



Technical Manual

Instructions for installation, operation and maintenance



667

SPU3 + PEM4 SYSTEM

For connecting VAF T(T)-Sense, PT2 Flowmeters, AQ-rate, ViscoSense 3(D), 3rd Party Torque meter, Shaft Generator

Valid for SPU3 software version 4.81 and later

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1. PREFACE

1.1 GENERAL

The PEM4 Propulsion Efficiency Monitoring System is a microprocessor-based system for monitoring and analyzing the propulsion performance and fuel efficiency of a vessel. The system comprises the PEM4.8 Touch Screen and the SPU3 Signal Processing Unit.

The robust SPU3 collects and processes data from all connected sensors and systems, while the PEM4.8 Touch Screen provides clear, real-time insight into measured and calculated values, alarms and settings.

The SPU3 supports a wide range of inputs, including:

- VAF T(T)-Sense Optical Torque (and Thrust) Measuring Systems (torque, shaft speed, power additionally thrust)
- Third-party torque meters
- VAF Volumetric (PD) flowmeters with temperature sensors, and VAF AQ-Rate mass (Coriolis) flowmeters
- GPS and other NMEA 0183 navigation data, and speed logs
- Shaft generator and auxiliary engine power data
- VAF ViscoSense 3(D) with density and viscosity sensors data
- Draft, pitch, roll and yaw sensors

Measured and calculated data can be shared with external systems, such as an Alarm Monitoring System (AMS) via Modbus, or the VAF IVY Propulsion Performance Management System via Ethernet.



To ensure safe and correct installation and operation, read this manual completely before installing the equipment and starting operations.



The (micro) SD card should not be exposed to computer viruses, since this could contaminate the (micro) SD card. Contamination could disturb good working of the system.

For any additional information contact:



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1.2 SYMBOLS

The following symbols are used to call attention to specific types of information.



A warning to use caution! In some instances, personal injury or damage to the instrument or control system may result if these instructions are not followed properly.



An explanation or information of interest.

1.3 COPYRIGHT

This Technical Manual is copyrighted with all rights reserved.

While every precaution has been taken in the preparation of this manual, no responsibility for errors or omissions is assumed. Neither is any liability assumed for damages resulting from the use of the information contained herein. Specifications can be changed without notice.

2. SYSTEM DESCRIPTION

2.1 PEM4 Propulsion Efficiency Monitoring System

The PEM4 system is a modular propulsion efficiency system. This manual describes the combination of the PEM4 with the SPU3 (Signal Processing Unit). The PEM4 stand alone system is able to calculate torque, speed and power output data. The PEM4 stand alone is described in a separate technical manual, (TIB-669 T-Sense® and PEM4 stand alone).

The PEM4 system in combination with the SPU3 can manage a maximum of 12 volume flowmeter (PD) and 12 mass flowmeters via Modbus. The volumetric flowmeters inputs are combined with PT100 temperature inputs for temperature compensation. These volumetric flow and mass flow meters can be connected to a maximum of 8 consumers.

Furthermore, a maximum of 6 ViscoSense®3D inputs, a speed log pulse, GPS NMEA signal, draft meter and inclino meter can be added as input to the system.

The SPU3 converts all these input signals to one RJ45 Ethernet signal for monitoring purposes through a PEM4 touch screen or using the IVY® Propulsion Performance Management system.

A RS485 Modbus signal is available for connection an external system like Alarm and Monitoring System (AMS) or to connect a separate PC running the optional SPU3 datalogger software.

Functions, which can be performed with the PEM4 + SPU3 system are:

- Measurement and display of the torque, thrust, shaft speed and power.
- Calculation of the average shaft power, shaft speed and torque during the last 1, 4 and 24 hours.
- Calculation of the total energy, total revolutions and total CO₂ emissions including reset.
- Calculation of the fuel consumption in kg per nautical mile, fuel consumption in kg per hour, fuel consumption in gram per kWh (*Specific Fuel Oil Consumption - SFOC*), average fuel consumption per nautical mile, fuel temperature compensation and calculation of the total mass per fuel type per consumer including reset.
- Calculation of thrust, thrust power quotient, when a TT-Sense® sensor is installed.
- Displaying of parameters, engine load diagram and power/speed diagram.
- Above mentioned calculations for twin screw vessels when an additional T-Sense® or TT-Sense® system is installed.

The SPU3 can be installed in the vicinity of the flow meter(s) and/or booster unit or in the engine control room (ECR). The PEM4 touch screen can be installed in a control cabinet or control panel in the ECR and/or on the bridge.

2.2 SYSTEM SECURITY

Besides checking the status of the torque measurement system and/or flowmeters the PEM4 + SPU3 system also checks itself continuously for program and configuration data integrity, normal program flow and power supply conditions. All alarm messages will be logged in a dedicated alarm screen.

3. TECHNICAL SPECIFICATIONS

SPU3 – General Specifications

Drawing 0815-1120 (section 17)

Supply voltage	115 - 230 VAC
Power consumption	Max. 30 W
Protection class	IP65
Net weight	Approx. 10 kg
Operating temperature	Lower than 55°C
Dimensions	660 x 300 x 165 mm (w x h x d)
CPU	BeagleBone®, Sitara AM3358, 1GHz, SDRAM 512MB DDR3L 800 MHZ, On board flash 4GB, 8bit embedded MMC

Table 1 SPU-3 General Specifications

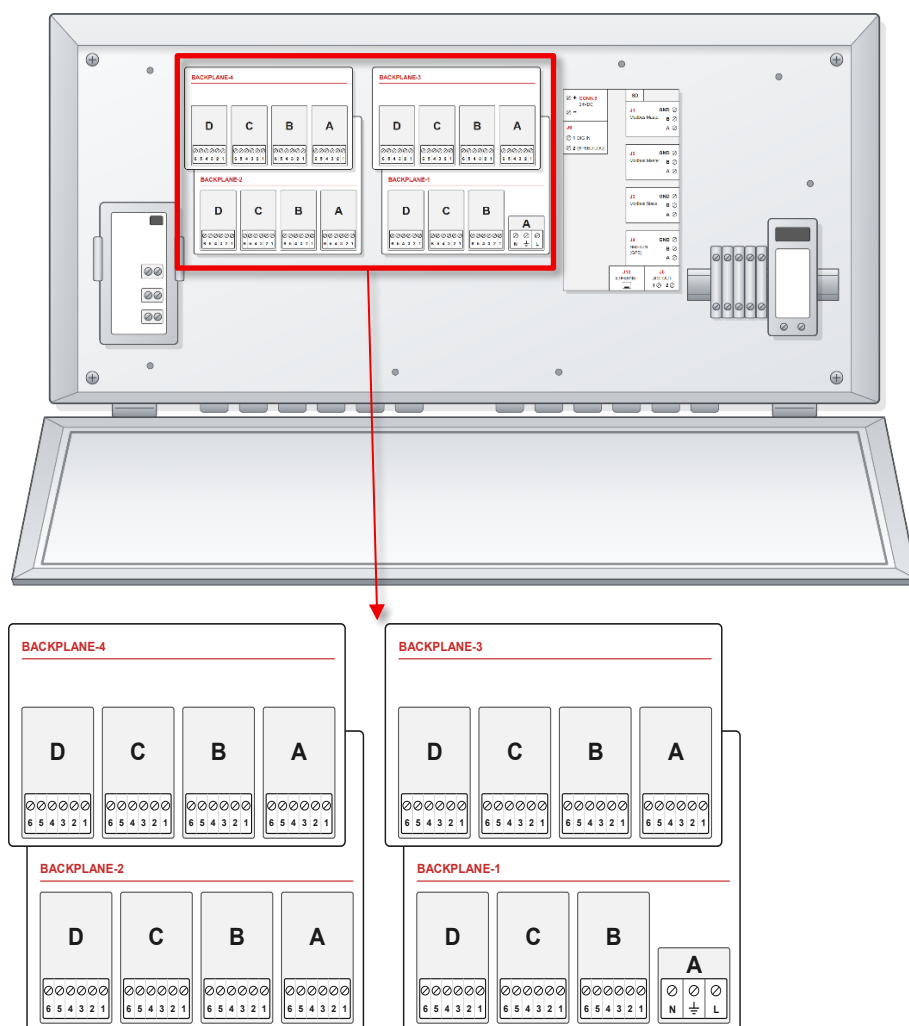


Figure 1 Backplanes 1–4, slot and terminal layout

SPU3 – Inputs on Backplane(s)

Input type:	Channel:	Drawing 0815-2019 (section 17)	
Pulse inputs VAF PD Flowmeter (PT2 or Namur)	Pulse PCB on backplane (Figure 1)	Number of pulse inputs:	Up to 12 (max. 8 consumers)
		Input type:	VAF PT2 sensor, Namur
		Max. freq. pulse input:	1000 Hz
		Threshold voltage:	3 V
		Maximum pulse voltage:	8,2 V
Temperature inputs VAF PD Flowmeter	Temp PCB on backplane (Figure 1)	Number of temp. inputs:	Up to 12 (max. 8 consumers)
		Input type:	PT100 (3 wire)
		Range:	0 °C to 200 °C
		Accuracy:	± 1°C
		Update time:	1 Hz
Analog inputs	Analog PCB on backplane (Figure 1)	Number of analog inputs:	Up to 18 (3 analogue inputs per analog PCB)
		Input type:	4-20 mA each. Ri = 100Ω
		Used for:	Max. 2 shaft generators (1 analog input each)
			Max. 2 torque meters Torque/speed/power/thrust (4 analog inputs each)
			Max. 6 auxiliary power - Total auxiliary power (1 analogue input each)
			Max. 6 ViscoSense3D - Density, Temperature and Viscosity (3 analog inputs each)
			Max. 4 draft meters – Front, Middle SB, Middle PS, Back (1 analog input per meter)
			Max. 1 Inclino meter – Pitch, Roll, Yaw (1 analog input per signal)

Table 2: SPU-3 Inputs on Backplanes

SPU3 – I/O's and communication ports on processor module

Input type:	Channel:	Drawing 0815-2019 (section 17)	
Modbus Master for: · VAF T(T)-Sense (max. 2) Other sensors: · 3rd Party Torque meter (max. 2) · Shaft Generator (max. 2) · Auxiliary Engine Power (max. 6) For VAF AQ-rate input, see table below!	J1, J2 (Figure 2)	Number of VAF T(T)-Sense:	Max. 2
		Input type / Protocol:	Modbus RTU
		Serial interface:	RS-485 (2-wire)
		Cable length:	Up to 600 m (<i>for baudrate 19200</i>)
		Default T(T)-Sense Modbus COM-port settings: (<i>Other sensors: consult supplier</i>)	Baudrate: 19200 Data bits: 8 Parity: none Stop bits: 1 Flow control: none Function code: 3 (Holding registers)
Modbus Master for VAF AQ-rate Mass flowmeter	J1, J2 (Figure 2)	Number of mass flowmeters:	Up to 12 (max. 8 consumers)
		Input type / Protocol:	Modbus RTU
		Serial interface:	RS-485 (2-wire)
		Cable length:	Up to 1200 m (<i>for baudrate 9600</i>)
		Default Modbus COM-port settings:	Baudrate: 9600 Data bits: 8 Parity: none Stop bits: 1 Flow control: none
Modbus Slave for data transfer to an external system like AMS.	J3 (Figure 2)	Input type / Protocol:	Modbus RTU
		Serial interface:	RS-485 (2-wire)
		Cable length:	Up to 200 m (<i>for baudrate 57600</i>)
		Default Modbus COM-port settings:	Baudrate: 57600 Data bits: 8 Parity: none Stop bits: 1 Flow control: none Function code: 3 (Holding registers) Modbus slave address: 1
NMEA input for e.g. GPS	J4 (Figure 2)	Input type / Protocol:	NMEA 0183
		Serial interface:	RS-422 (2-wire)
		Max. cable length:	Up to 1200 m (<i>for baudrate 4800</i>)
		NMEA COM-port settings:	Baudrate: 4800 Data bits: 8 Parity: none Stop bits: 1 Flow control: none
		NMEA sentences:	For NMEA sentences see separate table in Chapter 17
Digital I/O	J5 (Figure 2)	I/O type:	Voltage free contact (Max. 30 VDC, 100mA)
Pulse I/O for Speed Log (STW) or Fuel Type Relay	J6 (Figure 2)	I/O type:	Voltage free contact (Max. 30 VDC, 100mA)
		Ship's speed log input:	1-999 p/NM
Ethernet connection for: · VAF PEM4.8 Touch screen · VAF IVY Propulsion Performance Management system · PC/network on board · NMEA over UDP to port 10110	J10 (Figure 2)	Ethernet protocols:	HTTP Modbus TCP/IP NMEA 0183 via UDP SMTP SSH
		Connection type:	RJ45
		Cable length:	Max. 100 m
		Cable type:	CAT6a S/FTP AWG26/7 CU

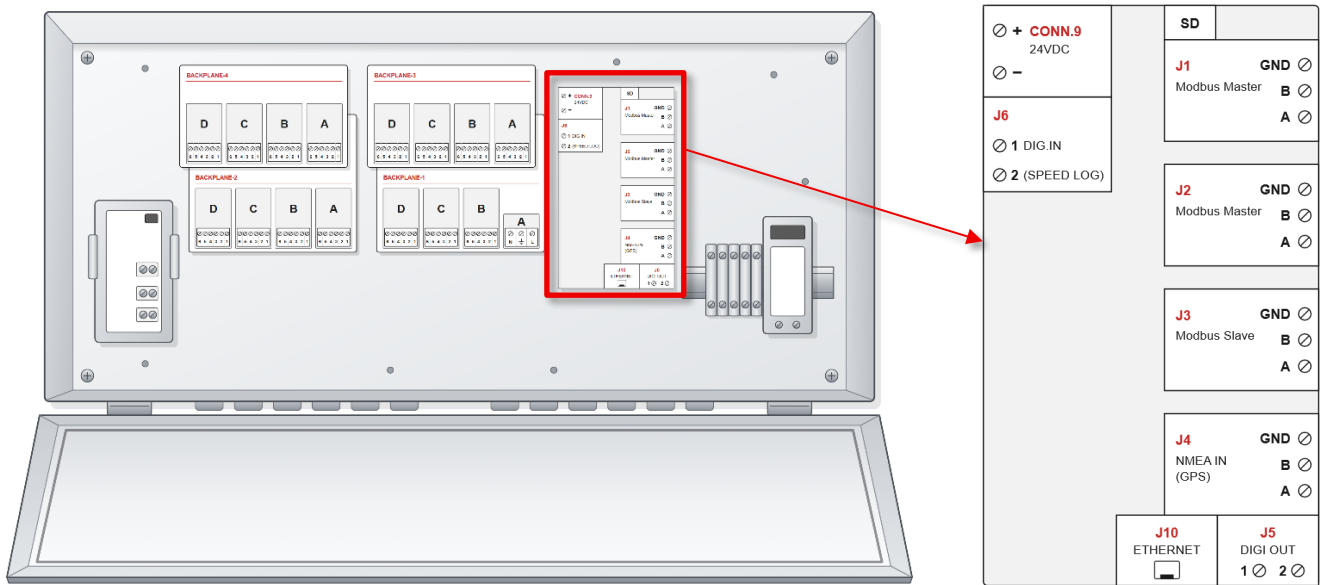


Figure 2 SPU3 – I/O's and communication ports on processor module

PEM4.8 Touch Screen	Drawing 0815-1025 (section 17)
Supply voltage:	115-230 VAC to power supply unit
Dimensions:	218,16 x 162,67 x 46,5 mm (w x h x d)
Cut out:	167 x 116 mm (w x h)
Cut out depth:	32 mm
Front panel thickness:	17 mm
Connections:	RJ45 Ethernet connection on the back-bottom side of the panel
Temperature range:	-10°C up to +60°C
Display:	Color TFT LCD, Touch screen 8" (1024 x 600 dots) with adjustable backlight
Net weight:	940 g

Table 3: PEM4.8 Touch Screen specifications



Figure 3 PEM4.8 screen

4. SAFETY INSTRUCTIONS

There are no special safety instructions for the equipment.

All precautions have been taken to ensure, in so far as reasonably practical, that the equipment has been designed and constructed to be safe and without risk to health or the environment when properly used.

Provided that the recommendations contained in this manual are carefully adhered to, no circumstances are foreseen where the equipment will present a health or safety hazard.

To ensure the safety of personnel, equipment and the environment:

- Always follow the safety, installation, repair and maintenance recommendations in this manual.
- Always observe warning labels on containers and packages.
- All personnel who installs, operates, repairs or maintains the equipment should read this manual completely and make themselves acquainted with the equipment before installing, operating, repairing or maintaining the equipment.
- Make sure that all safety requirements are met before installing, operating, repairing or maintaining the equipment.
- Always use personal protective means when necessary.
- Always use the right tools for the job.
- Make sure that all equipment is isolated from the electrical power supplies before installing, repairing or maintaining the equipment.
- Never assemble or disassemble electrical equipment with power switched ON.
- Always handle printed circuit boards with CMOS components according to the correct procedures for such components, to prevent any damage due to electrostatic discharges.
- Only use cleaning solvents in a well ventilated area.
- Avoid breathing fumes.
- Keep away from open fire.
- Do not use solvents on plastic components or parts.

5. UNPACKING

Let the equipment acclimatize inside the closed box for at least one hour at the location where the system will be installed.

When the equipment is taken out of the box, please leave the special protection supplied with the equipment as long as possible in place to avoid any damage.

The special protection should be stored for the unlikely event the equipment has to be sent for repair. Dispose of the packing material should be done according to the laws of the country where the equipment is installed, or according to the rules that are applicable on the vessel.

- Be careful when unpacking the electronic equipment. The content is fragile.
- Do not press on the PEM4 touch screen.
- Be careful not to damage any of the connectors, control modules or wiring.

6. INSTALLATION AND FIRST USE

The PEM4 + SPU3 system will be delivered with the software and correct data settings installed. First connect all the inputs and outputs to the components.

The power supply wires should be connected at last.

Note: There is an ON/OFF switch on PEM4 touch screen. When the power switch is switched ON the screen will turn on. Check if the inputs are connected correctly through menu <ALARMS> <Signals(raw)>.

In case of any errors the connection(s) or connected equipment(s) should be checked and corrected.

6.1 RECORD PEM4 + SPU3 SYSTEM DATA

This information is required when contact the supplier for any reason.

Type No.	SPU3	Serial No.	
Supply voltage	V	Frequency	Hz
Var.No.		Power Cons.	W

Table 4: SPU-3 Nameplate

Software Version	
Serial number	
Hull number	
Delivery date	

Table 5: PEM4.8 system info

6.2 INSTALLATION DIAGRAMS OF THE PEM4 + SPU3 SYSTEM

For the installation diagram of the SPU-3, refer to drawing 0815-2019 in section 17.

Figure 4 shows the installation diagram of the PEM4.

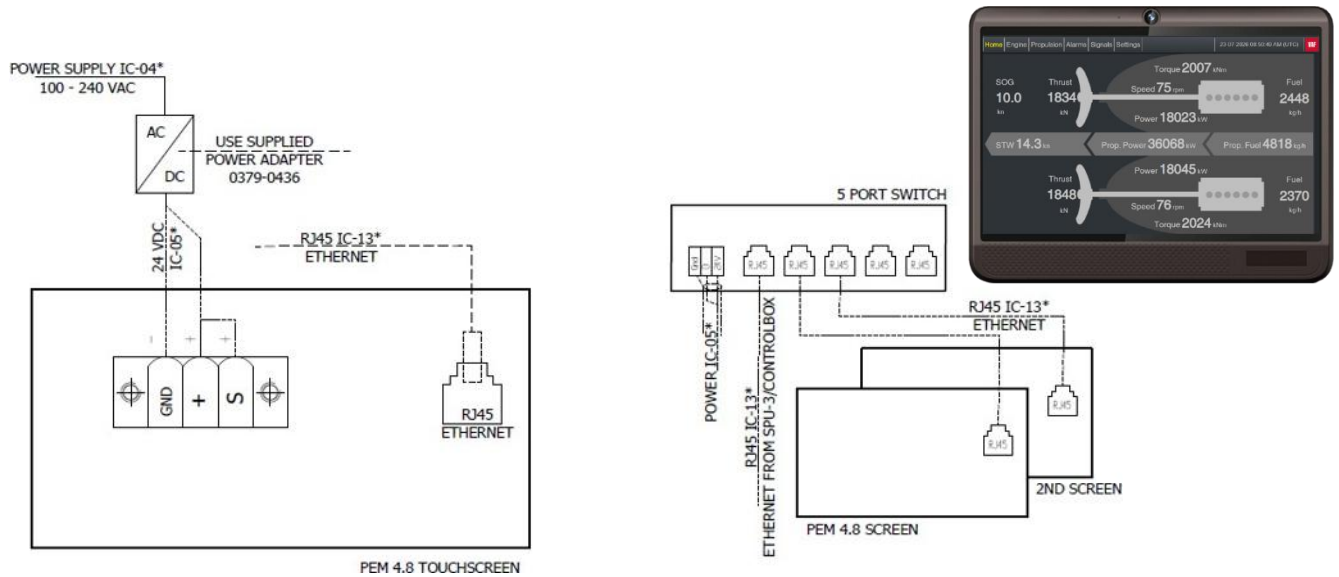


Figure 4 – Installation diagram (2x) PEM4.8

6.3 Installation position SPU-3 cabinet

The propulsion efficiency monitoring system consists of a SPU3 and a PEM4 touch screen, T-Sense or TT-Sense sensors, flowmeters, speed log/GPS/NMEA input and draft/inclino meters will be connected to the SPU3. The SPU3 will perform all calculations and data processing to the PEM4 touch screen.

1. Always install the SPU3 with cable glands facing downwards. Do not take electronics out of the cabinet.

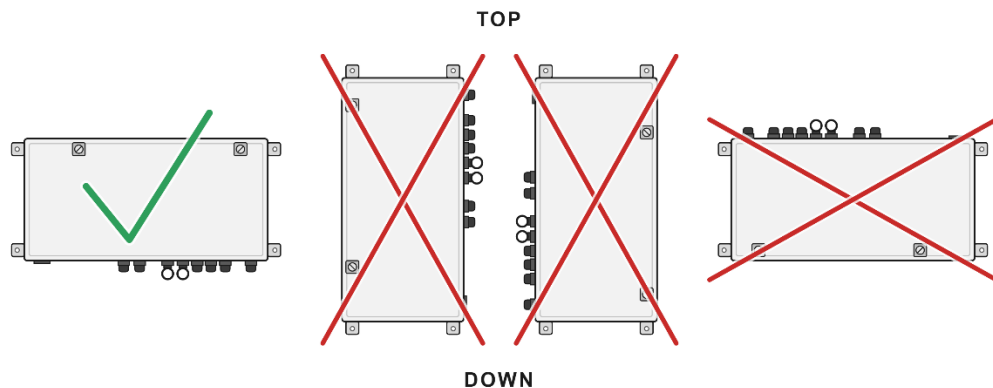


Figure 5 – SPU3 positioning

2. Install the SPU3 in the engine room (ER), engine control room (ECR) or near to the HFO booster units, but as much as possible free from moisture, free from large fluctuations of temperature and particularly free from vibration and shock. Also influences such as large magnetic fields must be avoided. Ambient temperature should under all circumstances be lower than 55°C. External dimensions drawings of the SPU3 can be found in section 17.

6.4 Configuration of the SPU3

The propulsion efficiency monitoring system is a modular system. Every system is specifically built and programmed.

The table “Flowmeter numbers, description and position” at the inside of the SPU3 cabinet, provides information regarding flow meter (TAG) numbers, configuration of the flow meters, speed log or GPS at the SPU3. The number of backplanes differs per SPU3 configuration.



