Product information
Radar

Autarkic level measurement in liquids and bulk solids

VEGAPULS Air 23
VEGAPULS Air 41
VEGAPULS Air 42

Document ID: 65343

VEGA

Contents

Take note of safety instructions for Ex applications

Please note the Ex specific safety information that you can find at www.vega.com and that comes with each instrument. In hazardous areas you should take note of the appropriate 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.

1 Measuring principle, voltage supply and measured value transmission

Measuring principle

The devices emit a continuous radar signal through their antennas. The emitted signal is reflected by the medium and received as an echo by the antenna.

The frequency difference between the emitted and received signal is proportional to the distance and depends on the filling height. The determined distance is converted into a respective output signal and output wirelessly as measured value.

80 GHz technology

The 80 GHz technology used enables a unique focusing of the radar beam and a wide dynamic range of the radar sensors. The greater the dynamic range of a radar sensor, the wider its application spectrum and the higher its measurement reliability.

Input variable

Depending on the type of device, the measurement is taken through the closed plastic ceiling of the vessel or a suitable nozzle opening on the vessel.

The measured variable and thus the input variable of the sensor is the distance between the reference plane of the sensor and the medium surface.

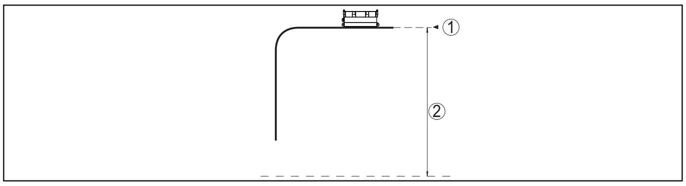

Fig. 1: Data of the input variable VEGAPULS Air 23

1. *Reference plane*
2. *Measured variable, max. measuring range*

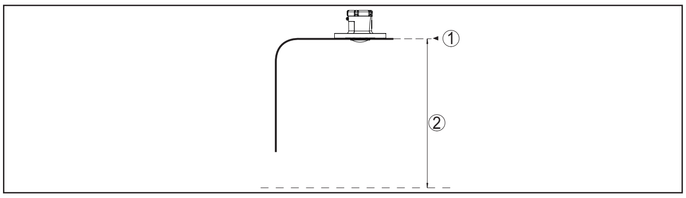

Fig. 2: Data of the input variable VEGAPULS Air 42

1. *Reference plane*
2. *Measured variable, max. measuring range*

Voltage supply

The devices are powered by integrated primary cells. The lithium cell used for this is a compact storage of high cell voltage and capacity for a long service life. Since no additional power supply is required and thus engineering and cabling effort are eliminated, the autarkic sensor offers a particularly economical solution.

Time-controlled measured value transmission

The measuring cycle described above is time-controlled via the integrated clock. Outside the measurement cycle, the device is in sleep mode. This concept of time-controlled sending of measured values and the sleep mode in between enables operation of the devices for more than 10 years, depending on the measuring interval.

Measured value transmission

The devices transmit their measured values and other data wirelessly to asset management systems, e.g. the VEGA Inventory System. For this purpose, they offer the following transmission paths:

- Mobile radio NB-IoT (LTE-CAT-NB1)
- Mobile radio LTE-M (LTE-CAT-M1)
- LoRaWAN network

Mobile radio via LTE-M (Long Term Evolution for Machines) as well as via NB-IoT (Narrow Band Internet of Things) is an extension of the mobile radio standard LTE to IoT applications.

This is the simplest way to bring the data directly - without additional transmission facilities - worldwide into the VEGA Inventory System.

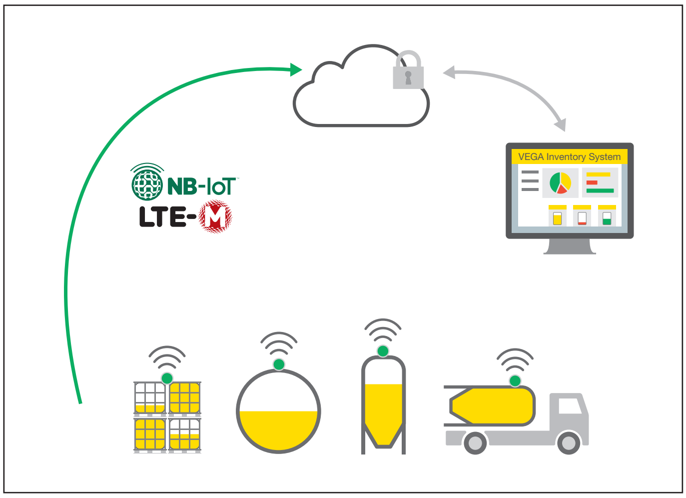

Fig. 3: Wireless measured value transmission via mobile radio

Another option is to transmit data into an existing private LoRaWAN network. LoRaWAN (Long Range Wide Area Network) is a network protocol for wireless signal transmission. A corresponding gateway is required for this. The data is transferred here to a user-side database.

