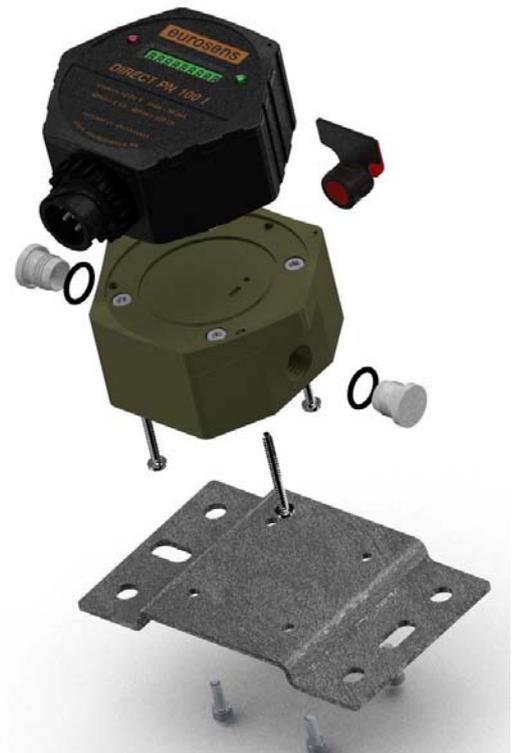


Eurosens flow meters operation manual



User manual content

The Operation Manual contains guidelines and rules which refer to Eurosens fuel flow meters (hereinafter Flow meter), developed by JSC Mechatronica, Vilejka, Belarus (mechatronics.by).

The Manual is intended for specialists who are familiar with automobile repair, mounting and maintenance and possess professional knowledge in the field of electrical and electronic equipment of various vehicles.

For quality installation and operation it is recommended to train installers in the manufacturing company or in the specialized centers. The installer and the person responsible for the maintenance of Flow meters should know composition of fuel systems and their operating features.

A source of danger at installation and operation of the flow sensors are electrical current and working fluid, which can be pressurized to 2.5 MPa and have temperature up to 85 ° C.

Installation and deinstallation of flow sensors must be carried out with completely no excess pressure in the pipeline.

1. Description and operation of flow meters

1.1. *Application*

Use of Eurosens flow meters:

- current fuel consumption records;
- registration of machinery working time;
- normalizing of fuel consumption limitations;
- fuel theft detection and prevention;
- real-time monitoring and fuel consumption optimization;
- fuel consumption tests for engines.

1.2. Eurosens modifications:

Table 1

Brand	Type	Interface type	Flow rate	Extra functions																					
eurosens	Delta	PN	250	I																					
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1.3. Operation parameters and recommendations for model selection

Fuel flow meters Eurosens can measure flow of the following liquids:

Table 2

Diesel fuel	GOST 305
heating oil	GOST 10585
motor fuel	GOST 1667
biofuels	GOST R 52808, STB 1658
Other liquid fuels and mineral oil with a kinematic viscosity of 1.5 to 6 mm ² / s.	

WARNING!

- 1) All the meters are calibrated for diesel fuel by the manufacturer. If you order it to measure another type of fluid please indicate its viscosity.
- 2) When working on the kinematic viscosity of more than 6 mm²/s, the upper limit of the measuring range of flow meters passport will be lower, and the pressure drop across the flow sensor - higher.
- 3) The amount of impurities in the liquid should be no more than 0.1 mm.
- 4) Flow meter is made of materials resistant to gasoline. However, when working with gasoline operation life may be shorter. All risks associated with the safe operation of the Eurosens sensors on petrol engines are assigned to the installer of the equipment.

Fuel flowmeters Eurosens PN (RS) is a unique equipment that allows to set individually any vehicle (or other type of fuel) through the service kit Eurosens Destination, taking into account their individual characteristics (air in the return pipe, hammering, temperature in the supply and return pipes, etc.).

Flow sensors Eurosens Delta can be used in differential mode (default setting), and in the summation mode or direct signals delivery from the working chambers (in this case differential flowmeter can measure up to 1000 liters/hour total fuel rate). Methods of settings are described in the service manual (given in Appendix A)

Recommendations for Eurosens Direct models selection depending on the power of the engine or boiler productivity.

Table 3

Power of engine, KW(HP)	Boiler productivity, KW	Recommended models Direct XXX PN(PN I, P, RS)
Less 100(136)	Less 600	100
From 100(136) to 250(340)	From 600 to 1200	250
From 250(340) to 600(816)	From 1200 to 3500	500

WARNING!

- 1) It is not recommended to use the flow meter with the max. upper limit.
- 2) It is recommended to take a final decision on the choice of the model after engine/boiler inspection.
- 3) Before choosing you must choose installation scheme in fuel line (direct measurement or differential).

