LEVEL GAUGE
U-150

Operation Manual

PLA150.208.018.000 RE

Rev. 05

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This Manual provides information for service personnel how to perform installation, commissioning and maintenance of the radar Level Gauge U-150 (hereinafter referred to as the U-150).

The U-150 exploitation is allowed to be used by personnel who has studied this manual, set of exploitation documentation and passed safety training.

The U-150 Level Gauge is required for level measurement of different types of fluids. The Level Gauge is used as part of the DEL-150 Drilling and Well Workover Monitoring System (hereinafter referred to as the DEL-150).

The U-150 has the following modifications:
- U-150 with the Modbus/RS-485 output;
- U-150D with the Modbus/RS-485, analogue and audible horn outputs, and display included.

Scope of application is explosive zones of premises and outdoor facilities according to Ex-marking. The U-150 is manufactured in accordance with the requirements of ISO 9001:2015.

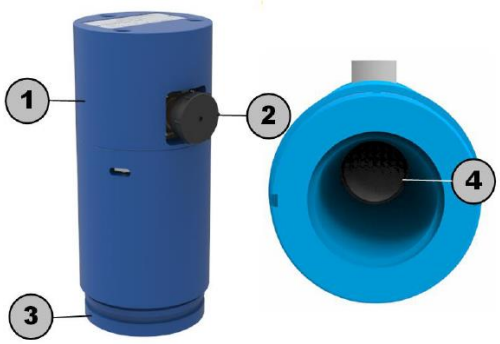
In order to exclude the possibility of mechanical damage, violation of electroplating and paint coatings, the rules of storage and transportation of the device should be observed. When studying the rules of operation, it is also necessary to be guided by the technical description and operating instructions of the DEL-150 System.

The U-150 Level Gauge is made in a cylindrical housing with a protection degree from external influences at least IP67. The housing consists of a base box and a cover, fastened with three screws. There are electronics units, which is a printed circuit board with electronic components located on them, inside the housing. External connections are made using a connector located on the side surface of the housing (see Fig. 1).

The U-150D modification's base box connected to the metal part of the housing with the glassed cap. There are display control panel included and additional plugs for analogue output and audible horn connection in the housing (see Fig. 2).

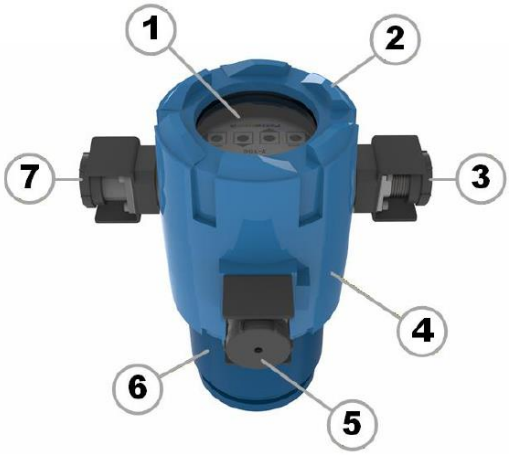
1. Technical Characteristics

Name of parameter	Value
Level measurement range, mm	300…3000
Accuracy, %FS	±1.0
Output signal	Digital
Output signal (optional)	Analogue 4…20 mA
Communication protocol	Modbus
Power supply range, VDC	7.5…28
Power consumption, max., Wt	1.6
Ex marking, TR CU 012/2011	0ExiaIIBT5GaX
Ex marking, ATEX	II2GExibIIAT3Gb
Ingress protection	IP67
Operating conditions: • Ambient temperature range, °C • Relative humidity, max., % • Atmospheric pressure range, kPa	 -40…+50 90 96…104
Dimensions (U-150), mm	Ø86 x 196
Dimensions (U-150D), mm	208 x 200 x 142
Weight (U-150), max., kg	1.6
Weight (U-150D), max., kg	2.4
Service life, min., years	10
Recommended calibration interval, months	24



1. Cover;
2. Connector;
3. Base box;
4. Radio-wave transmitter

Figure 1. The U-150 components



1. Display control panel;
2. Glassed cap;
3. Connector for audible horn connection;
4. Metal part of housing;
5. Connector for Modbus/RS-485 output;
6. Base box;
7. Connector for analogue 4…20 mA output

Figure 2. The U-150D components

2. Explosion Safety During Operation

Explosion protection is provided by an intrinsically safe electrical circuit ("i" type of explosion protection).