The combination of public mobile radio and LoRaWAN also makes it possible to set up a "*Fall-back concept*": automatic switching to LoRaWAN in the event of faults in the mobile radio transmission.

VEGA Inventory System

VEGA Inventory System was specially developed for inventory monitoring in liquid tanks and bulk solids silos.

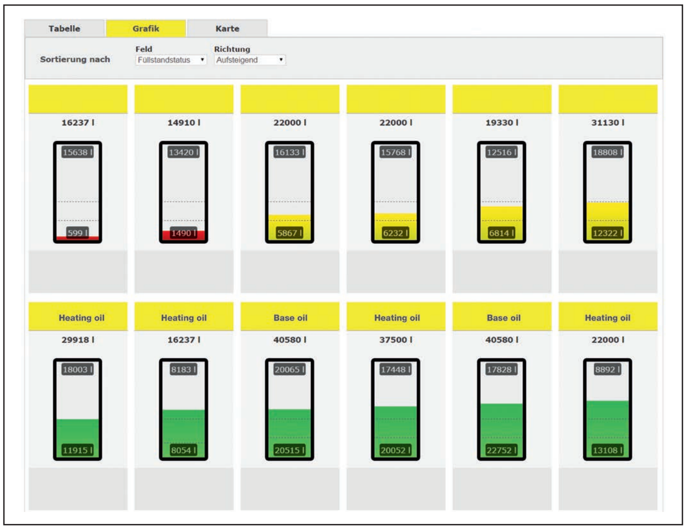

Fig. 4: VEGA Inventory System

The software works with measuring devices that continuously record the level of a wide variety of liquids (e.g. water, chemicals, fuels, lubricants, additives and liquid gas) as well as bulk solids (e.g. cement, grain, powder, granulate and pellets).

In addition, the data is also available for user-side data evaluation via corresponding API interfaces.

2 Type overview

	VEGAPULS Air 23	VEGAPULS Air 41	VEGAPULS Air 42
			
Applications	Plastic vessel, IBC container	Mobile silos, containers and tanks of all kinds	
Max. measuring range	3 m (9.84 ft)	15 m (49.21 ft)	30 m (98.42 ft)
Antenna/Material	Integrated antenna system/PVDF encapsulated	Integrated antenna system/PVDF encapsulated	Integrated antenna system/PVDF encapsulated
Beam angle	8°	8°	4°
Radio antenna	Integrated	Integrated	Integrated
Process fitting **Material**	-/ PVDF	G1½, 1½ NPT, R1½ PVDF	Compression flange DN 80/3", adapter flanges from DN 100/4" PVDF
Mounting technology	Adhesive, ceiling, magnet, tension belt mounting	Threaded mounting socket	Flange
Process temperature	-20 … +60 °C (-4 … +140 °F)	-20 … +60 °C (-4 … +140 °F)	-20 … +60 °C (-4 … +140 °F)
Process pressure	-	-1 … +2 bar/-100 … +200 kPa (-14.5 … +29.00 psi)	-1 … +2 bar/-100 … +200 kPa (-14.5 … +29.00 psi)
Deviation	≤ 5 mm	≤ 2 mm	≤ 2 mm
Frequency range	W-band	W-band	W-band
Signal output	• NB-IoT (LTE-Cat-NB1), LTE-M (LTE-CAT-M1) • LoRaWAN	• NB-IoT (LTE-Cat-NB1), LTE-M (LTE-CAT-M1) • LoRaWAN	• NB-IoT (LTE-Cat-NB1), LTE-M (LTE-CAT-M1) • LoRaWAN
Communication interface	NFC	NFC/Bluetooth	NFC/Bluetooth
Indication/Adjustment	Without	Smartphone/tablet (VEGA Tools app, PC/Notebook PACTware/DTM, VEGA Inventory System)	Smartphone/tablet (VEGA Tools app, PC/Notebook PACTware/DTM, VEGA Inventory System)
Voltage supply	Integrated lithium cells 2 x 3.6 V (not exchangeable)	Optional integrated 3.6 V battery (replaceable)	Optional integrated 3.6 V battery (replaceable)
Operating time[1]	> 10 years	> 10 years	> 10 years
Approvals	-	-	-

[1] Dependent on measurement interval, radio network quality and operating conditions

3 Instrument selection

Application area

VEGAPULS Air 23, 41, 42 series radar sensors are used for autarkic, non-contact level measurement of liquids and bulk solids.

They can be used in both simple and aggressive liquids. The sensors also measure light and heavy bulk solids absolutely reliably, both with strong dust and noise generation and independently of buildup or condensation.

Device overview

VEGAPULS Air 23

VEGAPULS Air 23 is the ideal sensor for level measurement in IBC and plastic vessels. The device measures through the closed vessel top and is suitable for almost all liquids and bulk solids.