Recommendations for Eurosens Delta models selections depending on the values of fuel consumption in the supply and return fuel lines

Table 4

Minimum flow rate , l/h	Maximum flow rate, l/h	Recommended models Delta XXX PN(PN I), XXX
5	100	100
10	250	250
25	500	500

1.4. Dimensions

See appendix B

1.5. Specification

Table 5. Flow rate specification

Eurosens Modification	Qstart, l/h	Qmin, l/h	Qnom, l/h	Qmax, l/h	Pulses/liter	Measurement error	Note
Direct P100	0,5	2	50	100	96-100	±2%	
Direct P250	0,5	5	125	250	96-100	±2%	
Direct P500	1,0	10	250	500	48-50	±2%	
Direct PN(RS)100	0,5	1	–	100	100	±1%	
Direct PN(RS)250	0,5	2	–	250	100	±1%	
Direct PN(RS)500	0,5	5	–	500	50	±1%	
Direct PN(RS)100I	0,5	1	–	100	100	±1%	With display
Direct PN(RS)250I	0,5	2	–	250	100	±1%	With display
Direct PN(RS)500I	0,5	5	–	500	50	±1%	With display

Table.6. Main specifications

Parameter, measurement units	Value
Max pressure, MPa	2.5
Nominal pressure, MPa	0.2
Filtering degree of measured fluid, mm, not more than	0.08
Connection thread	M14x1.5 M16x1.5
Pressure drop at maximum flow rate, nominal pressure, diesel fuel at 20 °C, MPa, not more than	0.02
Supply voltage range, V	from 10 to 50
Current consumption at 12 V, mA, not more than	50
Current consumption at 24 V, mA, not more than	25

Temperature range, °C	from -40 to +80*
Environment relative humidity at t 40 °C, %, not more than	95
Vibration resistance	Max. acceleration to 100 m/s ² in the frequency range from 5 to 250 Hz (GOST 3940, GOST R 50607)
Resistance to aggressive environments	Oil and petrol resistance (GOST 3940, GOST R 52230)
Electromagnetic compatibility	ESD Protection, severity level II (GOST 30378, GOST R 50607); electromagnetic interference protection, severity level IV (STB ISO 7637-2, GOST 28751).
Overall dimensions, weight	See Annex 2
* Data is displayed in environment temperature range from -20 to +60 °C for flow meters with built-in display.	

1.6. Contents of package

Table 7

№	Position	Quantity
1.	Flow meter eurosens	1
2.	Passport	1
3.	Cable*	1

* Can be supplied separately.

1.7. Flow meter design and operation

1.7.1 Operation principle

The flow sensor measures the amount of fuel flowing through the measuring chamber. Pressurized fluid coming through the inlet nozzle flow sensor in the inlet of the measuring chamber, the piston slides along the inner surface of the chamber and simultaneously slides along the jumper. The piston displaces fluid enclosed in it inside and outside of the piston chamber through its outlet to the outlet port (see. Figure 1).

The enclosure provides the orientation of the rotation axes of the cover pin with the magnets and the hub of the piston, thanks to the number of dimensions of the cover and the housing which provides the optimum rotation of the ring chamber.

During one rotation of the piston volume of liquid equal to the volume of chamber is displaced. In this case, the electronic position sensors generate pulses as the turnover of the piston, which are transmitted to the electronic control unit for the selected interface.

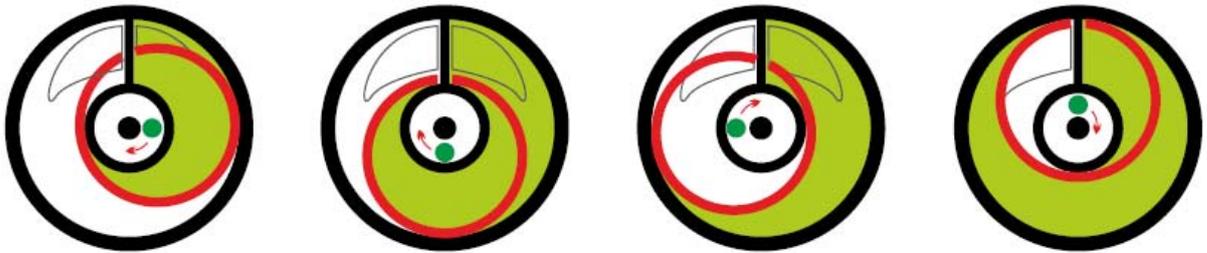


Figure 1 — Operation of Eurosens flow measuring chamber

1.7.2. Operation modes

Table 8

Flow meter modification	Flow rate, l/hour				Interference
	Normal flow rate $Q_0 < Q \leq Q_{max}$			Tampering	
eurosens XYZV, где Y(max. flow rate)= l/hour	Idle	Normal operation	Overload		
100	< 2	2-70	70-100	> 100	Attempts are fixed
250	< 5	5-200	200-250	> 250	
500	< 10	10-400	400-500	> 500	

1.7.3. Information screens (flow meters with LCD display)

Table 9

Direct I*		Delta I*	
№ Screen	Parameter	№ Screen	Parameter
1	Total consumption, l	1	Total consumption, l
2	Idle consumption l	2	Idle consumption l
3	Consumption under nominal load,	3	Consumption under nominal load, l
4	l		
5	Overload consumption l	4	Overload consumption, l
6	Cheat consumption, l / h	5	Cheat consumption, l
7	Negative volume, l	6	Negative volume, l
8	Total operating time (Motor.)	7	Total operating time (Motor.), h
	Hour		
9	Intervention time, hour	8	Intervention time, h
10	Flow rate	9	Supply flow rate, l / h
11	Chamber temperature, deg., C	10	The total volume of supply, l
12	Battery charge, %		
13	Firmware version	11	Cheat volume of supply chamber, l
		12	Supply flow rate, l / h
		13	Temperature in supply chamber, C
		14	The total volume of return, l
		15	Cheat volume of return chamber, l
		16	Return flow rate, l / h
		17	Temperature in return chamber, C
		18	Battery charge, %
		19	Firmware version