Flow meter numbers, description and position

This table belongs to drawing 0815-2019 Interconnection diagram T-Sense SPU-3 PEM4

Date:

18-11-15 14:14

Flow meter number and TAG	Temp corr.	Alarm temp	Time sample	K-factor	Serial number
		°C	Sec	Pulses/tr	No.
Flow meter 1 ME supply	yes	150	10	4.983	707724
Flow meter 2 ME return	yes	150	10	4.975	707730
Flow meter 3 GE supply	yes	150	10	11.952	707734
Flow meter 4 GE return	yes	150	10	11.940	707740

General info PEM4 monitoring system

Consumers	Configuration of flow meters	Net flow cut-off	
1 ME	supply/return	ltr/min 0.08	
2 GE	supply/return	0.04	
	Serial number T-Sense/SPU-3 Serial nr. : 15.2076 Serial number touch screen(s) Screen nr. 1 : OE2700082 Screen nr. 2 : Delivery date Month/day/year: November 18 2015		Speedlog puls no
			Speedlog NMEA yes
			GPS (SOG) yes

Figure 6 Example table “Flowmeter numbers, description and position”

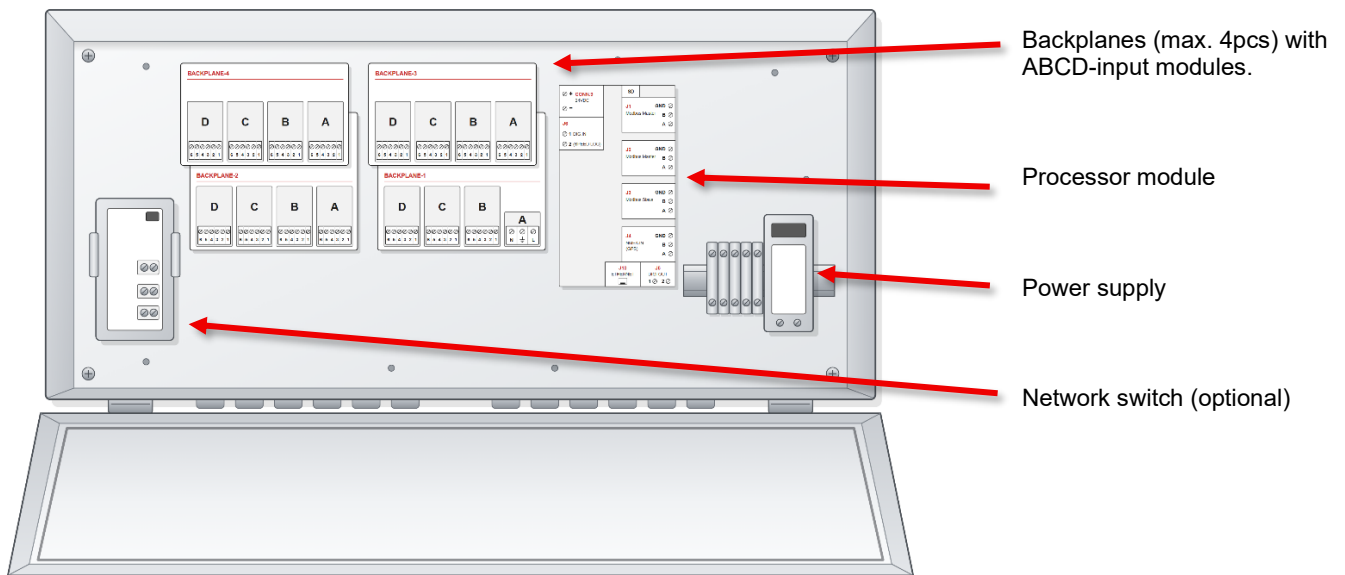


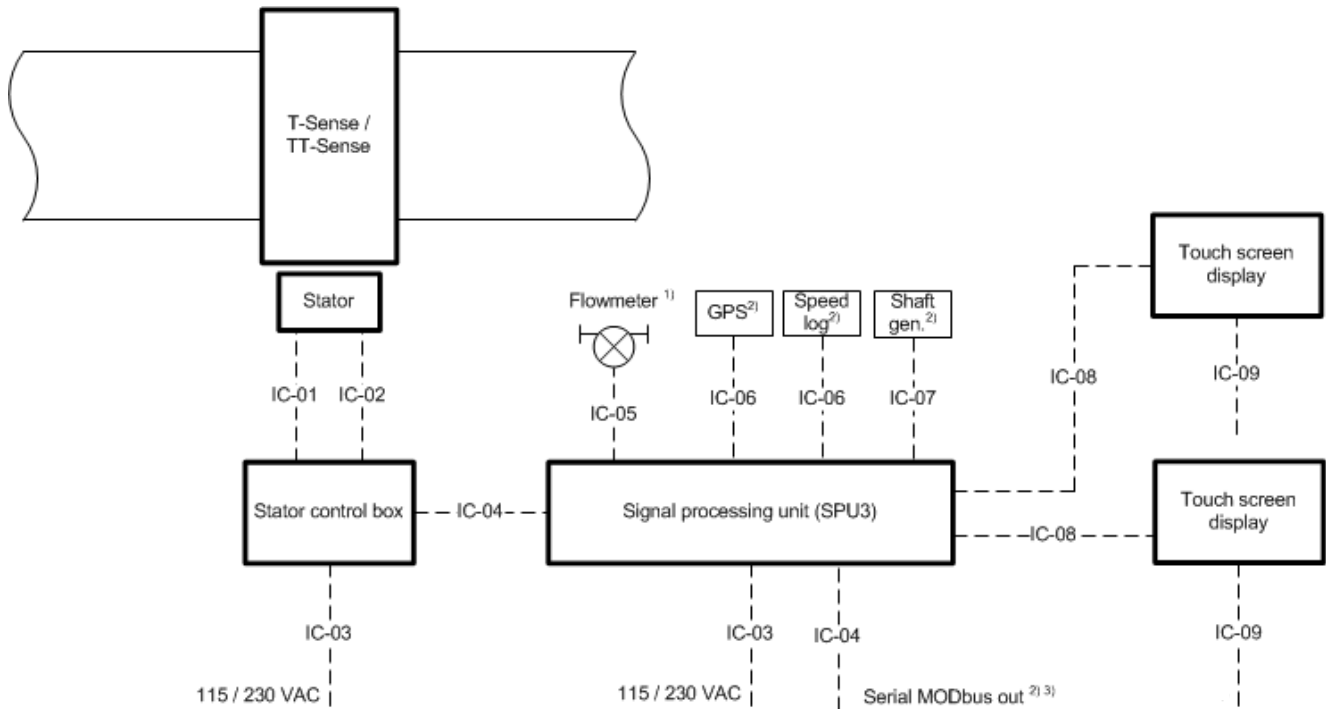
Figure 7 SPU3 Cabinet layout



PT2 Flowmeters should be connected to the SPU3 according drawing/table 0815-2019 in section 17

6.5 Cable Specifications

Specification of the input, output and power supply cables used for connecting the PEM4 + SPU3 system.



¹⁾ Number of flowmeters can add up to max. 12 for 8 engines or consumers

²⁾ Optional

³⁾ When used with VAF Datalogger, please refer to SIG 918 for PC settings and connections

⁴⁾ Pulse and PT100 signals should not be joined within 1 pair

Cable specifications:

IC-01	Integrated antenna cable 5m	VAF supply
IC-02	Integrated stator cable 5m	VAF supply
IC-03	Power supply (115 / 230 VAC) cable	3 x 1,5 mm ²
IC-04	Modbus connection cable	1 x 2 x 0,50 mm ² , twisted pair, braid shielded
IC-05	Flowmeter cable for pulse and PT100 (3m integrated),	2 x 3 x 0,50 mm ² or 4 x 2 x 0,50 mm ² , individual screened twisted pair, braid shielded 4)
IC-06	Connection cable GPS or speed log	1 x 2 x 0,50 mm ² twisted pair, braid shielded
IC-07	Connection cable shaftgen. 4-20mA input	1 x 2 x 0,50 mm ² twisted pair, braid shielded
IC-08	Ethernet cable	Cat6a A/FTP Braid shielded with a RJ45 plug
IC-09	From Power Supply Unit 24 VDC cable 5)	2 x 0,50 mm ²

Table 6 Cable specifications



All screens to be connected under the cable gland on the SPU3 side only. Cable glands are M20 for cable dia. 7-12 mm.



Note: The maximum number of analogue inputs is 9 inputs, depending on the system configuration.

6.6 Connection steps SPU-3

1. Connect the RS485 Modbus output from the stator control box of one T-/TT-Sense® sensor to the SPU3 in accordance with drawing 0815-2019 in section 17. When available, the second T(T)-Sense sensor cable needs to be connected as well.
2. Referring to chapter 17, drawing 0815-2019 for connecting different sensors to the SPU-3.
3. Connect the signal outputs of the flow meters, speed log and/or shaft generator to the SPU3 in accordance with drawing 0815-2019 in section 17.

Cable shields of the flowmeter cables should always be connected to the SPU3 side only.

4. Connect the RJ45 Ethernet output from the SPU3 to the PEM4 touch screen in accordance with drawing 0815-2019 in section 17.
5. Ensure that all relevant signal cables are properly connected and grounded.
6. Connect the power supply to the SPU3 and PEM4 touch screen(s) in accordance with drawing 0815-2019 in section 17.
7. Check if the output data is available on the touch screen(s) through menu <SIGNALS>. If any applicable output data is not available on the touch screen a pop-up alarm screen describing the failure(s) will show up.



Important notes

- Never connect cable shields at both ends to ground, but at one end only, to avoid earth loops.
- Avoid interference on the signal cables by installing them as far as possible away from electric power cables.
- Ensure that the ambient temperature at the SPU3 never exceeds 55°C.

6.7 How to operate

The PEM4 touch screen is designed in such a way that it is easy to operate and self-explaining. By touching the keys on the touch screen gently the next menu is selected, or specific values can be changed.

Browsing through the sections and submenus by touching the relevant keys at the touch screen will help you to find the information you are looking for.

6.7.1 Entering values

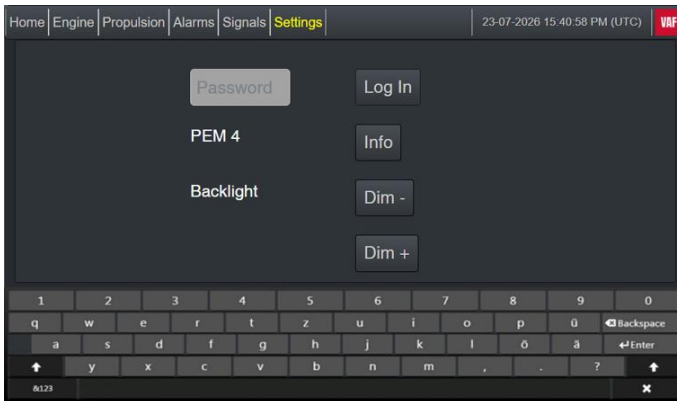


Figure 8 Screen brightness settings

Settings

- Specific values can be changed using the keypad
- By touching the light grey section, the keypad will appear
- Via the <Backspace tap you can remove the current value
- Fill in the section and tap anywhere outside the keypad to close it

6.7.2 Screen brightness settings

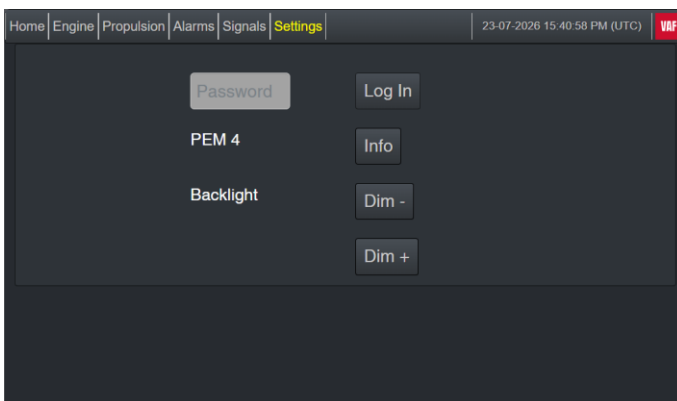


Figure 9 Screen brightness settings

Settings

- Go to Settings
- Touch DIM – to reduce the screen brightness
- Touch DIM + to increase the screen brightness

6.8 Explanation of the menus

The PEM4 + SPU3 system is divided into 6 main menus:

- Home
- Engine
- Propulsion
- Alarms
- Signals
- Settings (User and Advanced)

The first five menus are all relevant system menus for daily use. By touching the relevant keys softly, the specific screen will be displayed.

6.9 Home

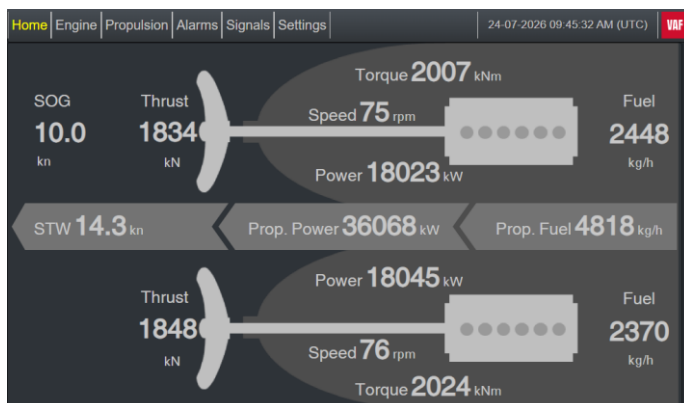


Figure 10 Home

Home

- Click on >Home< to view all main efficiency monitoring indicators

The screen on the left displays an engine layout of two engines. If the ship has only one engine, this screen will look slightly different.

The *Home screen* shows all important actual information regarding the Main Engine(s). Fuel consumption, torque, shaft speed and shaft power will be monitored per propeller shaft line. Propulsion system (if thrust measurement is available) and ship speed (if a speedlog or GPS unit is connected). Fuel consumption can be monitored per engine depending on the number of flow meters incorporated in the fuel system.

Ship's speed input:

In case the speedlog signal or GPS-STW signal is connected to the PEM4 + SPU3 system, the Home screen will show the ship's speed through the water (STW). In case the GPS-SOG signal is connected to the PEM4 + SPU3 system, the Home screen will show the ship's speed over ground (SOG).

Note: If more than one speed signal is connected, the PEM4 + SPU3 system uses the signal selected under Settings → Ship Speed (SOG, speed log STW or GPS-STW) for display and calculations

When both SOG and STW are used as input to the PEM4 + SPU3 system you will be able to detect that the vessel is sailing against or with the current.

For example: When SOG is below STW the vessel is sailing against the current.

6.10 Engine menu

The **Engine** menu is divided into 11 submenus.

The Engine menu is submitting detailed information about the actual and average fuel consumption per consumer, total fuel consumption per engine, actual and average power per engine, total energy consumed and engine efficiency. By selecting a submenu, the output data is shown of the PD volumetric flowmeters, Mass flowmeters, T(T)-Sense sensors, 3rd party torque meters etc. that are directly related to the engine(s) or other consumers.

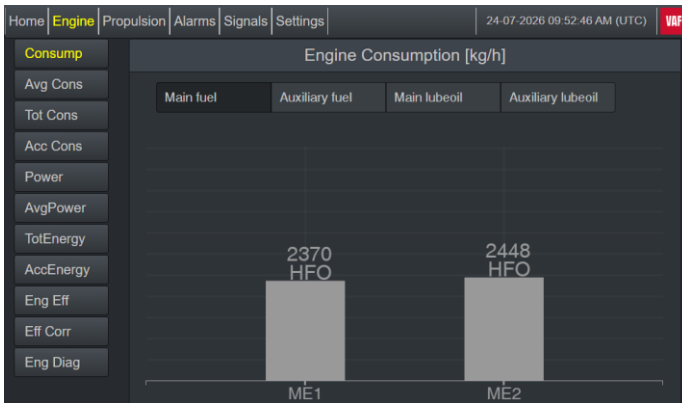


Figure 11 Engine - Consumption

Consumption

Consumption per Engine

For the Main and Auxiliary Fuel consumption, configure the Y-axis range in the Range menu. For more information, refer to the Range section later in this document.

For the Lube Oil graphs, a separate Y-axis range can be configured in the Range menu. For more information, refer to the Range section later in this document.

Engine	Value	1 hr	4 hrs	24 hrs
ME1	2370	0	0	0
ME2	2448	0	0	0
Aux 1	900	0	0	0
Aux 2	120	0	0	0
Aux 3	2400	0	0	0

Figure 12 Engine - Average Consumption

Average Consumption

Average consumption (Fuel & Lubeoil) per engine per 1hr, 4hr and 24hr

Engine	HFO	MDO	Lube 1	Lube 2	Lube 3	Lube 4
ME1	443290	15557	338767	0	15832	2769
ME2	464172	470704	8088	0	7562	0
Aux 1	170399	65284	0	3868	0	6958
Aux 2	22771	63889	0	6778	9463	0
Aux 3	299	464291	974505	0	2410	0
Aux 4	754	341652	775099	0	1485	0
Aux 5	0	227753	0	647977	0	14173

Figure 13 Engine - Total Consumption

Total Consumption

Total consumption per engine and fuel

The values can be set back to zero by touching the Reset button.

Home	Engine	Propulsion	Alarms	Signals	Settings	24-07-2026 10:19:05 AM (UTC)	VAF
Consump	Accumulated Consumption [kg]						
Avg Cons	Engine	HFO	MDO	Lube 1	Lube 2	Lube 3	Lube 4
Tot Cons	ME1	2304307	36146	338908	0	15832	5024
Acc Cons	ME2	2449633	489281	8175	0	8896	0
Power	Aux 1	801334	96225	92	3869	0	7208
AvgPower	Aux 2	913077	78734	167	6779	12143	0
TotEnergy	Aux 3	461209	464330	1055592	0	2410	0
AccEnergy	Aux 4	2156092	341683	805901	0	1485	0
Eng Eff	Aux 5	1912254	227776	1458	680552	0	18389
Eff Corr							
Eng Diag							

Figure 14 Engine - Accumulated Consumption

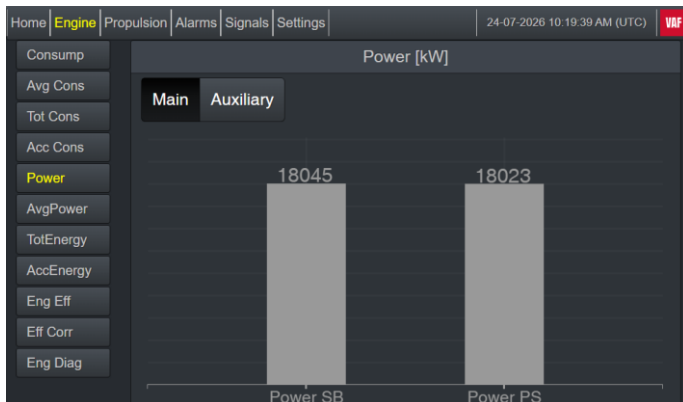


Figure 15 Engine - Power

Home	Engine	Propulsion	Alarms	Signals	Settings	24-07-2026 10:19:59 AM (UTC)	VAF
Consump	Power Averages						
Avg Cons	Main	Auxiliary					
Tot Cons			Value	1 hr	4 hrs	24 hrs	
Acc Cons							
Power	Power SB [kW]		18045	18045	18045	18045	
AvgPower	Power PS [kW]		18023	18023	18023	18023	
TotEnergy	Speed SB [rpm]		76	76	76	76	
AccEnergy	Speed PS [rpm]		75	75	75	75	
Eng Eff							
Eff Corr							
Eng Diag							

Figure 16 Engine - Average Power

Home	Engine	Propulsion	Alarms	Signals	Settings	24-07-2026 10:20:26 AM (UTC)	VAF
Consump	Total Energy						
Avg Cons	Main	Auxiliary					
Tot Cons	Total	Value		Reset All			
Acc Cons							
Power	Energy SB [kWh]	7613371		Reset			
AvgPower	Energy PS [kWh]	7087329		Reset			
TotEnergy	Revolutions SB	3530734		Reset			
AccEnergy	Revolutions PS	3206010		Reset			
Eng Eff							
Eff Corr							
Eng Diag							

Figure 17 Engine - Total Energie

Accumulated Consumption

Accumulated consumption per engine and fuel

Power

Actual power Main Engine(s) and Auxiliary Engines

Average Power

Average power Main Engine(s) and Auxiliary Engines per 1hr, 4 hrs and 24hrs

Total Energie

Total energy Main Engines and Auxiliary Engines

The values can set back to zero by touching the Reset button.

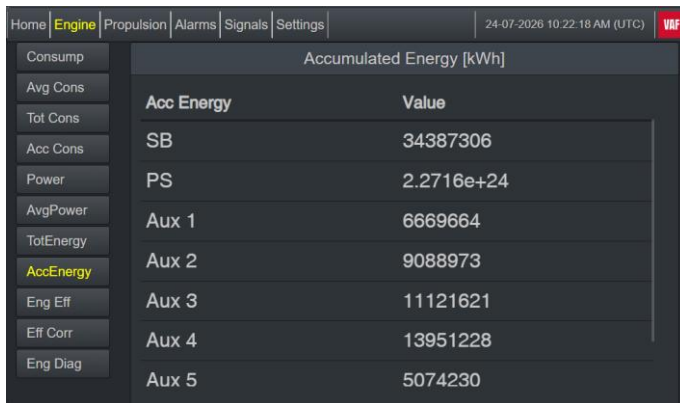


Figure 18 Engine - Accumulated Energie

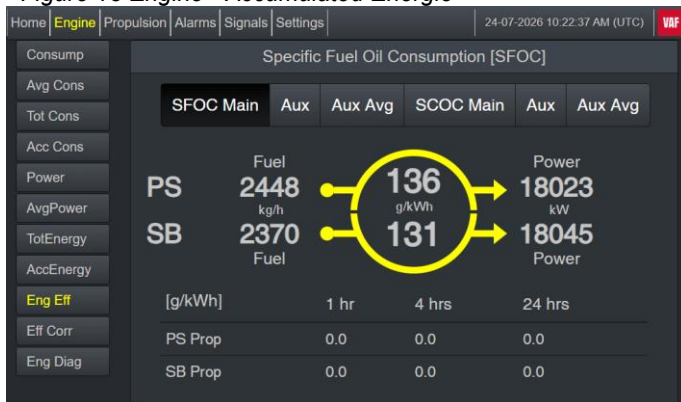


Figure 19 Engine - Engine Efficiency

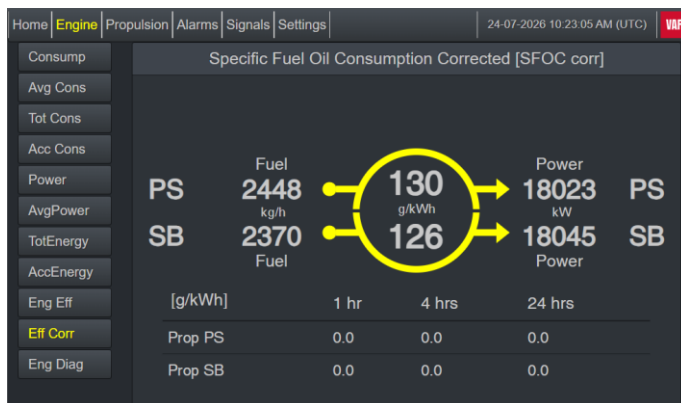


Figure 20 Engine - Efficiency Corrected

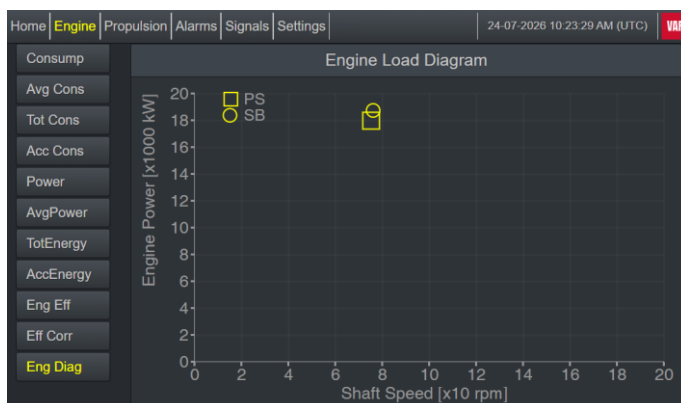


Figure 21 Engine - Engine Diagram

Accumulated Energie

Accumulated energy Main Engines and Auxiliary Engines

Engine Efficiency

Specific Fuel Oil Consumption (SFOC), Main Engine, Auxiliary Engine, Auxiliary Engine Average

Specific Cylinder Oil Consumption (SCOC), Main Engine, Auxiliary Engine, Auxiliary Engine Average

Efficiency Corrected

Specific Fuel Oil Consumption Corrected (SFOC corrected)

Engine Diagram

Engine Load Diagram (Shaft Power vs Shaft Speed)

6.11 Propulsion menu

The Propulsion menu is submitting detailed output data regarding efficiency of the propulsion system. In this menu, the ship speed is the variable that is compared to fuel consumption, CO2 emissions and power generated by the main engines. In the Environment submenu you can look up the ship's Energy Efficiency Operational Indicator (EEOI) value, which is an indicator of the CO2 exhaust gas emissions per nautical mile per cargo load unit.

The **Propulsion** menu is divided into 8 submenus:

- Ship Efficiency
- Propulsive Efficiency
- Propeller Efficiency
- Power/Speed Diagram
- Environment
- Averages
- Trim
- Conning

The submenus contain indicators representing overall ship efficiency, propeller efficiency and EEOI (Energy Efficiency Operational Indicator).

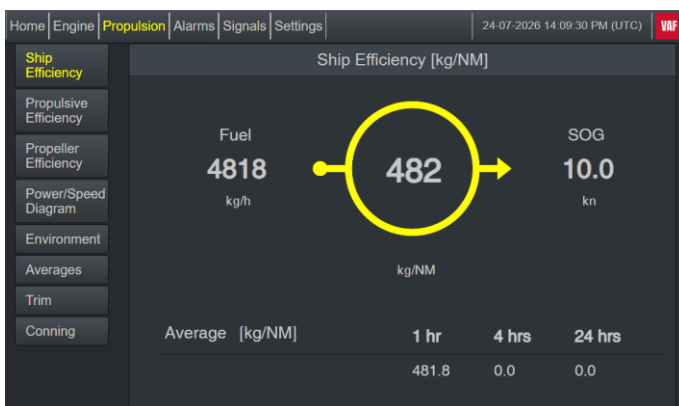


Figure 22 Propulsion – Ship Efficiency

Propulsion – Ship Efficiency

In this submenu the fuel consumption of the main engines and the actual and average fuel consumption per Nautical Mile are indicated.

