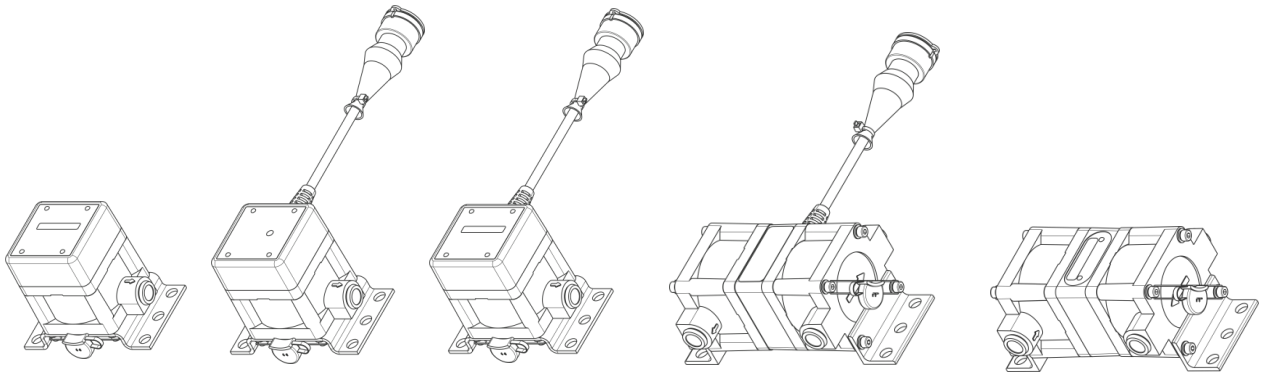
FUEL FLOW METERS



DFM 50/100/250/500
one-chamber and differential

OPERATION MANUAL
(includes Service S6 DFM software manuals)

Version 6.4

This document is intended for fuel flow meters manufactured after 01.01.2016

TECHNOTON

Contents

Revision history

Version	Date	Editor	Description of changes
1.0	01.2007		Basic version.
6.2	12.2016	OD	• Concept of recommended re-calibration interval of DFM is introduced. Re-calibration interval of DFM is defined by volume of fuel went through measuring chamber of DFM (see 1.6.3 and 8). • Description of new version of flow meter available for order is added - DFM 250 HP and DFM 500 HP characterized by higher fuel consumption rate (see Introduction, figure 1).
6.3	01.2017	OD	• DFM COM data transfer protocol updated (see annex E, table E.5).
6.4	06.2017	OD	• Clarifications in DFM order identification codes added (see. Introduction, figure 1). • Table of measurement range and accuracy is divided in two separate parts: for one-chamber and for differential flowmeters (see 1.4). • General installation instructions are amended with description of symbols on DFM body for proper installation into fuel lines (see 2.3, figure 20).

Terms and Definitions

ORF 4 — is the Telematics service by Technoton developed for receiving and processing Onboard reports via Internet, displaying Operational data overlapped on area maps, information storage in database and Analytical reports generation upon user's request.

S6 — is the vehicle onboard data bus developed by TECHNOTON to enable integrating the GPS/GLONASS-based vehicle monitoring system into the vehicle electrical equipment. It comprises a set of cables, interfaces and protocols. Physically, it is implemented on the basis of CAN 2.0B (ISO 11898-1:2003) and K-Line (ISO 9141). S6 bus data exchange protocol complies with SAE J1939 International Standard.
To get more details on S6 telematics bus visit http://s6.jv-technoton.com/en/

PGN (Parameter Group Number) — is a combined group of S6 parameters, which has common name and number. Functional Modules (FM) of the Unit can have input/output PGNs and setup PGNs.

SPN (Suspect Parameter Number) — informational unit of S6. Each SPN has determined name, number, extension, data type and numerical value. The following types of SPN exist: Parameters, Counters, Events. SPN can have a qualifier which allows qualification of parameter's value (e.g. – Onboard power supply limit/Minimum).

Analytical report — report generated in ORF 4 on vehicle or group of vehicles operation for chosen time period (usually a day, week or month). Can be composed of numbers, tables, charts, mapped route of vehicle, diagrams.

Onboard equipment (OE) — Telematics system elements, directly installed in vehicle.

Onboard Reports (the Reports) — iInformation about vehicle which is returned to a user of Telematics system in accordance with inputted criteria. The Reports are generated by a terminal unit both periodically (Periodic reports) and on Event occurrence (Event report).

GNSS (Global Navigation Satellite System) — System for area positioning of an object through satellite signal processing. GNSS is composed of space, ground and user segments. Currently, there are several GNSSs: GPS (USA), GLONASS (Russia), Galileo (EU), Compass (China).

Online monitoring — remote monitoring of location and vehicle operation in real time, the accumulation of information and preparation of Analytical reports by requests of ORF 4 user.

Parameter — vehicle's characteristics varying over time or in space. E.g. hourly fuel consumption, speed, fuel volume in tank, coordinates. The Parameter is usually depicted as a chart and an average value.

Route — data massive, consisting of coordinates, speed and direction of vehicle's movement. Corresponds to a real route of the vehicle. Depicted as lines on the Map. Direction of vehicle's movement is depicted by arrows.

Server — hardware and software combination of Telematics service ORF 4, designed for Operation data processing and storage, also for generation and transfer of Analytical Reports upon User's request.

Event — relatively rare and sudden change in SPN. For example, the attempt to falsify values of "Instant fuel consumption" counter by applying electromagnetic field to fuel flow meter will be recognized as "Interference" Event. An Event can have one or several characteristics. "Interference" Event has the following: date/time and duration of interference. When the Event occurs, a terminal unit registers the time of occurrence, which is later mentioned in a report on the event. Thus, the Event is always attached to exact time and place of occurrence.

Counter — cumulative numerical characteristics of Parameter. Counter is represented by a number, which can only grow in time. Examples of Counters: fuel consumption, engine operation time, total distance and other.

Telematics system — complex solution for real-time and after trip vehicle monitoring and control. Main vehicle parameters monitored: route, fuel consumption, operation time, technical condition of vehicle, safety. Consists of OE, Communication channels, Telematics Service ORF 4.

Vehicle — an object controlled within Telematic system. Usually Vehicle means a truck, tractor or bus, sometimes a locomotive or river boat. From Telematic system point of view, stationary objects are also considered to be vehicles: diesel gensets, stationary tanks, boilers/burners.

Function Module (FM) — unit-embedded component of hardware and software combination, executing a group of special functions. Uses input/output PGNs and settings PGNs.

Unit — an element of Onboard Equipment of Vehicle, which is connected to Telematics Interface S6. Particularly, in this document Unit means DFM fuel flow meter.

Introduction

The Operation Manual contains guidelines and rules which refer to **DFM fuel flow meters** (hereinafter DFM), developed by JV Technoton, Minsk, Belarus.
The manual contains information on design, operation principle, specifications and instructions on installation, use and maintenance of DFM. The manual provides guidelines on DFM configuration with Service S6 DFM software (version 1.11 and higher).

DFM® **— is a precise tool for fuel consumption measurement. DFM can be as a part of Teleamtic system or as stand-alone solution.**

DFM features:

- conformity with European and national automotive standards and directives;
- fuel consumption and operation time control – overall and in different engine operation modes;
- protection against unauthorized interference in operation and data "tampering";
- maximum information richness of output data*;
- high reliability of data transmission over digital interfaces*;
- unique self-diagnostics feature to monitor the stability and accuracy of data*;
- possibility of integration into on-board S6 Telematics interface of vehicles**;
- embedded battery allows data (Counters, Events) storage in the internal non-volatile memory of flow meter;
- thermal correction function with adjustable coefficient which ensures automatic correction of values to the ambient temperature***;
- easiness of flow meter configuration with S6 SK service adapter, which is similar for all Onboard Equipment based on S6 Interface***;
- built-in mud filter;
- minimum fluid flow resistance;
- 100 % of DFM are verified with a certified metrological test rig;
- full set of high-quality elements for installation;
- great operating experience, high-quality technical support, affordable price.

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* DFM 232/485/CAN.
** DFM CAN.
*** For DFM with interface cable.

See figure 1 for identification codes for DFM ordering:

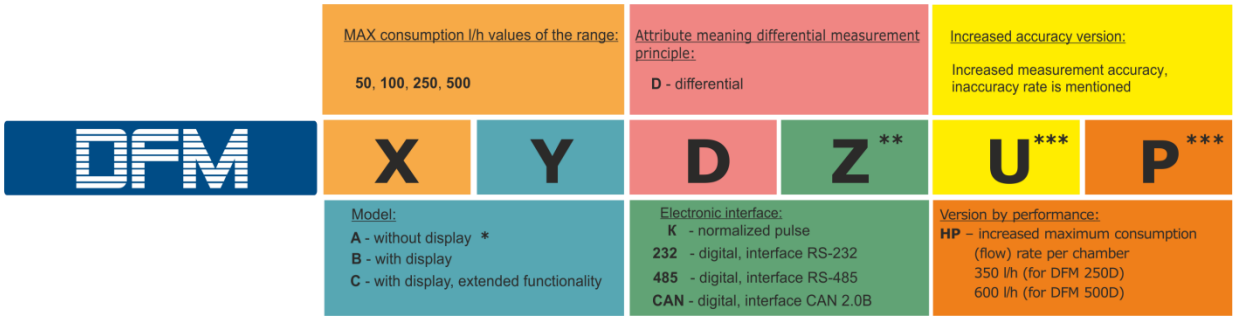

Figure 1 — DFM order identification codes

Example of DFM order identification codes:

"Fuel flow meter DFM 50B"

(max. flow rate 50 l/h, model - autonomous with display)

"Fuel flow meter DFM 250 AK, 0.5 %"

(max. flow rate 250 l/h, model - without display, output interface – normalized pulse, increased measurement accuracy, inaccuracy is ±0.5%)

"Fuel flow meter DFM 500DK HP"

(max. flow rate 600 l/h, model - differential without display, output interface – normalized pulse, higher maximum consumption rate)

"Fuel flow meter DFM 500CD"

(max. flow rate 500 l/h, model - differential autonomous with display)

"Fuel flow meter DFM 500CCAN"

(max. flow rate 500 l/h, model - differential with display, output interface – CAN 2.0B)

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* **A** symbol is not specified for differential fuel flow meters.

** For autonomous fuel flow meters **Z** version is not used.

*** This version is delivered upon special order. Designation **U** is available only for one-chamber flowmeters, designation **P** — only for differential DFM flowmeters.

For DFM fuel flow meter with output interface configuration a service adapter is used (S6 SK or SK DFM), which is ordered additionally, and software Service S6 DFM. You can download and/or update your Service DFM software at http://www.jv-technoton.com/, in Software/Firmware category.

ATTENTION: It is strongly recommended to follow strictly the instructions of the present Manual when using, mounting or maintaining DFM.

The Manufacturer guarantees DFM compliance with the requirements of technical regulations subject to the conditions of storage, transportation and operation set out in this Manual.

ATTENTION: Manufacturer reserves the right to modify DFM specifications that do not lead to a deterioration of the consumer qualities without prior customer notice.

1 DFM general information and technical specifications

1.1 Purpose of use and application area

DFM® flow meters are designed for fuel consumption measurement directly in fuel line of vehicles and stationary engines.

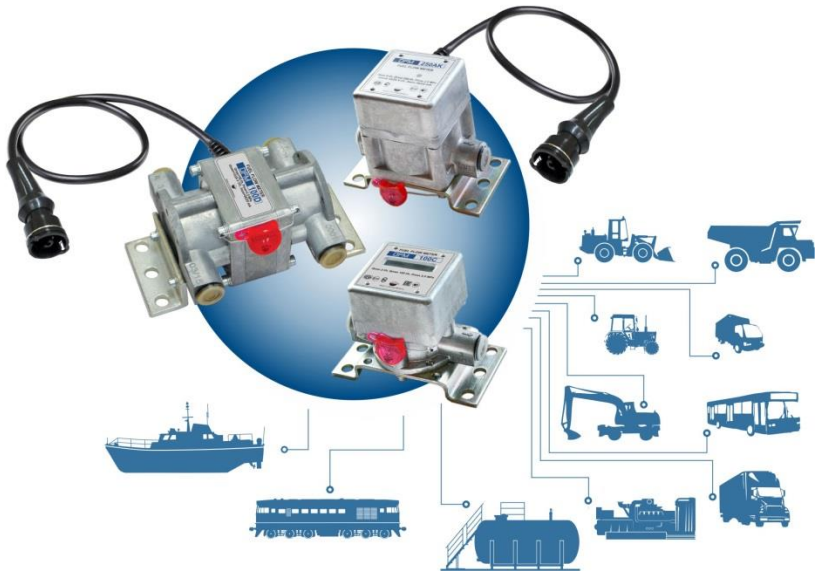
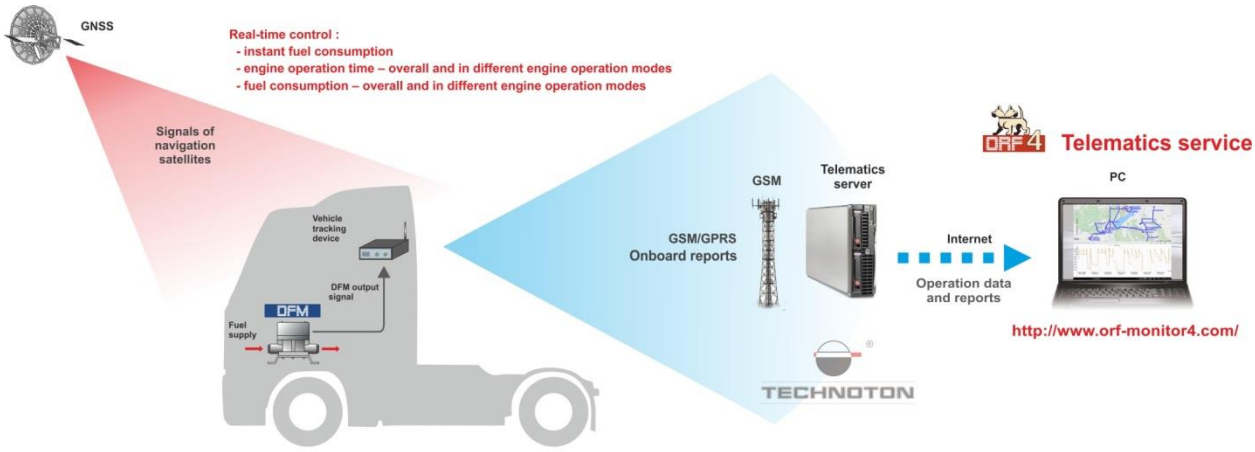
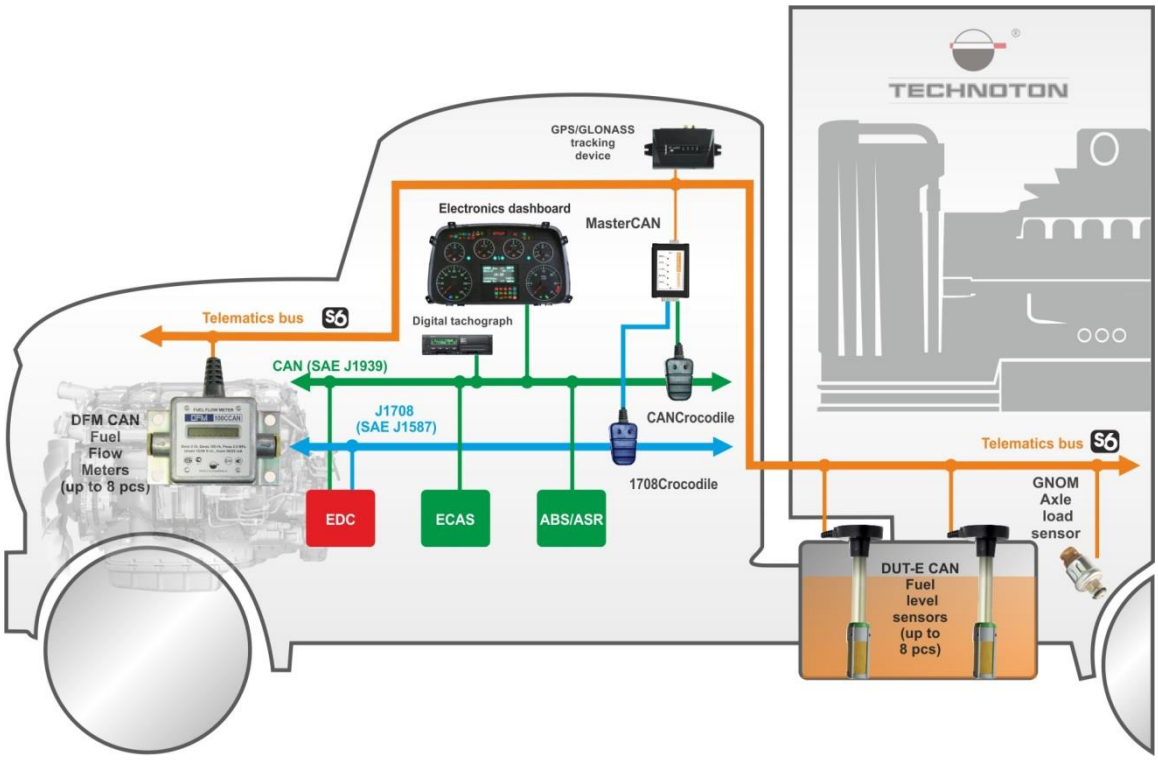


Figure 2 — DFM puprose of application

Application area — DFM fuel flow meters are used both as a part of Telematics system and as a stand-alone solution (see figure 3).



a) within GPS/GLONASS vehicle telematics system



b) within S6 Telematics Interface *

Figure 3 — DFM examples of application

DFM are mounted into fuel supply line of the vehicle engine. DFM measure actual (instant) fuel consumption rate and generates an output signal to forward it to a vehicle tracking device (see figure 3 a).

Terminal unit gathers, registers, stores received signals and transfers them to telematic Server. Software installed on the Server generates Analytical reports, which allow time-related Route control and Vehicle fuel consumption monitoring via web-browser (see figure 4).

DFM with pulse output interface provide data on actual fuel consumption of engine (overall fuel consumption and average instant fuel consumption).

DFM with digital output interface provide real-time control over extended set of information:

- instant fuel consumption;
- engine operation time – overall and in different engine operation modes;
- fuel consumption – overall and in different engine operation modes;
- voltage in on-board power network;
- total operation time of flow meter and duration of power-supply from embedded battery;
- flow meter's malfunctions;
- evidence of interference to flow meter's operation.

* Only for DFM CAN.

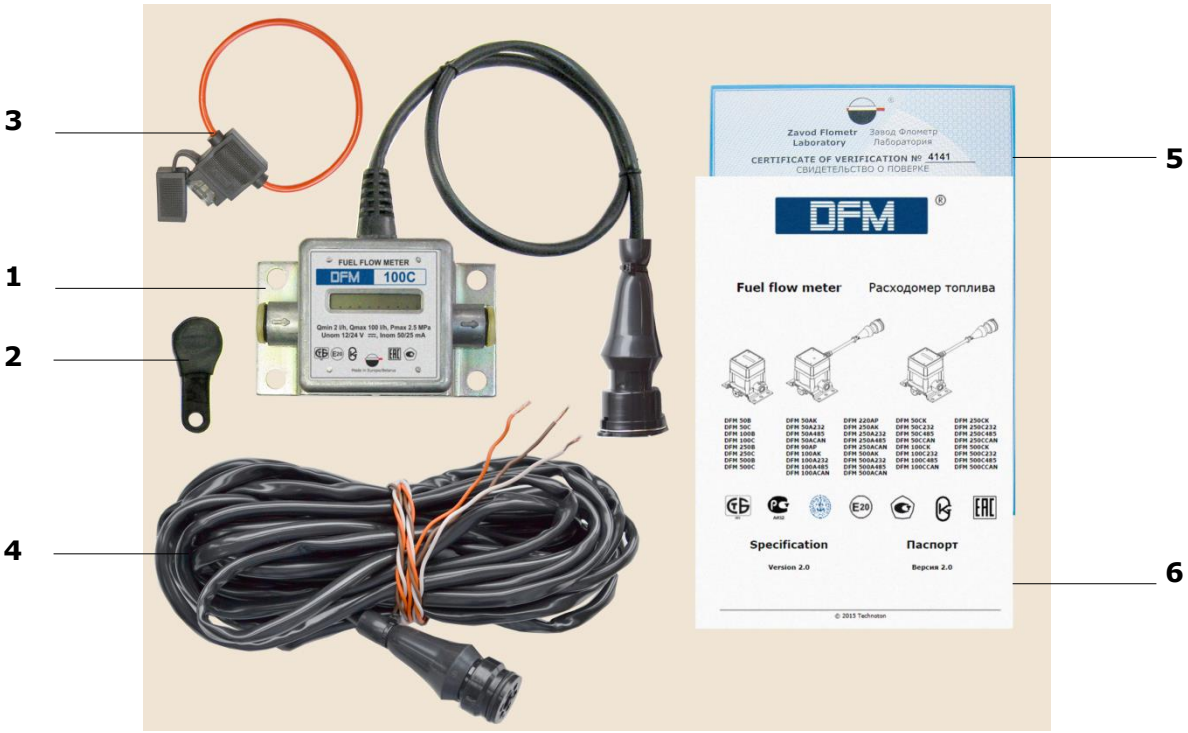
Using J1939 output protocol makes possible DFM CAN operation as a part of S6 telematics interface together with DUT-E CAN fuel level sensors and other factory-built or additional equipment (see figure 3 b). Tracking device with a single CAN interface port can receive data from up to 8 DUT-E CAN sensors and up to 8 DFM CAN meters. This possibility is especially useful while Vehicles with several engines (river boats, locomotives, technological vehicles, diesel genset stations) are equipped.

Figure 4 — Example of Analytical Report generated in ORF 4 sofware, based on the DFM CAN data

Use of DFM provides vehicle owners with the following:

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

1.2 Exterior view and delivery set



1	DFM fuel flow meter	– 1 pc;
2	iButton key *	– 1 pc;
3	fuse with holder (2 A) **	– 1 pc;
4	7.5m connection cable CABLE DFM 98.20.003 (7.5 m) ***	– 1 pc;
5	Verification certificate	– 1 pc;
6	Specification	– 1 pc.

Figure 5 — DFM delivery set

* For DFM meters with built-in display.
** Not applicable for autonomous DFM fuel flow meters.
*** Only for DFM meters with pulse interface output.

1.3 DFM modifications

Following DFM **types** are available:

1) One-chamber — measure volume of fuel passing through engine supply fuel line.
The following **modifications** of one-chamber meters are produced:

- autonomous fuel flow meters with display;
- fuel flow meters with display and interface cable:
  - with pulse output interface;
  - with digital output interfaces;
- fuel flow meters output interface cable:
  - with pulse output interface;
  - with digital output interfaces.

2) Dual-chamber (bidirectional or differential) fuel flow meters measure fuel consumption as the difference in volume of fuel flowing through the supply and return fuel lines.

- The following modifications of dual-chamber meters with output interface are available:
  - differential meters with pulse output
  - differential meters with digital output interfaces
- differential autonomous meters with display

1.3.1 Autonomous fuel flow meters with display

Autonomous fuel flow meters with display (**DFM B/DFM C** models) — are used in organizing fuel consumption monitoring system which does not need additional hardware or software (see figure 6).

Figure 6 — Exterior of autonomous DFM fuel flow meter

Fuel consumption and vehicle operating time data is displayed on the built-in LCD display. Monitoring and recording is to be performed visually, copying out the data into a fuel timesheet, by a responsible person.

1.3.2 Fuel flow meters with display and interface cable

One-chamber DFM **fuel flow meters with display and interface cable** (**DFM CK/C232/C485/CCAN** models) (see figure 7) can be used autonomously and as a part of automated vehicle monitoring and fuel consumption control systems.

Figure 7 — Exterior of DFM fuel flow meters with display and interface cable

Fuel consumption and vehicle operating time data is displayed on the built-in LCD display. Fuel consumption data is sent to the pulse output as well (**DFM CK**).
RS-232 (**DFM C232**), RS-485 (**DFM C485**), CAN 2.0B (**DFM CCAN**) digital interfaces contain fuel consumption data together with Counters values, data on engine operation modes, flow meter settings and malfunctions, Events.

1.3.3 Fuel flow meters with interface cable

One-chamber DFM **fuel flow meters with interface cable** (**DFM AK/A232/A485/ACAN** models) (see figure 8) are used for fuel consumption measurement in automated vehicle monitoring and fuel consumption control systems.

Figure 8 — Exterior of DFM fuel flow meters with interface cable

Fuel consumption data is sent to the pulse output (**DFM AK**). RS-232 (**DFM A232**), RS-485 (**DFM A485**), CAN 2.0B (**DFM ACAN**) digital interfaces contain fuel consumption data together with Counters values, data on engine operation modes, flow meter settings and malfunctions, Events.
These models do not have display but have a LED indicator. Flashing light signal indicates the correct operation of the flow meter measuring chamber.

1.3.4 Differential fuel flow meters with interface cable

Dual-chamber differential DFM **fuel flow meters with interface cable** (**DFM DK/D232/D485/DCAN** models) (see figure 9) are used for fuel consumption measurement in automated vehicle monitoring and fuel consumption control systems for vehicles with modern diesel engines EURO (TIER) 3/4/5.

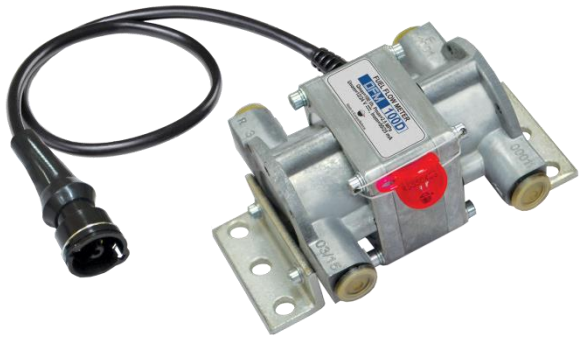


Figure 9 — Exterior of differential DFM fuel flow meters with interface cable

DFM D has two LED indicators on its body. Flashing light signal indicates the correct operation of each of the measuring chambers.

Differential meters calculate fuel consumption as the difference in volume of fuel flowing through the supply and return fuel lines. Data is sent out via pulse output interface (**DFM D**).
RS-232 (**DFM D232**), RS-485 (**DFM D485**), CAN 2.0B (**DFM DCAN**) digital interfaces contain fuel consumption data together with Counters values, data on engine operation modes, flow meter settings and malfunctions, Events.

1.3.5 Differential autonomous fuel flow meters with display

Differential autonomous DFM **fuel flow meters with display** (**DFM CD** models) (see figure 10) are used in organizing fuel consumption monitoring system which does not need additional hardware or software. Flow meters can be installed on machinery with modern diesel engines (incl. EURO (TIER) 3/4/5).

Figure 10 — Exterior of differential autnomous DFM fuel flow meters with display

DFM differential autonomous flow meter is power-supplied from embedded battery and measures fuel consumption as a difference between flow rate in forward and revers chambers, the data is show on flow meter's display. Data control is performed by responsible person, who records values from display manually.

1.4 Measurement range and accuracy

Table 1 — Measurement range and accuracy of one-chamber DFM flowmeters

Model (by size)	Starting flow rate*, L/h	Minimum flow rate, L/h	Maximum flow rate, L/h	Relative accuracy error, %, not more than**
DFM 50	0,5	1	50	±1
DFM 100		2	100	
DFM 250	2	5	250	
DFM 500	5	10	500	

* Minimum threshold flow rate value when the meter starts operating. The value is indicated for reference only as accuracy is not standardized for operation on the starting flow rate.

** Available for special order fuel flow meters with increased measurement accuracy (see figure 1).

Table 2 — Measurement range and accuracy of differential DFM flowmeters

Model (by size)	Minimum differential consumption, L/h	Minimum flow rate per chamber, L/h	Maximum flow rate per chamber, L/h	Relative accuracy error, %, not more than
DFM 100D	5	10	100	±1…3 **
DFM 250D	10	50	250*	
DFM 500D	20	100	500*	

* Available for special order fuel flow meters with higher fuel consumption rate per chamber (see figure 1)

** Depends on ratio of flow rate in forward chamber to flow rate in return chamber of DFM.

RECOMMENDATION: In case the average flow rate in engine of Vehicle is close to the upper capacity limit of a certain DFM model it is recommended to use DFM with a higher measurement range. That will ensure absence of a fuel flow meter's influence on the fuel system as well as longer DFM operating life.

