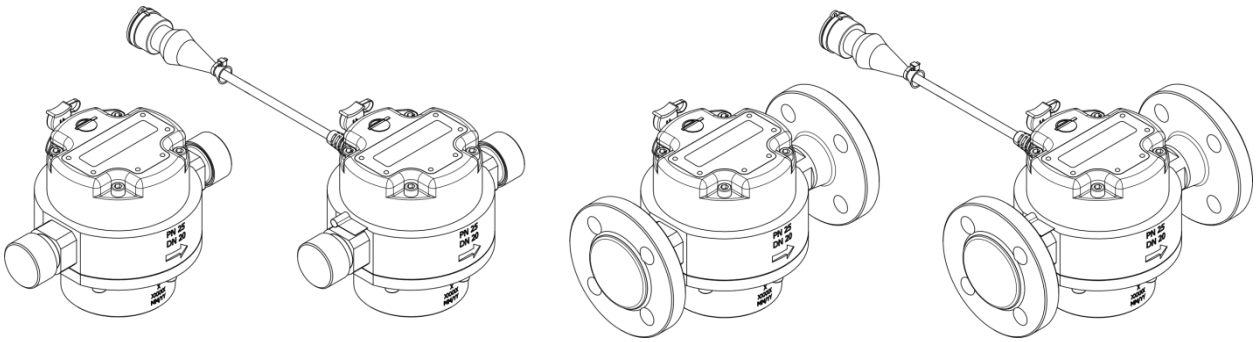
FUEL FLOW METERS



DFM Marine 1000/2000/4000

OPERATION MANUAL

Version 3.3

TECHNOTON

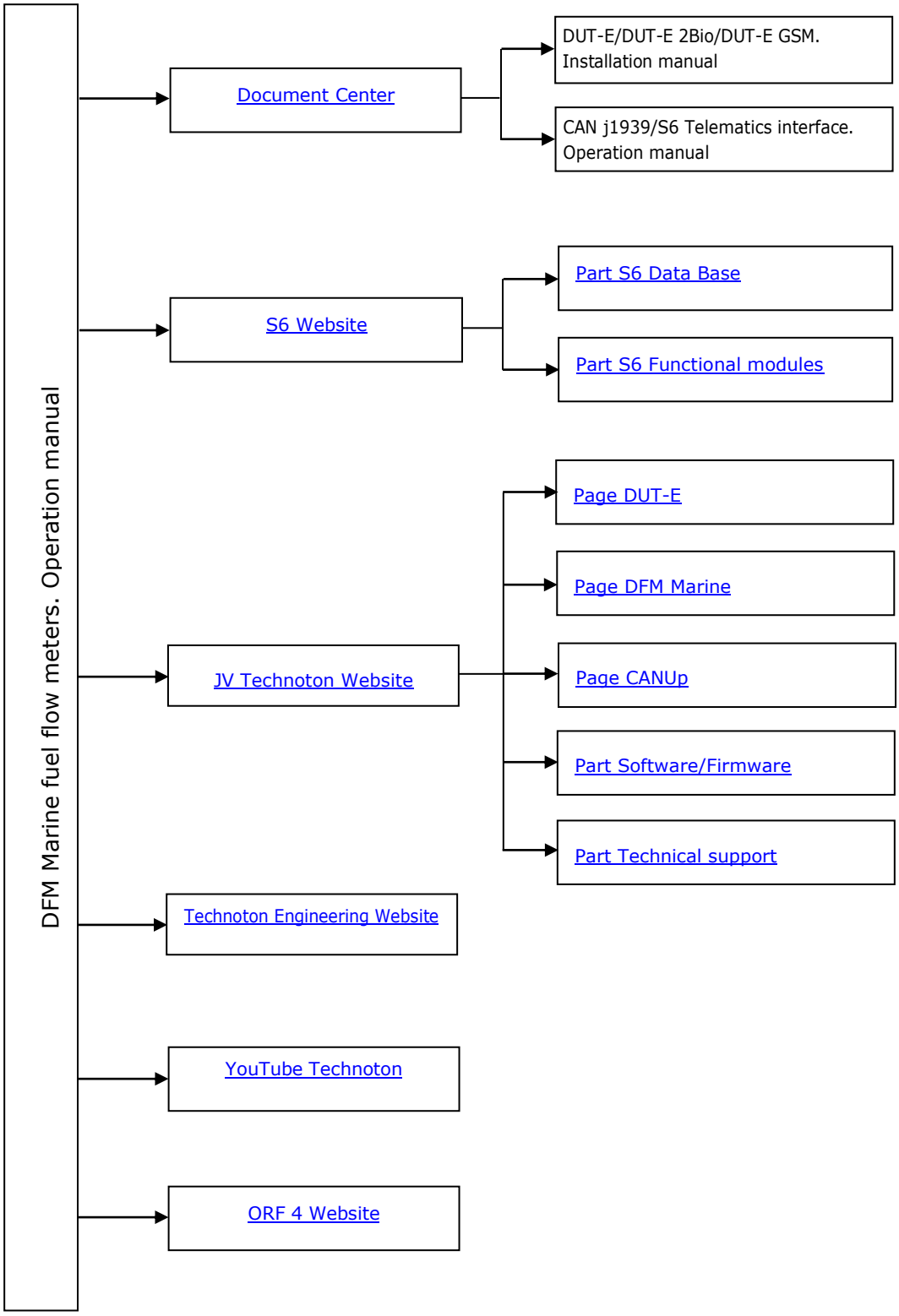
ADVANCED VEHICLE TELEMATICS

Contents

Revision history

Version	Date	Editor	Description of changes
1.0	08.2017	OD	Basic version.
2.0	09.2017	OD	• DFM Marine paired measurement modes are added – differential and summarization of fuel consumption. • DFM Marine CCAN data transfer protocol description is updated with new PGN. • Flowmeter FM (v.3) is updated with new PGN, which are displayed and/or edited with Service DFM Marine (v.1.6) software. • New screens of DFM Marine CCAN flow meters display are added. • Exterior of DFM Marine is changed. • Mounting holes placement schemes are added. • Dimensions and weight of DM Marine are updated. • Structure of external links of this manual is added.
3.0	10.2018	OD	• Information on DFM Marine CCAN operation over NMEA 2000 protocol is added. • Added description of configuration of new functional module – Display Marine. • Delivery set is updated. • Detailed information on electromagnetic compatibility is added. • E28 certificate of international E-mark standard is added. • Document terminology is updated (CAN j1939/S6 Telematics interface, S6 Technology and IoT Burger Technology). • Flow meter model codes are updated. • Added packaging information.
3.1	06.2019	OD	• Information on DFM Marine fuel flow meter is added (MK DFM M1000/M2000/M4000 mounting kits, the mud filter etc.). • Clarifications regarding the utilization/recycling procedure for DFM Marine are made.
3.2	12.2019	OD	• The list of messages and composition of data output from DFM Marine CAN fuel flow meters sent over CAN j1939/S6 interface has been updated. • Information about special version of DFM Marine for systems with a high temperature of measured fluid (up to +150 ° C) is added. • DFM Marine flow meters settings (firmware v.6.28 and higher) in Service DFM Marine software (v.2.8 and higher) are updated for differential measurement mode: - smoothing capacity (smoothing buffer); - displaying of graphs of differential instant flow rate and flow rate in feed and reverse fuel pipelines in one window. • DFM fuel flow meters Certificates of Conformity are added: - European RoHS Directive (Restriction of Hazardous Substances); - European 2014/30/EU Directive (Electromagnetic Compatibility). • Minimal requirements for PC for work with Service DFM Marine software are added. • The procedure for elimination of problems that arise sometimes in relation to running Service DFM Marine software in Windows 10 is described.
3.3	01.2020	OD	ABS (American Bureau of Shipping) approval certificate for DFM Marine is added.

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 Marine fuel flow meters are 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).

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.

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).

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).

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

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

Telematics 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.

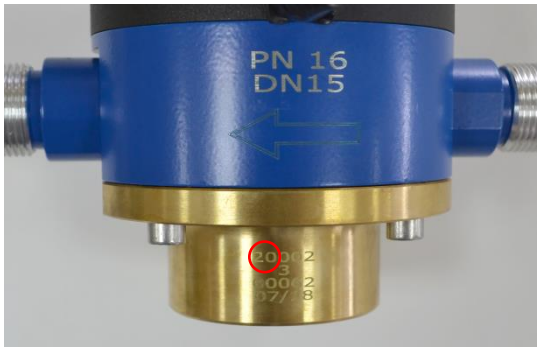
Vehicle an object controlled within Telematics system. Usually Vehicle means a truck, tractor or bus, sometimes a locomotive or river boat. From Telematics system point of view, stationary objects are also considered to be vehicles: diesel gensets, stationary tanks, boilers/burners.

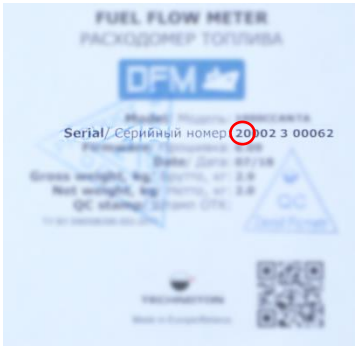
Function module (FM) unit-embedded component of hardware and software combination, executing a group of special functions. Uses input/output PGNs and settings PGNs.

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 Marine fuel flow meters** (hereinafter DFM Marine), models codes — **01, 02, 03, 10, 11, 12, 20, 21, 22**, developed by JV Technoton, Minsk, Belarus.
DFM Marine 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 Marine. Besides, this document defines the procedure for configuration of flow meters.

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

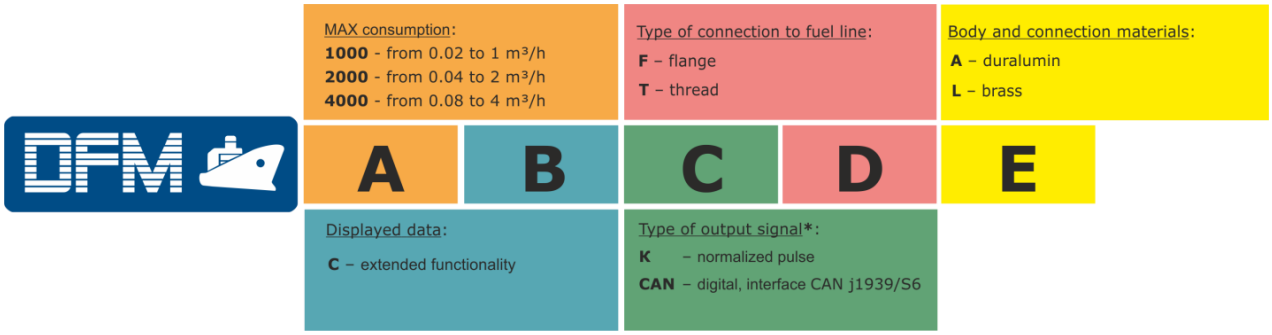
DFM Marine features:

- 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";
- conformity to the Rules of American Bureau of Shipping;
- implementation of data transfer using NMEA 2000 marine equipment communication protocol allows to integrate the flow meter into ship automation systems*;
- combination of 1…8 flow meters into a single network using S6 Technology*;
- could be used for differential measurement or summarization of fuel consumption data when flow meters are used in pair and connected using S6 Technology*;
- protection against unauthorized interference in operation and data "tampering";
- maximum information richness of output data*;
- high reliability of data transmission over digital interfaces*;
- unique self-diagnostics feature to monitor the stability and accuracy of data*;
- 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**;
- Operability in fuel systems with high (up to +150 °C) temperature of measured liquid***.

* For DFM Marine CAN.
** For DFM Marine with interface cable.
*** For special version of DFM Marine (any model can be made).

- 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;
- measuring chamber is made of high-strength anti-corrosion material - brass
- installed in fuel line using thread or flange connection elements;
- electronic part of DFM Marine can be disconnected without dismounting flow meter from the fuel line;
- straight segments of fuel line are not necessary for flow meter installation;
- accuracy of measurement is not decreasing when flow meter is operated in tough operation conditions;
- minimum fluid flow resistance;
- 100 % of DFM Marine are verified with a certified metrological test rig;
- high quality mounting accessories
- conformity with European and national standards and directives;
- high-quality technical support and documentation.

See figure 1 for identification codes for DFM Marine ordering:



* Interfaces RS-232/RS-485 (protocols DFM COM and Modbus RTU) - under the order

Figure 1 — DFM Marine order identification codes

Example of DFM Marine order identification codes:

"DFM Marine 1000C FL Fuel flow meter",
(max. flow rate — 1 m³/h, autonomous with display, with flange connection, material — brass).

"DFM Marine 2000CK TL Fuel flow meter",
(max. flow rate — 2 m³/h, with output normalized pulse, with thread connection, material — brass).

"DFM Marine 4000CCAN FA Fuel flow meter",
(max. flow rate — 4 m³/h, output interface — CAN j1939/S6, with flange connection, material — duralumin).

Summary table of technical characteristics of DFM Marine

Parameter, measurement units			Model		
			DFM Marine 1000	DFM Marine 2000	DFM Marine 4000
1) General specifications					
Nominal diameter (DN)		mm	15	20	25
		inch	1/2	3/4	1
Maximum flow rate (Q_{max})		m^3/h	1	2	4
Minimum flow rate (Q_{min})		m^3/h	0.02	0.04	0.08
Starting flow rate*		m^3/h	0.01	0.02	0.04
Maximum inaccuracy rate**		%	±0.5		
Nominal volume of the measuring chamber		ml	30	75	150
Measurement chamber material			brass		
Body and connection materials			duralumin (A models) brass (L models)		
Type of connection to fuel line			flange type of connection (F models) thread type of connection (T models)		
Ingress protection rating			IP54		
Maximum pressure of working fluid	flange type of connection	bar	25		
	thread type of connection		16		
Maximum temperature of working fluid		°C	+95 +150***		
Fluid kinematic viscosity		mm^2/s (cSt)	1.5…6.0		
Installation length	flange type of connection	mm	200	214	232
	thread type of connection		172	194	216
Distance of flange holes	flange type of connection	mm	65	75	85
Type of connection thread (BSP)	thread type of connection	inch	3/4	1	1 1/4
Maximum width of rough filter		mm	0.25	0.40	0.40
Maximum weight		kg	1.9 (TA models) 2.5 (FA models) 3.3 (TL models) 4.9 (FL models)	2.8 (TA models) 3.4 (FA models) 4.5 (TL models) 6.6 (FL models)	4.4 (TA models) 5.1 (FA models) 7.3 (TL models) 9.6 (FL models)
2) Electronic module specifications					
Supply voltage range (only for models with interface cable DFM Marine CK/CCAN)		V	10…45		
Maximum current consumption at 12/24 V (only for models with interface cable DFM Marine CK/CCAN)		mA	50/25		
Estimated autonomous operation time until full battery discharge		month	36		

Parameter, measurement units			Model		
			DFM Marine 1000	DFM Marine 2000	DFM Marine 4000
Temperature range of LCD display		°C	-20…+80		
System of units on LCD display			metric (m^3)/US (gallon)/metric (l)		
Output digital interfaces			CAN j1939/S6 (SAE J1939 and NMEA 2000 protocols)		
			RS 232/RS 485 (DFM COM and Modbus RTU protocols)***		
Normalized pulse output	U_{LOW} (min amplitude)	V	U_{HIGH} =U_{BATT} (not more than 36 V), U_{BATT} - voltage of on-board electrical system		
	U_{HIGH} (max amplitude)	V	U_{LOW} ≤0.7 V		
	T_{pulse} (period)	ms	100…5400	135…6750	135…6750
	t_{LOW} (interval)	ms	0.5 T_{pulse} (then T_{pulse} <1 s) and 500 ms (then T_{pulse} >1 s)		
	Pulse value	m^3/puls	0.000030	0.000075	0.000150
Service digital interface			K-Line (ISO 14230)		

* The value is indicated for reference only. Inaccuracy is not standardized for operation on the starting flow rate.

** If fuel consumption in the range from Q_{min} to 3·Q_{min} and in "Differential"/"Summarization" measurement mode, inaccuracy is not higher than ±1.0 %.

*** Under the order.

For DFM Marine with output interface configuration a service adapter S6 SK is used, which is ordered additionally, and software Service DFM Marine you can download and/or update your Service DFM Marine software at https://www.jv-technoton.com/, in Software/Firmware category.

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

The Manufacturer guarantees DFM Marine 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 Marine specifications that do not lead to a deterioration of the consumer qualities without prior customer notice.

1 DFM Marine general information and technical specifications

1.1 Purpose of use and application area

is designed for (see figure 2):

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

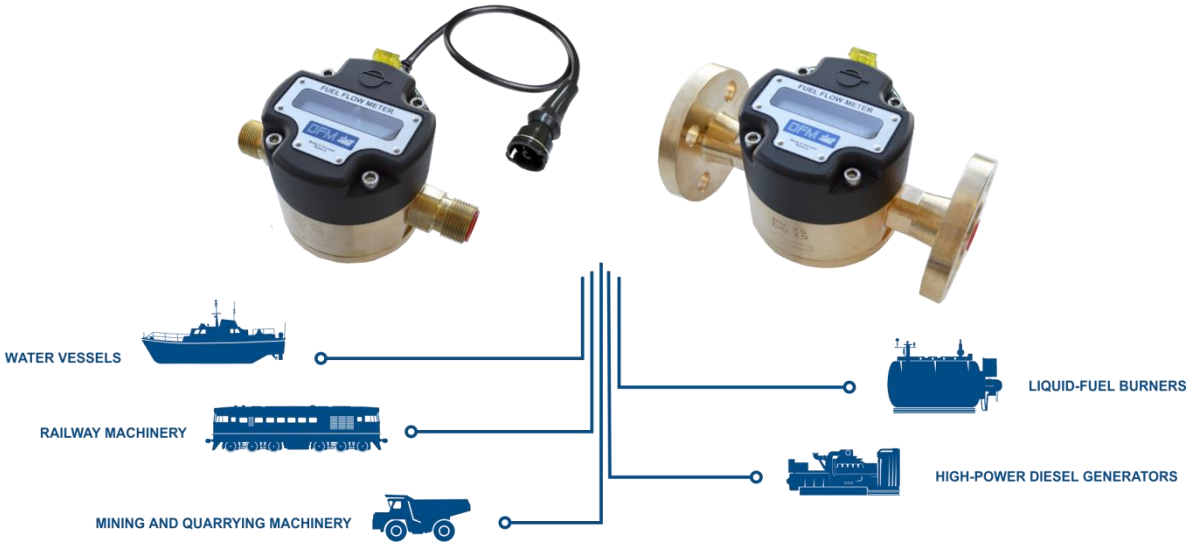
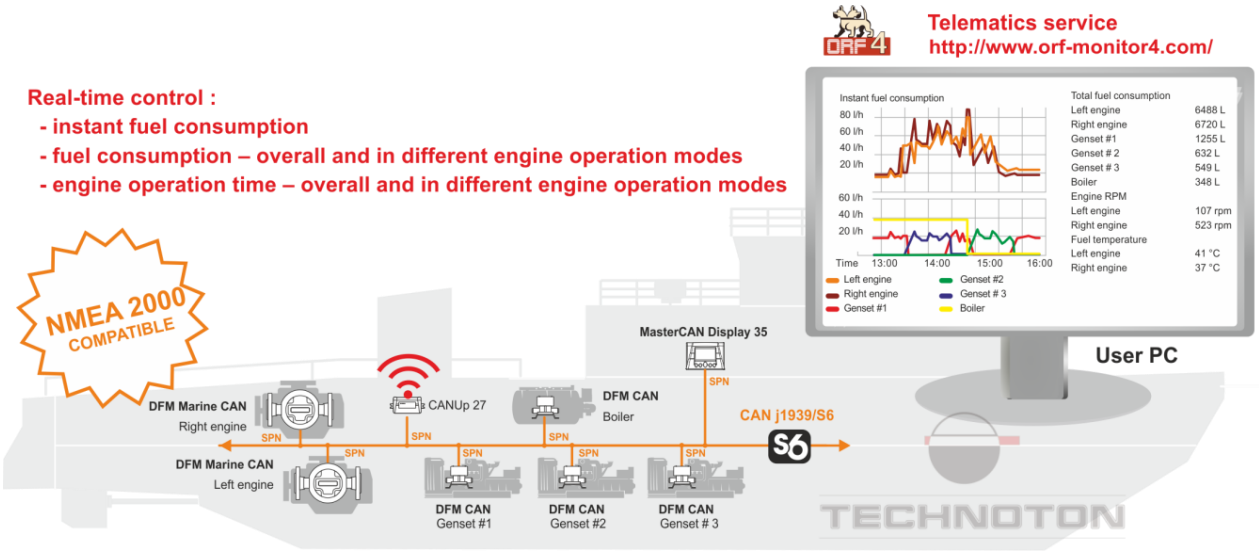


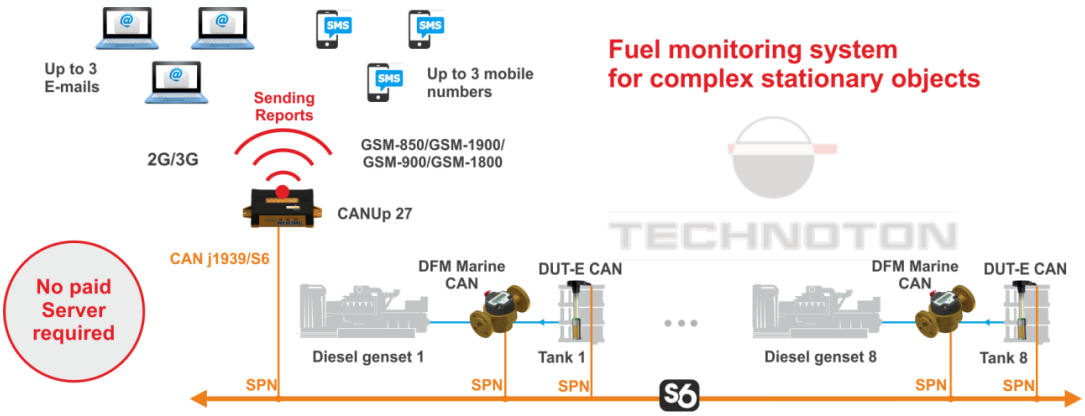
Figure 2 — Purpose of DFM Marine fuel flow meters

Application areas (see figure 3)

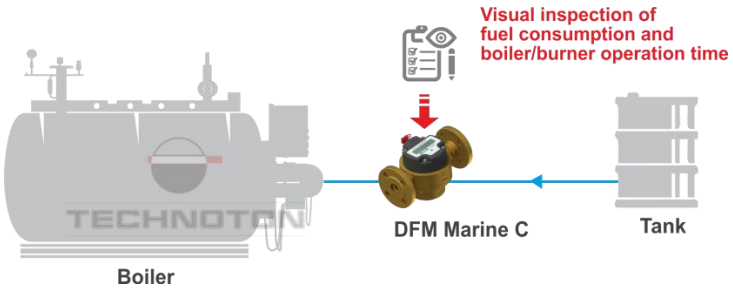
1) DFM Marine fuel flow meters can be used as part of Telematics system of complex mobile and stationary objects (ships, diesel locomotives, diesel generator sets, boiler equipment, etc.).



a) example of using DFM Marine as part of Telematics system of a complex mobile object.



