VAF

INSTRUMENTS

Fuel Consumption Measurement

124

Application Bulletin

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REALLY
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Introduction

Due to the increasing awareness of the impact of exhaust emissions on the environment, combined with the continued increases in fuel costs, there is great need for reduction in fuel consumption. This has led to a high demand for accurate measurement systems to monitor the fuel consumption per engine. For the large variety in fuel systems, VAF Instruments offers a dedicated fuel consumption measurement system.

Where can fuel consumption be measured ?

Fuel consumption measurement can be performed in engine-driven installations in all kinds of power and propulsion plants. Various types of fuel can be measured, such as heavy fuel oil, marine diesel oil or bio-oils. Depending on the design of the fuel system and the preferences of the customer one or multiple flowmeters can be used in combination with dedicated flowcomputers to obtain the most accurate measurements.

Your advantage

VAF Instruments has over 75 years experience in the development, production and application of precision measuring instruments for (fuel) flow measurement. The very high accuracy (down to 0.1%) and high repeatability (0.05%) of the flow meters are not affected by pressure, viscosity or temperature of the fuel. In addition the design of the systems is very robust and easy to operate, making them ideal for use in the typical environmental conditions on board ships or power plants. Depending on the specifications and requirements, a large variety of counters, computers and flowmeters with integrated temperature sensors is available.

Quality

VAF Instruments' products are especially designed to fit the demanding circumstances in the maritime industry and are the result of many years of extensive research.

Fuel consumption measurement

Most of the operating costs of a ship are fuel related. Therefore it is very important to use fuel in the most efficient way. The real-time measurement of fuel consumption provides helpful information for shipowners, shipmanagers and crew about the influences of their actions on the consumed fuel. VAF Instruments offers various kinds of systems for the most accurate measurement of fuel consumption.

In most fuel systems fuel is circulated over the engine with a flow rate which is 2,5 to 5 times the maximum fuel consumption. When the engine consumes fuel, this is taken out of the circulation circuit. To maintain the fuel flow in the circulation system, new fuel is supplied from the daytank. Directly measuring the fuel flow from daytank to circulation system is therefore the easiest and most accurate solution.

There are fuel systems where these measurements are not possible or give too little information, for example when there is no closed circulation circuit or in case of multiple consumers . In that case it is necessary to measure all fuel lines separately and calculate the differences to obtain the fuel consumption. Since there is also a temperature difference between supply and return flow, compensation for temperature is necessary.

When measuring the fuel consumption over an engine, it is often necessary to install one flowmeter in the fuel supply line towards the engine and one flowmeter in the fuel return line. In such system it is absolutely necessary to have temperature compensation for the calculation of the fuel consumption, because the volume flow is temperature dependent and there is a temperature difference between the fuel in the supply line and the fuel in the return line.

When not compensating for these temperature effects there will be a decreased accuracy in the calculated volume. This inaccuracy is almost 1% for each 10°C temperature difference when not compensated. Because the circulation flow is in general 2,5 to 5 times the maximum fuel consumption, this means that the error on the calculated fuel consumption will also at least be multiplied by 2,5 to 5.

Mass Flow Measurement

In general fuel is bought in tonnes so, to be consistent, fuel consumption is preferably monitored in kilograms. Smart usage of existing components of the fuel system in combination with an upgrade of the viscosity sensor will make this possible.

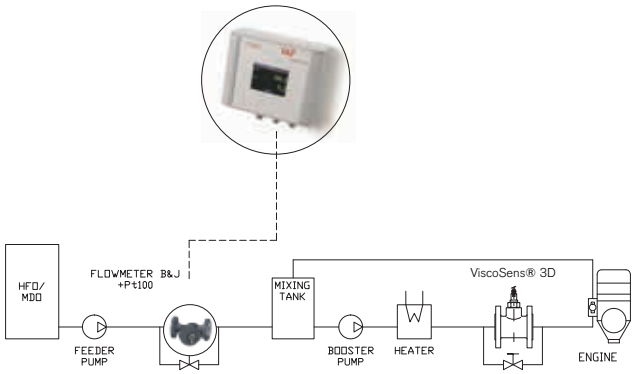
VAF Instruments offers a cost effective solution combining the strengths of two of the most installed measuring instruments in the maritime industry. The flowmeter MidFlow® PT2 allows for simultaneous flow and temperature measurements. The ViscoSense®3D is based on the proven ViscoSense® technology and offers density, viscosity and temperature measurements.

Fuel consumption measurement by MidFlow® PT2 flowmeters in combination with density measurement by the ViscoSense®3D system ensures mass flow measurements with highest accuracy, reliability and repeatability.

Typical system arrangements

Single flowmeter system

A single flowmeter system provides the most accurate fuel consumption measurement, measuring the fuel flow between daytank and the circulation system. Temperature compensation can be used if the volume at a specified reference temperature is required, to ensure correct and comparable results.