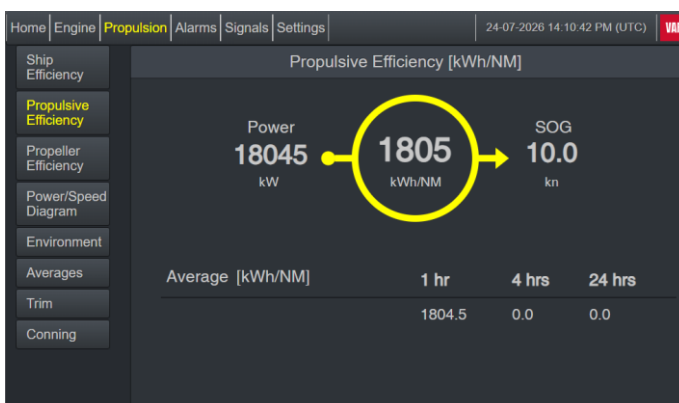


Figure 23 Propulsion – Propulsive Efficiency

Propulsion – Propulsive Efficiency

In this submenu the actual power and the average power level of the main engine(s) are indicated per Nautical Mile.

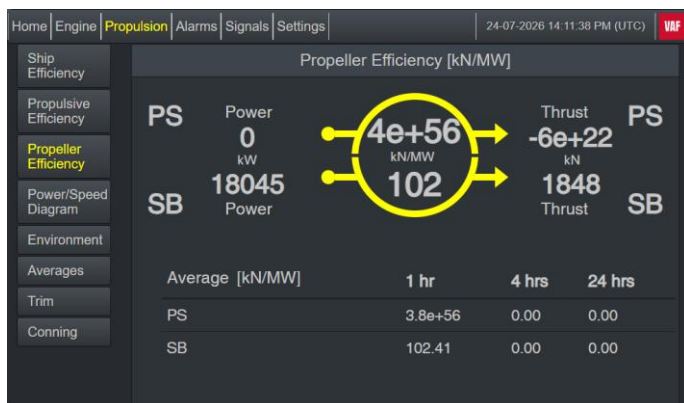


Figure 24 Propulsion – Propeller Efficiency

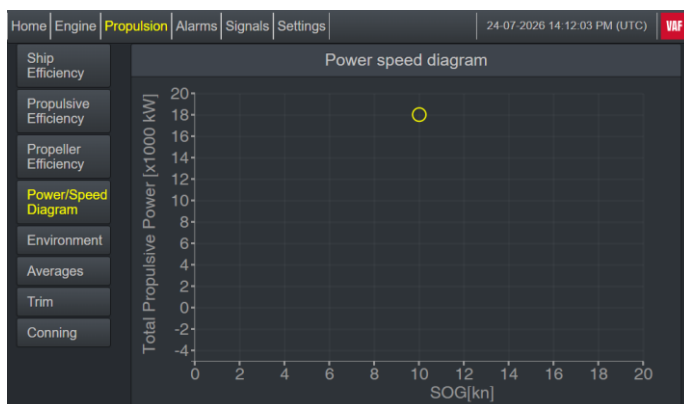


Figure 25 Propulsion – Power/Speed Diagram

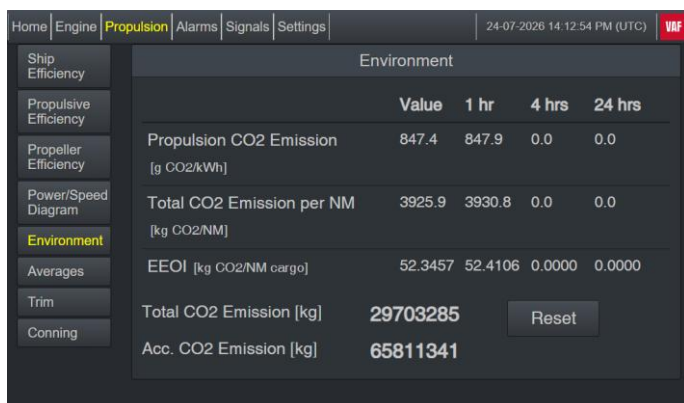


Figure 26 Propulsion - Environment

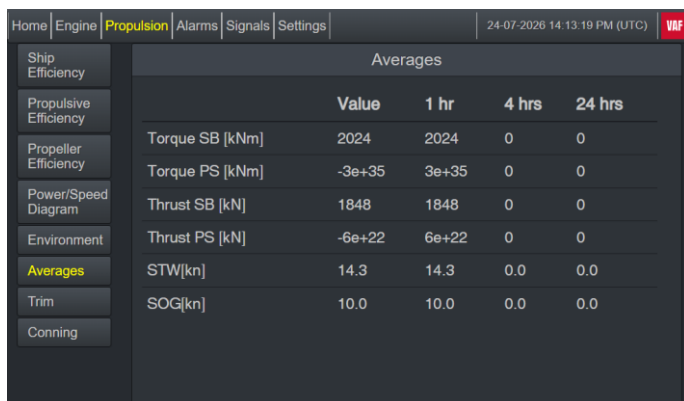


Figure 27 Propulsion - Averages

Propulsion – Propeller Efficiency

Propeller Efficiency indicates the amount of thrust generated per MW propulsion power. The thrust quotient is an indicator of propeller efficiency.

Propulsion – Power/Speed Diagram

In this submenu the actual power of the main engine(s) is presented in a Power/Speed diagram. The graph shows the Total Propulsion Power of the main engine(s) and the respective vessel speed in Nautical Miles. SOG = Speed Over Ground, STW = Speed Through Water.

In the Settings menu there is a possibility to enter a reference curve.

In this case the reference curve is a guideline to judge if the vessel is sailing as efficient as just after sea trials.

Propulsion – Environment

When fuel flowmeters are incorporated in the PEM4 + SPU3 system, this screen displays the CO2 emissions in kg CO2 per kWh.

When an additional speed signal is incorporated, the system also displays the CO2 emissions per nautical mile and the Energy Efficiency Operational Indicator (EEOI). The EEOI represents the CO2 emissions in kilograms per nautical mile per metric tonne of cargo.

The emissions in kg CO2/NM and kg CO2/kWh represent the CO2 emissions of the main engine. The EEOI represents the total CO2 emissions of all consumers monitored by the PEM4 + SPU3 system.

Propulsion - Averages

The Averages submenu indicates the average vessel speed and average torque values.

When Speed Over Ground (SOG) and Speed Through Water (STW) are measured simultaneously you will be able to judge if the vessel is sailing with or against the current



Figure 28 Propulsion - Trim

Propulsion - Trim

The Trim submenu shows the draft, trim and list of the vessel.

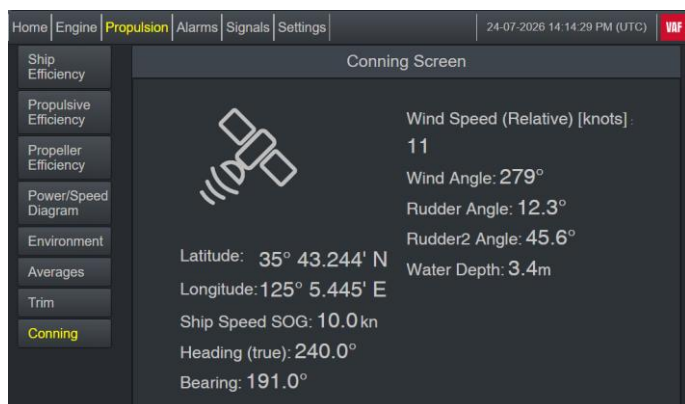


Figure 29 Propulsion - Conning

Propulsion - Conning

The Conning submenu indicates the vessel position, speed through water and the wind speed and angle.

6.12 Alarms menu

At the top of the screen, you will find a key representing the internal alarm functions. In case the PEM4 + SPU3 system detects an alarm, the Alarm key becomes red. An Alarm Message will appear on the Alarm Screen.

In the Signals menu, the output values of the faulty sensor are set to "0" and shown in red. The related values in other menus are also shown in red. When the alarm condition has been eliminated the alarm will no longer be active and the Alarm key will turn to normal again.

The **Alarms** menu is divided into 2 submenus:

- Current Alarms
- Alarm log

6.12.1 Current

Date	Time	Desc.	Extra	Accept
24-07-2026	09:21:50 AM	Engine 1 - Flow Alarm	ME1, volume flow return > supply	Accept
24-07-2026	09:21:55 AM	Mass Flow 1 - CommFail	Mass 1 supply	Accept

Figure 30 Alarms - Current Alarms

Current

- In the situation of an alarm due to an error in the system or for example too high fuel temperature, an alarm message will pop-up in the >Current Alarms< submenu.
- Click on >Alarms< for an overview of the Current alarms
- An overview of all active alarms are shown and can be accepted by touching the >Accept< button behind the specific alarm.

6.12.2 Alarm log

Date	Time	Desc.	Extra	State
24-07-2026	09:21:55 AM	Mass Flow 1 - CommFail	Mass 1 supply	Alarm
24-07-2026	09:21:50 AM	Engine 1 - Flow Alarm	ME1, volume flow return > supply	Alarm
23-07-2026	13:57:28	AuxPower 1 - CommFail		Alarm

Figure 31 Alarms – Alarm log

Alarm Log

- Click on >Alarm log< for an overview of all previous alarms
- This overview can be scrolled vertically for additional information about the alarm
- Click on >Clear Log< to reset the alarm log

The following alarms might appear:

Alarm	Cause
Flowmeter 1-12, pulse sensor fail	Faulty sensor or connection/cable between SPU and meter
Flowmeter 1-12, temp sensor fail	Faulty sensor or connection/cable between SPU and meter
Flowmeter 1-12, temp sensor high	Temperature high set point override
T-Sense 1-2, communication fail	Modbus connection/cable between SPU and control box is broken or wrongly connected. Remark: First try to swap the 2 Modbus signal wires.
GPS/ship speed, communication fail	Connection/cable between SPU and sensor is broken or wrongly connected. Remark: First try to swap the 2 NMEA signal wires.
Shaft Gen. 1-2, sensor fail	Connection/cable or 4-20 mA analogue output is faulty
Shaft Gen. 1-2, communication fail	Modbus connection/cable between SPU and control box is broken or wrongly connected. Remark: First try to swap the 2 Modbus signal wires.
Engine 1-8, flow alarm	Return flow > supply flow
Mass flowmeter 1-12, communication fail	Modbus connection/cable between SPU and AQ-Rate is broken or wrongly connected. Remark: First try to swap the 2 Modbus signal wires.
Mass flowmeter 1-12, invalid units received	Mass flowmeter configured as VAF AQ-Rate, but communicating with non-VAF device
Torque/Speed/Power/Thrust 1-2, communication fail	Connection/cable or 4-20 mA analogue output is faulty
Density/DensTemp/DensVisco 1-6, communication fail	Connection/cable or 4-20 mA analogue output is faulty
AuxPower CommFail	(Modbus connection) Modbus connection/cable between SPU and Aux power sensor is broken or wrongly connected. Remark: First try to swap the 2 Modbus signal wires.
AuxPower Alarm	(Analog connection) Connection/cable or 4-20 mA analogue output is faulty
DraftFront/Mid/Back Alarm	Connection/cable or 4-20 mA analogue output is faulty
Pitch/Roll/Yaw Alarm	Connection/cable or 4-20 mA analogue output is faulty
IO-Module Alarm	No communication with IO backplanes, check flat-cable connection to CPU unit

Table 7 Overview Alarms and possible causes

6.13 Signals menu

The >Signals< tab shows the raw signals which allow you to monitor the raw signals coming in from the T(T)-Sense. Also, other signals like the pulses and temperature of the flow meters, density, ships's speed and other sensors. coming in from the sensors connected to the PEM4 + SPU3 system like flowmeters, GPS etc.

The **Signals menu** is divided into 8 submenus:

- Torque
- Flowmeters
- Density
- Auxiliary Power
- Draft
- Clino
- Ship
- Analog

Signal	Value
Torque 1 [kNm]	2024.000
Torque 2 [kNm]	-2.5443e+35
Speed 1 [rpm]	76
Speed 2 [rpm]	-0
Power 1 [kW]	18045
Power 2 [kW]	-0

Torque

- Click on >Torque< for an overview of all available torque meter data, including Torque, Speed, Power, and Thrust in case of a TT-Sense
- In the screenshot on the left, in total two Torquemeters are installed

Figure 32 Signals – Torque

Signal	Mass flow [kg/min]	Volume flow [l/min]	Temperature [°C]	Density [kg/l]
Mass 10 (Mass)	30.0	30.0	23.3	1.002
Mass 11 (Mass)	20.0	20.0	23.3	0.999
Mass 12 (Mass)	20.0	21.5	122.3	0.823
Aux 3 Return (PD)	-	29.6	37.3	-
Aux 4 Return (PD)	-	8.5	23.6	-

Flowmeters

- Click on >Flowmeters< for an overview of all available flow meter data, including Mass flow [kg/min], Volume flow [kg/min], Temperature [°C] and Density [kg/L]
- In the screenshot on the left, Mass flowmeters (10, 11, 12) are installed. In case a Volume are flowmeter installed (3, 4) with a temperature sensor for compensating to the reference temperature of 15.6 [°C], the mass flow and density values are not measured and therefore not visible.

Figure 33 Signals – Flowmeters incl. mass flowmeters

Home	Engine	Propulsion	Alarms	Signals	Settings	24-07-2026 12:39:15 PM (UTC)	VAF
Torque	Flowmeters	Density	Aux. Power	Draft	Clino	Ship	Analog
Signal	Density [kg/l]	Temp [°C]	Visco [mPa s]				
Density 1st	1.056	111.9	0.0				
Density 2nd	1.186	126.3	0.0				

Figure 34 Signals – Density

Home	Engine	Propulsion	Alarms	Signals	Settings	24-07-2026 12:39:36 PM (UTC)	VAF
Torque	Flowmeters	Density	Aux. Power	Draft	Clino	Ship	Analog
Signal	Value						
Aux 1 [kW]	281						
Aux 2 [kW]	594						
Aux 3 [kW]	926						
Aux 4 [kW]	1313						
Aux 5 [kW]	1597						
Aux 6 [kW]	1883						

Figure 35 Signals – Auxiliary Power

Home	Engine	Propulsion	Alarms	Signals	Settings	24-07-2026 12:40:02 PM (UTC)	VAF
Torque	Flowmeters	Density	Aux. Power	Draft	Clino	Ship	Analog
Signal	Value [m]						
Draft Front	52.8						
Draft Middle SB	55.9						
Draft Middle PS	59.3						
Draft Back	63.1						

Figure 36 Signals – Draft

Home	Engine	Propulsion	Alarms	Signals	Settings	24-07-2026 12:40:35 PM (UTC)	VAF
Torque	Flowmeters	Density	Aux. Power	Draft	Clino	Ship	Analog
Signal	Value [°]						
Pitch	1.7						
Roll	3.6						
Yaw	5.6						

Figure 37 Signals – Clino

Density

- Click on >Density< for an overview of all available ViscoSense 3 and/or ViscoSense 3D data, including Density, Temperature and Viscosity
- In the screenshot on the left, in total two ViscoSense 3D are installed

Aux. Power

- Click on >Aux. Power< for an overview of all available Auxiliary Engine Power data
- In the screenshot on the left, in total six Auxiliary Engines are set

Draft

- Click on >Draft< for an overview of all available draft data

Clino

- Click on >Clino< for an overview of all available Pitch, Roll an Yaw data

Home	Engine	Propulsion	Alarms	Signals	Settings	24-07-2026 12:40:55 PM (UTC)	VAF
Torque							
Flowmeters							
Density							
Aux. Power							
Draft							
Clino							
Ship							
Analog							

Signal	Value
Date-Time	24-07-2026 12:40:54 PM
SOG [kn]	10.0
Latitude	35° 51.041' N
Longitude	125° 22.093' E
STW [kn]	14.3
SOG Long [kn]	0.3

Figure 38 Signals – Ship

Home	Engine	Propulsion	Alarms	Signals	Settings	24-07-2026 12:41:13 PM (UTC)	VAF
Torque							
Flowmeters							
Density							
Aux. Power							
Draft							
Clino							
Ship							
Analog							

Signal	Value
Analog Input 1 [mA]	12.453
Analog Input 2 [mA]	12.952
Analog Input 3 [mA]	13.482
Analog Input 4 [mA]	14.098
Analog Input 5 [mA]	14.555
Analog Input 6 [mA]	15.013

Figure 39 Signals – Analog

Ship

- Click on >Ship< for an overview of all available ship data, in the picture on the left: Date-Time, SOG, Latitude, longitude, STW and SOG Long

By scrolling down, the raw NMEA sentences can be viewed.

Analog

- Click on >Analog< for an overview of all available analog signals in mA
- In the screenshot on the left, in total six analog inputs are used

The following 4-20 mA alarms can be generated:

- **Under range:**
4-20 mA signal below 4 mA
- **Upper range:**
4-20 mA signal above 20 mA
- **Not. Conn. / Twisted:**
analogue 4-20 mA connection/cable is broken or wrongly connected

6.14 Settings - Users

In the >**Settings**< you can change the settings of the PEM4 + SPU3 system. The Settings menu is divided into a protected area for adjusting *User settings* and a protected area for adapting *Advanced settings*.

Adapting Advanced settings should only be done by VAF authorized personnel or in cooperation with VAF authorized representatives.



WARNING:

WRONG SETTINGS MAY RESULT IN SYSTEM FAILURE. VAF INSTRUMENTS B.V. WILL NOT TAKE ANY RESPONSIBILITY FOR OPERATIONS CARRIED OUT BY UNAUTHORIZED PERSONS.

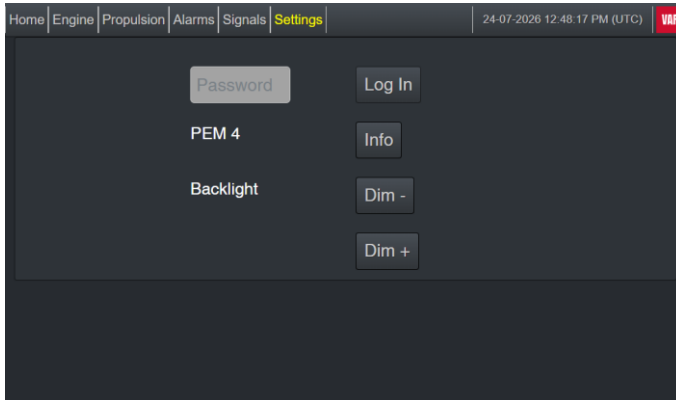


Figure 40 Settings menu

- By entering the password (**1234**) and touching >Log In< the User settings menu is opened

The settings menu for users is divided into 4 submenus:

- Fuel Type
- Engine Flow
- Engine Fuels
- MRV Cargo



Figure 41 Settings – Fuel Type

FUEL TYPE

For a detailed explanation, refer to section 6.8.1

The following fuel parameters can be set per fuel type:

Name of the Fuel	e.g. HFO, VLSFO, MDO, MGO or other
Density	default 0.998 kg/l
Thermal expansion	default 0.070 %/°C
Reference temperature	default 15.6 °C
ROB (Remain on Board)	default 0 ton
CO ₂ conversion factor for calculating the CO ₂ emissions per kg of fuel	default 3.1144 for HFO
Caloric value of the fuel	default 40.87 MJ/kg
Water percentage	default 0 %
Sulfur percentage	default 0 %

Table 8: Default values menu Fuel Type



Unifuel systems:

When a fuel change-over is done with an Unifuel system, please note that the type of fuel needs to be changed for both (sets of) engines.

The standard unit for fuel flow output at the PEM4 touch screen is kilogram. It is possible to read out all fuel consumption measurements in litres instead of kilograms. By selecting the “Consumption in kg/ litres” key at the right upper corner you can switch over from kg to litre and vice versa.

NOTICE

ACCUMULATED FUEL TOTALS BECOME INVALID

Switching the consumption unit from kg to litres, or from litres to kg, makes the accumulated fuel consumption totals incorrect.

- ▶ **Select the consumption unit during commissioning and do not change it afterwards.**
- ▶ **If the unit must be changed, first note down the accumulated totals.**

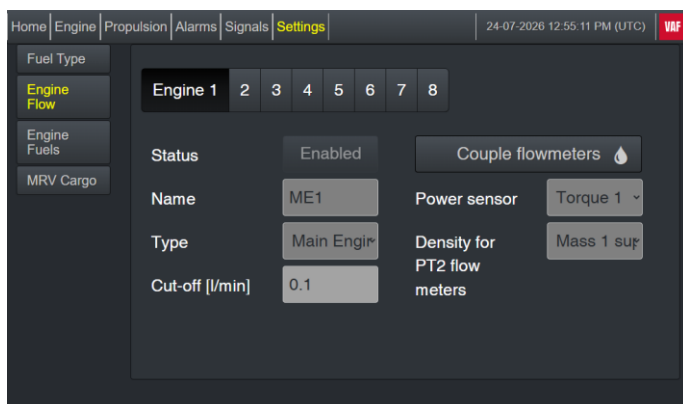


Figure 42 Settings – Engine Flow

ENGINE FLOW

For a detailed explanation, refer to section 6.8.1

ENGINE FUELS

Click on >Engine Fuels< to change the Engine Fuel type per engine/consumer.
In case two different fuels are allocated to an engine/consumer the system can be switched manual or on Temperature (automatic) to the actual fuel the engine/consumer is running on.

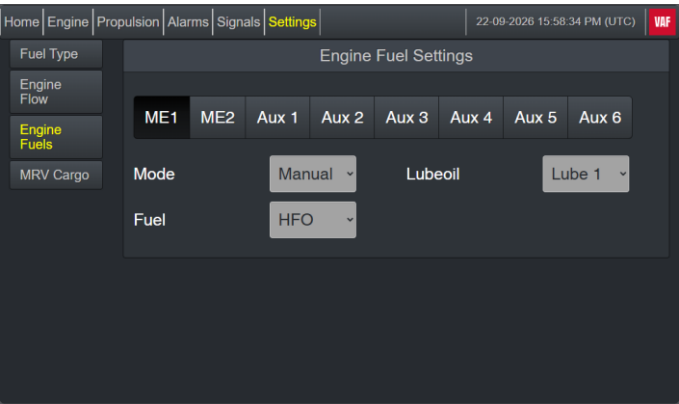


Figure 43 Settings – Engine Fuels – Manual mode

Engine Fuels – Manual mode

For a detailed explanation, refer to section 6.8.2

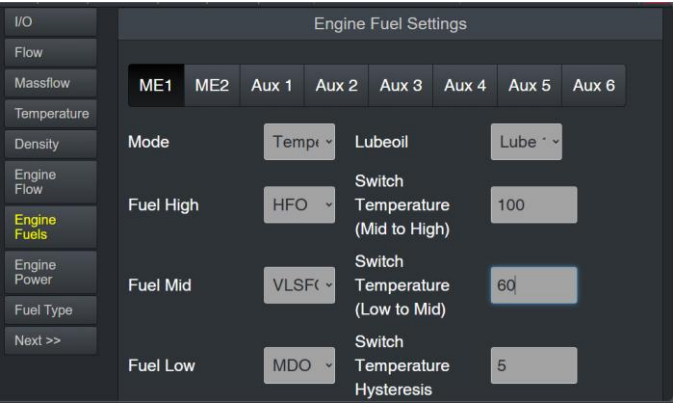


Figure 44 Settings – Engine Fuels – Temperature (automatic) mode

Engine Fuels – Temperature (automatic) mode

For a detailed explanation, refer to section 6.8.2

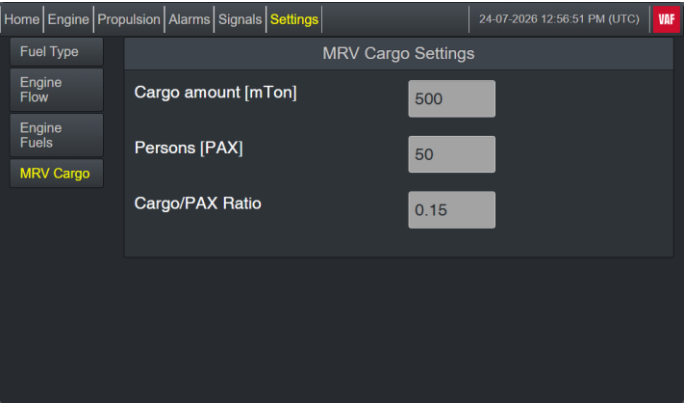


Figure 45 Settings – MRV Cargo

MRV CARGO

For a detailed explanation, refer to section 6.17

6.15 Settings - Advanced level

By entering the “Advanced” password and touching <Log in> the Advanced settings menu is opened. This mode is used to set the customized parameters. These parameters are programmed at the VAF factory as specified by the customer.

Adapting of Advanced settings should only be done by VAF authorized personnel or in cooperation with VAF authorized representatives. The “Advanced” password is only granted by VAF personnel and VAF authorized representatives.

Process control will be interrupted when the PEM4 is in this mode.



WARNING:
WRONG SETTINGS MAY RESULT IN SYSTEM FAILURE. VAF INSTRUMENTS B.V. WILL NOT TAKE ANY RESPONSIBILITY FOR OPERATIONS CARRIED OUT BY UNAUTHORIZED PERSONS.

6.16 Settings - I/O - for configuring I/O modules on the backplanes

In the I/O Settings menu, you can configure the I/O modules/PCBs installed on the backplane(s), see figure below. Three different types of I/O modules can be installed on the backplanes:

- Pulse
- Temperature (3-wire PT100)
- Analog 4-20 mA

These PCB's can be installed in positions A, B, C, and D. Position A on Backplane 1 is always occupied by a 24 VDC power supply module. After the I/O modules have been installed, they must also be configured in the I/O Settings menu on the PEM4 screen.