1.5 Unit structure and operation principle

DFM consists* of a ring-type measuring chamber **1,** top cover **2** with a microprocessor board inside, bracket **3** and interface output cable with connector **4**.

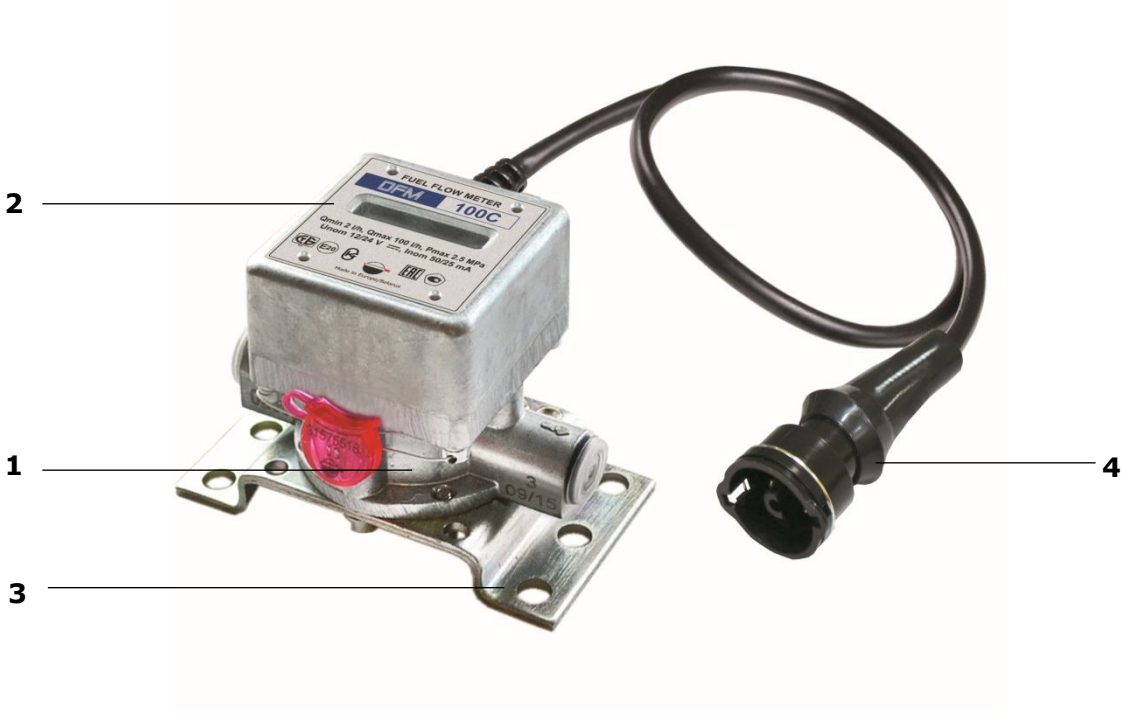


Figure 11 — DFM components

DFM is a direct volumetric fuel consumption measurement device with ring-type measuring chamber.

The principle of DFM operation is based on measurement of fuel volume that passes through its measuring chamber. Because of the pressure of the fuel coming to the measuring chamber through the inlet fitting the ring slides along the inner surface of the chamber and along the jumper at the same time. The ring pushes the fluid inside and outside itself out to the outlet fitting (see figure 12).
Volume of fluid equal to the inner volume of the measuring chamber is pushed out during the full single turn of the ring (see animation on DFM fuel flow meter operational principle). DFM electronics generates one output impulse at the same time.

Figure 12 — DFM measuring chamber operation scheme

***** Structure is shown in an instance of one-chamber DFM CK with built-in display and interface output.

When DFM is used within Telematics system, signal cable is connected to an appropriate input of telematic terminal (logging device).

Specification of flow meter with pulse output interface (DFM AK/CK/DK) includes ratio which represent quantity of pulses per 1 litre, going through measurement chamber of DFM. This ratio should be entered to the respective setting menu of Server software.

Distinctive design features of DFM fuel flow meters:

- DFM structure provides fluid flow even in case the ring is blocked (e.g. as a result of clogging of the chamber);
- special coating of the ring ensures its durability and wear resistance;
- measuring chamber is made of durable and lightweight zinc-aluminum (ZA) alloy;
- built-in mud filter effectively protects the chamber from clogging. Filter can be removed and cleaned without disassembling the body of the DFM;
- M14x1.5 and M16x1.5 threaded fittings allow DFM mounting on any automotive vehicles without any special adapters;
- increased nominal bore for minimum fuel flow hydraulic resistance;
- improved magnetic circuit reduces sensitivity to hydraulic shocks in the engine fuel system.

1.6 Technical specifications

1.6.1 Working fluids

DFM can be used for following fluids flow measurement:

- diesel fuel (GOST 305, STB 1658);
- heating oil (GOST 10585);
- burner oil (GOST 10585, STB 1906);
- motor fuel (GOST 1667);
- biofuel (GOST R 52808, STB 1658);
- Other liquid fuels and mineral oils with kinematic viscosity of **1.5 to 6 mm^2/s**.

ATTENTION:

1) All DFM units are verified with diesel fuel. Indicate viscosity when ordering DFM for measuring different fluid type.

2) When operating with fluids having kinematic viscosity over 6 mm^2/s the upper limit of DFM capacity range will get lower than nominal one and the pressure drop will increase.

3) DFM flow meters are made of petrol resistant materials. However the declared lifetime of the measuring chamber is not guaranteed when operating with petrol (see 1.6.3).

1.6.2 Main specifications

Table 3 — DFM main specifications

Parameter, measurement units	Value
Max pressure, bar	25
Nominal pressure, bar	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, bar, not more than	0.2**
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
Ambient operation temperature range, °C	from -40 to +80***
Environment relative humidity at 40 °C temperature, %, 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).
Ingress protection rating	IP54
Overall dimensions	see annex A
Weight	

* For DFM 500 series.
** See figure 13 for details.
*** Data is displayed in environment temperature range from -20 to +60 °C for flow meters with built-in display.

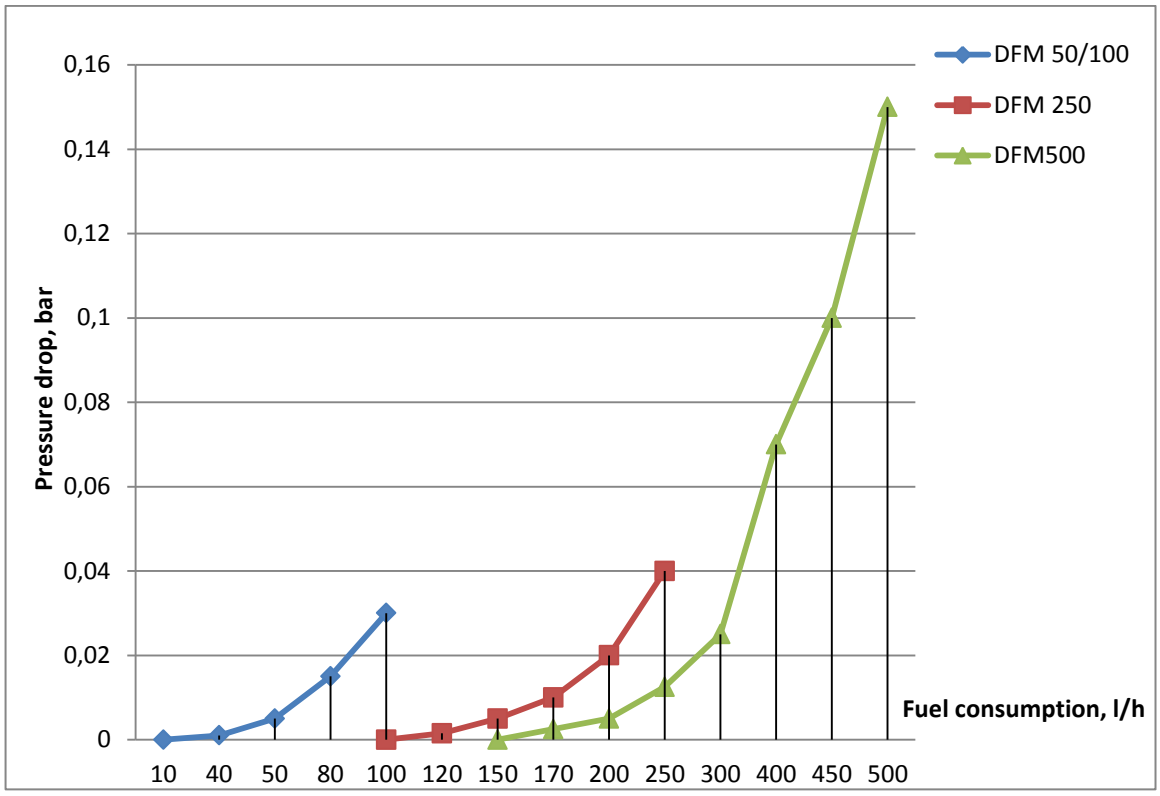


Figure 13 — Chart of pressure drop in DFM related to flow rate

According to figure 13 pressure drop on maximum flow rate does not exceed:

- for DFM 50/90/100 — 0.03 bar;
- for DFM 220/250 — 0.04 bar;
- for DFM 500 — 0.15 bar.

1.6.3 Specifications of measuring chambers

Table 4 — Specifications of DFM measuring chambers

Flow meter capacity model	Nominal diameter (DN), mm	Nominal volume of the measuring chamber, ml	Re-calibration interval *, l
DFM 50	6	5	100 000
DFM 90			
DFM 100			
DFM 220	8	12.5	250 000
DFM 250			
DFM 500	12	20	500 000
* See 8			

1.6.4 Power supply modes

DFM fuel flow meters can operate in the following power supply modes:

- **Stand-alone power supply** (**DFM B/C** models) DFM is powered from the built-in lithium-silicon battery. Estimated DFM operation time until full battery discharge is not less than 36 months.
- **Combined power supply** (**DFM AK/A232/A485/ACAN/CK/C232/C485/ CCAN/DK/D232/D485/DCAN** models) — DFM is powered from the external power source or built-in battery (in case external power is off). Power supply is switched to stand-alone mode in case of low level of external power supply (less than 10V). Estimated DFM operation time in this mode is not less than 36 months.

ATTENTION: During the time when power supply from vehicle on-board power network is off **DFM AK/A232/A485/ACAN/CK/C232/C485/CCAN/ DK/D232/D485/DCAN** automatically enable option of data readings recording into internal meter memory. When powered from internal battery **DFM CK/C232/C485/CCAN** can display data according to Table 6. Data transfer to the output interface starts only when external power supply from vehicle on-board network is provided.

1.6.5 Operation modes

Table 5 — Operation modes of DFM fuel flow meters

<table>
<tr><th colspan="3">Engine operation</th><th rowspan="2">Interference</th></tr>
<tr><td colspan="3">Normal consumption
$Q_0<Q\leq Q_{max}$</td><td rowspan="2">Tampering
$Q>Q_{max}$</td></tr>
<tr><td>Idle
$Q_0<Q<2.5Q_{min}$</td><td>Optimal
$2.5Q_{min}\leq Q<0.75Q_{max}$</td><td>Overload
$0.75Q_{max}\leq Q\leq Q_{max}$</td><td>The impact of constant magnetic field for more than 5 seconds</td></tr>
<tr><td colspan="4">Q — instant consumption;
Q_0 — starting flow rate;
Q_{min} — lower limit of the meter capacity range;
Q_{max} — upper limit of the meter capacity range.</td></tr>
</table>

WARNING: Operation mode boundaries of flow meters with pulse output interface can be adjusted via Service S6 DFM software at FM Flow meter section (see annex H).

1.6.6 Displayed data

Display information switching is performed by 1-2 seconds light touch to the top cover of the fuel flow meter by iButton key (see figure 14).

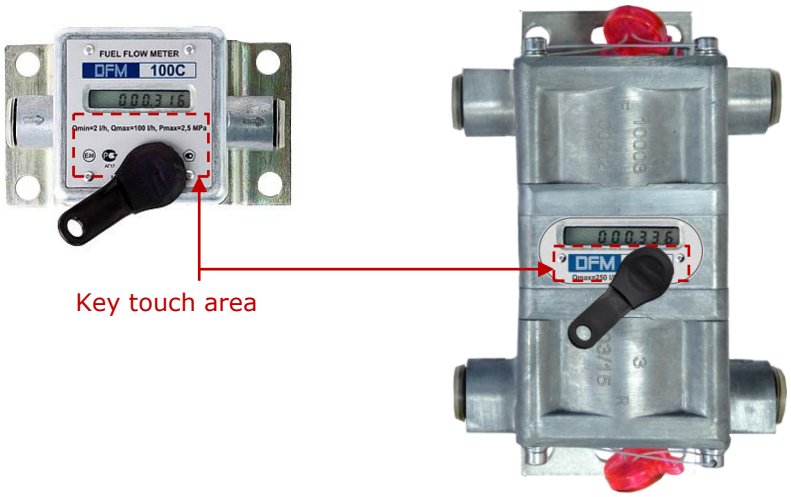


Figure 14 — Switching display screens

In order to save the charge of the built-in battery the DFM display goes to sleep mode one minute after the last touch of the cover by the iButton. At the same time dots are shown on the display (see figure 15).

Figure 15 — Display view in sleep mode

When the display is touched next time it wakes up and shows data again.

Table 6 — DFM display information screens

Screen No	Displayed data	Digit capacity	Units	Data set		
				DFM B	DFM C/CK/C232/ C485/CCAN	DFM CD
1	Total Fuel Consumption counter	0.1	liters	+	+	+
2	Total Fuel Consumption counter with higher digit capacity	0.001	liters	+	+	+
3	Engine Operation Time counter	0.1	hours	-	+	+
4	Engine Operation Time in Idle Mode counter	0.1	hours	-	+	+
5	Engine Operation Time in Optimal Mode counter	0.1	hours	-	+	-
6	Engine Operation Time in Overload Mode counter	0.1	hours	-	+	-
7	Fuel Consumption in Tampering Mode counter	0.1	liters	+	+	+
8	Interference Time counter	0.1	hours	+	+	+
9	Instant Fuel Consumption*	0.1	liters/hour	+	+	+
10	Battery Charge in Percentage of the Maximum	10	%	+	+	+
11	Temperature in the Measuring Chamber	1	°C	-	+	-
12	Firmware Version (X.X)	—	—		X.X	
13	Total “Negative” fuel consumption	0.1	liters	-	-	+
14	Instant consumption in direct chamber	0.1	liters/hour	-	-	+
15	Instant consumption in reverse chamber	0.1	liters/hour	-	-	+

***** for **DFM CD** — instant differential consumption.

Screen 1 displays **Total Fuel Consumption** counter value (with 0.1 L step) accumulated since DFM release.

Screen 2 displays **Total Fuel Consumption counter value with higher digit capacity** (0.001 L), accumulated since DFM release.

Screen 3 displays the counter reading **Engine Operation Time** accumulated as the total time of engine operation in all modes including idle run.

Screens 4, 5, and 6 display the counter readings of **Engine Operation Time In Idle, Optimal and in Overload Modes** accumulated by DFM as a total engine operation time in corresponding modes (see 1.6.5).

Screen 7 displays the counter readings of **Fuel Consumption In Tampering Mode** accumulated by DFM measured as the amount of fuel higher than maximum consumption (see 1.6.7). Value increase of this counter indicates the incorrect installation of the fuel flow meter or possible facts of fuel theft.

Screen 8 displays the counter reading **Interference Time** accumulated by DFM as the total time of exposure to external factors (strong magnetic field). Increase of the values of this counter may indicate an installation of the fuel flow meter near a source of strong electromagnetic radiation or deliberate attempts to lock the fuel meter (see 1.6.7).

Screen 9 Instant Fuel Consumption displays current value of fuel consumption. It can serve for a visual check of device operability and its correct installation.

Screen 10 Battery Charge in Percentage of the Maximum displays the value of remaining charge of integrated battery.

Note — When the environment temperature is below 10 °C, displayed value of remaining charge can decrease by 10-30 %.

Screen 11 Temperature in the Measuring Chamber displays current temperature value in the measuring chamber of the fuel flow meter.

Screen 12 Firmware Version and the Chamber Volume displays the firmware version installed on the fuel meter, as well as the exact volume of the measuring chamber.

Screen 13 Total "negative" fuel consumption displays total fuel consumption of Vehicle in situation, when fuel consumption in reverse chamber was higher than fuel consumption in direct chamber. The Counter is available only in differential DFM. "Negative" fuel consumption growth indicates higher volumes of foam caused by air presence in reverse fuel line while engine is operated on high RPM.

Screen 14 Instant fuel consumption in direct chamber displays instant consumption rate of fuel flowing through direct chamber of differential fuel flow meter.

Screen 15 Instant fuel consumption in reverse chamber displays instant consumption rate of fuel flowing through reverse chamber of differential fuel flow meter.

1.6.7 DFM protection from tampering and intervention

In order to avoid false readings, meter damage or blocking DFM have the following modes of protection against malicious acts of third parties:

1) Tampering Mode is to protect from tampering which has a purpose to increase fuel consumption counters readings (e.g. blowing with air). Tampering usually causes a rapid increase of readings exceeding maximum flow rate limit. DFM electronics registers this increase and suspends fuel consumption counters. At the same time Tampering counter is activated. It records volume value that passes through the meter at the increased flow rate.

DFM B/C/CK/C232/C485/CCAN/CD displays dashes being in Tampering Mode (see figure 15).

Figure 15 — Display view in Tampering Mode

The meter will automatically exit Tampering Mode in few seconds since back to normal operation conditions.

2) Interference Mode is made to protect DFM from magnetic field impact with the purpose to stop fuel counting or to tamper readings of fuel consumption. When exposed to external magnetic field, DFM registers an attempt of interference, and as the result increment of all the counters stops, and the time of exposure is recorded in a special Interference Time counter.

DFM B/C/CK/C232/C485/CCAN/CD displays vertical strokes in Interference Mode (see figure 16).

Figure 16 — Display view in Interference Mode

The meter will automatically exit Interference mode in few seconds since back to normal operation conditions.

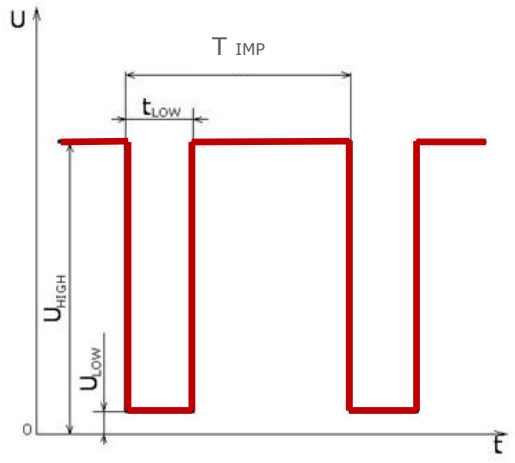
ATTENTION: Data on events of Tampering/Interference during the external power supply of **DFM** is off is recorded into the internal memory and sent to output interface since the power supply is on.

3) Stand-alone power supply mode of **DFM AK/A232/A485/ ACAN/CK/C232/C485/CCAN/DK/D232/D485/DCAN** when external power supply is off. Flow meter is powered by own battery. Embedded battery ensures autonomous functioning within 36 months.

RECOMMENDATION: sealing all connection in fuel line after DFM can help Vehicle owner to reveal unauthorized intervention in fuel line.
Valves, bolts and other elements in Technoton-branded mounting kits for DFM has special holes for sealing.

1.6.8 DFM pulse output signal specifications

Fuel flow meters with **normalized pulse output** (**DFM AK/CK/DK**) generate certain number $\mathbf{N}_{pulse/l}$ of output pulses for 1 liter of measured fuel flow (see table 7). This number is indicated in product specification as well.



U_{HIGH} = U_{BATT} (not more than 36 V);
U_{BATT} - voltage of on-board electrical system;
U_{LOW} =0,7 V;
t_{LOW} and T_{imp} see table 7.

Figure 18 — Pulse output signal shape of DFM AK/CK/DK models

Table 7 — Parameters of normalized pulse of DFM AK/CK/DK models

Model	**T_{imp}, ms**	**t_{LOW}, ms**	**$N_{pulse/liter}$, pcs**
DFM 50AK/CK	from 360 to 18000	if T_{pulse}<1s, then t_{LOW}=0,5·T_{pulse} if T_{pulse} >1s, then t_{LOW}=500 ms	200
DFM 100AK/CK	from 180 to 9000		
DFM 100DK	from 200 to 36000		
DFM 250AK/CK	from 180 to 9000		80
DFM 250DK	from 200 to 90000		
DFM 500AK/CK	from 144 to 7200		50
DFM 500DK	from 180 to 144000		

1.6.9 RS-232 and RS-485 output interfaces specifications and protocol

Digital output interfaces of **DFM A232/C232/D232** and **DFM A485/C485/D485** are physically implemented on the base of RS-232 and RS-485 interfaces.

Data transfer from DFM to RS-232 and RS-485 interfaces is carried out in request/response mode according to Modbus protocol. Baudrate can be selected out of the following values: 2400; 4800; 9600; 19200; 38400; 57600; 115200 bit/s with the help of Service S6 DFM (default baudrate is 9600 bit/s).

Up to four flow meters can be simultaneously connected to the tracking device under Modbus protocol. Unique decimal addresses from 0 to 255 are used for their identification in network (default address is 111).

See annex D for the map of 16-bit registers of DFM output messages available under Modbus protocol.

DFM flow meters with RS-232 and RS-485 output interfaces also support data transfer under **DFM COM Protocol** (see annex E for details).

1.6.10 CAN output interface specifications and protocol

DFM ACAN/CCAN/DCAN output interface specifications correspond to specifications of S6 Telematics Interface.

DFM ACAN/CCAN/DCAN data is sent to S6 bus in automatic transmission mode (basic mode) or by request. Baudrate can be selected out of the following values: 100; 125; 250; 500; 1000 Kbit/s with the help of Service S6 DFM (default baudrate 250 Kbit/s).

Telematics interface S6 allows connection of up to 8x DFM ACAN/CCAN/DCAN fuel flow meters to one input of telematic terminal. Unique decimal addresses (SA) from 111 to 114 should be set for each meter (default address 111).

DFM ACAN/CCAN/DCAN generate and transfer output messages according to table 8.

Table 8 — Messages of DFM ACAN/CCAN/DCAN data transfer protocol

Message ID	Short message description	Note
PGN 62995	Unit passport	
PGN 62994	Unit work counters	
PGN 65226	Active diagnostic trouble codes	PGN length is variable, depending on malfunctions quantity (up to 20).
PGN 65227	Previously active diagnostic trouble codes	
PGN 63026	Fuel consumption factors	
PGN 63044	Calibration table. Fuel rate (DFM)	Quantity of calibration points – 5. PGN length is variable: One-chamber DFM – 21 byte; Differential DFM – 41 byte.
PGN 63065	Fuel rate mode borders	
PGN 65266	Fuel economy (liquid)	
PGN 65257	Fuel consumption (liquid)	
PGN 62981	Flowmeter. Parameters	
PGN 62992	Flowmeter. Counters 1	
PGN 62993	Flowmeter. Counters 2	
PGN 64777	High resolution fuel consumption (liquid)	
PGN 65244	Idle operation	
PGN 65101	Total averaged information	
PGN 63064	Battery voltage mode borders	PGN Length – 8 byte: 2 bytes – lower boundary of on-board electrical system (step 0.05V, data range from 0 to 3212.75V); 2 bytes – upper boundary of on-board electrical system (step 0.05V, data range from 0 to 3212.75V); 4 bytes – reserve.
PGN 62987	Vehicle voltage	
PGN 63086	Battery	
PGN 65254	Time/Date	
PGN 63011	Time origin settings	

Table 8 continued

Message ID	Short message description	Note
PGN 63051	Emergency events list (hasta 15)	PGN length – 210 bytes allowing transmission of up to 15 Events. At the same time, empty data sets are filled with 0xFF value. Emergency Events are not generated by DFM. Important Events: SPN 521216 – flow meter tampering; SPN 521217 – interference into flow meter's oepration. Informational Events: SPN 521204 – ignition is on; SPN 521205 – ignition is off; SPN 521223 – on-boar electrical system voltage is too high; SPN 521224 - on-boar electrical system voltage is too low. Unstructured data SPN is described in Database S6.
PGN 63055	Important events list (hasta 15)	
PGN 63056	Information events list (hasta 15)	
PGN 59904	Request	
PGN 63236	Message 4	
PGN 63106	Fuel used/Hours of operation in idle mode	For DFM with firmware version 4.32 and higher.
PGN 63107	Total fuel used/Hours of operation in optimal mode	
PGN 63108	Total fuel used/Hours of operation in overload mode	
PGN 63109	Total fuel used/Hours of operation in cheat mode	
PGN 63110	Total fuel used/Hours of operation in negative mode	
PGN 63111	Engine total hour of operation in interference mode	
PGN 63112	Total fuel used (feed chamber) 1	
PGN 63113	Total fuel used (feed chamber) 2	
PGN 63114	Total fuel used (feed chamber) 3	
PGN 63115	Total fuel used (feed chamber) 4	
PGN 63116	Total fuel used (feed chamber) 5	
PGN 63117	Total fuel used (reverse chamber) 1	
PGN 63118	Total fuel used (reverse chamber) 2	
PGN 63119	Total fuel used (reverse chamber) 3	
PGN 63120	Total fuel used (reverse chamber) 4	
PGN 63121	Total fuel used (reverse chamber) 5	
PGN 65262	Engine temperature 1	

More details on parameters, structure and contents of DFM CAN communication protocol messages you will find in Database S6 at http://s6.jv-technoton.com.

1.7 DFM and tracking devices compatibility

Technoton regularly conducts tests for compatibility and joint accuracy of DFM with different models of terminals (vehicle tracking devices) of popular brands. Table 9 shows the models of terminals compatible with DFM providing accuracy of joint measurement of fuel consumption not more than **±1 %.**

Table 9 — Vehicle tracking devices compatible with DFM

Tracking device			Analytical software (tracking platform)
Brand	**Name**	**Model**	
СКРТ	CKPT	31 25 45	ORF-MONITOR
GALILEOSKY	GALILEOSKY	GPS GLONASS	Wialon
АвтоГРАФ	Autograf	GSM+ GSM(GLONASS)	AutoGRAF
TELTONIKA	Teltonika	FM4200 FM5300	Wialon Hosting
Ruptela MOBILE SOLUTIONS	Ruptela	FM-Pro3	Trust-Track web server
mapon	MapOn	GBOX6	MapOn web server
ГЛОСАВ	GLOSAV	BK11-02	GLOSAV
LOCARUS	Locarus	702X 702R 702S	LocarusInformer
ВСЕ	BCE	Fm Light	Wialon
ritm GSM	VOYAGER	2	RITM-PCN
simbiotecha	Simbiotecha	GATE-FM 200	Monitoring server software "Fuel control system" www.tracking.lt
СКАУТ	СКАУТ	MT-530 MT-600 GP PRO	Scout Explorer
NAVISET	Naviset	GT-10	GPS-Trace Orange
EcoTelematics Group	NaviFleet	ET100	NaviFleet

Relevant information on the compatibility of specific tracking device and DFM models and recommendations for their connections and settings can be found at www.jv-technoton.com

1.8 DFM selection

IMPORTANT: Final decision on applicability of particular DFM model for a particular vehicle must be made by a trained installation specialist and should be based on results of vehicle inspection.

For detailed algorithm of selection proper DFM fuel flow meter model, mounting scheme, accessories and mounting kit check out animation video DFM fuel flow meters: selection of mounting scheme, accessories and mounting kit.

