"EPSILON"®
FUEL LEVEL SENSOR

"ESx - H" model

User Manual

EH.000 UM

v. 171228

CONTENTS pages

The present installation manual is intended to provide information necessary for users during operation and maintenance of “Epsilon” fuel level sensor “ESx-H model” (hereinafter – sensor, FLS or product).

Personnel familiar with the present manual is allowed to install the sensor.

1 SPECIFICATION AND PRINCIPLE OF OPERATION

1.1 Specification and operation of device

1.1.1 Intended use

Sensor is purposed for fuel level measurement in fuel tanks of vehicles and stationary fuel tanks. Sensor can be used to measure level of other nonconductive liquids.

ES2-H, ES4-H sensor can be used with equipment that supports unified communication protocol Epsilon Data Exchange. (hereinafter - EDE).

ESA-H model sensors can be used with analogue interface devices.

Sensor has electronic galvanic isolation through interface and power circuits.

Sensor is compatible with different GPS tracking devices, such as:

- "Автограф";
- "Скаут";
- "Locarus";
- "Intellitrac";
- "Patriot";
- "Teletrack";
- "Teltonika";
- "M2M – Cyber GLX";
- "Ruptela FM";
- "BCE FM blue» and others.

Additional features

Model ES2-H sensors provide frequency interface (signal outputting from 500 to 1500 Hz frequency with linear frequency dependence vary with measured level of fuel). Also, model ES2-H sensors can provide analogue interface (signal outputting from 0 to 10 V voltage with linear voltage dependence vary with measured level of fuel), when using FV-10 frequency-to-voltage converter.

1.1.2 Technical specification

Table 1.1

Parameter or characteristic name	Unit	Value	Note (Note number)
1	2	3	4
Operational temperature range	°C	– 40 … + 75	
Ingress protection rating		IP67	
Mode of operation		Continuous	
Upper variation range of level measurement	mm	from 150 to 2000	(1)
Ranges of permissible reduced error of level measurement	%	±1,0	(2)
Variation range of relative dielectric permittivity in controlled fuel (ε)	-	1,5…5,0	
The period of measurement results averaging	Sec.	0…128	
Code length of presentation of measurement results	bit	10;12;14;16	(3)
Temperature measurement range of measuring head	°C	- 40…+ 85	
Code length presentation of measuring head temperature	bit	8	
Power supply voltage, operational range	V	+9.5…+36	Nominal value
Current consumption, max	mA	25	
Acceptable exposure of impulse voltage through power circuits	V	+120, long-term + 180 V, 1 sec. -1000 V, long-term	(4)
Acceptable short-term exposure of potentials difference between signal ground and body of measuring head	V	±1500 V, 1 sec.	
Digital interface		RS-485	ES4-H
		RS-232	ES2-H
Exchange rate through the serial port	bps	2400, 4800, 9600, 19200, 38400, 57600, 115200	programmed

Table end 1.1

1	2	3	4
Frequency interface (when using ES.700 compatible device)	Hz	500…1500	ES2-H
Analogue interface	V	0…10	ESA-H model
Analogue interface (when using frequency to voltage converter FV-10)	V	0…10	ES2-H
Flange version		4 holes, ∅4,2 mm	
Height of a measuring head over a tank top, including flange and gasket, max	mm	26	

Notes for table 1:

1 Level measurement range – Ly distance from the lower cut of metal tube (lower threshold of measurement) to the lower edge of drain orifice (highest threshold of measurement), according to Figure 1.1:

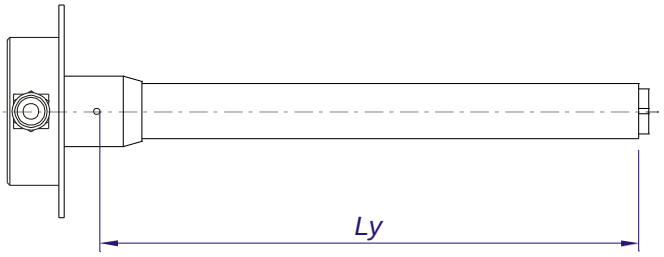

Figure 1.1 - Level measurement range

2 When testing fuel with the same dielectric permittivity as the fuel which was used during calibration process. To ensure precise monitoring with other fuel grades (according to dielectric permittivity of fuel grade) adjustment of calibration table must be used.