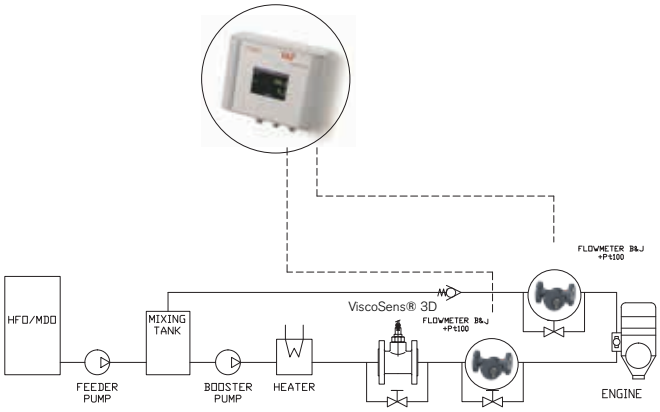


Supply and return flowmeter system

When it is not possible to measure the fuel consumption with a single flowmeter, the consumption can be calculated from the difference between the fuel supply and return flow. For this layout the volume flow and the actual temperature from both supply and return should be measured and the difference calculated real-time.

A typical system consists of flowmeters with integrated PT100, and a flowcomputer displaying information about the supply and return fuel flow, temperatures, the actual- temperature compensated- fuel consumption and totals.

VAF Instruments offers a wide range of flow computers to meet the demands and requirements for the displayed information and data output.

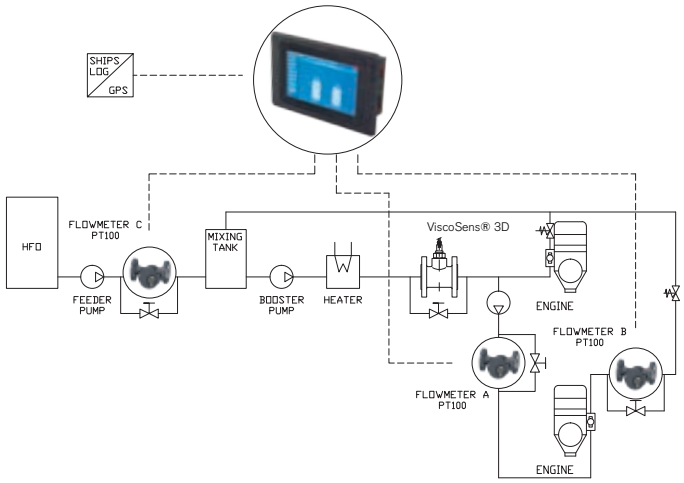


FCM2 flowcomputer

For display of the measured data in combination with a single flowmeter or in a supply/return system, VAF Instruments advises the FCM2 flowcomputer. As a standard this computer includes temperature compensation calculation. Furthermore it can be connected to the ViscoSense®3D for mass flow calculations.

Uni-fuel system

In uni-fuel systems there are multiple engines supplied from the same fuel treatment system, for example both main engine and auxiliary engine(s).
If information about fuel consumption for each engine(group) is needed, separate supply and return flowmeter systems should be installed.
Another solution is using a setup consisting of three flowmeters, strategically placed. For this solution a single flowmeter is placed between daytank and the fuel circulation system to measure the total fuel consumption. Additional flowmeters will be installed in the fuel supply and return lines from the auxiliary engine(s), measuring the consumption of this engine only. By subtraction the consumption data from the other engine is calculated.



PEM4 monitoring system

For monitoring of the fuel consumption data VAF Instruments has developed the PEM4 fuel efficiency monitoring system. On its large touch screen display all important information is available at a glance. The intuitive navigation through the different screens offers not only real-time consumption data (compensated for temperature differences), but also other valuable information. For example the average fuel consumption over a specified period of time can be given. Also the system can make automatic distinction between different fuel types. The system is able to monitor up to 12 flowmeters (6 separate consumers) and can additionally be connected to speedlog or GPS to obtain the specific fuel consumption per nautical mile.

Connecting the PEM4 with the innovative ViscoSense®3D systems allows mass flow calculation.

Further insight in fuel consumption and propulsion efficiency can be gained by combining the fuel flow measurement with shaft power or propeller thrust measurement. Monitoring shaft power with T-Sense® together with fuel consumption will give you useful information about the SFOC (Specific Fuel Oil Consumption) of the main engine(s) and makes clear how efficient your engines are running in real-life conditions. The TT-Sense® Thrust & Torque sensor will measure the real resistance of your vessel and will accurately inform you about hull fouling and propeller efficiency.

Please refer to Product Bulletin 660 for more information about the T-Sense® optical torque measuring system or refer to PB663 for the innovative TT-Sense® Thrust & Torque measuring system.