1.8.1 Selection depending on engine power (boiler output capacity)

Table 10 — DFM Selection depending on the engine power (boiler output capacity)

Engine power, kW	Boiler output, kW	Recommended DFM model
up to 80	up to 400	**DFM 50AK** **DFM 50A232** **DFM 50A485** **DFM 50ACAN** **DFM 50B** **DFM 50C** **DFM 50CK** **DFM 50C232** **DFM 50C485** **DFM 50CCAN**
from 80 to 150	from 400 to 800	**DFM 100AK** **DFM 100A232** **DFM 100A485** **DFM 100ACAN** **DFM 100B** **DFM 100C** **DFM 100CK** **DFM 100C232** **DFM 100C485** **DFM 100CCAN**
from 150 to 300	from 800 to 1500	**DFM 250AK** **DFM 250A232** **DFM 250A485** **DFM 250ACAN** **DFM 250B** **DFM 250C** **DFM 250CK** **DFM 250C232** **DFM 250C485** **DFM 250CCAN**
from 300 to 600	from 1500 to 3500	**DFM 500AK** **DFM 500A232** **DFM 500A485** **DFM 500ACAN** **DFM 500C** **DFM 500CK** **DFM 500C232** **DFM 500C485** **DFM 500CCAN**

1.8.2 Selection depending on fuel flow rate in supply and return lines of the engine

Table 11 — Selection of the differential DFM depending on fuel flow rate values in supply and return lines

Minimum flow rate, l/h	Maximum flow rate, l/h	Recommended differential fuel flow meters
10	100	**DFM 100D** **DFM 100D232** **DFM 100D485** **DFM 100DCAN**
25	250	**DFM 250D** **DFM 250D232** **DFM 250D485** **DFM 250DCAN**
100	500	**DFM 500D** **DFM 500D232** **DFM 500D485** **DFM 500DCAN**

IMPORTANT:

1) Maximum and minimum fuel flow rate values in supply and return lines of the engine can be found in performance specification of the engine fuel pump.

2) Installation of a differential DFM on the fuel system with high performance pump and engine with small fuel consumption is not recommended. For example, the booster pump performance is 300 l/h, fuel consumption in idle run mode is 5-6 l/h, and relative fuel measurement error in supply and return lines is 1 %, absolute error value of differential measurement is up to 6 l/h. That is comparable with the amount of fuel consumed by the engine.

3) Counter-indication to install a differential fuel flow meter is the fact of air bubbles presence in supply or return fuel lines. A task of removing air from fuel is resolved by installation of deaeration device (dearator) (see 4.4).

2 DFM installation

For DFM correct operation its mounting and configuration should be carried out by certified specialists who have passed corporate technical training.

ATTENTION: Strictly follow safety rules of automobile repair works as well as local safety rules of the customer company when mounting DFM.

This section contains general recommendations on DFM mounting.

Check out DFM flow meter installation video for an example of mounting DFM on tractor.

2.1 Exterior inspection prior to works start

It is required to conduct DFM exterior inspection 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;
- backlash of component parts or gaps between them.

Contact the supplier if any defects detected.

2.2 Estimation of vehicle condition

Before DFM installation the Vehicle condition must be estimated and conclusion made on possibility to install DFM.

Estimation of the vehicle includes the following sequence:

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, loss of power must not be felt.

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 DFM. Injectors maintenance is recommended prior to DFM installation in this case.

5) Check pressure in the fuel line with a pressure gauge. Hydraulic resistance of a selected DFM working at nominal flow rate should not lower the pressure by more than 5 %.

6) Check the quality of the chassis ground of the vehicle. Resistance between any point of chassis and the "-" clamp of the battery should not exceed 1 Ohm.

According to the results of the check a **Vehicle Inspection Report** should be filled in and signed (see annex B).

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

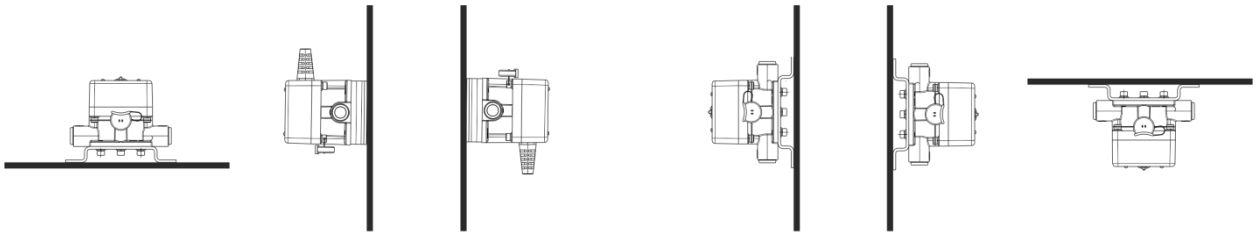
2.3 General installation instructions

ATTENTION: This chapter provides particular cases of the engine operation scheme. Read carefully the technical documentation of the vehicle in order to make a decision on applicability of the meter on this particular vehicle.

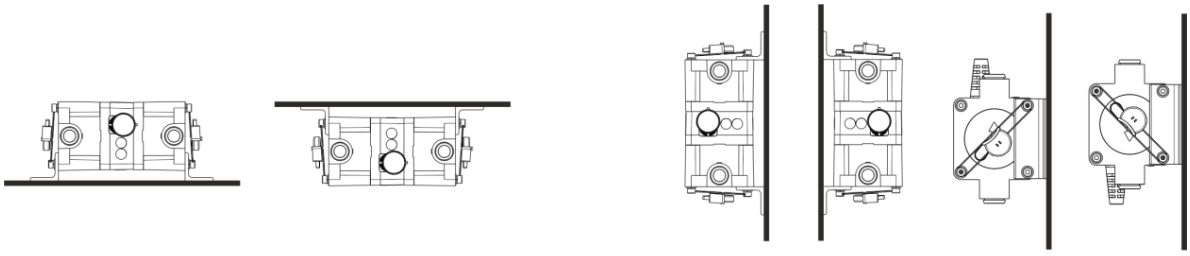
The following is needed for DFM mounting:

- DFM;
- mounting kit (does not come with DFM delivery set, ordered separately);
- bracket (ordered separately), is optional and is not needed in some cases;
- automobile hand tool kit (sets of spanners, screwdrivers, etc.);
- purometer (ordered separately);
- glycerine filled manometer (ordered separately)

CAUTION:
1) In order to ensure the declared accuracy of measurement, one-chamber DFM flow meters should be installed only in "bracket directed down" and "bracket directed sideway" positions (see figure 19 a). Differential DFM should be installed only in "bracket directed down" and "bracket directed up" positions (see figure 19 b).
2) When fitting the mounting bracket of the DFM **vehicle frame drilling is prohibited!** If fitting of the mounting plate is impossible with bolts, **spot welding** is **allowed.**
3) Avoid sharp bends of cable and fuel pipes when mounting.



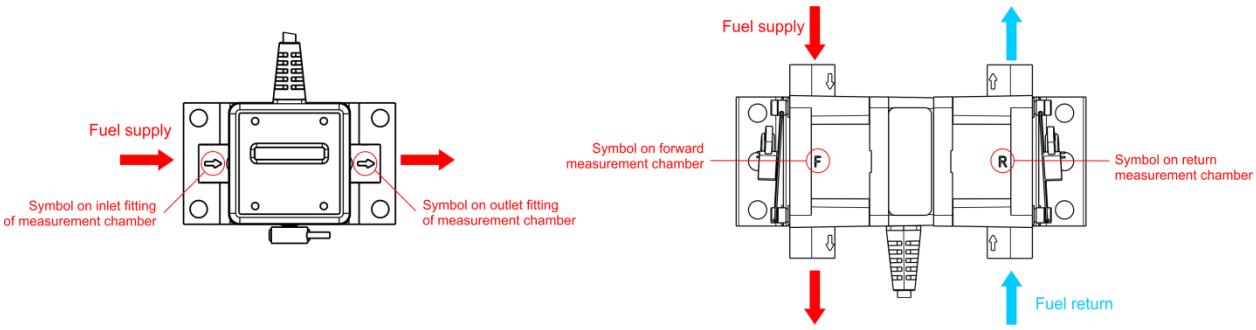
a) one-chamber



b) two-chamber

Figure 19 — DFM operating position relatively to vertical and horizontal planes

IMPORTANT: Make sure you install fuel flow meter into fuel lines strictly according to symbols on DFM body (see figure 20).



a) one-chamber *b) differential*

Figure 20 — Symbols on DFM body for proper installation into fuel lines

The following **rules** must be observed when mounting:

1) Vehicle fuel lines must be protected from any external damage.

2) It is prohibited to reduce internal dimension of the fuel pipes on bends.

3) Mounting of the fuel pipes of the vehicle should be made with buckles every 0.5 m.

4) Fuel pipes need to have some spare length in order to compensate length changes due to the temperature.

5) DFM installation on the elements of the vehicle subject to heating or vibration in not recommended.

6) When connecting fuel pipes, flanges and threaded connections must be clean.

7) When installing, only **new** copper sealing washers from a mounting kit have to be used.

8) Rubber fuel pipes must be connected to the elements of the fuel system using drive type nipples or direct flow fittings and secured with hose clamps or with crimping coupling of necessary diameter.

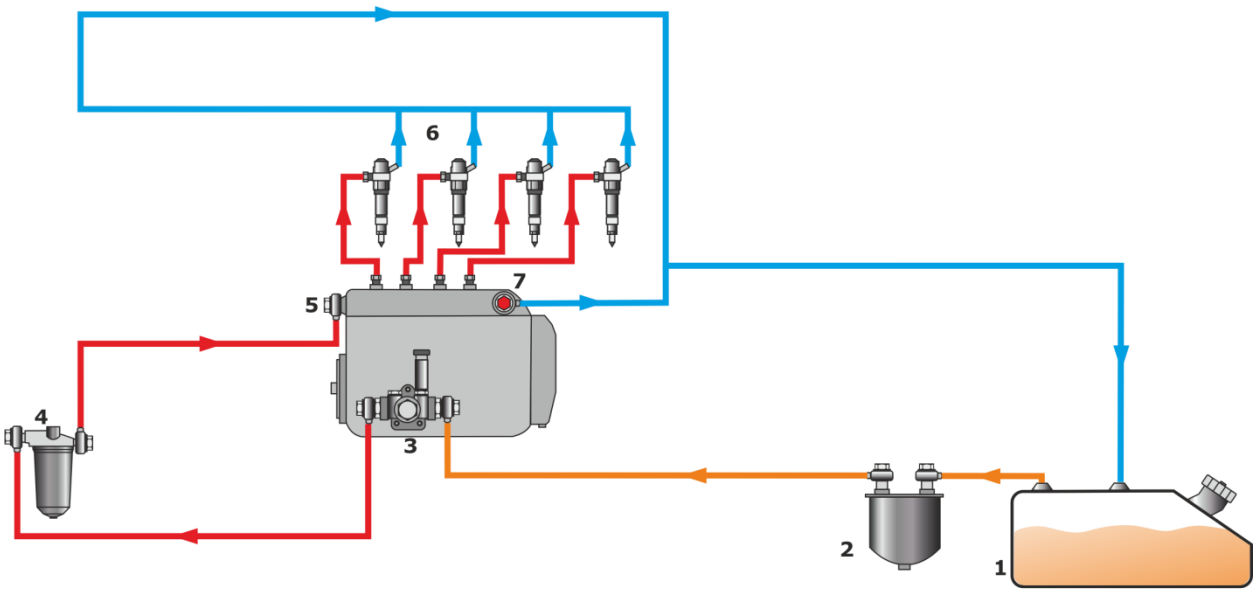
9) After DFM installation, it is necessary to remove air from the fuel system.

ATTENTION:
1) Only consumed volume of fuel should pass through DFM in case of using one-chamber meter. It is required to modify return fuel line of the fuel system in this case (see 2.4.2, 2.4.3).
2) If foam is present in the return pipe, installation of fuel deaeration system is required. To eliminate air bubbles and prevent them from getting into the fuel line **deaerators** are used (see 4.4).

2.4 Fuel flow meters mounting schemes

2.4.1 Typical diesel engine fuel system scheme

The most common scheme of the fuel system of diesel engine is shown in figure 21.



1 – Fuel tank; **2** – Rough filter; **3** – Low pressure fuel pump; **4** – Fine filter; **5** – High pressure fuel pump; **6** – Injectors; **7** – Bypass valve.

Figure 21 — Typical fuel system scheme

The low pressure fuel pump pumps significantly more fuel to the input of the high pressure fuel pump than the engine consumes in any of operation modes. Excess fuel from the high pressure fuel pump and injectors flows back to the fuel tank.

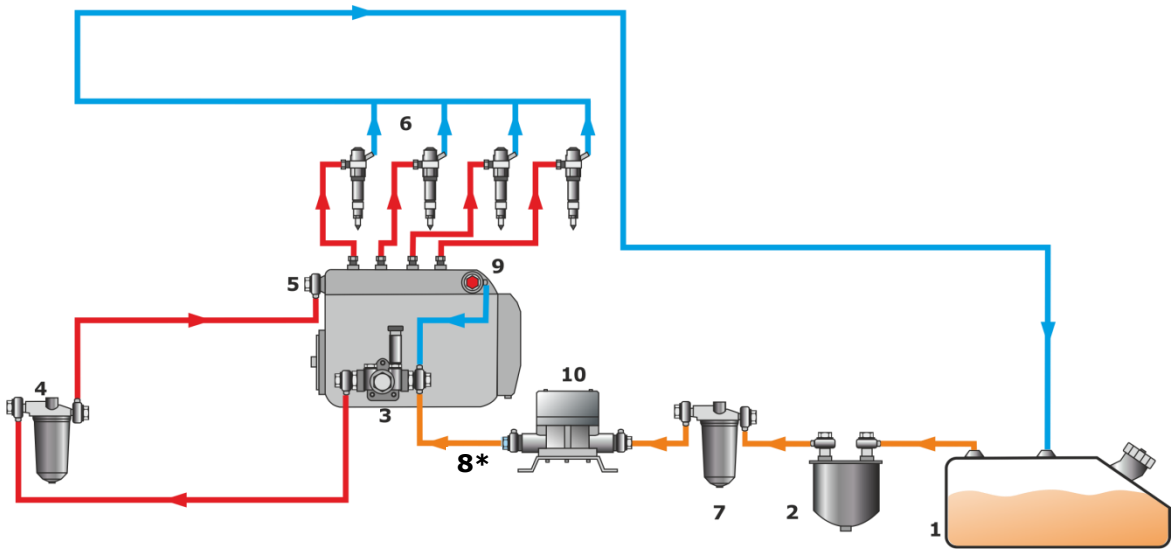
2.4.2 DFM installation before the pump

DFM installation according to Before the Pump scheme (on suction side) involves installation of a fuel flow meter in the part of the fuel system where the flow of fuel is carried out due to depression created by a low pressure fuel pump.

ATTENTION: DFM installation before the pump requires compulsory use of additional fine filter on the line from the tank to the DFM.

Particular case of DFM installation according to Before the Pump scheme:

In order to install a DFM in the fuel system with a low pressure fuel pump (see figure 22) according to this scheme, it is necessary to use the line between the rough filter and the low pressure fuel pump input.



1 – Fuel tank; **2** – Rough filter; **3** – Low pressure fuel pump; **4** – Fine filter; **5** – High pressure fuel pump;
6 – Injectors; **7** – Additional fine filter; **8** – Non-return valve; **9** – Bypass valve;
10 – DFM Fuel Flow Meter.

***** Is used only against hydro shocks (if any in the system).

Figure 22 — DFM installation on suction side (Before the Pump scheme)

When injectors operate correctly their return flow is less than 0.1 % of fuel consumption, and therefore this can be negligible.

In order to prevent measuring of the fuel returns back to the tank, it is necessary to make changes in the return line.

In this particular case the return line from the high pressure fuel pump has to be modified in such way that fuel could circulate in a small circle without fuel tank participation. It can be done by connecting return line of the high pressure fuel pump with low pressure fuel pump input.
Thus fuel from two lines flows to the low pressure fuel pump input:

1) from the fuel tank through DFM flow meter;
2) from high pressure fuel pump return line.

For proper operation of the modified fuel system install a bypass valve at the high pressure fuel pump output, which will support necessary constant pressure of 1-1.5 atmosphere. At DFM output a 0.1-0.35 atmosphere non-return valve has to be installed which will prevent fuel flow in the opposite direction and will reduce fuel system's hydraulic shocks at the DFM.

After the fuel system is modified according to depression scheme, all excess fuel pumped by the low pressure fuel pump will be directed from the high pressure fuel pump output to low pressure fuel pump input.

Thus only the fuel that is consumed by the engine flows through the DFM.

RECOMMENDATION: One of advantages when excess fuel returns back to the tank is fuel heating in the tank. Therefore, when a vehicle is used in low temperature environment, it is not recommended to modify the fuel system. Use differential DFM flow meters instead or install a fuel heater.

Advantages of the scheme:

- minimal modification of the fuel system;
- simple installation;
- applicable for most engines.

Disadvantages of the scheme:

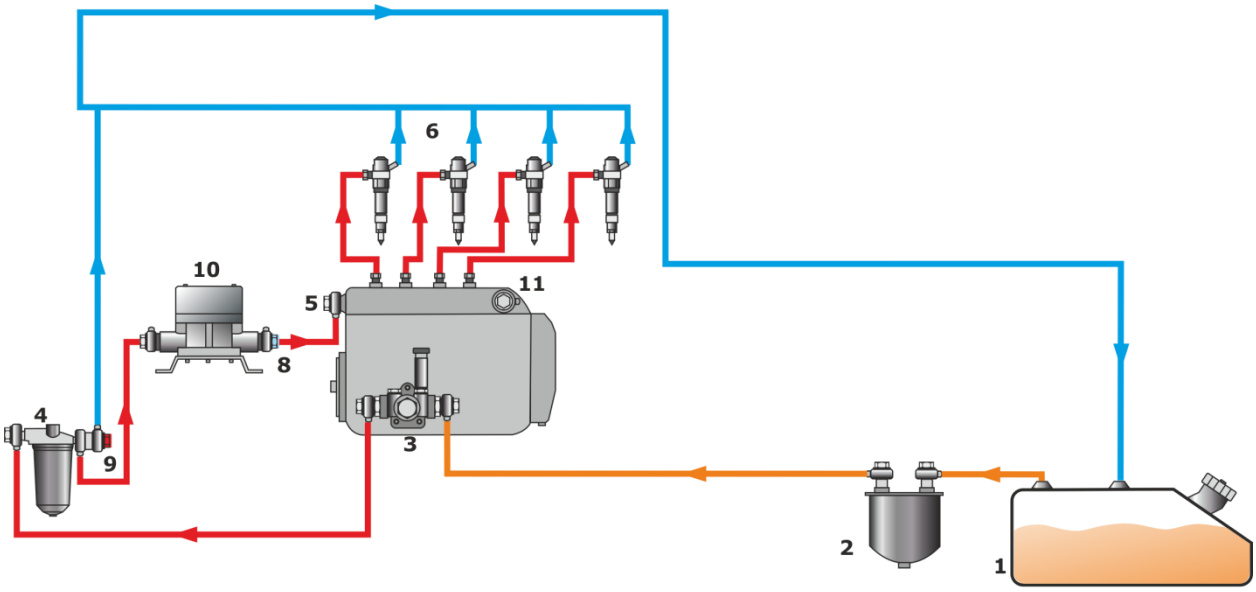
- requires installation of an additional fine filter and causes additional costs;
- additional load on the low pressure fuel pump;
- fuel in the tank is not warmed with return fuel flow (fuel heater installation is required in some cases).

2.4.3 DFM installation after the pump

DFM installation after the pump involves installation of flow meter in the line after the low pressure pump where fuel flows under pressure.

Particular case of DFM installation according to After the Pump scheme:

In order to install DFM according to pressure scheme in the fuel system with LPFP (see figure 23), it is necessary to use the line between fine filter and high pressure fuel pump input.



1 – Fuel tank; **2** – Rough filter; **3** – Low pressure fuel pump; **4** – Fine filter; **5** – High pressure fuel pump;
6 – Injectors; **7** – Additional fine filter; **8** – Non-return valve; **9** – Bypass valve;
10 – DFM Fuel Flow Meter; **11** – Plug.

Figure 23 — DFM installation on pressure side (After the Pump scheme)

Return flow from the high pressure fuel pump has to be modified to fuel circulation in a small circle without fuel tank involvement i.e. the return line needs to be moved from high pressure fuel pump output to fine filter input, and high pressure fuel pump output needs to be plugged.

For correct operation of modified fuel system a bypass valve has to be installed at the fine filter input which will support necessary constant fuel pressure at 1-1.5 atmosphere in the line between the fine filter and high pressure fuel pump input. Install a 0.1-0.35 atmosphere non-return valve at the DFM output to prevent fuel flow through the DFM in the opposite direction. This will decrease fuel system hydraulic shocks at the DFM.

Thus, excess fuel pumped by low pressure fuel pump will be dropped back to the fuel tank from fine filter's side; and only amount of fuel consumed by the engine will flow through the flow meter.

Advantages of the scheme:

- DFM is installed after a regular fine filter;
- fuel flows under pressure and doesn't overload the low pressure fuel pump;
- return fuel flow can heat fuel in the tank.

Disadvantages of the scheme:

- high pressure fuel pump cooling efficiency is slightly decreased;
- return flow fuel temperature is lower than with a regular fuel system.

2.4.4 Differential DFM installation scheme

RECOMMENDATION: Differential fuel flow meters installation in fuel systems with high performance low pressure fuel pump and small fuel consumption is not recommended due to increase of measurement errors higher than allowed (see 1.4).

Fuel circulation in the fuel system doesn't change with differential measurement. Supply-flow chamber of differential DFM is to be installed in the gap of supply fuel line of the engine. Return-flow chamber is to be installed in the gap of the return line. Fuel consumption is calculated as a difference of measured values of fuel flows in straight-flow and return-flow chambers.

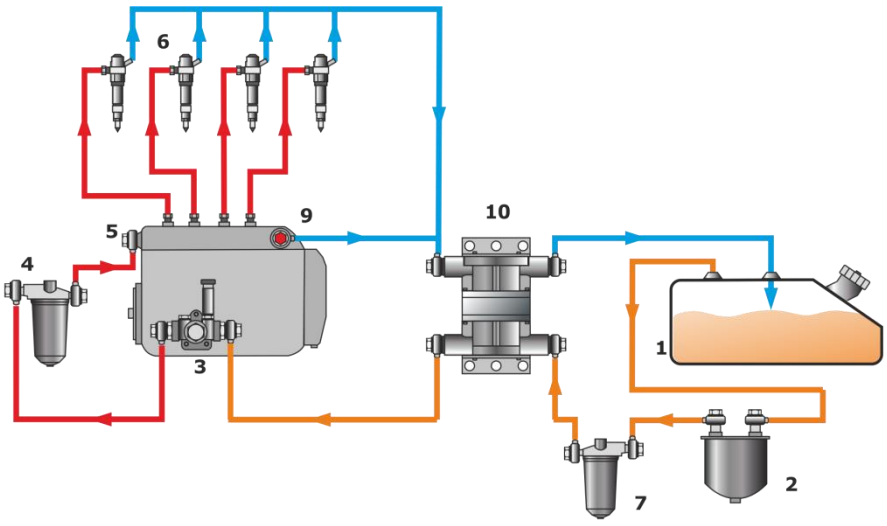
Particular cases of differential DFM installation scheme:

1) In fuel system with plunger injection pump forward chamber of DFM can be installed into:
- a section after suction pump **(on pressure side)** (see figure 24 a).
- A section before suction pump **(on suction side)**. In this case it is onligatory to use additional fine fuel filter (see figure 24 b).

2) Installation of the supply chamber on unit injector fuel system (jerk system) is made after the low pressure fuel pump (**after the Pump scheme**) (see figure 24 c).

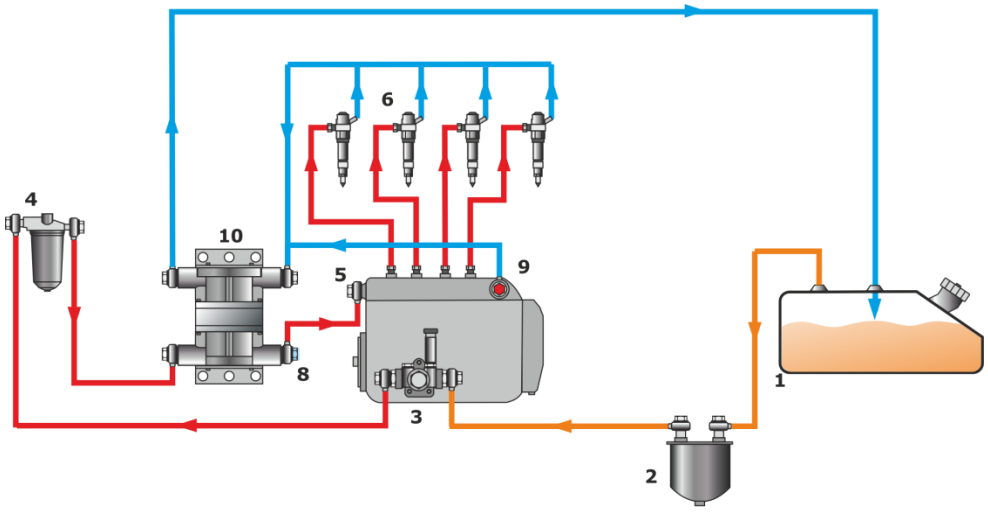
3) On Common Rail fuel system installation of the supply chamber is made before the low pressure fuel pump (**before the Pump scheme**). In this case **additional fine filter** installation is required (see figure 24 d).

Return-flow chamber of differential DFM in both cases is to be installed in return line between high pressure fuel pump output and the fuel tank.



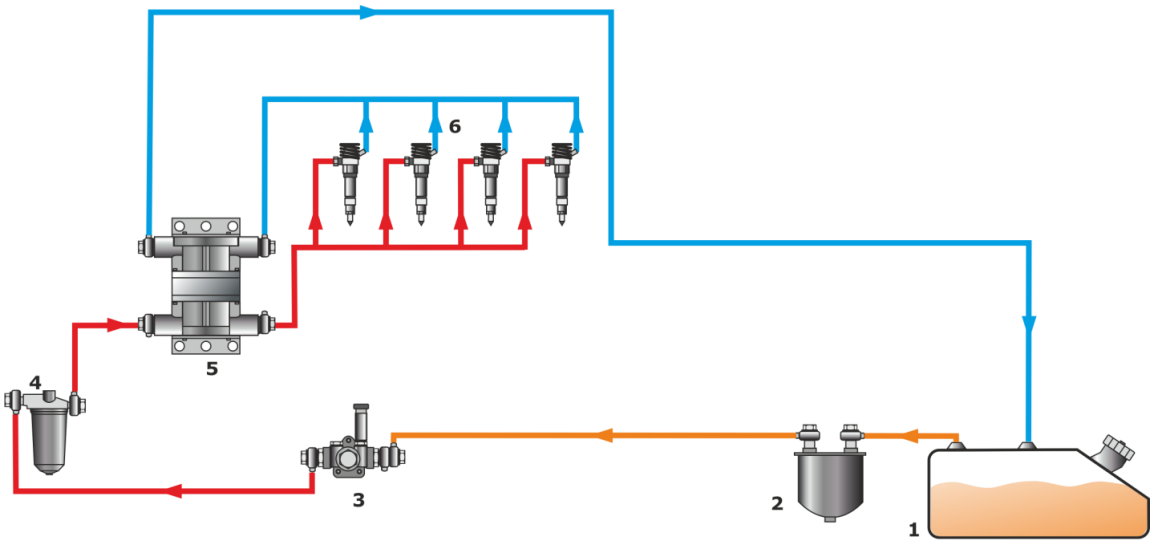
1 – Fuel tank; **2** – Rough filter; **3** – Low pressure fuel pump; **4** – Fine filter; **5** – High pressure fuel pump; **6** – Injectors; **7** – Additional fine filter; **8** – Non-return valve; **9** – Bypass valve; **10** – DFM Fuel Flow Meter.

a) supply chamber installation before the pump (in a fuel system with plunger injection pump)



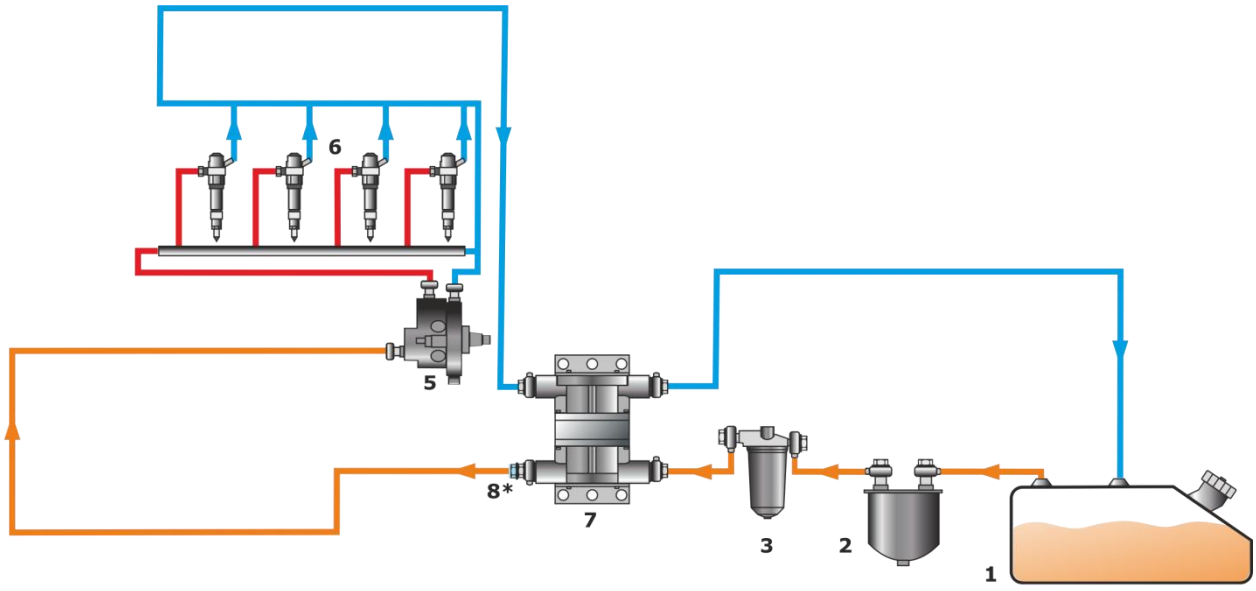
1 – Fuel tank; **2** – Rough filter; **3** – Low pressure fuel pump; **4** – Fine filter; **5** – High pressure fuel pump; **6** – Injectors; **7** – Additional fine filter; **8** – Non-return valve; **9** – Bypass valve; **10** – DFM Fuel Flow Meter.

b) supply chamber installation after the pump (in a fuel system with plunger injection pump)



1 – Fuel tank; **2** – Rough filter; **3** – Low pressure fuel pump; **4** – Fine filter; **5** – DFM Fuel Flow Meter; **6** – Unit injector.

c) supply chamber installation after the pump (unit injector fuel system)



1 – Fuel tank; **2** – Rough filter; **3** – Fine filter; **5** – High pressure fuel pump;
6 – Injectors; **7**– DFM Fuel Flow Meter; **8** – Non-return valve.