The device is quickly mounted by simple and secure adhesive, ceiling or tensioning belt mounting.

The sensor housing with high protection rating IP69 enables maintenance-free continuous operation even outdoors or when cleaning the container.

VEGAPULS Air 41, 42

VEGAPULS Air 41, 42 are the ideal sensors for all autarkic applications with bulk solids and liquids. They are particularly suitable for level measurement in mobile bulk solids silos holding dry mortar, concrete or plaster, as well as in liquid tanks of all kinds.

The devices allow safe mounting via versatile threaded or flange connections on almost all containers.

The sensor housing with high protection rating IP66/IP68 (0.2 bar) enables also maintenance-free continuous operation outdoors.

Configuration

VEGAPULS Air 20 and 40 series radar sensors are available in different designs and mounting techniques. The following illustrations give an overview.

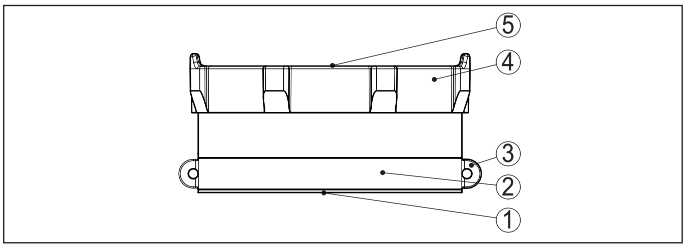

Fig. 5: Components of the VEGAPULS Air sensor (example version for adhesive joint)

1 *Radar antenna*
2 *Unscrewable mounting ring with glue surface*
3 *Eyelets for transport lock*
4 *Housing lid*
5 *Contact surface for activation via NFC communication or magnet*

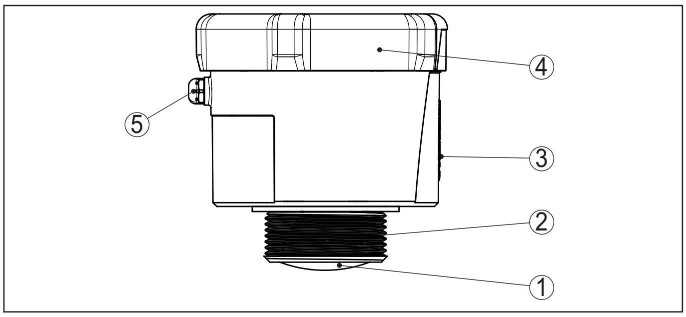

Fig. 6: Components of the radar sensor VEGAPULS Air 41 (example version with thread G1½)

1 *Radar antenna*
2 *Process fitting*
3 *Contact surface for activation via NFC communication or magnet*
4 *Housing lid*
5 *Ventilation*

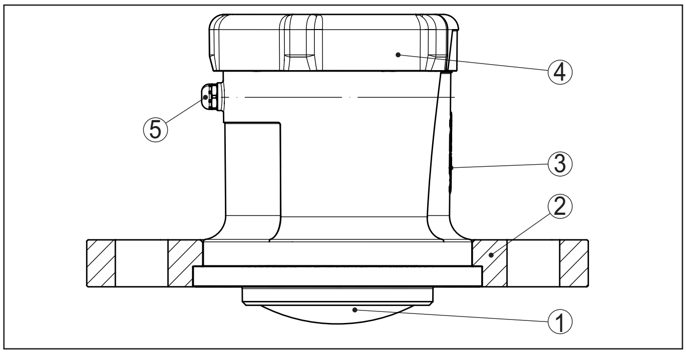

Fig. 7: Components of the radar sensor VEGAPULS Air 42 (example version with compression flange DN 80)

1 *Radar antenna*
2 *Compression flange*
3 *Contact surface for activation via NFC communication or magnet*
4 *Housing lid*
5 *Ventilation*

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4 Mounting

Mounting position VEGAPULS Air 23

Glued connection

The device version for adhesive bonding has a mounting ring with adhesive surface on the lower side of the housing.

The device is for example mounted on the top of an IBC container in one of the areas shown below:

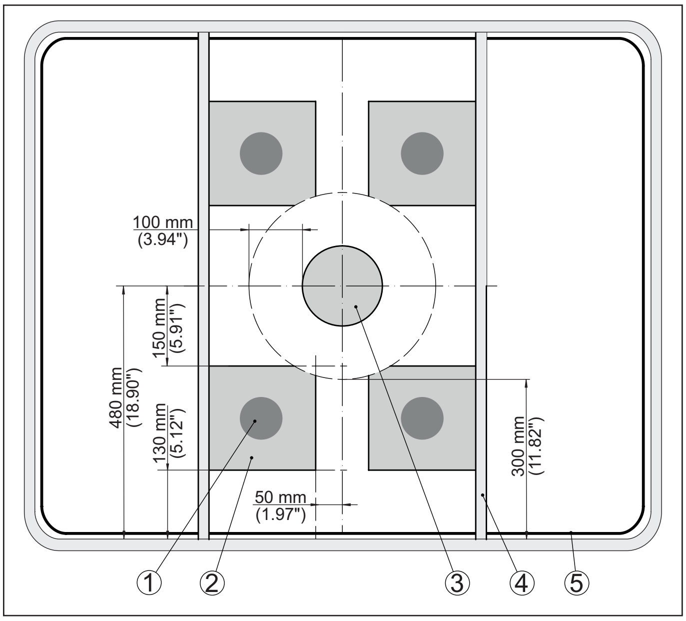

Fig. 8: Mounting position on the tank ceiling

1. *Recommended mounting position*
2. *Permissible mounting range*
3. *Filling opening*
4. *Cross strut*
5. *Vessel edge*

Flexibly exchangeable holder

The device version with flexibly exchangeable holder is attached to the vessel via a tension belt.

To prevent the device from slipping out of its mounting position, it has an anti-slip foam pad on the bottom side.

Ceiling mounting with screws

The device version for ceiling mounting has mounting brackets on the housing cover. The mounting is carried out using suitable screws and dowels provided by the customer.

Ceiling mounting with magnets

The device version for ceiling mounting with magnets has three magnets on the housing lid. This allows the sensor to be attached to ferromagnetic surfaces without drilling or screwing.

Mounting position VEGAPULS Air 41, 42

Mount the device in a position which is at least 200 mm (7.874 in) away from the vessel wall. If the device is installed in the center of dished or round vessel tops, multiple echoes can arise. However, these can be suppressed by an appropriate adjustment.

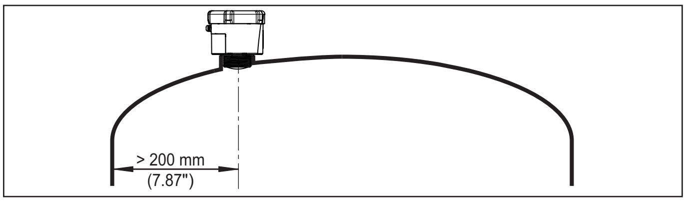

Fig. 9: Mounting of the radar sensor on round vessel tops

Liquids

In vessels with conical bottom it can be advantageous to mount the device in the centre of the vessel, as measurement is then possible down to the bottom.

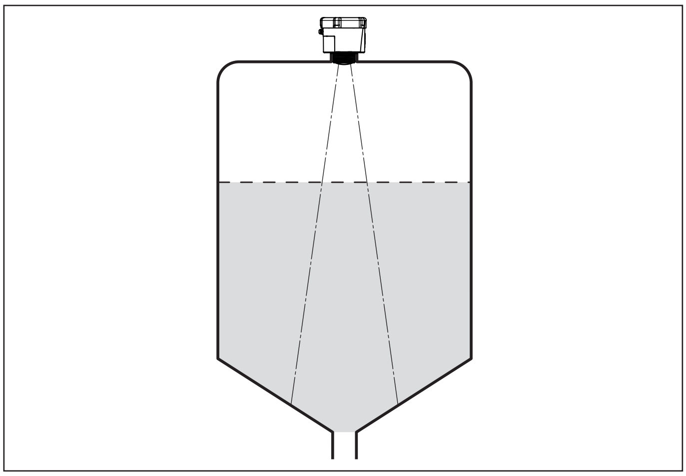

Fig. 10: Mounting of the radar sensor on vessels with conical bottom

Bulk solids

In order to measure as much of the vessel volume as possible, the device should be aligned so that the radar signal reaches the lowest level in the vessel. In a cylindrical silo with conical outlet, the sensor is mounted anywhere from one third to one half of the vessel radius from the outside wall (see following drawing).

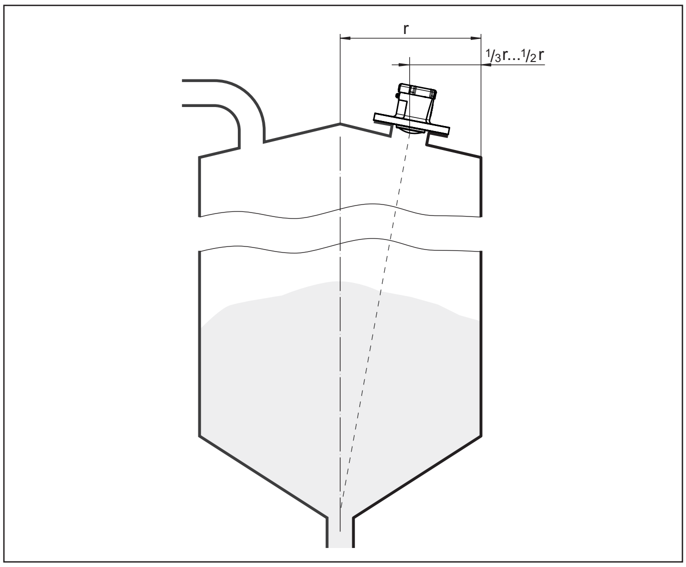

Fig. 11: Mounting position and orientation

5 Application examples, measurement setups

The following illustrations show mounting examples and possible measurement setups.