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



c) example of autonomous DFM Marine operation

Figure 3 — Application areas of DFM Marine fuel flow meters

DFM Marine installed into a fuel line of fuel consumer, measures hourly (instant) fuel consumption and generates output signal, which is sent to Telematics unit.
Availability of CAN j1939/S6 interface allows to connect 8 pcs. of DFM Marine CCAN flow meters and 8 pcs. of DUT-E CAN fuel level sensor combined in a single network using S6 Technology to just one CAN-port of Telematics unit (for example, to CANUp 27 online telematic gateway).
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 Marine with CAN j1939/S6 interface 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.

* When used a pair of DFM Marine CAN.

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

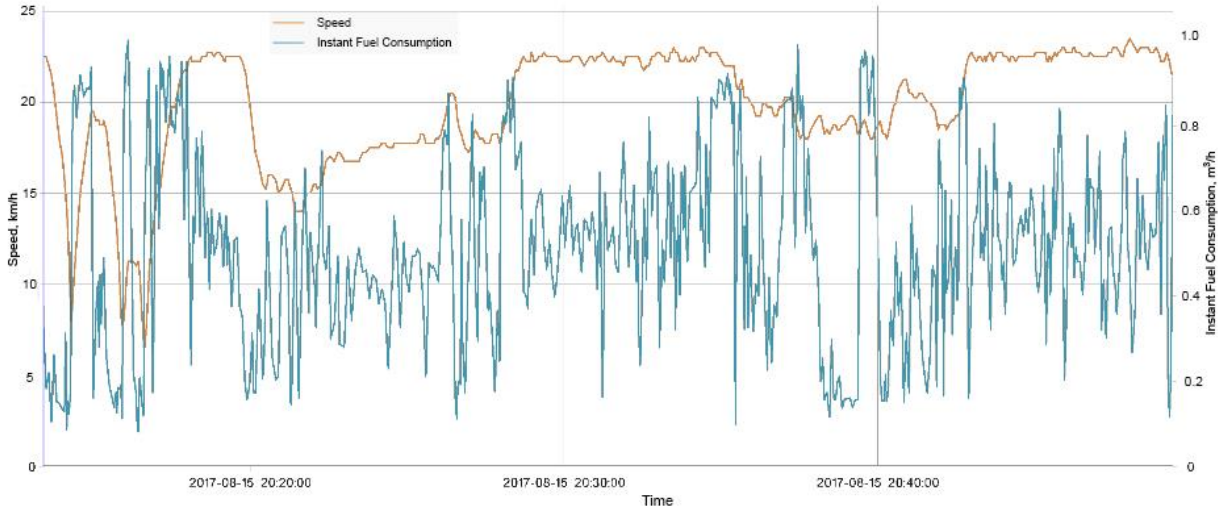


Figure 4 — Example of Analytical Report generated in ORF 4 software, based on the DFM Marine CAN data

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

When using **autonomous DFM Marine** 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 Marine provides vehicle owners with the following:

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

1.2 Exterior view and delivery set

1	DFM Marine fuel flow meter	– 1 pc.;
2	Magnetic key	– 1 pc.;
3	Signal cable CABLE DFM 98.20.003 (7.5 m)*	– 1 pc.;
4	Fuse with holder (2 A)**	– 1 pc.;
5	PTFE gasket***	– 2 pcs.;
6	Fastening bracket	– 1 pc.;
7	Verification certificate	– 1 pc.;
8	Specification with a card containing description of informational screens and sample of flow meter operation journal	– 1 pc.

Figure 5 — DFM Marine delivery set

* Only for DFM Marine CK meters with pulse interface output.
For DFM Marine CAN, S6 SC-CW-700 signal cable is purchased separately.
** Not applicable for autonomous DFM Marine.
*** Supplied only with DFM Marine with flange connection.

1.3 DFM Marine models

DFM Marine fuel flow meters is represented by the following **models**:

1) By output interface:

- autonomous fuel flow meters with display;
- fuel flow meters with display and interface cable:
  - with pulse output;
  - with digital CAN j1939/S6 interface.

2) By connection type to fuel line:

- flange – according to DIN 2501;
- thread – according to DIN 259, ISO R228.

3) By type of body and connection materials:

- duralumin;
- brass.

1.3.1 Autonomous fuel flow meters with display

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

*a) duralumin body, thread connection (**TA** modification)*

*b) duralumin body, flange connection (**FA** modification)*

*c) brass body, thread connection (**TL** modification)*

*d) brass body, flange connection (**FL** modification)*

Figure 6 — Exterior of autonomous fuel flow meters with display

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

Fuel flow meters with display and interface cable (**DFM Marine CK/CCAN** models) (see figure 7) can be used autonomously and as a part of the Telematics system.

*a) duralumin body, thread connection (**TA** modification)*

*b) duralumin body, flange connection (**FA** modification)*

*c) brass body, thread connection (**TL** modification)*

*d) brass body, flange connection (**FL** modification)*

Figure 7 — Exterior of 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 Marine CK**).
In CAN j1939/S6 digital interface (**DFM Marine CCAN**) contain fuel consumption data together with Counters values, data on engine operation modes, flow meter Parameters and malfunctions, Events.

1.4 Measurement range and accuracy

Table 1 — Measurement range and accuracy of DFM Marine flow meters

Model (by size)	Starting flow rate*, m³/h	Minimum flow rate (Q_{min}), m³/h	Maximum flow rate (Q_{max}), m³/h	Relative accuracy error, %, not more than***
DFM Marine 1000	0.01	0.02	1	±0.5**
DFM Marine 2000	0.02	0.04	2	
DFM Marine 4000	0.04	0.08	4	

* 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.

** In "Differential"/"Summarization" measurement mode, inaccuracy is not higher than ±1.0 % (depending on the proportion of fuel consumption in chamber of each flow meter used).

***If fuel consumption in the range from Q_{min} to $3 \cdot Q_{min}$, the allowed inaccuracy is not more than ±1.0 %, for "Differential" and "Summarization" fuel consumption modes – not more than ±2.0 %.

⚠ **RECOMMENDATION:** In case the average flow rate in engine is close to the upper capacity limit of a certain DFM Marine model it is recommended to use DFM Marine 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 Marine operating life.

1.5 Unit structure and operation principle

DFM Marine* consists of a ring-type measuring chamber (**1**), measuring "head" with display and with electronic unit inside (**2**), body with connection (flanged or threaded) (**3**), interface output cable (**4**) with connector (**5**) (see figure 8).

Figure 8 — DFM Marine components

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

The principle of DFM Marine 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 9).
Volume of fluid equal to the inner volume of the measuring chamber is pushed out during the full single turn of the ring (see animation on DFM fuel flow meter operational principle). DFM Marine electronics generates one output impulse at the same time.

Figure 9 — DFM Marine measuring chamber operation scheme

***** Structure is shown in an instance of DFM Marine CK.

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

Distinctive design features of DFM Marine fuel flow meters:

- DFM Marine 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 brass, which is durable and corrosion-proof;
- straight segments of fuel line at input and output of flow meter are not necessary for correct operation of measuring chamber;
- electronic part of DFM Marine can be disconnected without dismounting flow meter from the fuel line;
- increased nominal bore for minimum fuel flow hydraulic resistance;
- DFM Marine sensitivity to hydraulic shocks in fuel line is decrease by improved magnetic scheme and broad configuration options (with service software), also allowing to achieve higher accuracy.

1.6 Technical specifications

1.6.1 Working fluids

DFM Marine 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 Marine units are verified with diesel fuel. Indicate viscosity when ordering DFM Marine 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 Marine capacity range will get lower than nominal one and the pressure drop will increase.

3) Foreign inclusions size in the liquid should not be more than 0.250 mm (for DFM Marine 1000) and 0.400 mm (for DFM Marine 2000 and DFM Marine 4000).

4) DFM Marine 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).

5) When measuring liquid **+95...+150 °C** and ambient temperature is higher than **+50 °C**, it is recommended to use **fan** (should be purchased separately) for cooling down flow meter's electronic unit.

1.6.2 Main specifications

Table 2 — DFM Marine main specifications

Parameter, measurement units	Value		
	DFM Marine 1000	**DFM Marine 2000**	**DFM Marine 4000**
Maximum pressure for flange connection, bar	25		
Maximum pressure for thread connection, bar	16		
Type of male connection thread (BSP), inch	3/4	1	1 1/4
Distance of flange holes, mm	65	75	85
Kinematic viscosity range of the measured fluid, mm^2/s (cSt)	1.5…6.0		
Maximum temperature of working fluid, °C	+95*		
Supply voltage range, V	10…45		
Current consumption at 12 V/24 V, mA, not more than	50/25		
Ambient operation temperature range, °C	-20…+80		
Vibration resistance	max. acceleration to 100 m/s^2 in the frequency range from 5 to 250 Hz		
Resistance to aggressive environments	oil and petrol resistance		
Electromagnetic compatibility	see annex E		
Ingress protection rating	IP54		
Overall dimensions	see annex A		
Weight			
* Any model of flow meter can be made for measuring liquid with maximum temperature of +150 °C.			

1.6.3 Specifications of measuring chambers

Table 3 — Specifications of DFM Marine measuring chambers

Flow meter capacity model	Nominal diameter (DN), mm	Nominal volume of the measuring chamber, ml	Re-calibration interval *, m³
DFM Marine 1000	15	30	1200
DFM Marine 2000	20	75	2800
DFM Marine 4000	25	150	5250
* See 7			

1.6.4 Power supply modes

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

- **Stand-alone power supply** (**DFM Marine C** models) DFM Marine is powered from the built-in lithium-silicon battery. Estimated DFM Marine operation time until full battery discharge is not less than 36 months.

- **Combined power supply** (**DFM Marine CK/CCAN** models) — DFM Marine 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 8 V).
  Estimated DFM Marine 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 Marine CK/CCAN automatically enable option of data readings recording into internal meter memory. When powered from internal battery this fuel flow meters can display data according to table 5. 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 4 — Operation modes of DFM Marine fuel flow meters

<table>
<tr><th colspan="3">Engine operation</th><th rowspan="2">"Tampering"
$Q>Q_{max}$</th><th rowspan="3">"Interference"
The impact of constant magnetic field</th></tr>
<tr><th colspan="3">Normal consumption
$Q_0<Q\leq Q_{max}$</th></tr>
<tr><th>"Idle"
$Q_0<Q<2.5Q_{min}$</th><th>"Optimal"
$2.5Q_{min}\leq Q<0.75Q_{max}$</th><th>"Overload"
$0.75Q_{max}\leq Q\leq Q_{max}$</th></tr>
<tr><td colspan="5">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 DFM Marine software at Flowmeter Marine FM section (see F.4).

1.6.6 Displayed data

Informational screens of DFM Marine's display (see table 5) are switched when surface under the display is tapped with a magnetic key (see figure 10).

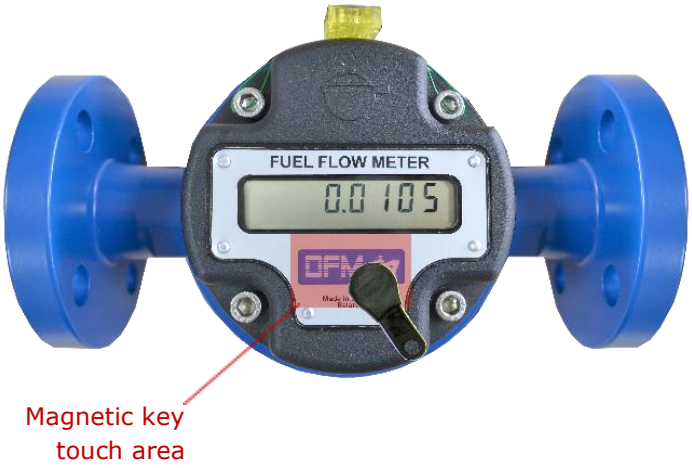


Figure 10 — Switching DFM Marine display information screens

In order to save the charge of the built-in battery the DFM Marine 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 11).

Figure 11 — Display view in sleep mode

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

If it is necessary to continuously display the readings on the flow meter's display, uncheck **Enable Sleep mode** box in configurations of Display Marine FM using service software (see F.2). After saving profile changes to the Unit, display of the flow meter will not switch into sleep mode anymore.

Keep in mind, that when "sleep" mode is switched off, current consumption of flow meter is increased. Long-term operation of flow meter from its built-in battery (without external power supply) will lead to shorter lifetime of the battery.

Table 5 — DFM Marine display information screens

Screen No	Displayed data	Digit capacity	Units	
			Metric System of Measures	US System of Measures
1	"Total Fuel Consumption" Counter	0.00001	m³	gal
		0.01	l	
2	"Total Fuel Consumption" Counter with higher digit capacity	0.000001	m³	gal
		0.001	l	
3	"Engine Operation Time" Counter	0.1	h	h
4	"Engine Operation Time" in "Idle" Mode Counter	0.1	h	h
5	"Engine Operation Time" in "Optimal" Mode Counter	0.1	h	h
6	"Engine Operation Time" in "Overload" Mode Counter	0.1	h	h
7	"Engine Operation Time" in "Tampering" Mode Counter	0.1	h	h
8	"Engine Operation Time" Counter. Clearable	0.1	h	h
9	"Total Fuel Consumption" Counter. Clearable	0.00001	m³	gal
		0.01	l	
10	"Total Fuel Consumption" Counter. Tampering Mode	0.00001	m³	gal
		0.01	l	
11	"Interference Time" Counter	0.1	h	h
12	"Instant Fuel Consumption"	0.00001	m³/h	gal/h
		0.01	l/h	
13*	"Total Differential Fuel Consumption" Counter	0.00001	m³	gal
		0.01	l	
14*	"Instant Differential Fuel Consumption"	0.00001	m³/h	gal/h
		0.01	l/h	
15	"Battery Charge in Percentage of the Maximum"	1	%	%
16	"Temperature in the Measuring Chamber"	1	°C	°F
17	"Firmware Version"	-	X.X	

***** Only for DFM Marine CCAN.

Required system of measurement units can be configured using service software in the corresponding area of **Display Marine FM** (see F.2) or **Desktop** window (see figure 29). After saving profile changes to the Unit, data on the flow meter's display will be displayed in accordance with the specified system.

Screen 1 displays **"Total Fuel Consumption"** Counter value accumulated since DFM Marine release.

Screen 2 displays **"Total Fuel Consumption value with higher digit capacity"** Counter, accumulated since DFM Marine release. Reading accuracy is increased by one decimal.

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

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

Screen 7 displays the Counters readings of **"Engine Operation Time in "Tampering" Mode"** accumulated by DFM Marine as a total time of engine operation when consumption was higher that maximum possible (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 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 Marine's cap when Screen 8 is active.

Screen 9 displays the Counter readings of **"Total Fuel Consumption. Clearable"**, which was accumulated by DFM Marine 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 Marine's cap when Screen 9 is active.

Screen 10 displays the Counter readings of **"Total Fuel Consumption. "Tampering" Mode"** accumulated by DFM Marine 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 11 displays the Counter readings **"Interference Time"** accumulated by DFM Marine 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 12 "Instant Fuel Consumption" displays current value of fuel consumption. It can serve for a visual check of device operability and its correct installation.

Screen 13 displays **"Total Differential Fuel Consumption"** counter value, accumulated in differential mode (see 2.6.8) by DFM Marine installed in fuel supply line (Master Flow meter), while used in pair with DFM Marine installed in fuel reverse line (Slave Flow meter).

Note — When Slave-flow meter is disconnected, Counter increase is paused, and Master-flow meter's display will look like it has switched to "Tampering" mode (see figure 12).

Screen 14 "Instant Differential Fuel Consumption" displays current differential fuel consumption (a difference between fuel consumption in chamber of each flow meter) on display of DFM Marine installed in fuel feed line and operating in pair with DFM Marine installed in fuel reverse line.

Note — If Slave Flow meter is disconnected, current differential fuel consumption will not be displayed. Master Flow meter's display will show screen similar to "Tampering" mode screen (see figure 12).

Screen 15 "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 16 "Temperature in the Measuring Chamber" displays current temperature value in the measuring chamber of the fuel flow meter.

Screen 17 "Firmware Version" displays the firmware version (X.X) installed on the fuel meter.

If necessary, any unused informational screens can be switched off in configuration of **Display Marine FM** (see F.2) using service software. To do that, in **Enabled screens** area uncheck the boxes near the corresponding screens. After saving the profile changes to the Unit, disabled informational screens will not appear on flow meter's display.

1.6.7 DFM Marine protection from tampering and intervention

In order to avoid false readings, meter damage or blocking DFM Marine 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 Marine 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 Marine displays dashes being in "Tampering" Mode (see figure 12).

Figure 12 — 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 Marine 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 Marine 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 Marine displays vertical strokes in "Interference" Mode (see figure 13).

Figure 13 — Display view in "Interference" Mode

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

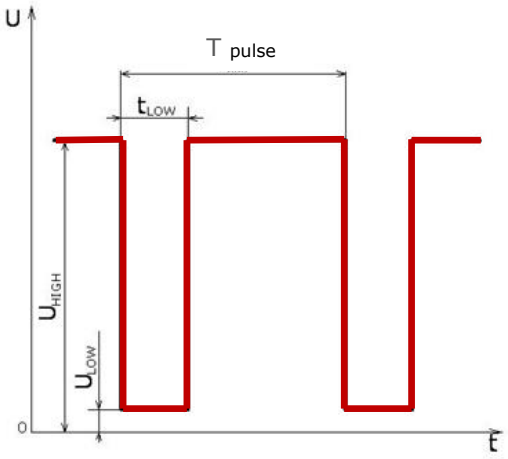
ATTENTION: Data on Events of "Tampering"/ "Interference" during the external power supply of DFM Marine is off is recorded into the internal memory and sent to output interface since the power supply is on.

3) "Stand-alone power supply" Mode for models **DFM Marine CK/CCAN** 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 Marine can help Vehicle owner to reveal unauthorized intervention in fuel line.
Valves, bolts and other elements in Technoton-branded mounting kits for DFM Marine has special holes for sealing.

1.6.8 Pulse output signal specifications

Fuel flow meters with **normalized pulse output** (**DFM Marine CK**) generate certain number $\mathbf{N_{pulse/l}}$ of output pulses for 1 liter of measured fuel flow (see table 6). 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 6).

Figure 14 — Pulse output signal shape of DFM Marine CK models

Table 6 — Parameters of normalized pulse of DFM Marine CK models

Model	T_{pulse}, ms	t_{LOW}, ms	Pulse value, m^3/pulse
DFM Marine 1000CK	from 100 to 5400	if T_{pulse}<1s, then t_{LOW}=0.5·T_{pulse} if T_{pulse} >1s, then t_{LOW}=500 ms	0.000030
DFM Marine 2000CK	from 135 to 6750		0.000075
DFM Marine 4000CK	from 135 to 6750		0.000150

1.6.9 CAN j1939/S6 digital interface specifications and protocols

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

The user configuration of CAN j1939/S6 interface is conducted via K-Line (ISO 14230) interface using Service DFM Marine service software (see 2.6.5).

DFM Marine CCAN 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 D.

DFM Marine CCAN 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...8 pcs. of DFM Marine CCAN flow meters at a time into a single network. For each flow meter a unique network address (SA) from 111 to 118 should be specified (default address 111).

1.7 DFM Marine and tracking devices compatibility

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

Technoton regularly conducts tests for compatibility and joint accuracy of DFM Marine 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 Marine selection

IMPORTANT: Final decision on possibility to use particular model of DFM Marine should be made by installation specialist after inspection of the engine/burner, where flow meter will be installed.

1.8.1 Selection depending on engine power (boiler output capacity)

Table 7 — DFM Marine selection depending on the engine power (boiler output capacity)

Engine power *, kW	Boiler output *, kW	Recommended DFM model
from 600 to 3600	from 3500 to 10 000	**DFM Marine 1000**
from 3600 to 7300	from 10 000 to 20 000	**DFM Marine 2000**
from 7300 to 14 700	from 20 000 to 40 000	**DFM Marine 4000**
* 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

For differential fuel consumption measurement, a pair of DFM Marine CCAN, connected through CAN j1939/S6 interface (see 2.6.8). The first flow meter is installed in feed line, the second flow meter in reverse line. Flow meters are selected depending on the flow range in the relevant fuel line (see table 8).

