at any time. You can choose any one of four different positions - each displaced by 90°. It is not necessary to interrupt the power supply.

Proceed as follows:

1. Unscrew the housing lid

2. Place the display and adjustment module on the electronics in the desired position and turn it to the right until it snaps in.

3. Screw housing lid with inspection window tightly back on

Disassembly is carried out in reverse order.

The display and adjustment module is powered by the sensor, an additional connection is not necessary.

Fig. 28: Insertion of the display and adjustment module

Note:
If you intend to retrofit the instrument with a display and adjustment module for continuous measured value indication, a higher lid with an inspection glass is required.

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6.3 Adjustment system
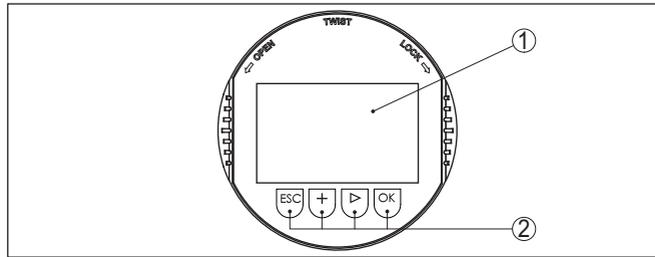
Fig. 29: Display and adjustment elements

1 LC display
2 Adjustment keys

Key functions

- *[OK]* key:
  - Move to the menu overview
  - Confirm selected menu
  - Edit parameter
  - Save value

- *[->]* key:
  - Change measured value presentation
  - Select list entry
  - Select menu items in the quick setup menu
  - Select editing position

- *[+]* key:
  - Change value of the parameter

- *[ESC]* key:
  - Interrupt input
  - Jump to next higher menu

Operating system - Keys direct

The instrument is operated via the four keys of the display and adjustment module. The individual menu items are shown on the LC display. You can find the function of the individual keys in the previous illustration.

Adjustment system - keys via magnetic pen

With the Bluetooth version of the display and adjustment module you can also adjust the instrument with the magnetic pen. The pen operates the four keys of the display and adjustment module right through the closed lid (with inspection window) of the sensor housing.
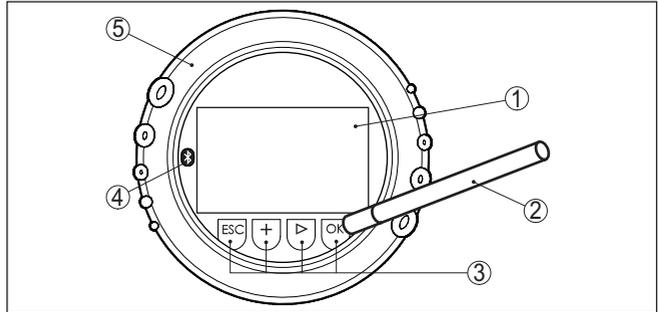
Fig. 30: Display and adjustment elements - with adjustment via magnetic pen

1   LC display
2   Magnetic pen
3   Adjustment keys
4   Bluetooth symbol
5   Lid with inspection window

Time functions

When the *[+]* and *[->]* keys are pressed quickly, the edited value, or the cursor, changes one value or position at a time. If the key is pressed longer than 1 s, the value or position changes continuously.

When the *[OK]* and *[ESC]* keys are pressed simultaneously for more than 5 s, the display returns to the main menu. The menu language is then switched over to "*English*".

Approx. 60 minutes after the last pressing of a key, an automatic reset to measured value indication is triggered. Any values not confirmed with *[OK]* will not be saved.

6.4   Measured value indication - Selection of national language

Measured value indication

With the *[->]* key you move between three different indication modes.

In the first view, the selected measured value is displayed in large digits.

In the second view, the selected measured value and a corresponding bar graph presentation are displayed.

In the third view, the selected measured value as well as a second selectable value, e.g. the temperature of the electronics, are displayed.
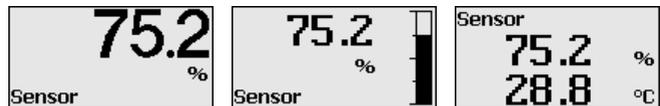
During the initial setup of an instrument shipped with factory settings, use the "*OK*" key to get to the menu "*National language*".

Selection of national language

This menu item is used to select the national language for further parameter adjustment. You can change the selection via the menu item "*Setup - Display, Menu language*".

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```
Language
  Deutsch
√ English
  Français
  Español
  Русский
        ▼
```

With the "*OK*" key you move to the main menu.

6.5 Parameter adjustment

The instrument is adapted to the application conditions via the parameter adjustment. The parameter adjustment is carried out with an adjustment menu.

Main menu

The main menu is divided into five sections with the following functions:

```
Setup
Display
Diagnostics
Additional adjustments
Info
```
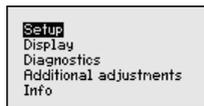
Setup: Settings, e.g., for measurement loop name, medium, application, vessel, adjustment, signal output

Display: Settings, e.g., for language, measured value display, lighting

Diagnosis: Information, e.g. on instrument status, pointer, measurement reliability, simulation, echo curve

Further settings: Instrument unit, false signal suppression, linearisation curve, reset, date/time, reset, copy function

Info: Instrument name, hardware and software version, date of manufacture, instrument features

ⓘ   Information:
In this operating instructions manual, the instrument-specific parameters in the menu sections "*Setup*", "*Diagnosis*" and "*Additional settings*" are described. The general parameters in these menu sections are described in the operating instructions manual "*Display and adjustment module*".

In the operating instructions manual "*Display and adjustment module*" you can also find the description of menu sections "*Display*" and "*Info*".

In the main menu item "*Setup*", the individual submenu items should be selected one after the other and provided with the correct parameters to ensure optimum adjustment of the measurement. The procedure is described in the following.

Setup - Measurement loop name

In the menu item "*Sensor TAG*" you edit a twelve-digit measurement loop designation.

You can enter an unambiguous designation for the sensor, e.g. the measurement loop name or the tank or product designation. In digital systems and in the documentation of larger plants, a singular designation must be entered for exact identification of individual measuring points.

The available digits include:

- Letters from A … Z
- Numbers from 0 … 9
- Special characters +, -, /, -
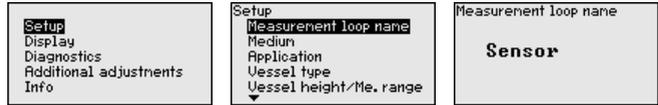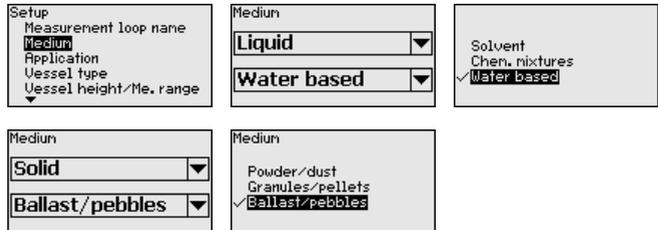
```
Setup
Setup                         Measurement loop name    Measurement loop name
Display                       Medium
Diagnostics                   Application                   Sensor
Additional adjustments        Vessel type
Info                          Vessel height/Me.range
```

Setup - Medium Every medium has different reflective properties. With liquids, there are additional interfering factors such as turbulent product surface and foam generation. With bulk solids, the additional interfering factors are dust generation, angle of repose and secondary echoes from the vessel wall.

To adapt the sensor to these different measuring conditions, the selection "*Liquid*" or "*Bulk solid*" should be made in this menu item.

```
Setup                      Medium
  Measurement loop name    Liquid                    Solvent
  Medium                                             Chem.mixtures
  Application                                      ✓ Water based
  Vessel type              Water based
  Vessel height/Me.range
```

```
Medium                     Medium
Solid                        Powder/dust
                             Granules/pellets
                           ✓ Ballast/pebbles
Ballast/pebbles
```

Through this selection, the sensor is optimally adapted to the product, and measurement reliability, particularly in products with poor reflective properties, is considerably increased.

Enter the requested parameters via the appropriate keys, save your settings with *[OK]* and jump to the next menu item with the *[ESC]* and the *[->]* key.

Setup - Application In addition to the medium, also the application, i.e. the measuring site, can influence the measurement.

With this menu item, the sensor can be adapted to the applications. The adjustment possibilities depend on the selection "*Liquid*" or "*Bulk solid*" under "*Medium*".

```
Setup
  Measurement loop name
  Medium
  Application
  Vessel type
  Vessel height/Me.range
```
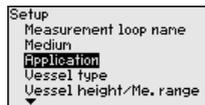
The following options are available when "*Liquid*" is selected:

```
Application                Application              Application
✓ Storage tank              Stilling tube            Mob.plastic vessel
  Storage tank agitation  ✓ Bypass                   Open waters
  Storage tank on ships     Plastic vessel          ✓ Open flume
  Stirred vessel            Mob.plastic vessel       Rainwater overfall
  Dosing vessel             Open waters              Demonstration
```
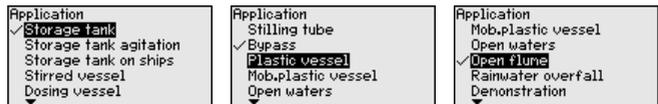
The selection "*Standpipe*" opens a new window in which the inner diameter of the applied standpipe is entered.
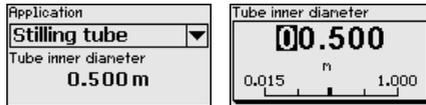
Following the characteristics of the applications and the metrological features of the sensor are described.

Note:
Probably the operation of the instrument in the following applications is subject to national restrictions in respect to the radio license (see chapter "*For your safety*"):

- Plastic tank
- Transportable plastic tank
- Open water
- Open flume
- Rain water spillover

Storage tank:
- Setup: large-volumed, upright cylindrical, spherical
- Medium speed: slow filling and emptying
- Process/measurement conditions:
  – Condensation
  – Smooth product surface
  – High requirements on measurement accuracy
- Properties, sensor:
  – Low sensitivity to sporadic false echoes
  – Stable and reliable measured values through averaging
  – High measurement accuracy
  – Short reaction time of the sensor not required

Storage tank, circulation:
- Setup: large-volumed, upright cylindrical, spherical
- Medium speed: slow filling and emptying
- Installations: small, laterally mounted or large, top mounted stirrer
- Process/measurement conditions:
  – Relatively smooth product surface
  – High requirements on measurement accuracy
  – Condensation
  – Slight foam generation
  – Overfilling possible
- Properties, sensor:
  – Low sensitivity to sporadic false echoes
  – Stable and reliable measured values through averaging
  – High measurement accuracy, because not set for max. speed
  – False signal suppression recommended

Storage tank on ships:
- Medium speed: slow filling and emptying
- Vessel:
  – Installations in the bottom section (bracers, heating spirals)
  – High sockets 200 … 500 mm, also with large diameters
- Process/measurement conditions:

- Condensation, buildup by movement
- Max. requirement on measurement accuracy from 95 %
● Properties, sensor:
  - Low sensitivity to sporadic false echoes
  - Stable and reliable measured values through averaging
  - High measurement accuracy
  - False signal suppression required

Stirrer vessel:
● Setup: all vessel sizes possible
● Medium speed:
  - Fast to slow filling possible
  - Vessel is filled and emptied very often
● Vessel:
  - Socket available
  - Large agitator blades of metal
  - Vortex breakers, heating spirals
● Process/measurement conditions:
  - Condensation, buildup by movement
  - Strong spout generation
  - Very agitated surface, foam generation
● Properties, sensor:
  - Higher measurement speed through less averaging
  - Sporadic false echoes are suppressed

Dosing vessel:
● Setup: all vessel sizes possible
● Medium speed:
  - Fast filling and emptying
  - Vessel is filled and emptied very often
● Vessel: tight installation situation
● Process/measurement conditions:
  - Condensation, buildup on the antenna
  - Foam generation
● Properties, sensor:
  - Measurement speed optimized by virtually no averaging
  - Sporadic false echoes are suppressed
  - False signal suppression recommended

Standpipe:
● Medium speed: very fast filling and emptying
● Vessel:
  - Vent hole
  - Joins like flanges, weld joints
  - Shifting of the running time in the tube
● Process/measurement conditions:
  - Condensation
  - Buildup
● Properties, sensor:
  - Measurement speed optimized through little averaging
  - Entering the tube inside diameter takes the running time shift into consideration
  - Echo detection sensitivity reduced

Bypass:
● Medium speed:
  – Fast up to slow filling with short up to long bypass tube possible
  – Often the level is hold via a control facility
● Vessel:
  – Lateral outlets and inlets
  – Joins like flanges, weld joints
  – Shifting of the running time in the tube
● Process/measurement conditions:
  – Condensation
  – Buildup
  – Separation of oil and water possible
  – Overfilling into the antenna possible
● Properties, sensor:
  – Measurement speed optimized through little averaging
  – Entering the tube inside diameter takes the running time shift into consideration
  – Echo detection sensitivity reduced
  – False signal suppression recommended

Plastic tank:
● Vessel:
  – Instrument fix mounted or built in
  – Measurement through the vessel top, if appropriate to the application
  – With empty vessel, the measurement can go through the bottom
● Process/measurement conditions:
  – Condensation on the plastic ceiling
  – In outdoor facilities, water and snow on vessel top possible
● Properties, sensor:
  – False signals outside the vessel are not taken into consideration
  – False signal suppression recommended

Transportable plastic tank:
● Vessel:
  – Material and thickness different
  – Measurement through the vessel top
● Process/measurement conditions:
  – Measured value jump with vessel change
● Properties, sensor:
  – Quick adaptation to changing reflection conditions due to vessel change
  – False signal suppression required

Open water:
● Rate of level change: slow level change
● Process/measurement conditions:
  – Large distance from sensor to water surface
  – Extreme damping of output signal due to wave generation
  – Ice and condensation on the antenna possible
  – Spiders and insects build nests in the antennas

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– Floating material and animals sporadically appear on water surface
● Properties, sensor:
  – Stable and reliable measured values through frequent averaging
  – Insensitive in the close range

Open flume:
● Rate of level change: slow level change
● Process/measurement conditions:
  – Ice and condensation on the antenna possible
  – Spiders and insects build nests in the antennas
  – Smooth water surface
  – Exact measurement result required
  – Distance to the water surface normally relatively large
● Properties, sensor:
  – Stable and reliable measured values through frequent averaging
  – Insensitive in the close range

Rain water spillover:
● Rate of level change: slow level change
● Process/measurement conditions:
  – Ice and condensation on the antenna possible
  – Spiders and insects build nests in the antennas
  – Turbulent water surface
  – Sensor flooding possible
● Properties, sensor:
  – Stable and reliable measured values through frequent averaging
  – Insensitive in the close range

Demonstration:
● Adjustment for all applications which are not typically level measurement
  – Instrument demonstration
  – Object recognition/monitoring (additional settings required)
● Properties, sensor:
  – Sensor accepts all measured value changes within the measuring range immediately
  – High sensitivity to interference, because virtually no averaging

Caution:
If liquids with different dielectric constants separate in the vessel, for example through condensation, the radar sensor can detect under certain circumstances only the medium with the higher dielectric constant. Keep in mind that layer interfaces can cause faulty measurements.

If you want to measure the total height of both liquids reliably, please contact our service department or use an instrument specially designed for interface measurement.

VEGA

Setup - Vessel form   Apart from the medium and the application, the vessel form itself can influence the measurement. To adapt the sensor to these measuring conditions, this menu item offers different options for vessel bottom and ceiling for certain applications.
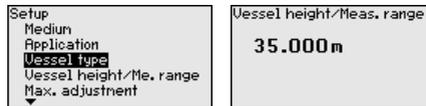
```
Setup                  Vessel bottom        Vessel top
  Medium
  Application          ✓ Straight             Straight
  Vessel type            Conical            ✓ Dished boiler
  Vessel height/Me.range Angular
  Max. adjustment
▼
```

Enter the requested parameters via the appropriate keys, save your settings with *[OK]* and jump to the next menu item with the *[ESC]* and the *[->]* key.

Setup - Vessel height, measuring range   Through this selection the operating range of the sensor is adapted to the vessel height, which considerably increases measurement reliability under different basic conditions.

The min. adjustment must be carried out independently of this.

