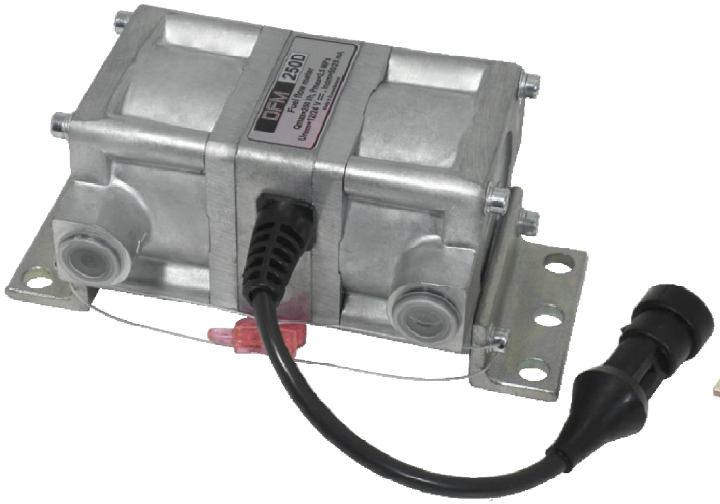
DFM®

Fuel flow meters



INSTALLATION MANUAL
Version 5.0

TECHNOTON®

Content

Introduction

Recommendations and regulations given in the installation manual are related to fuel flow meters DFM (hereinafter DFM), developed by JV Technoton, Minsk, Belarus. This document defines the procedure for installation and connection of DFM.

DFM flow meters are designed to measure the flow of liquid fuel in the car engines, river boats, tractors, locomotives, diesel - generators, as well as in boilers, burners and other liquid fuel consuming devices.

DFM model range includes single- and dual-chamber (differential) flow meters (see fig. 1).

A **B**

Fig.1. Single-chamber (A) and differential (B) flow meters

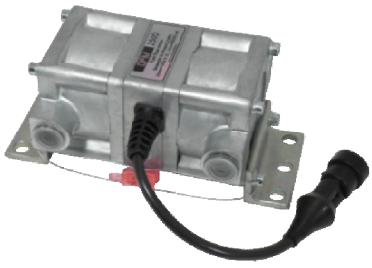
There are several DFM models that differ in type of data transfer like interface DFM (with the connector), autonomous DFM (with display to show information), and hybrid DFM (they have both display and interface output).

During installation of DFM it is necessary strongly to follow the manufacturer's recommendations mentioned in this manual.

The manual is for the professional users who are familiar with the rules for repair and installation works on vehicles and who have professional knowledge in the field of electrical and electronic equipment of various transport vehicles, experience and qualifications for work with the fuel equipment of vehicles.

To ensure the proper functioning of the DFM, its installation and set-up should be carried out by certified professionals trained by the manufacturer.

Table 1. Model range of DFM flow meters

Marking	Model	Remark	
		Type	Fuel consumption, l/h
DFM 50B	Single-chamber autonomous flow meter		1-50
DFM 100B			2-100
DFM 250B			5-250
DFM 50C	Single-chamber autonomous flow meter with extended functions		1-50
DFM 100C			2-100
DFM 250C			5-250
DFM 400C			30-400
DFM 50AK	Single-chamber interface flow meter AK – normalized impulse AP – regular (non-normalized) impulse		1-50
DFM 90AP			3-90
DFM 100AK			2-100
DFM 220AP			8-220
DFM 250AK			5-250
DFM 400AK			30-400
DFM 50CK	Single-chamber hybrid flow meter		1-50
DFM 100CK			2-100
DFM 250CK			5-250
DFM 400CK			30-400
DFM 250D	Differential interface flow meter		max. diff. consumption -150 max. consumption in chamber - 250
DFM 400D			max. diff. consumption -200 max. consumption in chamber - 400

1. Main data and technical characteristics

1.1 Purpose of use

Table 2. DFM main characteristics

The maximum acceptable size of solid insoluble particles (particulate matter) in the measured liquid, mm	0,08
Connecting thread	M14x1,5
Nominal pressure, MPa	0,2
MAX pressure, MPa	2,5
Pressure drop at maximum flow rate, nominal pressure, diesel fuel at 20 ° C, no more	0,02 MPa*
Supply voltage range, V	10 – 50
Overvoltage protection (short term), V	till 100
Current consumption, mA	≤50 at 12V ≤25 at 24V
Ambient humidity, %, at T 40 °C	≤95
Vibration resistance	max. acceleration ≤ 100 m/s^2 in the frequency range 5-250 Hz
Corrosive medium	oil-and-petrol resistant
Ambient temperature, °C	For flow meters without display: from -40 to +80; For flow meters with display: from -20 to +60
Electromagnetic compatibility	E20 10R – 03 2782

*more detailed, see Fig.2

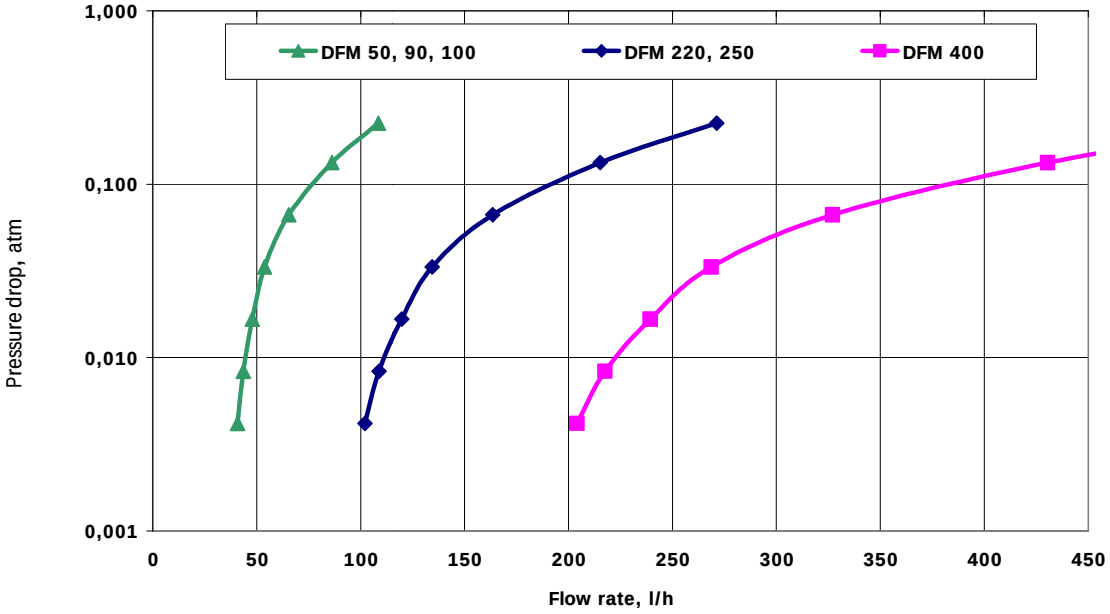


Fig.2. Diagrams of pressure drop in the DFM flow meters depending on the fuel consumption

1.2 Information on display

Flow meters with display have letters B or C in their marking. The letter B means a standard set of the displayed information, and the letter C – the extended one.

Switching of the information screens is performed by a light touch of the magnetic key (supplied) to the upper lid of the flow meter.

Fig. 3. Magnetic key

In order to save the battery power, the flow meter automatically turns the display into "sleep mode" in 1 minute after the last touch of the magnetic key. As well, "dots" are shown on the display.

Fig. 4. Display view in "Sleep mode"

As soon as the key is brought close to the display, it "wakes up" and shows information.

Table 3. Information screens of DFM with a standard set of the displayed info

Displayed data	№ of screen	Units of measure
Counter "Total fuel consumption"	1	0,1 l
Counter "Total fuel consumption" of the increased imaging accuracy"	2	0,001 l
Counter "Fuel consumption in the artificial fuel overrating" mode	7	0,1 l
Counter "Tampering time"	8	0,1 h
Instant fuel consumption	9	0,1 l/h
Battery charge in percentage of the maximum	10	10 %
Firmware version and the chamber volume	12	-

Table 4. Information screens of DFM with extended set of the displayed info

Displayed data	№ of screen	Units of measure
Counter "Total fuel consumption"	1	0,1 l
Counter "Total fuel consumption of the increased imaging accuracy"	2	0,001 l
Counter "Operational engine time"	3	0,1 h
Counter "Operational engine time in "Idling" mode"	4	0,1 h
Counter "Operational engine time in "Optimal" mode"	5	0,1 h
Counter "Operational engine time in "Overload" mode"	6	0,1 h
Counter "Fuel consumption in artificial fuel overrating" mode	7	0,1 l
Counter "Tampering time"	8	0,1 h
Instant fuel consumption	9	0,1 l/h
Battery charge in percentage of the maximum	10	10 %
Temperature in the measuring chamber	11	1°C
Firmware version and the chamber volume	12	-

- **screen № 1 displays the counter reading "The total fuel consumption" measured by the flow meter since its release up to 0.1 liters;**

- **screen №2 shows the counter "Total fuel consumption with increased accuracy" measured by the flow meter since its release up to 0,001 l;**

- **screen № 3 displays the counter reading "The engine operational time" measured as the total time of the engine operation in all load ranges, including idling;**

- **screens №4, 5 & 6 display the counter readings "Operational engine time" in "Idling", "Optimal" & "Overload" modes accordingly measured as the total time of the engine operation in corresponding modes;**

- **screen № 7 displays the counter reading "The fuel consumption" in "Artificial fuel overrating" mode measured as amount of fuel liters passing through the flow meter at a flow rate above the maximum. Value increase of this counter indicates the improper installation of the flow meter or possible facts of fuel thefts;**

- **screen № 8 displays the counter reading "Tampering time" measured as total time of the impact of external factors (strong magnetic field) that prevent the flow meter to work properly. Increase of values for this counter can indicate that the flow meter has been installed near the source of strong electromagnetic radiation or can state the deliberate attempt to lock the flow meter;**

- **screen №9 "Instant fuel consumption" shows the current value of fuel flow rate and can serve as a visual diagnostic for device operability and accuracy of its installation;**

- **screen № 10 "The battery charge in percentage of the maximum" displays the residual charge of internal battery;**

- **screen № 11 "Temperature in the measuring chamber" shows the current value of the fuel temperature in the measuring chamber of the flow meter;**

- **screen № 12 "Firmware version and the chamber volume" displays the firmware № which is set on the flow meter and the exact volume of the measuring chamber.**

1.3 Protection means of DFM from intervention / tampering

It is possible to apply different methods of external impact in order to make changes to the readings of the flow meter, its damage or blocking by third parties.