* These parameters (plus some additional) are displayed on all flow meters PN (RS) with Eurosens Destination service kit and PC

In order to avoid cheating of flow sensor, its damage or blocking Delta and Direct PN, RS models has the following modes of protection against cheating actions of third parties:

1) Mode "Cheat" - protection against cheating in order to increase the counter value of the consumed fuel (eg. air blowing). Cheat usually leads to a rapid increase in fuel consumption that exceeds the maximum one. Electronic circuit board of a flow sensor detects overstated costs, while fuel meter operation is stopped and counter "Cheat" is activated, which records the amount of fuel flow through the flow sensor at high speed.

Mode "Cheat" is automatically exited in few seconds after the normalization of conditions of flow sensor work.

2) Mode "Intervention" - under the influence of an external magnetic field, the flow sensor detects an attempt to interfere and as the result the sensor itself is operating in standard mode and the exposure time is recorded in a special counter "Intervention time."

Mode "Intervention" is automatically exited in few seconds after the end of attempts to interfere.

3) Sealing of connections - mounting accessories (fuel connectors, clamps, etc.) supplied by JSC Mechatronics have holes for sealing, that allows to determine the facts of unauthorized interference in the fuel system after the installation of the flow sensor.

1.7.4 Characteristics of the pulse signal of Eurosens

Flow meter with non-standard pulse (model P) has an output pulse signal shown in Figure 2.

For each flow meter the number of pulses generated by flowing of 1 liter of fuel through the measuring chamber is shown in the data sheet for the product (passport).

The type and characteristics of the output signals EUROSENS X P (PN) ZV are shown in Figures 2, 3 and tables 10, 11 (see below). Characteristics of the output signals EUROSENS X RS ZV match the specified item in the digital protocols.

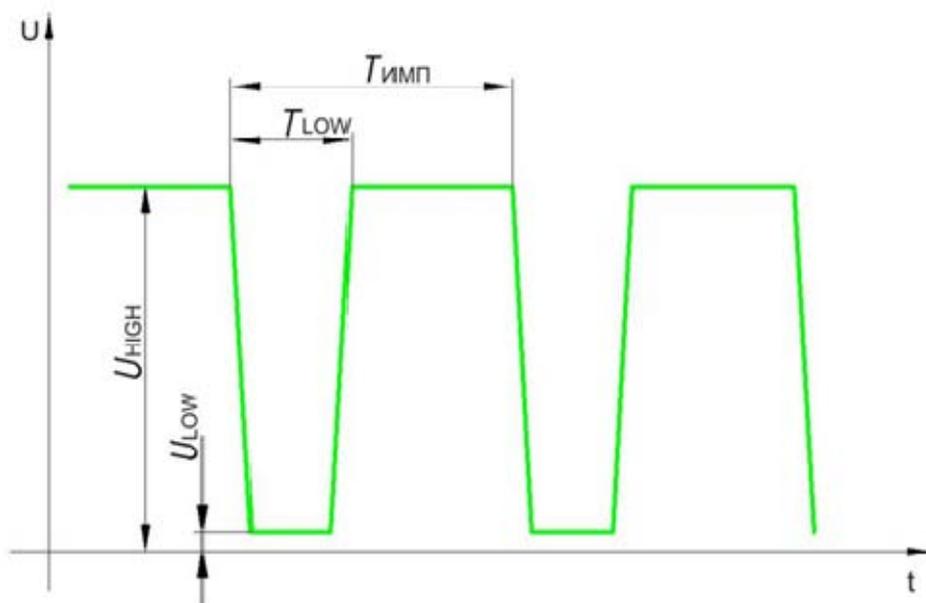


Figure 2. Output signal of EUROSENS X P Z V(also see tables 10,11).

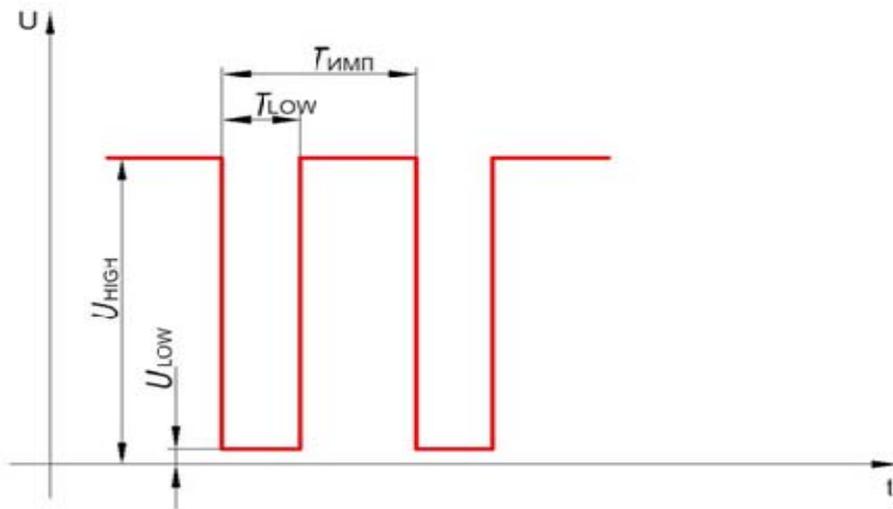


Figure 3. Output signal of EUROSENS X PN Z V(also see tables 1,2).

