Product Information

Density measurement

PROTRAC

VEGA

Contents

Take note of safety instructions for Ex applications

Please note the Ex specific safety information which you can find on our homepage www.vega.com » Downloads » Approvals and which comes with every instrument. In hazardous areas you should take note of the corresponding regulations, conformity and type approval certificates of the sensors and power supply units. The sensors must only be operated on intrinsically safe circuits. The permissible electrical values are stated in the certificate.

37281-EN-100719

1 Measuring principle

Measuring principle

Gamma rays can penetrate matter. During the transit, part of the radiation is absorbed depending on the density and thickness of the medium. For radiation-based density measurement, this physical property can be used to measure contactlessly through a pipeline from the outside.

A detector detects the intensity of the gamma rays from a small radiation source. If medium is between detector and radiation source, a corresponding portion of the radiation is absorbed. The measurement is contactless from outside and hence suitable for extreme applications, for example, in very corrosive, aggressive and abrasive products.

Source holder

A Caesium or Cobalt isotope (gamma emitter) with low radiating intensity is enclosed in a source holder VEGASOURCE. The container consists of a lead-filled steel mantle that absorbs the gamma rays of the radioactive source, lowering them to permissible limit values. The focused radioactive rays can escape through a defined, closable radiation channel. Through a 180° rotation of the insert, the radiation channel is opened and the radiating isotope is swivelled into the radiation channel. The radioactive rays can thus escape.

The switch position (ON or OFF) is clearly visible from outside. The switch position "OFF" can be secured with a padlock.

A fire-proof version with an expansion tank is optionally available. In case of fire, the liquefied lead can spread into the expansion tank.

Sensor

The source holder VEGASOURCE with gamma emitter and the detector MINITRAC are mounted on opposite sides of the pipeline. The strength of the received radiation is proportional to the density of the medium in the pipeline. The electronics of the detector calculates therefrom the density or concentration of the medium. When a temperature sensor is also connected, the electronics takes the heat expansion of the medium into account. The sensor then outputs the density of the medium at the reference temperature selected by the user, not the actual measured density.

Medium and pipeline

The pipeline or the medium itself does not become radiactive when penetrated by gamma rays. Matter cannot become radioactive in this way. The implemented pipeline will not get contaminated and can be disposed of normally when the system is disassembled.

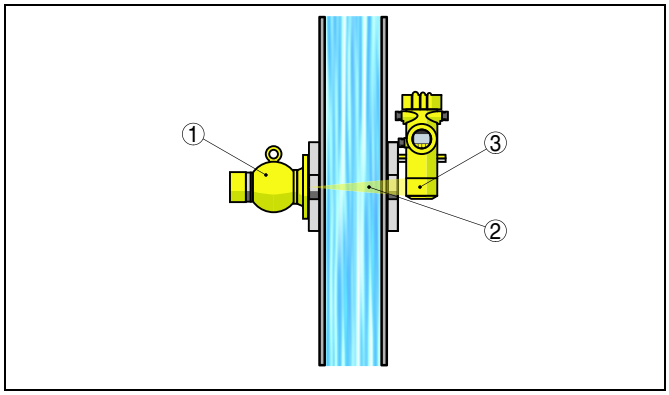

Fig. 1: Density measurement in a pipeline

1 Source holder (VEGASOURCE)
2 Radiation area
3 Detector (MINITRAC)

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2 Type overview

MINITRAC 31

Application	Density measurement
Version	NaI detector integrated in the sensor housing
Installation	Installation from outside on the pipeline
Process temperature	any
Ambient temperature	-50 … +60 °C
Process pressure	any
Measuring range	Depends on the application
Measuring accuracy	±1 g (field adjustment necessary)
Temperature stability	±0.05 % (50 … 60° C)
Reproducibility	±0.1 %
Voltage supply	20 … 72 V DC, 20 … 253 V AC, 50/60 Hz
Signal output	• 4 … 20 mA/HART • Profibus PA • Foundation Fieldbus
Indication/Adjustment	• PLICSCOM • PACTware • VEGADIS 61
Approvals	• ATEX • IEC • FM • CSA • GOST

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VEGASOURCE 31

Application	Density measurement
Attenuation factor typ.	Cs-137: 294 Co-60: 37
Number of the half-value layers typ.	Cs-137: 8.2 Co-60: 5.2
Damping of the useful beam approx.	0.3 half-value layers (attenuation factor 1.2)
Max. activity of the source	Cs-137: 22.2 GBq (600 mCi) Co-60: 740 MBq (20 mCi)
Exit angle	5° 20° 40°
Beam width	6°
Vessel material	Steel C22.8, 304, 316L
Screening material	Lead
Weight approx.	40 kg
Process fitting	Flange DN 100/PN 16 (not pressurized, not in contact with the process)
Fire resistance	For all versions: 5 min. at 538 °C For fire-resistant version: 30 min. at 821 °C
Ambient temperature	-40 … +200 °C
Transport packaging	Is deemed to be type A packaging according to the IATA directives

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3 Instrument selection

Application areas

Overview

The measuring system PROTRAC comprises the radiation-based sensors FIBERTRAC, SOLITRAC and MINITRAC as well as the source holder VEGASOURCE with integrated radioactive source. The sensors consist of an active measuring component, the detector, as well as an electronics module. They have different designs and are suitable for many different application areas and uses.

A radiation-based measuring system consists generally of the following components:

- Radioactive source
- Source holder
- Radiation-based sensor

The selection of the radioactive source and the radioactive activity as well as the sensor depends on the dimensions of the vessel or the pipeline, the wall thicknesses, the density of the medium, installations in the path of the beam as well as the measuring range.