3. Requirements for Keeping Equipment Specifications that Cause its Explosion Safety

During operation, it is forbidden to break the seals and open the U-150 housing.

When the MU-150 / MU-150E / MK-140 unit of the DEL-150 System is switched on, it is forbidden to connect and disconnect cables, power cable and grounding conductors. In case of malfunctions, it is necessary to turn off the MU-150 / MU-150E / MK-140 unit and disconnect the power cable from the power source. Then replace the faulty U-150 with a serviceable one by connecting it according to the documentation (operation manual for the DEL-150).

During operation, check the condition of communication cables periodically. If a violation of the protective layer on the cable lines is detected, replace the damaged cable immediately.

Do not allow sealing violations. If a damage is detected, replace the faulty equipment.

Ensuring explosion safety during operation is according to the safety regulations, applicable to the equipment with which (or as part of which) the equipment is used.

ATTENTION!!! During operation, it is necessary to monitor the equipment status and its cables. In case of any mechanical damage of the equipment or any of the cables connected, further operation is strictly prohibited!

4. Operating Principle

The U-150 Level Gauge is designed on the basis of radio wave (radar) technology.

The Level Gauge is installed at the top of the tank and emits short microwave pulses towards the product surface in the tank. When the pulse reaches the surface, part of the energy is reflected back into the signal transducer, where it is processed by the electronic unit of the Level Gauge. The time difference between the emitted and reflected pulse is determined by the microprocessor and converted into the distance on the basis of which the level is calculated.

The minimum measurement reference point is 0.3 m from the radio-wave transmitter (see Fig. 6). It is called "dead zone" of the Level Gauge, when the reflected signal arrives to the sensor so soon that the Level Gauge does not have time to adjust from transmission to reception and the surface cannot be detected.

5. Installation

NOTIFICATION. Installation and further commissioning of the equipment should be carried out only by qualified specialists.

Before installing the U-150, it is necessary to make sure that:

- Basic dimensions at the processing facilities correspond to the dimensions of the U-150 (see Fig. 3, 4 and 5);
- Fixing bolts and screws are present;
- There is no damage of the connector insulation;
- There is no external damage of the components;
- There is no damage of insulation of the signal cable.

Disregard of this instruction may lead to a serious failure of the U-150.

Installation requirements

Proper installation of the Level Gauge is necessary for reliable operation of the radio wave level measurement system. The Level Gauge with a stand is designed to be installed on the top of the tank using bolts and nuts. Guide slots of the Level Gauge in the base box and guide screws of the stand help to attach it to the stand quickly (see Fig. 6).

Install the Level Gauge vertically for a sufficient level of reflected echo/signal from the surface of the liquid and the greatest amplitude of the echo/signal captured.

Obstacles to the "beam" propagation lead to strong false echoes/signals, thus install the Level Gauge so as to avoid false reflections.

It is recommended to install the U-150 Level Gauge at a distance of at least 0.5 m from the walls of the tank in order to avoid weakening or loss of the echo/signal (see Fig. 6).

In the absence of agitators, the Level Gauge should be installed in the center of the tank (installation the Level Gauge in the center of the tank reduces the dependence of the mud level readings on the inclination of the tank).