***** Is used only against hydro shocks (if any in the system).

d) supply chamber installation before the pump (Common Rail fuel system)

Figure 24 — Differential DFM installation scheme

Advantages of differential installation scheme:

- no changes in the fuel system;
- installation possible for engine during warranty period.

Disadvantages of differential installation scheme:

- higher cost;
- higher fuel consumption measurement error;
- additional fine filter and DFM increase load on the low pressure fuel pump.

Interactive animation video DFM fuel flow meters: selection of mounting scheme, accessories and mounting kit helps to select DFM, its mounting scheme, mounting kit and other accessories depending on type of fuel pump and according to technical specifications of particular vehicle.

2.5 Electrical connection

Fuel flow meters with interface cable (**DFM AK/A232/A485/ACAN/CK/C232/C485/CCAN/DK/D232/D485/DCAN**) are supplied with electrical power from onboard vehicle power source.

ATTENTION:

1) Before mounting and connecting DFM switch off power supply of the vehicle electrical circuits. To do this switch off the battery switch or release the terminals of the wires connected to the battery.

2) It is recommended to use **fuses** (supplied within delivery set) when connecting DFM power supply. Nominal fuse current is not more than 2 A.

3) When connecting DFM to onboard power source it is necessary to connect feed "+" and chassis "-" wires to the same sockets where appropriate wires of recording and display devices (trackers) are connected.

4) Before starting electrical connection of the sensor special attention must be paid to the quality of the chassis ground. Resistance between any point of the chassis and the negative clamp of the battery must not exceed 1 Ohm.

5) It is **strongly recommended** to lay DFM connection cable together with standard electrical vehicle wiring with mandatory cable ties fixing of every 50 cm (see figure 25).

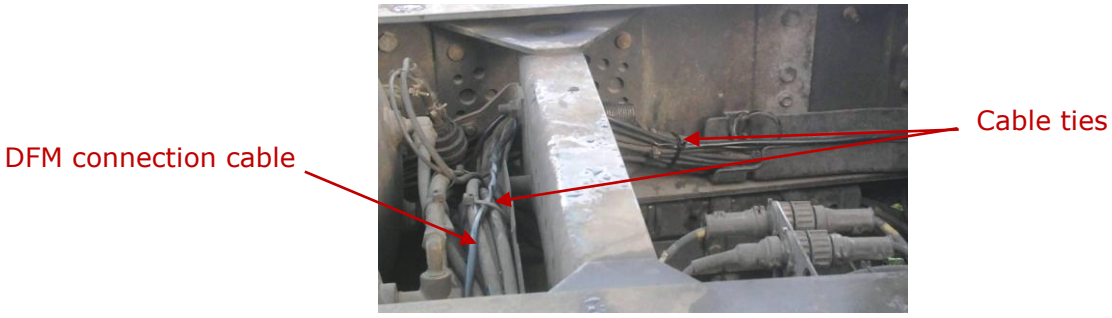


Figure 25 — Laying DFM connection cable

Electrical connection of DFM is carried out by connecting **signal cable** (see annex F) to telematic terminal (or data logger) in accordance with pinout and wires designation (see table 12-14)

Quick splice connectors (ordered separately) are recommended for electrical connection of power supply wires (see figure 26).

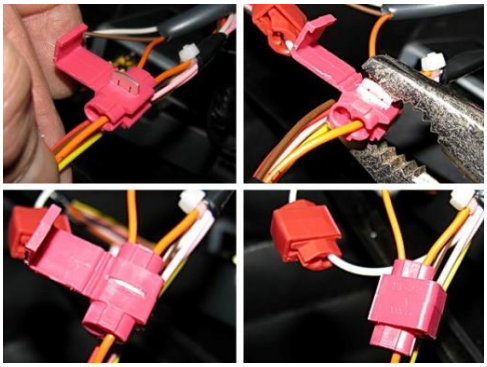


Figure 26 — Wiring connection made with the plastic connectors

Table 12 — Interface cable pinout and wire assignment of DFM AK/CK/DK

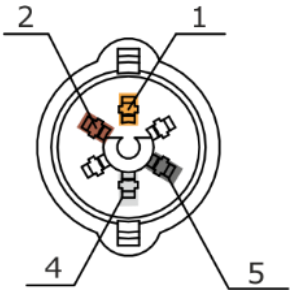
Connector view	Pin number	Wire color		Assignment
	1	Orange		Power supply “+”
	2	Brown		Ground
	4	White		Pulse output (see 1.6.8)
	5	Black		K-Line (ISO 14230)

Table 13 — Interface cable pinout and wire assignment of DFM A232/A485/C232/C485/D232/D485

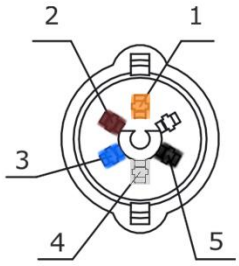
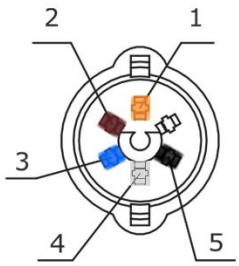
Connector view	Pin number	Wire color		Assignment
	1	Orange		Power supply “+”
	2	Brown		Ground
	3	Blue		Transmitted data (232T). Data exchange (485B)
	4	White		Received data (232R) Data exchange (485A)
	5	Black		K-Line (ISO 14230)

Table 14 — Interface cable pinout and wire assignment of DFM ACAN/CCAN/DCAN

Connector view	Pin number	Wire color		Assignment
	1	Orange		Power supply “+”
	2	Brown		Ground
	3	Blue		CAN-High (SAE J1939)
	4	White		CAN-Low (SAE J1939)
	5	Black		K-Line (ISO 14230)

Check annex G for DFM ACAN/CCAN/DCAN and tracking devices connection options and required connection cables models.

2.6 Fuel flow meter configuration

All DFM fuel flow meters are calibrated and verified by the manufacturer with a diesel fuel and supplied ready for use.

When DFM with output interface (**DFM AK/A232/A485/ACAN/CK/C232/C485/CCAN/DK/D232/D485/DCAN**) is connected to external device or it is necessary to adjust DFM parameters to specific operation mode, you can configure it through K-line interface (ISO 14230).

In order to start configuration it is necessary to connect DFM to PC via SK DFM or S6 SK service adapters. SK DFM description can be found in DFM fuel flow meters operation manual v.5.0. S6 SK description can be found in Cabling and accessories for Telematics interface S6 manual.

Before connecting DFM to PC via service adapter, please download the USB driver and software Service S6 DFM (higher than version 1.11) from http://www.jv-technoton.com (section Software/Firmware) and install it to your PC. Installation file name contains: ServiceS6_DFM_X_X_Setup.exe, where X_X — version of software.

2.6.1 Connecting DFM to PC

ATTENTION: To avoid any SK DUT-E faults in communication between PC and sensor make sure there are no sources of electromagnetic enterference close to the workplace (running electric motors, welding equipment, high-power transformers, power lines, etc.).

Before starting to use service adapter, have a closer look on its elements to detect defects which can occur while service adapter was transported, stored or handled carelessly.

When connecting service adapter to DFM, which is installed on vehicle, avoid the following: ingress of fuel, oil or moisture to the pins of connector; damage of elements by rotating or heated parts of engine/vehicle.

ATTENTION: Power down the electrical system of the vehicle prior to DFM connecting to the PC. Use the battery switch or take off the battery contact terminals.

DFM meters are connected to PC according to the connection schemes (see figure 27) in the following order:

1) Connect the adapter to flow meter

When configuring DFM within Telematics Interface S6 the connector of CAN service cable (applicable for SK DFM) or service cable (applicable for S6 SK) is connected to an appropriate free S6 input. Flow meter and adapter power supply is done through S6 cabling system (see figures 27 a, b);

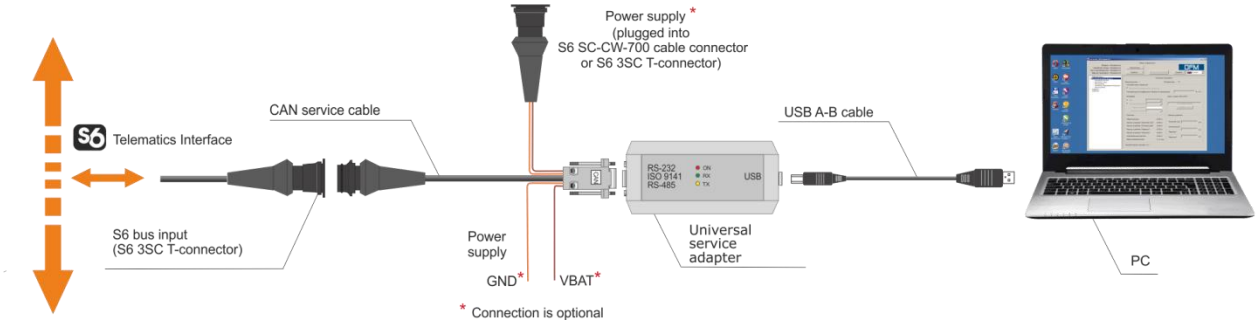
When configuring DFM not within Telematics Interface S6 the connector of CAN service cable (applicable for SK DFM) or service cable (applicable for S6 SK) is connected through coupler (supplied with S6 SK) to DFM output interface cable. Flow meter and adapter power supply is connected through one of free connectors of the coupler (see figures 27 c, d)

2) Connect the adapter with USB cable (applicable for S6 SK) or USB A-B cable (applicable for SK DFM) to a free USB-port of your PC.
Adapter can also be connected to USB-port of your PC after turning Vehicle's electrical system ON and starting the software.

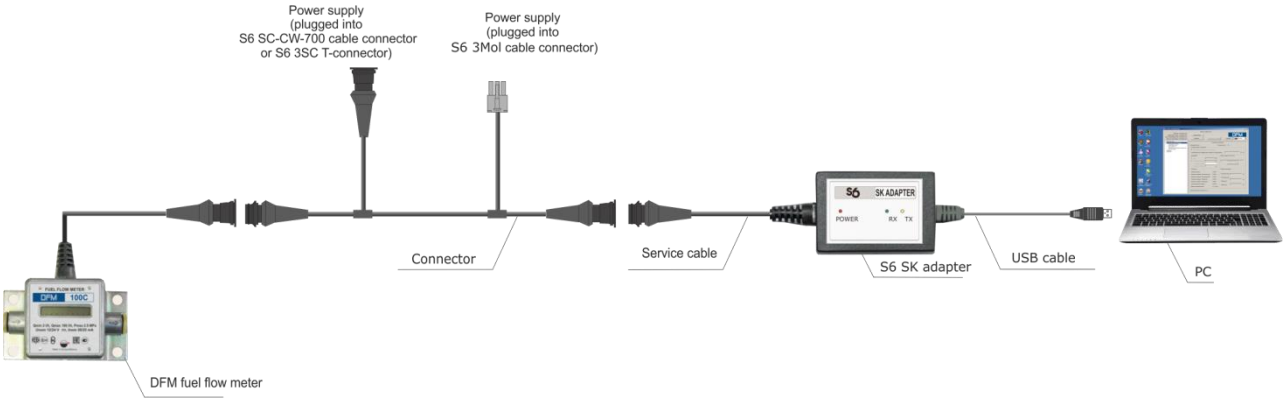
3) Connect power wires to on-board electrical system or to an external power supply unit.

4) Turn Vehicle's electrical system ON.

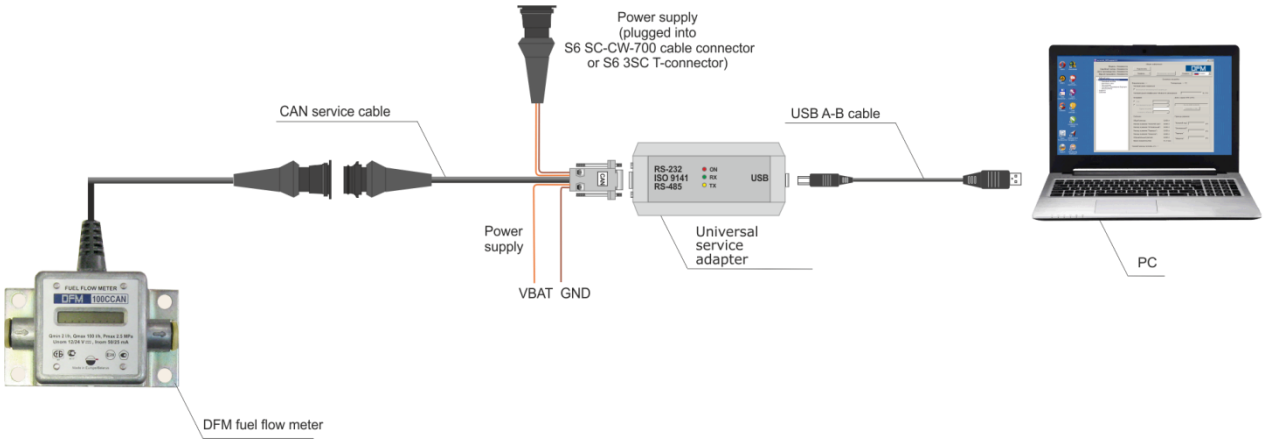
a) while using S6 SK for configuration of DFM within S6 Telematics interface



b) while using SK DFM for configuration of DFM within S6 Telematics interface



c) while using S6 SK for configuration of DFM out of S6 Telematics interface

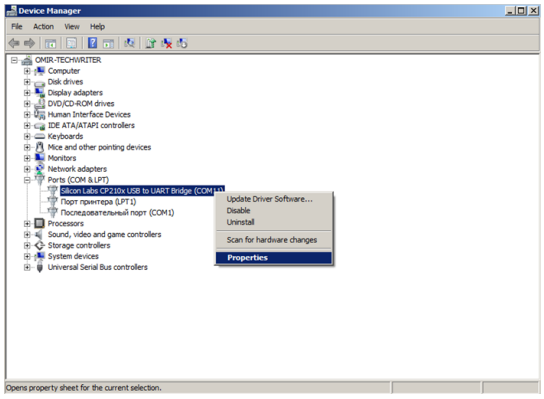


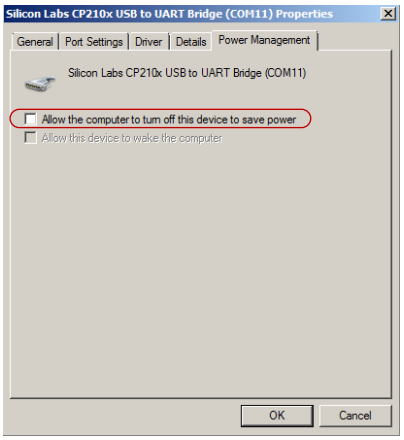
d) while using SK DFM for configuration of DFM out of S6 Telematics interface

Figure 27 — DFM to PC wiring schemes

Windows automatically detects adapter connected to PC's USB port as USB device and enables virtual COM port driver for it. The virtual COM port will be displayed in the list of ports of Windows Device manager (see figure 28 a).

ATENTION: to work with Service DFM it is recommended:
1) It is recommended to use the same USB port of the PC for adapter connections.
2) Untick power save check box in virtual COM-port properties (see figure 28 b).





a) selecting port properties *b) disabling power save option*

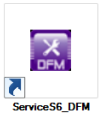
Figure 28 — Virtual COM-port configuration in Device manager

Service adapter is ready for operation straight after power supply connection. Check for a description of blinking LED-indicators placed on the top of the adapter in table 15.

Table 15 — Description of adapter's LEDs

LED Indicator				Signal description
Marking		Status	Light color	
for S6 SK adapter	for SK DFM adapter			
POWER	**ON**		Red	Power supply is on
		No signal		Power supply is off (or voltage is less than minimum required)
RX			Green	DFM data is being received
		No signal		No data from DFM
TX			Yellow	Data is being transmitted to DFM
		No signal		No data to DFM

2.6.2 User interface

Service S6 DFM is launched with a 

label which is created during the installation process. Service S6 DFM user interface consists of **Horizontal menu**, **Vertical menu, Flow meter's ID zone** and **Information and configuration area** (see figure 29).

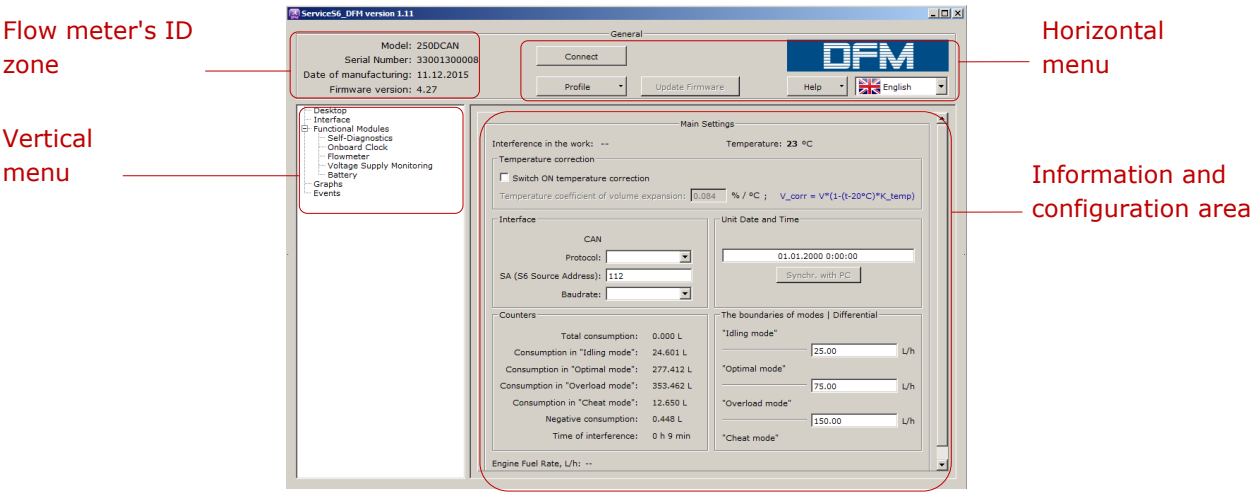


Figure 29 — Service S6 DFM software interface

Flow meter's ID zone displays data on model, serial number, production date and firmware version of the connected meter.

Horizontal menu provides following options:

- connection/disconnection of the flow meter;
- meter profile options (loading profile, saving profile, printing profile);
- updating firmware of the meter;
- selection of interface language;
- viewing help file and information about the utility.

Vertical menu is used for selection of Functional Modules (hereinafter FM) of the meter. The actual parameters of FM and settings are displayed at **Information and configuration area**.
Connectivity of software with FM is based on PGNs and SPNs (S6 Database) exchange. SPNs of DFM Functional Module which are read and/or edited in **Information and configuration area** are listed in Annex H.

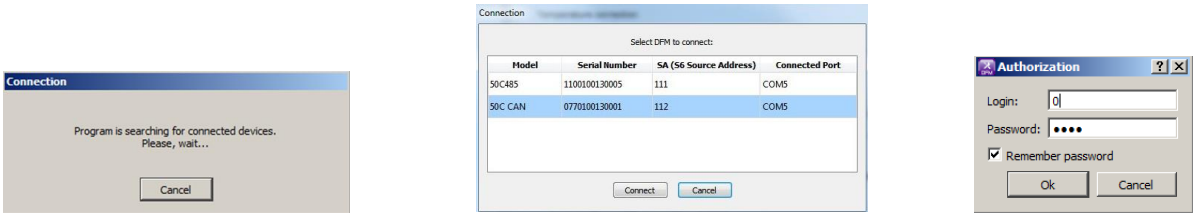
Vertical menu also contains entries on real-time diagnostics of measuring chambers and events records.

2.6.3 User authorization

To establish connection with DFM push Connect at **Horizontal menu**. Service S6 DFM will run a search of connected meters (see figure 30 a).

Note — When connecting adapter to S6 Telematics interface which has more than one DFM CAN select the required flow meter out of the list in **Connection** window and push Connect button (see figure 30 b).

Enter installer's login and password in the fields of **Authorization** window. Default login is 0. Default 1111. Tick **Remember password** checkbox to save the password for further launches (see figure 30 c).



a) search of connected meters *b) selecting one of several DFM CAN connected to S6 bus* *c) user authorization*

Figure 30 — Establishing connection between PC and DFM

For password recovery (if it was lost) press Ctrl+F10 in the password field of **Authorization**. Service S6 DFM will generate restore code (see figure 31). Send the restore code to Technoton support via e-mail support@technoton.by together with recovery request.

Requirements for password recovery request:

- scan copy of the request signed and sealed by the official representative of the company the flow meter been purchased by should be attached;
- request should contain serial number of the meter;
- email should contain full name and contact e-mail of a person who should receive the recovered password.

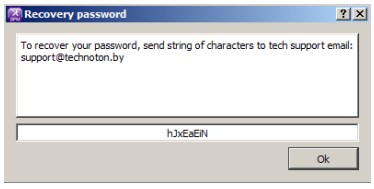


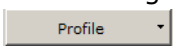
Figure 31 — Generated recovery code window

In case of entering incorrect login/password or in case of wrong connection to PC the software will show an error message.

In case of successful authorization with login and password the software will automatically prompt **Desktop** window (see figure 29), which displays currently connected DFM's configurations and parameter values of Functional modules.

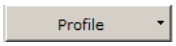
2.6.4 Working with DFM profile

Profile of DFM is represented by a set of PGNs (specifications, counters and configuration of Functional Modules of DFM).

For managing DFM profiles in both meter connected mode and autonomous mode 

button with drop-down list is used (see figure 32). This button is placed at **Horizontal menu** of Service S6 DFM. Profile can be stored as a file to PC hard drive or loaded into the memory of the meter. It can be printed as well.

Figure 32 — Profile menu



menu has following entries:

1) Load profile. Service S6 DFM has following options of flow meter profile load:

- Load from file — for loading of previously saved profile from the hard drive or removable disk. Select the **DFM_*.prf** file of the flow meter profile in the appeared Open window.
- Load from Unit — used for loading profile from the connected flow meter.

ATTENTION: When there is an active connection between DFM and PC it is possible to load profile from file of only the same interface as connected Unit. Otherwise the warning message will appear (see figure 33).

Figure 33 — Warning on interfaces incompatibility of profiles of loaded and connected Unit

- Load default profile — is used for loading profile with default factory settings. With this profile it is possible to study utility operation without real DFM connection. Default profile is stored in **DFM_default.prf** file in the folder of Service S6 DFM.

ATTENTION: In autonomous mode only default profile or previously saved profile is available for loading.

2) Saving profile. Service S6 DFM has following profile saving options:

- Save to file — for saving profile to the hard drive or removable disk. This option is available only for profile loaded from file or Unit.
  Select the location and give a name to file according to format **DFM_*.prf**.

ATTENTION: Saved profile then can be loaded only when DFM with the corresponding output interface is connected.

- Sace to Unit — is used for saving modified settings into profile of the connected DFM. It is available only during the time when there is an active connection between PC and DFM.

  If the modified settings were not saved into Unit and 

button was pressed or Service S6 DFM window is being closed there will appear a notification. Pressing 

will save all the unsaved parameters and settings into DFM.

3) Print profile. This window allows selection of the printer and printing settings.

The printed copy will contain flow meter profile data as well as the date when it been printed.

RECOMMENDATION: It is recommended to attach the hardcopy of the profile to the meter's specification to log the history of the settings and configurations.

2.6.5 Configuration for connection to external terminal unit

Fuel flow meters with pulse output interface (**DFM AK/CK/DK**) does not require any output signal configuration.

Fuel flow meters with pulse digital interface (**DFM A232/A485/ACAN/C232/ C485/CCAN/D232/D485/DCAN)** require output signal configuration to be connected to external terminal unit. Go to **Desktop** or **Interface** to configure output signal parameters:

1) From the drop-down menu of **Protocol** list choose required data transfer protocol. For DFM CAN — **SAE 1939+S6** or **NMEA 2000**. For DFM 232/DFM 485 — **MODBUS** or **DFM COM**.

The following settings are vailable for DFM COM protocol:

- **Automatic transmission mode** drop-down list for selection of output data transmission mode:
  - Off — no automatic message transmission, sensor waits for tracking device request;
  - HEX — automatic message transmission in hexadecimal format (used by default);
  - ASCII — automatic message transmission in text format;
  - ASCII EXT — automatic message transmission in extended text format. Additional **Prefix** and **Postfix** configurable parameters are available for this mode to insert required header or ending of the message (max 32 symbols).
- **Message interval** time period the sensor automatically send output message to the tracking device. Parameter value range is 1…255 seconds with 1 seconds step. Default value is 1 second.

ATTENTION: Data transfer protocol of CAN interface cannot be changed with the utility.

2) If several DFM 232 or DFM 485 are connected, for each of them specify the address in the field **Device address.** You can choose addresses from 0 to 255 (by default -111);
If several DFM CAN are connected, for each of them specify the address in the field **SA (address on S6 bus).** You can choose addresses from 111 to 118 (by default -111).

3) From the drop-down menu of **Data transfer rate** list choose data transfer speed:
for CAN interface you can choose one of the following data transfer speeds: 100; 125; 250; 500; 1000 Kb/s (by default— 250 Kb/s);
for RS-232/RS-485 interfaces you can choose one of the following data transfer speeds: 2400; 4800; 9600; 19200; 38400; 57600; 115200 bit/s (by default — 9600 bit/s).

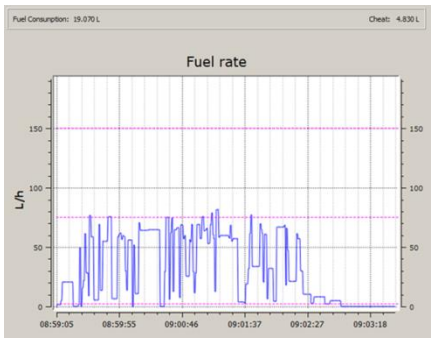
ATTENTION: Parameters modified in Desktop window are automatically modified in corresponding windows of FM setting entries and vice versa.