```
Setup                  Vessel height/Meas.range
  Medium
  Application            35.000 m
  Vessel type
  Vessel height/Me.range
  Max. adjustment
▼
```

Enter the requested parameters via the appropriate keys, save your settings with *[OK]* and jump to the next menu item with the *[ESC]* and the *[->]* key.

Setup - Adjustment   Since the radar sensor is a distance measuring instrument, the distance from the sensor to the product surface is measured. To indicate the actual level, an allocation of the measured distance to the percentage height must be carried out.

To perform the adjustment, enter the distance with full and empty vessel, see the following example:
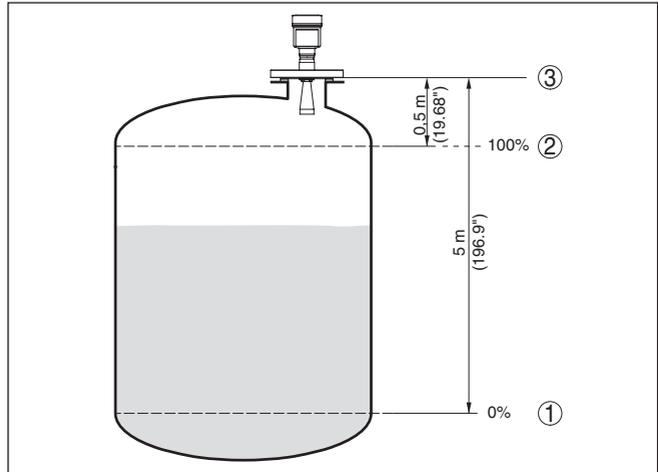
Fig. 31: Parameterisation example, Min./max. adjustment

1   Min. level = max. measuring distance
2   Max. level = min. measuring distance
3   Reference plane

If these values are not known, an adjustment with the distances of e.g. 10 % and 90 % is possible. Starting point for these distance specifications is always the sealing surface of the thread or flange. You can find further specifications on the reference plane in the chapters "*Mounting instructions*" and "*Technical data*". The actual level is calculated on the basis of these settings.

The actual product level during this adjustment is not important, because the min./max. adjustment is always carried out without changing the product level. These settings can be made ahead of time without the instrument having to be installed.

Setup - Min. adjustment
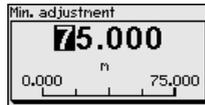
Proceed as follows:

1. Select the menu item "*Setup*" with *[->]* and confirm with *[OK]*. Now select with *[->]* the menu item "*Min. adjustment*" and confirm with *[OK]*.

2. Edit the percentage value with *[OK]* and set the cursor to the requested position with *[->]*.

3. Set the requested percentage value with *[+]* and save with *[OK]*. The cursor jumps now to the distance value.

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```
Min. adjustment
   75.000
        m
 0.000      75.000
```
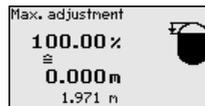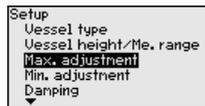
4. Enter the suitable distance value in m for empty vessel (e.g. distance from the sensor to the vessel bottom) corresponding to the percentage value.

5. Save settings with *[OK]* and move with *[ESC]* and *[->]* to the max. adjustment.

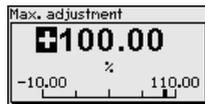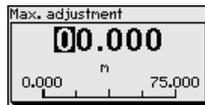**Setup - Max. adjustment**   Proceed as follows:

1. Select with *[->]* the menu item Max. adjustment and confirm with *[OK]*.

```
Setup
 Vessel type
 Vessel height/Me. range
 Max. adjustment
 Min. adjustment
 Damping
```
```
Max. adjustment
  100.00 %
     ≙
   0.000 m
      1.971 m
```

2. Prepare the percentage value for editing with *[OK]* and set the cursor to the requested position with *[->]*.
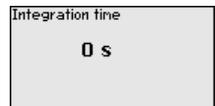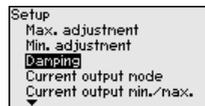
```
Max. adjustment
  100.00
      %
 -10.00      110.00
```

3. Set the requested percentage value with *[+]* and save with *[OK]*. The cursor jumps now to the distance value.

```
Max. adjustment
   00.000
        m
 0.000      75.000
```

4. Enter the appropriate distance value in m (corresponding to the percentage value) for the full vessel. Keep in mind that the max. level must lie below the min. distance to the antenna edge.

5. Save settings with *[OK]*

Setup - Damping   To damp process-dependent measured value fluctuations, set an integration time of 0 … 999 s in this menu item.

```
Setup
 Display
 Diagnostics
 Additional adjustments
 Info
```
```
Setup
 Max. adjustment
 Min. adjustment
 Damping
 Current output mode
 Current output min./max.
```
```
Integration time
    0 s
```
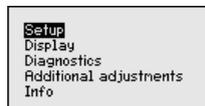
Depending on the sensor type, the factory setting is 0 s or 1 s.

Setup - Current output, mode   In the menu item "*Current output mode*" you determine the output characteristics and reaction of the current output in case of fault.

```
Setup
 Display
 Diagnostics
 Additional adjustments
 Info
```
```
Setup
 Measurement loop name
 Medium
 Application
 Vessel type
 Vessel height/Me. range
```
```
Current output mode
Output characteristics
 4 ... 20 mA      ▼
Failure mode
 < 3.6 mA         ▼
```

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Output characteristics

✓ 4 … 20 mA
20 … 4 mA

Failure mode

22.0 mA
20.5 mA
No change
✓ < 3.6 mA
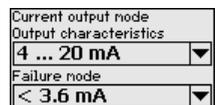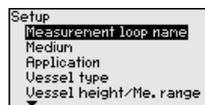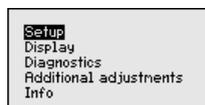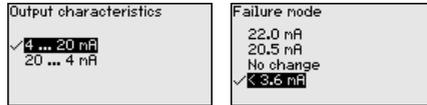
The default setting is output characteristics 4 … 20 mA, fault mode
< 3.6 mA.

Setup - Current output Min./Max.

In the menu item "*Current output Min./Max.*", you determine the reaction of the current output during operation.

Setup
Display
Diagnostics
Additional adjustments
Info

Setup
Damping
Current output mode
Current output min./max.
Lock adjustment

▼

Current output min./max.
Min. current
3.8 mA ▼
Max. current
20.5 mA ▼

Min. current

✓ **3.8 mA**
4 mA

Max. current

20 mA
✓ **20.5 mA**

The default setting is min. current 3.8 mA and max. current 20.5 mA.

Setup - Lock adjustment

In this menu item, the PIN is activated/deactivated permanently. Entering a 4-digit PIN protects the sensor data against unauthorized access and unintentional modifications. If the PIN is activated permanently, it can be deactivated temporarily (i.e. for approx. 60 min.) in any menu item.

Setup
Display
Diagnostics
Additional adjustments
Info

Setup
Current output mode
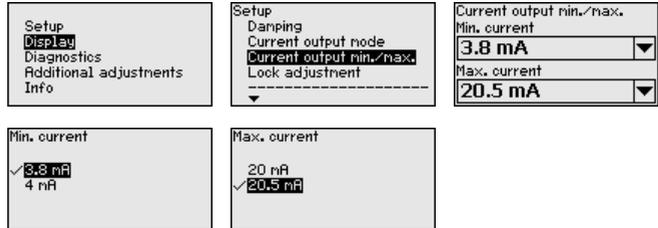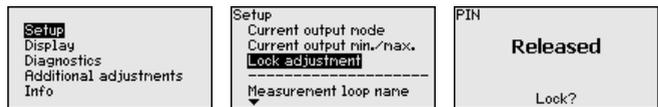Current output min./max.
Lock adjustment

Measurement loop name
▼

PIN

Released

Lock?

Only the following functions are permitted with activated PIN:

● Select menu items and show data
● Read data from the sensor into the display and adjustment module

⚠ **Caution:**
When the PIN is active, adjustment via PACTware/DTM as well as other systems is also blocked.

In delivery status, the PIN is "*0000*".

Display - Language

This menu item enables the setting of the requested national language.

Setup
Display
Diagnostics
Additional adjustments
Info

Display
Language
Displayed value
Scaling variable
Scaling
Backlight

Display
Menu language
Indication value 1
Indication value 2
Backlight

Language

English ▼

Language
Deutsch
✓ **English**
Français
Español
Pycckuu
▼

Language
Deutsch
✓ **English**
Français
Español
Pycckuu
▼

VEGA
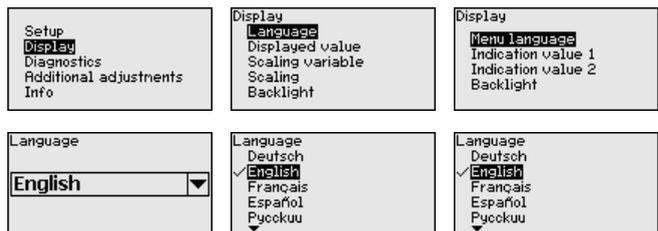
In delivery status, the sensor is set to the ordered national language.

Display - Indicated value

In this menu item you can define the indication of the measured value on the display.

Setup	Display	Displayed value
Display	Language	
Diagnostics	**Displayed value**	**Distance** ▼
Additional adjustments	Scaling variable	
Info	Scaling	
	Backlight	

✓ **Distance**	Percent
Height	Linear percent
Percent	✓ **Scaled**
Linear percent	Current
Scaled	--------------------
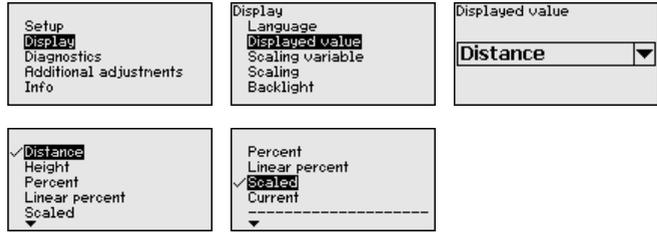
The default setting for the indicated value is e.g. "Distance" on radar sensors.

Display - Backlight

The optionally integrated background lighting can be switched on via the adjustment menu. This function depends on the level of the supply voltage, see operating instructions of the respective sensor.
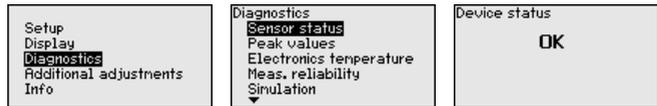
Setup	Display	Display
Display	Language	Menu language
Diagnostics	Displayed value	Indication value 1
Additional adjustments	Scaling variable	Indication value 2
Info	Scaling	**Backlight**
	Backlight	

In delivery status, the lighting is switched on.

Diagnostics - Device status

In this menu item, the device status is displayed.

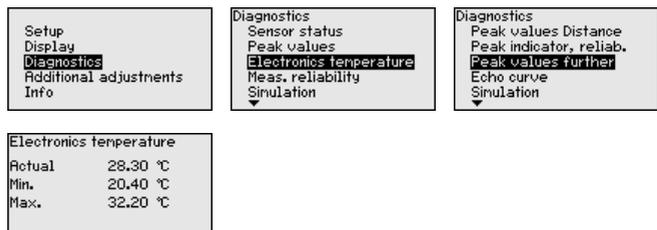| Setup	Diagnostics	Device status
Display	**Sensor status**	
Diagnostics	Peak values	**OK**
Additional adjustments	Electronics temperature	
Info	Meas. reliability	
	Simulation	

Diagnostics - Peak values (distance)

The respective min. and max. measured distance values are saved in the sensor. The values are displayed in the menu item "*Peak values*".
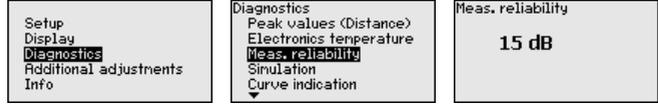
Setup	Diagnostics	Peak values (Distance)
Display	Device status	Min.
Diagnostics	**Peak values (Distance)**	0.108 m
Additional adjustments	Electronics temperature	Max.
Info	Meas. reliability	12.911 m
	Simulation	
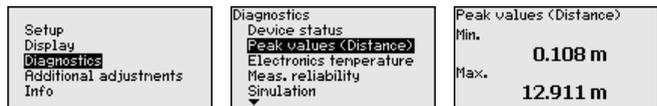
Diagnosis - Electronics temperature

The respective min. and max. measured values of the electronics temperature are saved in the sensor. These values as well as the current temperature value are displayed in the menu item "*Peak values*".

Setup	Diagnostics	Diagnostics
Display	Sensor status	Peak values Distance
Diagnostics	Peak values	Peak indicator, reliab.
Additional adjustments	**Electronics temperature**	**Peak values further**
Info	Meas. reliability	Echo curve
	Simulation	Simulation

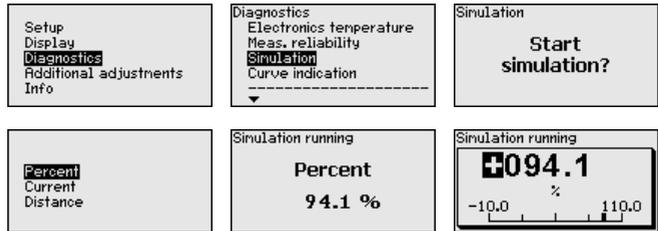| Electronics temperature	
Actual	28.30 °C
Min.	20.40 °C
Max.	32.20 °C

Diagnosis - Measurement reliability

When non-contact level sensors are used, the measurement can be influenced by the respective process conditions. In this menu item, the measurement reliability of the level echo is displayed as a dB value. Measurement reliability equals signal strength minus noise. The higher the value, the more reliable the measurement. A well functioning measurement normally has a value > 10 dB.

| Setup Display **Diagnostics** Additional adjustments Info | Diagnostics Peak values (Distance) Electronics temperature **Meas. reliability** Simulation Curve indication ▼ | Meas. reliability **15 dB** |

Diagnosis - Simulation

In this menu item you can simulate measured values via the current output. This allows the signal path to be tested, e.g. through downstream indicating instruments or the input card of the control system.

| Setup Display **Diagnostics** Additional adjustments Info | Diagnostics Electronics temperature Meas. reliability **Simulation** Curve indication ──────────── ▼ | Simulation **Start simulation?** |

| **Percent** Current Distance | Simulation running **Percent** **94.1 %** | Simulation running **⊞094.1** % -10.0 ⌐ 110.0 |

How to start the simulation:

1. Push *[OK]*
2. Select the requested simulation variable with *[->]* and confirm with *[OK]*.
3. With *[OK]* you start the simulation, first of all the actual measured value is displayed in %
4. Start the editing mode with *[OK]*
5. Set the requested numerical value with *[+]* and *[->]*.
6. Push *[OK]*

● **Note:**
ⓘ During simulation, the simulated value is output as 4 … 20 mA current value and digital HART signal.
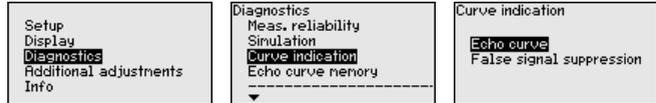
How to interrupt the simulation:

→ Push *[ESC]*

● **Information:**
ⓘ The simulation is automatically terminated 10 minutes after the last pressing of a key.