Table 10 Output signal of EUROSENS X PN Z V

Modification	U _{high} ,V	U _{low} , V
Direct 100 P	0.9 U _{bat}	0.7 V
Direct 250 P	0.9 U _{bat}	0.7 V
Direct 500 P	0.9 U _{bat}	0.7 V
Direct 100 PN	0.6 U _{bat}	1.4 V
Direct 250 PN	0.6 U _{bat}	1.4 V
Direct 500 PN	0.6 U _{bat}	1.4 V
Delta 100 PN	0.6 U _{bat}	0.7 V
Delta 250 PN	0.6 U _{bat}	0.7 V
Delta 500 PN	0.6 U _{bat}	0.7 V

Table 11. Output signal of EUROSENS X PN Z V

Modification	Signal parameters,ms							
	T _{ИМП} max,	T _{ИМП} min,	T _{low} max(0,6 T _{ИМП}),	T _{low} max(0,5 T _{ИМП})	T _{low} max(0,4 T _{ИМП})	T _{low} min(0,6T _{ИМП})	T _{low} min(0,5 T _{ИМП})	T _{low} min(0,4T _{ИМП})
Direct 100 P	9000	180	5400	4500	3600	108	90	72
Direct 250 P	7200	144	4320	3600	2880	86,4	72	57,6
Direct 500 P	7200	144	4320	3600	2880	86,4	72	57,6
Direct 100PN	18000	180		500			90	
Direct 250PN	7200	144		500			72	
Direct 500PN	7200	144		500			72	
Delta 100 PN	18000	180		500			90	
Delta 250 PN	36000	144		500			72	
Delta 500 PN	72000	144		500			72	

2. WARRANTY CONDITIONS

2.1 The manufacturer guarantees that the sensors meet the requirements of this specification under the conditions of storage, transportation and operation, as well as application notes set in these specifications.

2.2 The warranty period for sensors is 36 months from date of manufacture.

2.3 Sensors with cracks and splits, dents, signs of blows, pollutions of measuring chambers, caused by the consumer fault as a result of violation of usage, storage and transportation conditions are not covered under warranty.

3. Installation recommendations for Eurosens flow meter

This section contains general recommendations on Eurosens flow meter installation.

3.1 Visual inspection of fuel flow meter

It is required to inspect a flow meter visually for the presence of the possible defects arisen during transportation, storage or careless use:

- visible damages of the meter body, fittings, bracket, display, interface cable and connector;
- play of component parts or gaps between them.

Contact the supplier if any defects detected.

3.2 Estimation of vehicle condition

Before flow meter installation the vehicle condition should be estimated to make a conclusion regarding installation possibility.

Estimation of the vehicle includes the following steps:

1. Start the engine and check its operation for 5-10 minutes at idle and 5-10 minutes in movement under load. The engine must run evenly, not stall under load, there shouldn't be loss of power.
2. Inspect all fuel pipes of the vehicle for damage and fuel leakage.
3. Check electric system voltage with a voltmeter. 12 V onboard power system should have voltage in the range from 10 to 18 V. 24 V onboard power system should have voltage in the range from 18 to 32 V.
4. Check the return flow of the injectors. In case of significant return flow of the injectors measurement accuracy error will get higher because this returned volume gets back to tank and is double-counted by the fuel meter. In this case it is recommended to do injectors maintenance before the fuel meter installation.

5. Check pressure in the fuel line with a pressure gauge. Hydraulic resistance of a selected flow meter working at nominal flow rate should not lower the pressure for more than 5%.
6. Check the quality of the ground of the vehicle. Resistance between any point of ground and the “-” clamp of the battery should not exceed 1 Ohm.

The customer should eliminate any malfunctions recorded to the report before flow meter installation.

WARNING!

1. The values of the maximum and minimum fuel rate in the supply and return pipe of the engine can be found on fuel feed pump plate installed in the machine.
2. Do not install differential flow sensor on the fuel system with high power pump and small engine fuel consumption. For example, if delivery volume of pump is 300 l / h, fuel consumption in the "Idle" mode (5 ... 6) l / h and the relative error of flow measurement in the supply and return fuel lines is 1%, the absolute error of the differential measurement is up to 6 l / h. That is comparable with the amount of fuel consumed by the engine.
3. Differential fuel flow sensor can't be installed if there are air bubbles in the flow and (or) return fuel lines.

3.3 Common installation recommendations

WARNING!

This chapter provides the special cases of the scheme of the engines work. Carefully read the technical documentation of the vehicle on which you install the flow sensor before you decide to install a flow sensor on the vehicle.

To install the flow sensor you need:

- a flow sensor
- Service kit Eurosens Destination
- PC
- mounting kit (sold separately);
- Hand tools (wrenches, screwdrivers).