Radiation-based sensor

The radiation-based sensor MINITRAC has a point-shaped detector with an anorganic scintillator of sodium iodide (NaI) for non-contact level detection and density measurement. This scintillator is characterized by a high sensitivity. The sensor is used on vessels with any geometry and on pipelines.

Source holder

The source holder VEGASOURCE serves as a receptacle for the radioactive material and as a radiation emitter. It is available in two sizes. Isotope Co-60 or Cs-137 with selectable radiating activity is used as radiation source. The radiation activity depends on the application.

Density measurement in pipelines

MINITRAC is used for density measurement in pipelines. The impulse rates of the medium with known density is stored in the MINITRAC as calibration data for the density measurement. As an alternative, the impulse rate of the actual medium can also be detected and the density determined in the laboratory. From this the electronics generates a table with impulse rate/density value pairs (linearisation curve). These data are used to calculate the corresponding density from the actual impulse rate.

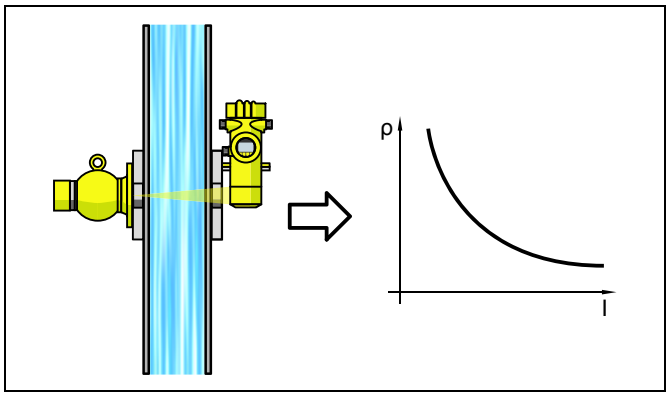

Fig. 2: Density measurement

I Impulse rate
ρ Density

The concentration of the medium can be determined from the measured density. For this purpose, an additional table with value pairs density/concentration (linearization curve) must be entered. The concentration of acids and lyes as well as the solid content in liquids can thus be measured.

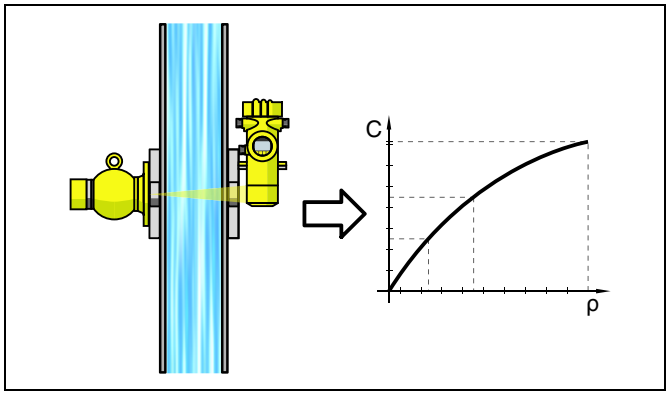

Fig. 3: Concentration measurement

ρ Density
C Concentration

4 Selection criteria source holder

	Version	VEGASOURCE 31
Source	Cs-137	●
	Co-60	●
Source activity	Cs-137: 22.2 GBq (600 mCi) Co-60: 0.74 GBq (20 mCi)	●
	Cs-137: 111 GBq (3000 mCi) Co-60: 3.7 GBq (100 mCi)	–
Manual switching on/off	Insertable lock for securing the switch position "*On/Off*"	●
Stirrup for manual switching on/off	Padlock for securing the switch position "*Off*"	●
	Insertable lock for securing the switch position "*On*" or "*Off*"	●
	Insertable lock for securing the switch position "*On*" or "*Off*" Better protection against moisture and contamination	●
Pneumatic switching on/off	Padlock for securing the switch position "*Off*"	●
	Padlock for securing the switch position "*Off*" Better protection against moisture and contamination	●
Fire-proof version	821 °C/30 min.	●

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5 Housing overview

Housing configuration

The housing is divided into the following chambers:

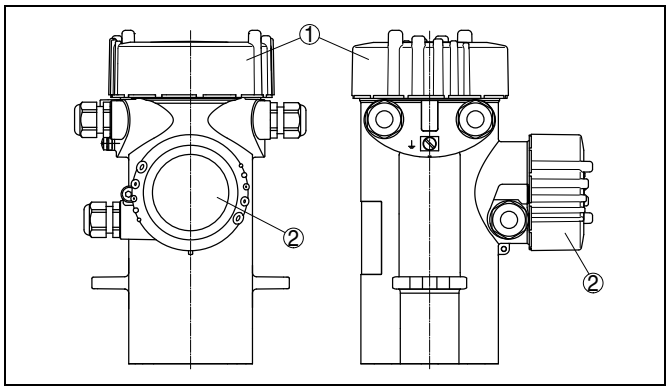

Fig. 4: Instrument housing

1 Electronics and connection compartment (top)
2 Adjustment and connection compartment (lateral)

Aluminium	
Protection rating	IP 66/IP 67, IP 66/IP 68 (1 bar)
Version	Double chamber
Application area	Industrial environment with increased mechanical wear

Stainless steel 316L	
Protection rating	IP 66/IP 67, IP 66/IP 68 (1 bar)
Version	Double chamber precision casting
Application area	Aggressive environment, strong mechanical wear

6 Mounting

Mounting position

The ideal measurement arrangement for the density measurement, is the mounting on a vertical pipeline. The pipe diameter can be 50 … 600 mm. The flow direction should be from bottom to top.