DFM flow meters have protection against the following tampering:

Artificial fuel overrating* with a purpose to increase the counter of the consumed fuel. Artificial fuel overrating usually leads to a sharp increase in fuel consumption that exceeds the maximal flow rate. DFM electronic board detects the overstated consumption, in the meanwhile, the counter of the fuel flow meter stops running and the counter "Artificial fuel overrating" is activated. It registers the amount of fuel passing through the flow meter at high speed.

"Artificial fuel overrating" mode is indicated by the display as "dash"-sign.

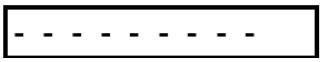


Fig.5. Display view in "Artificial fuel overrating" mode

Exit from "Artificial fuel overrating" mode is going on automatically in a few seconds after the working conditions of the flow meter have been normalized.

The impact of the magnetic field* with a purpose to stop registration or to fake the readings of the consumed fuel. Under the influence of external magnetic field DFM fixes a tampering attempt, as a result, value increasing of all the counters *as well as pulse signal transfer over interface cable* are stopped. The impact time is registered in a special counter, "Intervention/Tampering time".
"Tampering" mode is displayed as vertical bars.

Fig.6. Display view in "Tampering" mode

Exit from "Tampering" mode is going on automatically in a few seconds after the working conditions of the flow meter have been normalized.

Disconnection from external power supply. Due to built-in battery a stand-alone operation of the flow meter is provided up to 2 years.**

Disconnection from the fuel system. Brand accessories (fuel connectors, valves, etc.) have openings for the sealing that allow determine the facts of unauthorized interference into the fuel system.

**** Only for autonomous and hybrid DFM flow meters***
***** Only for DFM flow meters with processor***

1.4 Characteristics of output signal

DFM flow meters with interface output have a pulse output signal. The signal source is a reed relay MK-4-1A71B-500W from MEDER.

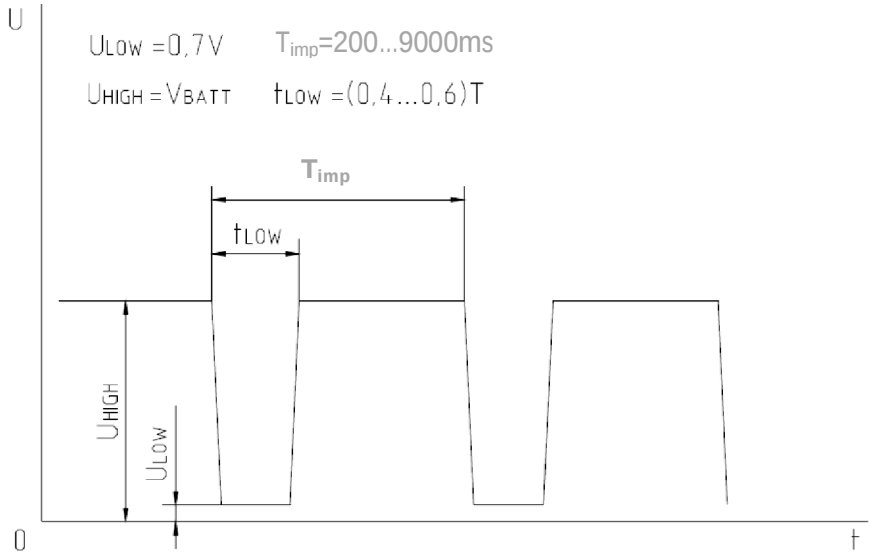
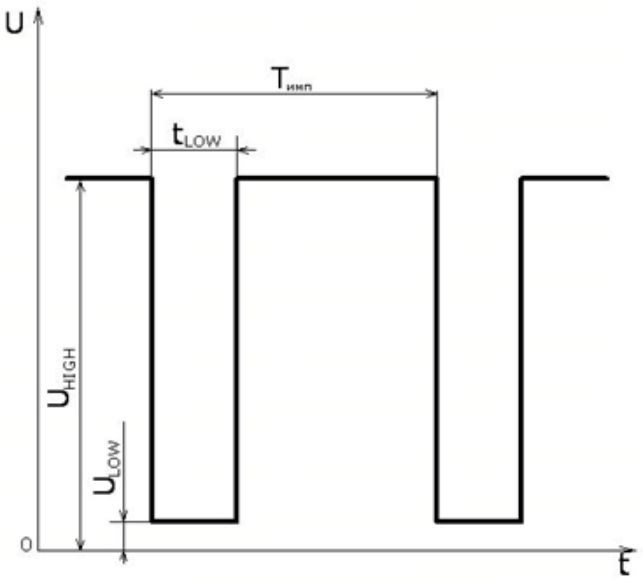


Fig.7. Characteristics of the regular pulse signal

Feature of the flow meter operation with regular impulse (DFM XXXAP) is a little difference in quantity of pulses per 1 liter in flow meter models. It occurs due to production peculiarities of measuring chambers of flow meters. The quantity of impulses generated during the flow of 1 liter of fuel is shown in specification for each unit and pointed out on the interface output.

DFM flow meters with normalized impulse (DFM XXXAK) produce a certain amount of impulses per fuel liter.

The pulse normalization of the output signal for DFM flow meters is carried out by the integrated electronic board which is set up at the manufacturing plant (see Figure 9).



$U_{HIGH} = U_{BATT}$
$U_{LOW} = 0,7V$
$t_{LOW} = 80ms$

model	$T_{имп}$, ms	
	from	to
DFM 50AK	360	18000
DFM 100AK	180	9000
DFM 250AK	180	9000
DFM 400AK	180	2400

Fig.8. Normalized pulse signal of DFM

2. Installation and set-up

2.1 Exterior examination before starting of works

Before you start, you should make external check of DFM for any possible defects that occurred during transportation, storage or careless handling:

a) visible damage of the housing, connecting parts, mounting plate, display and/ or signal cable and connector;

b) play of the constituent DFM parts in relation to each other or gaps between them.

By discovering any defects, please, contact the product supplier.

2.2 Choosing an installation place of DFM on the vehicle

DFM can be mounted in any position: vertical, horizontal or angled. During mounting, try to avoid the break of cables and fuel line.

ATTENTION! It is prohibited to drill frames and other supporting elements of the car body for DFM installation! If you cannot mount the mounting plate with bolts, fasten the plate by means of welding.

One of the features of the automotive fuel system is uneven fuel consumption. Also, there are hydraulic shocks that occur in the fuel system what may cause significant inaccuracy in the DFM. Therefore, we strongly recommend you to install a return valve in the area of fuel system behind the flow meter.

ATTENTION! This chapter gives special cases of the engine working scheme. Study carefully the technical documentation of the vehicle on which you install the flow meter in order to take a decision if the flow meter should be applied on this vehicle.

2.2.1 Evaluation of the vehicle operational status

Before you install the DFM, check the condition of the vehicle and make a conclusion if such installation is possible.

Vehicle inspection includes the following checks:

1) start the engine and check its work for 5-10 minutes at idle and 5-10 minutes in the movement under load. The engine should run evenly, not stall, there should not be loss of power under the load;

2) inspect all fuel lines for damage and leakage of fuel;

3) check the voltage of on-board power system with the voltmeter. For a vehicle with onboard voltage 12 V the operating voltage must be at least 10 V and not more than 18 V. For the vehicle with on-board voltage 24 Volt the operating voltage must be at least 18 V and not more than 32 V;

4) check the amount of fuel residues to be removed over return fuel line from the motor injectors. If there is a big amount of fuel remains, absolute inaccuracy increases, because these fuel residues come back into the fuel tank and are taken into account by the flow meter DFM;

5) check the fuel pressure, then make sure that the resistance at the selected DFM at a nominal flow rate is less than 5% of the pressure in the system (see item 1.1. Fig. 2);

6) check the "ground" of the vehicle. You need to measure the resistance between the input contact of the "ground" and the car body. Resistance should be no more than 1-2 Ohm.

You should make and sign a Vehicle Inspection Act based on the check results (see Appendix 1)

Prior to the installation of DFM, remove the defects identified in the Act.

2.2.2 General recommendations for mounting

During DFM installation you should observe the following rules:

1) fuel lines on the vehicle must be protected from external destructive effects;

2) no reduction of the inner dimensions of fuel lines by their bending is allowed;

3) mounting of the fuel lines on the vehicle should be made with tie-laps every 0.5 m;

4) fuel lines in length should have a small reserve to compensate the temperature changes of the length;

5) do not install DFM on the elements exposed to severe vibration and heat;

6) by connecting the fuel lines, please, make sure that flanges and threaded connections are clean;

7) you should use only new copper sealing washers from the mounting kit for all seals;

8) rubber fuel lines should be connected to elements of the fuel system with help of angle joint and fix them with clamps of the required diameter;

9) after you install the DFM, remove air from the fuel system.

ATTENTION! To measure the fuel consumption with single chamber DFM, you need to ensure that only the amount of fuel consumed by the engine passes through the flow meter. Modification of the return fuel line is often required in order to fulfill this condition (see items 2.2.3-2.2.4).

The most common scheme of the fuel system of diesel engine is shown in Figure 9.