Table 8 — Selection of DFM Marine depending on fuel flow rate values in feed and reverse lines

Minimum flow rate, m^3/h	Maximum flow rate, m^3/h	Recommended models
0.02	1	**DFM Marine 1000**
0.04	2	**DFM Marine 2000**
0.08	4	**DFM Marine 4000**

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) During the use of differential measurement for monitoring fuel consumption by the engine 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 (deaerator)**.

2 DFM Marine installation

ATTENTION:
1) To ensure proper operation of DFM Marine, 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 Marine from the moment of its purchase.
3) When installing DFM Marine 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 Marine mounting.

2.1 Exterior inspection prior to works start

It is required to conduct DFM Marine 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 Marine, 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 tom ka 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 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 Marine. Injectors maintenance is recommended prior to DFM Marine installation in this case.

3) Check pressure in the fuel line with a pressure gauge. Hydraulic resistance of a selected DFM Marine 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 Marine installation.

2.3 General installation instructions

IMPORTANT:
1) Installation and electrical connection of DFM Marine is strongly recommended at a positive ambient temperature.
2) For proper selection of installation place, carefully read technical documentation for the machinery unit.

The following is needed for DFM Marine mounting:

- hand tools (spanner and socket wrench sets, screwdrivers);
- mounting kit including bolt and flange connectors, O-rings, mounting consumables – appropriate materials are purchased separately for each particular installation case, takin in account type and size of fuel tubes, installation and operation conditions;
- pyrometer or contact thermometer (ordered separately);
- glycerin filled manometer (ordered separately);
- mud filter (purchased separately);
- S6 SK service adapter;
- PC with installed service Software;
- signal cable (see annex I).

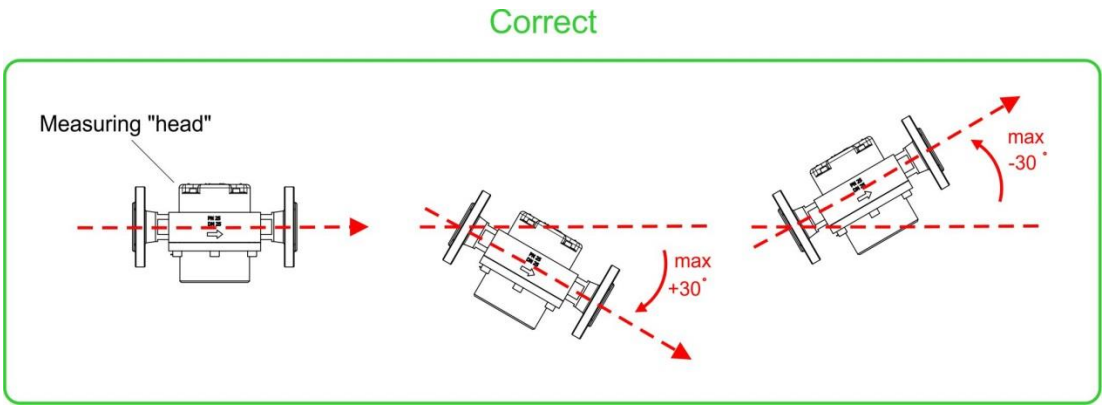
The following rules must be observed when DFM Marine mounting:

1) Fuel flow meter should be installed in an easy accessible place, reachable for data reading from display and technical maintenance of the device.

2) **Before installation, smoothly close shut-off valves and using a manometer make sure that there is no pressure inside the fuel line!**

3) Prepare fuel tubes and flow meter installation place, taking in account its dimensions. Use additional intermediate element for fuel line, if necessary.

4) To ensure declared accuracy of measurement, it is allowed to install fuel flow meter **in "head up"** position only. Flow meter can be slightly **(up to 30 degrees**) inclined up or down from its horizontal axis. **Installation of flow meter heading down is not allowed** (see figure 15).



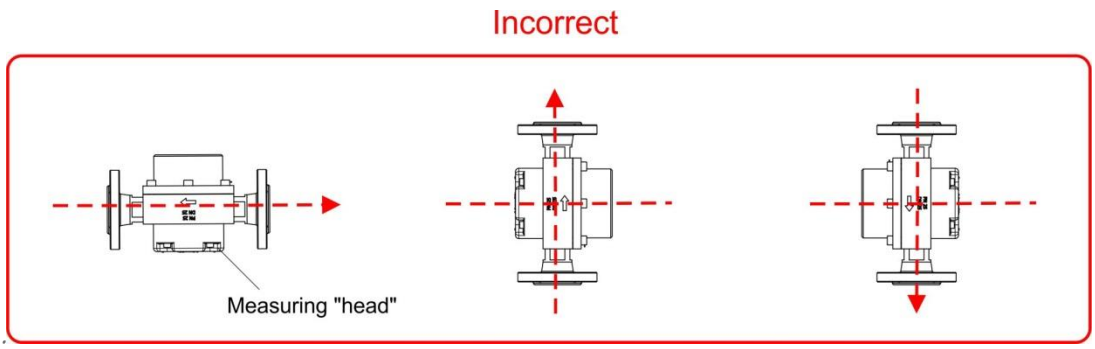


Figure 15 — DFM Marine operating position relatively to horizontal plane

5) To prevent the damaging of DFM Marine measuring chamber, be sure to mount the protecting **mud filter** in the fuel line right before the fuel flow meter. The mud filter should be mounted in the horizontal position, with its cap down (see figure 16).

The width of the filter cells — **no less than 0.6 mm**.

It is forbidden to mount DFM Marine without the mud filter!
If the fuel contains a lot of mud, it is recommended to use the mud filter with magnetic elements (see 8.2).

a) filter with a flange connector

b) filter with a thread connector

c) example of the filter connection to the fuel flow meter

Figure 16 — Mud filter

6) Tightening forces of threaded connections when installing flow meter is:

- for M6 thread – 6 N·m;
- for M8 thread – 16 N·m;
- for M12 thread – 47 N·m.

7) **DFM Marine should be installed in a way, that provides fuel flow inside the fuel line will be in the same direction, as the pointing arrow on the body of DFM Marine.**

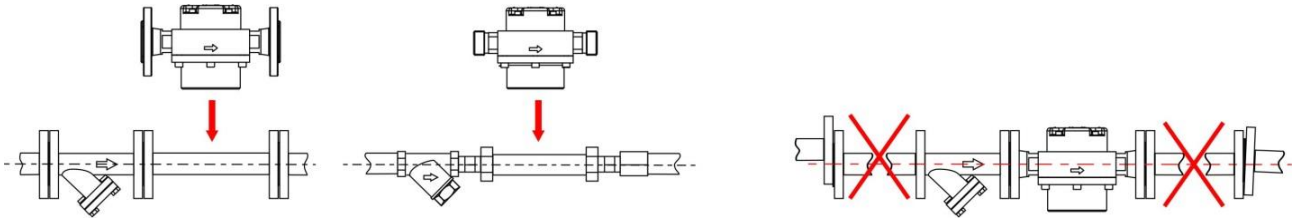
For proper operation of measuring chamber of DFM Marine, it is not obligatory to have straight fuel line sections before and after the flow meter.

When connecting flow meter to the fuel line, make sure that flanges and threads clean of mud and dirt.

Use new tightening materials (washers and gaskets) only!

When installing DFM Marine with a threaded connection, it is recommended to use duralumin **mounting plate** from the delivery set (see annex H). Mounting holes on DFM Marine body are described in annex A.

Flanges and threads should be connected precisely, without excessive effort, also make sure they are not skewed (see figure 17).



a) with flange connection *b) with thread connection* *c) skewed fuel line*

Figure 17 — Flow meter installation in fuel line

8) After DFM Marine installation make sure that fuel system is tight and let air out of it. Measuring chamber of flow meter should always contain fuel without air in it.

9) Maximum allowed pressure drop after the flow meter is **not more than 0.5 bar**. If a pressure drop after the fuel flow meter is more than 0.5 bar, it is recommended to select DFM Marine of bigger size, which has bigger nominal bore (DN).

10) **To avoid water hammers (hydraulic shocks) in fuel line, valves should be opened and closed smoothly.**

ATTENTION:
1) To avoid exceeding upper boundary of operating temperature range of DFM Marine, measuring head of installed flow meter should be isolated from heat sources.
2) If you spot foam or air bubbles in reverse fuel line of the machinery, it is necessary to additionally install **de-aeration system**.

2.4 Example schemes of flow meter installation into fuel line

1) Using shut-off return valve

One of the features of diesel engines is its uneven fuel consumption. Additionally, water hammers (hydraulic shocks) inside fuel line can add extra inaccuracy. To compensate water hammer effects and to avoid back fuel flow through DFM Marine, it is necessary to install **return valve** after the flow meter (see figure 18).

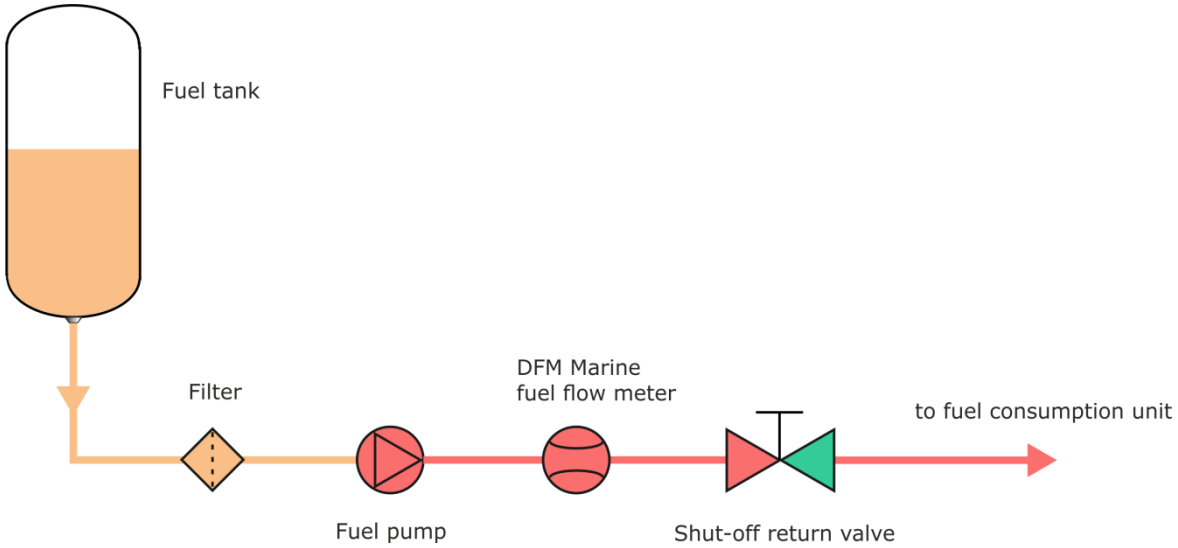


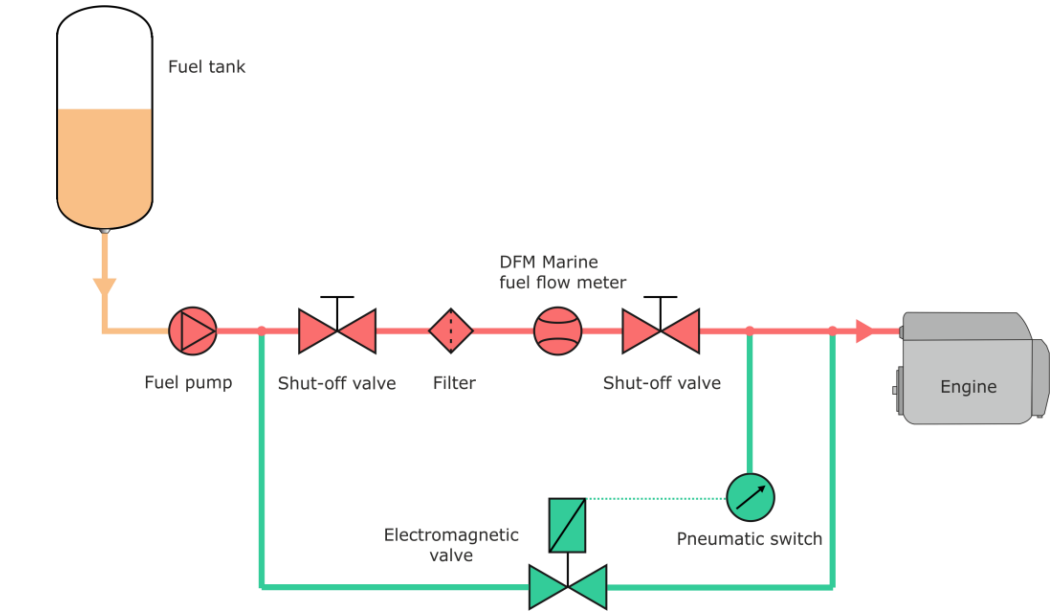
Figure 18 — Using shut-off return valve to increase accuracy and protect DFM Marine against water hammers

2) Additional details for installation on vessels and locomotives

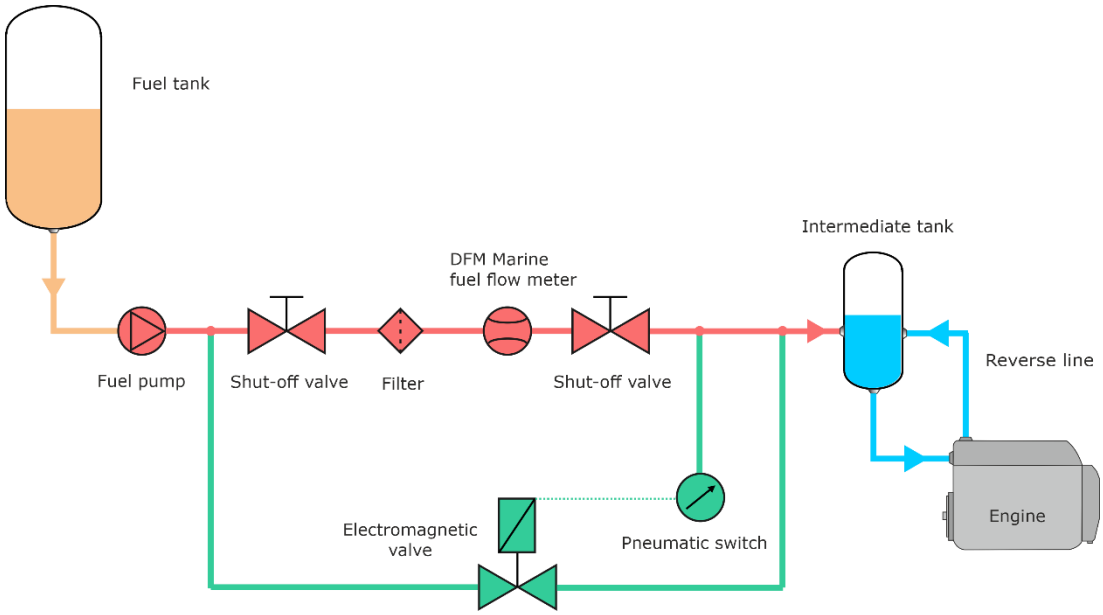
When installing DFM Marine on vessels and locomotives it is very important that fuel feed will be uninterruptable in case of hard clogging of mud filter or during flow meter maintenance. So, **it is necessary to ensure temporary redirection of fuel feed through additional bypass fuel tubes.**

When pressure in fuel line drops below specific value, pneumatic switch cuts off fuel feed though main tube and automatically opens electromagnetic valve on bypass tube. From this point, fuel is supplied through bypass tube in full amount, but without consumption measurement. If you see air bubbles in fuel going through feed and/or reverse line, it is recommended to connect both lines through intermediate fuel tanks to de-aerate the fuel (see figure 19).

If one machinery unit has several engines, you will need to install DFM Marine to fuel feed system of each engine.



a) standard scheme



b) scheme with intermediate tank

Figure 19 — Examples of DFM Marine installations schemes for vessels, using automatic fuel feed redirection through bypass tube

3) Flow meter installation on suction side

DFM Marine installation on suction side of fuel system assumes that fuel flow meter will be installed before fuel pump, where fuel flows due to underpressure created by pump.
To implement scheme of installation on suction side, it might be necessary to modify reverse line of fuel system.

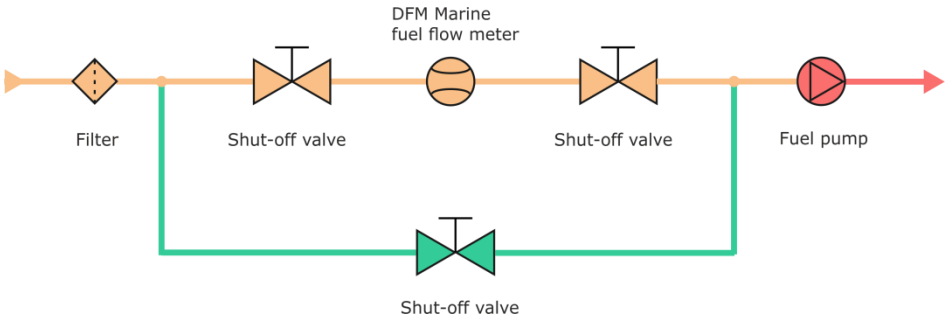


Figure 20 — Example of DFM Marine installation on suction side, using bypass tube

4) Flow meter installation on pressure side

DFM Marine installation on pressure side assumes, that flow meter will be installed in fuel system after the pump, where fuel flows due to pressure created by pump.
To implement scheme of installation on pressure side, it might be necessary to modify reverse line of fuel system.

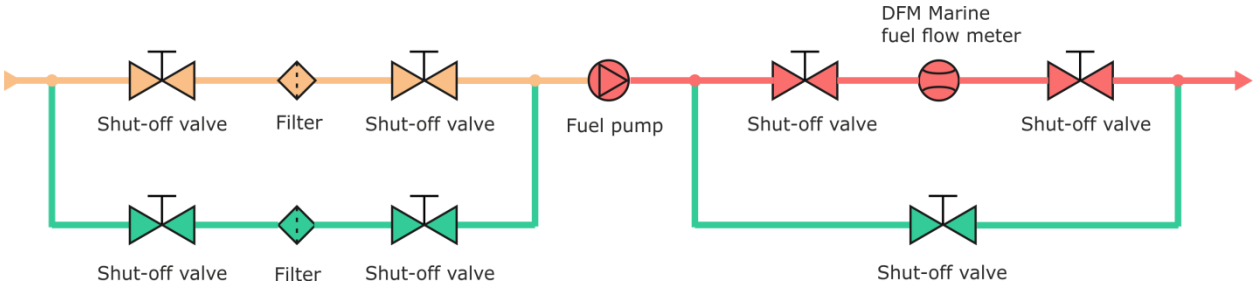


Figure 21 — Example of DFM Marine installation on pressure side, using bypass tube

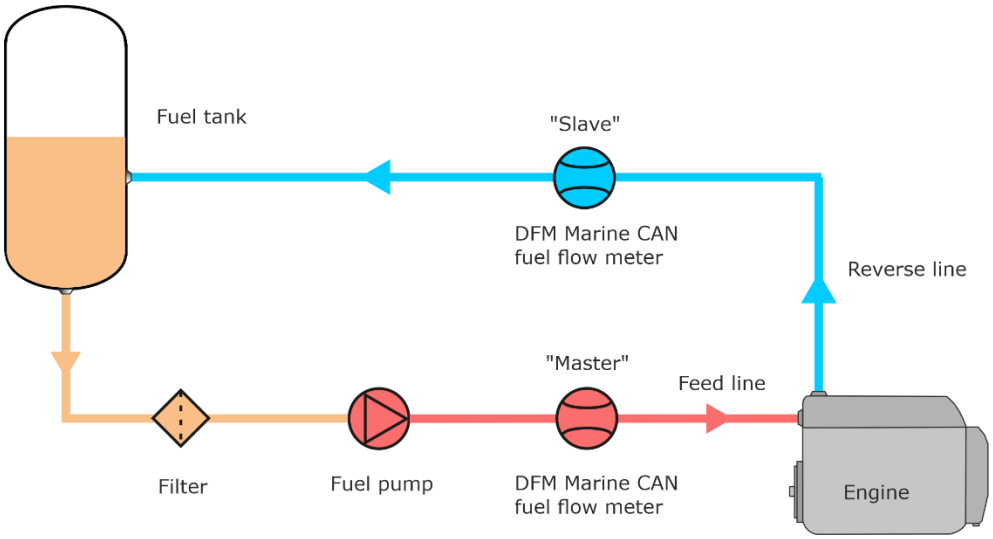
5) DFM Marine installation according to "Differential" and "Summarization" schemes

ATTENTION:
1) To use "Differential" and "Summarization" installation schemes you will need to use a pair of **DFM Marine CAN** flow meters, which are connected with each other using S6 Technology (see 2.6.8).
2) It is allowed to use a pair of flow meters which have different fuel flow rates (e.g. DFM Marine 4000 for feed line and DFM Marine 2000 for reverse line).