Mounting brackets, angled attachments as well as mounting clips are available for mounting.

Vertical pipeline, diameter 50 … 100 mm

With pipeline diameters of 50 … 100 mm, a diagonal radiation path is recommended. The distance of the beam through the medium is thus longer and an improved measuring effect is achieved. For this the optional lead shielding for the detector is recommended in order to avoid influence from secondary radiation sources.

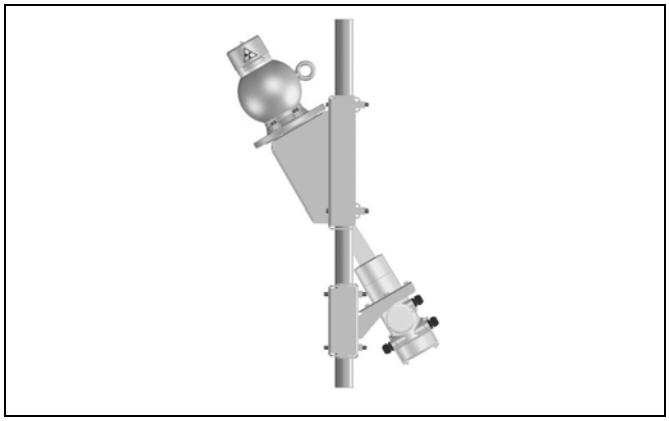

Fig. 5: Measurement arrangement on a pipeline with a diameter of 50 … 100 mm

Vertical pipeline, diameter 100 … 420 mm

With pipeline diameters of 100 … 420 mm, a straight radiation path is possible. The radiation-based sensor can be mounted either horizontally or vertically.

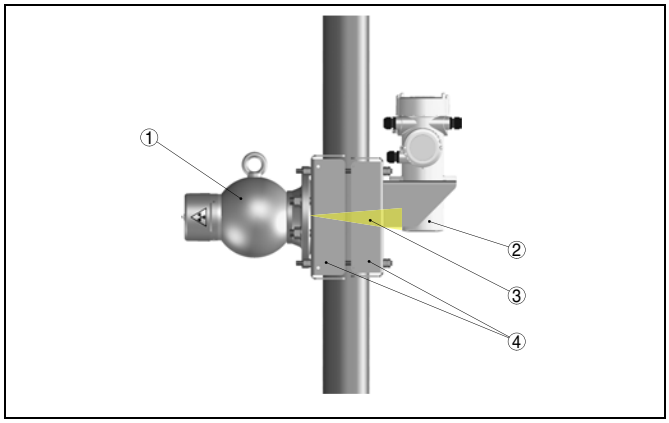

Fig. 6: Measurement arrangement on a pipeline with a diameter of 100 … 420 mm, detector mounting vertically

1 Source holder (VEGASOURCE)
2 Radiation-based sensor (MINITRAC)
3 Radiation area
4 Mounting brackets

When mounting the radiation-based sensor horizontally, the optional lead shielding is recommended in order to avoid influence from secondary radiation sources.

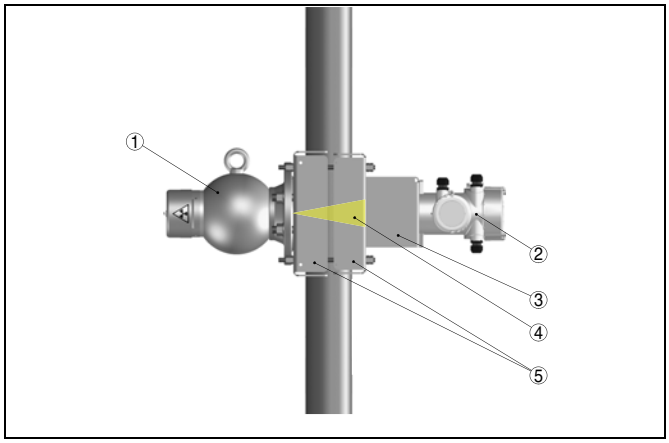

Fig. 7: Measurement setup on a pipeline with a diameter of 100 … 420 mm, detector mounted horizontally

1 Source holder (VEGASOURCE)
2 Radiation-based sensor (MINITRAC)
3 Mounting
4 Radiation area
5 Mounting brackets

Horizontal pipeline

With a horizontal pipeline, the line must be radiated with vertical radiation level to avoid interferences by air pockets.

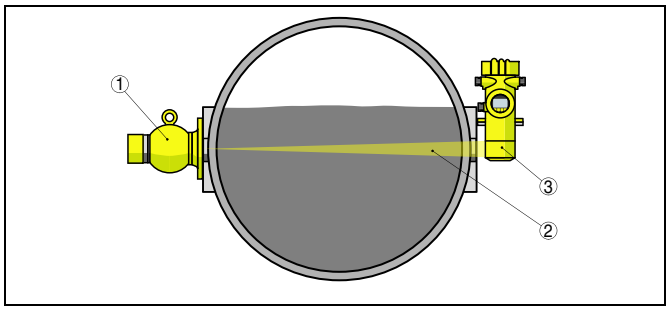

Fig. 8: Measurement arrangement on a horizontal pipeline

1 Source holder (VEGASOURCE)
2 Radiation area
3 Detector (MINITRAC)

Mounting instructions - VEGASOURCE

The exit angle of the source holder VEGASOURCE must be directed to the measuring range of the sensor mounted on the opposite side.