IBC vessels

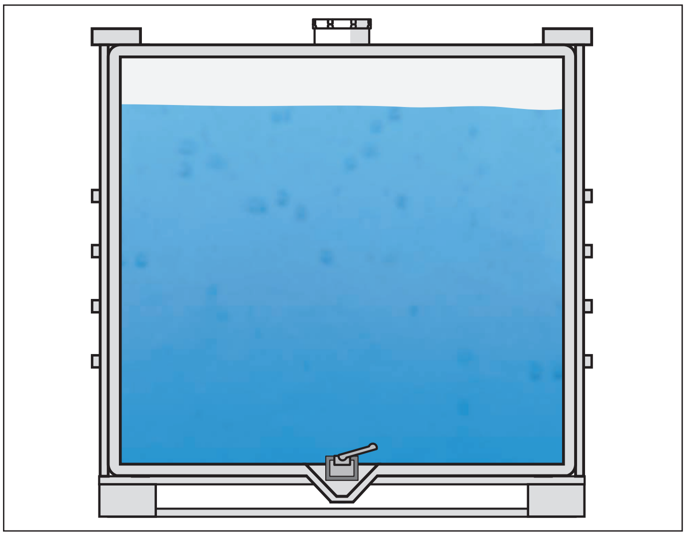

Fig. 12: Level measurement with VEGAPULS Air 23 in the IBC container

Litter bin

Fig. 13: Level measurement with VEGAPULS Air 23 in the litter bin

Liquid tank

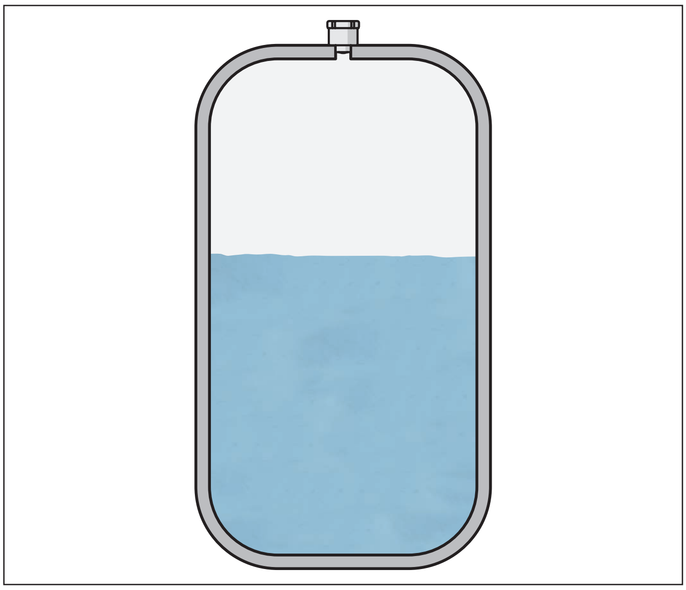

Fig. 14: Level measurement with VEGAPULS Air 41 in the liquid tank

Building material silo

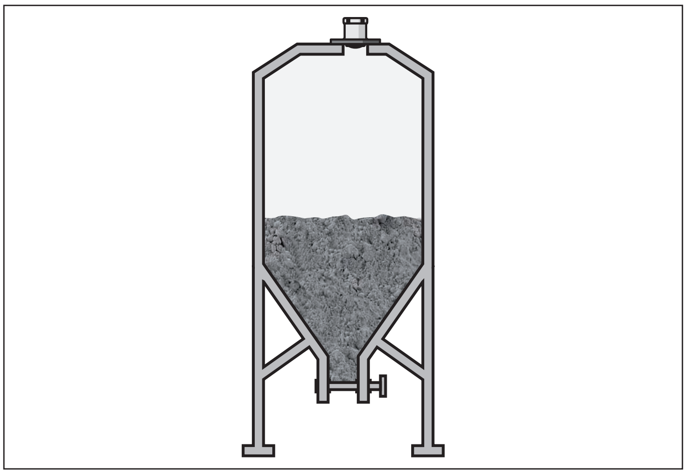

Fig. 15: Level measurement VEGAPULS Air 42 in the building material silo

6 Measured value transmission

6.1 Overview

The following measured values or data are transmitted:

- Distance to the medium surface
- Electronics temperature
- Geographical position determined by GNSS
- Installation position
- Remaining life of Lithium cells
- Device status

The VEGAPULS Air 20, 40 device series offer several ways of data transmission. In addition to device versions with mobile radio NB-IoT (LTE-CAT-NB1)/LTE-M (LTE-CAT-M1) plus LoRa, there are also versions available with LoRa only. In this case, the data remain in the customer's own LoRaWAN network and are not routed/hosted via a VEGA network server.

