

**AutoSat**.com

Fuel Level Sensor for Satellite Vehicle  
Tracking Systems



**SAT-FUEL**

**User's Manual**

**Version 2.3.3**

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## 1 Introduction

The User's Manual is intended to provide users with the information about the Fuel Level Sensor (FLS) 12, its operating principle and operating rules.

The types of fuel in which the FLS works: gasoline, summer and winter diesel fuel and other liquid petroleum products, which maintain their aggregate state in the operating temperature range.

The devices are produced in different designs depending on the length of the measuring apparatus (indicated in millimeters at the end of the product name, for example FLS12-02-700) and design features:

FLS 12-01 is undismountable, the cable is mechanically connected to the body; data output is via RS232 and RS485 interfaces.

FLS 12-02 is undismountable, the cable is mechanically connected to the body; data output is in analog-frequency form.

FLS 12-03 is undismountable, the cable is mechanically connected to the body.

FLS 12-04 differs by the presence of a cable connector, as well as a cap protecting the connector and fixing bolts from external influences; data output is via RS485 interface.

FLS 12-05 differs by the presence of a cable connector, as well as a cap protecting the connector and fixing bolts from external influences.

The connecting wires are retracted into the metal hose.

The standard length of manufactured FLSs is 700 mm, 1,000 mm. If desired, it is possible to manufacture FLSs with a longer measuring length (1,500 mm, 2,000 mm, 2,500 mm, 3,000 mm) for installation in fuel tanks of various heights.

For all questions related to the operation of the FLSs and the use of the AutoSat FLS software, contact the FLS supplier or the technical support service of the AutoSat Group. Contact details are available on [autosat.com](http://autosat.com).

## 2 Main Parameters

### 2.1 Technical Data

The main technical data for FLS-12 is given in Table 1.

Table 1. Specification data for FLS12.

Electrical Data	
Supply voltage, V	from 9 to 50
Average consumption current at supply voltage 12 V, mA	30
Presence of galvanic isolation of supply circuit and measuring apparatus	yes
Insulation voltage, kV	2.5
Interfaces with External Devices	
Configuration interface	RS-485
Data Output Interfaces	
Digital interfaces FLS12-01	RS-232, RS-485
Digital interfaces FLS12-02	none
Digital interfaces FLS12-04	RS-485
Analog output voltage (FLS12-02), V	from 0.1 to 4.75
Output frequency (FLS12-02), Hz	from 100 to 1,000
PWM output (FLS12-02)	2 Hz, 10..90%
Other Specifications	
Reduced measuring error	Not more $\pm 1\%$
Operating temperature, $^{\circ}$ C	from -40 to 85
Ingress protection rating, category	IP57
Weight (without gauge tube and cable), kg, not more than	0.3
Type of mounting sensor to fuel tank	SAE-5
Length of measuring apparatus of sensor (depending on model), mm	from 150 to 3,000
Overall Dimensions (without gauge tube and cable)	
FLS12-01, FLS12-02 and FLS12-03, mm	85 x 79 x 34
FLS12-04 and FLS12-05, mm	122 x 94 x 39

## 2.2 Scope of Supply

Scope of supply is given in Table 2.

Table 2. Scope of Supply.

Fuel level sensor with gauge tube, stem and cable	1 psc.	FLS12-01, FLS12-02 and FLS12-03
Fuel level sensor with gauge tube and stem	1 psc.	FLS12-04 and FLS12-05
Cap with cable	1 psc.	FLS12-04 and FLS12-05
Gasket	1 psc.	
Mounting self-tapping screws	5 psc.	
Insulation cap for gauge tube	1 psc.	
Technical datasheet	1 psc.	

## 2.3 Device Labeling

The labeling of the FLS is printed on its body and contains:

- serial number of device;
- trademark or manufacturer's logo;
- supply voltage;
- symbol of device;
- year of manufacture;
- "Made in Russia".

## 2.4 Packaging

The scope of supply is packed in a cardboard box. It is allowed to use a group package for two FLSs. In this case, the labeling of the package should contain information on the number of FLSs in the package.

## 3 Intended Use

### 3.1 Use Limits

- 1) The ambient temperature should not exceed the values specified in the technical datasheet;
- 2) The FLS should not have any mechanical damages like dints, cracks, bends;
- 3) Do not damage the insulation of the mounting cable;
- 4) Use the FLS only with liquid petroleum products that maintain their aggregate state in the operating temperature range;
- 5) Use of poor quality fuel can lead to incorrect operation of the FLS;
- 6) The dielectric constant of the target medium must be constant. Non-compliance with this requirement leads to an increase in the measurement error;
- 7) When mounting the sensor, it is not allowed to use fasteners that are not in the scope of supply;
- 8) It is not allowed to trim the finished FLS when it is set to a length of less than 100 mm.

### 3.2 Safety Features

Only personnel that are certified to mount FLSs are allowed to carry out installation work.

When installing, observe the safety requirements specified in the operating documentation of the vehicle manufacturer and also the requirements of the regulatory documentation for this type of equipment.

