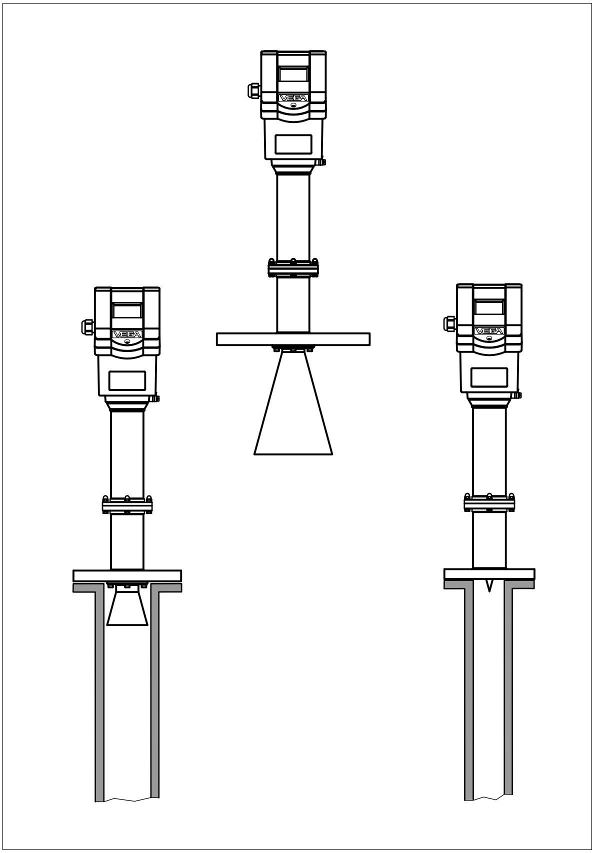
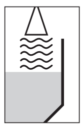
Level and Pressure

Operating Instruction

VEGAPULS 56K





Contents

Safety information

The described module must only be installed and operated as described in this operating instruction. Please note that other action can cause damage for which VEGA does not take responsibility.

Note Ex-area

Please note the attached approval documents (yellow binder) and especially the included safety data sheet.

1 Product description

Level measurement on high temperature processes or on mediums with high temperatures was formerly very difficult or even impossible. If in addition the measurement should be made under high pressure, up to now there was no measuring system available. Apart from a non-contact measurement with good measuring accuracy.

In distillation and stripper columns, up to now levels (e.g. of sump, plate and head products) could generally only be measured by pressure sensors or differential pressure measurements. The installation required for such pressure measuring system (pressure lines, pressure transmitters …) is considerable and expensive often amounting to several times the value of the sensor itself. Due to missing of suitable alternatives, instrumentation departments have not only to arrange with this fact but also with high maintenance costs (cleaning of measuring pipes, errors by condensation, build-up on the diaphragm…) and often had to accept inadequate accuracy (temperature errors, density fluctuations, installation faults …).

The requirements of the petrochemical industry for a non-contact level sensor are the following:

- independent of temperature and pressure
- process temperature up to 350°C
- process pressure up to 64 bar
- high-resistance wetted parts for universal use
- accuracy 0,1 %
- rugged metal housing
- Ex-approved (available in EEx d and EEx ia)
- Loop-powered as well as digitally connectable

This initial position defines the development aims for a high-temperature radar level measuring system of VEGAPULS 56 series. A special new development of high-temperature radar sensors for level measurement in temperatures up to 350°C and pressures up to 64 bar.

Sensors which would not have been possible without the new results in the material and production technology. An especially developed ceramics is used as coupling material. This ceramic is chemically and thermically very high resistant.

The sensor materials in contact with the process are all highly resistant. This refers not so much to the flange material of high-alloy stainless steel (1.4571 or superior), as to the specially developed ceramic (Al_2O_3) and its gland. The ceramic rod receives from the high frequency module (from the intelligent Fuzzy-Logic-processing electronics) the radar signals and the cone-shaped end works as emitter and receiver. The seal bet-ween stainless steel flange and ceramic rod is made with a Tantalum seal ring.

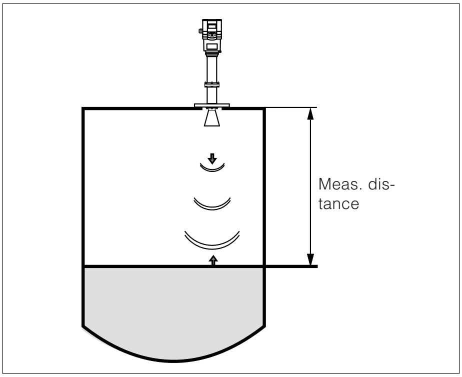
1.1 Function

Radio **d**etecting **a**nd **r**anging: Radar. VEGAPULS radar sensors are used for non-contact and continuous distance measurement. The measured distance corresponds to a filling height and is provided as level.

Measuring principle:

emission – reflection – receipt
Smallest 5,8 GHz radar signals are emitted from the antenna of the radar sensor as short pulses. The radar impulses reflected by the sensor environment and the product are received by the antenna as radar echoes. The running period of the radar impulses from emission to receipt is proportional to the distance and hence to the level.

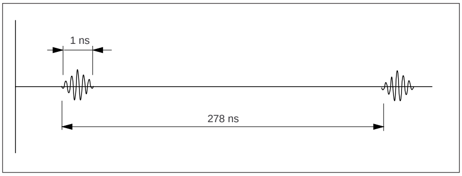
The radar impulses are emitted by the antenna



emission - reflection - receipt

system as impulse packets with a pulse duration of 1 ns and pulse breaks of 278 ns; this corresponds to a pulse package frequency of 3,6 MHz. In the impulse breaks the antenna system operates as receiver. Signal running periods of less than one millionth of a second must be processed and the echo pictures must be evaluated in a fraction of a second.

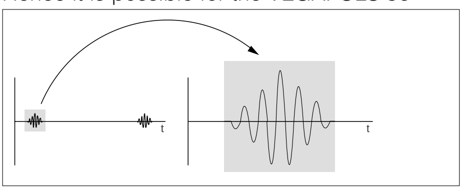
VEGAPULS radar sensors can reach this in a



Pulse sequence

special procedure of time transformation which spreads more than 3,6 million echo pictures per second in a slow-motion picture, then freezes and processes them.

Hence it is possible for the VEGAPULS 56



Time transformation

radar sensors to process the slow-motion pictures of the sensor environment precisely and in detail in cycles of 0,5 up to 1 second without using very time consuming frequency analysis (e.g. FMCW) necessary for other radar principles.

Virtually all products can be measured

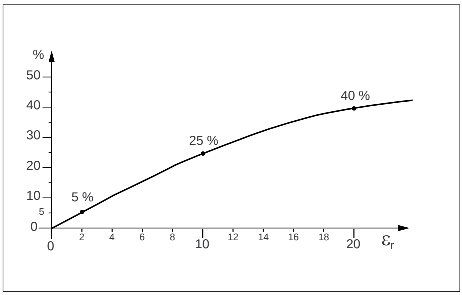
Radar signals physically react similar to visible light. According to the quantum theory they penetrate empty space. Hence they are not bound such as e.g. sound to a conductive product (air) and spread like with light velocity. The radar signals react to two electrical primary quantities:

- the electrical conductivity of a substance.
- the dielectric constant of a substance.

All products which are electrically conductive reflect radar signals very well. Even only slightly conductive products ensure a sufficient signal reflection for a reliable measurement.

All products with a dielectric constant ε_r of more than 2,0 reflect radar impulses sufficiently (note: air has a dielectric constant figure ε_r of 1).

The signal reflection increases with the con-



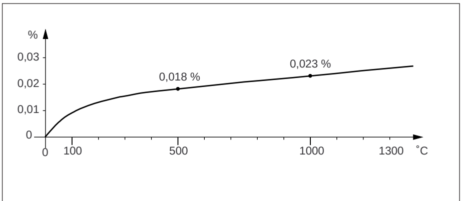
Reflected radar power dependent on the dielectric constant figure of the measured product ductivity or with the dielectric constant of the medium. Hence virtually all mediums can be measured.

Due to standard flanges from DN 50 to DN 250, ANSI 2“ to ANSI 10“ the sensor antenna systems are adapted to the various measured products and process environments. High-quality materials withstand also extremely chemical and physical conditions. The sensors deliver reliably, precise and longterm stable, reproducible analogue or digital level signals.

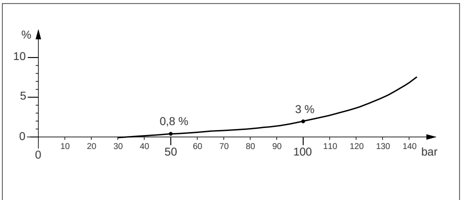
Continuous and reliably

Unaffected by temperature, pressure and atmosphere type, VEGAPULS radar sensors detect quickly and precise levels of different mediums.

VEGAPULS 56 enable level measurements



Temperature influence:
Temperature error absolutely zero (e.g. at 500°C 0,018 %)



Pressure influence:
Error with pressure increase very low (e.g. at 50 bar 0,8 %)

where radar sensors could not be used before.

1.2 Application features

Applications
- level measurement of liquids and solids
- measurement also in vacuum
- all slightly conductive materials and substances with a dielectric constant ε_r > 2,0 can be measured
- measuring ranges 0 … 20 m

Two-wire technology
- supply and output signal on one two-wire line
- 4 … 20 mA-output signal or digital output signal

Rugged and abrasion proof
- non-contact
- high resistance materials

Exact and reliable
- resolution 1 mm
- unaffected by noise, vapours, dusts, gas compositions and inert gas layering
- unaffected by varying density and temperature of the medium
- measurement with pressures up to 64 bar and medium temperatures up to 350°C

Communicative
- individually connectable, with 15 sensors on one two-wire line (digital output signal)
- integral measured value indication
- optionally indication separated from the sensor
- connection to all BUS-systems: Interbus S, Modbus, Siemens 3964R, Profibus DP, Profibus FMS, ASCII
- adjustment from the DCS-stage

Ex-approvals
- CENELEC, FM, CSA, ABS, LRS, GL, LR, ATEX, PTB

1.3 Adjustment

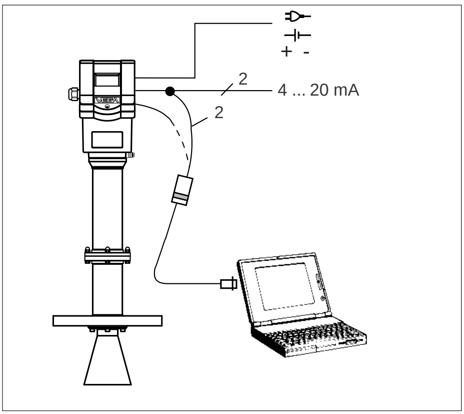
Each measuring distance is different, hence each radar sensor must be given some basic information on the application and the environment.

The adjustment and parameter adjustment of the radar sensors are carried out with
- the PC
- the detachable adjustment module MINICOM
- the HART®-handheld

Adjustment with PC

The set-up and adjustment of the radar sensors is generally made on the PC with the adjustment program VVO (**V**EGA **V**isual **O**perating) under Windows®.

The program leads quickly through the adjustment and parameter adjustment via pictures, graphics and process visualisations.

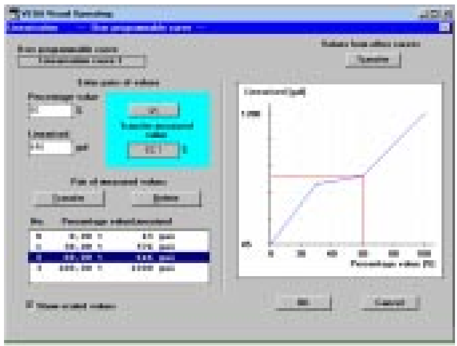


Adjustment with the PC on the analogue 4 … 20 mA-signal and supply line or directly on the sensor

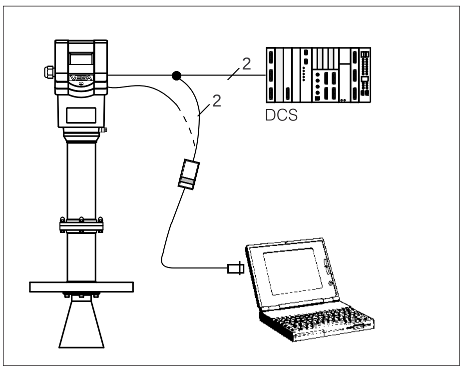
The PC can be connected to any individual position of the system or the signal line. It is hence connected with the two-wire PC-interface converter VEGACONNECT 2 to the sensor or to the signal line.

The adjustment and parameter adjustment data can be saved with the adjustment software on the PC and protected with passwords. If required the adjustments can be transmitted quickly to other sensors.

The adjustment program recognizes the sensor type



Visualised input of a vessel linearisation curve

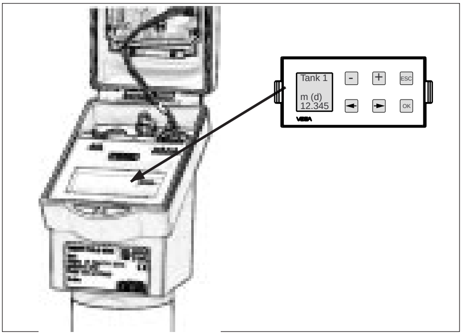


Adjustment with PC on the 4 … 20 mA signal and supply line to the DCS or directly on the sensor

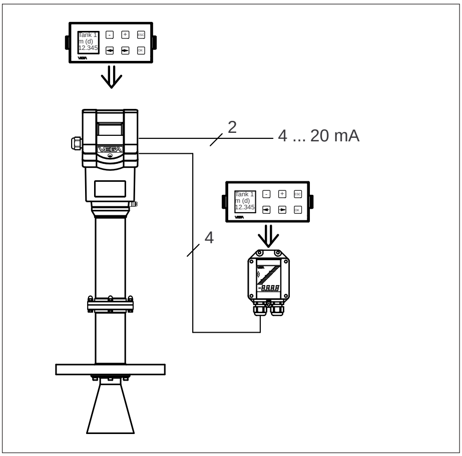
Adjustment with adjustment module MINICOM

With the (3,2 cm x 6,7 cm) 6-key adjustment module with display you can carry out the adjustment in clear text. The adjustment module can be plugged into the radar sensor or into the optional external indicating instrument.

By removing the adjustment module unauthor-



Detachable adjustment module MINICOM



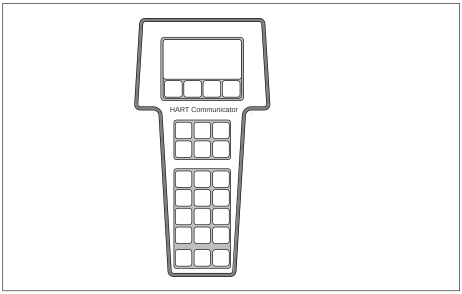
Adjustment with detachable adjustment module on the radar sensor or on the external indicating instrument VEGADIS 50

ized adjustments are avoided.

Adjustment with HART®-handheld

VEGAPULS 56 sensors with 4 … 20 mA-output signal can also be adjusted with the HART®-handheld. A special DDD (Data Device Description) is not required so that the sensors can be adjusted with the HART®-standard menus of the handheld.

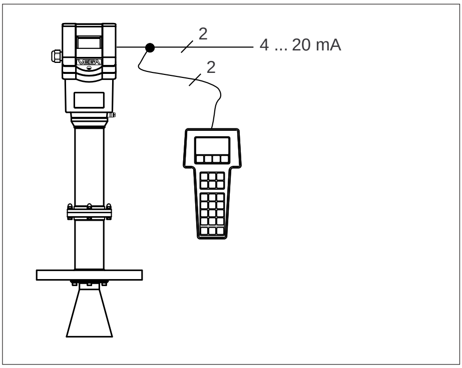
For adjustment just connect the HART®-handheld in any position of the 4 … 20 mA-



HART®-handheld

output signal line or to the sensor connection terminals.

1.4 Antennas

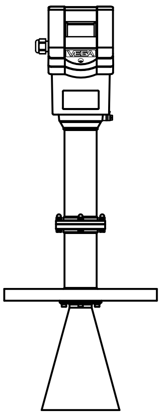


HART®-handheld on the 4 … 20 mA-signal line

The antenna is the eye of the radar sensor. Various antenna configurations are available for different applications and process conditions. Each system differs in the physical features.

Horn antenna

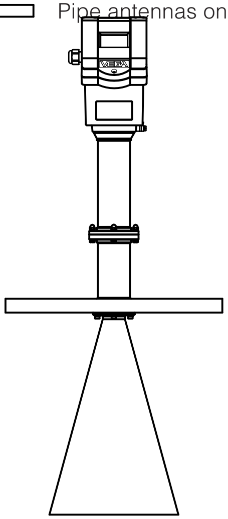
Horn antennas focus the radar signals very well. Manufactured of 1.4571 (stst) or Hastelloy C22 they are very rugged and physically as well as chemically resistant. Horn antennas are used for the measurement in closed or open vessels.



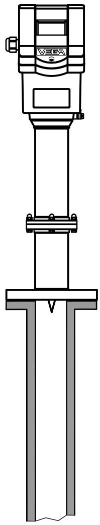
DN 150

Pipe antenna

Pipe antennas on surge or bypass pipes only form a complete antenna system in conjunction with a measuring pipe which can also be bent. Pipe antennas are best suited for products with extreme product movements or products with low dielectric constant figure.



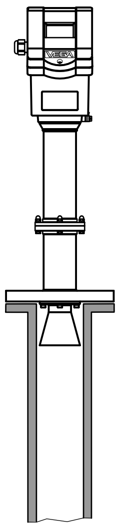
DN 250



DN 50

The antenna can be with or without horn. Antenna with horn characterize by very good antenna gain. A very good antenna reliability can be achieved even in case of products with very bad reflection features.

The measuring pipe means a conductor for radar signals. The running period of the radar signals changes in the pipe and depends on the pipe diameter. The pipe inner diameter must be programmed in the electronics so that the running period can be compensated.



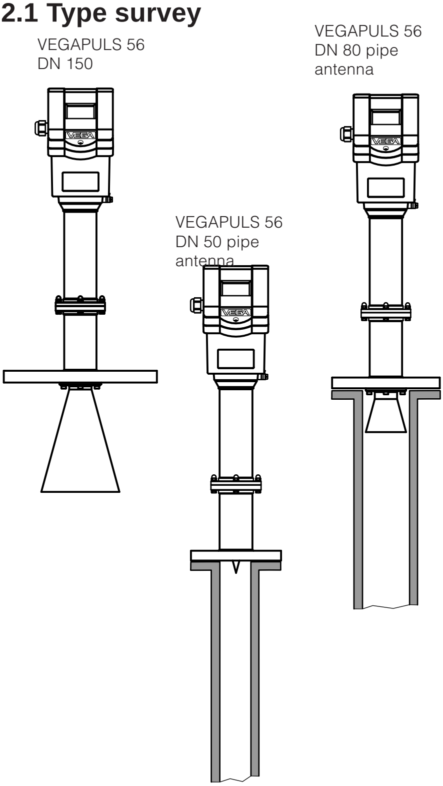
DN 80

2 Types and versions

VEGAPULS 56 sensors are a new developed generation of very compact high temperature radar sensors. For the first time it is now possible to carry out a non-contact level measurement under high temperatures and pressures. They open the advantages of a radar level measurement for applications where the special advantages of radar were formerly not applicable due to the extreme process conditions.

VEGAPULS 56 radar sensors dominate the two-wire technology perfectly. They are the first radar sensors transmitting the supply voltage and the output signal via one two-wire line. An analogue 4 ... 20 mA-output signal is available as output or measuring signal.