2.6.6 Operation check

In order to check operation of installed fuel flow meter go to **Charts** menu of the Software where live data is displayed (see figure 34):

- For one-chamber flow meters:
  - Chart of hourly (instant) consumption of fuel, which went through the only measuring chamber (blue line) (SPN 183);
  - Current Counter values — Total fuel consumption (SPN 5054) and fuel consumption in "Tampering" mode (SPN 5054/9.3).
- for differential fuel flow meters:
  - Chart of hourly (instant) consumption of fuel, which goes through direct chamber (green line) (SPN 521027/18.0) and through reverse chamber (red line) (SPN 521027/18.1) of the flow meter installed on direct and reverse fuel lines. Additionally, the result of two lines – difference in volumes of fuel going through each chamber of the flow meter – is shown as blue line (SPN 183);
  - Current Counter values — Total fuel consumption (SPN 5054), "Negative" consumption (SPN 5054/9.4) and fuel consumption in "Tampering" mode (SPN 5054/9.3).

Horizontal pink dotted lines display configured boundaries of operation modes (see 1.6.5). You can change configuration of operation modes boundaries in **Desktop** or F**M fuel flow meter** window (see annex H, FM fuel flow meter).



a) one-chamber

b) differential

Figure 34 — DFM operation test with Charts window

2.6.7 Configuration for specific operation conditions

In order to get better accuracy for specific conditions of operation, you can change the following settings through the Software (FM fuel flow meter or Desktop window):

1) Set up boundaries of operation modes of DFM, which are used to define current workload of Vehicle depending on its hourly consumption rate (SPN 521392):

- «Idle» – workload less than 10 % of maximal hourly consumption rate;
- «Optimal» – workload 10 to 75 % of maximal hourly consumption rate;
- «Overload» – workload 75 to 100 % of maximal hourly consumption rate.

In one-chamber flow meters a user can adjust only "Idle" (SPN 521392/9.0) and «Optimal» (SPN 521392/9.1) modes. Factory-set configuration for "Overload" mode (SPN 521392/9.2) could not be adjusted.
In differential fuel flow meters a user can adjust all boundaries of operation modes for differential consumption measurement. Factory-set configurations for "Direct" and "Return" chambers could not be adjusted.

2) Turn on temperature correction function, i.e. automatic correction of fuel volume consumption data adjusted to fuel temperature (SPN 521311).
Temperature correction function is used because volume of fuel changes when fuel temperature is going up/down.
After turning on temperature correction function a user can enter temperature correction coefficient of volumetric expansion (coefficient of volumetric expansion of oil products **β** in relation to temperature change by 1 °C) (SPN 521433).
β coefficient value should be chosen from table 16, taking in account density **ρ** of oil product at the temperature of plus 20 °C.

Table 16 — Selection of oil products volumetric expansion coefficient

ρ, kg/m^3	β, 1/°C	ρ, kg/m^3	β, 1/°C
690.0 - 699.9	0.00130	850.0 - 859.9	0.00081
700.0 - 709.9	0.00126	860.0 - 869.9	0.00079
710.0 - 719.9	0.00123	870.0 - 879.9	0.00076
720.0 - 729.9	0.00119	880.0 - 889.9	0.00074
730.0 - 739.9	0.00116	890.0 - 899.9	0.00072
740.0 - 749.9	0.00113	900.0 - 909.9	0.00070
750.0 - 759.9	0.00109	910.0 - 919.9	0.00067
760.0 - 769.9	0.00106	920.0 - 929.9	0.00065
770.0 - 779.9	0.00103	930.0 - 939.9	0.00063
780.0 - 789.9	0.00100	940.0 - 949.9	0.00061
790.0 - 799.9	0.00097	950.0 - 959.9	0.00059
800.0 - 809.9	0.00094	960.0 - 969.9	0.00057
810.0 - 819.9	0.00092	970.0 - 979.9	0.00055
820.0 - 829.9	0.00089	980.0 - 989.9	0.00053
830.0 - 839.9	0.00086	990.0 - 999.9	0.00052
840.0 - 849.9	0.00084	—	—

3) Configure consumption correction coefficient (SPN 521434). This parameter allows increasing accuracy of fuel consumption measurement if a user constantly detects derivation (values are too high/low) of measured consumption related to specific conditions of operation (increased vibration of Vehicle, air presence in fuel lines, higher fuel flow in reverse line of nozzles).
For example, if fuel flow meter shows 3 % higher results of measurement, it is necessary to enter consumption correction coefficient equal minus 3 %. If fuel flow meter shows 2 % lower results of measurement, it is necessary to enter consumption correction coefficient equal plus 2 %.

3 Measurement accuracy check

To determine measurements accuracy of DFM flow fuel meter mounted on the vehicle it is required to carry out a test.

3.1 Test conditions

Representatives of the parties should attend the test.

Only people who have studied DFM and recording devices operational documentation and who have experience with testing equipment are allowed to conduct the tests.

Install the DFM fuel flow meter and connect it to recording and display devices. Conduct all works in accordance with the installation manuals for fuel flow meters and recording and display devices.

Tests are conducted on properly operating (fault-free) vehicles.

Conditions of the test:

1) Engine run time - not less than 1 hour.
2) The engine must run at medium speed (RPM).
3) Engine shutdown is not allowed during the test.
4) Only verified measurement containers can be used to determine the amount of the fuel. The containers must be clean.
5) Fuel must not contain any mud or other impurities.

3.2 Conducting the tests

1) Pour fuel into Tank 1. The amount of fuel must be enough to eliminate air from the fuel system and warm up the engine (see figure 35).

2) Use a verified measuring container to fill Tank 2 with testing fuel in the amount of 10 liters.

3) Connect fuel pump inlet with Fuel line 1.

4) Put the other end Fuel line 1 into Tank 1.

5) Put return Fuel line 2 in to Tank 1.

6) Disconnect the injectors return line from the fuel tank and put it into Tank 1.

7) Use manual pump of the fuel pump to pump through the fuel system in order to remove air.

8) Start the engine and let it warm up to operating temperature. At the same time make sure there is no air coming out from return Fuel line 2.

9) Simultaneously close inlets of Fuel pipes 1 and 2 and stop the engine.

10) Move Fuel pipes 1 and 2 from Tank 1 into Tank 2 (the air must not get into the hoses).

11) Close inlet of injectors return Fuel pipe 3 and move it from Tank 1 into empty Tank 3.

12) Record the initial readings of the DFM according to the readings of a tracking device or the DFM display.

13) Record the time when the test was started.

14) Start the engine and set medium run.

15) Let the engine run until Tank 2 is empty. At the same time air cannot be let into Fuel pipe 1.

16) Stop the engine.

17) Measure the fuel left in Tank 2 (V_{remain}) with a verified container.

18) Use a verified container to measure **actual fuel consumption** from Tank 2 (V_m=10 l–V_{remain}).

19) By difference of initial and final DFM readings determine **measured fuel consumption** ($V_{measured}$).

20) Calculate the **relative measurement error of fuel consumption** by the formula:

$$\delta = \frac{V_{measured} - V_m}{V_m} \cdot 100\%$$

where $V_{measured}$ – measured fuel consumption, l;
V_m – actual fuel consumption, l.

21) Use a verified container to determine **actual fuel amount from the injectors return line** ($V_{inj.return}$).

22) Determine the **proportion of the return flow from the injectors in overall fuel** consumption for a tested vehicle by the formula: $\frac{V_{inj.return}}{V_m} \cdot 100\%$.

23) Record the result into the protocol. See annex C for protocol template.

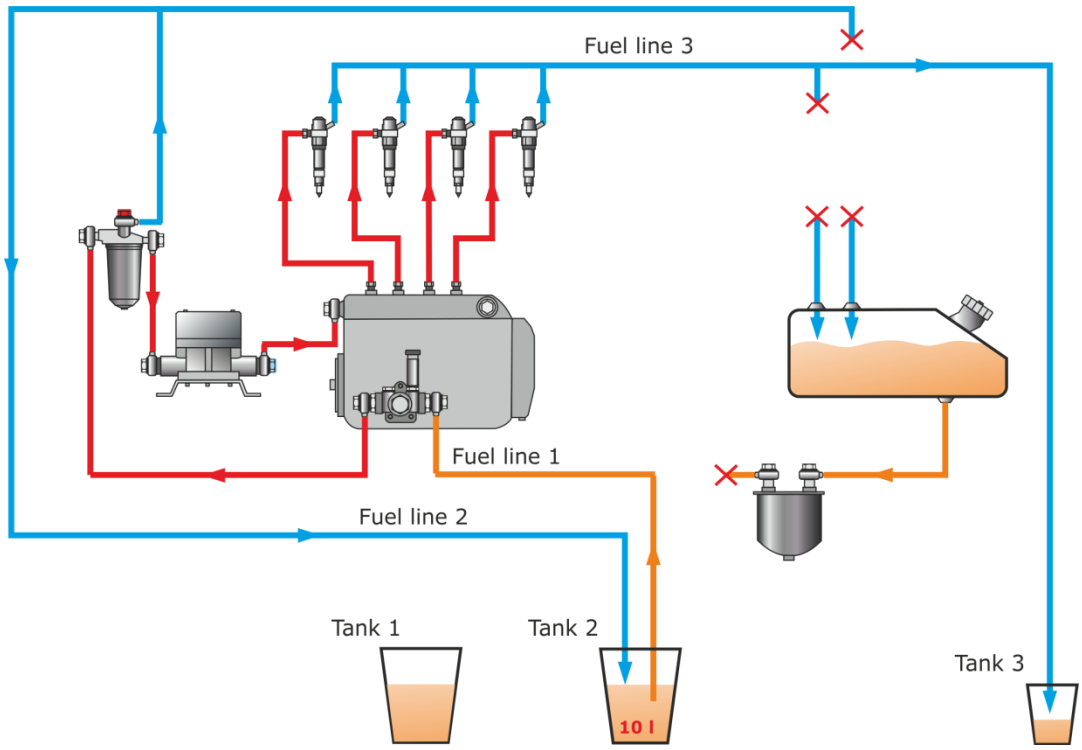


Figure 35 — Fuel system scheme during test

ATTENTION:
When carrying out accuracy test of DFM flow meter, you can use the values from "Total fuel consumption" Counter (see Annex H, FM Flow meter), at the same time:

- **keep in mind**, that there is a 12 s time lag in DFM with display between the moment when values appearing on the display of flow meter and sent to output interface of flow meter.
- **It is not recommended** to use data from "Total fuel consumption" Counter when signal transmission is set to **HEX** (see 2.6.5) data format because the step of increasing values in the Counter is 1 L in this mode.
- **It is possible** to use data from "Total fuel consumption" Counter when signal transmission is set to **ASCII** (see 2.6.5) data format because the step of increasing values in the Counter is 0.005 L in this mode.

4 Accessories

To install, connect, and operate DFM fuel flow meters Technoton offers **high quality accessories.**

4.1 Mounting kits

DFM mounting kits (hereinafter MK DFM) are designed to connect fuel flow meters to the engine fuel system using fuel pipes with diameters of 8 mm and 10 mm.

MK DFM use only high quality components designed for use in the fuel system of vehicles.

MK DFM distinctive features

- No burrs and shavings which can be found in kits from other manufacturers. **No clogging and fuel system malfunction!**
- Increased nominal bore to preserve the pressure in the fuel system. **The engine does not lose power!**
- Made of high-strength metals, resistant to wear and corrosion. Hot stamping and groove manufacture technology used. **Lifetime of the kit elements significantly increases!**
- Threaded connections of the kit elements meet the standards of the fuel systems of leading automakers. **Elements are mounted easily and quickly!**
- Special valves are included into each kit. Specifications of the valves conform fuel system requirements. **No engine failure due to jamming of the valve!**
- Fittings, valves, banjo bolts have holes for sealing. **No fuel thefts and unauthorized tampering into fuel system!**

Table 17 — MK DFM application

Kit name	Application
DFM MK20	Universal, to install one-chamber flow meters using Ø 8 mm pipe
DFM MK40	Universal, to install one-chamber flow meters using Ø 10 mm pipe
DFM MK45	Universal, to install DFM 500 one-chamber flow meters using Ø 10 mm pipe
DFM MK90	To install one-chamber flow meters on D243, D245 and D260 engines using Ø 8 mm pipe
DFM MK100	To install one-chamber flow meters on YaMZ, KAMAZ engines using Ø 8 mm pipe
DFM MK DIFF10	To install differential fuel flow meters DFM 100D and DFM 250D using Ø 10 mm pipes
DFM MK DIFF20	To install DFM 500D differential fuel flow meters using Ø 10 mm pipe

MK DFM sets (see table 18) are selected on the basis of many years of experience of installing fuel flow meters on various types of machinery.
There are differences in compositions of MK DFM for differential and one-chamber flow meters depending on an installation scheme and engine features of a vehicle.

Table 18 — MK DFM components

View	Component name	Description	Kit name						
			DFM MK20	DFM MK40	DFM MK45	DFM MK90	DFM MK100	DFM MK DIFF10	DFM MK DIFF20
1	2	3	4	5	6	7	8	9	10
	Banjo bolt BB 14	To couple the fuel line and the flow meter to the units of the fuel supply system of the engine (high pressure fuel pump or fine fuel filter)	3	3	2	2	3	6	4
	Banjo bolt BB 16		-	-	1	-	-	-	2
	Banjo bolt double BB 14/2	To couple two branches of the fuel line to the units of the fuel supply system of the engine (high pressure fuel pump or fine fuel filter)	1	1	1	1	-	-	-
	Banjo fitting BF 14/8	For connection of ø 8mm fuel pipe to mounting elements	8	-	-	6	4	-	-
	Banjo fitting BF 14/10	For connection of ø 10mm fuel pipe to mounting elements	-	8	6	-	-	8	4
	Banjo fitting BF 16/10		-	-	2	-	-	-	4
	Non-return valve K10	To eliminate hydraulic shocks influence on the measurement accuracy of the flow meter (white valve)	1	1	-	1	1	2	-
	Non-return valve K15		-	-	1	-	-	-	2

Table 18 continued

1	2	3	4	5	6	7	8	9	10
	Bypass valve K20	To release excessive pressure in the fuel line at the output of the booster pump	1	1	1	-	-	-	-
	Bolt plug BP14	To plug the high pressure fuel pump hole to the return line	1	1	1	1	1	-	-
	Nipple adapter NA 14-4	To connect the fuel line with a return fuel line through the bypass valve	1	1	-	1	-	-	-
	Nipple adapter NA 14-20	To reverse the return fuel line from the fine filter via the bypass valve	1	1	1	-	1	-	-
	Nipple adapter NA 10-14	To connect the fuel line and heater tube	1	1	1	-	-	-	-
	Nipple adapter double NA 10-14/2	For joining two fuel lines with heater line	1	1	1	1	-	-	-
	Nipple adapter double NA 10-16/2	For joining two fuel lines with heater line	1	1	1	-	-	-	-
	Copper washer CW 14-19	To seal connections	16	16	12	14	11	16	8
	Copper washer CW 16-21	To seal connections	-	-	4	-	-	-	8
	Copper washer CW 20-26	To seal connections on the fine filter of YaMZ engines	1	1	1	-	1	-	-
	Hose clamp HC 10-16	To fix ø 8 mm fuel hose onto the banjo fitting or filter	8	-	-	6	4	-	-

Table 18 continued

1	2	3	4	5	6	7	8	9	10
	Bolt B8x16	To mount the flow meter to the bracket	4	4	4	4	4	4	4
	Nut N8	To mount the flow meter to the bracket	4	4	4	4	4	4	4
	Washer W8	To mount the flow meter to the bracket	4	4	4	4	4	4	4
	Lock washer WL8.65	To mount the flow meter to the bracket	4	4	4	4	4	4	4

ATTENTION: The manufacturer reserves the right to modify the MK DFM sets and replace components with equivalent ones without prior customer notice.

4.2 Connecting cables

Table 19 — Connection cables for electrical connection of DFM with interface cable

View	Component name	Description
	S6 SC-CW-700 (signal cable) (see Annex F)	Designed to connect DFM CAN to recording and display devices and to external power supply. 7 meters long. Not included into delivery set. Equipped with 2 terminating resistors (120 Ohm).
	SC-CW-700-RS (signal cable) (see Annex F)	Designed to connect DFM 232/485 to recording and display devices and to external power supply. 7 meters long. Not included into delivery set.
	CABLE DFM 98.20.003 (signal cable) (see Annex F)	Used for DFM flow meter with pulse output interface connection to telematic terminal (or data logger) and on-board power supply network. Length - 7,5 m. The cable is included in delivery set of DFM with pulse output interface.
Note – designation of additional cables which can be necessary for DFM CAN operation within Telematics Interface S6 is mentioned on pictures of Annex G.		

4.3 Additional accessories

Additional accessories may be required for DFM mounting and maintenance depending on fuel system configuration and selected mounting scheme (see table 20).

Table 20 — DFM additional accessories

View	Marking	Name	Application	Note
1	2	3	4	5
	TC 8	T-joint	To join/separate fuel flows	For ø 8 mm pipe
	TC 10			For ø 10 mm pipe
	BV 8	Ball valve	To control flow separation in a semi-differential scheme	For ø 8 mm pipe
	BV 10			For ø 10 mm pipe
	TR 10-2	Double fitting	To join/separate fuel flows and connecting fuel hose to fuel system units	For ø 10 mm pipe
	K5	Flow-dividing valve	To separate fuel flows in semi-differential DFM installation scheme	0.3-0.5 Bar, M14x1.5 thread , with a sealing hole
	KP2	DFM mounting bracket	Additional bracket for fastening DFM to the vehicle	Universal, 150x105 mm, fixed with bolt connection
	KT	iButton key	To read out DFM data from the built-in display	—
	CRYSTAL seal	Plastic seal	Sealing fuel connectors, valves etc. in order to prevent interference into the fuel system	—

Table 20 continued

1	2	3	4	5
	FT 240-1117010	Fine fuel filter	To install as an additional fine fuel filter	Used when meter is mounted according “before pump” scheme
	FUB dn8x3	Fuel hose	To connect fuel system parts	Coil 10 m, for ø 8 mm pipe, (-30...+70) °C
	FUB dn10x3			Coil 8 m, for ø 10 mm pipe, (-30...+70) °C
	GMM-06	Glycerin-filled manometer pressure gauge	To check pressure in fuel line before and after meter installation	With adapter for a ø 10 mm pipe
	PP 201	Instant fuel flow heater	To heat the fuel flowing through the line	12 V, up to 150 l/h, automatic control
	PP 202			24 V, up to 420 l/h, automatic control
	NTP 101	Fuel tank heater	To heat the fuel in the tank	Attachment for the fuel intake, 12 V, up to 420 l/h
	NTP 102			Attachment for the fuel intake, 24 V, up to 420 l/h
	D-19	Spiral wrap hose	For additional protection of cables and fuel lines	PVC coating 50m coil, Ø 19 mm
	CoTube9.8	Split corrugated tubing	Fast assembly plastic tube for DFM cable protection	50m coil, Ø 9.8 mm

4.4 DFM DA 250 deaerator

Air bubbles which come into the fuel supply system from the fuel tank or supply fuel line can lead to engine (boiler) operation malfunctions and even engine stop. Also cause an increase of harmful emissions. DFM measurement is not correct if there is a lot of foam in the fuel line.

Technoton recommends **DFM DA 250 deaerator** (hereinafter deaerator) to eliminate air bubbles and prevent them from getting into the fuel line (see figure 36).

Figure 36 — DFM DA 250 deaerator

DFM DA 250 features:

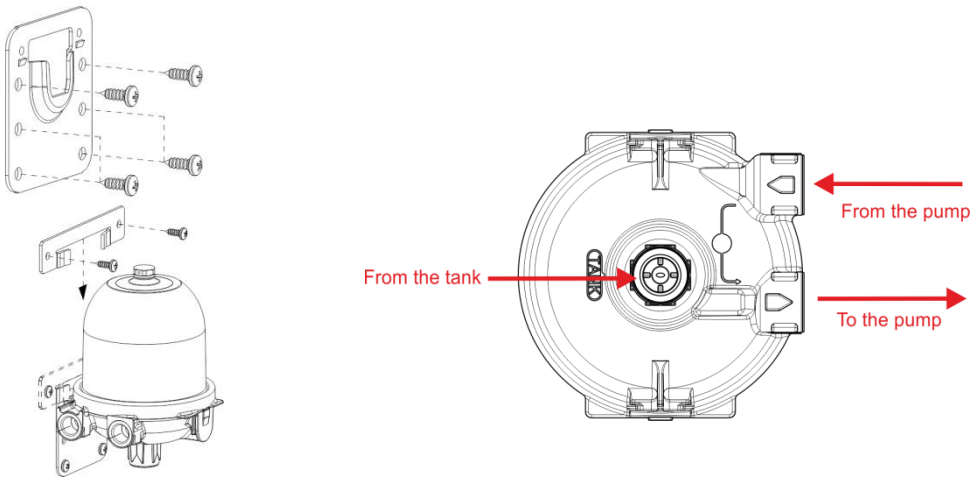
- increases flow meter accuracy;
- decreases engine (boiler) malfunction possibility;
- increases service life of the fuel system;
- provides an effective and stable combustion of fuel;
- improves the environmental parameters of the combustion process and reduces emissions;
- mounting accessories included.

Table 21 — DFM DA 250 technical specifications

Parameter, units	Value
Fuel types	diesel, biodiesel fuel
Max flow rate, liters/hour	250
Max deaeration capacity, liters/hour	8
Max operating temperature, °C	+85
Min/max operation pressure in the supply fuel line, bar	-0.6/0
Connection to the fuel pump	1/4” female thread
Connection to the tank	1/4” female thread
Overall dimensions, mm	not more than 136 x 95 x 97

IMPORTANT:
1) Deaerator should be installed in the engine compartment of a vehicle or near the burner in the boiler in upright position.
2) The ambient temperature should not exceed 85 °C.
3) The space between deaerator and heated and moving parts of the engine or unisolated boiler parts should not be less than 30cm.

Deaerator is mounted using the mounting kit elements according to figure 37 a. Fuel lines are connected according to figure 37 b).



a) fastening *b) fuel lines connection*

Figure 37 —DFM DA 250 mounting

Check out the interactive animation video for cases when deaerator is required as well as for examples of deaerator mounting schemes for various types of fuel supply systems DFM fuel flow meters: selection of mounting scheme, accessories and mounting kit.

5 Registered Events control

Upper area of **Events** window displays a list of the latest **Important Events** and lower area displays a list of **Information Events** registered by DFM and saved in its internal memory (see figure 38).

1) Important Events:

- flow meter tampering (indicating total tampered volume);
- interference in flow meter operation (indicating total interference time);
- low level of supply voltage (indicating voltage value);
- high level of supply voltage (indicating voltage value).

2) Information Events:

- ignition switched ON;
- ignition switched OFF.

Max 15 events are displayed for each of the lists. Each event has an indication of event name, date and time of occurrence and additional info (if there any).

Events are displayed in chronological order starting with the oldest. Upon reaching the maximum number of displayed events new events overwrite the previous ones.

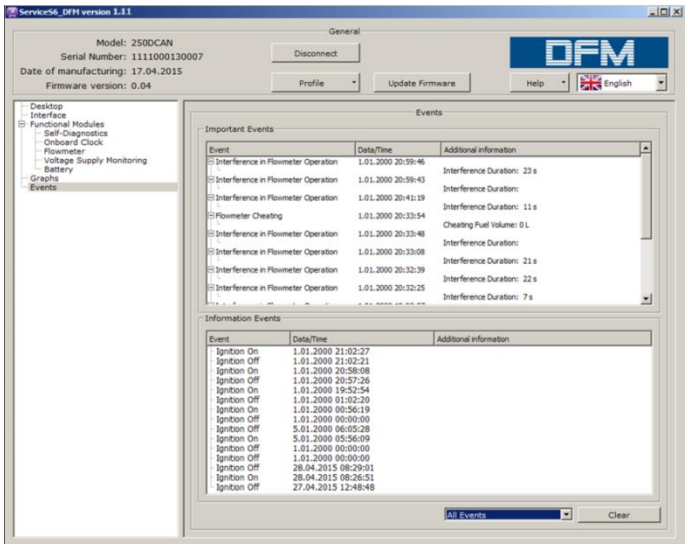


Figure 38 — Browsing thorugh Events registered by DFM

You can delete all registered Event from DFM by clicking Clear. Important Events cannot by deleted by use.

6 Diagnostics and troubleshooting

Contact your DFM supplier in case of malfunction.

DFM repair works can be carried out only by certified regional service centers. Full list of service centers can be found at www.jv-technoton.com

Limited troubleshooting may be self-conducted (see table 22).

Table 22 — DFM malfunctions, which can be removed without full dismounting of the device

Malfunction	Model	Possible cause	Troubleshooting
No output signal*	**DFM AK/CK/DK/ A232/C232/D232/ A485/C485/D485/ ACAN/CCAN/DCAN**	Incorrect connection	Check DFM connection to the tracking device/data logger
		Fuel filter clogging	Remove and clean the fuel filter
Fuel does not flow through the meter	**All models DFM**	Fuel filter clogging	Remove and clean the fuel filter
Fuel consumption readings are higher than real consumption rate	**DFM AK/B/C/CK/ DK/A232/C232/D232 /A485/C485/D485/ ACAN/CCAN/DCAN**	Wrong fuel flow meter model selection or error in the mounting scheme	Study the technical documentation of the engine and check the mounting scheme
		Hydraulic shocks in the fuel system	Install a non-return valve into the fuel line on the meter's outlet side**. Check valve's operational performance in case it is already installed.

* Differential DFM can stop sending output signals in case of negative consumption.
** When installing differential DFM, non-return valve should be mounted after direct chamber of flow meter.

7 Verification

At product release each DFM flow meter passes departmental metrological verification on metrologically certified automated test rigs.

Verification certificate confirming DFM metrological verification is included into delivery set of each DFM.

8 Maintenance

To ensure measurement accuracy it is recommended to re-calibrate DFM. Re-calibration interval is defined by increase of "High Resolution Engine Total Fuel Used" Counter (SPN5054 see table H.3) since previous calibration and equal to:

- for DFM 50, DFM 100 — 100 000 l;
- for DFM 250 — 250 000 l;
- for DFM 500 — 500 000 l.

ATTENTION: Re-calibration with subsequent verification of flow meters is done in Regional Service Centers (RSC).

It is recommended to perform visual inspection and DFM operation check at least once a year.

In order to provide DFM operability, it is recommended to remove and clean the mud filter from time to time (see figure 39).

Figure 39 — Mud filter

ATTENTION: When you remount DFM, replace used copper washers with new ones.

***** Re-calibration interval is defined by increase of "High resolution engine total fuel used/18.0 Feed chamber" Counter (SPN5054/18.0 see table H.3) for differential fuel flow meters.

9 Packaging

DFM delivery sets come in cardboard boxes of the following shape (figure 40)

Figure 40 — Packaging

Label sticker with information on the product name, certificates, serial number, firmware version, manufacture date, weight as well as Quality Control seal and QR code is stuck on two sides of the DFM box (see figure 41).

Figure 41 — Packaging label

Note — label design and contents can be modified by the Manufacturer.

10 Storage

DFM is recommended to be stored in dry enclosed areas.

DFM storage is allowed only in original packaging at temperature range from -50 to +40° C and relative humidity up to 100 % at 25° C.

Do not store DFM in the same room with substances that cause metal corrosion and/or contain aggressive impurities.

DFM shelf life must not exceed 24 months.

11 Transportation

Transportation of DFM is recommended in closed transport that provides protection from mechanical damage and precipitation.

When transporting by air, DFM must be stored in heated pressurized compartments.

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

Shipping containers with packed DFM should be sealed.

12 Utilization/re-cycling

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

DFM does not contain precious metals in amount that should be recorded.