### 3.3 Preparation for Use

List and order of all necessary installation work:

- 1) Selecting the location for the FLS to be installed;
- 2) Preparing the fuel tank for installation;
- 3) Trimming the FLS for a specific fuel tank;
- 4) Configuring the FLS using Autosat FLS;
- 5) Installing the FLS;
- 6) Preparing and laying the cable to connect the FLS to an external device;
- 7) Connecting the FLS;
- 8) Calibrating the fuel tank;
- 9) Sealing the FLS.

#### 3.3.1 Choosing Location for Fuel Level Sensor

Installation of the FLS must be performed depending on the geometric shape of the tank in the places indicated in the figure (Fig. 1). The installation of the FLS in these places ensures the independence of the FLS value from the inclination angle of the vehicle.

In cases where it is not possible to install the FLS in the locations indicated in the figure (Fig. 1), the installation site should be as close as possible to those indicated. The installation of two FLSs in one fuel tank will significantly reduce the dependence of the fuel level on the inclination angle of the vehicle. The installation of two FLSs should be performed at the locations indicated in the figures (Fig. 2).

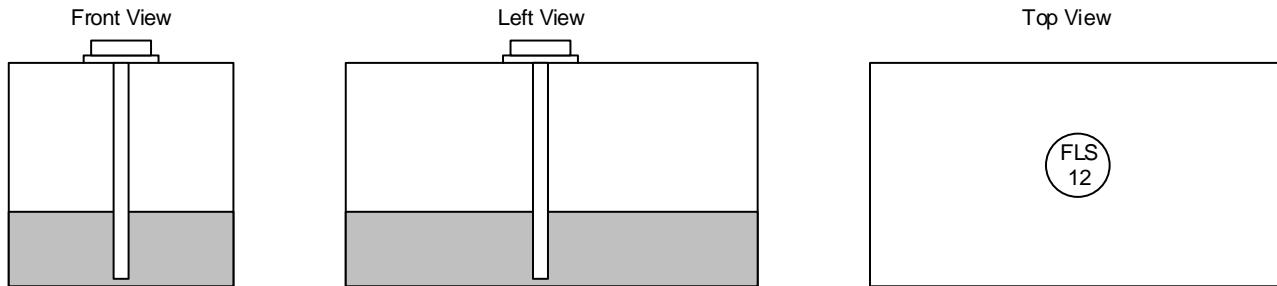


Fig. 1

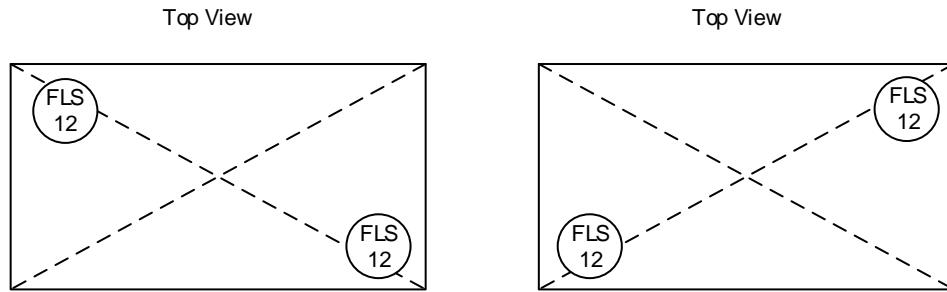


Fig. 2

When choosing the installation site, it is also necessary to make sure that there is no internal dividing in this part of the fuel tank.

### 3.3.2 Preparing Fuel Tank for Installing Fuel Level Sensor

After determining the installation site, carefully clean the contaminated surface of the tank around it within a radius of 20 cm. After that, cut a hole of 38-40 mm for the FLS measuring apparatus. While doing so, ensure that the metal shavings do not fall into the vehicle's tank during drilling.

### 3.3.3 Trimming Fuel Level Sensor for Specific Tank

- 1) Measure the depth of the tank with a ruler by lowering it into the drilled hole for the FLS;
- 2) On the working length of the device L, measure the length L1, which is equal to the depth of the tank minus 15 mm.

Example: When measured tank depth is 560 mm, the length of the FLS should be 545 mm.

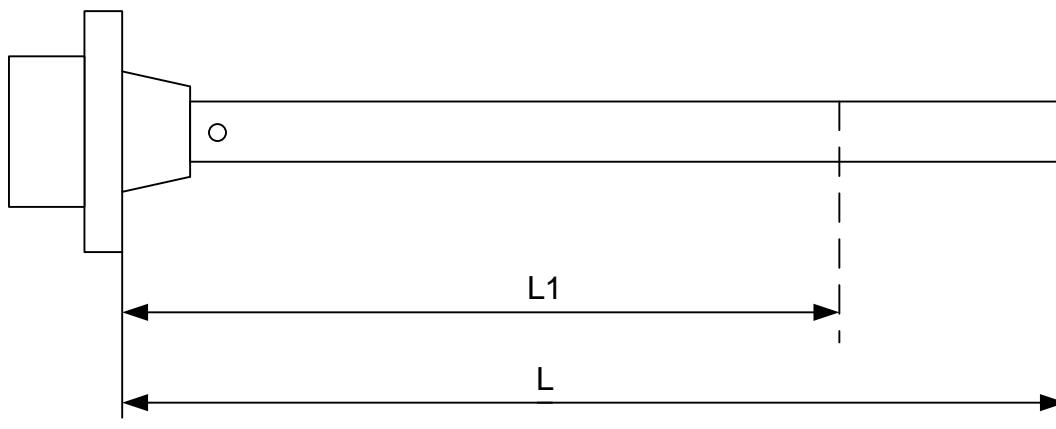


Fig. 3

- 3) Cut L1 length with a hacksaw (or another suitable tool) so that the cut line is strictly perpendicular to the longitudinal axis of the FLS (Fig. 3);

4) Fill the sealing cap, which is supplied with the FLS, with the sealant, 1/4 - 1/5 of the volume of the inner cavity of the insulating cap;

5) Put the plastic insulating cap, which is supplied with the FLS, on the central core of the FLS.