2.1 Type survey



General features
- level measurement on process and products under high temperatures and high pressures
- measuring range 0 … 20 m
- Ex-approved in Zone 1 and Zone 10 (IEC) or Zone 0 and Zone 20 (ATEX) classification EEx ia IIC T6 or EEx d ia IIC T6
- integral measured value indication
- external measured value indication which can be mounted up to 25 m separated in Ex-area

Survey of features

Signal output
- 4 … 20 mA active (four-wire sensors)
- 4 … 20 mA passive (two-wire sensor)

Voltage supply
- two-wire technology (voltage supply and signal output via one two-wire line)
- four-wire technology (voltage supply separated from the signal line)

Process connection
- DN 50; ANSI 2“
- DN 80; ANSI 3“
- DN 100; ANSI 4“
- DN 150; ANSI 6“
- DN 200; ANSI 8“
- DN 250; ANSI 10“

Adjustment
- PC
- adjustment module in the sensor
- adjustment module in external indicating instrument
- HART®-handheld

Antennas
- horn antenna with stainless steel horn and ceramic tip
- standpipe antenna only with ceramic tip

Type code

56… high temperature radar sensor
...K 4 … 20 mA-output signal
…V digital output signal

VEGAPULS 56 K EXXX X X X X X X X

- J - Tube extension for horn antenna
- X - without

- A - Aluminium housing
- D - Aluminium housing with Exd-terminal box

- T - Seal of the antenna system of Tantalum

- KVX - Process connection DN 50 PN 16 (for standpipe)
- LV6 - Process connection DN 80 PN 16 (for standpipe)
- EV1 - Process connection DN 100 PN 16 (for standpipe)
- FV2 - Process connection DN 150 PN 16
- SVX - Process connection ANSI 2“ 150 psi (for standpipe)
- WV6 - Process connection ANSI 3“ 150 psi (for standpipe)
- PV1 - Process connection ANSI 4“ 150 psi (for standpipe)
- VV2 - Process connection ANSI 6“ 150 psi
- 0V2 - Process connection ANSI 6“ 300 psi
- 1V2 - Process connection ANSI 6“ 600 psi (1.4571)
- 1M2 - Process connection ANSI 6“ 600 psi (Hastelloy C22)
- YYY - Other process connections and materials

- X - without indication
- A - with integral indication

- X - without adjustment module MINICOM
- B - with adjustment module MINICOM (pluggable)

- B - 20 … 72 V DC; 20 … 250 V AC; 4 … 20 mA; HART®
- D - Two-wire (loop-powered); 4 … 20 mA; HART®
- E - Supply via signal conditioning instrument
- P - 90 … 250 V AC (only in USA)
- N - 20 … 36 V DC, 24 V AC (only in USA)
- Z - Supply via signal conditioning instrument (only in USA)

- .X - FTZ approval (Germany)
- EX.X - approved for Zone 1 and Zone 10
- EX0.X - Ex approved Zone 0

- K - Analogue 4 … 20 mA output signal (two-wire technology)
- V - Digital output signal (two-wire technology)

Instrument series for high temperature application

Measuring principle (PULS for radar)

2.2 Configuration of measuring systems

A measuring system consists of a sensor with a 4 … 20 mA-signal output and a unit evaluating or processing the level proportional level signal.

On the following pages you find the instrument configurations called measuring system and shown in the following partly with a signal processing.

Measuring systems in two-wire technology:

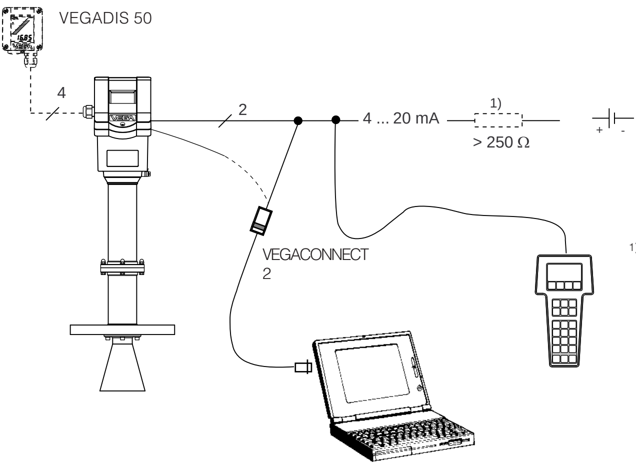
- 4 … 20 mA drawing without processing unit; *(bottom picture)*
- 4 … 20 mA on active DCS; *(page 13)*
- 4 … 20 mA on active DCS in Ex-area (ia); *(page 14)*
- 4 … 20 mA on passive DCS in Ex-area (ia); *(page 15)*
- 4 … 20 mA on passive DCS in Ex-area (d); *(page 16)*
- 4 … 20 mA on indicating instrument VEGADIS 371 Ex; *(page 17)*

Measuring systems in four-wire technology:

- 4 … 20 mA shown without signal conditioning instrument, (page 18)

Measuring systems with VEGAPULS 56K

- Two-wire technology (loop powered), supply and output signal via one two-wire line
- Optionally external indicating instrument with analogue and digital indication (can be mounted up to 25 m separated from the sensor)
- Adjustment with PC, HART®-handheld or adjustment module MINICOM (can be plugged into the sensor or into the external indicating instrument VEGADIS 50)

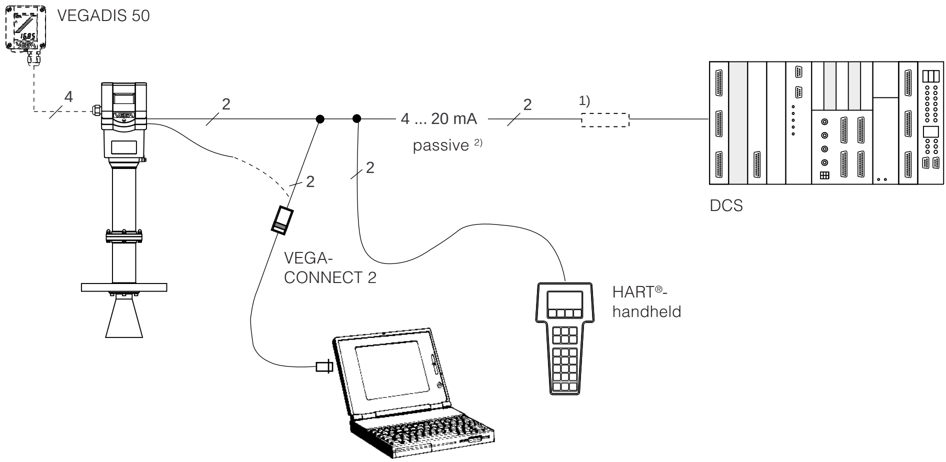


1) If the resistors of the processing systems connected to the 4 … 20 mA-signal output are less than 200 Ω, a resistor of 250 Ω to 350 Ω must be connected to the connection line during adjustment.

Otherwise the digital adjustment signal would be extremely damped or short-circuited via too small input resistors of a connected processing system so that the digital communication with the PC would no more be ensured.

Measuring system with VEGAPULS 56K on active DCS

- Two-wire technology, supply from active DCS
- Output signal 4 … 20 mA (passive)
- Measured value indication integrated in the sensor
- Optionally external indicating instrument (can be mounted up to 25 m separated from the sensor)
- Adjustment with PC, HART®-handheld or adjustment module (can be plugged into the sensor or into the external indicating instrument)



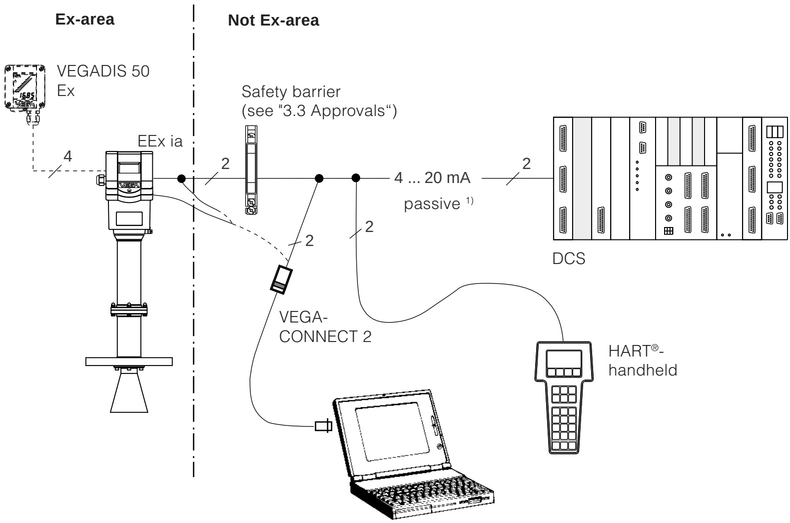
1) If the resistors of the processing systems connected to the 4 … 20 mA-signal output are less than 200 Ω, a resistor of 250 Ω to 350 Ω must be connected to the connection line during adjustment.

Otherwise the digital adjustment signal would be extremely damped or short-circuited via too small input resistors of a connected processing system so that the digital communication with the PC would no more be ensured.

2) 4 … 20 mA passive means that the sensor takes level dependent a current in the range of 4 … 20 mA. The sensor reacts then electrically like a consumer on the DCS.

Measuring system with VEGAPULS 56K Ex, 56K Ex0 via a safety barrier in Ex-area on active DCS

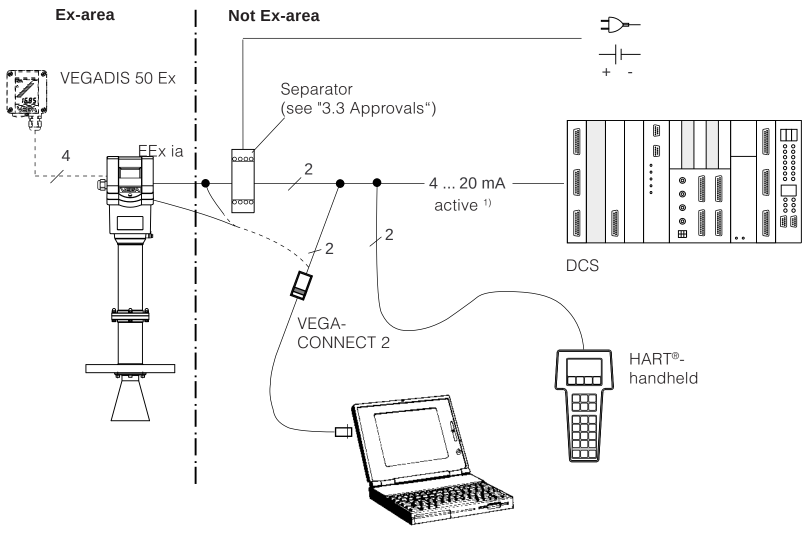
- Two-wire technology (loop powered), supply via the signal line from the DCS; output signal 4 … 20 mA (passive)
- Safety barrier transfers the not-intrinsically safe DCS-circuit into an intrinsically safe circuit, the sensor can then be used in Ex-zone 1 (VEGAPULS 56K Ex) or in zone 0 (VEGAPULS 56K Ex0)
- Max. resistance of the signal line 15 Ω per wire
- Optionally external indicating instrument with analogue and digital indication (can be mounted up to 25 m separated from the sensor)
- Adjustment with PC, HART®-handheld or adjustment module MINICOM (can be plugged into the sensor or in the external indicating instrument VEGADIS 50)



1) 4 … 20 mA passive means that the sensor takes level dependent a current in the range of 4 … 20 mA. The sensor reacts then electrically like a consumer on the DCS.

Measuring system with VEGAPULS 56K Ex, 56K Ex0 via a separator (Smart-Transmitter) on passive DCS

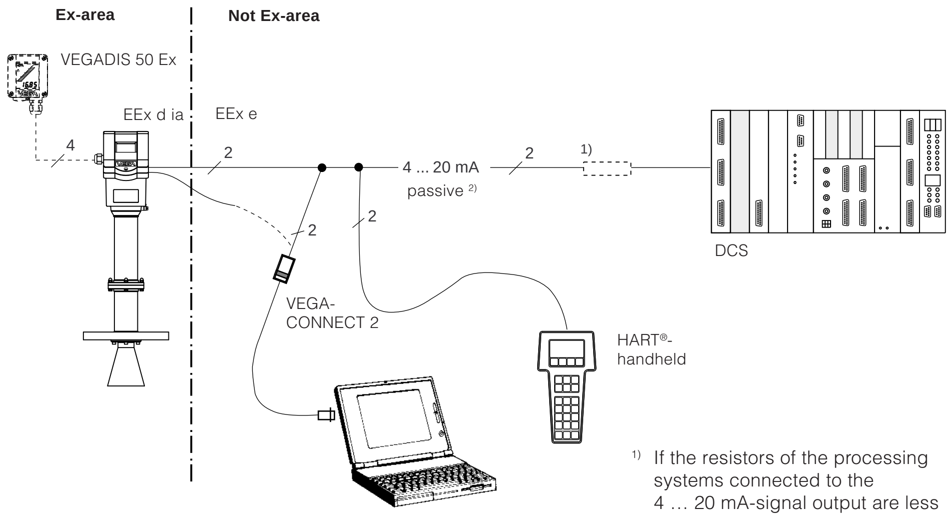
- Two-wire technology (loop powered), intrinsically safe ia-supply via the signal line of the separator for operation of the sensor in Ex-zone 1 (VEGAPULS 56K Ex) or in zone 0 (VEGAPULS 56K Ex0)
- Output signal sensor 4 … 20 mA passive
  Output signal separator 4 … 20 mA active
- Optionally external indicating instrument with analogue and digital indication (can be mounted up to 25 m separated from the sensor in Ex-area)
- Adjustment with PC, HART®-handheld or adjustment module MINICOM (can be plugged into the sensor or into the external indicating instrument VEGADIS 50)
- Max. signal line resistor 15 Ω per wire



1) 4 … 20 mA active means that the separator delivers level dependent a current of 4 … 20 mA. The separator reacts then electrically against the DCS like a current source.

Measuring system with VEGAPULS 56K Ex, 56K Ex 0 with pressure-tight encapsulated connection box on active DCS

- Two-wire technology, supply via the signal line from active DCS to Exd-terminal box for operation in Ex-zone 1 (VEGAPULS 56K Ex) or Ex-zone 0 (VEGAPULS 56K Ex 0)
- Output signal 4 … 20 mA (passive)
- Measured value indication integrated in the sensor
- Optionally external indicating instrument (can be mounted up to 25 m separated from the sensor Ex-area)
- Adjustment with PC, HART®-handheld or adjustment module MINICOM (can be plugged into the sensor or into the external indicating instrument)



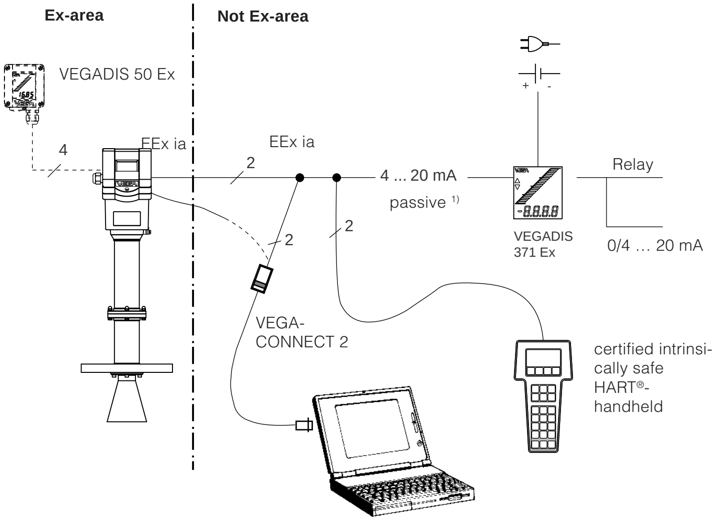
1) If the resistors of the processing systems connected to the 4 … 20 mA-signal output are less than 200 Ω, a resistor of 250 Ω to 350 Ω must be connected to the connection line during adjustment.

Otherwise the digital adjustment signal would be extremely damped or short-circuited via too small input resistors of a connected processing system so that the digital communication with the PC would no more be ensured.

2) 4 … 20 mA passive means that the sensor takes level dependent a current in the range of 4 … 20 mA. The sensor reacts then electrically like a consumer on the DCS.

Measuring system with VEGAPULS 56K Ex, 56K Ex0 on the indicating instrument VEGADIS 371 Ex with current and relay output

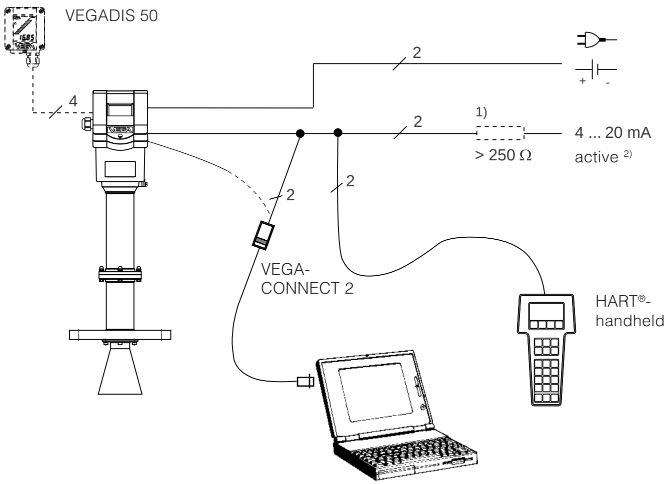
- Two-wire technology (loop powered), intrinsically safe ia-supply via the signal line from the indicating instrument VEGADIS 371 Ex for operation of the sensor in Ex-zone 1 (VEGAPULS 56K Ex) or in zone 0 (VEGAPULS 56K Ex0)
- Optionally external indicating instrument with analogue and digital indication (can be mounted up to 25 m separated from the sensor in Ex-area)
- Adjustment with PC, HART®-handheld or adjustment module MINICOM (can be plugged into the sensor or into the external indicating instrument)
- Max. line resistance 15 Ω per wire



1) 4 … 20 mA passive means that the sensor takes level dependent a current in the range of 4 … 20 mA. The sensor reacts then electrically like a consumer on the DCS.

Measuring system with VEGAPULS 56K in four-wire technology

- Four-wire technology, supply and output signal via two separate two-wire lines
- Output signal 4 … 20 mA active
- Optionally external indicating instrument with analogue and digital indication (can be mounted up to 25 m separated from the sensor)
- Adjustment with PC, HART®-handheld or adjustment module MINICOM (can be plugged into the sensor or into the external indicating instrument VEGADIS 50)
- Load max. 500 Ω



1) If the resistors of the processing systems connected to the 4 … 20 mA-signal output are less than 200 Ω, a resistor of 250 Ω to 350 Ω must be connected to the connection line during adjustment.

Otherwise the digital adjustment signal would be extremely damped or short-circuited via too small input resistors of a connected processing system so that the digital communication with the PC would no more be ensured.

2) 4 … 20 mA active means that the sensor delivers a level dependent current of 4 … 20 mA (source). The sensor reacts then electrically against a processing system (e.g. indication) like a current source.

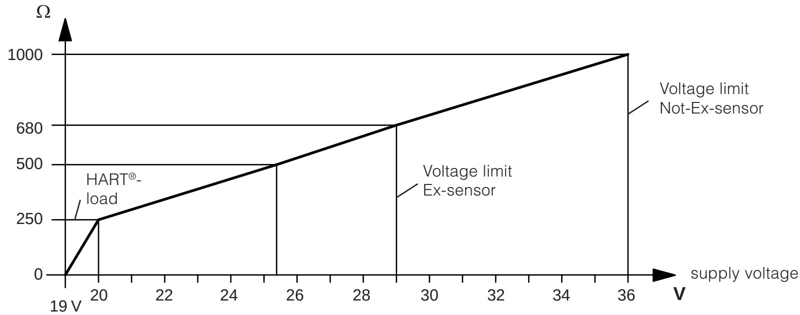
3 Technical data

3.1 Data

Power supply

Supply voltage
- two-wire sensor — 24 V DC (20 … 36 V DC)
- four-wire sensor — 24 V DC (20 … 72 V)
  230 V AC (20 … 250 V), 50/60 Hz
  fuse 0,5 A TR

Load diagram (loop resistance of e.g. DCS and supply line)



Current consumption
- two-wire sensor — max. 22,5 mA
- four-wire sensor — max. 60 mA

Power consumption
- two-wire sensor — max. 80 mW, 0,45 VA
- four-wire sensor — max. 200 mW, 1,2 VA

Measuring range [1]

Standard — 0 … 20 m

Measurement in a standpipe
- VEGAPULS 56 on DN 50 — 0 … 16 m
- VEGAPULS 56 on DN 100 — 0 … 19 m

Output signal (see also "Outputs and processings“)

4 … 20 mA-current signal

Load
- four-wire sensor — max. 500 Ω
- two-wire sensor — see above diagram

Adjustment

- PC and adjustment software VEGA Visual Operating
- adjustment module MINICOM
- HART®-handheld

[1] Min. distance of the antenna tip to the medium 5 cm

Accuracy (typical values under reference conditions) [1]

Class accuracy (deviation in characteristics including repeatability and hysteresis acc. to the limit point method)	< 0,1 % (relating to max. meas. range)
Linearity error	better than 0,05 %
Influence	
- of the ambient temperature [1]	0,06 %/10 K
- of the process temperature [1]	negligible (0,004 %/10 K at 5 bar) (0,003 %/10 K at 40 bar)
- of the process pressure [21]	negligible (0,025 %/bar)
Resolution of the 4 … 20 mA-output signal	0,01 %
Adjustment time	1 … 10 s (dependent on factory setting)
Resolution	1 mm

Characteristics

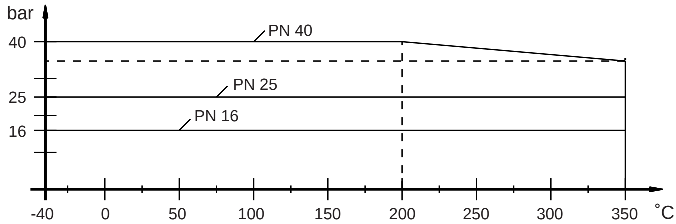
Measuring frequency	5,8 GHz (USA 6,3 GHz)
Measuring intervals	
- two-wire sensor	1,0 s
- four-wire sensor	0,3 s
Min. span between full and empty adjustment	10 mm (recommended 50 mm)
Beam angle (at –3 dB)	
- with DN 80	38° (only for standpipe measurement)
- with DN 100	30° (only for standpipe measurement)
- with DN 150	20°
- with DN 200	16°
- with DN 250	14°