The transmission options are described below.

6.2 NB-IoT/LTE-M plus LoRa – VEGA Inventory System

With NB-IoT (Narrow Band Internet of Things) and LTE-M (Long Term Evolution for Machines), the focus is on low data rates and high transmission ranges. Another focus is on penetrating propagation obstacles, such as buildings, for which the long-wave signal is well suited.

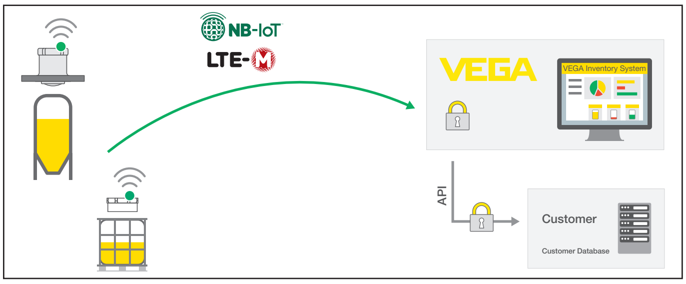

Fig. 16: Wireless measured value transmission via NB-IoT and LTE-M to the VEGA Inventory System

Data is sent via an eSIM card integrated in the sensor. This card sends the data via mobile network directly to the VEGA Inventory System. If no mobile network is available, a fallback to LoRa takes place automatically (see below).

After data transmission via the mobile network, the sensors are automatically made known in the VEGA Inventory System via their serial number. As soon as the sensors are integrated there, the data are available for visualisation.

6.3 LoRaWAN (Fall back) – VEGA Inventory System

LoRaWAN (Long Range Wide Area Network) is the data transmission mode that is available when the mobile network fails. However, this requires a corresponding gateway. This gateway picks up the data via LoRa from the sensors and transmits them via mobile radio to VEGA's own LoRa server.

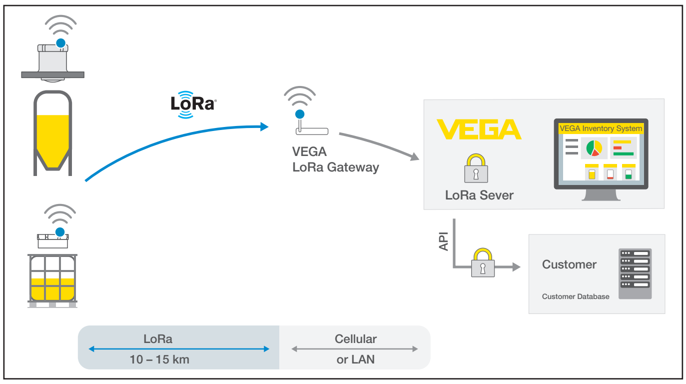

Fig. 17: Wireless measured value transmission via LoRaWAN, LoRA server to the VEGA Inventory System

Both the end devices and the gateways are stored there with their data. The sensors and gateways have so-called Device EUIs via which they can be clearly identified. The LoRa server then transmits the data to the VEGA Inventory System.

6.4 NB-IoT/LTE-M – VEGA cloud (API interface)

Data is sent via an eSIM card integrated in the sensor. This card sends the data via the mobile network directly to the VEGA cloud.

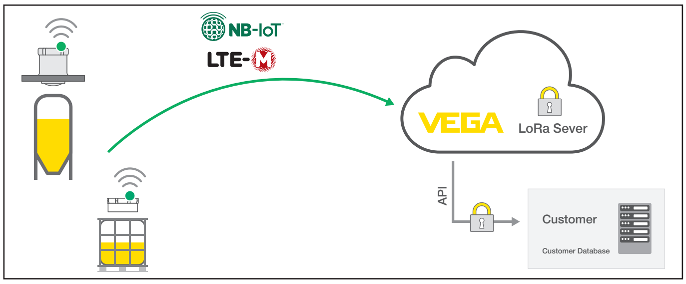

Fig. 18: Wireless measured value transmission via NB-IoT and LTE-M to the VEGA cloud

From there, they can be transferred to the user's database via an API interface.

6.5 LoRaWAN - private networks

Another possibility is to send the data via the user's private LoRaWAN network. In this case, the sensor must be made known in this network.