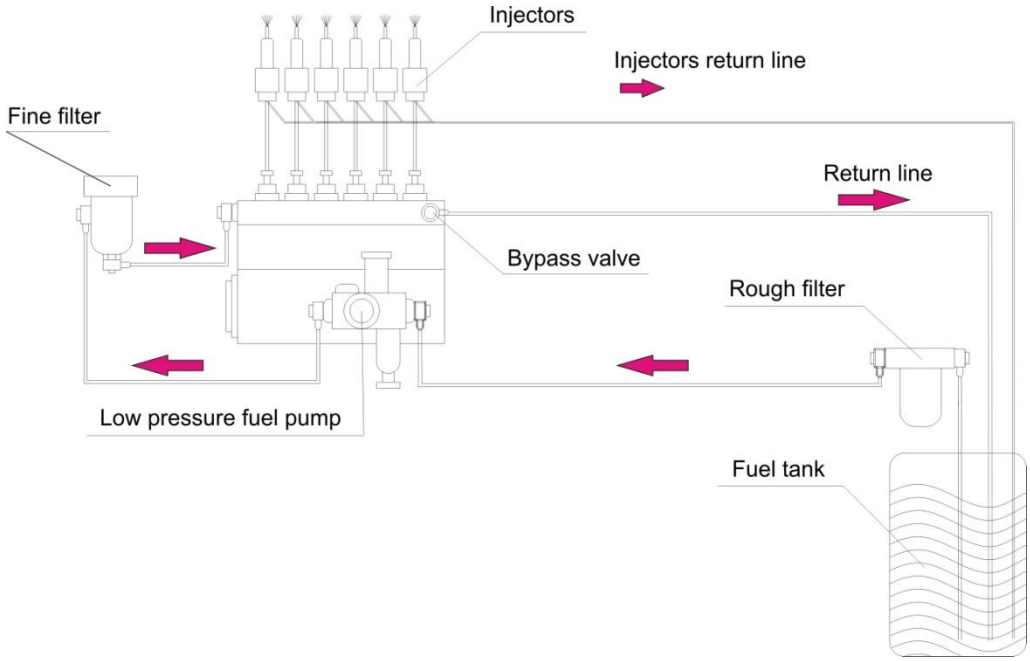


Fig. 9. Typical scheme of fuel system

The following items are needed to install the flow meter on the vehicle:

- **DFM;**
- **mounting kit;**
- **bracket for DFM mounting (in some cases, the installation of DFM can be performed directly, without bracket);**
- **tools: a set of wrenches and screwdrivers. If it's necessary to mount the mounting plate of DFM to the frame of the vehicle, you may also need a welding device and all needed accessories for that.**

2.2.3 Installation of DFM acc. to the scheme "Before pump"

DFM installation acc. to the scheme "before pump" involves the installation of flow meter in the area of fuel system where the flow of fuel is carried out due to underpressure created by the fuel pump.

ATTENTION! DFM installation acc. to the scheme "before pump" requires the mandatory use of an additional fine filter on the fuel line between the tank and flow meter.

Below you will see a special case of DFM installation acc. to the scheme "Before pump".

To install the DFM "Before pump" inside the engine fuel system that has no low pressure pump (see Fig. 10), it is necessary to use the fuel line between the rough filter and high-pressure fuel pump. Also, it is necessary to install an additional fine filter in the area between DFM and rough filter.

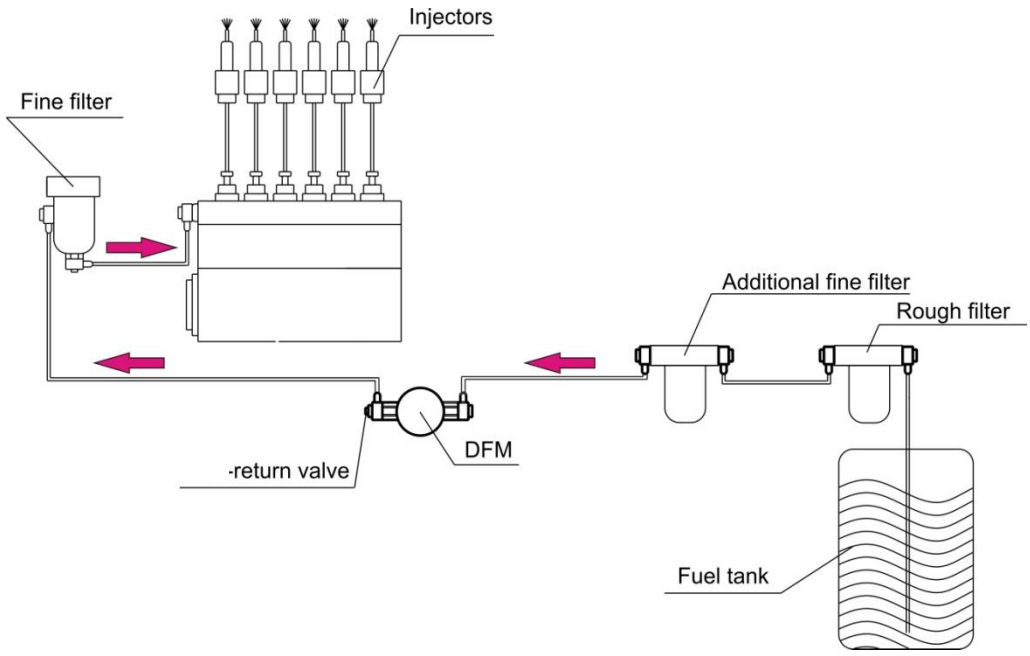


Fig.10. Installation scheme of DFM "Before pump" without low pressure pump

To install the DFM "Before pump" into the engine fuel system that has a low pressure pump (see Fig. 11), it is necessary to use the fuel line between the rough filter and inlet of the low pressure pump.

The capacity of the low pressure pump exceeds the fuel consumption by the engine in many times. For this reason, there is a discharge of extra fuel amount from the high pressure fuel pump and from injectors back into the fuel tank.

To prevent the repeated flow of the same fuel via the DFM it is necessary to "transfer" the return fuel line.

If injectors work properly, extra fuel amount that remains there is minimal and can be neglected.

The return line of high pressure fuel pump is necessary to "transfer" for the circulation of fuel in a small circle without the fuel tank. You can do it by connecting the return line of high pressure fuel pump to the inlet of the low pressure pump.

So there are two fuel lines at the inlet of the low pressure pump:
1) the fuel line from the tank that passes through the DFM;
2) the return line of the high pressure fuel pump.

For the proper operation of the upgraded system you need to install the bypass valve at the output of high pressure fuel pump that will maintain the necessary pressure in the pump. Also, you need to install a return valve at the output of DFM that will prevent the flow of fuel via the DFM in return direction, as well as it will reduce the impact of hydraulic shocks of fuel system on DFM.

After the fuel system acc. to scheme "Before pump" has been modified, fuel remains pumped with a low pressure pump are discharged from the output of high pressure fuel pump into the input of the low pressure pump.

Thus, only the amount of fuel, consumed by the engine, flows through the DFM.

ATTENTION! One of the advantages of fuel remains discharge into the tank over the return fuel line is heating of fuel in the tank. Therefore, during the car operation at very low temperatures it is recommended not to change the fuel supply scheme, but to use differential DFM flow meters or to install a fuel heater.

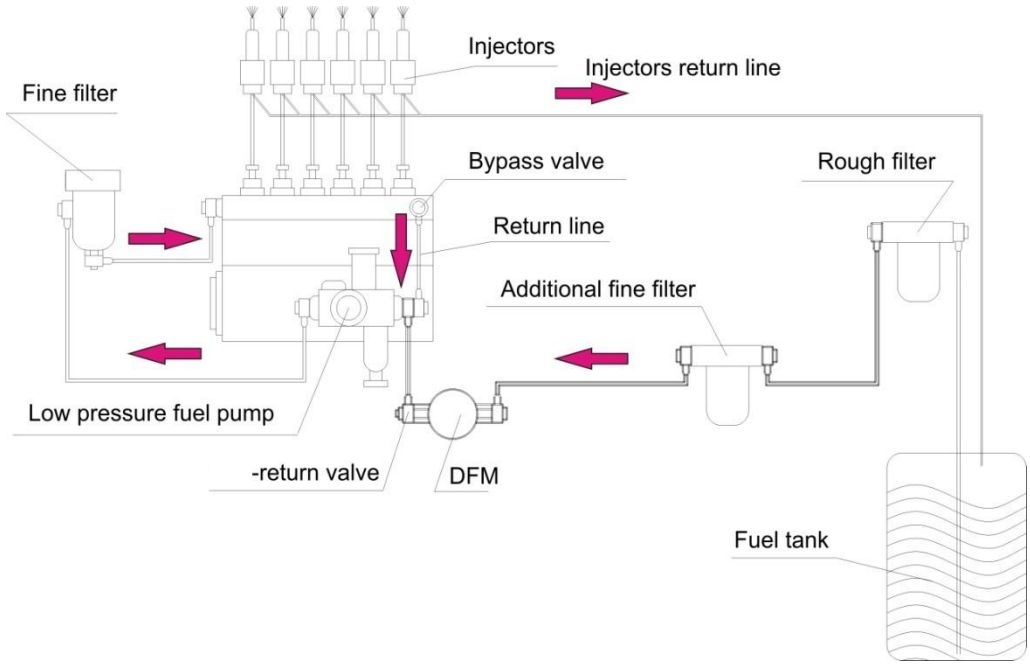


Fig.11. Installation scheme of DFM "Before pump" with a low pressure pump

Advantages :

1) minimal interference into the fuel system.

Disadvantages:

1) installation of additional fine filter is required;

2) additional fine filter increases the hydraulic resistance to the fuel flow;

3) fuel in the tank is not heated with the fuel from the return fuel line;

4) it's difficult to find places of loose connection of fuel lines (areas of possible air leak/inflow).