**Important! Do not cut the FLS for a length of less than 100 mm.**

### 3.3.4 Tuning Fuel Level Sensor

When installing the FLS on the vehicle, its measuring tube is shortened to the size of the tank. Changing the length of the tube entails a change in the characteristics of the sensor, so the installation requires adjustment of the main parameters. These parameters include the length of the measuring tube, as well as the level values when the tank is empty and full.

When adjusting the FLS, you need to specify the actual length of the tube L1 - from the plastic head of the sensor to the end of the tube (Fig. 3).

Next, you need to set the frequency value of the full tank. Before entering the value, it is necessary to fill the measuring tube with fuel completely. This can be done in one of the following ways:

- Seal the ventilation openings on the tube near the head of the sensor with adhesive tape, turn the FLS over and fill it with fuel using a funnel.
- Fully immerse the measuring tube of the FLS in the fuel tank.
- If the FLS is installed in the tank of the vehicle, fill the tank with fuel completely.

When filling the measuring tube with fuel, it is necessary to take measures so that no bubbles and air pockets remain inside the tube. After filling, wait for the value to stabilize and record it.

The next step is to enter a value for an empty tank. Before entering the value, it is necessary to drain the fuel from the measuring tube completely. If the FLS is installed in the tank of the vehicle, drain the fuel from the tank completely. Enter the value for an empty tank after the measuring tube was first filled with fuel, and then when the fuel was drained. There is a certain amount of fuel on the inner walls of the tube, so after draining, wait at least 1 minute. Entering the value for an empty tank without filling the tube with fuel first increases the level measurement error.

In detail, the process of product configuration using the software *AutoSat FLS* is described in the document *AutoSat FLS User's Manual*.

### 3.3.5 Mounting Fuel Level Sensor

- 1) Apply an even thin layer of sealant to both sides of the gasket;
- 2) Put the sealing gasket, which is supplied with the device, on the base of the measuring part of the FLS;
- 3) Place the sensor in the hole, which was previously cut;
- 4) Drill five mounting holes for self-tapping screws. For tanks with a thickness of less than 3 mm, a Ø4.0 mm drill bit is recommended. For tanks with a thickness of 3-6 mm, a Ø4.0-4.2 mm drill bit is recommended. For tanks with a thickness of more than 6 mm, a Ø4.2-4.5 mm drill bit is recommended;
- 5) Secure the FLS to the tank with screws, which are supplied with the FLS. Self-tapping screws supplied with the FLS have a washer with a sealing rubber ring. The thickness of the rubber seal in uncompressed form is about 2 mm. (See photo 1).



Photo 1

To tighten the self-tapping screws, it is recommended to do that in the following sequence 1-2-3-4-5 (see photo 2) to prevent skewing and uneven force.

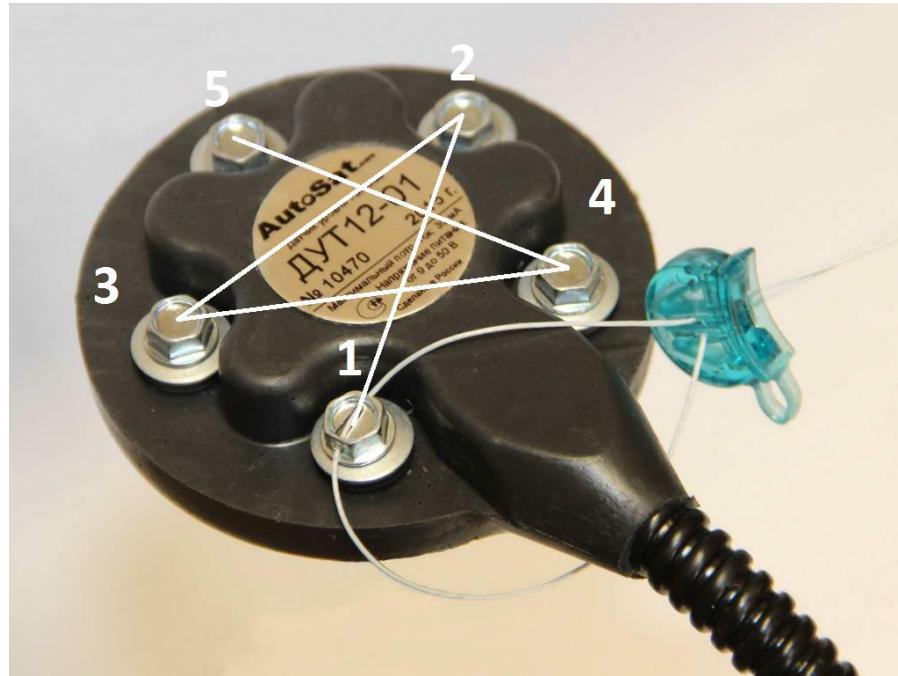


Photo 2

In the tightened form, the toric joint of the self-tapping screw should be compressed to a thickness of about 1 mm. The self-tapping screw tightened with a normal force is shown in photo 3.