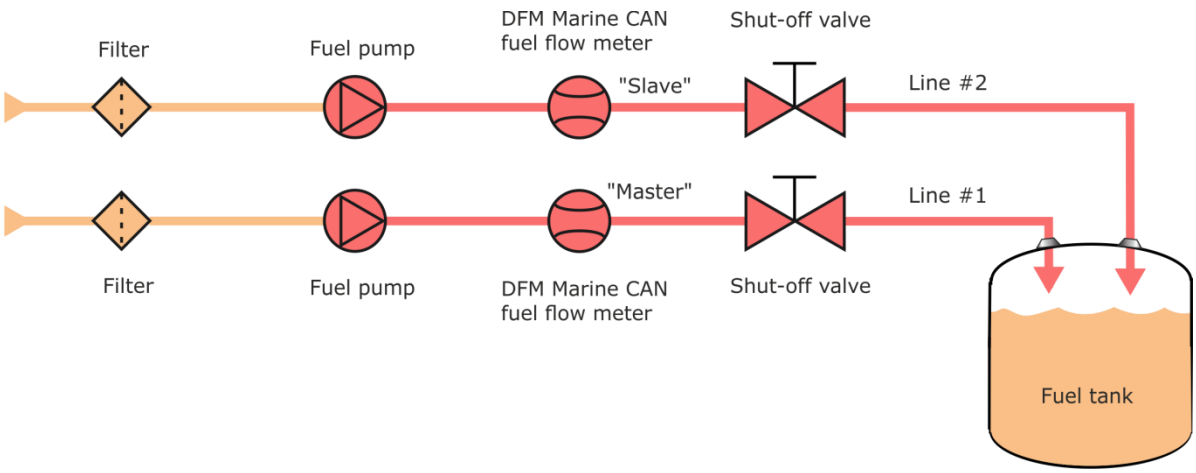
When using "Differential" installation scheme, fuel circulation in fuel system is not changed. The first flow meter (Master) is installed in feed line, the second flow meter (Slave) in reverse line. Differential consumption is defined as difference between measurements of those two DFM Marine CAN flow meters (see figure 22 a).

RECOMMENDATION: Do not use "Differential" scheme if fuel pump capacity is much higher than fuel consumption by engine. In this case the inaccuracy could be higher than acceptable.

DFM Marine CAN fuel flow meters can be also used to summarize consumption of fuel, which goes through two lines (e.g. when stationary tank is refilled). First flow meter (Master) is installed in line #1, second flow meter (Slave) is installed in line #2. Summarized fuel consumption is defined by aggregation of fuel consumption data from both DFM Marine CAN flow meters (see figure 22 b).



a) "Differential" installation scheme



b) "Summarization" installation scheme

Figure 22 — Examples of schemes when a pair of DFM Marine is installed

6) Fuel line ventilation scheme

When cleaning fuel line from mud/dirt with air, it is necessary to ensure that the air will not go through measuring chamber of the flow meter. Before using air, close shut-off valves before and after DFM Marine. After cleaning the tubes, rinse valves with fuel to remove small pieces of dirt.

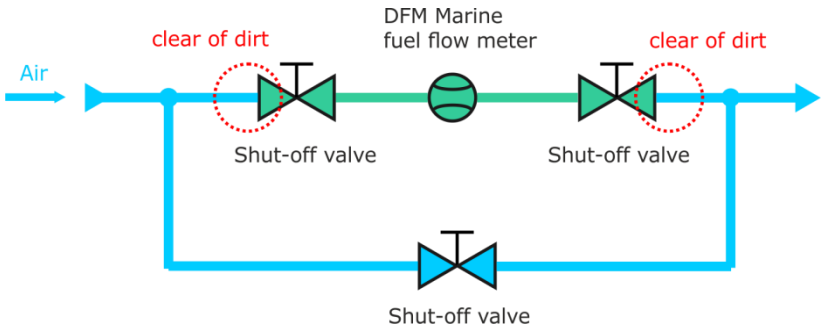


Figure 23 — Scheme of cleaning fuel tubes with air

7) Fuel dispensing scheme

When dispensing fuel, the valve is installed between flow meter and fuel line outlet. Short segment of fuel line between valve and outlet will provide higher accuracy. Taking in account possible water hammers, open and close valves smoothly.

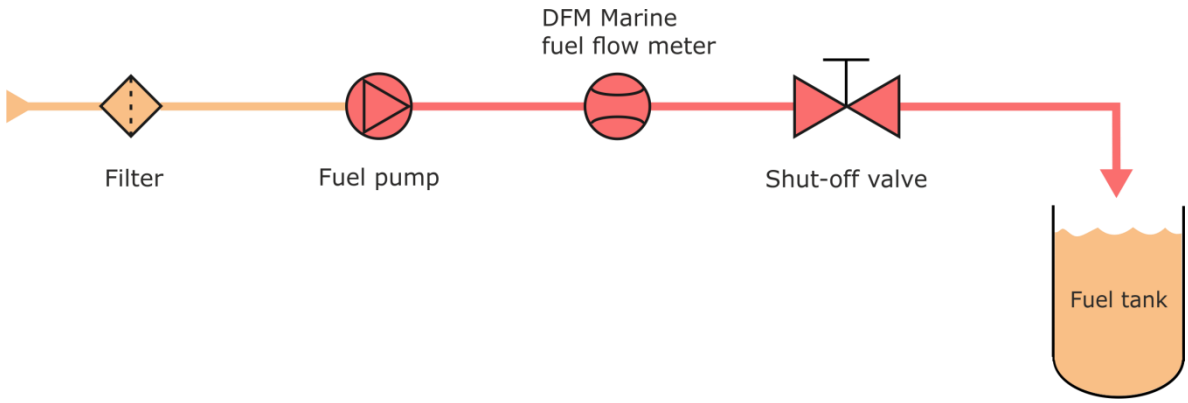


Figure 24 — Fuel dispensing scheme

2.5 Electrical connection

ATTENTION:
1) To ensure proper operation of DFM Marine, it should be electrically connected by specialist, who finished official technical training and was certified for that.
2) When installing DFM Marine 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 Marine CK/CCAN**) are supplied with electrical power from onboard vehicle power source

IMPORTANT:
1) Before mounting and connecting DFM Marine 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 Marine power supply. Nominal fuse current is not more than 2 A.
3) When connecting DFM Marine to onboard power source it is necessary to connect feed "+" and chassis "-" wires to the same sockets where appropriate wires of recording and display devices (trackers) are connected.
4) Before starting electrical connection of the sensor special attention must be paid to the quality of the chassis ground. Resistance between any point of the chassis and the negative clamp of the battery must not exceed 1 Ohm.
5) It is **strongly recommended** to lay DFM Marine connection cable together with standard electrical vehicle wiring with mandatory cable ties fixing of every 50 cm, at a positive ambient temperature (see figure 25).

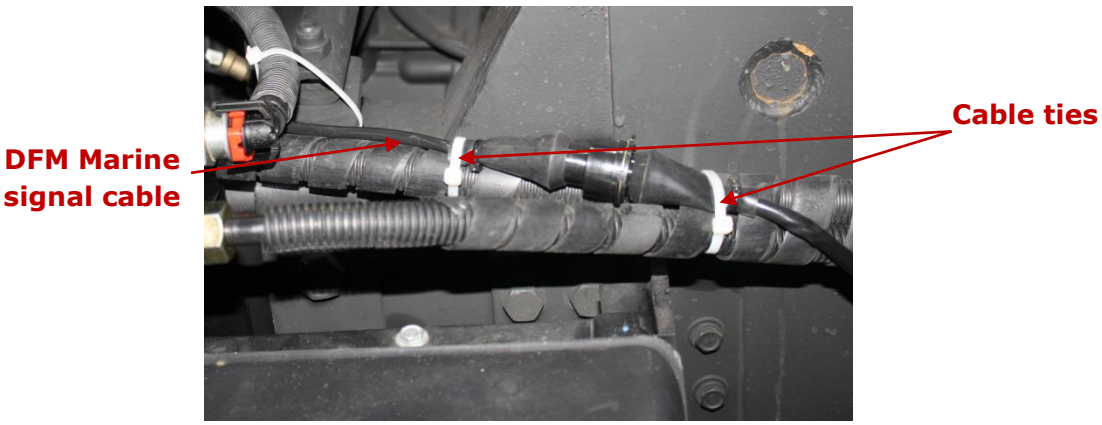


Figure 25 — Laying DFM Marine signal cable

Electrical connection of DFM Marine is carried out by connecting **signal cables** (see table 9) in accordance with pinout and wires designation (see tables 10 and 11).

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

Table 9 — Cables for electrical connection of DFM Marine with interface cable

View	Component name	Description
	S6 SC-CW-700 (signal cable) (see annex I)	Designed to connect DFM Marine CCAN to recording and display devices and to external power supply. 7 meters long. Not included into delivery set. Equipped with 2 terminating resistors (120 Ohm).
	CABLE DFM 98.20.003 (signal cable) (see annex I)	Used for DFM Marine CK 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 Marine CK with pulse output interface.

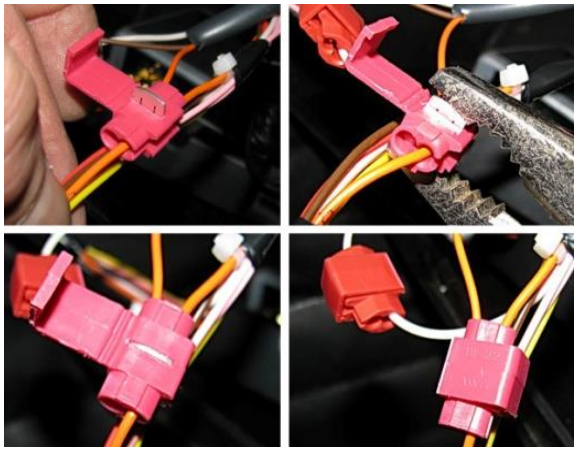


Figure 26 — Wiring connection made with the plastic connectors

Table 10 — Interface cable pinout and wire assignment of DFM Marine CK

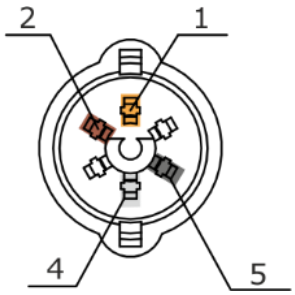
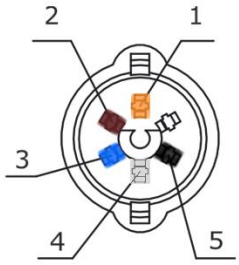
Connector view	Pin number	Wire color		Assignment
	1	Orange		Power supply “+”
	2	Brown		Ground
	4	White		Pulse output (see 1.6.8)
	5	Black		K-Line (ISO 14230)

Table 11 — Interface cable pinout and wire assignment of DFM Marine CCAN

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, which should be ordered for connecting DFM Marine CCAN to registration and display devices, are given in the j1939/S6 Telematics Interface Operation Manual.

2.6 Fuel flow meters configuration

All DFM Marine fuel flow meters are calibrated and verified by the manufacturer with a diesel fuel and supplied ready for use.
When DFM Marine with interface cable (**DFM Marine CK/CCAN**) is connected to external device or it is necessary to adjust DFM Marine 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 Marine 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 Marine to PC via service adapter, please download special software from https://www.jv-technoton.com/ (section Software/Firmware) and install it to your PC:

- USB driver;
- Service DFM Marine.

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

ATTENTION: For work with Service DFM Marine 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 F for DFM Marine CK/CCAN settings, displayed and/or made by service software.

2.6.1 Connecting DFM Marine to PC

ATTENTION: To avoid any service adapter faults in communication between PC and fuel flow meter make sure there are no sources of electromagnetic interference 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 Marine, 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 Marine 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 Marine installed on Vehicle. When configuring flow meters connected by S6 Technology, power supply of onboard network (battery) can be turned on.

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

1) Connect the adapter to DFM Marine.

- 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).

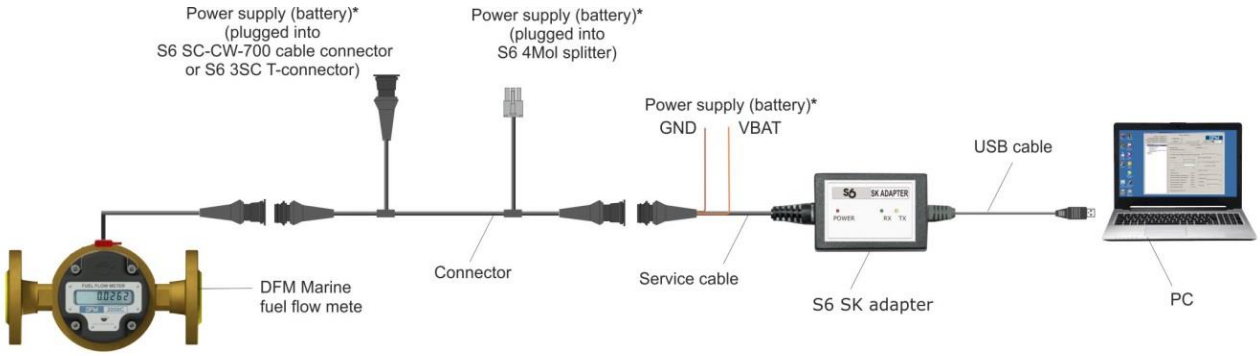
  Note — During the setup you need to provide power supply for the flow meter and adapter either from the accumulator battery, or from the power source. Power supply is provided through any of the free connectors of the connection cord.
- During the setup of DFM Marine connected using S6 Technology the 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.

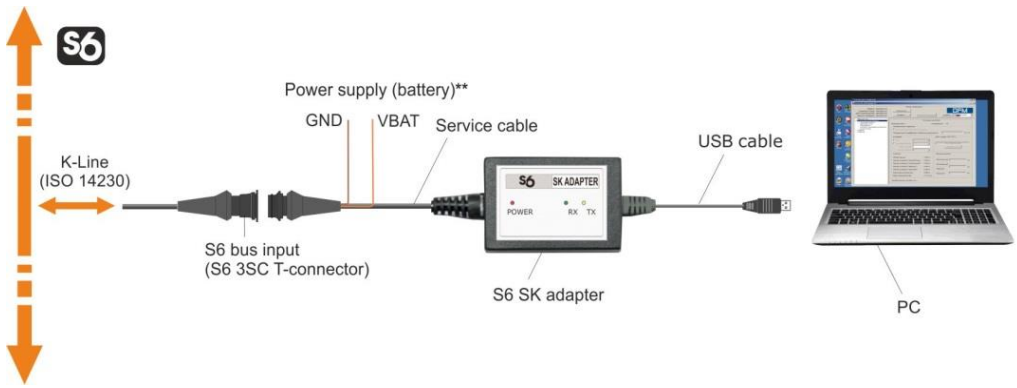
Note – it is allowed to connect adapter to USB-port of your PC after turning on power supply of flow meter and running Service DFM Marine software.

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

4) Power on the vehicle (battery).



a) connecting DFM Marine CK/CCAN using S6 SK



b) connecting DFM Marine CCAN using S6 SK via S6 Technology

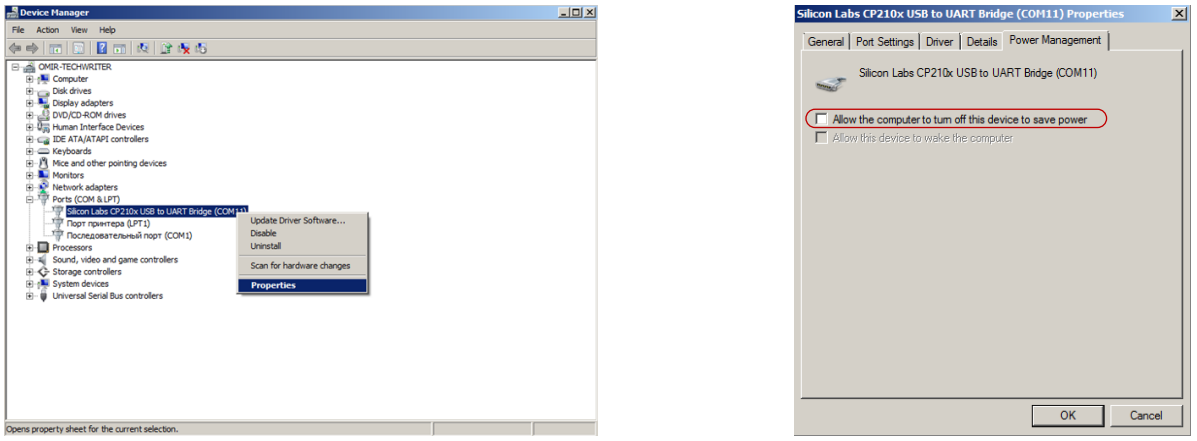
Figure 27 — Schemes of DFM Marine connection to PC

* 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 DFM Marine 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

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 12.

Table 12 – LED signal description

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 Marine data is being received
	No signal		No data from DFM Marine
TX		Yellow	Data is being transmitted to DFM Marine
	No signal		No data to DFM Marine

2.6.2 User interface

Service DFM Marine is launched with a  label which is created during the installation process. Service DFM Marine 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 DFM Marine software (versions up to 2.8) 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.

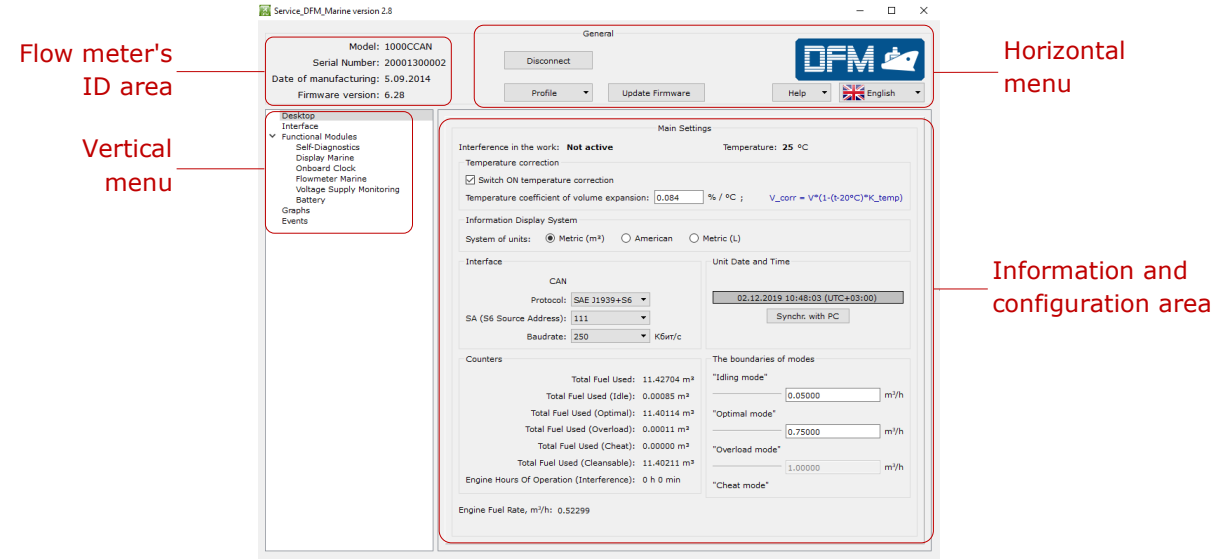


Figure 29 — Service DFM Marine software interface

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 flow meter;
- selection of interface language;
- viewing help file and information about the utility.

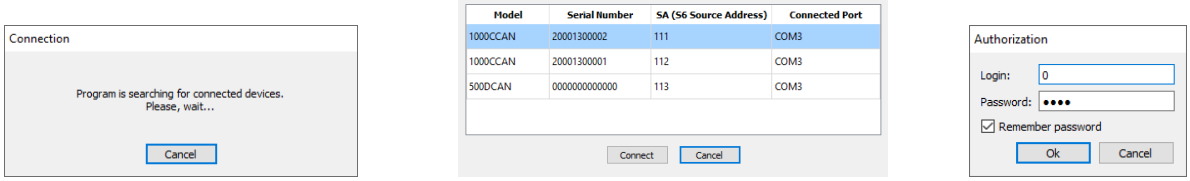
Vertical menu is used for selection of Functional modules (hereinafter FM) of the flow meter. The actual parameters of FM and settings are displayed at **Information and configuration area**.
Connectivity of software with FM is based on PGNs and SPNs (S6 Database) exchange. SPNs of DFM Marine Functional Module which are read and/or edited in **Information and configuration area** are listed in annex F.
Vertical menu also contains entries on real-time diagnostics of measuring chambers and events records.

2.6.3 User authorization

To establish connection with DFM Marine push Connect at **Horizontal menu**. Service DFM Marine 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 Marine

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 DFM Marine 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.

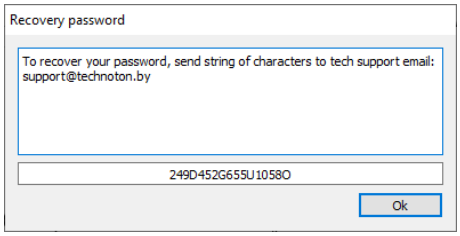
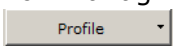


Figure 31 — Generated recovery code window

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 Marine's configurations and parameter values of Functional modules.

2.6.4 Working with DFM Marine profile

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

For managing DFM Marine 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 DFM Marine. 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.

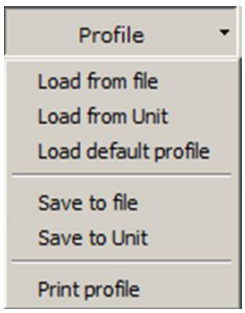
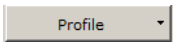


Figure 32 — Profile menu



menu has following entries:

1) Load profile. Service DFM Marine 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 Marine 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).

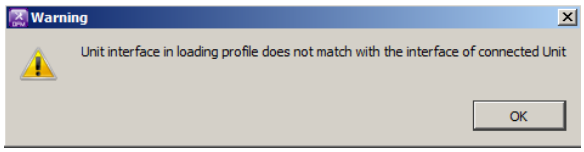


Figure 33 — Warning on interfaces incompatibility of profiles of loaded and connected Unit

- 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 Marine connection. Default profile is stored in **DFM_*_default.prf** file in the folder of Service DFM Marine.

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

***** Maximum flow rate and output signal type of corresponding flow meter model is specified (e.g. **1000CAN** or **2000K** etc.).

2) Saving profile. Service DFM Marine 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 Marine with the corresponding output interface is connected.

- Save to Unit — is used for saving modified settings into profile of the connected DFM Marine. It is available only during the time when there is an active connection between PC and DFM Marine.
  If the modified settings were not saved into Unit and Disconnect button was pressed or Service DFM Marine window is being closed there will appear a notification. Pressing Yes will save all the unsaved parameters and settings into DFM Marine.