Contacts

Distribution, technical support and service

JV Technoton

Tel/fax: +375 17 240-39-73

info@jv-technoton.com

support@technoton.by

Manufacturer

Zavod Flometr

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

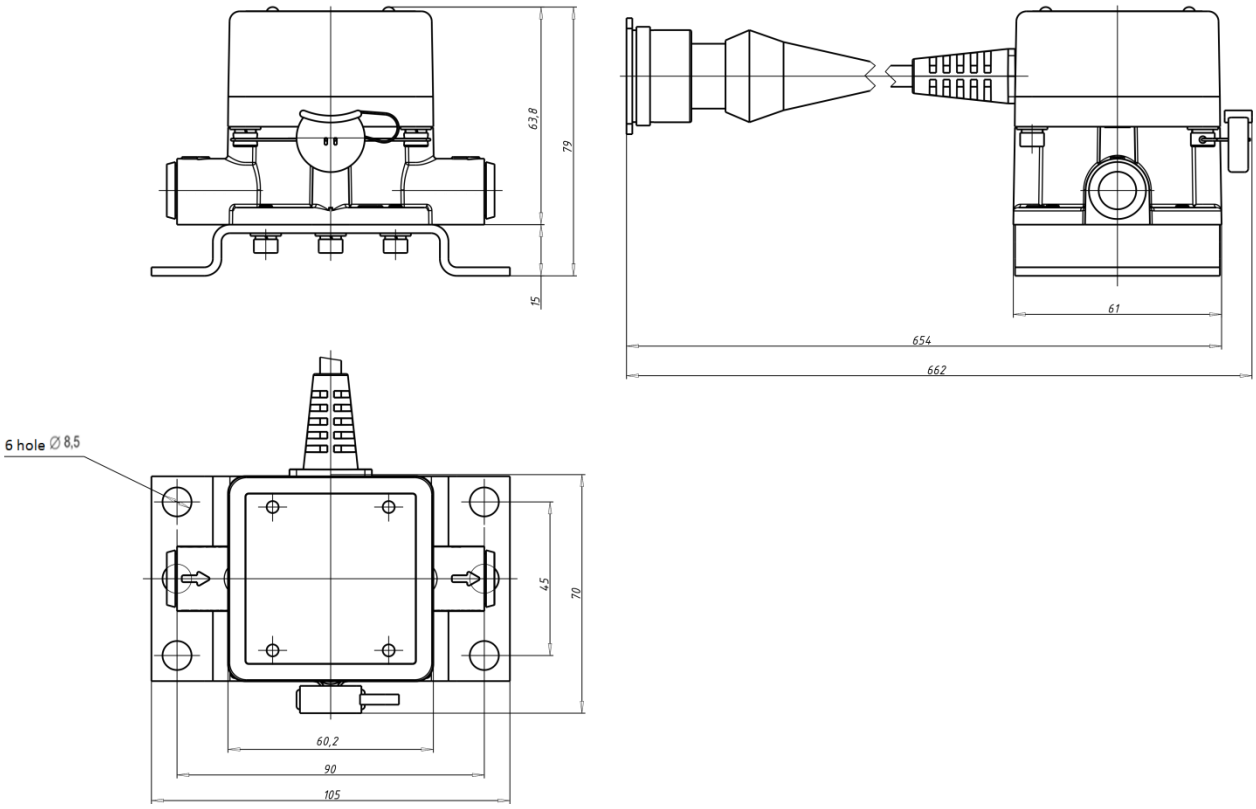
office@flowmeter.by

Annex A

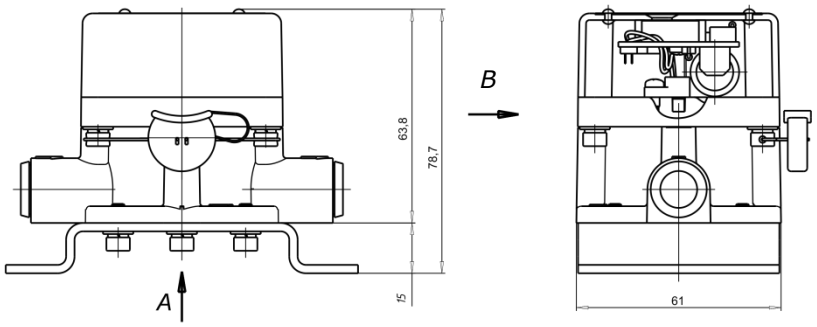
Overall dimensions and weight

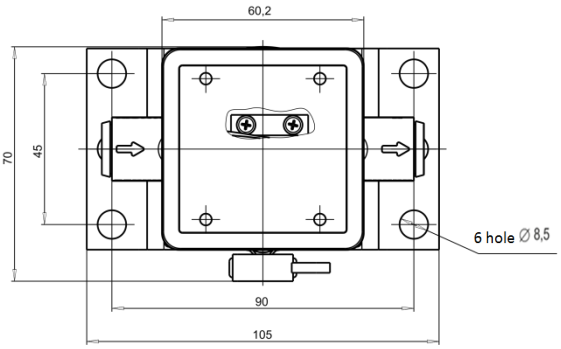
DFM 50AK/CK/A232/A485/ACAN/C232/C485/CCAN

DFM 100AK/CK/A232/A485/ACAN/C232/C485/CCAN

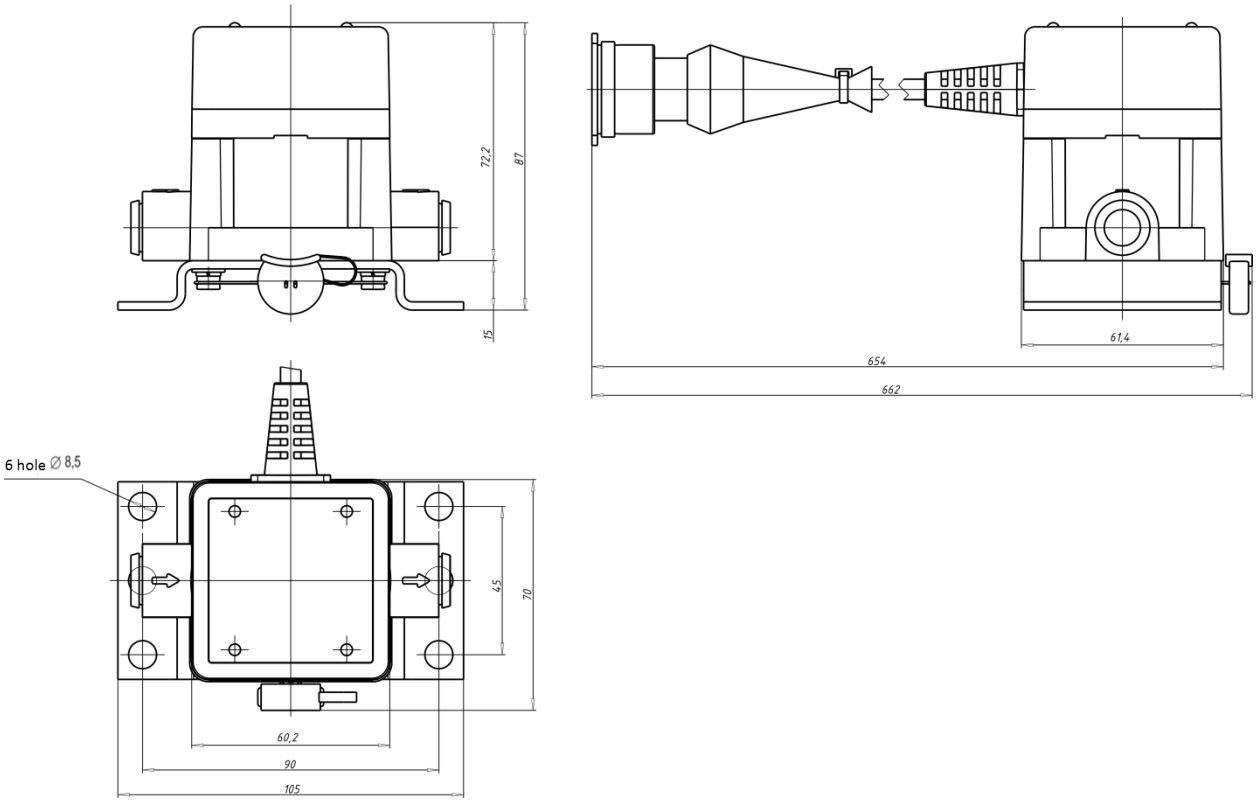


DFM 50B/C
DFM 100B/C

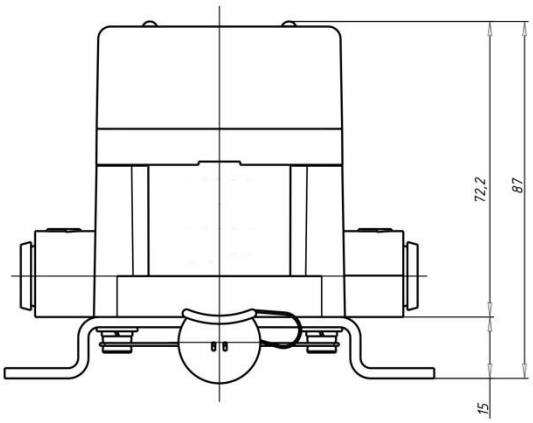


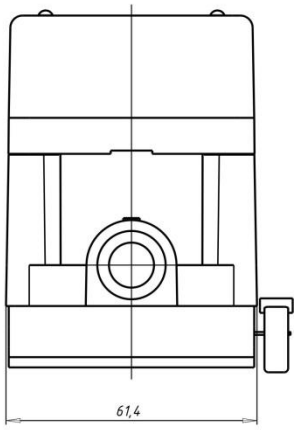


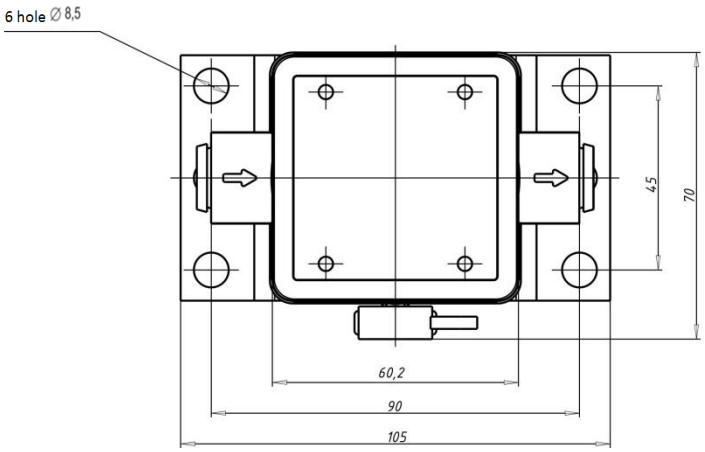
DFM 250AK/CK/A232/A485/ACAN/C232/C485/CCAN



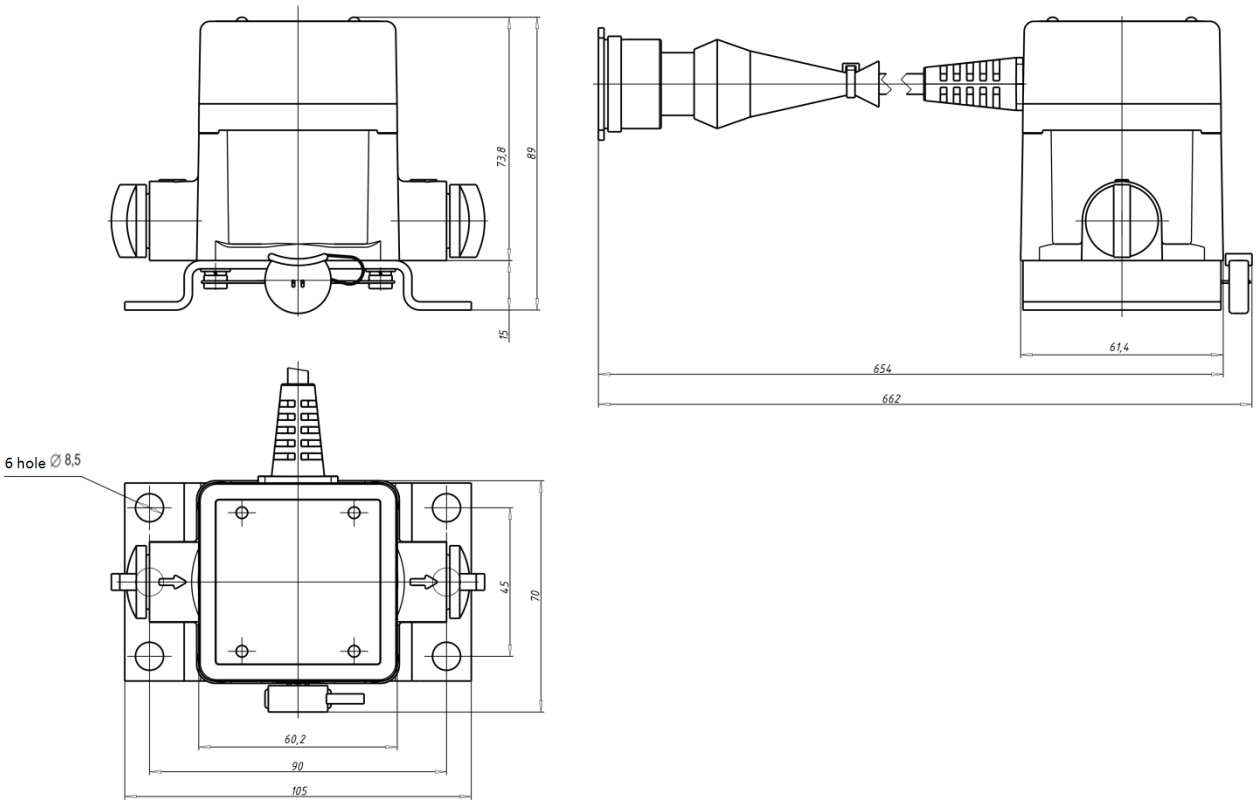
DFM 250B/C



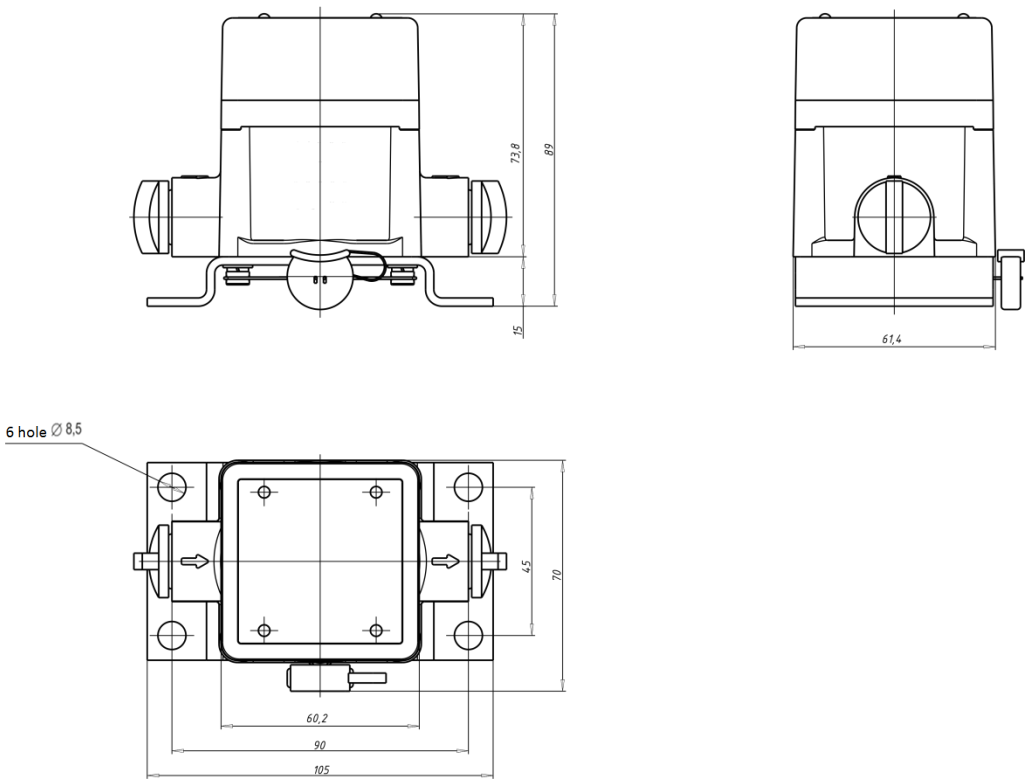




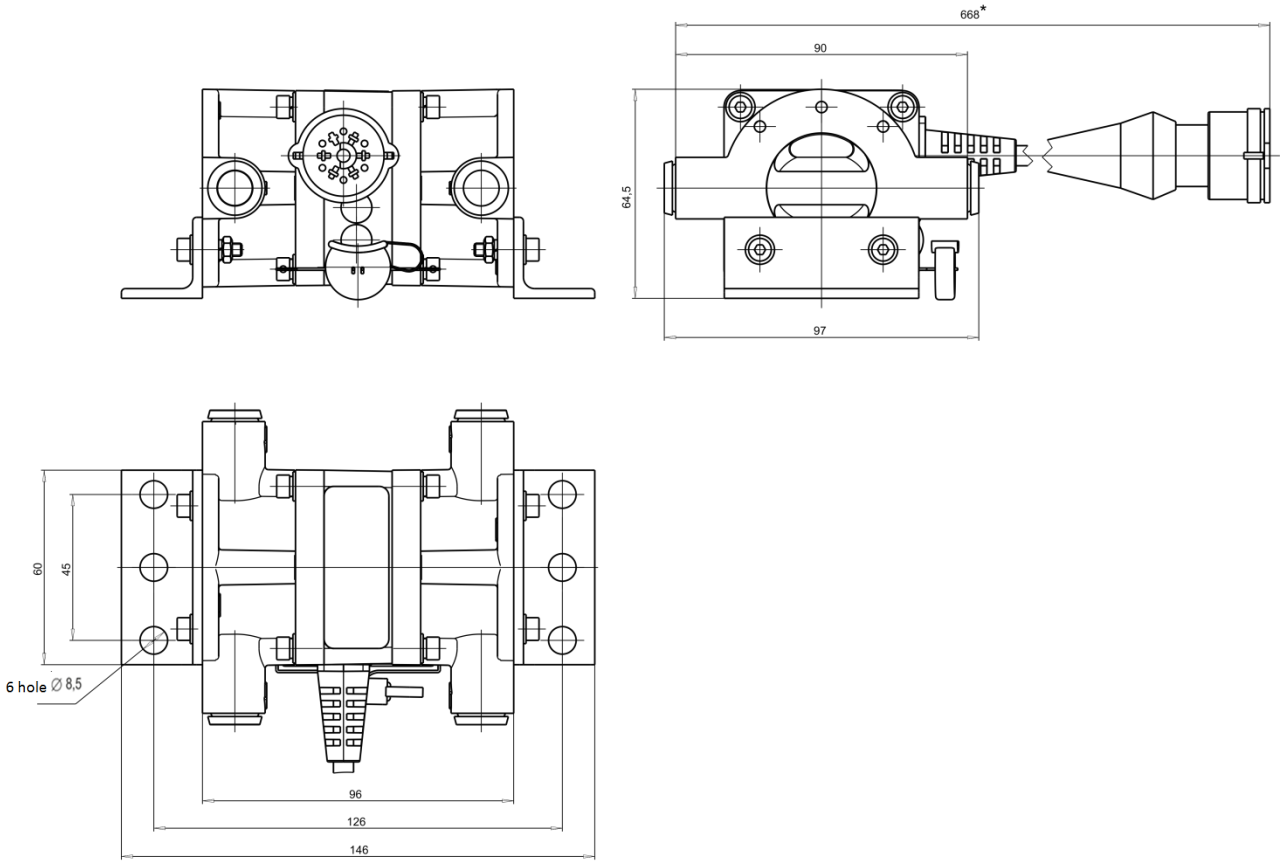
DFM 500AK/CK/A232/A485/ACAN/C232/C485/CCAN



DFM 500B/C

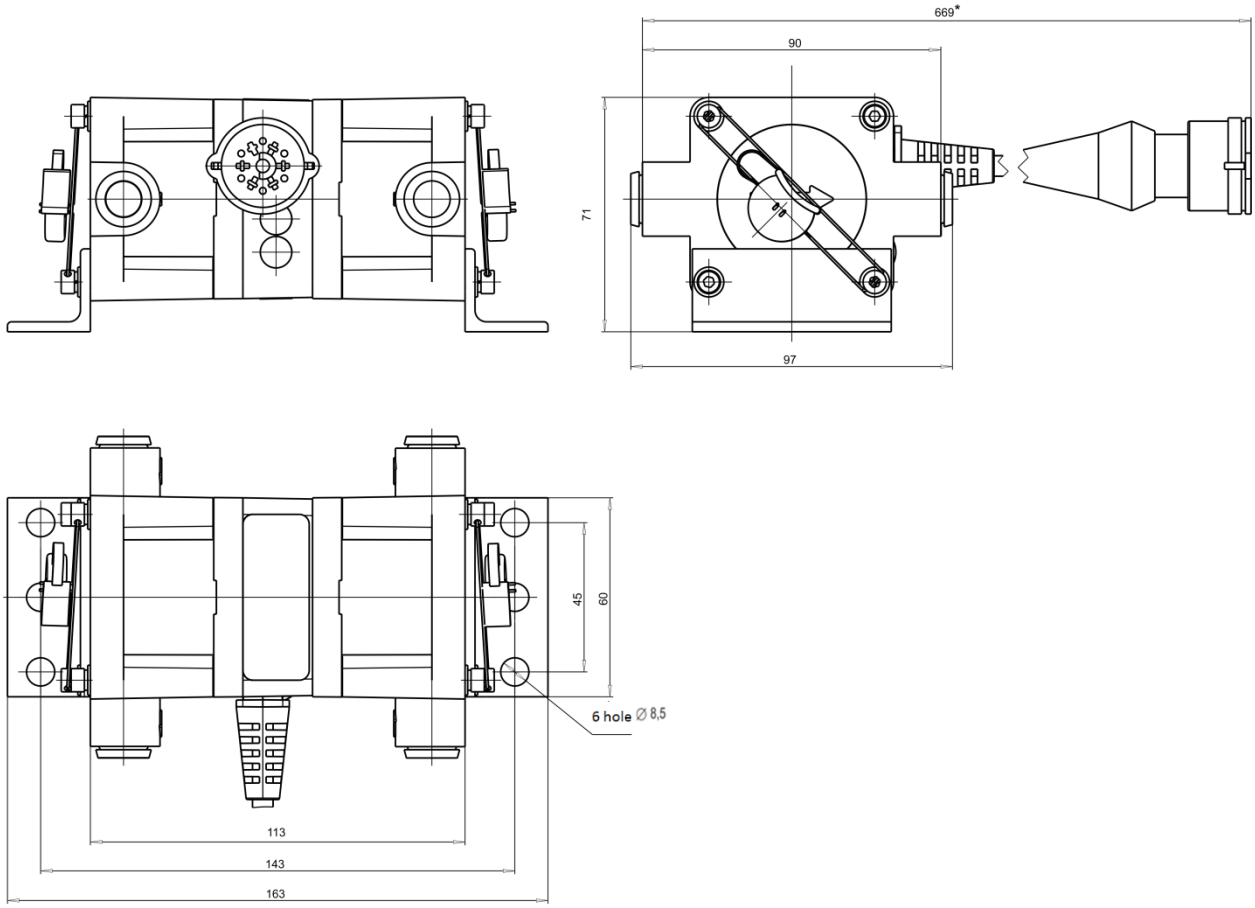


DFM 100DK/D232/D485/DCAN
DFM 100CD



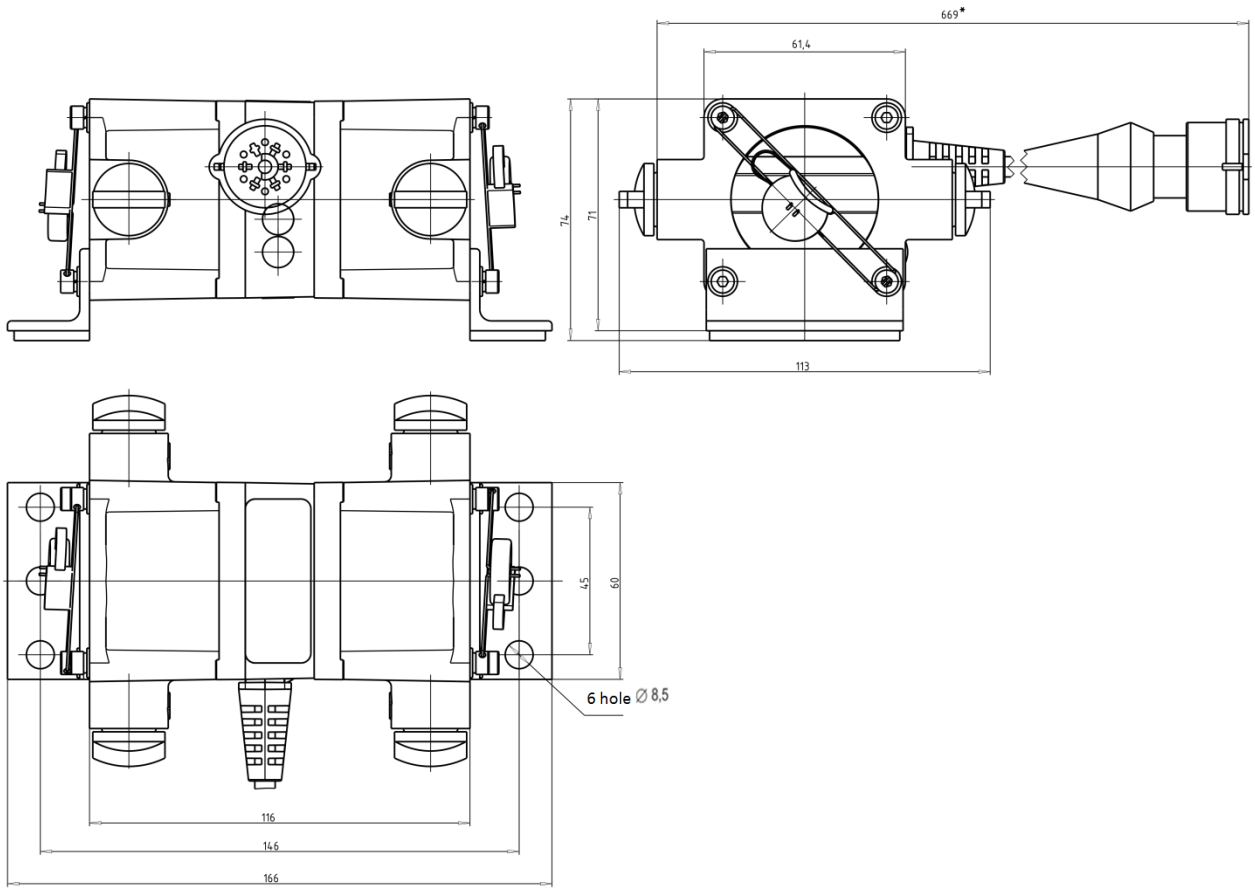
***** Applicable only for DFM 100DK/D232/D485/DCAN

DFM 250DK/D232/D485/DCAN
DFM 250CD



***** Applicable only for DFM 250DK/D232/D485/DCAN

DFM 500DK/D232/D485/DCAN
DFM 500CD



***** Applicable only for DFM 500DK/D232/D485/DCAN

Table A.1 — DFM weight

Model	Weight, kg, not more than
DFM 50AK **DFM 50A232** **DFM 50A485** **DFM 50ACAN** **DFM 50B** **DFM 50C** **DFM 50CK** **DFM 50C232** **DFM 50C485** **DFM 50CCAN**	0.8
DFM 100AK **DFM 100A232** **DFM 100A485** **DFM 100ACAN** **DFM 100B** **DFM 100C** **DFM 100CK** **DFM 100C232** **DFM 100C485** **DFM 100CCAN**	
DFM 250AK **DFM 250A232** **DFM 250A485** **DFM 250ACAN** **DFM 250B** **DFM 250C** **DFM 250CK** **DFM 250C232** **DFM 250C485** **DFM 250CCAN**	1.2
DFM 500AK **DFM 500A232** **DFM 500A485** **DFM 500ACAN** **DFM 500C** **DFM 500CK** **DFM 500C232** **DFM 500C485** **DFM 500CCAN**	1.5
DFM 100DK **DFM 100CD** **DFM 100D232** **DFM 100D485** **DFM 100DCAN**	1.7
DFM 250DK **DFM 250CD** **DFM 250D232** **DFM 250D485** **DFM 250DCAN**	2.4
DFM 500DK **DFM 500CD** **DFM 500D232** **DFM 500D485** **DFM 500DCAN**	3.3

Annex B

Vehicle inspection report

_____/ _____ /20___
Date Month Year

We, the undersigned representatives of the Customer
_____,
and representatives of the Contractor
_____,
have conducted vehicle (installation) inspection

Vehicle type _____
Brand, model _____
Registration number _____
for conformity to DFM installation requirements, and have concluded the following:

Requirement	Conforms/ Does not conform	Notes
Leakage resistance of the fuel system		Measurement accuracy and DFM performance is not guaranteed in case of a leakage in the fuel system. Fuel system repair is recommended to eliminate leaks
Pressure of the fuel supply system		DFM performance is not guaranteed in case of an insufficient pressure in the fuel system. Maintenance of the fuel pump is recommended.
Injectors return flow rate		Injectors return flow being higher than normal can significantly affect measurement accuracy. Injectors maintenance or replacement is recommended.
Onboard voltage		DFM performance is not guaranteed in case of insufficient power supply voltage. Maintenance of the onboard power supply network and/or generator.
Chassis ground switch condition		DFM performance is not guaranteed in case of significant resistance/oxidation ot the switch. Maintenance or replacement is recommended.

representative of the CUSTOMER:

_____

name, signature

representative of the CONTRACTOR:

_____

name, signature

Annex C

Template of check test report

_____/ _____ /20___
Date Month Year

Vehicle type, model, registration number	
DFM model, serial number	

Fuel consumption	Actual fuel consumption. according to calibrated container V_m , liters	
	Fuel consumption measured According to DFM reading $V_{measured}$, liters	
Relative error of fuel consumption measurement	$\delta = \frac{V_{measured} - V_m}{V_m} \cdot 100\%$, %	
Actual fuel amount from injectors return line	$V_{inj.return}$, liters	
Proportion of the return flow from the injectors in overall fuel consumption	$\frac{V_{inj.return}}{V_m} \cdot 100\%$, %	

Resume:

Fuel consumption measurement **corresponds /does not correspond** to the technical specification.