Ambient conditions

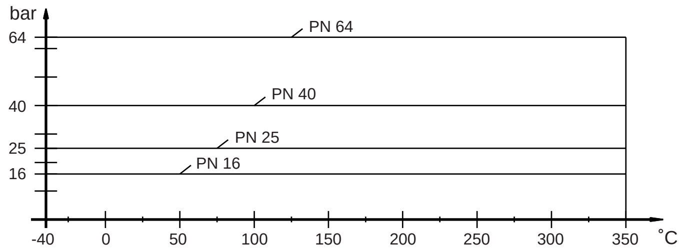
Ambient temperature on the housing	-20°C … +60°C
Flange temperature (process temp.)	-40°C … +350°C (pressure dependent), see following diagrams
Vessel isolation	with process temperatures exceeding 200°C the rear of the flange must be covered with a heat isolation, see chapter "4 Mounting and installation“.
Storage and transport temperature	-40°C … +80°C
Protection	IP 66/IP 67
Protection class	
- two-wire sensor	II
- four-wire sensor	I
Overvoltage category	III
Vessel pressure	max. 64 bar (temperature dependent), see following diagrams

[1] Reference conditions acc. to IEC 770

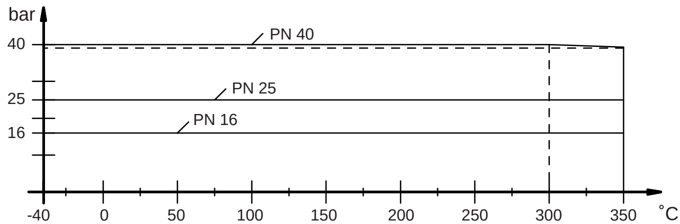
Flange DIN DN 50
Material: 1.4571
seal surface acc. to
DIN 2526 form B, C, D, E



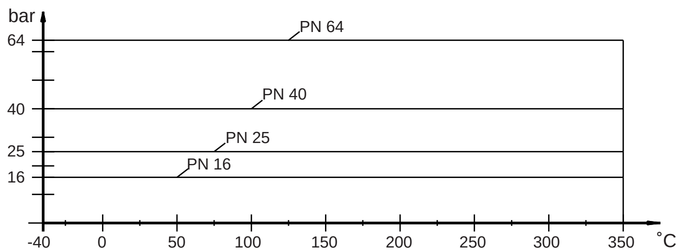
Flange DIN DN 50
Material: 1.4571
groove and tongue acc. to
DIN 2512 form F, N



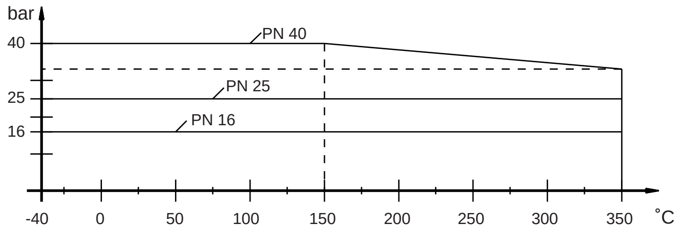
Flange DIN DN 80
Material: 1.4571
seal surface acc. to
DIN 2526 form B, C, D, E



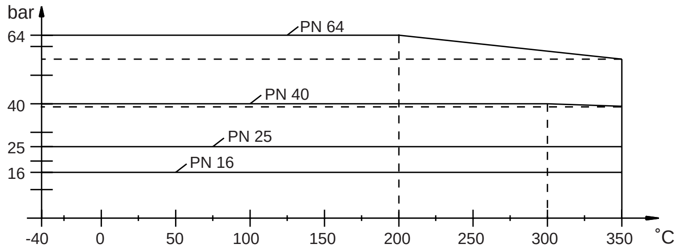
Flange DIN DN 80
Material: 1.4571
groove and tongue acc. to
DIN 2512 form F, N



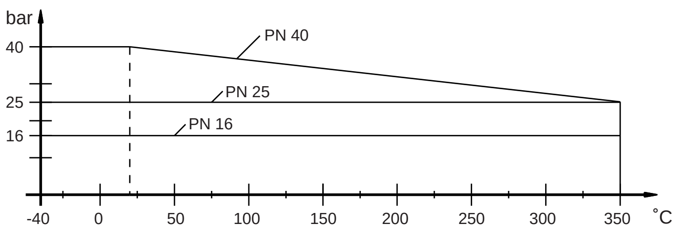
Flange DIN DN 100
Material: 1.4571
seal surface acc. to
DIN 2526 form B, C, D, E



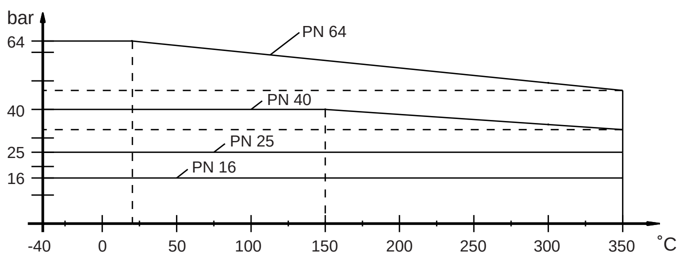
Flange DIN DN 100
Material: 1.4571
groove and tongue acc. to
DIN 2512 form F, N



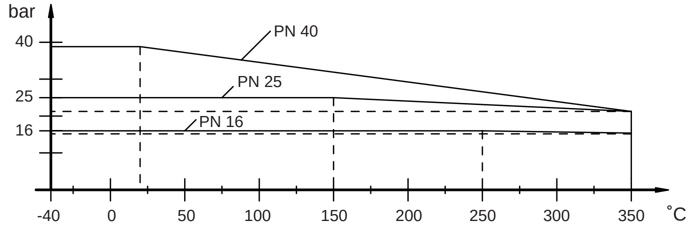
Flange DIN DN 150
Material: 1.4571
seal surface acc. to
DIN 2526 form B, C, D, E



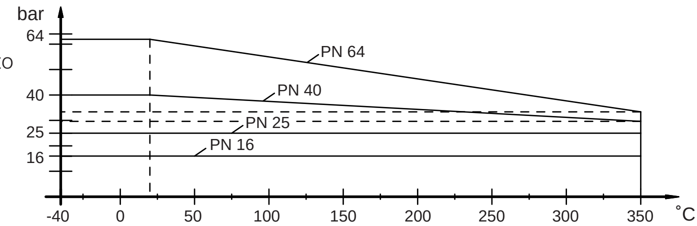
Flange DIN DN 150
Material: 1.4571
groove and tongue acc. to
DIN 2512 form F, N



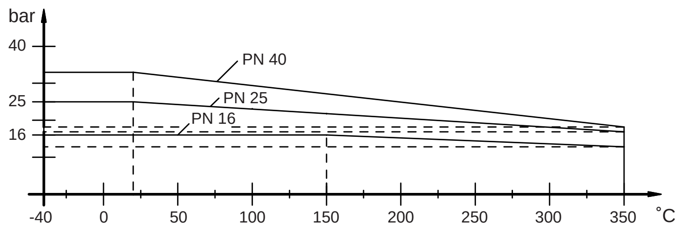
Flange DIN DN 200
Material: 1.4571
seal surface acc. to
DIN 2526 form B, C, D, E



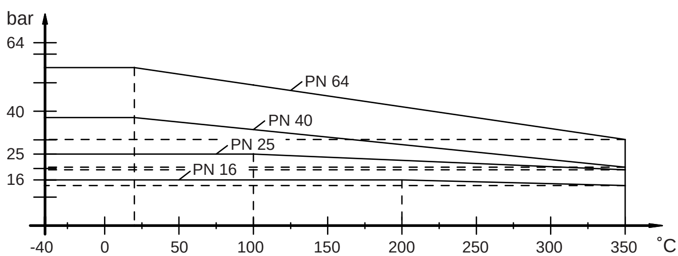
Flange DIN DN 200
Material: 1.4571
groove and tongue acc. to
DIN 2512 form F, N



Flange DIN DN 250
Material: 1.4571
seal surface acc. to
DIN 2526 form B, C, D, E



Flange DIN DN 250
Material: 1.4571
groove and tongue acc. to
DIN 2512 form F, N



Flanges acc. to ANSI (ASA) B16.5 seal surface RF, material 1.4571 in sizes 2“ to 10“ can be used over the whole temperature range of -40°C … 350°C with the appropriate nominal pressures of 150 lbs, 300 lbs, 600 lbs and 900 lbs.

Further flanges and process data on request.

Ex-technical data

Version without Exd-connection housing	
VEGAPULS 56K Ex	
- classification	II 2 G EEx ia IIC T6
- Ex-approved	Zone 1 (ATEX) Zone 1 (CENELEC; PTB, IEC)
VEGAPULS 56K Ex0	
- classification	II 1 G EEx ia IIC T6
- Ex-approved	Zone 0, Zone 1 (ATEX) Zone 0, Zone 1 (CENELEC, PTB, IEC)
Version with Exd-connection housing	
VEGAPULS 56K Ex	
- classification	II 2 G EEx d ia IIC T6
- Ex-approved	Zone 1 (ATEX) Zone 1 (CENELEC, PTB, IEC)
VEGAPULS 56K Ex0	
- classification	II 1/2 G EEx d ia IIC T6
- Ex-approved	Zone 0, Zone 1 (ATEX) Zone 0, Zone 1 (CENELEC, PTB, IEC)

Materials

Housing	Aluminium diecasting (GD-AlSi10Mg)
Flange	1.4571 or Hastelloy C22
Antenna	ceramic (Al_2O_3), 1.4571 or Hastelloy C22
Seal	Tantalum
Exd-terminal box (only EExd-version)	Aluminium-chill casting (GK-Alsi7Mg)

Weights in kg (1 psi = 0,0689 bar)

DIN	16 bar	25 bar	40 bar	64 bar
- DN 50	6,9	--	7,7	8,5
- DN 80	8,8	--	10,0	10,9
- DN 100	9,8	--	11,7	14,1
- DN 150	14,6	--	18,7	27,5
- DN 200	21,0	--	26	48
- DN 250	29,6	38,2	38,5	61,4

ANSI	150 psi	300 psi	600 psi	900 psi
- 2“	6,3	7,6	8,5	15,3
- 3“	8,1	11,3	13,1	17,2
- 4“	11,7	16,2	22,6	28,5
- 6“	15,8	26,7	44,0	56,2
- 8“	27,0	50,0	85,0	100,0
- 10“	35,8	60,7	108,0	136,0

Connection lines

Two-wire sensors	supply and signal via one two-wire line
Four-wire sensor	supply and signal separately, line resistor of the 4 … 20 mA-signal line max. 500 Ω
Cross-section area of conductor	generally 2,5 mm^2
Earth connection	max. 4 mm^2
Cable entry	
- Ex ia-terminal box (adjustment module)	2 x M20 x 1,5 (cable diameter 5 … 9 mm)
- Exd-terminal box	2 x $^1/_2$“ NPT EEx d (cable diameter of 3,1 … 8,7 mm or 0,12 … 0,34 inch)

CE-conformity CE

VEGAPULS radar sensors meet the protective regulations of EMVG (89/336/EWG) and NSR (73/23/EWG). The conformity has been judged acc. to the following standards:

EMVG	Emission	EN 50 081 - 1: 1992
	Susceptibility	EN 50 082 - 1: 1995
NSR		EN 61 010 - 1: 1993

Outputs and processings

Display indication

Indication	- optionally mounted scalable analogue and digital indication of measured values - optionally external measured value indication, separated up to 25 m from the sensor, supplied from the sensor

Signal output

Signal output	
- two-wire technology	4 … 20 mA
- four-wire technology	4 … 20 mA
Resolution of the 20 mA-signal	1,6 µA (0,01 % of operating range)
Load	
- four-wire	0 … 500 Ω
- two-wire	see load diagram under "Power supply“
Integration time	0 … 999 seconds

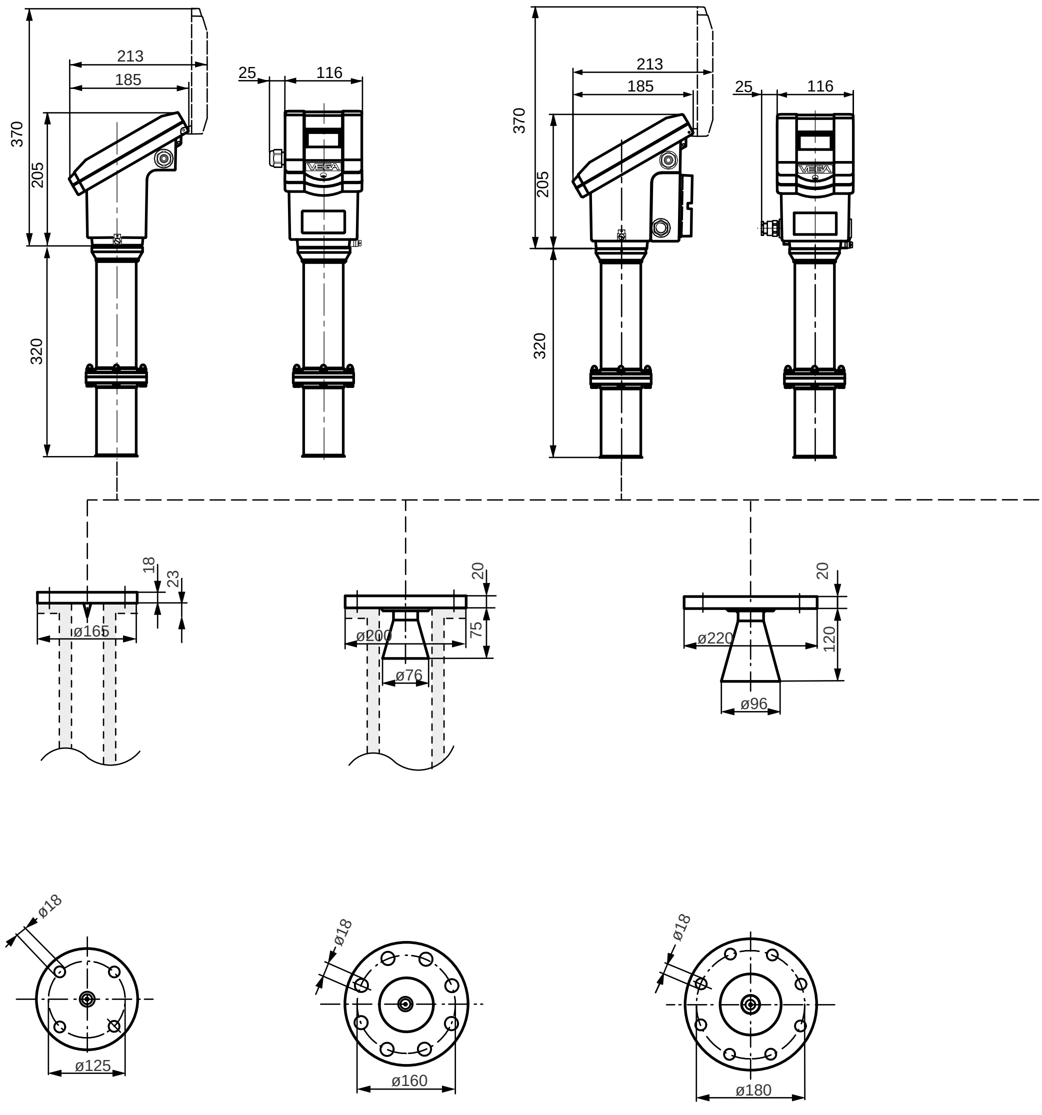
Two-wire technology:
The analogue 4 … 20 mA-output signal (meas. signal) is transmitted together with the power supply via one two-wire line.

Four-wire technology:
Separate power supply.
The analogue 4 … 20 mA-output signal (meas. signal) is looped in a line separated from the supply voltage.

3.2 Dimensions

Aluminium housing

Aluminium housing with Exd-terminal box



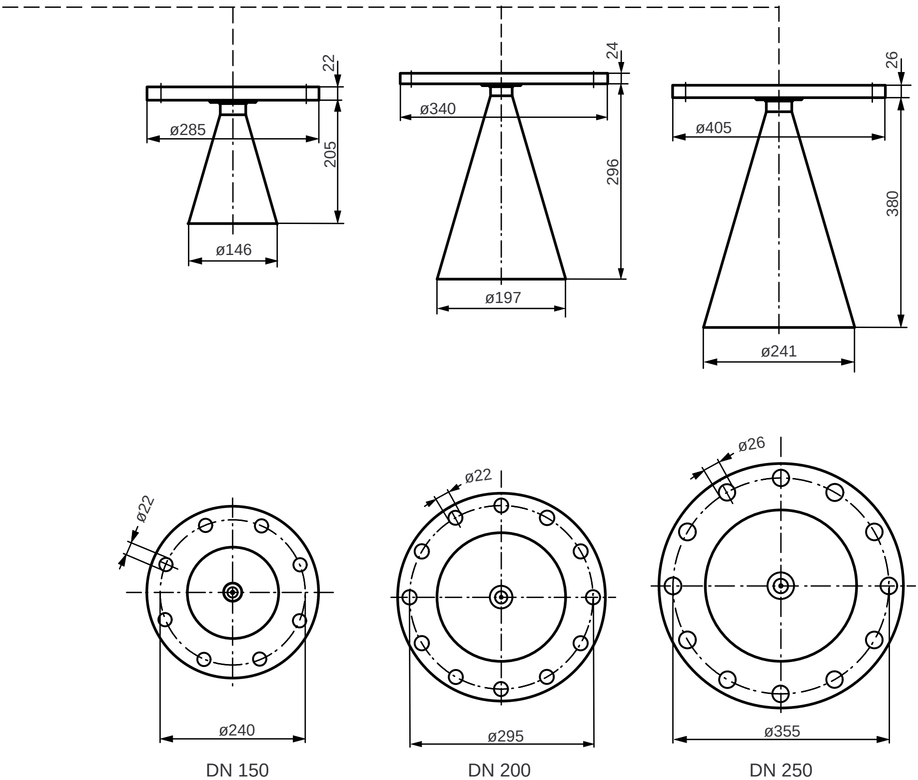
DN 50

Pipe antenna

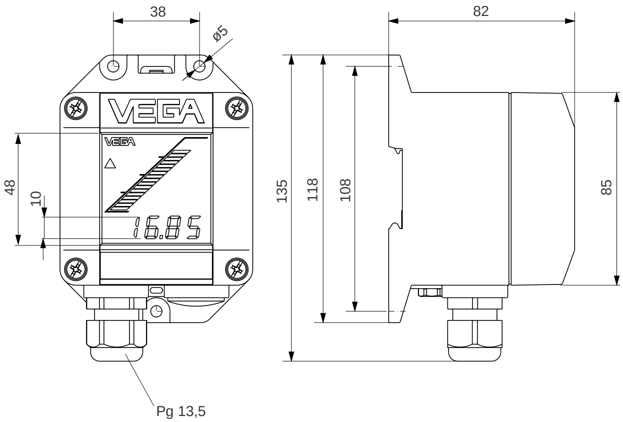
DN 80

Pipe antenna

DN 100


22
ø285
205
ø146
24
ø340
296
ø197
26
ø405
380
ø241
ø22
ø240
DN 150
ø22
ø295
DN 200
ø26
ø355
DN 250

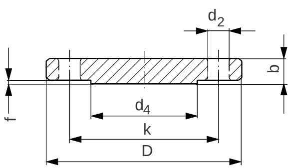
External indicating instrument VEGADIS 50



Mounting on carrier rail 35 x 7,5 acc. to EN 50 022 or flat screwed

Note:
Cable diameter of the connection cable min. 5 mm and max. 9 mm. Otherwise the seal effect of the cable entry will not be ensured.

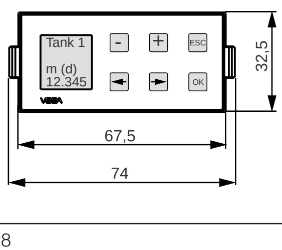
Flange dimensions acc. to ANSI



D = outer flange diameter
b = flange thickness
k = diameter of hole circle
d_1 = seal ledge diameter
f = seal ledge strength
$^1/_{16}$" = approx. 1,6 mm
d_2 = diameter of holes

Size	Flange			Seal ledge	Holes	
	D	b	k	d_1	No.	d_2
2" 150 psi	152,4	19,0	120,7	91,9	4	19,1
3" 150 psi	190,5	23,8	152,4	127,0	4	19,1
4" 150 psi	228,6	23,8	190,5	157,2	8	19,1
6" 150 psi	279,4	25,4	241,3	215,9	8	22,4

Adjustment module MINICOM



Adjustment module for insertion into the sensors VEGAPULS 56 or into the external indicating instrument VEGADIS 50

3.3 Approvals

When using radar sensors in Ex and StEx-areas or on ships the instruments must be suitable and approved for these explosion zones and applications. The suitability is checked by the approval authorities and is certified in approval documents.

VEGAPULS 56 radar sensors are approved for Ex-zone 1 and zone 0.

Please note the attached approval documents (yellow binder) when you want to use a sensor in Ex-area.