Diagnosis - Curve indication

The "*Echo curve*" shows the signal strength of the echoes over the measuring range in dB. The signal strength enables an evaluation of the quality of the measurement.

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The "*False signal suppression*" displays the saved false echoes (see menu "*Additional settings*") of the empty vessel with signal strength in "dB" over the entire measuring range.

A comparison of echo curve and false signal suppression allows a more detailed statement about measurement reliability.
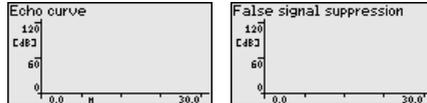

The selected curve is continuously updated. A submenu with zoom functions is opened with the *[OK]* key:

- "X-Zoom": Zoom function for the meas. distance
- "Y-Zoom": 1, 2, 5 and 10x signal magnification in "*dB*"
- "Unzoom": Reset the presentation to the nominal measuring range without magnification

**Diagnostics - Echo curve memory**

The function "*Echo curve memory*" makes it possible to save the echo curve at the time of setup. This is generally recommended, and it is absolutely necessary if you want to use the Asset Management functions. If possible, the curve should be saved with a low level in the vessel.

With the adjustment software PACTware and a PC, a high resolution echo curve can be displayed and used to recognize signal changes during operation. In addition, the echo curve of setup can be displayed in the echo curve window and compared with the current echo curve.
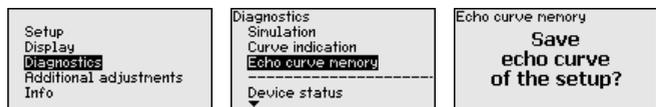
Additional adjustments - Instrument units

In this menu item you select the measured variable of the system and the temperature unit.
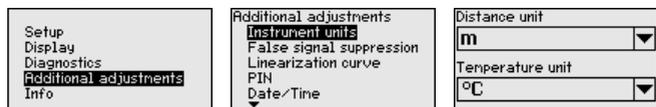
Additional settings - False signal suppression

The following circumstances cause interfering reflections and can influence the measurement:

- High mounting sockets
- Vessel internals such as struts
- Agitators
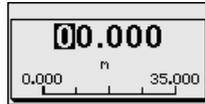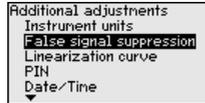- Buildup or welded joints on vessel walls

● Note:
ⅰ A false signal suppression detects, marks and saves these false signals to ensure that they are ignored in the level measurement.

This should be done with the lowest possible level so that all potential interfering reflections can be detected.

Proceed as follows:

1. Select with *[->]* the menu item "*False signal suppression*" and confirm with *[OK]*.

```
Additional adjustments
 Instrument units
 False signal suppression
 Linearization curve
 PIN
 Date/Time
▼
```

```
False signal suppression

 Create new
```

```
 00.000
        m
0.000        35.000
```

2. Confirm 3-times with *[OK]* and enter the actual distance from the sensor to the product surface.

3. All interfering signals in this range are detected by the sensor and stored after being confirmed with *[OK]*.

● Note:
ⅰ Check the distance to the product surface, because if an incorrect (too large) value is entered, the existing level will be saved as a false signal. The level would then no longer be detectable in this area.

If a false signal suppression has already been saved in the sensor, the following menu window appears when selecting "*False signal suppression*":

```
False signal suppression

 Delete
 Update
 Create new
```

Delete: An already created false signal suppression will be completely deleted. This is useful if the saved false signal suppression no longer matches the metrological conditions in the vessel.

Extend: is used to extend an already created false signal suppression. This is useful if a false signal suppression was carried out with too high a level and not all false signals could be detected. When selecting "*Extend*", the distance to the product surface of the created false signal suppression is displayed. This value can now be changed and the false signal suppression can be extended to this range.

Additional settings - Linearization

A linearization is necessary for all vessels in which the vessel volume does not increase linearly with the level - e.g. a horizontal cylindri-

cal or spherical tank - and the indication or output of the volume is required. Corresponding linearization curves are preprogrammed for these vessels. They represent the correlation between the level percentage and vessel volume.

By activating the appropriate curve, the volume percentage of the vessel is displayed correctly. If the volume should not be displayed in percent but e.g. in l or kg, a scaling can be also set in the menu item "*Display*".
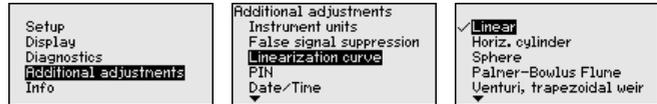
Enter the requested parameters via the appropriate keys, save your settings and jump to the next menu item with the *[ESC]* and *[->]* key.

⚠ **Caution:**
Note the following if instruments with appropriate approval are used as part of an overfill protection system according to WHG:

If a linearisation curve is selected, the measuring signal is no longer necessarily linear to the filling height. This must be considered by the user especially when setting the switching point on the limit signal transmitter.

Additional settings - PIN   Entering a 4-digit PIN protects the sensor data against unauthorized access and unintentional modification. In this menu item, the PIN is displayed or edited and changed. However, this menu item is only available if adjustment is enabled in the menu "*Setup*".
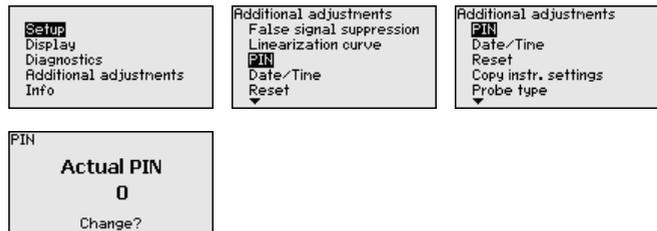
In delivery status, the PIN is "*0000*".

Additional settings - Date/ Time   In this menu item, the internal clock of the sensor is set.
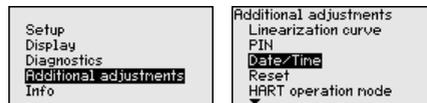
Additional settings - Reset   After a reset, certain parameter adjustments made by the user are reset.

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The following reset functions are available:

Delivery status: Restores the parameter settings at the time of ship-ment from the factory, incl. order-specific settings. Any stored false signal suppression or user-programmed linearisation curve, as well as the measured value memory, are deleted.

Basic settings: Restores the parameter settings, incl. special param-eters, to the default values of the respective instrument. Any stored false signal suppression or user-programmed linearisation curve, as well as the measured value memory, are deleted.

Setup: Restores the parameter settings made in the menu item Setup to the default values of the respective instrument. False signal suppression, user-programmed linearisation curve, measured value memory and event memory remain untouched. The linearisation is set to linear.

False signal suppression: Deletes a previously created false signal suppression. The false signal suppression created at the factory remains active.

Peak values, measured value: Resets the measured min. and max. distances to the current measured value.

The following table shows the default values of the instrument. De-pending on the instrument version, not all menu items are available or some may be differently assigned:

Menu	Menu item	Default value
Setup	Measurement loop name	Sensor
	Medium	Liquid/Water
		Bulk solids/Crushed stones, gravel
	Application	Storage tank
		Silo
	Vessel form	Vessel bottom, dished form
		Vessel top, dished form
	Vessel height/Measur-ing range	Recommended measuring range, see "*Technical data*" in the supplement.
	Min. adjustment	Recommended measuring range, see "*Technical data*" in the supplement.
	Max. adjustment	0,000 m(d)
	Damping	0.0 s
	Current output mode	4 … 20 mA, < 3.6 mA
	Current output, min./max.	Min. current 3.8 mA, max. current 20.5 mA
	Lock adjustment	Released

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Menu	Menu item	Default value
Display	Language	Like order
	Displayed value	Distance
	Display unit	m
	Scaling size	Volume
		l
	Scaling	0.00 lin %, 0 l
		100.00 lin %, 100 l
	Backlight	Switched on
Additional adjustments	Distance unit	m
	Temperature unit	°C
	Probe length	Length of standpipe ex factory
	Linearisation curve	Linear
	HART mode	Standard
		Address 0

Additional settings - HART mode

The sensor offers the HART modes standard and Multidrop. In this menu item you specify the HART mode and enter the address for Multidrop.
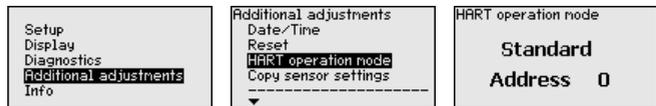
The mode "standard" with the fixed address 0 means outputting the measured value as a 4 … 20 mA signal.

In Multidrop mode, up to 63 sensors can be operated on one two-wire cable. An address between 1 and 63 must be assigned to each sensor.[1]

The default setting is standard with address 0.

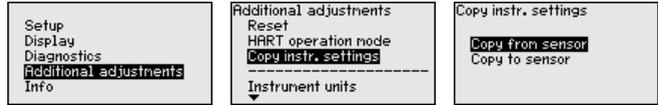**Additional settings - Copy instrument settings**

The instrument settings are copied with this function. The following functions are available:

● Store data from sensor in the display and adjustment module.
● Store data from display and adjustment module in the sensor

The following data or settings for adjustment of the display and adjustment module are saved:

● All data of the menu "*Setup*" and "*Display*"
● In the menu "*Additional settings*" the items "*Distance unit, temperature unit and linearization*"
● The values of the user-programmable linearisation curve

---

[1] The 4 … 20 mA signal of the sensor is switched off. The sensor uses a constant current of 4 mA. The measuring signal is transmitted exclusively as a digital HART signal.

VEGAPULS 61 • Modbus and Levelmaster protocol

Setup
Display
Diagnostics
Additional adjustments
Info

Additional adjustments
Reset
HART operation mode
Copy instr. settings
_____
Instrument units

Copy instr. settings

Copy from sensor
Copy to sensor

The copied data are permanently saved in an EEPROM memory in the display and adjustment module and remain there even in case of power failure. From there, they can be written into one or more sensors or kept as backup for a possible sensor exchange.

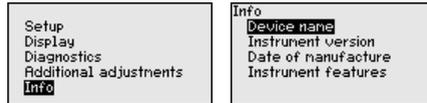The type and the volume of the copied data depend on the respective sensor.

Note:

Before the data are stored in the sensor, a check is carried out to determine if the data fit the sensor. If the data do not fit, a fault signal is triggered or the function is blocked. When data are being written into the sensor, the display shows which instrument type the data originate from and which TAG-no. this sensor had.
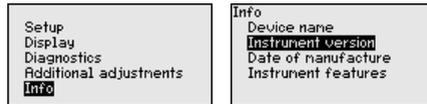
Info - Instrument name   In this menu, you read out the instrument name and the instrument serial number:

Setup
Display
Diagnostics
Additional adjustments
Info

Info
Device name
Instrument version
Date of manufacture
Instrument features

Info - Instrument version   In this menu item, the hardware and software version of the sensor is displayed.

Setup
Display
Diagnostics
Additional adjustments
Info

Info
Device name
Instrument version
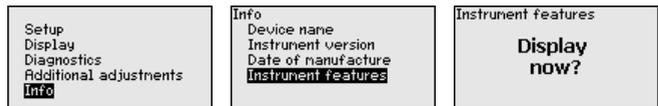Date of manufacture
Instrument features

Info - Date of manufacture   In this menu item, the date of factory calibration of the sensor as well as the date of the last change of sensor parameters are displayed via the display and adjustment module or via the PC.

Setup
Display
Diagnostics
Additional adjustments
Info

Info
Device name
Instrument version
Date of manufacture
Instrument features

Instrument features   In this menu item, the features of the sensor such as approval, process fitting, seal, measuring range, electronics, housing and others are displayed.

Setup
Display
Diagnostics
Additional adjustments
Info

Info
Device name
Instrument version
Date of manufacture
Instrument features

Instrument features

**Display
now?**

6.6 Saving the parameterisation data

On paper

We recommended writing down the adjustment data, e.g. in this operating instructions manual, and archiving them afterwards. They are thus available for multiple use or service purposes.

In the display and adjustment module

If the instrument is equipped with a display and adjustment module, the parameter adjustment data can be saved therein. The procedure is described in menu item "*Copy device settings*".

7 Setting up sensor and Modbus interface with PACTware

7.1 Connect the PC

To the sensor electronics Connection of the PC to the sensor electronics is carried out via the interface adapter VEGACONNECT.

Scope of the parameter adjustment:

● Sensor electronics

Fig. 32: Connection of the PC directly to the sensor via the interface adapter
1 USB cable to the PC
2 Interface adapter VEGACONNECT
3 Sensor

To the Modbus electronics Connection of the PC to the Modbus electronics is carried out via a USB cable.

Scope of the parameter adjustment:

● Sensor electronics
● Modbus electronics

Fig. 33: Connecting the PC via USB to the Modbus electronics
1 USB cable to the PC

To the RS 485 cable Connection of the PC to the RS 485 cable is carried out via a standard interface adapter RS 485/USB.

VEGA

Scope of the parameter adjustment:

- Sensor electronics
- Modbus electronics

● **Information:**
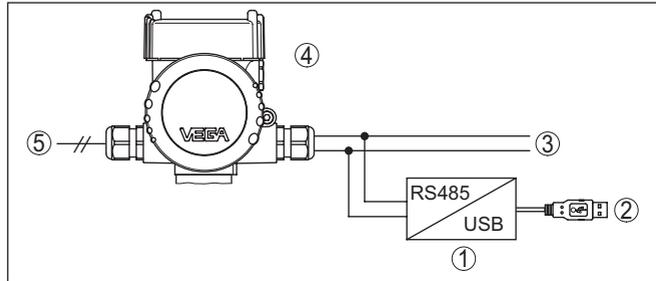ℹ For parameter adjustment, it is absolutely necessary to disconnect from the RTU.

Fig. 34: Connection of the PC via the interface adapter to the RS 485 cable

1 Interface adapter RS 485/USB
2 USB cable to the PC
3 RS 485 cable
4 Sensor
5 Voltage supply

7.2 Parameter adjustment

Prerequisites

For parameter adjustment of the instrument via a Windows PC, the configuration software PACTware and a suitable instrument driver (DTM) according to FDT standard are required. The latest PACTware version as well as all available DTMs are compiled in a DTM Collection. The DTMs can also be integrated into other frame applications according to FDT standard.

● **Note:**
ℹ To ensure that all instrument functions are supported, you should always use the latest DTM Collection. Furthermore, not all described functions are included in older firmware versions. You can download the latest instrument software from our homepage. A description of the update procedure is also available in the Internet.

Further setup steps are described in the operating instructions manual "*DTM Collection/PACTware*" attached to each DTM Collection and which can also be downloaded from the Internet. Detailed descriptions are available in the online help of PACTware and the DTMs.
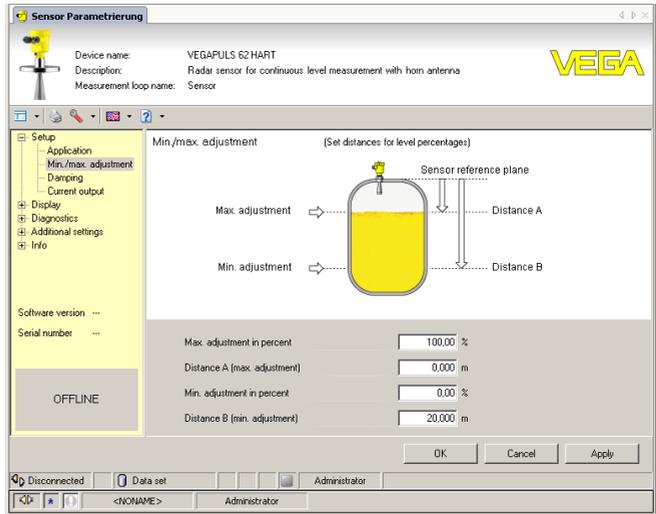
Fig. 35: Example of a DTM view

Standard/Full version

All device DTMs are available as a free-of-charge standard version and as a full version that must be purchased. In the standard version, all functions for complete setup are already included. An assistant for simple project configuration simplifies the adjustment considerably. Saving/printing the project as well as import/export functions are also part of the standard version.