Comments:

_____

_____

_____

representative of the CUSTOMER:

_____

name, signature

representative of the CONTRACTOR:

_____

name, signature

Annex D

Register map of DFM output messages under Modbus protocol

See Table D.1 for Register map of DFM output messages under Modbus protocol.
Check http://s6.jv-technoton.com for detailed data on SPN (J1939)

Table D.1 — Register map of DFM output messages under Modbus protocol

Register address	Register contents	Corresponding SPN (J1939)	Specifier
0	Engine Fuel Rate	183	
1	Engine Total Fuel Used (high word)	250	
2	Engine Total Fuel Used (low word)	250	
3	Engine Fuel Temperature 1	174	
4	High Resolution Engine Total Fuel Used (high word)	5054	
5	High Resolution Engine Total Fuel Used (low word)	5054	
6	Engine Total Idle Fuel Used (high word)	236	
7	Engine Total Idle Fuel Used (low word)	236	
8	Engine Total Idle Hours (high word)	235	
9	Engine Total Idle Hours (low word)	235	
10	Engine Total Average Fuel Rate	1834	
11	Engine Mode by Fuel Rate	521181	
12	Chamber Fuel Rate in Supply chamber	521027	18.0
13	Chamber Fuel Rate in Return chamber	521027	18.1
14	Chamber Working Mode. Supply chamber	521028	18.0
15	Chamber Working Mode. Return chamber	521028	18.1
16	High Resolution Engine Total Fuel Used (high word)	5054	9.0
17	High Resolution Engine Total Fuel Used (low word)	5054	9.0
18	High Resolution Engine Total Fuel Used (high word)	5054	9.1
19	High Resolution Engine Total Fuel Used (low word)	5054	9.1
20	High Resolution Engine Total Fuel Used (high word)	5054	9.1

Table D.1 continued

Register address	Register contents	Corresponding SPN (J1939)	Specifier
21	High Resolution Engine Total Fuel Used (low word)	5054	9.2
22	High Resolution Engine Total Fuel Used (high word)	5054	9.3
23	High Resolution Engine Total Fuel Used (low word)	5054	9.3
24	High Resolution Engine Total Fuel Used (high word)	5054	9.4
25	High Resolution Engine Total Fuel Used(low word)	5054	9.4
26	Engine hours of operation (high word)	521171	
27	Engine hours of operation (low word)	521171	
28	Engine hours of operation (high word)	521171	9.0
29	Engine hours of operation (low word)	521171	9.0
30	Engine hours of operation (high word)	521171	9.1
31	Engine hours of operation (low word)	521171	9.1
32	Engine hours of operation (high word)	521171	9.1
33	Engine hours of operation (low word)	521171	9.2
34	Engine hours of operation (high word)	521171	9.3
35	Engine hours of operation (low word)	521171	9.3
36	Engine hours of operation (high word)	521171	9.4
37	Engine hours of operation (low word)	521171	9.4
38	Engine hours of operation (high word)	521171	9.5
39	Engine hours of operation (low word)	521171	9.5
40	High Resolution Engine Total Fuel Used (high word)	5054	18.0
41	High Resolution Engine Total Fuel Used (low word)	5054	18.0
42	High Resolution Engine Total Fuel Used (high word)	5054	18.0, 9.0
43	High Resolution Engine Total Fuel Used (low word)	5054	18.0, 9.0
44	High Resolution Engine Total Fuel Used (high word)	5054	18.0, 9.1
45	High Resolution Engine Total Fuel Used (low word)	5054	18.0, 9.1
46	High Resolution Engine Total Fuel Used (high word)	5054	18.0, 9.2
47	High Resolution Engine Total Fuel Used (low word)	5054	18.0, 9.2
48	High Resolution Engine Total Fuel Used (high word)	5054	18.0, 9.3
49	High Resolution Engine Total Fuel Used (low word)	5054	18.0, 9.3

Table D.1 continued

Register address	Register contents	Corresponding SPN (J1939)	Specifier
50	Flowmeter Chamber Time Counter (low word)	521189	18.0
51	Flowmeter Chamber Time Counter (high word)	521189	18.0
52	Flowmeter Chamber Time Counter (low word)	521189	18.0, 9.0
53	Flowmeter Chamber Time Counter (high word)	521189	18.0, 9.0
54	Flowmeter Chamber Time Counter (low word)	521189	18.0, 9.1
55	Flowmeter Chamber Time Counter (high word)	521189	18.0, 9.1
56	Flowmeter Chamber Time Counter (low word)	521189	18.0, 9.2
57	Flowmeter Chamber Time Counter (high word)	521189	18.0, 9.2
58	Flowmeter Chamber Time Counter (low word)	521189	18.0, 9.3
59	Flowmeter Chamber Time Counter (high word)	521189	18.0, 9.3
60	High Resolution Engine Total Fuel Used (high word)	5054	18.1
61	High Resolution Engine Total Fuel Used (low word)	5054	18.1
62	High Resolution Engine Total Fuel Used (high word)	5054	18.1, 9.0
63	High Resolution Engine Total Fuel Used (low word)	5054	18.1, 9.0
64	High Resolution Engine Total Fuel Used (high word)	5054	18.1, 9.1
65	High Resolution Engine Total Fuel Used (low word)	5054	18.1, 9.1
66	High Resolution Engine Total Fuel Used (high word)	5054	18.1, 9.2
67	High Resolution Engine Total Fuel Used (low word)	5054	18.1, 9.2
68	High Resolution Engine Total Fuel Used (high word)	5054	18.1, 9.3
69	High Resolution Engine Total Fuel Used (low word)	5054	18.1, 9.3
70	Flowmeter Chamber Time Counter (low word)	521189	18.1
71	Flowmeter Chamber Time Counter (high word)	521189	18.1
72	Flowmeter Chamber Time Counter (low word)	521189	18.1, 9.0
73	Flowmeter Chamber Time Counter (high word)	521189	18.1, 9.0
74	Flowmeter Chamber Time Counter (low word)	521189	18.1, 9.1
75	Flowmeter Chamber Time Counter (high word)	521189	18.1, 9.1
76	Flowmeter Chamber Time Counter (low word)	521189	18.1, 9.2
77	Flowmeter Chamber Time Counter (high word)	521189	18.1, 9.2
78	Flowmeter Chamber Time Counter (low word)	521189	18.1, 9.3
79	Flowmeter Chamber Time Counter (high word)	521189	18.1, 9.3
80	Engine total average fuel rate *	1834	
81	Engine total average fuel economy *	1835	
* For DFM with firmware version 4.32 and higher.			

Annex E

DFM COM data transfer protocol

E.1 Application

The present protocol is used for data exchange of DFM 232 and DFM 485 fuel flow meters designed by JV Technoton, Minsk, BELARUS.

E.2 General info

Data exchange on physical and channel level is implemented according to ANSI/TIA-485-A and TIA/EIA 232-F standards.

Addressing on RS-485 bus is according to flow meter network address. Default factory address value is 111.

Master-slave operation mode of DFM is supported. The only one flow meter in the bus can be defined as Master.

Data exchange interval between bytes should not exceed 100 ms.

E.3 Session

The following data exchange options are available through DFM settings:

1) Automatic data transmission. Interval of data transmission can be configured. This is a default data transmission mode set on the factory. Interval is 1 second by default.

2) Request-Response data exchange mode. Flow meter acts as Slave. Time intervals should be observed during data exchange.

Table E.1 — Time intervals

Time intervals	Min, ms	Max, ms
Time between Request and Response	1	300
Time between Response and next Request	3	500

E.4 Automatic data transmission

Three formats of automatic data transmission are available:

1) HEX — data is transferred in hexadecimal format (HEX).

Table E.2 — Format of automatic data transmission message

0x3e	Adr	Fmt	Data	CS
1 byte	1 byte	0x06	5 bytes	1 byte

Adr field contains flow meter address. **Fmt** field has constant value of 0x06 which defines Response message.

Data field values are listed in Table E.5.

See E.6 for **CS** checksum calculation instructions.

2) ASCII — data is transferred in character mode (ASCII character codes).

For example, Q=10000.250 B=60.5 t=20<CR><LF>

Q is high resolution total fuel consumption value, liters;

B is instant value of hourly fuel consumption rate, liters/hour;

t – actual temperature value, °C.

3) ASCII-EXT — data is transferred in character mode (ASCII character codes) together with Prefix and Postfix:

For example, <prefix>10000.250< postfix ><CR><LF>

<prefix> is a message header, max 32 characters

<postfix> is message footer max 32 characters

Characters transmitted between Prefix and Postfix stand for a total fuel consumption counter value in liters.

Prefix and Postfix are set with Service S6 DFM configuration utility.

E.5 Request-Response data exchange mode

1) Request

Table E.3 — Request format

0x31	Adr	Fmt	Data	CS
1 byte	1 byte	1 byte	from 0 to 128 bytes	1 byte

Adr field contains address of the flow meter the request is addressed to.

Address byte value 255 means Request broadcast to all the possible addresses.

Fmt field defines Request type. Types are listed in Table E.5.

Data field values are listed in Table E.5.

See E.6 for **CS** checksum calculation instructions.

2) Response

Table E.4 — Response format

0x3e	Adr	Fmt	Data	CS
1 byte	1 byte	1 byte	from 0 to 128 bytes	1 byte

Adr field contains address of the flow meter sending the Response.

Fmt field defines Request type the Response is sent on.

Data field values are listed in Table E.5.

See E.6 for **CS** checksum calculation instructions.

Table E.5 — Requests and Responses

#	Request					Response – Data field		
	Fmt		Data					
	Value	Description	Type	Description	Resolution step	Type	Description	Resolution step
1	0x06	Reading parameters	-	-	-	S8 U16 U16	Temperature Total fuel consumption Hourly fuel consumption rate	1 °C 1 L 0.1 L/h
2	0x23	Reading operation parameters	-	-	-	U8 U16 U8 U32 U32 U32 U32 U32 U32 U32 U32 U32 U32 U32	Fuel temperature Hourly fuel consumption rate Engine operation mode according to flow rate High resolution total fuel consumption High resolution total fuel consumption in Idle mode High resolution total fuel consumption in Optimal mode High resolution total fuel consumption in Overload mode High resolution total fuel consumption in Cheat (Tampering) mode Engine working time Engine working time in Idle mode Engine working time in Optimal mode Engine working time in Overload mode Engine working time in Cheat (Tampering) mode Engine working time in Interference mode	1 °C 0.05 l/h 1 0.001 L 0.001 L 0.001 L 0.001 L 0.001 L 1 s 1 s 1 s 1 s 1 s 1 s
	Types: U8 – unsigned 8-bit value S8 – signed 8-bit value U16 – unsigned 16-bit value U32 – unsigned 32-bit value							

Malfunction code will be transmitted through temperature field value if there any malfunction of DFM is self-detected (see table E.6).

Table E.6 — Malfunction codes of DFM

Code	Malfunction description
120 (-128)	DFM error
121 (-127)	Battery charge level is less than 10 %
122 (-126)	Interference event
123 (-125)	Cheat (tampering) event

E.6 Checksum

Checksum is calculated with a polynomial for each byte of the message (excluding checksum) a^8+a^5+a^4+1.

CRC can be calculated using an algorithm (C programming language):

1)

```
U8 CRC8(U8 data, U8 crc)
{
        U8 i = data ^ crc;
        crc = 0;
        if(i & 0x01) crc ^= 0x5e;
        if(i & 0x02) crc ^= 0xbc;
        if(i & 0x04) crc ^= 0x61;
        if(i & 0x08) crc ^= 0xc2;
        if(i & 0x10) crc ^= 0x9d;
        if(i & 0x20) crc ^= 0x23;
        if(i & 0x40) crc ^= 0x46;
        if(i & 0x80) crc ^= 0x8c;
        return crc;
}
```

2)

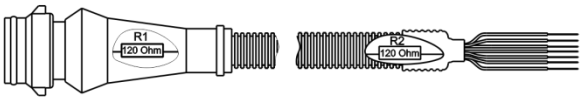
```
U8 CRC8 (U8 b, U8 crc)
{
        U8 i = 8;
        do {
                if ( (b ^ crc) & 0x01) {
                crc = ( (crc ^ 0x18) >> 1 ) | 0x80;
        } else {
                crc >>= 1;
        }
        b >>= 1;
        } while (--i);
        return crc;
}
```

3) Table method described in Dallas APPLICATION NOTE 27: Understanding and Using Cyclic Redundancy Checks with Dallas Semiconductor iButton Products.

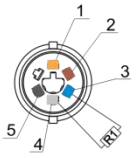
Annex F

Signal cables

S6 SC-CW-700 Cable



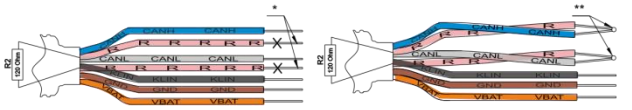
Cable length 700±5 cm.



Pin	Wire color	Circuit
1	orange	VBAT
2	brown	GND
3	blue	CANH
4	white	CANL
5	black	KLIN
6	-	-

Connecting

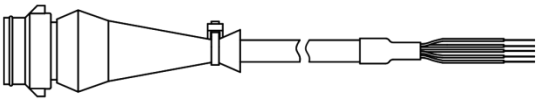
without built-in terminal resistor R2 | with built-in terminal resistor R2



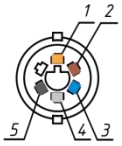
* Do not connect R2 resistor wires (pink, identification mark R), insulate.

** Connect electrically one of the R2 resistor wires (pink, identification mark R) with CANH wire, and the other - with CANL wire.

SC-CW-700-RS Cable

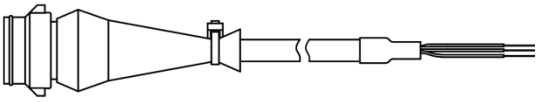


Cable length 700±5 cm.

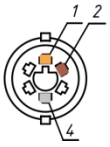


Pin	Wire color	Circuit
1	orange	VBAT
2	brown	GND
3	blue	TX/B
4	white	RX/A/imp
5	black	KLIN
6	-	-

CABLE DFM.98.20.003 Cable



Cable length 750±5 cm.



Pin	Wire color	Circuit
1	orange	VBAT
2	brown	GND
3	-	-
4	white	imp
5	-	-
6	-	-

Annex G

DFM CAN connection options

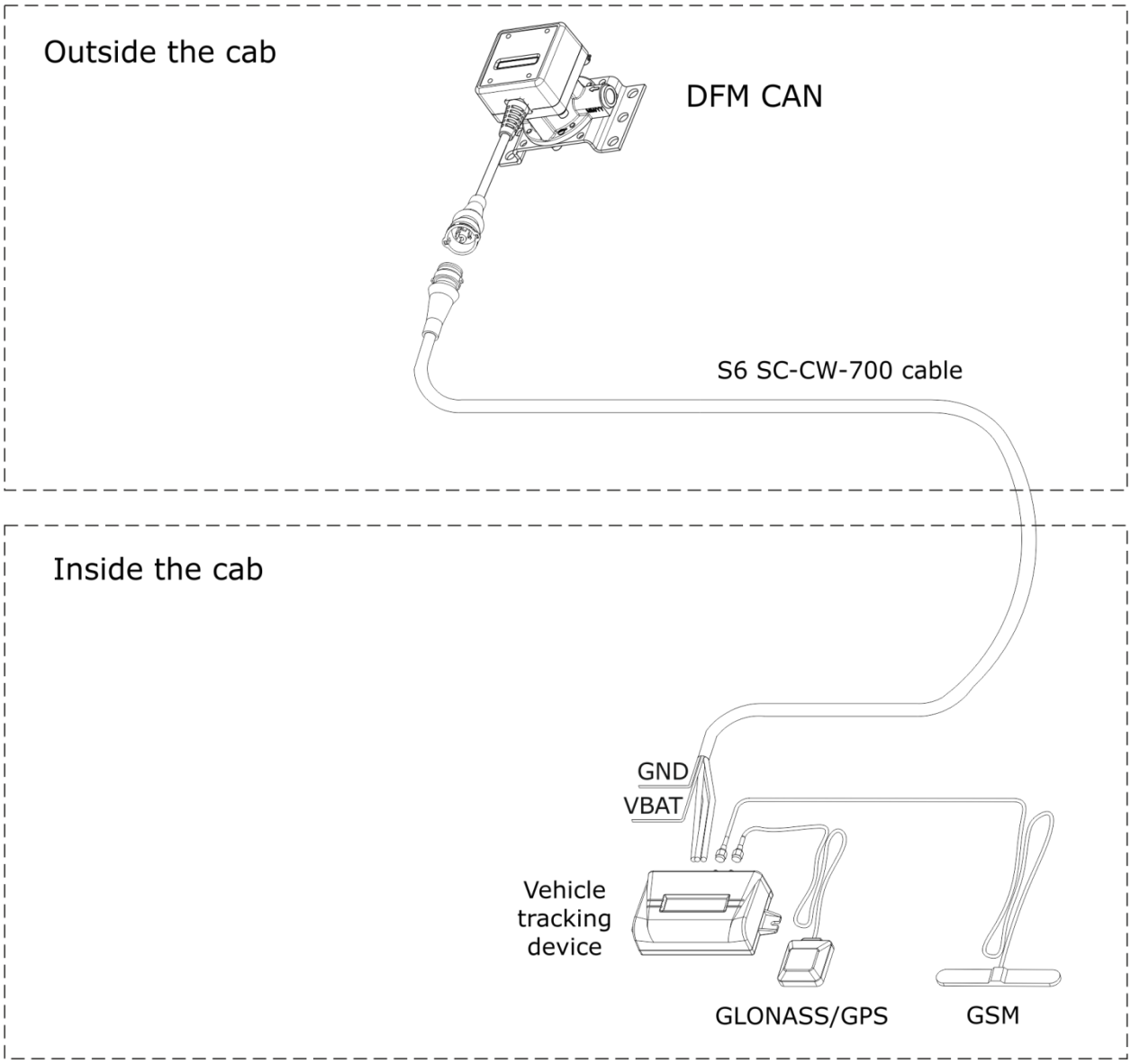


Figure G.1 — Connection of single DFM CAN to recording and display unit non-compatible with S6 cable system

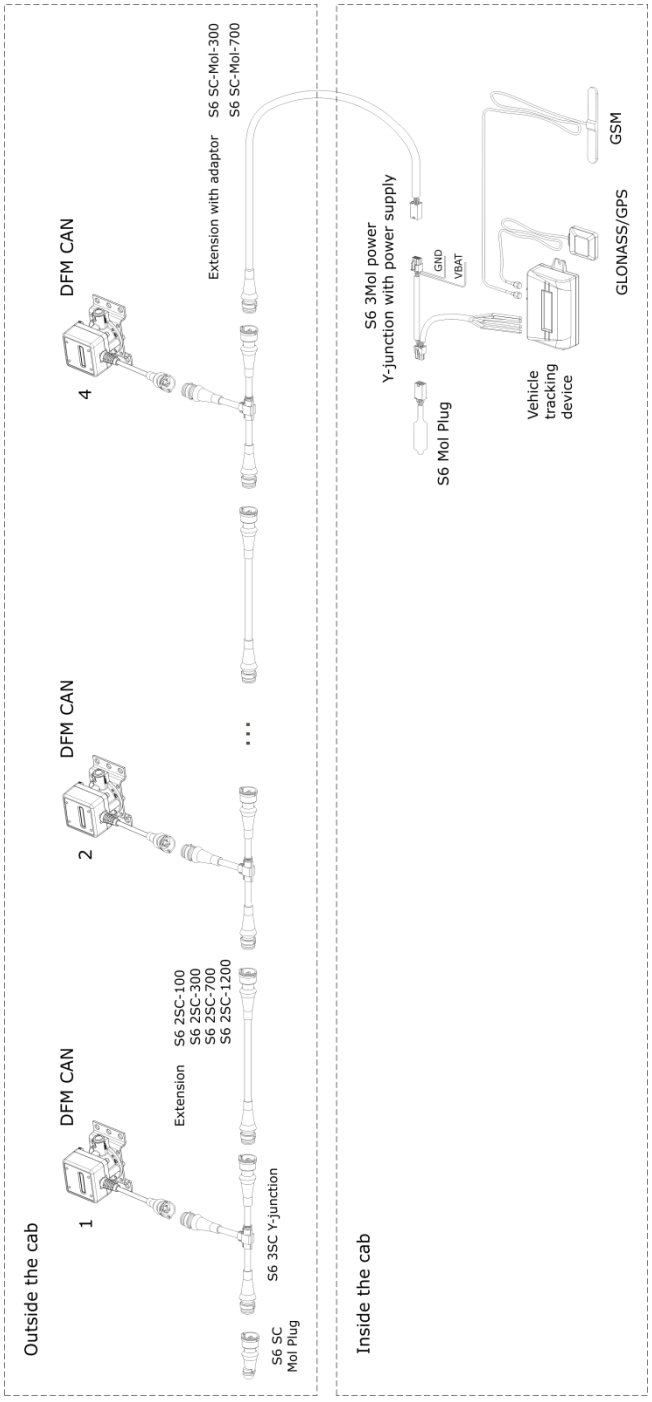


Figure G.2 — Connection of several DFM CAN to recording and display unit non-compatible with S6 cable system

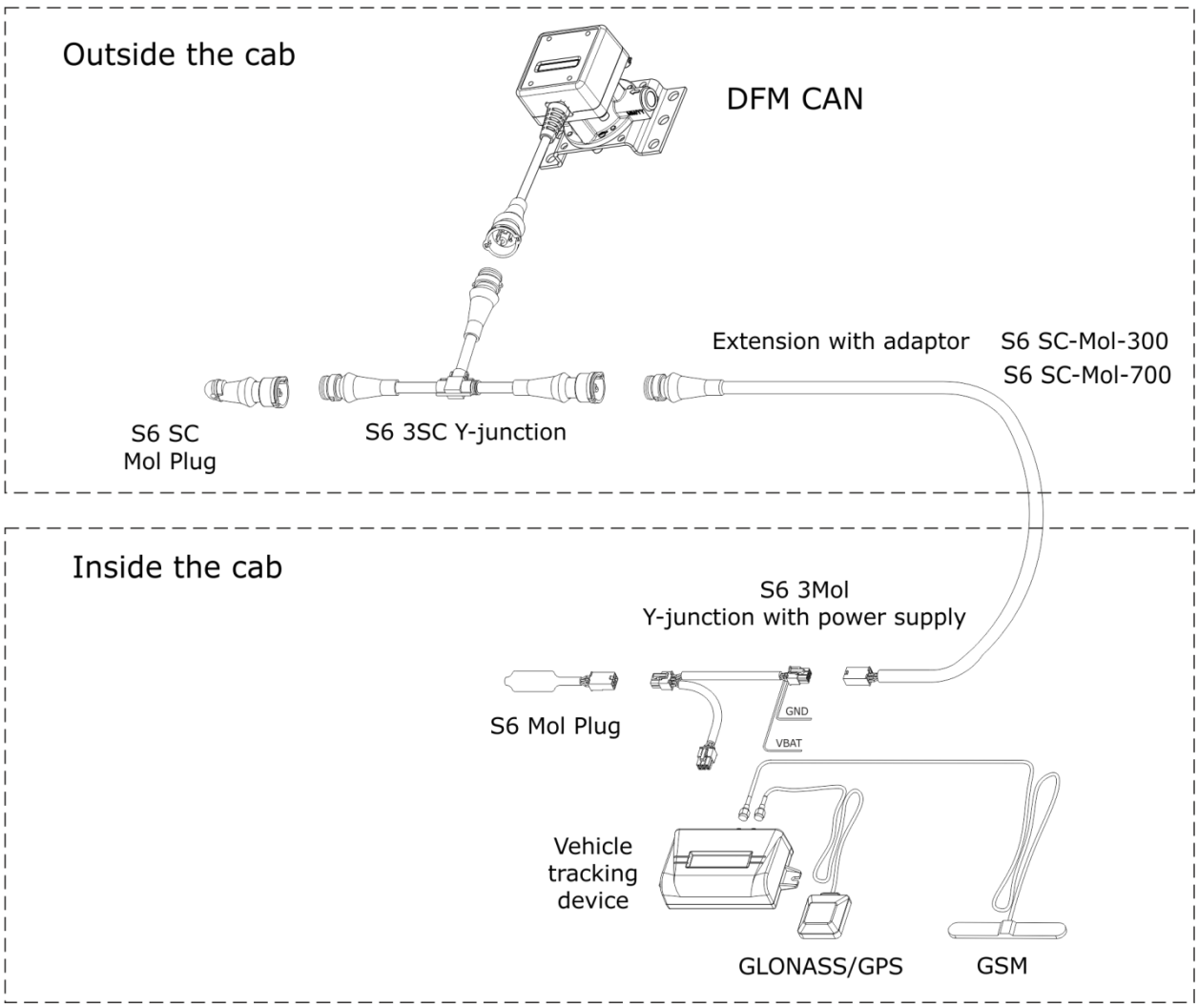


Figure G.3 — Connection of single DFM CAN to recording and display unit compatible with S6 cable system

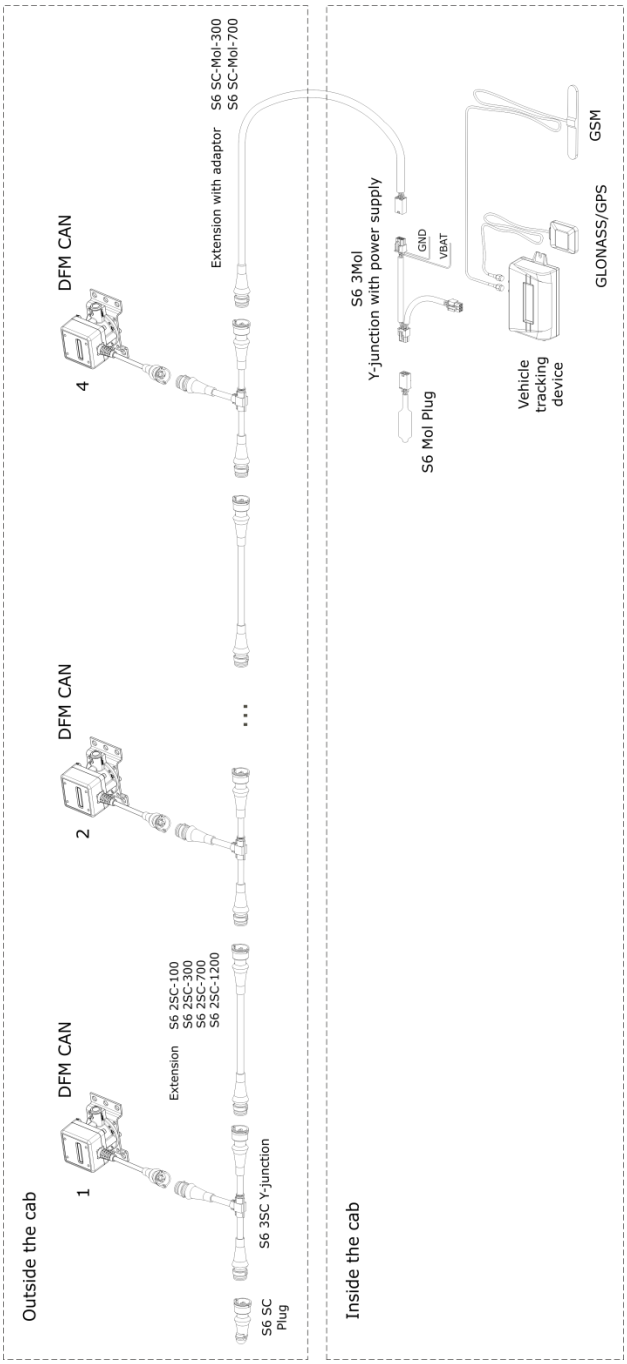


Figure G.4 — Connection of several DFM CAN to recording and display unit compatible with S6 cable system

Annex H

SPN of DFM Functional Modules

Hourly (instant) fuel consumption measurement, Counters, Events registration, Parameters configuration and self-diagnostics of DFM is ensured by coordinated operation of its Functional Modules (FM).