Test and approval authorities

VEGAPULS radar sensors are tested and approved by the following monitoring, test and approval authorities:

- **PTB**
  (Physikalisch Technische Bundesanstalt - Physical Technical Approval Authority)
- **FM**
  (Factory Mutual Research)
- **ABS**
  (American Bureau of Shipping)
- **LRS**
  (Lloyds Register of Shipping)
- **GL**
  (German Lloyd)
- **CSA**
  (Canadian Standards Association)

Ex-area zone 0/zone 1

Series 50 sensors require for use in Ex-areas special safety barriers or separators providing intrinsically safe (ia) circuits.

Following a choice of instruments with which VEGAPULS 56 sensors work reliably. In conjunction with safety barriers the resistor of the signal line and the separator resistor (separator voltage loss) must not exceed the max. load (see load diagram in chapter "3.1 Data“).

Ex-area zone 0/zone 1 without Exd-connection housing:
Separators and signal conditioning instruments:

- VEGADIS 371 Ex
- VEGAMET 614 Ex
- A puissance 3 PROFSI 37-24070A
- Apparatebau Hundsbach
  AH MS271-B41EEC010

Separator:

- Stahl 9303/15/22/11
- CEAG GHG 124 3111 C1206
- VEGATRENN 149 Ex

Separator/Safety barrier:

- Stahl 9001/01/208/110/10
- CEAG GHG 11 1 9140 V0728
- Type 9130 (VEGA)
- Stahl 9001/51/280/110/14
- MTL 787 St
- CEAG CS3/420-106

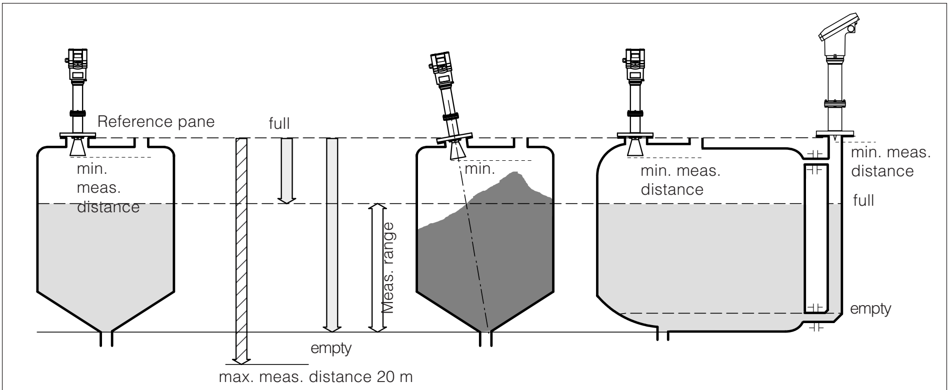
4 Mounting and installation

4.1 General installation instructions

Measuring range

The reference pane for the measuring range of the sensors is the flange face. The measuring range is 0 … 20 m. For measurements in surge or bypass pipes (pipe antenna) the max. meas. distance is reduced (see "Technical data - Measuring range").

Please note that for measurements where the measured product reaches the sensor flange, build-up on the antenna is possible which can cause measurement errors.

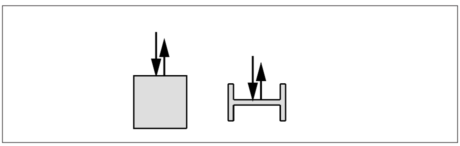


Measuring range (operating range) and max. measuring distance
Note: The use of the sensors in solid applications is restricted.

False reflections

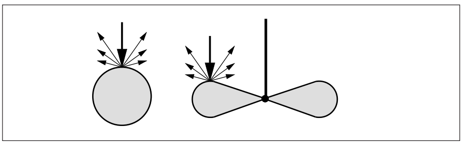
Flat obstructions and struts cause large false reflections. They reflect the radar signal with high amplitude.

Round profile interfering surfaces have a diffuse reflection of the radar signals and cause false reflections with low density. Hence they are less critical than reflections from flat surfaces.

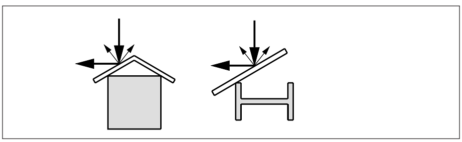


Profiles with smooth interfering surfaces cause large false signals

If flat obstructions in the range of the radar signals cannot be avoided, it is recommended to reflect the interfering signals with a deflector. Due to this scattering the interfering signals will be low in amplitude and diffuse so that they can be filtered out by the sensor.



Round profiles diffuse the radar signals

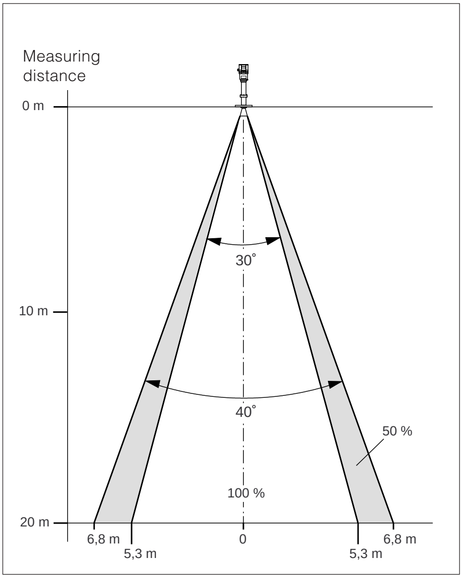


A deflector causes signal scattering

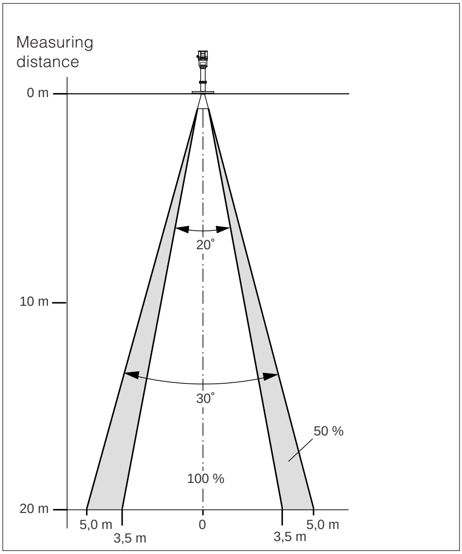
Emission cone and false reflections

The radar signal is focused by the antenna system. The signal leaves the antenna in conical form similar to the beam pattern from a spotlight. This emission cone angle depends on the antenna used.

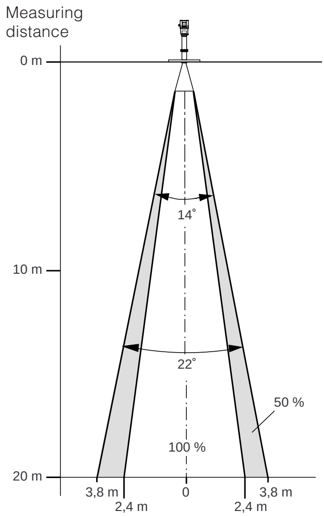
Any object in this emission cone causes a reflection of the radar signal. Within the first few metres of the emission cone mechanical obstructions cause strong false reflections. In a distance of 6 m the false signal of a pipe has 9-times more amplitude than at a distance of 18 m.



Emission cone of a DN 100 horn antenna



Emission cone of a DN 150 horn antenna

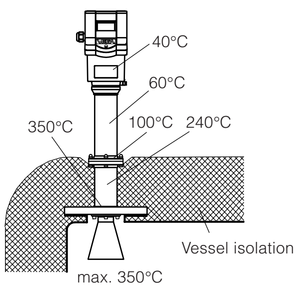


Emission cone of a DN 250 horn antenna

Heat isolation

In case of process temperatures of more than 200°C an isolation on the rear of the flange is necessary to separate the radiation heat from the sensor electronics.

The best would be to include the sensor isolation into the vessel isolation and isolate it up to approx. to the first pipe segment.

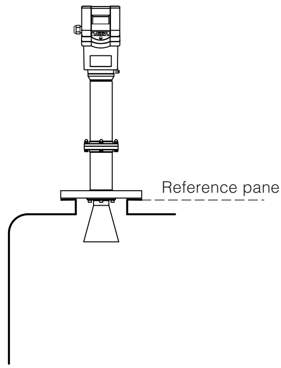


Heat isolation

4.2 Measurement of liquids

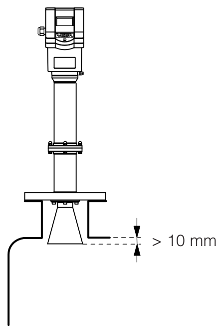
Sensor on DIN-socket piece

Most of the time the mounting of radar sensors is made on short DIN-socket pieces. The instrument flange is the reference pane of the measuring range. The antenna should always protrude out of the flange pipe.



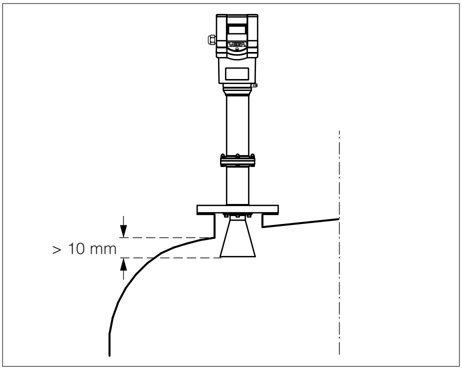
Mounting on short DIN-socket piece

When the DIN-socket piece is longer, note that the horn antenna must protrude at least 10 mm out of the socket.



Mounting on a longer DIN-socket piece

When mounting on dished end vessels the antenna has to protrude at least 10 mm.

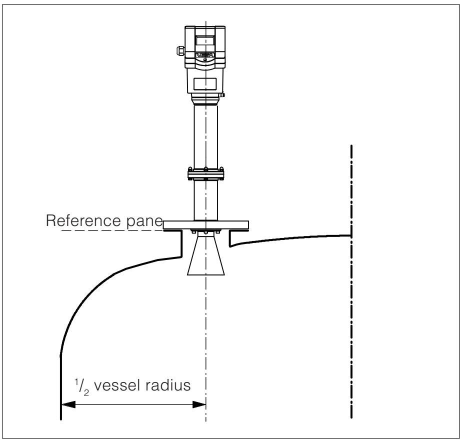


Mounting on dished end vessel

Do not mount the transmitter in the centre of the dished end of the tank or close to the wall of the vessel, but approx. $^1/_2$ vessel radius from the middle or from the outer wall of the vessel.

Dished tank ends can act as paraboloidal reflectors. If the radar sensor is placed in the "focus" of a parabolic tank end, the sensor receives amplified false echoes. The radar sensor must be mounted outside the "focus" hence parabolic amplified echoes are avoided.

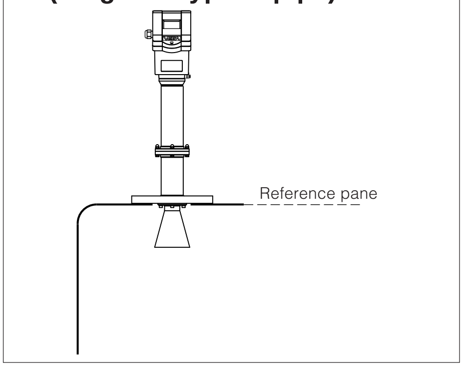
Sensor directly on the vessel top



Mounting on dished vessel end

Dependent on the construction of the vessel (sensor weight), flat mounting directly on the vessel top would be a favourable solution. The top side of the vessel is the reference pane.

4.3 Measurement in a standpipe (surge or bypass pipe)



Mounting directly on flat vessel top

General instructions

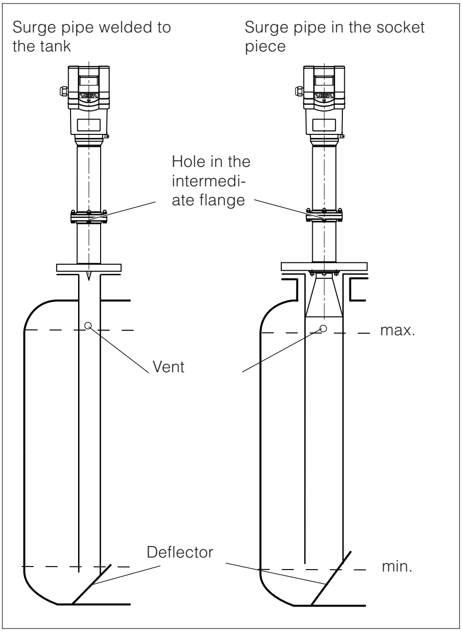
Pipe antennas are an option in vessels which are mechanically complex or where the product surface is very turbulent.

By focusing of the radar signals within the measuring pipe, also products with small dielectric constant figures (ε_r= 1,6 to 3) can be reliably measured.

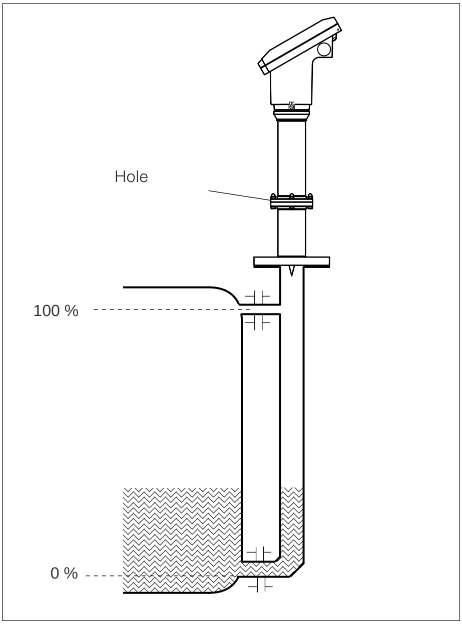
The surge pipes which are open at the bottom must extend over the full measuring range (i.e. down to 0% level).

Suitable will be a deflector at the tube end. The medium is therefore reliably detected in the range of the min. level. This is mainly important for mediums with a dielectric constant figure of less than 5.

Also note the required vent in the surge pipe. These vent or compensation holes must be in one axis with the hole in the intermediate



Pipe antenna system in the tank



Pipe flange system as bypass pipe

flange (polarisation direction of the radar signals).

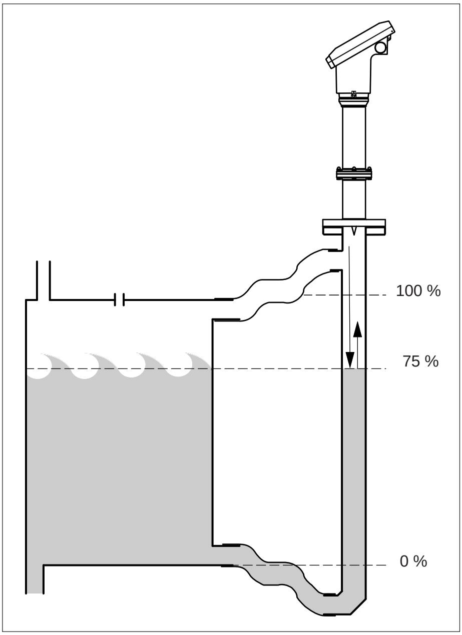
As an alternative to the surge pipe in the vessel, a pipe antenna system outside the vessel is possible as bypass pipe.

Note that with a measurement in the surge or bypass pipe the max. measuring range is reduced by 5 … 20 % (e.g. DN 50: 16 m instead of 20 m and DN 100 only 19 m instead of 20 m).

Direct the sensor such that the hole is in one axis with the pipe holes or the pipe connection openings. The polarisation of the radar signals enables considerably more stable measurements with this directing.

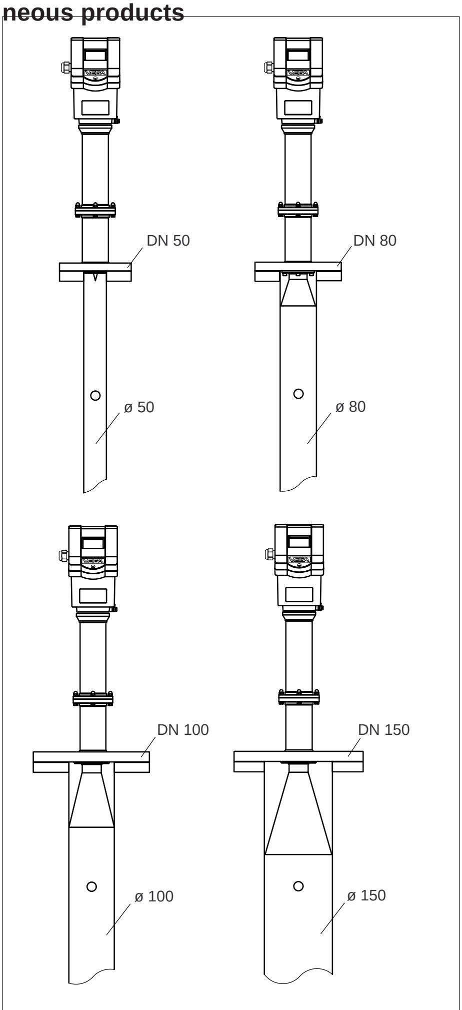
Adhesive products

When measuring adhesive products, the inner



Extended bypass pipe on the vessel with strong product movements diameter of the surge pipe must have a larger nominal width, e.g. 100 mm, so that build-up does not cause measuring errors. Surge pipe diameters of DN 50 to DN 150 can be connected.

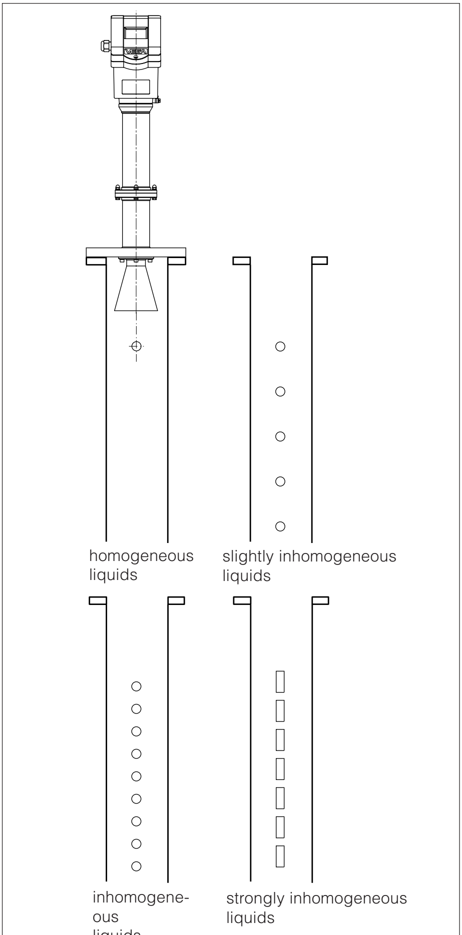
Standpipe measurement in inhomogeneous products



Pipe antenna with DN 50, DN 80, DN 100 and DN 150

If you want to measure inhomogeneous or laminated products in a surge pipe, it must have holes, long holes or slots. These openings ensure that the liquid is mixed and corresponds to the other vessel liquid.

The more inhomogeneous the measured product, the closer the openings should be.



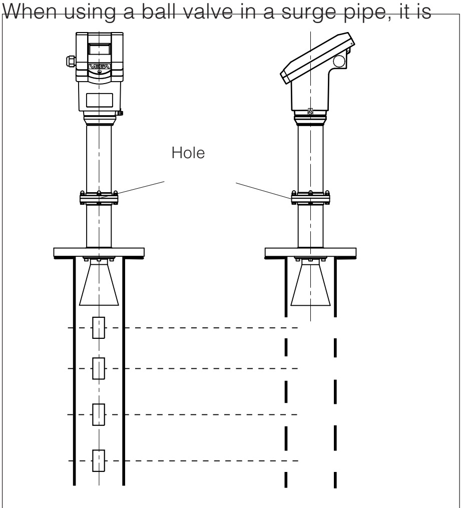
Openings in a surge pipe for mixing of inhomogeneous products

Polarisation direction

For reasons of radar signal polarisation the holes and slots must be positioned in two rows displaced by 180°. The mounting of the radar sensor is then such that the hole is in one axis with the row of holes.

Standpipe with ball valve

When using a ball valve in a surge pipe, it is

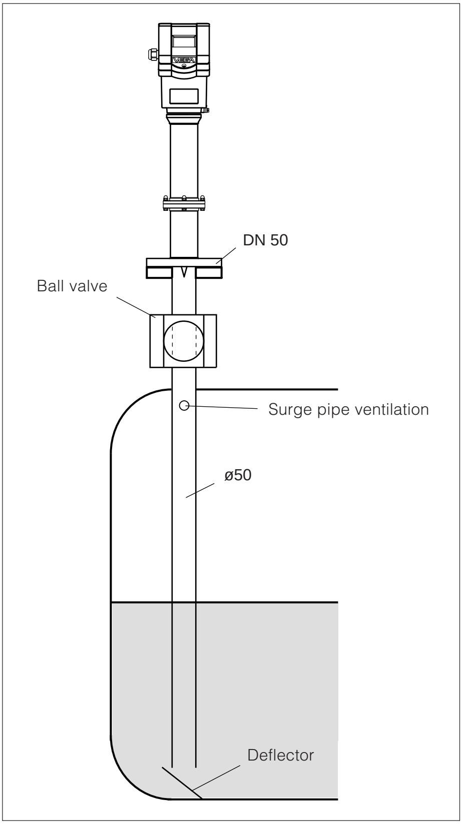


Row of holes in one axis with the hole

possible to carry out maintenance and ser-vice work without opening the vessel (e.g. with liquid gas or toxic products).

