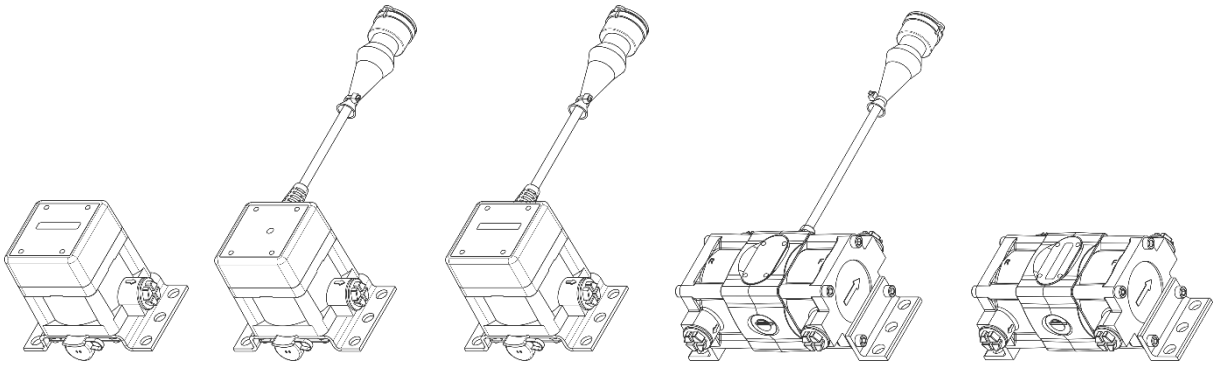
FUEL FLOW METERS



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

OPERATION MANUAL

Version 8.0

TECHNOTON
ADVANCED VEHICLE TELEMATICS

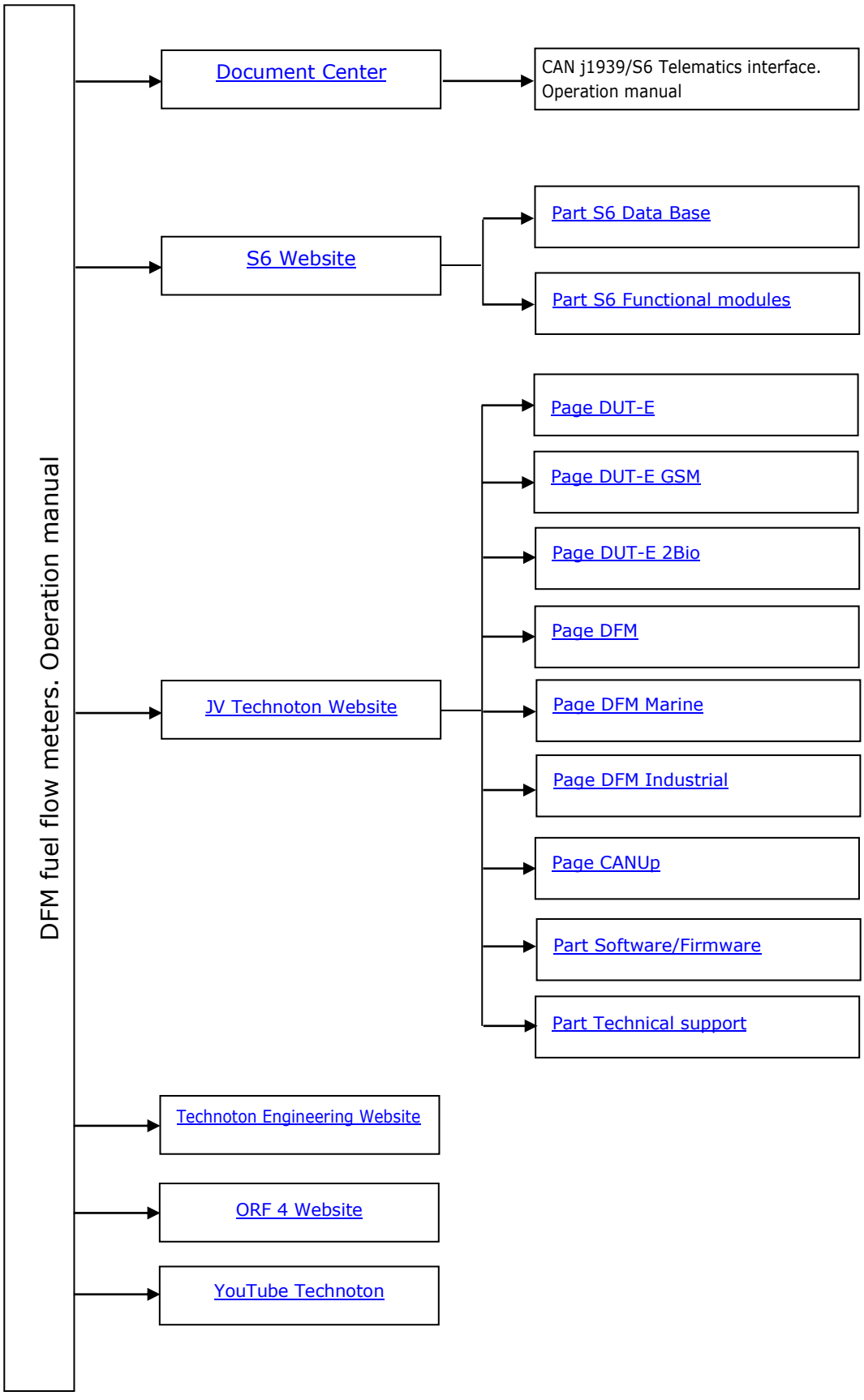
Contents

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. • 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.
6.3	01.2017	OD	• DFM COM data transfer protocol updated.
6.4	06.2017	OD	• Clarifications in DFM order identification codes added. • Table of measurement range and accuracy is divided in two separate parts: for one-chamber and for differential flowmeters. • General installation instructions are amended with description of symbols on DFM body for proper installation into fuel lines.
7.0	03.2019	OD	• List of DFM CAN output messages according to SAE J1939 protocol updated. • Information on DFM CAN operation according to NMEA 2000 protocol added. • List of DFM 232/485 registers of output messages according to Modbus protocol supplemented with specificators descriptions. • Tables of SPN of Functional Modules for DFM fuel flow meters are updated. • Certificate E28 of E-mark International Standard added. • Procedure for DFM wireless connection to an Android device via Bluetooth using S6 BT Adapter added, as well as the flow meter configuration via the Android device using the Service S6 DUT-E (Android) mobile application. • New information screens added (resettable Counters of total fuel consumption and time of operation) for flow meters models with displays. • Feature of correcting the differential fuel consumption using the correction coefficients set by means of service software for specific modes of operation of DFM D added. • The flow meters model codes updated. • Detailed information on electromagnetic compatibility added. • Structure of external links for websites and documents added. • List of Telematics terminals compatible with DFM fuel flow meters updated. • Information on MK DFM mounting kits updated. • Document terminology updated (CAN j1939/S6 Telematics interface, S6 Technology and IoT Burger Technology).

Version	Date	Editor	Description of changes
7.1	11.2019	OD	• The list of output messages of DFM CAN fuel flow meters is updated; the data composition for PGN that are transmitted according to SAE J1939 and NMEA 2000 protocols is provided. • Information on Modbus RTU data transmission protocol for DFM 232/485 fuel flow meters with examples of Request/Response messages for data reading is added. • Minimal requirements for PC for work with Service S6 DFM service software are added. • The procedure for elimination of problems that arise sometimes in relation to running Service S6 DFM software in Windows 10 is described. • A Certificate of the Declaration of Conformity of DFM fuel flow meters to the RoHS Directive (Restriction of Hazardous Substances) is added.
8.0	06.2020	OD	• Improvement of design of differential DFM D models of flow meters (new casing cover made of polymer composite) (see Introduction, 1.3, 2.3, annex A). • New functional capabilities of DFM CAN fuel flow meters during their operation according to S6 Technology: - Uniting up to 16 pcs. flow meters to form a network (see Introduction, 1.1, 1.6.10, 2.8, annex H.1); - Application of single-chamber flow meters in pairs for operation in the "Differential"/"Summation" modes of measurement (see Introduction, 2.4.4, 2.11, annex H.3); - Summation of fuel consumption readings of up to 16 pcs. of flow meters using the Summator DFM Functional module (see Introduction, 2.12, annex H.4). • The list of ouput messages and the data composition of DFM CAN fuel flow meters transmitted via CAN j1939/S6 interface (see annex F) are updated.

Structure of external links



Terms and Definitions

IoT Burger is the Technology of creating smart sensors and complex telematics IIoT devices operating in real time with built-in analytic features (further on – IoT Burger). The basis of IoT Burger is the software/hardware core, a set of ready-to-use universal Functional Modules, the database of standartized IoT parameters.

Particular features of IoT Burger:

- inbuilt analytic features for maximum treatment of signals within the device itself;
- a possibility to design devices with extremely low power consumption;
- doesn't require programming in the majority of applications, flexible setup;
- using inexpensive industrially manufactured equipment parts;
- measurement and treatment of "quick" processes which is impossible to implement using cloud technologies;
- an option of ready Reports delivery to the user avoiding server platforms;
- the inbuilt system of data authenticity assurance (self-diagnostics, authorization, impact control).

The technology provides for the availability of several measurement channels in any device including pre-set analytical treatment (filtration, linearization, thermal compensation) and the controlled error of measurement.

Devices created using IoT Burger may be united to form a wire-connected or wireless connection network. Data may be transmitted to the telematics server, to popular IoT platforms, by SMS, E-mail, to social networks.

At present, GSM 2G/3G data transmission standards are used in devices with IoT Burger. The reports transmitted contain data on instant and average values of Parameters, Counters, Events. The flexible system of Reports setup enables the user to select the optimal ratio of the data completeness and the volume of traffic.

DFM fuel flow meters is designed using IoT Burger Technology.

S6 is the Technology of combining smart sensors and other IoT devices within one wire network for monitoring of complex stationary and mobile objects: vehicles, locomotives, smart homes, technological equipment etc. The Technology is based and expands SAE J1939 automotive standards.

Information on cabling system, service adapter and S6 software refer to CAN j1939/S6 Operation manual.

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).

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.

NMEA 2000 — is a high-level network protocol, which is defined by international standard of marine electronic equipment NMEA 2000 Standard. NMEA 2000 protocol allows to combine several units of marine equipment into a single network for data exchange. NMEA 2000 is based on data transfer protocol, which is used in CANbus.

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), BeiDou (China).

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) — information 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).

Route — coordinates, speed and direction of vehicle movement. It matches with the route of the vehicle on the road. The map is displayed in the form of lines. Vehicle direction is displayed in the form of arrows.

Parameter — time-varying or space characteristic of the Vehicle (SPN value). For example, speed, fuel volume in the tank, hourly fuel consumption, coordinates. Parameter is usually displayed in the form of graph, or averaged data.

Server (AVL Server) — hardware-software complex of Telematics service ORF 4, used for processing and storage of Operational data, formation and transmission of Analytical reports through Internet by request of ORF 4 users.

Event — relatively rare and sudden change in SPN. For example, applying the magnetic field to the fuel flow meter in order to falsify indications of the hourly fuel consumption is the "Interference" Event. An Event can have one or several characteristics. Thus, the "Interference" Event has the following characteristics: date/time and duration of the 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 characteristic of Parameter. Counter is displayed by a single number and over time its value is increasing. Examples of counters: fuel consumption, trip, engine hours counter etc.

Telematics terminal (Terminal, Tracking device, Telematics unit) is a unit of Telematics system used for reading the signals of Vehicle standard and additional sensors, getting location data and transmitting the data to the Server.

Telematics system — complex solution for vehicle monitoring in real time and trip analysis. The main monitored characteristics of the vehicle: Route, Fuel consumption, Working time, technical integrity, Safety. In includes On-board report, Communication channels, Telematics service ORF 4.

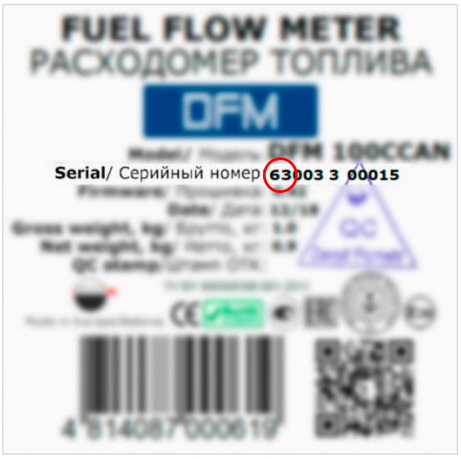
Vehicle an object controlled within Telematics system. Usually Vehicle means a truck, tractor or bus, sometimes a locomotive or river boat. From Telematics system point of view, stationary objects are also considered to be vehicles: diesel gensets, stationary tanks, boilers/burners.

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 is an element of vehicle on-board equipment compatible with S6 bus, which uses S6 Technology.

Introduction

The Operation manual contains guidelines and rules which refer to **DFM fuel flow meters** (hereinafter DFM), models codes — **01…04, 06…09, 11…18, 20…34, 40…47, 50…57, 60…67** developed by JV Technoton, Minsk, Belarus.
DFM model code is defined by first two digits of its serial number, which is placed on measurement chamber's body and on packaging label:



The manual contains information on design, operation principle, specifications and instructions on installation, use and maintenance of DFM and defines the procedure for their configuration by means of cable connection and wireless connection.

DFM **— precise tool for fuel consumption measurement of vessels, locomotives, diesel generators, burners, quarrying machinery. DFM could be used both as a part of** Telematics system **and autonomously.**

DFM features:

- compliance with Units, Database and cabling system S6 Technology;
- IoT Burger Technology provides internal data processing (Parameter filtration and normalization, Events logging, Counters recording) for easier server operation and data traffic saving;
- recording real fuel consumption and operation time of fuel consumer – total and in different consumption modes: "Idle", "Optimal", "Overload", "Tampering" and "Interference";
- implementation of data transfer using NMEA 2000 marine equipment communication protocol allows to integrate the flow meter into ship automation systems*;
- maximum information richness of output data and high reliability of data transmission over digital interfaces*;
- unique self-diagnostics feature to monitor the stability and accuracy of data*;
- thermal correction function with adjustable coefficient which ensures automatic correction of values to the ambient temperature**;
- setting the boundaries of operation modes for hourly consumption**;

* For DFM CAN.
** For DFM with interface cable.

- feature of fuel consumption correction during differential measurement in different modes of engine operation using correction coefficients ensures enhanced reliability of measurement*;
- combination of 1…16 flow meters into a single network using S6 Technology**;
- Possibility to apply methods of differential measurement or summation of fuel consumption readings in case of single-chamber flow meters connection in pairs**;
- Summation of fuel consumption readings of up to 16 pcs. fuel flow meters**;
- protection against unauthorized interference in operation and data "tampering";
- resettable Counters of liquid consumption and operation time of flow meter;
- embedded battery allows data (Counters, Events) storage in the internal non-volatile memory of flow meter when external power supply is switched off;
- accuracy of measurement is not decreasing when flow meter is operated in tough operation conditions, shaking and vibrations;
- minimum fluid flow resistance;
- built-in mud filter;
- 100 % of DFM are verified with a certified metrological test rig;
- Casing cover which is made of polymer composite material*** ensures: the enhancement of the flow meter endurance towards mechanical loads, the improvement of electrical insulation and protection from inside condensation, lower weight;
- full set of high-quality elements for installation;
- conformity with European and national standards and directives;
- rich experience accumulated during the period of its use, high-quality technical support and documentation.

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* For differential flow meters with the firmware version not lower than 4.55, when using Service S6 DFM software, version 1.24 and higher.

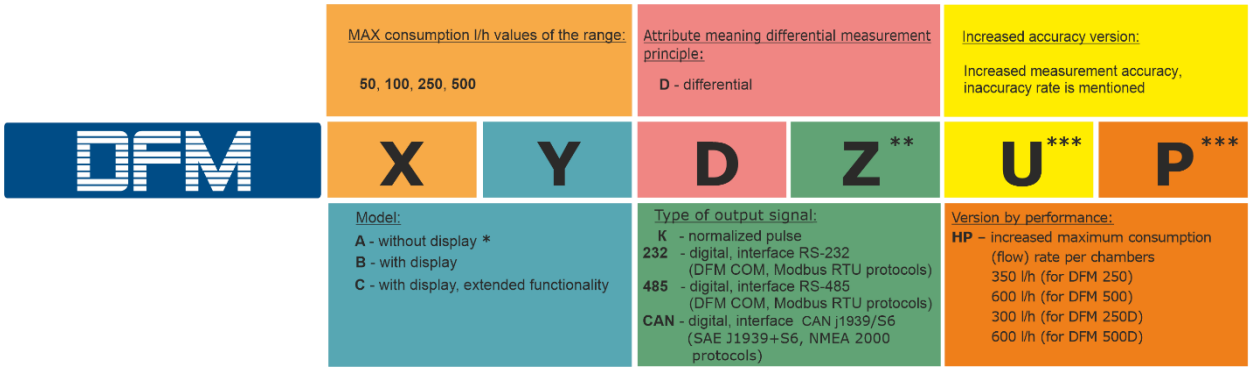
** For DFM CAN with the firmware version not lower than 4.63, when using Service S6 DFM software, version 1.27 and higher.

***For all differential DFM D fuel flow meters manufactured after 1.10.2019.

See figure 1 for identification codes for DFM ordering.

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, with output 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, with output 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 - with display, output interface — CAN j1939/S6).



* **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 flow meters.

Figure 1 — DFM order identification codes

S6 SK service adapter (purchased separately) and Service S6 DFM service software are used for DFM configuration by means of cable connection to the PC (the current version of the service software can be downloaded at https://www.jv-technoton.com/, section Software/Firmware).

For wireless configuration of DFM flow meters with interface cables by means of an Android device, S6 BT Adapter (purchased separately) and Service S6 DFM (Android) service mobile application are used (the current version of the service software can be downloaded from Google Play ; search request: "Technoton").

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 is designed for (see figure 2):

- fuel consumption measurement in fuel lines of engines of Vehicles and stationary units;
- monitoring operation time of fuel consumer.

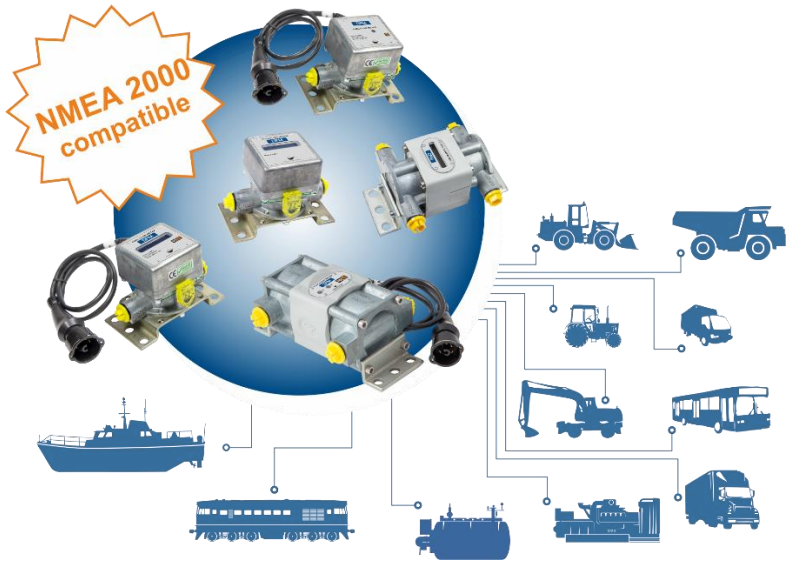
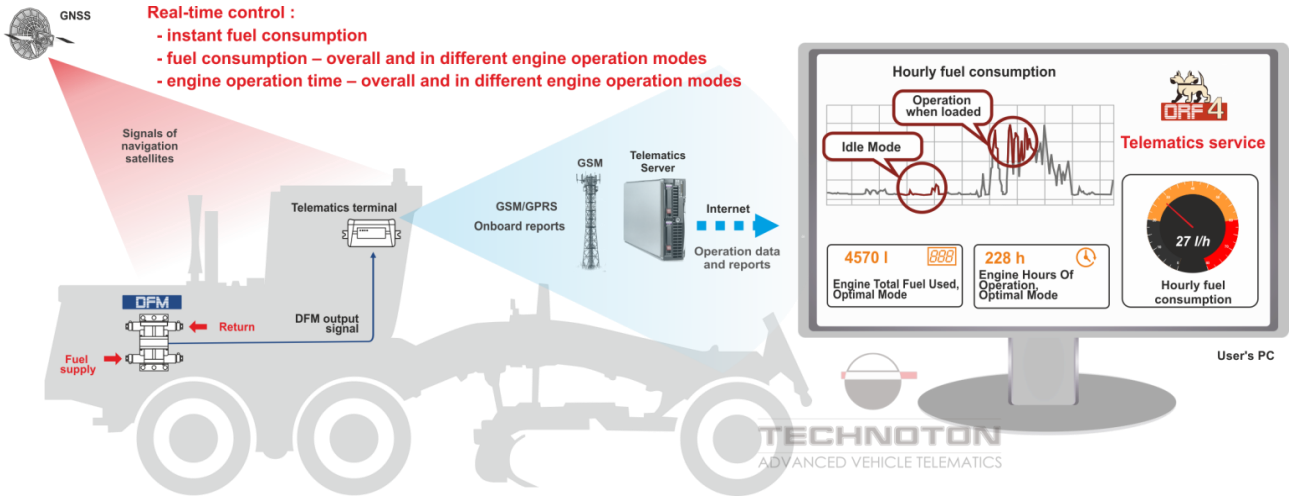


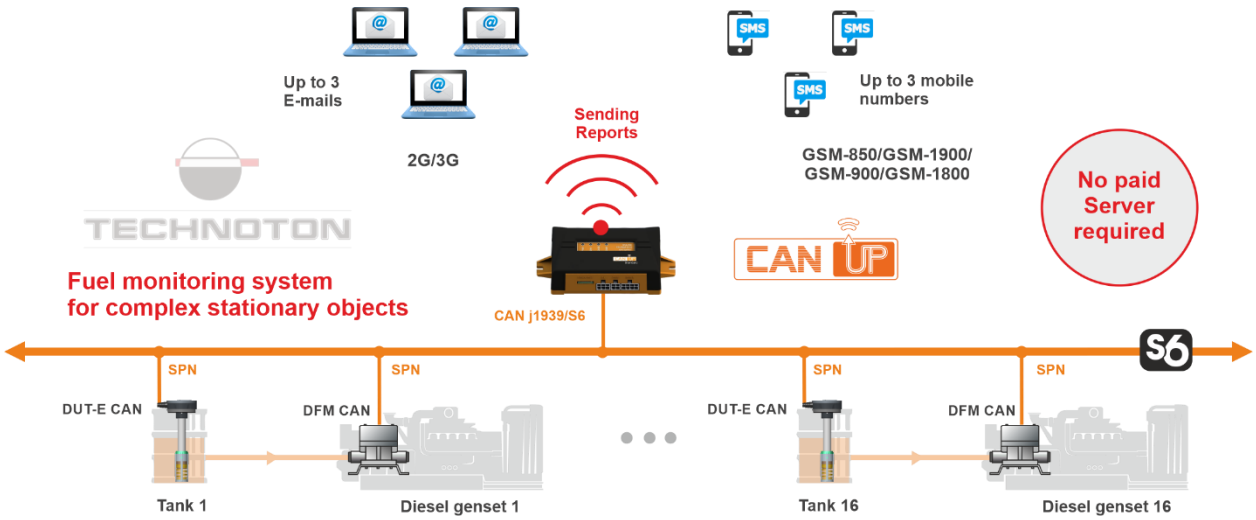
Figure 2 — Purpose of DFM fuel flow meters

Application areas (see figure 3):

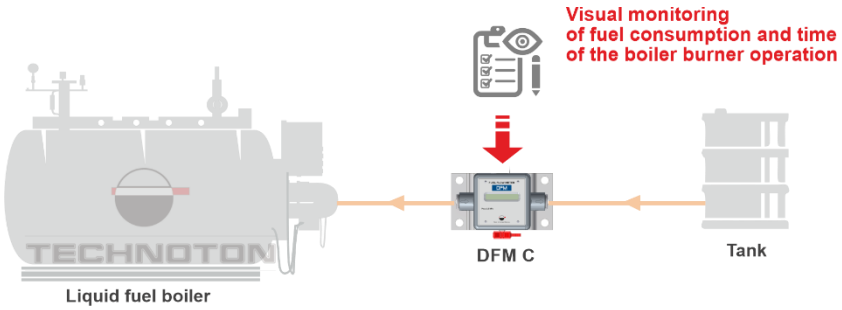
1) DFM fuel flow meters can be employed within the Telematics system on vehicles and tractors and on mobile/fixed equipment, including sophisticated equipment (locomotives, sea and river vessels, diesel generators, boiler equipment etc.).



a) example of DFM D employment as component of the Telematics system on Vehicles and tractors



b) example of using DFM CAN as part of Telematics system of a complex stationary object



c) example of autonomous DFM C operation

Figure 3 — Application areas of DFM fuel flow meters

DFM installed into a fuel line of fuel consumer, measures hourly (instant) fuel consumption and generates output signal, which is sent to Telematics unit (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 interfaces provide real-time control over extended set of information:

- instant fuel consumption;
- differential/ summary fuel consumption in two fuel lines;
- 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.

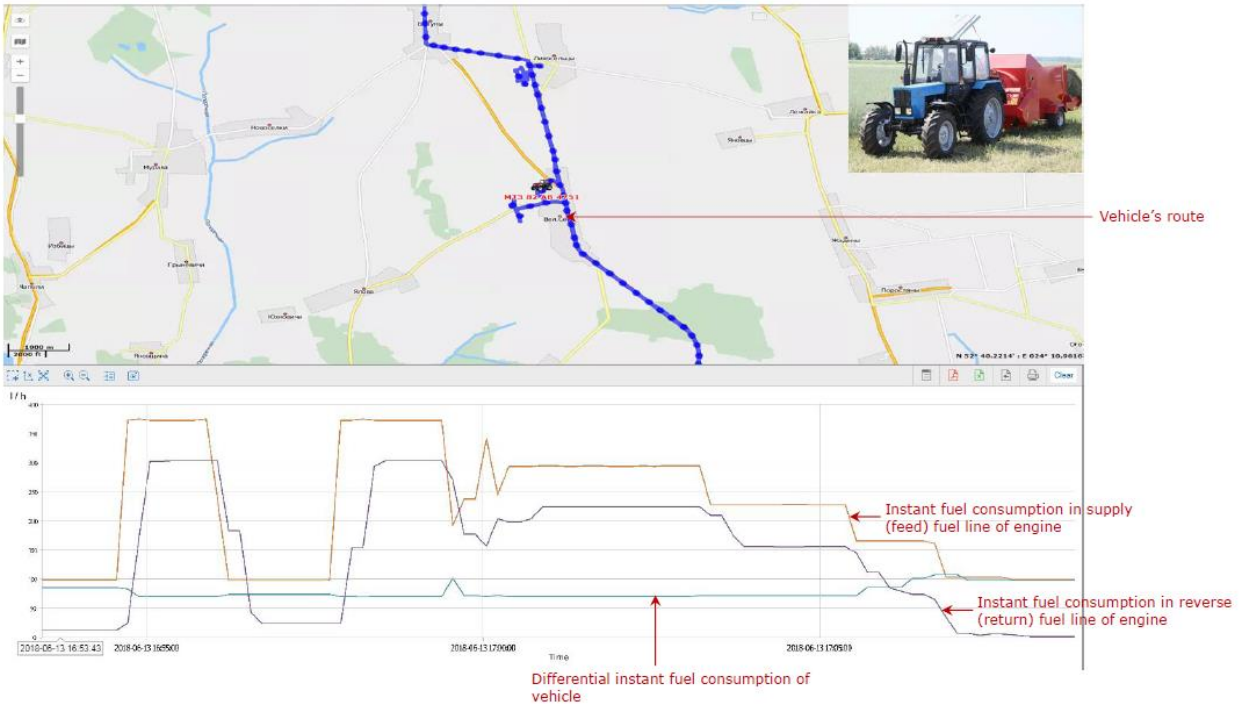
Availability of CAN j1939/S6 interface allows to connect 16 pcs. of DFM CAN flow meters and 16 pcs. of DUT-E CAN/DUT-E 2Bio fuel level sensors combined in a single network using S6 Technology to just one CAN-port of Telematics unit (for example, to CANUp 27 online telematic gateway) (see figure 3 b).

2) DFM fuel flow meters can be used autonomously (for example, in fuel oil boilers and burners).

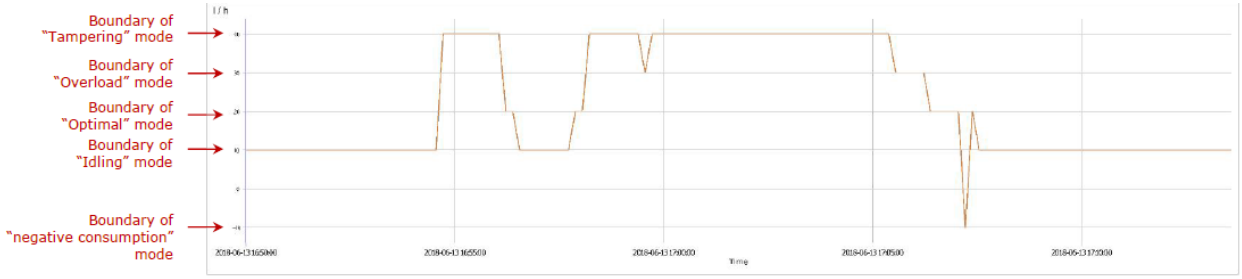
When using **autonomous DFM** fuel consumption and vehicle operating time data (overall and in different engine operation modes) is displayed on the built-in LCD display (see figure 3 c).