Follow the steps below to configure the installed I/O modules.

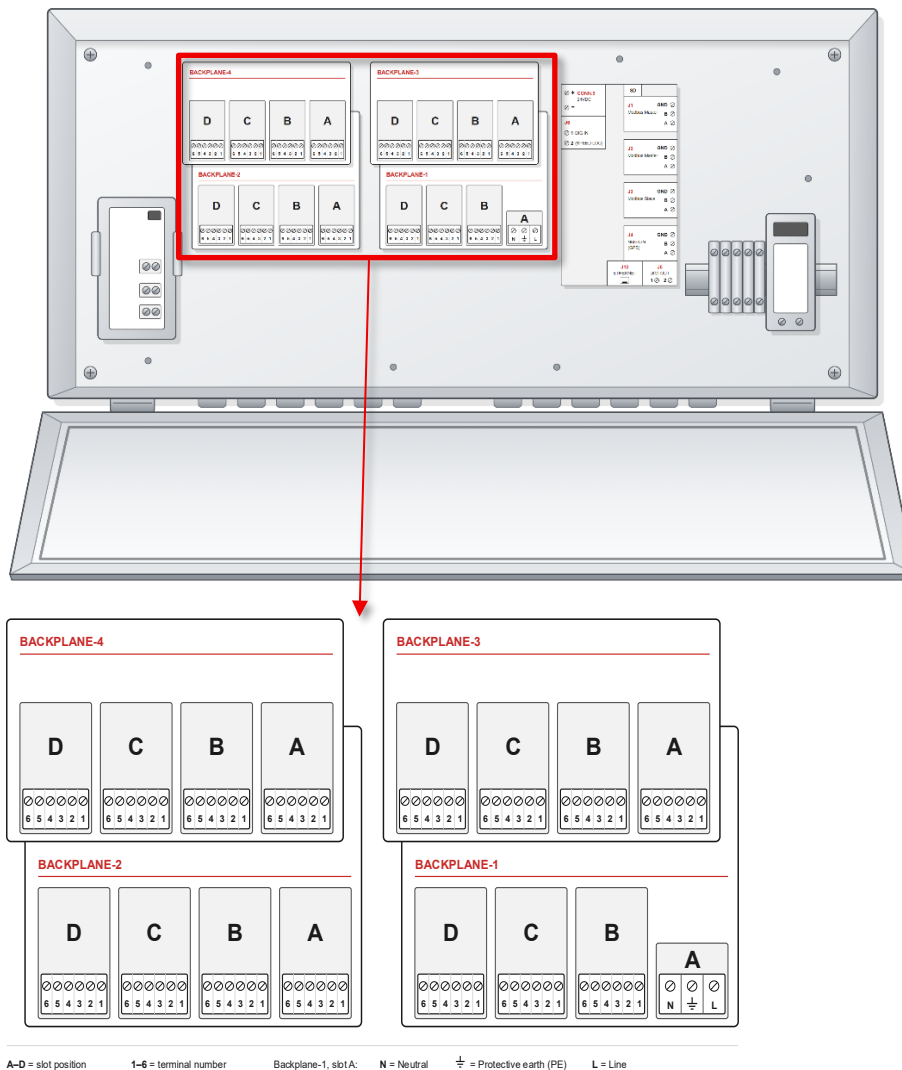


Figure 46 Backplanes 1–4, slot and terminal layout

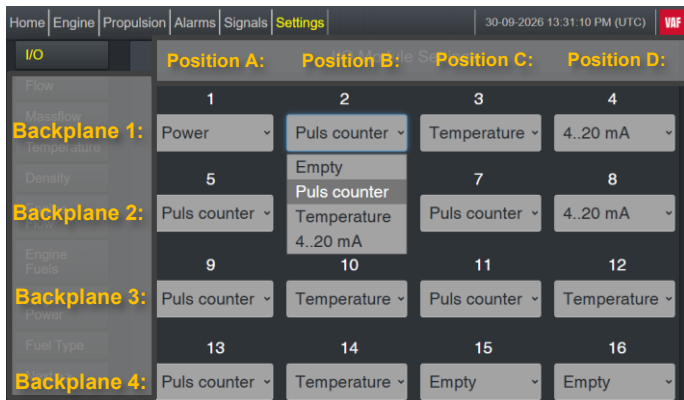


Figure 47 Advanced settings – I/O

I/O – Refer to figure 46

- By entering the advanced password and touching >Log In< the Advanced settings menu is opened
- Click on >I/O< to configure the I/O modules on the backplanes. Select the correct I/O module in the pull-down menu: Pulse counter, Temperature, 4..20 mA

Ensure that the physical location of each I/O module corresponds to the configuration shown here!

6.16.1.1 Analog input numbering

In the screenshot above, position D on Backplane 1 holds an analog 4-20 mA module. Each 4-20 mA module has three analog inputs, and each analog input has two terminals: (+) and (–), see figure 48.

In Figure 47, position D on Backplane 1 represents analog inputs 1, 2 and 3. On Backplane 2, position D represents analog inputs 4, 5 and 6. This is very important when setting up analog sensors!

The leftmost analog input on each 4-20 mA module accepts both passive and active sensor signals. The signal type is detected automatically.

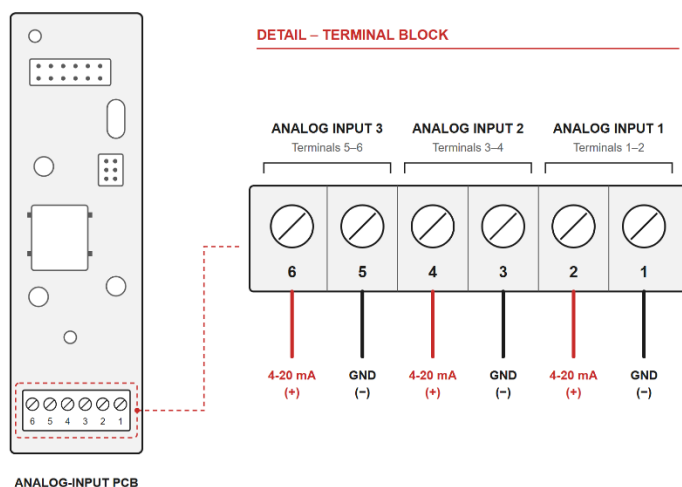


Figure 48 Analog module, three analog inputs, 6 terminals (+)(–)

6.17 Settings - Flow – for configuring the flowmeters including K-factor

In total, up to 2 flowmeters can be connected to one Pulse I/O module.

	Status	Name	K-Factor [puls/l]	Sample-time [s]
1	Enabled	Aux 3 Returr	12.002	10
2	Enabled	Aux 4 Returr	12.003	10
3	Enabled	Aux 5 Returr	12.004	10
4	Enabled	Aux 6 Returr	12.004	10
5	Disabled			

Figure 49 Advanced settings – Flow

Flow

- Click on >Flow< to configure the volumetric flowmeters connected to the I/O module(s)
- Click on Disabled to change the input to Enabled
- Enter the correct name for the flowmeter
- Enter the correct K-factor in pulses per litre. The K-factor can be found on the VAF flowmeter nameplate and/or on its calibration certificate
- Enter the correct sample time in seconds

Default Sample Time: 10 s

6.18 Settings - Temperature – for configuring the Flowmeter Temperature

A volumetric flowmeter measures volume at the actual fuel temperature. To ensure accurate volume and flow rate calculations, the fuel temperature is measured by the VAF flowmeter PT2. This enables the measured volume and flow rate to be temperature-compensated and converted to a reference temperature.

When temperature sensors are integrated into the fuel system, all flow values are converted to the reference temperature of 15.6°C. The difference between the Supply Flow and Return Flow represents the fuel consumption of the engine.

	Status	Hi-setpoint [°C]	Correction
1	Enabled	140	Yes
2	Enabled	140	Yes
3	Enabled	140	Yes
4	Enabled	140	Yes
5	Disabled		
6	Disabled		

Figure 50 Advanced settings – Temperature

Temperature:

- Click on >Temperature< to configure the temperature measured by the Volumetric Flowmeter connected to the I/O module
- Click on Disabled to change the input to Enabled
- Enter the Hi-setpoint [°C] temperature. An alarm will be generated when the measured temperature exceeds this value
- Select from the drop-down menu whether the volumetric flow should be corrected to the reference temperature. In some applications, the flow rate may already be temperature-compensated, in which case no additional correction is required.

6.19 Settings - Massflow

6.19.1 VAF AQ-Rate Modbus

The Massflow menu is used for configuring VAF AQ-Rate mass flowmeters via **Modbus**. Up to 12 AQ-Rate mass flowmeters can be connected to the SPU3.

Connect the Modbus signal from the VAF AQ-Rate to connector J2 (see Figure 2).

For detailed instructions on connecting a VAF AQ-Rate to the SPU3, refer to TIB-229.

Note: The VAF AQ-rate can be connected via either the pulse output or the Modbus interface. However, the use of the Modbus interface is recommended, as it provides more comprehensive and reliable data communication.

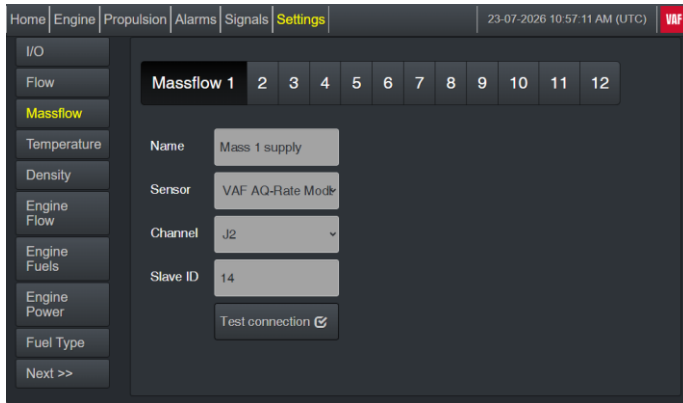


Figure 51 Advanced settings – Massflow, setting up VAF AQ-Rates

- Click on >Settings< and log in in the advanced level menu
- Click on >Massflow<
- Click on >Massflow 1< Select 2, 3, 4 etc. when more VAF AQ-rates are installed
- Fill in the name of the VAF AQ-rate
- At Sensor, select VAF AQ-rate Modbus/RTU
- Select the channel to which the VAF AQ-rate is connected, select J2.
- Enter the correct Slave ID. The Slave ID is the address of the VAF AQ-rate that will be queried by the SPU3/PEM4.
- For the Slave ID, check the serial number on the VAF AQ-rate. The last part of the serial number, after the backslash (\), consists of the letter X or Y followed by three digits.

Example: X004

In this example, the Slave ID is 4.

Serial Number.: 241590365/X004 / 000196
Model Number.: FCB150-F2Y0050R0A1A1C3D2H2

6.19.2 3rd party massflow meter Modbus

The Massflow menu is used for configuring 3rd-party torque meters connected via **Modbus**. Up to 12 third-party massflow meters can be connected to the SPU3.

Connect the Modbus signal from the 3rd party massflow meter to connector J2 (see Figure 2).

For detailed instructions on connecting a 3rd-party massflow meters, refer to the technical manual of the 3rd party supplier.

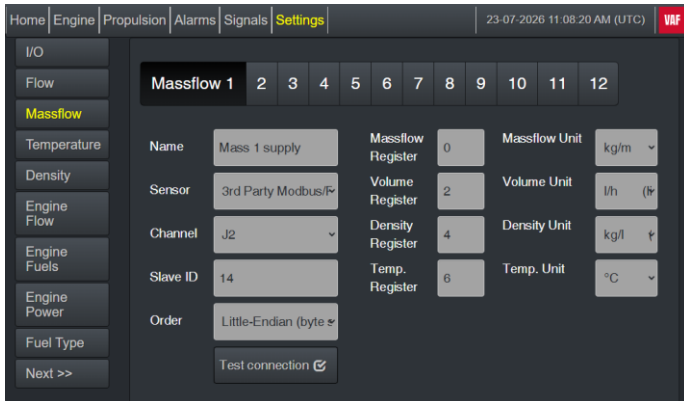


Figure 52 Advanced settings – Massflow, setting up 3rd-Party Massflow meters

Massflow

- Click on >Settings< and log in in the advanced level menu
- Click on >Massflow<
- Click on >Massflow 1< Select 2, 3, 4 etc. when more 3rd Party Torque meters are installed
- Enter a name for the 3rd party massflow meter.
- At Sensor, select 3rd Party Modbus/RTU
- Select the channel to which the third-party massflow meter is connected, select J2.
- Enter the correct Slave ID. The Slave ID is the address of the 3rd party massflow meter that will be queried by the SPU3/PEM4.
- Select the correct byte Order (Big-Endian, Little-Endian (byte swap), Big-Endian (register swap), Little-Endian (byte+register swap))
- Enter the correct Modbus registers for Massflow, Volume, Density and Temperature.
- Select the appropriate Massflow Unit, Volume Unit, Density Unit and Temperature Unit.

6.20 Settings - Density

6.20.1 Density - for configuring VAF ViscoSense3(D) settings

Up to six ViscoSense3(D) sensors can be connected to the SPU3. When using ViscoSense3D, density can also be measured and transmitted to the SPU3. Using the density and temperature input the mass flow within the fuel system can be calculated and be shown on the PEM4 screen.

Because the ViscoSense3D measurement and the volume flow measurement (PT2) possibly have different temperatures, both measurements (mass and volume) will be calculated at reference temperature and accordingly be multiplied with each other to get the mass flow.

The 4-20mA output signals of the ViscoSense 3(D) interface box, density, temperature and viscosity, must be connected to an Analog input module installed on one of the backplanes (see Figure 1). Up to three analog inputs can be connected to a single Analog Input Module. Each input is equipped with two terminals: positive (+) and negative (-).

Follow the steps below to configure the density, temperature, and viscosity inputs from the ViscoSense3(D).

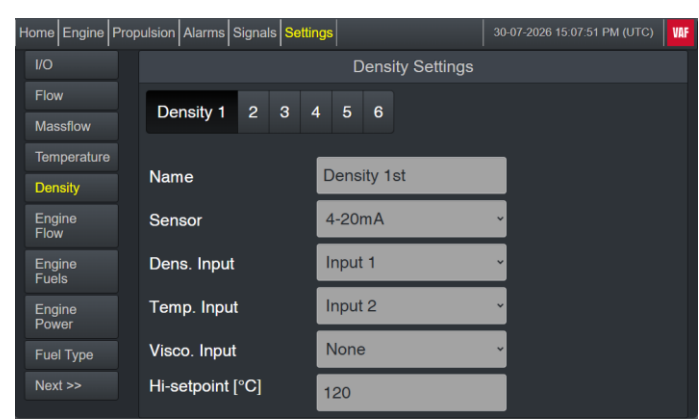


Figure 53 Advanced settings – Massflow, setting up 3rd-Party Massflow meters

Density

- Click on >Settings< and log in in the advanced level menu
- Click on >Density<
- Click on >Density 1< Select 2, 3, 4 etc. when more VAF ViscoSense3(D) sensors are installed
- Enter a name for the VAF ViscoSense3(D).
- At Sensor, select 4-20mA (or disabled if no sensor is installed)
- Select the analog channel to which the Density, Temperature, Viscosity is connected: *Input 1, Input 2, Input 3 etc.

***For input refers to section 6.16**

- Enter the Hi-setpoint [°C] temperature. An alarm will be generated when the measured temperature exceeds this value

Analog input – ViscoSense3(D)		
Signal	Type of input signal	Terminal number on SPU3 Backplane-`X`
Density	4–20mA - active	Terminal nr. X1 and X2
Temperature	4–20mA - active	Terminal nr. X3 and X4
Viscosity	4–20mA - active	Terminal nr. X5 and X6

Table 9 Analog Input – ViscoSense 3(D)



The number of Backplane-“X” might differ per PEM4 configuration, depending on the total system. Please refer to the connection diagram what comes with the project.

6.21 Settings - Engine Flow – for configuring the engine(s)/consumer(s)

Before carrying out the following steps, refer to Appendix C for an explanation of the three different fuel system layouts: Supply, Supply/Return and Unifuel.

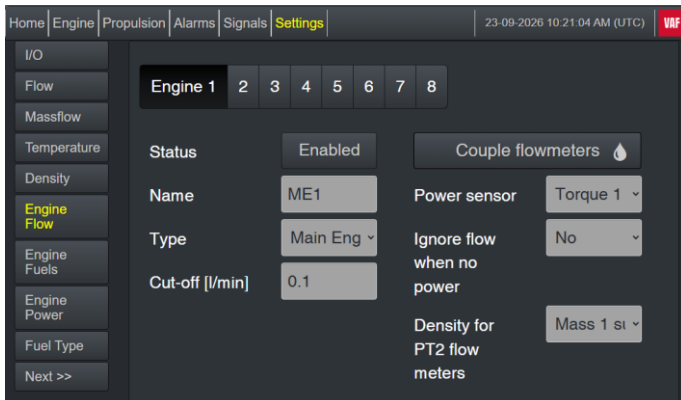


Figure 54 Advanced settings – Engine Flow, setting up an Engine/consumer

- Click on >Settings< and log in in the advanced level menu
- Click on >Engine Flow<
- Click on >Engine 1< Select 2, 3, 4 etc. when multiple (mass) flowmeters are installed and multiple engines/consumers need to be configured.
- Enter a name for engine/consumer.
- At type select the type of the engine/consumer like: Main Engine, Generator, Auxiliary Engine, Boiler Engine, Incinerator, Biodryer, Bunker (meter)
- Set the Cut-off value in L/min for the specific engine/consumer.
- Select the Power Sensor which is installed to the shaft of the corresponding engine. Use the Engine Power menu to configure the Power Sensor.
- Choose where you want to take the Density from. You can select: (Use fueldensity), Density (1,2,3...6)(VS3D), Mass (1,2,3...12)(Massflow)

For coupling flowmeters to an engine/consumer, see the next step!



Figure 55 Advanced settings – Engine Flow, couple Flowmeters to an Engine/Consumer

- For coupling flowmeters to an engine/consumer, click on >Couple flowmeters<
- Under Type, select the flowmeter type, such as a PD (Positive Displacement) Flowmeter or Mass Flowmeter. Depending on the flowmeter configuration, repeat these steps for the Supply, Return, Common, and Leak Common flowmeters.
- Under Name, select the flowmeter name or Mass flowmeter name. De flowmeter name is configured in menu Flow. The mass flow name is configured in menu Massflow
- Under Type, on the right-hand side of the PEM4 screen, select the applicable flowmeter type, such as a PD (Positive Displacement) Flowmeter or a Mass Flowmeter. Repeat this step for the Leak Supply, Leak Return, Lube Supply, and Lube Return flowmeters. If a flowmeter is not installed or not applicable, set the Type to None.
- Repeat this for the name of the flowmeter
- At Temp. Switch, select the temperature source from the PD Flowmeter or Mass Flowmeter.

6.22 Settings - Engine Fuels

6.22.1 Engine Fuels – for configuring the Fuel Settings per engine/consumer

In the *Engine Fuels* submenu, fuel types are assigned to each engine/consumer. If two different fuel types are assigned to an engine/consumer, the system can switch between them either manually or automatically based on fuel temperature, depending on the fuel currently being used by the engine/consumer.

The different fuel types must be entered into the Fuel Type submenu. If this has not yet been done, complete this step first.

When set to “Manual Mode” the type of Fuel can be selected.

When set to “Temperature Mode” the Fuel High, Fuel Mid and Fuel Low can be selected. The system will switch automatically to the specific fuel depending on the “Switching Temperature”.

Higher as switching temperature will select “Fuel High”. Lower as switching temperature will select “Fuel Low”.

When set to “Relay Switch” an external digital signal will be used for fuel switchover. This signal must be connected to connector J6 which is a voltage free contact.

6.22.1.1 Mode: Manual

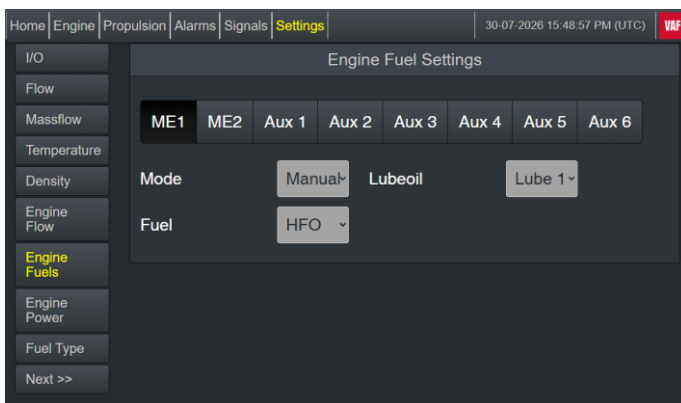


Figure 56 Advanced settings – Engine Fuels, Manual Mode

Engine Flow – Manual mode

- Click on >Settings< and log in in the advanced level menu
- Click on >Engine Fuels<
- Click on >ME1< This is the name of the engine/consumer you gave at submenu Engine Flow.
- Click on one of the other engine/consumer names to configure them.
- At Mode, select Manual if you would like to switch between fuels manually
- At fuel, select the appropriate Fuel were the engine/consumer is running on

6.22.1.2 Mode: Temperature (automatic)

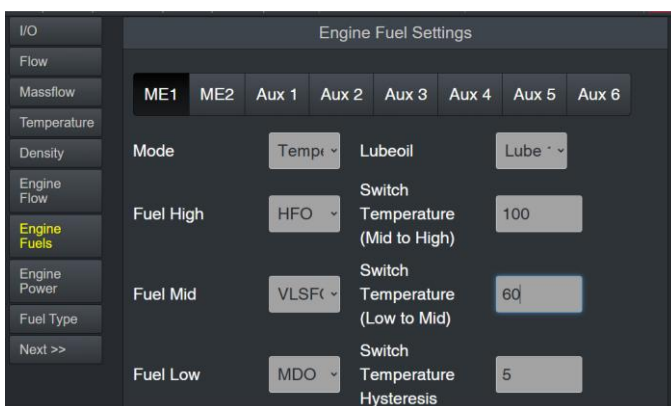


Figure 57 Advanced settings – Engine Fuels, Temperature Mode

Engine Flow – Temperature mode

- Click on >Settings< and log in in the advanced level menu
- Click on >Engine Fuels<
- Click on >ME1< This is the name of the engine/consumer you gave at submenu Engine Flow.
- Click on one of the other engine/consumer names to configure them.
- At Mode, select Temperature if you would like to have an automatic switch between fuels
- Enter the Fuel type at Fuel High, Fuel Mid and Fuel Low and the corresponding Switching Temperature on the left-hand side: Switch Temperature (Mid to High), Switch Temperature (Low to Mid).

For a visual representation of the Temperature mode, see figure below.

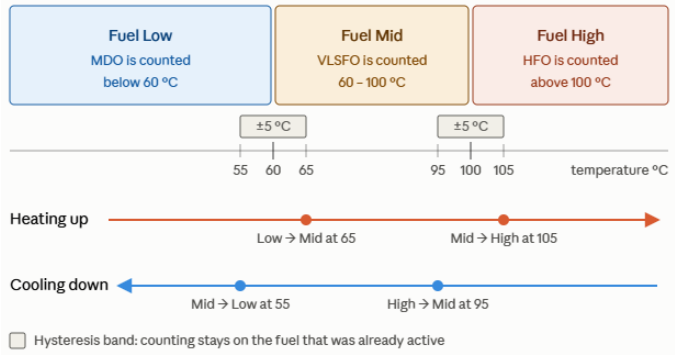


Figure 58 Advanced settings – Engine Fuels, Visual representation Temperature mode

6.22.1.3 Mode: Relay switch

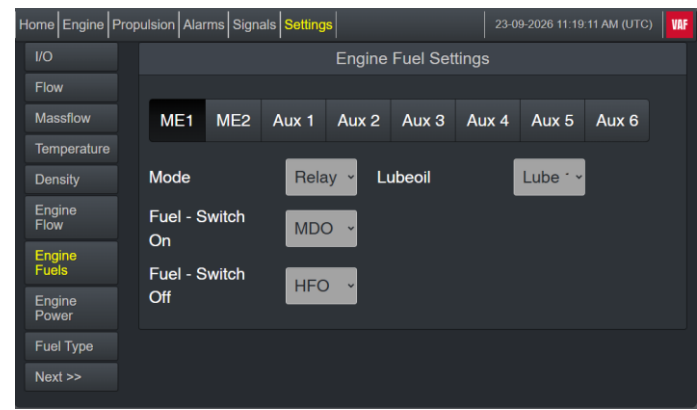


Figure 59 Advanced settings – Engine Fuels, Relay Switch Mode

Relay Switch mode

- Click on >Settings< and log in in the advanced level menu
- Click on >Engine Fuels<
- Click on >ME1< This is the name of the engine/consumer you gave at submenu Engine Flow.
- Click on one of the other engine/consumer names to configure them.
- At Mode, select Relay Switch if you would like to set the Fuel type with an external digital signal on connector J6 (Voltage free contact Max. 30 VDC, 100mA)

6.23 Settings - Engine Power – for configuring the Engine Power meter

There are three options for connecting a power meter to the SPU3:

- Modbus/RTU for T(T)-Sense
- Modbus/RTU for a 3rd party power meter
- Analog 4-20 mA power meter

These connection options are described in the following paragraphs.