In the full version there is also an extended print function for complete project documentation as well as a save function for measured value and echo curves. In addition, there is a tank calculation program as well as a multiviewer for display and analysis of the saved measured value and echo curves.

The standard version is available as a download under www.vega.com/downloads and "*Software*". The full version is available on CD from the agency serving you.

7.3   Set instrument address

The VEGAPULS 61 requires an address for participating as a Slave in the Modbus communication. The addess setting is carried out via a PC with PACTware/DTM or Modbus RTU.

The default settings for the address are:

- Modbus: 246
- Levelmaster: 31

Note:
The setting of the instrument address can only be carried out online.

Via PC through Modbus electronics

Start the project assistant and wait until the project tree has been set up. Then, in the project tree, go to the symbol for the Modbus gateway.

Select with the right mouse key "*Parameter*", then "*Online parameter adjustment*" and start the DTM for the Modbus electronics.

In the menu bar of the DTM, go to the list arrow next to the symbol for "*Screwdriver*". Select the menu item "*Change address in the instrument*" and set the requested address.

Via PC through RS 485 cable

In the device catalogue, select the option "*Modbus Serial*" under "*Driver*". Double click on this driver and integrate it into the project tree.

Open the device manager on your PC and find out which COM interface the USB/RS 485 adapter is located on. Then go to the symbol "*Modbus COM.*" in the project tree. Select "*Parameter*" with the right mouse key and start the DTM for the USB/RS 485 adapter. Enter the COM interface no. from the device manager under "*Basic settings*".

Select with the right mouse key "*Additional functions*" and "*Instrument search*". The DTM then searches for the connected Modbus participants and integrates them into the project tree. Now, in the project tree, go to the symbol for the Modbus gateway. Select with the right mouse key "*Parameter*", then "*Online parameter setting*" and start the DTM for the Modbus electronics.

In the menu bar of the DTM, go to the list arrow next to the symbol for "*Screwdriver*". Select the menu item "*Change address in the instrument*" and set the requested address.

Then move again to the symbol "*Modbus COM.*" in the project tree. Select with the right mouse key "*Additional functions*" and "*Change DTM addresses*". Enter here the modified address of the Modbus gateway.

Via Modbus-RTU

The instrument address is set in register no. 200 of the Holding Register (see chapter "*Modbus register* " in this operating instructions manual).

The procedure depends on the respective Modbus-RTU and the configuration tool.

7.4 Saving the parameterisation data

We recommend documenting or saving the parameterisation data via PACTware. That way the data are available for multiple use or service purposes.

8 Diagnosis, asset management and service

8.1 Maintenance

Maintenance

If the device is used properly, no special maintenance is required in normal operation.

Cleaning

The cleaning helps that the type label and markings on the instrument are visible.

Take note of the following:

- Use only cleaning agents which do not corrode the housings, type label and seals
- Use only cleaning methods corresponding to the housing protection rating

8.2 Measured value and event memory

The instrument has several memories available for diagnostic purposes. The data remain there even in case of voltage interruption.

Measured value memory

Up to 100,000 measured values can be stored in the sensor in a ring memory. Each entry contains date/time as well as the respective measured value. Storable values are for example:

- Distance
- Filling height
- Percentage value
- Lin. percent
- Scaled
- Current value
- Measurement reliability
- Electronics temperature

When the instrument is shipped, the measured value memory is active and stores distance, measurement reliability and electronics temperature every 3 minutes.

The requested values and recording conditions are set via a PC with PACTware/DTM or the control system with EDD. Data are thus read out and also reset.

Event memory

Up to 500 events are automatically stored with a time stamp in the sensor (non-deletable). Each entry contains date/time, event type, event description and value. Event types are for example:

- Modification of a parameter
- Switch-on and switch-off times
- Status messages (according to NE 107)
- Error messages (according to NE 107)

The data are read out via a PC with PACTware/DTM or the control system with EDD.

Echo curve memory

The echo curves are stored with date and time and the corresponding echo data. The memory is divided into two sections:

Echo curve of the setup: This is used as reference echo curve for the measurement conditions during setup. Changes in the measurement conditions during operation or buildup on the sensor can thus be recognized. The echo curve of the setup is stored via:

● PC with PACTware/DTM
● Control system with EDD
● Display and adjustment module

Further echo curves: Up to 10 echo curves can be stored in a ring buffer in this memory section. Additional echo curves are stored via:

● PC with PACTware/DTM
● Control system with EDD

8.3 Asset Management function

The instrument features self-monitoring and diagnostics according to NE 107 and VDI/VDE 2650. In addition to the status messages in the following tables, detailed error messages are available under menu item "*Diagnostics*" via the display and adjustment module, PACTware/DTM and EDD.

Status messages

The status messages are divided into the following categories:

● Failure
● Function check
● Out of specification
● Maintenance requirement
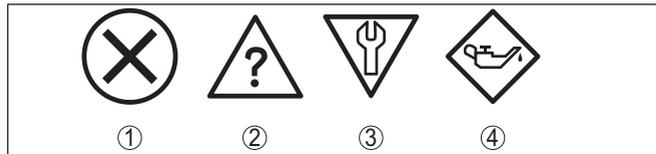
and explained by pictographs:

Fig. 36: Pictographs of the status messages

1 Failure - red
2 Out of specification - yellow
3 Function check - orange
4 Maintenance - blue

Failure: Due to a malfunction in the instrument, a fault message is output.

This status message is always active. It cannot be deactivated by the user.

Function check: The instrument is being worked on, the measured value is temporarily invalid (for example during simulation).

This status message is inactive by default. It can be activated by the user via PACTware/DTM or EDD.

Out of specification: The measured value is unreliable because an instrument specification was exceeded (e.g. electronics temperature).

This status message is inactive by default. It can be activated by the user via PACTware/DTM or EDD.

Maintenance: Due to external influences, the instrument function is limited. The measurement is affected, but the measured value is still valid. Plan in maintenance for the instrument because a failure is expected in the near future (e.g. due to buildup).

This status message is inactive by default. It can be activated by the user via PACTware/DTM or EDD.

Failure (failure)

Code Text message	Cause	Rectification	DevSpec Diagnosis Bits
F013 no measured value available	● Sensor does not detect an echo during operation ● Antenna system dirty or defective	● Check or correct installation and/or parameter settings ● Clean or exchange process component or antenna	Bit 0
F017 Adjustment span too small	● Adjustment not within specification	● Change adjustment according to the limit values (difference between min. and max. ≥ 10 mm)	Bit 1
F025 Error in the linearization table	● Index markers are not continuously rising, for example illogical value pairs	● Check linearisation table ● Delete table/Create new	Bit 2
F036 No operable software	● Failed or interrupted software update	● Repeat software update ● Check electronics version ● Exchanging the electronics ● Send instrument for repair	Bit 3
F040 Error in the electronics	● Hardware defect	● Exchanging the electronics ● Send instrument for repair	Bit 4
F080	● General software error	● Disconnect operating voltage briefly	Bit 5
F105 Determine measured value	● The instrument is still in the start phase, the measured value could not yet be determined	● Wait for the end of the switch-on phase ● Duration up to approx. 3 min. depending on the version and parameter settings	Bit 6
F113 Communication error	● Error in the internal instrument communication	● Disconnect operating voltage briefly ● Send instrument for repair	Bit 12
F125 Impermissible electronics temperature	● Temperature of the electronics in the non-specified range	● Check ambient temperature ● Insulate electronics ● Use instrument with higher temperature range	Bit 7
F260 Error in the calibration	● Error in the calibration carried out in the factory ● Error in the EEPROM	● Exchanging the electronics ● Send instrument for repair	Bit 8
F261 Error in the configuration	● Error during setup ● False signal suppression faulty ● Error when carrying out a reset	● Repeat setup ● Repeat reset	Bit 9

| Code | Cause | Rectification | DevSpec |
Text message			Diagnosis Bits
F264 Installation/Setup error	● Adjustment not within the vessel height/measuring range ● Max. measuring range of the instrument not sufficient	● Check or correct installation and/or parameter settings ● Use an instrument with bigger measuring range	Bit 10
F265 Measurement function disturbed	● Sensor no longer carries out a measurement ● Operating voltage too low	● Check operating voltage ● Carry out a reset ● Disconnect operating voltage briefly	Bit 11

Tab. 7: Error codes and text messages, information on causes as well as corrective measures

Function check

| Code | Cause | Rectification | DevSpec |
Text message			State in CMD 48
C700 Simulation active	● A simulation is active	● Finish simulation ● Wait for the automatic end after 60 mins.	"Simulation Active" in "Standardized Status 0"

Out of specification

| Code | Cause | Rectification | DevSpec |
Text message			State in CMD 48
S600 Impermissible electronics temperature	● Temperature of the electronics in the non-specified range	● Check ambient temperature ● Insulate electronics ● Use instrument with higher temperature range	Bit 5 of Byte 14 … 24
S601 Overfilling	● Danger of vessel overfilling	● Make sure that there is no further filling ● Check level in the vessel	Bit 6 of Byte 14 … 24

Tab. 9: Error codes and text messages, information on causes as well as corrective measures

Maintenance

| Code | Cause | Rectification | DevSpec |
Text message			State in CMD 48
M500 Error during the reset "delivery status"	● The data could not be restored during the reset to delivery status	● Repeat reset ● Load XML file with sensor data into the sensor	Bit 0 of Byte 14 … 24
M501 Error in the non-active linearisation table	● Hardware error EEPROM	● Exchanging the electronics ● Send instrument for repair	Bit 1 of Byte 14 … 24
M502 Error in the diagnostics memory	● Hardware error EEPROM	● Exchanging the electronics ● Send instrument for repair	Bit 2 of Byte 14 … 24

Code Text message	Cause	Rectification	DevSpec State in CMD 48
M503 Measurement reliability too low	● The echo/noise ratio is too small for reliable measurement	● Check installation and process conditions ● Clean the antenna ● Change polarisation direction ● Use instrument with higher sensitivity	Bit 3 of Byte 14 … 24
M504 Error at a device interface	● Hardware defect	● Check connections ● Exchanging the electronics ● Send instrument for repair	Bit 4 of Byte 14 … 24
M505 No echo available	● Level echo can no longer be detected	● Clean the antenna ● Use a more suitable antenna/sensor ● Remove possible false echoes ● Optimize sensor position and orientation	Bit 7 of Byte 14 … 24

Tab. 10: Error codes and text messages, information on causes as well as corrective measures

8.4 Rectify faults

Reaction when malfunction occurs

The operator of the system is responsible for taking suitable measures to rectify faults.

Procedure for fault rectification

The first measures are:
● Evaluation of fault messages via the adjustment device
● Checking the output signal
● Treatment of measurement errors

Further comprehensive diagnostics options are available with a PC with PACTware and the suitable DTM. In many cases, the reasons can be determined in this way and faults rectified.

Treatment of measurement errors with liquids

The below tables show typical examples of application-related measurement errors with liquids. The measurement errors are differentiated according to the following:
● Constant level
● Filling
● Emptying

The images in column "*Error pattern*" show the real level as a broken line and the level displayed by the sensor as a continuous line.
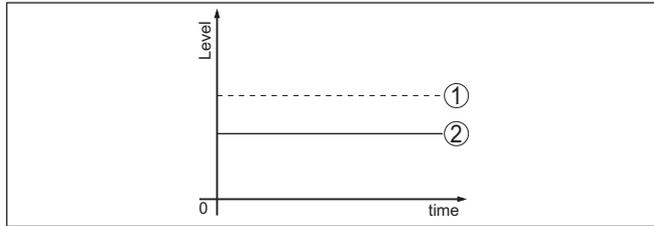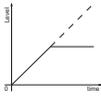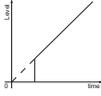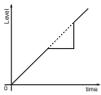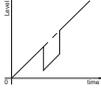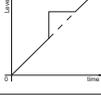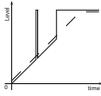
1 Real level
2 Level displayed by the sensor

Notes:
- Wherever the sensor displays a constant value, the reason could also be the fault setting of the current output to "*Hold value*"
- If the level indication is too low, the reason could be a line resistance that is too high

Measurement error with constant level

Fault description	Cause	Rectification
1. Measured value shows a too low or too high level	● Min./max. adjustment not correct	● Adapt min./max. adjustment
	● Incorrect linearisation curve	● Adapt linearisation curve
	● Installation in a bypass tube or standpipe, hence running time error (small measurement error close to 100 %/large error close to 0 %)	● Check parameter "Application" with respect to vessel form, adapt if necessary (bypass, standpipe, diameter)
2. Measured value jumps towards 0 %	● Multiple echo (vessel top, product surface) with amplitude higher than the level echo	● Check parameter "Application", especially vessel top, type of medium, dished bottom, high dielectric constant, and adapt if necessary
3. Measured value jumps towards 100 %	● Due to the process, the amplitude of the level echo sinks ● A false signal suppression was not carried out	● Carry out a false signal suppression
	● Amplitude or position of a false signal has changed (e.g. condensation, buildup); false signal suppression no longer matches actual conditions	● Determine the reason for the changed false signals, carry out false signal suppression, e.g. with condensation

Measurement error during filling

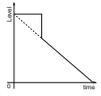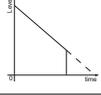| Fault description	Cause	Rectification
4. Measured value remains unchanged during filling	● False signals in the close range too big or level echo too small ● Strong foam or spout generation ● Max. adjustment not correct	● Eliminate false signals in the close range ● Check measurement situation: Antenna must protrude out of the socket, installations ● Remove contamination on the antenna ● In case of interferences due to installations in the close range: Change polarisation direction ● Create a new false signal suppression ● Adapt max. adjustment
5. Measured value remains in the bottom section during filling	● Echo from the tank bottom larger than the level echo, for example, with products with ε_r < 2.5 oil-based, solvents	● Check parameters Medium, Vessel height and Floor form, adapt if necessary
6. Measured value remains momentarily unchanged during filling and then jumps to the correct level	● Turbulence on the product surface, quick filling	● Check parameters, change if necessary, e.g. in dosing vessel, reactor
7. Measured value jumps towards 0 % during filling	● Amplitude of a multiple echo (vessel top - product surface) is larger than the level echo	● Check parameter "Application", especially vessel top, type of medium, dished bottom, high dielectric constant, and adapt if necessary
	● The level echo cannot be distinguished from the false signal at a false signal position (jumps to multiple echo)	● In case of interferences due to installations in the close range: Change polarisation direction ● Chose a more suitable installation position
8. Measured value jumps towards 100 % during filling	● Due to strong turbulence and foam generation during filling, the amplitude of the level echo sinks. Measured value jumps to false signal	● Carry out a false signal suppression
9. Measured value jumps sporadically to 100 % during filling	● Varying condensation or contamination on the antenna	● Carry out a false signal suppression or increase false signal suppression with condensation/contamination in the close range by editing

Fault description	Cause	Rectification
10. Measured value jumps to ≥ 100 % or 0 m distance	● Level echo is no longer detected in the close range due to foam generation or false signals in the close range. The sensor goes into overfill protection mode. The max. level (0 m distance) as well as the status message "Overfill protection" are output.	● Check measuring site: Antenna must protrude out of the socket ● Remove contamination on the antenna ● Use a sensor with a more suitable antenna
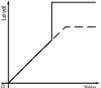
Measurement error during emptying

Fault description	Cause	Rectification
11. Measured value remains unchanged in the close range during emptying	● False signal larger than the level echo ● Level echo too small	● Eliminate false signal in the close range. Check: Antenna must protrude from the socket ● Remove contamination on the antenna ● In case of interferences due to installations in the close range: Change polarisation direction ● After eliminating the false signals, the false signal suppression must be deleted. Carry out a new false signal suppression
12. Measured value jumps towards 0 % during emptying	● Echo from the tank bottom larger than the level echo, for example, with products with ε_r < 2.5 oil-based, solvents	● Check parameters Medium type, Vessel height and Floor form, adapt if necessary
13. Measured value jumps sporadically towards 100 % during emptying	● Varying condensation or contamination on the antenna	● Carry out false signal suppression or increase false signal suppression in the close range by editing ● With bulk solids, use radar sensor with purging air connection
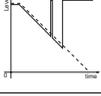
Reaction after fault rectification	Depending on the reason for the fault and the measures taken, the steps described in chapter "*Setup*" must be carried out again or must be checked for plausibility and completeness.
24 hour service hotline	Should these measures not be successful, please call in urgent cases the VEGA service hotline under the phone no. **+49 1805 858550**. The hotline is also available outside normal working hours, seven days a week around the clock. Since we offer this service worldwide, the support is provided in English. The service itself is free of charge, the only costs involved are the normal call charges.