The source holder VEGASOURCE should be mounted close to the vessel. If there are gaps, protect the area by a safety fence and a grid against grasping into the dangerous area. Such areas should be marked respecitively.

7 Electronics - 4 … 20 mA/HART

Configuration of the electronics

The pluggable electronics is mounted in the electronics and connection compartment of the instrument and can be exchanged by the user when servicing is required. The electronics is completely encapsulated to protect against vibration and moisture.

On the upper side of the electronics, you can find the terminals for voltage supply, measuring signal output as well as further analogue, digital and serial interfaces.

This output is located in the adjustment and connection compartment with instrument versions with intrinsically safe (IS) measuring signal output.

Voltage supply/Signal processing

If a reliable separation is required, the voltage supply and the signal processing are carried out via separate two-wire connection cables.

- Operating voltage
  - 20 … 72 V DC, 20 … 253 V AC, 50/60 Hz

Connection cable

For power supply, an approved installation cable with PE conductor is necessary.

The 4 … 20 mA current output is connected with standard two-wire cable without screen. If electromagnetic interference is expected which is above the test values of EN 61326 for industrial areas, screened cable should be used.

Cable screening and grounding

If screened cable is necessary, the cable screen must be connected on both ends to ground potential. If potential equalisation currents are expected, the connection on the evaluation side must be made via a ceramic capacitor (e.g. 1 nF, 1500 V).

Connection non-Ex instruments

Electronics and connection compartment

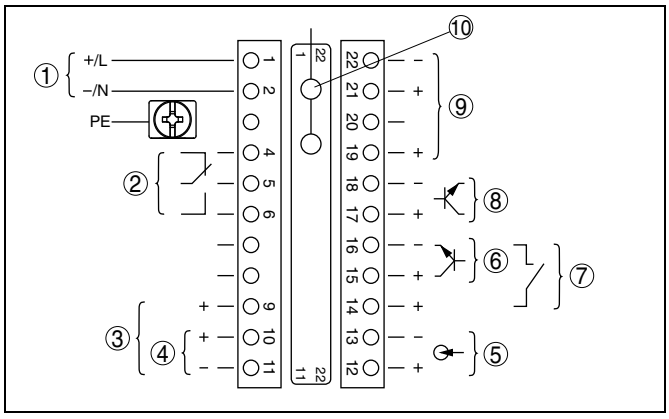

Fig. 9: Electronics and connection compartment with non-Ex instruments

1 Voltage supply
2 Relay output
3 Signal output 4 … 20 mA/HART active
4 Signal output 4 … 20 mA/HART passive
5 Signal input 4 … 20 mA
6 Switching input for NPN transistor
7 Switching input floating
8 Transistor output
9 Interface for sensor-sensor communication
10 Adjustment bus address for sensor-sensor communication

Adjustment and connection compartment

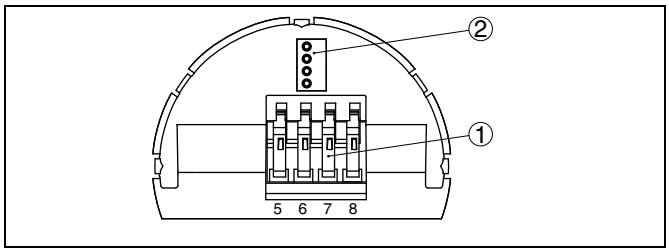

Fig. 10: Adjustment and connection compartment with non-Ex instruments

1 For external indicating and adjustment unit
2 Contact pins for the indicating and adjustment module or interface adapter

Connection Ex instruments

Electronics and connection compartment

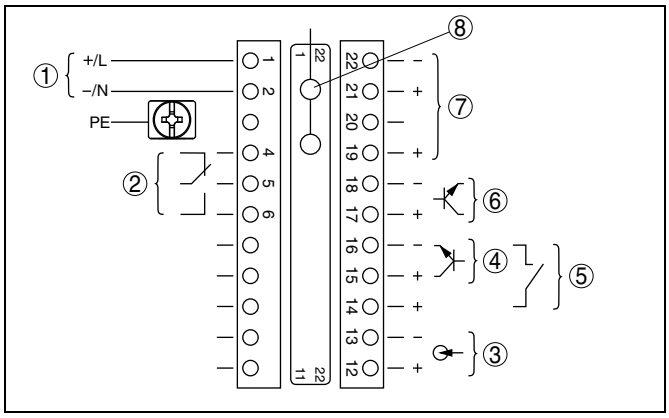

Fig. 11: Electronics and connection compartment with Ex instruments

1 Voltage supply
2 Relay output
3 Signal input 4 … 20 mA
4 Switching input for NPN transistor
5 Switching input floating
6 Transistor output
7 Interface for sensor-sensor communication
8 Adjustment bus address for sensor-sensor communication

Adjustment and connection compartment

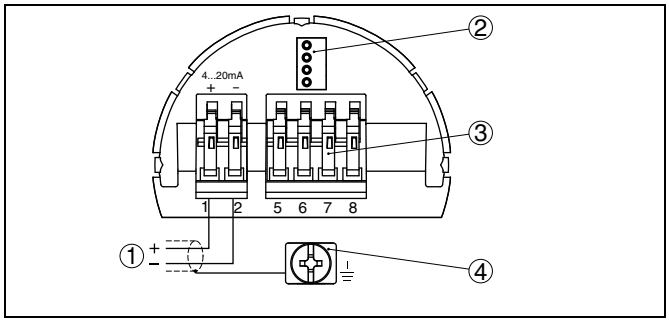

Fig. 12: Adjustment and connection compartment with Ex instruments

1 Signal output 4 … 20 mA/HART active
2 Contact pins for the indicating and adjustment module or interface adapter
3 For external indicating and adjustment unit
4 Ground terminal for connection of the cable screen

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8 Electronics - Profibus PA

Configuration of the electronics

The pluggable electronics is mounted in the electronics and connection compartment of the instrument and can be exchanged by the user when servicing is required. The electronics is completely encapsulated to protect against vibration and moisture.