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

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

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

2.6.5 Configuration for connection to external terminal unit

Fuel flow meters with pulse output signal (**DFM Marine CK**) does not require any output signal configuration.

Fuel flow meters with CAN j1939/S6 digital interface (**DFM Marine CCAN)** require output signal configuration to be connected to external terminal unit. Go to **Interface** to configure output signal parameters (see figure 34):

1) From the drop-down menu of **Protocol** list choose required data transfer protocol. For DFM Marine CCAN — **SAE 1939+S6** or **NMEA 2000**.

2) For identification of flow meter in a network of several Units connected via S6 Technology, enter unique network address of DFM Marine CCAN from a range 111…118 (by default – 111) to **SA (S6 Sourse Address)** field

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 kb/s (by default— 250 kb/s).

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

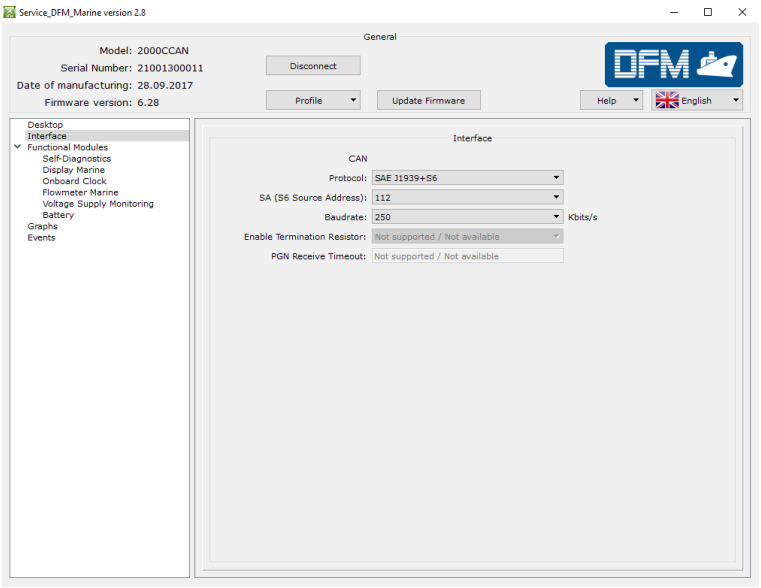


Figure 34 — Flow meter connection parameters settings when using CAN j1939/S6 interface

2.6.6 Operation check

In order to check operation of installed fuel flow meter go to **Graphs** menu of the Software where live data is displayed (see figure 35):

- for one flow meter:

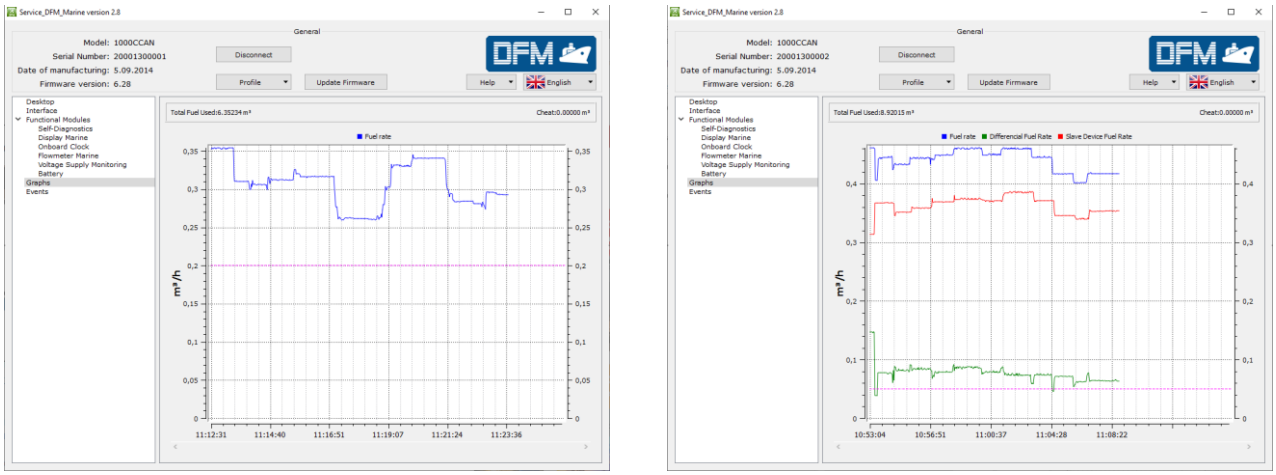
  - graph of hourly (instant) consumption of fuel, which went through the only measuring chamber (blue line) (SPN 521313);
  - current Counters values — total fuel consumption (SPN 521314) and fuel consumption in "Tampering" mode (SPN 521314/9.3).

- for differential measurement:

  - hourly (instant) flow rate graph is displaying fuel flow through measuring chambers of Master flow meter (blue line) and Slave flow meter (red line) (SPN 521313), which are connected to supply and return lines respectively. Additionally, the graph displays differential flow rate (fuel flow through measuring chambers of Master and Slave flow meters) with green line (SPN 521313/2.15) (see 2.6.8).

  - current Counters values — total fuel consumption (SPN 521314/2.15) and fuel consumption in "Tampering" mode (SPN 521314/2.15/9.3) for Master flow meter.

Horizontal pink dotted lines display configured boundaries of operation modes (see 1.6.5). You can change configuration of operation modes boundaries in **Desktop** or **Flowmeter Marine FM** window (see F.4).



a) graph example of one flow meter *b) graph example of differential measurement*

Figure 35 — DFM Marine operation test with Graphs window

2.6.7 Configuration for specific operation conditions

For improving accuracy of flow meter readings under specific conditions of operation, it is possible to adjust the following settings using service Software, **Flowmeter Marine FM** window or **Desktop window** (see F.4 and figures 29, 36-38):

1) Set up boundaries of operation modes of DFM Marine (in **Borders. Fuel Rate** area), which are used to define current workload of Vehicle depending on its hourly consumption rate (PGN 63163):

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

In flow meters a user can adjust only "Idle" (SPN 521317/9.0) and «Optimal» (SPN 521317/9.1) modes. Factory-set configuration for "Overload" mode (SPN 521317/9.2) could not be adjusted.

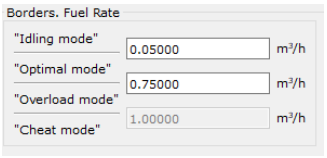


Figure 36 — Example of flow rate boundaries configurations for DFM Marine

2) Turn on temperature correction function, i.e. automatic correction of fuel volume consumption data adjusted to fuel temperature (SPN 521311).
Temperature correction function is used because volume of fuel changes when fuel temperature is going up/down.
After turning on temperature correction function a user can enter temperature correction coefficient of volumetric expansion (coefficient of volumetric expansion of oil products **β** in relation to temperature change by 1 °C) (SPN 521433).
β coefficient value should be chosen from table 13, taking in account density **ρ** of oil product at the temperature of plus 20 °C.

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

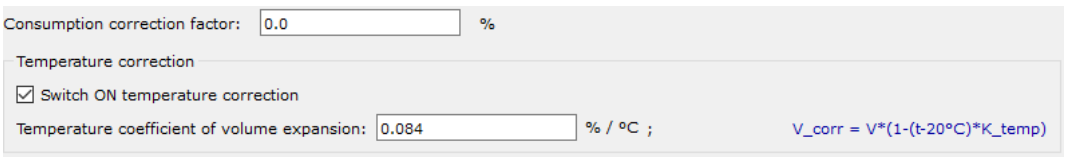


Figure 37 — Example of temperature correction and correction coefficient configuration

4) System of units, i.e. necessary measurement units for displaying measurement results on the display of DFM Marine (SPN 521332):

- metric (m^3);
- metric (l);
- US (gallon).

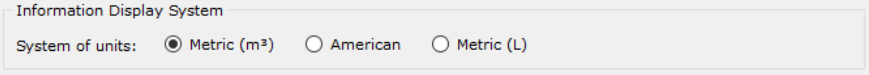


Figure 38 — Example of configuring displayed units of measurement on DFM Marine's display

Note – Measurement units systems can also be adjusted in the corresponding area of **Display Marine FM** (see F.2).

ATTENTION: Keep in mind, that all internal Parameters and Counters of Flowmeter Marine FM always correspond to metric (m^3) system and do not depend on selected measurement units for showing on the display.

Table 13 — 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	—	—

2.6.8 "Differential"/"Summarization" operation mode

ATTENTION: For operation in "Differential"/"Summarization" mode, any pair of DFM Marine CCAN flow meters is connected using S6 Technology.
A network address from 111…118 range should be attached to each flow meter (see 2.6.5).

Flow meter configuration is carried out in **Flowmeter Marine FM** window in the following sequence (see F.4 and figure 39):

1) In **Master Mode** dropdown list enable Master mode for primary flow meter and disable for secondary flow meter (SPN 521268).

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

- **Differential** – fuel consumption is calculated as a difference between fuel consumption measured by flow meter in feed and reverse lines (see 2.4, figure 22 a);
- **Summing** – fuel consumption is calculated as a sum of fuel consumption measured by flow meter in first and second fuel lines (see 2.4, figure 22 b).

ATTENTION: For differential measurement a Master-flow meter is a flow meter, which is installed in fuel feed line, Slave-flow meter is a flow meter installed in reverse fuel line.
In summarization mode, primary and secondary roles of flow meters are assigned arbitrary.

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 **Borders. Differential Fuel Rate** area, define values for differential instant fuel consumption range (PGN 63205) (similar to **Borders. Fuel Rate** configuration, see 2.6.7)

5) If necessary, enter **Differential Fuel Rate Correction Coefficient** (SPN 521271) for Master-flow meter to increase accuracy of measurement (similar to **Consumption correction factor** configuration, see 2.6.7)

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).
This setting is available only for DFM Marine CCAN which have v.6.28 firmware and higher and are configured in Service DFM Marine service software v.2.8 and higher.

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.

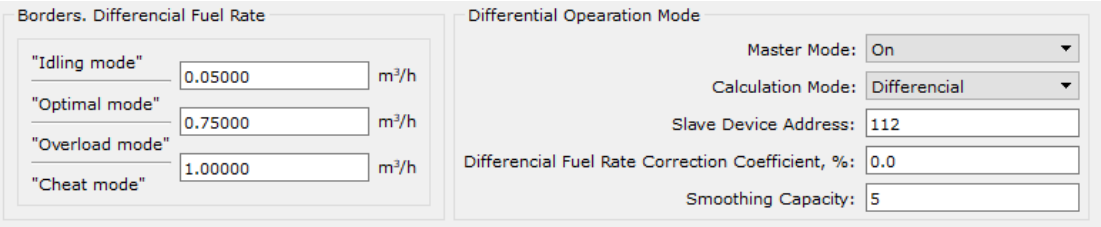


Figure 39 —Example of configuring DFM marine for "Differential"/"Summarization" operation mode

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

3 Measurement accuracy check

ATTENTION: To determine measurements accuracy of DFM Marine 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 Marine and recording devices operational documentation and who have experience with testing equipment are allowed to conduct the tests.

Install the DFM Marine 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

DFM Marine measurement accuracy check sequence:

1) Measure precise volume of fuel, which is contained in fuel tank on the beginning of procedure ($V_{initial}$).

2) Start the engine and set the average speed.

3) Record the time when the test was started.

4) Write down starting value of fuel consumption from DFM Marine screen (V_0).

5) Let engine consume at least 10 % of tank volume, while engine running time should not be less than 1 hour.

6) Stop the engine.

7) Measure volume of fuel remaining in tank (V_{remain}).

8) Write down final value of fuel consumption (V_1) from DFM Marine screen.

9) Calculate **real fuel consumption** ($V_m = V_{initial} - V_{remain}$).

10) By difference of initial (V_0) and final (V_1) DFM Marine readings determine **measured fuel consumption** ($V_{measured}=V_1 - V_0$).

11) 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, m^3;

V_m – actual fuel consumption, m^3.

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

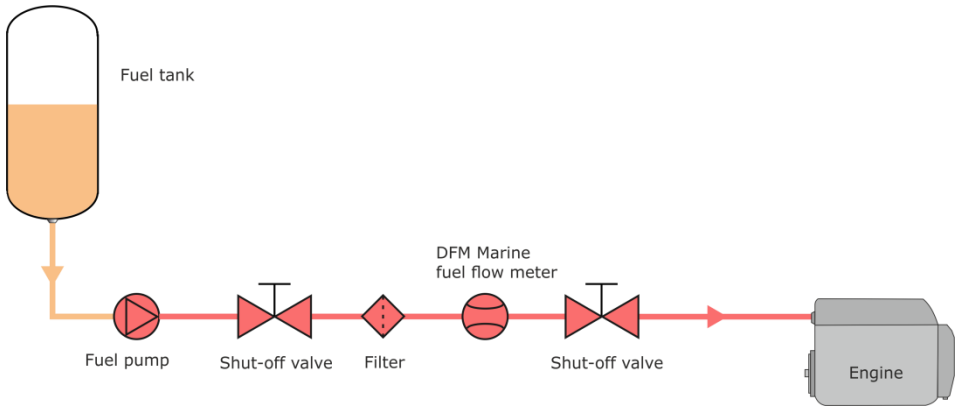


Figure 40 — Example of a fuel system diagram for measurement accuracy check

IMPORTANT: When carrying out accuracy test of DFM Marine flow meter, you can use the values from "Total Fuel Used" Counter (see F.4), at the same time: **keep in mind**, that there is a 12 s time lag in DFM Marine with display between the moment when values appearing on the display of flow meter (see table 5) and sent to output interface of flow meter.

4 Registered Events control

Upper area of **Events** window displays a list of the latest **Important Events** and lower area displays a list of **Information Events** registered by DFM Marine and saved in its internal memory (see figure 41).

1) Important Events:

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

2) Information Events:

- ignition switched ON;
- ignition switched OFF.

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

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

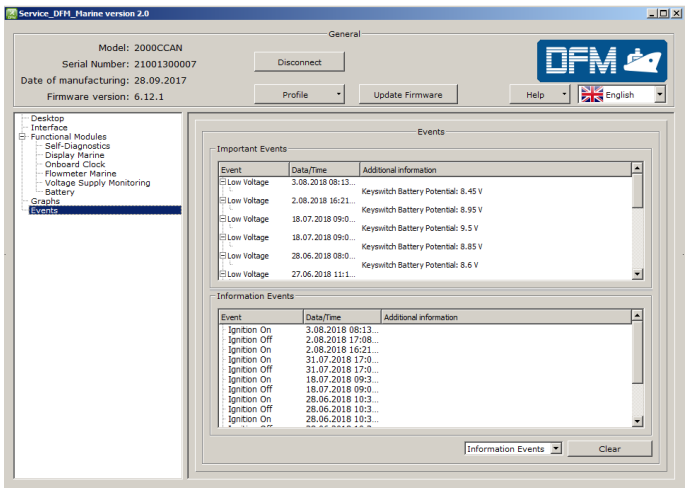


Figure 41 — Browsing through Events registered by DFM Marine

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

5 Diagnostics and troubleshooting

Contact your DFM Marine supplier in case of malfunction.

DFM Marine repair works can be carried out only by certified Regional Service Centers (RSC). Full list of service centers can be found at https://www.jv-technoton.com/.

Limited troubleshooting may be self-conducted (see table 14).

Table 14 — DFM Marine malfunctions, which can be removed without full dismounting of the device

Malfunction	Model	Possible cause	Troubleshooting
No output signal	**DFM Marine CK/CCAN**	Incorrect connection	Check DFM Marine connection to the tracking device/data logger
		Fuel filter clogging	Remove and clean the fuel filter
Fuel does not flow through the meter	**DFM Marine C/CK/CCAN**	Fuel filter clogging	Remove and clean the fuel filter
Fuel consumption readings are higher than real consumption rate		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.

6 Verification

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

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

7 Maintenance

To ensure measurement accuracy it is recommended to re-calibrate DFM Marine. **Re-calibration interval** is defined by increase of "Total Fuel Used" Counter (see F.4, SPN 521314) since previous calibration and equal to:

- for DFM Marine 1000 — 1200 m^3;
- for DFM Marine 2000 — 2800 m^3;
- for DFM Marine 4000 — 5250 m^3.

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

It is recommended to perform visual inspection and DFM Marine operation check at least once a year. In order to provide DFM Marine operability, it is recommended to remove and clean the mud filter from time to time.

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

8 Accessories

Technoton offers to purchase **high quality accessories** for mounting DFM Marine fuel flow meters.

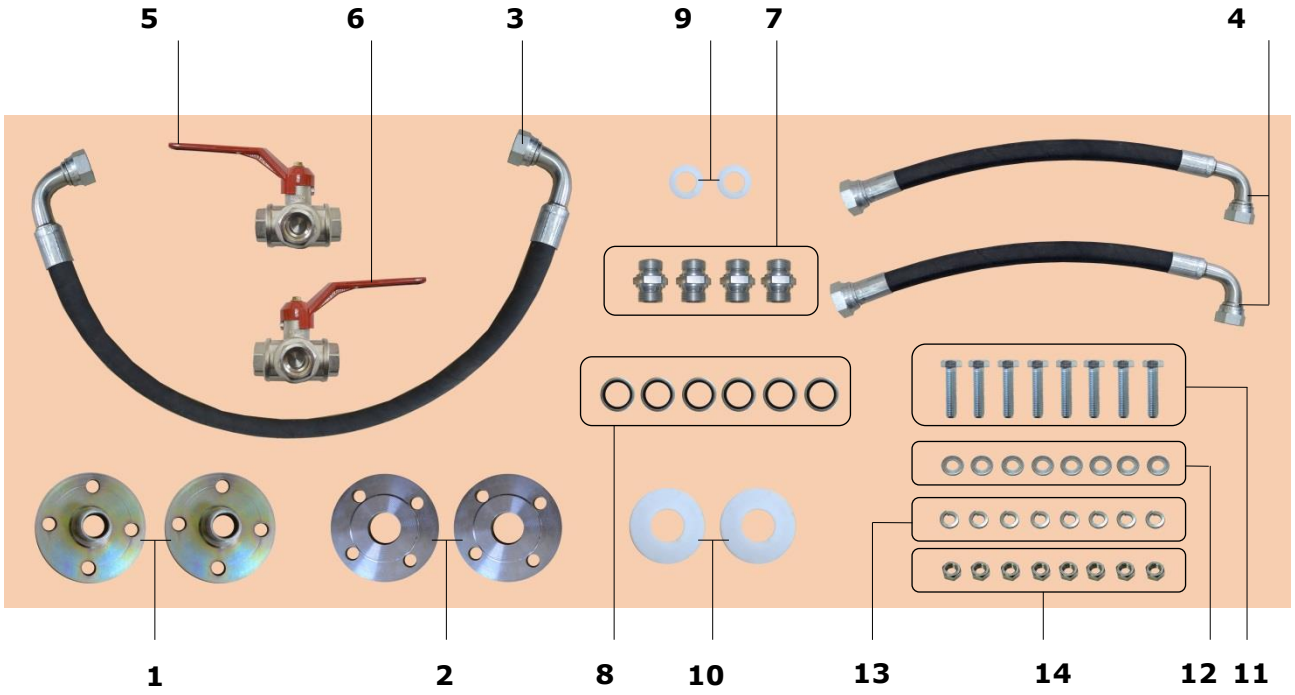
8.1 Mounting kits

MK DFM M1000/M2000/M4000 mounting kits (further on — MK DFM M) are designed for quick and secure mounting of DFM Marine fuel flow meters with thread connection (models **DFM Marine TA/TL**) in the fuel system of the fuel consumer (see figure 42).

Figure 42 — MK DFM M1000 mounting kit assembly with DFM Marine 1000 TA fuel flow meter

Paricularities of MK DFM M

- thoroughly elaborated mounting kit with a minimum of thread connections;
- only high-quality components that can be employed in the fuel system of any fuel consumers, including water and railway transport, are used;
- armored hoses made of oil-and-petrol resistant rubber are hermetic, reliable and have a long period of service life in severe operating conditions;
- thanks to the employment of flexible connections, it is allowed to mount the flow meter without its precise positioning along the fuel line;
- special ball valves provide convenient switching over the fuel feed to bypass without stopping the fuel consumer operation, in case of the fuel flow meter maintenance;
- fittings, thread connections and flanges are manufactured, in compliance with international standards.



1	Threaded flange	– 2 pcs.;
2	Welded flange	– 2 pcs.;
3	Rubber hose 90-90	– 1 pc.;
4	Rubber hose 0-90	– 2 pcs.;
5	"T" ball valve	– 1 pc.;
6	«L» ball valve	– 1 pc.;
7	Adapter	– 4 pcs.;
8	Ring	– 6 pcs.;
9	Fluorine washer	– 2 pcs.;
10	Fluorine washer between the flanges	– 2 pcs.;
11	M12x50 bolt	– 8 pcs.;
12	Washer	– 8 pcs.;
13	Lockwasher	– 8 pcs.;
14	M12 nut	– 8 pcs.

Figure 43 — MK DFM M delivery set

ATTENTION: the Manufacturer reserves the right to modify the MK DFM M contents as well as to replace any components by similar ones, without prior customer notice.