SPN format of DFM FM is in accordance with Database (DB) of Telematics Interface S6.

The following FM are included in DFM fuel flow meters:

1) FM Self-diagnostics — designed for user authorization, identification of DFM passport data, operation time recording and also active and saved malfunctions.

Table H.1 — FM Self-diagnostics. SPN. SPNs, displayed and/or editable in Service S6 DFM software

SPN	Name	Factory value	Unit of measure	Clarification
Unit passport PGN 62995				
521120	Serial number	On the fact	No	Serial number is a set of numbers that is used for identification of specific DFM. Serial number DFM has the following format: AABBB C DDDDD, where: AA – code of DFM model; BBB – digits that reflect changes product changes; C – Manufacturer code; DDDDD – sequential number. Setting is not available for editing.
521345	Model	On the fact	No	Model – this is version of the sensor inside of DFM product line. Each model has its own functional and constructive features. Setting is not available for editing.
521123	Line	DFM	No	Name of the product line. The line represents a group of similar products – fuel flow meters produced under general trademark DFM. Setting is not available for editing.
521344	Brand	TECHNOTON	No	Name of DFM Manufacturer. Setting is not available for editing.
521121	Firmware version	On the fact	No	Version of built in Software DFM. Setting is not available for editing.
521125	Manufacturing date	On the fact	No	Date (day, month, year) of DFM production. Setting is not available for editing.
521188	S6 address (SA)	111	No	Network DFM address at Telematics interface S6. Network address value can be selected by user in range: 111…118.
Unit work counters PGN 62994				
521116	Unit hours of operation	On the fact	s	Counter of summarized working time of the DFM since its production moment. The user can not reset the value of this counter. It can be reset by the Manufacturer or RSC only.
521118	Unit reset counter	On the fact	pc.	Counter of DFM's processor restarts at a time when the power is On or there is an impact of conducted interferences of the vehicle's on-board network. Restarts accounting is carried out since production date of the DFM. The user can not reset the value of this counter. It can be reset by the Manufacturer or RSC only.

SPN	Name	Factory value	Unit of measure	Clarification
Passwords PGN 63017				
521593/3.3	Password/ 3.3 Installer	1111	No	Password is entered for user authorization while establishing connection session between fuel flow meter and service Software for configuring the DFM. Password is a specific combination of four digits. By default used: Login – 0, password – 1111. User can change password of the DFM. After entering and confirming the new password is recorded into internal memory of the DFM.
Active diagnostic trouble codes PGN 65226				
521044	Fault identifier (SID)	On the fact	No	List of current DFM malfunctions are displayed at the settings field (in case of its presence — up to 10). For each active malfunction is indicated following: - faulty nod; - malfunction name. This setting allows to monitor DFM working performance. In case of lack of active malfunctions the following message is displayed “No malfunctions”.
Previously active diagnostic trouble codes PGN 65227				
521044	Fault identifier (SID)	On the fact	No	List of saved DFM malfunctions are displayed at the settings field (in case of its presence — up to 20). For each saved malfunction is indicated following: - faulty nod; - malfunction name; - malfunction counter. This setting allows to monitor DFM working performance. In case of lack of saved malfunctions the following message is displayed “No malfunctions”.

2) FM Onboard Clock — designed for generation of signals of time and its transmission to other functional modules DFM.

Table H.2 — FM Onboard Clock. SPNs, displayed and/or editable in Service S6 DFM software

SPN	Name	Factory value	Unit of measure	Range	Clarification
Time/Date PGN 65254					
959	Seconds	On the fact	s	0…62.5	Present time — seconds. Used during Events registration. Present time is available for user for editing manually or synchronizing of date/time with computer clock. By default time is set in UTC format (Coordinated Universal Time standard) and displayed according to local displacement.
960	Minutes	On the fact	Min	0…250	Present time — minutes. Used during Events registration. Present time is available for user for editing manually or synchronizing of date/time with computer clock. By default time is set in UTC format (Coordinated Universal Time standard) and displayed according to local displacement.

SPN	Name	Factory value	Unit of measure	Range	Clarification
961	Hours	On the fact	h	0…250	Present time — hours. Used during Events registration. Present time is available for user for editing manually or synchronizing of date/time with computer clock. By default time is set in UTC format (Coordinated Universal Time standard) and displayed according to local displacement.
963	Month	On the fact	month	0…250	Present date — month. Used during Events registration. Present time is available for user for editing manually or synchronizing of date/time with computer clock. By default time is set in UTC format (Coordinated Universal Time standard) and displayed according to local displacement.
962	Day	On the fact	d	0…62.5	Present date — day. Used during Events registration. Present time is available for user for editing manually or synchronizing of date/time with computer clock. By default time is set in UTC format (Coordinated Universal Time standard) and displayed according to local displacement.
964	Year	On the fact	year	1985…2235	Present date — year. Used during Events registration. Present time is available for user for editing manually or synchronizing of date/time with computer clock. By default time is set in UTC format (Coordinated Universal Time standard) and displayed according to local displacement.
1601	Local minute offset	0	min	0…59 min	Time displacement (in minutes) in relation to Coordinated Universal Time that matches with local time (Time zone). It is activated and available for editing when configuring present time manually and when synchronizing time with PC.
1602	Local hour offset	+3	h	-24…+24 h	Time displacement (in hours) in relation to Coordinated Universal Time that matches with local time (Time zone). It is activated and available for editing when configuring present time manually and when synchronizing time with PC.
Time origin settings PGN 63011					
521350	Automatic daylight savings time and back	Off	No	On/Off	Daylight saving time automatic adjustment ON/OFF.

3) FM Flowmeter — shows hourly (instant) fuel consumption, total fuel consumption and engine operation time – in total and in several operation modes.

Table H.3 — FM Flowmeter. SPN, displayed and/or editable via Service S6 DFM software

SPN	Name	Factory value	Unit of measure	Clarification
Flowmeter. Parameters PGN 62981				
183	Engine fuel rate	On the fact	l/h	Hourly rate consumption of fuel, going through measuring chamber of DFM (applicable for one-chamber). For differential DFM – hourly rate of differential consumption of fuel, going through both measuring chambers.
521181	Engine mode by fuel rate	On the fact	No	Current operation mode of fuel consumer, correspondent to hourly rate of fuel consumption (applicable for one-chamber DFM). For differential DFM - current operation mode of fuel consumer, correspondent to hourly differential rate of fuel consumption.
521027/18.0	Chamber fuel rate/ 18.0 Feed chamber	On the fact	l/h	Rate of instant consumption of fuel, going through "Direct" chamber of differential flow meter.
5210281/18.0	Chamber working mode/ 18.0 Feed chamber	On the fact	No	Current operation mode of fuel consumer, correspondent to hourly rate of fuel consumption in "Direct" chamber of differential fuel flow meter.
521027/18.1	Chamber fuel rate/ 18.1 Reverse chamber	On the fact	l/h	Rate of instant consumption of fuel, going through "Reverse" chamber of differential flow meter.
5210281/18.1	Chamber working mode/ 18.1 Reverse chamber	On the fact	No	Current operation mode of fuel consumer, correspondent to hourly rate of fuel consumption in "Reverse" chamber of differential fuel flow meter.
Flowmeter. Counters 1 PGN 62992				
5054	High resolution engine total fuel used	On the fact	l	"Total fuel consumption, L" Counter, i.e. overall fuel consumption of the Vehicle in all operation modes including "Idle". The Counter is increasing from the date of flow meter production and cannot be reset by user.
5054/9.0	High resolution engine total fuel used/ 9.0 Idle	On the fact	l	"Total fuel consumption in Idle mode, L" Counter, i.e. overall fuel consumption of the Vehicle in "Idle" operation mode. The Counter is increasing from the date of flow meter production and cannot be reset by user.
5054/9.1	High resolution engine total fuel used/ 9.1 Optimal	On the fact	l	"Total fuel consumption in Optimal mode, L" Counter, i.e. overall fuel consumption of the Vehicle in "Optimal" operation mode. The Counter is increasing from the date of flow meter production and cannot be reset by user.
5054/9.2	High resolution engine total fuel used/ 9.2 Overload	On the fact	l	"Total fuel consumption in Overload mode, L" Counter, i.e. overall fuel consumption of the Vehicle in "Overload" operation mode. The Counter is increasing from the date of flow meter production and cannot be reset by user.
5054/9.3	High resolution engine total fuel used/ 9.3 Cheat	On the fact	l	"Total fuel consumption in Tampering mode, L" Counter, i.e. overall fuel consumption, which was higher than configured highest boundary of fuel consumption rate for installed flow meter. Increasing numbers on the Counter can mean either possible fuel line intervention or incorrect installation of fuel flow meter. The Counter is increasing from the date of flow meter production and cannot be reset by user.
5054/9.4	High resolution engine total fuel used/ 9.4 Negative	On the fact	l	"Total "Negative" fuel consumption" Counter, i.e. overall fuel consumption of Vehicle, when fuel consumption in reverse chamber was higher than in direct chamber of fuel flow meter. The Counter can be found only in differential fuel flow meters. "Total "Negative" fuel consumption" Counter increasing numbers can mean increased volume of foam in reverse fuel line when Vehicle is operated at higher RPMs. The reason of foam volume growing is air presence in reverse fuel line cause by not tight hose connections or specifics of fuel system of Vehicle.

SPN	Name	Factory value	Unit of measure	Clarification
521171	Engine hours of operation	On the fact	s	"Engine operation time, h" Counter, i.e. overall vehicle's engine operation time in various operation modes , including operation time in "Idle" mode. The Counter is increasing from the date of flow meter production and cannot be reset by user.
521171/9.0	Engine hours of operation/ 9.0 Idle	On the fact	s	"Engine operation time (Idle), h" Counter, i.e. overall vehicle's engine operation time in "Idle" mode. The Counter is increasing from the date of flow meter production and cannot be reset by user.
521171/9.1	Engine hours of operation/ 9.1 Optimal	On the fact	s	"Engine operation time (Optimal), h" Counter, i.e. overall vehicle's engine operation time in "Optimal" mode. The Counter is increasing from the date of flow meter production and cannot be reset by user.
521171/9.2	Engine hours of operation/ 9.2 Overload	On the fact	s	"Engine operation time (Overload), h" Counter, i.e. overall vehicle's engine operation time in "Overload" mode. The Counter is increasing from the date of flow meter production and cannot be reset by user.
521171/9.3	Engine hours of operation/ 9.3 Cheat	On the fact	s	"Engine operation time (Tampering), h" Counter, i.e. overall vehicle's engine operation time when fuel consumption was higher than configured highest boundary of fuel consumption rate for installed flow meter. The Counter is increasing from the date of flow meter production and cannot be reset by user.
521171/9.4	Engine hours of operation/ 9.4 Negative	On the fact	s	"Engine operation time ("Negative" consumption), h" Counter, i.e. overall vehicle's engine operation time when fuel consumption in reverse chamber was higher than in direct chamber of fuel flow meter. The Counter can be found only in differential fuel flow meters. The Counter is increasing from the date of flow meter production and cannot be reset by user.
521171/9.5	Engine hours of operation/ 9.5 Interference	On the fact	s	"Engine operation time (Interference), h" Counter, i.e. overall time of external factors influence (e.g. magnetic field), which prevent normal functioning of DFM. The Counter is increasing from the date of flow meter production and cannot be reset by user.
Flowmeter. Counters 2 PGN 62993				
174	Engine fuel temperature 1	On the fact	°C	Current temperature of fuel in measurement chamber.
5054/18.0	High resolution engine total fuel used/ 18.0 Feed chamber	On the fact	l	"Total fuel consumption, L" Counter, i.e. overall Vehicle's fuel consumption in "Direct" chamber of differential fuel flow meter for all operation modes, including "Idling" mode. The Counter is increasing from the date of flow meter production and cannot be reset by user.
5054/9.0/18.0	High resolution engine total fuel used/ 9.0 Idle/ 18.0 Feed chamber	On the fact	l	"Total fuel consumption (Idle), L" Counter, i.e. overall Vehicle's fuel consumption in "Direct" chamber of differential fuel flow meter in "Idling" operation mode. The Counter is increasing from the date of flow meter production and cannot be reset by user.
5054/9.1/18.0	High resolution engine total fuel used/ 9.1 Optimal/ 18.0 Feed chamber	On the fact	l	"Total fuel consumption (Optimal), L" Counter, i.e. overall Vehicle's fuel consumption in "Direct" chamber of differential fuel flow meter in "Optimal" operation mode. The Counter is increasing from the date of flow meter production and cannot be reset by user.
5054/9.2/18.0	High resolution engine total fuel used/ 9.2 Overload/ 18.0 Feed chamber	On the fact	l	"Total fuel consumption (Overload), L" Counter, i.e. overall Vehicle's fuel consumption in "Direct" chamber of differential fuel flow meter in "Overload" operation mode. The Counter is increasing from the date of flow meter production and cannot be reset by user.
5054/9.3/18.0	High resolution engine total fuel used/ 9.3 Cheat/ 18.0 Feed chamber	On the fact	l	"Total fuel consumption (Tampering), L" Counter, i.e. overall Vehicle's fuel consumption in "Direct" chamber of differential fuel flow meter when fuel consumption was higher than configured highest boundary of fuel consumption rate for installed flow meter. The Counter is increasing from the date of flow meter production and cannot be reset by user.

SPN	Name	Factory value	Unit of measure	Clarification
5054/18.1	High resolution engine total fuel used/ 18.1 Reverse chamber	On the fact	l	"Total fuel consumption, L" Counter, i.e. overall Vehicle's fuel consumption in "Reverse" chamber of differential fuel flow meter in all operation modes, including "Idling" mode. The Counter is increasing from the date of flow meter production and cannot be reset by user.
5054/9.0/18.1	High resolution engine total fuel used/ 9.0 Idle/ 18.1 Reverse chamber	On the fact	l	"Total fuel consumption (Idle), L" Counter, i.e. overall Vehicle's fuel consumption in "Reverse" chamber of differential fuel flow meter in "Idling" operation mode. The Counter is increasing from the date of flow meter production and cannot be reset by user.
5054/9.1/18.1	High resolution engine total fuel used/ 9.1 Optimal/ 18.1 Reverse chamber	On the fact	l	"Total fuel consumption (Optimal), L" Counter, i.e. overall Vehicle's fuel consumption in "Reverse" chamber of differential fuel flow meter in "Optimal" operation mode. The Counter is increasing from the date of flow meter production and cannot be reset by user.
5054/9.2/18.1	High resolution engine total fuel used/ 9.2 Overload/ 18.1 Reverse chamber	On the fact	l	"Total fuel consumption (Overload), L" Counter, i.e. overall Vehicle's fuel consumption in "Reverse" chamber of differential fuel flow meter in "Overload" operation mode. The Counter is increasing from the date of flow meter production and cannot be reset by user.
5054/9.3/18.1	High resolution engine total fuel used/ 9.3 Cheat/ 18.1 Reverse chamber	On the fact	l	"Total fuel consumption (Tampering), L" Counter, i.e. overall Vehicle's fuel consumption in "Reverse" chamber of differential fuel flow meter when fuel consumption was higher than configured highest boundary of fuel consumption rate for installed flow meter. The Counter is increasing from the date of flow meter production and cannot be reset by user.
521189/18.0	Flowmeter chamber time counter/ 18.0 Feed chamber	On the fact	s	"Chamber operation time, h" Counter, i.e. overall operation time of "Direct" chamber of differential fuel flow meter for all operation modes, including "Idling" mode. The Counter is increasing from the date of flow meter production and cannot be reset by user.
521189/9.0/18.0	Flowmeter chamber time counter/ 9.0 Idle / 18.0 Feed chamber	On the fact	s	"Chamber "Idle" operation time, h" Counter, i.e. overall operation time of "Direct" chamber of differential fuel flow meter in "Idling" operation mode. The Counter is increasing from the date of flow meter production and cannot be reset by user.
521189/9.1/18.0	Flowmeter chamber time counter/ 9.1 Optimal/ 18.0 Feed chamber	On the fact	s	"Chamber "Optimal" operation time, h" Counter, i.e. overall operation time of "Direct" chamber of differential fuel flow meter in "Optimal" operation mode. The Counter is increasing from the date of flow meter production and cannot be reset by user.
521189/9.2/18.0	Flowmeter chamber time counter/ 9.2 Overload/ 18.0 Feed chamber	On the fact	s	"Chamber "Overload" operation time, h" Counter, i.e. overall operation time of "Direct" chamber of differential fuel flow meter in "Overload" operation mode. The Counter is increasing from the date of flow meter production and cannot be reset by user.
521189/9.3/18.0	Flowmeter chamber time counter/ 9.3 Cheat/ 18.0 Feed chamber	On the fact	s	"Chamber "Tampering" operation time, h" Counter, i.e. overall operation time of "Direct" chamber of differential fuel flow meter when fuel consumption was higher than configured highest boundary of fuel consumption rate for installed flow meter. The Counter is increasing from the date of flow meter production and cannot be reset by user.
521189/18.1	Flowmeter chamber time counter/ 18.1 Reverse chamber	On the fact	s	"Chamber operation time, h" Counter, i.e. overall operation time of "Reverse" chamber of differential fuel flow meter for all operation modes, including "Idling" mode. The Counter is increasing from the date of flow meter production and cannot be reset by user.
521189/9.0/18.1	Flowmeter chamber time counter/ 9.0 Idle/ 18.1 Reverse chamber	On the fact	s	"Chamber "Idle" operation time, h" Counter, i.e. overall operation time of "Reverse" chamber of differential fuel flow meter in "Idling" operation mode. The Counter is increasing from the date of flow meter production and cannot be reset by user.

SPN	Name	Factory value	Unit of measure	Clarification
521189/9.1/18.1	Flowmeter chamber time counter/ 9.1 Optimal/ 18.1 Reverse chamber	On the fact	s	"Chamber "Optimal" operation time, h" Counter, i.e. overall operation time of "Reverse" chamber of differential fuel flow meter in "Optimal" operation mode. The Counter is increasing from the date of flow meter production and cannot be reset by user.
521189/9.2/18.1	Flowmeter chamber time counter/ 9.2 Overload/ 18.1 Reverse chamber	On the fact	s	"Chamber "Overload" operation time, h" Counter, i.e. overall operation time of "Reverse" chamber of differential fuel flow meter in "Overload" operation mode. The Counter is increasing from the date of flow meter production and cannot be reset by user.
521189/9.3/18.1	Flowmeter chamber time counter/ 9.3 Cheat/ 18.1 Reverse chamber	On the fact	s	"Chamber "Tampering" operation time, h" Counter, i.e. overall operation time of "Reverse" chamber of differential fuel flow meter when fuel consumption was higher than configured highest boundary of fuel consumption rate for installed flow meter. The Counter is increasing from the date of flow meter production and cannot be reset by user.
Fuel rate mode borders PGN 63065				
521392/9.0	Fuel rate mode border/ 9.0 Idle	On the fact	l/h	"Idle" operation mode boundary setting – less than 10% of maximal hourly consumption rate of fuel, going through the measurement chamber of DFM (applicable for one-chamber fuel flow meters). For differential fuel flow meters – less than 10% of maximal hourly differential consumption rate of fuel, going through both chambers. The setting is used for defining current vehicle operation mode depending on hourly fuel consumption rate. The setting is available for editing by user in one-chamber and differential fuel flow meters DFM.
521392/9.1	Fuel rate mode border/ 9.1 Optimal	On the fact	l/h	"Optimal" operation mode boundary setting – 10% to 75% of maximal hourly fuel consumption rate. The setting is used for defining current vehicle operation mode depending on hourly fuel consumption rate. The setting is available for editing by user in one-chamber and differential fuel flow meters DFM.
521392/9.2	Fuel rate mode border/ 9.2 Overload	On the fact	l/h	Optimal" operation mode boundary setting – 75% to 100% of maximal hourly fuel consumption rate. The setting is used for defining current vehicle operation mode depending on hourly fuel consumption rate. The setting is available for editing by user in one-chamber and differential fuel flow meters DFM.
521392/9.0/18.0	Fuel rate mode border/ 9.0 Idle/ 18.0 Feed chamber	On the fact	l/h	Factory setting of "Idle" operation mode boundary for "Direct" chamber of differential fuel flow meter. The setting cannot be altered by user.
521392/9.1/18.0	Fuel rate mode border/ 9.1 Optimal/ 18.0 Feed chamber	On the fact	l/h	Factory setting of "Optimal" operation mode boundary for "Direct" chamber of differential fuel flow meter. The setting cannot be altered by user.
521392/9.2/18.0	Fuel rate mode border/ 9.2 Overload/ 18.0 Feed chamber	On the fact	l/h	Factory setting of "Overload" operation mode boundary for "Direct" chamber of differential fuel flow meter. The setting cannot be altered by user.
521392/9.0/18.1	Fuel rate mode border/ 9.0 Idle/ 18.1 Reverse chamber	On the fact	l/h	Factory setting of "Idle" operation mode boundary for "Reverse" chamber of differential fuel flow meter. The setting cannot be altered by user.
521392/9.1/18.1	Fuel rate mode border/ 9.1 Optimal/ 18.1 Reverse chamber	On the fact	l/h	Factory setting of "Optimal" operation mode boundary for "Reverse" chamber of differential fuel flow meter. The setting cannot be altered by user.
521392/9.2/18.1	Fuel rate mode	On the fact	l/h	Factory setting of "Optimal" operation mode boundary for "Overload"

SPN	Name	Factory value	Unit of measure	Clarification
	border/ 9.2 Overload/ 18.1 Reverse chamber			chamber of differential fuel flow meter. The setting cannot be altered by user.
Fuel consumption factors PGN 63026				
521311	Temperature correction enable	Off	On/Off	Function of automatic volumetric fuel consumption measurement correction depending on fuel temperature, which allows to increase accuracy of DFM. A use can turn on/off the function.
521433	Temperature correction coefficient	0.084	%/°C	Setting-up coefficient of volumetric expansion of fuel depending on fuel temperature change may increase accuracy of measurements by DFM. The seeting can be adjusted by user only after turning on function of temperature correction (see 2.6.7)
521434	Correction coefficient	0.0	%	Setting-up correction coefficient of consumption may increase accuracy of fuel consumption measurement when constant over/undermeasurement during specific conditions of operation (high vibration, air in fuel lines, higher return flow from nozzles) is detected. The setting is available for editing by user (see 2.6.7)
Calibration table. Fuel rate (DFM) PGN 63044				
521355	Array elements count	5	pc.	Quantity of points in calibration table made by Manufacturer during calibration process.
521231	Chamber volume	On the fact	ml	Fuel flow meter's measurement chamber(s) volume (see. 1.6.3). The setting cannot be altered by user.

4) FM Voltage supply monitoring — designed for monitoring of onboard power voltage and ignition key status.

Table H.4 — FM Voltage supply monitoring. SPN, displayed and/or editable via Service S6 DFM software

SPN	Name	Factory value	Unit of measure	Range	Clarification
Vehicle voltage PGN 62987					
158	Keyswitch battery potential	On the fact	V	0…3212.75	Setting displays present onboard voltage of ignition key on the Vehicle.
521049	Ignition key state	On the fact	No	On/Off	Setting displays present status of ignition key of the vehicle (On/Off).
521053	Ignition on time	On the fact	s	0…4211080000	Counter of summarized time when the ignition key is On since the moment of DFM installation on the vehicle. The user can not reset the value of this counter. It can be reset by the Manufacturer or RSC only.
	Battery voltage mode borders PGN 63064				
521391/2.8	Battery voltage mode border/ 2.8 Min	10.0	V	8.0…15.0	Value of the lower level of onboard voltage range of DFM. This setting is available for editing by user. Set value of the voltage is used as a threshold while registering an important Event "Low level of onboard power supply".

SPN	Name	Factory value	Unit of measure	Range	Clarification
521391/2.7	Battery voltage mode border/ 2.7 Max	30.0	V	15.0…32.0	Value of the upper level of onboard voltage range of DFM. This setting is available for editing by user. Set value of the voltage is used as a threshold while registering an important Event "High level of onboard power supply".

5) FM Battery — designed for power supply status check, built-in battery condition and total DFM operation time from the battery.

Table H.5 — FM Battery. SPN, displayed and/or editable via Service S6 DFM software

SPN	Name	Factory value	Unit of measure	Clarification
Battery PGN 63086				
521129	Unit power status	On the fact	No	Current power-supply status of DFM: - powered from embedded power source; - powered from on-board electrical system; - power is off; - power-supply status is not available/not supported by this device. While working with service software, data exchange between PC and fuel flow meter is possible only if flow meter is power-supplied from external source and power-supply status of DFM will always be displayed as "powered from on-board electrical system".
167	Charging system potential (voltage)	On the fact	V	Current voltage of embedded battery of DFM. When working with service software, this setting will always be displayed as "not available/not supported by this device".
521061	Battery charge level	On the fact	%	Current charge of embedded battery of DFM. When working with service software, this setting will always be displayed as "not available/not supported by this device".
521116/16.1	Unit hours of operation/ 16.1 Battery	On the fact	s	Counter of total operation time of DFM from embedded battery since installation to Vehicle. The Counter cannot be reset by user. Reset is possible in Regional Service Centers.

Detailed parameters description (SPN), structure and content of messages (PGN) of FM DFM are placed at the following web site http://s6.jv-technoton.com/en (to access S6 DB registration is required).

Annex I

DFM firmware upgrade

ATTENTION: DFM firmware update should be done only for implementation of improvements, recommended by Manufacturer.

To upgrade firmware the following actions shold be made:

1) Connect sensor to PC with the help of service adapter and establish connection session between DFM and PC (see 2.6.3).

2) Press Update firmware button at Service S6 DFM Software.

3) Choose firmware upgrade file **(*.blf3)** on PC or memory stick.

4) Press Open button, that will start firmware file downloading into DFM memory.

After firmware file integrity and compatibility check by Service S6 DFM Software window of firmware uploading into DFM memory will appear. In case of any errors the Software will send warning message.
To cancel firmware upgrade it is needed to press Stop button.

ATTENTION: Before the end of the update process and automatic Service S6 DFM Software reset it is **forbiden**
1) Disconnect DFM from the adapter.
2) Disconnect adapter from the PC.
3) Power down the PC.
4) Run any resource-intensive applications on the PC.

Service S6 DFM Software will display appropriate message and automatically will disconnect DFM from PC in case the update is successful. DFM is ready for further operation.
Service S6 DFM Software will display a new firmware version with the next connection session between PC and DFM.

In case of any error occur that leaded to the damage of present DFM firmware check all cables and adapter connections and retry. In this case the internal firmware loader is activated and will try to fix DFM operation performance. Contact Technoton technical support at support@technoton.by if another try is also unsuccessful.

Annex J

Videos

1) **DFM Fuel Flow Meter Installation** video (DFM installation on MTZ tractor. After pump (pressure side) scheme).

Link: https://www.youtube.com/watch?v=ATscYhBsD3c

2) **DFM fuel flow meter operation principle** video (fuel flow measurement principle of DFM measuring chamber).

Link: https://www.youtube.com/watch?v=RXjvwyy1zlY

3) Interactive flash animation **DFM fuel flow meter features**

Link: http://www.jv-technoton.com/data/editor/dfm_fuel_flow_meter.swf

4) Interactive flash animation **DFM fuel flow meter: selection of mounting scheme, accessories and mounting kit**

Link: http://www.jv-technoton.com/data/editor/flash/DFM_choose_an_installation_scheme.swf

5) Check out YouTube channel for other **Technoton videos** at:

https://www.youtube.com/channel/UCq7EF3DHrgl7fOWB2ynsR-A