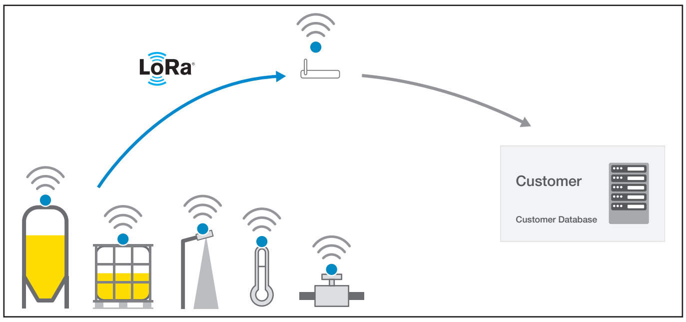

Fig. 19: Wireless measured value transmission

To do this, the user creates the sensor in his interface with its identification values (DevEUI, AppKey and JoinEUI). After a "Join" has been triggered, the sensor appears in the user interface. The payload - i.e. the transmitted bytes - are described in the operating instructions of the respective sensor and are decoded accordingly in the application system.

7 Adjustment

7.1 VEGAPULS Air 23 – Adjustment on the device

The following options are available for activating the device from the deactivated delivery status:

- By smartphone with VEGA Tools app via NFC
- Via magnet

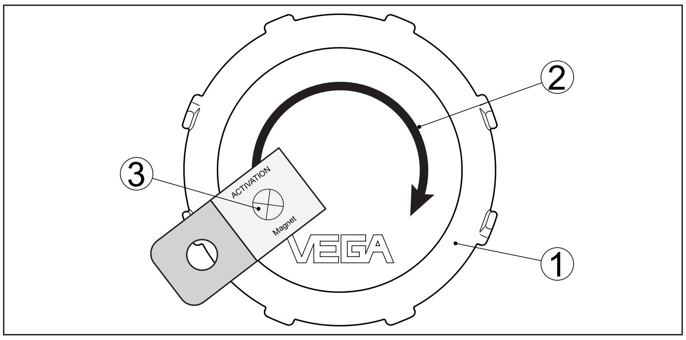

Fig. 20: Activate sensor - Magnet

1 *Radar sensor*
2 *Contact surface for magnet*
3 *Magnet*

After activation, a single measurement is carried out and the cyclic measurement interval is started. The measured value is sent once via mobile radio or LoRaWAN.

When the activation is repeated, a single measurement is carried out again. VEGAPULS Air 23 thus offers the possibility to test the communication in the respective network.

There are no additional adjustment options on the device.

7.2 VEGAPULS Air 41, 42 – Adjustment on the device

The following options are available for activating the device from the deactivated delivery status:

- By smartphone with VEGA Tools app via NFC
- Via magnet

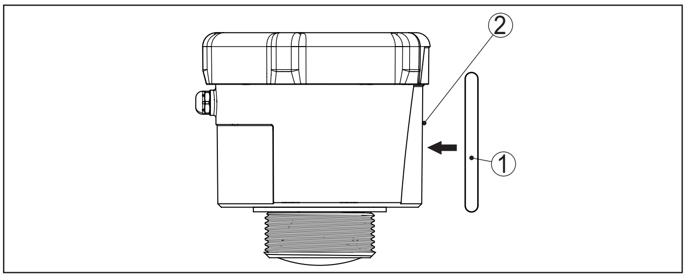

Fig. 21: Sensor activation - NFC technology

1 *Adjustment tool, e.g. smartphone*
2 *Contact surface for NFC communication*

After activation, a single measurement is carried out and the cyclic measurement interval is started. The measured value is sent once via LoRaWAN or mobile radio.

When the activation is repeated, a single measurement is carried out again. VEGAPULS Air 41, 42 thus offer the possibility to test the communication in the respective network.

The devices have an integrated Bluetooth module and can be operated wirelessly using standard operating tools:

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

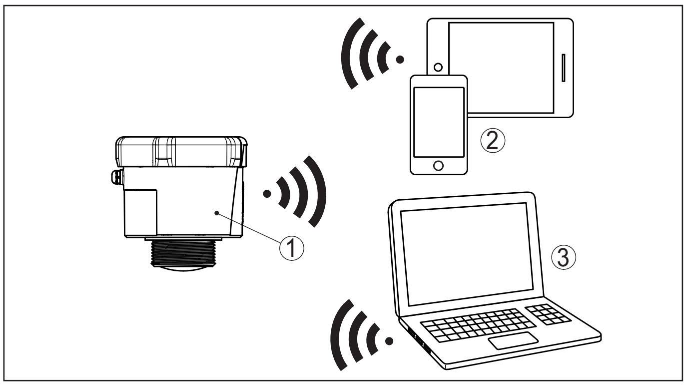

Fig. 22: Wireless connection to standard operating devices via Bluetooth

Operation is via a free app from the "*Apple App Store*", the "*Google Play Store*" or the "*Baidu Store*". As an alternative, adjustment can also be carried out via PACTware/DTM and a Windows PC.

