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New

ULM-3D-64

MULTI-BEAM NON-CONTACT RADAR LEVEL TRANSMITTER FOR MEASURING 3D LEVEL AND **VOLUME** OF BULK PRODUCTS AND MATERIALS.

BRIEF TECHNICAL DESCRIPTION

Tula

1. Purpose

ULM-3D-64 level transmitter is designed for continuous non-contact measurement of the level of any bulk materials and is intended for use in technological accounting and product inventory management systems. ULM-3D-64 level transmitter can be used to measure the level and volume in tanks and open storage facilities. A system of several level transmitters can be used for large tanks and storage facilities. Multi Beam Radar Surface Plotter software calculates volume and displays on the computer screen a three-dimensional picture of the material being measured.

2. Delivery set

The delivery set includes:
- Radar level transmitter;
- Documentation and software on electronic media:
- Multi Beam Radar Surface Plotter SW
- Operating and Installation manual
- Additional documentation (certificates and permits, other technical information, if necessary).

Software and documentation on electronic media can be supplied in the amount of 1 pc. for the entire scope of supply according to the specification.

Additional equipment that may be included in the order specification:
- power supply;
- RS-485 interface converters;
- installation kit.

The specific type of additional equipment (interface adapters, installation appliances) may have different design, which is negotiated when ordering equipment and specified in the order specification.

3. Principle of operation

ULM-3D-64 antenna system emits radio signals that form radio beams and receives echo signals reflected from the surface of the product. The electronics unit through the software and hardware complex processes the echo signal and converts it into a corresponding output signal, which carries information about the measured value.

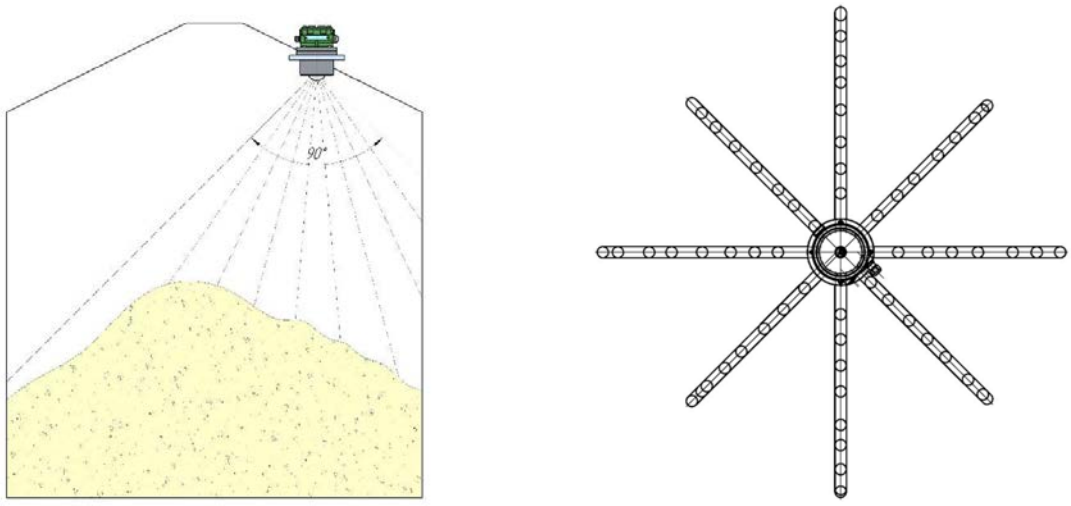
Every single beam operates as a linear FM (frequency-modulated continuous wave - FMCW) radar. This is one of conventional methods of non-contact distance measurement, which minimizes the influence of spurious interference and interference associated with irregularities (disturbances) of the measured product surface.

ULM-3D-64 level transmitter uses 64 directional measuring radio beams. Each beam is generated by a separate independent product level transmitter and has a fixed direction. All directions are evenly distributed in a solid angle of 90 degrees (Fig. 1). During the measurement process, the processor system receives signals from each

measurement direction. During their processing the distances to the product are calculated.

Within each beam's coverage area, the point with the best reflection is found and selected in the measuring spot on the product surface.

As a result of the measurement, an array of the measured product levels from different directions is collected in the instrument. Multi Beam Radar Surface Plotter software (Fig. 2, Fig. 3) receives an array of measured distances, builds a model of the product surface profile and calculates the volume of measured material taking into account the shape and geometric dimensions of the tank.



A) B)