Photo 3

It is not acceptable to use excessive force when tightening the self-tapping screw, when the deformation of the toric joint is 0.5 mm or less. An example of inadmissible force when tightening screws is shown in photo 4.



Photo 4

### 3.3.6 Preparing and Installing Cable

- 1) When installing, it is necessary to use cables manufactured by AutoSat, which are included in the scope of supply or purchased separately;
- 2) To connect the FLS to the vehicle module, use the cable in the corrugated hose (the cable is supplied). The cable has a length of 7 m and, if necessary, can be lengthened or cut off;
- 3) On the way of cable laying, there should be no heated parts of the mechanisms and components of the vehicle in order to avoid melting of the wires insulation;
- 4) On the way of cable laying, there should be no moving parts of the vehicle's mechanisms;
- 5) When laying the cable, it is necessary to secure it safely to the stationary parts of the car body at least every 50 cm, in order to avoid sagging the cable.

### 3.3.7 Connecting Fuel Level Sensor

The pin assignment of the outputs of the FLS cable routing and the color of the cable wires for connecting to an external device is shown in Fig. 4 and in Tables 3 and 4.

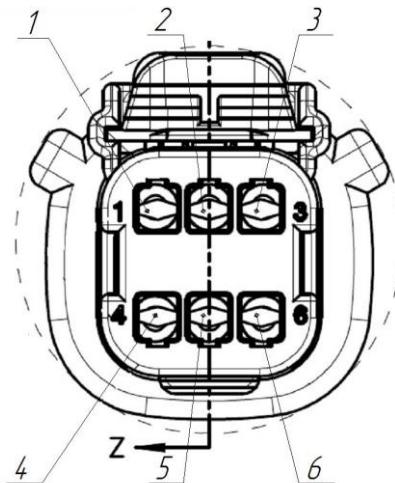


Fig. 4. View of FLS cable routing output (output view).

Table 3. Wire assignment and colors FLS12-01.

#	Color	Assignment
1	Black	Ground
2	Gray	RX line of RS232 interface
3	Blue	B line of RS485 interface
4	Yellow	Power supply +9–50 V
5	Green	TX line of RS232 interface
6	Orange	A line of RS485 interface

Table 4. Wire assignment and colors FLS12-02.

#	Color	Assignment
1	Black	Ground
2		Not used
3		Not used
4	Yellow	Power supply +9–50 V
5	Violet	Analog-frequency output
6		Not used

Connect the FLS via the RS-232 interface according to the scheme (Fig. 5).