6.23.1 MODBUS/RTU for T(T)-Sense

The T(T)-Sense signal must be connected to the J1 Modbus connector (Channel 1). If a second T(T)-Sense device is installed, it must be connected to the J2 Modbus connector (Channel 2).

The J1 and J2 Modbus connectors (Channels 1 and 2, respectively) can also be used for connecting Auxiliary Engine (AE) inputs.

In such configurations, two or more Modbus devices can be connected to the J1 and/or J2 Modbus channels. Each device must be assigned to the appropriate channel (Channel 1 or Channel 2) and configured with a unique Modbus slave address corresponding to the connected device.

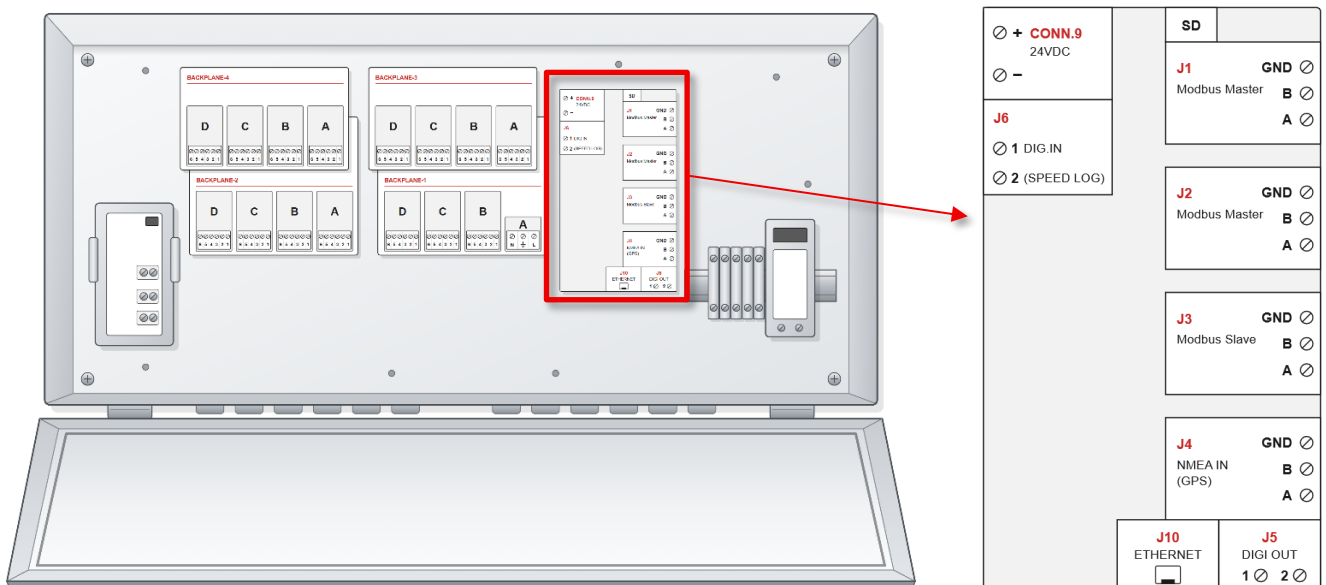


Figure 60 Connector J1 and J2

The T(T)-Sense Stator Control Box slave address is factory set by VAF Instruments.

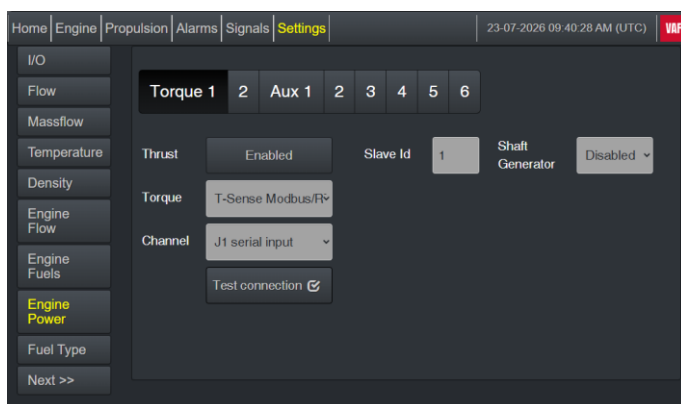


Figure 61 Setting up one or two VAF T(T)-Sense sensors

Torque meter

- Go to >Settings< and log in the advanced level
- Go to Engine Power
- Go to Torque 1 (Torque 2 if a 2nd T(T)-Sense is installed)
- At Torque, select T-Sense Modbus/RTU
- Select channel J1 serial input (Select J2 in tab Torque 2 if a 2nd T(T)-Sense is installed)
- Set the correct Slave Id, the Slave Id is the Id of the T(T)-Sense which will be requested by the SPU3/PEM4
- Enable Thrust if a TT-Sense is installed

6.23.2 MODBUS/RTU FOR 3rd-PARTY TORQUE METER

A 3rd party torque meter will be connected to the J1 Modbus input connection. When a second 3rd party torque meter is installed, the signal will be connected to the J2 Modbus input connection.



Figure 62 Setting up one or two 3rd Party torque meters

- Go to >Settings< and log in in the advanced level
- Go to Engine Power
- Go to Torque 1 (Torque 2 if a second 3rd Party Torque meter is installed)
- At Torque, select 3rd Party Modbus/RTU
- Select channel J1 serial input (Select J2 in tab Torque 2 if a 2nd 3rd-Party Torque meter is installed)
- Set the correct Slave Id, the Slave Id is the Id of the 3rd Party Torque meter which will be requested by the SPU3/PEM4
- Set the correct Modbus registers for Torque, Speed, Power and Thrust
- Select the correct Unit (Kilowatt / Watt), Data type (Float32 / Uint16) and Order (Big-Endian, Little-Endian, Byte-swap big-endian, Byte-swap little-endian)
- Enable Thrust when a 3rd-party torque meter is equipped with a thrust output.

6.23.3 Analog 4-20 mA power meter

It is possible to connect an analog 4-20 mA signal from a power meter to the SPU3 system. The power meter must be equipped with analog 4-20 mA outputs.

The analog 4-20 mA signals can be connected to the SPU3 (Backplane-X) and may represent the torque, speed, and power signals.

Analog input for Torque, Speed and Power		
Signal	Type of input signal	Terminal number on SPU3 Backplane-`X`
Shaft torque signal	4–20mA - active	Terminal nr. X1 and X2
Shaft speed signal	4–20mA - active	Terminal nr. X3 and X4
Shaft power signal	4–20mA - active	Terminal nr. X5 and X6

Table 10 Analog Input – Analog input for Torque, Speed and Power



The number of Backplane-“X” might differ per configuration, depending on the total system. Please refer to the connection diagram what comes with the project.

Make sure that the torque meter settings in the SPU3 system itself are set correctly.

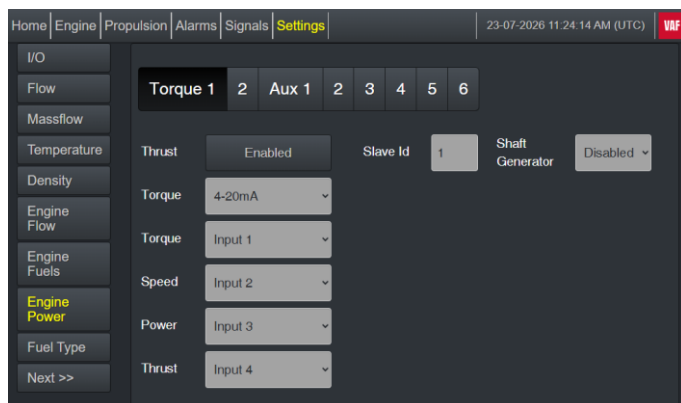


Figure 63 Setting up 3rd-Party Massflow meters

- Go to >Settings< and log in in the advanced level
- Go to Engine Power
- Go to Torque 1 (Torque 2 if a 2nd Torque meter is installed)
- At Torque, select 4-20mA
- Select at Torque, Speed, Power and Thrust (if available) the specific Input*

*For input refers to section 6.16

- Enable Thrust if the installed Torque meter is equipped with a thrust output.

When passive analogue outputs must be connected to the SPU3 system please contact VAF Instruments.

6.24 Settings - Engine Power – for configuring the Shaft Generator

The PEM4 + SPU3 system can calculate the total power generated by the main engine(s) when shaft generators are integrated into the vessel's propulsion system. When the generators are installed on the propeller shaft line (inline or tunnel-gear configuration) or connected to the gearbox as a Power Take-Off (PTO), the PEM4 + SPU3 system combines the propulsion power with the measured generator power to calculate accurate SFOC values for each engine.



Please be aware that the efficiency of the generators themselves is decreasing the overall SFOC value by a certain percentage.

In the Engine Power menu, the Shaft Generator can be configured. The Shaft Generator can be connected to the SPU3 using one of the following methods:

- Analog 4-20 mA input
- Modbus input

6.24.1 Analog 4-20 mA input for Shaft Generator

A maximum of 2 input signals can be connected to the SPU3 representing the shaft generator power level(s).

When 2 passive shaft generator outputs have to be connected to the PEM4 + SPU3 system please contact VAF Instruments.

Analog input for shaft generator		
Signal	Type of input signal	Terminal number on SPU3 Backplane-'X'
Shaft generator one	4–20mA - active	Terminal nr. X1 and X2
Shaft generators two	4–20mA - active	Terminal nr. X1 and X2 + X3 and X4
Shaft generator one	4–20mA - passive	Terminal nr. X5 and X6

Table 11 Analog input for shaft generator



The number of Backplane-"X" might differ per PEM4 configuration, depending on the total system. Please refer to the connection diagram what comes with the project.

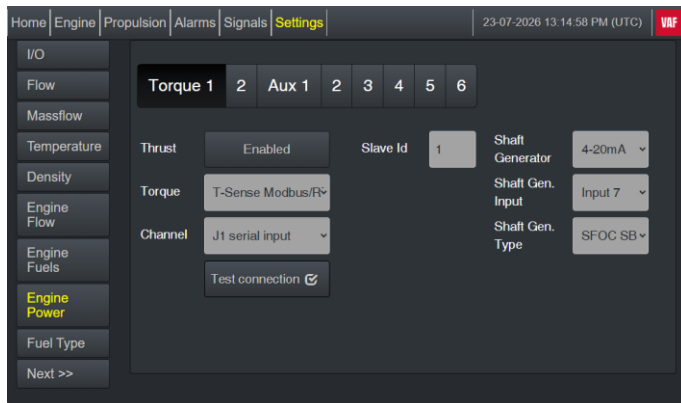


Figure 64 Setting up Analog settings for Shaft Generator

- Go to Settings and log in in the advanced level
- Go to Engine Power
- Go to Torque 1 (Torque 2 if a 2nd Torque meter is installed)
- At Shaft Generator, select 4-20mA
- At Shaft Gen. Input select the specific Input*
- Select Shaft Gen. Type (None, SFOC, SFOC SB, SFOC SB)

*For input refers to section 6.16

6.24.2 Modbus input for Shaft Generator

A maximum of 2 input signals can be connected to the SPU3 representing the shaft generator power level(s).

MODBUS MASTER for shaft generator		
Signal	Type of input signal	Terminal number on SPU3
Shaft generator one	Modbus	Terminal nr. J1
Shaft generators two	Modbus	Terminal nr. J2

Table 12 Modbus Master for Shaft generator

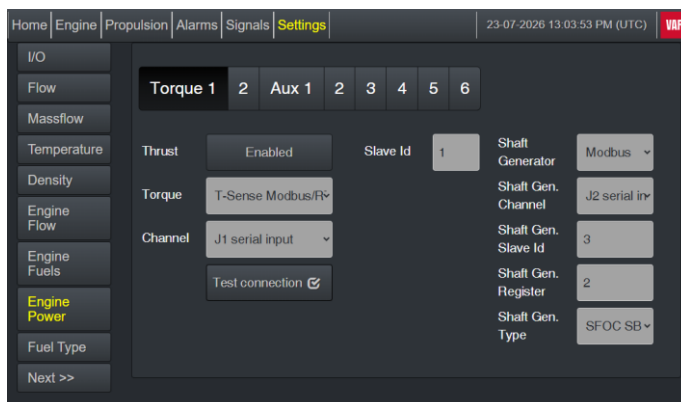


Figure 65 Setting up Analog settings for Shaft Generator

- Go to Settings and log in in the advanced level
- Go to Engine Power
- Go to Torque 1 (Torque 2 if a 2nd Torque meter is installed)
- At Shaft Generator, select Modbus
- At Shaft Gen. Channel select J1 serial input. Select J2 when J1 is already in use
- Set the correct Slave ID, the Slave ID is the ID of the Shaft Generator which will be requested by the SPU3/PEM4
- Set the correct Modbus registers for the Shaft Generator
- Select Shaft Gen. Type (None, SFOC, SFOC SB, SFOC SB)

6.25 Settings - Engine Power – for configuring the Auxiliary Power

When Auxiliary Engines (AE) are monitored by VAF PT2 flow meters, it is possible to measure the Specific Fuel Oil Consumption (SFOC) of the AE driving the generators.

To measure the electric power supplied by the generators to the board net, 4-20 mA signals or Modbus signals representing the power level of the generators can be connected to an input inside of the SPU3. A maximum of 6 AE's can be connected.

A maximum of 6 input signals (4-20 mA or Modbus) can be connected to the SPU3 representing the AE's power level.

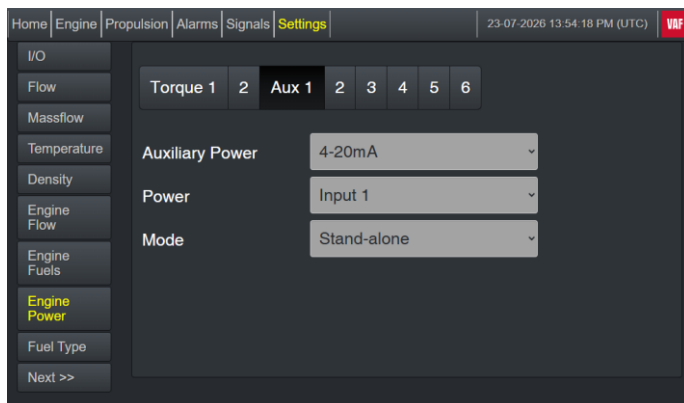
6.25.1 Analog 4-20mA input for Auxiliary Power

Analog 4-20mA input for Auxiliary Power		
Signal	Type of input signal	Terminal number on SPU3 Backplane-'X'
Auxiliary power 1	4–20mA - active	Terminal nr. X1 and X2
Auxiliary power 2	4–20mA - active	Terminal nr. X3 and X4
Auxiliary power ...	4–20mA - active	Terminal nr. X... and X...

Table 13 Analog input for Auxiliary Power



The number of Backplane-"X" might differ per PEM4 configuration, depending on the total system. Please refer to the connection diagram what comes with the project.



Engine Power

- Go to Settings and log in in the advanced level
- Go to Engine Power
- Go to Aux 1 (Choose Aux 2, 3, 4 etc. when more Aux engines are installed)
- At Auxiliary Power, select 4-20mA
- At Power, select the specific Input*
- Select the mode of the Auxiliary Engine (Stand-alone, Diesel-electric propulsion, PTO/PTI (SB-Shaft), PTO/PTI (SB-Shaft))

*Input refers to the position of the analog PCBs on the backplanes in the SPU3. For example, Input 1 corresponds to both terminals (+/-) on the first analog PCB encountered in the system.

Figure 66 Setting up Analog settings for Shaft Generator

6.25.2 Modbus input for Auxiliary Power

Modbus input Auxiliary Power		
Signal	Type of input signal	Terminal number on SPU3
Auxiliary power 1	Modbus	Terminal nr. J1
Auxiliary power 2	Modbus	Terminal nr. J2
Auxiliary power ...	Modbus	Terminal nr. J1

Table 14 Analog input for Auxiliary Power

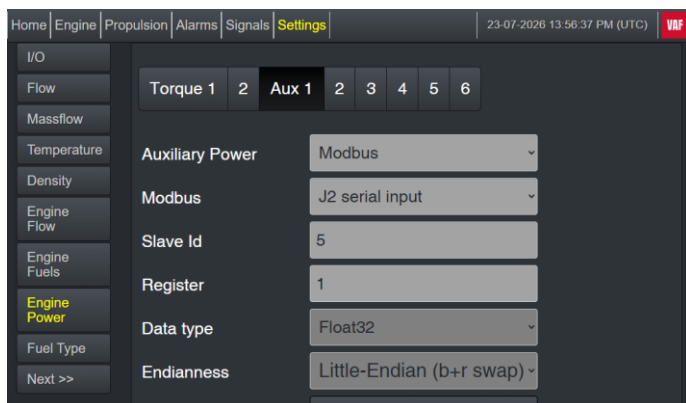


Figure 67 Setting up Analog settings for Shaft Generator

- Go to Settings and log in in the advanced level
- Go to Engine Power
- Go to Aux 1 (Choose Aux 2, 3, 4 etc. when more Aux engines are installed)
- At Auxiliary Power, select Modbus
- At Modbus, select J1 serial input. Select J2 when J1 is already in use
- Set the correct Slave ID, the Slave ID is the ID of the Auxiliary Engine which will be requested by the SPU3/PEM4
- Set the correct Modbus registers for the Auxiliary Engine
- Select the mode of the Auxiliary Engine (Stand-alone, Diesel-electric propulsion, PTO/PTI (SB-Shaft), PTO/PTI (SB-Shaft))

6.26 Settings - Fuel Type – for configuring the Fuel Types

When fuel flow meters are connected to the PEM4 + SPU3 system, Fuel specifications can be set

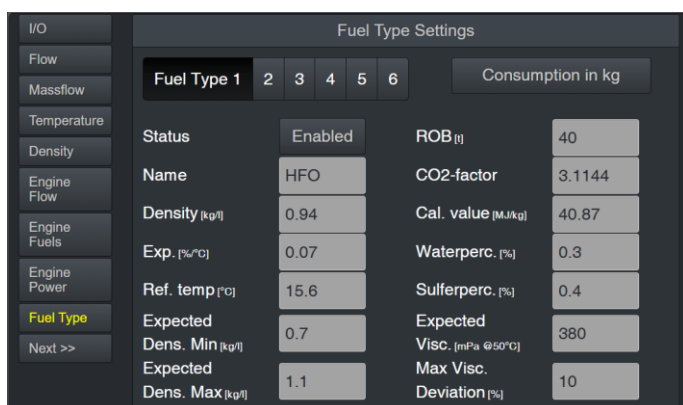


Figure 68 Fuel Type settings

Fuel Type

- Click on >Fuel Type< to change the fuel type specifications like: fuel density, thermal expansion, reference temperature, Remain on Board (ROB), CO2 conversion factor, caloric value, water percentage and sulfur percentage of the fuel can be set.
- Up to six fuel types can be defined
- Each fuel type is freely selectable per engine/consumer through the Engine Fuels submenu.

The following fuel parameters can be set per fuel type:

Name of the Fuel	e.g. HFO, VLSFO, MDO, MGO or other
Density	default 0.998 kg/l
Thermal expansion	default 0.070 %/°C
Reference temperature	default 15.6 °C
ROB (Remain on Board)	default 0 ton
CO ₂ conversion factor for calculating the CO ₂ emissions per kg of fuel	default 3.1144 for HFO
Caloric value of the fuel	default 40.87 MJ/kg
Water percentage	default 0 %
Sulfur percentage	default 0 %

Table 15 Fuel parameters



Unifuel systems:

When a fuel change-over is done with an Unifuel system, please note that the type of fuel needs to be changed for both (sets of) engines.

6.26.1 Consumption in kg or L

The standard unit for fuel flow output at the PEM4 touch screen is kilogram. It is possible to read out all fuel consumption measurements in litres instead of kilograms. By selecting the “Consumption in kg/ litres” key at the right upper corner you can switch over from kg to litre and vice versa.

NOTICE

ACCUMULATED FUEL TOTALS BECOME INVALID

Switching the consumption unit from kg to litres, or from litres to kg, makes the accumulated fuel consumption totals incorrect.

- ▶ **Select the consumption unit during commissioning and do not change it afterwards.**
- ▶ **If the unit must be changed, first note down the accumulated totals.**

6.27 Settings - Ship Speed

Use this menu to configure the Ship Speed settings.

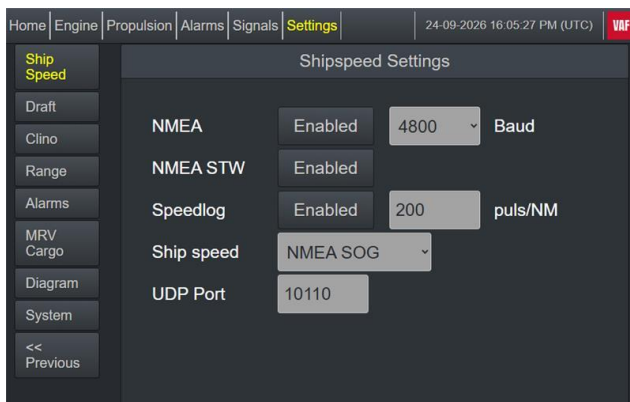


Figure 69 Ship Speed NMEA settings

SHIP SPEED

- Go to Settings and log in in the advanced level
- Click Next
- Go to Ship Speed
- If NMEA is enabled, the screen shown on the left-hand side is displayed. The NMEA signals are then received by the SPU3 via connector J4.
- Set the baudrate. The default value is 4800. Verify the required baudrate with the supplier or the equipment connected to connector J4 on the SPU3.
- At NMEA STW, click Enabled if you want to receive STW data via the NMEA protocol.
- Enable Speedlog if you would like to receive STW via the Speed Log Pulse input (J6).
- Set the pulse per nautical mile (puls/Nm) value according to the specifications of the connected speed log.

In short:

- NMEA STW → **Disabled** → Speedlog Pulse J6
- NMEA STW → **Enabled** → NMEA STW
- At Ship Speed, select either NMEA SOG or NMEA STW. This value is used for KPI calculations.
- UDP Port: 10110 (default port for NMEA multiplexers using NMEA over Ethernet).
- If NMEA data is received via both connector J4 and UDP, the SPU3 combines the incoming NMEA signals and processes data from both sources simultaneously.

6.28 Settings - Draft (4-20 mA)

Use this menu to configure the Draft settings.

Draft	Status	Input
Front	Enabled	Input 1
Middle SB	Enabled	Input 2
Middle PS	Enabled	Input 3
Back	Enabled	Input 4

Distance between front/back sensors: 600 [m]

Distance between PS/SB sensors: 80 [m]

Figure 70 Draft settings

6.29 Settings - Clino (4-20 mA)

Use this menu to configure the Inclino Settings.

Status	Input
Enabled	Input 1
Enabled	Input 2
Enabled	Input 3

Pitch

Roll

Yaw

Figure 71 Inclino settings

DRAFT

- Go to Settings and log in in the Advanced level
- Click Next
- Go to Draft
- Enable or disable the different draft sensors.
- Select for every Draft input the analog input number/channel to which the specific Draft sensor is connected: *Input 1, Input 2, Input 3 etc.

***For input refers to section 6.16**

- Enter the Distance between front/back sensors in meters for calculating the Trim of the vessel
- Enter the Distance between PS/SB sensors in meters for calculating the List of the vessel

Clino

- Go to Settings and log in in the Advanced level
- Click Next
- Go to Clino
- Enable or disable the required sensors (Pitch, Roll, and Yaw).
- Select for every Inclino sensor input the analog input number/channel to which the specific Inclino sensor is connected: *Input 1, Input 2, Input 3 etc.

***For input refers to section 6.16**

6.30 Settings - Range (4-20 mA)

6.30.1 Range settings – Torque, Speed, Power, (Thrust)

Use this menu to configure the Range Settings.

The screenshot shows the 'Range Settings' menu with the 'Torque' tab selected. The menu includes a sidebar with navigation options: Ship Speed, Draft, Clino, Range (highlighted), Alarms, MRV Cargo, Diagram, System, and << Previous. The main area has tabs for Torque, Engine, Aux, Gen, Clino, and General. Under the 'Torque' tab, there are two columns for 'Torque meter 1' and 'Torque meter 2', each with a 'Standard' button and a table of Min and Max values. The table for Torque meter 1 has values: Torque [kNm] (0, 2000), Speed [rpm] (0, 200), Power [kW] (0, 20000), and Thrust [kN] (0, 1000). The table for Torque meter 2 has identical values.

Figure 72 Analog Range settings - Torque

Range – Torque, Speed, Power, (Thrust)

- Go to Settings and log in in the Advanced level
- Click Next
- Go to Range
- Go to Torque
- Enable or disable the required sensors (Pitch, Roll, and Yaw).
- Click Standard to change the setting to Inverse. Use this option only if you want to invert the torque values received from the T(T)-Sense sensor.

Normally, this setting is not required. However, if the torque direction is configured incorrectly in the Stator Control Box, this option can be used to invert the torque values from the T(T)-Sense sensor.

- Configure the 4-20 mA ranges for Torque, Speed, Power, and Thrust (if applicable). These settings are only required when the power meter is connected to the SPU3 using analog 4-20 mA outputs. If Modbus communication is used, these settings are ignored.