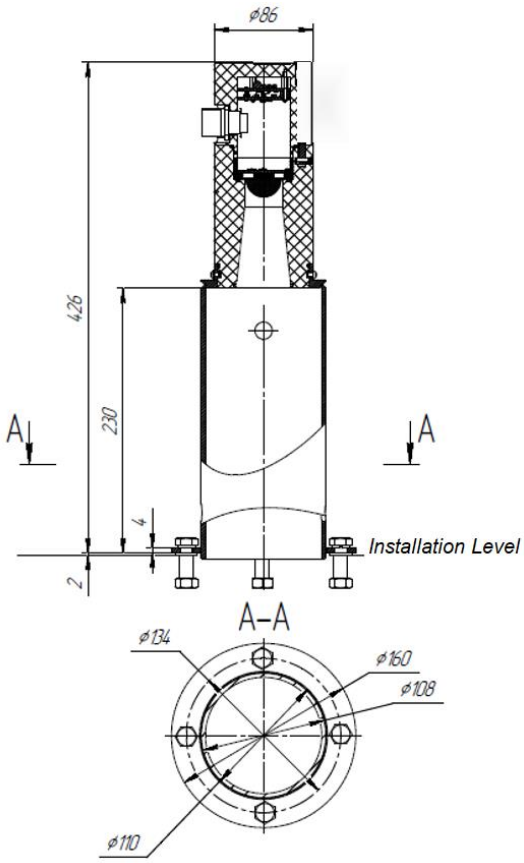


Figure 3. Overall dimensions of the U-150 Level Gauge with the general stand

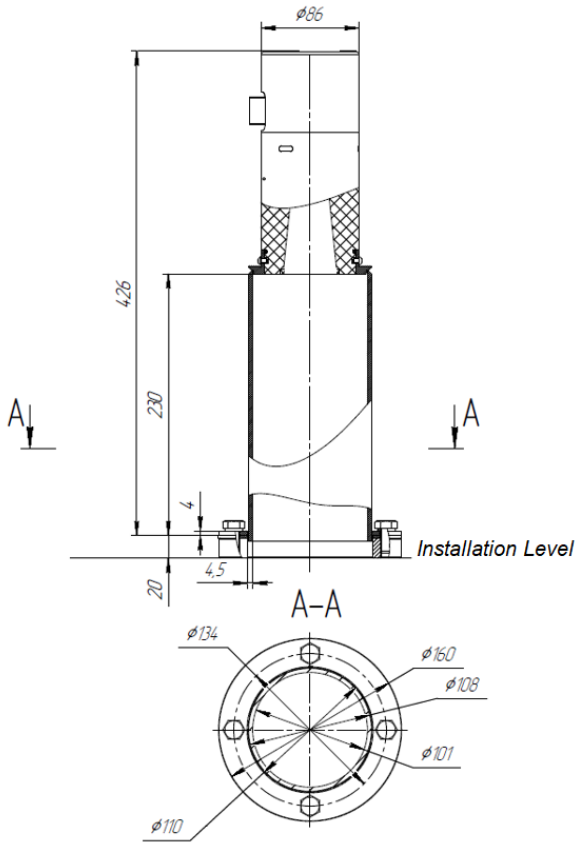


Figure 4. Overall dimensions of the U-150 Level Gauge with the enclosed stand

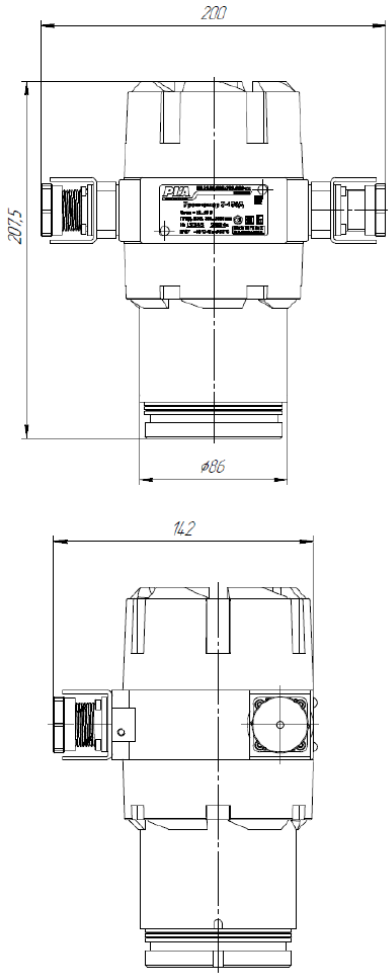


Figure 5. Overall dimensions of the U-150D Level Gauge

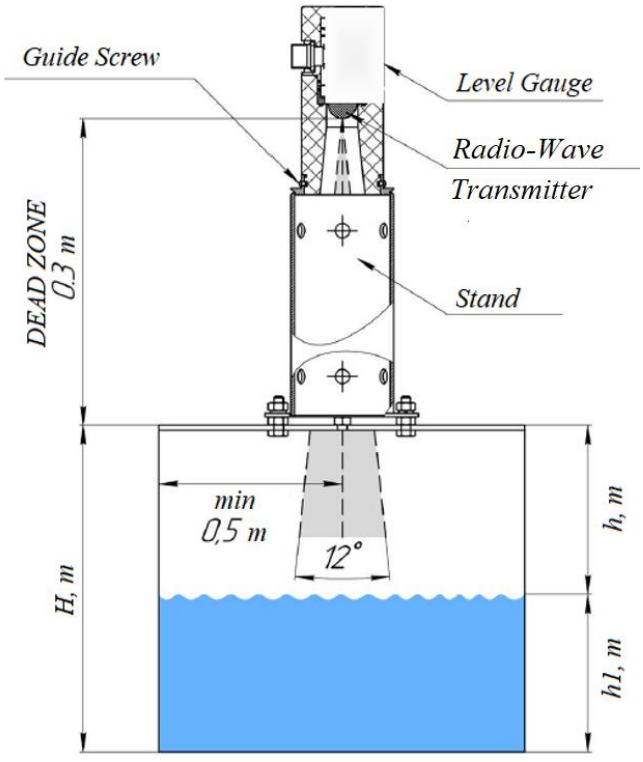


Figure 6. Installation Requirements

Fluid surface effect

Foaming liquids can weaken the echo/signal level, because foam is a poor signal reflector. If the foam is conductive and thick, the Level Gauge can measure its surface. If the foam has low electrical conductivity, microwaves can penetrate the foam and measure the surface of the liquid. Therefore, it is advisable to install the Level Gauge in a place where the surface of the liquid will always be clean. Do not install the U-150 Level Gauge directly above the liquid flow into the tank.

Tank design effect