8.5 Exchanging the electronics module

If the electronics module is defective, it can be replaced by the user.

In Ex applications, only instruments and electronics modules with appropriate Ex approval may be used.

If there is no electronics module available on site, the electronics module can be ordered through the agency serving you. The electronics modules are adapted to the respective sensor and differ in signal output or voltage supply.

The new electronics module must be loaded with the default settings of the sensor. These are the options:

● In the factory
● Or on site by the user

In both cases, the serial number of the sensor is needed. The serial numbers are stated on the type label of the instrument, on the inside of the housing as well as on the delivery note.

When loading on site, the order data must first be downloaded from the Internet (see operating instructions "*Electronics module*").

Caution:
All application-specific settings must be entered again. That's why you have to carry out a fresh setup after exchanging the electronics.

If you saved the parameter settings during the first setup of the sensor, you can transfer them to the replacement electronics module. A fresh setup is then not necessary.

8.6 Software update

The device software can be updated in the following ways:

● Interface adapter VEGACONNECT
● HART signal
● Bluetooth

Depending on the method, the following components are required:

● Instrument
● Voltage supply
● Interface adapter VEGACONNECT
● Display and adjustment module PLICSCOM with Bluetooth function
● PC with PACTware/DTM and Bluetooth USB adapter
● Current instrument software as file

You can find the current instrument software as well as detailed information on the procedure in the download area of our homepage: www.vega.com.

Caution:
Instruments with approvals can be bound to certain software versions. Therefore make sure that the approval is still effective after a software update is carried out.

You can find detailed information in the download area at www.vega.com.

8.7 How to proceed if a repair is necessary

You can find an instrument return form as well as detailed information about the procedure in the download area of our homepage: www.vega.com. By doing this you help us carry out the repair quickly and without having to call back for needed information.

In case of repair, proceed as follows:

● Print and fill out one form per instrument
● Clean the instrument and pack it damage-proof
● Attach the completed form and, if need be, also a safety data sheet outside on the packaging
● Ask the agency serving you to get the address for the return shipment. You can find the agency on our home page www.vega.com.

9   Dismount

9.1   Dismounting steps

⚠️ **Warning:**
Before dismounting, be aware of dangerous process conditions such as e.g. pressure in the vessel or pipeline, high temperatures, corrosive or toxic products etc.

Take note of chapters "*Mounting*" and "*Connecting to voltage supply*" and carry out the listed steps in reverse order.

9.2   Disposal

The instrument consists of materials which can be recycled by specialised recycling companies. We use recyclable materials and have designed the electronics to be easily separable.

WEEE directive
The instrument does not fall in the scope of the EU WEEE directive. Article 2 of this Directive exempts electrical and electronic equipment from this requirement if it is part of another instrument that does not fall in the scope of the Directive. These include stationary industrial plants.

Pass the instrument directly on to a specialised recycling company and do not use the municipal collecting points.

If you have no way to dispose of the old instrument properly, please contact us concerning return and disposal.

10 Supplement

10.1 Technical data

Note for approved instruments

The technical data in the respective safety instructions are valid for approved instruments (e.g. with Ex approval). These data can differ from the data listed herein - for example regarding the process conditions or the voltage supply.

General data	
316L corresponds to 1.4404 or 1.4435	
Materials, wetted parts	
Encapsulated antenna system	
– Process fitting	PVDF, 316L
– Process seal	FKM (IDG FKM 13-75)
– Antenna	PVDF
Plastic horn antenna	
– Adapter flange	PP-GF30 black
– Seal, adapter flange	FKM (COG VI500), EPDM (COG AP310)
– Focussing lense	PP
Rinsing connection	
– Flushing ring	PP-GFK
– O-ring seal, rinsing connection	FKM (SHS FPM 70C3 GLT), EPDM (COG AP310)
– Reflux valve	316 Ti
– Sealing, reflux valve	FKM (SHS FPM 70C3 GLT), EPDM (COG AP310)
Materials, non-wetted parts	
Mounting parts	
– Antenna cone with plastic horn antenna	PBT-GF 30
– Compression flange	PP-GF30 black
– Mounting strap	316L
– Fixing screws, mounting strap	316L
– Fixing screws, adapter flange	304
Housing	
– Plastic housing	Plastic PBT (Polyester)
– Aluminium die-cast housing	Aluminium die-casting AlSi10Mg, powder-coated (Basis: Polyester)
– Stainless steel housing	316L
– Cable gland	PA, stainless steel, brass
– Sealing, cable gland	NBR
– Blind plug, cable gland	PA
– Seal between housing and housing lid	Silicone SI 850 R, NBR silicone-free

| − Inspection window housing cover | Polycarbonate (UL-746-C listed), glass[2] |
| − Ground terminal | 316L |

Weight depending on process fitting and housing material   0.7 … 3.4 kg (1.543 … 7.496 lbs)

Torques

Max. torques, threaded version

| − G1½ | 7 Nm (5.163 lbf ft) |

Max. torques, version plastic horn antenna

− Mounting screws, mounting strap on sensor housing	4 Nm (2.950 lbf ft)
− Flange screws, compression flange DN 80	5 Nm (3.689 lbf ft)
− Terminal screws, adapter flange - antenna	2.5 Nm (1.844 lbf ft)
− Flange screws, adapter flange DN 100	7 Nm (5.163 lbf ft)

Max. torques for NPT cable glands and Conduit tubes

| − Plastic housing | 10 Nm (7.376 lbf ft) |
| − Aluminium/Stainless steel housing | 50 Nm (36.88 lbf ft) |

Input variable

Measured variable   The measured quantity is the distance between the end of the sensor antenna and the product surface. The reference plane for the measurement is the sealing surface on the hexagon or the lower side of the flange.
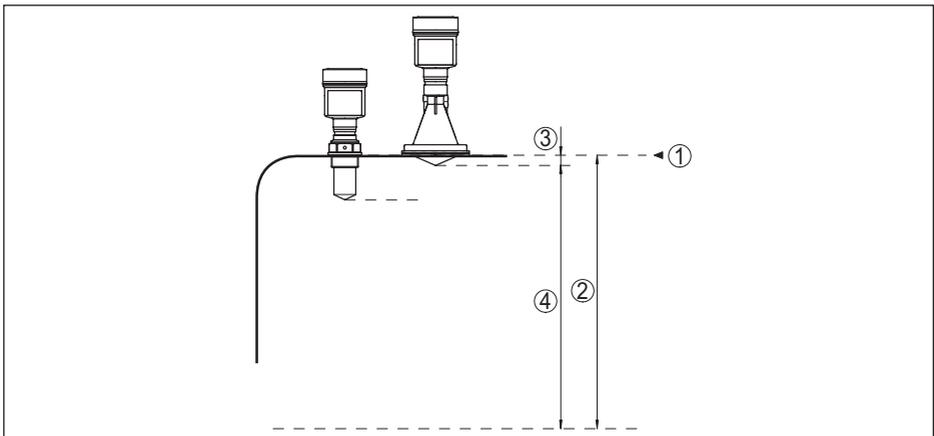
Fig. 51: Data of the input variable

1   Reference plane
2   Measured variable, max. measuring range
3   Antenna length
4   Utilisable measuring range

[2]   Glass with Aluminium and stainless steel precision casting housing

Standard electronics

Max. measuring range	35 m (114.8 ft)
Recommended measuring range	
– Encapsulated antenna system	up to 10 m (32.81 ft)
– Plastic horn antenna	up to 20 m (65.62 ft)

Electronics with increased sensitivity

Max. measuring range	35 m (114.8 ft)
Recommended measuring range	
– Encapsulated antenna system	up to 10 m (32.81 ft)
– Plastic horn antenna	up to 20 m (65.62 ft)

Output variable

Output	
– Physical layer	Digital output signal according to standard EIA-485
– Bus specifications	Modbus Application Protocol V1.1b3, Modbus over serial line V1.02
– Data protocols	Modbus RTU, Modbus ASCII, Levelmaster
Max. transmission rate	57.6 Kbit/s

Deviation (according to DIN EN 60770-1)

Process reference conditions according to DIN EN 61298-1	
– Temperature	+18 … +30 °C (+64 … +86 °F)
– Relative humidity	45 … 75 %
– Air pressure	860 … 1060 mbar/86 … 106 kPa (12.5 … 15.4 psig)
Installation reference conditions	
– Min. distance to internal installations	> 200 mm (7.874 in)
– Reflector	Flat plate reflector
– False reflections	Biggest false signal, 20 dB smaller than the useful signal
Deviation with liquids	≤ 2 mm (meas. distance > 0.5 m/1.6 ft)
Non-repeatability[3]	≤ 1 mm
Deviation with bulk solids	The values depend to a great extent on the application. Binding specifications are thus not possible.

---

[3] Already included in the meas. deviation

VEGAPULS 61 • Modbus and Levelmaster protocol
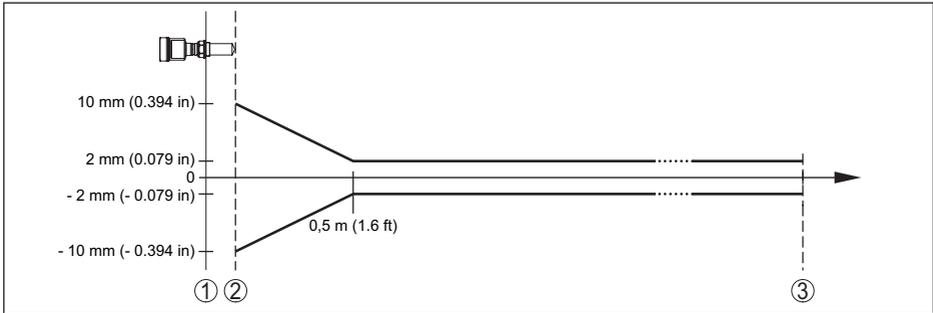
Fig. 52: Deviation under reference conditions - encapsulated antenna system

1   *Reference plane*
2   *Antenna edge*
3   *Recommended measuring range*
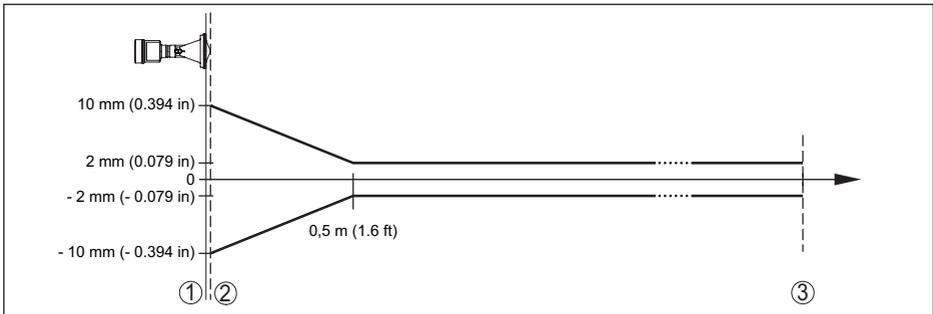
Fig. 53: Deviation under reference conditions - plastic horn antenna

1   *Reference plane*
2   *Antenna edge*
3   *Recommended measuring range*

Variables influencing measurement accuracy

Temperature drift - Digital output	< 3 mm/10 K, max. 10 mm
Additional deviation through electromagnetic interference acc. to EN 61326	< 50 mm

Characteristics and performance data

Measuring frequency	K-band (26 GHz technology)
Measuring cycle time	
− Standard electronics	approx. 450 ms
− Electronics with increased sensitivity	approx. 700 ms
Step response time[4]	≤ 3 s

---

[4]   Time span after a sudden measuring distance change by max. 0.5 m in liquid applications, max 2 m with bulk solids applications, until the output signal has taken for the first time 90 % of the final value (IEC 61298-2).

Beam angle[5]

- Ɫ Encapsulated antenna system | 22°
- Ɫ Plastic horn antenna | 10°

Emitted HF power (depending on the parameter setting)[6]

- Ɫ Average spectral transmission power density | -14 dBm/MHz EIRP
- Ɫ Max. spectral transmission power density | +43 dBm/50 MHz EIRP
- Ɫ Max. power density at a distance of 1 m | $< 1\ \mu W/cm^2$

Ambient conditions

| Ambient, storage and transport temperature | -40 … +80 °C (-40 … +176 °F) |

Process conditions

For the process conditions, please also note the specifications on the type label. The lower value always applies.

Vessel pressure

- Ɫ Encapsulated antenna system | -1 … 3 bar (-100 … 300 kPa/-14.5 … 43.5 psi)
- Ɫ Plastic horn antenna | -1 … 2 bar (-100 … 200 kPa/-14.5 … 29.0 psig)
- Ɫ Version with adapter flange from DN100 PP or PP-GF 30 | -1 … 1 bar (-100 … 100 kPa/-14.5 … 14.5 psig)

| Process temperature (measured on the process fitting) | -40 … +80 °C (-40 … +176 °F) |

Vibration resistance

- Ɫ With adapter flange | 2 g at 5 … 200 Hz according to EN 60068-2-6 (vibration with resonance)
- Ɫ with mounting strap | 1 g at 5 … 200 Hz according to EN 60068-2-6 (vibration with resonance)

| Shock resistance | 100 g, 6 ms according to EN 60068-2-27 (mechanical shock) |

Electromechanical data - version IP 66/IP 67

| Cable gland | M20 x 1.5 or ½ NPT |

Wire cross-section (spring-loaded terminals)

- Ɫ Massive wire, stranded wire | 0.2 … 2.5 mm² (AWG 24 … 14)
- Ɫ Stranded wire with end sleeve | 0.2 … 1.5 mm² (AWG 24 … 16)

Display and adjustment module

| Display element | Display with backlight |

Measured value indication

- Ɫ Number of digits | 5

---

[5] Outside the specified beam angle, the energy level of the radar signal is 50% (-3 dB) less.
[6] EIRP: Equivalent Isotropic Radiated Power.