Fig. 1. An array of directions of measuring beams. A) Side view B) Top view

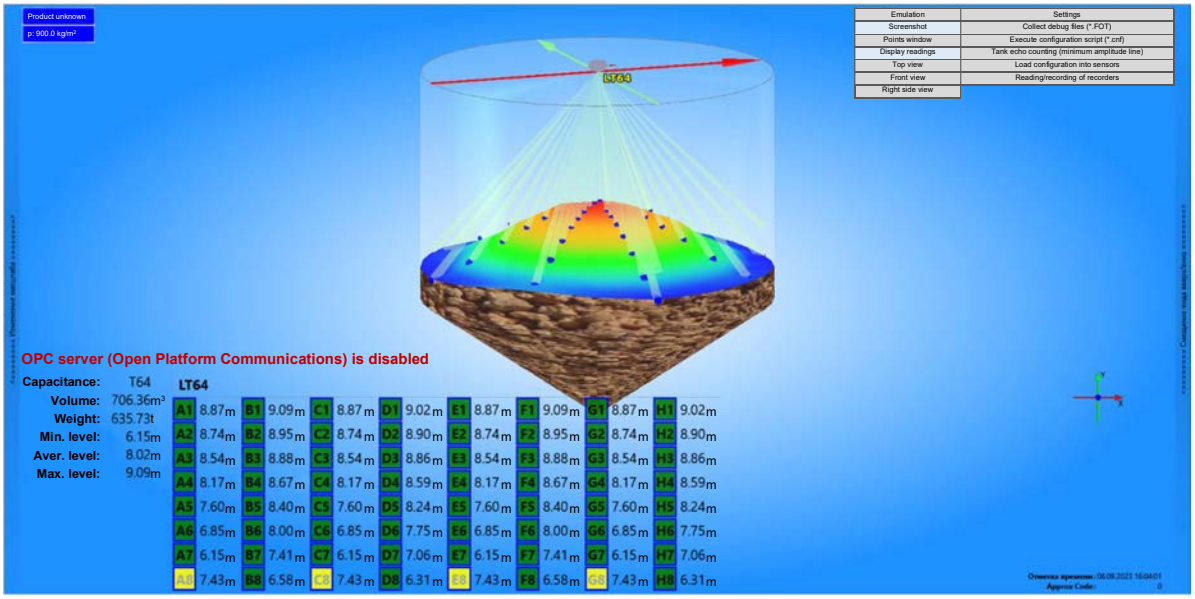


Fig. 2

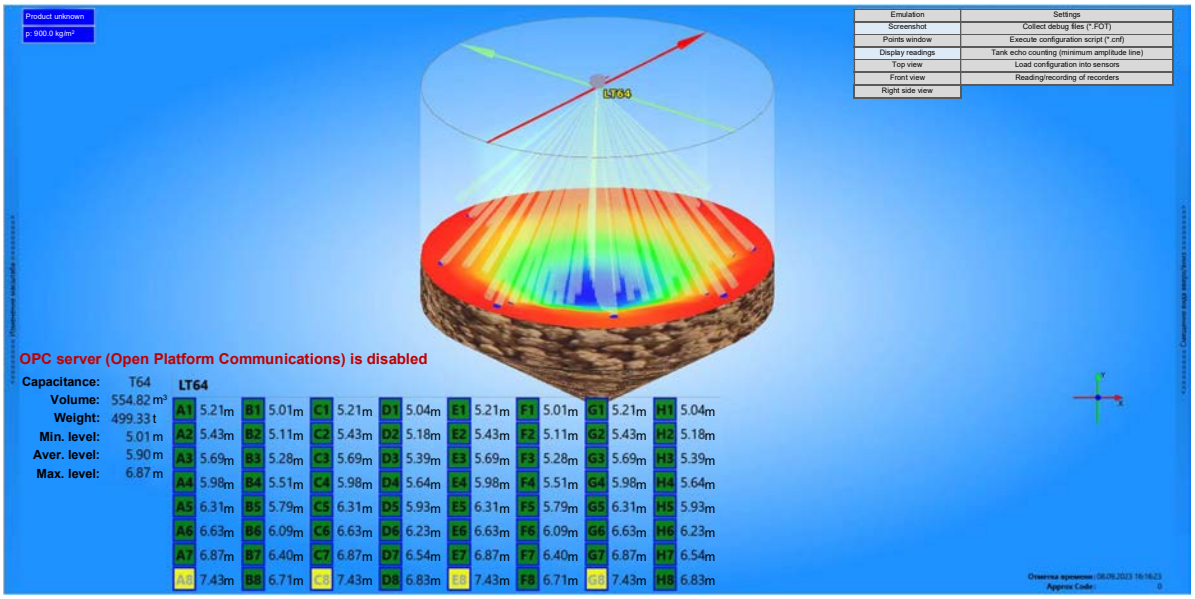


Fig. 3.

To increase the detailing of the 3D profile of the measured bulk product surface, as well as to eliminate probable blind spots, it is possible to install several ULM-3D-64 level transmitters on one silo (Fig. 4).

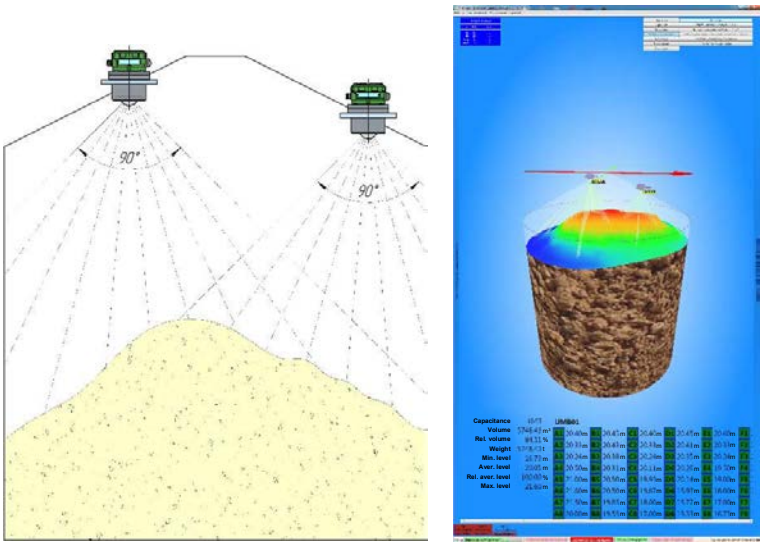


Fig. 4. Use of several ULM-3D-64 on one tank (silo).

4. Bulk Product Volume Measurement. Measurement Accuracy.

An unique feature of ULM-3D series level transmitters is their product volume measuring function.