If there are agitators in the tank, install the Level Gauge away from the swirl center created by the agitator.

To install the Level Gauge, it is necessary to:

- Determine the installation location of the Level Gauge;
- Cut a hole of 110 x 110 mm on the top of the tank and drill holes (4 pcs.) for mounting the support (see Fig.3);
- Install a Level Gauge.

NOTIFICATION. The stability of the readings and the accuracy of the level measurements depend on the correct installation of the Level Gauge

6. External Electrical Connections Installation

The WY20/WY20 universal commutation cable from the supplied package (see Fig. 7) is used for connection of the U-150 to the MU-150 / MU-150E / MK-140 unit of the DEL-150 System.

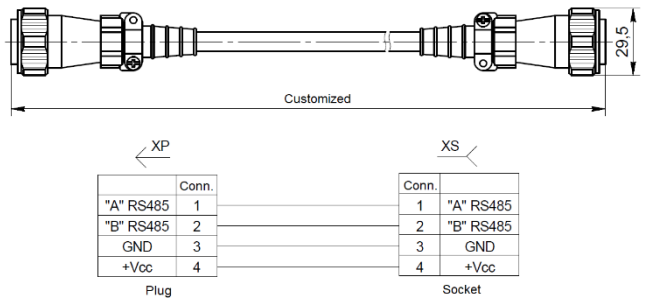


Figure 7. WY20/WY20 universal commutation cable

The cable from the U-150 is connected to any of the connectors of the MU-150 / MU-150E / MK-140 unit marked “RS-485” / “Sensor” (see Fig. 8).