The ball valve diameter must correspond to the pipe size and provide a flush surface when in open position.

Note that a surge pipe ventilation is available.

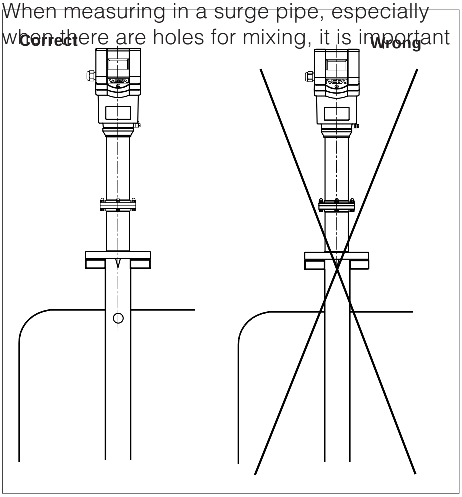


Lockable measuring pipe on a pipe antenna system

Installation error in standpipe

Missing ventilation hole

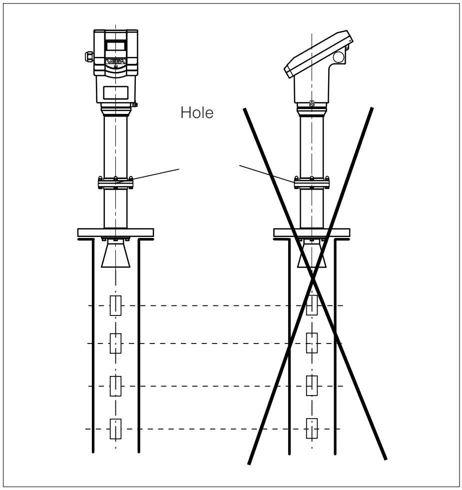
Pipe antenna systems must be provided with a vent at the upper end of a surge pipe. A missing hole causes wrong measurements.



Pipe antenna: The surge pipe open to the bottom must have a ventilation or compensation hole on top

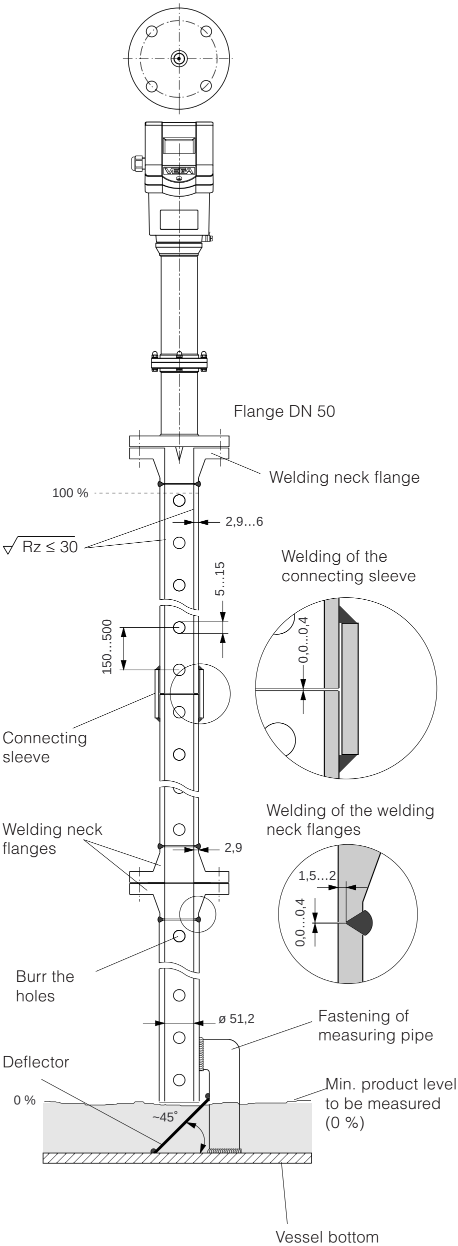
Wrong polarisation direction

When measuring in a surge pipe, especially when there are holes for mixing, it is important that the radar sensor is directed to the rows of holes. The two rows of holes of the surge pipe displaced by 180° must be in one pane with the polarisation direction of the radar signals. The polarisation direction is in one pane with the hole.



The polarisation direction is in one pane with the hole. The sensor must be directed with the hole to the rows of holes or the openings.

Construction instructions for the standpipe



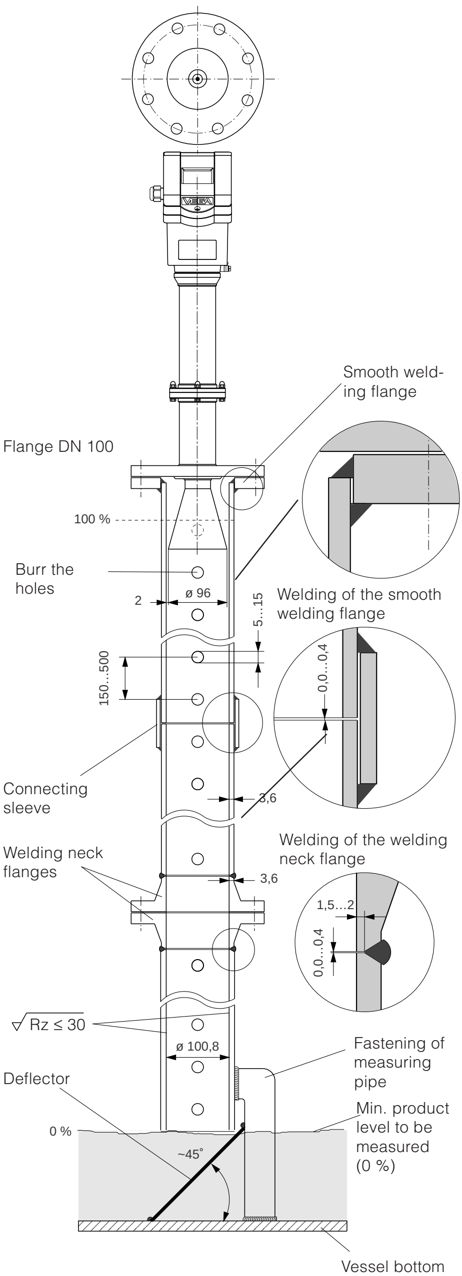
Radar sensors for measurement on surge or bypass pipes are used in flange sizes DN 50, DN 80, DN 100 and DN 150.

On the left is the construction of a measuring pipe (surge or bypass pipe) in the example of a sensor with a DN 50 flange.

The radar sensor with a DN 50 flange is only in conjunction with a measuring pipe a functional system.

The measuring pipe must be smooth inside (average roughness Rz ≤ 30). Use as measuring pipe a stainless steel pipe without joint. Extend the measuring pipe to the required length with welding neck flanges or with connecting sleeves. Note that no shoulders are caused in the pipe during welding. Fasten the pipe and the flange before welding in alinement with the inner sides.

Do not just weld through the pipe wall. Roughnesses or joints must be smooth inside. Roughnesses or joints must be removed carefully as otherwise strong false echoes and build-up will be caused.



On the left you see the construction of a measuring pipe on the example of a radar sensor with a DN 100 flange.

Radar sensors with flanges of DN 80, DN 100 and DN 150 are equipped with a horn antenna. Instead of the welding neck flange also a smooth welding flange can be used on the sensor side of these sensors.

In agitated products, fasten the measuring pipe to the vessel bottom. Provide additional fastenings for longer measuring pipes.

With the deflector on the measuring pipe end, the radar signals are reflected from the vessel bottom. This avoids that in nearly empty vessel and products with low dielectric constants, not the measured product but the vessel bottom is detected. In products with low dielectric constant figures the product is penetrated by radiation and the vessel bottom delivers at low level considerably clearer radar echoes than the product surface.

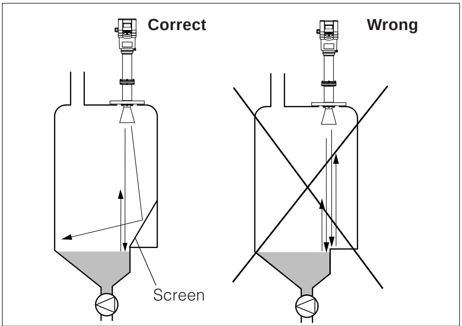
Due to the deflector the useful signal remains and hence the measured value can be clearly detected in nearly empty vessel and the 0 %-level is reliably detected.

4.4 False echoes

The installation place of the radar sensor must be chosen such that no struts or inflowing material cross the radar signals. The following examples and instructions show frequent meas. problems and how they can be avoided.

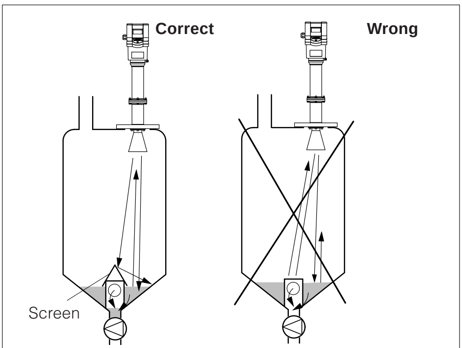
Shoulders

Vessel forms with flat shoulders pointing to the antenna can influence the measurement due to their hard false echoes. Deflectors above these flat shoulders diffuse the false echoes and ensure a reliable measurement.



Flat shoulders

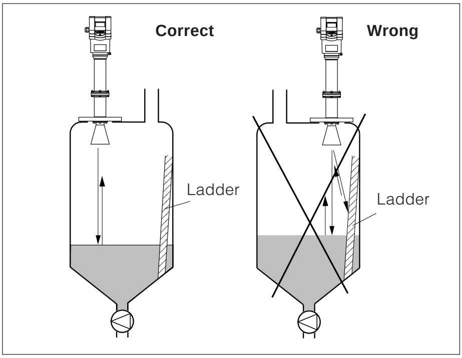
Inlets, e.g. for material mixing with flat surface pointing to the radar sensor, should be covered by a screen. False echoes are hence gated out.



Shoulders (inlets)

Vessel installations

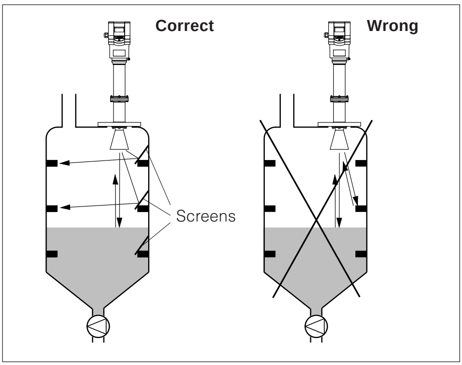
Struts, such as e.g. a ladder often cause false echoes. Note when planning a measurement loop that the radar signals reach the measured product without problems.



Vessel installations

Struts

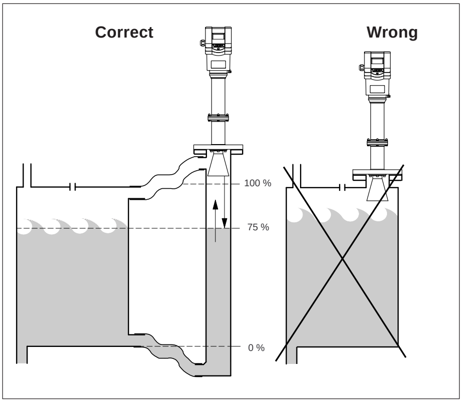
Struts such as vessel installations can cause strong false echoes which can overlay the useful echo. Small screens avoid a direct false echo reflection. The false echoes are diffused and filtered out by the measuring electronics as "echo noise“.



Struts

Strong product movements

Heavy turbulences in the vessel, e.g. by strong stirrers or strong chemical reactions influence the measurement. A surge or bypass pipe (figure) of sufficient size allows, provided that the product causes no build-up in the pipe, always a reliably measurement even with strong turbulences in the vessel.

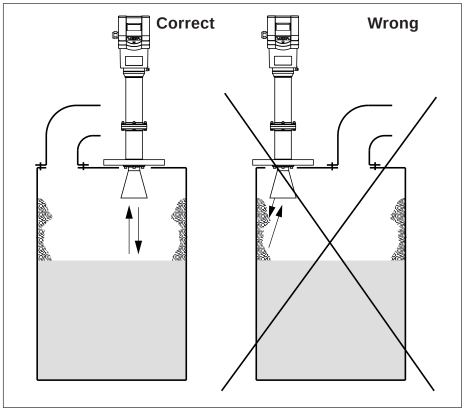


Heavy turbulences

Products which can cause slight build-up can be measured by using a measuring pipe with 100 mm nominal width and more. In a measuring pipe of this size, slight build-up is not a problem.

Build-up

If the radar sensor is mounted too close to the vessel wall, build-up on the vessel walls causes false echoes. Position the radar sensor in a sufficient distance to the vessel wall. Also note chapter "4.1 General installation instructions“.

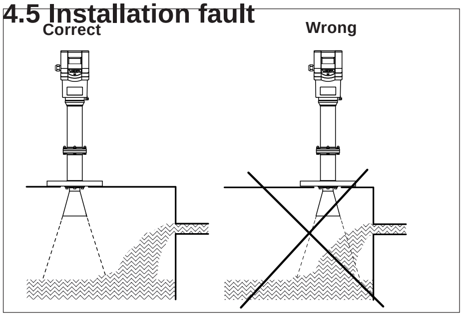


Build-up

Inflowing material

Do not mount the instruments in or above the filling stream. Ensure that you detect the product surface and not the inflowing material.

4.5 Installation fault

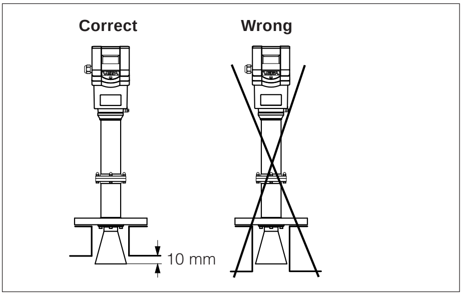


Inflowing liquid

Socket piece too long

When mounting the antenna in a too long socket piece, strong false reflections are caused, aggravating the measurement. Note that the horn antenna protrudes at least 10 mm out of the socket piece.

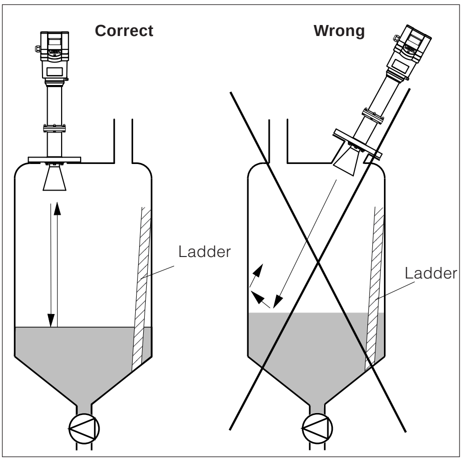
Wrong directing to the product surface



Horn antenna: Correct and wrong length of the socket piece

A directing of the sensor which does not point to the product surface will cause weak measuring signals. If possible direct the sensor axis vertically to the product surface, to reach optimum measuring results.

Parabolic effects on dished boiler head

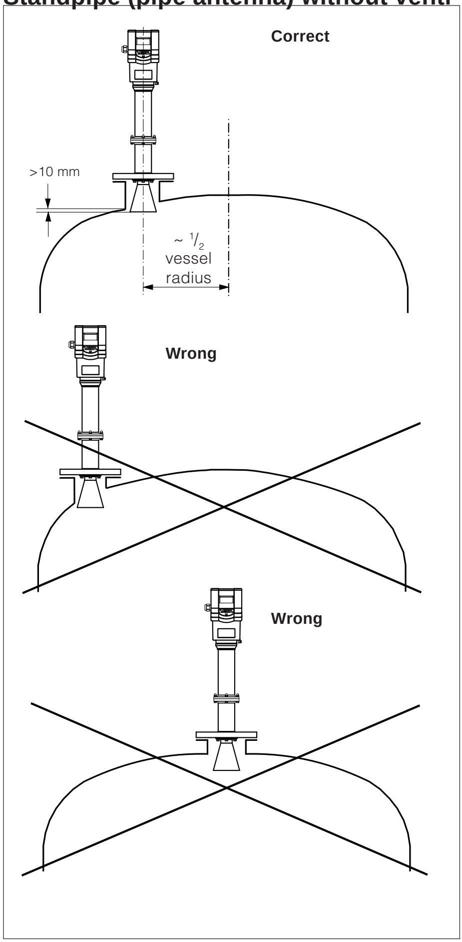


Direct sensor vertically to the product surface

or basket arch vessel

Round and parabolic tank tops act for the radar signals like a parabolic mirror. If the radar sensor is placed to the focus of such a parabolic tank top, the sensor receives amplified false echoes. The optimum mounting is generally in the range of the half vessel radius from the centre.

Standpipe (pipe antenna) without venti-

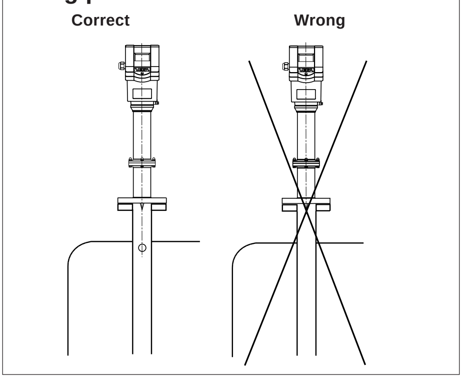


Mounting on a vessel with parabolic tank top

lation hole

Pipe antenna systems must be provided with a breathing hole on the upper edge of the surge pipe. A missing hole will cause faulty measurements.

Wrong polarisation direction of the



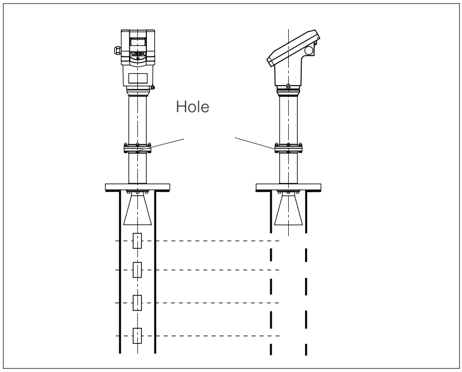
Pipe antenna: The surge pipe open to the bottom must have a ventilation hole on top

standpipe

When measuring in a surge pipe, especially if there are holes or slots in the pipe for mixing, it is important that the radar sensor is directed to the row of holes.

The two rows of holes of the surge pipe displaced by 180° must be in line with the polarisation direction of the radar signals. The polarisation direction is in line with the hole. The sensor is precisely directed by means of the hole in the intermediate flange.

Sensor too close to the vessel wall



The polarisation direction is in line with the hole. The sensor must be directed with the hole to the row of holes.

If the radar sensor is mounted too close to the vessel wall, strong interfering signals can be caused. Build-up, rivets, screws or weld joints superimpose their echoes to the useful signal or useful echo. Hence note a sufficient distance of the sensor to the vessel wall.

We recommend to choose the sensor distance such that there are no installations or the vessel wall within the inner emission cone.

In products with bad reflection conditions, it is useful that there are also no interfering installations within the outer emission cone. Note chapter "4.1 General installation instructions - Emission cone and fault reflections“.

Foam generation

Strong, dense and creamy foam on the product can cause faulty measurements. Provide measures to avoid foam or measure in a bypass pipe. Check if necessary the use of another measuring principle, e.g. capacitive electrodes or hydrostatic pressure transmitters.

5 Electrical connection

5.1 Connection and connection cable

Safety information

Ensure that the instrument is in currentless condition. Always switch off the power supply before you carry out terminal work on the radar sensors. Protect yourself and the instrument, especially when you use sensors which do not work with low voltage.

Skilled staff
Instruments which are not operated with a protective low voltage must only be connected by skilled staff.

Connection

A standard two or four-wire cable (sensors with separate supply) with max. 2,5 mm^2 can be used for connection. Very often the "Electromagnetic pollution“ by electronic actuators, energy lines and transmitting stations is so considerable that the two or four-wire cable should be screened.

We recommend to use a screening. This screening prevents against future interferences. Only earth the cable screens at two ends (on the sensor and on the processing system) when you have determined by a measurement that no or only low earth compensating currents flow via the screens. Use a very low impedance earth connection (foundation, plate or mains earth).

Ex-protection

If an instrument is used in hazardous areas, the appropriate regulations, conformity certificates and type approvals for systems in Ex-areas must be noted (e.g. DIN 0165).

Connection cable

Note that the connection cables must be specified for the expected operating conditions in your systems. The cable must have an outer diameter of 5 … 9 mm (M20x1,5) or 3,5 … 8,7 mm ($^1/_2$“ NPT). Otherwise the seal effect of the cable entry will not be ensured.

Cables for intrinsically safe circuits must be marked blue and must not be used for other circuits.