Table 15 —Specifications of MK DFM M

Parameter, measurement units	Value		
	MK DFM M1000	**MK DFM M2000**	**MK DFM M4000**
Applicability for the flow meters mounting	DFM Marine 1000 TA/TL	DFM Marine 2000 TA/TL	DFM Marine 4000 TA/TL
Maximum pressure of working fluid, bar	16		
Working temperature range for the rubber hoses, °C	-10…+100		
Nominal diameter (DN), mm	15	20	25
Male connection thread (BSP) of adapters and threaded flanges, inches	1/2	3/4	1
Female connection thread (BSP) of "T"/ "L" ball valves and coupling nuts of 90-90 hose, inches	1/2	3/4	1
Female connection thread (BSP) of coupling nuts of 90-90 hoses, inches	3/4	1	1 1/4
	1/2	3/4	1
Center-to-center spacing of the flanges holes, mm	65	75	85
Length of hoses 0-90, mm	212	284	358
Length of hose 90-90, mm	584	758	926

MK DFM M should be assembled, in accordance with the diagram shown in figure 44, based on general instructions for DFM Marine flow meters installation (see 2.3).

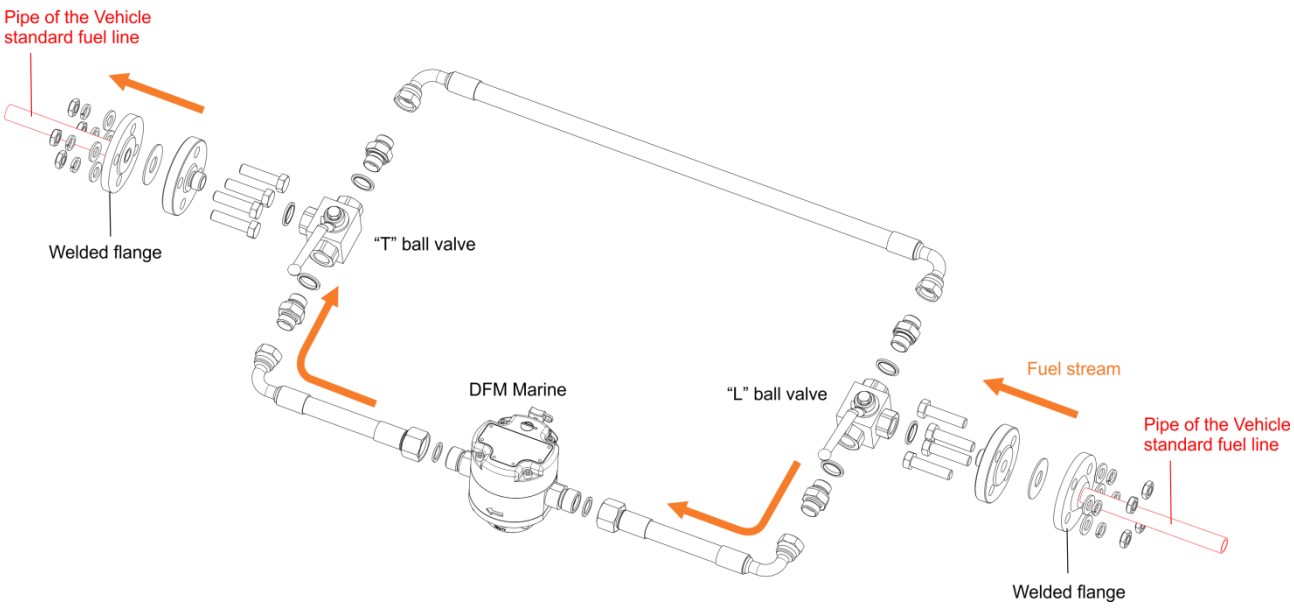
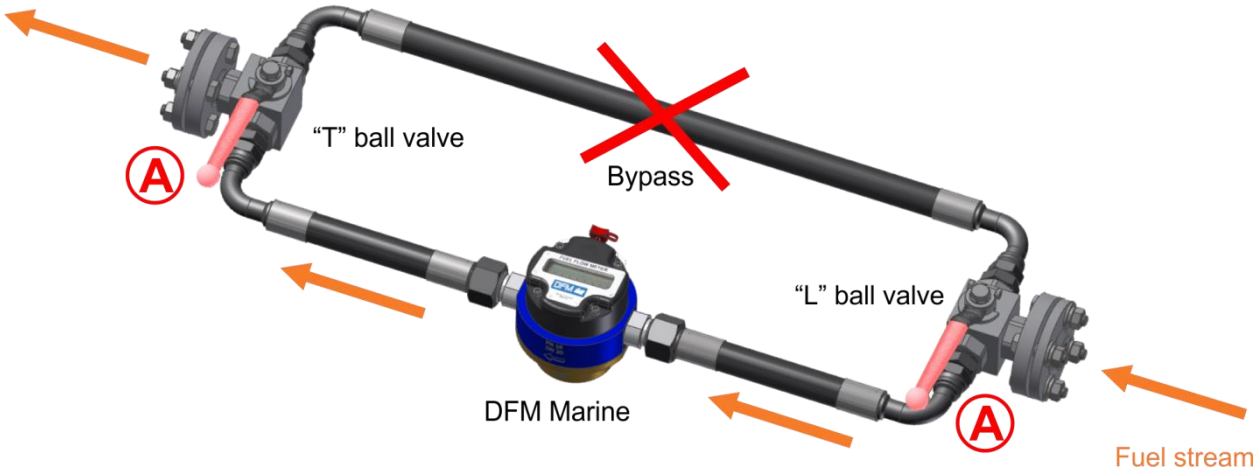
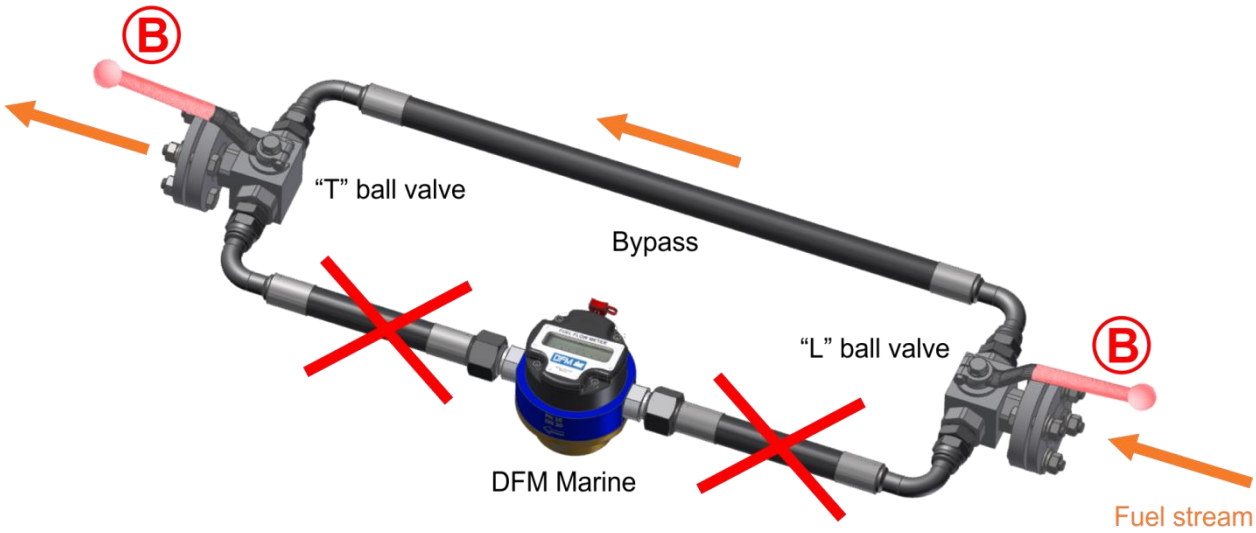


Figure 44 — Diagram of MK DFM M assembly

It is convenient to switch over the fuel stream from the flow meter to the bypass and vice versa by turning "T" and "L" handles of the ball valves.
During the operation of DFM Marine measuring chamber "T" and "L" handles of the ball valves are set in the **A position**. In this case, the bypass is shut and all the fuel flows only through the flow meter measuring chamber (see figure 45 a).
In case maintenance is needed for DFM Marine, "T" and "L" handles of the ball valves are set in the **B position**. In this case, the passage for the fuel stream to the measuring chamber is blocked, and all the fuel flows only through the bypass (see figure 45 b).



a) fuel flows only through the flow meter



b) fuel flows only through the bypass

Figure 45 — Switching over the fuel stream using "T" and "L" ball valves

8.2 Additional accessories

During the installation of DFM Marine fuel flow meter on the Vehicle you may need additional components, depending on the fuel system configuration and the selected scheme of the flow meter installation (see table 16).

Table 16 — Additional accessories for DFM Marine

External view	Name	Model designation	Purpose	Note
	**Mud filter**	Mud filter 1000 F	Filter to protect the measuring chamber of DFM Marine 1000 F from mud	DN=15 mm, P_{max} = 16 bar, cell size of the filtering element – 0.6 mm, with a magnetic element
		Mud filter 2000 F	Filter to protect the measuring chamber of DFM Marine 2000 F from mud	DN=20 mm, P_{max} = 16 bar. Cell size of the filtering element – 0.6 mm, with a magnetic element
		Mud filter 4000 F	Filter to protect the measuring chamber of DFM Marine 4000 F from mud	DN=25 mm, P_{max} = 16 bar. Cell size of the filtering element – 0.6 mm, with a magnetic element
		Mud filter 1000 T	Filter to protect the measuring chamber of DFM Marine 1000 T from mud	DN=20 mm, P_{max} = 16 bar. Cell size of the filtering element – 0.6 mm, with a magnetic element. The delivery set includes the adapter and the sealing ring
		Mud filter 2000 T	Filter to protect the measuring chamber of DFM Marine 2000 T from mud	DN=25 mm, P_{max} = 16 bar. Cell size of the filtering element – 0.6 mm, with a magnetic element. The delivery set includes the adapter and the sealing ring
		Mud filter 4000 T	Filter to protect the measuring chamber of DFM Marine 4000 T from mud	DN=32 mm, P_{max} = 16 bar. Cell size of the filtering element – 0.6 mm, with a magnetic element. The delivery set includes the adapter and the sealing ring

External view	Name	Model designation	Purpose	Note
	**Fitting** Manufactured of (material): **L** – brass; **A** – duraluminum; **S** – steel	G3/4"	Matching counterpart to mount DFM Marine in the fuel line	Male thread BSP G3/4-A, P_{max}=16 bar, In accordance with ISO 228-1
		G1"		Male thread BSP G1-A, P_{max}=16 bar, In accordance with ISO 228-1
		G1 1/4"		Male thread BSP G1 1/4-A, P_{max}=16 bar, In accordance with ISO 228-1
	**Flange** Manufactured of (material): **L** – brass; **A** – duraluminum; **S** – steel	DN 15		DN=15 mm, P_{max}=25 bar, In accordance with EN 1092-1
		DN 20		DN=20 mm, P_{max}=25 bar, In accordance with EN 1092-1
		DN 25		DN=25 mm, P_{max}=25 bar, In accordance with EN 1092-1

9 Packaging

DFM Marine delivery set is placed in a sealed plywood box (see figure 46).

Figure 46 — DFM Marine packaging

Label sticker with information on the product name, serial number, firmware version, manufacture date, weight as well as Quality Control seal and QR code is stuck on two sides of the DFM Marine box (see figure 47).

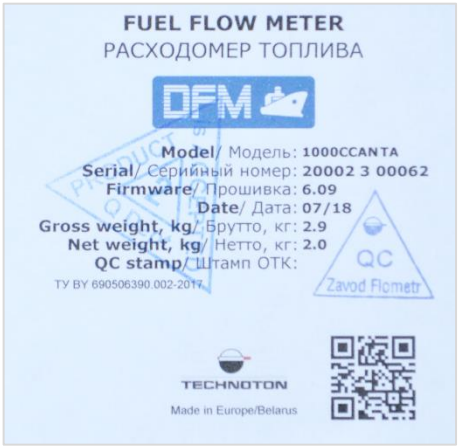


Figure 47 — DFM Marine packaging label

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

10 Storage

DFM Marine is recommended to be stored in dry enclosed areas.

DFM Marine 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 Marine in the same room with substances that cause metal corrosion and/or contain aggressive impurities.

DFM Marine shelf life must not exceed 24 months.

11 Transportation

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

When transporting by air, DFM Marine 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 Marine should be sealed.

12 Utilization/re-cycling

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

The inbuilt lithium-thionyl chloride battery of DFM Marine 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

Distribution, technical support and service

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

marketing@technoton.by

support@technoton.by

Manufacturer

Zavod Flometr

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

office@flowmeter.by

Annex A

Overall dimensions and weight

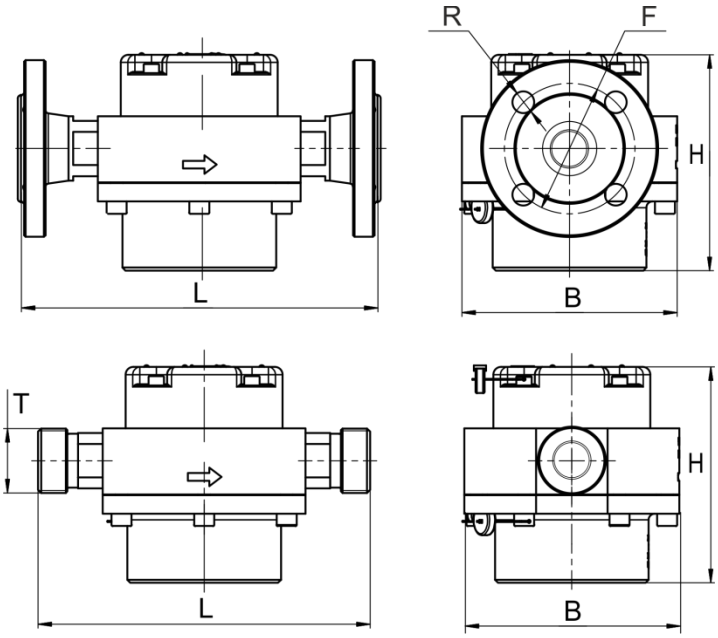
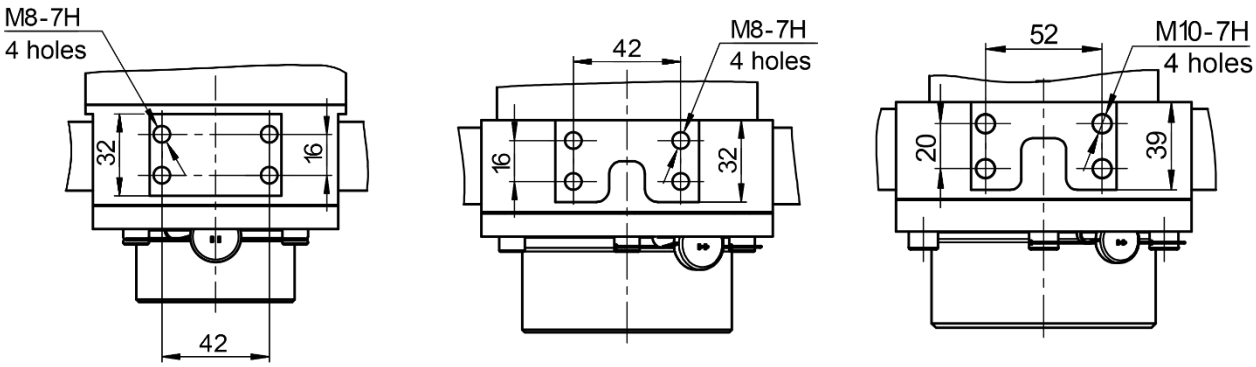


Figure A.1 — DFM Marine overall dimensions

Table A.1— DFM Marine overall dimensions

Model	Type of connection	T, inch	F, mm	R, mm	L, mm	B, mm	H, mm
DFM Marine 1000	thread	BSP G3/4	-	-	172	102	117
	flange	-	Ø65	Ø14 (4 holes)	200		
DFM Marine 2000	thread	BSP G1	-	-	194	120	123
	flange	-	Ø75	Ø14 (4 holes)	214		
DFM Marine 4000	thread	BSP G1 1/4	-	-	216	140	141
	flange	-	Ø85	Ø14 (4 holes)	232		



a) for DFM Marine 1000 *b) for DFM Marine 2000* *c) for DFM Marine 4000*

Figure A.2 — Mounting holes placement scheme

Table A.2— DFM Marine weight

Model	Weight, kg, not more than
DFM Marine 1000C FA	2.4
DFM Marine 1000C TA	1.8
DFM Marine 1000C FL	4.8
DFM Marine 1000C TL	3.2
DFM Marine 1000CK FA	2.5
DFM Marine 1000CK TA	1.9
DFM Marine 1000CK FL	4.9
DFM Marine 1000CK TL	3.3
DFM Marine 1000CCAN FA	2.5
DFM Marine 1000CCAN TA	1.9
DFM Marine 1000CCAN FL	4.9
DFM Marine 1000CCAN TL	3.3
DFM Marine 2000C FA	3.3
DFM Marine 2000C TA	2.7
DFM Marine 2000C FL	6.5
DFM Marine 2000C TL	4.5
DFM Marine 2000CK FA	3.4
DFM Marine 2000CK TA	2.8
DFM Marine 2000CK TL	6.6
DFM Marine 2000CCAN FA	4.5
DFM Marine 2000CCAN TA	3.4
DFM Marine 2000CCAN FL	6.6
DFM Marine 2000CCAN TL	4.5
DFM Marine 4000C FA	5.0
DFM Marine 4000C TA	4.3
DFM Marine 4000C FL	9.5
DFM Marine 4000C TL	7.2
DFM Marine 4000CK FA	5.1
DFM Marine 4000CK TA	4.4
DFM Marine 4000CK FL	9.6
DFM Marine 4000CK TL	7.3
DFM Marine 4000CCAN FA	5.1
DFM Marine 4000CCAN TA	4.4
DFM Marine 4000CCAN FL	9.6
DFM Marine 4000CCAN TL	7.3

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 Marine installation requirements, and have concluded the following:

Requirement	Conforms/ Does not conform	Notes
Leakage resistance of the fuel system		Measurement accuracy and DFM Marine 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 Marine performance is not guaranteed in case of an insufficient pressure in the fuel system. Maintenance of the fuel pump is recommended
Injectors return flow rate		Injectors return flow being higher than normal can significantly affect measurement accuracy. Injectors maintenance or replacement is recommended
Onboard voltage		DFM Marine 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 Marine performance is not guaranteed in case of significant resistance/oxidation of 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 Marine model, serial number	

Fuel consumption	Actual fuel consumption. according to calibrated container V_m, m^3	
	Fuel consumption measured According to DFM Marine reading $V_{measured}$, m^3	
Relative error of fuel consumption measurement	$\delta = \frac{V_{measured} - V_m}{V_m} \cdot 100\%$	

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
Data composition in the flow meters output messages that are transmitted via CAN j1939/S6 interface

Table D.1 — Data composition in DFM Marine CCAN outgoing messages, that are transmitted via SAE J1939 protocol

Field number	Length	Parameter	Description	Rules of output
Flowmeter. Engine total hours of operation PGN 63157 (0xF6B5)				1000 ms
1	4 bytes	SPN 521314	Total Fuel Used	
5	4 bytes	SPN 521171	Flowmeter Hours Of Operation	
Flowmeter. Parameters PGN 63159 (0xF6B7)				1000 ms
1	4 bytes	SPN 521313	Engine Fuel Rate	
5.1	4 bits	SPN 521181	Engine Mode by Fuel Rate	
Flowmeter. Counters PGN 63160 (0xF6B8)				On request
1	4 bytes	SPN 521314	Total Fuel Used	
5	4 bytes	SPN 521314/9.0	Total Fuel Used. Idle	
9	4 bytes	SPN 521314/9.1	Total Fuel Used. Optimal	
13	4 bytes	SPN 521314/9.2	Total Fuel Used. Overload	
17	4 bytes	SPN 521314/9.3	Total Fuel Used. Cheating	
21	4 bytes	SPN 521314/28.0	Total Fuel Used. Clearable	
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 521171/28.0	Flowmeter Hours Of Operation. Clearable	
49	4 bytes	SPN 521171/9.5	Flowmeter Hours Of Operation. Interference	
High resolution fuel consumption (liquid) PGN 63161 (0xF6B9)				1000 ms
1	4 bytes	SPN 521316	High Resolution Engine Trip Fue	
5	4 bytes	SPN 521331	Total Engine Fuel. High Resolution	
Average fuel rate PGN 63162 (0xF6BA)				1000 ms
1	4 bytes	SPN 521313/2.1	Engine Fuel Rate. Mean	
Flowmeter. Engine total hours of operation (clearable) PGN 63167 (0xF6BF)				1000 ms
1	4 bytes	SPN 521314/28.0	Total Fuel Used. Clearable	
5	4 bytes	SPN 521171/28.0	Flowmeter Hours Of Operation. Clearable	
Flowmeter. Engine total hours of operation in Idle PGN 63170 (0xF6C2)				1000 ms
1	4 bytes	SPN 521314/9.0	Total Fuel Used. Idle	
5	4 bytes	SPN 521171/9.0	Flowmeter Hours Of Operation. Idle	
Flowmeter. Engine total hours of operation in Optimal mode PGN 63171 (0xF6C3)				1000 ms
1	4 bytes	SPN 521314/9.1	Total Fuel Used. Optimal	
5	4 bytes	SPN 521171/9.1	Flowmeter Hours Of Operation. Optimal	