VEGAPULS 61 • Modbus and Levelmaster protocol

Adjustment elements
- 4 keys   *[OK]*, *[->]*, *[+]*, *[ESC]*
- Switch   Bluetooth On/Off

Bluetooth interface
- Standard   Bluetooth smart
- Effective range   25 m (82.02 ft)

Protection rating
- unassembled   IP 20
- Mounted in the housing without lid   IP 40

Materials
- Housing   ABS
- Inspection window   Polyester foil

Functional safety   SIL non-reactive

Interface to the external display and adjustment unit

Data transmission   Digital (I^2C-Bus)

Connection cable   Four-wire

Sensor version	Configuration, connection cable			
	Cable length	Standard cable	Special cable	Screened
4 … 20 mA/HART	50 m	●	–	–
Profibus PA, Foundation Fieldbus	25 m	–	●	●

Integrated clock

Date format   Day.Month.Year

Time format   12 h/24 h

Time zone, factory setting   CET

Max. rate deviation   10.5 min/year

Additional output parameter - Electronics temperature

Range   -40 … +85 °C (-40 … +185 °F)

Resolution   < 0.1 K

Deviation   ±3 K

Output of the temperature values
- Indication   Via the display and adjustment module
- Analogue   Via the current output, the additional current output
- Digital   Via the digital output signal (depending on the electronics version)

Voltage supply

Operating voltage   8 … 30 V DC

Power consumption   < 500 mW

Reverse voltage protection	Integrated

Potential connections and electrical separating measures in the instrument

Electronics	Not non-floating
Reference voltage[7]	500 V AC
Conductive connection	Between ground terminal and metallic process fitting

Electrical protective measures

Housing material	Version	Protection acc. to IEC 60529	Protection acc. to NEMA
Plastic	Single chamber	IP 66/IP 67	Type 4X
	Double chamber	IP 66/IP 67	Type 4X
Aluminium	Single chamber	IP 66/IP 68 (0.2 bar) IP 68 (1 bar)	Type 6P -
	Double chamber	IP 66/IP 68 (0.2 bar) IP 68 (1 bar)	Type 6P -
Stainless steel (electro-polished)	Single chamber	IP 66/IP 68 (0.2 bar)	Type 6P
Stainless steel (precision casting)	Single chamber	IP 66/IP 68 (0.2 bar) IP 68 (1 bar)	Type 6P -
	Double chamber	IP 66/IP 68 (0.2 bar) IP 68 (1 bar)	Type 6P -

Connection of the feeding power supply unit	Networks of overvoltage category III

Altitude above sea level

– by default	up to 2000 m (6562 ft)
– with connected overvoltage protection	up to 5000 m (16404 ft)
Pollution degree (with fulfilled housing protection)	4
Protection rating (IEC 61010-1)	III

Approvals

Instruments with approvals can have different technical specifications depending on the version.

For that reason the associated approval documents of these instruments have to be carefully noted. They are part of the delivery or can be downloaded under www.vega.com, "*Instrument search (serial number)*" as well as in the download area.

10.2 Basics Modbus

Bus description

The Modbus protocol is a communication protocol for the communication between instruments. It is based on a Master/Slave or Client/Server architecture. By means of Modbus, a Master and several

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[7] Galvanic separation between electronics and metal housing parts

Slaves can be connected. Each bus participant has an unambiguous address and can send messages to the bus. This is initiated by the Master, the addressed Slave answers. For data transfer, the versions serial (EIA-485) as well as the mode RTU are available. In the RTU and ASCII mode interesting here, data will be transmitted in binary form. The telegram consists generally of the address, the function, the data as well as the transmission check.

Bus architecture

In the version Modbus RTU, up to 32 participants can be connected to the bus. The length of the twisted two-wire cable can be up to 1200 m. The bus must be terminated on both sides at the last bus participant with a terminating resistor of 120 Ohm. The resistor is already integrated in the VEGAPULS 61 and is activated/deactivated via a slide switch.
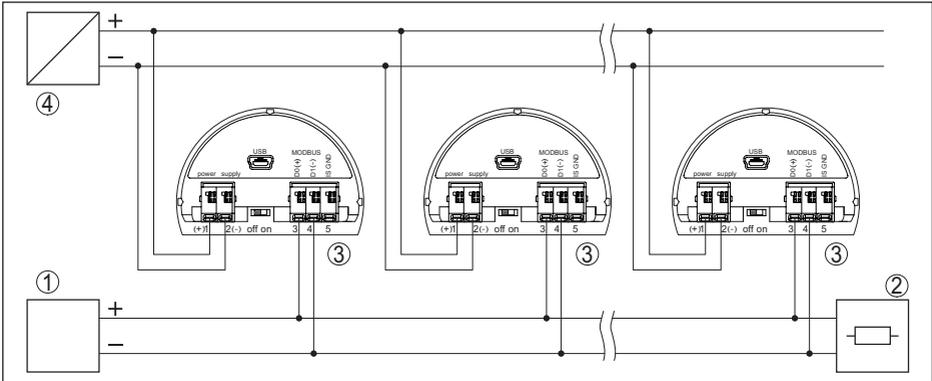

Fig. 54: Bus architecture Modbus

1   RTU
2   Connection resistor
3   Bus participant
4   Voltage supply

Protocol description

The VEGAPULS 61 is suitable for connection to the following RTUs with Modbus RTU or ASCII protocol.

RTU	Protocol
ABB Totalflow	Modbus RTU, ASCII
Bristol ControlWaveMicro	Modbus RTU, ASCII
Fisher ROC	Modbus RTU, ASCII
ScadaPack	Modbus RTU, ASCII
Thermo Electron Autopilot	Modbus RTU, ASCII

Parameters for the bus communication

The VEGAPULS 61 is preset with the default values:

Parameter	Configurable Values	Default Value
Baud Rate	1200, 2400, 4800, 9600, 19200	9600

Parameter	Configurable Values	Default Value
Start Bits	1	1
Data Bits	7, 8	8
Parity	None, Odd, Even	None
Stop Bits	1, 2	1
Address range Modbus	1 … 255	246

Start bits and data bits cannot be modified.

General configuration of the host

The data exchange with status and variables between field device and host is carried out via register. For this, a configuration in the host is required. Floating point numbers with short prevision (4 bytes) according to IEEE 754 are transmitted with individually selectable order of the data bytes (byte transmission order). This "*Byte transmission order*" is determined in the parameter "*Format Code*". Hence the RTU knows the registers of the VEGAPULS 61 which must be contacted for the variables and status information.

Format Code	Byte transmission order
0	ABCD
1	CDAB
2	DCBA
3	BADC

10.3 Modbus register

Holding Register

The Holding registers consist of 16 bit. They can be read and written. Before each command, the address (1 byte), after each command, a CRC (2 byte) is sent.

Register Name	Register Number	Type	Configurable Values	Default Value	Unit
Address	200	Word	1 … 255	246	–
Baud Rate	201	Word	1200, 2400, 4800, 9600, 19200, 38400, 57600	9600	–
Parity	202	Word	0 = None, 1 = Odd, 2 = Even	0	–
Stopbits	203	Word	1 = None, 2 = Two	1	–
Delay Time	206	Word	10 … 250	50	ms
Byte Oder (Floating point format)	3000	Word	0, 1, 2, 3	0	–

Input register

The input registers consist of 16 bits. They can only be read out. Before each command, the address (1 byte) is sent, after each command a CRC (2 bytes) is sent.

PV, SV, TV and QV can be adjusted via the sensor DTM.

Register Name	Register Number	Type	Note
Status	100	DWord	Bit 0: Invalid Measurement Value PV
			Bit 1: Invalid Measurement Value SV
			Bit 2: Invalid Measurement Value TV
			Bit 3: Invalid Measurement Value QV
PV Unit	104	DWord	Unit Code
PV	106		Primary Variable in Byte Order CDAB
SV Unit	108	DWord	Unit Code
SV	110		Secondary Variable in Byte Order CDAB
TV Unit	112	DWord	Unit Code
TV	114		Third Variable in Byte Order CDAB
QV Unit	116	DWord	Unit Code
QV	118		Quarternary Variable in Byte Order CDAB
Status	1300	DWord	See Register 100
PV	1302		Primary Variable in Byte Order of Register 3000
SV	1304		Secondary Variable in Byte Order of Register 3000
TV	1306		Third Variable in Byte Order of Register 3000
QV	1308		Quarternary Variable in Byte Order of Register 3000
Status	1400	DWord	See Register 100
PV	1402		Primary Variable in Byte Order CDAB
Status	1412	DWord	See Register 100
SV	1414		Secondary Variable in Byte Order CDAB
Status	1424	DWord	See Register 100
TV	1426		Third Variable in Byte Order CDAB
Status	1436	DWord	See Register 100
QV	1438		Quarternary Variable in Byte Order CDAB
Status	2000	DWord	See Register 100
PV	2002	DWord	Primary Variable in Byte Order ABCD (Big Endian)
SV	2004	DWord	Secondary Variable in Byte Order ABCD (Big Endian)
TV	2006	DWord	Third Variable in Byte Order ABCD (Big Endian)
QV	2008	DWord	Quarternary Variable in Byte Order ABCD (Big Endian)
Status	2100	DWord	See Register 100
PV	2102	DWord	Primary Variable in Byte Order DCBA (Little Endian)
SV	2104	DWord	Secondary Variable in Byte Order DCBA (Little Endian)

Register Name	Register Number	Type	Note
TV	2106	DWord	Third Variable in Byte Order ABCD DCBA (Little Endian)
QV	2108	DWord	Quarternary Variable in Byte Order DCBA (Little Endian)
Status	2200	DWord	See Register 100
PV	2202	DWord	Primary Variable in Byte Order BACD (Middle Endian)
SV	2204	DWord	Secondary Variable in Byte Order BACD (Middle Endian)
TV	2206	DWord	Third Variable in Byte Order BACD (Middle Endian)
QV	2208	DWord	Quarternary Variable in Byte Order BACD (Middle Endian)

Unit Codes for Register 104, 108, 112, 116

Unit Code	Measurement Unit
32	Degree Celsius
33	Degree Fahrenheit
40	US Gallon
41	Liters
42	Imperial Gallons
43	Cubic Meters
44	Feet
45	Meters
46	Barrels
47	Inches
48	Centimeters
49	Millimeters
111	Cubic Yards
112	Cubic Feet
113	Cubic Inches

10.4   Modbus RTU commands

FC3 Read Holding Register

With this command, any number (1-127) of holding registers can be read out. The start register, from which the readout should start, and the number of registers are transmitted.

	Parameter	Length	Code/Data
Request:	Function Code	1 Byte	0x03
	Start Address	2 Bytes	0x0000 to 0xFFFF
	Number of Registers	2 Bytes	1 to 127 (0x7D)

	Parameter	Length	Code/Data
Response:	Function Code	1 Byte	0x03
	Start Address	2 Bytes	2*N
	Register Value	N*2 Bytes	Data

FC4 Read Input Register

With this command, any number (1-127) of input registers can be read out. The start register, from which the readout should start, and the number of registers are transmitted.

	Parameter	Length	Code/Data
Request:	Function Code	1 Byte	0x04
	Start Address	2 Bytes	0x0000 to 0xFFFF
	Number of Registers	N*2 Bytes	1 to 127 (0x7D)
Response:	Function Code	1 Byte	0x04
	Start Address	2 Bytes	2*N
	Register Value	N*2 Bytes	Data

FC6 Write Single Register

With this function code an individual holding register can be written.

	Parameter	Length	Code/Data
Request:	Function Code	1 Byte	0x06
	Start Address	2 Bytes	0x0000 to 0xFFFF
	Number of Registers	2 Bytes	Data
Response:	Function Code	1 Byte	0x04
	Start Address	2 Bytes	2*N
	Register Value	2 Bytes	Data

FC8 Diagnostics

With this function code different diagnostic functions can be triggered or diagnostic values read out.

	Parameter	Length	Code/Data
Request:	Function Code	1 Byte	0x08
	Sub Function Code	2 Bytes	
	Data	N*2 Bytes	Data
Response:	Function Code	1 Byte	0x08
	Sub Function Code	2 Bytes	
	Data	N*2 Bytes	Data

Implemented function codes:

Sub Function Code	Name
0x00	Return Data Request
0x0B	Return Message Counter

With sub function codes 0x00 only one 16 bit value can be written.

FC16 Write Multiple Register

With this function code, several holding registers can be writen. Only registers can be written in an enquiry which are immediately consecutive. If there are gaps (registers do not exist) between the registers, then they cannot be written in a telegram.

	Parameter	Length	Code/Data
Request:	Function Code	1 Byte	0x10
	Start Address	2 Bytes	0x0000 to 0xFFFF
	Register Value	2 Bytes	0x0001 to 0x007B
	Byte Number	1 Byte	2*N
	Register Value	N*2 Bytes	Data
Response:	Function Code	1 Byte	0x10
	Sub Function Code	2 Bytes	0x0000 to 0xFFFF
	Data	2 Bytes	0x01 to 0x7B

FC17 Report Slave ID

With this function code, the Slave ID can be queried.

Request:

	Parameter	Length	Code/Data
Request:	Function Code	1 Byte	0x11
Response:	Function Code	1 Byte	0x11
	Byte Number	1 Byte	
	Slave ID	1 Byte	
	Run Indicator Status	1 Byte	

FC43 Sub 14, Read Device Identification

With this function code, the Device Identification can be queried.

	Parameter	Length	Code/Data
Request:	Function Code	1 Byte	0x2B
	MEI Type	1 Byte	0x0E
	Read Device ID Code	1 Byte	0x01 to 0x04
	Object ID	1 Byte	0x00 to 0xFF

	Parameter	Length	Code/Data
Response:	Function Code	1 Byte	0x2B
	MEI Type	1 Byte	0x0E
	Read Device ID Code	1 Byte	0x01 to 0x04
	Confirmity Level	1 Byte	0x01, 0x02, 0x03, 0x81, 0x82, 0x83
	More follows	1 Byte	00/FF
	Next Object ID	1 Byte	Object ID number
	Number of Objects	1 Byte	
	List of Object ID	1 Byte	
	List of Object length	1 Byte	
	List of Object value	1 Byte	Depending on the Object ID

10.5 Levelmaster commands

The VEGAPULS 61 is also suitable for connection to the following RTUs with Levelmaster protocol. The Levelmaster protocol is often called "*Siemens*" "*Tank protocol*".

RTU	Protocol
ABB Totalflow	Levelmaster
Kimray DACC 2000/3000	Levelmaster
Thermo Electron Autopilot	Levelmaster

Parameters for the bus communication

The VEGAPULS 61 is preset with the default values:

Parameter	Configurable Values	Default Value
Baud Rate	1200, 2400, 4800, 9600, 19200	9600
Start Bits	1	1
Data Bits	7, 8	8
Parity	None, Odd, Even	None
Stop Bits	1, 2	1
Address range Levelmaster	32	32

The Levelmaster commands are based on the following syntax:

- Capital letters are at the beginning of certain data fields
- Small letters stand for data fields
- All commands are terminated with "<*cr*>" (carriage return)
- All commands start with "*Uuu*", whereby "*uu*" stands for the address (00-31)
- " *** " can be used as a joker for any position in the address. The sensor always converts this in its address. In case of more than one sensor, the joker must not be used, because otherwise several slaves will answer
- Commands that modify the instrument return the command with "*OK*". "*EE-ERROR*" replaces "*OK*" if there was a problem changing the configuration

Report Level (and Temperature)

	Parameter	Length	Code/Data
Request:	Report Level (and Temperature)	4 characters ASCII	Uuu?
Response:	Report Level (and Temperature)	24 characters ASCII	UuuDlll.llFtttEeeeeWwwww uu = Address lll.ll = PV in inches ttt = Temperature in Fahrenheit eeee = Error number (0 no error, 1 level data not readable) wwww = Warning number (0 no warning)

PV in inches will be repeated if "*Set number of floats*" is set to 2. Hence 2 measured values can be transmitted. PV value is transmitted as first measured value, SV as seconed measured value.

Information:
The max. value for the PV to be transmitted is 999.99 inches (corresponds to approx. 25.4 m).

If the temperature should be transmitted in the Levelmaster protocol, then TV must be set in the sensor to temperature.

PV, SV and TV can be adjusted via the sensor DTM.