6.30.2 Range settings – Engine

Use this menu to configure the analog 4-20 mA ranges for the Engines/consumers. These settings are used when analog 4-20 mA signals are connected to the SPU3.

The screenshot shows the 'Range Settings' menu with the 'Engine' tab selected. The sidebar is the same as in Figure 72. The main area has tabs for Torque, Engine (highlighted), Aux, Gen, Clino, and General. Under the 'Engine' tab, there is a table with Min and Max values for various parameters: Fuel Consump. Rate [kg/h] (0, 5000), LO Consump. Rate [kg/h] (0, 150), Density [kg/l] (0.75, 1.1), Density temp.[°C] (0, 200), and Density visco.[mPa s] (0, 25).

Figure 73 Analog Range settings - Engine

Range - Engine

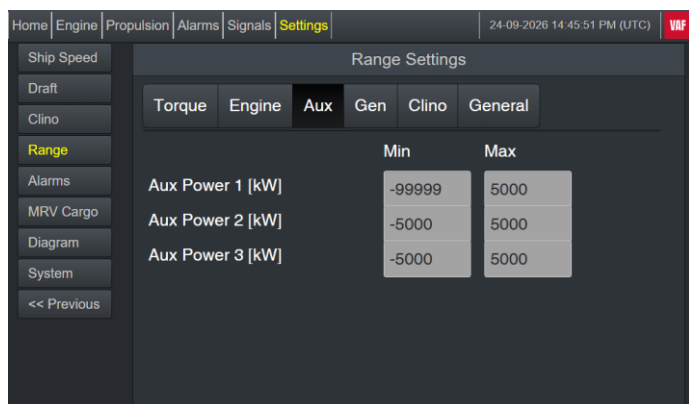
- Go to Settings and log in in the Advanced level
- Click Next
- Go to Range
- Go to Engine
- Set the minimum and maximum values for Fuel Consumption Rate [kg/h]. These values are used only to define the Y-axis scale of the graph in the Engine Consumption menu on the right-hand side of the Home tab. They do not represent a 4-20 mA input range.
- Set the minimum and maximum values for LO Consumption Rate [kg/h]. These values are used only to define the Y-axis scale of the graph in the Engine Consumption menu on the right-hand side of the Home tab. They do not represent a 4-20 mA input range.
- Configure the 4-20 mA ranges for the ViscoSense 3(D). Set the ranges for Density, Temperature, and Viscosity.

Default ranges ViscoSense 3(D):

Density [kg/l] 0.75-1.1
Density Temp [°C] 0 – 200
Density visco [mPa s] 0-25 / 0-50

6.30.3 Range settings – Auxilliary Engine

Use this menu to configure the analog 4-20 mA ranges for the Auxiliary Engine(s). These settings are used when analog 4-20 mA signals are connected to the SPU3.



Range - Aux

- Go to Settings and log in in the Advanced level
- Click Next
- Go to Range
- Go to Aux
- Configure the 4-20 mA ranges for Aux Power 1, Aux Power 2, etc., in [kW].

Figure 74 Analog Range settings - Aux

6.30.4 Range settings – Generator Engine(s)

Use this menu to configure the analog 4-20 mA ranges for the Generator Engine(s). These settings are used when analog 4-20 mA signals are connected to the SPU3.



Range - Gen

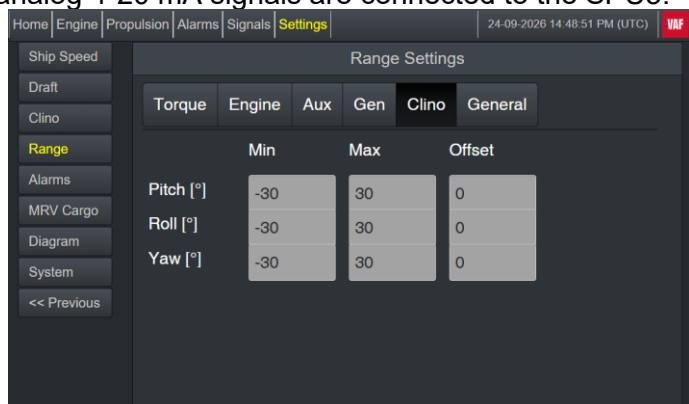
- Go to Settings and log in in the Advanced level
- Click Next
- Go to Range
- Go to Gen
- Configure the 4-20 mA ranges for Shaft Gen 1 in [kW]

Any shaft generators configured in the Engine Power menu using analog 4-20 mA signals will be available in this menu.

Figure 75 Analog Range settings - Gen

6.30.5 Range settings – Clino

Use this menu to configure the analog 4-20 mA ranges for the Clino sensors. These settings are used when analog 4-20 mA signals are connected to the SPU3.



Range - Clino

- Go to Settings and log in in the Advanced level
- Click Next
- Go to Range
- Go to Clino
- Configure the 4-20 mA ranges for Pitch, Roll and Yaw in [°]

Figure 76 Analog Range settings - Clino

6.30.6 Range settings – General

Use this menu to configure the General (Range) Settings.

Figure 77 Analog Range settings - General

- **Range - General**
- Go to Settings and log in in the Advanced level
- Click Next
- Go to Range
- Go to General
- Enter the draft manually in meters. This value is used for the speed axis of the Power/Speed graph.
- Configure the 4-20 mA ranges for Ship Speed [kn] and Draft [m]

6.31 Settings - Alarms

Use this menu to enable or disable alarms for all sensors connected to the SPU3.

Figure 78 Alarms settings

- **Alarms**
- Go to Settings and log in in the Advanced level
- Click Next
- Go to Alarms

In the Alarms menu, alarms for individual sensors can be enabled or disabled.

Check the alarms in the Alarm Log menu of this document.

6.32 Settings - MRV Cargo

Use this menu to configure the MRV Cargo Settings.

Figure 79 MRV Cargo settings

- **MRV Cargo**
- Go to Settings and log in in the Advanced level
- Click Next
- Click on >MRV Cargo< to change the MRV Cargo settings. The amount of cargo, number of persons and the Cargo/PAX Ratio can be set.

MRV (Monitoring, Reporting and Verification) is the European system for monitoring, reporting, and verifying fuel consumption and greenhouse gas emissions from ships. The PEM4 + SPU3 system provides the required fuel consumption and operational data to support MRV reporting.

6.33 Settings - Diagram

Use this menu to configure the Diagram Settings.

The screenshot shows the 'Diagram Settings' menu with a sidebar on the left containing options: Ship Speed, Draft, Clino, Range, Alarms, MRV Cargo, Diagram (highlighted), System, and << Previous. The main area is titled 'Diagram Settings' and has tabs for 'Power-Ship Speed', 'Eng. Load 1-4', and '5-10'. The 'Power-Ship Speed' tab is active, displaying a table with 6 rows of reference points. Each row has columns for 'Name', 'Ship Speed[kn]', and 'Power [kW]'. All values are currently set to 0.

Name	Ship Speed[kn]	Power [kW]
1. Ref. Point 1	0	0
2. Ref. Point 2	0	0
3. Ref. Point 3	0	0
4. Ref. Point 4	0	0
5. Ref. Point 5	0	0
6. Ref. Point 6	0	0

Figure 80 Diagram settings – Power-Ship Speed

Diagram

- Go to Settings and log in in the Advanced level
- Click Next
- Go to Diagram
- The values configured in this menu are used for the following diagrams: the Power vs. Ship Speed diagram, Engine Load 1-4, and Engine Load 5-10.
- This data is used to generate reference lines in these graphs for performance analysis and comparison of measured data.

6.34 Settings - System

6.34.1 System Settings - Factory

Use this menu to configure the factory settings.

Under normal circumstances, these settings do not need to be changed!

NOTICE

CHANGING SYSTEM UNITS AFFECTS LOGGED DATA

The system units can be changed to SI or US units. Changing the system units may affect previously logged totals and historical data. As a result, total values may no longer be directly comparable.

- **Before changing the system units, note down the accumulated totals.**

The screenshot shows the 'Factory Settings' menu with a sidebar on the left containing options: Ship Speed, Draft, Clino, Range, Alarms, MRV Cargo, Diagram, System (highlighted), and << Previous. The main area is titled 'Factory Settings' and has tabs for 'Factory', 'Network', 'Email', 'Password', 'MODBUS', and 'Pulse IO's'. The 'Factory' tab is active, displaying various configuration fields: Date / Time (23-09-2026 - 15:46), Delivery Date (Apr 14 2025), Hull Number (LR4366), Serial Number (SPU300718), System Units (SI), Language (English), Viscosity Unit (mPa s), LCV shop (42.7), and MJ/kg. There are GET and SET buttons next to the Date / Time field.

Figure 81 System - Factory settings

System - Factory

- Go to Settings and log in in the Advanced level
- Click Next
- Go to System
- Go to Factory

Date / Time: Actual Date and Time

Delivery Date: Date when SPU-3 is configured

Hull Number: Number of the Vessel

Serial Number: SN of the SPU-3

- System Units can be changed to SI or US units.
- Viscosity Unit can be changed to mPa·s or cSt. Be aware: the selected viscosity unit must correspond to the unit configured in the ViscoSense 3(D) Interface Box.
- The Lower Calorific Value (LCV) is an internationally standardized value used for SFOC calculations.
- Under normal circumstances, this value should not be changed.

Again, under normal circumstances, these settings do not need to be changed!

6.34.2 System Settings - Network

This menu displays the network settings.

Changes to the network settings should only be made by authorized personnel. If changes are required, please contact VAF Service!

Network Settings						
	Factory	Network	Email	Password	MODBUS	Pulse IO's
Network mode	Static					
IP Address	192.168.150.81					
Netmask	255.255.255.0					
Gateway	192.168.150.254					
Hostname	SPU3					
Zone	.local					
Submit						

Figure 82 System - Network settings

System - Network

- Go to Settings and log in in the Advanced level
- Click Next
- Go to System
- Go to Network

Changes to the network settings should only be made by authorized personnel. If changes are required, please contact VAF Service!

6.34.3 System Settings - Email

This menu displays the Email settings for IVY.

Changes to the Email settings should only be made by authorized personnel. If changes are required, please contact VAF Service!

Factory Settings						
	Factory	Network	Email	Password	MODBUS	Pulse IO's
IMO / Name	4711222	Qualitytest	IVY mailing	Enabled		
SMTP	smtp.gmail.com		Port	587		
Password	*****		SSL/TLS	Disabled		
From	qualitytest@gvafrmail.nl		Mail Interval (minutes)	15		
To	ivy@vaf.nl;Gertjan.Sterkm		Test-mail	Send		

Separate addresses with semicolon ;

Figure 83 System - Email settings

System - Email

- Go to Settings and log in in the Advanced level
- Click Next
- Go to System
- Go to Email

Changes to the Email settings should only be made by authorized personnel. If changes are required, please contact VAF Service!

6.34.4 System Settings - Password

Use this menu to change the password for the Advanced Settings level.

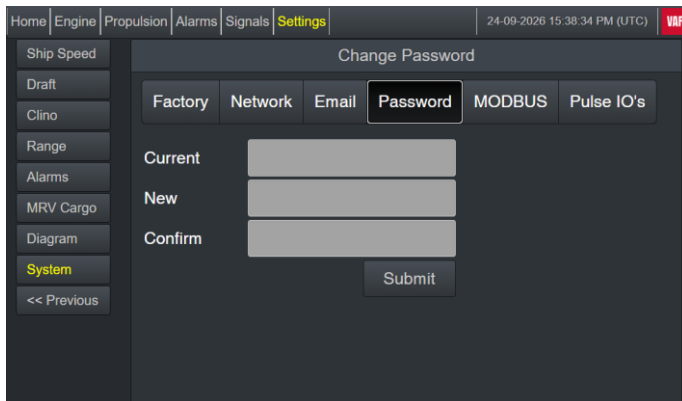


Figure 84 System – Password settings

System - Password

- Go to Settings and log in in the Advanced level
- Click Next
- Go to System
- Go to Password

6.34.5 System Settings - Pulse IO's

Use this menu to change the Pulse-settings for the Pulse IO's.

These settings should only be modified when pulse counting issues are encountered and only after consultation with VAF Service!

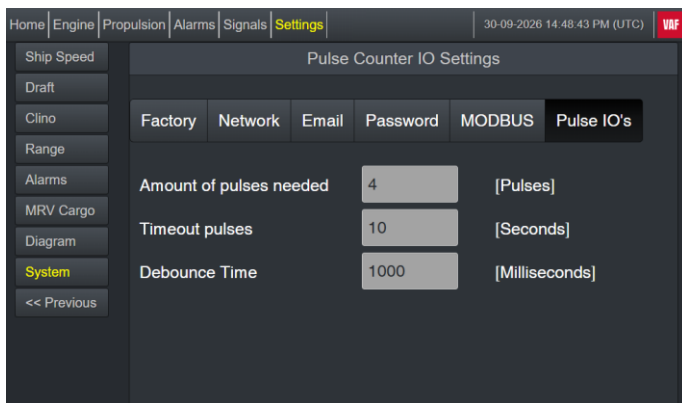


Figure 85 System - Pulse IO's settings

System – Pulse IO's

- Go to Settings and log in in the Advanced level
- Click Next
- Go to System
- Go to Pulse IO's
- Here you can change the:
 - **Amount of pulses needed [Pulses]**
Number of pulses used for the flow calculation. The measured pulse time is divided by this value to determine the flow rate.
Default: 4
 - **Timeout pulses [Seconds]**
Maximum time without a valid pulse before the pulse time is considered invalid and flow calculation is stopped.
Default: 10
 - **Debounce Time [Milliseconds]**
Minimum time between two consecutive pulses. Prevents false pulse detection caused by signal bouncing or noise.
Default: 1000

These settings should only be modified when pulse counting issues are encountered and only after consultation with VAF Service!

6.35 System menu – MODBUS

6.35.1 MODBUS Master – J1 & J2

The SPU-3 has in total 2 Modbus Master connections, J1 and J2.

The settings of the Modbus Master channels can be configured in the Modbus menu under Channel 1 and Channel 2. Here, the baudrate, data bits, parity, and stop bit(s) can be configured.

6.35.2 MODBUS Slave – J3 (Modbus output to external system)

If required, the PEM4 + SPU3 system can be connected to an external system, such as an Alarm and Monitoring System (AMS), via the J3 Modbus Slave connection located on the processor module in the SPU3 cabinet.

The Modbus Slave J3 is disabled by default, unless it has been ordered with the system. If the Modbus output is disabled, contact VAF.

Channel1	Channel2	Output Slave
19200 Baud	9600 Baud	57600 Baud
8 Databits	8 Databits	8 Databits
N Parity	N Parity	N Parity
2 Stopbit(s)	1 Stopbit(s)	2 Stopbit(s)
		1 SlaveID

System Modbus

- Go to Settings and log in in the Advanced level
- Click Next
- Go to System
- Go to Modbus
- Select the correct Baudrate, Databits, Parity, Stopbit(s) and SlaveID in case the SPU-3 will be used as a Modbus Slave (J3)

For the Modbus COM-port settings for reading out the J3 Modbus signal at SPU3, refer to Chapter 4!

Figure 86 Setting up the Modbus Master Channel 1 (J1) & Channel 2 (J2) and Modbus Slave (Output Slave J3)

The Modbus output data is made available at two 16 bits integers which will have to be converted to 32 bits float according to IEEE754.

IEEE754 is a standard for binary floating-point arithmetic.



Modbus address list

To receive a full list containing the available standard SPU3 Modbus addresses (*ASL-668 SPU3 Modbus registers list*) or in case your AMS system is programmed for 16 or 32 bit integer input signals, please contact VAF Instruments for additional information.



In case more than one (1) SPU3 is connected in the same MODBUS-loop, the slave addresses of these SPU3's are factory set resp. slave-"1", slave-"2", etc.

6.36 MODBUS connections - Multidrop

For connection of multiple slaves to J1 and/or J2 Modbus SPU3 master input, following “multidrop” connection and settings need to be considered. This is particularly important when multiple VAF AQ-Rates need to be connected to J1 or J2.

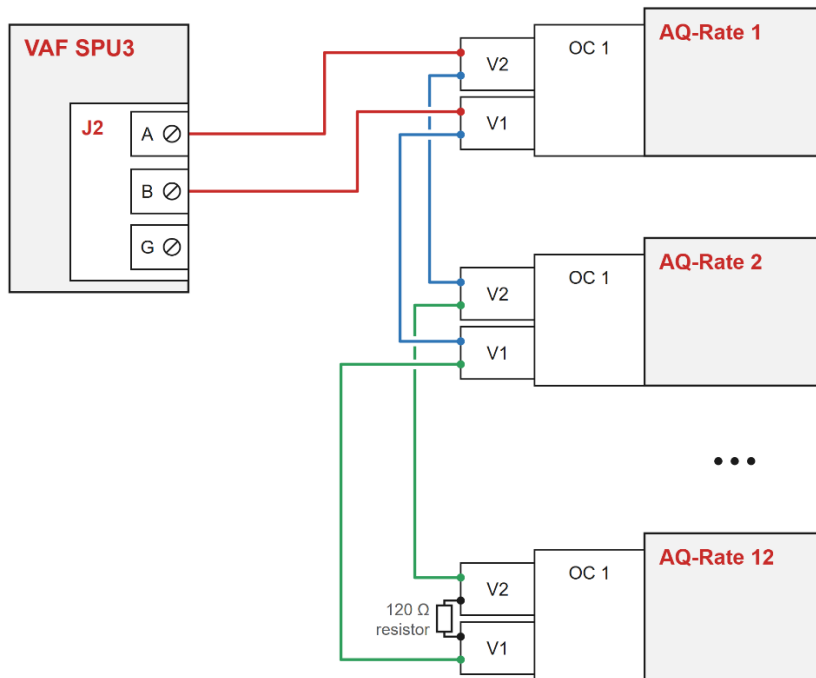


Figure 87 – Multidrop connection diagram with VAF AQ-Rates connected to connector J2 in the SPU-3

The connection loop needs to be “closed” with a termination resistor of 120 ohm.

In the example above the termination resistor needs to be placed at the last connected device which is in this case the AQ-rate 12.

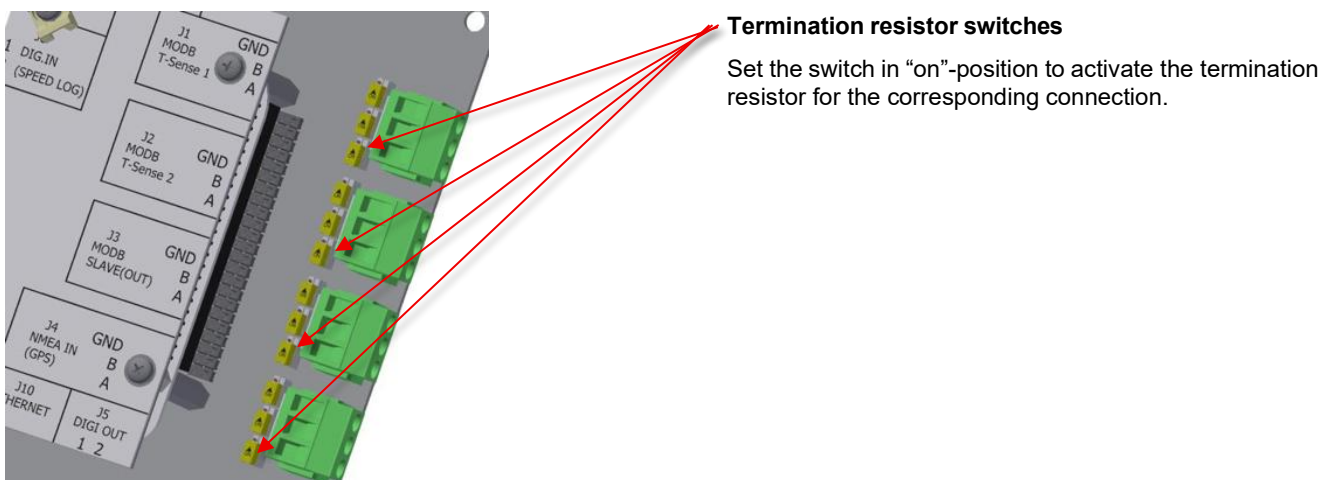


Figure 88 Termination resistor switch

The SPU3 termination resistor can be set by way of a jumper switch in “on”-position.

The termination resistor of the last device depends on the device. This can be done using a resistor or by way of a switch. Please contact your supplier.



NOTE: Do not connect the signal ground to the ship hull.

7. OPERATING PRINCIPLES

7.1 General

A zero-setting procedure is always necessary in order to obtain a correct measurement and reading of the T(T)-Sense.

For more detailed information see section 6.4 of TIB-661 T-Sense® or TIB-664 TT-Sense®.

The PEM4 + SPU3 system is an integrated solution for monitoring engine power, fuel consumption and a wide selection of additional data and indicators. The PEM4 + SPU3 system will display the engine load diagram and the actual load of the main engine. The menu structure of the PEM4 + SPU3 system is self-explaining and the system is easy to operate.

A number of conditional messages will inform you about error/fault conditions if applicable.

Setups determining functionality are subdivided into two levels and access is only possible via a right-of-access code. All setups and computations are stored in a battery backup RAM. The PEM4 + SPU3 system is self-checking as for correct functioning of its memories, program run and existence of supply voltage.

7.2 DISPLAYED PARAMETER AND ENGINEERING UNITS

(*) for a maximum of 8 engines/consumers

The following parameters are available	Unit
Shaft torque	kNm
Shaft speed	rpm
Shaft power	kW
Shaft thrust	kN
Total energy	kWh, MWh, GWh
Total mass	kg
Time-base	hours, minutes, seconds
Shaft generator power (to calculate total power)	kW or MW
Fuel oil flowmeters, max. 12x (*)	l/min
K-factors flowmeters	pulses/litre
Fuel temperature sensors, max. 12x (*)	°C
GPS NMEA Ship's SOG	knots
GPS NMEA Ship's STW	knots
Speed log (input)	pulses/NM
Fuel oil consumption	kg/h, ltr/h or kg/NM, ltr/NM
Specific gravity	kg/l
Thermal expansion	%/°C
Ref. Temperature	°C
Caloric value	MJ/kg
Specific Fuel Oil Consumption (SFOC)	g/kWh
Propeller thrust	kN
Thrust power quotient	kN/MW
Viscosity	mPa*s
Density	kg/l
Draft	m
Ship Speed	kn
Clino	°
Pitch	°
Roll	°
Yaw	°
Ship speed	kn

Table 16 Parameters and Units SPU3

7.3 EXPLANATION OF PARAMETERS

7.3.1 Shaft torque

The shaft torque is measured in the T(T)-Sense® rotor part and sent wireless to the control box. The shaft torque output of the control box is connected to SPU3 via RS485 Modbus. *) **)

7.3.2 Shaft speed

The shaft speed is measured via a gravity sensor in the T(T)-Sense® rotor part and sent wireless to the control box. The shaft speed output of the control box is connected to SPU3 via RS485 Modbus. *) **)

7.3.3 Shaft power

The measured torque and shaft speed are the input values to the power calculation, which is performed in the T(T)-Sense® stator control box. The shaft power output of the control box is connected to SPU3 via RS485 Modbus. *) **)

7.3.4 Shaft thrust (option)

When a TT-Sense® is installed, which additionally measures shaft thrust, the measured thrust is sent wireless to the control box. The shaft thrust output of the control box is connected to SPU3 via RS485 Modbus. *) **)

*) Adjustment of the bar-graph-ranges (“Engine Consumption” and “Engine Power”) and the horizontal/vertical axis (“Propulsion Power/Speed diagram”) at the PEM4 touch screen are programmed at VAF location.

**) Zero torque adjustment will be done during commissioning of the T(T)-Sense® rotor and control box. For more detailed information see section 6.4 of TIB-661 T-Sense® or TIB-664 TT-Sense®.

7.3.5 Shaft generator (option)

The shaft generator output signal should be an active 4–20mA or Modbus signal. The input range is programmed at VAF location.

The total power delivered by the main engine can be calculated by:

Total power main engine = Shaft power + shaft generator power.

Specific Fuel Oil Consumption (SFOC) value is calculated by dividing the engine’s fuel consumption by above mentioned Total power.

7.3.6 Fuel oil consumption

Up to 12 flowmeters, each with a pulse and temperature output, can be connected to the SPU3. The SPU3 can handle a maximum of 8 engines and/or consumers. Please refer to section 3 for the flowmeter pulse and temperature specifications.

The K-factor of each flowmeter is programmed at VAF location or can be set via the settings menu by VAF authorised representatives through the PEM4 touch screen.

7.3.7 Fuel oil temperature

For an accurate calculation of fuel oil consumption, it is recommended to connect PT100 temperature sensors within the system. Temperature sensors are strongly recommended when a supply/return system is programmed. VAF type PT2 flowmeters are as a standard equipped with PT100 temperature

sensors. The PT100 sensors are connected to the SPU3.

The PT100 range is programmed in the SPU3. No further settings are needed.

7.3.8 Speed over ground (SOG) via NMEA0183

A GPS signal can be connected to the SPU3 through the RS422 port (J4).

The ship's speed over ground is hidden in the NMEA0183 protocol. The PEM4 + SPU3 system will read out the \$--VTG sentence ("speed over ground") and the value will be displayed in knots.