Field number	Length	Parameter	Description	Rules of output
Flowmeter. Engine total hours of operation in Overload mode PGN 63172 (0xF6C4)				1000 ms
1	4 bytes	SPN 521314/9.2	Total Fuel Used. Overload	
5	4 bytes	SPN 521171/9.2	Flowmeter Hours Of Operation. Overload	
Flowmeter. Engine total hours of operation in Cheating mode PGN 63173 (0xF6C5)				1000 ms
1	4 bytes	SPN 521314/9.3	Total Fuel Used. Cheating	
5	4 bytes	SPN 521171/9.3	Flowmeter Hours Of Operation. Cheating	
Flowmeter. Total hours of operation in Interference mode PGN 63174 (0xF6C6)				1000 ms
1	4 bytes	SPN 521171/9.5	Flowmeter Hours Of Operation. Interference	
5	4 bytes	SPN 521267	Interference sensor occurrence count	
Differencial fuel rate. Params PGN 63196 (0xF6DC)				1000 ms
1	4 bytes	SPN 521313/2.15	Engine Fuel Rate. Differencial	
5.1	4 bytes	SPN 521181/2.15	Engine Mode by Fuel Rate. Differencial	
Differencial fuel rate. Counters PGN 63197 (0xF6DD)				On request
1	4 bytes	SPN 521314/2.15	Total Fuel Used. Differencial	
5	4 bytes	SPN 521314/9.0/2.15	Total Fuel Used. Idle. Differencial	
9	4 bytes	SPN 521314/9.1/2.15	Total Fuel Used. Optimal. Differencial	
13	4 bytes	SPN 521314/9.2/2.15	Total Fuel Used. Overload. Differencial	
17	4 bytes	SPN 5213149.3/2.15	Total Fuel Used. Cheating. Differencial	
21	4 bytes	SPN 521314/28.0/2.15	Total Fuel Used. Clearable. Differencial	
25	4 bytes	SPN 521314/9.4/2.15	Total Fuel Used. Negative. Differencial	
29	4 bytes	SPN 521171/2.15	Flowmeter Hours Of Operation. Differencial	
33	4 bytes	SPN 521171/9.0/2.15	Flowmeter Hours Of Operation. Idle. Differencial	
37	4 bytes	SPN 521171/9.1/2.15	Flowmeter Hours Of Operation. Optimal. Differencial	
41	4 bytes	SPN 521171/9.2/2.15	Flowmeter Hours Of Operation. Overload. Differencial	
45	4 bytes	SPN 521171/9.3/2.15	Flowmeter Hours Of Operation. Cheating. Differencial	
49	4 bytes	SPN 521171/28.0/2.15	Flowmeter Hours Of Operation. Clearable. Differencial	
53	4 bytes	SPN 521171/9.4/2.15	Flowmeter Hours Of Operation. Negative. Differencial	
Flowmeter. Global Counters PGN 63506 (0xF812)				1000 ms
1	4 bytes	SPN 521313	Engine Fuel Rate	
5	4 bytes	SPN 521674	Global Fuel Used	
Flowmeter. Global Counters. Slave PGN 63507 (0xF813)				1000 ms
1	4 bytes	SPN 521313	Engine Fuel Rate	
5	4 bytes	SPN 521674	Global Fuel Used	
Differencial fuel rate. Engine total hours of operation PGN 63198 (0xF6DE)				1000 ms
1	4 bytes	SPN 521314/2.15	Total Fuel Used. Differencial	
5	4 bytes	SPN 521171/2.15	Flowmeter Hours Of Operation. Differencial	
Differencial fuel rate. Engine total hours of operation (clearable) PGN 63199 (0xF6DF)				1000 ms
1	4 bytes	SPN 521314/28.0/2.15	Total Fuel Used. Clearable. Differencial	
5	4 bytes	SPN 521171/28.0/2.15	Flowmeter Hours Of Operation. Clearable. Differencial	

Field number	Length	Parameter	Description	Rules of output
Differential fuel rate. Engine total hours of operation in Idle PGN 63200 (0xF6E0)				1000 ms
1	4 bytes	SPN 521314/9.0/2.15	Total Fuel Used. Idle. Differencial	
5	4 bytes	SPN 521171/9.0/2.15	Flowmeter Hours Of Operation. Idle. Differencial	
Differential fuel rate. Engine total hours of operation in Optimal mode PGN 63201 (0xF6E1)				1000 ms
1	4 bytes	SPN 521314/9.1/2.15	Total Fuel Used. Optimal. Differencial	
5	4 bytes	SPN 521171/9.1/2.15	Flowmeter Hours Of Operation. Optimal. Differencial	
Differencial fuel rate. Engine total hours of operation in Overload mode PGN 63202 (0xF6E2)				1000 ms
1	4 bytes	SPN 521314/9.2/2.15	Total Fuel Used. Overload. Differencial	
5	4 bytes	SPN 521171/9.2/2.15	Flowmeter Hours Of Operation. Overload. Differencial	
Differencial fuel rate. Engine total hours of operation in Cheating mode PGN 63203 (0xF6E3)				1000 ms
1	4 bytes	SPN 521314/9.3/2.15	Total Fuel Used. Cheating. Differencial	
5	4 bytes	SPN 521171/9.3/2.15	Flowmeter Hours Of Operation. Cheating. Differencial	
Differential opearation mode PGN 63204 (0xF6E4)				On request
1.1	2 bits	SPN 521268	Master Mode	
1.3	2 bits	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	
Borders. Differencial fuel rate PGN 63205 (0xF6E5)				On request
1	4 bytes	SPN 521317/9.0/2.15	Fuel Rate Mode Border. Idle. Differencial	
5	4 bytes	SPN 521317/9.1/2.15	Fuel Rate Mode Border. Optimal. Differencial	
9	4 bytes	SPN 521317/9.2/2.15	Fuel Rate Mode Border. Overload. Differencial	
Differencial fuel rate. Engine total hours of operation in negative mode PGN 63207 (0xF6E7)				1000 ms
1	4 bytes	SPN 521314/9.4	Total Fuel Used. Negative	
5	4 bytes	SPN 521171/9.4	Flowmeter Hours Of Operation. Negative	
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 bits	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	
Request PGN 59904 (0xEA00)				1000 ms
1	3 bytes	SPN 2540	Parameter Group Number (RQST)	
Borders. Fuel rate PGN 63163 (0xF6BB)				On request
1	4 bytes	SPN 521317/9.0	Fuel Rate Mode Border. Idle	
5	4 bytes	SPN 521317/9.1	Fuel Rate Mode Border. Optimal	
9	4 bytes	SPN 521317/9.2	Fuel Rate Mode Border. Overload	

Field number	Length	Parameter	Description	Rules of output
Flowmeter characteristics PGN 63165 (0xF6BD)				On request
1.1	2 bits	SPN 521333	Flowmeter Type	
1.3	4 bits	SPN 521230	Nominal Chamber Volume	
Information display system PGN 63166 (0xF6BE)				On request
1.1	2 bits	SPN 521332	System Of Units	
Vehicle voltage PGN 62987 (0xF60B)				1000 ms
1	3 bytes	SPN 158	Keyswitch Battery Potential	
3.1	2 bits	SPN 521049	Ignition Key State	
4	4 bytes	SPN 521053	Ignition ON Time	
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	
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	
77	1 byte	SPN 521188	Address at S6 (SA) bus	
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	
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	
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)	

Field number	Length	Parameter	Description	Rules of output
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	
Time origin settings PGN 63011 (0xF623)				On request
1.1	2 bytes	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	
CAN Settings PGN 63054 (0xF64E)				On request
1.1	4 bytes	SPN 521530	CAN Protocol Type	
2.1	3 bytes	SPN 521531	CAN Baudrate	
2.4	2 bits	SPN 521533	Enable Termination Resistor	
Engine temperature 1 PGN 65262 (0xFEEE)				1000 ms
2	1 byte	SPN 174	Engine Fuel Temperature 1	

Table D.2 — Messages of DFM Marine CCAN, that are transmitted via NMEA 2000 protocol

Message format*	Brief message transcript
PGN 127489	Engine Parameters, Dynamic
PGN 127497	Trip Fuel Consumption, Engine
PGN 130316	Temperature, Extended Range
PGN 123159	Flowmeter. Parameters
PGN 123160	Flowmeter. Counters
* Information on structure and parameters of messages of DFM Marine CCAN sending data using NMEA 2000 protocol can be obtained from Technoton's technical support: support@technoton.by.	

Annex E

Electromagnetic compatibility specifications

Table E.1 — Protection of power circuits of DFM Marine 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 E.2 — Protection of signal circuits of DFM Marine 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 E.3— DFM Marine 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 F

SPN of DFM Marine Functional modules

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

SPN format of DFM Marine FM is in accordance with Data base S6 (DB).

F.1 Self-diagnostics FM

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

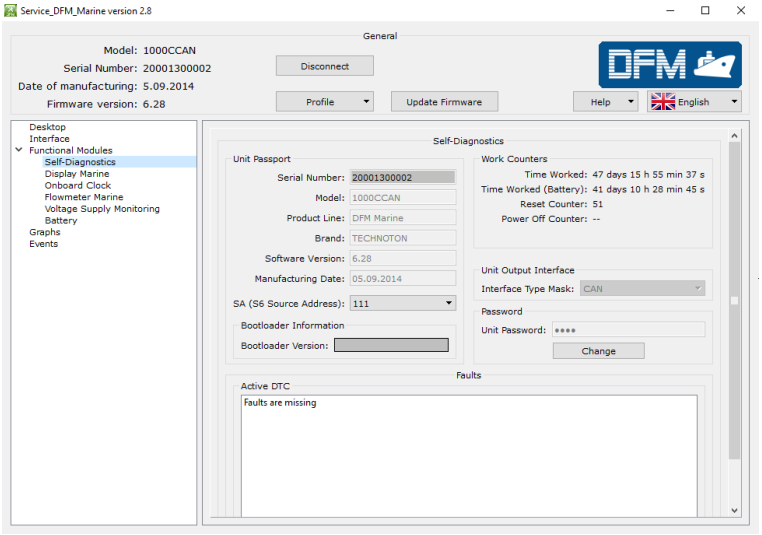


Figure F.1 — Window of settings of Self-diagnostics FM in Service DFM Marine software

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

SPN	Name	Factory value	Unit of measure	Clarification
Unit passport PGN 62995				
521120	Serial number	On the fact	No	Serial number is a set of numbers that is used for identification of specific DFM Marine. Serial number DFM Marine has the following format: AABBB C DDDDD, where: AA – code of DFM Marine model; BBB – digits that reflect changes product changes; C – Manufacturer code; DDDDD – sequential number. Setting is not available for editing.
521345	Model	On the fact	No	Model – this is version of the sensor inside of DFM Marine product line. Each model has its own functional and constructive features. Setting is not available for editing.
521123	Line	DFM Marine	No	Name of the product line. The line represents a group of similar products – fuel flow meters produced under general trademark DFM Marine. Setting is not available for editing.

SPN	Name	Factory value	Unit of measure	Clarification
521344	Brand	TECHNOTON	No	Name of DFM Marine Manufacturer. Setting is not available for editing.
521121	Firmware version	On the fact	No	Version of built in Software DFM Marine. Setting is not available for editing.
521125	Manufacturing date	On the fact	No	Date (day, month, year) of DFM Marine production. Setting is not available for editing.
521188	S6 address (SA)	111	No	Network DFM Marine address at Telematics interface CAN j1939/S6. Network address value can be selected by user in range: 111…118.
Unit work counters PGN 62994				
521116	Unit hours of operation	On the fact	s	Counter of summarized working time of the DFM Marine since its production moment. The user cannot 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 Marine 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 Marine. The user cannot 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 Marine. Password is a specific combination of four digits. By default, used: Login – 0, password – 1111. User can change password of the DFM Marine. After entering and confirming the new password is recorded into internal memory of the DFM Marine.
Active diagnostic trouble codes PGN 65226				
521044	Fault identifier (SID)	On the fact	No	List of current DFM Marine 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 Marine working performance. In case of lack of active malfunctions, the following message is displayed "No malfunctions".
Previously active diagnostic trouble codes PGN 65227				
521044	Fault identifier (SID)	On the fact	No	List of saved DFM Marine malfunctions are displayed at the settings field (in case of its presence — up to 20). For each saved malfunction is indicated following: - faulty nod; - malfunction name; - malfunction counter. This setting allows to monitor DFM Marine working performance. In case of lack of saved malfunctions, the following message is displayed "No malfunctions".
Unit output interface PGN 63168				
521438	Interface Type Mask	On the fact	No	Shows type of connected unit's interface (CAN//pulse). Depending on interface type, service software loads Unit's Functional Modules configurations. Setting is not available for editing.

F.2 Display Marine FM

Display Marine FM — designed for selecting measurement unit system of data on DFM Marine's display, switching ON/OFF Sleep Mode and informational screens.

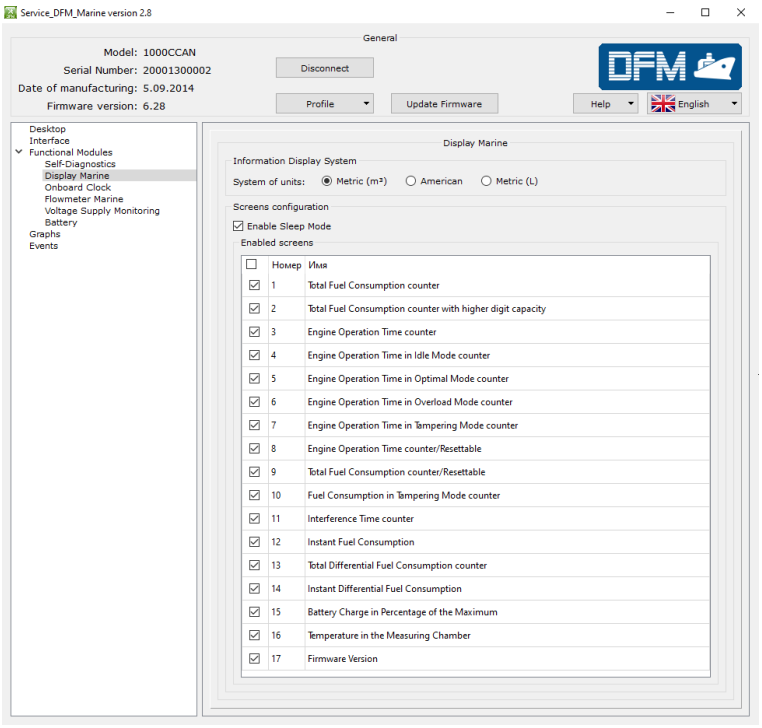


Figure F.2 — Window of settings of Display Marine FM in Service DFM Marine software

Table F.2 — Display Marine FM. SPN. SPNs, displayed and/or editable in Service DFM Marine software

SPN	Name	Factory value	Unit of measure	Clarification
Information Display System PGN 63166				
521332	System Of Units	Metric	m^3	The area for selecting necessary system of showing instant fuel consumption and all fuel consumption Counters on the display flow meter. In DFM Marine, you can select one of the following display systems: • metric (in m^3); • metric (in liters); • US (gallons).
Screen Configuration PGN 63276				
521455	Sleep Mode	On	No	Field for switching on/off automatic transition of the flow meter to "sleep" mode after 1 min from the moment of last touch of display with magnetic key. When "sleep" mode is turned on, it allows to save the charge of built-in battery of DFM Marine. For continuous display of data on flow meter's display, "sleep" mode should be switched off. Keep in mind, this operation mode leads to a decrease in of built-in battery's lifetime.
521454	Screens Mask	On	No	Fields of switching on/off any of 17 informational screens of DFM Marine.

F.3 Onboard clock FM

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

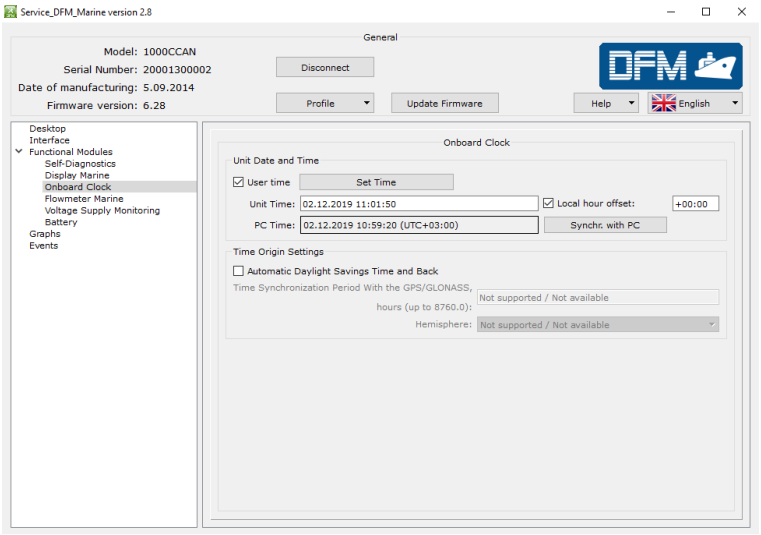


Figure F.3 — Window of settings of Onboard Clock FM in Service DFM Marine software

Table F.3 —Onboard Clock FM. SPNs, displayed and/or editable in Service DFM Marine software

SPN	Name	Factory value	Unit of measure	Range	Clarification
Time/Date PGN 65254					
959	Seconds	On the fact	s	0…62.5	Present time — seconds*.
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.					

F.4 Flowmeter Marine FM

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

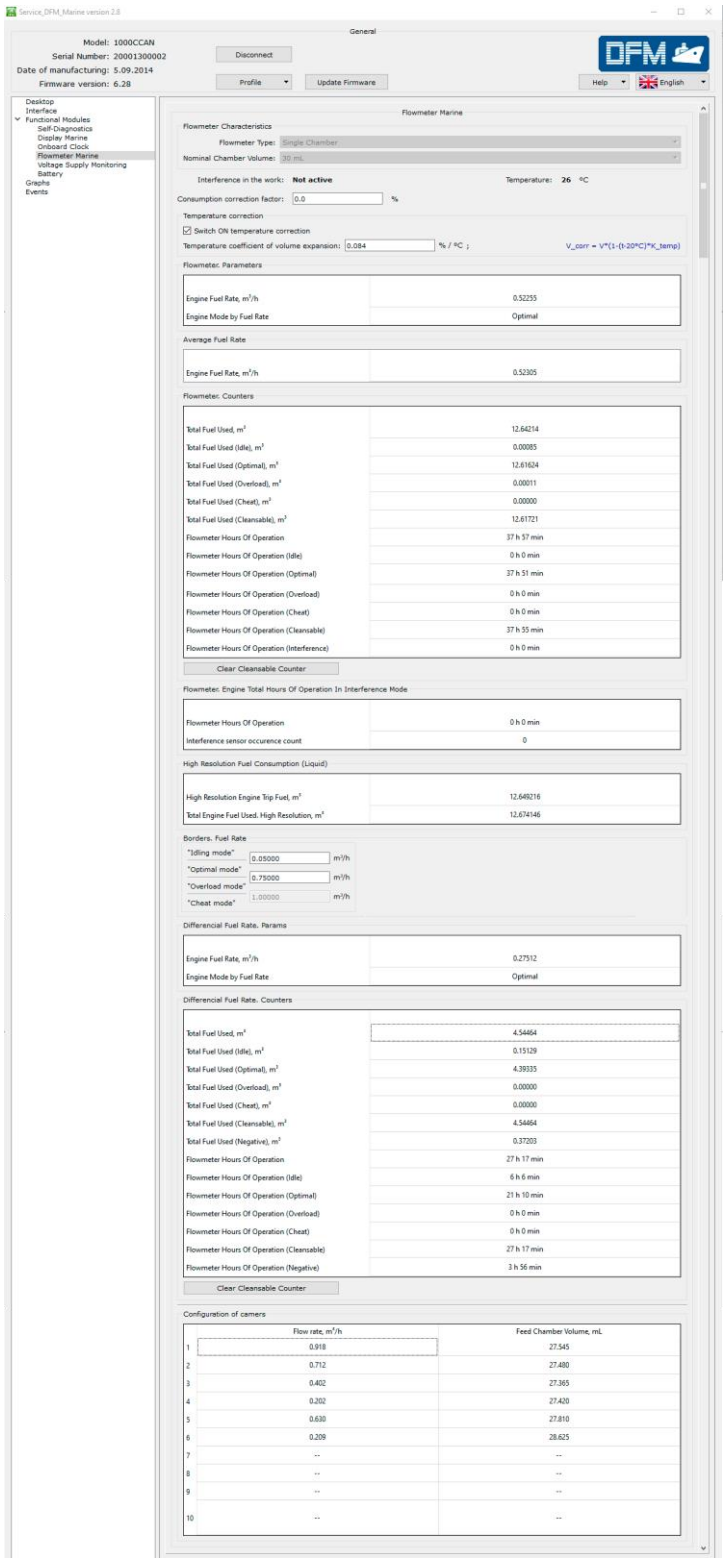


Figure F.4 — Window of settings of Flowmeter Marine FM in Service DFM Marine software

Table F.4 — Flowmeter Marine FM. SPN, displayed and/or editable in Service DFM Marine software

SPN	Name	Factory value	Unit of measure	Clarification
Flowmeter. Parameters PGN 63159				
521313	Engine Fuel Rate	On the fact	m^3/h	Hourly rate consumption of fuel, going through measuring chamber of DFM Marine.
521181	Engine Mode by Fuel Rate	On the fact	No	Current operation mode of fuel consumer, correspondent to hourly rate of fuel consumption.
Average fuel rate PGN 63162				
521313/2.1	Engine Fuel Rate / 2.1 Mean	On the fact	m^3/h	Value of instant (hourly) consumption of fuel, which goes through measuring chamber of flow meter, averaged 30 s interval. This parameter provides possibility of handy instant fuel consumption monitoring when fuel consumer works unevenly.
Flowmeter. Counters PGN 63160				
521314	Total Fuel Used	On the fact	m^3	Overall fuel consumption of the Vehicle in all operation modes including "Idle". The Counter is increasing from the date of flow meter production and cannot be reset by user.
521314/9.0	Total Fuel Used/ 9.0 Idle	On the fact	m^3	Overall fuel consumption of the Vehicle in "Idle" operation mode. The Counter is increasing from the date of flow meter production and cannot be reset by user.
521314/9.1	Total Fuel Used/ 9.1 Optimal	On the fact	m^3	Overall fuel consumption of the Vehicle in "Optimal" operation mode. The Counter is increasing from the date of flow meter production and cannot be reset by user.
521314/9.2	Total Fuel Used/ 9.2 Overload	On the fact	m^3	Overall fuel consumption of the Vehicle in "Overload" operation mode. The Counter is increasing from the date of flow meter production and cannot be reset by user.
521314/9.3	Total Fuel Used/ 9.3 Cheat	On the fact	m^3	Overall fuel consumption, which was higher than configured highest boundary of fuel consumption rate for installed flow meter. Increasing numbers on the Counter can mean either possible fuel line intervention or incorrect installation of fuel flow meter. The Counter is increasing from the date of flow meter production and cannot be reset by user.
521314/28.0	Total Fuel Used/ 28.0 Clearable	On the fact	m^3	Overall fuel consumption of the Vehicle in all operation modes including "Idle". Counter is growing since the moment of previous reset by User. This Counter is useful for precise fuel dosing.
521171	Engine Hours Of Operation	On the fact	s	Overall vehicle's engine operation time in various operation modes, including operation time in "Idle" mode. The Counter is increasing from the date of flow meter production and cannot be reset by user.
521171/9.0	Engine Hours Of Operation/9.0 Idle	On the fact	s	Overall vehicle's engine operation time in "Idle" mode. The Counter is increasing from the date of flow meter production and cannot be reset by user.
521171/9.1	Engine Hours Of Operation/9.1 Optimal	On the fact	s	Overall vehicle's engine operation time in "Optimal" mode. The Counter is increasing from the date of flow meter production and cannot be reset by user.
521171/9.2	Engine Hours Of Operation/9.2 Overload	On the fact	s	Overall vehicle's engine operation time in "Overload" mode. The Counter is increasing from the date of flow meter production and cannot be reset by user.
521171/9.3	Engine Hours Of Operation/9.3 Cheat	On the fact	s	Overall vehicle's engine operation time when fuel consumption was higher than configured highest boundary of fuel consumption rate for installed flow meter. The Counter is increasing from the date of flow meter production and cannot be reset by user.
521171/28.0	Engine Hours Of Operation/ 28.0 Clearable	On the fact	s	Overall vehicle's engine operation time in various operation modes, including operation time in "Idle" mode. Counter is growing since the moment of previous reset by user. This Counter is useful for precise fuel dosing.