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.



a) Report on the Vehicle route and changes of fuel consumption per hour by the engine



b) Report on modes of the Vehicle engine operation depending on values of hourly fuel consumption

Grouping	Liters	Fuel Idle	Fuel Optimal	Fuel Overload	Hours Idle	Hours Optimal	Hours Overload
2018-06-13	6.46	4.02	0.60	1.84	0.30	0.01	0.02
2018-06-14	74.44	0.16	0.06	74.20	0.04	0.00	0.90
2018-06-15	103.18	14.80	87.34	0.00	0.67	1.77	0.00
Total	**184.08**	**18.98**	**88.00**	**76.04**	**1.01**	**1.79**	**0.91**

Fuel consumption for in each operation mode on engine (related to engine load) within selected time interval of 3 days

Engine operation time in each operation mode (related to engine load) within selected time interval of 3 days

c) Report on fuel consumption and operation time in each Vehicle engine mode of operation

Figure 4 — Examples of Analytic Reports based on data from DFM CAN for the selected period of time created by ORF 4 Telematics service

1.2 Exterior view and delivery set

1	DFM fuel flow meter	– 1 pc;
2	Magnetic key*	– 1 pc;
3	Fuse with holder (2 A)**	– 1 pc;
4	Signal 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 (see 1.3.1 and 1.3.5).
*** Only for DFM meters with pulse interface output.

1.3 DFM models

DFM fuel flow meters are represented by the following **models**:

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

- autonomous fuel flow meters with display (1.3.1);
- fuel flow meters with display and interface cable (1.3.2):
  - with pulse output interface;
  - with digital output interfaces;
- fuel flow meters output interface cable (1.3.3):
  - 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 feed and reverse fuel lines.
The following **models of dual-chamber meters** are produced:

- The following modifications of dual-chamber meters with output interface are available (1.3.4):
  - differential meters with pulse output;
  - differential meters with digital output interfaces;
- differential autonomous meters with display (1.3.5).

1.3.1 Autonomous fuel flow meters with display

Autonomous fuel flow meters with display (**DFM B/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 operate both in the autonomous mode, and within the Telematics system.

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**).
CAN j1939/S6 (**DFM CCAN**), RS-232 (**DFM C232**), RS-485 (**DFM C485**) digital interfaces contain fuel consumption data together with Counters values, data on engine operation modes, flow meter Parameters 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 designed to measure fuel consumption within the Telematics system.

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

Fuel consumption data is sent to the pulse output (**DFM AK**). CAN j1939/S6 (**DFM ACAN**), RS-232 (**DFM A232**), RS-485 (**DFM A485**) digital interfaces contain fuel consumption data together with Counters values, data on engine operation modes, flow meter Parameters 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 D **fuel flow meters with interface cable** (**DFM DK/D232/D485/DCAN** models) (see figure 9) are designed for employment within the Telematics system. They are installed on vehicles and tractors or on fixed equipment with up-to-date diesel engines equipped with Common Rail fuel injection systems or pump-injector units.

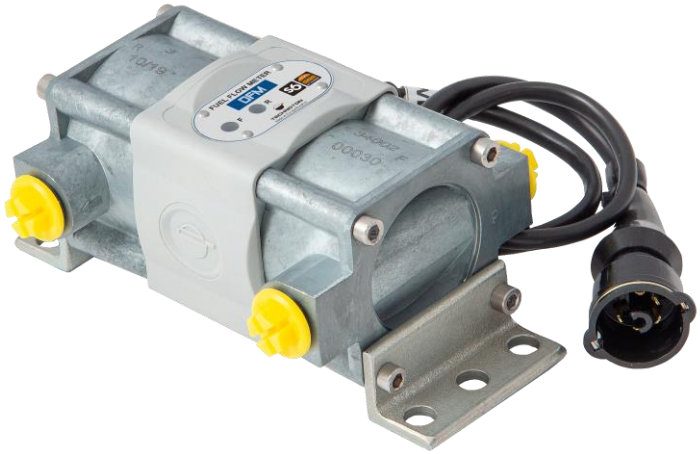


Figure 9 — Exterior of differential DFM fuel flow meters with interface cable

Two LED indicators are located on top, on the casing cover of differential DFMs: one indicates the feed measuring chamber operation (**F**-red), the other indicates the operation of the flow meter reverse measuring chamber operation (**R**-green).
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 feed and reverse fuel lines. Data is sent out via pulse output interface (**DFM DK**).
CAN j1939/S6 (**DFM DCAN**), RS-232 (**DFM D232**), RS-485 (**DFM D485**) digital interfaces contain fuel consumption data together with Counters values, data on engine operation modes, flow meter settings Parameters and malfunctions, Events.

1.3.5 Differential autonomous fuel flow meters with display

Differential autonomous DFM D **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. They are installed on vehicles and tractors or on fixed equipment with up-to-date diesel engines equipped with Common Rail fuel injection systems or pump-injector units.

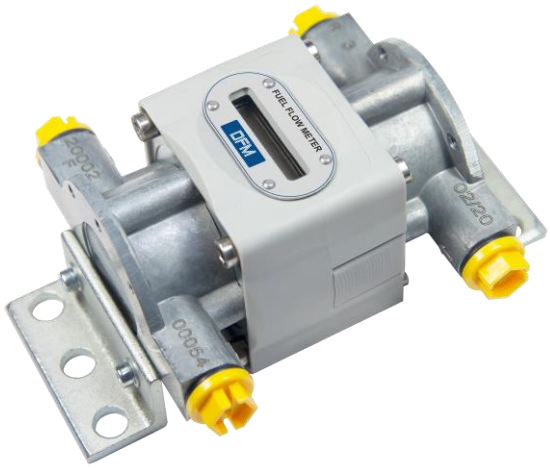


Figure 10 — Exterior of differential autnomous DFM fuel flow meters with display

Differential autonomous flow meter is power-supplied from embedded battery and measures fuel consumption as a difference between flow rate in feed and reverse 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 fuel flow meters

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 one-chamber meters with increased measurement accuracy (see figure 1).

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

Table 2 — Measurement range and accuracy of differential DFM D fuel flow meters

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 dual-chamber meters with higher fuel consumption rate per chamber (see figure 1).

** Depends on ratio of flow rate in feed chamber to flow rate in reverse 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 cable with connector **4** (see figure 11).

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).
The volume of fluid equal to the volume of the measuring chamber is pushed out during the full single turn of the ring. The flow meter electronic unit automatically adds the fuel volume increment to the accumulating Counter; this fuel volume is equal to the volume of the measuring chamber (see animation on DFM fuel flow meter operational principle).

Figure 12 — DFM measuring chamber operation scheme

***** The single-chamber model of DFM is taken as the device example.

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;
- heating oil;
- burner oil;
- motor fuel;
- biofuel;
- other liquid fuels and mineral oils with kinematic viscosity of **1.5 to 6.0 mm^2/s (cSt)**.

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 6.0 mm^2/s (cSt) 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
Kinematic viscosity range of the measured fluid, mm^2/s (cSt)	1.5…6.0
Size of inclusions in the measured fluid, mm, not more than	0.08
Connection thread	M16x1.5*/M14x1.5
Pressure drop at maximum flow rate, nominal pressure, diesel fuel at 20 °C, bar, not more than	0.2**
Supply voltage range, V	10…45
Current consumption at 12 V / 24 V, mA, not more than	50 / 25
Ambient operation temperature range, °C	-40…+85***
Vibration resistance	max. acceleration to 100 m/s^2 in the frequency range 5…250 Hz
Resistance to aggressive environments	oil and petrol resistance
Electromagnetic compatibility	see annex G
Ingress protection rating	IP54
Overall dimensions	see annex A
Weight	

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

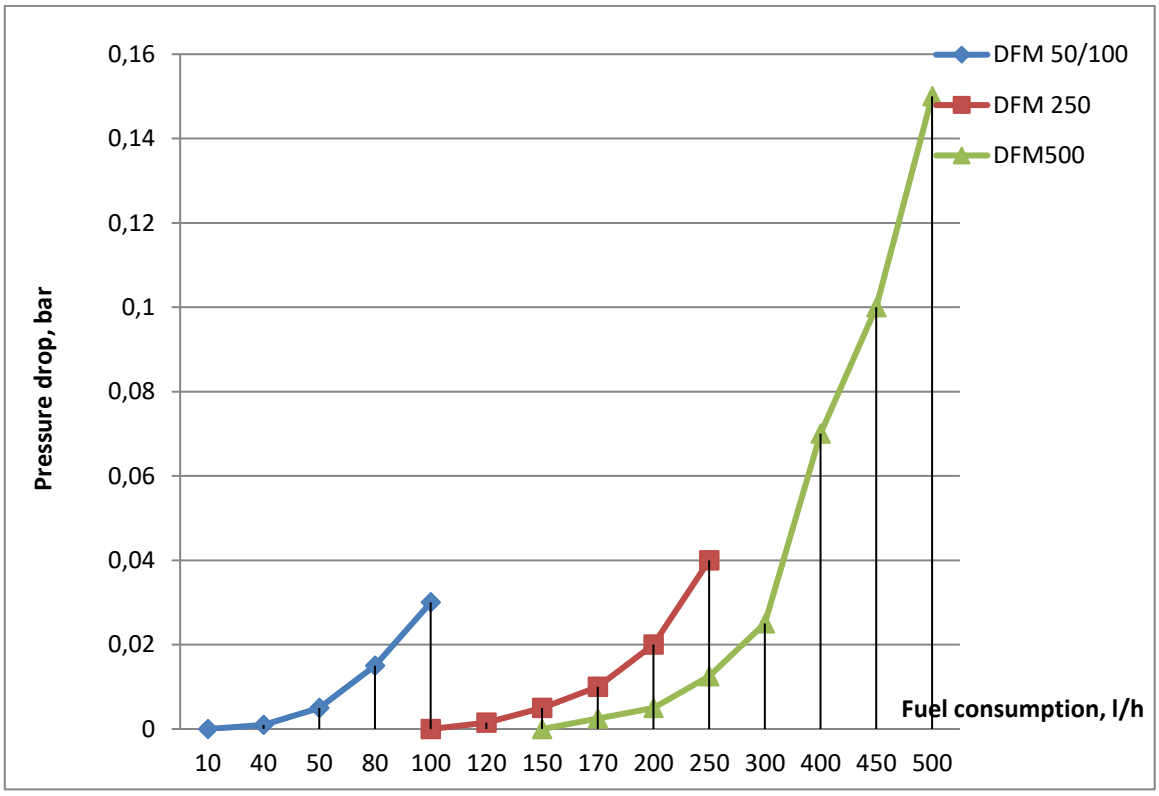


Figure 13 — Chart of pressure drop in DFM related to flow rate

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/CD** 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 10 V). 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
$Q>Q_{max}$

The impact of constant magnetic field for more than 5 seconds</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></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 or Service S6 DFM (Android) service mobile application at Flowmeter FM section (see H.3).

1.6.6 Displayed data

Display information (see table 6) switching is performed by (1…2) seconds light touch to the top cover of the fuel flow meter by magnetic key (see figure 14).

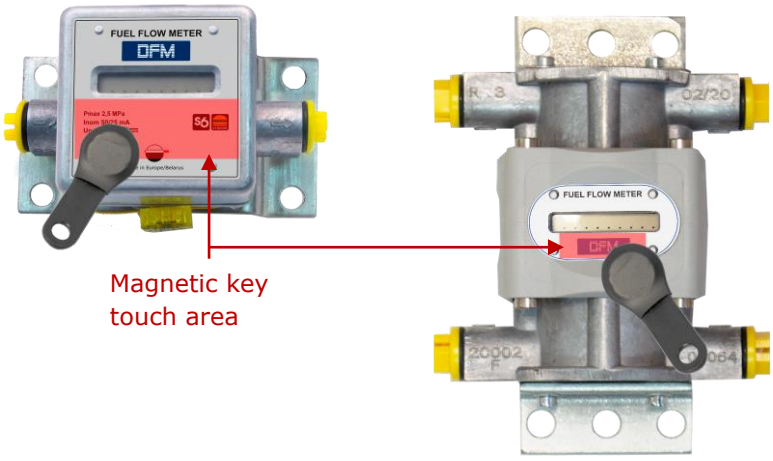


Figure 14 — Switching display DFM screens

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 magnetic key. 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	
13	"Total "Negative" fuel consumption"	0.1	liters	-	-	+
14	"Instant consumption in feed chamber"	0.1	liters/hour	-	-	+
15	"Instant consumption in reverse chamber"	0.1	liters/hour	-	-	+
16	"Total Fuel Consumption. Clearable" Counter	0.1	liters	-	+	+
17	"Engine Operation Time. Clearable" Counter	0.1	hours	-	+	+

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

Screen 1 displays **"Total Fuel Consumption"** Counter value (with 0.1 liter step) accumulated since DFM release.

Screen 2 displays **"Total Fuel Consumption value with higher digit capacity"** Counter (0.001 liter), 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" displays the firmware version installed on the fuel meter.

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 feed 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 feed chamber" displays instant consumption rate of fuel flowing through feed 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.

Screen 16 displays the Counter readings of "**Total Fuel Consumption. Clearable"**, which was accumulated by DFM since its production. Counter data could be reset using service software or by applying a magnetic key (3…5) s to a switching zone of DFM's cap when Screen 16 is active.

Screen 17 displays the Counter readings of **"Engine Operation Time. Clearable"**, which was accumulated as a total time of engine operation in all modes, including idling. Counter data could be reset using service software or by applying a magnetic key (3…5) s to a switching zone of DFM's cap when Screen 17 is active.

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 16).

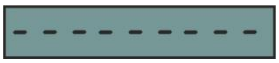


Figure 16 — Display view in "Tampering" Mode

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 17).

Figure 17 — Display view in "Interference" Mode

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

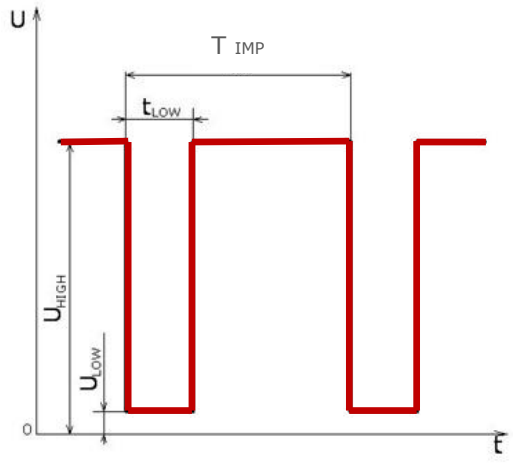
ATTENTION: Data on Events of Tampering/Interference during the external power supply of DFM is off is recorded into the internal memory and sent to output interface since the power supply is on.

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 (see 4) 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 Specifications and protocols of RS-232 and RS-485 digital interfaces

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

It is possible to connect simultaneously 1…4 DFM 485***** fuel flow meters to the Telematics terminal by means of RS-485 interface.

It is possible to connect no more than one DFM 232 fuel flow meter to the Telematics tterminal by means of RS-232 interface.

DFM 232/485 fuel flow meters support the transmission of data:

- According to **Modbus RTU** protocol, in the "request-response" mode (see annex D).
- According to **DFM COM** protocol (extended LLS) in the "request-response" modes and automatic deliverance (ASCII/ASCII EXT/HEX) (see annex E).

To identify DFM 232/485 fuel flow meters in the network, unique network addresses from 0 to 255 should be used (default address is 111).

The data transmission rate for DFM 232/485 may be selected from the range of values: 2400; 4800; 9600; 19200; 38400; 57600; 115200 bit/s (default — 9600 bit/s).

The selection of the data transmission protocol by the user as well as the configuration of DFM 232/485 parameters are conducted using Service S6 DFM service software or Service S6 DFM (Android) service mobile application via K-Line (ISO 14230) interface.

***** The maximum number of devices manufactured by Technoton (DFM 485, DUT-E 485, DUT-E 2Bio 485) simultaneously connected to the Telematics terminal by means of RS-485 interface — no more than 4 pcs., in any combination of types of devices.

1.6.10 CAN j1939/S6 digital interface specifications and protocols

Specifications of CAN j1939/S6 **DFM ACAN/CCAN/DCAN** digital interface correspond to S6 Technology.

The user configuration of CAN j1939/S6 interface is conducted via K-Line (ISO 14230) interface using Service S6 DFM service software or Service S6 DFM (Android) service mobile application.

DFM CAN fuel flow meters support data transmission according to **SAE J1939** and **NMEA 2000** protocols. The data composition of the flow meters output messages that are transmitted via CAN j1939/S6 interface is provided in annex F.

DFM CAN data is sent in automatic transmission mode and by request. Baud rate can be selected out of the following values: 100; 125; 250; 500; 1000 kbit/s (default baud rate 250 kbit/s).

S6 Technology allows to combine 1...16 pcs. of DFM CAN flow meters at a time into a single network. For each connected flow meter a unique network address (SA) from the main (111…118) or additional (151…158)***** ranges must be specified (default address 111).

***** You may specify addresses from the additional range only by using Service S6 DFM software, version 1.27 and higher for DFM CAN flow meters with the version of firmware not lower than 4.63.

1.7 DFM and Telematics terminals compatibility

DFM can be used in conjunction with Telematic units or other recording and display devices, which have inputs compatible with the parameters of DFM output signals – see 1.6.8, 1.6.9 and 1.6.10.

Technoton regularly conducts tests for compatibility and joint accuracy of DFM with different models of Terminals (vehicle tracking devices).

https://www.jv-technoton.com/ web-page contain a table with up-to-date list of Compatibility declarations of Technoton products and Telematic units of various manufacturers.

Recommendations on connecting and setting up the equipment can be obtained from Technical support of Technoton.

1.8 DFM selection

IMPORTANT: The final decision on the applicability this or that DFM model for a specific mobile or fixed fuel consumer should be taken by the installer personnel after the equipment examination and evaluation of its operability.

The detailed scheme for DFM selection, its installation layout, its accessories and mounting kit is shown in the interactive animated video DFM fuel flow meters: selection of installation layout, accessories and mounting kit.

1.8.1 Selection depending on engine power (boiler output capacity)

Table 8 — 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**
* Data is for reference purpose only. To choose flow meter properly, it is necessary to know maximum and minimum fuel consumption in fuel feed line of fuel consumer.		

1.8.2 Selection depending on fuel flow rate in feed and reverse lines of the engine

Table 9 — Selection of the differential DFM D depending on fuel flow rate values in feed and reverse lines

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

IMPORTANT:

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

2) When mounting differential DFM D in the fuel system with relatively low fuel consumption, but with great consumption in the feed and reverse lines, the measurement error may grow.

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

2 DFM installation

ATTENTION:
1) To ensure proper operation of DFM, it should be mounted, electrically connected and configured by specialist, who finished official technical training and was certified for that.
2) Officials, who carry out installation and operation, are responsibility for proper installation and operation of DFM from the moment of its purchase.
3) When installing DFM it is obligatory to follow safety rules on carrying out repair works applicable to the machinery being equipped.

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 the fuel consumer condition

IMPORTANT:
1) Before staring installation of DFM, carefully read technical specification of the machinery unit (Vehicle/diesel generator/boiler/burner) being equipped, inspect the condition of its fuel and electric systems and make a conclusion whether it's possible to make installation of the flow meter.
2) Make sure, that specifications of fuel system are within a range of main flow meter specification (kinematics viscosity of the liquid, consumption rate, pressure, operating temperature, nominal bore (DN)).

Machinery unit condition inspection is carried out according to 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) 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.

3) 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 %.

4) Inspect all fuel pipes of the vehicle for damage and fuel leakage.

5) 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.

6) 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.

7) Check and eliminate any external electromagnetic interference at the place of installation.

According to the results of the check a **Protocol of inspecting machinery unit** should be filled in and signed (see annex B).

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

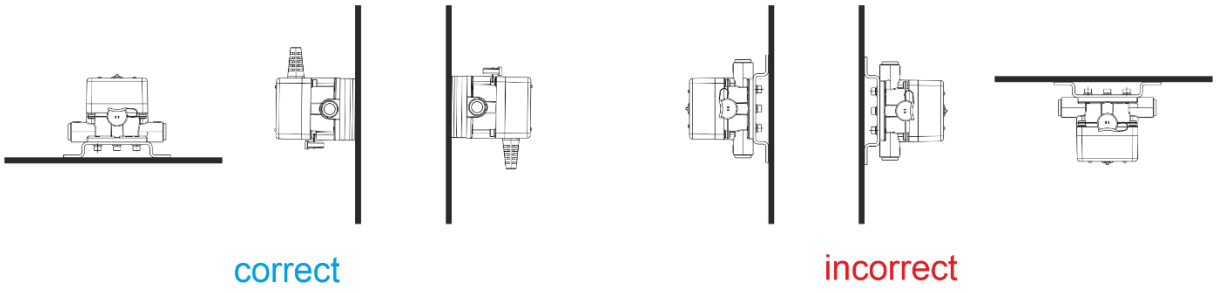
2.3 General installation instructions

IMPORTANT:
1) Installation and electrical connection of DFM is strongly recommended at a positive ambient temperature.
2) Particular cases of engines operation layouts are described in this subsection. To take the decision on the flow meter applicability on the particular vehicle, study thoroughly the operating documentation for the vehicle on which the flow meter is to be mounted.

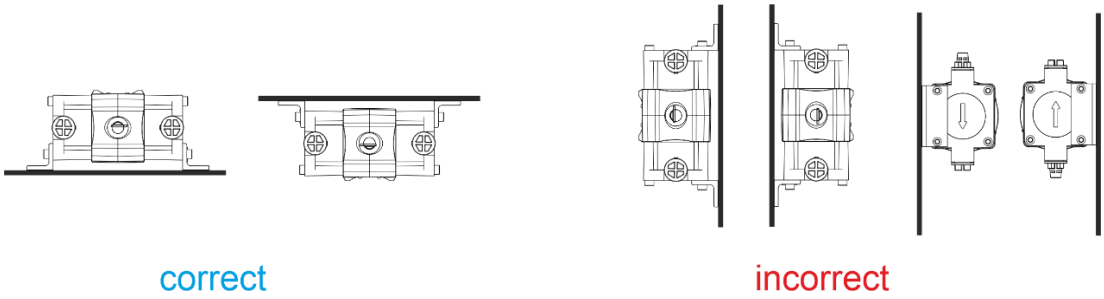
The following is needed for DFM mounting:

- automobile hand tool kit (sets of spanners, screwdrivers, etc.);
- mounting kit MK DFM (does not come with DFM delivery set, ordered separately);
- mounting plate (purchased separately). In some cases the flow meter can be mounted without the mounting plate;
- pyrometer or contact thermometer (ordered separately);
- glycerin filled manometer (ordered separately);
- S6 SK service adapter (purchased separately) and PC with installed Service S6 DFM service software (in case of configuration using wire connection);
- S6 BT Adapter service adapter (purchased separately) and the Android device with installed Service S6 DFM (Android) service mobile application (in case of wireless configuration);
- signal cable (ordered separately for DFM CAN/232/485).

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.



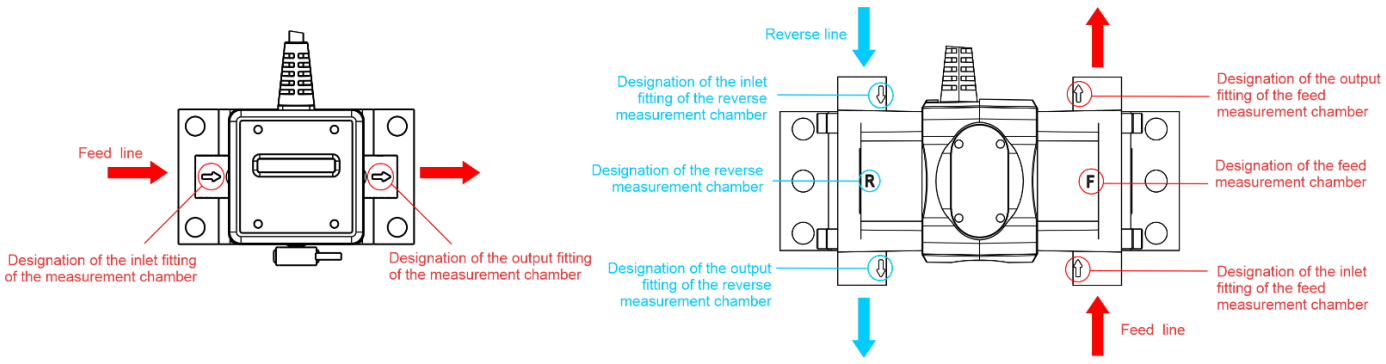
a) one-chamber



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) two-chamber*

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

The following rules must be observed when DFM 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.

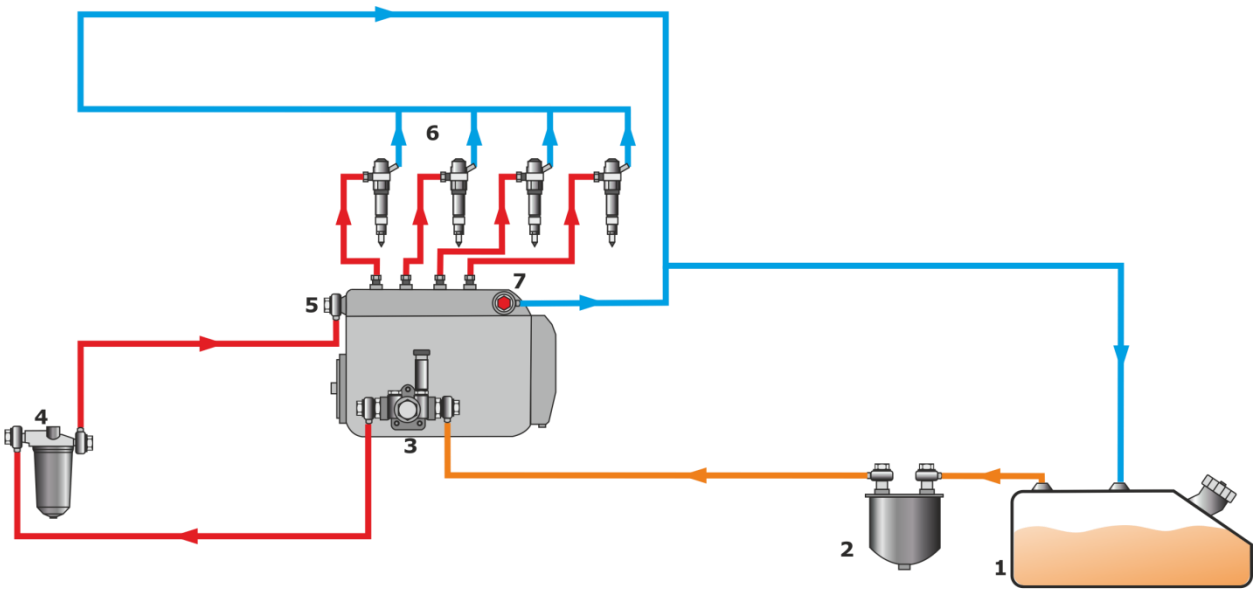
9) After DFM installation, it is necessary to remove air from the fuel system.

ATTENTION:
1) Only consumed volume of fuel should pass through DFM in case of using one-chamber meter. It is required to modify reverse fuel line of the fuel system in this case (see 2.4.2, 2.4.3).
2) If foam is present in the reverse 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.

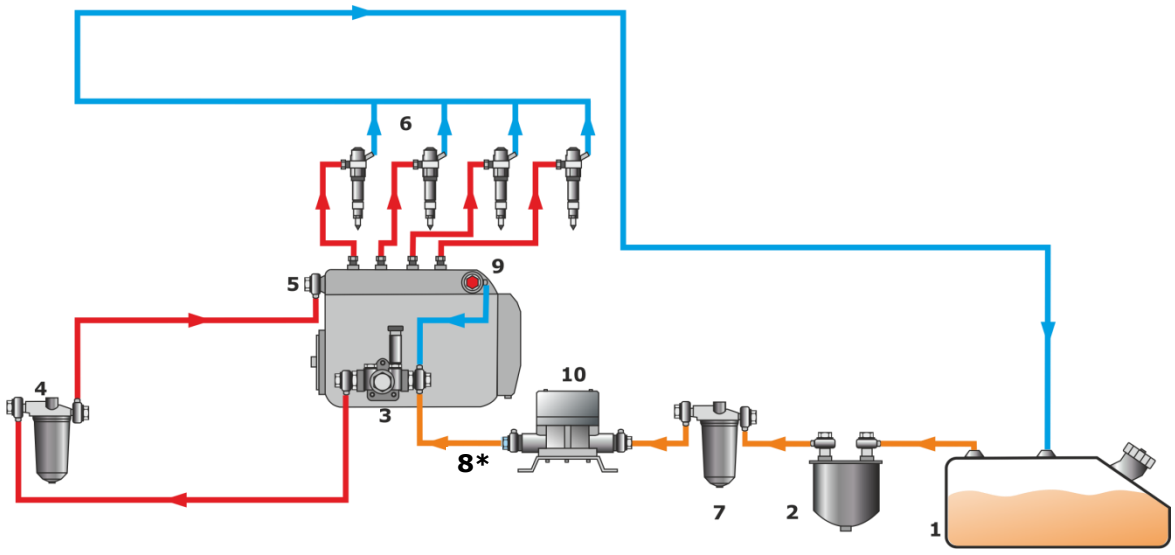
2.4.2 DFM installation before the pump

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 reverse line.

In this particular case the reverse 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 reverse 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 reverse 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) bar**.