In some cases, fuel in the return line foams after it has flown through the fuel pump what makes the DFM operation improper. To eliminate foaming of the fuel, you need to install the deaerator.

As an example, we can give you DFM installation scheme on the engine MAN with deaerator application (see Fig. 12-14)

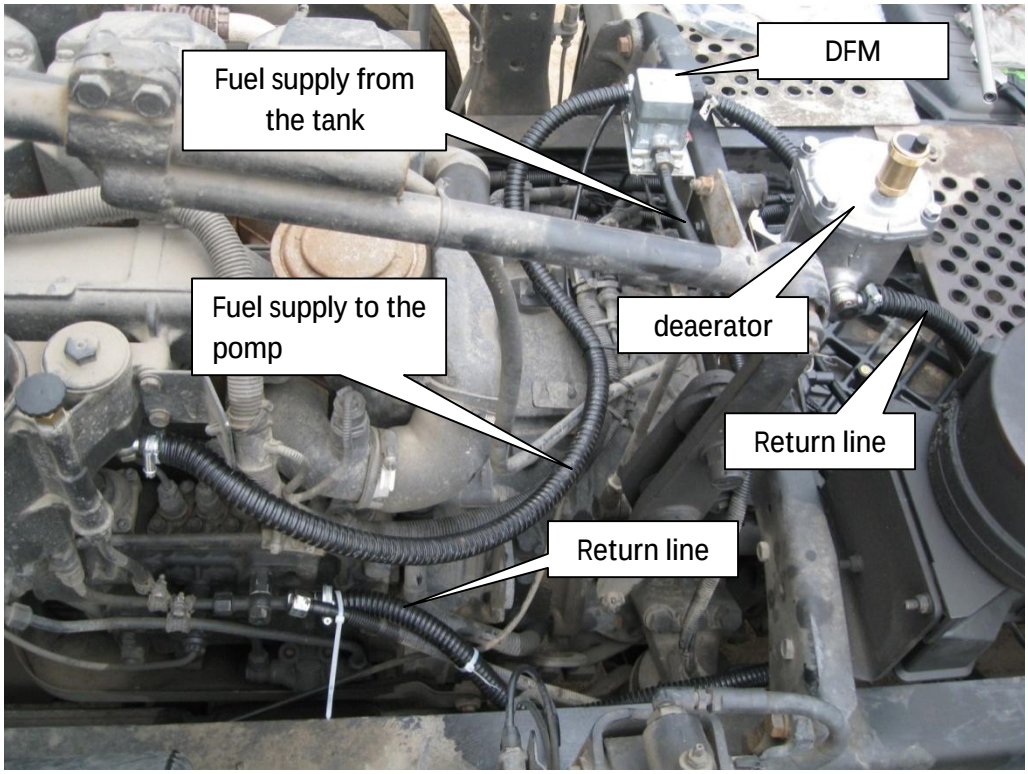


Fig.12. Photo of DFM installation acc. to "Before pump" scheme with deaerator onto the vehicle MAZ-MAN

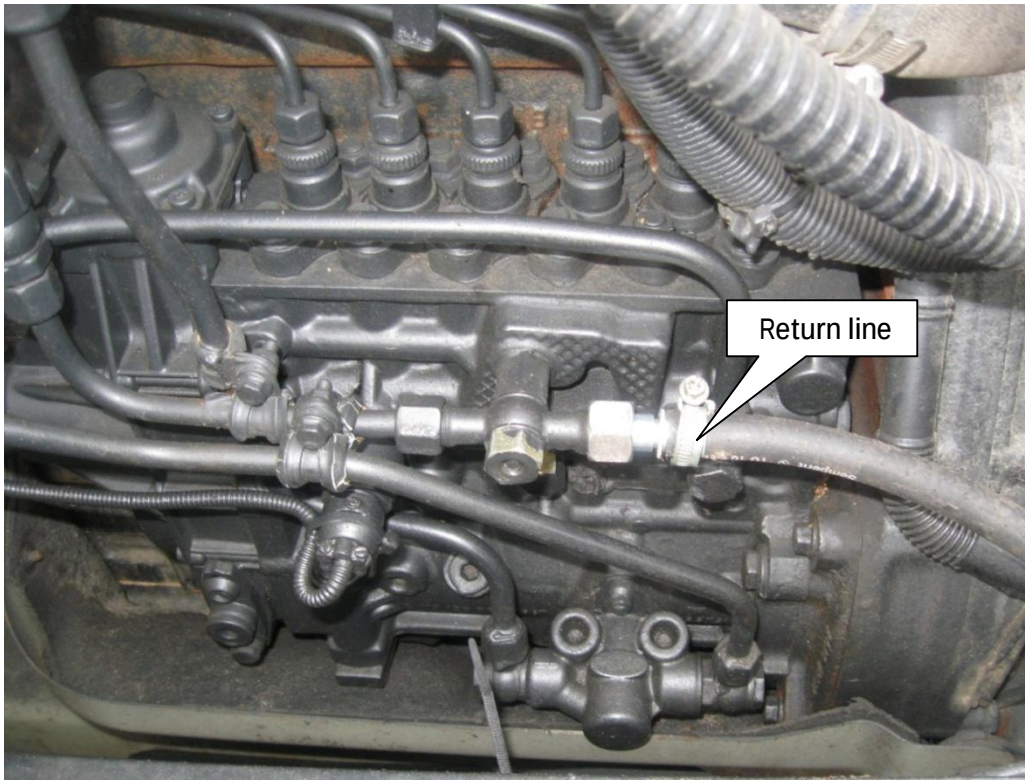


Fig.13. Connection of the return fuel line of high pressure fuel pump

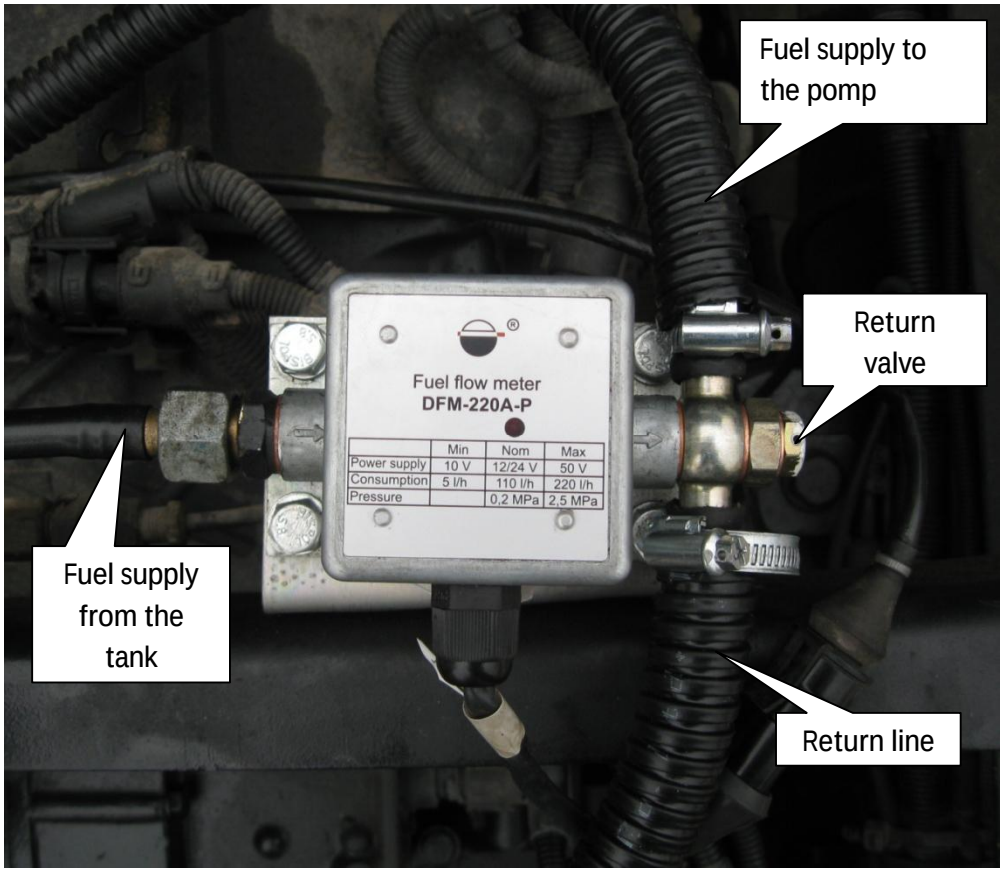


Fig.14. Connecting of the **fuel supply from the tank and return fuel line at the outlet of DFM**

2.2.4 Installation of DFM acc. to the scheme "After pump"

DFM installation acc. to the scheme, "After pump" involves the installation of flow meter in the area of fuel system after the low pressure pump where the flow of fuel is going on due to the pressure created by it.

Below you will find a special case of DFM installing over scheme "After pump".

To install the DFM over "After pump" scheme in the engine fuel system that has a low pressure pump (see Fig. 15) you need to use the fuel line between the fine filter and inlet of the high pressure fuel pump.