Earth conductor terminal

On all VEGAPULS 56 sensors the earth conductor terminal is galvanically connected to the metal process connection.

5.2 Connection of the sensor

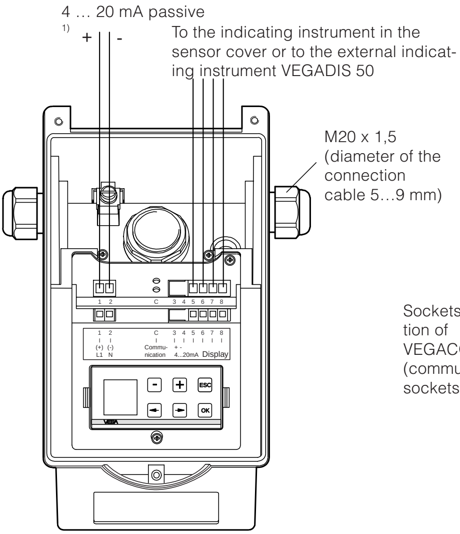
After having mounted the sensor in the measuring position acc. to the instructions in chapter "4 Mounting and installation“, loosen the closing screw on top of the sensor. The sensor cover with the optional display can then be opened. Unscrew the compression screw and shift the screw over the approx. 10 cm dismantled connection cable. The compression screw of the cable entry is protected with a safety lock-in position against automatic loosening.

Now loop the cable through the cable entry into the sensor. Screw the compression screw again to the cable entry and clamp the dismantled wires of the cable to the appropriate terminal positions.

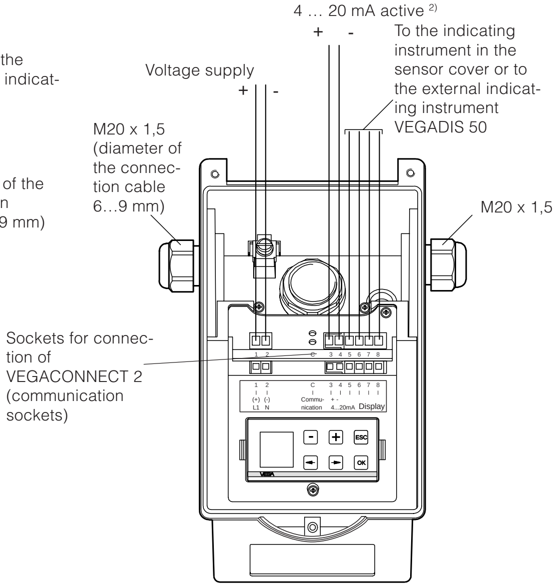
The terminals operate without terminal screw. Press the white opening buckets with a small screwdriver and insert the copper core of the connection line into the terminal opening. Check the position of the lines in the terminal position by slightly pulling on the connection lines.

Standard versions

Two-wire technology
(loop powered)

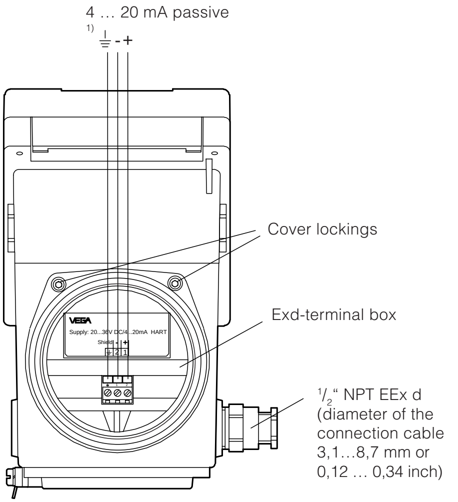


Four-wire technology

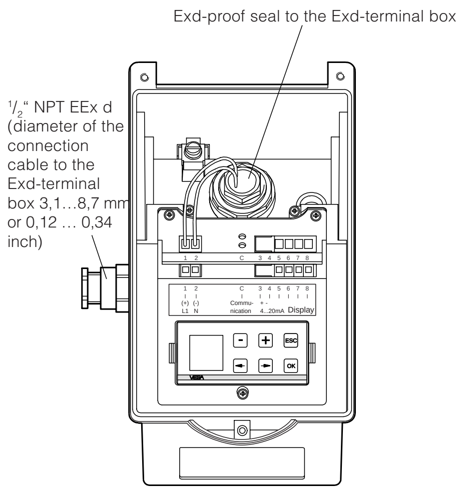


Exd-version (loop-powered with pressure-tight encapsulated terminal box)

EEx d-terminal box
(opening in Ex-area not permitted)



Adjustment module and indicating terminal box
(opening in Ex-area permitted)



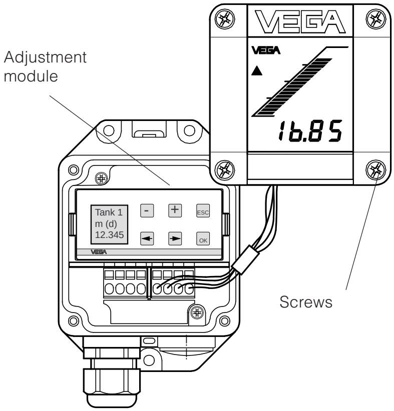
1) 4 … 20 mA passive means that the sensor takes a level dependent current of 4 … 20 mA (consumer).

2) 4 … 20 mA active means that the sensor provides a level dependent current of 4 … 20 mA (current source).

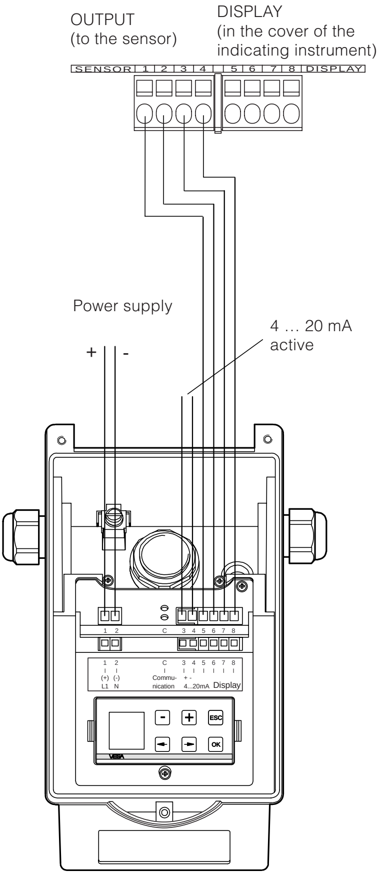
5.3 Connection of the external indicating instrument VEGADIS 50

Loosen the four screws of the housing cover on VEGADIS 50.
You can facilitate the connection procedure by fastening the housing cover during connection with one or two screws on the right of the housing (figure).

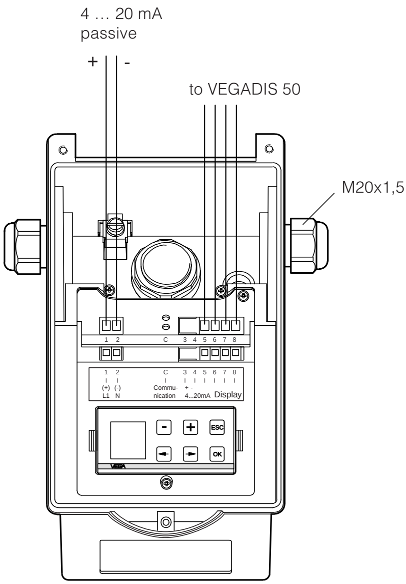
VEGADIS 50



Four-wire sensor
(separate supply)



Two-wire sensor
(loop powered)



6 Set-up

6.1 Adjustment structure

VEGAPULS 56 radar sensors can be adjusted with
- PC (adjustment program VVO),
- detachable adjustment module MINICOM or
- HART®-handheld.

The adjustment must only be carried out with one adjustment medium at the same time.

Adjustment program VVO
With the adjustment program VVO (VEGA Visual Operating) on the PC you can adjust the radar sensors very comfortably. The PC communicates via the interface converter VEGACONNECT 2 with the sensor. A digital adjustment signal is superimposed to the signal and supply line. The adjustment can be carried out in any individual position of the signal line or directly on the sensor.

Adjustment module MINICOM
With the adjustment module MINICOM you can adjust in the sensor or in the external indicating instrument VEGADIS 50. The adjustment module enables via text display with 6-key field the adjustment with the same function volume than with the adjustment program VVO.

HART®-handheld
VEGAPULS 56K radar sensors can be adjusted beside the PC and the adjustment module MINICOM also with the HART®-handheld. A manufacturer specific DDD (Data-Device-Description) is not necessary. The radar sensors communicate with the HART®-standard menus. All sensor functions will be accessible. Some very rarely used functions such as e.g. the scaling of the di-gital, analogue converter for the signal output or the adjustment with medium are not possible with the HART®-handheld or are blocked. These functions can be carried out with the PC or the MINICOM.

6.2 Adjustment with the PC

Connection

In chapter "2.2 Configuration of measuring systems“ the connection of the PC is shown in the various coordinations. The PC with the adjustment program VVO (VEGA Visual Operating) can be connected to the
- sensor or
- signal line.

PC on the sensor
For connection of the PC to the sensor you require the interface converter VEGACONNECT 2. Insert VEGACONNECT 2 into the provided CONNECT-socket in the sensor.

PC on the signal line
Connect the two-wire line of VEGACONNECT 2 to the signal or supply line (two-wire sensor) of the sensor. When the resistors of the systems (DCS, current source etc.) connected to the signal/supply line are less than 250 Ω, a resistor of 250 … 350 Ω must be connected to the signal/supply line during adjustment. The digital signals modulated to the signal line would be damped extremely or "short-circuited“ by too small system resistors so that the communication with the PC will be interfered.

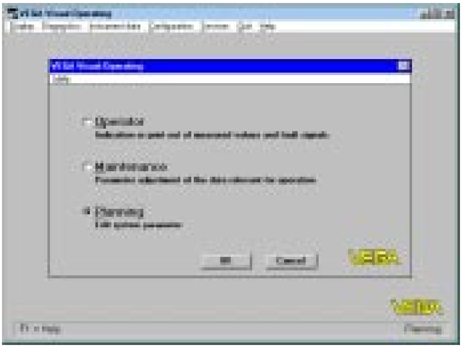
The individual adjustment steps are marked in the following with a dot.
Example:
- Choose …
- Start …

When you have connected the PC with the adjustment software VVO to your measuring system

- first switch on the power supply of the connected sensor.

The sensor needs in the first 10 … 15 seconds a current of approx. 22 mA (self check) and takes then a level proportional or distance proportional current (4 … 20 mA).

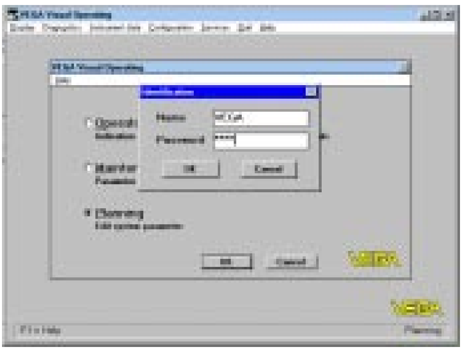
- Switch on the PC and start the adjustment software VVO
- In the entrance screen you choose with the



arrow keys or the mouse the item "*Planning*" and click to "*OK*".

You are asked for the identification.

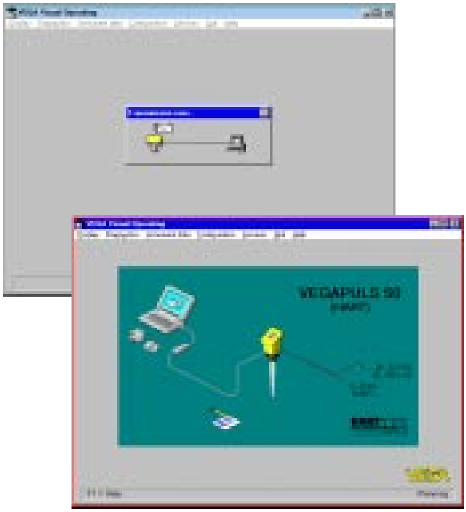
- Enter under the name "*VEGA*".



- Also enter under the password "*VEGA*".

The adjustment program (VVO), in the following just called VVO, gets in contact with the connected sensor …

… and shows after a few seconds if and with



which sensor a connection exists.

The pre-adjusted identification can be modified later in the menu "*User access*".

When you connect the adjustment software (VVO) to a sensor of which data had been saved previously, you will be asked if you want to transfer the saved data to the sensor or if the sensor data should be transmitted to the database of VVO which are then overwritten.

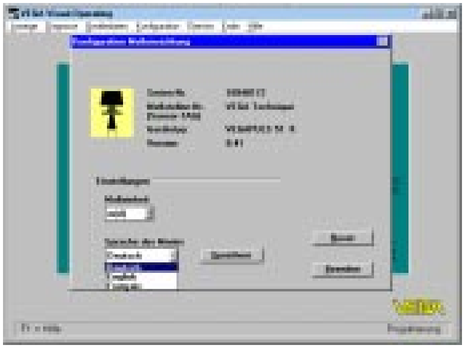
When you do not get a sensor connection, check the following:
- is the sensor fed with power supply (min. 20 V)?
- when VEGACONNECT 2 is connected to the signal line, is the load resistor then 250 … 350 Ω?
- do you use VEGACONNECT instead of the new VEGACONNECT 2?

Configuration

- Choose the menu "*Configuration/Measuring system*“, to get further information on the

  sensor type, the software version of the sensor, the meas. unit, the measurement loop designation etc.

- Click to "*Quit*“.



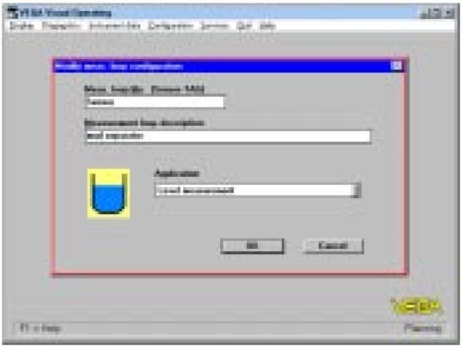
- Click to the menu "*Configuration/Measurement loop/Modify*“. This is the first step to set-up the sensor.

In the menu "*Configuration/Measurement loop/Modify*“ you can coordinate a name (e.g.

vessel 10) and a description to the measurement loop (e.g. mud separator).

- Enter in this menu whether a level, a distance or a gauge should be measured.

Parameter adjustment / Adjustment

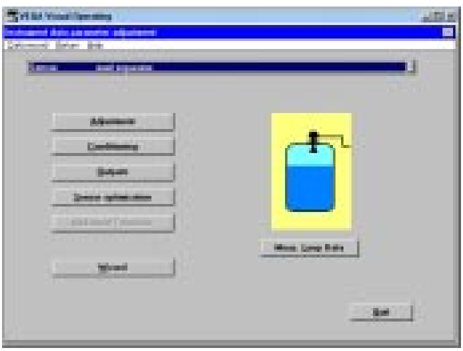


- Now choose the menu "*Parameter adjustment*".

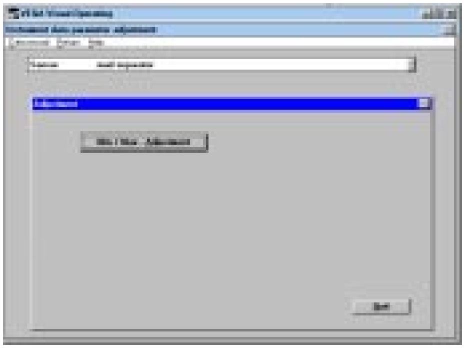
In the menu "*Instrument data/Parameter adjustment*" you carry out all important sensor

adjustments. In the headline you see the previously adjusted name and description of the measurement loop.

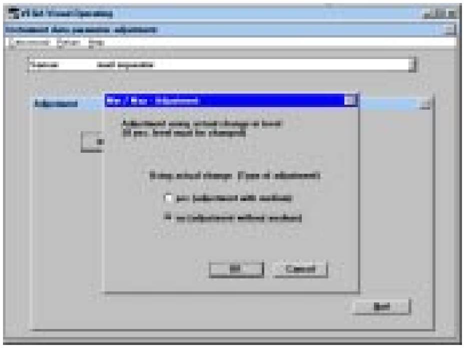
- First choose "*Adjustment*".



- Click to "*Min/Max-adjustment*".



You can carry out the min./max.-adjustment with medium or without medium. Generally you

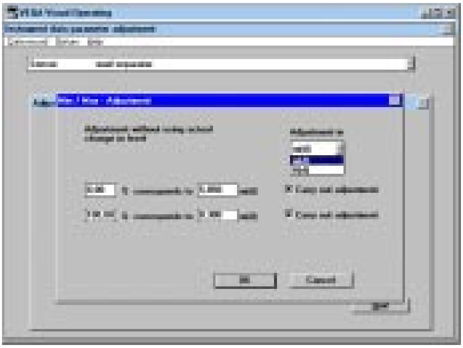


will carry out the adjustment without medium.

When you want to carry out the adjustment with medium, you have to carry out the min. adjustment with emptied vessel and the max. adjustment with filled vessel.

It is hence comfortable and quick to carry out the adjustment without medium as shown in the example.

- Choose if you want to carry out the adjustment in metres (m) or in *feet* (ft).
- Enter a distance for the upper and lower



level and the appropriate filling degree in percent.

In the example the 0 %-filling is at a product distance of 5,850 m and the 100 %-filling at a product distance of 0,300 m.

- Confirm with "*OK*“

Note:
For level detection outside the operating range, the operating range must be corrected appropriately in the menu "*Sensor optimisation/Meas. environment*“.

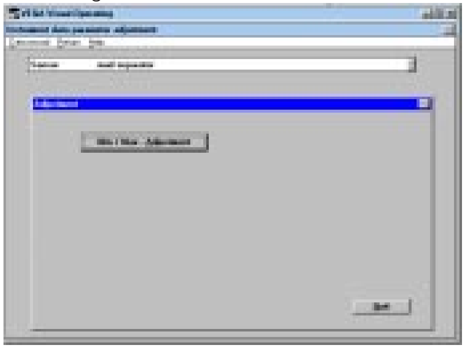
You are again in the menu "*Adjustment*“. Hence the sensor electronics has two characteristics points out of which a linear proportionality between level distance and the percentage filling of a vessel is generated.

The characteristics points however must not be at 0 % and 100 %, the difference should be as high as possible (e.g. at 20 % and at 80 %). The min. distance of the characteristics points for the min./max. adjustment should be 50 mm product distance. When the characteristics points are too close together, the possible measurement failure is increased.

In the menu "*Instrument data/Parameter adjustment/Conditioning/Linearisation*“ you can enter later if required another linear dependance between level distance and percentage filling degree.

- Click in the menu "*Adjustment*“ to "*Quit*“.

You are again in the menu window "Instrument *data parameter adjustment*“.



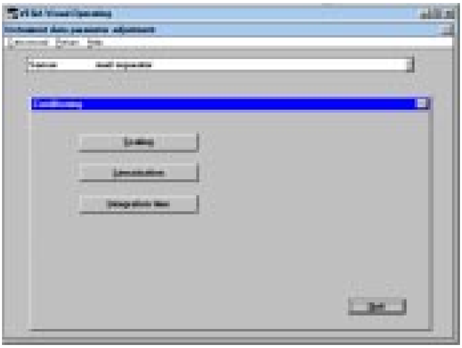
Conditioning

- Click to "*Conditioning*“.

The menu window "*Conditioning*“ opens.

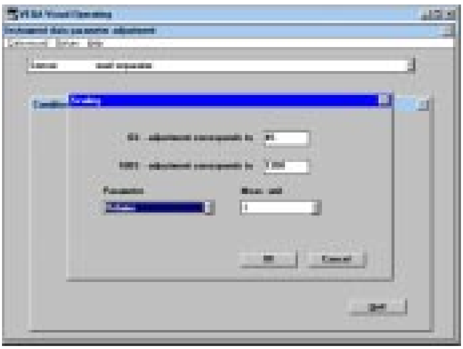
• Click to "*Scaling*".

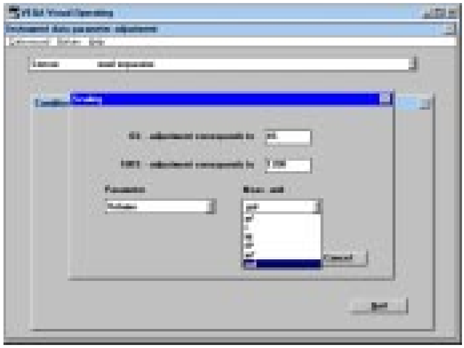
In the menu "*Scaling*" you adjust the actual 0 %- and 100 %-values of the parameter as well as its unit. This is the information for the



sensor that e.g. at 0 %-filling there are still 45 litres and at 100 %-filling 1200 litres in the vessel. The sensor indication then indicates with empty vessel (0 %) 45 litres and with full vessel (100 %) 1200 litres.

As parameter you can choose *"dimensionless* (figures), *volume, mass, height* and *distance"* and an appropriate unit (e.g. l, hl) can then be coordinated to the parameter. The sensor indication shows then the figure in the





selected parameter and unit.