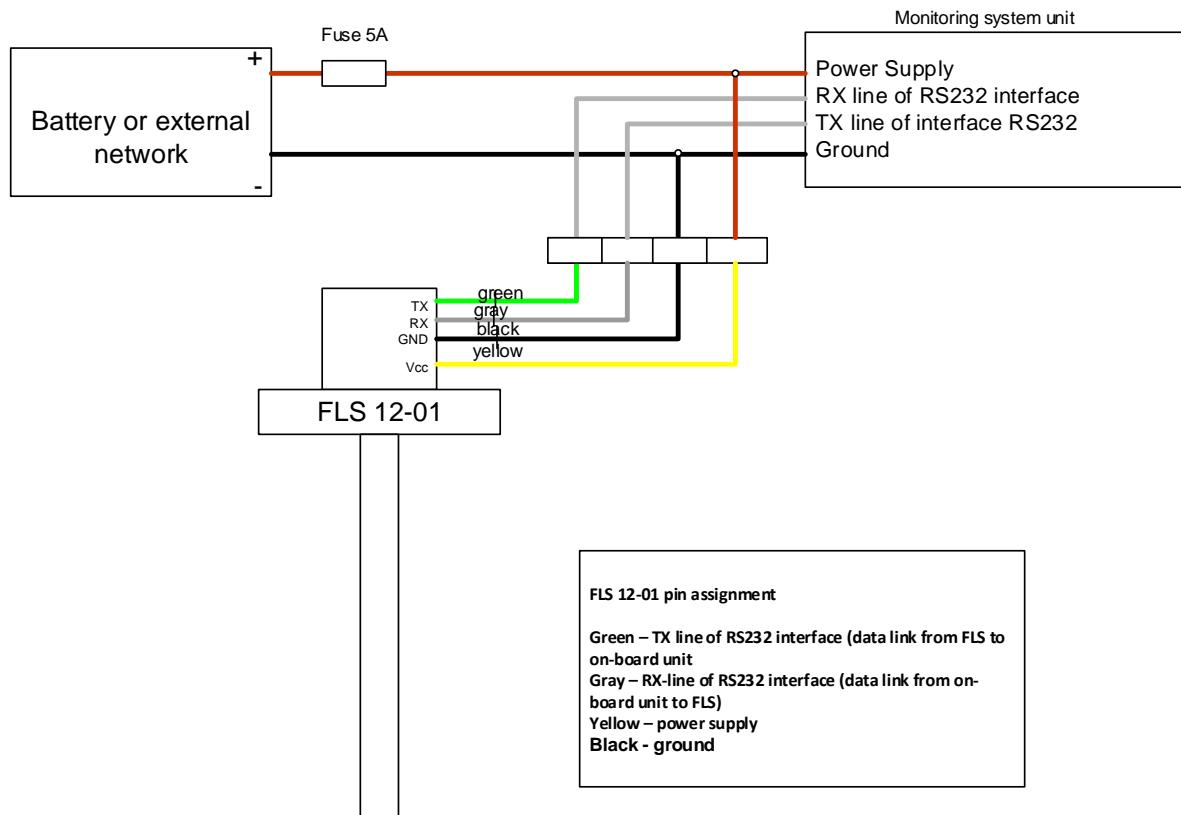


Fig. 5

When connecting to RS232 interface, remember that the RX and TX wires are switched crosswise. The FLS transmitting bus (TX) is connected to the receiving bus (RX) of the on-board unit and vice versa, the FLS receiving bus (RX) is connected to the transmitting bus (TX) of the unit.

**When connecting the FLS to terminals that have an additional power output for peripheral devices connection, it is recommended to connect the sensor power to this output.**

Connect the FLS via the RS-485 interface according to the scheme (Fig. 6).

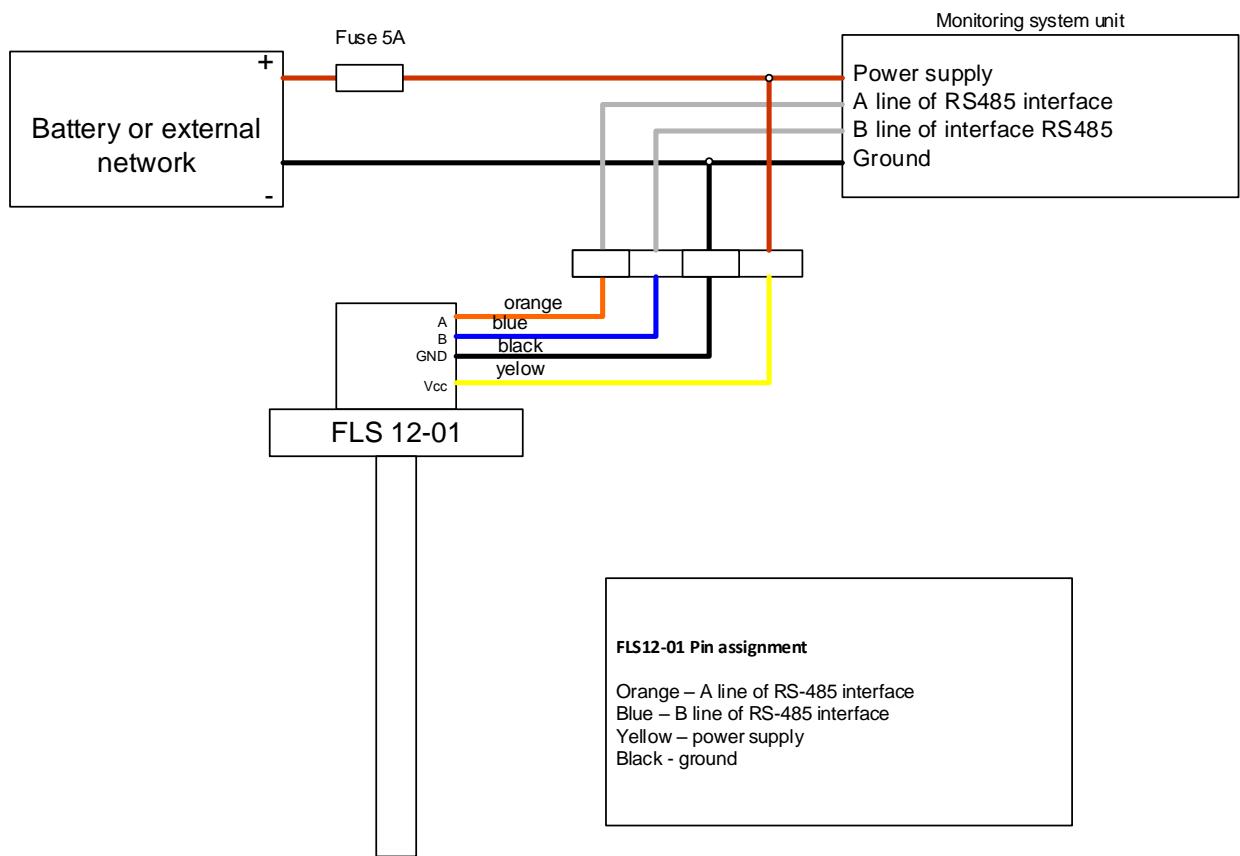


Fig. 6

When connecting via RS485 interface, remember that line A of the unit is connected to the FLS line A, and line B of the block is connected to the FLS line B.

**When connecting the FLS to terminals that have an additional power output for peripheral devices connection, it is recommended to connect the sensor power to this output.**

Connect 2 FLSs via the RS-485 interface according to the scheme (Fig. 7).