At DFM output a **(0.1…0.35) bar 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:

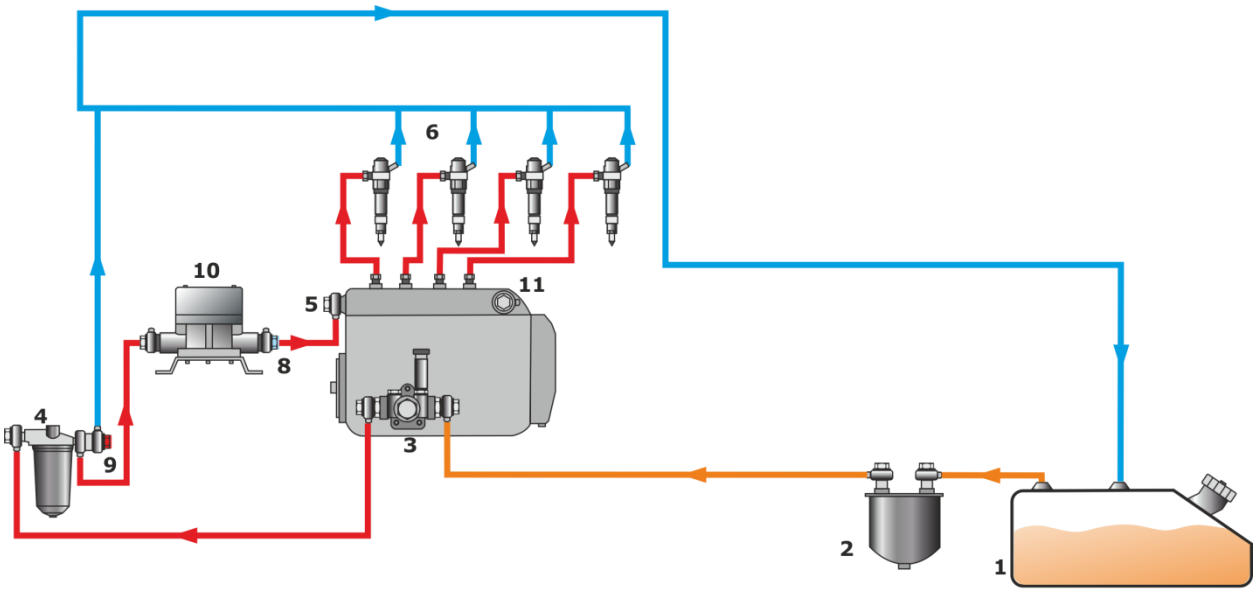
- requires installation of an additional fine filter and causes additional costs;
- additional load on the low pressure fuel pump;
- fuel in the tank is not warmed with return fuel flow (fuel heater installation is required in some cases).

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 reverse 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) bar** in the line between the fine filter and high pressure fuel pump input.

Install a **(0.1…0.35) bar 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.

One of the features of diesel engines is its uneven fuel consumption. Additionally, water hammers (hydraulic shocks) inside fuel line can add extra inaccuracy.

ATTENTION: To compensate water hammer effects and to avoid back fuel flow through DFM, it is necessary to install return valve after 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 D 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. Feed-flow chamber (marked with the letter **F** on the flow meter body, see figure 20 b) of differential DFM D is to be installed in the gap of feed fuel line of the engine. Return-flow chamber (marked with the letter **R** on the flow meter body, see figure 20 b) is to be installed in the gap of the reverse line. Fuel consumption is calculated as a difference of measured values of fuel flows in straight-flow and return-flow chambers.

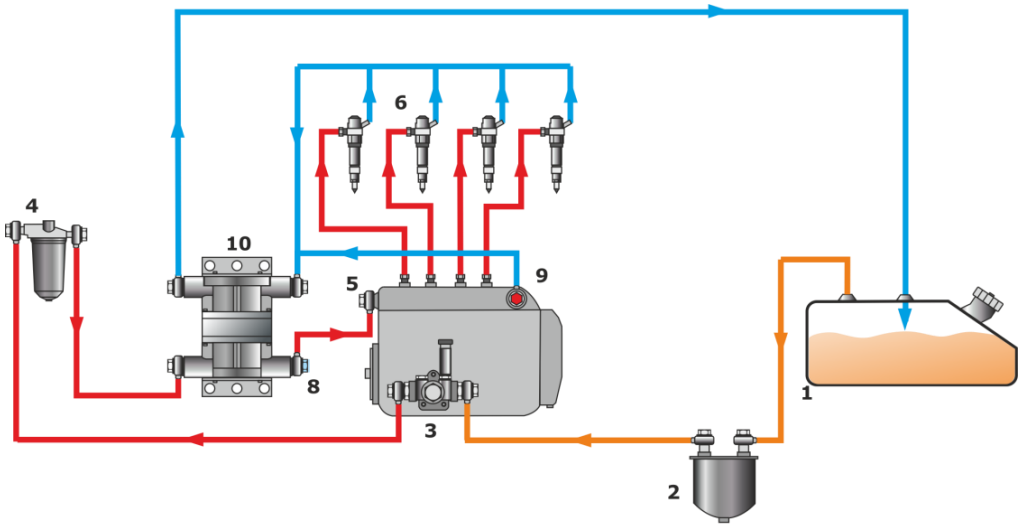
Particular cases of differential DFM D installation scheme:

1) In fuel system with plunger injection pump feed 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 feed chamber on unit injector fuel system (jerk system) is made after the low pressure fuel pump (**after the pump scheme**) (see figure 24 c).

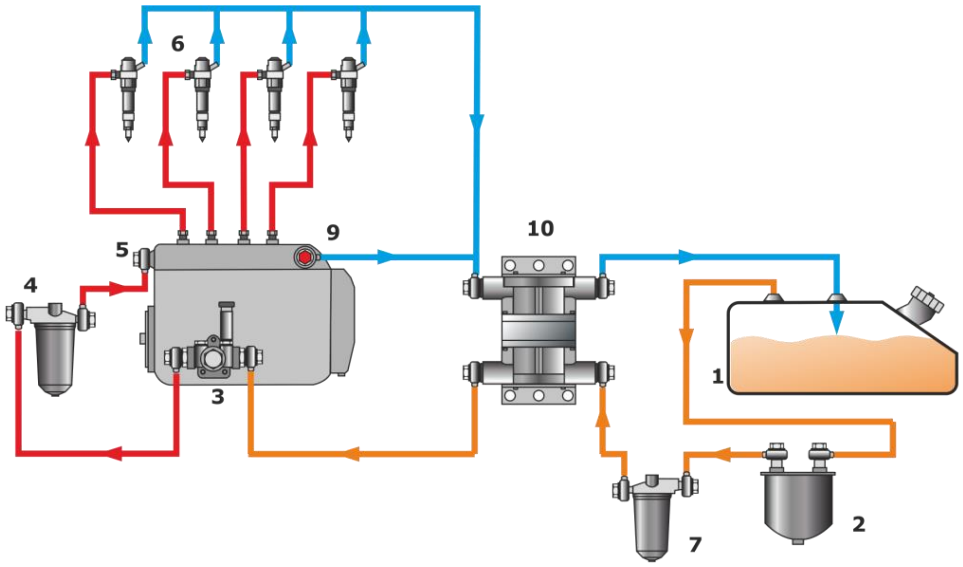
3) On Common Rail fuel system installation of the feed chamber is made before the low pressure fuel pump (**before the pump scheme**). In this case **additional fine filter** installation is required (see figure 24 d).

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



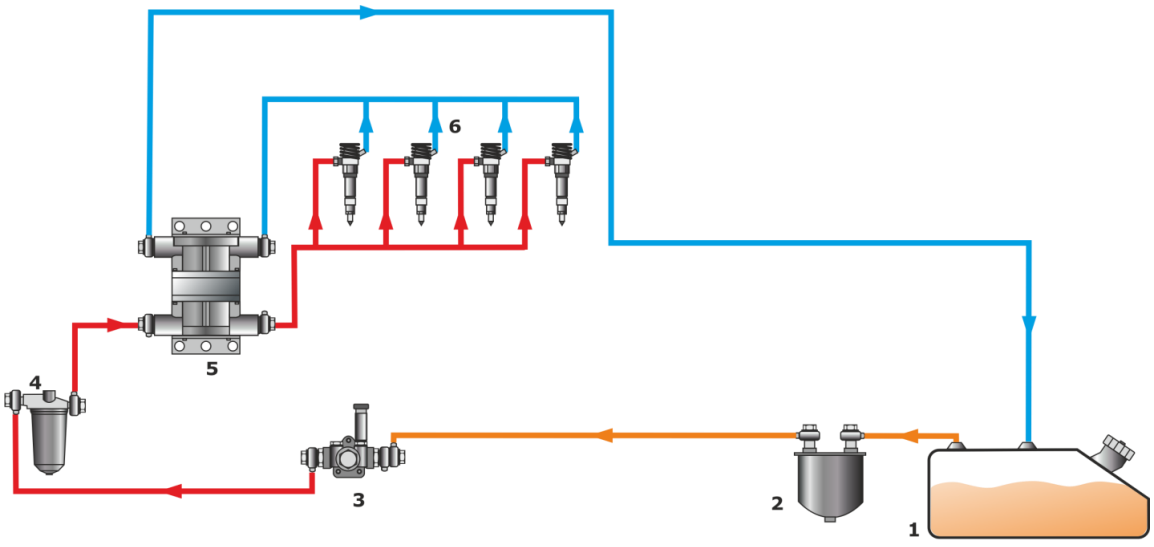
1 – Fuel tank; **2** – Rough filter; **3** – Low pressure fuel pump; **4** – Fine filter; **5** – High pressure fuel pump; **6** – Injectors; **7** – Additional fine filter; **8** – Non-return valve; **9** – Bypass valve; **10** – DFM Fuel Flow Meter.

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



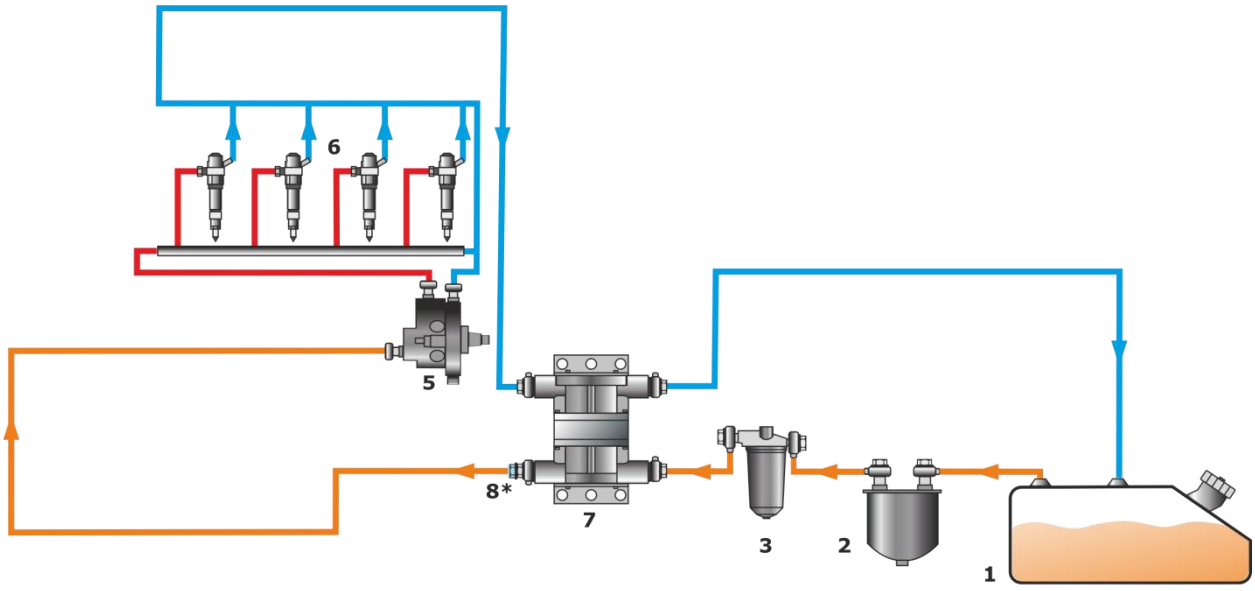
1 – Fuel tank; **2** – Rough filter; **3** – Low pressure fuel pump; **4** – Fine filter; **5** – High pressure fuel pump; **6** – Injectors; **7** – Additional fine filter; **8** – Non-return valve; **9** – Bypass valve; **10** – DFM Fuel Flow Meter.

b) feed 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** – DFM Fuel Flow Meter; **6** – Unit injector.

c) feed 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) feed chamber installation before the pump (Common Rail fuel system)

Figure 24 — Differential DFM D installation scheme

ATTENTION:

1) In some cases (e.g. for a big size engine) it is more convenient to employ **a pair of single-chamber DFM CAN flow meters** connected by means of S6 Technology to form a network (see 2.11) for differential measurement. The first flow meter (Master) is mounted into the break of the feed fuel line, while the other one (Slave) is mounted into the break of the reverse line, to the chambers "Feed" and "Reverse" of DFM D differential flow meter respectively, in accordance with figure 24. The differential consumption is defined as the difference between values of fuel consumption measured by the Master and Slave flow meters.

2) Also, you may employ DFM CAN single-chamber flow meters in pairs using S6 Technology for summation of consumption readings of fuel flowing through both the fuel lines. The first flow meter (Master) is mounted into the break of the first fuel line, while the other flow meter (Slave) is mounted into the break in the other fuel line. The total consumption is determined by means of summation of the fuel consumption values measured by the Master and Slave flow meters (see 2.11).

3) It is allowed to use a pair of DFM CAN of different types/sizes (see table 1).

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 D increase load on the low pressure fuel pump.

Interactive animation video DFM fuel flow meters: selection of installation layout, 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

ATTENTION:

1) To ensure proper operation of DFM, it should be electrically connected by specialist, who finished official technical training and was certified for that.

2) When installing DFM it is obligatory to follow safety rules on carrying out repair works applicable to the machinery being equipped.

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 DFM 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).

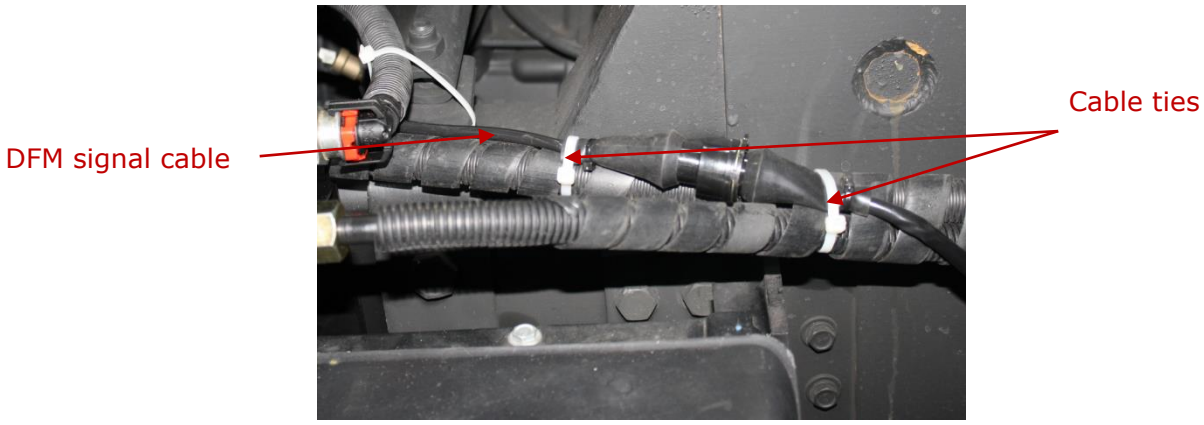


Figure 25 — Laying DFM signal cable

Electrical connection of DFM is carried out by connecting **signal cable** (see annex J) to telematic terminal (or data logger) in accordance with pinout and wires designation (see tables 10…12)

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

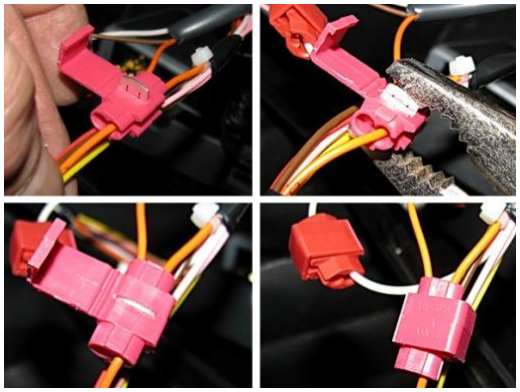


Figure 26 — Wiring connection made with the plastic connectors

Table 10 — Interface cable pinout and wire assignment of DFM AK/CK/DK

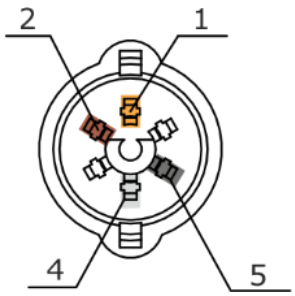
Connector view	Pin number	Wire color		Assignment
	1	Orange		Power supply "+"
	2	Brown		Ground
	4	White		Pulse output (see 1.6.8)
	5	Black		K-Line (ISO 14230)

Table 11 — Interface cable pinout and wire assignment of DFM A232/A485/C232/C485/D232/D485

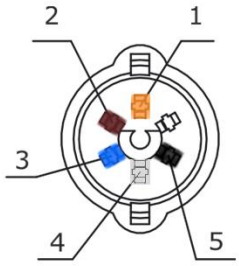
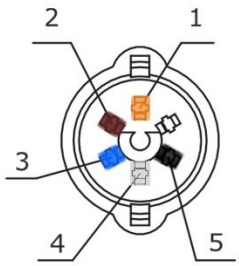
Connector view	Pin number	Wire color		Assignment
	1	Orange		Power supply “+”
	2	Brown		Ground
	3	Blue		Transmitted data (232T). Data exchange (485B)
	4	White		Received data (232R) Data exchange (485A)
	5	Black		K-Line (ISO 14230)

Table 12 — 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)

Examples of connection schemes including the elements of S6 cabling system, which should be ordered for connecting **DFM ACAN/CCAN/DCAN** to registration and display devices, are given in the j1939/S6 Telematics Interface Operation Manual.

2.6 Flow meters configuration by means of cable connection to the PC

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 S6 SK service adapter. S6 SK description can be found in Cabling and accessories for Telematics interface CAN j1939/S6 manual.
Before connecting DFM to PC via service adapter, please download special software from http://www.jv-technoton.com/ (section Software/Firmware) and install it to your PC:

- USB driver;
- Service S6 DFM.

Note — Installation file name contains: ServiceS6_DFM_X_X_Setup.exe, where X_X — version of software.

ATTENTION: For work with Service S6 DFM software, you need a separate PC (desktop or laptop) on which **only** Technoton service software that meets the following minimal requirements is installed:
- Windows 7/10 operating system of X32/X64 bit depth;
- CPU — Intel Core i3, dual-core, 2.0 GHz;
- RAM — 4 Gb;
- availability of USB 2.0 port;
- display resolution 1366x768.

See annex H for DFM settings, displayed and/or made by Service S6 DFM software.

2.6.1 Connection DFM to PC

ATTENTION: To avoid any service adapter faults in communication between PC and DFM 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: Prior to connecting DFM to a PC, it is necessary to turn off electrical circuits of the Vehicle*. To do this, use the battery switch or remove the battery terminals.

* When configuring DFM installed on Vehicle. When configuring flow meters connected by S6 Technology, power supply of onboard network (battery) can be turned on.

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

1) Connect the adapter to fuel flow meter:

- The connector of the service adapter is to be connected to the flow meter interface cable connector by means of the plug connector which is contained in the S6 SK supplied accessories kit (see figure 27 a).

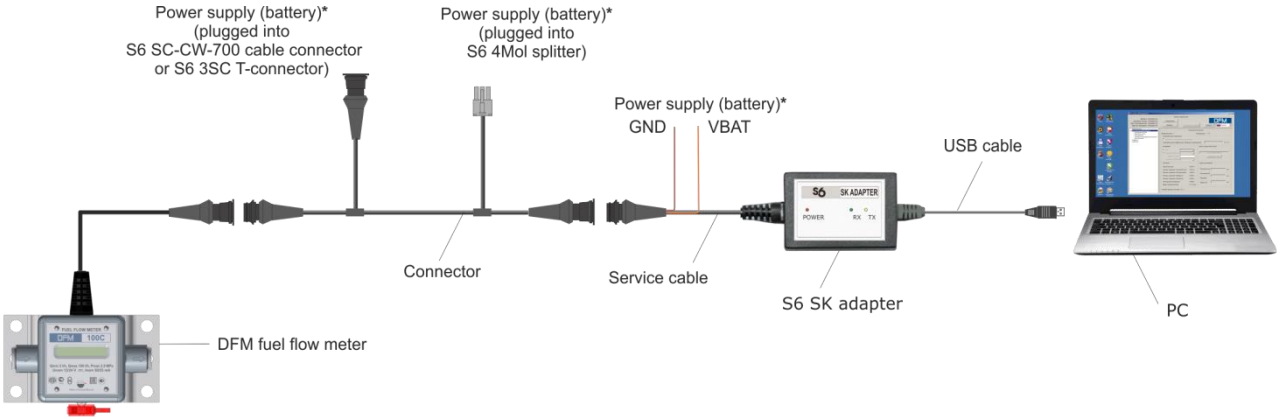
  Note — During the setup you need to provide power supply for the flow meter and adapter either from the accumulator battery, or from the power source. Power supply is provided through any of the free connectors of the connection cord.
- During the setup of DFM Marine connected using S6 Technology the connector of the adapter service cable is to be connected to the corresponding free S6 input connector (see figure 27 b). Power supply for the flow meter and adapter is provided through the S6 cable system.

2) Plug the adapter to USB port of PC with the USB cable.

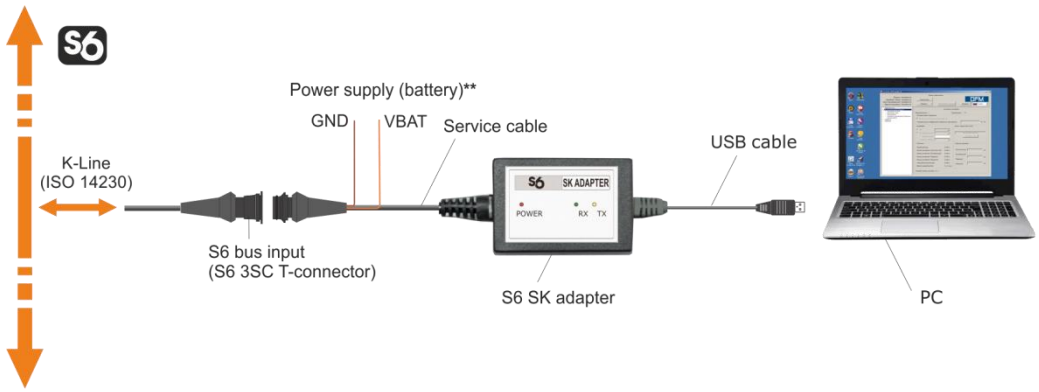
Note – it is allowed to connect adapter to USB-port of your PC after turning on power supply of flow meter and running Service DFM Marine software.

3) Connect power supply and ground wires to vehicle electrical system or battery.

4) Power on the vehicle (battery).



a) connecting DFM using S6 SK



b) connecting DFM CAN using S6 SK via S6 Technology

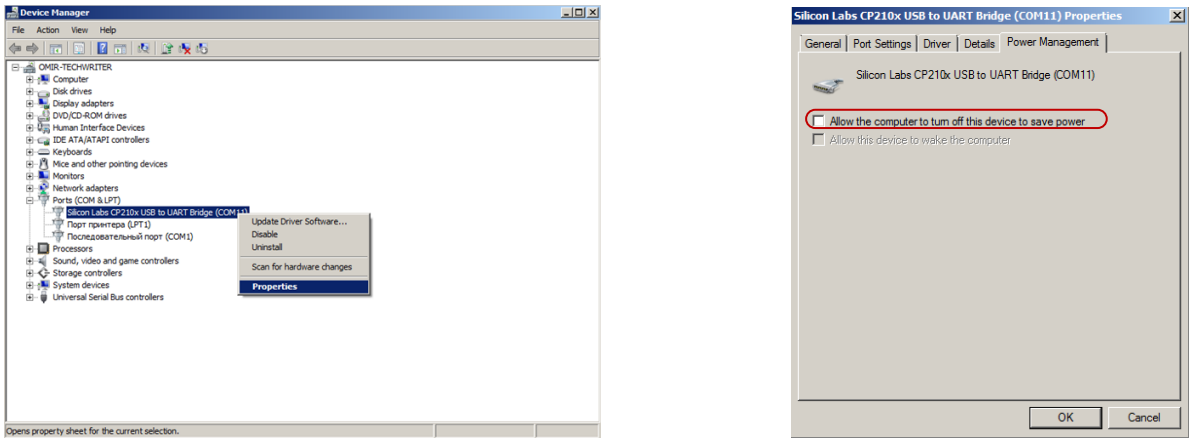
Figure 27 — Schemes of DFM connection to PC

* For connecting power supply (battery) you can choose any of marked places.

** No need to connect. Power supply (battery) is carried out though S6 cabling system.

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 S6 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*

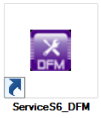
Figure 28 — Virtual COM-port configuration in Device manager

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 13.

Table 13 — Description of adapter's LEDs

LED Indicator			Signal description
Marking	**Status**	**Light color**	
POWER		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 area** and **Information and configuration area** (see figure 29).

ATTENTION: Sometimes, in case of problems while starting Service S6 DFM software in Windows 10, you may need to set the starting of the software in the mode of compatibility with Windows 7. For this purpose, perform the following operations:
1) Click the right button of the mouse on the service software icon and select its **Properties**.
2) In **Compatibility** tab tick the field **Run this program in compatibility for** (**Compatibility mode** area).
3) Select Windows 7 from the dropdown list of operating systems.

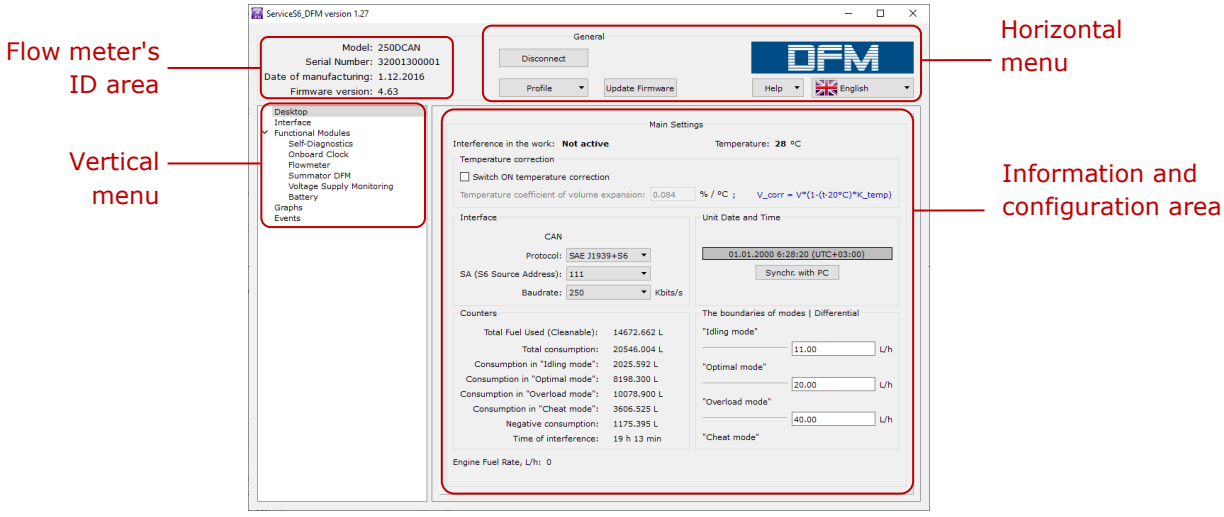


Figure 29 — Service S6 DFM software interface

Flow meter's ID area 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.

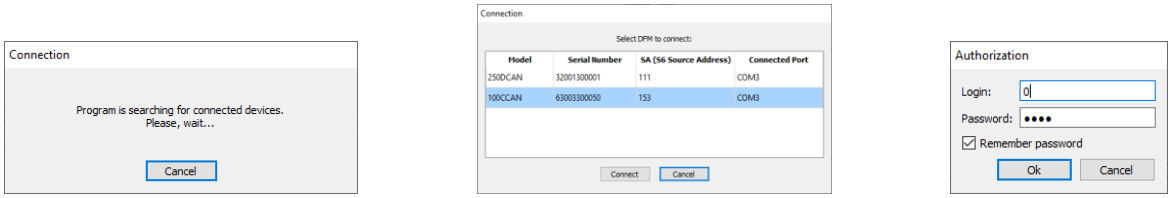
Vertical menu is used for selection of Functional modules (hereinafter FM) of the meter. The actual parameters of FM and settings are displayed at **Information and configuration area**.
Connectivity of software with FM is based on PGNs and SPNs (S6 Database) exchange. SPNs of DFM Functional module which 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 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).

When you connect service adapter via S6 Technology, which contains more than one Unit, in the **Connection** window from the list choose the unit, that will be used with software and click the button Connect (see figure 30 b).

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



a) search of connected Units *b) selecting one of several Units connected via S6 Technology* *c) user authorization*

Figure 30 — Establishing connection between PC and DFM

To recover the password (in case it is lost), you need to place the cursor into the **Login** or the **Password** field of the window **Authorization** and press **Ctrl+F10** key combination. Service S6 DFM software will display a code to recover the current password of the Unit (see figure 31). This message is being sent to Technoton technical department by e-mail support@technoton.by together with password 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.