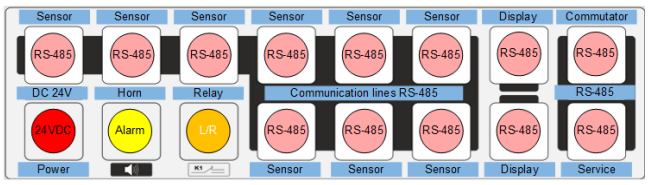


Figure 8. The MU-150 / MU-150E / MK-140 unit’s connectors “RS-485” / “Sensor” for the U-150 connection

The U-150D modification allows connection of the analogue output to the 3rd party systems by the 4-20 mA (WY, socket) cable (see Fig. 9) according to drawing on Fig. 10 and audible horn (see Fig. 11) to the corresponded connector.

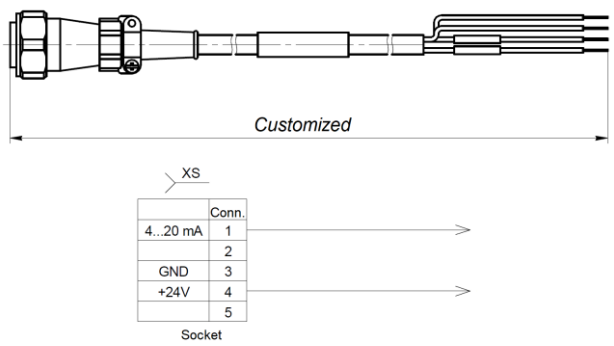


Figure 9. 4-20 mA (WY, socket) cable

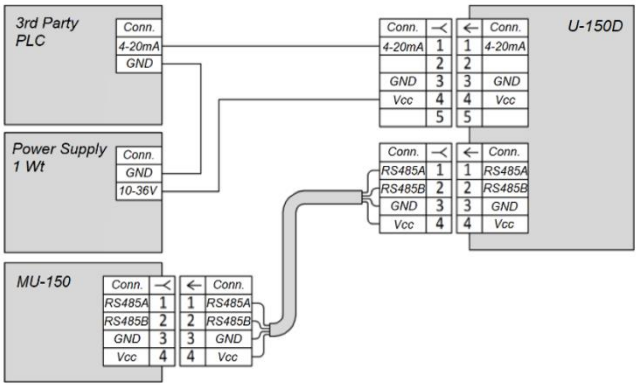


Figure 10. The U-150D connection

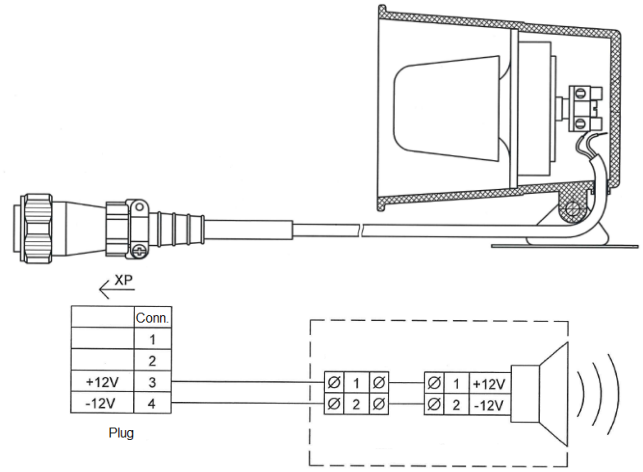


Figure 11. Audible horn

7. The U-150 Functional Test

For functional test of the U-150 Level Gauge it is necessary to connect the Level Gauge to MU-150 / MU-150E / MK-140 unit, to turn power on and to make sure that the parameter MUD VOLUME is displayed on the MU-150 / MU-150E EL screen (see Fig. 12).

Figure 12. Readings on the Control Module display

8. Readings Issues

If the connection with the U-150 is lost, the symbol "-----" opposite the parameter MUD VOLUME is displayed on the MU-150 / MU-150E EL screen (see Fig. 13).