On the upper side of the electronics, you can find the terminals for voltage supply, measuring signal output as well as further analogue, digital and serial interfaces.

This output is located in the adjustment and connection compartment with instrument versions with intrinsically safe (IS) measuring signal output.

Voltage supply/Signal processing

If a reliable separation is required, the voltage supply and the signal processing are carried out via separate two-wire connection cables.

- Operating voltage
  - 20 … 72 V DC, 20 … 253 V AC, 50/60 Hz

Connection cable

Connection is made with screened cable according to Profibus specification. A cable diameter of 5 … 9 mm ensures the seal effect of the cable gland.

Make sure that the entire installation is carried out according to the Profibus specification. In particular, make sure that the termination of the bus is done with appropriate terminating resistors.

Cable screening and grounding

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

In systems without potential equalisation, connect the cable screen directly to ground potential at the power supply unit and at the sensor. In the connection box or T-distributor, the screen of the short stub to the sensor must not be connected to ground potential or to another cable screen. The cable screens to the power supply unit and to the next distributor must be connected to each other and also connected to ground potential via a ceramic capacitor (e.g. 1 nF, 1500 V). Low-frequency potential equalisation currents are thus suppressed, but the protective effect against high frequency interference signals remains.

Connection non-Ex instrument

Electronics and connection compartment

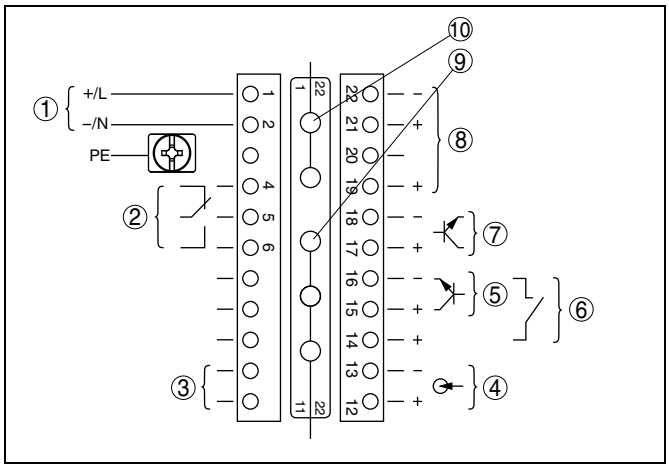

Fig. 13: Electronics and connection compartment non-Ex instrument

1 Voltage supply
2 Relay output
3 Signal output Profibus PA
4 Signal input 4 … 20 mA
5 Switching input for NPN transistor
6 Switching input floating
7 Transistor output
8 Interface for sensor-sensor communication
9 Adjustment Profibus PA address
10 Adjustment bus address for sensor-sensor communication

Adjustment and connection compartment

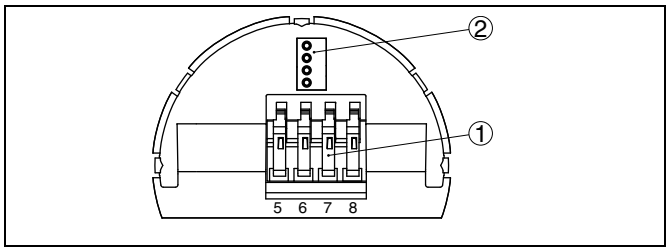

Fig. 14: Adjustment and connection compartment non-Ex instrument

1 For external indicating and adjustment unit
2 Contact pins for the indicating and adjustment module or interface adapter

Connection Ex instrument

Electronics and connection compartment

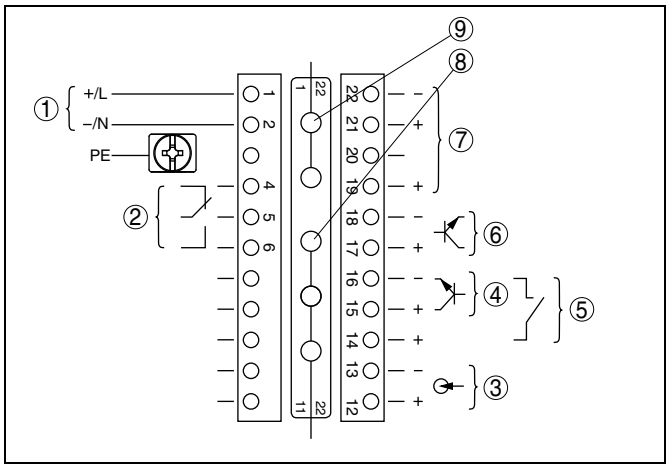

Fig. 15: Electronics and connection compartment Ex instrument

1 *Voltage supply*
2 *Relay output*
3 *Signal input 4 … 20 mA*
4 *Switching input for NPN transistor*
5 *Switching input floating*
6 *Transistor output*
7 *Interface for sensor-sensor communication*
8 *Adjustment Profibus PA address*
9 *Adjustment bus address for sensor-sensor communication*