Report Unit Number

	Parameter	Length	Code/Data
Request:	Report Unit Number	5 characters ASCII	U**N?
Response:	Report Level (and Temperature)	6 characters ASCII	UuuNnn

Assign Unit Number

	Parameter	Length	Code/Data
Request:	Assign Unit Number	6 characters ASCII	UuuNnn
Response:	Assign Unit Number	6 characters ASCII	UuuNOK uu = new Address

Set number of Floats

	Parameter	Length	Code/Data
Request:	Set number of Floats	5 characters ASCII	UuuFn
Response:	Set number of Floats	6 characters ASCII	UuuFOK

If the number is set to 0, no level is returned

Set Baud Rate

	Parameter	Length	Code/Data
Request:	Set Baud Rate	8 (12) characters ASCII	UuuBbbbb[b][pds] Bbbbb[b] = 1200, 9600 (default) pds = parity, data length, stop bit (optional) parity: none = 81, even = 71 (default), odd = 71
Response:	Set Baud Rate	11 characters ASCII	

Example: U01B9600E71

Change instrument on address 1 to baudrate 9600, parity even, 7 data bits, 1 stop bit

Set Receive to Transmit Delay

	Parameter	Length	Code/Data
Request:	Set Receive to Transmit Delay	7 characters ASCII	UuuRmmm mmm = milliseconds (50 up to 250), default = 127 ms
Response:	Set Receive to Transmit Delay	6 characters ASCII	UuuROK

Report Number of Floats

	Parameter	Length	Code/Data
Request:	Set Receive to Transmit Delay	4 characters ASCII	UuuF
Response:	Set Receive to Transmit Delay	5 characters ASCII	UuuFn n = number of measurement values (0, 1 or 2)

Report Receive to Transmit Delay

	Parameter	Length	Code/Data
Request:	Report Receive to Transmit Delay	4 characters ASCII	UuuR
Response:	Report Receive to Transmit Delay	7 characters ASCII	UuuRmmm mmm = milliseconds (50 up to 250), default = 127 ms

Error codes

Error Code	Name
EE-Error	Error While Storing Data in EEPROM
FR-Error	Erorr in Frame (too short, too long, wrong data)
LV-Error	Value out of limits

VEGA

10.6 Configuration of typical Modbus hosts

Fisher ROC 809
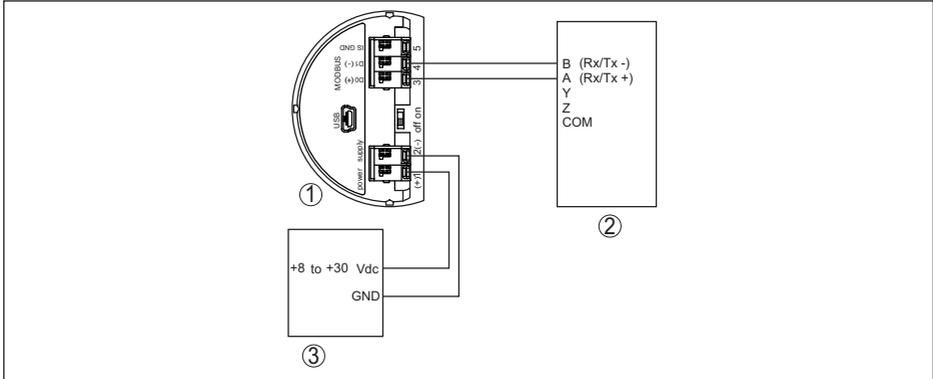
Fig. 55: Connection of VEGAPULS 61 to RTU Fisher ROC 809

1   *VEGAPULS 61*
2   *RTU Fisher ROC 809*
3   *Voltage supply*

ABB Total Flow
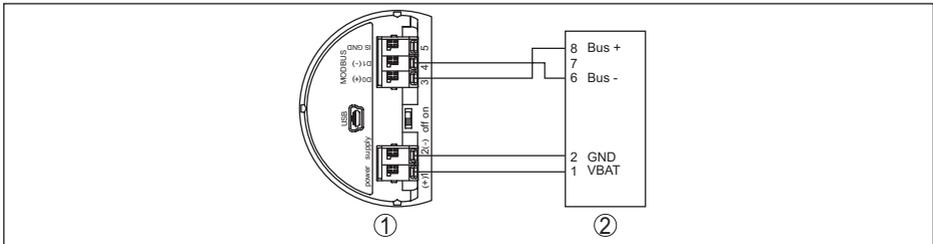
Fig. 56: Connection of VEGAPULS 61 to RTU ABB Total Flow

1   *VEGAPULS 61*
2   *RTU ABB Total Flow*

Thermo Electron Autopilot
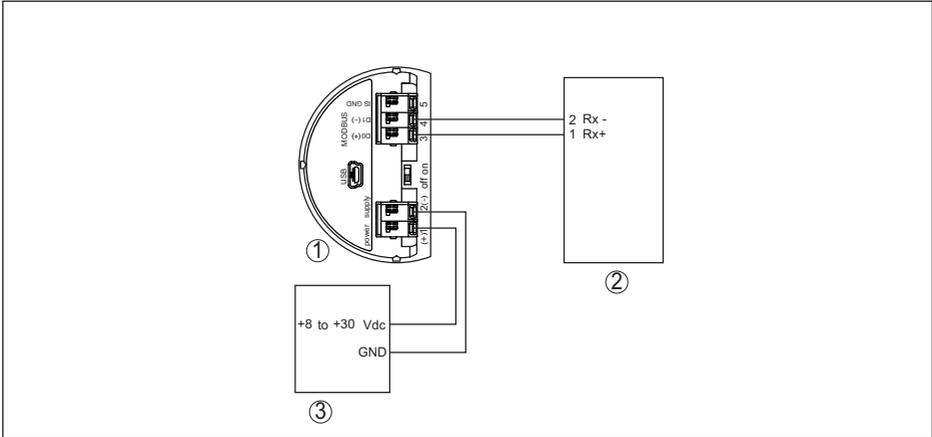
Fig. 57: Connection of VEGAPULS 61 to RTU Thermo Electron Autopilot

1   VEGAPULS 61
2   RTU Thermo Electron Autopilot
3   Voltage supply

Bristol ControlWave Micro
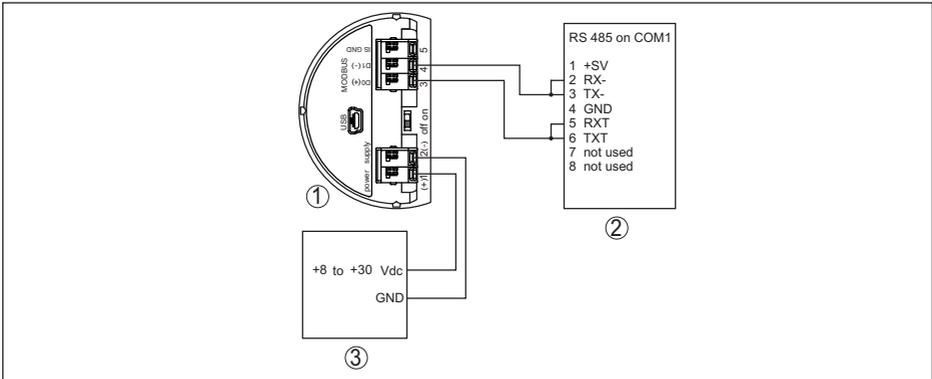
Fig. 58: Connection of VEGAPULS 61 to RTU Bristol ControlWave Micro

1   VEGAPULS 61
2   RTU Bristol ControlWave Micro
3   Voltage supply

ScadaPack
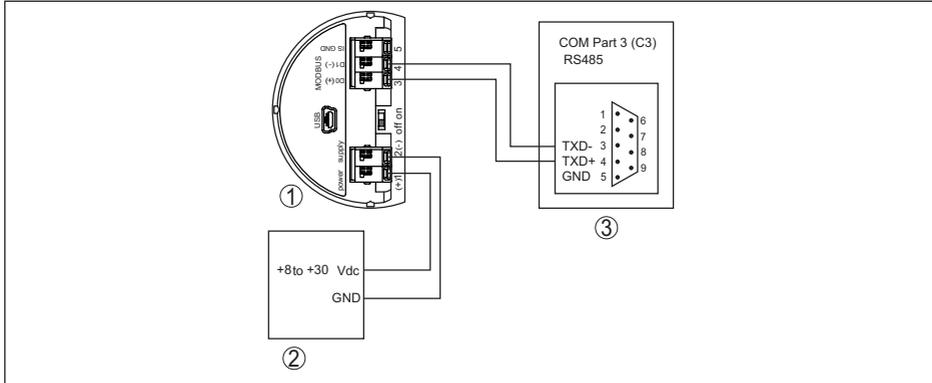
Fig. 59: Connection of VEGAPULS 61 to RTU ScadaPack

1   VEGAPULS 61
2   RTU ScadaPack
3   Voltage supply

Parameter

Parameter	Value Fisher ROC 809	Value ABB Total Flow	Value Fisher Thermo Elec-tron Autopilot	Value Fisher Bristol Control-Wave Micro	Value Scada-Pack
Baud Rate	9600	9600	9600	9600	9600
Floating Point Format Code	0	0	0	2 (FC4)	0
RTU Data Type	Conversion Code 66	16 Bit Modicon	IEE Fit 2R	32-bit registers as 2 16-bit reg-isters	Floating Point
Input Register Base Number	0	1	0	1	30001

The basic number of the input registers is always added to the input register address of VEGAPULS 61.

This results in the following constellations:

- Fisher ROC 809 - Register address for 1300 is address 1300
- ABB Total Flow - Register address for 1302 is address 1303
- Thermo Electron Autopilot - Register address for 1300 is address 1300
- Bristol ControlWave Micro - Register address for 1302 is address 1303
- ScadaPack - Register address for 1302 is address 31303

10.7   Dimensions

The following dimensional drawings represent only an extract of all possible versions. Detailed dimensional drawings can be downloaded at www.vega.com/downloads under "*Drawings*".

Housing
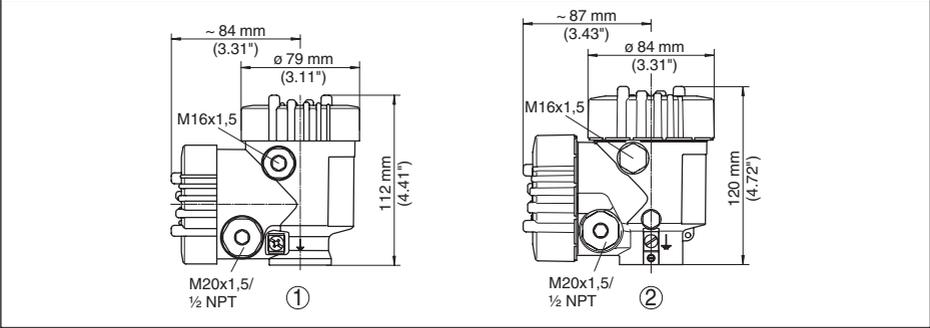
Fig. 60: Dimensions housing (with integrated display and adjustment module the housing is 9 mm/0.35 in higher, with metal housings 18 mm/0.71 in)

1   Plastic double chamber
2   Aluminium/Stainless steel double chamber

VEGAPULS 61, threaded version
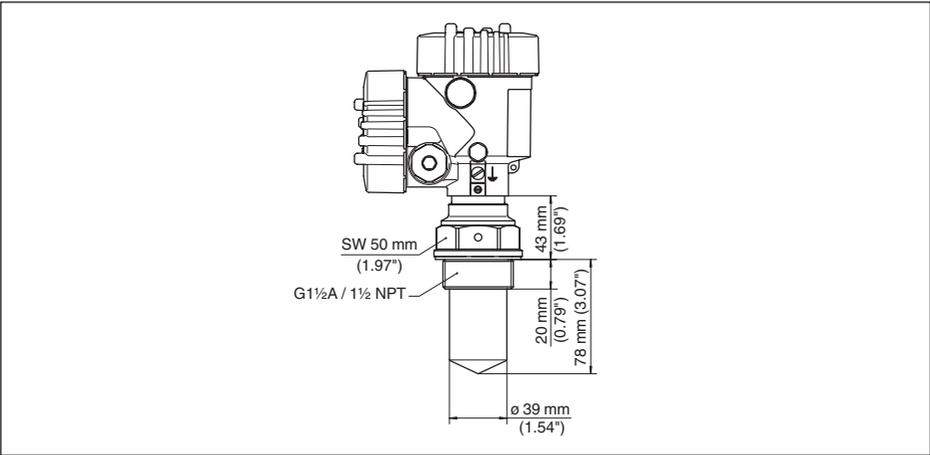
Fig. 61: VEGAPULS 61, Thread G1½, 1½ NPT

VEGAPULS 61, hygienic fitting
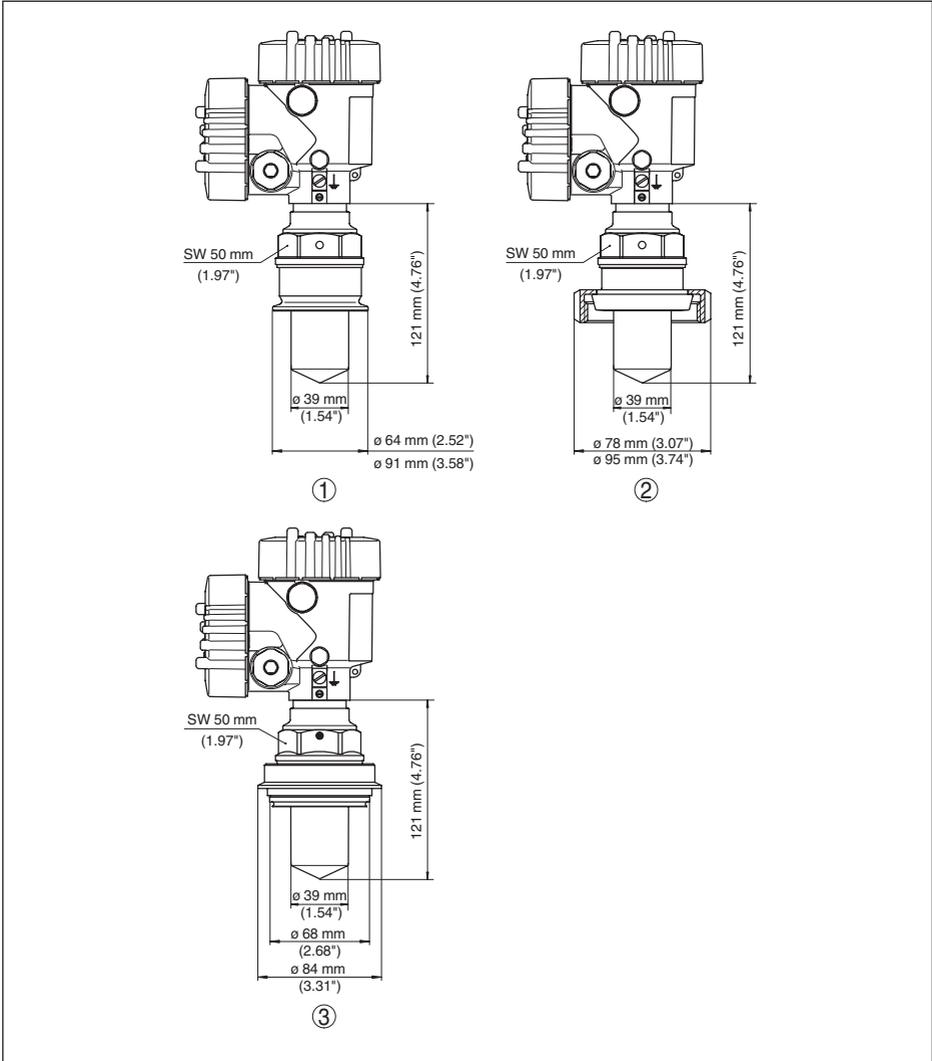
Fig. 62: VEGAPULS 61, hygienic fitting