3 Data output has two layouts: 16 bit and 10/12/14/16 bit. Capacity 10/12/14/16 bit is switched according to the program. 10 bit value is set by default.

4 Pulse parameters according to GOST (ГОСТ) 28751 (severity degree 3 for 24V on-board power use).

1.1.3 Marking of device

Sensor has different marking, depending on the interface type and fuel probe length (figure 1.2):

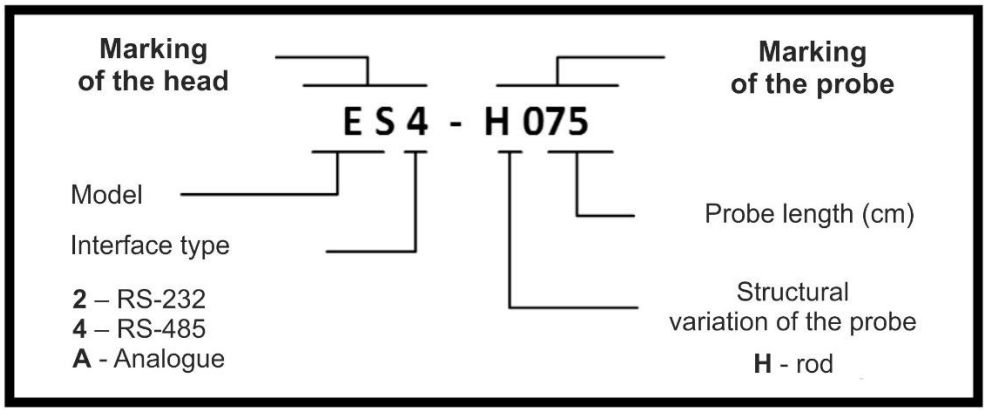

Figure 1.2 – Sensor legend

"Epsilon ES2-H" – exchanges data through RS-232 interface.
"Epsilon ES4-H" – exchanges data through RS-485 interface.
"Epsilon ESA-H" – exchanges data through analogue interface.

1.1.4 Device ordering

1.1.4.1 When ordering sensors marking includes:
- title name;
- sensor name - "Epsilon “
- model marking;
- interface type;
- fuel probe length in centimeters;

1.1.4.2 Example of “Epsilon” sensor marking for registration when ordering as well as in specification of other products it can be used with:

Fuel level sensor "Epsilon" ES4-H-075

where "Fuel level sensor" is a title name;

"Epsilon" – sensor name;
"ES-H" – model;
"4" – interface RS-485;
"-" – spacer;
"075" – fuel probe length 75 cm;