The flow sensor can be mounted in any position: vertically, horizontally or inclined. Do not kink the cable and fuel pipes (fuel supply lines). It is recommended to mount the sensor horizontally for the best operation. The sensor should be secured by at least three points on the plane.

WARNING!

When setting up on a vehicle it is prohibited to drill the base frame! If it's impossible to mount the mounting plate with screws, you can use spot welding.

Please observe the following rules:

- 1 Flanges and threaded connections must be clean during connection.
- 2 When installing, use only new copper sealing from the mounting kit.
- 3 Fuel lines must be protected from external destructive effects.
- 4 It is not allowed to reduce the internal cross section of the fuel lines on the bends.
- 5 Fuel hoses on the vehicle must be fixed every 0.5 m.
- 6 Fuel hoses in length should have a small length margin to compensate temperature changes.

7 Do not install a flow sensor on the elements of the vehicle, subject to strong vibrations and heat.

8 After flow sensor is installed it is necessary to remove air from the fuel system.

9 It is recommended to install extra fine fuel (or filters) filter before the flowmeter chambers and let engine run for 30 minutes to collect all possible dirt after installation. Then filters can be removed.

3.4 Installation schemes of Eurosens fuel flow meters

3.4.1 Typical fuel supply system

The most common scheme of the fuel system of diesel engine is shown on the figure 4.

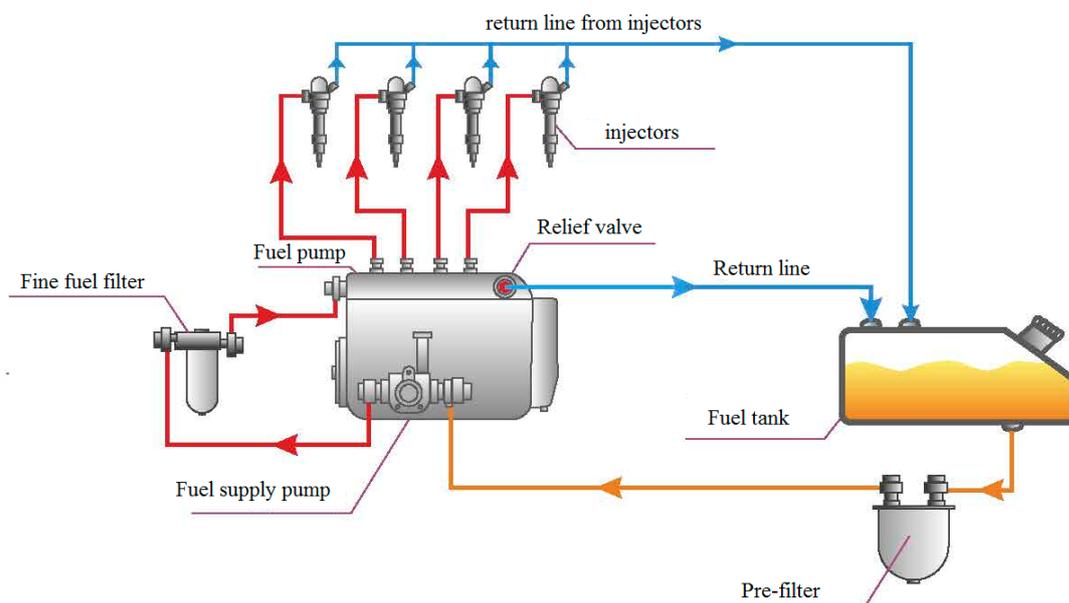


Figure 4 - Typical fuel system

Fuel backup pump (hereinafter – supply pump) supplies to the inlet of fuel injection pump (hereinafter - fuel pump) significantly larger amount of fuel than is consumed in each cycle of operation of the engine. Excess fuel from the fuel pump and injectors of the engine is discharged back into the tank through relief valve.

3.4.2 Installation of Eurosens fuel flow meter under "suction scheme"

Installation of fuel meter "on suction side" supposes the installation of a flow sensor in the area of the fuel system, where the fuel flow is forced by suction created by supply pump.

WARNING! Installation of Eurosens Direct flow meter "on suction side" requires an additional fuel filter on the fuel line from the tank to the flow sensor.

A special case of Direct flow meter installation under "suction scheme":

To install the Direct under scheme "on suction" in the engine fuel system with fuel backup pump (see. Figure 5), it is necessary to use the site between the fuel pre-filter and the inlet of fuel backup pump.