Adjustment and connection compartment

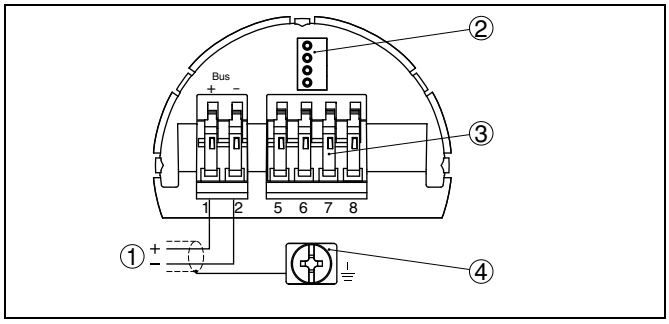

Fig. 16: Adjustment and connection compartment Ex instrument

1 *Signal output*
2 *Contact pins for the indicating and adjustment module or interface adapter*
3 *For external indicating and adjustment unit*
4 *Ground terminal for connection of the cable screen*

9 Electronics - Foundation Fieldbus

Configuration of the electronics

The pluggable electronics is mounted in the electronics and connection compartment of the instrument and can be exchanged by the user when servicing is required. The electronics is completely encapsulated to protect against vibration and moisture.

On the upper side of the electronics, you can find the terminals for voltage supply, measuring signal output as well as further analogue, digital and serial interfaces.

This output is located in the adjustment and connection compartment with instrument versions with intrinsically safe (IS) measuring signal output.

Voltage supply/Signal processing

If a reliable separation is required, the voltage supply and the signal processing are carried out via separate two-wire connection cables.

- Operating voltage
  - 20 … 72 V DC, 20 … 253 V AC, 50/60 Hz

Connection cable

Connection is made with screened cable according to Fieldbus specification. A cable diameter of 5 … 9 mm ensures the seal effect of the cable gland.

Make sure that the entire installation is carried out according to the Fieldbus specification. In particular, make sure that the termination of the bus is done with appropriate terminating resistors.

Cable screening and grounding

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

In systems without potential equalisation, connect the cable screen directly to ground potential at the power supply unit and at the sensor. In the connection box or T-distributor, the screen of the short stub to the sensor must not be connected to ground potential or to another cable screen. The cable screens to the power supply unit and to the next distributor must be connected to each other and also connected to ground potential via a ceramic capacitor (e.g. 1 nF, 1500 V). Low-frequency potential equalisation currents are thus suppressed, but the protective effect against high frequency interference signals remains.

Connection non-Ex instrument

Electronics and connection compartment

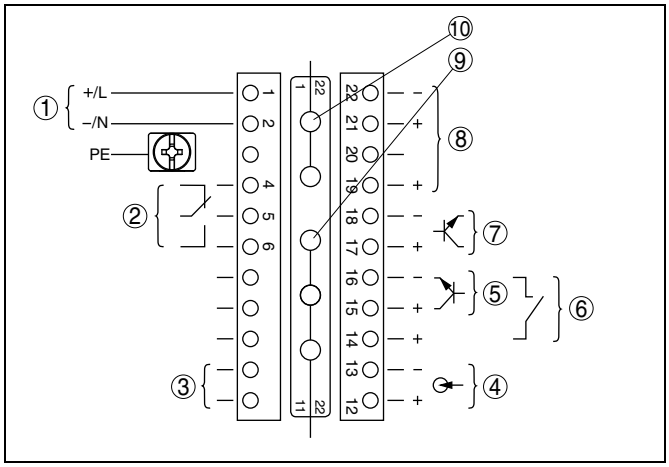

Fig. 17: Electronics and connection compartment non-Ex instrument

1 Voltage supply
2 Relay output
3 Signal output PA
4 Signal input 4 … 20 mA
5 Switching input for NPN transistor
6 Switching input floating
7 Transistor output
8 Interface for sensor-sensor communication
9 Adjustment bus address for sensor-sensor communication
10 Simulation switch ("on" = mode for simulation release)

Adjustment and connection compartment

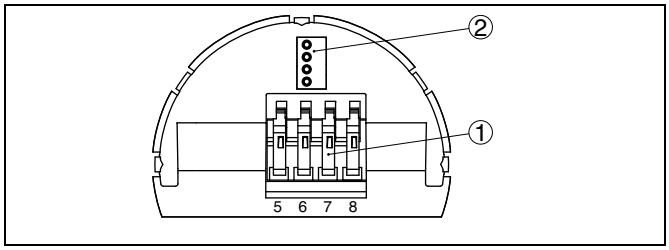

Fig. 18: Adjustment and connection compartment non-Ex instrument

1 For external indicating and adjustment unit
2 Contact pins for the indicating and adjustment module or interface adapter

Connection Ex instrument

Electronics and connection compartment

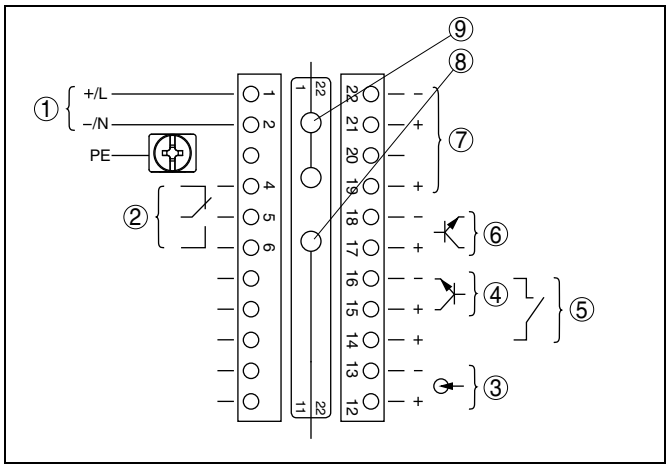

Fig. 19: Electronics and connection compartment Ex instrument

1 Voltage supply
2 Relay output
3 Signal input 4 … 20 mA
4 Switching input for NPN transistor
5 Switching input floating
6 Transistor output
7 Interface for sensor-sensor communication
8 Adjustment bus address for sensor-sensor communication
9 Simulation switch ("on" = mode for simulation release)