1.1.4.3 Evaluation of fuel probe length when ordering (See figure 1.4)

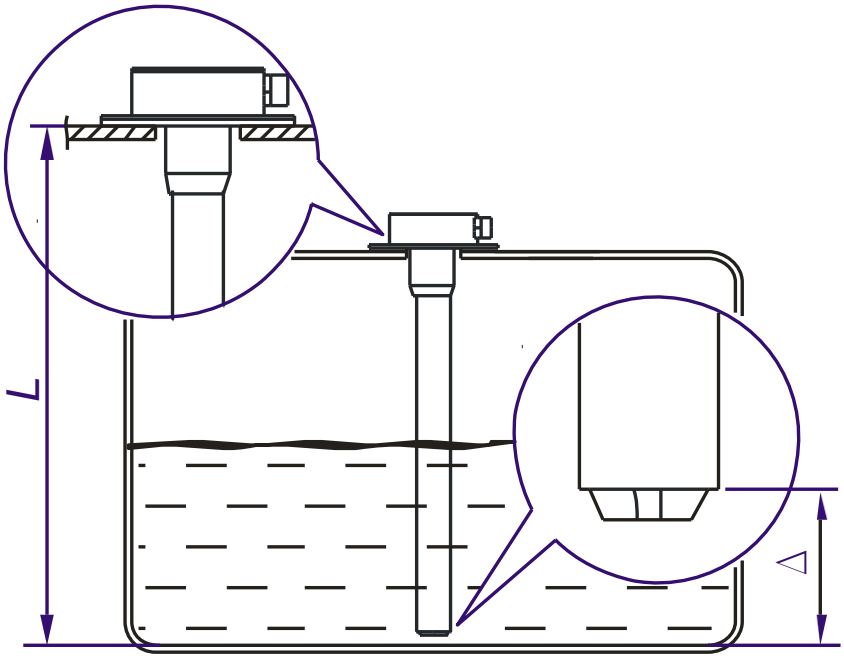

Figure 1.4 - Evaluation of fuel probe length when ordering

To evaluate the proper fuel probe length it is necessary to measure fuel tank depth in place of intended sensor installation and to calculate length of fuel probe according to the formula:

$$L_m = L - \Delta,$$

where L_m – approximate length of fuel probe as per order;
L– tank depth in place of intended sensor installation;
Δ - distance between measuring part and tank bottom.

Recommended values for distance Δ:

- Δ = 15…20 mm – for rigid metal tanks (the deeper the tank the bigger the distance);
- Δ = 30 mm – for tanks without enough rigidity (such as plastic tanks of considerable height).

During installation process, the necessity of reducing fuel probe length may arise (on-site).

You can find the procedure of reducing fuel probe length in “EH.000-EN IM_ Installation Manual”.

1.1.5 Delivery set

1.1.5.1 Basic delivery set

Table 1.2

Name	q.	Note
Assembled sensor	1	Assembled with ~ 40 cm cable
Interface cable	1	~ 7 m long
Self-drilling screw	1	With hole for safety seal
Self-drilling screw	3	∅ 4,2 x 19 mm
Gasket	1	
Tamper-evident seal	1	With wire for safety seal
Fuse SI 0,1 A	1	
Zip tie	15	200 x 3.6 mm
Passport	1	

1.1.5.2 Additional accessories and documentation (delivered by additional order)

Table 1.3

Name	Ref.	Note
EA2 sensor connection cable to PC	IEC EA C.100	For EA2-H models
EA4 sensor connection cable to PC	IEC EA C.100-01	For EA4-H, ESA-H models
Interface adapter	USC234-A	For ESA-H models
Matching device	ES.700	For EA2-H models
Frequency-to-voltage converter	FV-10	For EA2-H models
CD with software	EA.000 CD3	For ES2-H, ES4-H models
CD with software	EH.000 CD3	For ESA-H models
Installation manual	EH.000-EN IM	
User manual	EH.000-EN SM	

1.1.6 Design and operating principle

A measuring head together with a sensor probe submerged in fuel provides fuel level measurement.

Sensor probe acts as a condenser, which capacity linearly depends on a fuel level in a tank.

Measuring head of the sensor performs linear conversion of sensor probe volume into fuel level digital code, processes acquired digital information with averaged results, measures sensor head temperature and outputs data in unified EDE protocol through RS-232 or RS-485 interfaces (for ES2-H and ES4-H models) or through analogue output (for ESA-H model). Fuel level data outputs in 16-bits (additionally, data output can be selected in 10-, 12-, 14- or 16-bits), temperature data outputs in 8-bits.

To measure the volume of monitored fuel calibration of fuel tank must be performed. This procedure determines volume-level code dependence of fuel.

Calibration procedure and installation of data exchange parameters (by using “EP30_Install” software) described in appendix A of “EH.000 IM. Installation Manual”.

Data exchange protocol EDE can be found in appendix B of aforementioned document.

The process of firmware updating and methods of saving and restoring configuration data described in appendix B of aforementioned document.

1.1.7 Marking and sealing

1.1.7.1 Marking

1.1.7.1.1 Measuring head marking:

- title name and manufacturer brand mark;
- "**epsilon**® fuel level sensor” caption;
- marking of model;
- serial number according to the manufacturer.