Figure 13. Readings in case of loss of communication with the U-150

In case of loss of communication with the U-150 it is necessary to carry out actions in the following order:

1. Checking of integrity of the commutation cable;
2. Reconnection of the U-150 cable to free connector of the MU-150 / MU-150E / MK-140 unit marked “RS-485” / “Sensor”;
3. Checking of the presence of the parameter in the related menu’s list of the Control Module;
4. Replacement of the cable;
5. Checking of the presence of the parameter in the related menu’s list of the Control Module;
6. Replacement of the U-150;
7. Checking of the presence of the parameter in the related menu’s list of the Control Module.

9. Settings of the U-150

When the Level Gauge installation is completed, it is necessary to turn on the MU-150 Control Module and to enter the setting mode using the MU-150’s keyboard (see Fig. 14).

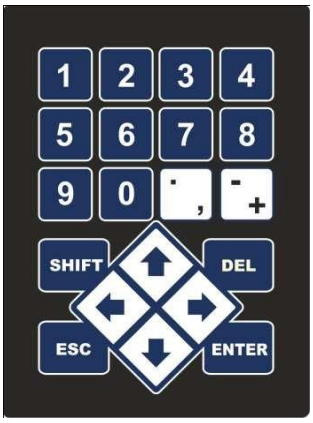


Figure 14. The MU-150 Control Module keyboard

Proceed in the following order to reach out required parameter:

1. Unblock the keyboard by pressing SHIFT + ENTER simultaneously;
2. Enter OPERATING PARAM’S menu by pressing SHIFT + 3 simultaneously;
3. Use ↓ , ↑ and ENTER to select required parameter. To return to the previous menu, use ESC.

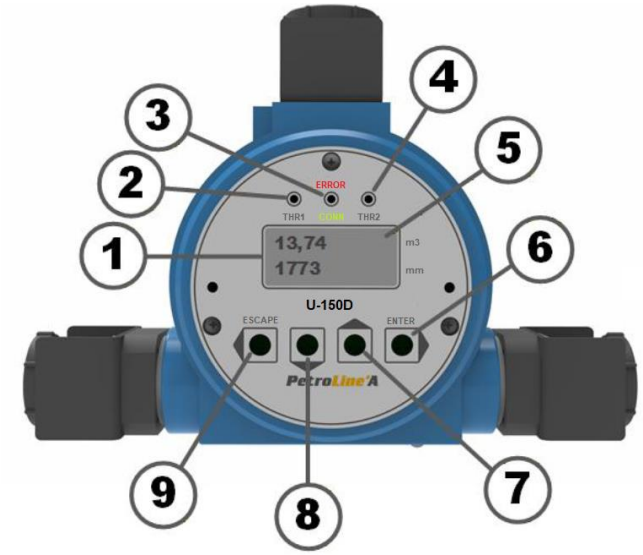
ENTER	MUD OUTPUT MUD VOLUMES GAS MUD DENSITY HOOK LOAD2
ENTER	MUD VOLUMES MUD VOLUME1 MUD VOLUME2 MUD VOLUME3 MUD VOLUME4
Setup the required settings described below	MUD VOLUME1,m3 MAX 010.00 MIN ----- MAX 2 ----- MIN 2 ----- HORN OFF TANK TYPE RECTANG AIN SETTINGS MIN 000000 MAX 000020 HOLDER HEIGHT.m 0.30 TANK HEIGHT.m 02.00 TANK VOL.m3 20.00

- **MAX / MIN (1st thresholds)** – the maximum and minimum values that are required for activating alarm and relay output. Alarm is activated when 95% of this value is reached. When 100% is reached, the assigned (first) relay of the MU-150 / MU-150E / MK-140 blocking unit (if available) will change its state (i.e. it will close or open the electrical circuit of the actuator);
- **MAX 2 / MIN 2 (2nd thresholds)** – the maximum and minimum values that are required for activating alarm and relay output. The algorithm of activation is the same as for the 1st thresholds considering the 2nd thresholds range covers the 1st one. Also, the another (second) relay of the MU-150 / MU-150E / MK-140 blocking unit is engaged if available;
- **HORN** – turning on and off the alarm when the maximum or minimum value of mud volume is exceeded. To change the setting, use ENTER;
- **TANK TYPE** – setting the type of tank using ENTER;