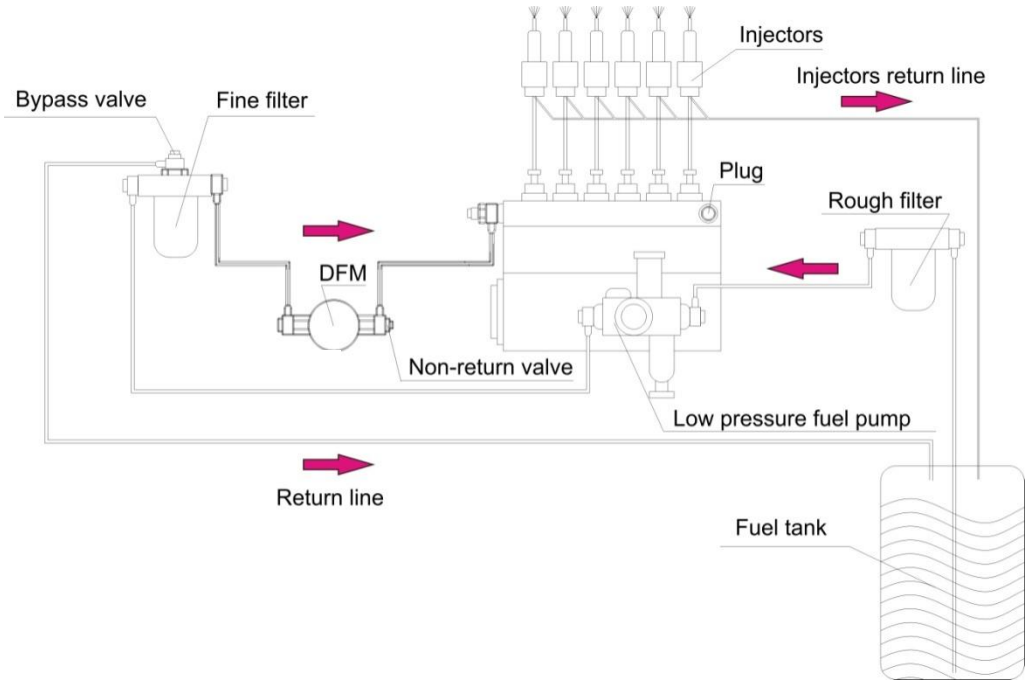


***Fig.15. DFM installation scheme* "*After pump*"**

The capacity of the low pressure pump exceeds the fuel consumption by the engine in many times. For this reason, there is a discharge of extra fuel amount from the high pressure fuel pump and from injectors back into the fuel tank.

To prevent the repeated flow of the same fuel via the DFM it is necessary to modify the return fuel line.

If injectors work properly, extra fuel amount that remains there is minimal and can be neglected.

The return supply of high pressure fuel pump is necessary to "transfer" on the area of the fuel line between low pressure fuel pump and DFM flow meter , for example, to the input of fine filter.

For the proper operation of the upgraded system you need to install the bypass valve at the input of fine filter that will maintain the necessary pressure at the inlet of the high pressure fuel pump. Also, you need to install a return valve at the output of DFM that will prevent the flow of fuel via the DFM in return direction, as well as it will reduce the impact of hydraulic shocks of fuel system on DFM.
As a result, fuel remains pumped with a low pressure pump will be discharged back from the fine filter inlet into the fuel tank. So, only the amount of fuel consumed by the engine will flow through the DFM.

Advantages

1) fuel passes through DFM under pressure;

2) DFM is installed after the regular fine filter. It does not require installation of additional filter. All this reduces the load on the low pressure fuel pump;

3) return supply line can heat the fuel in the tank.

Disadvantages

1) in some cases cooling of high pressure fuel pump is worsened;

2) fuel tank temperature is a bit lower than when a standard scheme of fuel remains discharge is used;

3) it's difficult to solve the problem with service centers to keep the warranty on power device.

Often, the installation place for DFM is a frame vehicle or fixing elements of the vehicle parts on the engine, but you can install the sensor on the other rigidly fixed part of the chassis.

The end cap on the high-pressure fuel pump (instead of the bypass valve) is installed from the mounting kit. Instead of it, you can install the fuel line loop which connects the outlet of the high-pressure fuel pump with its own inlet.

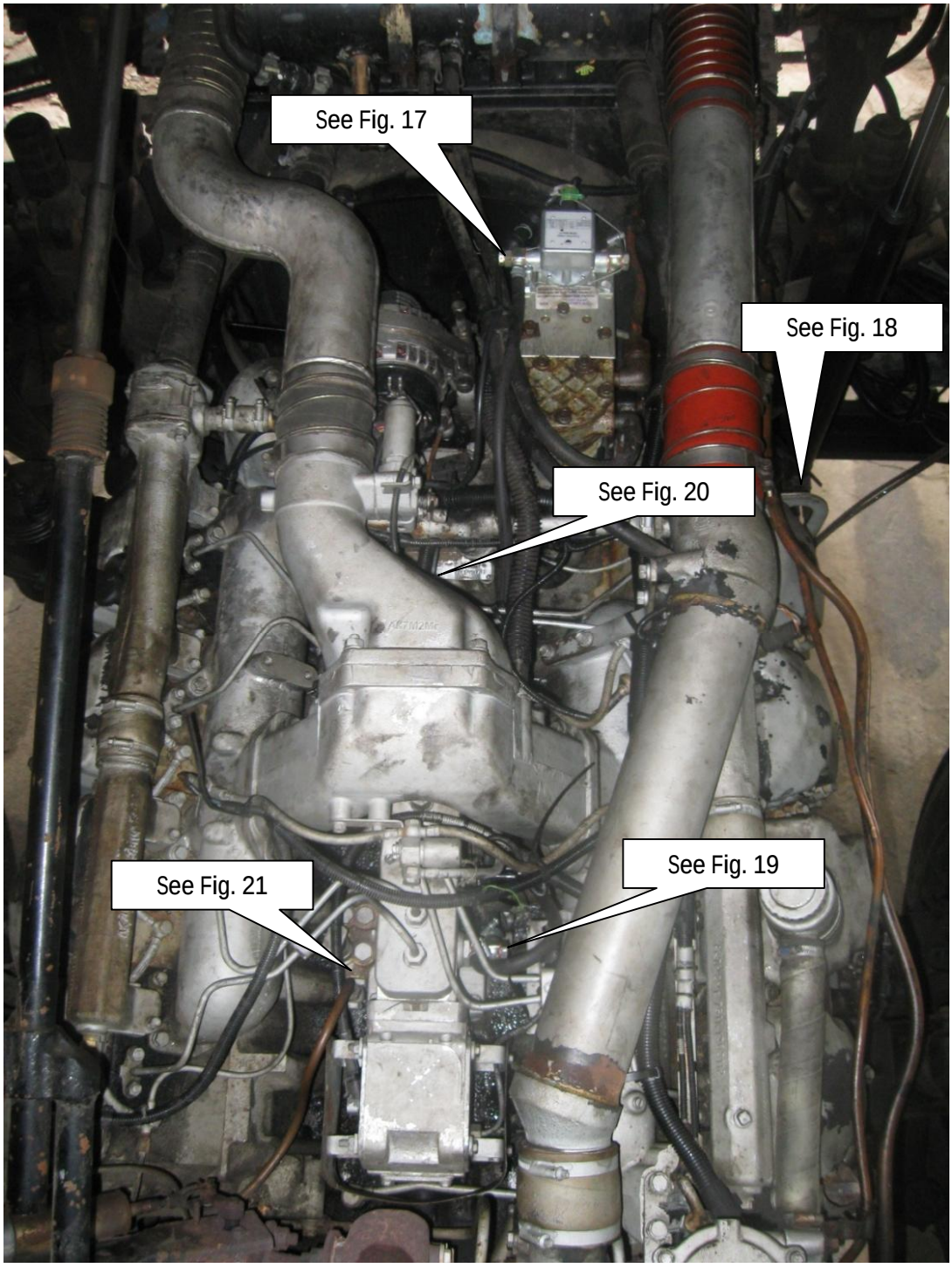


Fig.16. Photo of DFM installation onto the MAZ engine acc. to "After pump" scheme