1.1.7.1.2 Sensor package marking:

- title name and manufacturer brand mark;
- “**EPSILON**® fuel level sensor” caption;
- marking of model;
- fuel probe length (mm);
- manufacture date;

1.1.7.2 Sealing

To protect the sensor from tampering, two seals must be fixed after sensor installation. The first seal protects the measuring head from

unscrewing, and the second is installed on the detachable connection of the interface cable. Sealing procedure is described in Section 4 of “EH.000-EN IM. Installation Manual”.

1.1.8 Packaging

Sensor is packed in a polyethylene “sleeve”; components from basic delivery set (see table 1.2) are packed in several polyethylene packs.

1.2 Specification and operation of device components

1.2.1 General information

A measuring head together with the sensor probe provides fuel level measurement.

1.2.2 Measuring head

Measuring head contains (see figure 1.2):

- capacitymeter;
- digital circuit for data processing;
- data exchange device;
- power supply regulator and circuit for protection of incoming and outcoming electric circuits.

Sensor is connected to the external devices by the interface cable. Capacity meter performs conversion of current probe volume into digital code. Conversion is a linear function with variable parameters.

Digital circuit for data processing manages the capacity meter performance (limits of measurement, offset nulling, etc.), temperature compensation and received data scaling.

Data exchange device performs data exchange with GPS trackers, save/load of sensor calibration and configuration data and remote updating of embedded software. Sensor is mounted onto tank with self-drilling screws. Gasket ensures tightness between tank and flange.

1.2.3 Fuel probe

Fuel probe is a coaxial capacitor formed by an aluminum alloy tube (outer electrode) and an isolated aluminum rod (inner electrode). Required centering of the rod is achieved by placing a plug on the edge of the fuel probe and by isolated inner position-spacers.

2 INTENDED USAGE

2.1 Operating restrictions

2.1.1 During sensor operation, it is forbidden:

– to use sensor not on purpose;

– connect to the interface of devices, which do not meet requirements of the operational documentation;

– expose to influence of aggressive environments;

– apply a power with voltage exceeding the limit value of 120 V;

– allow pulse voltage exposure through power-supply circuits with values exceeding the limits in table 1.1.

2.1.2 It is not forbidden to use the sensor with liquids, which maintain their physical form within the operating temperature range.

2.1.3 Dielectric permittivity of measured liquid must correspond to dielectric permittivity of tested liquid. Error of measurement will rise if abovementioned requirements are not met.

2.3 Device preparation for use

Device preparation for use must be carried out according to “EA.000-EN IM. Installation Manual”.

2.4 Use of device

2.4.1 Sensor is used to send digital data about fuel level in tank to GPS tracking device.

Sensor is operated by external device through the interface cable and do not require additional human assistance.

2.4.2 The possible malfunctions of device and troubleshooting actions described in table 4.1.

2.4.3 Emergency actions

In case of fire at the sensor area, it is necessary to kill power supply and perform all standard firefighting procedures.

3 TECHNICAL SUPPORT

3.1 Technical support of device

3.1.1 General information

3.1.1.1 Sensor is a maintenance-free device but if it is necessary to perform a tank maintenance according to a vehicle servicing schedule, it’s a good practice to perform sensor maintenance as well.

3.1.1.2 Personnel familiar with the present manual and document "ES.000-EN IM. Installation manual" are allowed to install the sensor.

3.1.2 Safety measures

3.1.2.1 During installation of the fuel level sensor, organizational and technical actions that ensure the safety of the work with control and measuring equipment, ancillary equipment and consumable materials have to be carried out.

3.1.2.2 The responsibility for the implementation of security measures lies with the technical staff involved in the installation of the fuel level sensor, as well as the employees responsible for the equipment at the working site.

3.1.2.3 Requirements of fire safety regulations, according to ГОСТ (GOST) 12.1.004-91" Occupational safety standards system. Fire safety. General requirements," and electrical safety, according to ГОСТ (GOST) 12.1.019-91 "Occupational safety standards system. Electrical safety. General requirements" or other requirements in force within the consumer territory have to be observed on the working site.