- **AIN SETTING** – setting up an analog input (for using 3rd party sensor with an analog output);
- **HOLDER HEIGHT.m** – distance from the radio-wave transmitter to the stand's flange (0.3 m, see Fig. 6);
- **TANK HEIGHT**.m – distance H on Fig.6;
- **TANK VOL.m3 –** actual tank capacity.

9.1. Settings of the U-150D Modification

The U-150D sensor modification allows it configuring via internal display control panel (see Fig. 15) according to the diagram below (see Fig. 16).



1. Backlit display;
2. Red LED "THR1" lights up constantly when 1st alarm limit has been exceeded;
3. Sensor status LED blinks by red in case of sensor's failure and blinks by green in case of data exchanging by RS-485;
4. Red LED "THR2" lights up constantly when 2nd alarm limit has been exceeded;
5. Parameters values;
6. ENTER button:
   - Hold within 5 sec to enter program menu from the main screen;
   - Press to choose required menu;
   - Press to enter the value;
7. UP button:
   - Press to change up required menu;
   - Press to increase the value;
8. DOWN button:
   - Press to change down required menu;
   - Press to decrease the value;
8. ESCAPE button:
   - Hold within 5 sec to exit program menu;
   - Press to return to previous menu;
   - Press to escape from the menu.

Figure 15. The MU-150D's display control panel

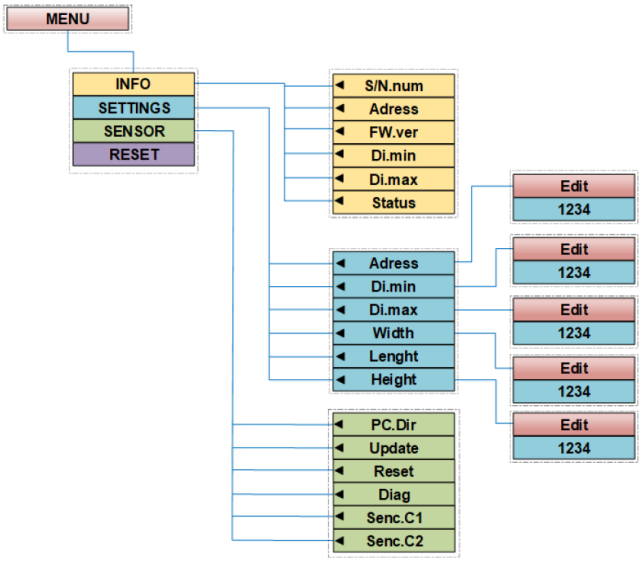


Figure 16. The MU-150D's program menu diagram

10. List of Critical Failures and Possible Issues in Maintenance Leading to Equipment Failures and Actions to Prevent these Failures (troubleshooting)

Incorrect power supply can lead to equipment failure.

Incorrect set maximum values for parameters can lead to incorrect operation of the external controlled equipment if the maximum level for the controlled parameter is exceeded.

A short circuit or a break circuit in the power and communication lines of the Level Gauge**,** may cause loss of communication with the Level Gauge with the following failures: lack of parameter data, symbols "????" or "----" instead of parameter data, lack of data on other parameters.

In case of failure of the Level Gauge or Control Module, it is necessary to check the equipment technical condition according to the Clause #8 of this Operation Manual. If troubleshooting did not lead to proper operation, it is necessary to stop operation and replace with obviously serviceable equipment. Defective equipment should be sent for repair to the manufacturer or to the specialized authorized service center.

In case of failures that can lead to emergency situations, it is necessary to replace the equipment that has failed. If necessary, disable additional external devices.