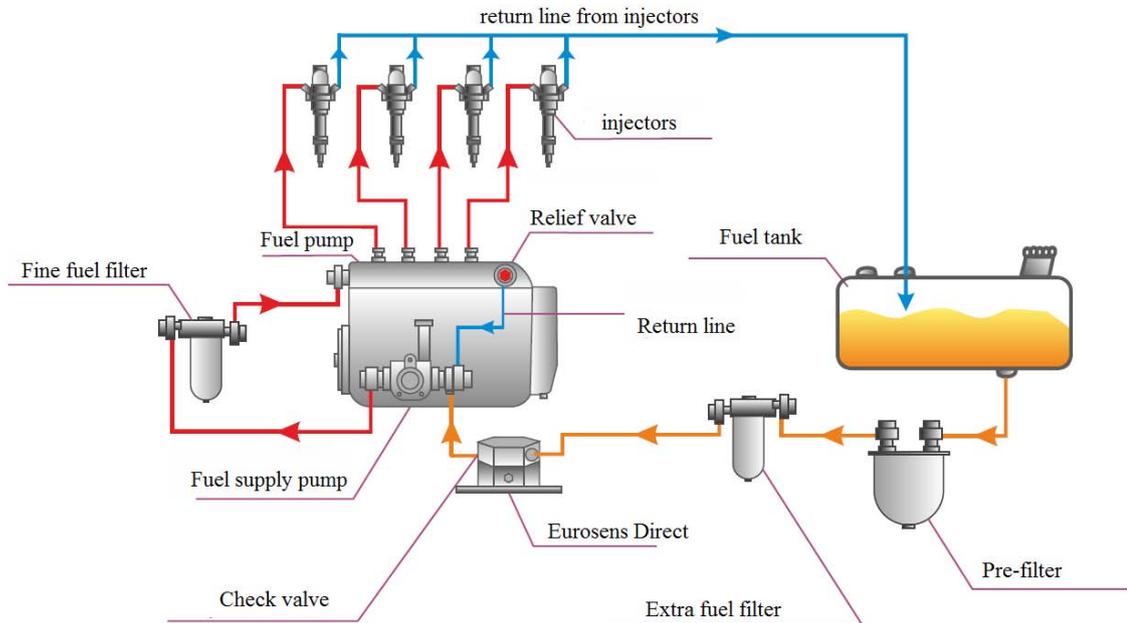


Figure 5 — Installation under scheme «on suction side» with fuel supply pump

Under successful operation of the injectors their return flow is not more than 0.1% of fuel consumption, so it can be neglected.

To prevent measuring the volume of fuel returned to the fuel tank it is necessary to change the circuit return line.

For this special case, it is necessary to change the fuel pump return line so that the fuel is circulated in a small circle without return to the fuel tank. This is done by connecting the return to the input of the fuel supply pump.

Thus, to the inlet of supply pump two lines are connected:

- 1) supply from the tank, passing through the flow sensor;
- 2) The return fuel pump.

Thus, through the flow sensor Direct goes only the amount of fuel which is consumed by the engine.

WARNING! One of the advantages of fuel return to the tank through the fuel line is heating the rest of fuel in the tank. Therefore, if vehicles work at low temperatures it is recommended not to change the scheme of the fuel but to use differential flow sensor Delta, or install extra fuel heater.

To install Eurosens Direct "on suction side" in the engine fuel system without the fuel supply pump (see. Figure 6), it is necessary to place the flow meter between the fuel pre-filter and the

fuel pump bypass valve. At the same time, an additional fine filter in the area between the place of installation of the flow sensor and the pre-filter should be installed.

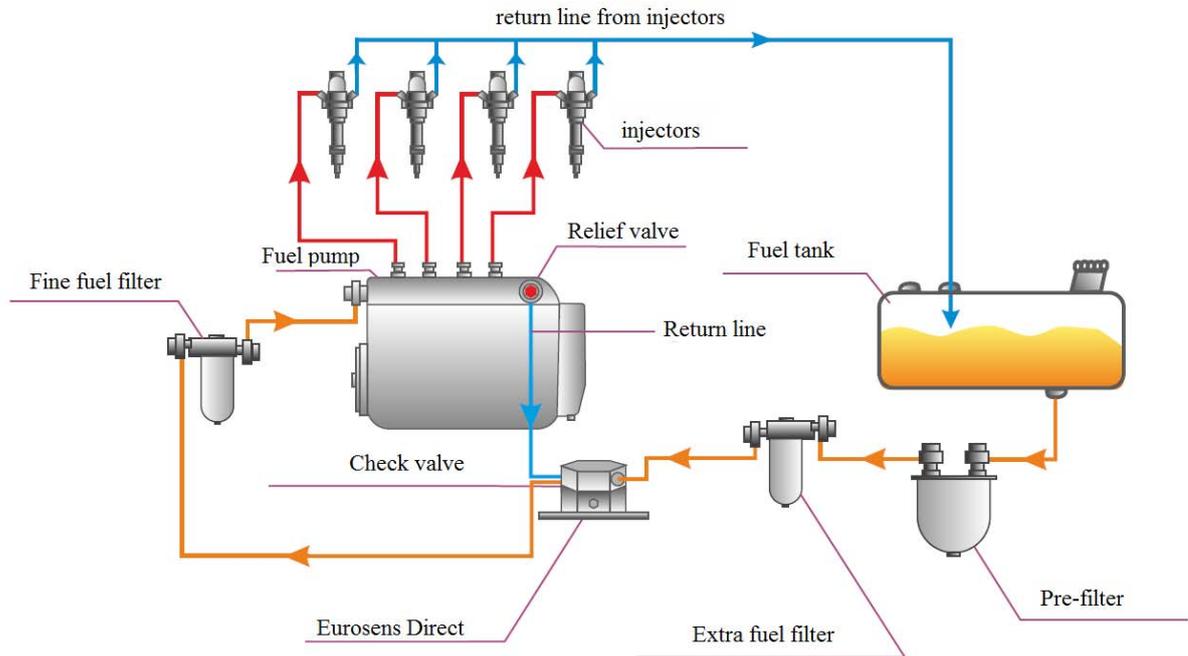


Figure 6 —Eurosens Direct «on suction side» installation scheme without fuel supply pump

Table.13 Advantages and disadvantages of «on suction side» scheme

Advantages	Disadvantages
Minimum changes in fuel system	Extra fuel filter is needed
Simple installation	Fuel supply pump overload
Can be used on the most of engines	Fuel in the tank is not heated by return flow

3.4.3 Installation of fuel flow meters Eurosens Direct "On pressure side" scheme

Installation of fuel flow sensor Eurosens Direct "On pressure side" scheme intends the installation of a flow sensor between fuel fine filter and fuel pump, where fuel is flown under pressure.