The measuring accuracy of the bulk product volume using ULM-3D-64 depends on the tank size and shape, the number of the level transmitters installed on the silo roof and their location. The level transmitters must be positioned in such a way as to reduce the area of "blind areas", i.e. such areas where the level transmitters' measuring beams do not reach, in all process modes (loading or emptying), subject to appropriate product surface shapes. In this case, ULM-3D-64 level transmitters will provide the best volume measurement accuracy.

As an example, Fig. 5.1 and 5.2 below shows a typical application of ULM-3D-64 level transmitter: measuring the grain level and volume in a flat-bottomed silo with a diameter of 27 m and a height of 35 m (one of the most common sizes). Installing one ULM-3D-64 level transmitter close to the silo roof center guarantees the absence of blind areas upon the maximum silo loading with grain. With such positioning of the level transmitter, the product is fully controlled by the level transmitter in all modes. This configuration of the measuring system provides for a volume measurement accuracy ranging from ±0.6 % to ±1.2 % of maximal load volume for this silo.

Such a high accuracy of volume measurement is possible due to the high density of measuring points on the product surface with both high and low filling levels. In addition, the large number of measurement points allows to automatically exclude a certain number of points from calculations without increasing the error, e.g., in case of weak reflection and loss of reflected signal at any point in time, thus ensuring the high stability and reliability of the level transmitter’s readings.

The predicted volume measurement accuracy for a specific storage facility, taking into account the number and location of the level transmitters, the type of product being measured, and the process features, can be obtained using a simulation system by LIMACO, JSC. Our specialists, using original software, carry out simulation with a high accuracy and reliability.

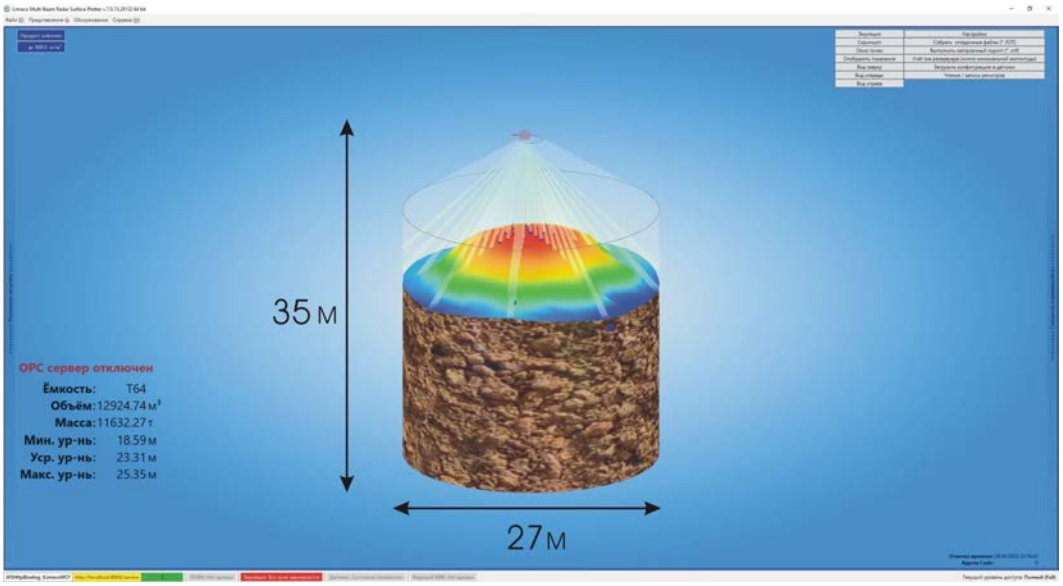


Fig.5.1. Example of measurement of level of grain in a flat-bottomed silo with one ULM-3D-64.

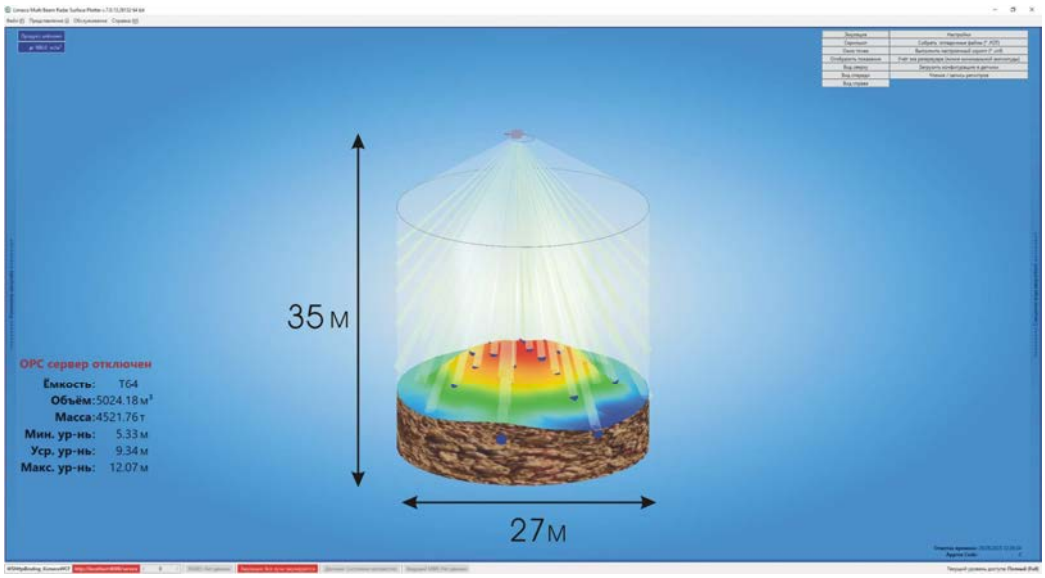


Fig.5.2. Example of measurement of level of grain in a flat-bottomed silo with one ULM-3D-64.