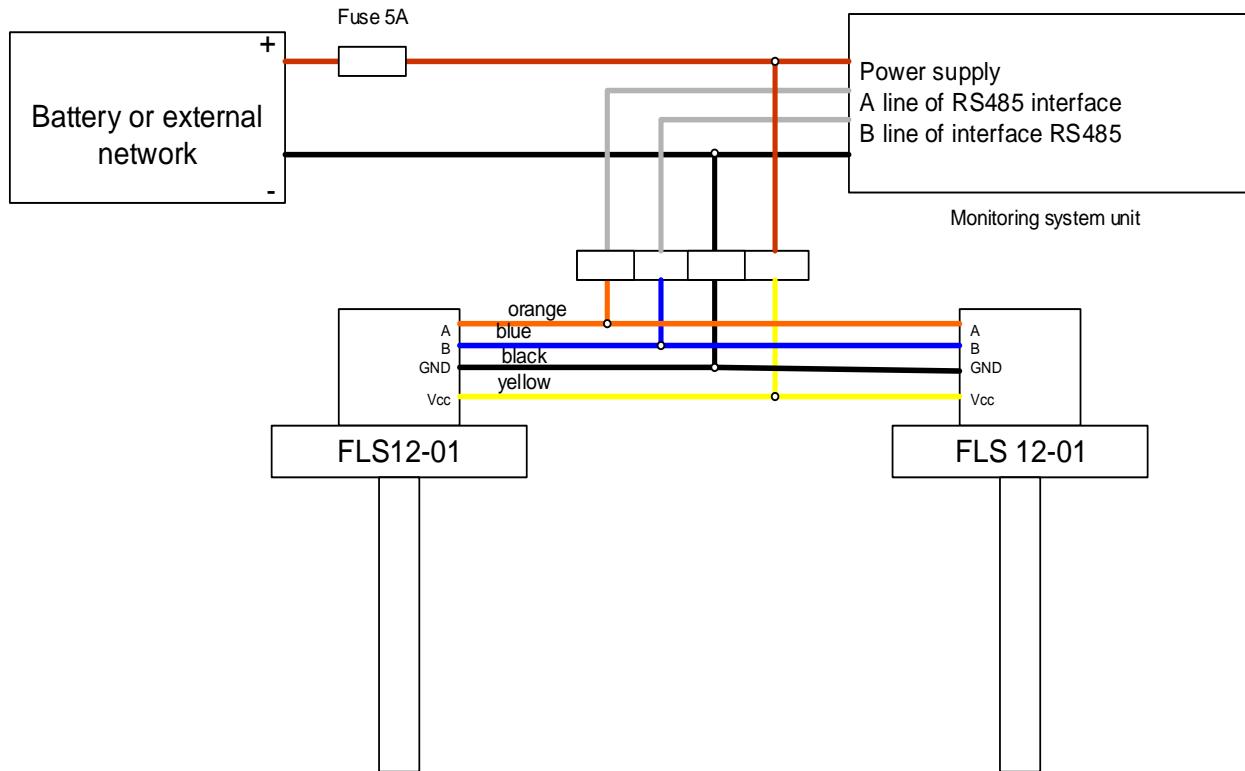


Fig. 7

**When connecting the FLS to terminals that have an additional power output for peripheral devices connection, it is recommended to connect the sensor power to this output.**

Connect the FLS to terminals that have an analog-frequency input according to the scheme (Fig. 8).

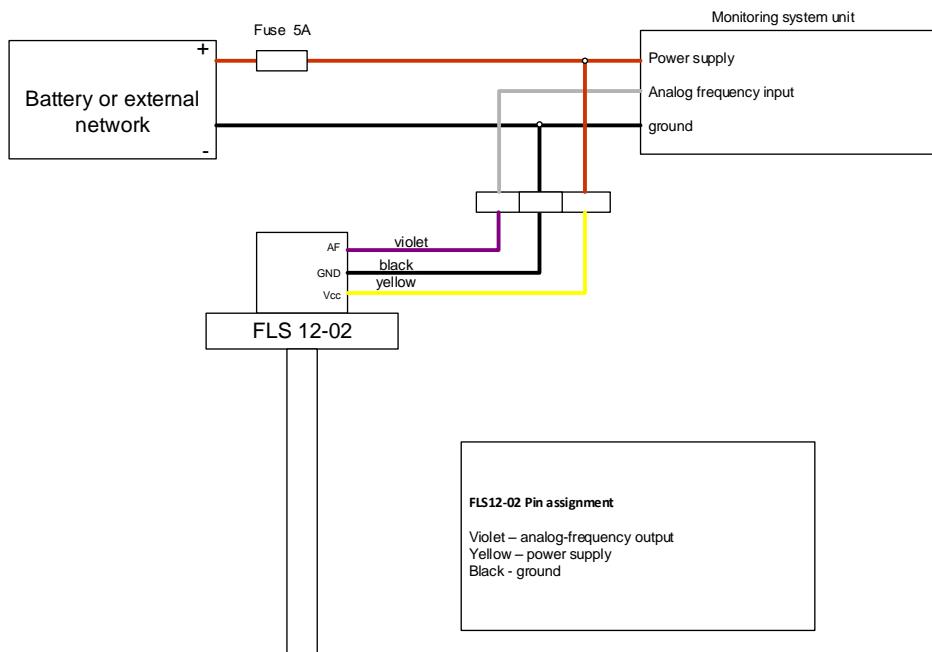


Fig. 8

**When connecting the FLS to terminals that have an additional power output for peripheral devices connection, it is recommended to connect the sensor power to this output.**

### 3.3.8 Calibrating Fuel Tank

Calibration of the fuel tank is necessary to check the compliance of the FLS indications and the fuel volume in the specific fuel tank.