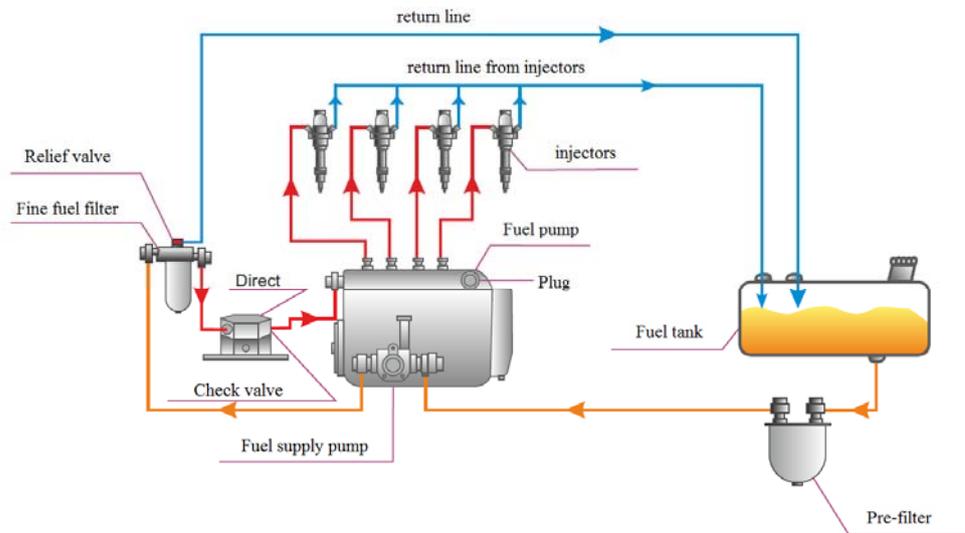


Figure 7 —Eurosens Direct installation «On pressure side»

Fuel pump return line should be changed to circulate fuel in a smaller circle: move the return line from the output of the high pressure pump to the fine filter and lock the output of the high pressure pump.

For correct operation of the modified fuel system you need to move bypass valve from fuel pump that maintain the required constant pressure (1 ... 1.5) bar in the area of the fine fuel filter and inlet of high pressure pump. At the output of the flow sensor a check valve (0.15 ... 0.5) atm should be installed, which prevents the fuel flow through the flow sensor in the opposite direction, as well as reduces the impact of hydrocracks in fuel system.

Thus, excess fuel from supply pump will go back to the tank from the inlet of fine filter and through eurosens Direct will flow only the amount of fuel which is consumed by engine.

Advantages of the scheme "on pressure side":

- Eurosens Direct is set after the regular fuel fine filter;
- Reduced flow resistance on the supply pump suction side.
- Return flow heats fuel in the tank.

Disadvantages of the scheme "on pressure side":

- cooling of fuel pump decreases a little;
- return line temperature is lower than in the standard fuel scheme.

3.4.4 Installation of Eurosens Delta under "Differential" scheme

In differential scheme the measuring circuit of fuel circulating in the fuel system is not changed. Supply chamber of Delta sensor is installed in fuel supply line, return chamber – in return line. Fuel consumption is thus determined as the difference between the measured values of flows in the supply and return chambers.

Particular cases of Delta installation under differential scheme:

- 1) The supply chamber is installed in the fuel line after supply pump and fine fuel filter (on pressure side)

2) Supply chamber is installed in the fuel line before supply pump (on suction side). In this case, the installation of an additional fine filter is necessary (see. Figure 8).

Return chamber of Delta flow meter in both cases is installed in return line " high-pressure fuel pump inlet - fuel tank."