5. ULM-3D-64 Level Transmitter's Speed Performance

The speed performance of a level measurement system often determines its applicability in the facility's technological process. In production, the speed of loading bulk materials into silos is often quite high; this is especially true for the mining industry where the product level can change by several meters in a few seconds during unloading of the material.

If the level transmitter's speed performance is slower than the level change rate in the silo, it will simply not have time to make measurements during this technological process, which can lead to process failure. Only few conventional radar level transmitters are capable of real time level measurements. If you need to measure product volume, i.e., if you need to monitor several points on the product surface at the same time, this task becomes much more complicated. If the level transmitter uses a single beam to monitor the level at several points (to calculate the product volume), the speed performance of such a level transmitter decreases many times in proportion to the number of points it monitors. This is true for level transmitters with both electronic scanning and mechanical scanning.

This drawback is most pronounced in level transmitters with mechanical scanning. In this case, to measure the level at several points, a radar level transmitter uses one beam, the angle of inclination of which is changed by mechanical movement (tilting) of the level transmitter antenna. Thus, the time is spent on mechanical movement of the antenna, preparing and carrying out measurements for each point. Therefore, all single-beam scanning level measurement systems (mechanical and electronic) have the measurement time of minutes and sometimes even tens of minutes. During this time, the product level in the silo can change dramatically, but a single-beam level transmitter will notice this only after everything has happened and an emergency may have occurred!

Unlike conventional single-beam scanning systems, an ULM-3D-64 radar level transmitter, as described above, is a multi-beam measuring instrument. Therefore, there is no need to spend time reorienting the measuring beam and preparing the measurement. Each level transmitter's beam is pre-oriented and configured in advance. Each area on the product surface within the coverage area of each measuring beam of the ULM-3D-64 level transmitter is under constant control: the level transmitter's processing system only performs periodic switching between these beams (activating the transceiver system), data collection and processing. Therefore, the complete cycle of level and volume measurement of the ULM-3D-64 level transmitter is a few seconds with any configuration of the measurement system!

6. Specifications

Description	Value
General	
Housing material	Aluminum casting alloy, anodized, powder coating
Seal material	Rubber mixture
Antenna lens material	Fluoroplastic
Cable gland material	Plastic
Weight, kg, max	5
Overall dimensions, mm, max	240x185x185
Type of installation for the process	flange
Output signals	
Analog	
4-20 mA	Active
Load	Line resistance is max. 300 Ohms, including the receiving device.
Limits of the permissible error of conversion to analog DC signal 4-20 mA, reduced to the full range of level measurements.	Max. 0.25% of measuring range
Digital	
RS-485	Modbus RTU
Resolution	0.1 mm
Description	Value
Instrument performance	
Absolute error of level measurement (on a flat surface*)	±5 mm
Distance measurement range	1…57 m
Principle of operation	Radar level transmitter using Frequency-Modulated Continuous Wave (FMCW)
Operating frequency	70-130 GHz
Output power	max. 10 mW
Number of measurement channels	64
Operation mode of channels	Sequential
Beam pattern width of each channel	3,5˚
Time for a full measurement cycle, max., s	3
Operating conditions	
Ambient temperature at the location of level transmitter installation:	-40 +60

Atmospheric pressure	84.0…106.7 kPa (630-800 mmHg)
Relative humidity at the location of level transmitter installation	Max. 95% @ 35 ˚C or lower temperatures, without moisture condensation
Mechanical impacts - vibration amplitude - vibration frequency	Max. 0.1 mm 5…25 Hz
Maximum deviation of the vertical axis from the recommended mounting point	Max. ±1 degree
Protective measures	
Protection class per GOST 14254-2015 (IEC 60539-0:2013), IP code	IP65
Design version	Standard industrial
Power supply	
Power voltage	18…36 VDC
Maximum power consumption, kW, max	15
Electromechanical data	
Cable gland	
Screw terminals for electrical connection of wires with cross section	Max. 2.5 mm (AWG 14)

7. Installation

The level transmitter is installed on the tank lid using a flange. ULM-3D-64 has upper and lower flange mounting points. It is advisable to install the level transmitter so that its antenna is immersed in the tank; to do this, an option with a top flange mounting is used.

The level transmitter is installed on the tank in such a way that there are no foreign objects or structural elements of the silo at the installation location in a solid angle of 100 degrees, the apex of which is in the center of the level transmitter antenna, that could interfere with the measurement. The level transmitter is located with the antenna down, or at an angle to the vertical line.

The level transmitter can be installed at a maximum tilt angle of 50 degrees from the vertical line. The location on the tank and the tilt angle are selected so as to optimally use the measuring channels of the level transmitter. Measuring channels whose beams intersect with the walls of the tank are automatically excluded from measurement when the product level is below the intersection point.