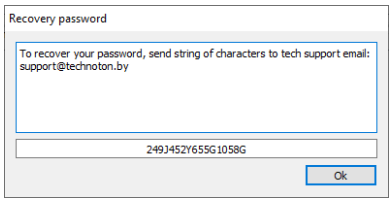
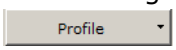


Figure 31 — Generated recovery code window

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 (see annex H).

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.

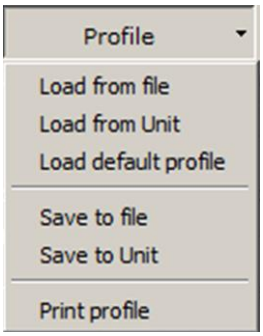
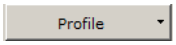


Figure 32 — Profile menu



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).

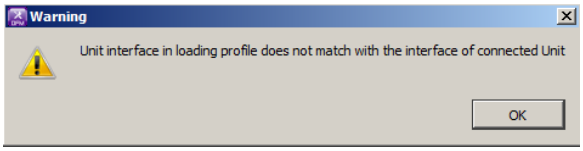


Figure 33 — Warning on interfaces incompatibility of profiles of loaded and connected Unit

- 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** (for one-chamber flow meter) and **DFM_D_default.prf** (for two-chamber flow meter) files 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**.
  Enter a name instead of an asterisk in the template. The prefix **DFM_** and the extension **.prf** will be inserted automatically.

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

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

2.7 Wireless configuration of flow meters using Android devices

Wireless configuration of DFM that have interface cables (models **DFM AK/A232/A485/ ACAN/CK/C232/C485/CCAN/DK/D232/D485/DCAN**) is conducted by means of their connection via Bluetooth to the smartphone/tablet based on the Android operating system (further on – Android device), version 4.4 or a later version using S6 BT Adapter service adapter (purchased separately).

ATTENTION:
1) To eliminate connection failures between the Unit and the Android device, you need to make sure that there are no sources of electromagnetic interference near your working place (radio telephones, video signal transmission units and other wireless devices operating within 2.4 or 5.0 GHz frequency bands, as well as running electric motors, powerful transformers and switching equipment, welding equipment, high-voltage lines etc).
2) The maximum allowed distance between the S6 BT Adapter and the Android device depends on the quality of the Bluetooth connection of the Android device. To assure the stable data transmission, it is recommended that this distance should not exceed 10 m.

Before using S6 BT Adapter, please, download Service S6 DFM service mobile application (further on S6 application) to the Android device from Google Play (search request "Technoton").

A description of S6 BT Adapter and the installation procedure for S6 application are provided in the CAN j1939/S6 Telematics Interface Operation Manual CAN j1939/S6.

Please, see in annex H configurations of DFM that may be displayed and/or edited using S6 application.

2.7.1 Wireless connection DFM to the Android device

ATTENTION: Prior to connecting DFM to the Android device, it is necessary to turn off electrical circuits of the Vehicle*. To do this, use the battery switch or remove the battery terminals.

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.

Avoid the following when connecting service adapter to DFM, mounted into the tank of the Vehicle:

- ingress of fuel and lubricants and moisture to the contact pins of adapter slots or connectors of service cables;
- potential damage of the adapter and cables by the rotating and heating elements of the engine.

* When configuring DFM installed on Vehicle. When configuring flow meters connected by S6 Technology, power supply of onboard network (battery) can be turned on.

The procedure for DFM wireless connection to the Android device (see figure 34) is as follows:

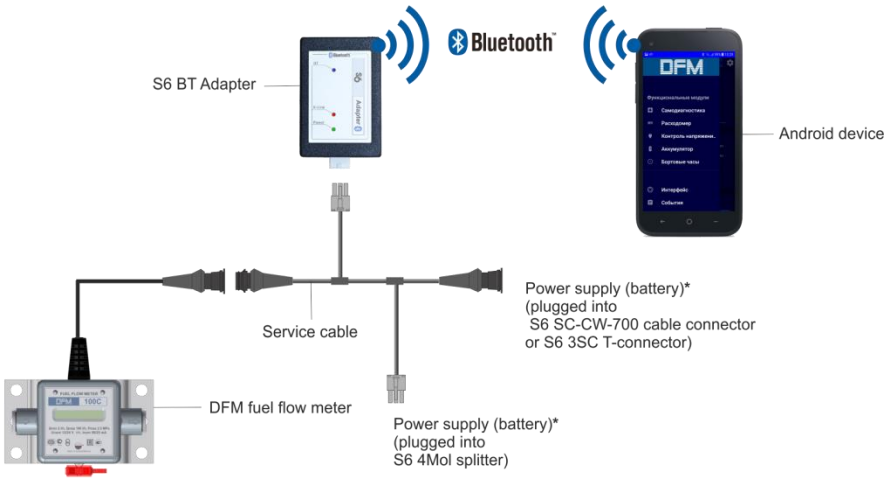
1) Connect the corresponding connector of the service cable to the connector of **S6** adapter.

2) Connect the adapter to DFM:

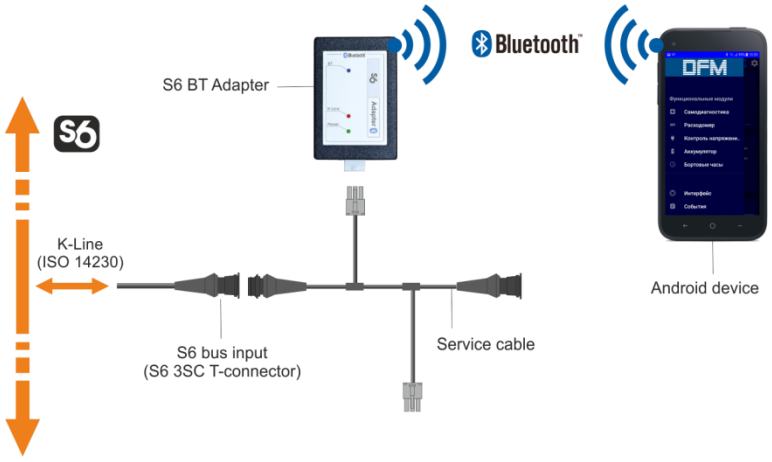
- The service cable connector is input to the interface cable connector of the flow meter. Note — During the wireless configuration of DFM you need to provide power supply for the flow meter and the adapter either from the accumulator battery or from the power source. Power supply is provided through any of the free connectors of the connection cord (see figure 34 a).
- During the wireless configuration of flow meters connected using S6 Technology the connector of the service cable is to be connected to any free connector of S6 cable system (see figure 34 b).

3) Connect power supply and ground wires to Vehicle electrical system or battery.

4) Power on the vehicle (battery). After the power supply is on, the green LED indicator **POWER** is lit. You will also see a blue blinking light of the **BT** LED indicator which means that S6 BT Adapter is available for connection with Android devices via the Bluetooth channel.



a) connecting DFM using S6 BT Adapter



b) connecting DFM using S6 BT Adapter via S6 Technology

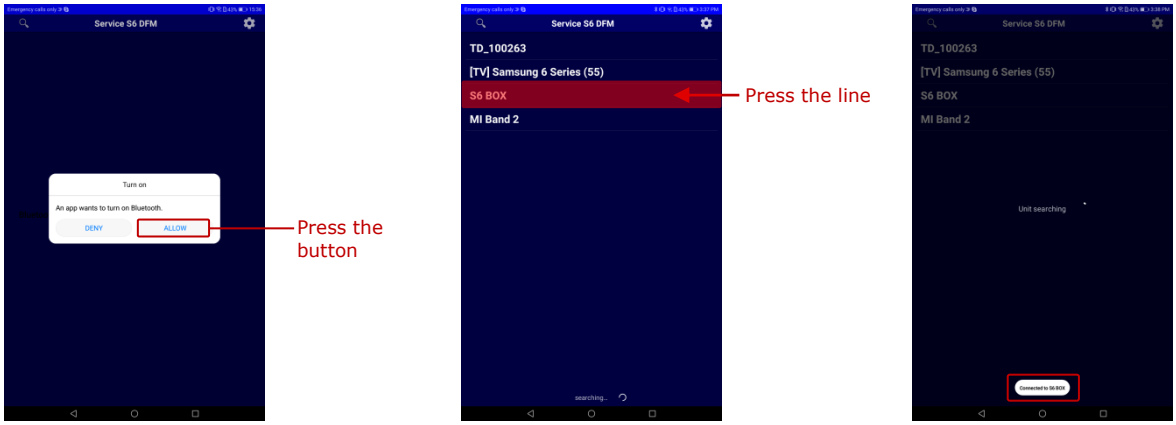
Figure 34 — Schemes of wireless connection of DFM to Android device

***** For connecting power supply (battery) you can choose any of marked places.

Start S6 application from the main menu of the Android device with 

icon which is created in the process of its installation.

S6 BT Adapter is ready for operation from the moment the power supply is on. If the S6 BT Adapter is connected correctly, after its initiation S6 application will offer to allow the activation of Bluetooth. After the Bluetooth is activated, a list of all devices available for wireless connection will appear on the display of the Android device. Select **S6 BOX** to connect the Android device to DFM (see figure 35).



a) authorization of the Bluetooth activation in the Android device

b) selection of S6 Units from the list of available Bluetooth devices

c) message of establishing a connection of the Android device to DFM

Figure 35 — Example of the flow meter functioning check using the Service S6 DFM service mobile application

During the operation of S6 BT Adapter signals of LED indicators should comply with those indicated in table 14.

Table 14 – LED-indicators' signal description. S6 BT Adapter – wireless configuration of DFM

LED Indicator			Signal description
Marking	**Status**	**Light color**	
POWER		Power on	Power supply is on
	No signal		Power off or power supply voltage is too low
K-Line		Red	Receiving data via K-Line interface
	No signal		Data are not received over K-Line interface
BT		Blue	S6 BT Adapter is initialized, but no connection with Andorid-based device (indicator is blinking each 1 s)
			Connection with S6 BT Adapter is established (blinking each 0.5 s)
			S6 BT Adapter is sending data over Bluetooth (blinking each 0.25 s)
	No signal		S6 BT Adapter is not initialized

2.7.2 Interface of S6 application

The interface of S6 application consists of **Information and Configuration Area** and **Tools Panel** (see figure 36).

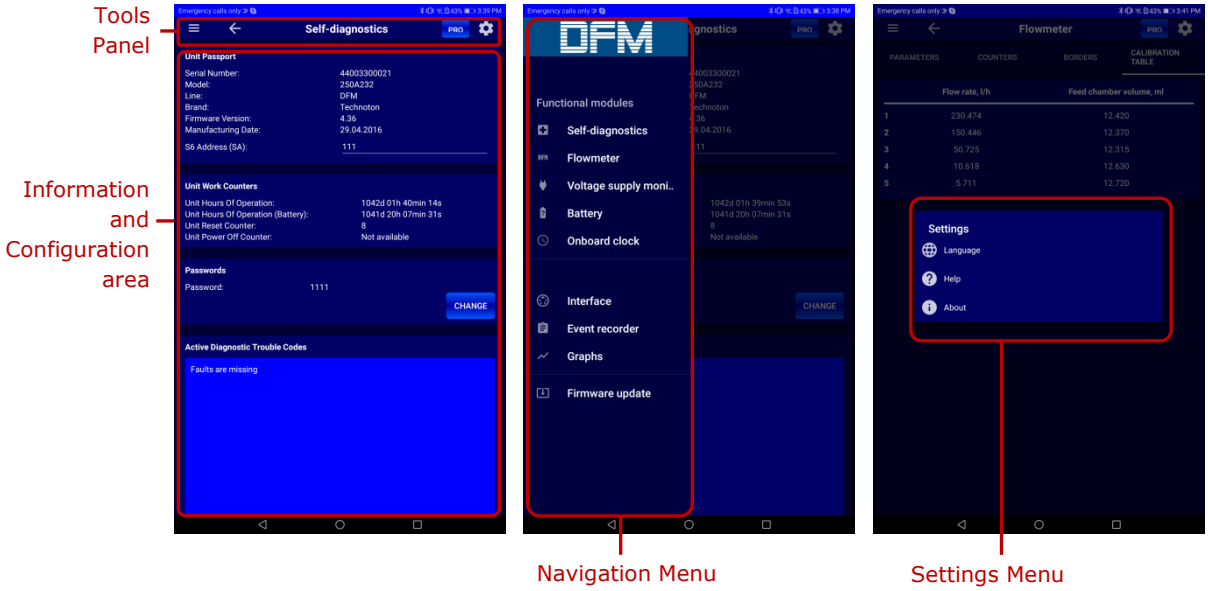


Figure 36 — Interface of Service S6 DFM service mobile application

In the **Information and Configuration** area current parameters and settings of the flow meter Functional modules (FM) are displayed.

In the **Tools Panel** area there are the following elements for use during work with S6 application:

- button to display the **Settings Menu** (selection of the interface language, help and software information);
- button to select operations with the flow meter Profile;
- name of the flow meter FM which is configured;
- icon to disconnect the Bluetooth channel;
- icon to display the **Navigation Menu** (selection of FM, functioning check, Counters review, firmware update).

When working with DFM, the Service S6 DFM (Android) mobile app operates with data (PGN and SPN) from S6 databases.

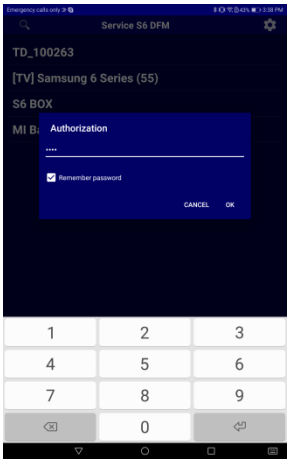
2.7.3 Authorization

To establish a wireless connection session between DFM and the Android device, select **S6 BOX** from the list of devices available for connection via the Bluetooth channel. S6 application will automatically carry out the search and connection of DFM (see figure 35).

While connecting S6 BT Adapter to the network consisting of several Units using S6 Technology, select the Unit required by DFM for the use of S6 application from the list displayed (see figure 37 a).

Enter the Unit password into the appropriate boxes of the **Authorization** window. The password by default is 1111. To save the password entered (to exclude its entering manually another time during the next session of work with the flow meter), checkmark the box **Remember Password** (see figure 37 b).

a) selection of one of the Units connected using S6 Technology for work with the application



b) entering the Unit password

Figure 37 — Establishing a wireless communication session between DFM and the Android device

In case of incorrect entering the password or incorrect connection to the Android device, an error message will appear.

If the user authorisation has been conducted successfully, the loading of the of the connected DFM profile will start.

To restore the Unit password (in case it is lost), you should connect DFM to the PC using S6 SK and proceed in accordance with 2.6.3.

2.7.4 Operations with profile

ATTENTION: Any operations with the DFM profile in the S6 service mobile application are possible only during a wireless connection session between the flow meter and the Android device. If there is a need to edit the profile in the off-line mode, connect DFM to the PC using S6 SK and proceed in accordance with 2.6.4.

To perform any operations with the DFM profile, the menu **Profile** is used which is opened by pressing the appropriate button on the **Tools Panel** (see figure 38).

The **Profile** menu contains the following options for operations with the DFM Profile:

- Load from file — is used to load the profile saved in the memory of the Android device before. In the window where the file is to be loaded you need to find and select the profile file (***.prf**);
- Save to file — is used to save the changed settings of the profile in the Android device memory;
- Load from Unit — is used to load the profile from the flow meter connected to the Android device;
- Save to Unit — is used to save the changed settings of the profile in the memory of the connected flow meter.

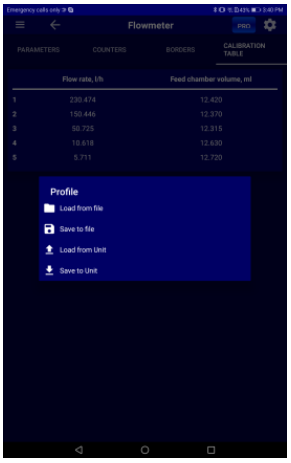


Figure 38 — View of Profile menu

2.8 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.

To connect flow meters with digital interfaces to an external device (**DFM A232/A485/ ACAN/C232/C485/CCAN/D232/D485/DCAN)**, you need to configure parameters of DFM output interface in the **Interface** window of the service software or S6 application:

1) From the drop-down menu of **Protocol** list choose required data transfer protocol:
- for interface CAN j1939/S6 — **SAE J1939+S6** or **NMEA 2000** (see figure 39);
- for RS-232 and RS-485 — **MODBUS** or **DFM COM** (see figure 40);

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, fuel flow meter 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 fuel flow meter automatically send output message to the tracking device. Parameter value range is 1…255 seconds with 1 seconds step. Default value is 1 second.

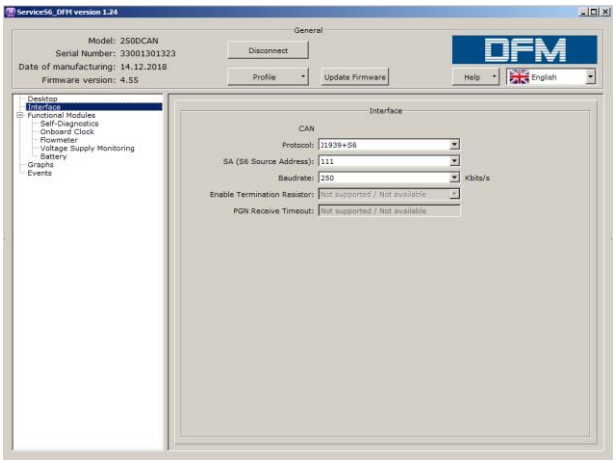
ATTENTION: For interface CAN j1939/S6 you can select NMEA 2000 data transmission protocol only using the service software, version 1.20 or later version. You cannot select NMEA 2000 protocol with S6 application.

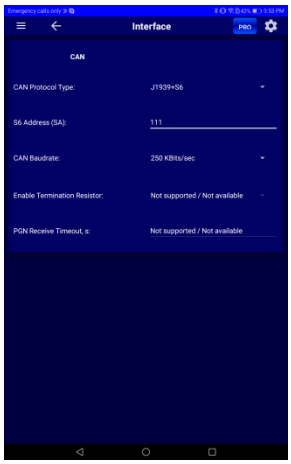
2) If you connect several DFM CAN at one time using S6 Technology, specify the network address from the main (111…118) or additional (151…158)* ranges in the field **SA (S6 Source Address)** for each flow meter (111 by default).
In case you connect several DFM 232/DFM 485 at one time, set the network address for each flow meter in the field **Device Address**. It is allowed to use addresses 0…255 (111 by default).

3) From the drop-down menu of **Baudrate** list choose data transfer speed:
for CAN j1939/S6 interface you can choose one of the following data transfer speeds: 100; 125; 250; 500; 1000 kbit/s (by default— 250 kbit/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: If you edit values of parameters in **Interface** window, the same values of the same parameters will automatically change in other windows and vice versa.

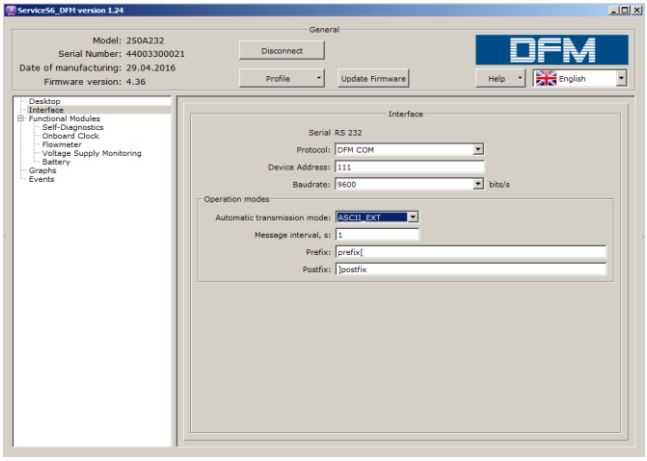
* You may specify addresses from the additional range only by using Service S6 DFM software, version 1.27 and higher for DFM CAN flow meters with the version of firmware not lower than 4.63.





a) in Service S6 DFM software *b) in Service S6 DFM (Android) app*

Figure 39 — Flow meter connection parameters settings when using CAN j1939/S6 interface



a) in Service S6 DFM software *b) in Service S6 DFM (Android) app*

Figure 40 — Flow meter connection parameters settings when using RS-232/RS-485 interface

2.9 Operation check

To conduct an operation test of the mounted flow meter, you need to use **Graphs** window of the service software or of S6 application in which are displayed in real time (see figure 41):

- For one-chamber DFM flow meters:
  - Chart of hourly (instant) consumption of fuel, which went through the only measuring chamber (SPN 183);
  - Current Counter values — Total fuel consumption (SPN 5054) and fuel consumption in "Tampering" mode (SPN 5054/9.3).

- For a pair of single-chamber DFM CAN during differential measurement*:

  - Charts of hourly (instant) consumption of fuel flowing through the measuring chambers of the Master flow meter (SPN 521027/18.0) and the Slave flow meter (SPN 521027/18.1) connected to the feed and reverse lines respectively;
  - Chart of differential consumption of fuel flowing through the measuring chambers of the Master and Slave flow meters (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).

- For DFM D differential fuel flow meters:
  - Chart of hourly (instant) consumption of fuel, which goes through feed chamber (green line) (SPN 521027/18.0) and through reverse chamber (SPN 521027/18.1) of the flow meter installed on feed and reverse fuel lines. Additionally, the result of two lines – difference in volumes of fuel going through each chamber of the flow meter (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 **Flowmeter FM** window (see H.3).

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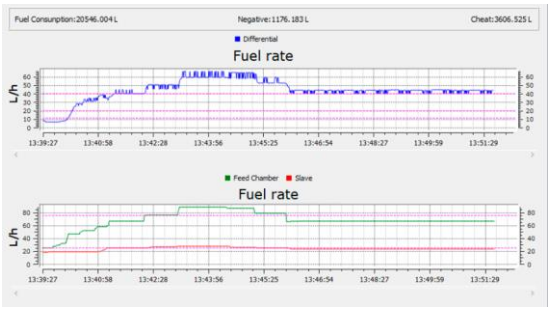
* Only for DFM CAN flow meters with the firmware version not lower than 4.63, when using Service S6 DFM software, version 1.27 and higher.

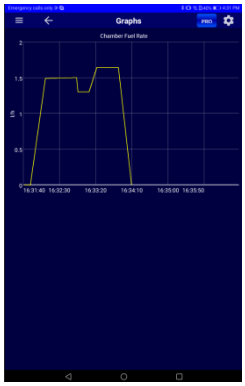
Example for a single-chamber DFM



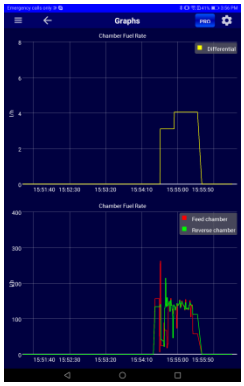
Example for a pair of single-chamber DFM CAN during differential measurement

Example for a differential DFM D

a) in Service S6 DFM software



Example for a single-chamber DFM



Example for a differential DFM D

b) in Service S6 DFM (Android) app

Figure 41 — DFM operation test with Graphs window

2.10 Configuration for specific operation conditions

To enhance the flow meter accuracy of measurement in specific operation conditions, you may configure the following settings using the service software or S6 application (**Flowmeter FM** window):

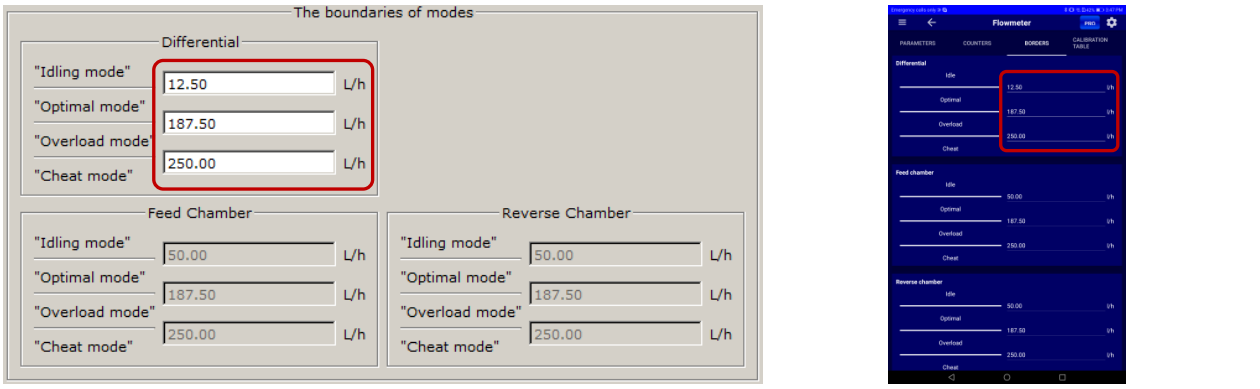
1) Set up boundaries of operation modes of DFM, which are used to define current workload of Vehicle depending on its hourly consumption rate (SPN 521392):

- "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.

You may find values of hourly fuel consumption in "Idle", "Optimal", "Overload" modes of operation for a specific type of engine in its operational documentation or define them experimentally.

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 "Feed" and "Reverse" chambers could not be adjusted (see figure 42).



a) in Service S6 DFM software *b) in Service S6 DFM (Android) app*

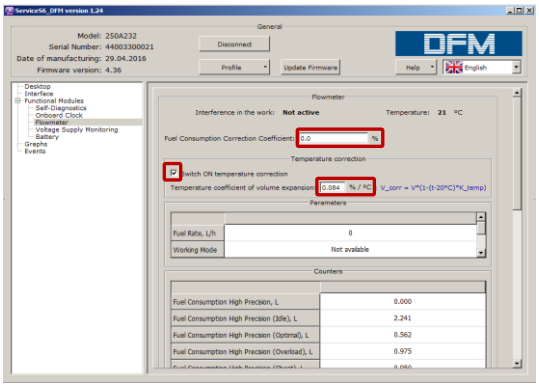
Figure 42 — Example of settings for limits of modes of operation for the differential DFM

2) Turn on temperature correction function (see figure 43), i.e. automatic correction of fuel volume consumption data adjusted to fuel temperature (SPN 521311).

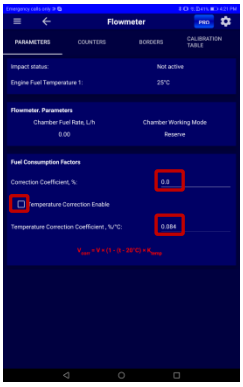
Temperature correction function is used because volume of fuel changes when fuel temperature is going up/down.

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 15, taking in account density **ρ** of oil product at the temperature of plus 20 °C.



a) in Service S6 DFM software



b) in Service S6 DFM (Android) app

Figure 43 — Example of thermal correction and consumption correction coefficient configuration

Table 15 — Selection of oil products volumetric expansion coefficient

ρ, kg/m³	β, 1/°C	ρ, kg/m³	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 (see figure 43) allows to enhance fuel consumption accuracy of measurement by **single-chamber** DFM in case of revealing repeated decreased/increased indications in specific operation conditions (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 %.

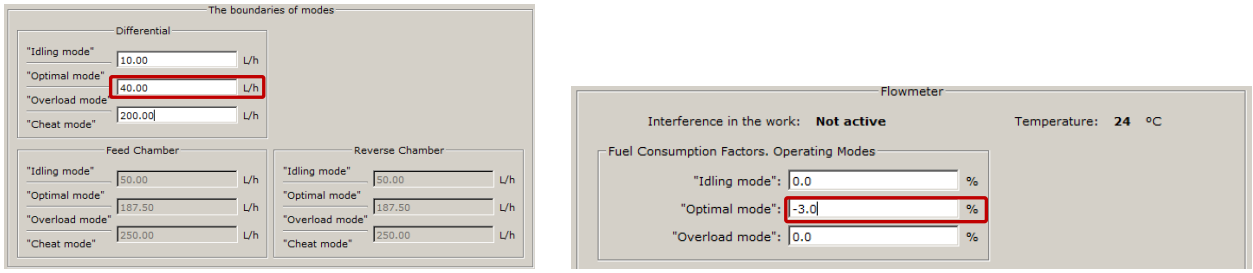
4) Set correction coefficients for modes of operation (PGN 63303). This feature allows to enhance measurement accuracy of differential hourly consumption only for **differential** flow meters models (DFM D) with firmware version not earlier than 4.55, using the service software version 1.24 and later versions. For correct implementation of this feature, you have to perform the following operations:

- Set limits for the flow meter modes of operation by which the current mode of the Vehicle operation is identified, depending on the differential hourly fuel consumption (PGN 63065).
- Test the flow meter measurement accuracy (measurement accuracy test) using testing procedure 3.
- Based on the test results, determine to which mode of the flow meter operation the value of average fuel consumption corresponded during the measurement accuracy test.
- If needed, enter the respective correction coefficient for the mode of operation used during the measurement accuracy test.

  From this moment on, the flow meter will calculate the value of differential fuel consumption, taking into account the correction coefficient entered for this mode of operation. This correction is not applicable for other modes.

E.g. based on the results of the measurement accuracy test, the calculated measurement error is + 3 %. The average differential fuel consumption during the test was 20 l/h. Therefore, the calculated measurement error should be considered as corresponding to the "Optimal" mode of operation (see figure 44 a).

