T-Sense®
Optical Torque Measuring Systems

660
Product Bulletin
Introduction

The use of a T-Sense® torque measuring system means efficiency improvement, overload protection and prevention of breakdown costs. For example in the shipping industry its application has lead to savings up to 10% on fuel costs. The system is based on extremely accurate optical sensor technology and can be mounted around shafts in power transmission systems.

Why a torque measuring system?
A torque meter provides you with precise information on engine performance related to consumed energy. By giving instantaneous read-out of torque, speed and power, the effects of operational changes are monitored. Because these effects are measured, you can use your engine-driven installation in its most efficient way. This will considerably reduce your fuel costs, one of the primary cost drivers.

Where is the T-Sense® torque measuring system used?
T-Sense® torque measuring systems are used for engine-driven installations in all kinds of power and propulsion plants. For example continuous power output measurement of ships propulsion, continuous power consumption measurement, continuous level check for torque, speed and power and direct visual control of changes in engine settings, trim and draught.

Possible system extensions
A full range of T-Sense® torque measuring systems is available. The standard output of the torque measuring system consists of a torque, shaft speed and power signal. The system can be extended with fuel consumption measurement and speedlog/GPS input.

Your advantage

**Designed for durability and accuracy**
The systems have a robust design. They are built to withstand the typical harsh environmental conditions in ships, engine rooms, dredgers, steelworks and heavy industries. Innovative optical sensor technology guarantees high accuracy with an overall error of less than 0,25% F.S.D.

**No maintenance required**
T-Sense® torque measuring systems are maintenance-free as a result of noncontact power and signal transmission. They are designed to work continuously. No recalibration is needed, because signals are stable during its lifetime.

**Easy installation and commissioning**
The intelligent design enables installation by customers staff.

Principle of operation

The T-Sense® measuring system can be mounted on propeller or drive shafts. When a shaft is subject to torque this will result in a small strain at the shaft surface. A LED and an extremely accurate optical cell can detect these small movements of the surface. The measured values are transferred continuously from the rotating shaft to the stator part through a 2,4 GHz wireless data connection. Power transmission from the stator to the rotating shaft is performed by means of induction.

**Propulsion Efficiency Monitor**
The PEM4 touch screen will display all fuel consumption data, engine load diagram, power data etc. when connecting T-Sense® with SPU3. Alternatively the stator part can optionally be connected to a PEM2 touch screen, which displays shaft power, torque and speed.
Typical system arrangement

Single flowmeter system

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

Supply and return flowmeter system

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

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

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

FCM2 flowcomputer

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

Uni-fuel system

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

PEM4 monitoring system

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

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

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

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

**FCM2 flowcomputer**

- **Display type**: 320 x 240 TFT colour display with resistive touch screen
- **Dimensions**: 160 x 130 x 71 mm
- **Weight**: 1.2 kg approx
- **Power supply**: 100 to 240 VAC
- **Power consumption**: maximum 10 Watt
- **Protection class**: IP65
- **Ambient temperature**: 0˚C to 60˚C
- **Operating humidity range**: 0 to 95 %RH (non-condensing)
- **Input**: 2 x pulse from Flowmeter PT2 or Namur
  - 2 x PT100 from Flowmeter PT2
  - 3 x analog input 4-20 mA (optional)
- **Output**: 1 x SSR
  - 1 x RS485 for Modbus
  - 1 x FCM bus
  - 2 x active analog output 4-20 mA (optional)
- **Cable glands**: 4x M20 x 1.5 mm, Ø7-12 mm (standard) / Ø10-14 mm (optional)
  - 3x M16 x 1.5 mm, Ø5-10 mm (standard)

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

### Features & benefits

VAF Instruments has developed the T-Sense® torque measuring system with modern and user-friendly electronics, based on proven very accurate optical sensor technology. The standard T-Sense® torque measuring system will be delivered with an interface box for easy connection to the ships data network, monitoring or control system. A PEM4 touch screen with SPUS or a PEM2 touch screen display can be supplied as a monitoring device.