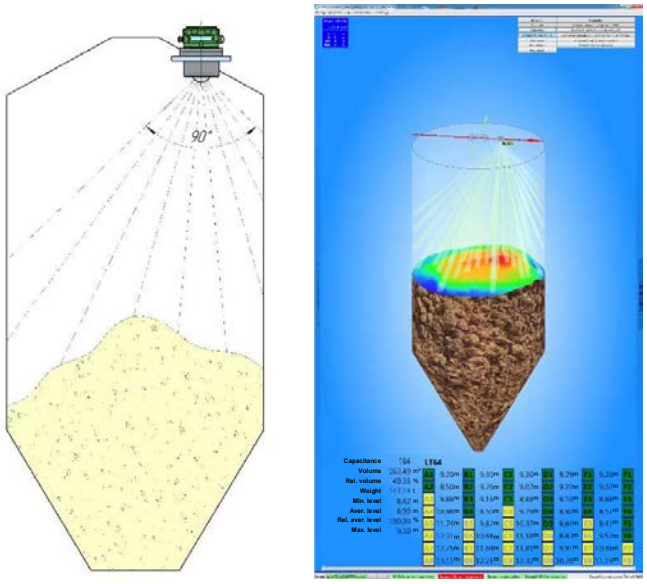


Fig. 6

ULM-3D-64 level transmitter can be equipped with flanges of various designs; it should be specified when placing an order. The standard delivery for the level transmitter option with an antenna immersed inside the tank (recommended) includes a flange DN150Ru10(16) or DN125Ru10 in accordance with GOST 33259-2015 (Fig. 9). In this case, the diameter of the hole in the tank lid (silo roof), necessary for measuring the level, depends on the thickness of the roof and is selected based on the free propagation of the measuring beams of the level transmitter in a solid angle of 100^0, but no less than 150 mm.

It is possible to install the ULM-3D-64 level transmitter without immersing the antenna inside the tank (silo) - this option is used for a flat roof with a thickness of max. 10 mm. In this case, the level transmitter can be equipped with a DN100RN10 flange in accordance with GOST 33259-2015 (Fig. 10). In this case, the diameter of the hole in the roof of the tank (silo roof) must be no less than 100 mm.

8. Electrical connection

All connections must be made with the power off.
Electrical connection operations must only be carried out by qualified personnel authorized for this type of work.

The level transmitter has the ability to install two cable glands with self-sealing NPT threads. When delivered from the factory, one cable gland with a process plug may be installed in the housing; in this case, a certified plug is installed in place of the second one.

The following is prohibited:

- leave the device in the mounting position without a process plug and without a cable connected;

- leave the level transmitter in its mounting position with the cable connected, but with the cable gland not tightened;

- leave unused cable glands unplugged; a certified plug must be installed in their place.

To connect the 4-20 mA analog output, use a standard pair of conductors in a separate shield.

To connect the RS-485 digital interface, it is necessary to use a pair of conductors in the shield; a cable with a common shield can be used.

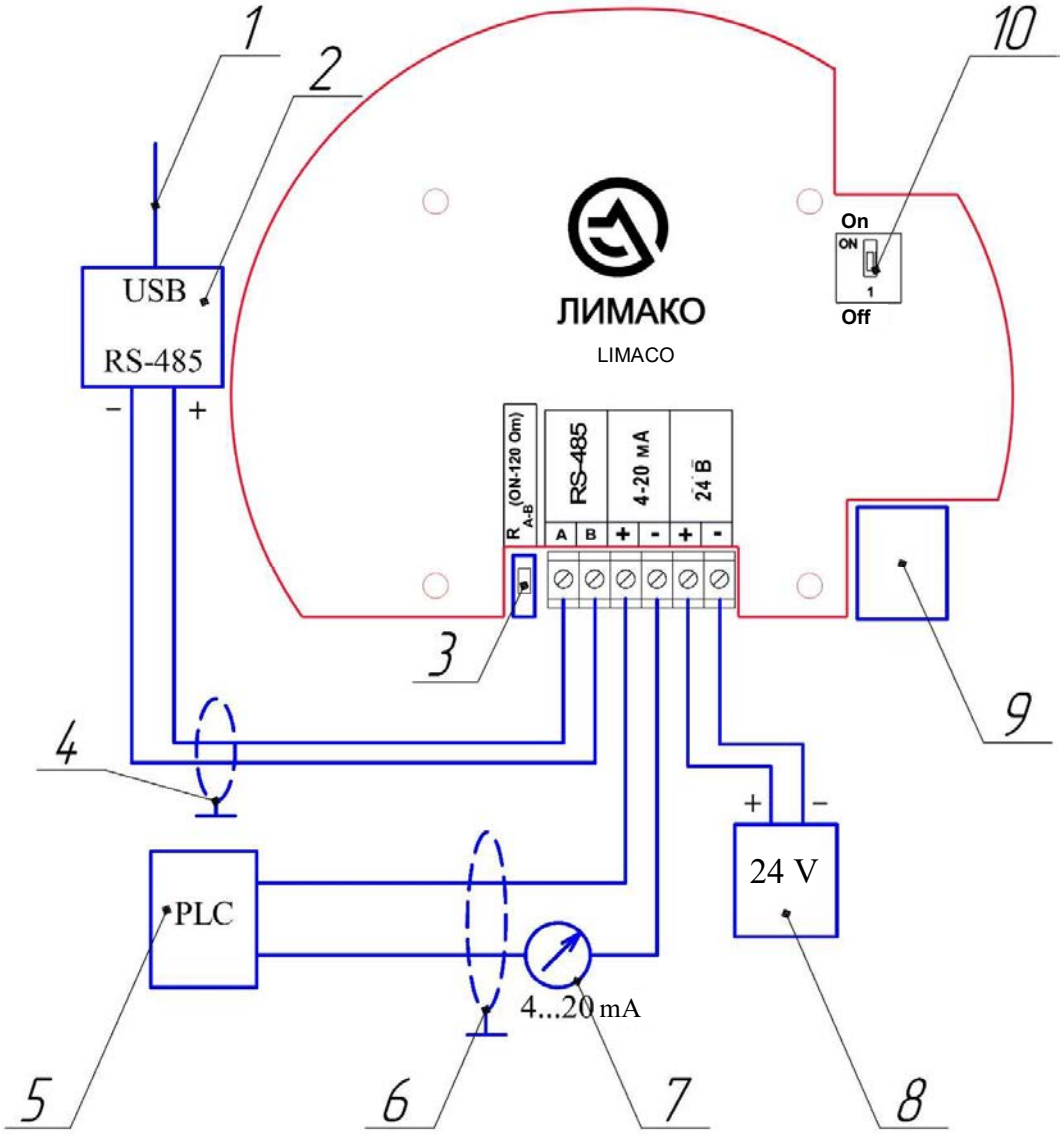
It is necessary to use round cable. It is necessary to use a cable of a diameter suitable for a corresponding cable gland to ensure the declared characteristics of protection against the ingress of dust and moisture.