Adjustment and connection compartment

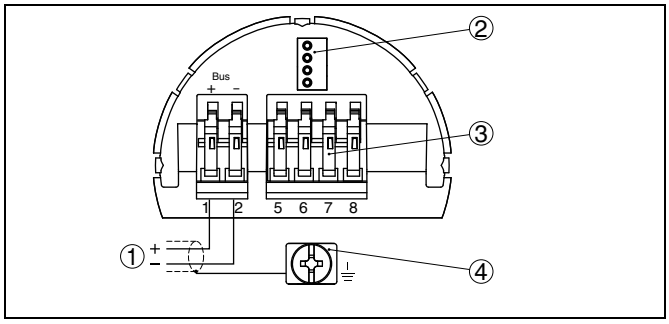

Fig. 20: Adjustment and connection compartment Ex instrument

1 Signal output
2 Contact pins for the indicating and adjustment module or interface adapter
3 For external indicating and adjustment unit
4 Ground terminal for connection of the cable screen

10 Operation

10.1 Overview

The sensors can be adjusted with the following adjustment media:
- with indicating and adjustment module
- an adjustment software according to FDT/DTM standard, e.g. PACTware and PC

and, depending on the signal output, also with:
- A HART handheld (4 … 20 mA/HART)
- The adjustment program AMS (4 … 20 mA/HART and Foundation Fieldbus)
- The adjustment program PDM (Profibus PA)
- A configuration tool (Foundation Fieldbus)

The entered parameters are generally saved in the sensor, optionally also in the indicating and adjustment module or in the adjustment program.

10.2 Indicating and adjustment module PLICSCOM

The pluggable indicating and adjustment module is used for measured value indication, operation and diagnosis. It is equipped with an illuminated full dot matrix as well as four keys for adjustment.

Fig. 21: Indicating and adjustment module PLICSCOM

The indicating and adjustment module is integrated in the respective sensor housing or in the external indicating and adjustment unit. After mounting, the sensor as well as the indicating and adjustment module are splash-proof even without housing cover.

10.3 PACTware/DTM

As an alternative to the indicating and adjustment module, the sensor can also be configured via a Windows PC. For this purpose, the configuration software PACTware and a suitable instrument driver (DTM) according to the FDT standard are required. The actual PACTware version as well as all available DTMs are compiled in a DTM Collection. Furthermore the DTMs can be integrated in other frame applications according to the FDT standard.

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

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

Connection of the PC via VEGACONNECT
The interface converter VEGACONNECT is required for connection of the PC. On the computer side, the connectionis made via USB interface. The VEGACONNECT is placed instead of the indicating and adjustment module to the sensor, the connection to the sensor is made automatically. As an alternative the connection via the HART signal can be carried out on any position of the signal cable with 4 … 20 mA/HART sensors.

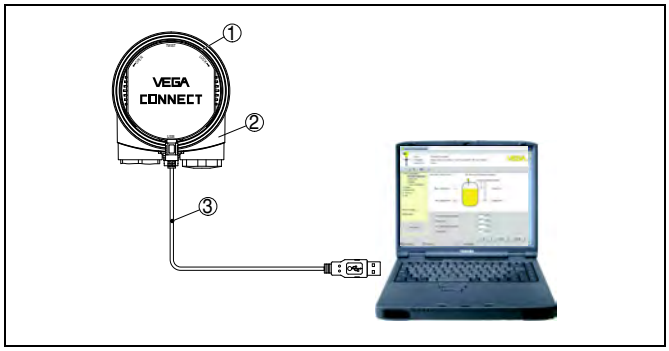

Fig. 22: Connection via VEGACONNECT and USB

1 VEGACONNECT
2 plics® sensor
3 USB cable to the PC

Necessary components:
- PROTRAC
- PC with PACTware and suitable DTM
- VEGACONNECT
- Voltage supply/Processing system

10.4 Alternative adjustment programs

PDM
For HART and Profibus PA sensors, device descriptions are available as EDDs for the adjustment program PDM. The device descriptions are already included in the current version of the PDM. Newer instrument drivers that are not yet delivered with the PDM are available in the download section.

AMS
For HART and Foundation Fieldbus sensors, device descriptions are available as EDDs for the adjustment program AMS. The device descriptions are already included in the current version of the AMS. Newer instrument drivers that are not yet delivered with the AMS are available in the download section.