SPN	Name	Factory value	Unit of measure	Clarification
521171/9.5	Engine Hours Of Operation/9.5 Interference	On the fact	s	Overall time of external factors influence (e.g. magnetic field), which prevent normal functioning of DFM Marine. The Counter is increasing from the date of flow meter production and cannot be reset by user.
Flowmeter. Engine total hours of operation in interference mode PGN 63174				
521171/9.5	Engine Hours Of Operation/ 9.5 Interference	On the fact	s	Overall time of external factors influence (e.g. magnetic field), which prevent normal functioning of DFM Marine. The Counter is increasing from the date of flow meter production and cannot be reset by user.
521267	Interference sensor occurrence count	On the fact	pcs.	Counter for recording quantity of interference attempts (e.g. with magnetic field), which are aimed to stop flow meter.
High Resolution Fuel Consumption (Liquid) PGN 63161				
521316	High Resolution Engine Trip Fuel	On the fact	m^3	Fuel consumption with higher accuracy, which is increasing since turning on ignition, and reset on turning off ignition. Counter is not available in current FW version.
521331	Total Engine Fuel Used. High Resolution	On the fact	m^3	Total fuel consumption with higher accuracy, which is increasing since the moment of flow meter manufacture. Counter cannot be reset by User.
Borders. Fuel Rate PGN 63163				
521317/9.0	Fuel Rate Mode Border/ 9.0 Idle	On the fact	m^3/h	"Idle" operation mode boundary setting – less than 10 % of maximal hourly consumption rate of fuel, going through the measurement chamber of DFM Marine. The setting is used for defining current vehicle operation mode depending on hourly fuel consumption rate. The setting is available for editing by user.
521317/9.1	Fuel Rate Mode Border/ 9.1 Optimal	On the fact	m^3/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.
521317/9.2	Fuel Rate Mode Border/ 9.2 Overload	On the fact	m^3/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. Not available for editing 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 Marine. 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 Marine. The setting can be adjusted by user only after turning on function of temperature correction (see 2.6.7)
521434	Correction coefficient	0.0	%	Setting-up correction coefficient of consumption may increase accuracy of fuel consumption measurement when constant over/undermeasurement during specific conditions of operation (high vibration, air in fuel lines, higher return flow from nozzles) is detected. The setting is available for editing by user (see 2.6.7)
Differential operation mode PGN 63204				
521268	Master Mode	Off	No	Enabling Master mode for primary flow meter (fuel feed line) and disabling Master (reverse fuel line) from a pair, which is used in differential mode (see 2.6.8).
521270	Calculation Mode	Differential	No	Selecting necessary mode of flow meter: 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.

SPN	Name	Factory value	Unit of measure	Clarification
521269	Slave Device Address	112	No	Enter a unique network address for Slave-flow meter (from 111…118 range). Elected address should not be the same as Master-flow meter has.
521271	Differential Fuel Rate Correction Coefficient	0.0	No	Setting-up correction coefficient of consumption may increase accuracy of fuel consumption differential 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
521671	Smoothing Capacity	5	No	Smoothing Capacity (buffer) is used for increasing accuracy of differential measurement in cases of uneven flow rate in feed/reverse lines. Value of smoothing buffer is selected experimentally from 2…100 range. In case of even flow rate in fuel lines it is not recommended to alter value of smoothing buffer (which is"5" by default. When unevenness of flow rate in feed and reverse lines is growing, it is recommended to increase value of smoothing buffer.
Borders. Differential fuel rate PGN 63205				
521317/9.0/2.15	Fuel Rate Mode Border/9.0 Idle/ 2.15 Differential	On the fact	m^3/h	"Idle" operation mode boundary setting – less than 10 % of maximal hourly consumption rate of fuel (differential mode), going through measuring chambers of Master-flow meter (fuel feed line) and Slave-flow meter (fuel reverse line). The setting is used for defining current vehicle operation mode depending on hourly fuel consumption rate. The setting is available for editing by user.
521317/9.1/2.15	Fuel Rate Mode Border/ 9.1 Optimal/ 2.15 Differential	On the fact	m^3/h	"Optimal" operation mode boundary setting – 10 to 75 % of maximal hourly fuel consumption rate (differential mode going through measuring chambers of Master-flow meter (fuel feed line) and Slave-flow meter (fuel reverse line). The setting is used for defining current vehicle operation mode depending on hourly fuel consumption rate. The setting is available for editing by user.
521317/9.2/2.15	Fuel Rate Mode Border/ 9.2 Overload/ 2.15 Differential	On the fact	m^3/h	"Overload" operation mode boundary setting – 75 to 100 % of maximal hourly fuel consumption rate (differential mode), going through measuring chambers of Master-flow meter (fuel feed line) and Slave-flow meter (fuel reverse line). Not available for editing by user.
Differential fuel rate. Params PGN 63196				
521313/2.15	Engine fuel rate/ 2.15 Differential	On the fact	m^3/h	Differential hourly (instant) fuel consumption, going through measuring chambers of Master-flow meter (fuel feed line) and Slave-flow meter (fuel reverse line).
521181/2.15	Engine mode by fuel rate/ 2.15 Differential	On the fact	No	Current fuel consumer operation mode, corresponding to the value of differential hourly fuel consumption mode.
Differential fuel rate. Counters PGN 63197				
521314/2.15	Total fuel used/ 2.15 Differential	On the fact	m^3	Overall fuel consumption (differential mode) of the Vehicle in all operation modes including "Idle". The Counter is increasing from the date of flow meter production and cannot be reset by user.
521314/9.0/2.15	Total fuel used/ 9.0 Idle / 2.15 Differential	On the fact	m^3	Overall fuel consumption (differential mode) of the Vehicle in "Idle" operation mode. The Counter is increasing from the date of flow meter production and cannot be reset by user.
521314/9.1/2.15	Total fuel used/ 9.1 Optimal / 2.15 Differential	On the fact	m^3	Overall fuel consumption (differential mode) of the Vehicle in "Optimal" operation mode. The Counter is increasing from the date of flow meter production and cannot be reset by user.
521314/9.2/2.15	Total fuel used/ 9.2 Overload/ 2.15 Differential	On the fact	m^3	Overall fuel consumption (differential mode) of the Vehicle in "Overload" operation mode. The Counter is increasing from the date of flow meter production and cannot be reset by user.
521314/9.3/2.15	Total fuel used/ 9.3 Cheat/ 2.15 Differential	On the fact	m^3	Overall fuel consumption (differential mode), which was higher than configured highest boundary of fuel consumption rate for installed flow meter. Increasing value of this Counter may point on improper installation of flow meter or possible events of fuel theft. 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
521314/28.0/2.15	Total fuel used/ 28.0 Clearable/ 2.15 Differential	On the fact	m^3	Overall fuel consumption (differential mode) of the Vehicle in all operation modes including "Idle". Counter is growing since the moment of previous reset by user. This Counter is useful for precise fuel dosing.
521314/9.4/2.15	Total fuel used/ 9.4 Negative/ 2.15 Differential	On the fact	m^3	Overall fuel consumption (differential mode) of Vehicle, when fuel consumption in reverse fuel line was higher than in direct fuel line. The Counter is incremented only in differential measurement. "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. The Counter is increasing from the date of flow meter production and cannot be reset by user.
521171/2.15	Engine hours of operation/ 2.15 Differential	On the fact	s	Overall vehicle's engine operation time (differential mode) in various operation modes, including operation time in "Idle" mode. The Counter is increasing from the date of flow meter production and cannot be reset by user.
521171/9.0/2.15	Engine hours of operation/ 9.0 Idle/ 2.15 Differential	On the fact	s	Overall vehicle's engine operation time (differential mode) in "Idle" mode. The Counter is increasing from the date of flow meter production and cannot be reset by user.
521171/9.1/2.15	Engine hours of operation/ 9.1 Optimal/ 2.15 Differential	On the fact	s	Overall vehicle's engine operation time (differential mode) in "Optimal" mode. The Counter is increasing from the date of flow meter production and cannot be reset by user.
521171/9.2/2.15	Engine hours of operation/ 9.2 Overload/ 2.15 Differential	On the fact	s	Overall vehicle's engine operation time (differential mode) in "Overload" mode. The Counter is increasing from the date of flow meter production and cannot be reset by user.
521171/9.3/2.15	Engine hours of operation/ 9.3 Cheat/ 2.15 Differential	On the fact	s	Overall vehicle's engine operation time (differential mode) when fuel consumption was higher than configured highest boundary of fuel consumption rate for installed flow meter. The Counter is increasing from the date of flow meter production and cannot be reset by user.
521171/28.0/2.15	Engine hours of operation/ 28.0 Clearable/ 2.15 Differential	On the fact	s	Overall vehicle's engine operation time (differential mode) in various operation modes, including operation time in "Idle" mode. Counter is growing since the moment of previous reset by user. This Counter is useful for precise fuel dosing.
521171/9.5/2.15	Engine hours of operation/ 9.5 Interference/ 2.15 Differential	On the fact	s	Overall time of external factors influence (e.g. magnetic field), which prevent normal functioning of DFM Marine (differential mode). The Counter is increasing from the date of flow meter production and cannot be reset by user.
521171/9.4/2.15	Engine hours of operation/ 9.4 Negative/ 2.15 Differential	On the fact	s	Overall vehicle's engine operation time when fuel consumption in reverse fuel line was higher than in direct fuel line (differential mode). Counter is increasing during differential measurement. Increasing value of negative consumption points on foaming in reverse line when engine is working on high RPM. Cause of foaming is air in reverse fuel line, which appears because of depressurization or special features of Vehicle's fuel system. The Counter is increasing from the date of flow meter production and cannot be reset by user.
Flowmeter characteristics PGN 63165				
521333	Flowmeter type	On the fact	No	Factory setting of flow meter type: one-chamber or differential. Cannot be modified by user.
521230	Nominal chamber volume	On the fact	ml	Factory setting of measurement chamber nominal volume from range: 5, 12.5, 20, 30, 75, 150 ml. Cannot be modified by user.
Calibration Table. Fuel Rate (DFM) PGN 63044				
521355	Array elements count	10	pcs.	Quantity of points in calibration table made by Manufacturer during calibration process. The setting cannot be altered by user.
521232	Impulse period	On the fact	ms	The period of the output pulse signal (see 1.6.8) is set during the calibration of the flow meter by the manufacturer.
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.

F.5 Voltage supply monitoring FM

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

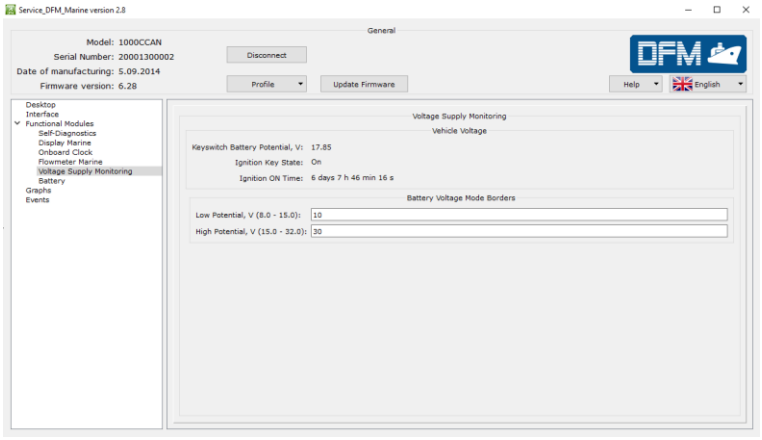


Figure F.5 — Window of settings of Voltage supply monitoring FM in Service DFM Marine software

Table F.5 — Voltage supply monitoring FM. SPN, displayed and/or editable in Service DFM Marine software

SPN	Name	Factory value	Unit of measure	Range	Clarification
Vehicle voltage PGN 62987					
158	Key switch 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 Marine installation on the vehicle. The user cannot 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 Marine. 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 Marine. 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”.

F.6 Battery FM

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

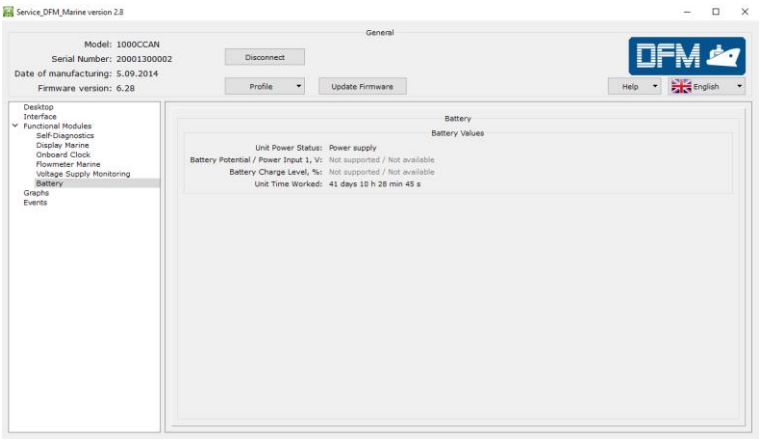


Figure F.6 — Window of settings of Battery FM in Service DFM Marine software

Table F.6 — Battery FM. SPN, displayed and/or editable in Service DFM Marine software

SPN	Name	Factory value	Unit of measure	Clarification
Battery PGN 63086				
521129	Unit power status	On the fact	No	Current power-supply status of DFM Marine: - 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 Marine 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 Marine. 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 Marine. 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 Marine 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 Marine are placed at the following web site http://s6.jv-technoton.com/ (to access S6 DB registration is required)

Annex G

DFM Marine firmware upgrade

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

To upgrade DFM Marine firmware the following actions should be made:

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

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

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

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

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

After firmware file integrity and compatibility check by Service DFM Marine Software window of firmware uploading into DFM Marine 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 Marine failure, before the end of the firmware upgrade process **is forbidden:**

- to switch off PC;
- to switch off the power supply for the Unit;
- to disconnect the Unit from the service adapter and the adapter from the PC;
- run any resource-intensive applications on the PC.

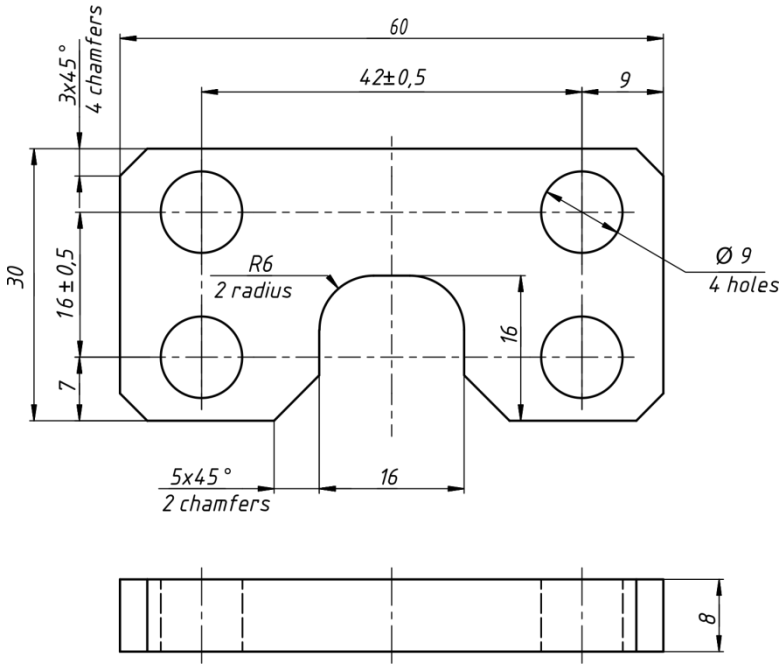
Service DFM Marine Software will display appropriate message and automatically will disconnect DFM Marine from PC in case the update is successful. DFM Marine is ready for further operation.

Service DFM Marine Software will display a new firmware version with the next connection session between PC and DFM Marine.

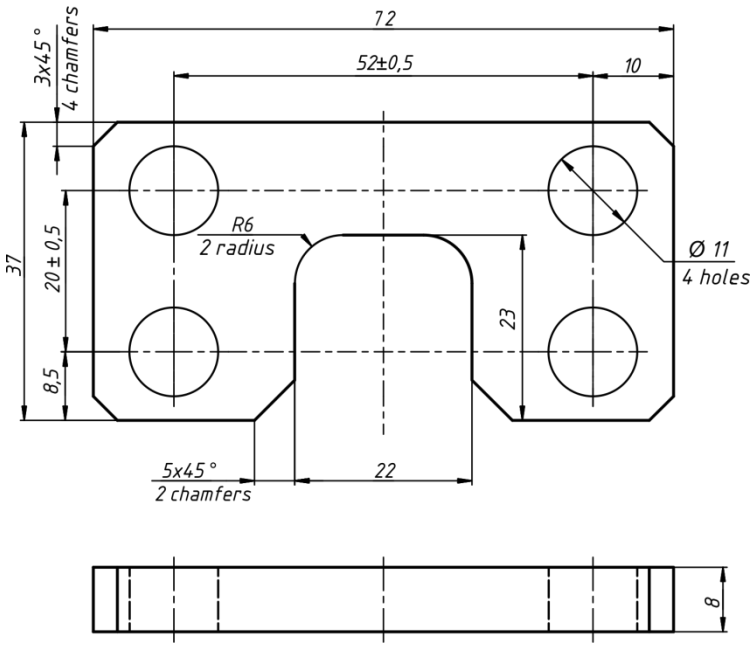
In case of any error occur that leaded to the damage of present DFM Marine firmware check all cables and adapter connections and retry. In this case the internal firmware loader is activated and will try to fix DFM Marine operation performance. Contact Technoton technical support at support@technoton.by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

Annex H

DFM Marine mounting plate drawing



a) for DFM Marine 1000/2000 installation



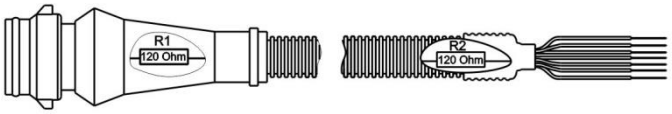
b) for DFM Marine 4000 installation

Figure H.1 — Mounting plate

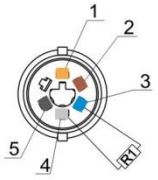
Annex I

Signal cables

S6 SC-CW-700 Cable



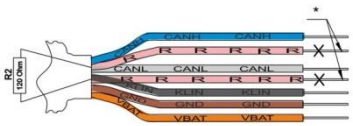
Cable length 700±5 cm.



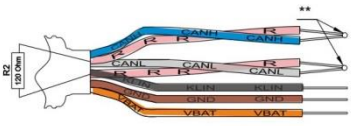
Pin	Wire color	Circuit
1	orange	VBAT
2	brown	GND
3	blue	CANH
4	white	CANL
5	black	KLIN
6	-	-

Connecting

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

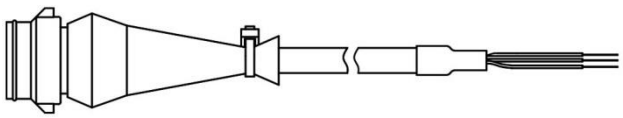


* Do not connect R2 resistor wires (pink, identification mark R), insulate.

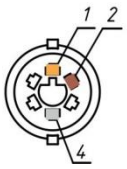


** Connect electrically one of the R2 resistor wires (pink, identification mark R) with CANH wire, and the other - with CANL wire.

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 J
Videos

1) DFM Marine Fuel Flow Meter video.

Link: https://www.youtube.com/watch?v=9lC4_RzfLik

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

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

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

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

4) Interactive flash animation **DFM fuel flow meter: selection of mounting scheme, accessories and mounting kit**.
Link: https://www.jv-technoton.com/choosing-installation-scheme-of-dfm-fuel-flow-meters/

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

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