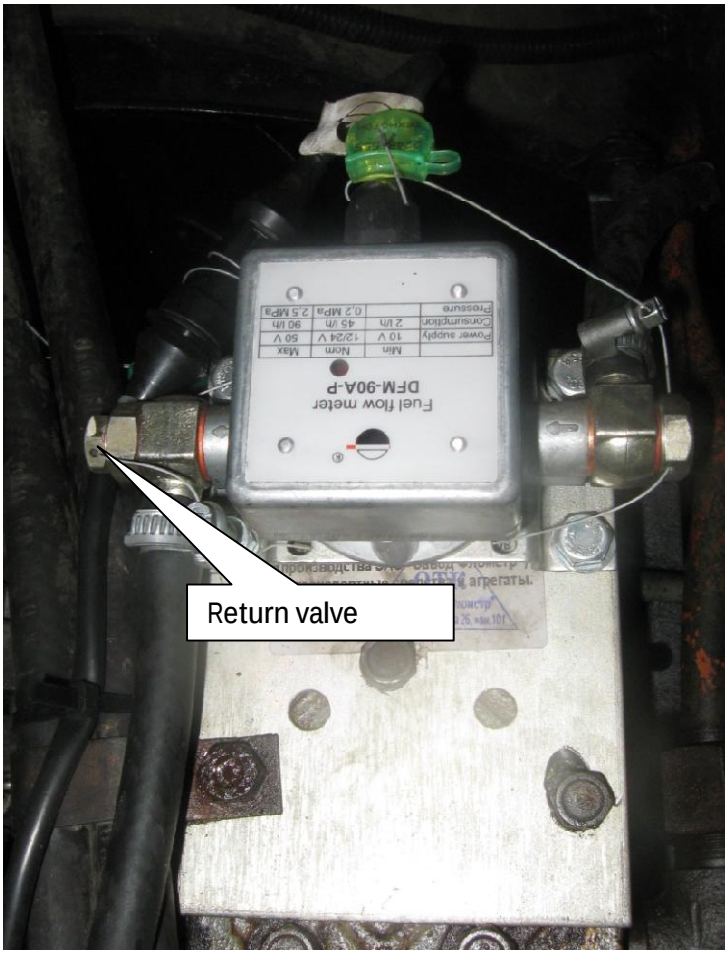


Fig.17. DFM connection

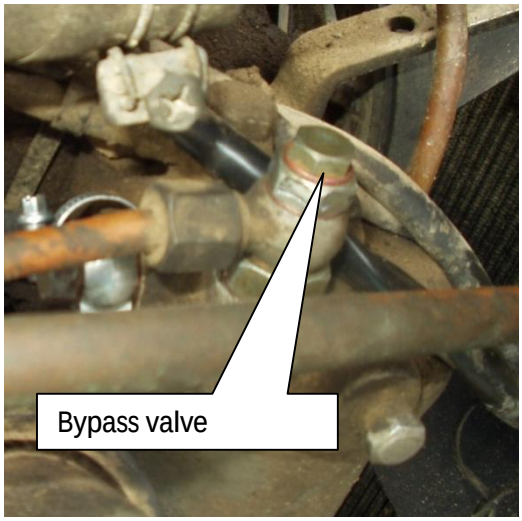


Fig.18. Fine filter connection

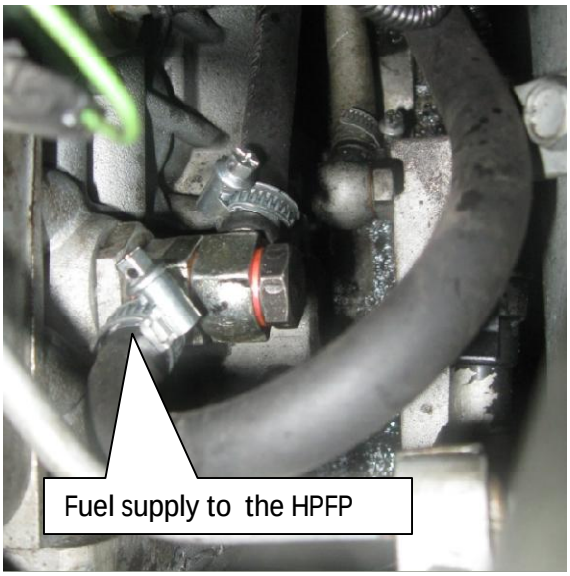


Fig.19. Connecting of the fuel line to the inlet of HPFP

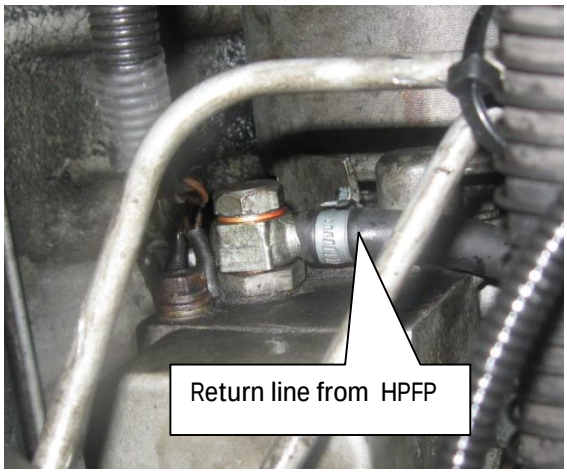


Fig.20. Connecting of the return fuel line to the inlet of HPFP

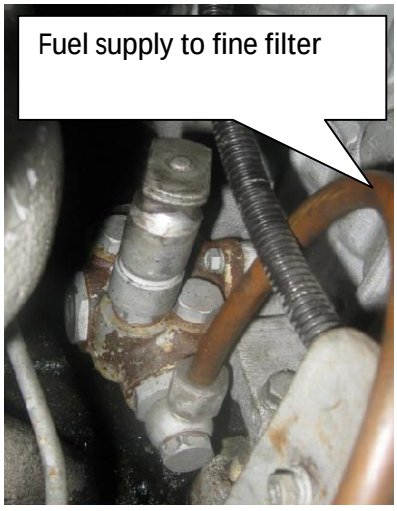


Fig.21. Low pressure pump

2.2.5 Installation of DFM acc. to the "Differential" scheme

ATTENTION! It's not recommended to install differential flow meters into the fuel system with high-efficiency low pressure pumps with low fuel consumption!

The DFM installing over the "Differential" scheme involves the installation of the flow meter so that it measures the volume of fuel entering the engine and the amount of fuel passing over the return fuel line. The volume of fuel consumed by the motor is calculated as difference between the obtained values .

During installation of differential flow meter it is necessary to specify the characteristics of the low pressure pump and fuel consumption by the engine. For example, if capacity of fuel pump is around 300 l / h, the absolute measurement inaccuracy will be 3-6 l / h what can be unacceptable in case of little fuel consumption by the engine.

Below you will find a special case of DFM installing over "Differential" scheme

To install the DFM over "differential" scheme in the engine fuel system (see Fig. 22), use the following sections of fuel line:

1) the area between fine filter and inlet of the high pressure fuel pump;

2) the area of the return supply line between the output of the high pressure fuel pump and fuel tank.

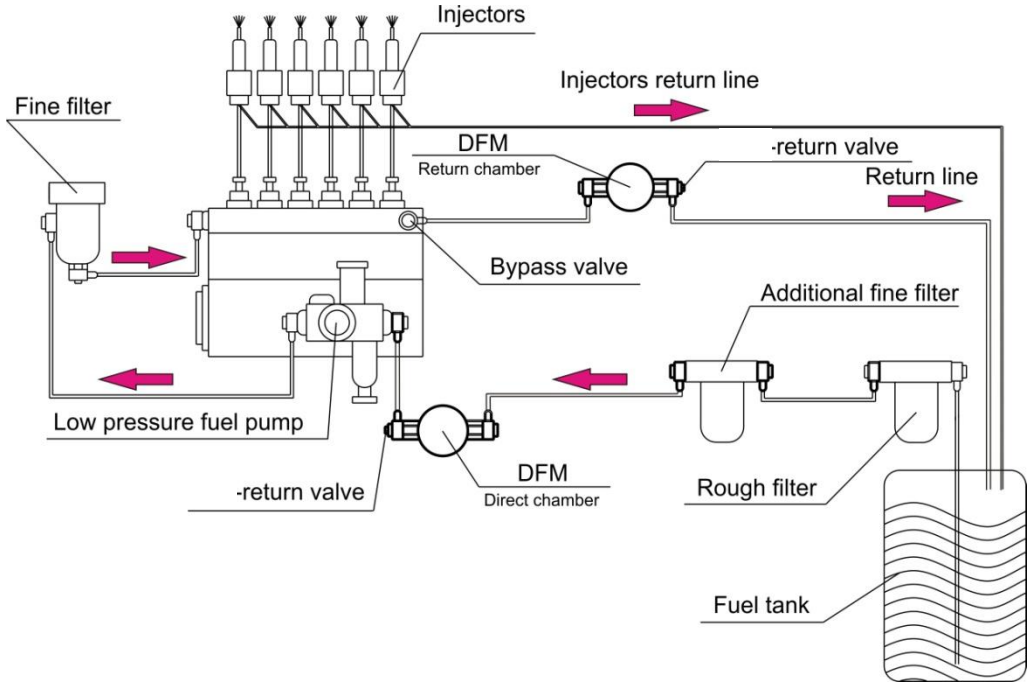


Fig.22. DFM installation over "Differential" scheme

Advantages:

1) no changes in the fuel system;

2) easier to coordinate the issue of keeping the warranty for the engine with the service center.

Disadvantages:

1) higher measurement inaccuracy of fuel consumption;

2) DFM and additional fine filter increase the load on the pump.

Problems in the application:

1) if there is foam in the return supply line, it requires installation of fuel de-aeration system.

2.3. Connection to the fuel system

Connection of the single-chamber and differential flow meters to the fuel system is carried out by means of bolts, drive type nipples, ty-raps and other mounting materials.

Mounting materials should be purchased separately. List and scope of the offered sets are given in Chapter 4.1 of this Guide.*

**** Choice of the proper mounting kit depends on the DFM installation scheme and features of the engine.***

Connection of the single-chamber flow meter 1 (Fig. 23) to the fuel system is performed with the help of two drive type nipples 3 fixed at the inlet of the flow meter with the hollow screw of the drive type nipple 5 and at the outlet – with the return valve 4. For sealing the angles you need to use copper washers 2. Connection of the fuel line 6 to the flow meter is done by means of three angles and hose clamps 7.

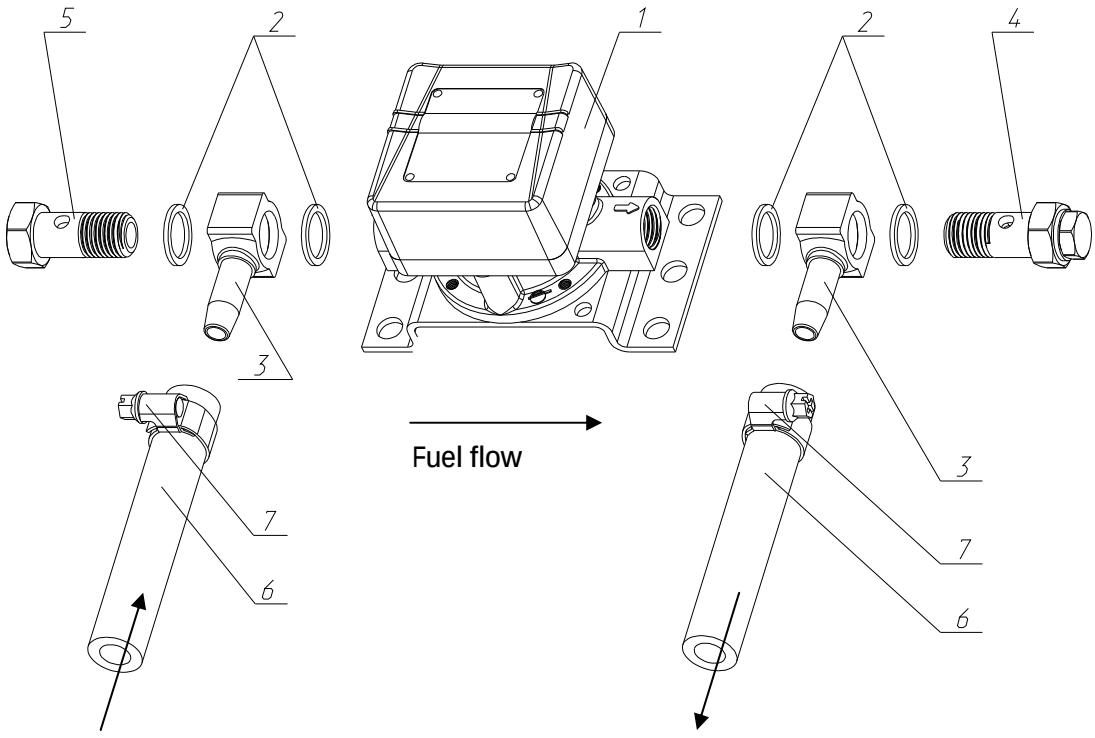


Fig.23. Connection of the single-chamber DFM to the fuel line

Connection of the differential flow meter 1 (Fig. 24) to the fuel system means connection of supply and return fuel line to the flow meter. Connection of the supply line is performed with the help of two drive type nipples 3 fixed at the inlet of the flow meter with the hollow screw of the drive type nipples 5 and at the outlet – with the return valve 4. For sealing the angles you need to use copper washers 2. Connection of the fuel line 6 to the flow meter is done by means of three angles 3 and hose clamps 7. Connection of the return fuel line is done acc. to the same scheme.