• Save the adjustments in the menu "*Scaling*" by confirming with "*OK*".

The adjustments are now transmitted to the sensor.

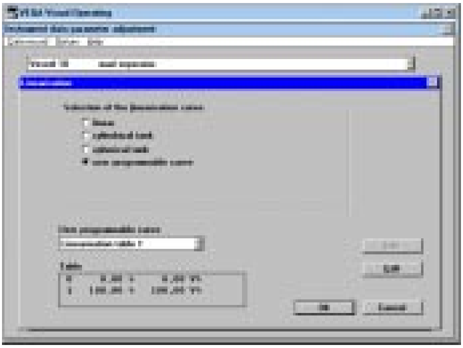
Linearisation

When in your vessel there is another dependence between product distance and the %-value of the filling than a linear one, choose in the menu window "*Conditioning*" the menu point "*Linearisation*".

• Click to "*Linearisation*".

The menu window "*Linearisation*" opens.

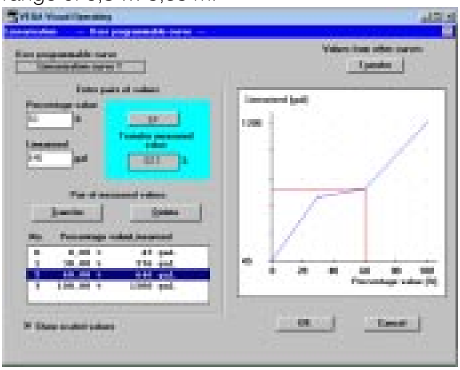
Pre-adjusted is a linear dependence bet-ween the percentage value of the filling. Beside the two programmed linearisation curves "*Cylindrical tank*" and "*Spherical tank*" you can also enter several "*user programmable curves*".



User programmable linearisation curves

- To enter an own vessel geometry or a user programmable filling curve, click to "*user programmable curve*".
- Click to "*Edit*".

In the field "*Transfer measured value*" the present level distance in percent is indicated of the adjusted meas. window. You have adjusted the meas. window during the min./max. adjustment. In our example the meas. window is in the range of 0,3 … 5,85 m.



The user programmable linearisation curve is generated with index markers of the value pairs "*Linearised*" (level distance or adjusted meas. unit) and "*Percentage value*" (percentage value of the filling). If the index markers or value pairs of your vessel are not known to you, you have to gauge the vessel by litres.

Gauging by litres

In the characteristics of the example you see four index markers or value pairs. There is always a linear interpolation between the index markers.
Click to "*Show scaled values*", to have to adjusted meas. unit displayed on the y-axis (bottom left in the menu window).

Index marker 1 is at 0 % filling (percentage value [%]), corresponding to an actual distance to the product surface of 5,850 m in the example (empty vessel). The volume value is hence 45 litres (rest filling of the vessel).

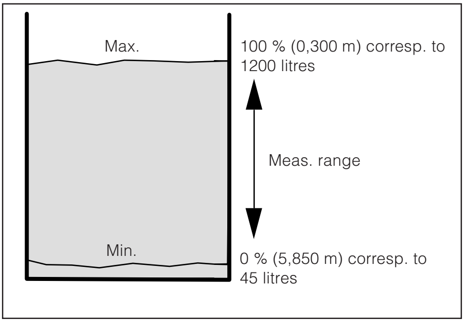
Index marker 2 is at a filling level of 30 % (30 % of the measuring distance of 0,3 m … 5,85 m). In our example there are at 30 % filling 576 litres in the vessel.

Index marker 3 is at a filling level of 60 %. At this filling level there are 646 litres in the vessel.

Index marker 4 is at a filling level of 100 % (product distance 0,300 m) at which 1200 litres are in the vessel.

You can adjust max. 32 index markers (value pairs).

- Quit the menu with "*OK*".
- Confirm the message with "*OK*", and your individual linearisation curve is saved in the



sensor.

Back again in the menu window "*Conditioning*" you can enter with the menu point "*Integration time*" a measured value integration. This is useful in case of agitated product surfaces to get no permanently changing measured value indication and measured value output.
As a standard feature an integration time of 0 seconds is adjusted.

- Quit the menu with "*OK*".

You are again in the menu window "Instrument data parameter adjustment".

- Quit the menu window with "*OK*".

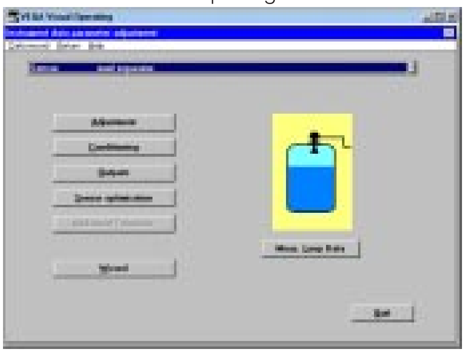
Outputs

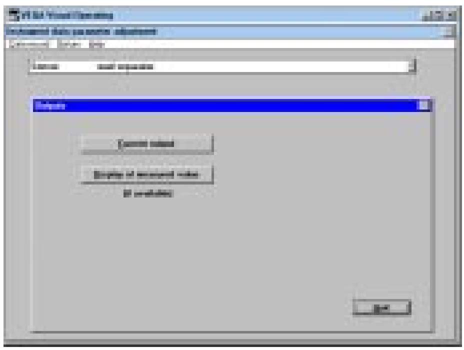
- Choose "*Instrument data parameter adjustment*".

- Choose in the menu window "*Instrument data parameter adjustment*" the menu point "*Outputs*".

You are in the menu window "*Outputs*".

Current output
With the menu point "*Current output*" you choose the menu window "*Current output*". In this window you can adjust the signal reaction of the 4 … 20 mA-output signal.





- If you have carried out adjustments in this menu window, click to "*Save*".
- If you want to keep these adjustments without saving the modifications, click to "*Quit*".

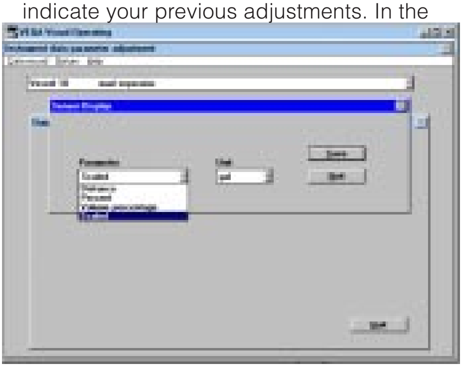
You are again in the menu window "*Outputs*".

Display of measured value

- Click in the menu window "*Outputs*" to the menu point "*Display of measured value*".

Now the menu window "*Sensor-Display*" opens. Here you can adjust once again the sensor display.

- Choose "*scaled*", when the display should indicate your previous adjustments. In the example a level of 45 … 1200 litres would be indicated.



- Choose "*Volume percent*", when you want that the level of 45 … 1200 litres is indicated as percentage value of 0 … 100 %.
- Choose "*Distance*", when the actual distance to the product surface should be indicated (in m).
- Choose "*Percent*", when the product distance of 0,300 … 5,850 m should be indicated as percentage value of 0 … 100 %.

With "*Save*" the adjustment is transferred to the sensor.

- Click to "*Quit*" in the window "*Sensor-Display*".
- Click to "*Quit*" in the window "*Outputs*".

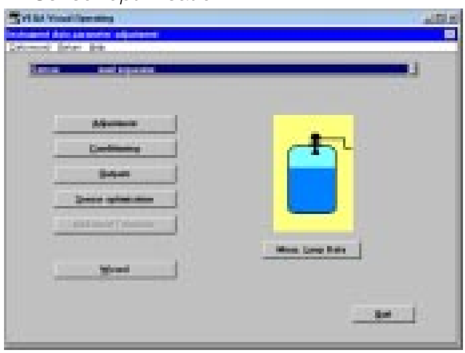
You are again in the initial menu window "*Instrument data parameter adjustment*".

Sensor optimisation

In the menu "*Sensor optimisation*" you can carry out special sensor optimising adjustments.

Meas. environment

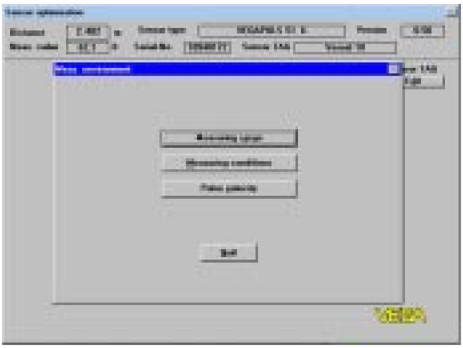
- Choose in the menu window "*Instrument data parameter adjustment*" the menu point "*Sensor optimisation*".



- First click to "*Meas. environment*".

With the menu point "*Measuring range*" you can define the measuring range of the sensor deviating from the "*Min/Max-adjustment*". As a standard feature the measuring range

corresponds to the min./max. adjustment.

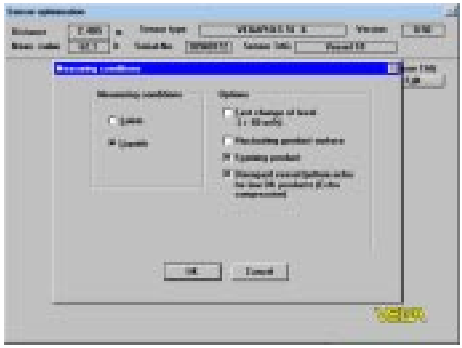


Generally it is more favourable to select the measuring range approx. 5 % bigger than the measuring window which has been determined by the min./max. adjustment. In the example the measuring range was 0,3 m … 5,85 m, so that the operating range was adjusted from 0,25 m to 6 m.

- Save the adjustments and quit the menu window "*Limitation of the operating range*".
- Click to "*Measuring conditions*".
- In the menu window "*Measuring conditions*" click to the options corresponding to your application.

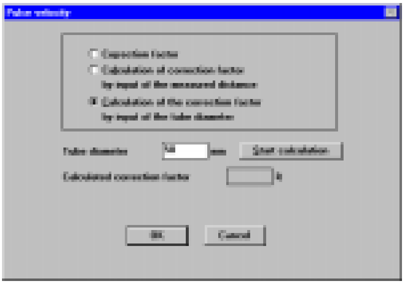
- Confirm with "*OK*".

After some seconds of saving during which the adjustments of the sensor are permanently saved, you are again in the window "*Meas. environment*".



In the menu point "*Pulse velocity*" you generally only make adjustments when you measure in a surge or bypass pipe (standpipe). With a standpipe measurement a shifting of the running time of the radar signals is caused which is dependent on the inner diameter of the standpipe. Therefore it is necessary to enter the required inner diameter of the standpipe.
In the menu point "*Pulse velocity*" it is additionally possible to enter a correction factor for the pulse velocity of the radar signal.

Note:
The radar signal spreads with light velocity.



- Quit this menu with "*Cancel*“ when you do not want to make any adjustments.
- Save with "*OK*“ the adjustments carried out.
- Click in the menu window "*Meas. environment*“ to "*Quit*“.

You are again in the menu window "*Sensor optimisation*“.

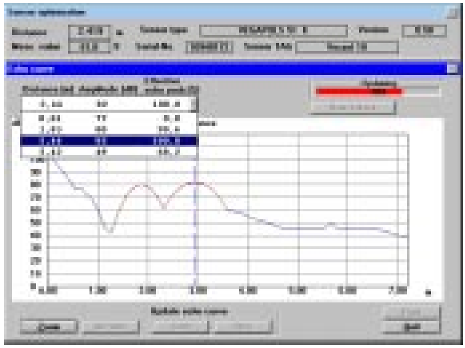
Echo curve

With the menu point "*Echo curve*“ you can display the course and the strength of the detected radar echo. If strong false echoes have to be expected due to struts, a correction of the installation position (if necessary) by observing the echo curve can help to localize and reduce the size of the false echo.

In the following figure you see the echo curve before the correction of the installation angle (directing to the product surface) with a false echo having nearly the same size than the product echo.

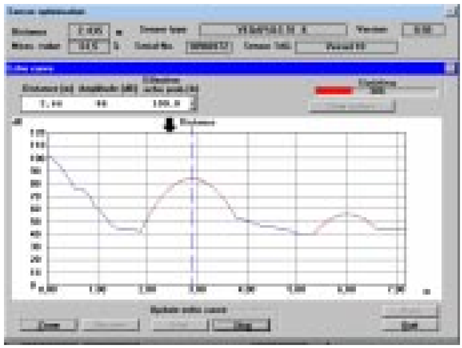
In the following figure you see the echo curve after optimum directing to the product surface (sensor axis reaches the product surface vertically).

- Leave the menu window "*Echo curve*“ with



"*Quit*“.

With the menu point "*False echo storage*“ in the menu window "*Sensor optimisation*“ you

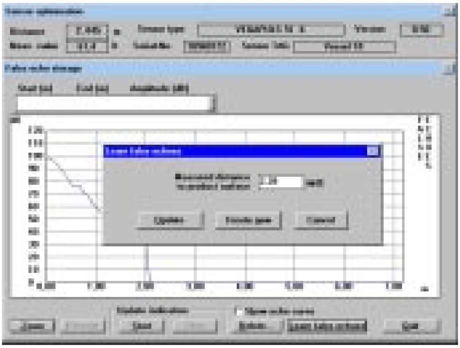


can cause the sensor to mark false echoes. The sensor electronics saves the false echoes in an internal database and treats the false echoes differently than the useful echo.

- Hence click in the menu window "*Sensor optimisation*“ to the menu point "*False echo storage*“.
- Now click in the opening menu window "*False echo storage*“ to "*Learn false echoes*“.

- Enter the checked product distance and click to "*Create new*“.

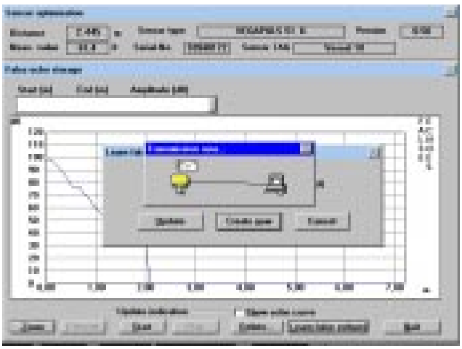
Hence you cause the sensor to mark all echoes in front of the product echo as false ech-



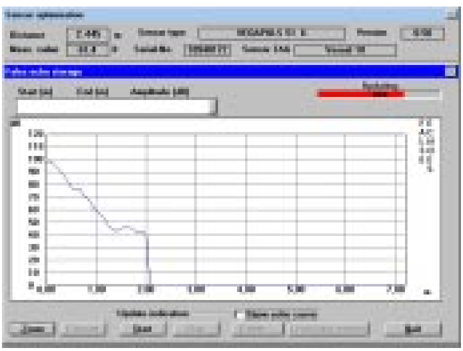
oes. This avoids that the sensor detects erroneously a false echo as level echo.

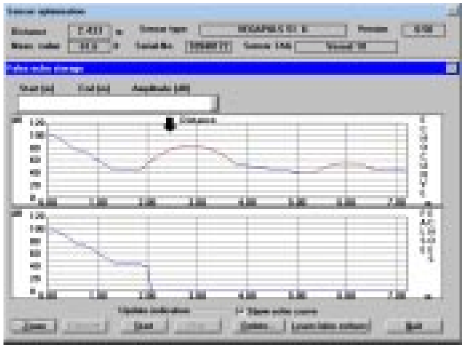
- Click to "*Show echo curve*".

The echo curve and the false echo marking are shown.



- Quit the menu with "*Quit*".





You are again in the menu window "*Sensor optimisation*".

With the menu point "*Reset*" you reset all options out of the menu "*Sensor optimisation*" to basic adjustment.

- Quit the menu window "*Sensor optimisation*" with "*Quit*".

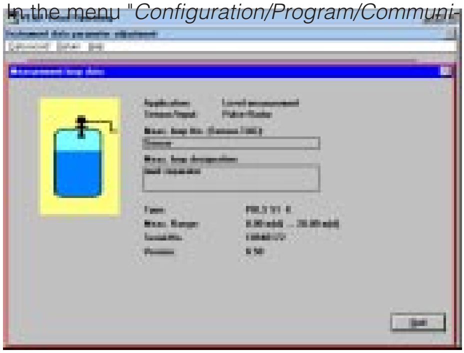
You are now in the entrance menu window "*Instrument data parameter adjustment*".

- Click to the menu point "*Measurement loop data*".

In the menu window measurement loop data all sensor characteristics data are shown.

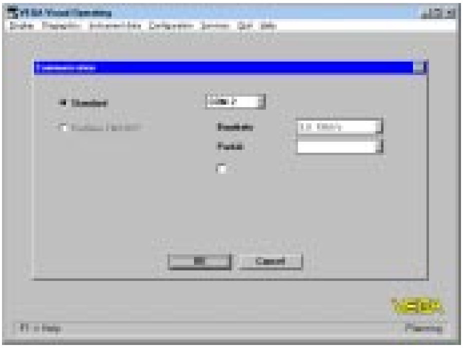
Parameter adjustment of interfaces

In the menu "*Configuration/Program/Communication*" you can adjust the interface parameters of your PC or change the used COM-Port.



Display of measured value

- Click in the entrance menu window to the menu "*Display*" and then to "*Display of measured value*".



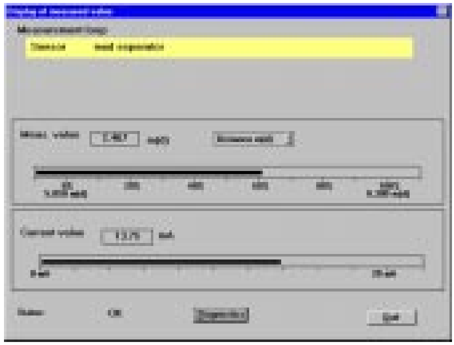
value":
- the measured value (the present measuring distance) in metres
- the percentage filling degree with the meas. limits adjusted in the min./max. adjustment (in the example 5,850 m at 0 % and 0,300 m at 100 %)
- the present signal current in the 4 … 20 mA-signal line

are displayed.

Simulation

- Click to the menu "*Diagnostics/Simulation*".

The menu window "*Display of measured value*" is opened which is similar to the previous menu window. In this menu window you can

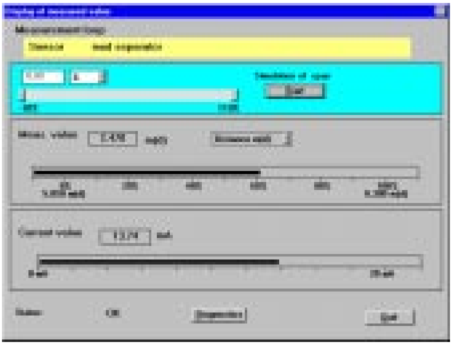


adjust the filling of the vessel or the signal current and the indication to an individual value (meas. value simulation).

First of all the present meas. value and the signal current are shown.

- Click in the turquoise window segment to "*Start*".

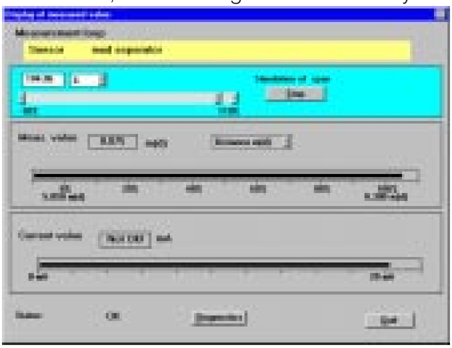
The grey scrollbar gets active. Here you can

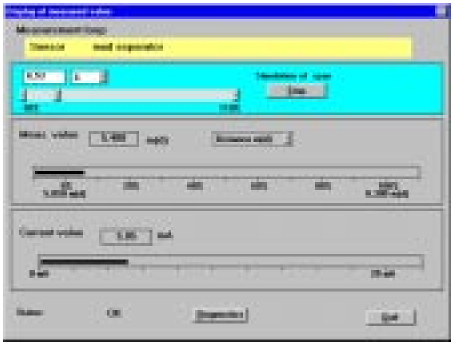


modify the meas. value in the range of -10 % … 110 % and hence simulate the filling or emptying of your vessel.

In the figure field of the turquoise window cut-out you can enter an individual %-value for the filling degree.

Note:
When no adjustment was made for more than 60 minutes, the sensor goes automatically





from the simulation mode to the operation mode. The indication flashes during simulation.

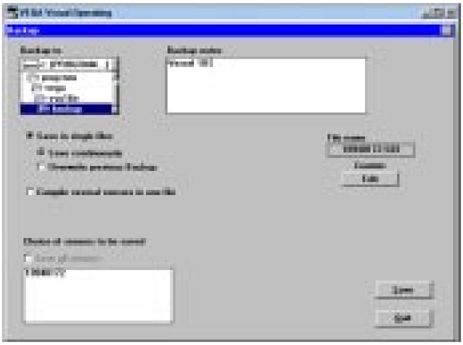
Backup

In the menu window "*Backup*“ the sensor with the series number is shown. You can save the sensor individually or in groups with all adjustments in a directory of your choice in the PC. You can add a small note to each backup.