It is prohibited to insert several cables into the instrument through one cable gland.

To protect the instrument from moisture ingress, it is recommended to bend the connecting cable downwards in the immediate vicinity of the cable gland to drain moisture from rain or condensate.

When using a shielded cable, we recommend connecting the cable shield to ground potential on one side. Use the ground terminal on the receiver side of the output signal.

The instrument must be grounded. There is an external ground terminal on the instrument housing, which is connected to the tank ground.



1 — Connection to PC; 2 — Transducer RS-485/USB; 3– Switch, matching load of the line RS-485R_{A-B}=120 Ohm; 4, 6 – Connection of interface line shields; 5 — Control unit, e.g. PLC; 7 — Analog display unit;	8 — 24V power supply 9 — microSD memory card slot. 10 — Backup Program switch, factory reset

Fig. 7 ULM-3D-64. Purpose of terminals Connection.

9. Measurement System Composition

The best volume measurement accuracy is provided by a combination of one or more ULM-3D-64 level transmitters and top-level software. In addition to the level transmitter, such a measurement system includes a personal computer with the Multi-Beam Radar Surface Plotter software, which is supplied with level transmitters. The level transmitter can be connected to the PC either via RS-485 interface or via Ethernet using an RS485/Ethernet converter.

This software, based on the original algorithms and measurements made by level transmitters, calculates the average level, volume and weight of the bulk product. The measured average level or volume are transmitted to the level transmitter for output on the 4-20 mA interface. For the measurement system to operate, the software must be running continuously.

In addition, the ULM-3D-64 level transmitter can measure the average level or volume independently, without top-level software, but with less accuracy than with the Multi-Beam Radar Surface Plotter.

However, a PC with software is required in both cases for initial configuration and adjustment of the level transmitter during its operation (see Item 11).

10.Requirements to PC.

Minimal requirement configuration of PC, sufficient for level-transmitter configuration and building of measurement system with minimal quantity of level-transmitters:

Processor : 4 cores, frequency 1,5 GHz
Memory: 8 Gb
Monitor: resolution 1920*1080
Operational system: Not below Windows 10 Home

Recommended configuration for constant working constantly measurement system.

Processor: 8 cores, frequency 3 GHz
Memory: 16 Gb
Monitor: resolution 1920*1080
Operational system: Not below Windows 10 professional,64 bit.

11. Initial setup and commissioning

The device is configured using Multibeam Radar Surface Plotter software in full or demo version (free). This software must first be installed on the PC. The level transmitter must be connected to a PC with the RS485 interface using appropriate equipment.

11.1. Install the initial configuration file containing the shape of the tank, locations and parameters of level transmitters installation. It can be supplied by the manufacturer in advance by agreement. This file should be copied to the ..\configs folder.

11.2. If the dimensions of the tank and the actual installation parameters (coordinates and tilt angles) differ from those specified in the file, it is necessary to make appropriate changes to the configuration. The tilt angles can be obtained from the level transmitter using the corresponding button or entered manually.

11.3. Next, the configuration is written to the level transmitter using the “Load configuration to level transmitters” button.

11.4. Tank echo counting. To fully configure the level transmitter, it is required to perform this operation on an empty tank. To do this, it is advisable to completely empty the tank. Moreover, this operation can be performed even if there is a product in the tank. It is required to click the “Tank echo counting (minimum amplitude line)” button. Next, it is necessary to specify the maximum level of the product in the tank using the view of the tank with the product and the scroll that appears on the right side of the screen. It is necessary to choose a level above which there is no product; it is advisable to take a reserve of 1 m. The operation is performed by clicking the “Calculate a line” button. If a level is lower than the actual one, the device may begin to work incorrectly; in this case, you can roll back to previous settings or to the factory settings of the minimum amplitude line.

The operation of recording the echo can be repeated later, for example, after emptying the tank.

11.5. After completing the setup, it is required to collect debug files. To do this, there is a button “Collect debug files”. The archive with debug files generated in the ..\logs folder should be sent to the manufacturer or dealer by email. Based on the sent data, a technical specialist can create a configuration script, which can be applied using the “Execute configuration script” button. The configuration process may require several iterations consisting of collecting debug files and executing the configuration script.

11.6. During further operation of the device, if false high levels appear on some channels, it is possible to repeat the operation of recording the tank echo and collecting debug files.

11.7. In some cases, to configure level transmitters, you may need the “Configurator” software ulmcfg.exe, which is provided free of charge upon request to be made to the manufacturer's e-mail.

12. Safety requirements

Inappropriate use of the instrument may lead to an emergency at work or render the instrument inoperative and is a source of potential danger.

Personnel who perform installation, commissioning, diagnostics, and maintenance of the level transmitter must read this manual and be admitted to work with the

instrument. When working with the equipment, personnel must use the required personal protective equipment in accordance with the regulations adopted by the company.