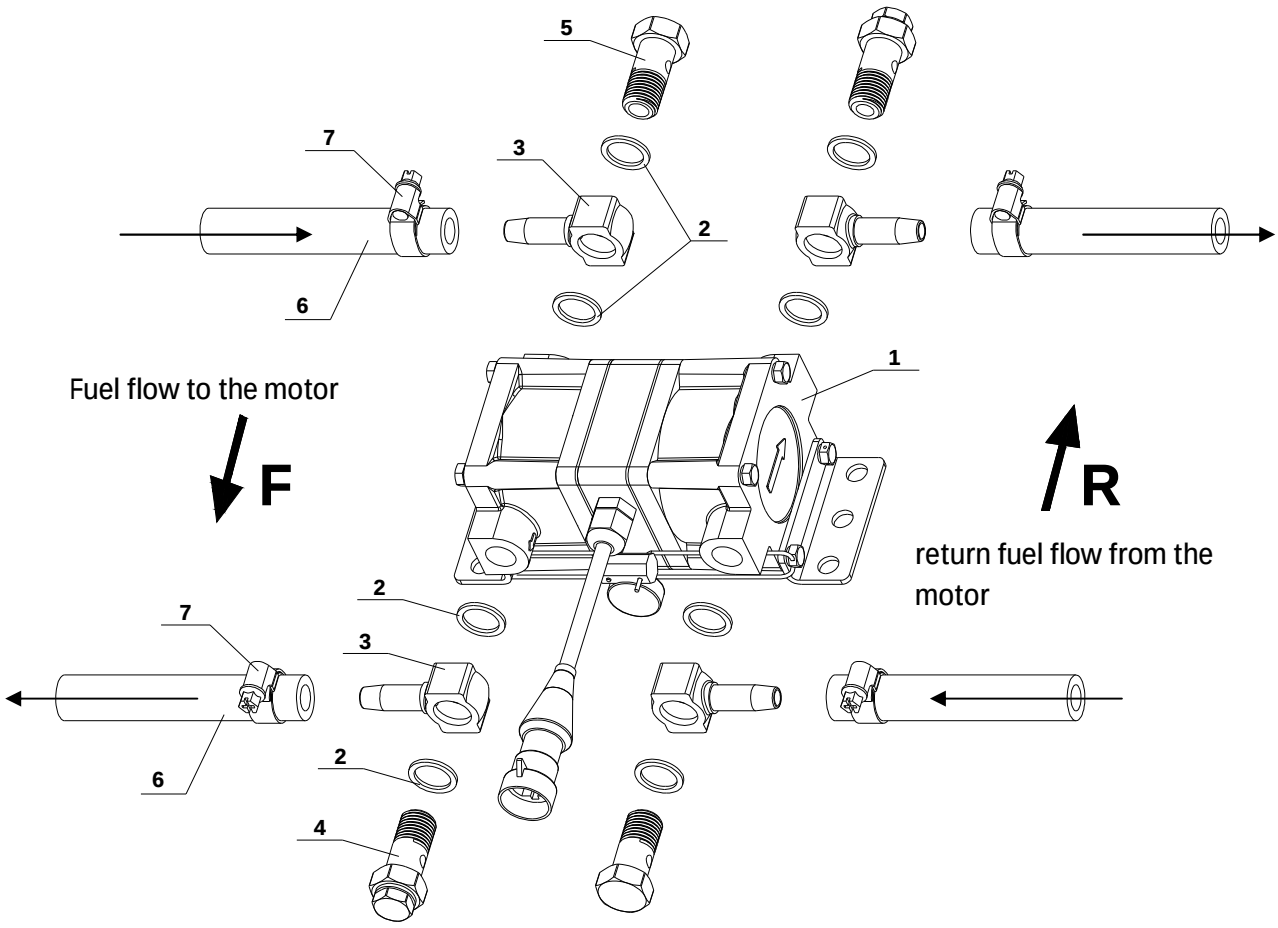


Fig.24. Connection of the differential DFM to the fuel line

2.4 Electrical connection

Electrical connection is required only for DFM with interface output.

Electrical mounting works should be done when the "ground" of the vehicle is off or when the battery is removed.

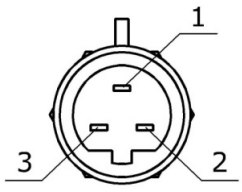
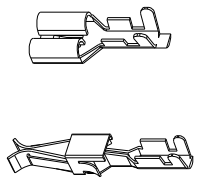


Fig.25. Pins of interface DFM flow meters

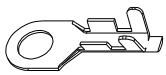
Table 4. Pin assignment for DFM

Pin No	Circuit name	Wire colour	Remark
1.	T701/T034	white	Frequency output
2.	GND/T734	brown	"ground" of the vehicle
3.	VBATT	orange	Power voltage

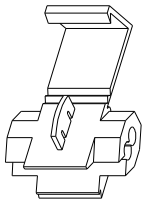
Special terminals and connectors (Fig. 26) are normally used for connections



Slot for the terminal block



terminal



connector

Fig.26.* Terminals and connectors *for electrical DFM connection

ATTENTION! Connection of the "ground" and DFM power supply is obligatory done in the same places where you connect the recording and display devices!

3. Measurement precision check

To determine the measurement accuracy of DFM installed on the vehicle, you need to make a "control checkout".

3.1 Conditions for testing

During tests there should be representatives of interested parties.

Only people who have studied the operational manuals for DFM and electronic terminals and who have experience with test equipment are allowed to make testing.

Tests are carried out on the proper vehicle.

Terms of control checkout:
1) Engine operation time - at least 1 hour;
2) Engine should run at medium/average speed;
3) During control checkout it's not allowed to stop the engine;
4) Use only verified measuring containers to control the fuel volume .

3.2 Preparation to testing

Install the flow meter on the vehicle and connect it to the recording and display device. Make calibration and setting up of the equipment. Make operations in accordance with the instructions for flow meter and recording and display device installations.

3.3 Testing

To make testing you need to fulfill the following operations:

1) **pour fuel into container 1 in amount sufficient for the de-aeration of fuel system and for warming up of the engine (see Fig. 20);**
2) **measure 10 liters of fuel (control volume) with a batcher into container 2;**
3) **connect the input of the low pressure pump with fuel line 1;**
4) **place the free end of fuel line into container 1;**
5) **put fuel return line 2 into container 1;**
6) **detach the injectors return flow from the tank (filter) and sink into container 1;**
7) **pump the fuel system with hand-pumping in order to remove air from it;**
8) **start the engine and let it warm up till the operating temperature. There should be no air leakage from the return fuel line 2;**
9) **close inlets of fuel lines 1 and 2 at the same time and stall the engine;**
10) **transfer the fuel lines 1 and 2 from container 1 to container 2 (air should not get into the hoses);**
11) **close the outlet of fuel line 3 of injectors return flow and move it from container 1 into an empty container 3;**
12) **record the initial DFM readings acc. to the readings of the recording and display device or acc. to the display data on DFM housing;**
13) **fix the start time of control checkout;**
14) **start the engine and set the average speed;**