Technical specification

All flowmeters provided by VAF Instruments can be used in the flowcomputer solutions for fuel consumption measurement. However due to the high importance of temperature compensation we strongly advise the flowmeter type MidFlow® PT2 with integrated PT100. For more information please refer to Product Bulletin 135.

FCM2 flowcomputer

For display of the measured data in combination with a single flowmeter or supply/return flowmeter system, VAF Instruments can deliver the FCM2 flowcomputer. The flowcomputer can be delivered with Modbus, analog or relay output.

Display type	320 x 240 TFT colour display with resistive touch screen
Dimensions	160 x 130 x 71 mm
Weight	1,2 kg approx
Power supply	100 to 240 VAC
Power consumption	maximum 10 Watt
Protection class	IP65
Ambient temperature	0°C to 60°C
Operating humidity range:	0 to 95 %RH (non-condensing)
Input	2 x pulse from Flowmeter PT2 or Namur
	2 x PT100 from Flowmeter PT2
	3 x analog input 4-20 mA (optional)
Output	1 x SSR
	1 x RS485 for Modbus
	1 x FCM bus
	2 x active analog output 4-20 mA (optional)
Cable glands	4x M20 x 1.5 mm, Ø7-12 mm (standard) / Ø10-14 mm (optional)
	3x M16 x 1.5 mm, Ø5-10 mm (standard)

PEM4 monitoring system

For uni-fuel systems and other configurations, VAF Instruments can deliver the PEM4 efficiency monitoring system which consists of a display unit PEM4 and a a separate SPU3 signal processing unit. Both components are interconnected through ethernet giving great flexibility in installation position.

PEM4

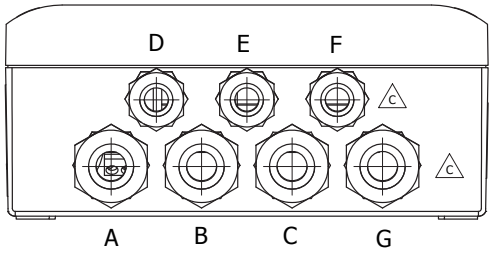
Display type	TFT LCD, PCAP touch screen, 7.0" (1024 x 600 dots) with adjustable LED backlight
Dimensions	235 x 150 x 44 mm (w x h x d)
Cut out	217,6 x 128,6 mm (w x h)
Cut out depth	38 mm
Front panel thickness	6 mm
Weight	1,3 kg
Power supply	115 - 230 VAC to power supply unit
Power consumption	8 W in full activity
Protection class	IP 65 at front facia
Ambient temperature	-20 up to + 60°C
Connections	RJ45 Ethernet connection on back (bottom side) of panel

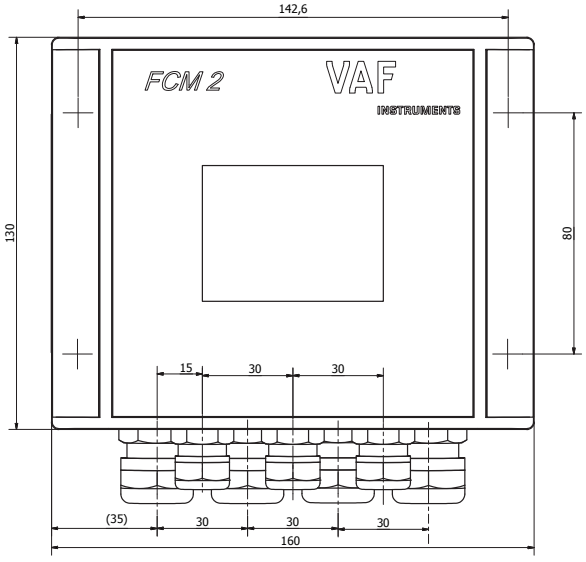
SPU3

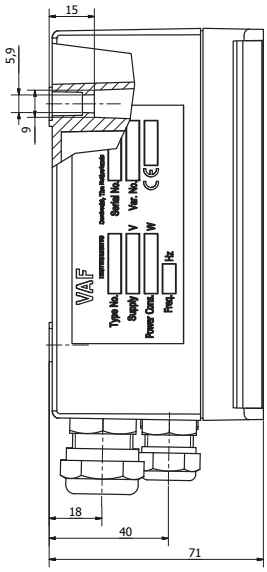
CPU	1GHz, SDRAM 512MB DDR3L 800 MHZ
Dimensions	660 x 300 x 165 mm (w x h x d)
Weight	approx. 10 kg
Power supply	115 - 230 VAC ± 10%
Power consumption	60 W,
Protection class	IP65
Input	Maximum 2x RS 485 Modbus connection for input signal from T-Sense® or TT-Sense® optical
	sensors. Maximum 9x analog signals (galvanic isolated), from shaft generator input, auxiliary power or
	ViscoSense®3D Maximum 12x Flowmeter pulse inputs, representing 6 engines/consumers Maximum
	12x, used for fuel temperature compensation at Flowmeters 1x pulse input for speed log NMEA 0183
	input signal from GPS or Speedlog
Output	Maximum 2x RJ45 ethernet for connection to the PEM4 display(s) and/or onboard network
	1x RS 485 Modbus connection for data transfer to an external system (AMS, datalogger, IVY)