To correct the flow meter operation, you need to specify the value of the correction coefficient for the "Optimal" mode as equal to – 3 %. No correction is needed for other modes of operation ("Idle" and "Overload"). That is why, we leave the values of their correction coefficients equal to 0 % (see figure 44 b).



a) defining average fuel consumption during the measurement accuracy test

b) entering the correction coefficient

Figure 44 — Example of entering the fuel consumption correction coefficient for modes of differential DFM operation

2.11 Configuration of single-chamber DFM CAN for operation in pairs in the "Differential"/"Summation" modes

ATTENTION: For operation in the "Differential"/ "Summation" modes you may use a pair of single-chamber DFM CAN flow meters (with a version of firmware not lower than 4.63) connected into a network using S6 Technology.
Each flow meter is to be assigned a unique network address from ranges of values (111…118) or (151…158) (see 2.8).

Flow meter configuration is carried out in **Flowmeter FM** window (by using Service S6 DFM software, version 1.27 and higher) in the following sequence (see H.3 and figure 45):

1) In the dropdown list **Master Mode (Differential Operation Mode** area) activate the Master mode (SPN 521268) for the leading flow meter (Master flow meter) and deactivate the Master mode for the led flow meter (Slave flow meter) in the pair being used.

2) In **Calculation Mode** dropdown list enable mode of counting DFM CAN (SPN 521270):

- **Differential** – fuel consumption is calculated as a difference between fuel consumption measured by flow meter in feed and reverse lines.
- **Summing** – fuel consumption is calculated as a sum of fuel consumption measured by flow meter in first and second fuel lines.

ATTENTION:
1) During the differential measurement DFM CAN is assigned the role of the Master flow meter which is mounted in the feed fuel line, while DFM CAN mounted in the reverse line is assigned the role of the Slave flow meter.
2) In the summation mode the Master flow meter and the Slave flow meter may be assigned at the discretion of the user.

3) Enter a unique network address in **Slave Device Address** field for Slave-flow meter (SPN 521269). Elected address should not be the same as Master-flow meter has.

4) In the area **The Boundaries Of Modes** you may specify values of the hourly fuel consumption limits in the "Idle" and "Optimal" modes, as well as values of differential hourly fuel consumption limits for "Idle", "Optimal" and "Overcharge" modes (PGN 63205) (similar to 2.10, see **Set up boundaries of operation modes of DFM**).

5) If necessary, enter **Differential Fuel Rate Correction Coefficient** (SPN 521271) for Master-flow meter to increase accuracy of measurement (similar to 2.10, see **Configure consumption correction coefficient**).

6) To increase accuracy of differential measurement for complex objects, which have uneven flow rate in feed and return fuel lines (e.g. fuel pulsation, increased fuel system inertia, waterhammers etc.), **Smoothing Capacity** (smoothing buffer) of Master flow meter can be configured (SPN 521671).

Value of smoothing buffer is selected experimentally from 2…100 range.

In case of even flow rate in feed and reverse lines, it is recommended to enter minimum value of buffer (in majority of cases default value "5" is enough). When unevenness of flow rate in feed and reverse lines is growing, it is recommended to increase value of smoothing buffer.

WARNING: Keep in mind, that increasing smoothing buffer leads to:
1) Duration of differential flow rate Counters recalculation by Master flow meter is increasing up to several minutes.
2) After fuel supply is stopped, values of Counters in Master flow meter are stabilized not sooner than in 15 seconds.

To get recommendation on configuring smoothing buffer for particular case, contact Technoton technical support team.

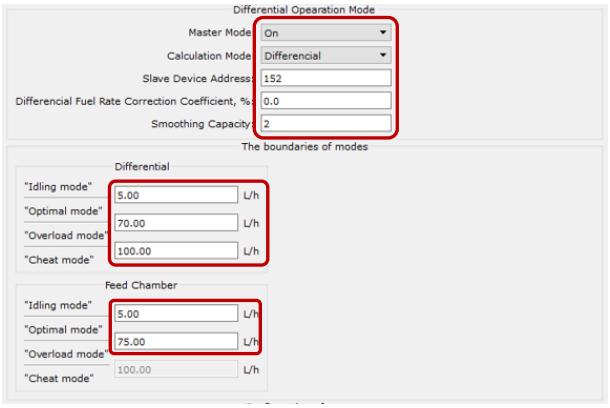


Figure 45 — Example of configuring DFM CAN for "Differential" operation mode

IMPORTANT: To operate in "Differential"/"Summarization" mode power supply voltage of flow meters should not drop out of (10…45) V range.

2.12 Summation of fuel consumption readings

ATTENTION: For summation of fuel consumption in two or more fuel lines (16 at a maximum) you may use DFM CAN / DFM DCAN flow meters (firmware version not lower than 4.63) connected into a network using S6 Technology in any type/size combination (see tables 1 and 2).
Each flow meter is to be assigned in advance a unique network address from the range of values (111…118) or (151…158) (see 2.8).

The flow meter which is to provide the signal of the fuel consumption readings total is configured in the window **Summator DFM FM** (see I.4 and figure 46) of Service S6 DFM software (version 1.27 and higher) in the following order:

1) In the area **DFM Summation Settings** tick **DFM Summation Mode Enable** field (SPN 521689).
2) Tick those flow meters of the fields **DFM 1 (111)…DFM 16 (158)** whose readings you need to sum up.

IMPORTANT: During the summation of readings of the flow meters that operate in pairs in the "Differential" mode (see 2.11) you need to tick only the fields of the Master flow meters.

WARNING: In case the output data of any of the selected flow meters are missing (e.g. due to switching off or malfunction), the appropriate message will be displayed in the field **Summation Errors**, with the specification of the flow meter number.

3) After saving the flow meter Profile in the Unit, the value of the fuel consumption total shown by the Counters is to be displayed in the line **Fuel Consumption High Precision, L** for the selected flow meters (SPN 5054/2.11).

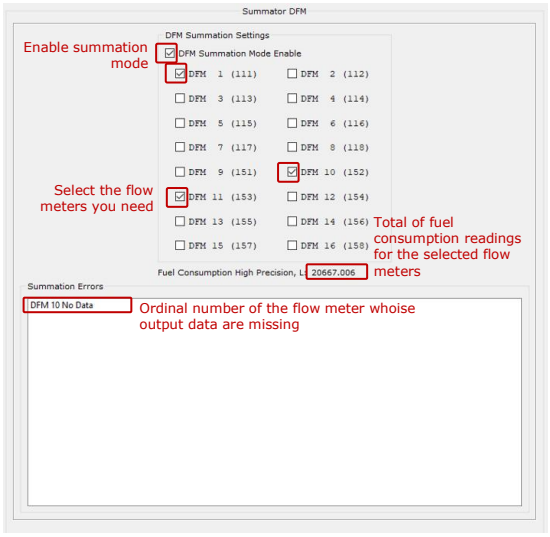


Figure 46 — Example of DFM CAN configuration using Service S6 DFM software for summation of the fuel volume readings

Examples of connection diagrams of DFM CAN flow meters using S6 Technology for summation of fuel consumption readings including the specification of cabling to be ordered are provided in CAN j1939/S6 Telematics interface Operation Manual.

3 Measurement accuracy check

ATTENTION: To determine measurements accuracy of DFM flow fuel meter mounted on the vehicle it is required to carry out a test.
Measurement accuracy check is an obligatory procedure, which defines relative inaccuracy of fuel consumption measurement on equipped Vehicle.

3.1 Test conditions

Tests must be conducted in presence and under control of representatives of all interested parties.

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.

Conditions of the test:

- tests are conducted on properly operating (fault-free) Vehicles. Before starting the test, remove air from the fuel system and warm up the engine to operating temperature;
- fuel must not contain any mud or other impurities;
- the engine must run at medium speed (RPM);
- duration of the tests — until running out of up to at least 2/3 of the average hourly fuel consumption by the consumer;
- engine shutdown is not allowed during the test;
- to measure the volume of fuel in tank during the tests, it is necessary to use the certified measuring instruments (measuring ruler or a measuring capacitance).

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 47).

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 reverse Fuel line 2 in to Tank 1.

6) Disconnect the injectors reverse 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 reverse 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 reverse 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:

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

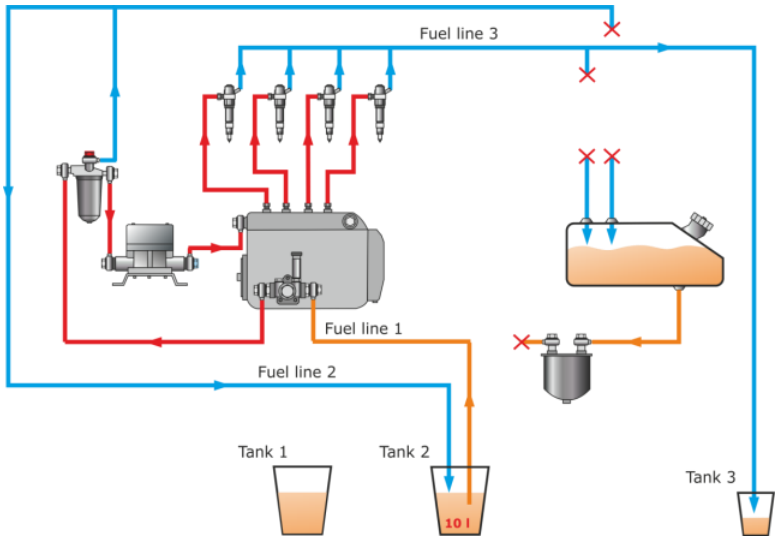
where $V_{measured}$ – measured fuel consumption, l;

V_m – actual fuel consumption, l.

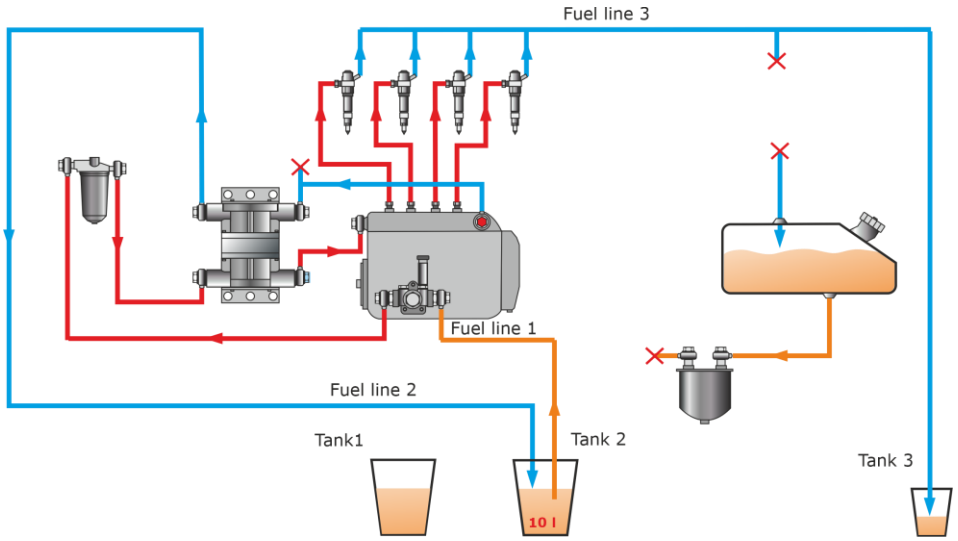
21) Use a verified container to determine **actual fuel amount from the injectors reverse line** ($V_{inj.return}$).

22) Determine the **proportion of the reverse 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.



a) for one-chamber flow meter



b) for two-chamber flow meter

Figure 47 — Examples of Fuel system schemes during testing

IMPORTANT:

When carrying out accuracy test of DFM flow meter, you can use the values from "Total fuel consumption" Counter (see H.3), 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 (see table 6).
- **It is not recommended** to use data from "Total fuel consumption" Counter when signal transmission is set to **HEX** (see 2.8) 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 2.8) 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

The DFM mounting kits (further on — MK DFM) are designed for quick and firm DFM flow meters connection to the engine fuel system using pipes of 8 and 10 mm in diameter.

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 16 — MK DFM application

Kit name	Application
DFM MK 20B	All-purpose, for mounting DFM 50/DFM 100/DFM 250 one-chamber flow meters using 8 mm fuel pipe
DFM MK 40B	All-purpose, for mounting DFM 50/DFM 100/DFM 250 one-chamber flow meters using 10 mm fuel pipe
DFM MK 45B	All-purpose, for mounting DFM 500 single-chamber flow meters using 10 mm fuel pipe
DFM MK 90B	To install DFM 50/DFM 100/DFM 250 one-chamber flow meters on D243, D245 and D260 engines using 8 mm fuel pipe
DFM MK 100B	To install DFM 50/DFM 100/DFM 250 one-chamber flow meters on YaMZ, KAMAZ engines using 8 mm fuel pipe
DFM MK DIFF11B	For mounting DFM 100D and DFM 250D differential flow meters using 10 mm fuel pipe
DFM MK DIFF21B	For mounting DFM 500D differential flow meters using 10 mm fuel pipe

MK DFM sets (see table 17) 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 17 — MK DFM components

View	Component name	Description	Kit name						
			DFM MK 20B	DFM MK 40B	DFM MK 45B	DFM MK 90B	DFM MK 100B	DFM MK DIFF11B	DFM MK DIFF21B
	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	8	4
	Banjo bolt BB 16		-	-	1	-	-	-	4
	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 8 mm fuel pipe to mounting elements	8	-	-	6	4	-	-
	Banjo fitting BF 14/10	For connection of 10 mm 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

View	Component name	Description	Kit name						
			DFM MK 20B	DFM MK 40B	DFM MK 45B	DFM MK 90B	DFM MK 100B	DFM MK DIFF11B	DFM MK DIFF21B
	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 reverse line	1	1	1	1	1	-	-
	Nipple adapter NA 14-4	To connect the fuel line with a reverse fuel line through the bypass valve	1	1	1	1	-	-	-
	Nipple adapter NA 14-20	To reverse the reverse 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	-	-	-	-
	Nipple adapter double NA 10-16/2	For joining two fuel lines with heater line	-	-	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 8 mm fuel hose onto the banjo fitting or filter	8	8	8	6	4	8	8

View	Component name	Description	Kit name						
			DFM MK 20B	DFM MK 40B	DFM MK 45B	DFM MK 90B	DFM MK 100B	DFM MK DIFF11B	DFM MK DIFF21B
	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 18 — Connection cables for electrical connection of DFM with interface cable

View	Component name	Description
	S6 SC-CW-700 (signal cable) (see annex J)	Designed to connect DFM CAN to recording and display devices and to external power supply. 7 meters long. Equipped with 2 terminating resistors (120 Ohm). If needed, one of the terminal resistors may be disabled. Not included into delivery set.
	SC-CW-700-RS (signal cable) (see annex J)	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 J)	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 – Designations of models of additional cables and other S6 system components which may be needed for connection of DFM CAN using S6 Technology are provided in j1939/S6 Telematics Interface Operation Manual.		

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 19).

Table 19 — DFM additional accessories

View	Marking	Name	Application	Note
	TC 8	T-joint	To join/separate fuel flows	For 8 mm fuel pipe
	TC 10			For 10 mm fuel pipe
	BV 8	Ball valve	To control flow separation in a semi-differential scheme	For 8 mm fuel pipe
	BV 10			For 10 mm fuel pipe
	TR 10-2	Double fitting	To join/separate fuel flows and connecting fuel hose to fuel system units	For 10 mm fuel 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	Magnetic 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	Exterior of seal can be different

View	Marking	Name	Application	Note
	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 8 mm fuel pipe, (-30...+70) °C
	FUB dn10x3			Coil 8 m, for 10 mm fuel 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 10 mm fuel 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 50 m coil, 19 mm diameter
	CoTube9.8	Split corrugated tubing	Fast assembly plastic tube for DFM cable protection	50 m coil, 9.8 mm diameter

4.4 DFM DA 250 deaerator

Air bubbles which come into the fuel supply system from the fuel tank or feed 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 48).

Figure 48 — DFM DA 250 deaerator

DFM DA 250 features:

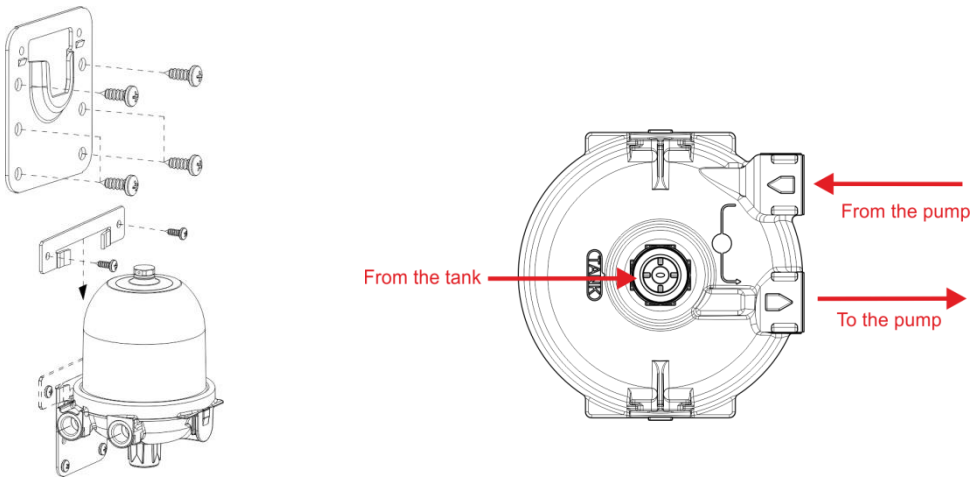
- increases flow meter accuracy;
- decreases engine (boiler) malfunction possibility;
- increases service life of the fuel system;
- provides an effective and stable combustion of fuel;
- improves the environmental parameters of the combustion process and reduces emissions;
- mounting accessories included.

Table 20 — 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 feed 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 30 cm.

Deaerator is mounted using the mounting kit elements according to figure 49 a. Fuel lines are connected according to figure 49 b.



a) fastening *b) fuel lines connection*

Figure 49 —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 installation layout, accessories and mounting kit.

5 Registered Events control

For monitoring Events recorded by DFM and saved in its internal memory, connect the flow meter to the PC (see 2.6.3) or to the Android device (see 2.7.3).
From the software **Vertical menu** or from **Navigation Menu** of S6 application select **Events** (see figure 50). Lists of **Important Events** and **Information Events** will be displayed in the window (up to 15 latest Events of each type).

1) Important Events include:

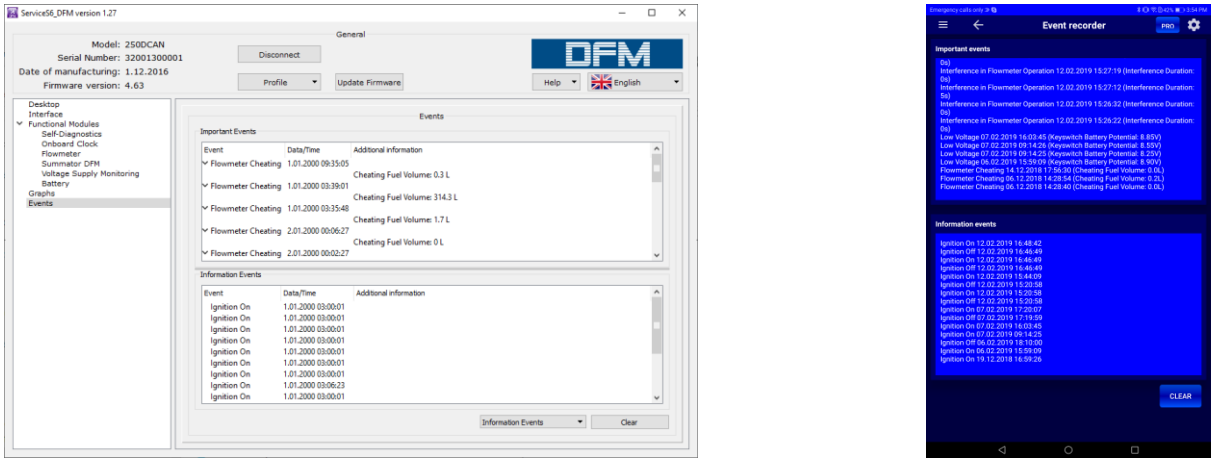
- flow meter tampering (indicating total tampered volume);
- interference in flow meter operation (indicating total interference time);
- low level of supply voltage (indicating voltage value);
- high level of supply voltage (indicating voltage value).

2) Information Events include:

- 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.



a) in Service S6 DFM software *b) in Service S6 DFM (Android) app*

Figure 50 — Browsing thorugh Events registered by DFM

You can delete all registered Event from DFM by clicking **Clear** button. 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 https://www.jv-technoton.com/.

Limited troubleshooting may be self-conducted (see table 21).

Table 21 — 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/CD**	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 feed 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 (SPN 5054 see 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 51).

Figure 51 — 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 (SPN 5054/18.0 see H.3) for differential fuel flow meters.

9 Packaging

DFM delivery sets come in cardboard boxes of the following shape (figure 52)

Figure 52 — DFM 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 53).

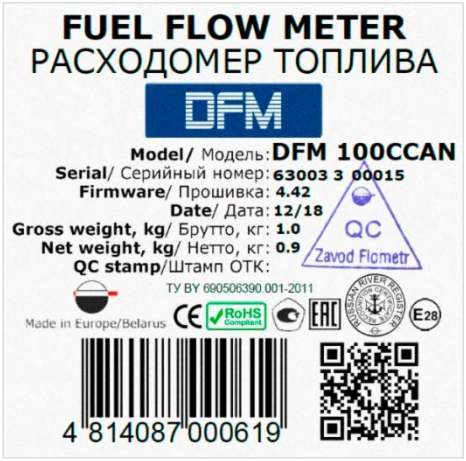


Figure 53 — DFM packaging label

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 precious metals in amount that should be recorded.

The inbuilt lithium-thionyl chloride battery of DFM contains harmful substances and components that are hazardous to human health and environment.

Battery must not be disposed of together with general domestic waste.
The Buyer is responsible for the disposal of battery by means of its delivery to the hazardous waste collecting center; this will ensure safety for human health and environment.

Technoton bears no responsibility for any non-compliance with the above disposal and recycling requirements for battery.

Contacts

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support@technoton.by

Manufacturer

Zavod Flometr

Tel/fax: +375 1771 3-29-21

office@flowmeter.by

Annex A

Overall dimensions and weight

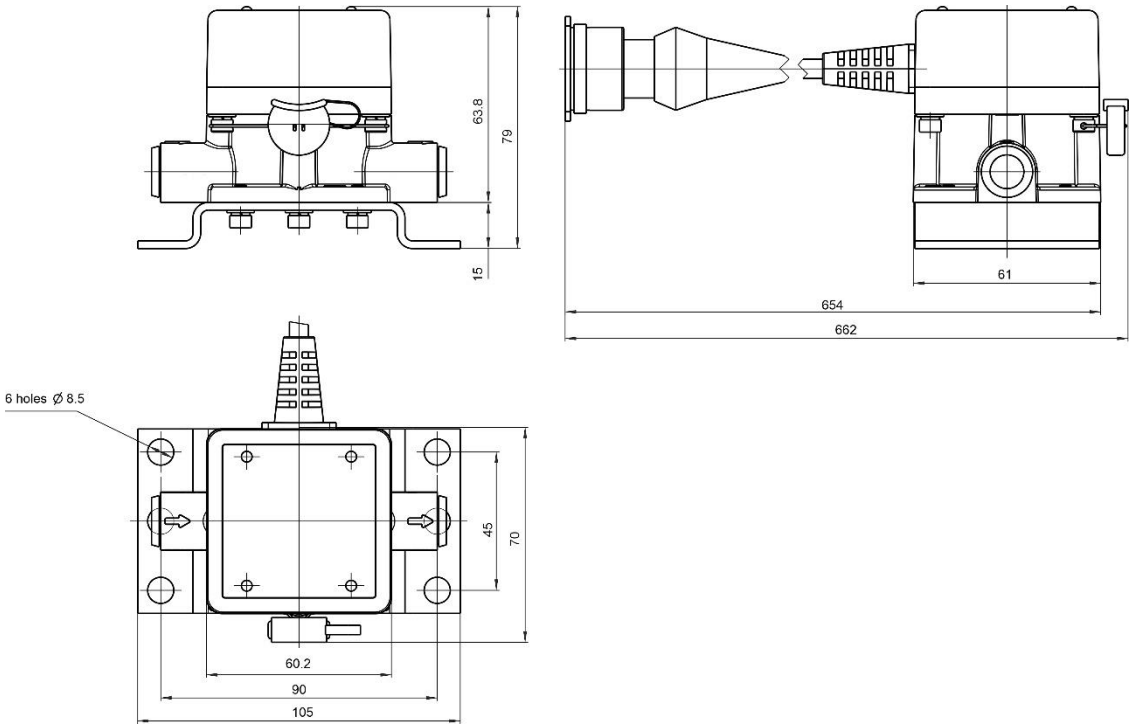


Figure A.1 — DFM 50AK/CK/A232/A485/ACAN/C232/C485/CCAN and DFM 100AK/CK/A232/A485/ACAN/C232/C485/CCAN overall dimensions