3.1.2.4 Requirements of occupational health and safety rules have to be observed on road transport at the working sites according to ПОТ РМ (POT RM)-027-2003 "Interindustry occupational safety and health rules on road transport" or requirements of regulatory documents in force within the consumer territory.

3.1.3 Maintenance procedure of device

3.1.3.1 Carry out dismantling of the sensor in next order (figure 3.1):

- disconnect interface cable from the sensor;
- unscrew 4 self-drilling screws and take out sensor from the tank;
- rinse the inner part of sensor probe with the fuel (in which the sensor was operating) and blow it with a compressed air;
- check the sensor parameters (with “EP30_ Install” software for ES2-H and ES4-H models and with “EP31_ Install” software for ESA-H model), according to the procedure described in Annex A of “EH.000 IM. Installation Manual”);
- perform sensor installation and sealing according to requirements in 1.1.7.2

4 TECHNICAL MAINTENANCE

4.1 Malfunctions diagnosis of device and troubleshooting actions

4.1.1 General instructions

4.1.1.1 Personnel familiar with the present manual and document “EH.000 IM. Installation Manual” are allowed to install the sensor.

4.1.1.3 Possible malfunctions during sensor operation and troubleshooting actions are described in table 4.1.

Table 4.1

Malfunctions	Probable causes	Troubleshooting actions
1	2	3
Fuel sensor shows value "0" in monitoring software	Fuel sensor head is faulty	– Poll the sensor using the “EP30_Install” * program. Replace the sensor head, if necessary.
Sensor isn't responding	Absence of external power on the fuel sensor	– Check the power supply on the interface cable connector; – Check the integrity of fuses in the power cable, replace them, if necessary.
	Fuel sensor head is faulty	– Poll the sensor using the “EP30_Install” * program. Replace the sensor head, if necessary.
Sensor transmits data showing the maximum level in tank, but in fact fuel level is lower than the maximum	Presence of water or other liquids on the tank bottom	– Disconnect the interface cable; – Unscrew and remove the measuring head, then unscrew the sensor probe from the flange; – Remove the tank, wash and dry it; – Install the sensor back and connect the interface cable.
The fuel indication vanishes and reappears periodically.	Loose contact on the fuel sensor fuse	– Check the power circuits of fuel sensor, reliability of fuse contact of fuel sensor, replace, if needed;
	There is no reliable connection through interface signal wires	– Check the alarm indicators of TXD" and "RXD" interfaces, reliability of cable connection;
	Supply voltage threshold of sensor head is underrated	– Check the supply voltage applied for fuel sensor, it should be ranged no lower than 10 V; – at undervalued level check the charge of accumulator battery of the vehicle.
During stops fuel level smoothly changes its value depending on the time of day	Temperature deformation of tank	The heating causes a tank to deform (usually plastic tanks), which leads to a variation of the fuel level in the tank. To correct this problem, it is necessary to eliminate the possibility of tank deformation.
	Change of dielectric constant of fuel in dependence on its temperature	Appearance of this dependence is associated with an expansion coefficient of fuel. This dependence must be considered in the overall measurement error.