Saved sensor data can be transferred later to

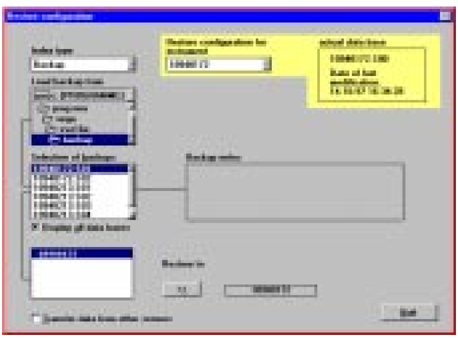
other sensors. If you have e.g. a plant with several, equal storage vessels and identical sensors, it is sufficient to configurate one sensor, save the adjustments and then transfer them to the other sensors.

- Choose the menu "*Services/Restore configu-*



ration/Sensors“

In this menu window, the present adjustment (database) with the data and time of the last system configuration is shown in the yellow window cut-out.
When you click to the series number of the sensor of which you want to take over the adjustments, you can transfer these sensor adjustments to the presently connected sensor



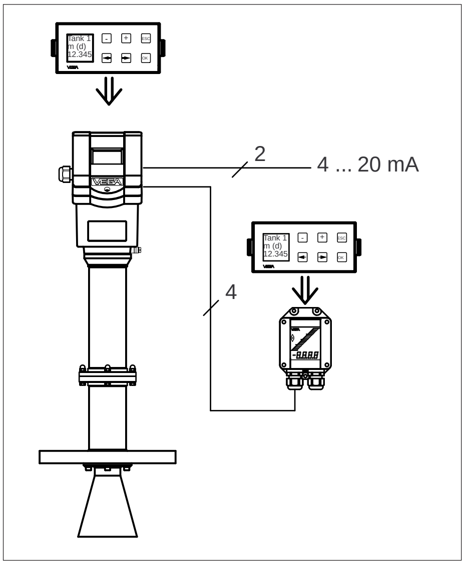
with "*Restore to*“.

6.3 Adjustment with adjustment module MINICOM

Like with the PC, the sensor can be also adjusted with the small, detachable adjustment module MINICOM. The adjustment module is hence plugged into the sensor or into the external indicating instrument (optionally).

For the adjustment with the adjustment module all adjustment options are available like with the PC and the adjustment program VVO. However the adjustment with MINICOM is different.

You carry out all adjustment steps with the 6 keys of the adjustment module. A small dis-



play gives beside the meas. value in short words the message on the menu point or the value of a menu adjustment.

The information volume of the small display however cannot be compared with the adjustment program VVO, however this should not be a problem and you will reach quickly to carry out directly adjustments with the small MINICOM.

Adjustment steps

At the end of this chapter you see the complete menu plan of the adjustment module MINICOM. Set-up the sensor in the following sequence. The numbers correspond to the sequence of a set-up. The numbers are listed with the appropriate menu points in the menu plan.

1. Measurement in a standpipe (only carry out when you measure in a standpipe).
2. Operating range
3. Adjustment
4. Conditioning
5. Meas. conditions
6. False echo storage (only necessary, when errors appear during operation).
7. Indication of the useful and noise level
8. Outputs

1. Measurement in a standpipe

Adjustment only necessary when the sensor is mounted on a standpipe (surge or bypass pipe).

With a standpipe measurement a shifting of the sound running time is caused which is dependent on the inner diameter of the standpipe. Measure the distance to the medium and correct the measured value indication (which can differ some percent from the measured value) according to the measurement to consider this shifting of the sound running time. The sensor then corrects future shiftings of the radar signal running time in the standpipe and indicates the correct levels in the standpipe (meas. pipe).

2. Operating range

Without special adjustment the operating range corresponds to the measuring range. The measuring range was already adjusted with the min./max. adjustment. It is generally useful to choose a slightly bigger operating range (approx. 5 %) than the measuring range.

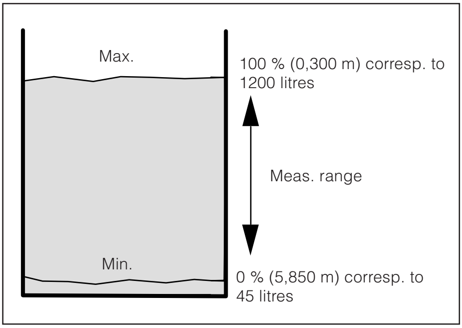
Example:
Min./max. adjustment: 0,300 … 5,850 m; adjust operating range to approx. 0,250 … 0,600 m.

3. Adjustment

Under the menu point "*Adjustment*" you inform the sensor with which meas. window it should work.

You can carry out the adjustment without and with medium. Generally you will carry out the adjustment without medium as you can adjust without filling cycle.

Adjustment without medium
Input (key)   Display indication

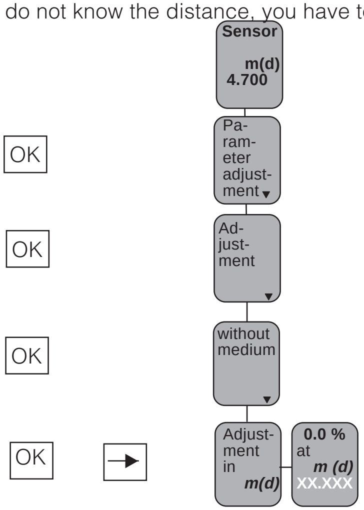


The distance indication flashes slowly

Now you can adjust with the "+" and "–"-key the distance of your sensor to the medium at 0

%-filling (example: 5,850 m)

If you do not know the distance, you have to measure



(Min-adjustment)

+

The indication stops flashing and the adjustment will be saved.

Hence you have adjusted the min. value.

For level detection outside the operating range, the operating range must be corrected appropriately in the menu "*Sensor optimisation/Meas. environment*“.

OK

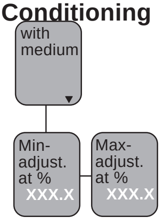
Carry out the max. adjustment like the min. adjustment with "*+*“, "*–*“ or "*OK*“ (example: 0,300 m).

Adjustment with medium

Fill the vessel e.g. to 10 % and enter 10 % in the menu "*Min-adjustment*“ with the "*+*“ and "*–*“-keys. Then fill the vessel e.g. to 80 % or 100 % and enter 80 % or 100 % in the menu "*Max-adjustment*“ with the "*+*“ and "*–*“-keys.

(Max-adjustment)

4. Conditioning

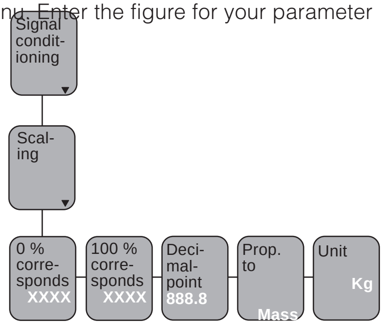


Under the menu point "*Conditioning*“ you choose the measuring distance at 0 % and at 100 %-filling. Finally you adjust the parameter and the unit as well as the decimal point.

Enter in the menu window "*0 % correspond*“ the figure of the 0 %-filling. In the example of the adjustment with the PC and the adjustment software VVO this would be 45 for 45 litres.

- Confirm with "*OK*“.

With the "—>“-key you change to the 100 %-menu. Enter the figure for your parameter



corresponding to a 100 %-filling. In the example this would be 1200 for 1200 litres.

- Confirm with "*OK*".

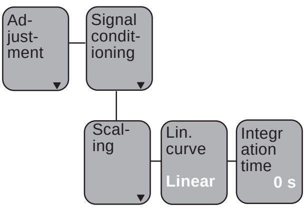
If necessary, choose a decimal point. However note that only max. 4 digits can be shown.

In the menu "*Prop. to*" you choose the parameter (mass, volume, distance…) and in the menu "*Unit*" the meas. unit (kg, l, ft^3, gal, m^3 …).

Linearisation:

A linear dependence between the percentage value of the product distance and the percentage value of the filling volume is pre-adjusted.

With the menu "Lin. curve" you can choose between linear, spherical tank and cylindrical tank. The adjustment of an own linearisation curve is only possible with the PC and the adjustment program VVO.



5. Meas. conditions

Here you choose the meas. conditions corresponding to your application (see following menu plan under no. 5).

6. False echo storage

A false echo storage is always useful when false echo sources such as e.g. struts must be reduced if not possible in another way (correction of the installation position). With the creation of a false echo storage you cause the sensor electronics to learn the false echoes and to save them in an internal database. The sensor electronics treats these (false) echoes differently than the useful echo and gates them out.

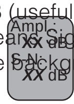
7. Useful and noise level

In the menu

you receive important information on the signal quality of the product echo.

The higher the amount out of "*Ampl.*" minus "*S-N*", the more reliable the measurement.

Ampl.: Means amplitude of the level echo in dB (useful level)



S-N: Means Signal-Noise, i.e. the level of the background noise (noise level)

The larger the distance of the amplitude (Ampl.) to the noise level (S-N), the better the measurement:

> 18 dB	Measurement very good
18 … 13 dB	Measurement good
13 … 8 dB	Measurement satisfactory
8 … 5 dB	Measurement sufficient
< 5 dB	Measurement very bad

Example:

Ampl. = 68 dB S-N = 53 dB

68 dB – 53 dB = 15 dB

15 dB signal distance mean a good reliability.

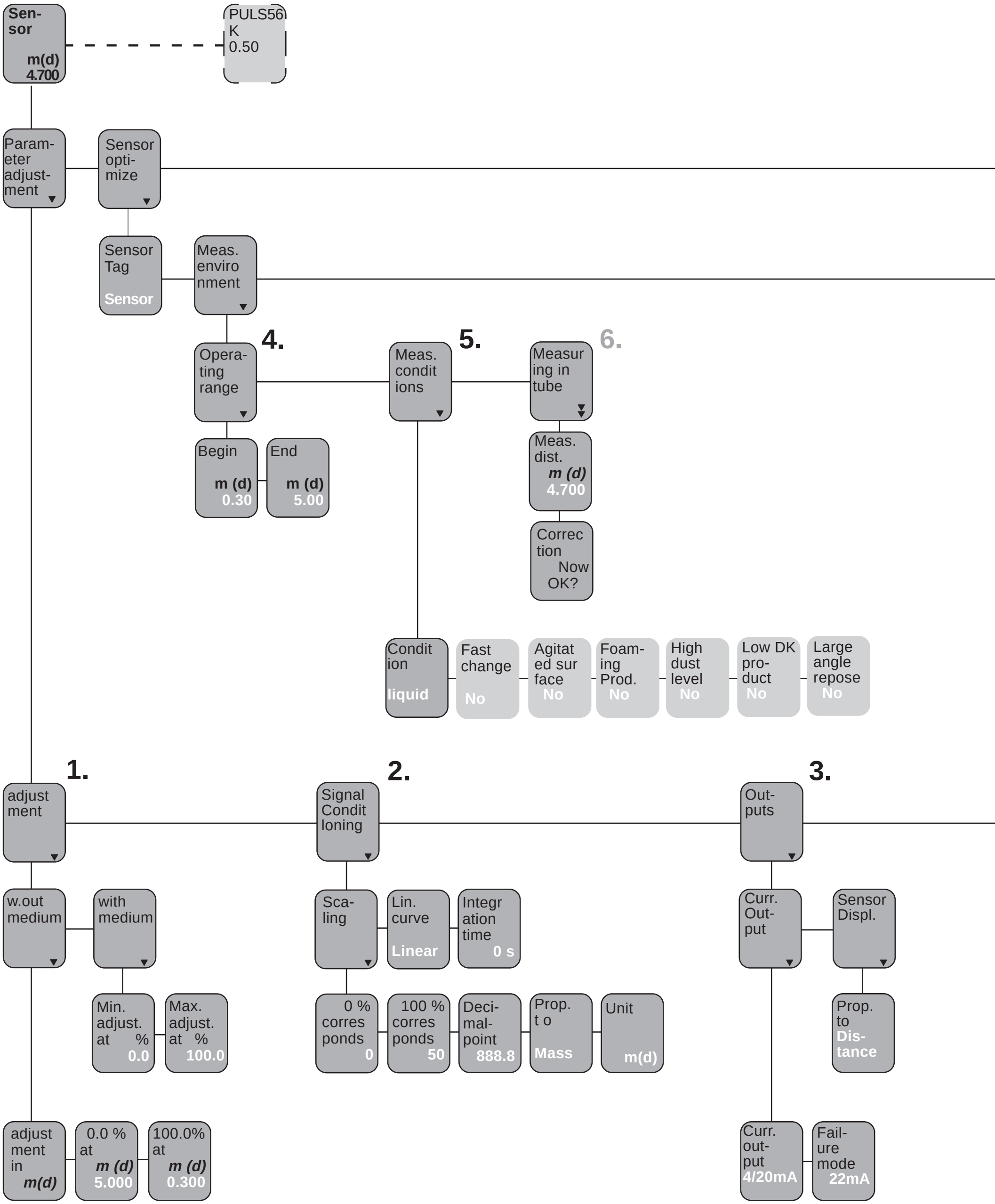
8. Outputs

Under the menu "*Outputs*" you determine if e.g. the current output should be inverted or which parameter should be provided by the sensor indication.

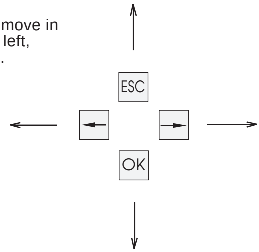
Failure indications:

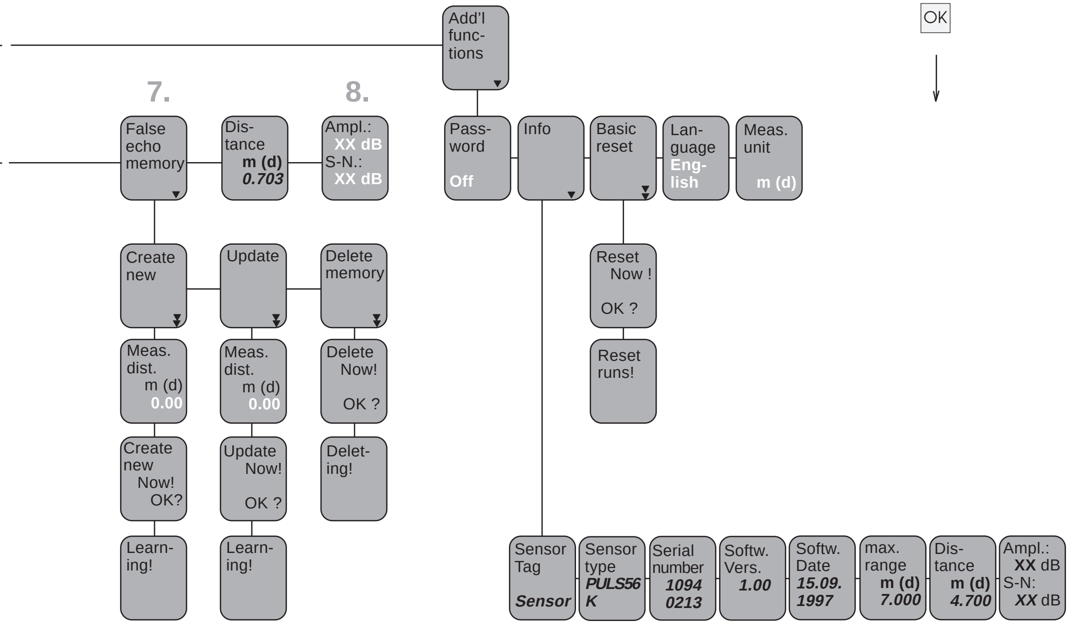
E	Hardware failure
E013	No valid measured value in the inlet phase or loss of the useful echo
E017	Adjustment span too small

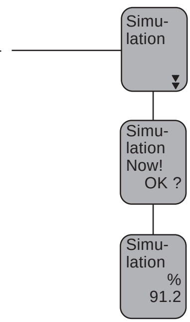
Menu plan of the adjustment module MINICOM



With these keys you move in the menu field to the left, right, top and bottom.

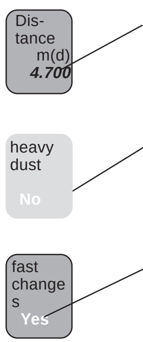






Simulation:
One hour after the last simulation adjustment the sensors goes automatically to normal operating condition.

Note:
Set-up the sensor in the sequence of the numbers. The menu points under the numbers 1 to 5 are required. The menus under the numbers 7 and 8 are only necessary under arduous measurement conditions. The menu under number 6 is only necessary for the measurement in a standpipe.



Menu points in bolt print provide sensor and measured value information and cannot be modified in this position.

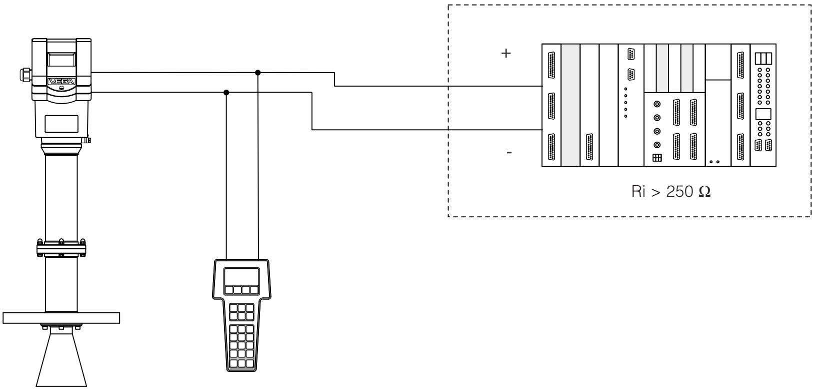
Light grey menu fields are only displayed if required (dependent on the adjustments in other menus).

White menu points can be modified with the "+" or "-"-key and saved with the "OK"-key.

6.4 Adjustment with the HART®-handheld

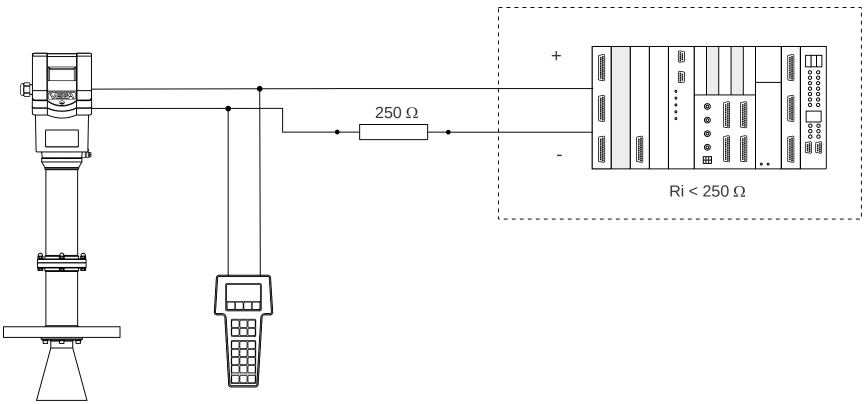
With each HART®-handheld it is possible to set-up VEGAPULS 56K radar sensors like all other sensors suitable for HART®-protocols. A special DDD (Data Device Description) is not required.

Just connect the HART®-handheld to the sensor signal line after you have connected the sensor to the power supply.



Note:
If the resistor of the power supply is less than 250 Ohm, a resistor must be looped into the signal/connection line during adjustment.

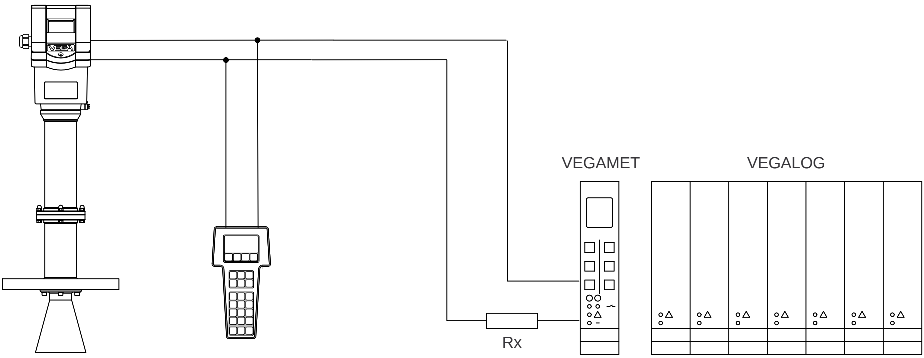
The digital adjustment and communication signals would be shortcircuited via too small resistors of the supply current source or the processing system, so that the sensor communication would no more be ensured.



Connection to a VEGA-signal conditioning instrument

If you operate a sensor suitable for HART®-protocols on a VEGA-signal conditioning instrument, you have to connect the sensor via a resistor acc. to the following table during the HART®-adjustment, to reach together with the inner resistor of the instrument the value of 250 Ohm required for the HART®-instrument.

VEGA-signal conditioning instr.	Rx
VEGAMET 513, 514, 515, 602	50 … 100 Ohm
VEGAMET 614 VEGADIS 371	no additional resistor required
VEGAMET 601	200 … 250 Ohm
VEGASEL 643	150 … 200 Ohm
VEGAMET 513 S4, 514 S4 515 S4, VEGALOG EA-card	100 … 150 Ohm



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