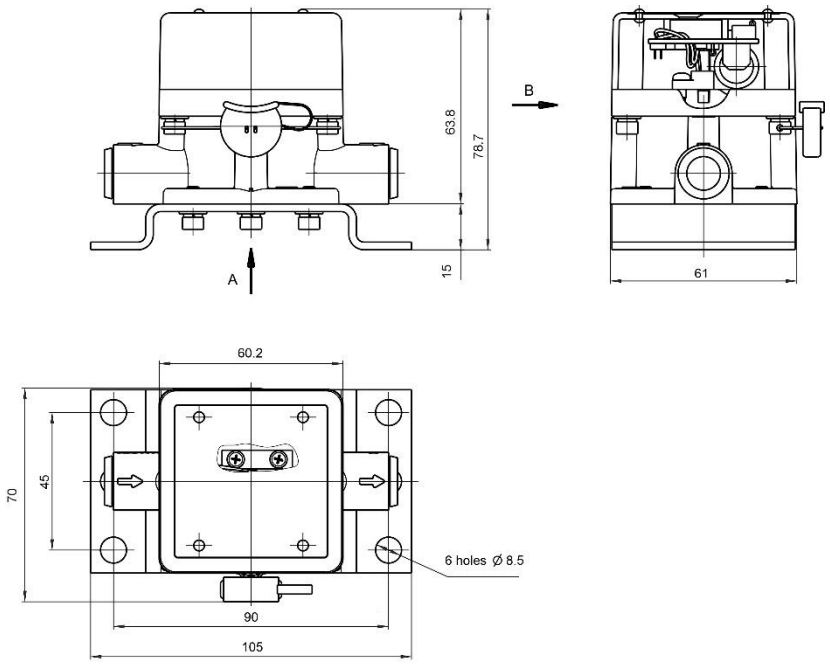


Figure A.2 — DFM 50B/C and DFM 100B/C overall dimensions

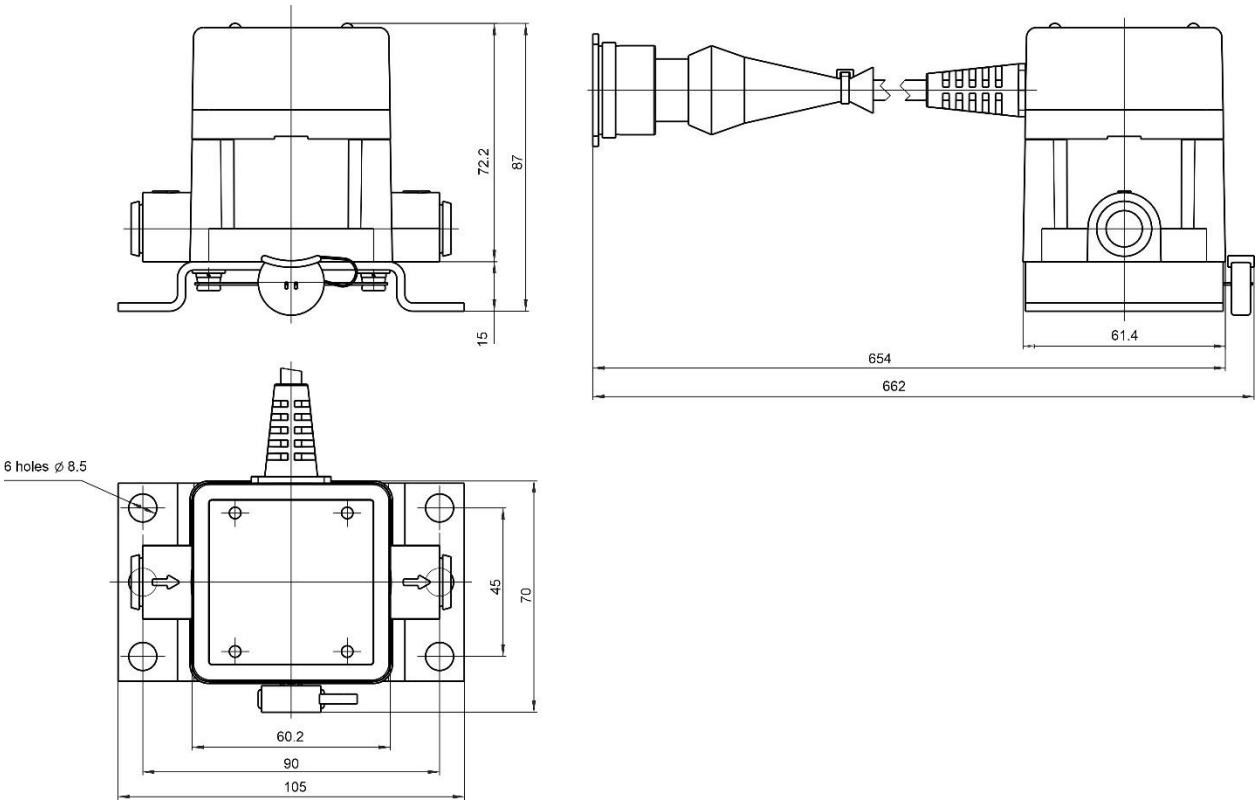


Figure A.3 — DFM 250AK/CK/A232/A485/ACAN/C232/C485/CCAN overall dimensions

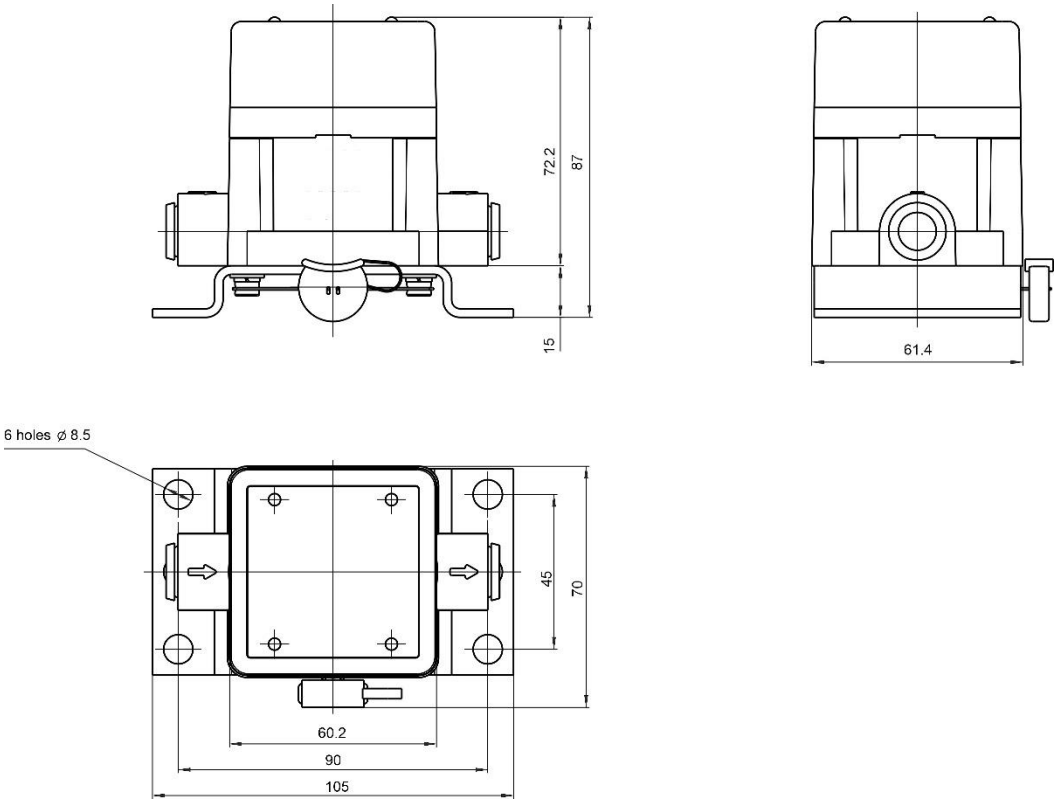


Figure A.4 — DFM 250B/C overall dimensions

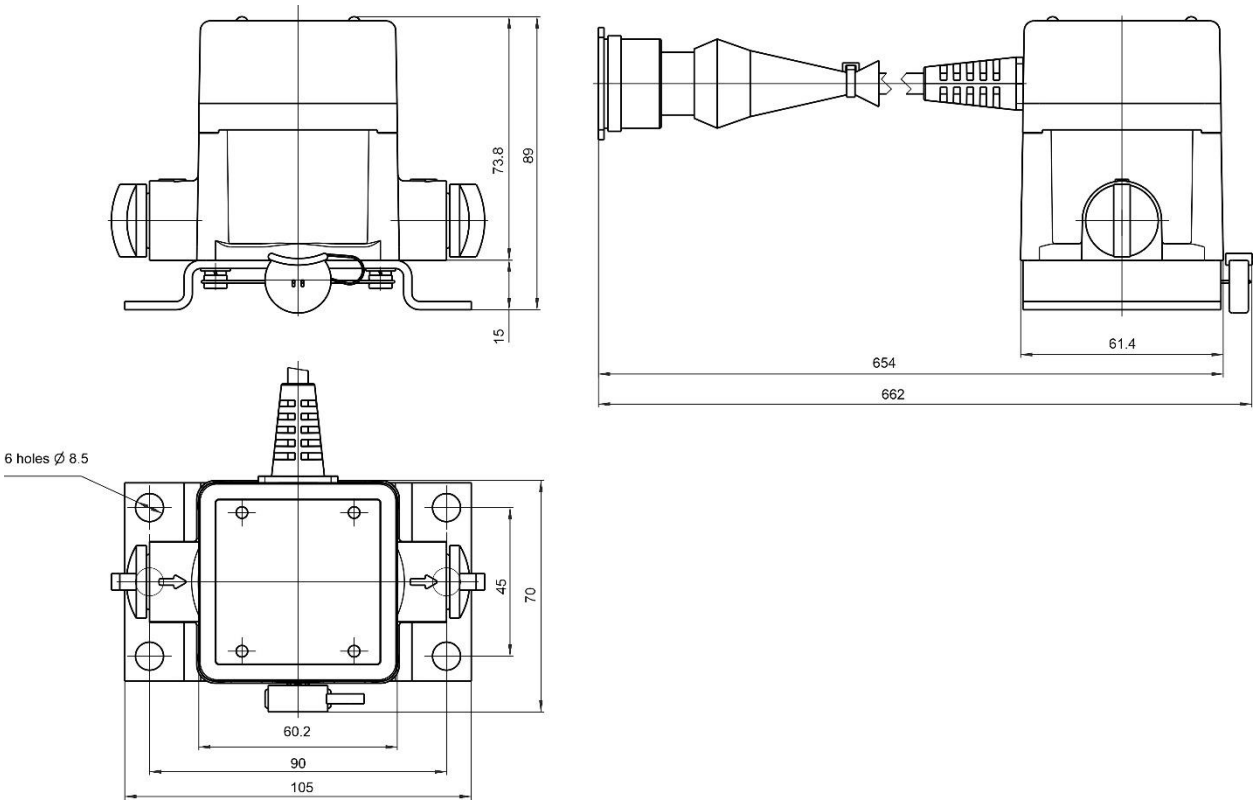


Figure A.5 — DFM 500AK/CK/A232/A485/ACAN/C232/C485/CCAN overall dimensions

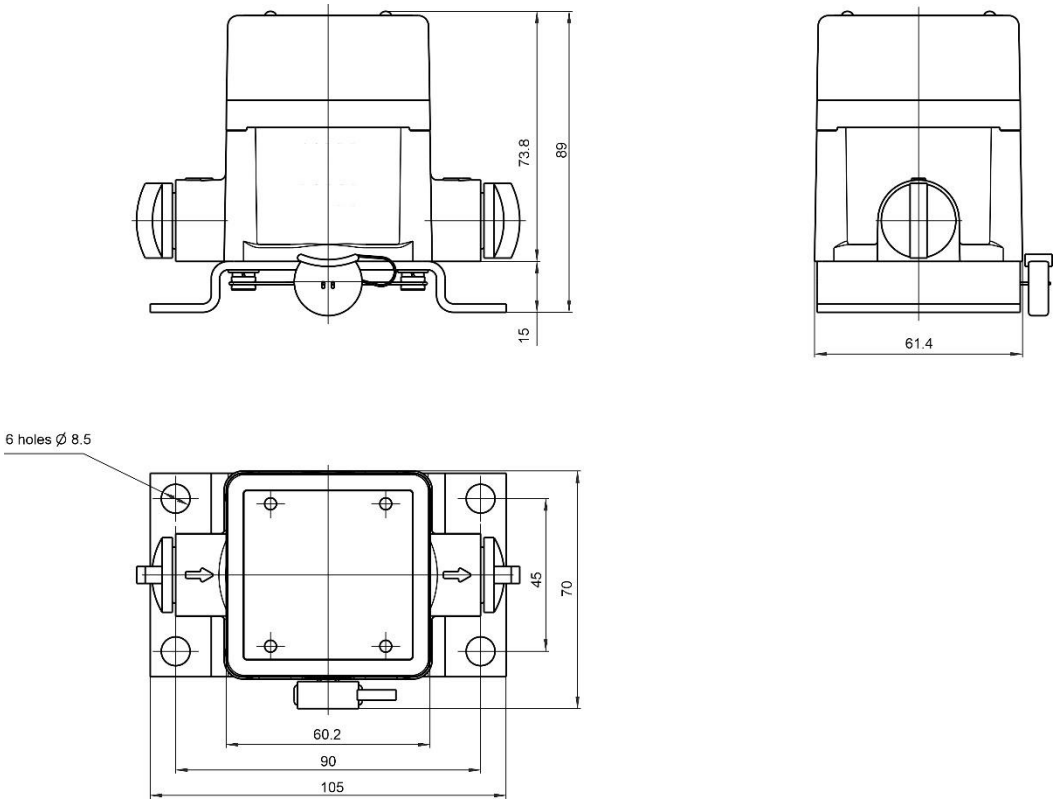


Figure A.6 — DFM 500B/C overall dimensions

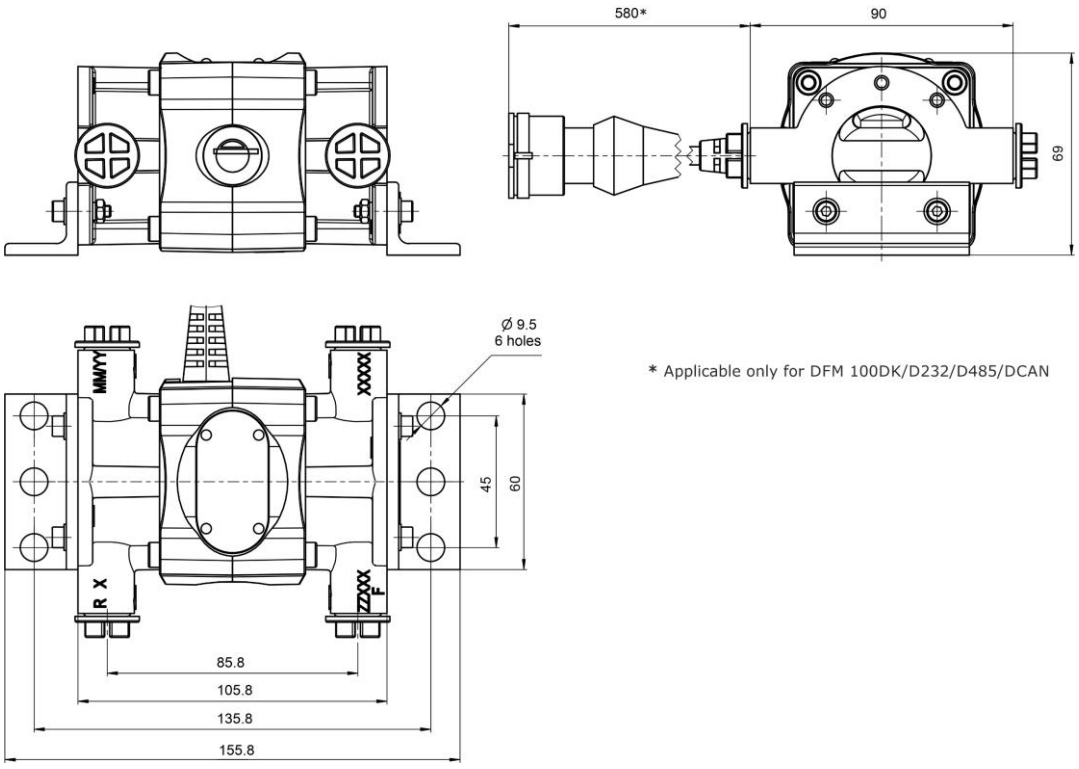


Figure A.7 — DFM 100DK/D232/D485/DCAN and DFM 100CD overall dimensions

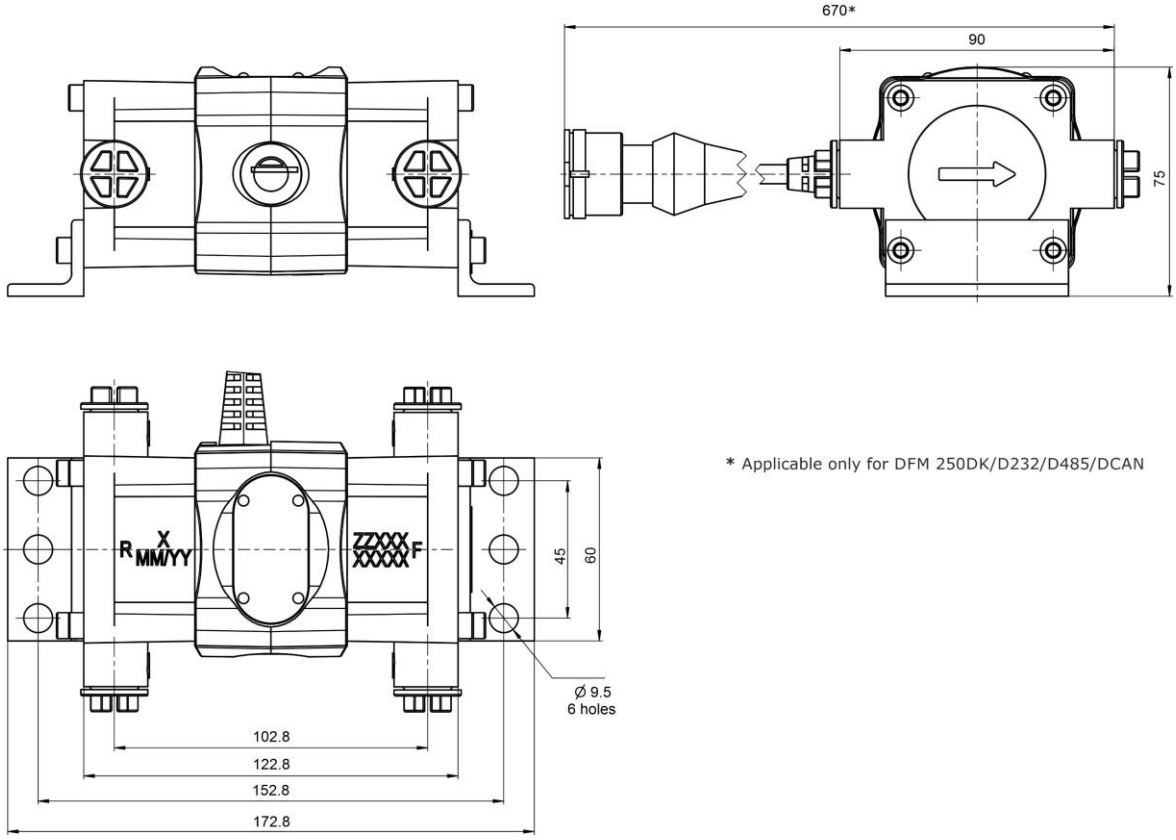


Figure A.8 — DFM 250DK/D232/D485/DCAN and DFM 250CD overall dimensions

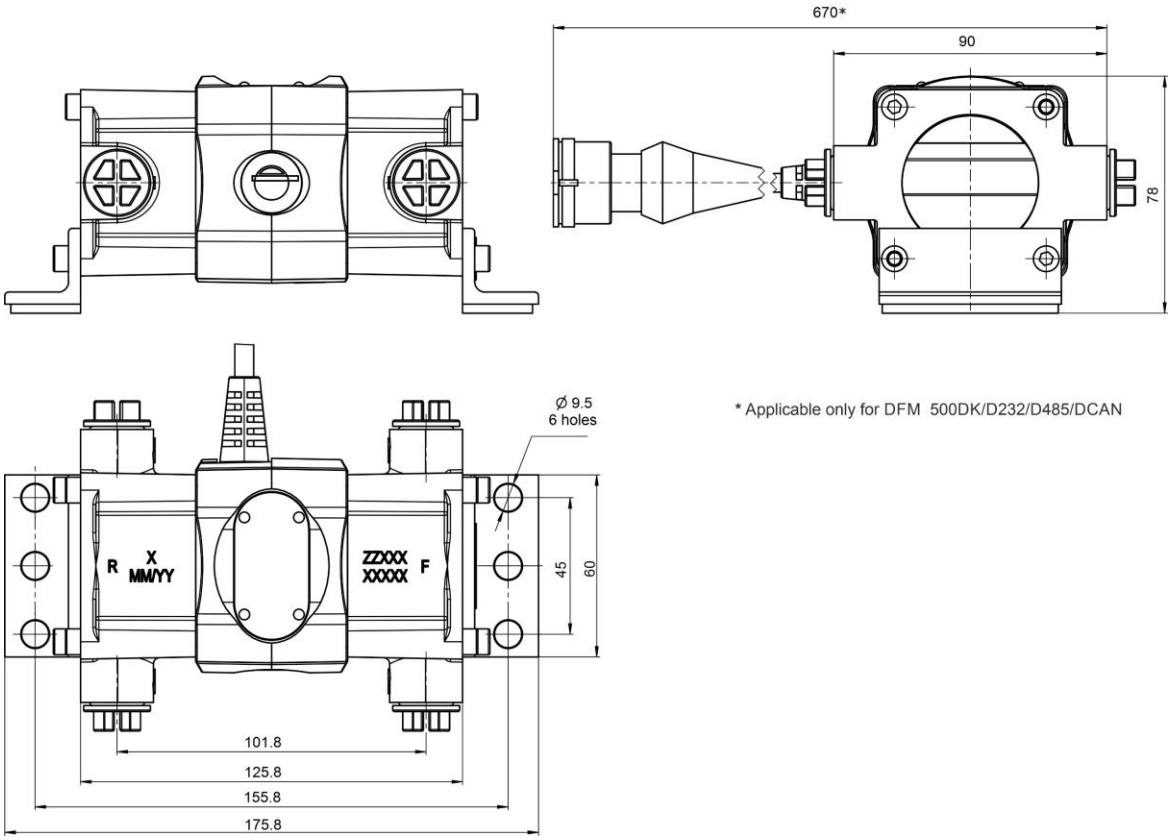


Figure A.9 — DFM 500DK/D232/D485/DCAN and DFM 500CD overall dimensions

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

Protocol of inspecting machinery unit

_____/ _____ /20____
Date Month Year

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

Machinery unit 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 reverse flow rate		Injectors reverse 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 reverse line	$V_{inj.return}$, liters	
Proportion of the reverse 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

Modbus RTU data transmission protocol and table of registers of DFM 232/485 output messages

Modbus RTU data transmission protocol for DFM 232/485 fuel flow meters is based on Master-Slave architecture.
The table of registers of DFM 232/485 output messages that are accessible according to Modbus RTU protocol (table of data Holding Registers) is provided in table D.1.
For reading Parameters from the table of registers, you need to employ the standard feature of Modbus RTU protocol — **3 (0x03) Read Holding Registers**.
DFM 232/485 output messages transmitted by means of Modbus RTU protocol contain:

- Device unique network address (Slave ID) from the range of 0…255 (default address 111).
- Function code (FCode=3).
- Data (Data).
- Checksum (CRC).

The data in DFM 232/485 output messages are presented as unsigned whole number — **unsigned int**.
The volume of data in each register — **2 bytes**.
The request execution timeout — **1000 ms**.
To read the register, the Telematics terminal (Master device) sends to DFM 232/485 address (Slave device) a request containing the code of function 3 (Read Holding Registers), the address of the requested register (Reg Addr) and the number of registers to be read (Reg Count). In response to the request, DFM 232/485 sends a data packet containing its network address (Slave ID), the number of function of the protocol (FCode=3), the number of bytes in the data field (Bytes Count) and the data field (DATA) containing the value of the requested register. For reading of several serial registers, the address of the first register and the total number of registers to be read should be specified in the request (see figure D.1).

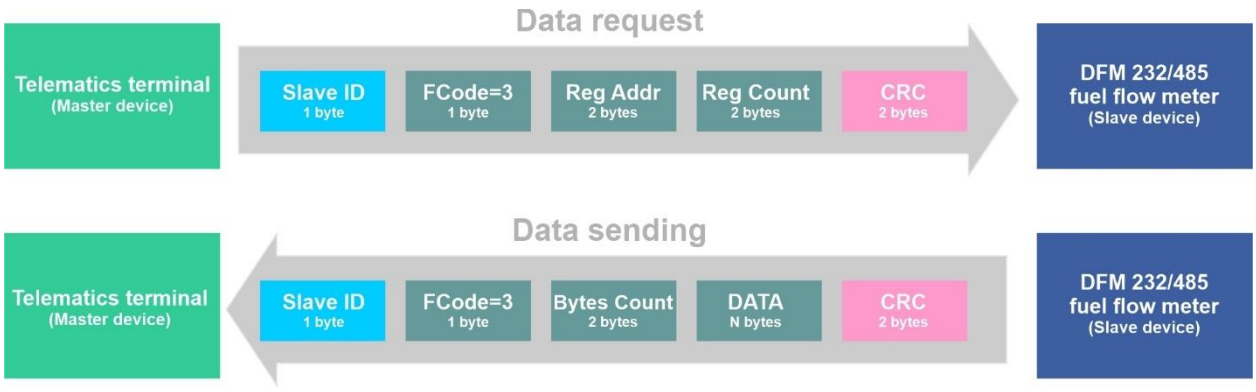


Figure D.1 — Scheme of data exchange according to Modbus RTU protocol between DFM 232/485 fuel flow meter and the Telematics terminal

Example 1: Read the value of SPN 183 "Engine Fuel Rate, l/h"

Reg Addr	Data	
	1 byte (high byte)	1 byte (low byte)
0	04	85

The Request structure: 0x6F 0x03 0x00 0x00 0x00 0x01 0x8C 0x84, where
0x – prefix of the hexadecimal system of numeration;
6F – network address of the requested flow meter: Slave ID=111;
03 – number of the function of reading registers: FCode=3;
00 00 – address of the requested register: Reg Addr=0;
00 01 – number of registers to be read: Reg Count=1;
8C 84 – field of checksum (CRC) calculated according to crc16 algorithm (2 bytes).

The Response structure: 0x6F 0x03 0x02 0x04 0x85 0x92 0xEE, where
0x – prefix of the hexadecimal system of numeration;
6F – network address of the flow meter from which data are read: Slave ID=111;
03 – number of the function of reading registers: FCode=3;
02 – number of bytes in the data field: Bytes Count=2;
04 85 – data field of register 0 (2 bytes): Data=0485;
92 EE – field of checksum (CRC) calculated according to crc16 algorithm (2 bytes).

Conversion of data for verification: 485 (Hex)=1157 (Dec) · 0.05 + 0 = 57.85 l/h,
where 0.05 l/h – factor (resolution); 0 l/h – offset for calculation of values of SPN 183.

Example 2: Read the value of SPN 174 "Engine Fuel Temperature 1, °C"

Reg Addr	Data	
	1 byte (high byte)	1 byte (low byte)
3	00	44

The Request structure: 0x6F 0x03 0x00 0x03 0x00 0x01 0x7C 0x84, where
0x – prefix of the hexadecimal system of numeration;
6F – network address of the requested flow meter: Slave ID=111;
03 – number of the function of reading registers: FCode=3;
00 03 – address of the requested register: Reg Addr=3;
00 01 – number of registers to be read: Reg Count=1;
7C 84 – field of checksum (CRC) calculated according to crc16 algorithm (2 bytes).

The Response structure: 0x6F 0x03 0x02 0x00 0x44 0x51 0xBE, where
0x – prefix of the hexadecimal system of numeration;
6F – network address of the flow meter from which data are read: Slave ID=111;
03 – number of the function of reading registers: FCode=3;
02 – number of bytes in the data field: Bytes Count=2;
00 44 – data field of register 3 (2 bytes): Data=0044;
51 BE – field of checksum (CRC) calculated according to crc16 algorithm (2 bytes).

Conversion of data for verification: 44 (Hex)=68 (Dec) · 1 - 40 = 28 °C,
where 1 °C – factor (resolution); -40 °C – offset for calculation of values of SPN 174.

Example 3: Read the value of SPN 5054 "High Resolution Engine Total Fuel Used, l"

Reg Addr	Data		Note
	1 byte (high byte)	1 byte (low byte)	
4	00	01	High word
5	13	28	Low word

The Request structure: 0x6F 0x03 0x00 0x04 0x00 0x02 0x8D 0x44, where
0x – prefix of the hexadecimal system of numeration;
6F – network address of the requested flow meter: Slave ID=111;
03 – number of the function of reading registers: FCode=3;
00 04 – address of the first from the requested registers: Reg Addr=4;
00 02 – number of registers to be read: Reg Count=2;
8D 44 – field of checksum (CRC) calculated according to crc16 algorithm (2 bytes).

The Response structure: 0x6F 0x03 0x04 0x00 0x01 0x13 0x28 0x29 0x1B, where
0x – prefix of the hexadecimal system of numeration;
6F – network address of the flow meter from which data are read: Slave ID=111;
03 – number of the function of reading registers: FCode=3;
04 – number of bytes in the data field: Bytes Count=4;
00 01 – data field of register 4 (2 bytes): Data=0001;
13 28 – data field of register 5 (2 bytes): Data=1328;
29 1B – field of checksum (CRC) calculated according to crc16 algorithm (2 bytes).

Conversion of data for verification: 11328 (Hex)=70440 (Dec) · 0.001 + 0 = 70.440 l, where 0.001 l – factor (resolution); 0 l – offset for calculation of values of SPN 5054.