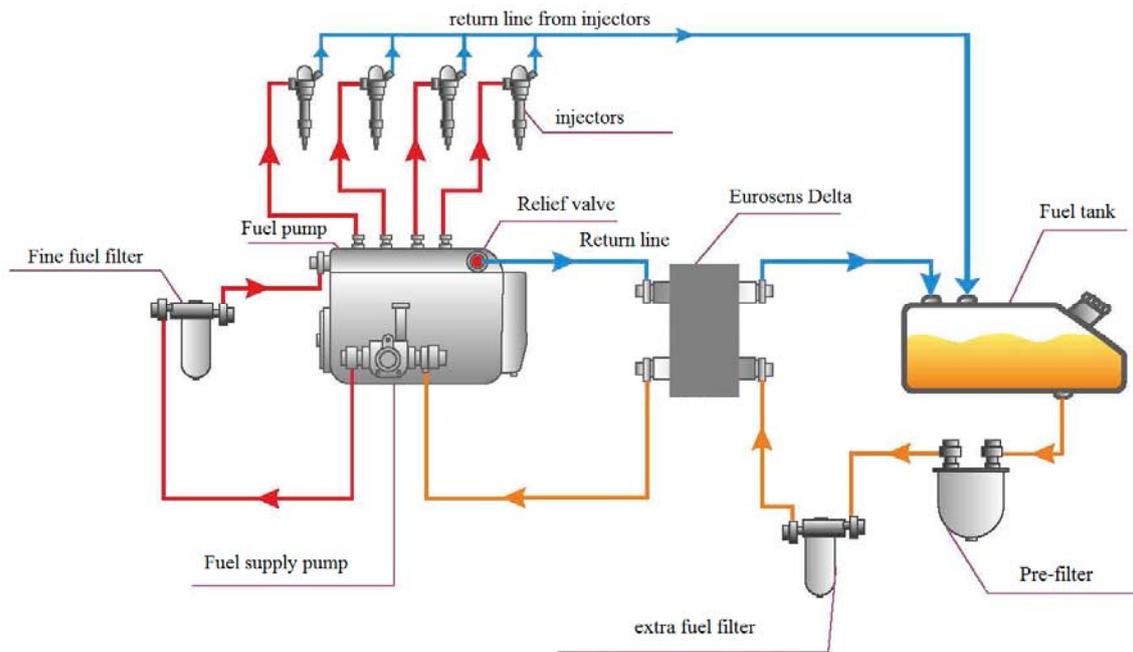


Figure 8. Eurosens Delta installation with supply chamber "on suction side"

Advantages of differential installation scheme:

- No changes in the fuel system;
- It can be mounted on the motors under warranty.

Disadvantages of the "Differential" scheme:

- higher cost;
- Higher fuel consumption measurement error;

3.4.5. Electric connection

Eurosens fuel flow sensors are powered from on-board vehicle circuit.

WARNING!

- 1) When connecting Eurosens flow meter to onboard power source it is necessary to connect power “+” and ground “-” wires to the same sockets where appropriate wires of recording devices are connected.
- 2) Before starting electrical connection of the sensor special attention must be paid to the quality of the vehicle ground. Resistance between any point of the ground and the negative clamp of the battery must not exceed 1 Ohm.
- 3) It is strictly recommended to lay Eurosens sensor cable together with standard electrical wiring of the vehicle with mandatory fixing with buckles every 50 cm.

Make electrical connection in accordance to the passport for the product.

Figure.10 Wiring in fuel sensors **EUROSENS P(PN)**

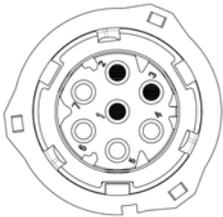
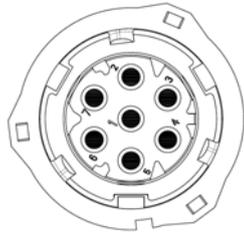
	pin	circuit	Color wires in the cable
	1	VBAT	Зелёный \ <i>green</i>
	2	GND	Чёрный \ <i>black</i>
	3	K-LINE/OUT	Голубой \ <i>blue</i>
	4	NC	no
	5	NC	no
	6	NC	no
	7	NC	no

Figure.11 Wiring in fuel sensors **EUROSENS RS**

	pin	circuit	Color wires in the cable
	1	VBAT	<i>red</i>
	2	GND	<i>brown</i>
	3	K-LINE/OUT	<i>blue</i>
	4	RS 232Rx	<i>black</i>
	5	RS 232Tx	<i>white</i>
	6	RS 485A	<i>yellow</i>
	7	RS 485B	<i>green</i>

4. Diagnostics and Troubleshooting

In case of malfunction of flow sensors eurosens please contact your dealer.
 Eurosens sensors can be repaired only by certified service center or manufacturer.
 Initial diagnosis can be carried out by installer in accordance with Table 14 either with a help of service kit Eurosens Destination.

Table 14. Table of faults

<i>Malfunction</i>	<i>Possible cause</i>	<i>Correction actions</i>
No output signal	Incorrect connection	Check sensor connection to AVL device
No fuel flow through sensor	Pollution of fuel filter	Remove and clean fuel filter
Results of measurement are too high or too low	Incorrect selection of sensor modification or incorrect installation scheme	Check installation scheme, vehicle parameters

5.Storage

Flow sensors eurosens should be stored in closed, dry premises.

Storage of flow sensors eurosens is allowed only in original package at temperature from -50 to +40 ° C and relative humidity up to 100% at 25° C.

Do not store Eurosens flow sensors in the same room with substances that cause corrosion of the metal and / or contain active agents.

Storage life of eurosens flow sensors should not exceed 12 months.

6.Transportation

It is recommended to transport Eurosens fuel flow sensors in closed transport that provides protection for sensors from mechanical damage and precipitation.

Air environment in transportation compartments should not contain acid, alkaline and other aggressive impurities.

Shipping containers with packed flow meters should be sealed.

7.Utilization/recycling

Eurosens fuel flow meters does not contain harmful substances and ingredients that are dangerous to human health and environment during and after the end of life and recycling.

Eurosens fuel flow meters do not contain precious metals in amount that should be recorded.