1   *Clamp 2" PN 16 (ø 64 mm), 3" PN 16 (ø 91 mm), (DIN 32676, ISO 2852)*
2   *Slotted nut DN 50 PN 80 (DIN 11851)*
3   *Tuchenhagen Varivent DN 32*

VEGAPULS 61 • Modbus and Levelmaster protocol

VEGAPULS 61, version with mounting strap
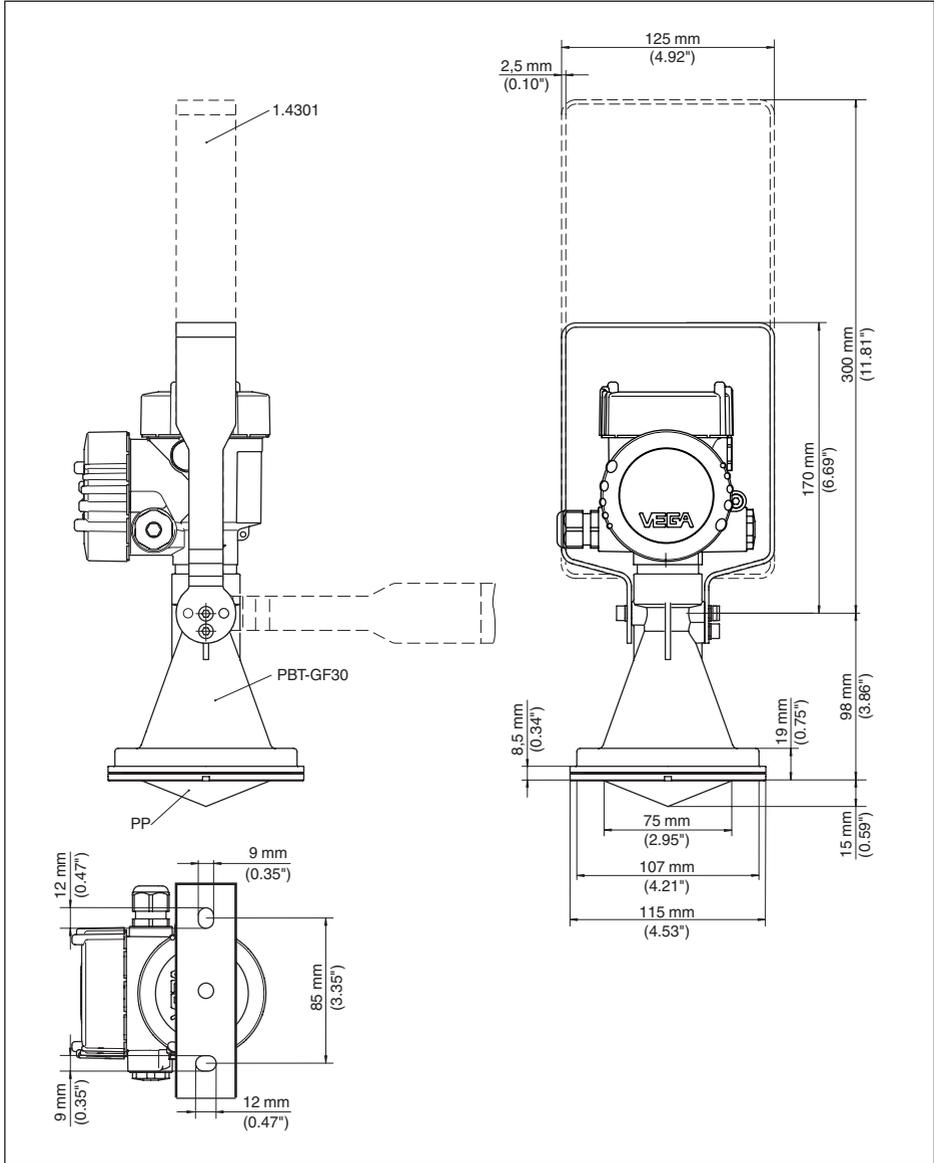
Fig. 63: VEGAPULS 61, mounting strap in 170 or 300 mm length

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VEGAPULS 61, version with mounting strap and clamp
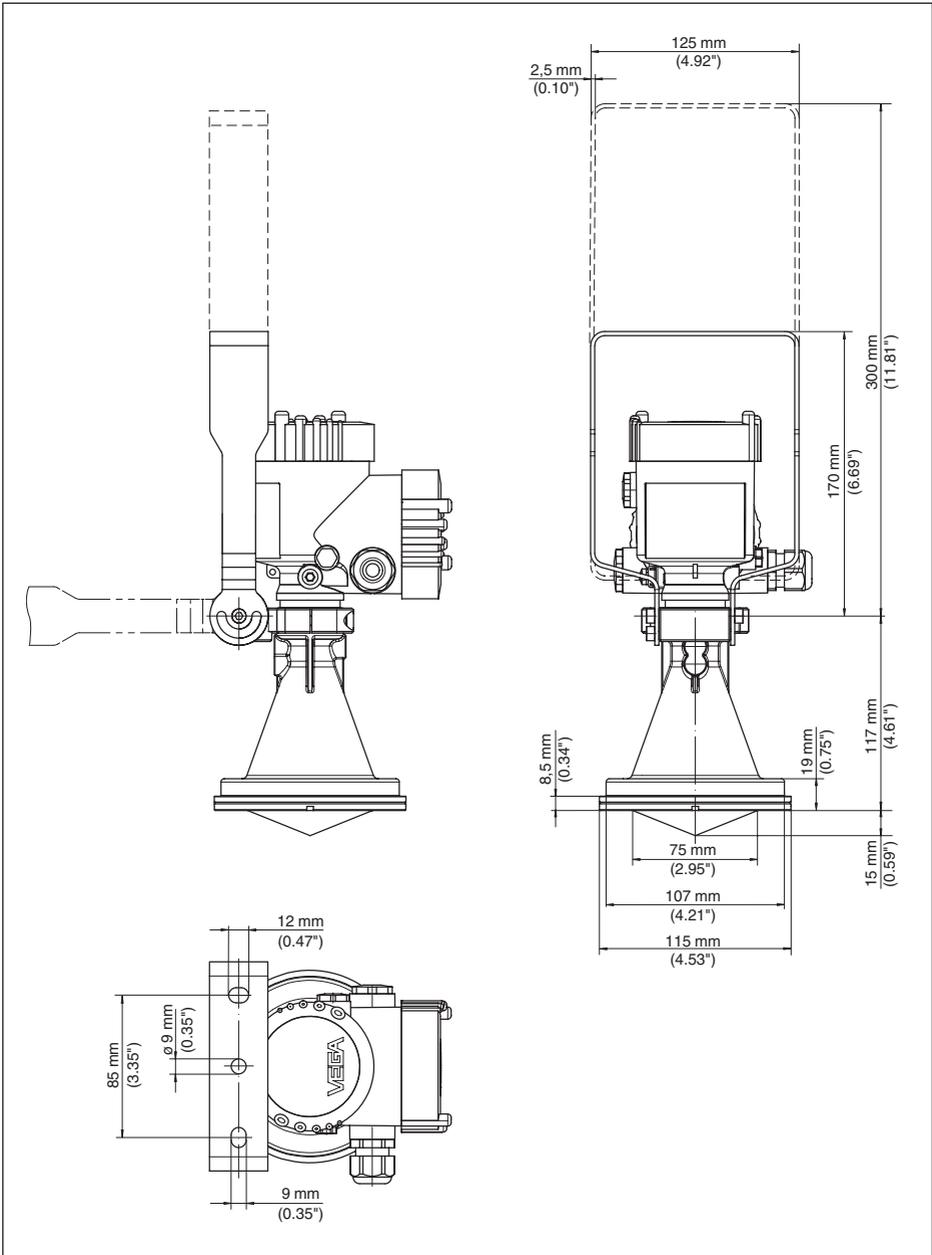
Fig. 64: VEGAPULS 61, mounting strap in 170 or 300 mm length

VEGAPULS 61 • Modbus and Levelmaster protocol

VEGAPULS 61, version with compression flange
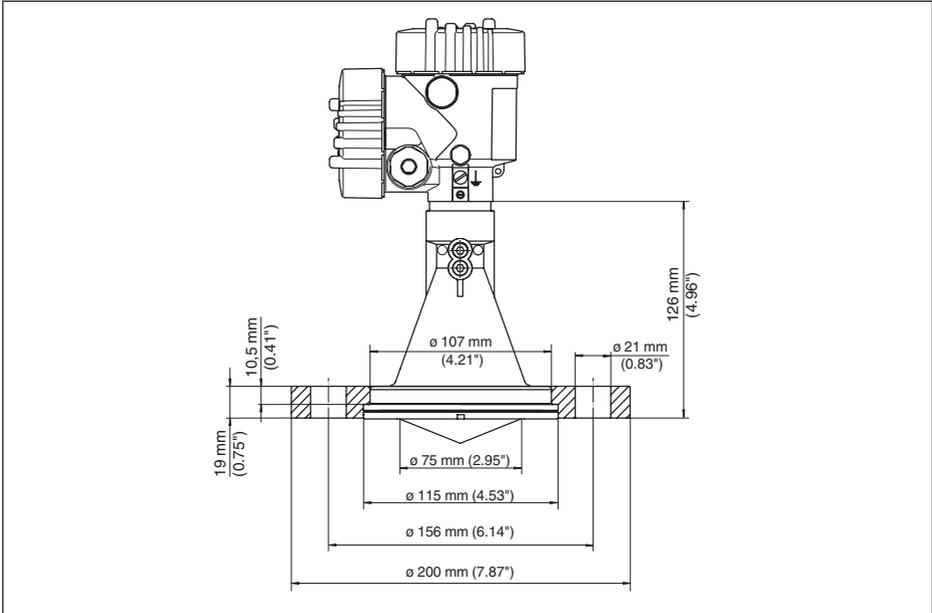
Fig. 65: VEGAPULS 61, compression flange suitable for DN 80 PN 16, ASME 3" 150lbs, JIS80 10K

VEGAPULS 61, version with compression flange and rinsing connection
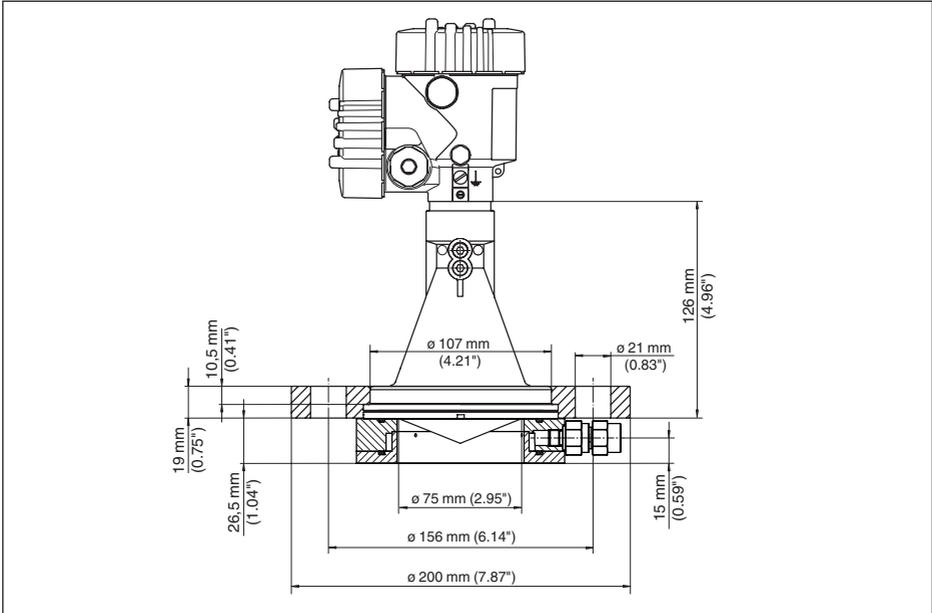
Fig. 66: VEGAPULS 61, compression flange with rinsing connection suitable for DN 80 PN 16, ASME 3" 150lbs, JIS80 10K

VEGAPULS 61, version with adapter flange
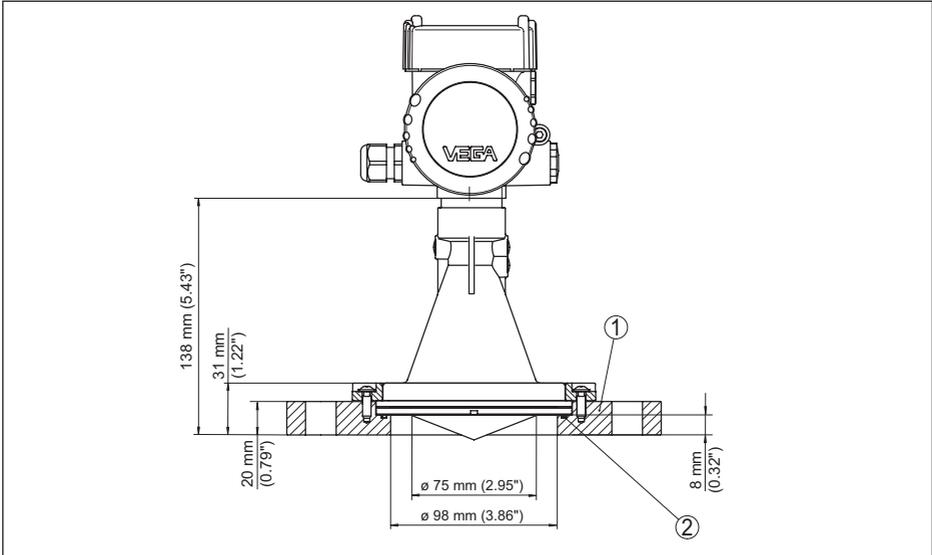
Fig. 67: VEGAPULS 61, adapter flange

1   Adapter flange
2   Seal

VEGAPULS 61, version with adapter flange and rinsing connection
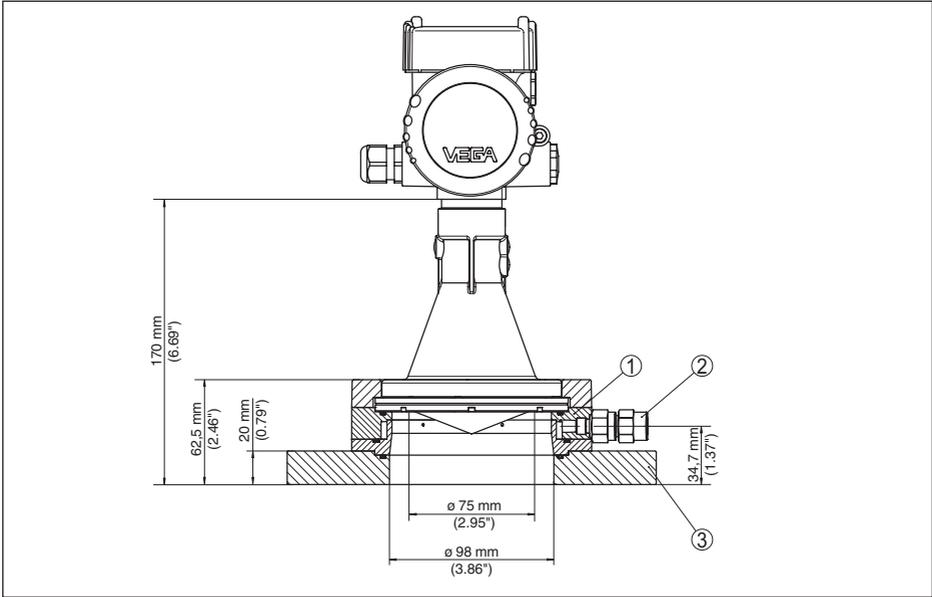
Fig. 68: VEGAPULS 61, adapter flange

1   *Rinsing connection*
2   *Reflux valve*
3   *Adapter flange*

10.8 Industrial property rights

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