Table D.1 — Register map of DFM 232/485 output messages under Modbus RTU protocol

Register address	Register contents	Corresponding SPN (SAE 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 Feed chamber	521027	18.0 Feed chamber
13	Chamber Fuel Rate in Reverse chamber	521027	18.1 Reverse chamber
14	Chamber Working Mode. Feed chamber	521028	18.0 Feed chamber
15	Chamber Working Mode. Reverse chamber	521028	18.1 Reverse chamber
16	High Resolution Engine Total Fuel Used (high word)	5054	9.0 Idle
17	High Resolution Engine Total Fuel Used (low word)	5054	9.0 Idle
18	High Resolution Engine Total Fuel Used (high word)	5054	9.1 Optimal
19	High Resolution Engine Total Fuel Used (low word)	5054	9.1 Optimal
20	High Resolution Engine Total Fuel Used (high word)	5054	9.2 Overload
21	High Resolution Engine Total Fuel Used (low word)	5054	9.2 Overload
22	High Resolution Engine Total Fuel Used (high word)	5054	9.3 Cheating
23	High Resolution Engine Total Fuel Used (low word)	5054	9.3 Cheating
24	High Resolution Engine Total Fuel Used (high word)	5054	9.4 Negative
25	High Resolution Engine Total Fuel Used (low word)	5054	9.4 Negative
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 Idle
29	Engine hours of operation (low word)	521171	9.0 Idle
30	Engine hours of operation (high word)	521171	9.1 Optimal
31	Engine hours of operation (low word)	521171	9.1 Optimal
32	Engine hours of operation (high word)	521171	9.2 Overload
33	Engine hours of operation (low word)	521171	9.2 Overload
34	Engine hours of operation (high word)	521171	9.3 Cheating
35	Engine hours of operation (low word)	521171	9.3 Cheating
36	Engine hours of operation (high word)	521171	9.4 Negative
37	Engine hours of operation (low word)	521171	9.4 Negative
38	Engine hours of operation (high word)	521171	9.5 Interference
39	Engine hours of operation (low word)	521171	9.5 Interference
40	High Resolution Engine Total Fuel Used (high word)	5054	18.0 Feed chamber
41	High Resolution Engine Total Fuel Used (low word)	5054	18.0 Feed chamber

Register address	Register contents	Corresponding SPN (SAE J1939)*	Specifier
42	High Resolution Engine Total Fuel Used (high word)	5054	9.0 Idle, 18.0 Feed chamber
43	High Resolution Engine Total Fuel Used (low word)	5054	9.0 Idle, 18.0 Feed chamber
44	High Resolution Engine Total Fuel Used (high word)	5054	9.1 Optimal, 18.0 Feed chamber
45	High Resolution Engine Total Fuel Used (low word)	5054	9.1 Optimal, 18.0 Feed chamber
46	High Resolution Engine Total Fuel Used (high word)	5054	9.2 Overload, 18.0 Feed chamber
47	High Resolution Engine Total Fuel Used (low word)	5054	9.2 Overload, 18.0 Feed chamber
48	High Resolution Engine Total Fuel Used (high word)	5054	9.3 Cheating, 18.0 Feed chamber
49	High Resolution Engine Total Fuel Used (low word)	5054	9.3 Cheating, 18.0 Feed chamber
50	Flowmeter Chamber Time Counter (low word)	521189	9.0 Idle
51	Flowmeter Chamber Time Counter (high word)	521189	9.0 Idle
52	Flowmeter Chamber Time Counter (low word)	521189	9.0 Idle, 18.0 Feed chamber
53	Flowmeter Chamber Time Counter (high word)	521189	9.0 Idle, 18.0 Feed chamber
54	Flowmeter Chamber Time Counter (low word)	521189	9.1 Optimal, 18.0 Feed chamber
55	Flowmeter Chamber Time Counter (high word)	521189	9.1 Optimal, 18.0 Feed chamber
56	Flowmeter Chamber Time Counter (low word)	521189	9.2 Overload, 18.0 Feed chamber
57	Flowmeter Chamber Time Counter (high word)	521189	9.2 Overload, 18.0 Feed chamber
58	Flowmeter Chamber Time Counter (low word)	521189	9.3 Cheating, 18.0 Feed chamber
59	Flowmeter Chamber Time Counter (high word)	521189	9.3 Cheating, 18.0 Feed chamber
60	High Resolution Engine Total Fuel Used (high word)	5054	18.1 Reverse chamber
61	High Resolution Engine Total Fuel Used (low word)	5054	18.1 Reverse chamber
62	High Resolution Engine Total Fuel Used (high word)	5054	9.0 Idle, 18.1 Reverse chamber
63	High Resolution Engine Total Fuel Used (low word)	5054	9.0 Idle, 18.1 Reverse chamber
64	High Resolution Engine Total Fuel Used (high word)	5054	9.1 Optimal, 18.1 Reverse chamber
65	High Resolution Engine Total Fuel Used (low word)	5054	9.1 Optimal, 18.1 Reverse chamber
66	High Resolution Engine Total Fuel Used (high word)	5054	9.2 Overload, 18.1 Reverse chamber
67	High Resolution Engine Total Fuel Used (low word)	5054	9.2 Overload, 18.1 Reverse chamber
68	High Resolution Engine Total Fuel Used (high word)	5054	9.3 Cheating, 18.1 Reverse chamber
69	High Resolution Engine Total Fuel Used (low word)	5054	9.3 Cheating, 18.1 Reverse chamber
70	Flowmeter Chamber Time Counter (low word)	521189	18.1 Reverse chamber
71	Flowmeter Chamber Time Counter (high word)	521189	18.1 Reverse chamber

Register address	Register contents	Corresponding SPN (SAE J1939)*	Specifier
72	Flowmeter Chamber Time Counter (low word)	521189	9.0 Idle, 18.1 Reverse chamber
73	Flowmeter Chamber Time Counter (high word)	521189	9.0 Idle, 18.1 Reverse chamber
74	Flowmeter Chamber Time Counter (low word)	521189	9.1 Optimal, 18.1 Reverse chamber
75	Flowmeter Chamber Time Counter (high word)	521189	9.1 Optimal, 18.1 Reverse chamber
76	Flowmeter Chamber Time Counter (low word)	521189	9.2 Overload, 18.1 Reverse chamber
77	Flowmeter Chamber Time Counter (high word)	521189	9.2 Overload, 18.1 Reverse chamber
78	Flowmeter Chamber Time Counter (low word)	521189	9.3 Cheating, 18.1 Reverse chamber
79	Flowmeter Chamber Time Counter (high word)	521189	9.3 Cheating, 18.1 Reverse chamber
80	Engine total average fuel rate **	1834	
81	Engine total average fuel economy **	1835	

* Detailed parameters description (SPN) are placed at the following web site http://s6.jv-technoton.com (to access S6 DB registration is required).
** 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
Data composition in the flow meters output messages that are transmitted via CAN j1939/S6 interface

Table F.1 — Data composition in DFM ACAN/CCAN/DCAN outgoing messages, that are transmitted via SAE J1939 protocol

Field number	Length	Parameter	Description	Rules of output
Flowmeter. Parameters PGN 62981 (0xF605)				1000 ms
1	2 bytes	SPN 183	Engine fuel rate	
3.1	4 bits	SPN 521181	Engine mode by fuel rate	
4	2 bytes	SPN 521027/18.0	Chamber fuel rate. Feed chamber	
6	2 bytes	SPN 521027/18.1	Chamber fuel rate. Reverse chamber	
8.1	4 bits	SPN 521028/18.0	Chamber working mode. Feed chamber	
8.5	4 bits	SPN 521028/18.1	Chamber working mode. Reverse chamber	
Flowmeter. Counters 1 PGN 62992 (0xF610)				1000 ms
1	4 bytes	SPN 5054	High Resolution Engine Total Fuel Used	
5	4 bytes	SPN 5054/9.0	High Resolution Engine Total Fuel Used. Idle	
9	4 bytes	SPN 5054/9.1	High Resolution Engine Total Fuel Used. Optimal	
13	4 bytes	SPN 5054/9.2	High Resolution Engine Total Fuel Used. Overload	
17	4 bytes	SPN 5054/9.3	High Resolution Engine Total Fuel Used. Cheating	
21	4 bytes	SPN 5054/9.4	High Resolution Engine Total Fuel Used. Negative	
25	4 bytes	SPN 521171	Flowmeter Hours Of Operation	
29	4 bytes	SPN 521171/9.0	Flowmeter Hours Of Operation. Idle	
33	4 bytes	SPN 521171/9.1	Flowmeter Hours Of Operation. Optimal	
37	4 bytes	SPN 521171/9.2	Flowmeter Hours Of Operation. Overload	
41	4 bytes	SPN 521171/9.3	Flowmeter Hours Of Operation. Cheating	
45	4 bytes	SPN 521171/9.4	Flowmeter Hours Of Operation. Negative	
49	4 bytes	SPN 521171/9.5	Flowmeter Hours Of Operation. Interference	
Flowmeter. Counters 2 PGN 62993 (0xF611)				1000 ms
1	1 byte	SPN 174	Engine Fuel Temperature 1	
2	4 bytes	SPN 5054/18.0	High Resolution Engine Total Fuel Used. Feed chamber	
6	4 bytes	SPN 5054/9.0/18.0	High Resolution Engine Total Fuel Used. Idle. Feed chamber	
10	4 bytes	SPN 5054/9.1/18.0	High Resolution Engine Total Fuel Used. Optimal. Feed chamber	
14	4 bytes	SPN 5054/9.2/18.0	High Resolution Engine Total Fuel Used. Overload. Feed chamber	
18	4 bytes	SPN 5054/9.3/18.0	High Resolution Engine Total Fuel Used. Cheating. Feed chamber	
22	4 bytes	SPN 521189/18.0	Flowmeter Chamber Time Counter. Feed chamber	
26	4 bytes	SPN 521189/9.0/18.0	Flowmeter Chamber Time Counter. Idle. Feed chamber	
30	4 bytes	SPN 521189/9.1/18.0	Flowmeter Chamber Time Counter. Optimal. Feed chamber	
34	4 bytes	SPN 521189/9.2/18.0	Flowmeter Chamber Time Counter. Overload. Feed chamber	
38	4 bytes	SPN 521189/9.3/18.0	Flowmeter Chamber Time Counter. Cheating. Feed chamber	
42	4 bytes	SPN 5054/18.1	High Resolution Engine Total Fuel Used. Reverse chamber	
46	4 bytes	SPN 5054/9.0/18.1	High Resolution Engine Total Fuel Used. Idle. Reverse chamber	
50	4 bytes	SPN 5054/9.1/18.1	High Resolution Engine Total Fuel Used. Optimal. Reverse chamber	
54	4 bytes	SPN 5054/9.2/18.1	High Resolution Engine Total Fuel Used. Overload. Reverse chamber	

Field number	Length	Parameter	Description	Rules of output
58	4 bytes	SPN 5054/9.3/18.1	High Resolution Engine Total Fuel Used. Cheating. Reverse chamber	
62	4 bytes	SPN 521189/18.1	Flowmeter Chamber Time Counter. Reverse chamber	
66	4 bytes	SPN 521189/9.0/18.1	Flowmeter Chamber Time Counter. Idle. Reverse chamber	
70	4 bytes	SPN 521189/9.1/18.1	Flowmeter Chamber Time Counter. Optimal. Reverse chamber	
74	4 bytes	SPN 521189/9.2/18.1	Flowmeter Chamber Time Counter. Overload. Reverse chamber	
78	4 bytes	SPN 521189/9.3/18.1	Flowmeter Chamber Time Counter. Cheating. Reverse chamber	
Total Fuel Used/Hours Of Operation In Idle Mode PGN 63106 (0xF682)				1000 ms
1	4 bytes	SPN 5054/9.0	High Resolution Engine Total Fuel Used. Idle	
5	4 bytes	SPN 521171/9.0	Flowmeter Hours Of Operation. Idle	
Total Fuel Used/Hours Of Operation In Optimal Mode PGN 63107 (0xF683)				1000 ms
1	4 bytes	SPN 5054/9.1	High Resolution Engine Total Fuel Used. Optimal	
5	4 bytes	SPN 521171/9.1	Flowmeter Hours Of Operation. Optimal	
Total Fuel Used/Hours Of Operation In Overload Mode PGN 63108 (0xF684)				1000 ms
1	4 bytes	SPN 5054/9.2	High Resolution Engine Total Fuel Used. Overload	
5	4 bytes	SPN 521171/9.2	Flowmeter Hours Of Operation. Overload	
Total Fuel Used/Hours Of Operation In Cheat Mode PGN 63109 (0xF685)				1000 ms
1	4 bytes	SPN 5054/9.3	High Resolution Engine Total Fuel Used. Cheating	
5	4 bytes	SPN 521171/9.3	Flowmeter Hours Of Operation. Cheating	
Total Fuel Used/Hours Of Operation In Negative Mode PGN 63110 (0xF686)				1000 ms
1	4 bytes	SPN 5054/9.4	High Resolution Engine Total Fuel Used. Negative	
5	4 bytes	SPN 521171/9.4	Flowmeter Hours Of Operation. Negative	
Engine Total Hour Of Operation In Interference Mode PGN 63111 (0xF687)				1000 ms
1	4 bytes	SPN 521171/9.5	Flowmeter Hours Of Operation. Interference	
5	4 bytes	SPN 521267	Interference sensor occurrence count	
Total Fuel Used (Feed Chamber) 1 PGN 63112 (0xF688)				1000 ms
1	4 bytes	SPN 5054/18.0	High Resolution Engine Total Fuel Used. Feed Chamber	
5	4 bytes	SPN 521189/18.0	Flowmeter Chamber Time Counter. Feed Chamber	
Total Fuel Used (Feed Chamber) 2 PGN 63113 (0xF689)				1000 ms
1	4 bytes	SPN 5054/9.0/18.0	High Resolution Engine Total Fuel Used. Idle. Feed Chamber	
5	4 bytes	SPN 521189/9.0/18.0	Flowmeter Chamber Time Counter. Idle. Feed Chamber	
Total Fuel Used (Feed Chamber) 3 PGN 63114 (0xF68A)				1000 ms
1	4 bytes	SPN 5054/9.1/18.0	High Resolution Engine Total Fuel Used. Optimal. Feed Chamber	
5	4 bytes	SPN 521189/9.1/18.0	Flowmeter Chamber Time Counter. Optimal. Feed Chamber	
Total Fuel Used (Feed Chamber) 4 PGN 63115 (0xF68B)				1000 ms
1	4 bytes	SPN 5054/9.2/18.0	High Resolution Engine Total Fuel Used. Overload. Feed Chamber	
5	4 bytes	SPN 521189/9.2/18.0	Flowmeter Chamber Time Counter. Overload. Feed Chamber	
Total Fuel Used (Feed Chamber) 5 PGN 63116 (0xF68C)				1000 ms
1	4 bytes	SPN 5054/9.3/18.0	High Resolution Engine Total Fuel Used. Cheating. Feed Chamber	
5	4 bytes	SPN 521189/9.3/18.0	Flowmeter Chamber Time Counter. Cheating. Feed Chamber	
Total Fuel Used (Reverse chamber) 1 PGN 63117 (0xF68D)				1000 ms
1	4 bytes	SPN 5054/18.1	High Resolution Engine Total Fuel Used. Reverse chamber	
5	4 bytes	SPN 521189/18.1	Flowmeter Chamber Time Counter. Reverse chamber	
Total Fuel Used (Reverse chamber) 2 PGN 63118 (0xF68E)				1000 ms
1	4 bytes	SPN 5054/9.0/18.1	High Resolution Engine Total Fuel Used. Idle. Reverse chamber	
5	4 bytes	SPN 521189/9.0/18.1	Flowmeter Chamber Time Counter. Idle. Reverse chamber	

Field number	Length	Parameter	Description	Rules of output
Total Fuel Used (Reverse chamber) 3 PGN 63119 (0xF68F)				1000 ms
1	4 bytes	SPN 5054/9.1/18.1	High Resolution Engine Total Fuel Used. Optimal. Reverse chamber	
5	4 bytes	SPN 521189/9.1/18.1	Flowmeter Chamber Time Counter. Optimal. Reverse chamber	
Total Fuel Used (Reverse chamber) 4 PGN 63120 (0xF690)				1000 ms
1	4 bytes	SPN 5054/9.2/18.1	High Resolution Engine Total Fuel Used. Overload. Reverse chamber	
5	4 bytes	SPN 521189/9.2/18.1	Flowmeter Chamber Time Counter. Overload. Reverse chamber	
Total Fuel Used (Reverse chamber) 5 PGN 63121 (0xF691)				1000 ms
1	4 bytes	SPN 5054/9.3/18.1	High Resolution Engine Total Fuel Used. Cheating. Reverse chamber	
5	4 bytes	SPN 521189/9.3/18.1	Flowmeter Chamber Time Counter. Cheating. Reverse chamber	
Engine Hours Of Operation/Total Fuel Used PGN 63236 (0xF704)				1000 ms
1	4 bytes	SPN 521171	Flowmeter Hours Of Operation	
5	4 bytes	SPN 5054	High Resolution Engine Total Fuel Used	
Flowmeter Hours Of Operation/Total Fuel Used. Clearable PGN 63261 (0xF71D)				1000 ms
1	4 bytes	SPN 5054/28.0	High Resolution Engine Total Fuel Used. Clearable	
5	4 bytes	SPN 521171/28.0	Flowmeter Hours Of Operation. Clearable	
High Resolution Fuel Consumption (Liquid) PGN 64777 (0xFD09)				1000 ms
1	4 bytes	SPN 5053	High Resolution Engine Trip Fuel	
5	4 bytes	SPN 5054	High Resolution Engine Total Fuel Used	
Total Averaged Information PGN 65101 (0xFE4D)				1000 ms
1	2 bytes	SPN 1834	Engine Total Average Fuel Rate	
3	2 bytes	SPN 1835	Engine Total Average Fuel Economy	
Idle Operation PGN 65244 (0xFEDC)				On request
1	4 bytes	SPN 236	Engine Total Idle Fuel Used	
5	4 bytes	SPN 235	Engine Total Idle Hours	
Fuel Consumption (Liquid) PGN 65257 (0xFEE9)				On request
1	4 bytes	SPN 182	Engine Trip Fuel	
5	4 bytes	SPN 250	Engine Total Fuel Used	
Engine temperature 1 PGN 65262 (0xFEEE)				1000 ms
2	1 byte	SPN 174	Engine Fuel Temperature 1	
Fuel Economy (Liquid) PGN 65266 (0xFEF2)				100 ms
1	2 bytes	SPN 183	Engine Fuel Rate	
3	2 bytes	SPN 184	Engine Instantaneous Fuel Economy	
5	2 bytes	SPN 185	Engine Average Fuel Economy	
Request PGN 59904 (0xEA00)				1000 ms
1	3 bytes	SPN 2540	Parameter Group Number (RQST)	
Vehicle Voltage PGN 62987 (0xF60B)				1000 ms
1	3 bytes	SPN 158	Keyswitch Battery Potential	
3.1	2 bites	SPN 521049	Ignition Key State	
4	4 bytes	SPN 521053	Ignition ON Time	
Unit Passport PGN 62995 (0xF613)				On request
1	16 bytes	SPN 521123	Line	
17	16 bytes	SPN 521344	Mark	
33	16 bytes	SPN 521345	Model	
49	16 bytes	SPN 521120	Serial number	
65	8 bytes	SPN 521121	Firmware version	
73	4 bytes	SPN 521125	Date of production	

Field number	Length	Parameter	Description	Rules of output
77	1 byte	SPN 521188	Address at S6 (SA) bus	
Unit Work Counters PGN 62994 (0xF612)				On request
1	4 bytes	SPN 521116	Unit Hours Of Operation	
5	4 bytes	SPN 521116/16.1	Unit Hours Of Operation. Battery	
9	4 bytes	SPN 521118	Unit Reset Counter	
13	4 bytes	SPN 521119	Unit Power Off Counter	
Time Origin Settings PGN 63011 (0xF623)				On request
1.1	2 bites	SPN 521350	Automatic Daylight Savings Time and Back	
6	1 byte	SPN 1601	Time Displacement In Minutes	
7	1 byte	SPN 1602	Time Displacement In Hours	
Fuel Consumption Factors PGN 63026 (0xF632)				On request
1	2 bytes	SPN 521433	Temperature Correction Coefficient	
3	2 bytes	SPN 521434	Lliquid Consumption Correction Coefficient	
5.1	2 bites	SPN 521311	Temperature Correction Enable	
Calibration Table. Fuel Rate (DFM) PGN 63044 (0xF644)				On request
1	1 byte	SPN 521355	Array Elements Count	
2	2 bytes	SPN 521232	Impulse Period	
4	2 bytes	SPN 521231	Chamber Volume	
List Of Importnant Events PGN 63055 (0xF64F)				On request
1	4 bytes	SPN 521166	SPN Events	
5	1728 bytes	SPN 521357	Data	
List Of Informative Events PGN 63056 (0xF650)				On request
1	4 bytes	SPN 521166	SPN Events	
5	1728 bytes	SPN 521357	Data	
Battery voltage mode borders PGN 63064 (0xF658)				On request
1	2 bytes	SPN 521391/2.8	Battery Voltage Mode Border. Min	
3	2 bytes	SPN 521391/2.7	Battery Voltage Mode Border. Max	
Fuel Rate Mode Borders PGN 63065 (0xF659)				On request
1	2 bytes	SPN 521392/9.0	Fuel Rate Mode Border. Idle	
3	2 bytes	SPN 521392/9.1	Fuel Rate Mode Border. Optimal	
5	2 bytes	SPN 521392/9.2	Fuel Rate Mode Border. Overload	
7	2 bytes	SPN 521392/9.0/18.0	Fuel Rate Mode Border. Idle. Feed chamber	
9	2 bytes	SPN 521392/9.1/18.0	Fuel Rate Mode Border. Optimal. Feed chamber	
11	2 bytes	SPN 521392/9.2/18.0	Fuel Rate Mode Border. Overload. Feed chamber	
13	2 bytes	SPN 521392/9.0/18.1	Fuel Rate Mode Border. Idle. Reverse chamber	
15	2 bytes	SPN 521392/9.1/18.1	Fuel Rate Mode Border. Optimal. Reverse chamber	
17	2 bytes	SPN 521392/9.2/18.1	Fuel Rate Mode Border. Overload. Reverse chamber	
Battery PGN 63086 (0xF66E)				5000 ms
1.1	2 bites	SPN 21129	Unit Power Status	
2	2 bytes	SPN 167	Charging System Potential (Voltage)	
4	1 byte	SPN 521061	Battery Charge Level	
5	4 bytes	SPN 521116/16.1	Unit Hours Of Operation. Battery	
Fuel consumption factors. Operating modes PGN 63303 (0xF747)				On request
1	2 bytes	521434/9.0	Lliquid Consumption Correction Coefficient. Idle	
3	2 bytes	521434/9.1	Lliquid Consumption Correction Coefficient. Optimal	
5	2 bytes	521434/9.2	Lliquid Consumption Correction Coefficient. Overload	

Field number	Length	Parameter	Description	Rules of output
Active diagnostic trouble codes PGN 65226 (0xFECA)				1000 ms
3	3 bytes	SPN 521044	Malfunction code (SID)	
Previously active diagnostic trouble codes PGN 65227 (0xFECB)				On request
3	3 bytes	SPN 521044	Malfunction code (SID)	
Time/Date PGN 65254 (0xFEE6)				On request
1	1 byte	SPN 959	Seconds	
2	1 byte	SPN 960	Minutes	
3	1 byte	SPN 961	Hours	
4	1 byte	SPN 963	Month	
5	1 byte	SPN 962	Day	
6	1 byte	SPN 964	Year	
7	1 byte	SPN 1601	Time Displacement In Minutes	
8	1 byte	SPN 1602	Time Displacement In Hours	
Differential Opearation Mode PGN 63204 (0xF6E4)				On request
1.1	2 bites	SPN 521268	Master Mode	
1.3	2 bites	SPN 521270	Calculation Mode	
2	1 byte	SPN 521269	Slave Device Address	
3	2 bytes	SPN 521271	Differencial Fuel Rate Correction Coefficient	
5	1 byte	SPN 521671	Smoothing Capacity	
Total Fuel Consumption PGN 63515 (0xF81B)				1000 ms
1	4 bytes	SPN 5054/2.11	High Resolution Engine Total Fuel Used. Summary Value	
5	2 bytes	SPN 521687	Summation Error Mask	

- For flow meters with the firmware version from 4.32 and higher.
- For flow meters with the firmware version from 4.46 and higher.
- The number of calibration points – 5. The length of PGN is variable: for a single-chamber flow meter — 21 bytes, for a differential flow meter — 41 bytes.
- The length of PGN — 210 bytes enables to transmit up to 15 Events, and the blank space for data is filled with values 0xFF.
  The following Events are considered important:
  SPN 521216 – tampering the flow meter;
  SPN 521217 – interference into the flow meter operation.
  The following Events are considered to be information Events:
  SPN 521204 – turning on the ignition;
  SPN 521205 – turning off the ignition;
  SPN 521223 – the on-board circuit voltage is too high;
  SPN 521224 - the on-board circuit voltage is too low.
  The description of SPN of unstructured data is provided in S6 Database.
- PGN length — 8 bytes:
  2 bytes — low limit of the on-board circuit (step - 0.05 V, range of data from 0 V to 3212.75 V);
  2 bytes — high limit of the on-board circuit (step - 0.05 V, range of data from 0 V to 3212.75 V);
  4 bytes — spare.
- For differential fuel flow meters with the firmware version not lower than 4.55, with the use of Service S6 DFM service software, version from 1.24 and higher.
- The length of PGN is variable, depending on the number of malfunctions (no more than 20, at a maximum).
- Only for DFM CAN single-chamber flow meters (firmware version not lower than 4.63) in the "Differential"/"Summation" mode using Service S6 DFM software version 1.27 and higher.
- For DFM CAN single-chamber and differential flow meters (firmware version not lower than 4.63) in the "Differential"/"Summation" mode using Service S6 DFM software version 1.27 and higher.

Table F.2 — Messages of DFM ACAN/CCAN/DCAN, that are transmitted via NMEA 2000 protocol

Message format*	Brief message transcript	Note
PGN 127489	Engine Parameters, Dynamic	For flow meters with firmware version not earlier than 4.49, using Service S6 DFM service software, version 1.20 and later versions.
PGN 127497	Trip Fuel Consumption, Engine	
PGN 130316	Temperature, Extended Range	
PGN 122981	Flowmeter. Parameters	
PGN 122992	Flowmeter. Counters 1	
PGN 122993	Flowmeter. Counters 2	
* Information on structure and parameters of messages of DFM CCAN sending data using NMEA2000 protocol can be obtained from Technoton's technical support: support@technoton.by.		

Annex G

Electromagnetic compatibility specifications

Table G.1 — Protection of power circuits of DFM against conductive, capacitive and inductive interference as described in ISO 7637-2:2002

Test pulse	Test level	U_S tested level, V for supply voltage	
		12 V	24 V
1	IV	-100	-600
2a	IV	+50	+50
2b	IV	+10	+20
3a	IV	-150	-200
3b	IV	+100	+200
4	IV	-7	-16
5	III	+65	+123

Table G.2 — Protection of signal circuits of DFM against conductive, capacitive and inductive interference as described in ISO 7637-3:2002

Test pulse	Test level	U_S tested level, V for supply voltage	
		12 V	24 V
Pulse "a" of short duration	IV	-60	-80
Pulse "b" of short duration	IV	+40	+80
Positive pulse of long duration (DCC)	IV	+30	+45
Negative pulse of long duration (DCC)	IV	-30	-45
Positive pulse of long duration (ICC)	IV	+6	+10
Negative pulse of long duration (ICC)	IV	-6	-10

Table G.3— DFM own radio interference field strength as per UNECE Regulation No.10 (Revision 4)

Tested bandwidth, MHz	Quasi-peak value of field strength of radio interference, dB μV/m		Average value of field strength of radio interference, dB μV/m	
	Horizontal polarization	Vertical polarization	Horizontal polarization	Vertical polarization
30…34	27	25	20	20
34…45	23	21	16	18
45…60	18	18	13	14
60…75	17	16	10	9
75…100	11	13	7	8
100…130	12	14	7	9
130…170	22	16	18	12
170…225	24	18	18	13
225…300	32	24	27	11
300…400	19	21	13	14
400…525	22	24	16	15
525…700	24	27	23	23
700…850	34	32	25	27
850…1000	35	33	27	26

Annex H

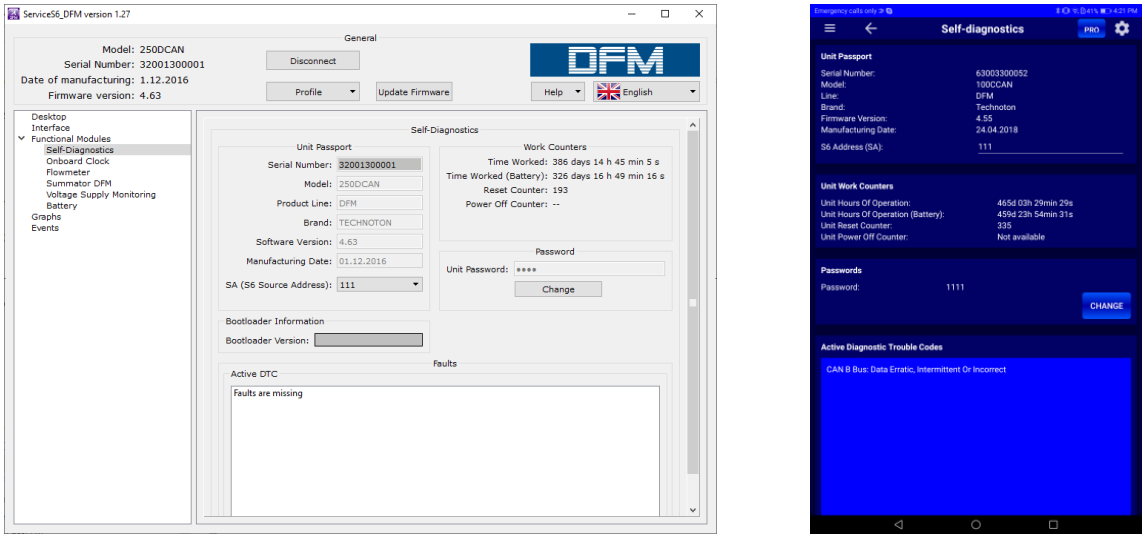
SPN of DFM Functional modules

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 Data base S6 (DB).

H.1 Self-diagnostics FM

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



a) in Service S6 DFM software *b) in Service S6 DFM (Android) app*

Figure H.1 — Window of settings of Self-diagnostics FM

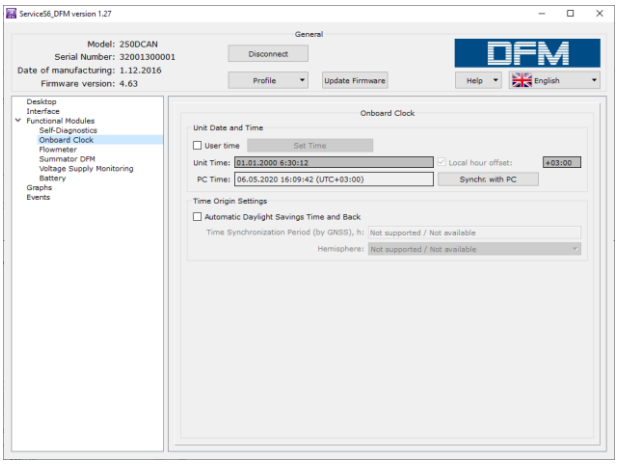
Table H.1 — Self-diagnostics FM. Displayed and/or editable SPN with the help of Service S6 DFM software or Service S6 DFM (Android) app

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 of 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. SPN is not available for editing.

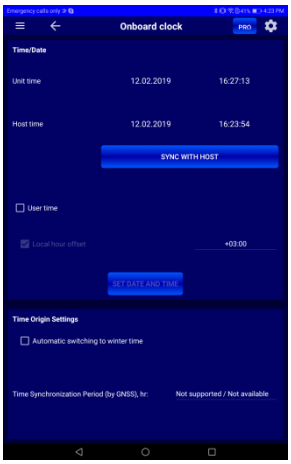
SPN	Name	Factory value	Unit of measure	Clarification
521345	Model	On the fact	No	Model – this is version of the flow meter inside of DFM product line. Each model has its own functional and constructive features. SPN is not available for editing.
521123	Line	DFM	No	Name of the product line. The line represents a group of similar products – fuel flow meters produced under general trademark DFM. SPN is not available for editing.
521344	Brand	TECHNOTON	No	Name of DFM Manufacturer. SPN is not available for editing.
521121	Firmware version	On the fact	No	Version of built in Software DFM. SPN is not available for editing.
521125	Manufacturing date	On the fact	No	Date (day, month, year) of DFM production. SPN is not available for editing.
521188	S6 address (SA)	111	No	Network address DFM which is connected via S6 Technology. Network address value can be selected by user in ranges: (111…118) and (151…158).
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.
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".