11. Maintenance Procedure

Maintenance is carried out in the following order:

1. Cleaning the Level Gauge's housing and radio-wave transmitter from contamination;
2. Checking the safety of seals (if available);
3. Checking the presence and strength of the mounting components;
4. Cleaning of connectors and terminals from contamination;
5. Checking for the absence of visible mechanical damages;
6. Replacement and (or) repair of damaged cable products;
7. Replacement of damaged connectors.

The contacts of the connector should be washed with an alcohol-gasoline mixture (need 3 ml.) using a soft brush.

Connectors after cleaning and drying should be treated with Vaseline or similar lubricant. It is recommended to treat the threads on the connectors with graphite grease.

NOTIFICATION. Absence of maintenance records in the passport (section "Maintenance Records") ENTAILS VIOLATION OF THE OPERATION RULES, and the manufacturer has the right to withdraw from warranty obligations

12. Limit Conditions Parameters

In case of severe mechanical damage, leakproofness violations, seals violations, heating of parts to unacceptable temperatures, supply of unacceptable currents and voltages, change of calibration data, further use is unacceptable or impractical, or restoration of its serviceable or operable condition is impossible or impractical.

13. Marking and Packaging

The U-150's nameplate includes the following components (see Fig. 17):

1. Trademark or name of the manufacturer;
2. Part number;
3. Name and model;
4. Serial number;
5. Manufacturing year;
6. Explosion protection marking together with certificate number;
7. Technical characteristics.

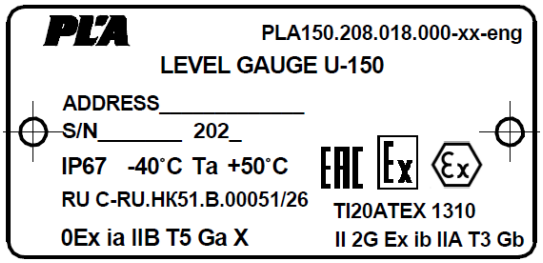


Figure 17. Example of the U-150 marking

Other data required by regulatory and technical documentation may also be reflected on the nameplate.

Boxes made of plywood with metal handles for carrying are used to transport the U-150 as part of the DEL-150 System.

14. List of Components

Full completeness is indicated in the passport for equipment released by the manufacturer.

15. Repair

Repair of the U-150 is carried out at the manufacturer or at a specialized authorized service center.

NOTIFICATION. Absence of repair records in the passport (section "Repair Records") ENTAILS VIOLATION OF THE OPERATION RULES, and the manufacturer has the right to withdraw from warranty obligations

16. Storage

The equipment requires careful handling, storage in dry, clean rooms with a constant temperature from -50°C to +65°C and a relative humidity of no more than 80%.

The long-term storage requires conservation, according to the requirements of the equipment conservation instructions. The equipment arriving at the warehouses in the manufacturer's containers are not unpacked, packed on flat pallets and stacked or in the cells of the racks.

Factory-sealed devices are not allowed to be opened in warehouses.
Small devices and devices arriving in individual packaging are stored in box pallets with installation in a stack.

Devices and components without individual packaging should be stored in shelving cells no more than 3 rows in height with the use of cushioning materials between them.

Small devices and products arriving without packaging can be stored in small-cell racks and cabinets, while devices or products of the same type should be stored in one cell.

NOTIFICATION. Absence of storage records in the passport (section "Storage Records") ENTAILS VIOLATION OF THE OPERATION RULES, and the manufacturer has the right to withdraw from warranty obligations

17. Transportation

Transportation of the equipment is allowed by all types of closed transport. The U-150 in a package for transportation allows the impact of transport shaking with an acceleration of 30 m/s^2 with a frequency of 100 beats per minute or 1500 beats with that acceleration.

18. Disposal

The U-150 is disposed of in accordance with the requirements and norms applicable in the oil and gas industry.

19. Warranty Obligations

The warranty period is 12 months from the date of sale.

A full description of the warranty obligations is described in the equipment passport.

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