<table>
<thead>
<tr>
<th>Features</th>
<th>Benefits</th>
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</thead>
<tbody>
<tr>
<td>Optical measuring principle</td>
<td>no time consuming mounting of strain gauges</td>
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<tr>
<td></td>
<td>high accuracy and repeatability</td>
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<tr>
<td></td>
<td>detection of torsional vibrations</td>
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<tr>
<td>Extreme accuracy of optical sensor (within nanometer range)</td>
<td>very accurate output signals resulting in high measuring accuracy and repeatability</td>
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<td>torsional vibration analysis is possible during long interval period</td>
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<tr>
<td>Wireless transmission of data and power</td>
<td>no maintenance</td>
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<td></td>
<td>no wear</td>
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<tr>
<td>Digital output signal available</td>
<td>easy and accurate digital data transfer to the vessels network, monitoring or control system</td>
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<tr>
<td></td>
<td>only 1 communication cable to the bridge</td>
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<td>user friendly installation</td>
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<td>Easy installation and commissioning without assistance</td>
<td>low overall installation costs</td>
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<td></td>
<td>no engineering or commissioning assistance needed</td>
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<td>Calibrated for life</td>
<td>no need for recalibration</td>
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<td></td>
<td>no servicing costs</td>
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<td></td>
<td>low costs of ownership</td>
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<tr>
<td>A genuine VAF Instruments product</td>
<td>78 years of experience in sensor technology for maritime applications</td>
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<td>Manufactured by a ISO 9001 certified organization</td>
<td>assured constant product quality</td>
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<td>Touch screen display</td>
<td>no operator training required</td>
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<td></td>
<td>user friendly human interface</td>
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</tbody>
</table>
Technical specification

T-Sense®

Control box at stator part

- Power supply: 115 or 230 VAC, 50 or 60 Hz ±10%
- Power consumption: 40 W maximum
- Input: 2.4 GHz fully protected encrypted signal
- Output: RS-485 for Modbus protocol or 4-20 mA isolated current output (optional)
- Dimensions: 430 x 360 x 111 mm

Rotor equipment

- Material of weighing rings: carbon steel
- Material outside cover: polymer coated high-density foam
- Material compensation arm: carbon steel
- Shaft speed detection: accelerometer signal
- Output: 2.4 GHz fully protected encrypted signal
- Shaft diameter: min. 100 mm, max. 1000 mm
- Dimensions: depending on shaft diameter
- Operating temperature: -20°C to +60°C
- Measuring tolerance: < 0.25% F.S.D. on torque

PEM4

- Supply voltage: 115 - 230 VAC to power supply unit
- Power consumption: 6 W in full activity
- Temperature range: -20 up to +60°C
- Input: Modbus signal from T-Sense®
- Connections: RJ45 Ethernet connection on back (bottom side) of panel
- Display colour: TFT LCD, PCAP touch screen, 7” (1024 x 600 dots) with adjustable LED backlight
- Protection class: IP 65 at front fascia
- Dimensions: 235 x 150 x 44 mm (w x h x d)
- Cut out: 217.6 x 128.6 mm (w x h)
- Cut out depth: 38 mm
- Front panel thickness: 6 mm
- Net weight: 1.3 kg

SPU3

- Supply voltage: 115 - 230 VAC ± 10%
- Power consumption: 60 W
- CPU: 128bit 8051MB 32MHz (16x32) 900 MHZ
- Digital input: 2x RS 485 Modbus connection for input signal from T-Sense® or T-Sense® optical sensors
- Analog input: 9 x optional (galvanic isolated), used for shaft generator input, auxiliary power or ViscoSense®/ViscoSense® signal
- Pulse counter: input available up to 17 Pulse meter pulse inputs, maximum 8 engines/consumers x pulse input
- Pulse counter: inputs available for input from VAF Instruments’ P2 Flowmeters or NAMUR pulses (optional)
- PT100 input: max. 12, used for fuel temperature compensation at Flowmeters
- NMEA input: NMEA 0183 input from GPS or Speeding RS422, Talker ID: “GP”, Baudrate:9600,PEM4 system can read out the SSVY16 sentence (“speed over ground”) and/or SSVY8W sentence (“longitudinal water speed”)
- Digital output: 1x RS 485 ethernet for connection to the PEM4 touch screen or to a pc on board (Optional 1x RS 485 ethernet for connecting a second PEM4 touch screen by RS 485 Modbus connection for data transfer to an external system like AMS (Alarm & Monitoring System) or for connection to a separate pc running PEM data logger software (optional)
- Dimensions: 690 x 300 x 165 mm (w x h x d)
- Net weight: approx. 10 kg
- Protection class: IP65