Dimensions:

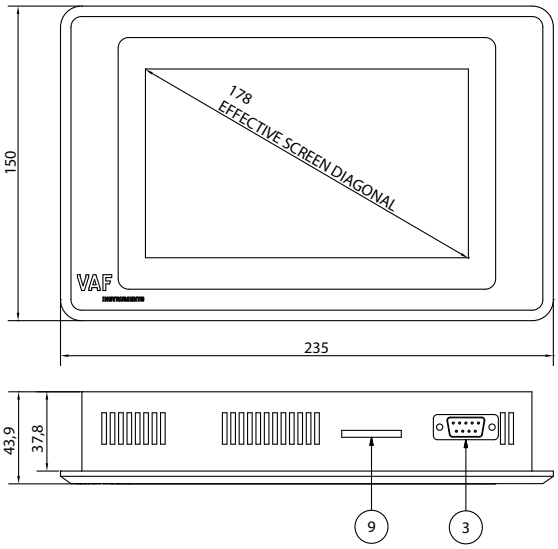
FCM2



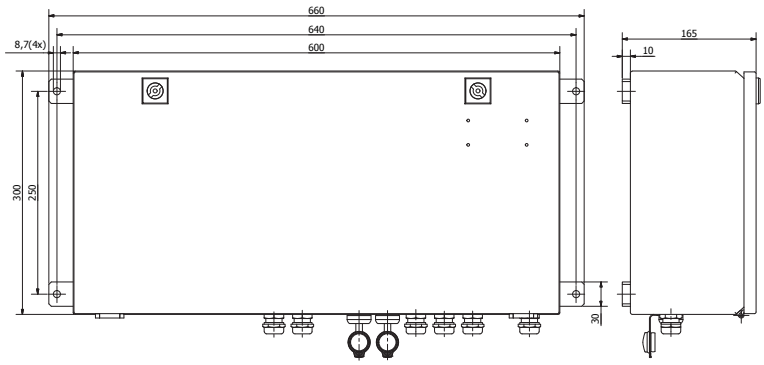




PEM4 display unit



SPU3 Signal processing unit



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Quotation & ordering information

The large variety in fuel systems requires receipt of fuel lay out drawing.
Based on fuel lay out drawing VAF Instruments is able to provide the best solution for flowmeter size and position.

All systems

General:	total engine power [kW]:		fuel type:	
	min. consumption [l/min] [1]:		max. consumption [l/min] [1]:	
	min. circulation flow [l/min] [2]:		max. circulation flow [l/min] [2]:	
	operating temperature [°C]:		operating pressure [bar]:	
Certification:	○ customer inspection	○ factory test and material certificate EN 10204 3.1	○ inspection by classification authority:	
Accessories:				
Liquid filter:	○ yes	○ no		

Single flowmeter system (Please also complete General)

Flowmeter:	diameter of piping:		material of piping:	
Flow direction:	○ left to right	○ right to left	○ top to bottom	○ bottom to top
Flange type:	○ DIN PN	○ ANSI [lbs]	○ JIS [K]	
Other options:	output (flowcomputer):	○ 4 - 20 mA	○ pulse (scalable)	○ RS485

Supply & return flowmeter system (Please also complete General)

Flowmeters:	diameter of piping:		material of piping:	
Flow direction (supply):	○ left to right	○ right to left	○ top to bottom	○ bottom to top
Flow direction (return):	○ left to right	○ right to left	○ top to bottom	○ bottom to top
Flange type:	○ DIN PN	○ ANSI [lbs]	○ JIS [K]	
Other options:	output (flowcomputer):	○ 4 - 20 mA	○ pulse (scalable)	○ RS485

Uni-fuel system (Please also complete General)

Flowmeters:	diameter of piping [3]:		material of piping:	
Flow direction [3]:	○ left to right	○ right to left	○ top to bottom	○ bottom to top
Flange type:	○ DIN PN	○ ANSI [lbs]	○ JIS [K]	
Other options:	speed input:	○ speed log	○ GPS	

Notes: [1] For uni-fuel systems minimum and maximum flowrate of flowmeter placed in common line towards the engines is required. Also minimum and maximum consumption of each engine or sum of group engines is required (indicate whether individual measurement is required).
[2] Not applicable for single flowmeter systems.
[3] Information for each flowmeter required.

Name:

Place and date:

For further information see relevant Product Bulletins or www.vaf.nl

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