The operational safety of the instrument can only be guaranteed if the instructions in this manual are observed.

To ensure operational safety and to comply with the warranty obligations, it is forbidden to make any changes to the instrument design. Operations with the instrument, other than those described in this manual, may only be performed with the official permission of the manufacturer.

ULM-3D-64 level transmitter meets all modern requirements and safety standards.

The operating frequency of the level transmitter radiation can be from 70 to 130 GHz. The radiation power does not exceed 10 mW, which is significantly lower than the maximum permissible values. The level transmitter is completely safe for humans and animals.

The level transmitters may only be operated in good condition in order to avoid emergencies at work.

13. Overall and setting dimensions

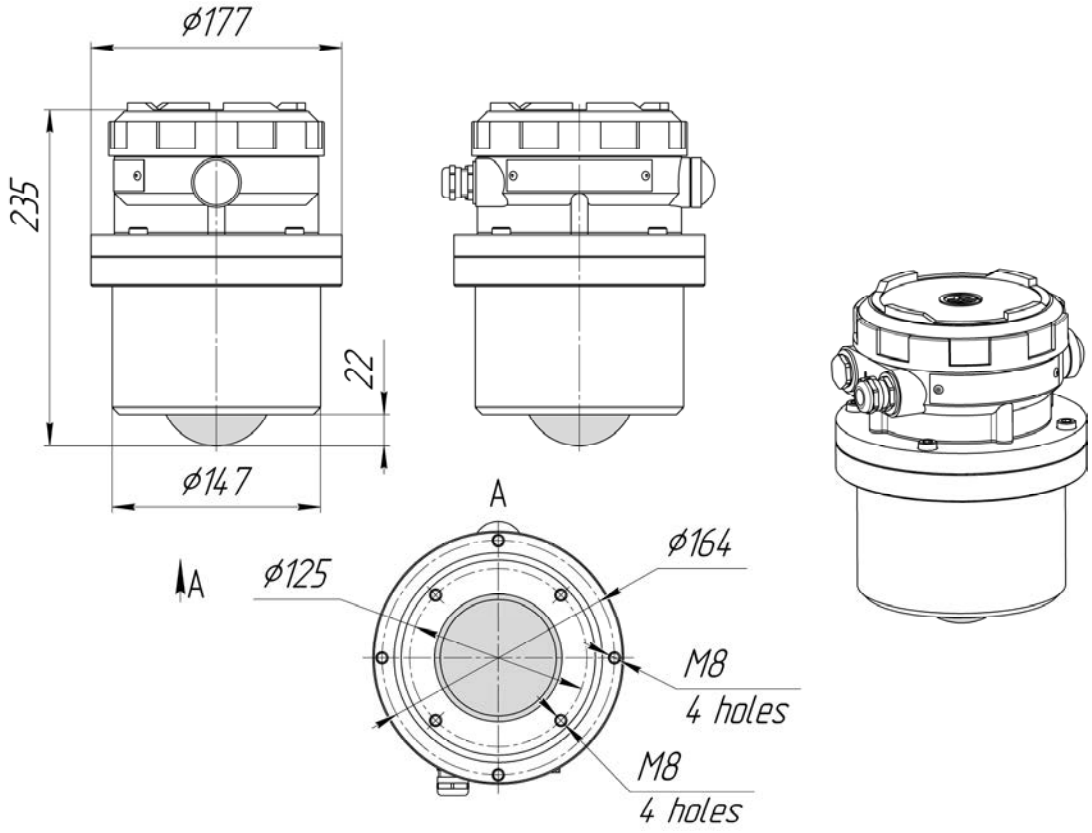


Fig.8 ULM-3D-64 Level transmitter without mounting flanges

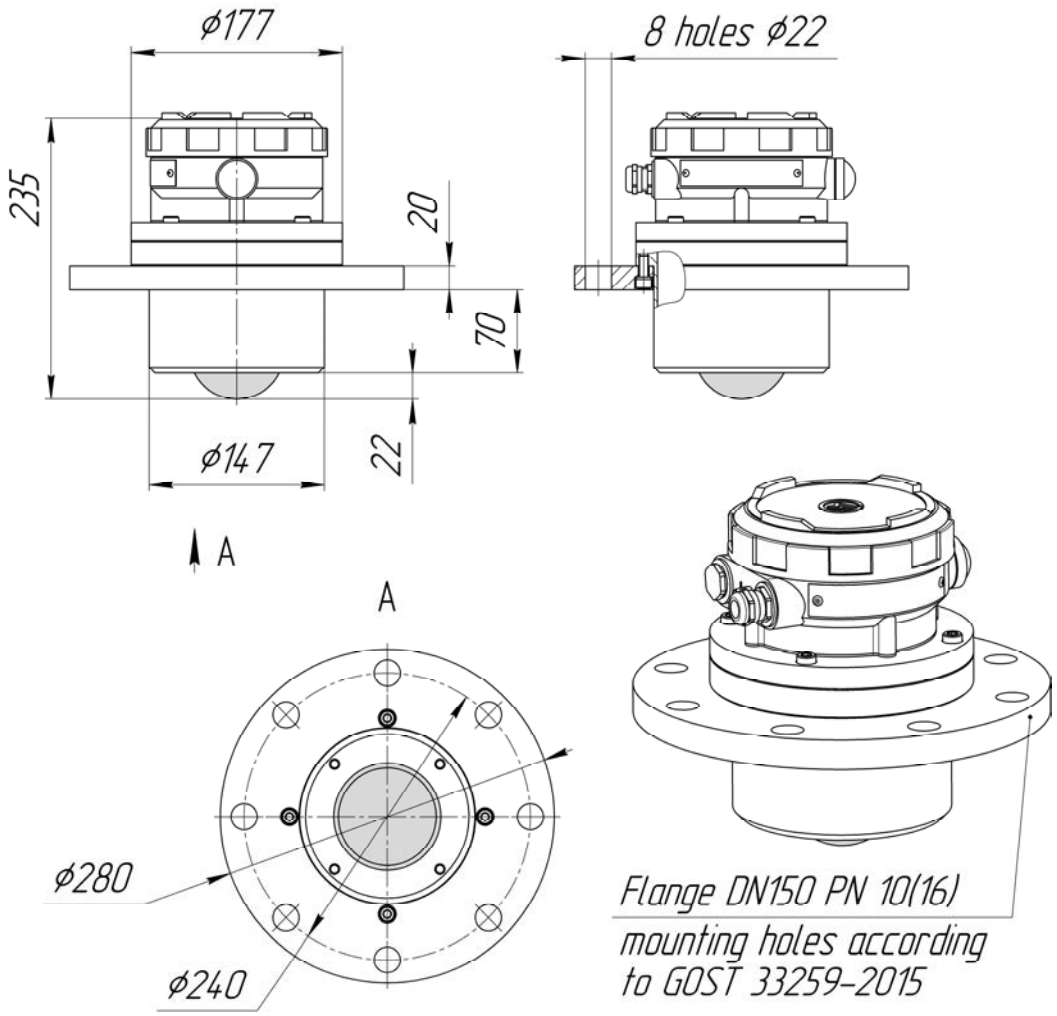


Fig. 9. Level transmitter with upper mounting flange DN150 for installing the level transmitter with the antenna immersed inside the tank.

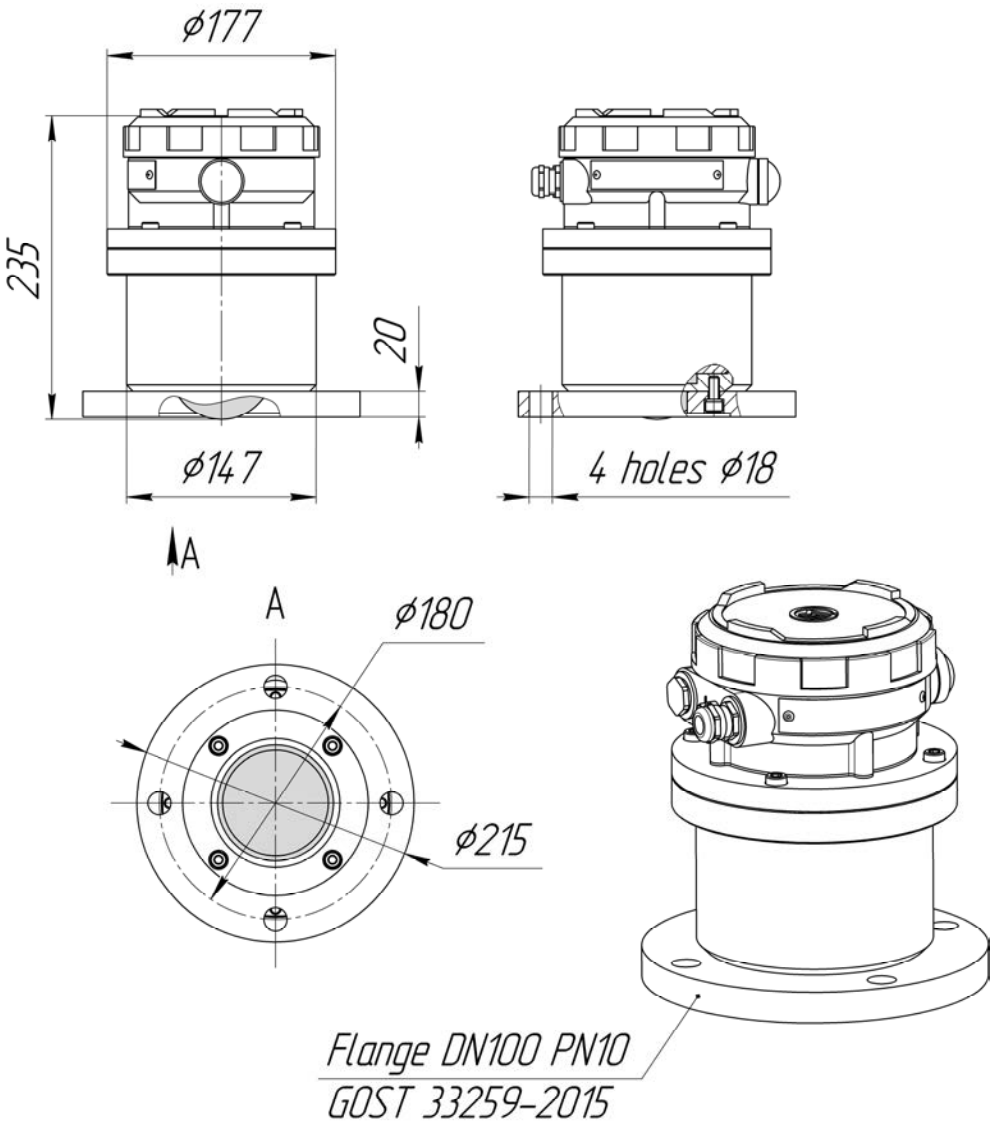


Fig. 10. Level transmitter with lower mounting flange DN100 for installing the level transmitter without immersing the antenna inside the tank.