The process of calibrating the fuel tank is refueling the tank (from empty to full, with a certain refueling step) and fixing the FLS readings in the calibration table. When installing two FLSs in the fuel tank, it is necessary to create a calibration table for each FLS.

The refueling step is selected independently, depending on the shape of the fuel tank - the more complex the shape of the tank is, the less refueling step it is required to select. The refueling step can be changed during the calibration. It is recommended to select the refueling step in such a way that the calibration table consists of 15-20 values. For large tanks (more than 1000 liters), the number of values of the calibration table should be bigger.

The calibration process using the *AutoSat FLS* software is described in detail in *AutoSat FLS User's Manual*.

### 3.3.9 Sealing Fuel Tank

Sealing is the process of installation of seals, which are designed to determine the fact of unauthorized access to the FLS, on the connectors and the FLS itself. The sealing process consists of two parts:

- 1) Sealing the FLS case
- 2) Sealing the FLS connector

To seal, use the materials, which are included in the filling kit.

#### Sealing the FLS case

When sealing the case, instead of one of the self-tapping screws, an additional self-tapping screw with a hole and a rope-type seal are used. A general view of the sealed FLS is shown in Photo. 5. The FLS cannot be removed from the fuel tank without damaging the integrity of the seal or rope.

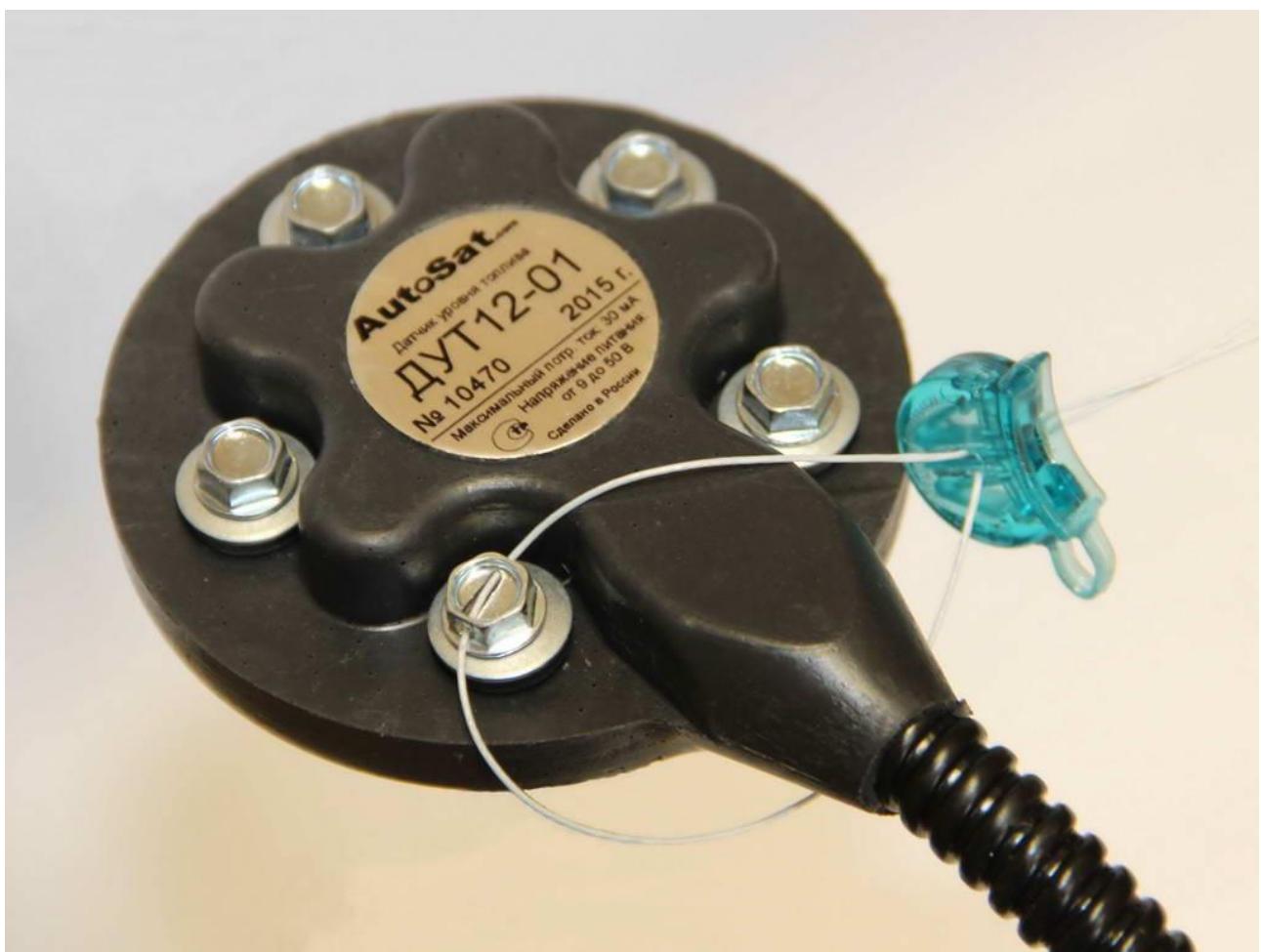


Photo. 5

### Sealing the FLS connector

To seal the FLS connector, an additional plastic seal is used. Photo 6 shows the process of installing the seal. After this procedure, it is impossible to disconnect the FLS connector without breaking the integrity of the seal.