Table continuation 4.1

1	2	3
The fuel sensor is not responding to "EP30_Install" software	Faulty converter COM-RS485 (RS232)	− In "My Computer" - "Properties" - "Task Manager" check converter availability; − In case of its absence drivers must be reinstalled; − If there is no communication with the computer, carry out the replacement of converter.
	No power consumption on the sensor head	− Check the supply voltage on the interface cable connector; − Check the fuses in the interface cable, replace them if needed; − Check the integrity of the power supply wires.
	Reversed connecting of "TXD" and "RXD" channels	− If the sensor is not responding it's necessary to change the wires via "TXD" and "RXD". Correct connection of " Green " - TXD, " Yellow "-RXD.
	No driver (or incorrect installation) for the converter COM-RS485 (RS232)*	− Configure the COM port converter COM-RS485 (RS232); − Check for proper installation of the driver. The driver is supplied with a converter set.
Offset the initial sensor N code during long continuous sensor operation	Changing the dielectric parameters of the fuel probe	− Disconnect the interface cable from the sensor; − Unscrew and remove the measuring head, then unscrew the sensor probe from the flange; − Check probe for external and internal impurities; − Wash the interior of the fuel probe (use the same fuel as it was used during sensor operation) and blow it with compressed air; − Install the sensor in the working position and connect the interface cable; − If necessary, perform re-calibration of the tank, according to the Section 5 of "EA.000 IM. Installation Manual".
During the movement the sensor does not change its value in the control software	Probe drain hole is clogged	− Disconnect the interface cable from the sensor; − Unscrew and remove the measuring head, then unscrew the sensor probe from the flange; − Check and clean the drain hole of the probe; − Install the sensor into the working position and connect the interface cable.
	The presence of sediment (mud) on the bottom of the tank	− Disconnect the interface cable from the sensor;

		– Unscrew and remove the measuring head, then unscrew the sensor probe from the flange; – Wash the interior of the fuel probe and clean the drain hole of the probe; – Remove the fuel tank; – Clean and wash the tank; – Set the tank into working position; – Install the sensor into the working position and connect the interface cable.
Invalid data from the fuel sensor (the discrepancy between the actual filling and data in the control software)	Incorrect calibration	Perform re-calibration of the tank, according to the Section 5 of “EA.000 IM. Installation Manual”.
	Offset of the initial sensor code during continuous exploitation	– Disconnect the interface cable from the sensor; – Unscrew and remove the measuring head, then unscrew the sensor probe from the flange; – perform re-calibration of the tank, according to the Section 5 of “EA.000 IM. Installation Manual”. – Install the sensor into the working position and connect the interface cable.
Large fluctuations in the readings of the fuel level when vehicle is on the move	Nonlinear calibration table	Perform re-calibration of the tank, according to the Section 5 of “EA.000 IM. Installation Manual”.
	Large fuel tank and (or) its complex structure	Consider installing two sensors in one fuel tank.
	Tilt an jolting of vehicle on the move	Increase the averaging time
Sudden change of the fuel readings from the current indication up to the maximum point in the control software.	The presence of water in the tank.	– Disconnect the interface cable from the sensor; – Unscrew and remove the measuring head, then unscrew the sensor probe from the flange; – Remove the fuel tank; – Clean and wash the tank; – Install the sensor into the working position and connect the interface cable.

* - Absence of sensor polling by “EP30_Install” software can be caused by incorrect COM port adjustment. This malfunction can be fixed by:

- Perform the interface converter (RS485, RS232) COM port adjustment.
- Check if driver installed correctly.
- Check the (RS485, RS232) converter availability and its adjustment in "My Computer" - "Properties" - "Task Manager".
- Choose the appropriate baud rate for sensor settings in “EP30_Install” software.

4.2 Replacement procedure of device

4.2.1. Sensor is a maintenance-free device and sustains stability of parameters during its warranty life.

In case of sensor functional loss, it must be replaced.

4.2.2. Sensor dismantling must be done as follows:

- Disconnect interface cable from the sensor;
- unscrew 5 self-drilling screws and take out sensor from the tank;
- upload configuration parameters into the new sensor (see annex B of “EH.000 IM. Installation Manual”);
- install and connect the new sensor (with the same probe length), perform the sealing procedure according to Section 4 of “EH.000 IM. Installation Manual” requirements.

4.2.3 In case of configuration data loss, it is necessary to perform a sensor configuration procedures described in Annex B of “EH.000-EN IM. Installation Manual”.

In case of successful restoration of configuration data, re-calibration of tank is not required.

5 TRANSPORTATION AND STORAGE

Transportation of the sensor in an avenue packing of the manufacturer is allowed by all types of covered land and sea transport (in railway cars, containers, closed-top cars, holds, etc.). Transportation in the pressurized compartments of planes is allowed.

Transportation and storage must comply with GOST (ГОСТ) 15150-69 requirements.