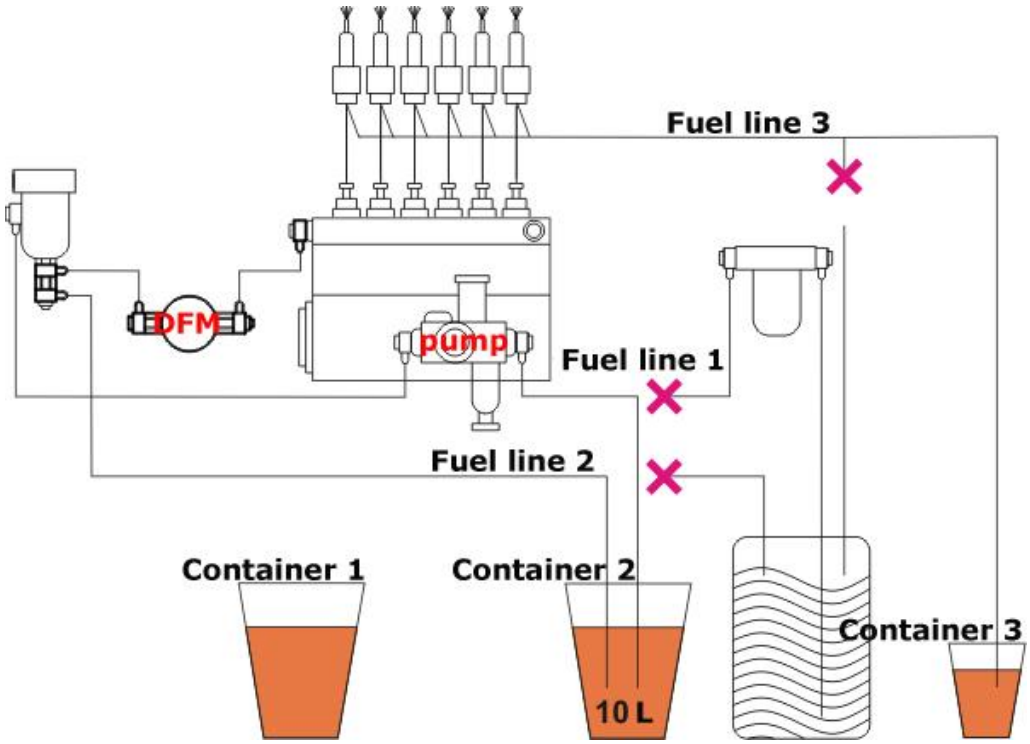


Fig.27. ***Fuel scheme of control checkout***

15) **let the engine take the maximum fuel amount from container 2. There should be no air inflow into fuel line 1;**
16) **stall the engine;**
17) **measure fuel remains in container 2;**
18) **determine with a batcher the "actual fuel consumption" from container 2: "*10 liters – remains in container 2*";**
19) **determine the "measured fuel consumption" based on difference in initial and final readings of DFM;**
20) **calculate the relative measurement inaccuracy of fuel consumption as follows: *(("measured fuel consumption" – "the actual fuel consumption") / "the actual fuel consumption" x 100%);***
21) **determine with a batcher the "actual volume of injectors return flow";**
22) **determine the proportion of injectors return flow in total fuel consumption for the tested vehicle using the following formula: *"The actual volume of injectors return flow" / "actual fuel consumption"x100%;***
23) **write test results in the protocol. Form of the protocol is given in Appendix 3.**

4. Accessories

We offer qualitative accessories for the DFM to simplify the installation, connection and sealing.

4.1 Mounting kits

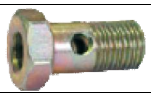
You can buy the necessary mounting kit to ease DFM installation.
Study the application purpose to choose the proper set (see Table 5).

Table 5. Application of DFM mounting kits.

№ set	Possible use
2	Universal (for pipe ø8 mm)
9	For engines D243, D245, D260 (for pipe ø8 mm)
10	For engines YMZ, KAMAZ (for pipe ø8 mm)
4	Universal (for pipe ø10 mm)
DIFF-01	For differential flow meters (for pipe ø10 mm)

Table 6. Mounting kits of DFM.

Exterior view	Name	Description	№ kit				
			2	9	10	4	DIFF-01
	Hollow screw	To connect the fuel line with fuel system units like high pressure fuel pump or fine filter	3	2	3	3	6
	Hollow screw	To connect two sections of fuel line with fuel system units like high pressure fuel pump or fine filter.	1	1	-	1	-
	Screw	To mount the flow meter to the bracket	4	4	4	4	4
	Nut	To mount the flow meter to the bracket	4	4	4	4	4
	Flat washer	To mount the flow meter to the bracket	4	4	4	4	4
	Spring washer	To mount the flow meter to the bracket	4	4	4	4	4
	Copper sealing washer	To seal the connections of mounting parts between each other	16	14	11	16	16
	Copper sealing washer	To seal the connections of mounting parts between each other on the fine filter of YMZ engines	1	-	1	1	-
	Return valve (white)	To remove the influence of hydraulic shocks on the accuracy of flow meters. (White valve) 0,35-0,5 Atm	1	1	1	1	2
	Bypass valve (red)	To release the over pressure in the fuel line at the output of the low pressure pump	1	-	-	1	-
	Drive type nipple	To connect the fuel hose d = 8 mm with mounting fittings	8	6	4	-	-
	Drive type nipple	To connect the fuel hose d = 10 mm with mounting fittings	-	-	-	8	8
	Hose clamp	To fix the fuel hose onto the angle joint or filter GB-612	8	6	4	8	-

	Nipple	To connect the fuel line with a return fuel line through the bypass valve	1	1	-	1	-
	Nipple	To reverse the return fuel line from the fine filter via the bypass valve	1	-	1	1	-
	Nipple	To connect the fuel line and heater tube	1	-	-	1	-
	Nipple	For joining two fuel lines with heater line	1	-	-	1	-
	Plug	For plugging the return line with the high pressure fuel pump	1	1	1	1	-

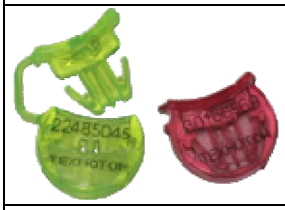
4.2 Connecting cables

Table 7. Connecting cables.

Exterior view	Name	Description
	Flow meter cable Cable 076-01	Designed to connect the flow meters to the recording and display device and to external power supply Supplied with all interface flow meters.
	Extension of flow meter cable Cable 084	Designed to increase the length of cable 076-01. Length 3 meters. Not included.

4.3 Other accessories

Table 8. DFM accessories.

Exterior view	Name	Description
	DFM mounting bracket KP 2	Universal 150x105 mm this kind of bracket is mounted to the equipment by bolts
	DFM mounting bracket KP 1	120x60x30 mm this kind of bracket is mounted to the equipment by welding (e.g. MTZ).
	Magnetic key KT	Used to switch screens in the DFM
	Plastic seal "Krystall"	Has the highest category of reliability among tamper-evident seals. The seal has the glowing effect in ultraviolet light. Solid design of the seal does not allow to replace its parts.
	Fuel hose hose ø8 mm hose ø10 mm	Designed for fuel supply between units of the fuel system. Hose is sold in rolls (roll of ø8 mm - 100 m, roll of ø10 mm - 50 m)

5. Diagnosis and troubleshooting

If any malfunctions in DFM flow meter operation appear, contact your supplier.

Allowed to correct the fault indicated in Table 9 by yourself.

Table 9. . DFM malfunctions that can be corrected by yourself

Malfunction type	Possible reason	Troubleshooting
No output signal (interface flow meters)	Improper connection	Check the connection of the flow meter to the registration and display device
	Clogging of fuel filter	Remove and clean/wash the filter
No fuel flow through the DFM or hydraulic resistance	Clogging of fuel filter	Remove and clean/wash the filter
Increased readings of fuel consumption	Wrong selection of the flow meter model or wrong installation scheme	Study the technical documentation for the engine and check the wiring diagram
	Hydraulic shocks in the fuel system	Install the return valve behind the flow meter or check its operation (if already installed)
No output signal (interface flow meters) or increment of fuel flow meters (autonomous and hybrid)	Sticking of the measuring chamber ring (possibly by long term storage of the flow meter)	To supply the fuel to the meter under high pressure
	Dirt in the measuring chamber, wear of the chamber or ring	Contact the supplier of the flow meters
No output signal (no signs of operation) with power supply and with rotating ring of the measuring chamber (typical rustling by blowing of the flow meter with the air)	Reason can be identified and corrected only by the employees of the service center	Contact the supplier of the flow meters

Contact information

Manufacturing plant

CJSC "Zavod Flometr"

222410, Republic of Belarus, Vileyka city, Chapaeva str., 26, room 101

Tel/fax: (+375 1771) 3-99-89

DEVELOPMENT, TECHNICAL SUPPORT

JV "Technoton"- CJSC

220033, Republic of Belarus, Minsk, Partizansky av. 2, dep. 4

Tel/fax: (+375 17) 298-07-04, 223-78-20;

E-mail: support@technoton.by

Additional information, addresses of official dealers are available at www.jv-technoton.com

Appendix 1. Act of the vehicle inspection

Dated "___" _____ 20___

We, the undersigned, representatives of the CUSTOMER
_____,
On one hand, and representatives of the CONTRACTOR
_____,
On the other hand, inspected the vehicle (device)

vehicle Type _____
Make, Model _____
Reg. plate_____
if it meets the requirements for DFM installation and concluded as follows:

Requirement	Correspondence YES / NO	Remark
Leak-tightness of the fuel system		If the fuel system is not leak-tight, measurement accuracy and work efficiency of DFM is not guaranteed. It is recommended to repair the fuel system to remove leakages.
Pressure in the fuel system		If there is not enough pressure in the fuel system, work efficiency of DFM is not guaranteed. It's recommended to make a repair or maintenance works of the low pressure pump.
Status of injectors return flow		The increased injectors return flow can seriously affect the measurement accuracy. We recommend maintaining or replacing the injectors.
On-board power system voltage		With low voltage the work efficiency of DFM is not guaranteed. It is recommended to repair the onboard power system and / or a generator.
Status of the ground switch		With considerable resistance / oxidation the work efficiency of DFM is not guaranteed. We recommend you to maintain or replace the switch.

representative of the CUSTOMER: **representative of the CONTRACTOR:**

_____ **_____**
name, signature **name, signature**

Appendix 2. Protocol for control checkout

Dated "___" _____, year

make, model, reg. plate of the vehicle	
model, serial No of DFM	

Fuel consumption	**The actual fuel consumption.** **Acc. to the batcher readings** V_B, **l**	
	Measured fuel consumption. **Acc. to DFM readings** V_{MSRD}, **l**	
The relative measurement inaccuracy of fuel consumption	$d = \frac{V_{MSRD} - V_B}{V_B} * 100\%$, **%**	
The volume of the injectors return flow acc. to the readings of the measuring container	V_{NRTRN}, **l**	
Proportion of the injectors return flow in total fuel consumption	$\frac{V_{NRTRN}}{V_B} * 100\%$, **%**	

Conclusions:

Result of the fuel consumption measurement corresponds (does not correspond) to the technical requirements.

Remarks: _____
_____
_____
_____

Customer representative _____ **/**_____**/**

Contractor representative _____**/**_____**/**