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11 Dimensions

Aluminium and stainless steel housing

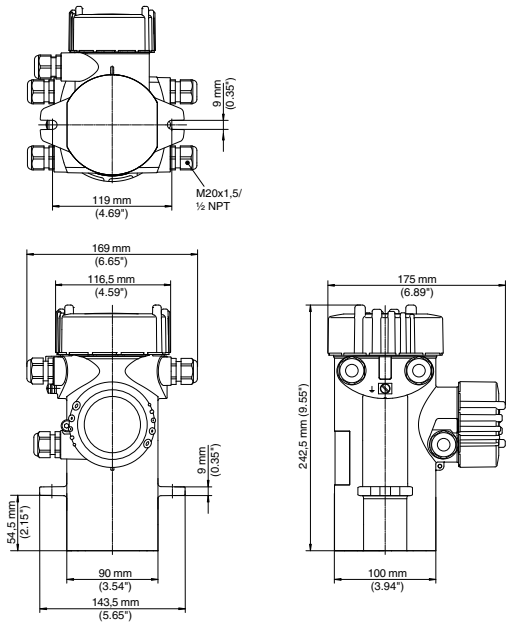
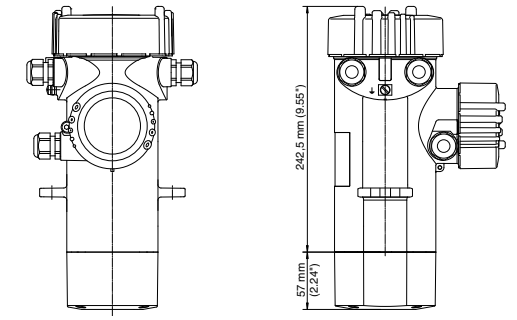


Fig. 23: Aluminium housing or stainless steel housing - Precision casting

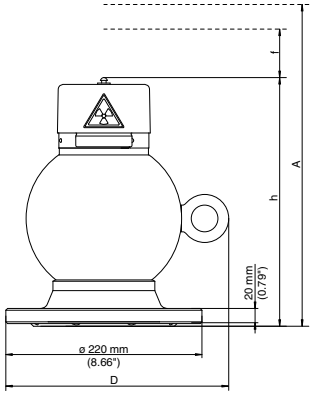
MINITRAC 31



Source holder VEGASOURCE 31

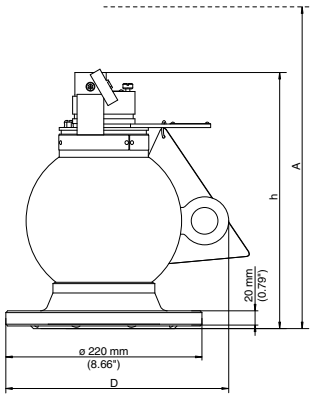
Version	Properties
A	Source insert for manual switching ON/OFF Insertable lock for securing the switch position ON/OFF Protective cover
B	Stirrup for manual switching on/off Fixing pin for securing the switch position ON Padlock for securing the switch position OFF
C	Stirrup for manual switching on/off Padlock for securing the switch position ON/OFF
D	Better protection against moisture and contamination Stirrup for manual switching on/off Padlock for securing the switch position ON/OFF
K **L**	Pneumatic switching on/off Padlock for securing the switch position OFF
M **N**	Better protection against moisture and contamination Pneumatic switching on/off Padlock for securing the switch position OFF

Source holder VEGASOURCE 31 A



D 251 mm
h 279 mm
f 75 mm (free height to detach the cover)
A 479 mm (free height for emitter exchange)

Source holder VEGASOURCE 31 B



D 251 mm
h 287 mm
A 450 mm (free height for emitter exchange)

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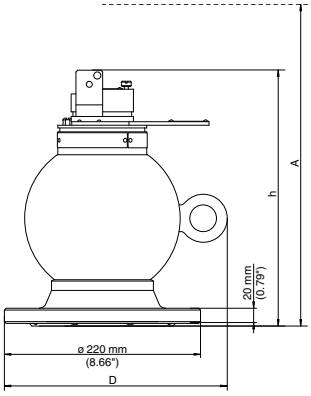
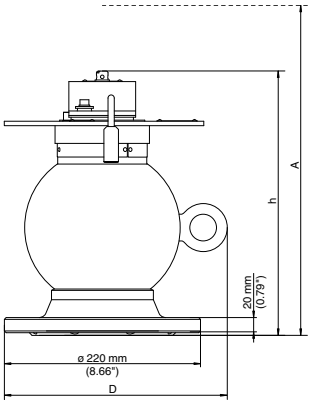
Source holder VEGASOURCE 31 C



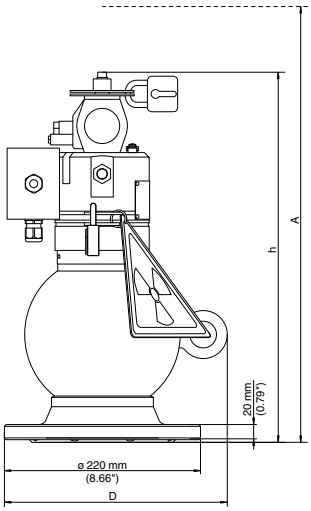
D 251 mm
h 287 mm
A 450 mm (free height for emitter exchange)

Source holder VEGASOURCE 31 D / 35 D



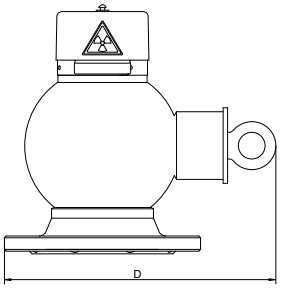
D 251 mm
h 297 mm
A 497 mm (free height for emitter exchange)

Source holder VEGASOURCE 31 K, L, M, N



D 251 mm
h 419 mm
A 483 mm (free height for emitter exchange)

Source holder VEGASOURCE 31 C - fire-proof version



D 305 mm

The listed drawings are only an excerpt of the available process fittings. You can find further drawings on our homepage www.vega.com » Downloads » Drawings.

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