H.2 Onboard clock FM

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



a) in Service S6 DFM software



b) in Service S6 DFM (Android) app

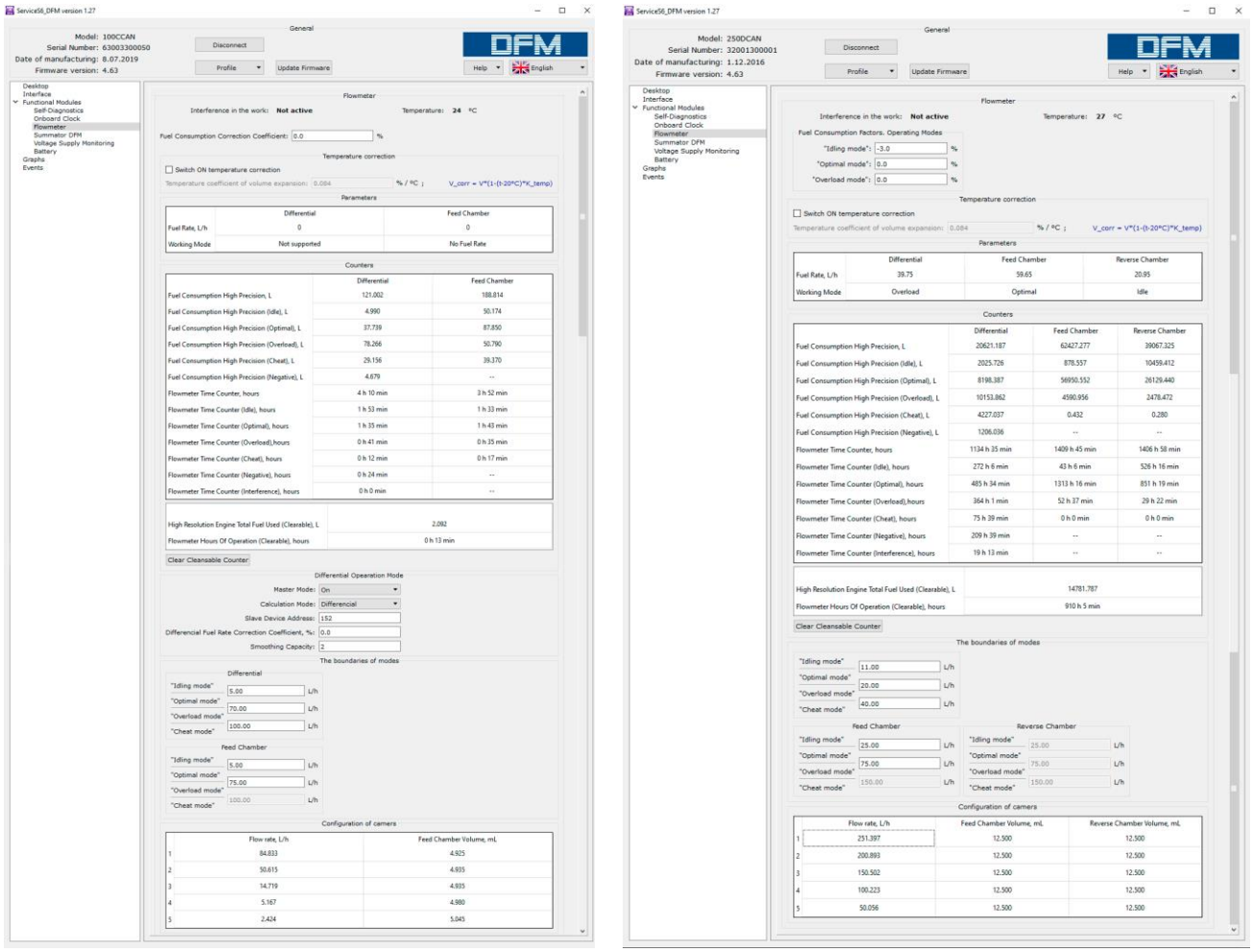
Figure H.2 — Window of settings of Onboard clock FM

Table H.2 — Onboard clock FM. Displayed and/or editable SPN with the help of Service S6 DFM software or Service S6 DFM (Android) app

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*.
960	Minutes	On the fact	min	0…250	Present time — minutes*.
961	Hours	On the fact	h	0…250	Present time — hours*.
963	Month	On the fact	month	0…250	Present date — month*.
962	Day	On the fact	d	0…62.5	Present date — day*.
964	Year	On the fact	year	1985…2235	Present date — year*.
1601	Local minute offset	0	min	0…59	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	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.
* 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.					

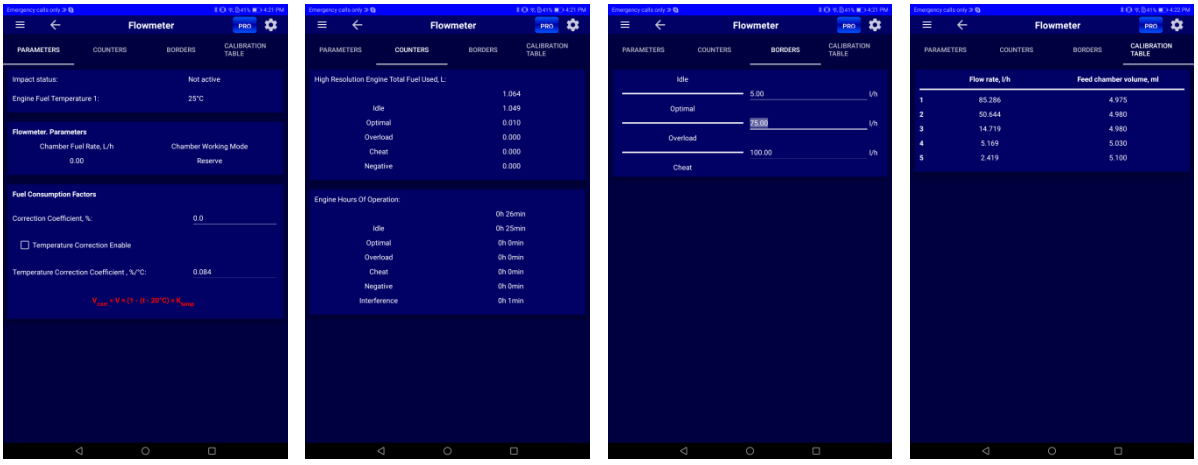
H.3 Flowmeter FM

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

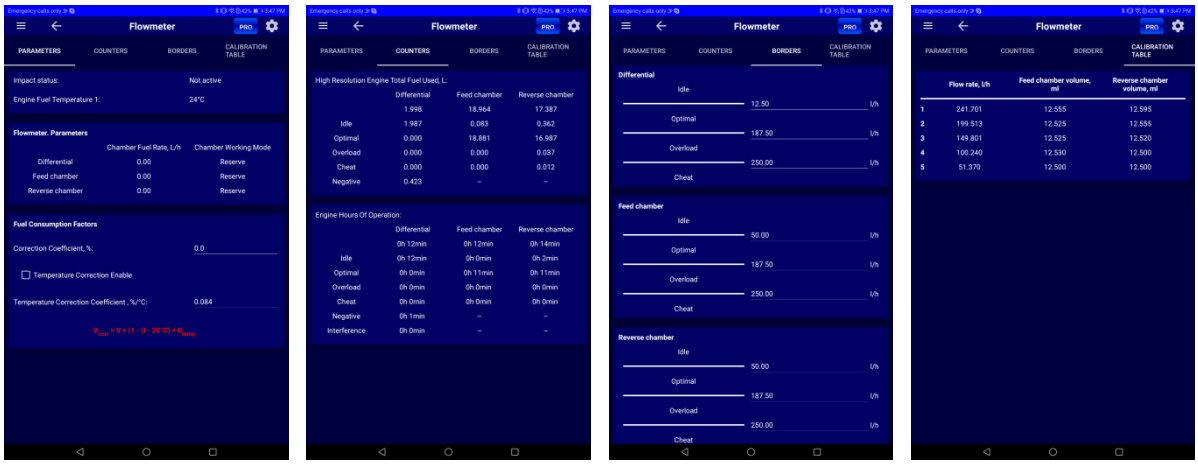


a) for one-chamber flow meter *b) for differential flow meter*

Figure H.3 — Window of settings of Flowmeter FM in Service S6 DFM software



a) for one-chamber flow meter



b) for differential flow meter

Figure H.4 — Window of settings of Flowmeter FM in Service S6 DFM (Android) app

Table H.3 — Flowmeter FM. Displayed and/or editable SPN with the help of Service S6 DFM software or Service S6 DFM (Android) app

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 “Feed” chamber of differential flow meter.
521028/18.0	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 “Feed” 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.
521028/18.1	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	Counter of total fuel consumption by the Vehicle within the whole range of loads, including the “Idle” mode of engine operation. 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	Counter of total fuel consumption by the Vehicle in the “Idle” mode of engine operation. 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
5054/9.1	High resolution engine total fuel used/9.1 Optimal	On the fact	l	Counter of total fuel consumption by the Vehicle in the "Optimal" mode of engine operation. 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	Counter of total fuel consumption by the Vehicle in the "Overload" mode of engine operation. 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	Counter of total fuel consumption by the Vehicle which exceeded the upper limit set for this particular flow meter model. 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	Counter of total fuel consumption by the Vehicle in case the amount of fuel coming back through the reverse line exceeded fuel consumption in the feed line. 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.
521171	Engine hours of operation	On the fact	s	Counter of total time of the flow meter operation within the whole range of loads, including the "Idle" mode of engine operation. 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	Counter of total time of the flow meter operation within the "Idle" mode of engine operation. 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	Counter of total time of the flow meter operation within the "Optimal" mode of engine operation. 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	Counter of total time of the flow meter operation within the "Overload" mode of engine operation. 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	Counter of total time of the flow meter operation during which the upper limit of fuel consumption set for the mounted flow meter model was exceeded. 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	Counter of total time of the flow meter operation during which the amount of fuel coming back through the reverse line exceeded fuel consumption in the feed line. This counter is foreseen only for differential models of DFM. 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	Counter of total time of external factors impact (e.g. strong magnetic field) impeding the flow meter operation. 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	Counter of total fuel consumption by the Vehicle in the "Feed" chamber of the differential flow meter within the whole range of loads, including the "Idle" mode of engine operation. 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
5054/9.0/18.0	High resolution engine total fuel used/ 9.0 Idle/ 18.0 Feed chamber	On the fact	l	Counter of total fuel consumption by the Vehicle in the "Feed" chamber of the differential flow meter in the "Idle" mode of engine operation. 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	Counter of total fuel consumption by the Vehicle in the "Feed" chamber of the differential flow meter in the "Optimal" mode of engine operation. 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	Counter of total fuel consumption by the Vehicle in the "Feed" chamber of the differential flow meter in the "Overload" mode of engine operation. 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	Counter of total fuel consumption by the Vehicle in the "Feed" chamber of the differential flow meter which exceeded the upper limit set for the mounted flow meter model. The Counter is increasing from the date of flow meter production and cannot be reset by user.
5054/18.1	High resolution engine total fuel used/ 18.1 Reverse chamber	On the fact	l	Counter of total fuel consumption by the Vehicle in the "Reverse" chamber of the differential flow meter within the whole range of loads, including the "Idle" mode of engine operation. 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	Counter of total fuel consumption by the Vehicle in the "Reverse" chamber of the differential flow meter in the "Idle" mode of engine operation. 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	Counter of total fuel consumption by the Vehicle in the "Reverse" chamber of the differential flow meter in the "Optimal" mode of engine operation. 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	Counter of total fuel consumption by the Vehicle in the "Reverse" chamber of the differential flow meter in the "Overload" mode of engine operation. 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	Counter of total fuel consumption by the Vehicle in the "Reverse" chamber of the differential flow meter which exceeded the upper limit set for the mounted flow meter model. 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	Counter of total time of the "Feed" chamber operation of the differential flow meter within the whole range of loads, including the "Idle" mode of engine operation. 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	Counter of total time of the "Feed" chamber operation of the differential flow meter in the "Idle" mode of engine operation. 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
521189/9.1/18.0	Flowmeter chamber time counter/ 9.1 Optimal/ 18.0 Feed chamber	On the fact	s	Counter of total time of the "Feed" chamber operation of the differential flow meter in the "Optimal" mode of engine operation. 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	Counter of total time of the "Feed" chamber operation of the differential flow meter in the "Overload" mode of engine operation. 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	Counter of total time of the "Feed" measuring chamber operation of the differential flow meter during which the fuel consumption exceeded the upper limit set for the mounted flow meter model. 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	Counter of total time of the "Reverse" chamber operation of the differential flow meter within the whole range of loads, including the "Idle" mode of engine operation. 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	Counter of total time of the "Reverse" chamber operation of the differential flow meter in the "Idle" mode of engine operation. The Counter is increasing from the date of flow meter production and cannot be reset by user.
521189/9.1/18.1	Flowmeter chamber time counter/ 9.1 Optimal/ 18.1 Reverse chamber	On the fact	s	Counter of total time of the "Reverse" chamber operation of the differential flow meter in the "Optimal" mode of engine operation. 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	Counter of total time of the "Reverse" chamber operation of the differential flow meter in the "Overload" mode of engine operation. 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	Counter of total time of the "Reverse" measuring chamber operation of the differential flow meter during which the fuel consumption exceeded the upper limit set for the mounted flow meter model. The Counter is increasing from the date of flow meter production and cannot be reset by user.
Flowmeter hours of operation/total fuel used. Clearable PGN 63261				
5054/28.0	High resolution engine total fuel used/ 28.0 Clearable	On the fact	l	Resettable Counter of total fuel consumption by the Vehicle within the whole range of loads, including the "Idle" mode of engine operation. The Counter indications increment from the moment of its previous reset by the user. This Counter may be useful for measuring out precise portions of fuel.
521171/28.0	Flowmeter hours of operation / 28.0 Clearable	On the fact	s	Resettable Counter of total time of the flow meter operation within the whole range of loads, including the "Idle" mode of engine operation. The Counter indications increment from the moment of its previous reset by the user. This Counter may be useful for measuring out precise portions of fuel.

SPN	Name	Factory value	Unit of measure	Clarification
Differential Opearation Mode* PGN 63204				
521268	Master Mode	Off	No	Activation of Master mode for the Master flow meter (feed fuel line) and deactivation of the Slave flow meter (reverse fuel line) of the pair of the flow meters used in the differential mode of operation (see 2.11).
521270	Calculation Mode	Differential	No	Selection of the required mode of the flow meter readings calculation: - differential — the fuel consumption is calculated as the difference in consumption measured by the flow meters in the feed and reverse fuel lines; - summation — the fuel consumption is calculated as the total of consumption measured by the flow meter in the two fuel lines.
521269	Slave Device Address	112	No	Entering the unique network address for the Slave flow meter (reverse fuel line) from the range of values (111…118) or (151…158). The selected address must not coinside with the network address of the Master flow meter.
521271	Differencial Fuel Rate Correction Coefficient	0.0	No	The fuel consumption correction coefficient enables to enhance the accuracy of the differential fuel consumption measurement in case of steady too low or too high readings in specific conditions of operation (intense vibration, presence of air in the fuel system, losses of fuel in the reverse lines of the injectors). The setting is accessible for the user for editing.
521671	Smoothing Capacity	5	No	The damping buffer is used to enhance the accuracy of the differential measurement in cases of uneven fuel consumption in the feed/reverse fuel lines. The buffer value is selected experimentally from the range (2…100). In case of uneven fuel consumption in the fuel lines, we do not recommend to change the value of the damping buffer specified by default (5). In case the uneven fuel consumption is increasing, the value of the damping buffer must be higher.
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	"Overload" 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 "Feed" 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 "Feed" chamber of differential fuel flow meter. The setting cannot be altered by user.

SPN	Name	Factory value	Unit of measure	Clarification
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 "Feed" 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 border/ 9.2 Overload/ 18.1 Reverse chamber	On the fact	l/h	Factory setting of "Optimal" operation mode boundary for "Overload" 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.
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.
Fuel consumption factors. Operating modes** PGN 63303				
521434/9.0	Lliquid Consumption Correction Coefficient/ 9.0 Idle	0.0	%	Setting the correction coefficient for the "Idle" mode of operation. It allows to enhance the measurement accuracy in case of revealing steady decreased/increased indications in the "Idle" mode of operation. This setting is accessible for editing by the user.
521434/9.1	Lliquid Consumption Correction Coefficient/ 9.1 Optimal	0.0	%	Setting the correction coefficient for the "Optimal" mode of operation. It allows to enhance the measurement accuracy in case of revealing steady decreased/increased indications in the "Optimal" mode of operation. This setting is accessible for editing by the user.
521434/9.2	Lliquid Consumption Correction Coefficient/ 9.2 Overload	0.0	%	Setting the correction coefficient for the "Overload" mode of operation. It allows to enhance the measurement accuracy in case of revealing steady decreased/increased indications in the "Overload" mode of operation. This setting is accessible for editing by the user.
Calibration table. Fuel rate (DFM) PGN 63044				
521355	Array elements count	5	pcs.	Quantity of points in calibration table made by Manufacturer during calibration process. The setting cannot be altered by user.
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.
* These settins are valid only for DFM CAN with the firmware version not lower than 4.63 , when using the service software version 1.27 and higher. ** These settings are valid only for DFM D with the firmware version not lower than 4.55, when using the service software version 1.24 and higher.				

H.4 Summator DFM FM

Summator DFM FM — is designed to receive data on the measured total fuel consumption in two or more fuel lines (16 at a maximum) using S6 Technology.

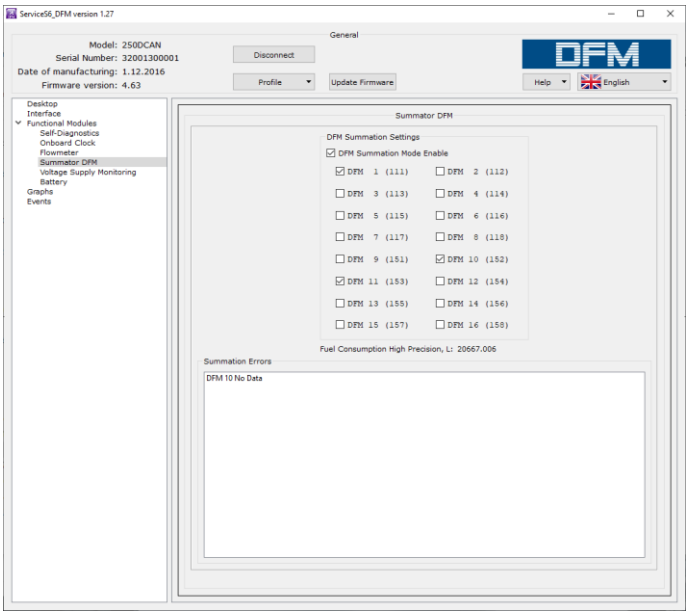


Figure H.5 — Window of settings of Summator DFM in Service S6 DFM software

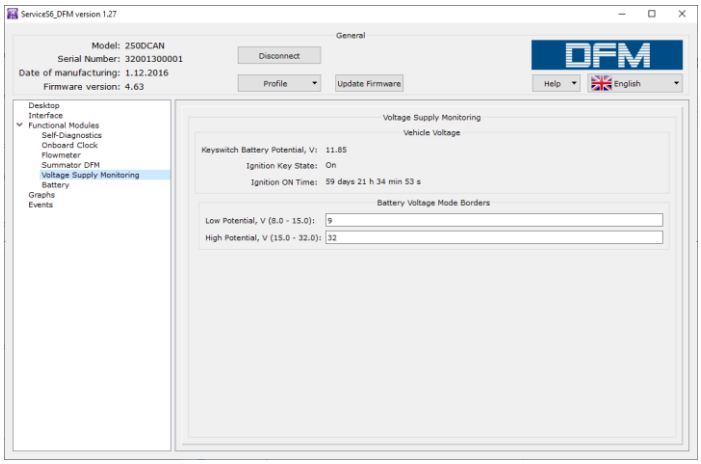
Table H.4 — Summator DFM. Displayed and/or editable SPN with the help of Service S6 DFM software

SPN	Name	Factory value	Unit of measure	Range	Clarification
Total Fuel Consumption PGN 63515					
5054/2.11	High Resolution Engine Total Fuel Used / 2.11 Summary Value	On the fact	l	0…4211080	Displays the total of values of the Counters of total fuel consumption for the selected DFM CAN flow meters connected by means of S6 Technology. The total fuel consumption is displayed only in case the summation mode is activated.
521687	Summation Error Mask	No	No	0…65535	Bit mask to identify the numbers of the flow meters selected for summation, the output data of which are missing: 2^0- no data from DFM 1; 2^1- no data from DFM 2; 2^2- no data from DFM 3; 2^3- no data from DFM 4; 2^4- no data from DFM 5; 2^5- no data from DFM 6; 2^6- no data from DFM 7; 2^7- no data from DFM 8; 2^8- no data from DFM 9; 2^9- no data from DFM 10; 2^{10}- no data from DFM 11; 2^{11}- no data from DFM 12; 2^{12}- no data from DFM 13; 2^{13}- no data from DFM 14; 2^{14}- no data from DFM 15; 2^{15}- no data from DFM 16.

SPN	Name	Factory value	Unit of measure	Range	Clarification
DFM Summation Settings PGN 63516					
521689	DFM Summation Mode Enable	Off	-	On/Off	Field to enable/disable the mode of summation of readings of the Counters that show the total fuel consumption of DFM CAN flow meters connected by means of S6 Technology.
521688/34.0	DFM Summation Enable / 34.0 DFM 1	Off	-	On/Off	Field to activate/deactivate the summation of readings of the total fuel consumption Counter of DFM CAN flow meter (network address 111) mounted in the fuel line 1.
521688/34.1	DFM Summation Enable / 34.0 DFM 2	Off	-	On/Off	Field to activate/deactivate the summation of readings of the total fuel consumption Counter of DFM CAN flow meter (network address 112) mounted in the fuel line 2.
521688/34.2	DFM Summation Enable / 34.0 DFM 3	Off	-	On/Off	Field to activate/deactivate the summation of readings of the total fuel consumption Counter of DFM CAN flow meter (network address 113) mounted in the fuel line 3.
521688/34.3	DFM Summation Enable / 34.0 DFM 4	Off	-	On/Off	Field to activate/deactivate the summation of readings of the total fuel consumption Counter of DFM CAN flow meter (network address 114) mounted in the fuel line 4.
521688/34.4	DFM Summation Enable / 34.0 DFM 5	Off	-	On/Off	Field to activate/deactivate the summation of readings of the total fuel consumption Counter of DFM CAN flow meter (network address 115) mounted in the fuel line 5.
521688/34.5	DFM Summation Enable / 34.0 DFM 6	Off	-	On/Off	Field to activate/deactivate the summation of readings of the total fuel consumption Counter of DFM CAN flow meter (network address 116) mounted in the fuel line 6.
521688/34.6	DFM Summation Enable / 34.0 DFM 7	Off	-	On/Off	Field to activate/deactivate the summation of readings of the total fuel consumption Counter of DFM CAN flow meter (network address 117) mounted in the fuel line 7.
521688/34.7	DFM Summation Enable / 34.0 DFM 8	Off	-	On/Off	Field to activate/deactivate the summation of readings of the total fuel consumption Counter of DFM CAN flow meter (network address 118) mounted in the fuel line 8.
521688/34.8	DFM Summation Enable / 34.0 DFM 9	Off	-	On/Off	Field to activate/deactivate the summation of readings of the total fuel consumption Counter of DFM CAN flow meter (network address 151) mounted in the fuel line 9.
521688/34.9	DFM Summation Enable / 34.0 DFM 10	Off	-	On/Off	Field to activate/deactivate the summation of readings of the total fuel consumption Counter of DFM CAN flow meter (network address 152) mounted in the fuel line 10.
521688/34.10	DFM Summation Enable / 34.0 DFM 11	Off	-	On/Off	Field to activate/deactivate the summation of readings of the total fuel consumption Counter of DFM CAN flow meter (network address 153) mounted in the fuel line 11.
521688/34.11	DFM Summation Enable / 34.0 DFM 12	Off	-	On/Off	Field to activate/deactivate the summation of readings of the total fuel consumption Counter of DFM CAN flow meter (network address 154) mounted in the fuel line 12.
521688/34.12	DFM Summation Enable / 34.0 DFM 13	Off	-	On/Off	Field to activate/deactivate the summation of readings of the total fuel consumption Counter of DFM CAN flow meter (network address 155) mounted in the fuel line 13.
521688/34.13	DFM Summation Enable / 34.0 DFM 14	Off	-	On/Off	Field to activate/deactivate the summation of readings of the total fuel consumption Counter of DFM CAN flow meter (network address 156) mounted in the fuel line 14.
521688/34.14	DFM Summation Enable / 34.0 DFM 15	Off	-	On/Off	Field to activate/deactivate the summation of readings of the total fuel consumption Counter of DFM CAN flow meter (network address 157) mounted in the fuel line 15.
521688/34.15	DFM Summation Enable / 34.0 DFM 16	Off	-	On/Off	Field to activate/deactivate the summation of readings of the total fuel consumption Counter of DFM CAN flow meter (network address 158) mounted in the fuel line 16.

H.5 Voltage supply monitoring FM

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



a) in Service S6 DFM software *b) in Service S6 DFM (Android) app*

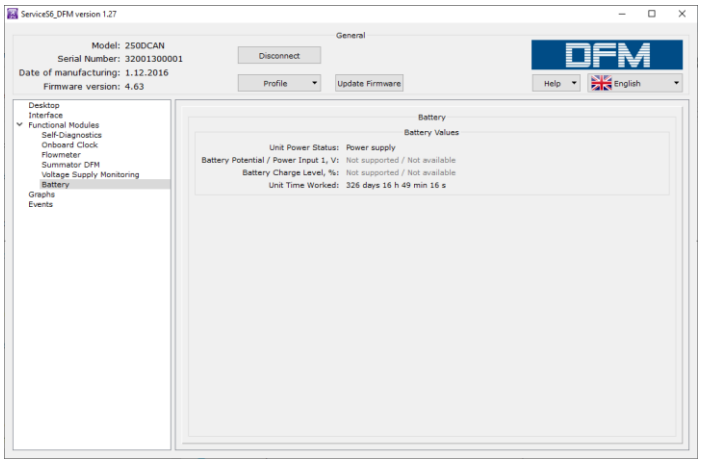
Figure H.6 — Window of settings of Voltage supply monitoring FM

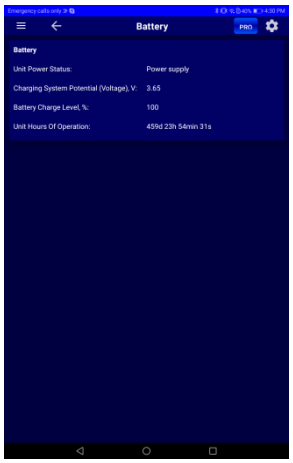
Table H.5 — Voltage supply monitoring FM. Displayed and/or editable SPN with the help of Service S6 DFM software or Service S6 DFM (Android) app

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”.
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”.

H.6 Battery FM

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





a) in Service S6 DFM software *b) in Service S6 DFM (Android) app*

Figure H.7 — Window of settings of Battery FM

Table H.6 — Battery FM. Displayed and/or editable SPN with the help of Service S6 DFM software or Service S6 DFM (Android) app

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 DFM firmware the following actions should be made:

1) In case you use Service S6 DFM software, connect flow meter to PC with the help of service adapter S6 SK (2.6.1) and establish connection session between DFM and PC (see 2.6.3).
In case you use Service S6 DFM (Android) service application, establish a wireless connection between the flow meter and the Android device using S6 BT Adapter service adapter (see 2.7.1). Establish a communication session between the flow meter and the Android device via the Bluetooth channel (see 2.7.3).

ATTENTION: When re-uploading firmware, power supply voltage of DFM should not drop out of 10…45 V range.

2) Start the firmware update procedure.
3) Select the firmware file **(*.blf3)** on the PC disc or in the memory of the Android device.
4) Start loading the firmware file into the DFM memory.

After firmware file integrity and compatibility check by Service S6 DFM software or Service S6 DFM (Android) mobile app 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: To avoid DFM failure, before the end of the firmware upgrade process **is forbidden**:

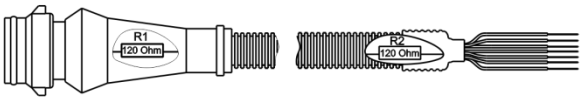
- to switch off PC (in case you use Service S6 DFM software) or the Android device (in case you use Service S6 DFM (Android);
- to switch off the power supply for the Unit;
- to disconnect the Unit from the service adapter and the adapter from the PC or the Android device;
- to connect to the Unit using S6 SK service adapter (cable) and S6 BT Adapter service adapter (wireless) at one time;
- Run any resource-intensive applications on the PC (in case you use Service S6 DFM software).

Service S6 DFM software or Service S6 DFM (Android) mobile app will display appropriate message in case the firmware update is successful. DFM is ready for further operation.
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.

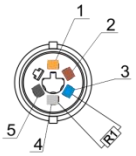
Annex J

Signal cables

S6 SC-CW-700 Cable



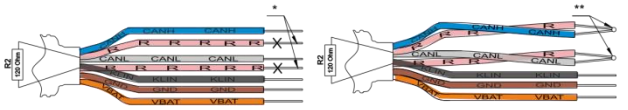
Cable length 700±5 cm.



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

Connecting

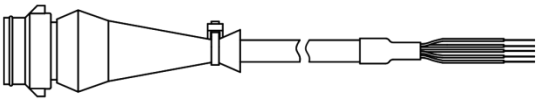
without built-in terminal resistor R2 | with built-in terminal resistor R2



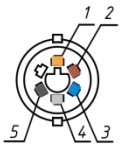
* Do not connect R2 resistor wires (pink, identification mark R), insulate.

** 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

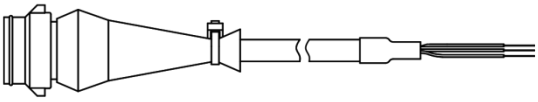


Cable length 700±5 cm.



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 K

Videography

1) DFM Fuel Flow Meter Installation video (DFM installation on 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 **Fuel Consumption Monitoring. DFM Fuel Flow Meter**

Link: https://www.youtube.com/watch?v=IOCQCNgGG7Uf

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

Link: DFM fuel flow meters: selection of installation layout, accessories and mounting kit

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

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