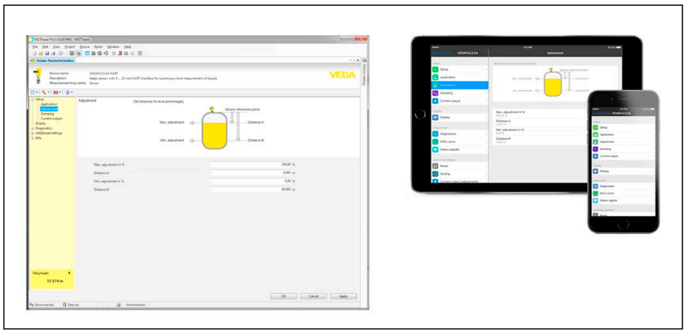

Fig. 23: Adjustment via PACTware or app

7.3 VEGAPULS Air 23, 41, 42 – Adjustment via remote access

The VEGA Inventory System offers the possibility to change parameters in the sensor by remote access via mobile radio (backward channel).

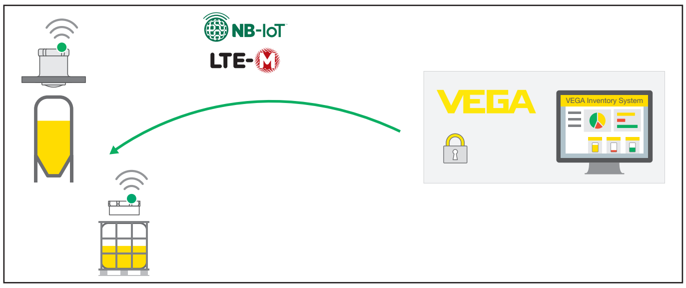

Fig. 24: Remote access from VEGA Inventory System via NB-IoT or LTE-M to the sensor

The following parameters can be changed:

- Vessel height/Operating range
- Measuring and transmission interval

In addition, the following actions can be triggered:

- Localization

8 Dimensions

VEGAPULS Air 23

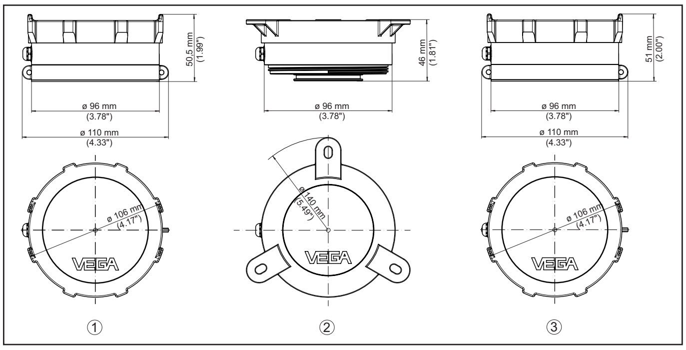

Fig. 25: Dimensions VEGAPULS Air

1 *Glued connection*
2 *Ceil mounting*
3 *Flexibly exchangeable holder*

VEGAPULS Air 41

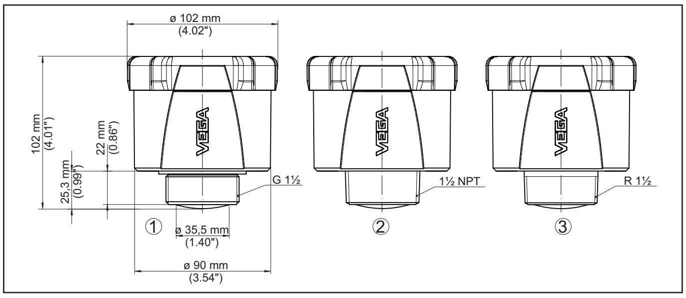

Fig. 26: Dimensions VEGAPULS Air

1 *Thread G1 ½*
2 *Thread 1½ NPT*
3 *Thread R1 ½*

VEGAPULS Air 42

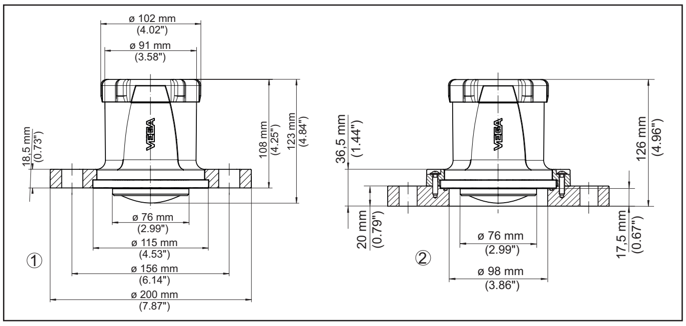

Fig. 27: Dimensions VEGAPULS Air

1 *Version with compression flange*
2 *Version with adapter flange*

The drawings listed are only an excerpt from the possible versions and installation options.

Further drawing are available on our homepage as well as "*myVEGA*".

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