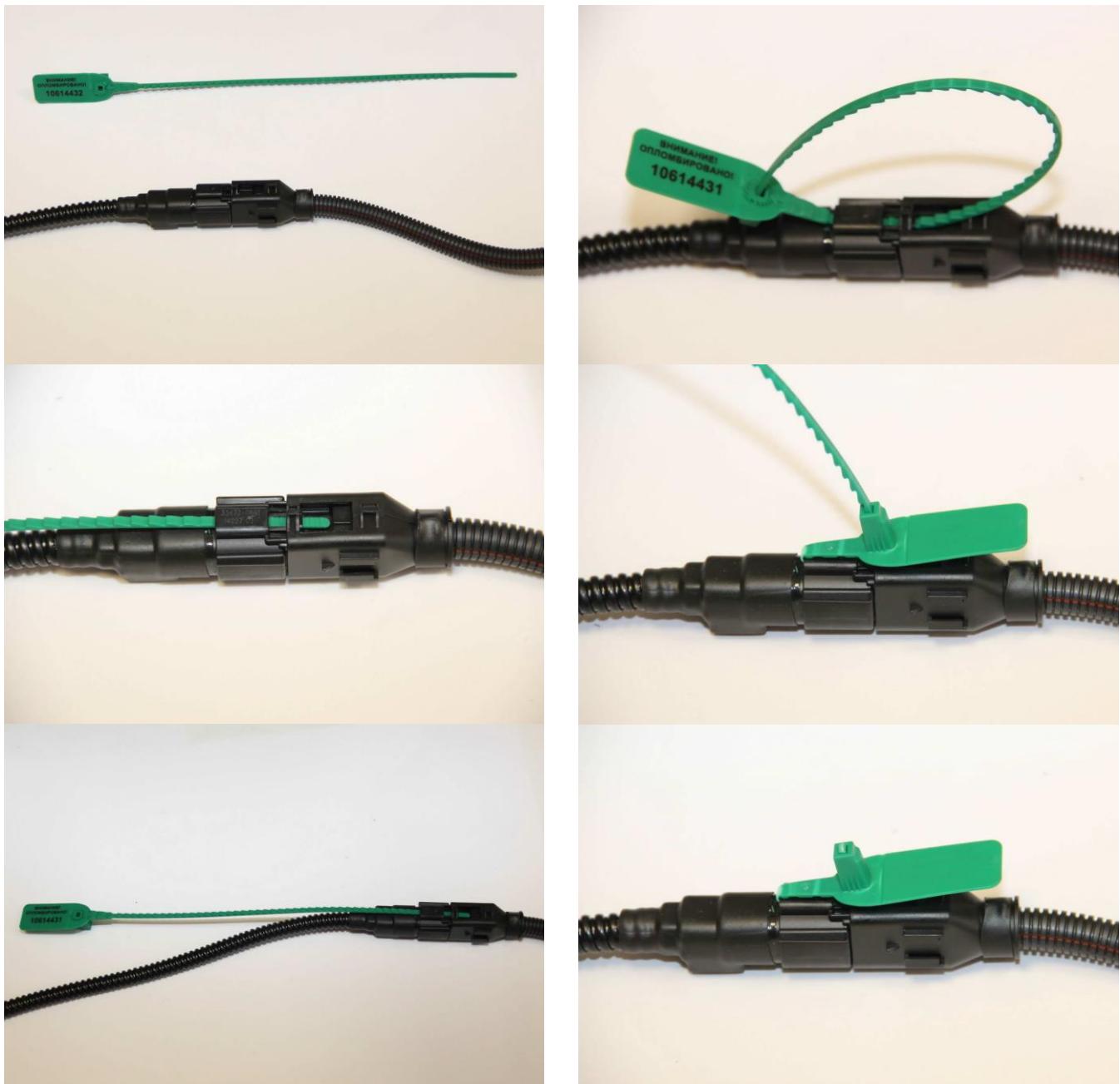


Photo. 6

After the FLS is completely sealed, it is necessary to record the numbers of the seals in the installation certificate.

## **4 Maintenance**

It is necessary to carry out scheduled checks of the FLS case, connectors and cable route for the presence of any mechanical damages. In case of damage to the cable route, connectors or FLS case, it is recommended to replace the equipment.

## **5 Routine Maintenance**

The repair of the FLS is carried out by specialists of the Maintenance Department of AutoSat Group.

## **6 Manufacturer's Warranty**

- 1) The warranty period is 3 years from the date of sale. The date of sale is indicated in the Technical Datasheet.
- 2) The manufacturer guarantees the normal operation of the FLS if the consumer complies with the operation, transportation and storage regulations.
- 3) The warranty applies to FLSs, which are installed by specialists who are trained in fuel level sensor installation programs.

## 5 Appendix A. Overview and overall dimensions of FLS12