PEM2

- Supply voltage: 24 V DC ± 10%
- Power consumption: 10 W
- Temperature range: 0 to 55 °C
- Display colour: TFT-touch screen, 5.6” (320x234 dots) with adjustable LED backlight
- Dimensions: 168 x 145 x 46 mm (w x h x d)
- Cut out: 145.5 x 132.5 mm (w x h)
- Cut out depth: 40 mm
- Front panel thickness: 6 mm
- Connections: screw terminals and RS485 connection on back panel
- Protection class: IP 65 at front fascia
- Net weight: 0.8 kg

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

PEM4 Propulsion Efficiency Monitor

The PEM4 instantly displays torque, speed, shaft power and other selected measuring data. Additional flowmeter signals and temperature sensor (PT100) signals enable calculation of the engines fuel consumption with optional temperature compensation.
In combination with input signals from speedlog or GPS, the PEM4 will calculate the temperature corrected fuel consumption per kW or per nautical mile.

Features:
- Touch screen display;
- Easy menu structure;
- Display of bar graphs and engine load diagram;
- User friendly, log functions for alarms and instant detection of missing signals;
- Display of fuel consumption per kW (SFOC);
- Display of fuel consumption per consumer;
- Display of fuel consumption per nautical mile;
- Remote accessible through standard webbrowsers;
- SPU3 Signal Processing Unit included.

The PEM4 helps the ship’s crew and the owner to find the best settings for engine, trim and propeller pitch, as the effect of the changes will be instantly displayed.

PEM2 Touch screen

For monitoring T-Sense® torque, shaft speed and power output only, we supply the PEM2 touch screen as a stand alone unit.

Applications

In combination with a PEM4 or with the vessels monitoring system, the T-Sense® measuring system can be used in a variety of applications such as:
- Continuous power output measurements for ship propulsion;
- Visualisation of engine load margin. Avoiding engine overload;
- Continuous power and consumption management including specific fuel oil consumption;
- Direct visual control of changes in engine setting, trim and draught;
- Continuous and long term monitoring of torque, speed and power;
- Torsional vibration analysis for frequencies up to 50 Hz.
Dimensions

T-Sense® components

PEM2 touch screen
For use with T-Sense® control box

SPU3 Signal Processing Unit

PEM4 touch screen
For use with SPU3 Signal Processing Unit
## Quotation & ordering information

1. Number of units per ship:
2. Ships name / hull:
3. Available shaft length (mm):
4. Please provide shaft line drawing for installation:
   - new building
   - retrofitting
5. Design conditions:
   - power (kW):
   - speed (rpm):
   - shaft material:
   - shear modulus G (N/mm²):
   - shaft diameter (+tolerance) (mm):
   - inside bore diameter (mm):
   - application:
     - propeller shaft
     - dredge pump
     - engine drive shaft
     - jet pump
     - other:
6. System:
   - required output
     - torque:
       - RS 485/Modbus
       - range 4 - 20 mA
       - klfm
     - speed:
       - RS 485/Modbus
       - range 4 - 20 mA
       - rpm
     - power:
       - RS 485/Modbus
       - range 4 - 20 mA
       - kW
       - other:
   - options:
     - touch screen display for torque, shaft speed and power read-out
     - fuel consumption measurement
     - total power calculation for twin screw vessels

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Name:
Place and date:

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

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Quotation & ordering information

1. Number of units per ship:
2. Ships name / hull:
3. Available shaft length (mm):
4. Please provide shaft line drawing for installation:
   - new building
   - retrofitting
5. Design conditions:
   - power (kW):
   - speed (rpm):
   - shaft material:
   - shear modulus G (N/mm²):
   - shaft diameter (+tolerance) (mm):
   - inside bore diameter (mm):
   - application:
     - propeller shaft
     - dredge pump
     - engine drive shaft
     - jet pump
     - other:
6. System:
   - required output
     - torque:
       - RS 485/Modbus
       - range 4 - 20 mA
       - klfm
     - speed:
       - RS 485/Modbus
       - range 4 - 20 mA
       - rpm
     - power:
       - RS 485/Modbus
       - range 4 - 20 mA
       - kW
       - other:
   - options:
     - touch screen display for torque, shaft speed and power read-out
     - fuel consumption measurement
     - total power calculation for twin screw vessels

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