No adjustments are needed. ***)

7.3.9 Speed through water (STW) via NMEA0183

A GPS signal can be connected to the SPU3 through the RS422 port (J4).

The *ship's speed through water* is hidden in the NMEA0183 protocol. The PEM4 + SPU3 system will read the NMEA sentences from chapter 17, NMEA sentences.

7.3.10 Speed through water (STW) via pulse signal from speed log

In case the ship's speed is measured with a (Doppler) speed log, the pulse output signal from the speed log's potential free contact is transmitted to the SPU3 through the speed log input (J6).

The ship's speed range is programmed at VAF location or can be set via the settings menu by VAF authorized representatives through the PEM4 touch screen.

The default setting is 200 pulses/nautical mile. ***)

***) The speed which is displayed and used for calculations is depending on the settings and availability of the signal to the input.

STW-NMEA is 1st choice, STW-Speed log is 2nd choice and SOG-NMEA is 3rd choice.

For example in the situation that "NMEA", "NMEA STW" and "Speed log" are selected as "Enable" in the PEM4 settings menu and their signals are available on the inputs. In this situation the PEM4

+ SPU3 system will use STW to display and use for calculations. In case the STW signal is not available, the PEM4 + SPU3 system will automatically use speed log.

7.3.11 Density

A maximum of 6 ViscoSense®3D systems can be connected to the SPU3 system. The density and temperature signals are connected to the SPU3 through analogue 4-20mA signals.

Using density the mass flow and mass consumption can be calculated.

7.3.12 Draft

The draft front, middle SB, middle PS and at the back can be connected to the SPU3 through 3 analogue 4-20mA signals.

7.3.13 Inclino

By use of an inclinometer the pitch, roll and yaw can be connected to the SPU3 through 3 analogue 4-20mA signals.

7.4 METHOD OF CALCULATIONS

Shaft power

Shaft power is calculated from the measured torque and the revolutions of the shaft.

$$P = M \cdot n \cdot \frac{2 \cdot \pi}{60} \quad (F1)$$

P	= Shaft power	[kW]
M	= Torque	[kNm]
n	= Rotations per minute	[rpm]

Total energy

Total energy is calculated from the integrating shaft power over time

$$E = \sum_t P_t \cdot \Delta t \quad (F2)$$

E	= Total energy	[kWh]
P_t	= Power at time t	[kW]
Δt	= Sample rate	[sec]

Specific gravity

The fuel oil specific gravity is a fixed or measured (ViscoSense®3D) value in the PEM4 system.
The reference temperature (15.6°C default) can be set per fuel type.

γ_T	= Specific gravity at T temperature	[kg/l]
$\gamma_{15.6}$	= Specific gravity at reference temperature	[kg/l]

Fuel oil consumption

Fuel oil volume flow measured by our VAF Series PT2 flowmeter is giving a fixed number of pulses per litre to the SPU3. Volume flow calculation is as follows:

$$\Delta V = \frac{\Delta p}{K_factor} \quad (F3)$$

ΔV	= Volume from one measurement	[litres]
Δp	= Number of pulses	[p]
K_factor	= Pulses per litre from flowmeter	[p/l]

Total volume flow

$$V = \sum \Delta V \quad (F4)$$

V	= Total Volume	[litres]
ΔV	= Volume from one measurement	[litres]

Volume flow rate

$$Q = \frac{\Delta V}{\Delta t} \quad (F5)$$

Q	= Flow rate	[l/sec]
ΔV	= Volume from one measurement	[litres]
Δt	= Sample rate	[sec]

$$Q_{tc} = Q \cdot \frac{\gamma_t}{\gamma_{15.6}} \quad (F6)$$

Q_{tc}	= Temperature compensated flow rate	[l/sec]
Q	= Flow rate	[l/sec]
$\gamma_{15.6}$	= Specific gravity at reference temperature	[kg/l]
γ_t	= Specific gravity heated to a temperature	[kg/l]

or:
$$Q_{tc} = Q \frac{1}{1 + (\Delta T \cdot \frac{gc}{100})} \quad (F7)$$

ΔT	= Temperature difference	[°C]
gc	= Thermal expansion (Gravity change)	[%/°C]

$$\Delta V_{tc} = \Delta V \cdot \frac{\gamma_t}{\gamma_{15.6}} \quad (F8)$$

ΔV_{tc}	= Temperature compensated volume	[litre]
ΔV	= Volume from one measurement	[litres]
$\gamma_{15.6}$	= Specific gravity at reference temperature	[kg/l]

γ_t = Specific gravity heated to a temperature [kg/l]

or:
$$\Delta V_{tc} = \Delta V \frac{1}{1 + (\Delta T \cdot \frac{gc}{100})}$$
 (F9)

ΔT = Temperature difference [°C]

gc = Thermal expansion (Gravity change) [%/°C]

$$\Delta M = \rho \cdot \Delta V_{tc}$$
 (F10)

ΔM = Mass from one measurement [kg]

ρ = Density [kg/l]

ΔV_{tc} = Temperature compensated volume [litre]

$$M = \sum \Delta M$$
 (F11)

M = Total Mass [kg]

ΔM = Mass from one measurement [kg]

$$G = \frac{\Delta M}{\Delta t}$$
 (F12)

G = Mass flow rate [kg/sec]

ΔM = Mass from one measurement [kg]

Δt = Sample rate [sec]

Specific Fuel Oil Consumption rate (S.F.O.C.)

$$SFOC = \frac{G \cdot 1000}{P}$$
 (F13)

$SFOC$ = Specific Fuel Oil Consumption [g/kWh]

G = Mass flow rate to M/E [kg/h]

P = Shaft power [kW]

Specific Cylinder Oil Consumption rate (S.C.O.C.)

$$SCOC = \frac{G \cdot 1000}{P} \quad (F14)$$

<i>SCOC</i>	= Specific Cylinder Oil Consumption	[g/kWh]
<i>G</i>	= Mass flow rate to M/E lubrication oil	[kg/h]
<i>P</i>	= Shaft power	[kW]

Ship efficiency

$$FOC = \frac{G}{v} \quad (F15)$$

<i>FOC</i>	= Fuel Oil Consumption	[kg/Nautical Mile]
<i>G</i>	= Mass flow rate to M/E	[kg/h]
<i>v</i>	= Ship speed	[knots]

Thrust quotient

$$TQ = \frac{T}{P / 1000} \quad (F16)$$

<i>TQ</i>	= Thrust quotient	[N/kW]
<i>T</i>	= Thrust	[kN]
<i>P</i>	= Shaft power	[kW]

This quotient indicates the amount of thrust generated per MW propulsion power. The thrust quotient is an indicator of propeller efficiency. Be aware that propeller thrust and ship speed influence each other.

Propulsive Efficiency

$$\eta_P = \frac{P}{v} \quad (F17)$$

η_P	= Propulsive efficiency	[kWh/NM]
<i>P</i>	= Shaft power	[kW]
<i>v</i>	= Ship speed	[Knots]

Total CO2 Emission

$$\Delta C = \Delta M \cdot K_{CO2} \quad (F18)$$

$$CO2_{tot} = \sum \Delta C \quad (F19)$$

DC	= CO2 Emission	[kg]
DM	= Mass fuel consumption from	[kg]
K_{CO2}	= CO2 conversion factor	[kg CO2 / kg fuel]
$CO2_{tot}$	= Total CO2 Emission	[kg]

$$M_{CO2} = \frac{\Delta C}{\Delta t} \quad (F20)$$

M_{CO2}	= Mass CO2 emission rate	[kg CO2 / h]
DC	= CO2 emission due to one measurement	[kg]
Dt	= Sample rate	[h]

Fuel CO2 Emission (FCO2)

$$FCO2 = \frac{M_{CO2}}{v} \quad (F21)$$

$FCO2$	= Fuel CO2 emission	[kg CO2/NM]
M_{CO2}	= Mass CO2 emission	[kg CO2 / h]
v	= Ship speed	[Knots]

Specific Fuel CO2 Emission (SFCO2)

$$SFCO2 = \frac{M_{CO2} \cdot 1000}{P} \quad (F22)$$

$SFCO2$	= Specific fuel CO2 emission per main engine	[g CO2/kW]
M_{CO2}	= Mass CO2 emission	[kg CO2 / h]
P	= Shaft power	[kW]

Energy Efficiency Operational Indicator (EEOI)

$$EEOI = \frac{M_{CO_2}}{Cargo \cdot Distance} \quad (F23)$$

<i>EEOI</i>	<i>[kgCO₂ / ton·NM]</i>
<i>M_{CO₂}</i>	<i>[kg CO₂ / h]</i>
<i>Cargo</i>	<i>[ton or TEU or persons]</i>
<i>Distance</i>	<i>[NM]</i>

This quotient indicates the operational efficiency of your vessel. The EEOI is taking into account CO₂ emissions from your consumers, which are monitored by the PEM4 system, the mass of cargo in DWT, number of TEU or number of persons and the distance sailed.

8. MAINTENANCE

No special maintenance is needed for the PEM4 equipment. The touch screen can be cleaned with a dry and clean cloth. Do not use any cleaning product or chemical on the screen.



When removing a PEM4 + SPU3 system precautions must be taken to prevent personal injuries and damage to the touch screen and SPU3.

9. REPAIR

Nothing on the PEM4 + SPU3 system can be repaired on site.

10. TAKE OUT OF SERVICE

Switch off the 24VDC and/or 230/115 VAC power supply.

11. REMOVAL AND STORAGE OF EQUIPMENT

Switch off the 24VDC and 230/115 VAC power supply.

Make sure that all wires that are connected to the PEM4 + SPU3 system are labelled correctly so that re-installation of the PEM4 + SPU3 system can be done without any errors.

Disconnect all the input and output wires.

Store the PEM4 + SPU3 system in a box in a cool and dry place, so that the PEM4 + SPU3 system cannot be damaged.

12. MALFUNCTION AND SEND FOR REPAIR

If the PEM4 + SPU3 system stops working completely contact VAF Instruments Service for instructions.

In the event the PEM4 + SPU3 system parts must be sent back for repair to VAF Instruments Service.

The shipment must be accompanied by a fault report as shown in table on the next page, giving full information about the reason for return, all other relevant information and further instructions.

Sender			
Company Name :	_____	Contact Person :	_____
Street :	_____	Department :	_____
Postal Code :	_____	Telephone :	_____
City :	_____	Fax :	_____
Country :	_____	E-mail :	_____
Shipping address for return of goods to user if different from above mentioned)			

Reason for return	
☐ Repair	_____
☐ Warranty Claim	_____
☐ Other:	_____

Type of FCM 2(see the nameplate on the instrument)	
Code / Type:	_____
Serial Number:	_____

Description of Complaint / Work to be performed	

Installation date:	_____
Failure date:	_____
Name & Title:	_____
Date & Signature	_____

Table 17 Example of a fault report to accompany a return shipment to the VAF Instruments factory or service agent. The fault report should be filled out in the English language

12.1 Conditions for return of goods

Return shipments of goods to VAF Instruments or local service agent must meet the following conditions:

- The shipment must be accompanied by a fault report as shown in Example of a fault report to accompany a return shipment to the VAF Instruments factory or service agent. The fault report should be filled out in the English language, giving full information about the reason for return, all other relevant information and further instructions.
- The shipping container must be strong enough to protect the PEM4.8 screen and SPU-3 during transport and should be packed with soft material to protect against shocks.
- Goods must be sent C.I.F. destination.

In the event the PEM4.8 screen and SPU-3 has to be sent back for repair, send it directly to:



VAF Instruments B.V.
Service Dept.
Vierlinghstraat 24
3316 EL Dordrecht
P.O. Box 40
3300 AA Dordrecht
The Netherlands

Tel.: +31 (0)78 6183100
Website: www.vaf.nl
E-mail: service@vaf.nl

13. ENVIRONMENT

The PEM4 and SPU-3 equipment has no negative influence on the environment during normal operation.

14. DISPOSAL

The PEM4.8 and SPU-3 consists of metal, plastics and electronic parts. It should be disposed according to local laws or regulations.

If in doubt or not able to dispose of the equipment it can be returned to VAF Instruments.

VAF Instruments will dispose of the equipment in a correct way.

Materials declaration in accordance with the latest IMO regulations can be supplied upon request.

Main materials:

- Body Steel
- PCBs Electronic parts
- Lithium Manganese Dioxide battery

15. TROUBLE SHOOTING

If the PEM4 + SPU3 system does malfunction, power down the PEM4 + SPU3 system, check all wiring and power up the PEM4 + SPU3 system back again. This will restart the program.

15.1.1 No torque signal

The connection between the SPU3 and the stator control box is broken

- Check wires for damage.
- Check the connections in the SPU3 or in the stator control box if applicable.

15.1.2 No signal from shaft generator

The connection between the SPU3 and the shaft generator sensor is broken.

- Check the wires for damage
- Check the connections to the backplane in the SPU3 (see section 17 Drawings)

15.1.3 Temperature sensor failure

The connection between the SPU3 and the temperature sensor is broken.

- Check the wires for damage
- Check all connections inside the temperature sensor.
- Check the connections to the backplane in the SPU3 (see section 17 Drawings)

15.1.4 Flowmeter alarms can occur when:

Flow meter 1 (supply) < Flow meter 2 (return)

Flow meter 1 (supply) > 0 and Flow meter 2 (return) = 0

- Check the wires for damage.
- Check all the connections at the flow meter side.
- Check the settings of the flow meters and relevant parameters and adjust them accordingly in cooperation with a VAF service engineer.

15.1.5 Temperature supply or return is too high

Adjust the temperature high set point of the alarm or adjust the maximum fuel temperature level(s) accordingly.

16. EMC CLASSIFICATIONS OF THE PEM4 + SPU3 SYSTEM

PEM4 + SPU3 system is tested in accordance with:

- General Vibration Strain, IEC publication 60068-2-6
- Also comply with EMC and ESD tests according to EN61000

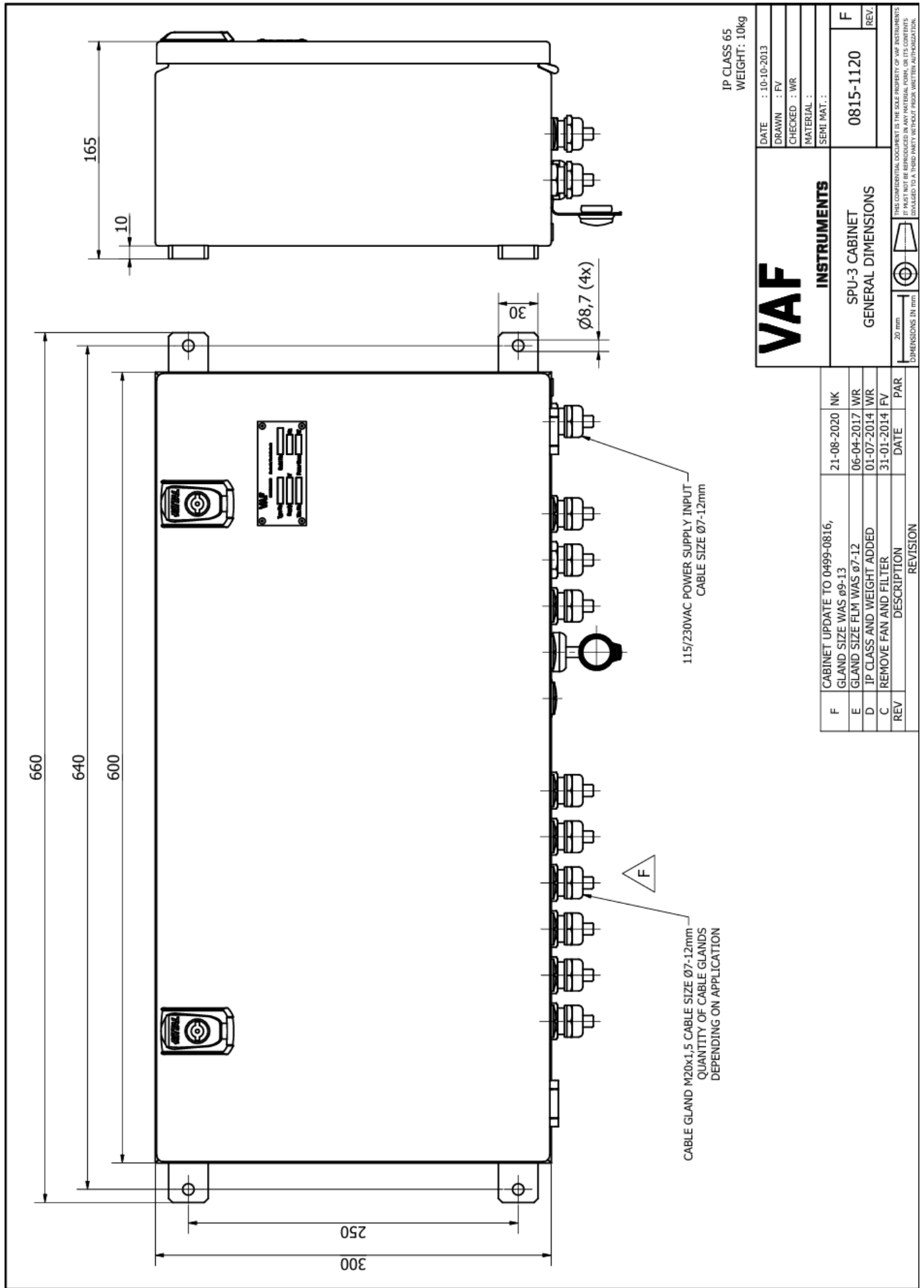
16.1 Certificates

For a torque measuring system, no classification certificates are required.

17. DRAWINGS

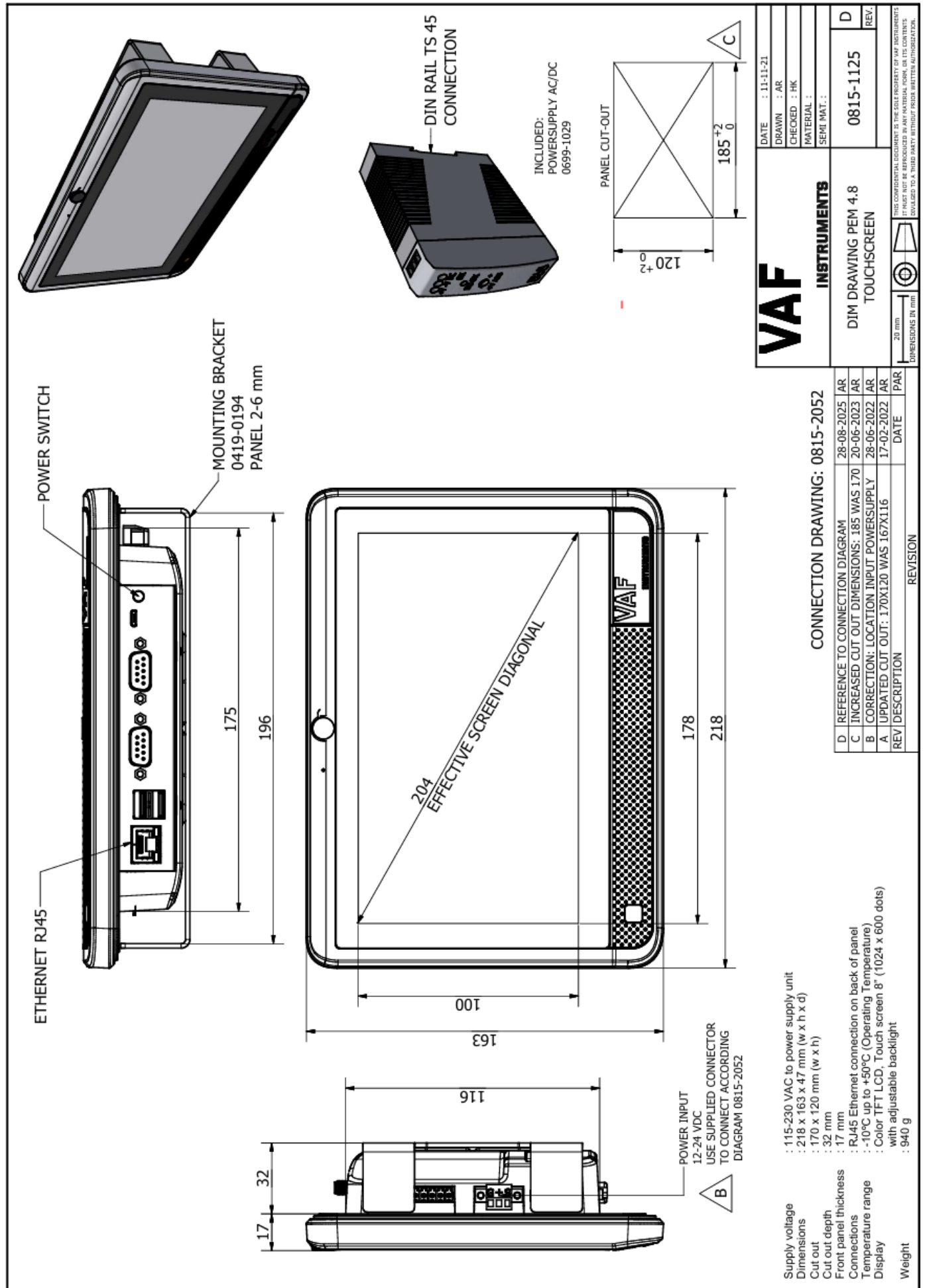
Drawing Number:	Drawing Name:	Sheets:
0815-1120	SPU3 CABINET GENERAL DIMENSIONS	
0815-1125	DIM DRAWING PEM4.8 TOUCH SCREEN	
0815-2052	CONNECTIONS PEM4.8 TOUCH SCREEN	
0815-2019	INTERCONN.DIAGRAM T&TT-SENSE SPU3 PEM4	3 SHEETS

Table 18 Drawing numbers and Drawing Names



IP CLASS 65
WEIGHT: 10kg

VAF		INSTRUMENTS		DATE : 10-10-2013
				DRAWN : FV
				CHECKED : WR
				MATERIAL :
				SEMI MAT. :
				REV. :
				0815-1120
				F
				SPU-3 CABINET
				GENERAL DIMENSIONS
				20 mm
		DIMENSIONS IN mm		THIS CONFIDENTIAL DOCUMENT IS THE SOLE PROPERTY OF VAF INSTRUMENTS. IT MUST NOT BE REPRODUCED IN ANY MATERIAL FORM, OR ITS CONTENTS DISCLOSED TO A THIRD PARTY WITHOUT PRIOR WRITTEN AUTHORIZATION.
F	CABINET UPDATE TO 0499-0816,	21-08-2020	NK	PAR
E	GLAND SIZE WAS $\phi 9-13$	06-04-2017	WR	DATE
D	GLAND SIZE FLM WAS $\phi 7-12$	01-07-2014	WR	DESCRIPTION
C	IP CLASS AND WEIGHT ADDED	31-01-2014	FV	
REV	REMOVE FAN AND FILTER			
		REVISION		



IDENTIFY SPU3 CONFIGURATION

POSITION BACKPLANE 1A ALWAYS POWER SUPPLY PCB

ALL OTHER POSITIONS CAN EITHER BE PULSE-INPUT PCB, TEMPERATURE-INPUT PCB OR ANALOG-INPUT PCB

PLEASE SEE BELOW VIEWS FOR PCB-TYPE IDENTIFICATION

PULSE-INPUT PCB	MAX. 2 PULSE INPUTS (HALL or NAMUR)	MAX. 6 PCB's
TEMP. -INPUT PCB	MAX. 2 TEMP. INPUTS (3-wire PT100)	MAX. 6 PCB's
ANALOG-INPUT PCB	MAX. 3 ANALOG INPUTS (4-20mA)	MAX. 6 PCB's

DIP SWITCHES
NAMUR/HALL

PULSE-INPUT PCB TEMP. -INPUT PCB ANALOG-INPUT PCB

THE PULSE INPUT CAN BE 2 DIFFERENT TYPES: HALL OR NAMUR
DIP-SWITCH NEEDS TO BE SET ACCORDINGLY (FOR VAF PT2 FLOWMETERS SET HALL)

CONNECTOR	FLOWMETER	DIP-SWITCH 'HALL'	DIP-SWITCH 'NAMUR'
1	FM-x	POWER +	NAMUR +
2	FM-x	PULSE SIGNAL	NAMUR -
3	FM-x	POWER GND	NOT USED
4	FM-y	POWER +	NAMUR +
5	FM-y	PULSE SIGNAL	NAMUR -
6	FM-y	POWER GND	NOT USED

SET SWITCHES ON FLOWMETER PCB
ACCORDINGLY:
HALL SIGNAL NAMUR SIGNAL

PULL-DOWN RESISTOR FOR
CUST. SPEC. FLOWMETER

6 5 4 3 2 1
SPEC. 2-ROW PULSE
PRINT CONNECTOR

GENERAL CONNECTIONS TEMPERATURE-INPUT

CONNECTOR	FLOWMETER	INPUT SIGNAL
1	FM-x	PT100 (1)
2	FM-x	PT100 (2)
3	FM-x	PT100 SENSE
4	FM-y	PT100 (1)
5	FM-y	PT100 (2)
6	FM-y	PT100 SENSE

GENERAL CONNECTIONS ANALOG-INPUT

CONNECTOR	ANALOG INPUT	INPUT SIGNAL
1	ANALOG-IN-x	GND
2	ANALOG-IN-x	4-20mA INPUT (ACTIVE)
3	ANALOG-IN-y	GND
4	ANALOG-IN-y	4-20mA INPUT (ACTIVE)
5	ANALOG-IN-z	GND
6	ANALOG-IN-z	4-20mA INPUT (ACTIVE OR PASSIVE)*

*WHEN INPUT SIGNAL IS PASSIVE THEN CONNECTIONS '5' AND '6' SHOULD BE REVERSED
(*5'=4-20mA AND *6'=GND)

CABLE END TERMINATION SPU-3 CABINET

LENGTH OF
LEADS SHOULD
BE AS SHORT
AS POSSIBLE

NOTE:
NO LOOSE SCREENING SHOULD
ENTER THE SPU-3 CABINET
TO PREVENT INTRODUCTION
OF NOISE

SCREEN WIRES
FOLDED BACK
OVER THE TOP
OF INSERT
FOILS TO CUT

VAF

INSTRUMENTS

INTERCONNECTION DIAGRAM
T-TT-SENSE SPU-3
PEM4

DATE: 11-10-2013
DRAWN: Regent
CHECKED: VP
MATERIAL:
SHEET: 2 OF 3

0815-2019
REV Q

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WITHOUT THE WRITTEN PERMISSION OF VAF INSTRUMENTS

BACKPLANE-01			
CONNECTOR FLOWMETER	DESIGNATION	PT2-CABLE-ID CABLE	INPUT SIGNAL(SWITCH SETTING: HALL)
1A1			
1A2			
1A3	PSU PCB	N/A	N/A
N/A			
N/A			
N/A			
1B1	FM-1	1 RED	POWER +
1B2	FM-1	2 YELLOW	PULSE SIGNAL
1B3	FM-1	3 BLACK	POWER GND
1B4	FM-2	1 RED	POWER +
1B5	FM-2	3 YELLOW	PULSE SIGNAL
1B6	FM-2	2 BLACK	POWER GND
1C1	FM-1	6 BROWN	PT100 (1)
1C2	FM-1	5 BLUE	PT100 (2)
1C3	FM-1	4 WHITE	PT100 SENSE
1C4	FM-2	6 BROWN	PT100 (1)
1C5	FM-2	5 BLUE	PT100 (2)
1C6	FM-2	4 WHITE	PT100 SENSE
1D1	ANALOG-IN-X	1	GND
1D2	ANALOG-IN-X	2	4-20mA INPUT (ACTIVE)
1D3	ANALOG-IN-Y	1	GND
1D4	ANALOG-IN-Y	2	4-20mA INPUT (ACTIVE)
1D5	ANALOG-IN-Z	1	GND
1D6	ANALOG-IN-Z	2	4-20mA INPUT (ACTIVE OR PASSIVE) *

BACKPLANE-02			
CONNECTOR FLOWMETER	DESIGNATION	PT2-CABLE-ID CABLE	INPUT SIGNAL(SWITCH SETTING: HALL)
2A1	FM-3	1 RED	POWER +
2A2	FM-3	3 YELLOW	PULSE SIGNAL
2A3	FM-3	2 BLACK	POWER GND
2A4	FM-4	1 RED	POWER +
2A5	FM-4	3 YELLOW	PULSE SIGNAL
2A6	FM-4	2 BLACK	POWER GND
2B1	FM-3	6 BROWN	PT100 (1)
2B2	FM-3	5 BLUE	PT100 (2)
2B3	FM-3	4 WHITE	PT100 SENSE
2B4	FM-4	6 BROWN	PT100 (1)
2B5	FM-4	5 BLUE	PT100 (2)
2B6	FM-4	4 WHITE	PT100 SENSE
2C1	FM-5	1 RED	POWER +
2C2	FM-5	3 YELLOW	PULSE SIGNAL
2C3	FM-5	2 BLACK	POWER GND
2C4	FM-6	1 RED	POWER +
2C5	FM-6	3 YELLOW	PULSE SIGNAL
2C6	FM-6	2 BLACK	POWER GND
2D1	FM-5	6 BROWN	PT100 (1)
2D2	FM-5	5 BLUE	PT100 (2)
2D3	FM-5	4 WHITE	PT100 SENSE
2D4	FM-6	6 BROWN	PT100 (1)
2D5	FM-6	5 BLUE	PT100 (2)
2D6	FM-6	4 WHITE	PT100 SENSE

BACKPLANE-03			
CONNECTOR FLOWMETER	DESIGNATION	PT2-CABLE-ID CABLE	INPUT SIGNAL(SWITCH SETTING: HALL)
3A1	FM-7	1 RED	POWER +
3A2	FM-7	3 YELLOW	PULSE SIGNAL
3A3	FM-7	2 BLACK	POWER GND
3A4	FM-8	1 RED	POWER +
3A5	FM-8	3 YELLOW	PULSE SIGNAL
3A6	FM-8	2 BLACK	POWER GND
3B1	FM-7	6 BROWN	PT100 (1)
3B2	FM-7	5 BLUE	PT100 (2)
3B3	FM-7	4 WHITE	PT100 SENSE
3B4	FM-8	6 BROWN	PT100 (1)
3B5	FM-8	5 BLUE	PT100 (2)
3B6	FM-8	4 WHITE	PT100 SENSE
3C1	FM-9	1 RED	POWER +
3C2	FM-9	3 YELLOW	PULSE SIGNAL
3C3	FM-9	2 BLACK	POWER GND
3C4	FM-10	1 RED	POWER +
3C5	FM-10	3 YELLOW	PULSE SIGNAL
3C6	FM-10	2 BLACK	POWER GND
3D1	FM-9	6 BROWN	PT100 (1)
3D2	FM-9	5 BLUE	PT100 (2)
3D3	FM-9	4 WHITE	PT100 SENSE
3D4	FM-10	6 BROWN	PT100 (1)
3D5	FM-10	5 BLUE	PT100 (2)
3D6	FM-10	4 WHITE	PT100 SENSE

BACKPLANE-04			
CONNECTOR FLOWMETER	DESIGNATION	PT2-CABLE-ID CABLE	INPUT SIGNAL(SWITCH SETTING: HALL)
4A1	FM-11	1 RED	POWER +
4A2	FM-11	3 YELLOW	PULSE SIGNAL
4A3	FM-11	2 BLACK	POWER GND
4A4	FM-12	1 RED	POWER +
4A5	FM-12	3 YELLOW	PULSE SIGNAL
4A6	FM-12	2 BLACK	POWER GND
4B1	FM-11	6 BROWN	PT100 (1)
4B2	FM-11	5 BLUE	PT100 (2)
4B3	FM-11	4 WHITE	PT100 SENSE
4B4	FM-12	6 BROWN	PT100 (1)
4B5	FM-12	5 BLUE	PT100 (2)
4B6	FM-12	4 WHITE	PT100 SENSE
4C1	ANALOG-IN-r	1	GND
4C2	ANALOG-IN-r	2	4-20mA INPUT (ACTIVE)
4C3	ANALOG-IN-s	1	GND
4C4	ANALOG-IN-s	2	4-20mA INPUT (ACTIVE)
4C5	ANALOG-IN-t	1	GND
4C6	ANALOG-IN-t	2	4-20mA INPUT (ACTIVE OR PASSIVE) *
4D1	ANALOG-IN-u	1	GND
4D2	ANALOG-IN-u	2	4-20mA INPUT (ACTIVE)
4D3	ANALOG-IN-v	1	GND
4D4	ANALOG-IN-v	2	4-20mA INPUT (ACTIVE)
4D5	ANALOG-IN-w	1	GND
4D6	ANALOG-IN-w	2	4-20mA INPUT (ACTIVE OR PASSIVE) *

Q	IC-08 CAT64 was CAT5	14-12-23	AK
P	JACKET SWITCH	27-10-21	AK
D	END FOR REMOVAL AND 4-14 ADDED	07-10-20	AK
D	CONNECTION TABLE UPDATED	07-10-20	AK
N	SH12 2 BACKPLANE-01 REMOVED ADDED	01-10-17	VR
N	SH12 REF INPUT IDLE WAS SWAPTED	02-11-16	VR
L	CONN J6 REPLACED	29-08-16	VR
K	GENERAL CABLE INFO UPDATE	10-12-15	VR
No	DESCRIPTION	DATE	PAR

DATE	11-10-2013
DRAWN	Regent
CHECKED	VP
MATERIAL	
SEMI MAT	
INSTRUMENTS	
INTERCONNECTION DIAGRAM	
T-&TT-SENSE SPU-3	
PEM4	
0815-2019	
REV	Q
SHEET	3 OF 3



18. ABBREVIATIONS

AMS	Alarm and Monitoring System
CPU	Central Processing Unit
ECR	Engine Control Room
EEOI	Energy Efficiency Operational Indicator
ER	Engine Room
LCD	Liquid Crystal Display
LCV	Lower Calorific Value
LED	Light Emitting Diode
NMEA 0183	National Marine Electronics Association protocol 0183 for serial data transfer
PCAP	Projected Capacitive
PEM4	Propulsion Efficiency Monitor touch screen
PT100	Temperature sensor type PT100
PT2	Type of flowmeter with Hall sensor and PT100 output
PTO	Power Take Off
ROB	Remain on Board
RS485	Serial interface for long distance data communication
SFOC	Specific Fuel Oil Consumption
SFOC Corr	Specific Fuel Oil Consumption Corrected
SI	Système International d'Unités
SPU3	Signal Processing Unit
TFT	Thin Film Transistor - Liquid Crystal Display
T-Sense®	Optical Torque Measuring System
TT-Sense®	Optical Thrust and Torque Measuring System

19. SPARE PARTS

A recommended spare parts list is not applicable, but for reference purposes, please find below main part numbers. Since SPU3 / PEM4 systems are configured for each application, not all parts are applicable for each individual situation.

Part name	Part number
PEM4.8 Screen	0379-0436
SPU3 Power supply 24VDC	0699-1029
Back-plane Base	0397-0383
Back-plane Power pcb	0397-0384
Pulse pcb	0397-0385
PT100 pcb	0397-0386
Analogue-in pcb	0397-0387
Processor Module	0379-0391

20. WARRANTY CONDITIONS

1. Without prejudice to the restrictions stated hereinafter, the contractor guarantees both the soundness of the product delivered by him and the quality of the material used and/or delivered for it, insofar as this concerns faults in the product delivered which do not become apparent during inspection or transfer test, which the principal shall demonstrate to have arisen within 12 months from delivery in accordance with sub article 1A exclusively or predominantly as a direct consequence of unsoundness of the construction used by the contractor or as a consequence of faulty finishing or the use of poor materials.
 - 1A. The product shall be deemed to have been delivered when it is ready for inspection (if inspection at the premises of the contractor has been agreed) and otherwise when it is ready for shipment.
2. Articles 1 and 1a shall equally apply to faults which do not become apparent during inspection or transfer test which are caused exclusively or predominantly by unsound assembly/installation by the contractor. If assembly/installation is carried out by the contractor, the guarantee period intended in article 1 shall last 12 months from the day on which assembly/installation is completed by the contractor, with the understanding that in this case the guarantee period shall end not later than 18 months after delivery in accordance with the terms of sub article 1A.
3. Defects covered by the guarantee intended under articles 1, 1a and 2 shall be remedied by the contractor by repair or replacement of the faulty component either on or off the premises of the contractor, or by shipment of a replacement component, this remaining at the discretion of the contractor. Subarticle 3A shall equally apply if repair or replacement takes place at the site where the product has been assembled/installed. All costs accruing above the single obligation described in the first sentence, such as are not restricted to shipment costs, travelling and accommodation costs or disassembly or assembly costs insofar as they are not covered by the agreement, shall be paid by the principal.
 - 3A. If repair or replacement takes place at the site where the product has been assembled/installed, the principal shall ensure, at his own expense and risk, that:
 - a. the employees of the contractor shall be able to commence their work as soon as they have arrived at the erection site and continue to do so during normal working hours, and moreover, if the contractor deems it necessary, outside the normal working hours, with the proviso that the contractor informs the principal of this in good time;
 - b. suitable accommodation and/or all facilities required in accordance with government regulations, the agreement and common usage, shall be available for the employees of the contractor;
 - c. the access roads to the erection site shall be suitable for the transport required;
 - d. the allocated site shall be suitable for storage and assembly;
 - e. the necessary lockable storage sites for materials, tools and other goods shall be available;
 - f. the necessary and usual auxiliary workmen, auxiliary machines, auxiliary tools, materials and working materials (including process liquids, oils and greases, cleaning and other minor materials, gas, water, electricity, steam, compressed air, heating, lighting, etc.) and the measurement and testing equipment usual for in the business operations of the principal, shall be available at the correct place and at the disposal of the contractor at the correct time and without charge;
 - g. all necessary safety and precautionary measures shall have been taken and adhered to, and all measures shall have been taken and adhered to necessary to observe the applicable government regulations in the context of assembly/installation;
4. the products shipped shall be available at the correct site at the commencement of and during assembly.

5. Defects not covered by the guarantee are those which occur partially or wholly as a result of:
 - A. non-observance of the operation and maintenance instructions or other than foreseeable normal usage;
 - B. normal wear and tear;
 - C. assembly/installation by third parties, including the principal;
 - D. the application of any government regulation regarding the nature or quality of the material used;
 - E. materials or goods used in consultation with the principal;
 - F. materials or goods provided by the principal to the contractor for processing;
 - G. materials, goods, working methods and constructions insofar as are applied at the express instruction of the principal, and materials or goods supplied by or on behalf of the principal;
 - H. components obtained from third parties by the contractor insofar as that party has given no guarantee to the contractor.
6. If the principal fails to fulfil any obligation properly or on time ensuing from the agreement concluded between the principal and the contractor or any agreement connected to it, the contractor shall not be bound by any of these agreements to any guarantee regardless of how it is referred to. If, without previous written approval from the contractor, the principal commences disassembly, repair or other work on the product or allows it to be commenced, then every agreement with regard to guarantee shall be void.
7. Claims regarding defects must be submitted in writing as quickly as possible and not later than 14 days after the discovery of such. All claims against the contractor regarding faults shall be void if this term is exceeded. Claims pertaining to the guarantee must be submitted within one year of the valid complaint on penalty of invalidity.
8. If the contractor replaces components/products under the terms of his guarantee obligations, the replaced components/products shall become the property of the contractor.
9. Unless otherwise agreed, a guarantee on repair or overhaul work carried out by the contractor or other services shall only be given on the correctness of the manner in which the commissioned work is carried out, this for a period of 6 months. This guarantee only covers the single obligation of the contractor to carry out the work concerned once again in the event of unsound work. In this case, sub article 3A shall apply equally.
10. No guarantee shall be given regarding the inspection conducted, advice given and similar matters.
11. Alleged failure to comply with his guarantee commitments on the part of the contractor shall not absolve the principal from his obligations ensuing from any agreement concluded with the contractor.
12. No guarantee shall be given on products which form a part of, or on work and services on, goods older than 8 years.

Appendices

Appendix:	Name:
A	NMEA Sentences
B	Modbus addresses
C	Fuel diagrams – Supply, Supply/Return, Unifuel

A. NMEA Sentences

NMEA data type	Supported sentences
GPS position	\$--RMC, \$--RMA, \$--GGA, \$--GLL, \$--GNS
GPS time	\$--RMC, \$--ZDA
GPS SOG speed	\$--RMC, \$--RMA, \$--VTG
STW speed	\$--VBW, \$--VHW
Heading / bearing	\$--VHW, \$--APA, \$--APB, \$--RMB, \$--HDT, \$--OSD, \$--HDG, \$--HDM
Wind heading and speed	\$--MWV, \$--VWR
Water temperature	\$--MTW
Track made good (actual heading corrected for wind and current)	\$--RMC, \$--RMA, \$--VTG
Depth	\$--DBT, \$--DBK, \$--DBS, \$--DPT
Revolutions	\$--RPM
Rudder	\$--RSA
Waypoint information	\$--WPL, \$--WNC, \$--RMB, \$--APA, \$--APB, \$--BWC, \$--BWR, \$--WCV, \$--AAM

B. Modbus addresses

On request

C. Fuel Diagram – Supply, Supply/Return, Unifuel

Supply system

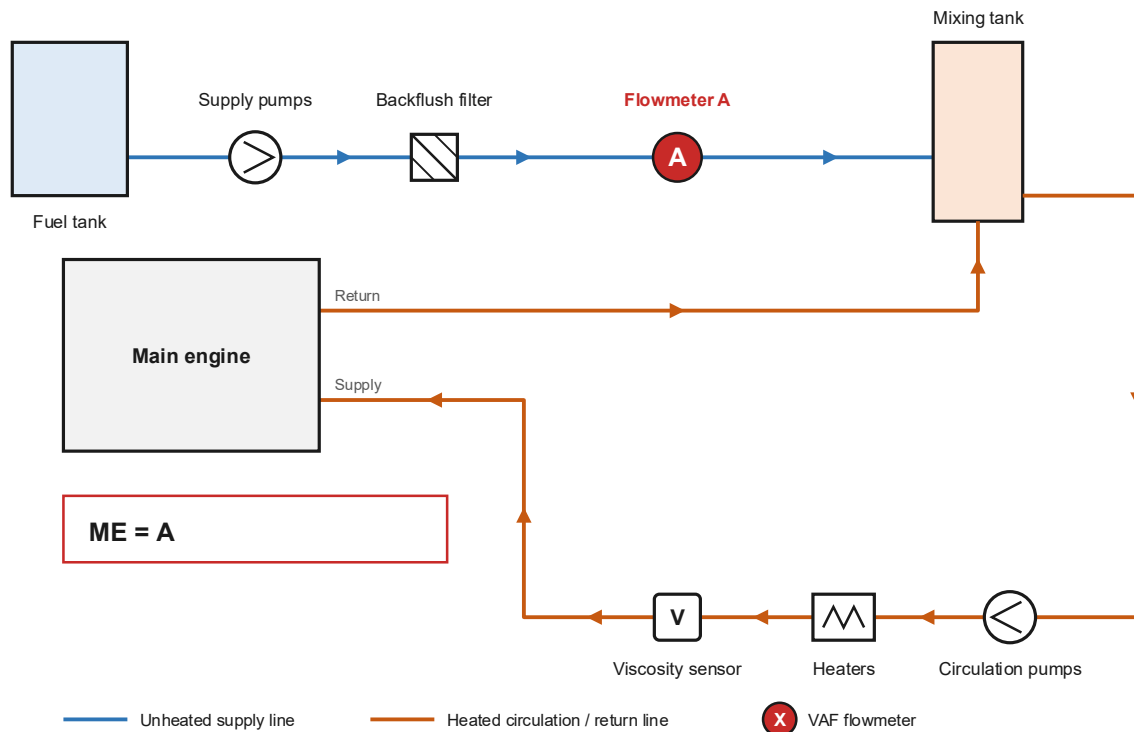


Figure 89 Fuel system with one flowmeter in the supply line

Supply/Return system

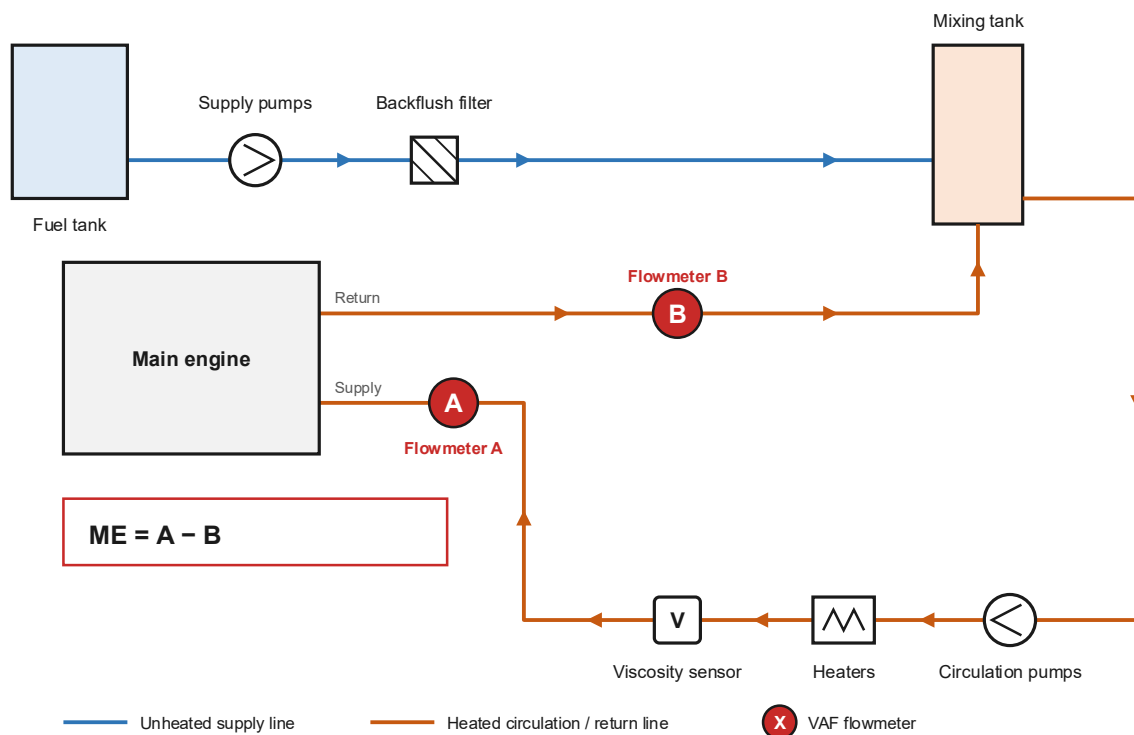


Figure 90 Fuel system with one flowmeter in the supply line and one flowmeter in the return line

Unifuel system

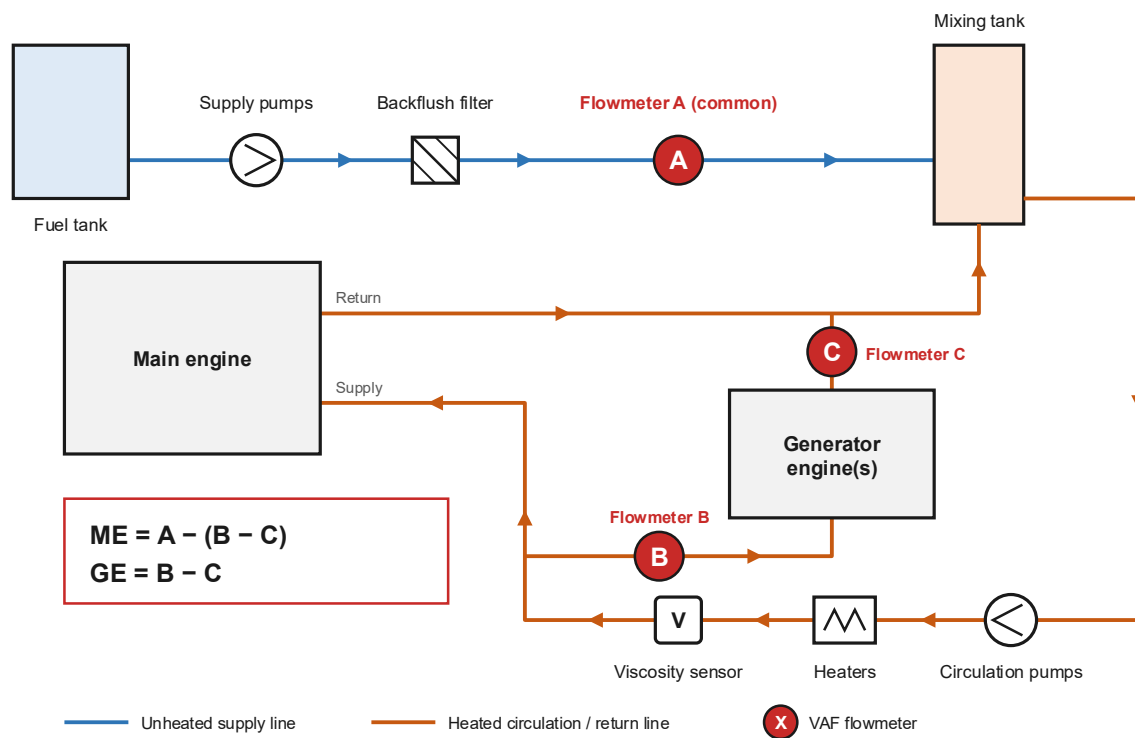


Figure 91 Fuel system according to the Unifuel principle

Revisions

Revision 1014(2)

Section 17, drawing 0815-2019 corrected

Revision 0315

Section 17, drawing 0815-2022 added

Revision 0116

Section 3, Technical specifications updated

Section 7, Operating information updated conform firmware version 0.3.16 Section 17, Drawings updated

Section 18, List of abbreviations updated

Revision 0117

Section 3 analog input specs updated

Section 6.6 and 6.7 updated with backplane-X Section 6.8, 6.9 and 6.10 added

Drawings updated with latest version

Revision 0817

Section 6.12 Additional slave addresses added

Revision 0418

Chapter 1.1 warnings added

Revision 0918

Initial release: PEM4 + SPU3 firmware version 4.31.

Revision 0525

Drawing changed, CAT5 changed to CAT6e

Revision 1026

PEM4.7, PEM4.10 screen removed, PEM4.8 screen updated, Explanation Settings menu added, NMEA sentences list added



Specifications subject to change without notice
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